AI Nano CNC for High-Speed, High-Accuracy machining

FANUC Series 30*i*/31*i*/32*i*
-MODEL A

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The FANUC Series 30*i*/31*i*/32*i*-MODEL A, the latest AI nano CNC, flexibly supports various machine tools such as automatic machines, lathes, compound machines, 5-axis machines and high-speed high-accuracy machines which are increasing control paths, feed axes, and spindles and getting more and more complex.

State-of-the-Art Hardware

State-of-the-art hardware, including ultra high-speed processors in use, high-speed CNC internal bus, and optical fiber cables used for high-speed data transfer, greatly improves the CNC's performance.

High-Speed, High-Precision and High-Quality Machining

High-speed, high-accuracy machining is realized by using detectors, servos, and the CNC that controls the machine with nanometer resolution without regard to the command unit.

Smooth, High-Speed and High-Precision 5-Axis Machining

These models are available for 5-axis machines with various configurations. A function which enables smooth, high-speed and high-precision machining and easy programming of machining of complex figures and a function of facilitating setup are included.

Excellent Operation

The 15-inch large LCD which can display much information and soft keys vertically arranged on the side of the screen greatly improve CNC's operability. Large-capacity CNC program memory can be managed with PC-like file management and edit functions.

Complete with Network Support Functions

A management system with personal computers connected via Ethernet can be constructed easily. Various types of field networks are also supported.

Powerful Software Tools

Powerful software tools are provided to support machine tool builders in a variety of fields such as simulation, customization, and data management.

Wide Application Range

The CNC best suited to the use can be selected.

FANUC Series 30*i*-MODEL A

Max. number of paths : 10 paths
Max. Total number of control axes : 40 axes (32 feed axes, 8 spindles)
Maximum number of simultaneous control axes : 24 axes

FANUC Series 31*i*-MODEL A

Max. number of paths : 4 paths
Max. Total number of control axes : 26 axes (20 feed axes, 6 spindles)
Maximum number of simultaneous control axes
: 4 axes (5 axes for the 31*i*-A5)

FANUC Series 32*i*-MODEL A

Max. number of paths : 2 paths
Max. Total number of control axes : 12 axes (9 feed axes, 3 spindles)
Maximum number of simultaneous control axes : 4 axes

High Reliability and Easy Maintainability

High-reliability hardware allows stable operation in a harsh factory environment. Various types of functions for improving maintainability are also available.

Easy Incorporation into Machine Tools

The CNC control unit is incorporated with the LCD panel and the power magnetics cabinet does not require its space. The use of the ultra-high-speed serial communication function reduces wiring. Complete servo adjustment functions facilitate the adjustment of the machine.

Customization of Machine Tools

Many functions such as Real-time custom macro, C Language Executor are available for customizing machine tools and realize machine tool builder's unique functions.

Personal computer function with Windows® OSs

The personal computer function with Windows®XP for the FANUC Series 30*i*/31*i*/32*i*-MODEL A can be added the function of a personal computer to the FANUC Series 30*i*/31*i*/32*i*-MODEL A without restricting CNC control function. The personal computer function with Windows®CE for the FANUC Series 30*i*/31*i*/32*i*-MODEL A are also available, which is the Open CNC compatible with Windows®CE, OSs requiring no hard disk.

Flexible Support of Various Mechanical Configurations

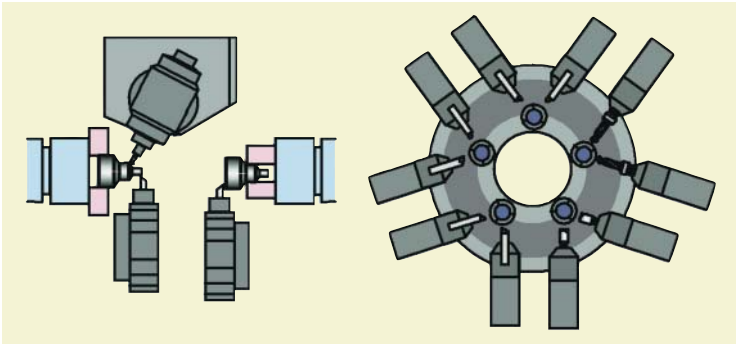
Flexible support for various machine configurations by expanded multi-axis and multi-path functions

For the Series 30*i*/31*i*/32*i*-MODEL A, the maximum number of control axes, control paths, and spindles has been significantly expanded. In addition to support of many paths and controlled axes, these series provide many functions required for multi-path control, including axis synchronization and recomposition, superposition control, inter-path spindle control. These functions enable the flexible support for various machine configurations comprising a compact a machine tool, multi-path lathe, automatic machine, combined machine and other machines which have a different number of control paths and control axes.

- Series 30*i*-A - 10 paths / 40 axes (32 feed axes / 8 spindles)
- Series 31*i*-A - 4 paths / 26 axes (20 feed axes / 6 spindles)
- Series 32*i*-A - 2 paths / 12 axes (9 feed axes / 3 spindles)

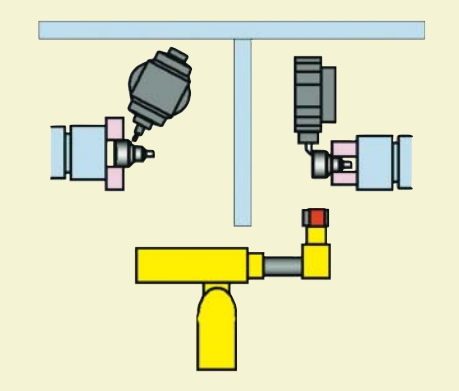
Multi-axis & Multi-path Lathe and Automatic Lathe

A single CNC can achieve complex control of a multi-path lathe with many turrets, compound machine tool with a milling head, or automatic lathe requiring many axes and command systems. In addition to supporting many paths and controlled axes, these series provide many functions required for multi-path control, such as synchronous/composite control, superimposed control, flexible axis assignment, waiting function, inter-path spindle function, and interference check for each path. A merger between high-speed, high-precision control technology that FANUC has nurtured over the years and multiaxis multipath control technology further promotes improvements in precision and efficiency of lathes and automatic lathes.



Compound Path Containing Machining Center, Lathe, and Loader Control Systems [Japanese patent No.3893334]

Machining center, lathe, and loader control systems can be used for each path and selected without restrictions. Functions that were limited to the machining center system (or lathe system) are allowed for other systems, which increases the flexibility in machining within a path. With these functions, these series easily achieve control of compound machine tools with both milling and turning required.



Loader Control Path

Loader control can also be controlled as a path, so no additional hardware component such as a loader-dedicated board is required. In much the same fashion as a CNC control path in a machining center system or lathe system, PMC axis control commands as well as G codes and custom macros can be specified. These functions promote streamlining and downsizing in a factory environment.

Integrated Tool Offset Screen

To meet the recent increase in compound machine tools, an integrated offset screen is provided, which allows the user to manage offset data for both milling tools and turning tools on the same offset screen.
With this screen, the user can manage tool offsets of a compound machine tool easily.

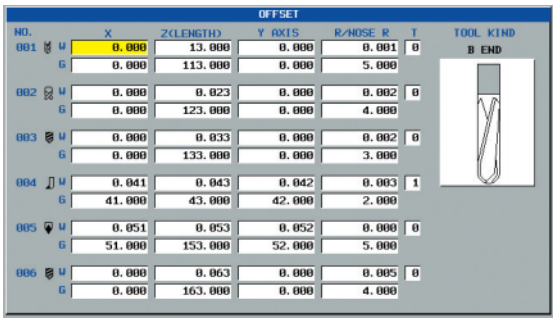
- Offset data for milling tools and turning tools can be managed and displayed on an integrated tool offset screen.
- Geometry compensation data and wear compensation data can be managed and displayed on an integrated tool offset screen.
- Tool shape is displayed graphically, therefore enhancing easy operations. A tool shape is specified on a dedicated screen.

Milling tool

Turning tool

Tool length compensation	Geometry
	Wear
Tool radius compensation	Geometry
	Wear

X-axis tool offset Z-axis tool offset	Geometry
	Wear
Tool-nose radius compensation	Geometry
	Wear
Tool-nose direction	



Integrated tool offset screen

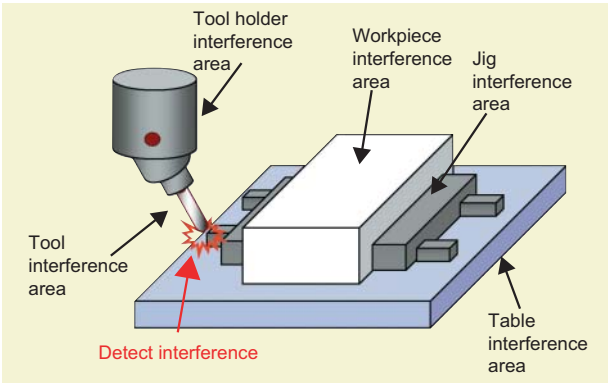
Enhanced Safety Measures (Series 30*i*-A, 31*i*-A, 31*i*-A5)

With compound machine tools and 5-axis machines, complicated machining can be performed without making a workpiece setup change, so high machining efficiency can be achieved; however, programming for such machine tools is difficult, and interference between machine components such as a spindle and a table may occur during automatic operation and manual operation. A 3-dimensional interference check function is therefore provided to check for such interference in advance to enhance safety operation.

Built-in 3D Interference Check [Patent pending]

This function checks for any interference between machine components such as the tool, tool holder, workpiece, jig, and table in 3-dimensional space in a real-time manner to detect interference in the machine in advance.

- This function is built into the CNC and does not require additional hardware or software.
- Interference areas are defined using rectangular prisms, circular cylinders, and planes.
- An interference area can be defined and modified using a dedicated screen or an NC program command.
- This function is enabled in both automatic operation by NC programming and manual operation by handle.
- This function is applicable also to 5-axis machines that turn the tool or table.
- This function supports up to four paths and is applicable also to multi-path compound lathes.

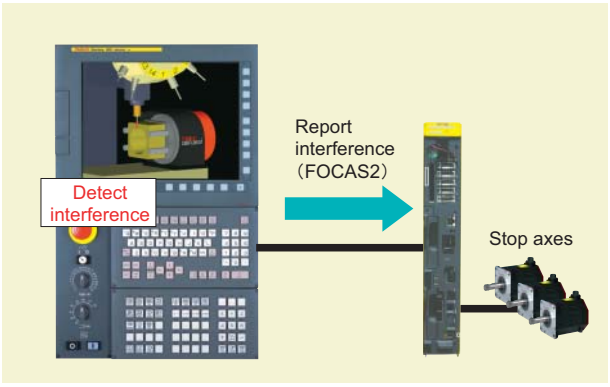


3D Interference Check with Personal computer function with Windows® XP [Patent pending]

When a 3-dimensional animated simulation feature used in CAM and so forth is included in the personal computer function of the Series 30*i*-A/31*i*-A/31*i*-A5, interference checks can be made in a realistic manner.

- 3-dimensional animated simulation shows machine motion realistically.
- Interference between machine components such as the tool and workpiece can be detected through animated simulation.
- The CNC notifies the animated simulation feature of a forecasted position ahead of machine operation, so interference may be detected through animated simulation before actual interference occurs.
- This function is enabled in both automatic operation by NC programming and manual operation by handle.
- An interface (FOCAS2) between animated simulation and the CNC is provided.

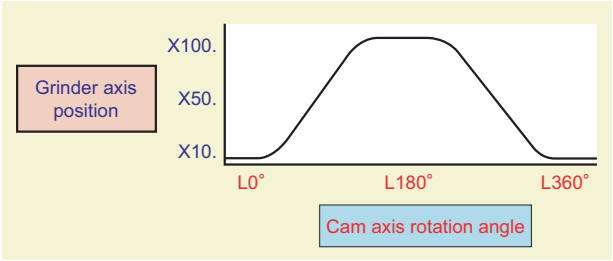
(Note) FANUC does not provide any 3-dimensional animated simulation feature. For animated simulation vendors supporting this function, contact FANUC.



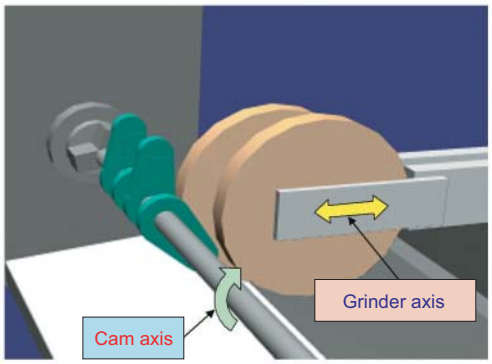
Path Table Operation Function (Series 30*i*-A, 31*i*-A, 31*i*-A5)

To reduce the part machining cycle time and enable complicated multi-axis & multi-path machining, Path Table Operation Function is provided, which allows the user to specify a free machining path independently of CNC blocks, interpolation functions such as linear/circular interpolation, and the paths of the system.

