Ultra-Compact, Ultra-Thin CNC with Embedded Network Interface

FANUC Series 16*i*/18*i*/21*i*
FANUC Series 160*i*/180*i*/210*i*
FANUC Series 160*is*/180*is*/210*is*
MODEL B

GOOD DESIGN AWARD

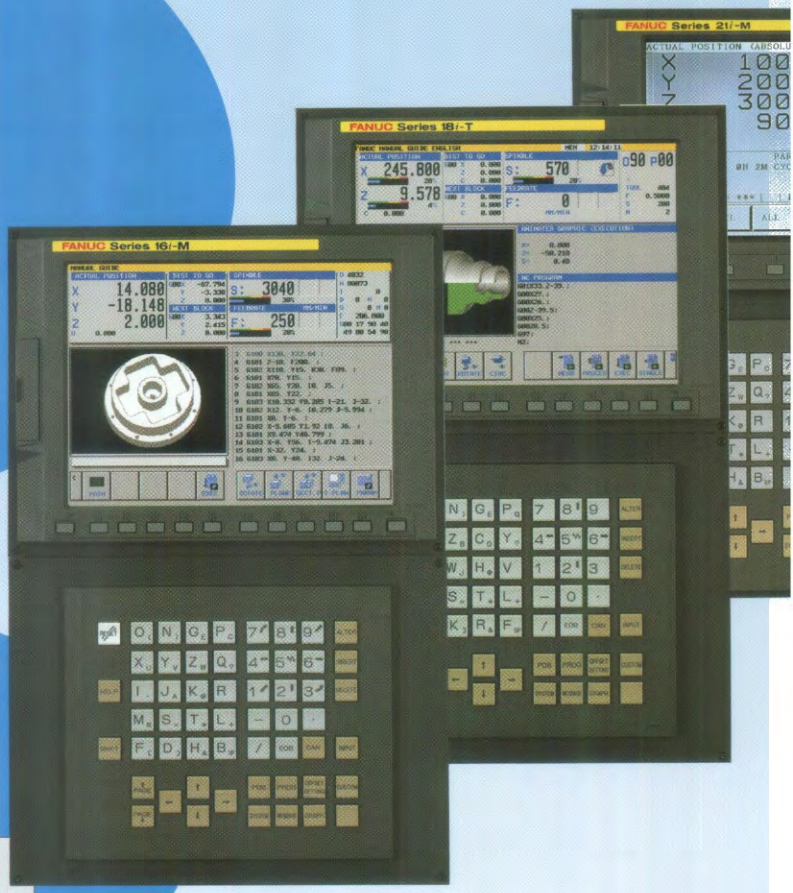
Ultra-Compact, Ultra-Thin CNC with Embedded Network Interface

FANUC Series 16*i*/18*i*/21*i*
FANUC Series 160*i*/180*i*/210*i*
FANUC Series 160*is*/180*is*/210*is*
MODEL B

FANUC Series 16*i*/18*i*/21*i* MODEL B is a series of ultra-compact, ultra-thin CNCs integrated with LCD displays and network features.

High Speed, High Precision and High Efficiency

- High Precision Nano CNC System
- State-of -the-Art Servo Technology (HRV control)
- High Performance PMC to Reduce Cycle Time

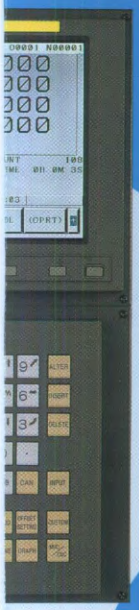


Versatile Network Function

- Ethernet Interface as Standard
- Integrated Supervising Software Package by Networking

Compact & Reduced Wiring

- Combined CNC and LCD Display
- Reduction of Cable by Ultra-High-Speed Serial Data Transfer
- Dual Safety Check Conformed with European Safety Standard



Operability & Maintainability

- Simple Operation Programming Support Tool
- Remote Diagnosis by Internet

Selectable with Application

- For versatile machine tools including machining center, lathe and many other applications.
- Maximum controllable axes: 4 to 20 axes

FANUC Series 16*i* : up to 20 axes control

FANUC Series 18*i* : up to 16 axes control

FANUC Series 21*i* : up to 8 axes control

OPEN CNC

- High performance OPEN CNC with Windows®2000
  FANUC Series 160*i*/180*i*/210*i*
- High reliability OPEN CNC with Windows®CE
  FANUC Series 160*is*/180*is*/210*is*

Machine Tool Customization

- C-language executor, embedded macro, etc.

Energy-Saving Servo System

- 1999 MITI Award for Energy-Saving Equipment

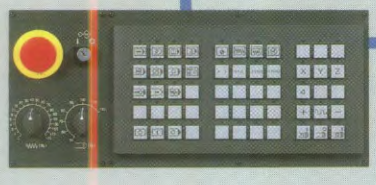
Advanced Technology on Hardware Configuration

Compact and Reduced Wiring

The amount of wiring cables is significantly reduced with an ultra high-speed communication function.

Operation Unit

LCD display incorporated CNC



Machine operator's panel

FANUC Serial Servo Bus (FSSB)

Optical fiber cable

The high-speed serial bus uses an optical fiber cable to connect between plural servo amplifiers and a CNC control unit.

FANUC I/O Link

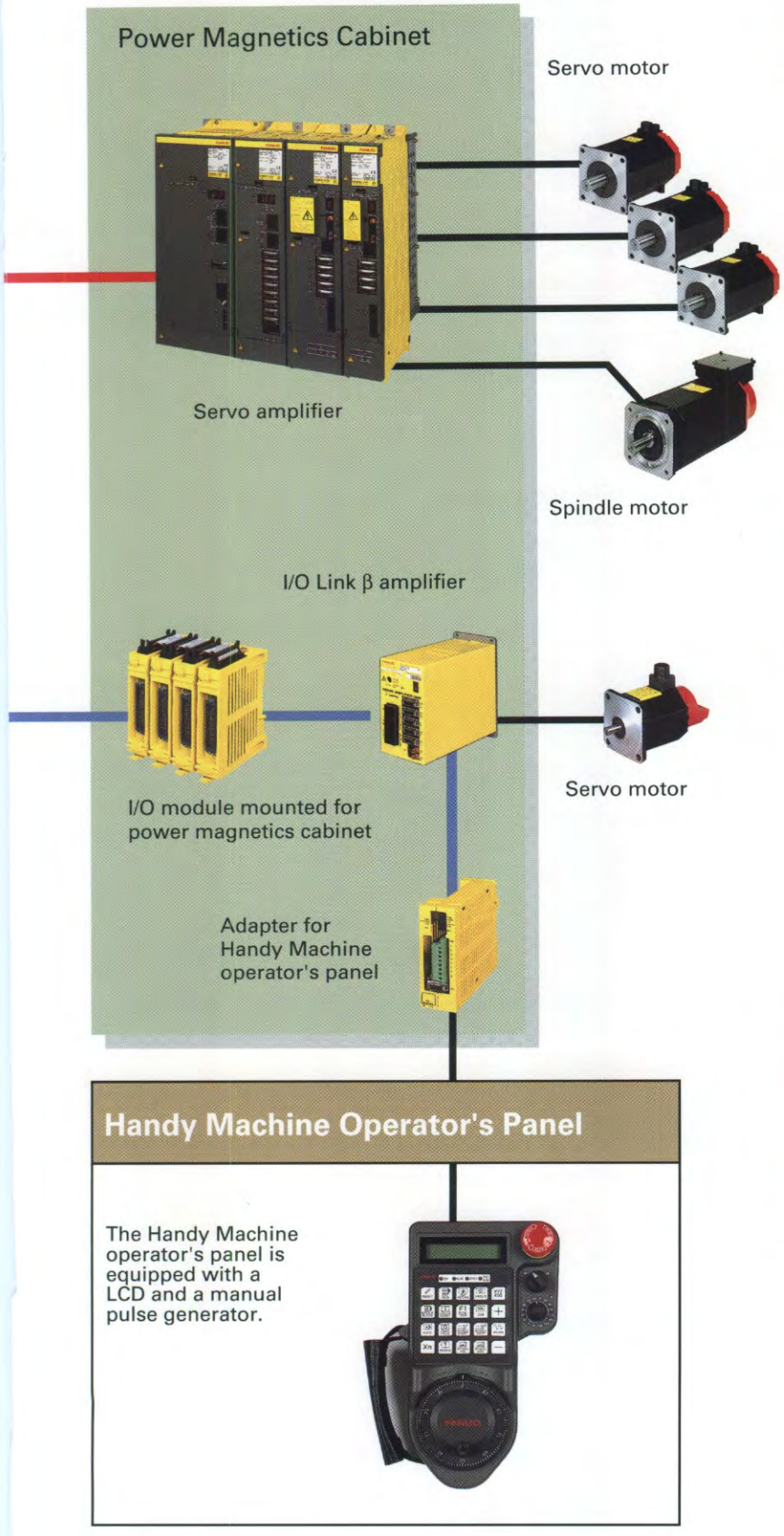
The FANUC I/O Link is an I/O network for connecting various I/O devices with the PMC.

