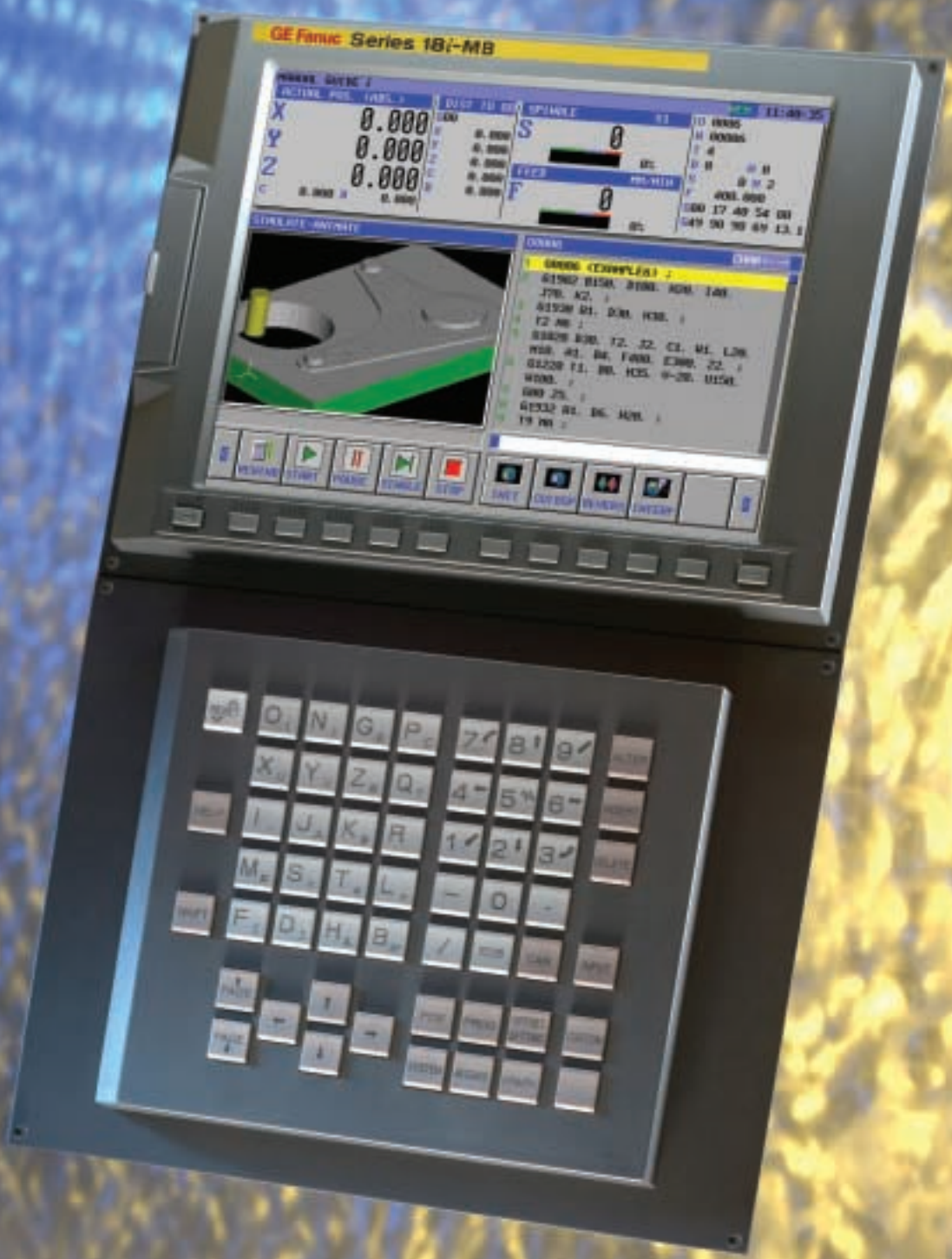
FANUC

i Series CNC

GE Fanuc Automation



www.gefanuc-europe.com

Precise, Fast and Reliable CNCs

CNC Controls from the Market Leader:

GE Fanuc Automation

was formed in 1986 as a joint venture by General Electric Co. (GE), USA, and FANUC Ltd, Japan. FANUC has had experience in production automation for more than 50 years and is the worldwide market leader in CNC technology. With its broad range of technology, manufacture, and services and roughly 300,000 employees, GE is one of the largest companies in the world.