- Commands each axis position in connection with time, spindle position, or other axis position individually.
- Controls spindle capabilities, including spindle rotation speed, spindle synchronous control or Cs contouring control, at any time.
- Specifies maximum 3 pairs of auxiliary functions at any time or position.



Grinder axis path table	
L0.	X10.
L1.	X11.
L3.	X13.
:	:
L180.	X100.
:	:

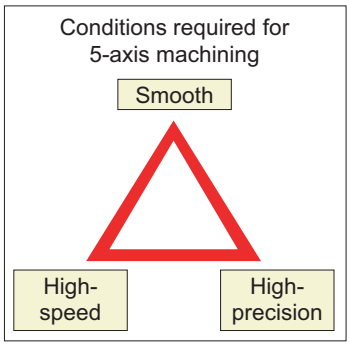


5-axis machining functions achieve a smooth, high-speed,

Provided for a smooth, high-speed, and high-precision 5-axis machining (Series30*i*-A, 31*i*-A5)

FANUC's 5-axis machining functions achieve a smooth machining not only in a high-precision mold machining but also in a high-speed part machining.

Smooth	In the case of not only tool center point machining but also side cut machining, a smooth 5-axis machining is achieved by automatic commands compensation of the machining programs. And it results in the reduction of the machining time because of eliminating needless accelerations/decelerations.
High-speed	A high-speed 5-axis machining is achieved by optimizing algorithms of CNC software.
High-precision	A high-precision 5-axis machining is achieved by applying the high-precision machining technology (AI contour control) that FANUC has cultivated for years.
Easy to use	Convenient functions, taking the operators on machining site into consideration, are supplied.
Cooperation with CAM	The latest 5-axis machining functions are supported by major CAM makers' cooperation.

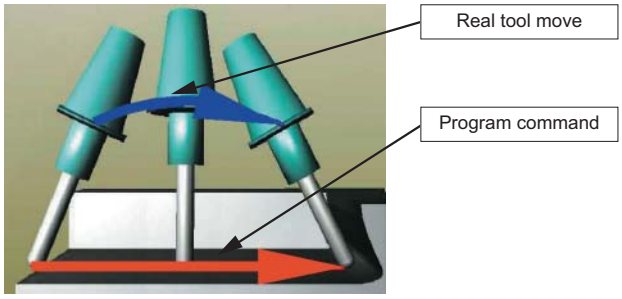


A machining Example
(impeller for automobiles)

The functions that achieve a smooth, high-speed, and high-precision 5-axis machining

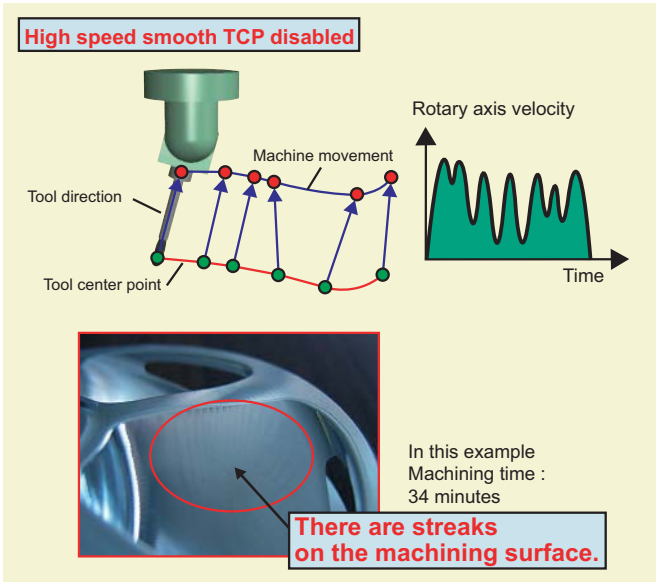
Tool center point control (TCP) [Japanese patent No.3643098, US patent No.6775586, European patent No.1302829]

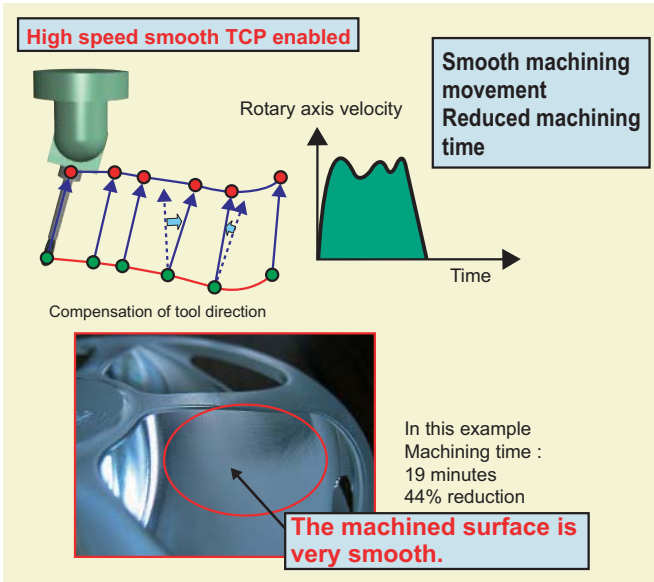
When the tool direction changes, the path and feedrate at the end of the tool are automatically controlled so that they indicate the path and feedrate specified in the program. As program specification formats, in addition to the "method in which the angle of the rotation axis is specified," the "method in which the angular displacement of the tool is specified" is available. The same program can be used for machining with different rotation axis mechanical configurations and different tool axe names.



High speed smooth TCP (Smooth and high-speed machining using tool center point) [Japanese patent No.4351281]

When a machining program with TCP (Tool Center Point control) has unevenness in tool direction command in comparison with TCP movement command, the tool direction varies, and a machined surface is degraded (streaks appear) and a machining time increases.
Smooth TCP makes the machining movement smooth by compensating tool direction so as to decrease the unevenness, and improves the quality of the machining surface and reduces the machining time.

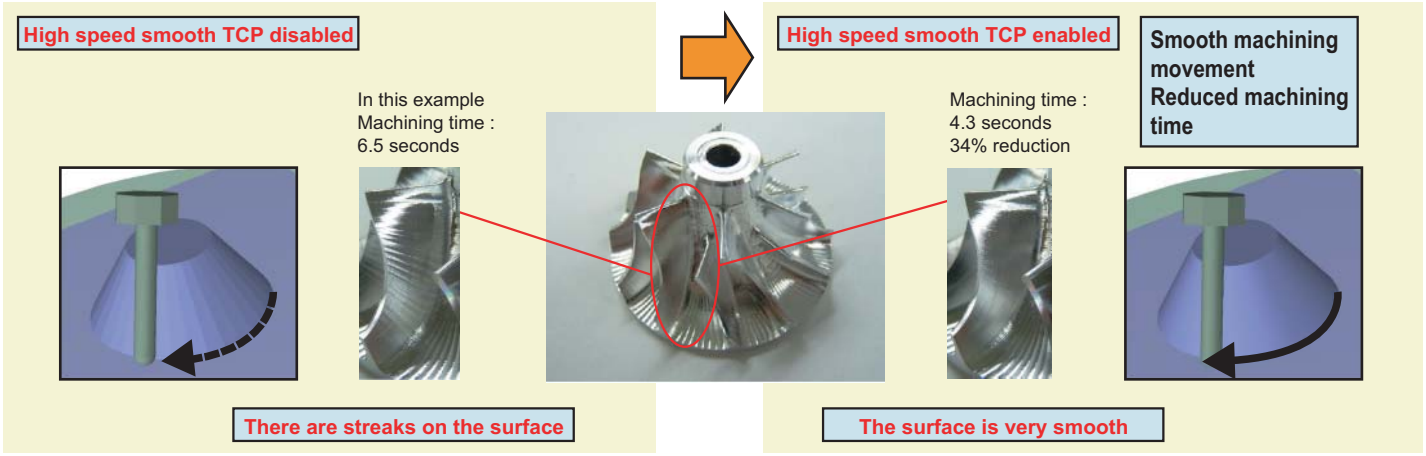




and high-precision machining

High speed smooth TCP (Smooth and high-speed machining using tool side cutter) [Patent pending]

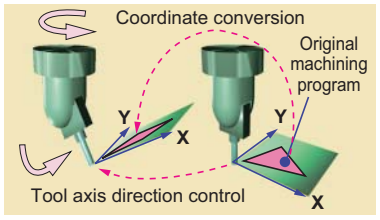
The side cut machining program using tool center point control (TCP) is made through minute planes approximation of the curved surface. So, the machining surface is not smooth if the tool posture is controlled faithfully to the instructions.
High speed smooth TCP improves the quality of the surface greatly by moving the tool posture and tool center point smoothly.

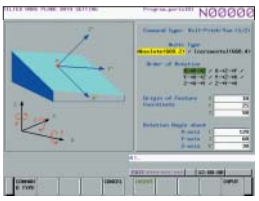


Functions to improve the convenience

Tilted working plane command with guidance

For machining a hole, pocket, or another figure on a tilted plane on a workpiece, specifying the working plane with plane (X, Y) makes programming very easy. The tilted working plane command enables this specification and also positions the tool automatically so that the tool becomes perpendicular to the tilted working plane without specifying the tool direction.



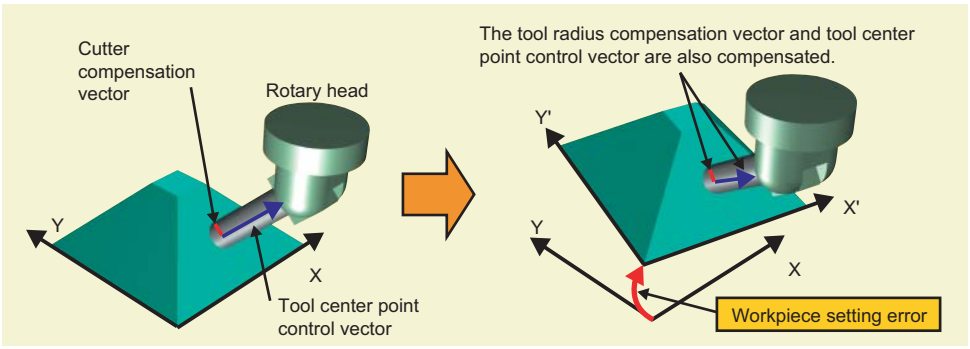


Guidance screen

There are 6 kinds of tilted working plane command types (Eulerian angle, two vectors, roll-pitch-yaw, projection angles, three points, tool axis direction), and they can be visually selected with the guidance screen. The necessary data for each command types can be directly inputted with the screen. So, the tilted working plane can be specified easier.

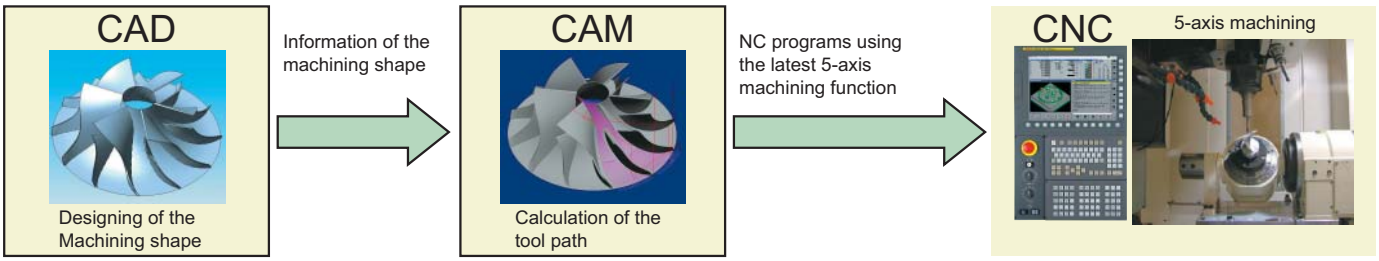
Workpiece setting error compensation

A workpiece placed on the table may be slightly displaced from its correct position. In this case, workpiece setting error compensation can be used to automatically compensate the position error so that the original machining program can be used as is. This function can be used with the 5-axis machining functions, scaling, coordinate system rotation, canned cycle for drilling, and so on.



Cooperation with CAM

With the cooperation of major CAM makers(※), the NC programs can be made using the latest 5-axis machining functions.