Ultra Compact, Ultra Thin CNC

The small-size CNC printed circuit board is integrated behind the LCD display, thereby realizing a very thin CNC control unit with a depth of 60mm (for models without extension slot).

Highly Reliable Hardware

In cooperation with parts manufacturers, FANUC develops reliable parts that can endure a severe FA environment, and employs only those parts that have passed rigorous evaluation tests. FANUC adopts high-reliability techniques energetically, such as the use of ECC (Error Correction Code) in memory for part programs and in memory used for the applications of machine tool builders.



Handy Machine Operator's Panel

The Handy Machine operator's panel is equipped with a LCD and a manual pulse generator.

AC SERVO MOTOR αi-Series

Smooth rotation and quick acceleration

- Very small speed deviation, best suitable for axis feed in machine tools
- High precision feed with high resolution absolute pulse coder
- Quick response with state-of-the-art HRV (High Response Vector) Control

AC SPINDLE MOTOR αi-Series

High power at a high speed

- High speed, high power lineups, best suitable for spindles in machine tools
- Quick response, and stable speed regulation with HRV Control
- High speed spindle orientation, high speed, high precision rigid tapping

SERVO AMPLIFIER αi-Series

Compact and energy-saving

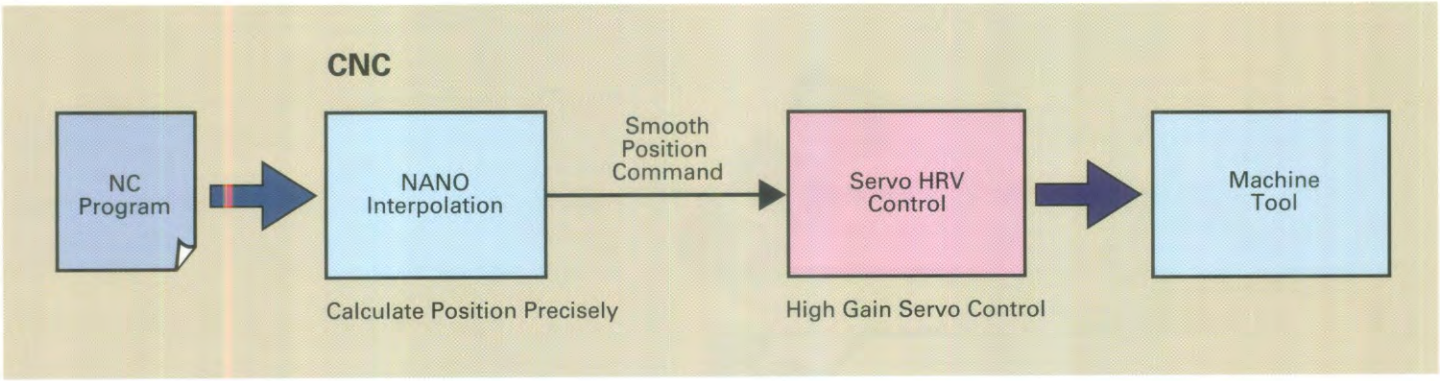
- Compact size with latest intelligent power device (IPM)
- Energy-saving by power regenerative control
- Excellent reliability, conforming to international standard

High Speed, High Precision and High Efficiency

High Precision Nano CNC System

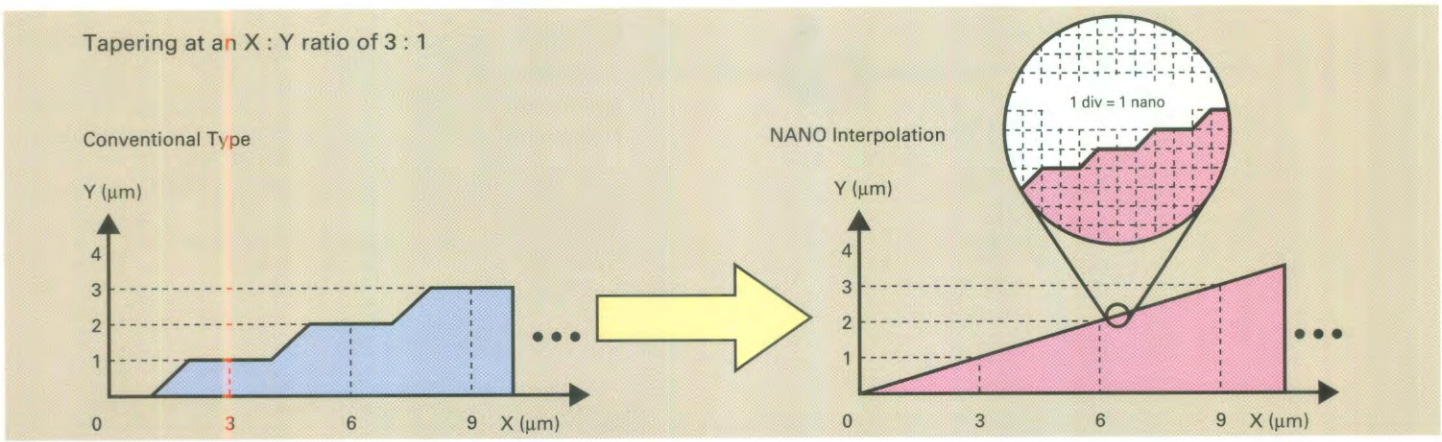
Nano CNC System (Series 16*i*-MB)

High precision machining is realized in cooperation with high speed and high precision servo control.



Nano Interpolation

This function calculates position commands to be sent to the digital servo system in nanometer units, even when the increment system of CNC is 1 μm. Since position commands are calculated in nanometer units, rather than rounded according to the increment system (least command increment), fluctuation of the commands to the digital servo system is minimized, thus allowing the machine tool to move smoothly and improving surface precision.



AI Nano High Precision Contour Control

By using a high-speed RISC processor, an optimum feedrate control can be performed in consideration of the performance of the machine while performing nano interpolation.

The acceleration can be set for individual axes separately, so that even a machine in which the inertia differs greatly depending on the axis can move efficiently.

- Smooth acceleration/deceleration over multiple blocks
- Control of the feedrate by automatically determining the specified shape
- Control of the feedrate so that the permissible acceleration of each axis is not exceeded
- Acceleration/deceleration that does not incur path errors (acceleration/deceleration before interpolation)

AI Nano Contour Control

Nano interpolation can be performed for linear and circular interpolations without special hardware.

AI High Precision Contour Control (Series 16*i*/18*i*-MB)

By using a high-speed RISC processor, an optimum feedrate control can be performed in consideration of the performance of the machine as same as AI nano high precision contour control. (Nano interpolation is not available.)

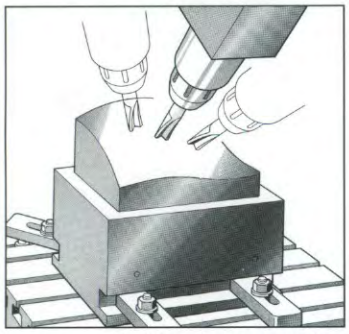
AI Contour Control (Series 16*i*/18*i*-MB)
AI Advanced Preview Control (Series 21*i*-MB)

By putting to practical use the know-how of high-precision contour control with RISC processor, the high-speed, high-precision machining is realized without special hardware.

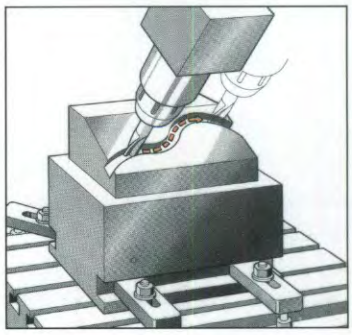
5-axis Machining Function (Series 16*i*-MB)

By using a high-speed RISC processor, complex machining with five axes including rotation axes can be performed more easily.

- Tool length compensation in the tool axis direction
  Even if the tool axis direction changes with the rotary head, tool length compensation can be performed in the tool axis direction.
- Tool center point control
  Even if the tool axis direction changes with the rotary head, the movement at the tool center point is controlled so that it follows the specified straight line.
- Three-dimensional cutter radius compensation
  Cutter radius compensation on a plane vertical to a slant tool, and leading edge offset are possible.
- Three-dimensional circular interpolation
  An arc on a slant plane can be specified.



Tool length compensation
in tool axis direction



3-dimensional cutter
radius compensation

NURBS Interpolation

When using CAD to design a mold die, NURBS is widely used to represent free-form curves. The CNC supports the programming of the NURBS curves.

- The CNC interpolates precisely NURBS curves so that a machined workpiece can approximate to the CAD-designed geometries.
- Compared with an NC part program where consecutive small line blocks are specified, the size of part program with NURBS is smaller and higher transfer rate from a host computer to the CNC is not required.
- NURBS interpolation, which supports 5 axes simultaneously, enables more complex machining of NURBS.