FANUC and GE Fanuc develop and manufacture state-of-the-art automation products and solutions. The product range includes both entry-level and high-performance CNC products with high-speed functions, digitally controlled servomotors and spindle motors, and user-friendly operator interfaces.

Continuity in the interest of the user

Despite all the innovation with the latest hardware and software, FANUC has always maintained continuity in its product development. The installation dimensions have been maintained wherever possible to make the changeover to new control generations as easy as possible for machine manufacturers. Above all, FANUC has always kept end users in mind. Anybody who has learned to handle a FANUC or a GE Fanuc CNC is able to cope with subsequent models within an extremely short period of time – thus saving on training costs.

Precise, Fast, Reliable and Easy to Use

High degree of reliability

The high degree of quality and reliability of FANUC or GE Fanuc controls is already almost proverbial. Statistics have shown that their MTBF (mean time between failures) is 14 years: So when the machine tool is operating normally, a control-caused failure will occur statistically only once every 14 years. Users have confirmed this reliability in many surveys, and even the automotive industry – known for its extremely high requirements – uses FANUC or GE Fanuc controls all over the world. This failure statistic has been honoured with various awards by many machine tool manufacturers. Success is a mirror of reliability and quality. A total of over 1.4 million FANUC and GE Fanuc CNC controls have been distributed to date all over the world.

So many satisfied users cannot be mistaken

In the field of CNC controls, FANUC and GE Fanuc CNCs are the yardsticks against which all others are measured. The standard versions of FANUC or GE Fanuc CNCs cover all production applications, from the simple milling or turning machine to complex systems and machining centres. They control single or double turret lathes, grinding machines, laser machines, stamping machines and electro-erosion machines. Adaptation to the relevant machine is achieved using the extensive range of hardware and the individual software and operator control solutions.

Automation from one source

GE Fanuc offers not only controls but also amplifiers, motors, I/O modules, control panels, cables and software solutions, all from one and the same company. All of its CNC products are designed from the outset as a system and matched as a CNC package, so that the optimum performance is attained.
The user also gets customer service and warranty services from one source – worldwide.

FANUC has been the forerunner in this technology since the very beginning of CNC development:

- In 1956 FANUC developed the first NC in the non-military sector.
- In 1969 FANUC introduced the first fully modular CNC to the market.
- In 1985 FANUC presented the CNC 0 Series – to date this is the most commonly used CNC in the world with sales of over 400,000 controls.
- In 1997, the start of the *i* Series – the latest generation of high-precision, high-speed CNCs.
- In 1999 FANUC launched the *is* series onto the market, the first CNC with Windows® CE.
- In 2001 the *i* Series MODEL B was introduced, the first CNC with an Ethernet interface as standard.

Technology for Our Customer

Applications:

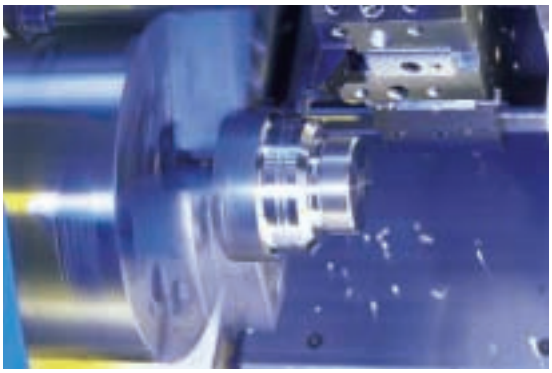
- Metal Working
- Wood, Marble and Glass Working
- Manufacturing Cells
- Laser, Water jet, Plasma and Glass Cutting
- EDM
- Handling
- etc.