(※) CNC software, Dassault Systems, DELCAM, DP Technology, EUKLID, Gibbs and Associates, OPEN MIND, Sescoi KK, Tebis AG, Vero International (Alphabetical order), etc.

State-of-the-Art High-Speed, High-Reliability Hardware

Remarkably Improved CNC Computing Power

Prominent CNC computing performance is realized by leading-edge hardware technologies.

- An ultra-fast microprocessor is employed as the CNC processor serving as command center.
- The original high-speed bus connects the CNC processor, the PMC processor and the digital servo processors, and quickly transfers a large amount of data.

Ultra-Compact, Ultra-Thin Control Unit

[US patent No. 5940292]

The LCD-mounted type CNC of which CNC functions are installed on the back of the LCD greatly reduces the CNC installation space of a machine and contributes to downsize the machine.

- The thin CNC control unit of 60 mm in depth.
- The stand-alone type CNC with a separate display is also available. In the maximum configuration, the stand-alone type CNC is about half the size of conventional CNC units.

Large LCD Improving Operability

Usability is improved by a large LCD unit and vertically arranged soft keys.

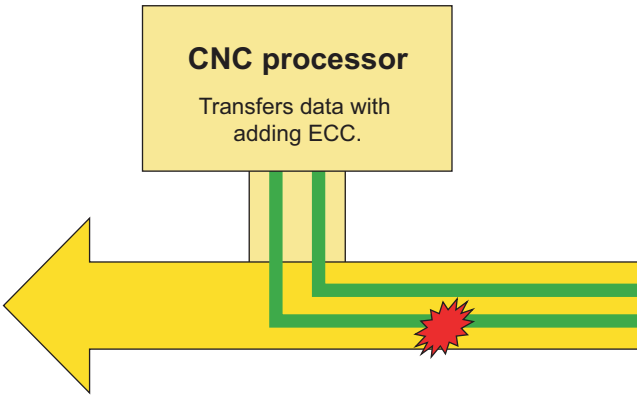
- A large display unit with a 15-inch color LCD is available. This unit makes full use of high resolution (1024 dots x 768 dots) to display various information on the screen.
- New soft keys have been arranged vertically on the side of the screen. Screen usability is improved by two types of soft keys.
- A PCMCIA interface is provided on the front of the LCD unit. DNC operation can be performed with a Compact Flash card completely stored in the CNC control unit with the lid closed.
- A QWERTY keyboard with the same layout as personal computer keyboards is available. Users can input data in the same manner as to a personal computer.

As CNC LCD units, in addition to the 15-inch color LCD unit, the following LCD units are available: 10.4-inch color LCD unit, 8.4-inch color LCD unit, and 7.2-inch monochrome LCD unit. The ONG keyboard compatible with previous models can also be selected.

15-inch color LCD unit, QWERTY keyboard, standard machine operator's panel

10.4-inch color LCD unit, QWERTY keyboard

8.4-inch color LCD unit, ONG keyboard



High-reliability, high-speed CNC internal bus with error correcting code (ECC) (Japanese patent No.3757204)

If an error occurs during data transfer, invalid data is not transferred.

Multi-Purpose Soft Keys

On the operation screen dedicated to the 15-inch color LCD, the soft keys are arranged separately according to their purposes. The soft keys vertically arranged on the right of the screen are used for selecting a screen. The soft keys horizontally arranged at the bottom of the screen are used for selecting an operation on each screen. This arrangement of the soft keys reduces the number of key touches required for operation, enabling quick screen switching and operation.
On the 10.4-inch color LCD, soft keys can be used as screen selection shortcut and one-touch macro call keys as required.
The machine operation menu for easy creation of the machine operator's panel is also provided.

FSSB optical fiber cable

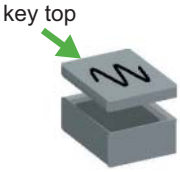
With optical fiber cables realizing high-speed, high-reliability data transfer by using error correcting code (ECC), a CNC is connected to multiple servo amplifiers in series.

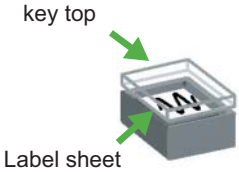
FANUC SERVO AMPLIFIER
αi series

FANUC AC SERVO MOTOR αi series
FANUC AC SPINDLE MOTOR αi series

Customizable standard operator's panel

Low-profile operator's panel designed to fit the CNC display and MDI. The key tops can be customized for each machine.

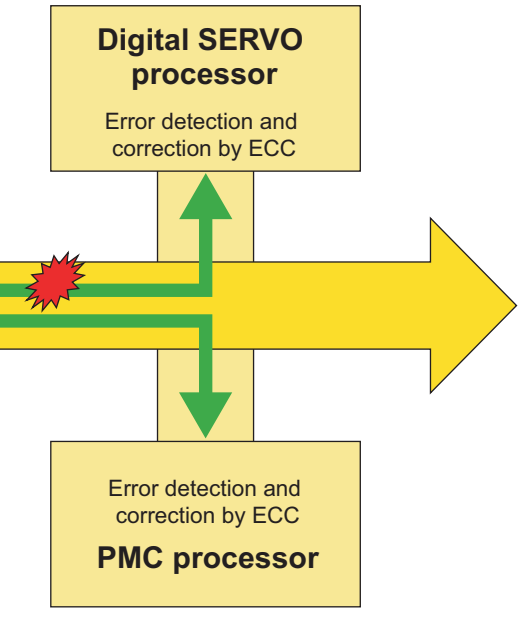




Leading-Edge Servo Control with High-Speed FSSB and High-Speed Processor

[US patent No.5990638, etc.]

The FANUC serial servo bus (FSSB) using optical fiber cables is used to connect a CNC to servo amplifiers. The use of the FSSB with a new design for which the transfer rate of optical signals is remarkably improved and the leading-edge digital servo processor enables multi-axis control for up to 32 axes and other faster current control. Leading-edge servo control functions are available, which improves machining performance.



High Reliability Enabled by ECC

[Japanese patent No.3565798, etc.]

Error correcting code (ECC) is a leading-edge high-reliability technology. With ECC, error correcting codes are added to data during transfer of various types of data. If an error occurs during data transfer, the error can be detected and corrected based on error correcting code.

Original ECC is applied to the semiconductor memory, FSSB and the high-speed CNC internal bus. This further enhances the reliability of FANUC CNCs that have a established reputation for high reliability.

High-Speed, High-Quality Machining

High-Quality Machining Realized for All Types of Machining from Part Machining to Complex Die Mold Machining

NANO CNC System

High-Quality Machining Achieved by Coordination between "High-Precision Operation in Nanometers" and "State-of-the-Art Servo Technology"

Nano interpolation that computes position commands for the digital servo control unit in nanometers, SERVO HRV Control and SPINDLE HRV Control for which the control cycle is made faster, and FANUC SERVO MOTOR αi series with a high-resolution pulse coder are used as standard and make up "NANO CNC System," which achieves high-speed, high-quality machining.

FANUC Series 30*i*/31*i*/32*i*-MODEL A

NANO Interpolation

FANUC SERVO AMPLIFIER αi series

High-response and high-resolution pulse coder 16 million/rev

FANUC AC SERVO MOTOR αi series

SERVO HRV Control
SPINDLE HRV Control

FANUC AC SPINDLE MOTOR αi series

NANO Interpolation

[Japanese patent No.3023648]

Use of "Nano Interpolation" for All Types of Machining as Standard

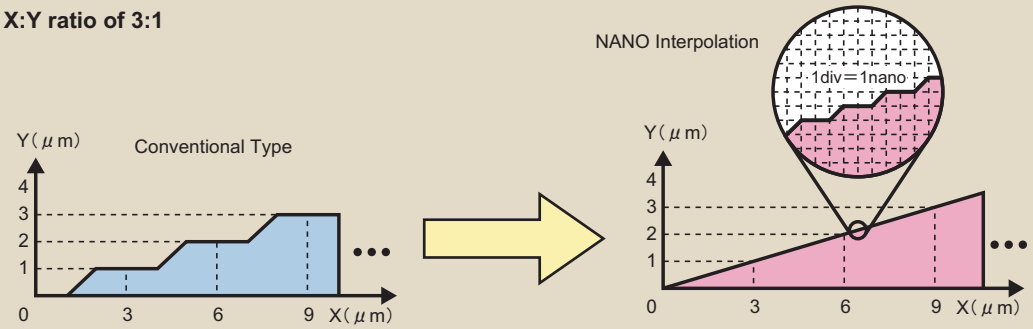
"Nano interpolation" which computes position commands precisely in nanometers to enable the machine to move smoothly and the machining precision to be improved is equipped as standard.
The use of "nano interpolation" for all types of interpolation realizes high-quality machining in the order of nanometers for both milling and turning.

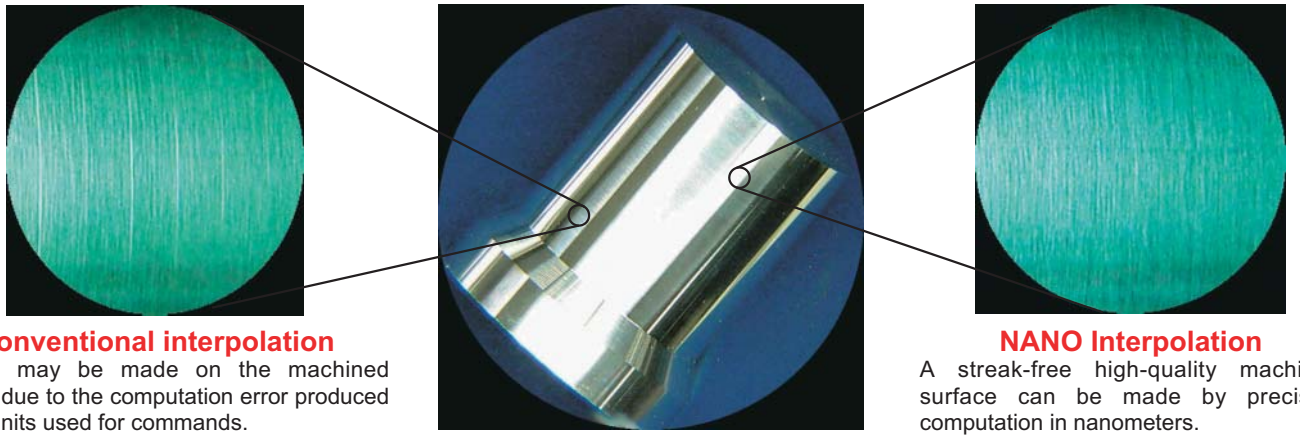
Use of "Nano Interpolation" for Spindle Functions

"Nano interpolation" can be used for spindle functions in addition to servo control, including:
- Cs contour control
- Rigid tapping

The scope of application of "nano interpolation" has greatly been widen, including lathes and compound machine tools as well as machining centers.

Tapering at an X:Y ratio of 3:1





Conventional interpolation
Streaks may be made on the machined surface due to the computation error produced by the units used for commands.

NANO Interpolation
A streak-free high-quality machined surface can be made by precision computation in nanometers.

AI Contour Control Ⅰ/AI Contour Control Ⅱ

Ultra-High-Speed Machining of Complex Free-Form Curved Surface

The use of the state-of-the-art ultra-high-speed processor allows high-speed machining of complex free-form curved surfaces of aircraft and automobile parts and metal dies that are specified in continuous small blocks. With AI contour control Ⅱ, powerfull look-ahead performance enables ultra-high-speed machining specified in continuous very small blocks.

High-Speed, High-Precision Machining Which Unleashes Machine Tool Performance

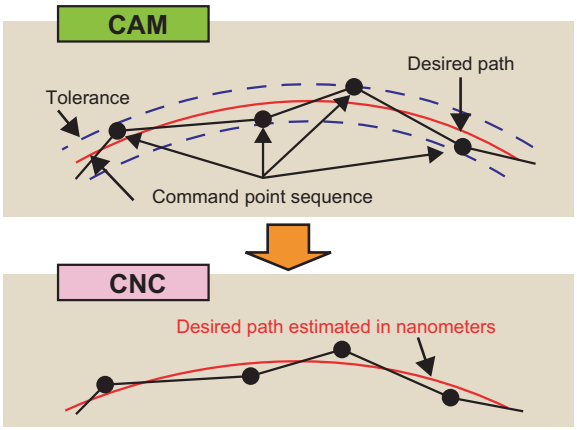
The specified figure is determined by programmed commands read in advance to control the feedrate and acceleration so that they are optimum for the machine performance. Corners and curves are automatically determined to enable machining at the feedrate optimum for the machining profile.