High Speed, High Precision and High Efficiency

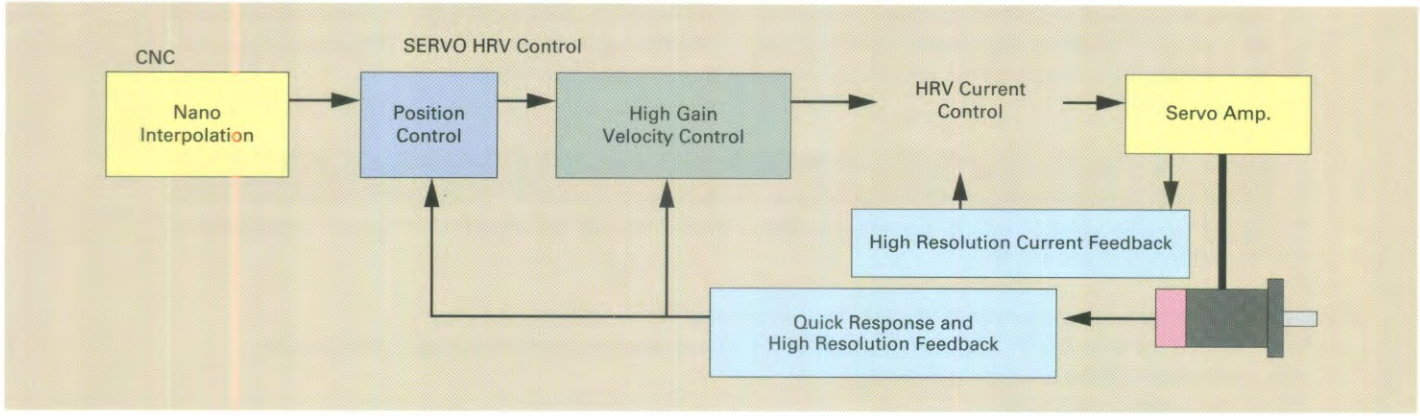
State-of-the-Art Servo Technology (HRV Control)

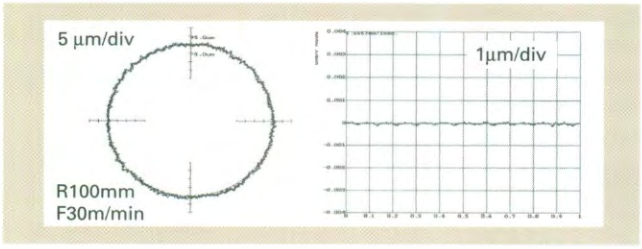
SERVO HRV Control

High speed and high precision servo control

In combination with smooth command by Nano CNC and SERVO HRV Control, higher speed and higher precision machining can be realized.

Control Block Diagram





High precision feed

Very smooth servo feed is realized by combination of the unique structure of servo motor, with high precision of current detection, high resolution pulse coder and high response servo control.

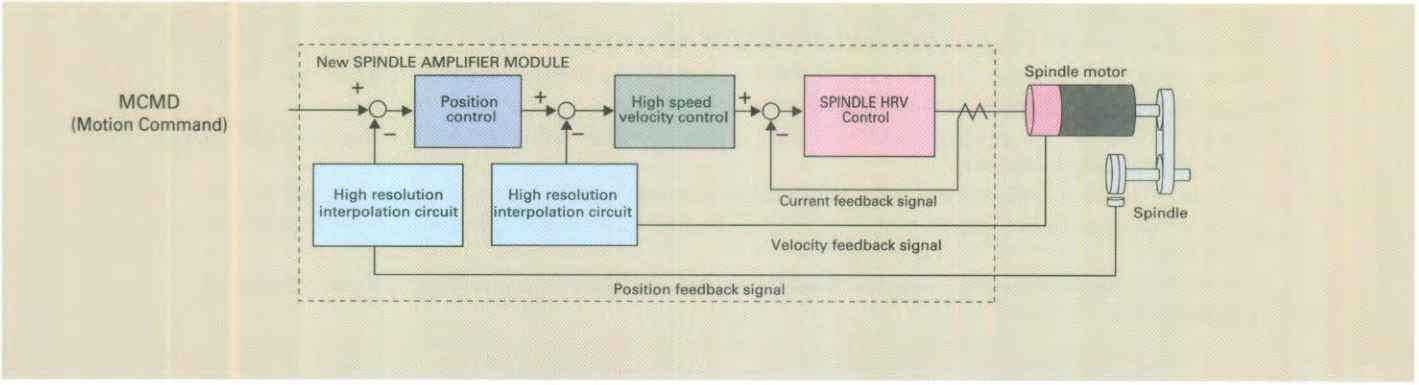
SPINDLE HRV Control

Quick acceleration and high response by SPINDLE HRV Control

High response and stability of the current loop are realized by using high speed DSP and advanced algorithm of current control (SPINDLE HRV Control). And high response and high precision control can be realized with faster control loop sampling time and high resolution detector circuit.

Controllability of C-axis contouring control is also enhanced.

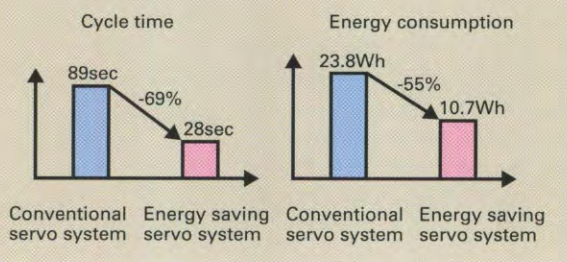
Control Block Diagram



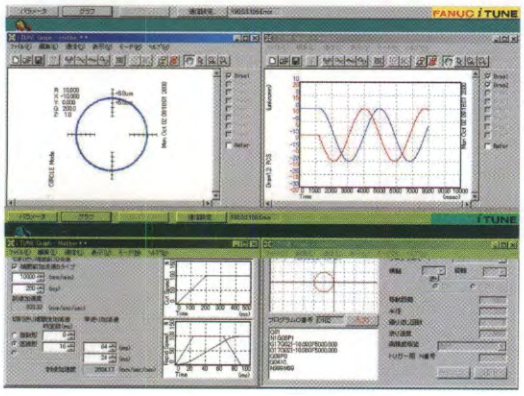
Energy-Saving

We promote the energy-saving of the servo system with "direct energy consumption reduction" by improving the efficiency of the servo system and "indirect energy consumption reduction" by shortening the cycle time with high speed and high acceleration control.

1999 Energy Saving prize-winning equipment by the Minister of International Trade and Industry.



Energy saving example
Work: Aluminium
5 deep holes
(dia. : 3mm, depth : 60mm)
5 tapping (M6, depth : 15mm)



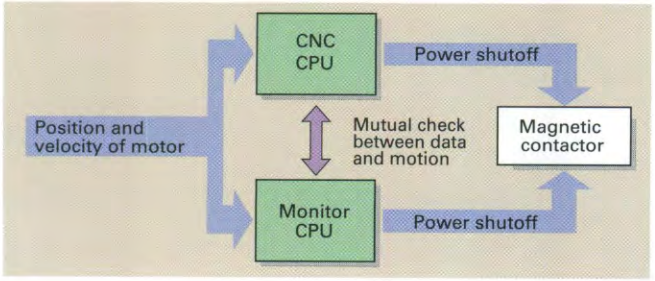
Servo Tuning Tool *i* TUNE

Quick and easy tuning for servo and spindle

This software provides the integrated environment to test programs, set parameters and measure data, needed for servo and spindle tuning.

Direct connection is possible between the PC and the CNC through a PCMCIA-LAN card, attached on the CNC front panel.

i TUNE allows a quick and easy optimization of servos and spindles.



Dual Check Safety

Dual Check Safety is an embedded safety function that conforms to European safety standards. By adding a processor dedicated to monitoring, the actual positions and speeds of the servo and the spindle motor and the I/O operations related to safety are monitored twice.

The safety function embedded in the CNC ensures conformance to safety standards without sacrificing the productivity of machining and without considerable cost increase.

High Efficiency Machining

High Performance PMC Reducing the Cycle Time

High Performance PMC Based on a Dedicated PMC Processor

Ladder and step-sequence programs are executed by a dedicated PMC processor. This architecture enables fast processing of large sequence control.

- Basic PMC instruction execution time: 0.033 μs/step
- Maximum ladder program size: 64,000 steps

High-speed Window Between CNC and PMC

Information can be exchanged between the CNC and PMC by means of a high-speed window. Using the window, functions unique to each machine tool builder can be incorporated.

FANUC I/O Link Capable of High-speed Data Transfer

The FANUC I/O Link is an I/O network used to establish a serial I/O connection of PMC with various I/O devices. Such as compact operator's panel I/O module, connection panel I/O module which does not require the connection cable and modular type FANUC I/O Unit-MODEL A. Up to 2048 DI points and up to 2048 DO points can be connected and used for control from the PMC.

Enriched PMC Diagnostic Functions

The CNC unit incorporates Ladder monitoring and editing functions as standard to improve its ease of use. The signal trace function has been improved to allow easy maintenance in the field.

PMC Program Development Environment Using Ethernet

By connecting the program development tool FAPT LADDER-III, which runs on a Windows® personal computer, with an Ethernet or RS-232-C communication port, Ladder programs can be monitored and edited through online remote operation. PMC program development tasks ranging from program creation to debugging can be performed in an integrated environment. The multi-window screen allows development of Ladder programs in an efficient way.