Both machine tool manufacturers and end users profit from the leading-edge technology of the *i* Series CNC. Thanks to the integrated LCD, the modular controls are ultra-compact and ultra-flat. The CNCs are equipped with an Ethernet interface as standard and have optional PC functionalities.

Highly integrated circuitry developed in-house contributes towards miniaturisation and a low component count. This contributes considerably to our renowned reliability and dependability.

Thanks to the limited number of components, the design of the control enclosure is simplified and requires a minimum of wiring.

If the control and the monitor are separated, an optical fibre connection provides failure-proof data interchange at distances of up to 100 m.
A similar optical fibre connection can also be utilised between the control and the drives. Digital technology throughout ensures that any data transfer can be performed quickly and loss-free.



Speed and precision

- Nano CNC system
- High-speed precision machining
- High-speed PMC
- 5-axis machining
- NURBS

Operator friendliness

- Continuity in product development
- Ergonomic menu configuration
- Easy workshop programming

Openness and modularity

- Individual configuration
- Ethernet as standard
- Openness for components from other manufacturers

GE Fanuc Series 18i-MB
MANUAL GUIDE i
ACTUAL POS. (ABS.)
DIST TO GO
SPINDLE
FEED
MM/MIN
SIMULATE-ANIMATE
REWIND
START
PAUSE
SINGLE
STOP
RESET
ALTER
INSERT
HELP
DELETE
SHIFT
INPUT
CAN
POS
PROG
SYSTEM
MESSAGE
CUSTOM

Speed and Precision

High speed and precision are two terms that are fundamentally contradictory. The higher the speed, the more the precision decreases – and vice versa. Although GE Fanuc's developers cannot change this basic physical law, they have managed to jointly enhance speed and precision to a very high level. The functionalities of the *i* Series CNC make a contribution towards this.