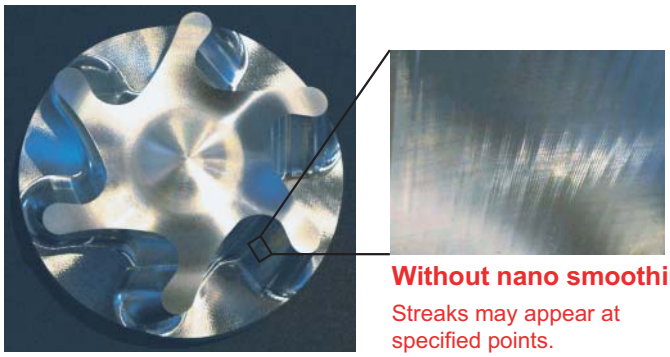
Intelligent Velocity Control with No Restrictions on Programmed Commands

AI contour control is available for programmed commands created for cycle machining and turning and using custom macros as well as linear and circular interpolation commands. Intelligent velocity control and fine acceleration/deceleration control with no path error that are provided by AI contour control can be combined with “nano interpolation”, “jerk control”, and “optimum torque acceleration/deceleration” to realize high-precision, high-quality machining and shortening cycle time of machining.

Nano Smoothing/Nano Smoothing 2 (Series 30*i*-A, 31*i*-A, 31*i*-A5) [Japanese patent No.3904993, US patent No.6823234]

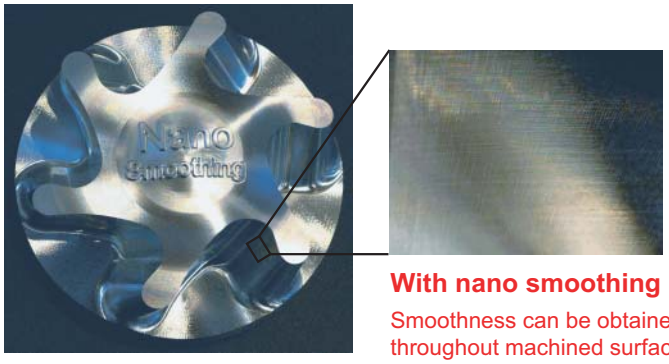
For machining of a die with a free-form curved surface, since a curve becomes a polygon when a machining program is specified with linear interpolation, streaks may be made on the finished surface.
“Nano smoothing” estimates a desired path within the tolerance with NURBS curves using a minute line segment command point sequence created by a CAD/CAM system and interpolates the generated NURBS curves in nanometers. This technology gives a smooth machined surface approximate to the designed figure and reduces manual finishing processes.
“Nano smoothing 2” applies the nano smoothing technology to 5-axis machining including rotary axes. Use of this function together with tool center point control or smooth TCP enables smoother movement of the tool posture and the tool tip, and is therefore suitable for machining the side surface of workpieces for airplane parts.





Without nano smoothing

Streaks may appear at specified points.



With nano smoothing

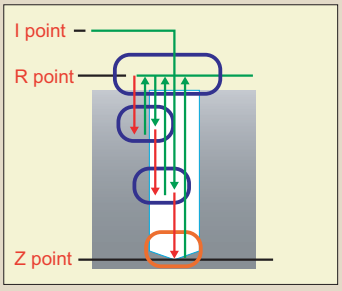
Smoothness can be obtained throughout machined surface.

In-Position Check Switching for Canned Cycle for Drilling

Reduction of Machining Time for Drilling Canned Cycle

A deep hole, for example, is gradually drilled by shuttling a drill to defecate chips made during drilling. In this operation, the higher position precision is required at the bottom of the hole, whereas high precision is not so necessary at points of direction change other than the bottom of the hole. Thus, the tolerance width, for which the commanded position is deemed to have reached (In-Position Width,) can be set separately either for the bottom of the hole or for other positions. This has enabled to shorten cycle time without affecting precision at the bottom of the hole, while speeding up the reverse motion made at positions other than the bottom.

Example) Peck drilling canned cycle (G83)



Uses In-Position Width for other than the bottom of the hole.
Sets the width relatively wide for higher speed operation.

Uses In-Position Width for the bottom of the hole.
Sets the width narrower for higher precision.

: Rapid traverse
: Cutting feed

Servo Control Achieving High-Speed, High-Quality Machining

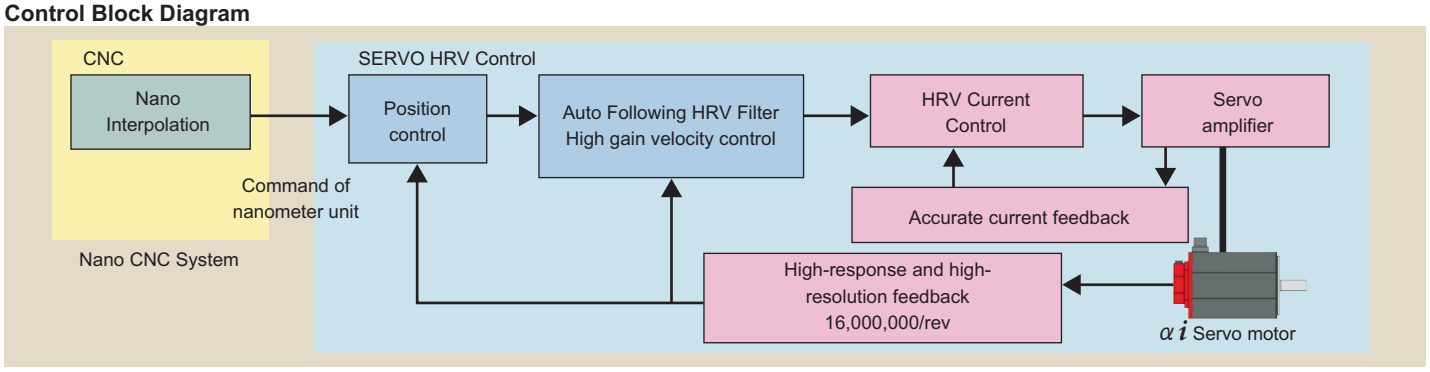
SERVO HRV (High Response Vector) Control [Japanese patent No. 3442340, seven registered patents, two pending patents]

High-speed and high-precision SERVO HRV Control realizes a nano CNC system. SERVO HRV4 Control (only for Series 30*i*-A and 31*i*-A, 31*i*-A5) has come along, as an extention of SERVO HRV3 Control proven with high-speed, high-precision machining. Its features are listed below:

- Always using servo position commands specified in nanometers.
- Using the αi Pulsecoder with an ultra-high resolution of 16 million resolution/rev as the standard detector.
- Using an ultra high-speed servo control processor, enabling high-speed current control and velocity control.
- Elimination of mechanical resonance using an auto following HRV filter and reduction of vibrations of the end of the machine using distortion prediction control.

With a combination of these functions, nano-level control achieves high-quality machining.

Control Block Diagram

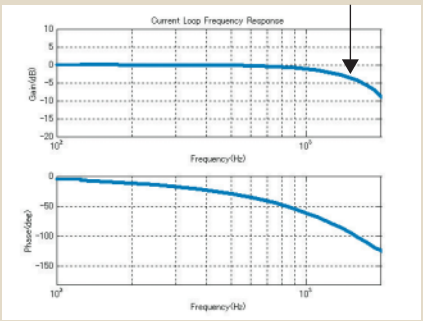


Basic Performance of SERVO HRV4 Control

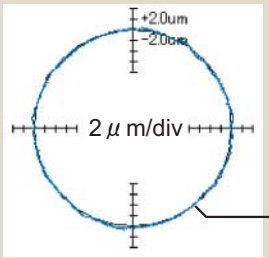
Each component of servo HRV control has been enhanced and the basic performance including response to commands and disturbance suppression characteristics has greatly been improved. Current control, base of all types of servo control, shows a fast response of more than 1 kHz at the maximum. High-speed current control can realize higher-gain velocity control.

Current loop frequency characteristics

Bandwidth of 1400 Hz



Example of an arc with a radius of 100 mm and a feed rate of 20 m/min



Error 0.5 μ m

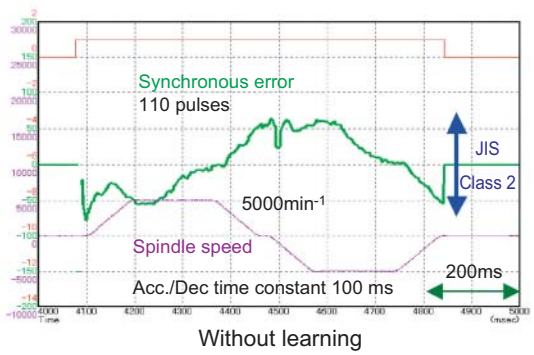
HRV4 (Velocity gain 1600%)

Learning Control (Series 30*i*-A, 31*i*-A, 31*i*-A5) [Nine Japanese patents, eight pending patents]

Learning control allows repetitive commands to be executed at much higher speed and with much higher accuracy. This function has the following features:

- Achieving high speed and high accuracy by eliminating servo delay
- Accurate following up a repetitive command with a high speed cycle
- Enabling suppression of disturbance synchronized with positions

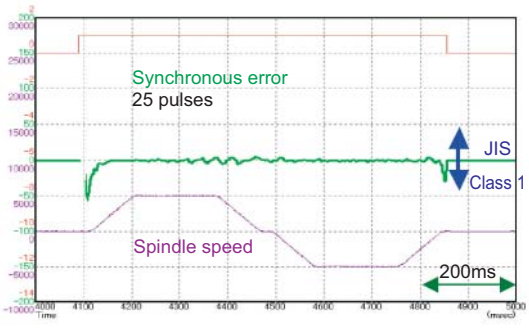
Typical applications that take advantages of these features include Piston lathes, Cam grinders, and Gear cutting machines.
In addition, Learning Control for Parts Cutting applicable to general parts machining fields and Learning Control for Rigid Tap that enhances accuracy in rigid tapping are also available. (Learning Control for Parts Cutting and Learning Control for Rigid Tap can be available also in the Series 32*i*-A.)



Without learning

Learning Control for Rigid Tap (Example)

After 3 times of learning



With learning

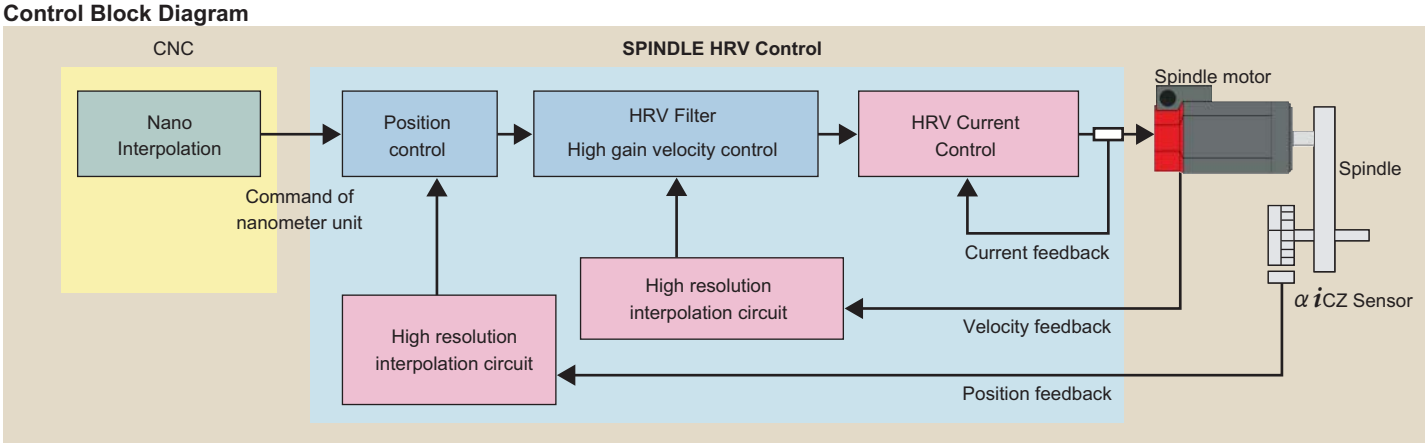
SPINDLE HRV (High Response Vector) Control [Japanese patent No. 3749237, No. 3754740]

SPINDLE HRV Control realizes fast response and high precision of a spindle. SPINDLE HRV4 Control has come along, as an extension of SPINDLE HRV3 Control which features high-precision position control. Its features are listed below:

- Supporting nano interpolation in position control mode enabling a nano CNC system for spindles as well as feed axes.
- Achieving high gain control and low heat generation from a high speed rotating motor through faster sampling time of the current control loop.