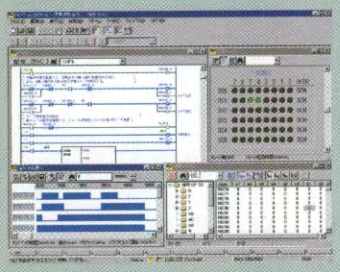
Programming Methods that Facilitate Customization

By dividing a large-scale Ladder program into modules of functional units using subprogram commands, the program can be designed with parts that can be used in common.

By programming with a step sequence function, a complex sequence control procedure can be divided into processes (steps) and transition conditions (transitions) so that it can be described with a flow chart. The movement of the object under control is represented by an easy-to-understand structured flow chart, thereby improving the efficiency of debugging and maintenance.

For advanced customization, programming in C language is possible. A 32-bit C language processor that runs in parallel with the PMC processor for ladder program execution can perform real-time multi-tasking.

Program development and maintenance using multi-window

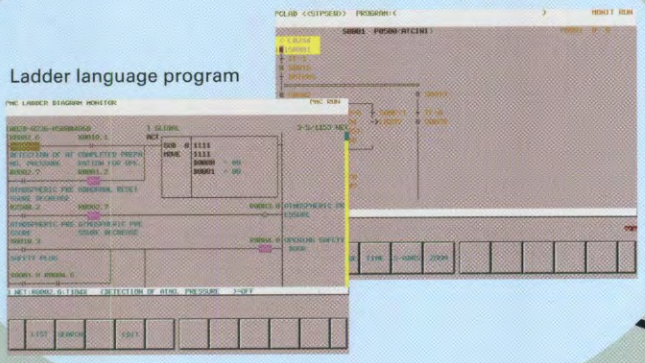


Environment for developing PMC programs using FAPT LADDER-III

Ethernet, RS-232C

Step sequence program

Ladder language program



PMC

PMC processor

32-bit C language processor

C language program

```
mode=*memc(K100);
memu();
while(i !=9999){
 if(model=20)&&(model=21)&&
cmd=pc rawio(key);
if(cmd!=0){
 cmd=cmd&0xof+mode;
 i=*(short*)key;
key(i+2)=" 0"
```

I/O Link

I/O Link β amplifier

Servo motor

Handy Machine operator's panel

Adapter

Connection panel I/O module

Operator's panel I/O module

Versatile Network Function

Ethernet Interface as Standard

With a full range of network functions and a variety of packages, it is possible to configure a system that is ideally suited to all machine tools.

Ethernet

Embedded Ethernet

Ethernet interface is standard. Either the embedded port of the main board or the PCMCIA slot can be used for this function. The networking of CNC is now easier than ever (option as for 21*i*).

FAPT LADDER-III and Servo Tuning Tool *i* TUNE can be connected easily.

Ethernet Board

Can serve various data to many PCs at higher speed, and at the same time.

Suitable for building the productive system where many machine tools and factory computers exchange data.

Data Server

A very large program for mold die machining, where the tool is moved through a vast number of very small increments, can be stored on a built-in ATA flash card or hard disk to enable faster machining.

Integrated Supervising Software Package
CIMPLICITY® HMI

Can easily manage many machine tools with a PC, displaying the machining status, reporting the running results and transferring part programs.

Furthermore, CIMPLICITY® HMI can easily develop the order-made user application system.

Field Network

FL-net

Control network conforming to OPCN-2, a standard based on Ethernet technology and established by Japan Electrical Manufacturers' Association (JEMA).

Suitable for controlling transfer lines, by having the capability of a high transfer-performance and cycle time guarantee.

PROFIBUS-DP

Field network conforming to the European Standard (EN50170), implementing fast I/O transfer at a speed of 12Mbps.

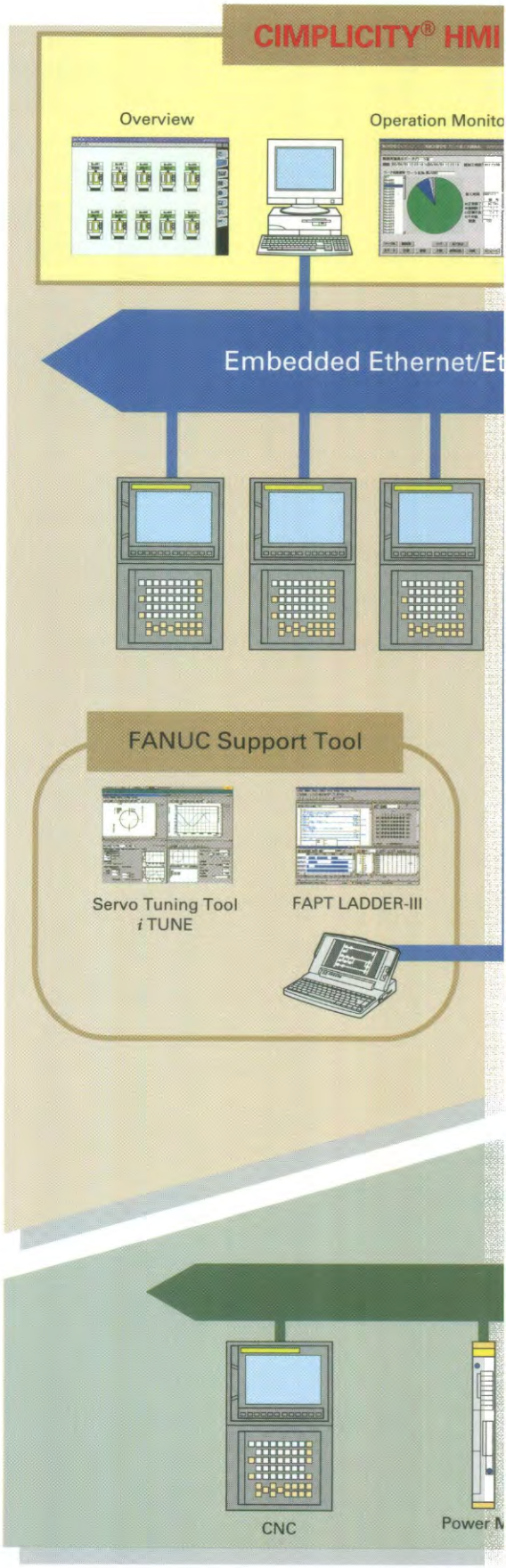
Enables connection of a CNC to FANUC robots and PLCs.

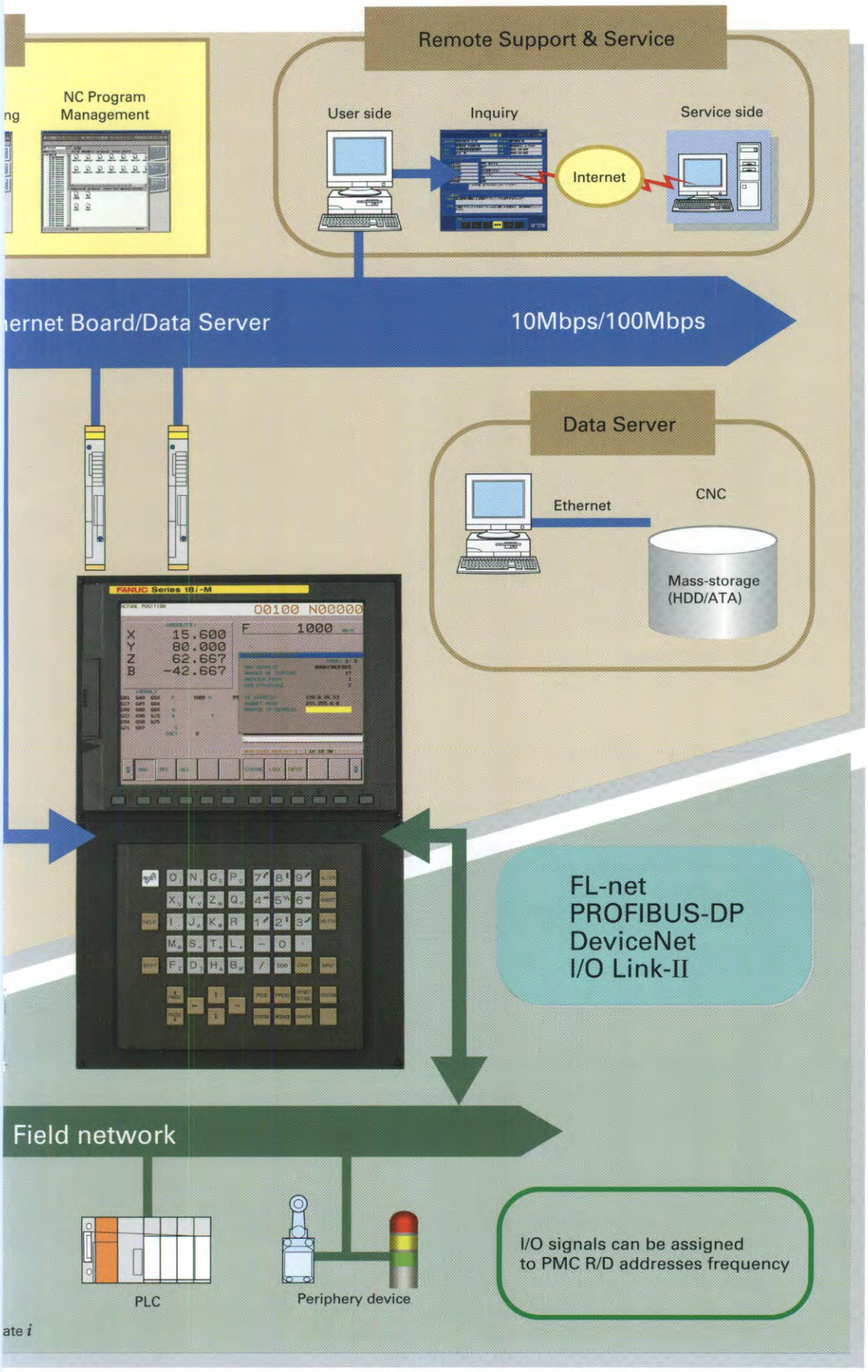
DeviceNet

Field network spreading world-wide, especially USA. Plenty of devices are corresponding to DeviceNet.