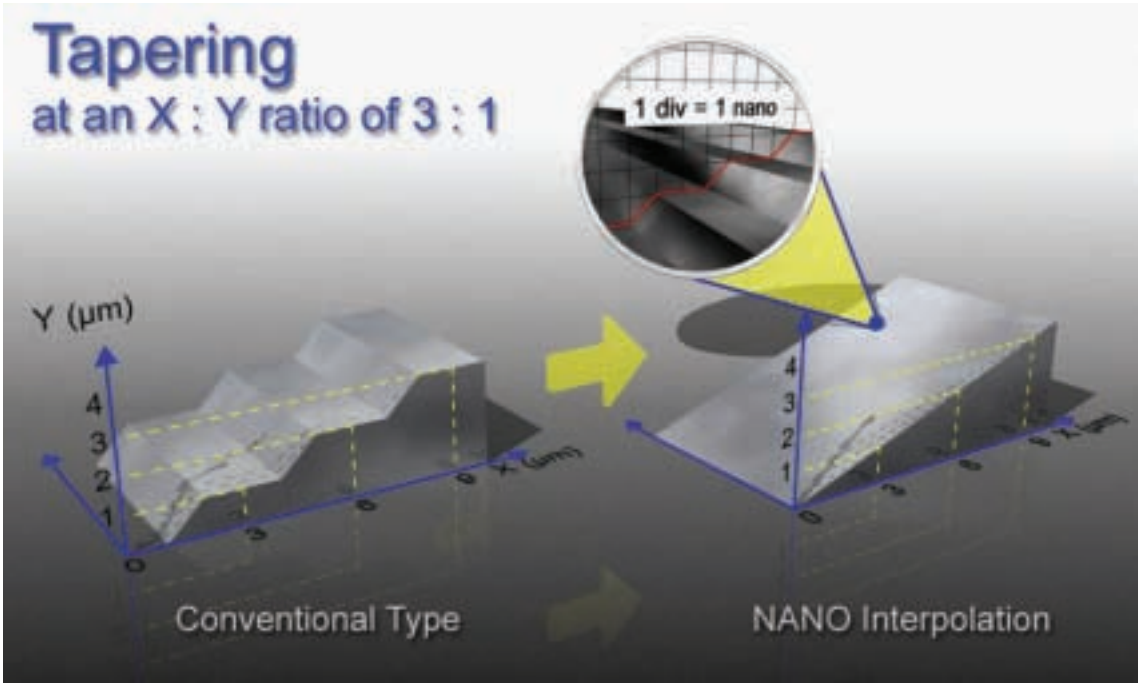
Nano CNC system

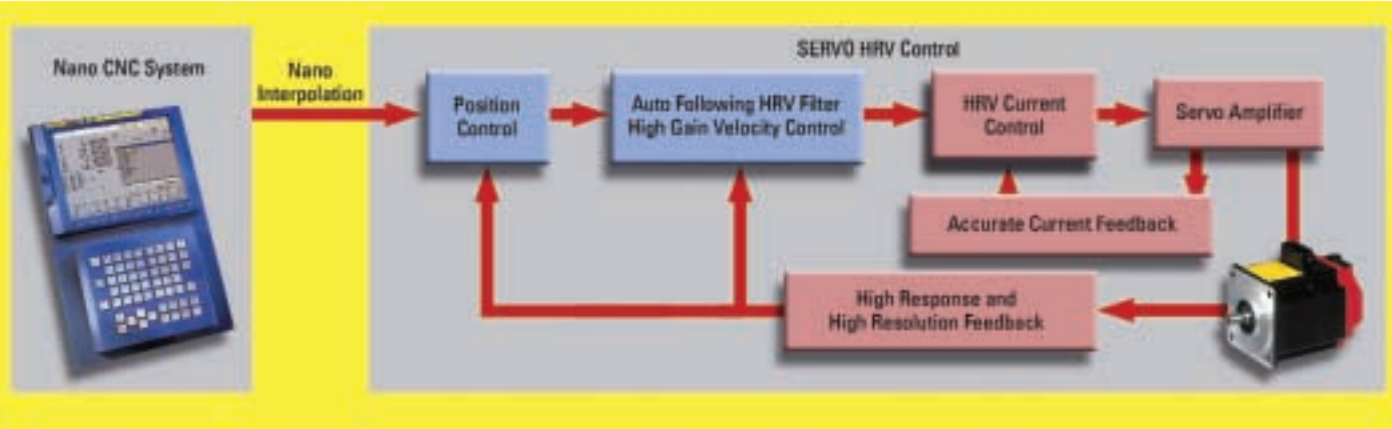
Nano interpolation is a highlight of the Series 16*i*/18*i*/18*i*-MB5 CNCs. This calculates the positioning commands for the digital precision servo-system with nanometre resolution. This interpolation, without rounding the Nano value to the smallest command increment, enables the digital system to track the tool path very accurately and smoothly thereby achieving a very high surface quality.

The High Response Vector control (HRV) servo-control, together with Nano interpolation, generate smooth motion resulting in high surface quality. These two features ensure a smooth servo-feed by exploiting servo-motor structure, exact current measurement, high-resolution pulse encoder (16,000,000/rev) and fast response servo-control. The HRV filter suppresses mechanical resonance and ensures a stable servo-system with high amplification.

Several resonance frequencies can be blocked. Fast Digital Signal Processor (DSPs) and advanced algorithms for automatic current control provide a fast response characteristic and stable current control circuit.

Shorter control loop sampling and a high-resolution detector contribute to the responsive and precise control system.