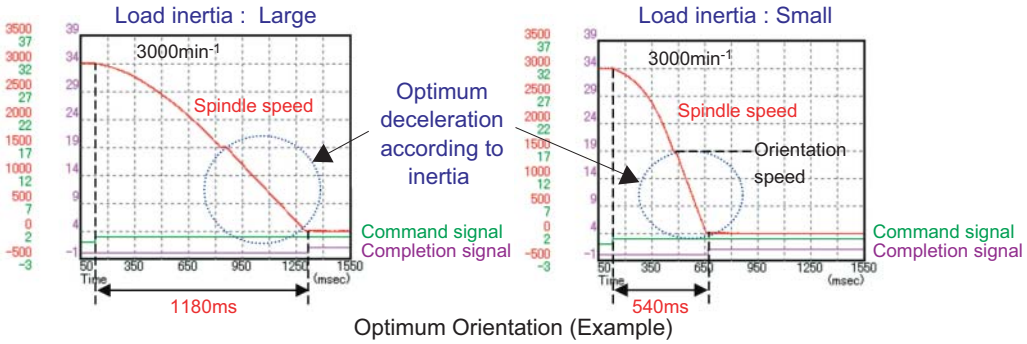
SPINDLE HRV Control realizes high precision, fast response, and high efficiency of spindles of machine tools.

Control Block Diagram



Optimum Orientation [Japanese patent No. 4099503]

Spindle orientation is performed by optimum deceleration control according to the inertia of the workpiece or tool. No parameter tuning is required for the deceleration rate. As the load inertia changes, this function automatically performs deceleration with the maximum torque to reduce orientation time.



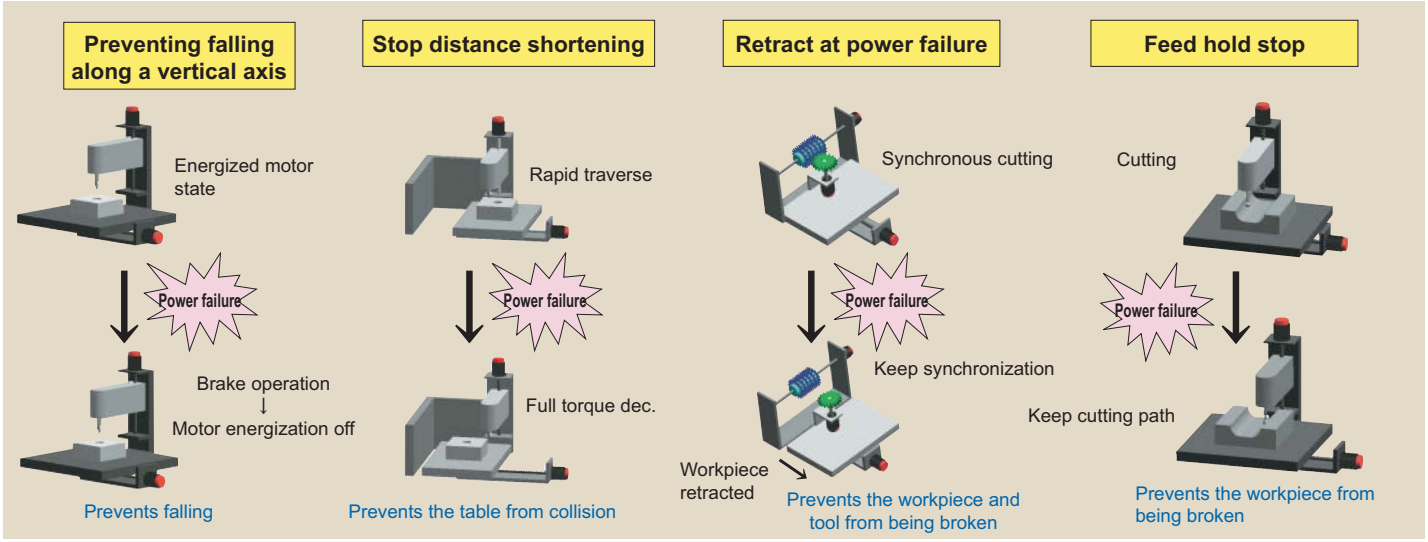
Optimum Orientation (Example)

Machine Protection Functions Operating at Power Failures [Three Japanese patents, three pending patents]

Machine protection functions operating at power failures protect the machine or tool and workpiece from being broken when a power failure occurs.

There are four functions including the function of preventing falling along a vertical axis that is available only for the standard servo amplifier system and the retract function operating at power failures that can be used by adding an optimum power failure backup module according to the application.

Optimum options can be added as required according to the user environment and protection level of the machine.



Excellent Operation

Program Management that Becomes Easy to Use

Large-Capacity Program Memory

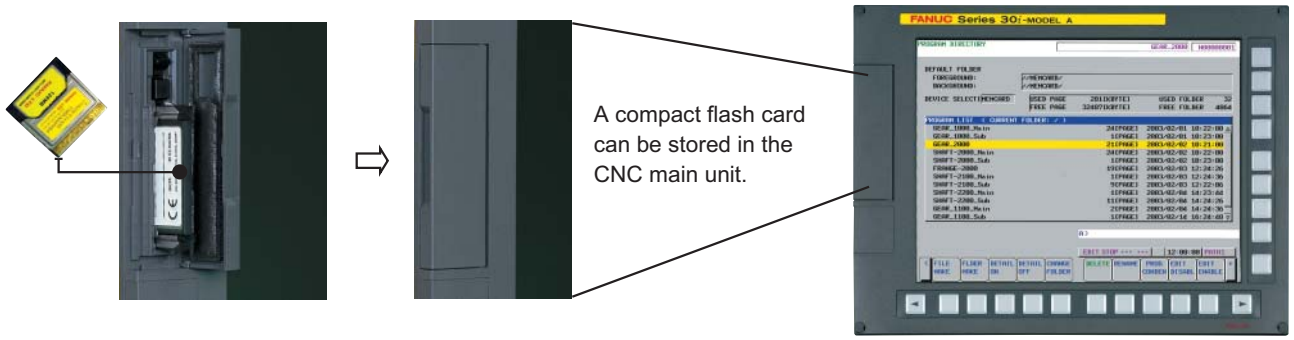
A maximum of 8 megabytes (2 megabytes for the Series 32*i*-A) of program memory is built into the CNC.
The maximum available capacity of a memory card (compact flash card) in program operation is 2 gigabytes. The maximum available capacity of a Fast Data Server is 4 gigabytes. The capacity of program memory has dramatically been expanded.

CNC built-in flash memory
Max. 8MB

Fast Data Server
Max. 4GB

Editing and Operation of a Memory Card and Data Server

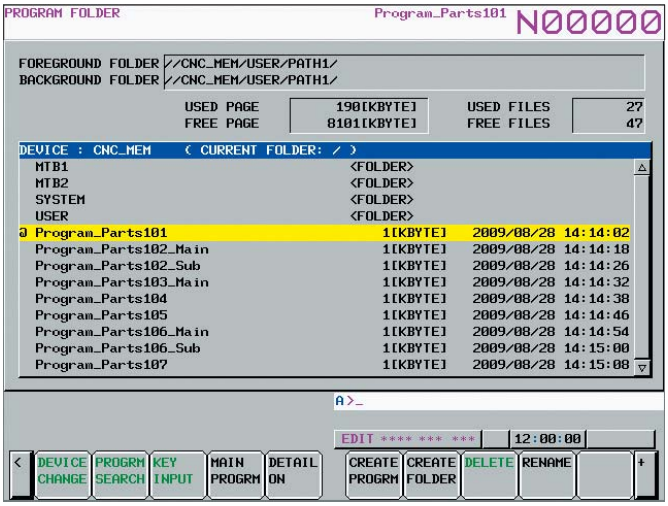
The CNC edit functions can be used to directly edit programs stored in a memory card and Data Server as well as built-in CNC program memory.
Program operation using subprogram calls and GOTO statement and other custom macros become available with both the Data Server and memory card, which makes it easier to use.



Program management by program folders and file names

The use of program folders and file names enables easy management of large-capacity program memory.
The PROGRAM DIRECTORY screen can be used to manage each device of program memory, memory cards, and Fast Data Server in a unified way. Program memory contains a folder dedicated to the machine tool builder and that dedicated to the user.

Each program can be managed with a file name consisting of up to 32 characters. An easy-to-identify name can be assigned to each program to manage programs easily.
(Conventional O numbers are also available as file names.)

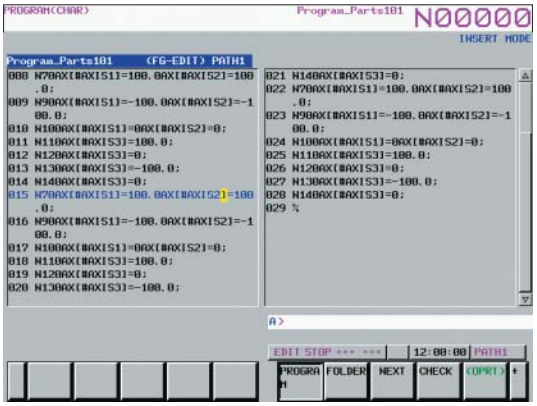


PROGRAM DIRECTORY screen

Editing in Character Units

In addition to edit functions in word units that are suited for NC language program editing, edit functions in character units are also available, which allows easy editing of macro and comment statements.

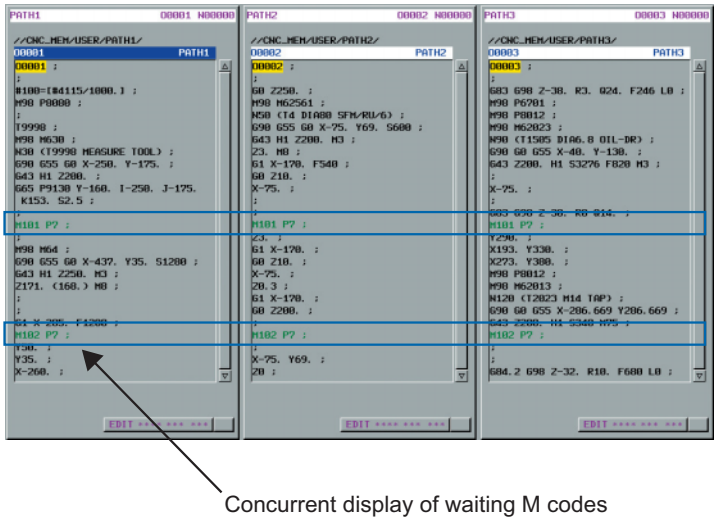
Operators who are familiar with edit functions of personal computers can easily create and edit programs.



Character Edit screen

Editing of Programs of Multiple Paths

Programs of multiple paths can be easily edited while concurrently scrolling the programs of all paths displayed using cursor operation. When a waiting M code appears during concurrent scrolling, the concurrent scrolling stops until the waiting M codes of the other paths appear side by side and the concurrent scrolling restarts again after waiting is completed, thereby making the checking and editing of waiting operation easy.
A waiting search enables the programs of all paths to be displayed at a waiting position synchronously, thereby making the checking and editing of waiting operation easy.



Concurrent display of waiting M codes

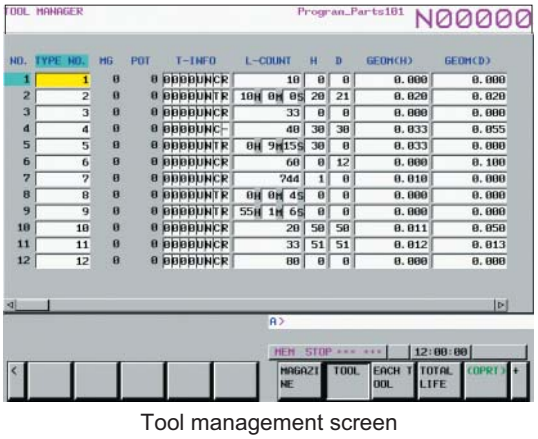
Integrated management of tool information

Tool management functions

A tool management data table for managing a variety of tool data and a cartridge management table for defining the relationships between tool numbers and pot numbers enable the integrated management of tool information.

Moreover, by assigning property data to cartridges and pots, whether tools are usable can be judged, and tool figures capable of being stored can be managed.

In addition, the special screen for tool attachment or removal and the extraction function using condition specification makes it easy to exchange the tool.