I/O Link-II

Implements I/O transfer conforming to OPCN-1, a standard established by JEMA.



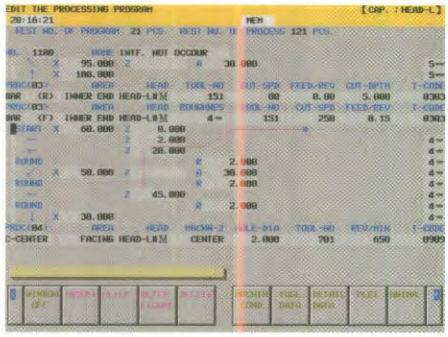

Remote Support & Service
NC Program Management
User side
Inquiry
Service side
Internet
ernet Board/Data Server
10Mbps/100Mbps
Data Server
Ethernet
CNC
Mass-storage (HDD/ATA)
FANUC Series 18i-M
00100 N00000
F 1000
X 15.600
Y 80.000
Z 62.667
B -42.667
FL-net
PROFIBUS-DP
DeviceNet
I/O Link-II
Field network
PLC
Periphery device
I/O signals can be assigned to PMC R/D addresses frequency

Operationability

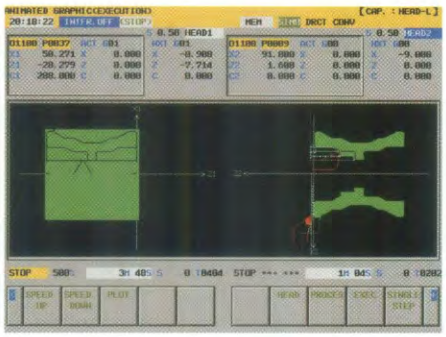
Simple Operation Programming Support Tool

Super CAP*i* T (for lathe)

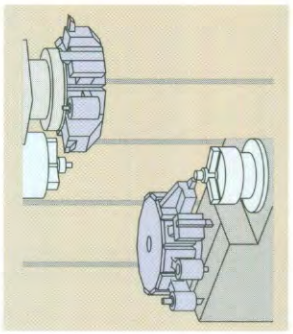
- A machining program is created by selecting a machining type.
- A setup guidance screen facilitates setup before machining.
- Automatic determination of tool, cutting condition and pretool for every process.
- Easy operation with window guidance.
- Direct operation of CAP program and ISO code generation.
- High speed and realistic animated simulation.
- Machining with C/Y axis and machining a slanted surface by rotary head are supported.
- 2-path and 3-path complex lathes are supported.



Program screen



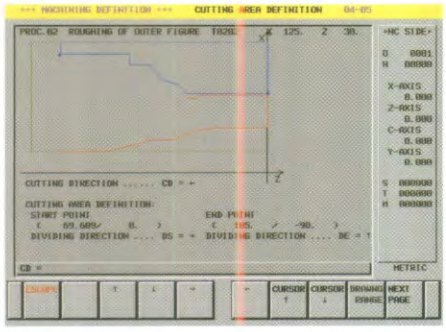
Animated screen for 2-path complex lathe



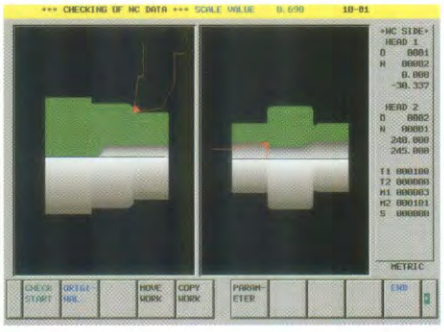
2-path complex lathe mechanical structure

Symbol CAP*i* T (for lathe)

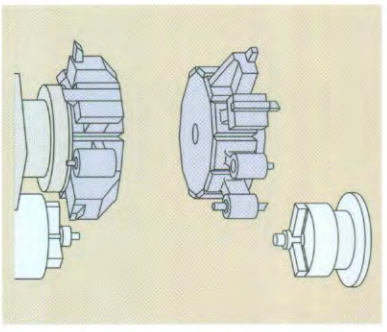
- A machining program is created by inputting a part profile only.
- Optimum cutting processes are determined automatically.
- Powerful profile input functions like a continuous groove input function, a batch input function for chamfering and figure element copy function.
- High speed and realistic animated simulation.
- Machining with C/Y axis and machining a slanted surface by rotary head are supported.
- 2-path complex lathes are supported.



Program screen



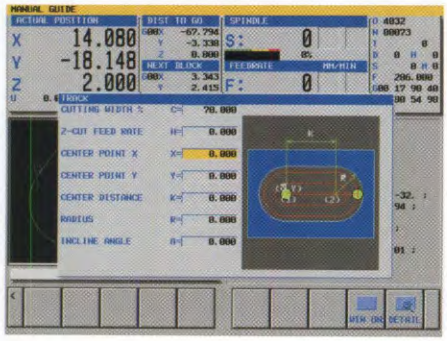
Animated screen for 2 opposing spindles lathe



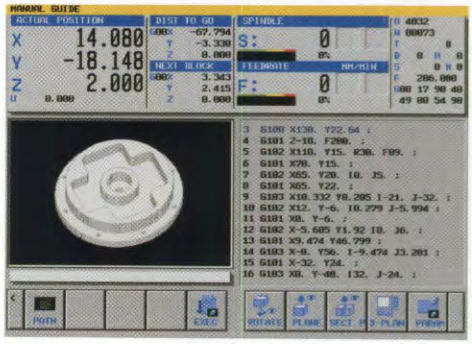
2 opposing spindles lathe mechanical structure

MANUAL GUIDE (for milling)

- All operation from programming to executing a program can be done on a screen.
- G code program in universal use is created easily by selecting icon menu soft-keys.
- Complicated machining is available by using abundant cycle machining such as Facing or Pocketing.
- Automatic work-piece measurement is available by using measurement cycle (option).
- High speed and realistic animated simulation with solid model.



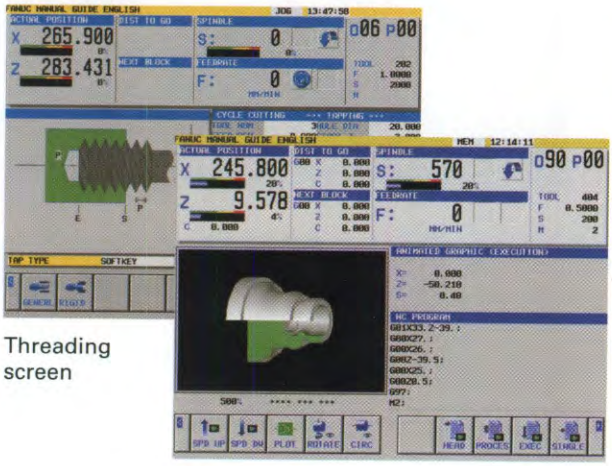
Program screen



Solid models animated screen

MANUAL GUIDE (for lathe)

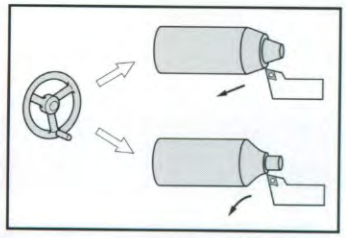
- All operation from programming to executing a program can be done on a screen.
- A rich choice of Machining menus, from simple machining to highly machining, are prepared.
- By using real and high speed Animated drawing, machining program can be checked easily.
- It is available for Back-side post lathe (option).
- Taper or arc figure can be machined easily by one handle.
- It is available for Lathe with C-axis (option).