High-speed precision machining

In conjunction with a fast RISC processor, the AI Nano High-Precision Contour Control (AI Nano HPCC) allows machining with Nano interpolation at an optimal feedrate thus to fully exploiting the machine capabilities.

With AI Nano HPCC, the acceleration values for the individual axes can be set separately, thus considering the differing inertia of the different axes. This results in smooth acceleration and deceleration resulting in a significantly reduced path error. Further the feedrate adapts itself automatically to the programmed contour. Although the motion always remains within the acceleration ranges permitted for each axis.

The jerk control is another function that ensures smooth motion and therefore high surface quality. Contours with sudden changes in direction, force sudden change in acceleration, causing mechanical shock. Jerk Control smoothens such awkward transitions by smoothing the acceleration profile, thus reducing the shock.

The smooth motion especially at the region of block transitions results in smooth motion and therefore an improved surface quality.

High-speed PMC

The Programmable Machine Control (PMC) is very important in relation to high speed. A specific PMC processor is used in the *i* series CNC, processing even extensive control sequences at lightning speed. The execution time for PMC basic commands is 0.033µs per instruction step.

The CNC and PMC interchange information via a high-speed interface through which custom functions can also be integrated. The CNC now has, as standard, ladder diagram monitoring and editing functions for easier interplay with the PMC.

In addition, the improved signal tracking function allows problem-free maintenance on site.

Easy Handling of 5-Axis Machining

The Series 16*i*-MB / 18*i*-MB5 CNCs support 5-axis machining in an inclined plane. Further, with the aid of a fast RISC processor they also support simultaneous 5-axis machining.

All standard machine configurations are supported. The machine tool can rotate the tool head, the rotary table or a combination of the two.

5-Axis Machining Highlights

- The rotational axes can be controlled and commanded easily to position the tool vertically to the inclined machining plane.
- Tool Centre Point control (TCP) (Tool length Compensation for simultaneous 5-axis machining): If the direction of the tool axis changes, the movement at the tool centre point is controlled in such a way that the tool centre point follows the programmed curve.
- The user can set a tool at a specific angle to the surface (Draft Angle) to avoid the zero speed zone of a spherical cutter.
- Three-dimensional cutter radius compensation enables the control system to compensate the milling cutter radius in a plane that runs vertically to the inclined tool direction. For Head Type machine configurations, it also compensates the leading edge of an inclined tool motion.
- An arc or an helix can be specified in the inclined plane, and for 5-axis simultaneous machining.
- The user can manually traverse the tool without difficulty by advancing it via a handwheel or in Jog mode along an inclined surface with the tool being vertically to that surface. This allows to retract the tool in tool direction, manually via jog mode or handwheel. The tool can be rotated manually around its tool centre point.