Tool management screen

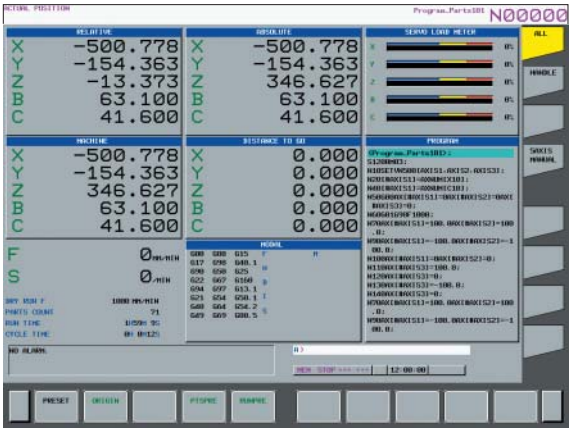
Easy Operation

Operator-Friendly Display and Operation

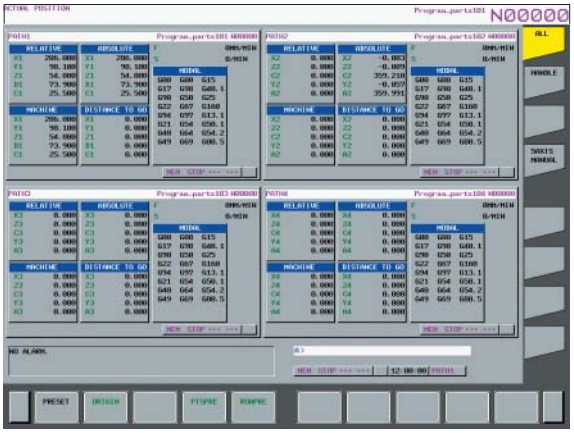
Operation Screen Dedicated to 15-inch Color LCD

The operation screen dedicated to the 15-inch color LCD has the following features:

- Allows the operator to check various types of information required for machining and setup on one screen, which relieves the operator of complicated screen switching operation.
- Allows information for up to four paths of a multipath system to be displayed at a time and enables the operator to set the paths to be displayed simultaneously with each path, which achieves excellent viewability and operability in construction of a complex multipath system.



Program check screen

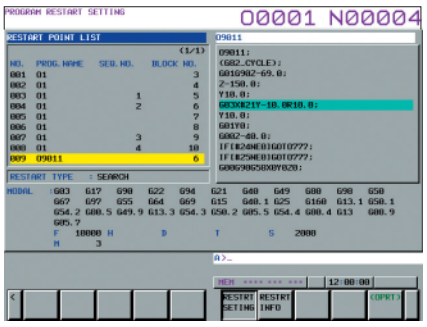


Simultaneous multipath screen

Quick Program Restart

It is possible to easily restart the machining that was interrupted due to an emergency stop or power failure.

- The block information required for restart, such as the interrupted block, rapid traverse command, and auxiliary function command is automatically memorized.
- The memorized block information and nearby program codes are displayed on the program restart setting screen.
- The program can be restarted if only a block to be restarted is selected on the screen and searched it.
- The conventional method for sequentially searching from the start of the program to a specified block or the direct jump method for searching for a specified block based on the memorized block information can be selected.



Quick program restart setting screen

Support of Multiple Languages and Dynamic Display Language Switching

If different operators use different languages, the display language can be changed to another with a simple operation without turning the power to the CNC off. This function eliminates the need for stopping the machine at the change of operators, which improves work efficiency. The CNC operation screen supports 18 languages:

English

Can be changed with a simple operation

Changed immediately

Japanese

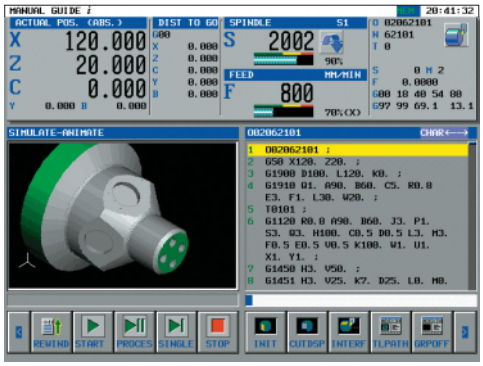
Integrated Operation & Programming Guidance with extremely simplified operations

FANUC MANUAL GUIDE *i*

This is an integrated operation guidance, which provides handy operation guidance for programming through machine operation on one single screen.

- Icon menu soft-keys provide convenient programming for sophisticated turning and milling.
- By adopting ISO code format, widely used in part programming, machining program made by CAD/CAM can be used as it is.
- Entered program can be checked easily by realistic animation of milling and turning.
- Set-up operations before and after of machining can be reduced by various automatic measuring of cutting tools and machined workpiece.
- For machining center, lathe, compound machine with milling and turning, and multi-path lathe with plural tool posts and spindles.

Menu-format program input screen



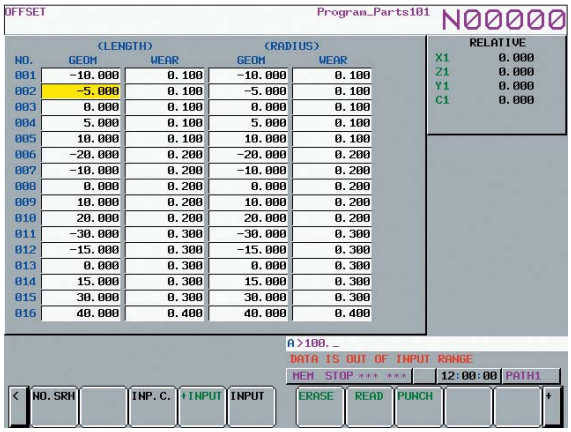
Animation screen

Positive Safety Measures

Prevention of Operator Errors

Various types of checks are made and many confirmation messages are displayed for CNC operation, which prevents unintentional operator errors from occurring.

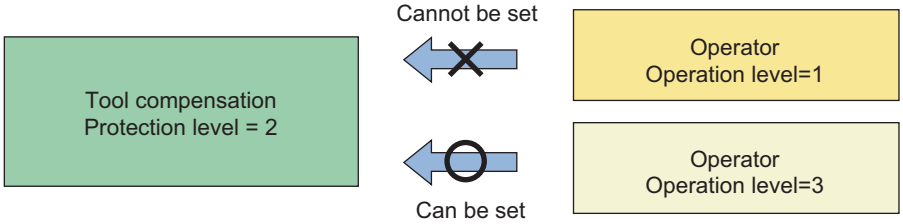
- Preventing data input errors
- Preventing execution of an invalid program



Tool offset screen

Protection of Data at Eight Levels

If operators having different degrees of skill operate the same machine, data can be protected from operators unfamiliar with operation.
More specifically, operators are classified into eight levels of skill and each types of CNC data are also classified into eight levels of protection. When an operator attempts to change data or output it to an external unit, the operator cannot change or output data if the operator level is lower than the data protection level. This function is effective particularly in automobile and other large plants.

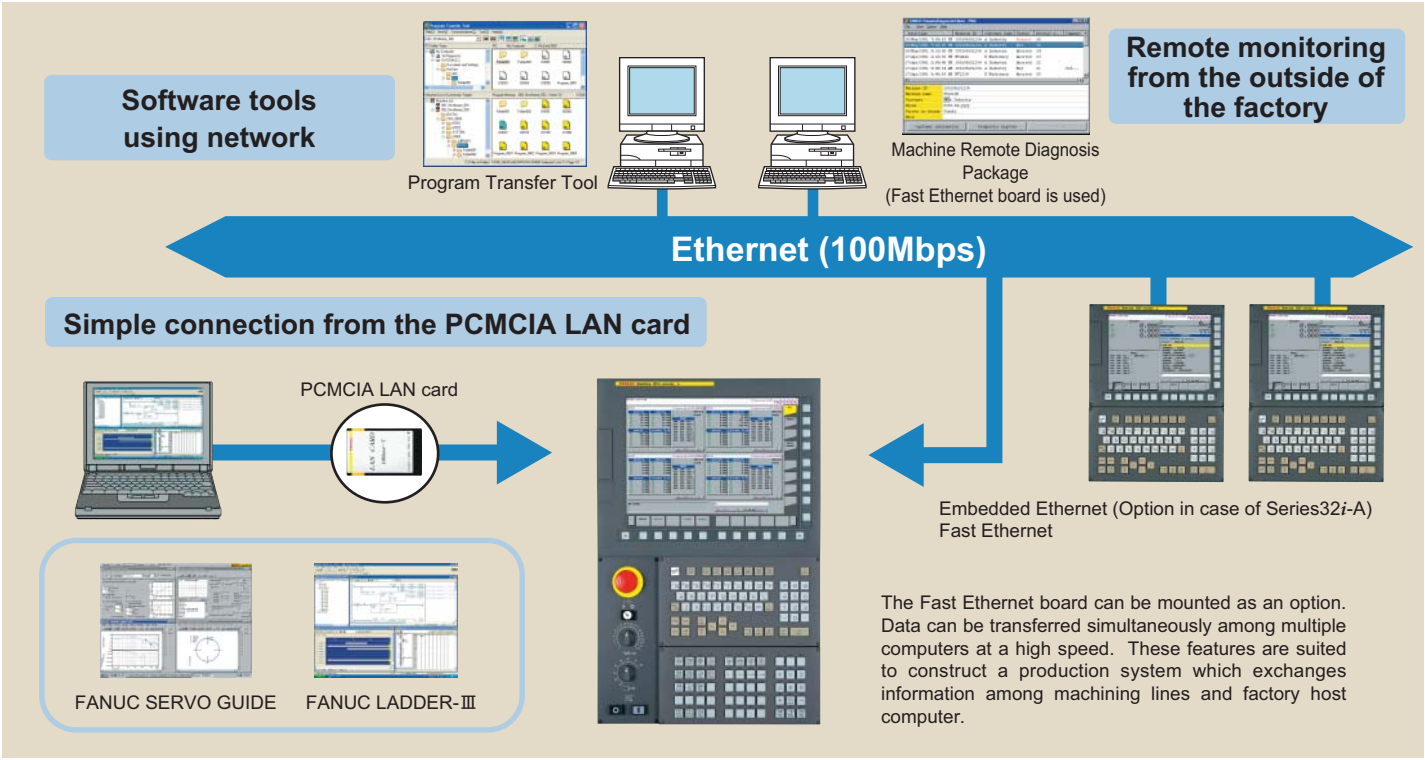


Network Support Functions

With plenty of network functions, you can construct an optimum system for CNC machine tools.

High-Speed Ethernet

Embedded Ethernet on which communication can be performed at a rate of 100 Mbps is supported as a basic function. A CNC can be connected to a personal computer to transfer NC programs and check the operating status of the machine, which allows real-time centralized monitoring of operation at the machining site. A CNC can also be connected to the office and machining site via a factory network. This connection allows the management of the entire factory using machining production directions and operation performance, which can improve productivity. Connection to the Internet allows remote monitoring of the operating status of a machine from another office outside the factory or home.
Inserting a PCMCIA LAN card into the slot on the side of a display unit allows simple connection to a personal computer for the adjustment and maintenance of a machine.



Various Types of Field Networks

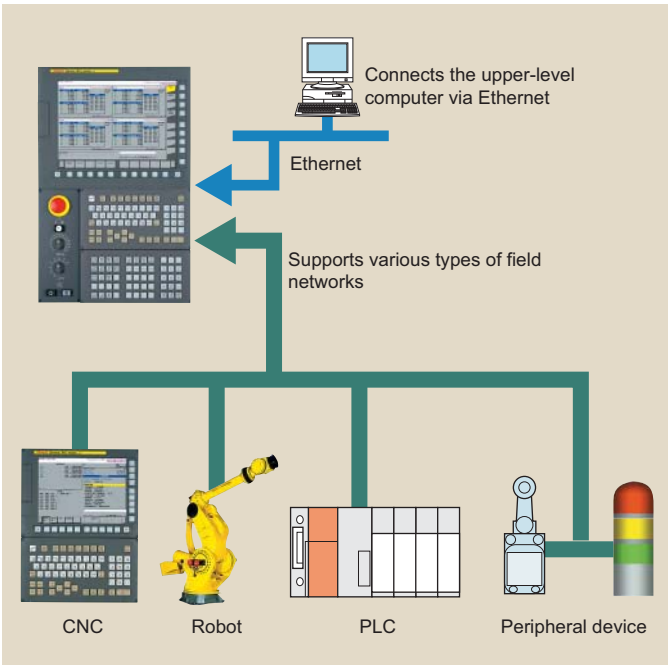
The following field networks are supported, which allows user-specified system construction and peripheral incorporation.