Threading screen

Animated screen

Guidance screen of arc cutting

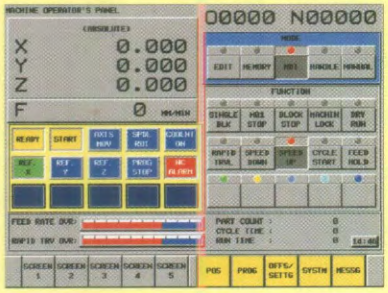


Taper and arc cutting by guidance handle

Operability and Maintainability

Remote Diagnosis by Internet

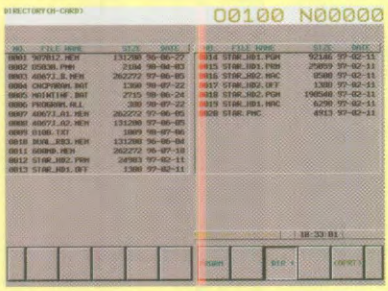
Touch Panel



Touching a key on the screen causes the corresponding function to be performed.

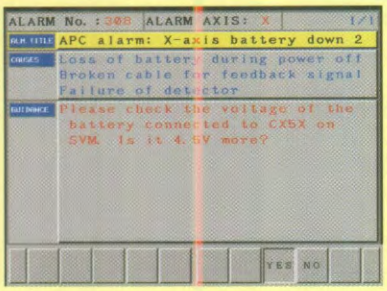
Note: This is machine operator's panel screen made by FAPT PICTURE.

Input/output by Memory Card



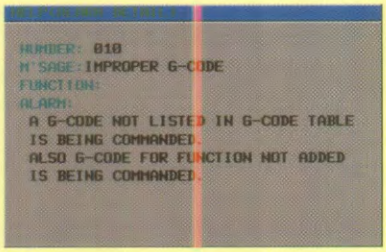
A wide range of data can be output to and input from the memory card installed on front of the LCD unit.

Trouble Diagnosis

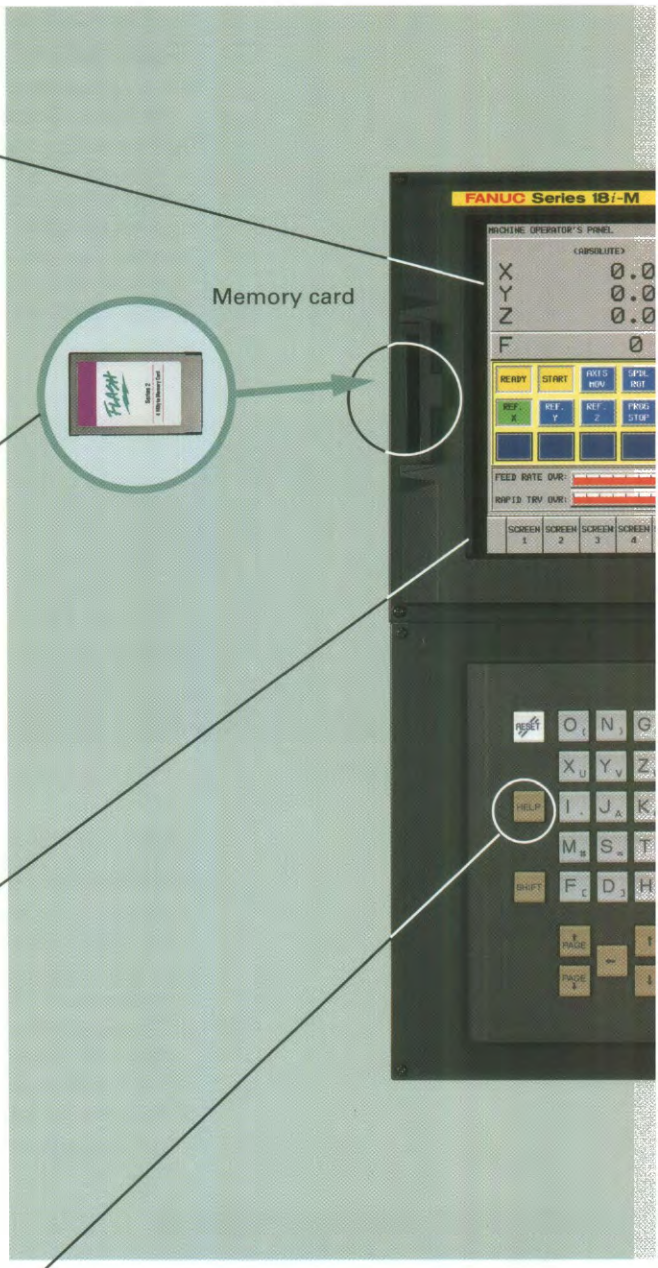


The cause of an alarm can be estimated in conversational mode. On the monitor screen, history of operation data collected before a servo/spindle alarm occurs, the amplifier and motor IDs, can be displayed.

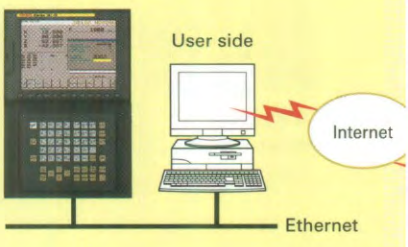
Help Screen

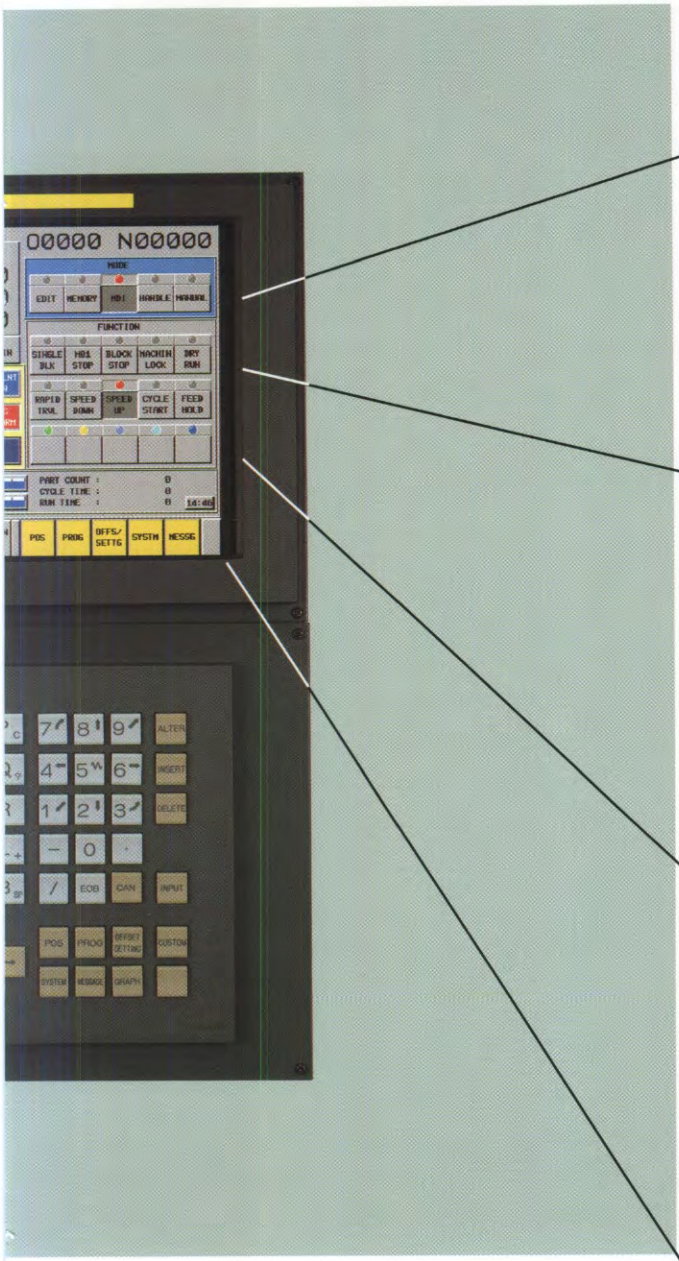


Details of alarm and required responses can be displayed. Moreover, a machine-specific help screen can be created.

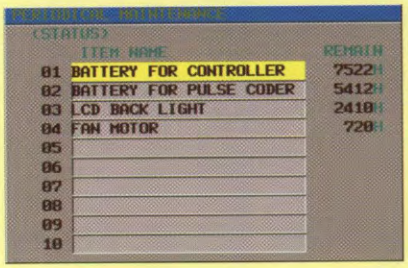


Remote diagnosis (through Interne



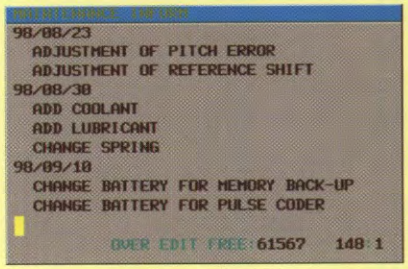


Periodical Maintenance Screen



The remaining lifetime of a part requiring regular replacement can be displayed.

Maintenance Information Screen

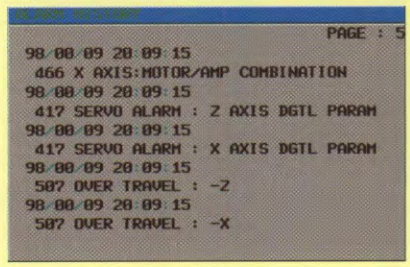


Information needed for machine maintenance can be stored.