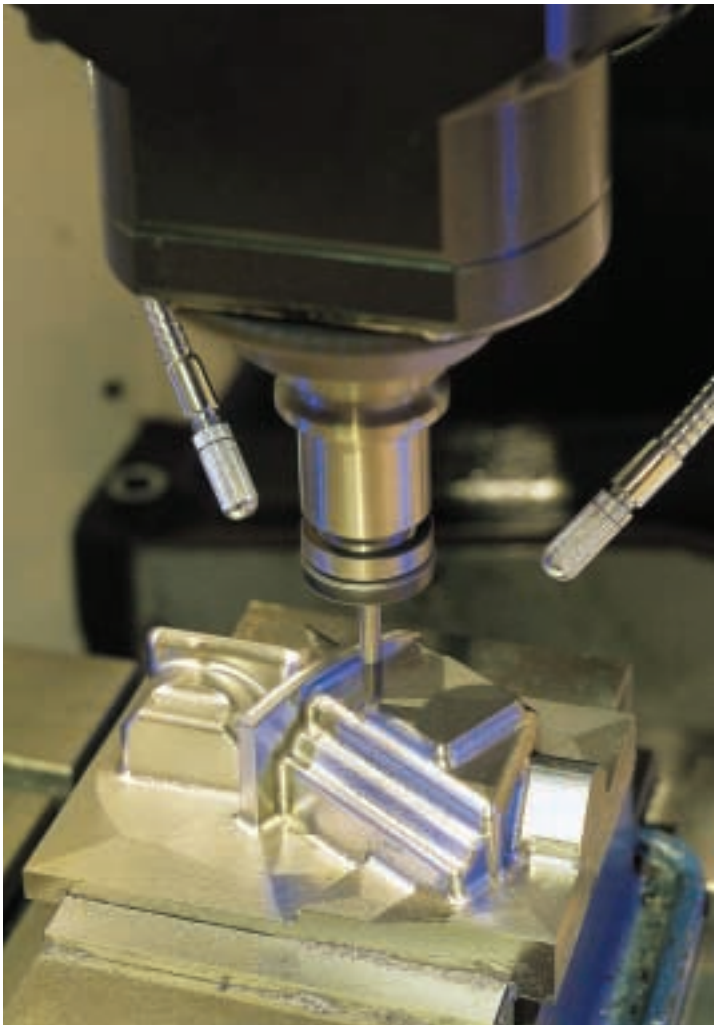
NURBS

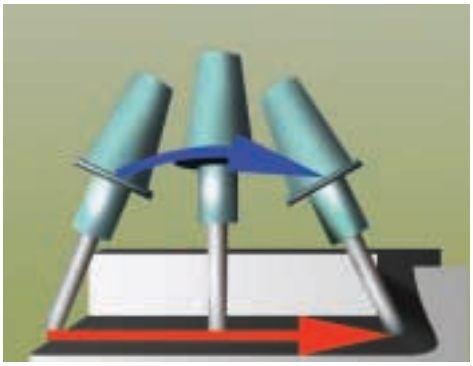
The Series 16*i*/18*i*/18*i*-MB5 CNCs provide the facility to use NURBS curves. NURBS present the original shape very accurately, since most CAD systems often store their geometrical data in a NURBS format.

Using NURBS allows to exploit their mathematical properties such as continuous transition among blocks. This reduces the jerk – mechanical shock – and ensure smooth, uniform surfaces. As a side effect this also can increase tool and machine life.

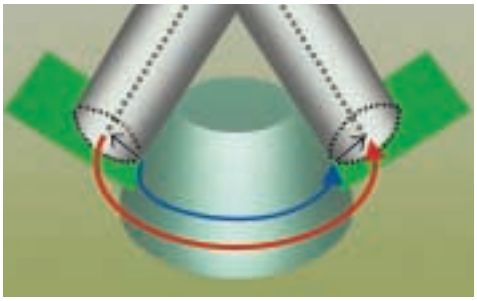
In comparison to an NC part program consisting of consecutive small program blocks, a NURBS part program is distinctly smaller. A higher transfer rate from host computer to CNC is not required.

NURBS interpolation supports up to five axis simultaneously and enables extremely complex machining operations.





Tool center point control for 5-axis machining



Tool radius compensation for 5-axis machining

Operator Friendliness and Easy Maintenance

A modern CNC must have a high-performance capability and at the same time must be easy to operate. Even the standard products of the *i* Series CNC provide an operator interface that is simply structured and self-explanatory. Anybody who has a command of one FANUC or GE Fanuc CNC is also able to cope with any other model. Continuity in further development ensures this.
In all modernisation measures, such as touch screens, embossed keys etc., the operator control concept has been retained so that extensive training courses are unnecessary.

Easy machine preparation

Easy handling begins with preparation of the machine. A single screen enables convenient setting of the parameters for machining, depending on the relevant machine configuration.

For workpiece setup, a selected screen provides simple instructions, according to which, the user can calibrate the measuring sensor and then measure the position, surfaces, angle, etc., on the part.