FL-net
- Network with Ethernet conformed with OPCN-2, standards by the Japan Electrical Manufacturers' Association (JEMA).
- The use of masterless mode allows data exchange among all devices. Suitable for controlling lines with high-speed data transfer and guaranteed cycle time.
- The FL-net/Ethernet coexisting function allows communication on the same network as the information Ethernet.

PROFIBUS-DP (Master/Slave)
- Field network conformed with the European Standards (EN50170), realizes fast I/O transfer at 12Mbps.
- The network is connected freely to a PLC having PROFIBUS-DP.

DeviceNet (Master/Slave)
- Field network popular world-wide, especially in USA
- The network is connected freely to a PLC having DeviceNet.

CC-Link (Remote device station)
- Field network standardized by CC-Link Partner Association in Japan



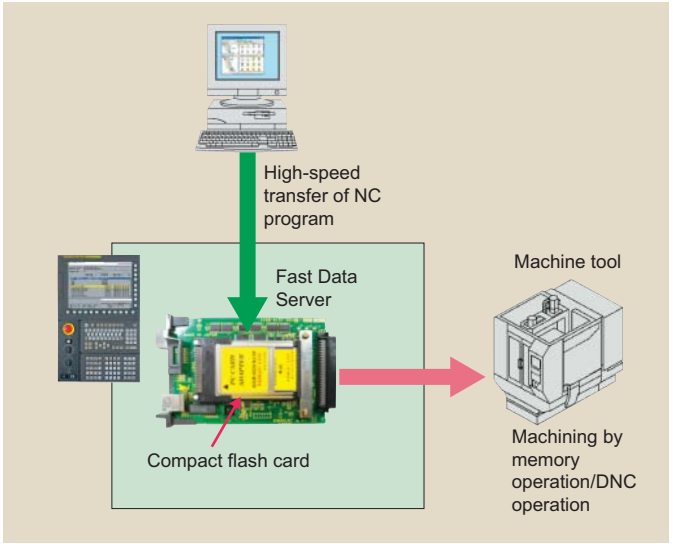
Fast Data Server

A huge program for machining a mold die that contains continuous blocks specifying minute travel distances can be stored in the built-in compact flash card in the Fast Data Server for high-speed machining.
Other Ethernet functions can be used simultaneously with the operation of the Data Server.

High speed transfer
- A machining program can be transferred between a personal computer and Data Server at a high speed.
- CNC parameters, tool information files, and other data can also be transmitted.

Memory operation
- Memory operation can be performed using macro statements and subprogram calls from the compact flash card.
- DNC operation can also be performed from a personal computer.

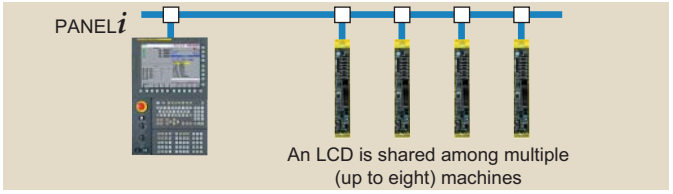
Program editing
- A program stored on the compact flash card can be edited.

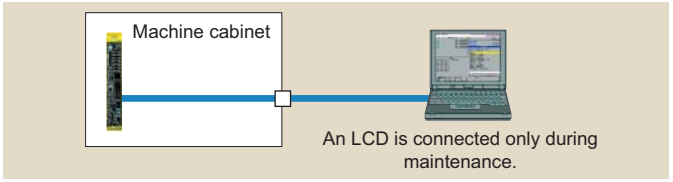


Ethernet Display Function

[Japanese patent No. 4220979]

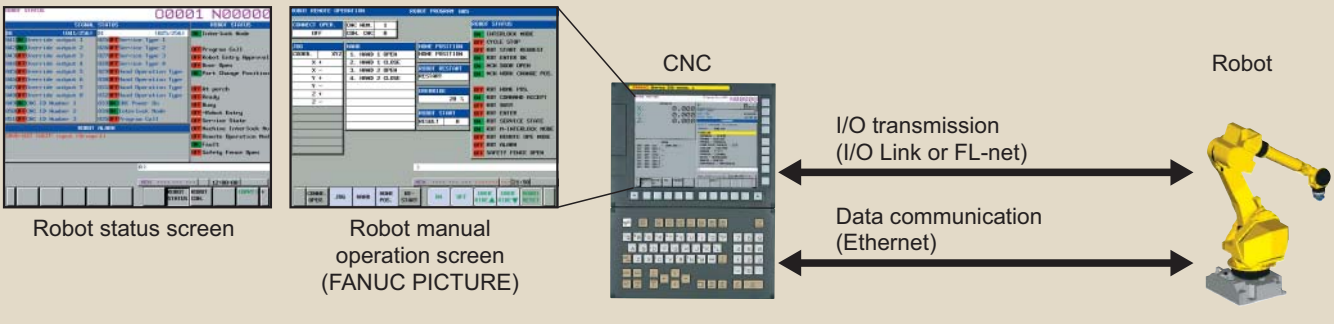
In a machine that needs no LCD during normal operation, a flexible system can be constructed by displaying the CNC screen on a PC using Embedded Ethernet.
- Supports maintenance screens (power-on screen/alarm screen).
- Available in stand-alone type CNCs.
- Application
  - Machining line that shares an LCD among multiple machines
  - Machine that uses an LCD only during maintenance





Robot Connection Function

The intelligent robot can be connected to the machine tool easily. For example, loading and unloading work-piece by the robot increases the productivity of the machine tool.
- Robot status is displayed on CNC screen. Robot program and NC program are managed with relating each other.
- Robot manual operations of Jog feed, Hand operation and so on are possible from CNC.
- Sample ladder program, FANUC PICTURE screen and standard interface are provided to make CNC and the robot cooperate.
- Up to four CNCs can be connected to one robot.



Easy Maintenance

In case of a fault, quick solution of the problem is supported

Automatic Data Backup

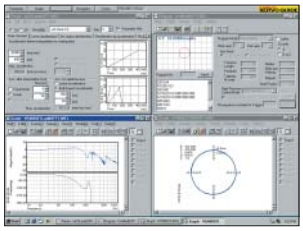
Various types of data including offsets that are stored in battery-backed SRAM are saved in the built-in flash memory. If the battery is exhausted and data is erased, easy data recovery is allowed.

Remote Diagnosis

Remote diagnosis using Internet communication is supported. Using a machine remote diagnosis package software, machine tool builders can easily construct remote machine maintenance systems.

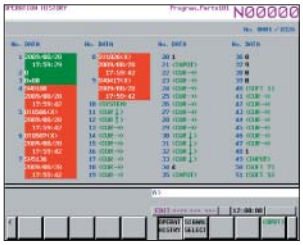
FANUC SERVO GUIDE

SERVO GUIDE provides the integrated environment for servo and spindle tuning. As well as waveform display and parameter management, Servo Guide supports kinds of auto-tuning functions, and it reduces tuning time.



Operation history, Alarm history

The update history of operation, alarm, and various data can be recorded. When an alarm occurs, more detail information such as modal information, absolute and machine coordinates can be recorded. It helps you identify the cause of the alarm.

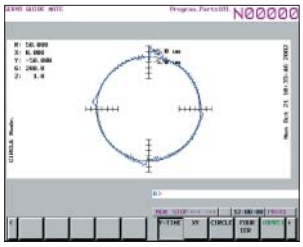


SERVO GUIDE Mate

This function displays following servo-related data on the CNC display to provide means of analysis.

- Geometric error display
- Path display, etc

Machine tool builders can use this function for inspection before shipment.



Easy Incorporation into Machine and Adjustment

- **The high-speed, large-capacity, and multi-path PMC increases the flexibility in machine design.**
- **The safety function incorporated into the CNC makes conformance of the machine to the safety standard easy.**

High-Speed, Large-Capacity, and Multi-path PMC

[Japanese patent No. 3896076, US patent No. 6999842]

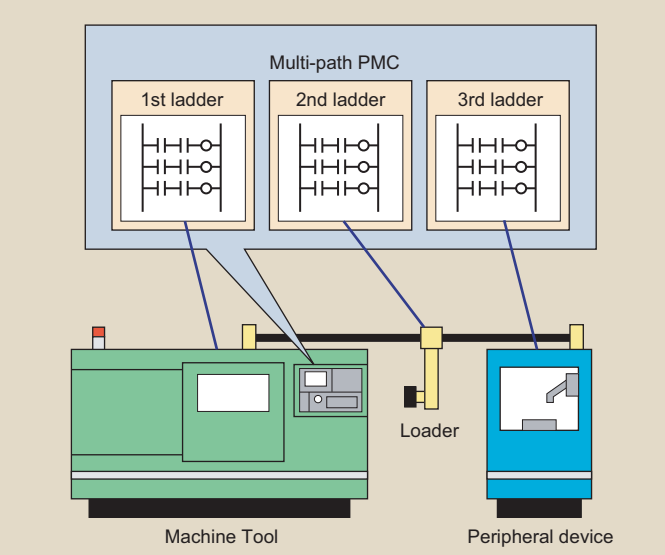
A PMC, which consists of a dedicated processor and custom LSI, processes large sequence control at a high speed.
When using multi-path PMC function, one PMC can execute up to three independent ladder programs.
Each ladder program has an independent data area, which enables programs to be developed as independent modules.

Extended PMC Ladder Instruction function

- The enhanced computation instructions enable to program complex sequence control of machine into a simple ladder circuit with high readability.

Function Block function

- This function enables to call up repeatedly used ladder circuit patterns in blocks.
  (Note: Function block does not have an effect to reduce the total program size.)



Dual Check Safety

Dual Check Safety is a safety function that conforms to the international safety standard (IEC 61508). This function offers a high level safety by redundant monitor, and by providing duplicate paths of breaking power for the servo/spindle amplifier.

- Cost can be reduced by significantly simplifying additional circuits for adherence to the safety standard.
- Two PMC functions have been incorporated into the CNC to duplicate sequence control for safety-related input/output signals.
- Safety-related input/output that is defined by a MTB allows redundant monitoring for controlling peripheral devices.

Plenty of Customize Functions

Customize functions are available, which allows machine tool builders to customize their own machine tools uniquely

・Make original operation screens	C Language Executor / FANUC PICTURE
・Implementing original PMC sequence control	FANUC LADDER-**III**
・Implement a machine operator's panel by soft keys	Machine Operation Menu
・Customizing machining and measuring cycle	Macro Executor
・Control of a peripheral axis with an NC program	Real-time Custom Macro
・Make the machine tool intelligent by using the personal computer technology	Personal computer function with Windows® OS

C Language Executor

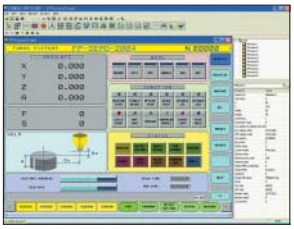
Machine tool builders can create their own operation screens.

- C Language with ANSI functions and functions for CNCs and PMCs is used for programming.
- High-level tasks of high execution priority can monitor signals etc..

FANUC PICTURE

Machine operation screen creating tool for PC without programming languages such as the C language

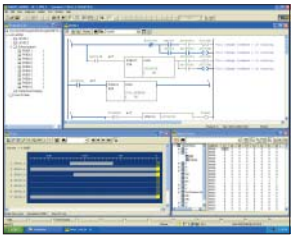
- Easy-to-use interface unique to FANUC
- Possible to coexist with a C language executor application



FANUC LADDER-III

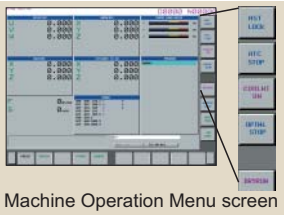
A PMC sequence program can be created on the personal computer by using FANUC LADDER-**III**. For machine customization, a machine tool builder's own sequence control can be incorporated into the built-in PMC.

- A program can be created with ladder and function block.
- Editing and debugging can be performed efficiently on an easy-to-use multi-window screen.
- Online monitoring and editing can be performed by connecting the personal computer with the CNC via Ethernet.



Machine Operation Menu

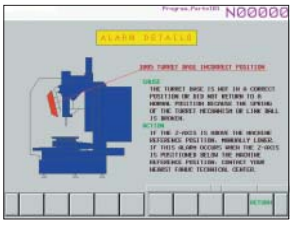
The machine operator's panel can be implemented by the CNC soft keys (only for 10.4" and 15" monitors)
This makes the operator's panel more compact and can easily adapt to the addition or change of machine functions.



Machine Operation Menu screen

Macro Executor

The user-friendly macro language is used for programming.
MTB's own canned or measuring cycle operation screens can be created.