Wave Display

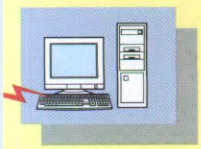
Servo adjustment is made easier by displaying the servo data waveforms.

Alarm History and Operation History



The analysis of the cause of any problem that may occur is made easy by recording all alarms and operator responses as they occur.

Service side



Maintenance information can be transmitted to service center over the Internet.

Machine Tool Customization

C Language Executer

Customizing screen display and operation

- Programming in C language.
- Machine tool builders can create their own unique screens. Such screens can be used in place of the standard CNC screens.
- Multiwindow display is supported.
- Operation screens can be created using the touch panel.
- The screen creation assist tool FAPT PICTURE makes it easy to create own screens, by arranging parts like buttons.

Macro Executer

Customizing the CNC function

- A user-friendly macro language is used for programming.
- Macros called using M and G codes can be created. For example, it is possible to create your own canned cycle or own measuring cycle.
- Machining program creation control and data input/output are supported.

Embedded Macro/One Touch Macro Call

Easy customizing CNC function

Embedded macros

- Allow programming in a familiar macro language.
- Can be edited on the CNC just like custom macro programs, thereby eliminating the need for development equipment such as a personal computer.
- When completed, custom macro programs are stored in memory for storage. Part program storage memory is not used.

One-touch macros

- Easily allow activation of macros created by machine tool builders, such as measurement and tool change macros, merely by operating on buttons.
- When combined with the FANUC-supplied, embedded milling cycle, allow easy addition of pocketing functions, etc.

PMC C Language

Customizing machine control

- Programming in C language.
- Multitasking can be implemented under the real-time OS.
- Applications closely related to ladder-controlled machine processes can be constructed.

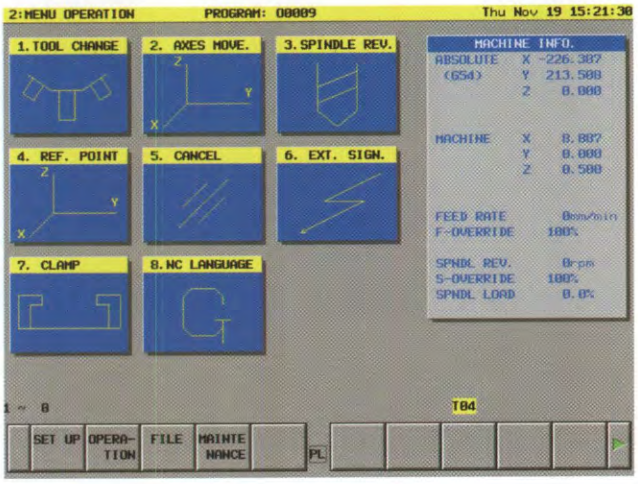
Customer's Board

Customizing real time function

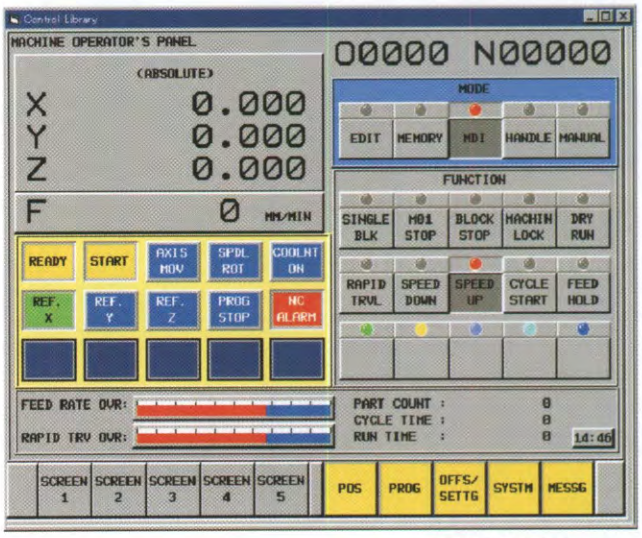
- Machine tool builders can create their own software which run on real-time by using a high-speed RISC processor.

Functions to Customize CNC Machine Tools and Realize MTB's Own Features Are Available.

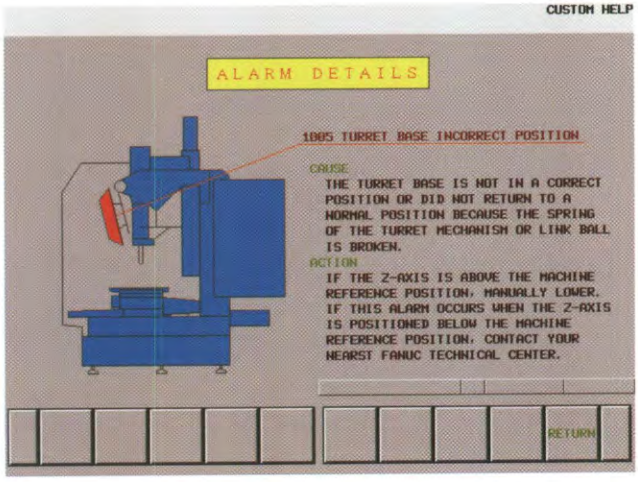
- Easy to see/operate CNC screen → C language executer
- Customizing machining and measuring cycle → Macro executer, Embedded macro, One-touch macro
- Customizing machine control such as tool management or peripheral control → PMC C language



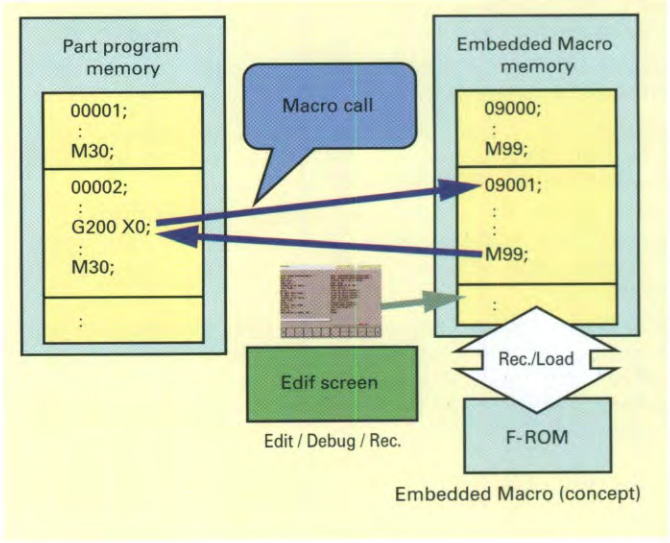
C language executer screen



FAPT PICTURE screen



Macro executer screen



Embedded Macro (concept)

OPEN CNC

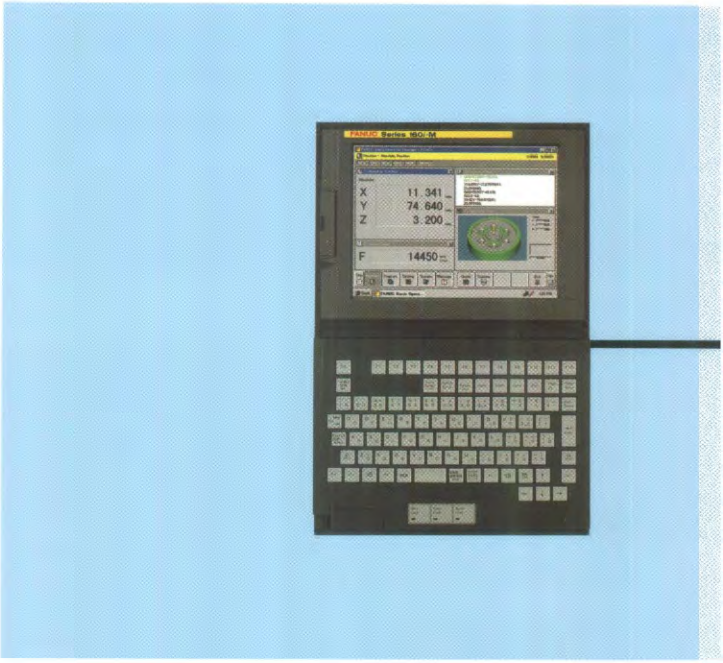
Optimum Combination of CNC and Personal Computer

Easy Customizing Machine Tools

FANUC OPEN CNCs realizes the optimum combination of CNC and personal computer by using a high-speed window, which enables a wide variety of data transfer at high-speed.

With the FANUC OPEN CNC, machine tool builders can easily implement unique functions and respond quickly to the demands of each customer.

For example, the CNC and machine can be operated using a personal computer's graphical user interface. And also, network functions can be used to exchange information, and database software can be used to manage tool files. By employing the most advanced personal computer functions, a machine tool can be turned into an intelligent machine.



High Performance OPEN CNC FANUC Series 160*i*/180*i*/210*i*

The FANUC Series 160*i*/180*i*/210*i* are high-performance OPEN CNCs with a Windows®2000 compatible GUI* function.

Because of compatibility with Windows®2000, they allow for the use of a variety of commercially available applications, thereby enabling machine tool builders to customize their machine tools and make them more intelligent and also allowing end users to customize their machine tools.