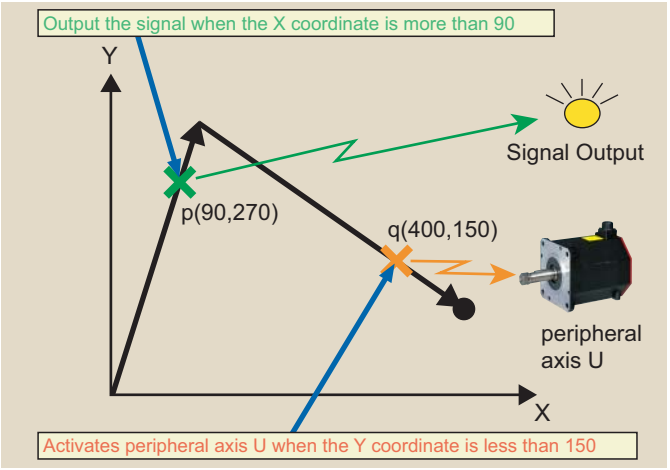


Real-time Custom Macro

Signals and peripheral axes can be controlled from machining programs.

- A macro statement can be executed in real time in synchronization with a machining program.
- Signals input and output available by using DI/DO variables. Operation that the signal status is used as a trigger can simply be created.
- Macro variables can dynamically be read and written. Operation that position information of a system variable is used as a trigger can be created.
- Multiple real-time macro statements can be executed concurrently. Peripheral axis control can be written in the same program during machining.

Example of real-time custom macro



Powerful Software Tools

Development by machine tool builders is supported in a variety of fields such as simulation, customization, and data management.

Simulation Tools Supporting Utilization of High-Level CNC Functions

Software tools for CNC operation simulation on the personal computer are provided to fully utilize the ever advancing CNC functions.
Two types of packages are available to meet applications:

- For CNC operation training ➡ FANUC NCGuide
- For application software development ➡ FANUC NCGuidePro

FANUC NCGuide (Training tool that enables learning of CNC/MANUAL GUIDE *i* operations)

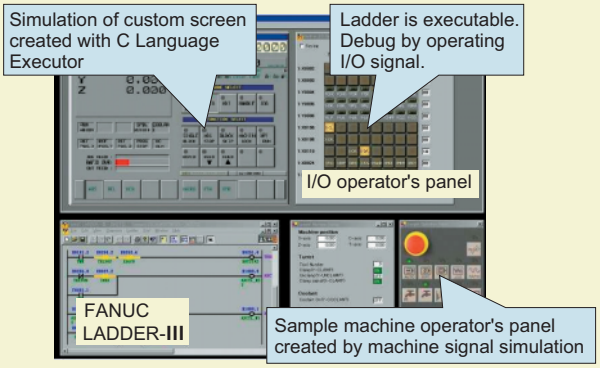
The FANUC NCGuide is a software tool that enables training of CNC/MANUAL GUIDE *i* operations on the personal computer without using an actual CNC. This software tool allows operators to be trained without using an actual machine tool. This software tool can also be used for CNC training in school.

- CNC and MANUAL GUIDE *i* training is possible.
- Machining programs and machining cycles can be edited in the EDIT mode.
- Machining simulation (animated simulation and tool path drawing) is possible.

FANUC NCGuidePro (Development tool that supports PMC ladder and customized software debugging)

The FANUC NCGuidePro is a development support tool that enables ladder to be executed on the personal computer. Moreover, the C Language Executor and Macro Executor can be executed, so that this development support tool can be used to debug a custom screen created by a machine tool builder.

- PMC ladder can be executed on PC.
- Ladder debugging operation interacting with the CNC simulation is enabled.
- Ladder editing and display interacting with FANUC LADDER-**III** are possible.
- PMC axis control simulation is possible.
- Customized software created with FANUC PICTURE, C Language Executor, or Macro Executor can be executed.



FANUC Customize Assist

The FANUC Customize Assist is a software tool that manages, in an integrated manner, multiple development tools used by a customer to perform development work.
Development tools that can be managed by this function:

- FANUC LADDER-**III**
- FANUC PICTURE
- C Language Executor
- Macro Executor

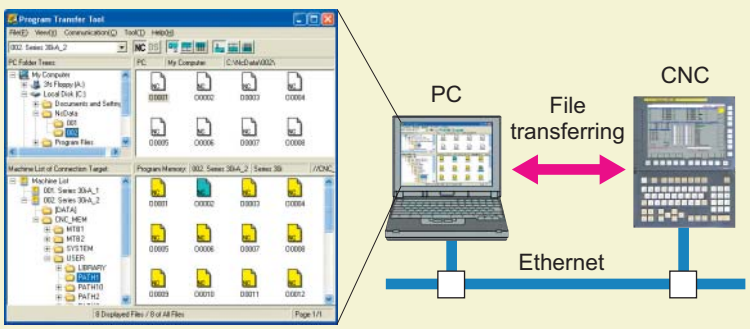
FANUC CNC Setting Tool

FANUC CNC Setting Tool is a software tool used to set and manage CNC parameters on a personal computer. Parameters can be set and managed efficiently without referring to the manual.

- Parameters are classified by the CNC function.
- Detailed explanation is displayed by selecting a parameter.
- CNC parameter is transmitted via Ethernet or memory card.

FANUC Program Transfer Tool

FANUC Program Transfer Tool is a software tool for transferring part programs and data by connecting PC and CNC via Ethernet.
Files and folders in the CNC program memory are displayed on the tool in an easy-to-understand way, so input/output operation can be easily performed with a mouse.



Personal computer function with Windows® OS

Optimum Combination of CNC and Personal Computer

Exhibiting Ability in Making Machine Tools Intelligent

The best combination between a CNC and personal computer is realized by transferring bulk data via an original high-speed interface. Unique dedicated applications can be realized easily by personal computer function, and the machine tools can meet special needs for machine tool customers. Personal computer function brings huge potentials through up-to-date computer and information technology for intelligent machine tools.

Personal computer function with Windows® XP

The FANUC PANEL *i* is a display unit that incorporates personal computer functions. PANEL *i* realizes a high performance personal computer function with Windows® XP connecting to Series 30*i*/31*i*/32*i*-MODEL A.
Various commercial Windows applications can be used.

It supports to individualize and to make intelligent the machine tools by machine tool builders and also it is possible to individualize by end users.

CNC with Windows® XP

PANEL *i*

Feature — Various commercially application software and hardware are available

Application — Best fit for flexibility with computer applications, such as tool file management by utilizing database

OS — Windows®XP Embedded

Personal computer function with Windows® CE

Personal computer function with Windows® CE is using Windows® CE which is a compact operating system without hard disk for embedded use, and ensures high reliability for harsh environment of machining site. Personal computer function with Windows® CE fits simple dedicated operator's panel design and/or dedicated machine operations. Personal computer function with Windows® CE has two types; the integrated CNC with LCD display, the stand-alone CNC connected to CNC display unit with Windows® CE computer through high speed serial bus interface.

Integrated CNC with LCD display

Feature — High reliability for harsh environment of machining site by using semiconductor memory

Application — Best fit for simple dedicated application, such as dedicated operator's panel, simple conversational system, production monitoring and management, etc.

OS — Windows®CE .NET
Windows®Embedded CE 6.0

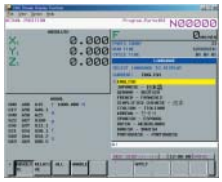
Application Software for individualizing machine tools

FOCAS2 Library

FOCAS2 library provides the functions which can be used in C or BASIC language to handle data of CNC/PMC. Users can make their own applications using FOCAS2 Library.

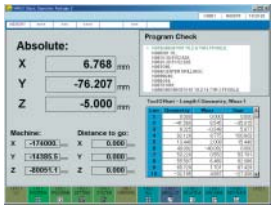
CNC Screen Display Function

The standard CNC screens can be displayed on a personal computer's display by this function.



Basic Operation Package 2 (Personal computer function with Windows® XP)

This application software enables the operators to display, input, and maintenance of CNC/PMC. Machine tool builders can customize its screens.



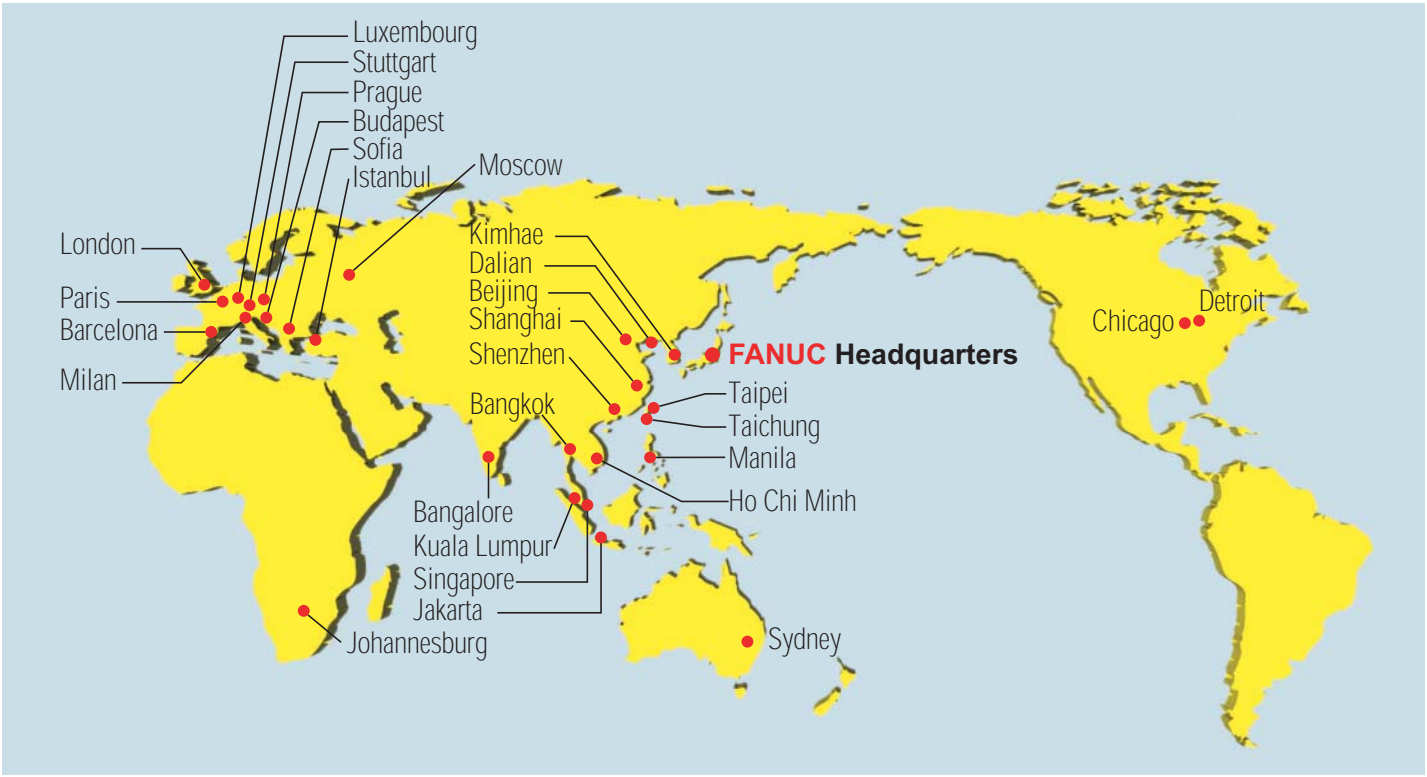
Screen for 19-inch LCD (Personal computer function with Windows® XP)

These screens are used for a PANEL *i* with 19-inch LCD. User and CNC screens can be displayed on one screen and the operability of the machine can be improved.

Maintenance and Customer Support

Worldwide Customer Service and Support

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

FANUC Training Center operates versatile training courses to develop skilled engineers effectively in several days.
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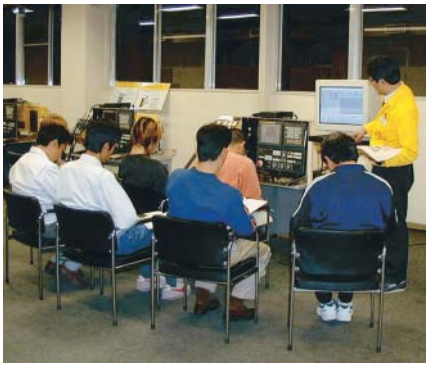
Japan 401-0501
Phone : 81-555-84-6030
Fax : 81-555-84-5540



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