A configuration in which a display/operation unit with built-in personal computer functions, FANUC PANEL *i*, is used with a stand-alone type CNC is available. A configuration in which a commercially available personal computer is used is also available.

High Reliability OPEN CNC FANUC Series 160*is*/180*is*/210*is*

The FANUC Series 160*is*/180*is*/210*is* are high-reliability OPEN CNCs with a Windows®CE compatible GUI function.

Windows®CE is a compact operating system developed for embedded applications. It does not require a hard disk, ensuring high reliability in the field.

It is suitable for machine operator's panels created by machine tool builders. It is also suitable for embedding dedicated applications such as simple conversation applications.

An LCD-mounted type in which the CNC is integrated with personal computer functions is available, as well as a configuration with a display/operation unit with built-in personal computer functions, FANUC PANEL *is*, is used with a stand-alone type CNC.

*Graphical User Interface, GUI

Feature

Versatile commercially supplied application software and hardware are available

Application

Best fit for the field of using the flexibility of personal computer, such as tool file management by utilizing database software

OS

Windows®2000

Feature

Highly reliable at factory environment because of semiconductor memory

Application

Best fit for the embedded application for each machine which is made by MTBs, such as operator's panel, simple conversational system, display of manufacturing result, etc.

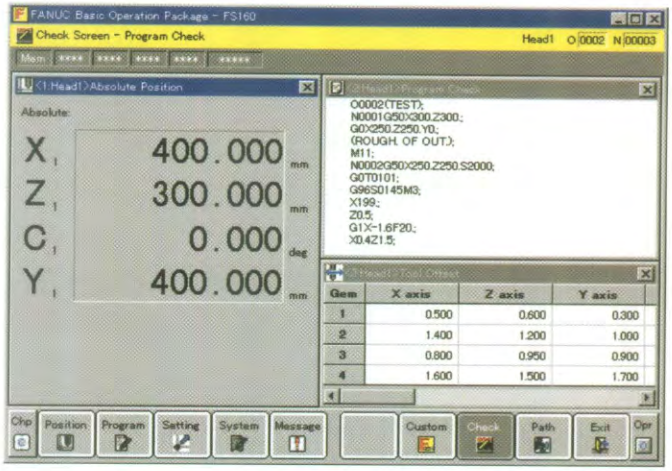
OS

Windows®CE

OPEN CNC

Application Software for OPEN CNC Capability

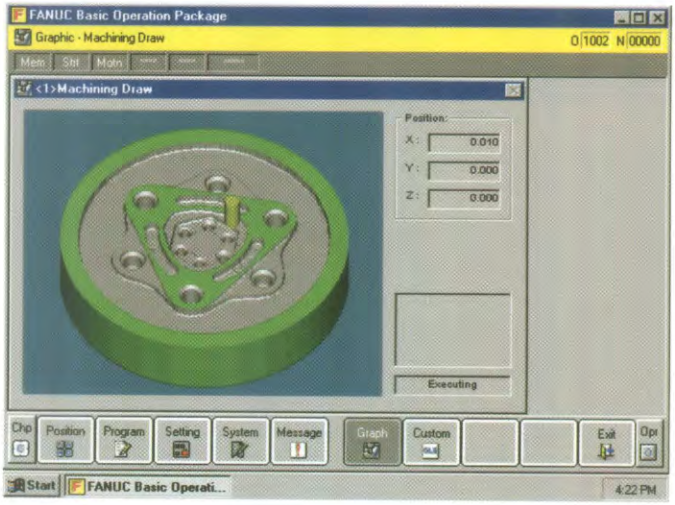
A range of convenient software programs are available for many machine tool applications. Therefore, the user does not have to create specific application software for most of the applications.

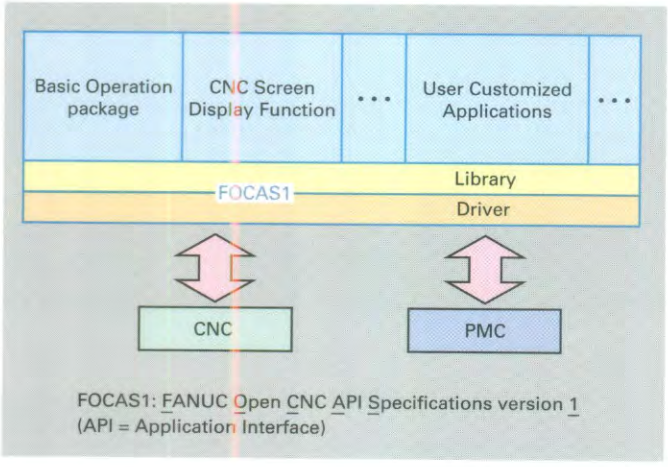


Software Configuration

FOCAS1 Driver and Library are provided to handle the data of CNC/PMC.

The users can make their own applications using FOCAS1 Library.

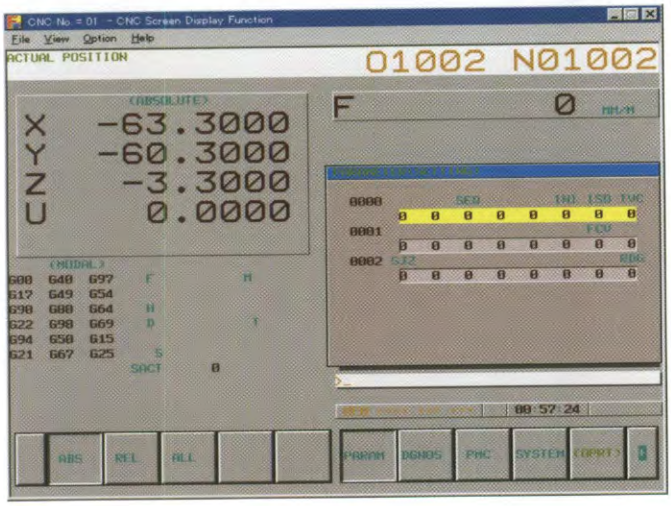


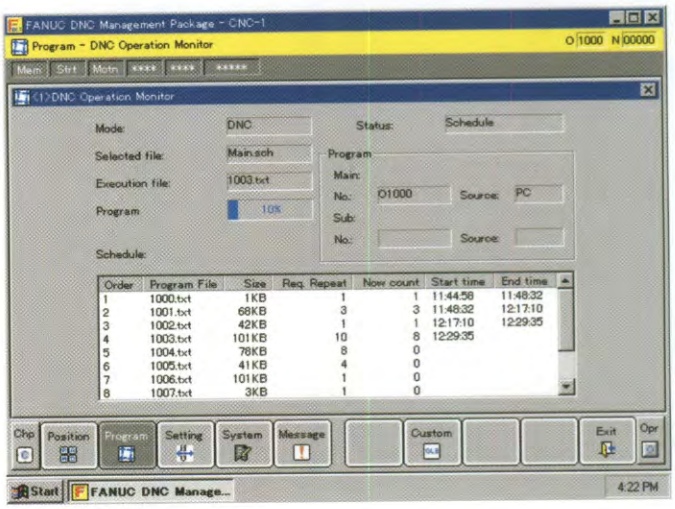


FOCAS1: FANUC Open CNC API Specifications version 1
(API = Application Interface)

CNC Basic Operation Package

This application software enables the user to do the display, input, and maintenance of CNC/PMC from the personal computer. Many screens such as status display, position display, program editing, and data setting are provided for the operator with the advanced user interface. "Milling Animation Function" is provided as an option. It enables the user to check the work machining status with the graphic drawing. This function is suitable for part program checks before machining or proceeding status checks during machining.
(Not available for *i* series)





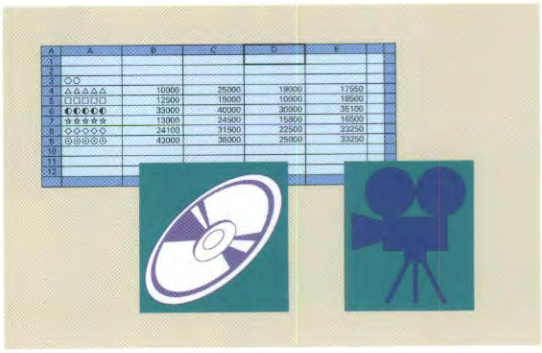
CNC Screen Display Function

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

- CNC control software screens
- PMC management software screens
- Macro executor screens
- C language executor screens
- PMC C language screens

DNC Operation Management Package

This application software enables to supply NC programs with very high-speed from a personal computer's HD into CNC. This software is very effective to die machining or piston lathe machining.
(Not available for *i*s series)



Commercially available software also supported

The FANUC OPEN CNC also allows various personal computer application software to be used.

Maintenance and Customer Support

Worldwide Customer Service and Support

FANUC offers customer service and support systems anywhere in the world through subsidiaries and affiliates. FANUC provides the highest quality service with the quickest response at the location nearest you.

Training

We offer structured training for machine tool builders, distributors and product end users. Training packages cover installation and maintenance, part programming, Conversational Automatic Programming (CAP), and PMC programming.

FANUC

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