Programming

The user has several ways of producing a NC program. Simple programs can be generated without difficulty via the standard screens. These operator interfaces are also suitable for quickly and easily checking and amending existing programs.

If the machining becomes more complicated, the user frequently prefers the assistance of a CAD/CAM software system. The NC program, which is produced in an external computer, can be transferred via a DNC connection or data carrier to the control unit.

Particularly popular is the interface, available on the display unit, for a PCMCIA memory card. This can be used for data input and output.

Workshop programming also has many friends, for which GE Fanuc offers special software. The highlight is the Manual Guide *i*. In version *i*, the developers have united the functionalities of the two predecessor versions, T (turning) and M (milling). With Manual Guide *i*, the user can now configure software for a turning, milling or compound machine.

Manual Guide *i* is a cycle control with a simplified CNC operator interface used to program cycles. Various functionalities are available to make communication as easy as possible.

- All relevant information is on a single CNC screen, so the user does not have to switch constantly between several screens and get lost at some stage in all the pop-up windows.
- Intuitive working is ensured via icons so that even a skilled worker is in a position, without any special CNC programming experience, to be able to write a program without any documentation whatsoever.
- The user can graphically and interactively construct on-screen the part to be machined, and simulate it in the volume model.
- He can also edit the NC programs with a word processing program and cut or paste random program segments.
- In addition, comments are displayed to him on the bottom area of the screen relating to the G and M codes marked by the cursor.

Maintenance friendliness

Easy handling of the CNC includes practical maintenance and service tools. The maintenance-friendly *i* Series CNC puts extensive tools at the disposal of the user:

- On the regular maintenance screen the user can display the remaining service life of the machine components that have to be regularly replaced.
- He can file and call up information on the maintenance information screen.
- If any faults occur, a well arranged alarm and process data archive allows system diagnosis and convenient troubleshooting.
- Alarms can be polled in a dialogue on the error diagnosis screen. This is also applies to the servo-alarms and spindle alarms.
- A Help screen provides alarm-related detailed information and the relevant diagnostics. These Help screens can be produced and adapted machine-specifically by the machine manufacturer. And if you are at your wits' end, you can always resort to the remote monitoring– provided that the control has an Internet connection.
- At our service centre, experts will analyse the problem and can frequently help out from afar. If a service call out is necessary, the service engineer receives important information so that he can select the right parts and optimally prepare his visit.

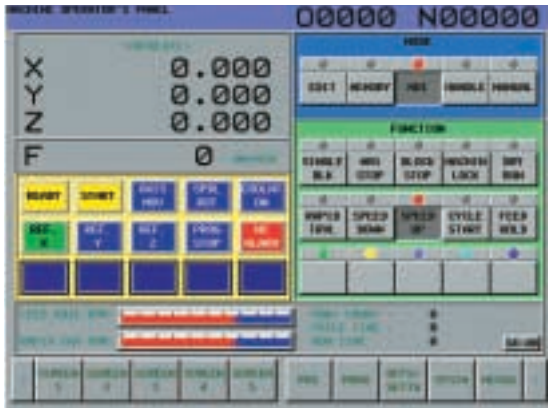
Openness and Modularity

A CNC-controlled machine tool requires close collaboration between the machine tool and control manufacturer for optimum performance. GE Fanuc therefore offers the machine tool manufacturer the possibility of configuring the control's operator interface to suit his own needs and to introduce his own functions. GE Fanuc has not only made the controls open for this purpose, but also offers support on various levels. The result is the increased user friendliness of the machine tool.

Customised adaptation

Screen display and operator control: Via C-EXECUTER the machine-tool manufacturer can create his own special screens, which can be used instead of the standard CNC screens. The programming language is C.

The FANUC PICTURE program supports the user in compiling his own screens by arranging components as graphical elements.



CNC functions: Machine tool manufacturers can generate custom library of macros that use M and G codes. In this way they can provide their users with fixed cycles that can be called off at the press of a button.

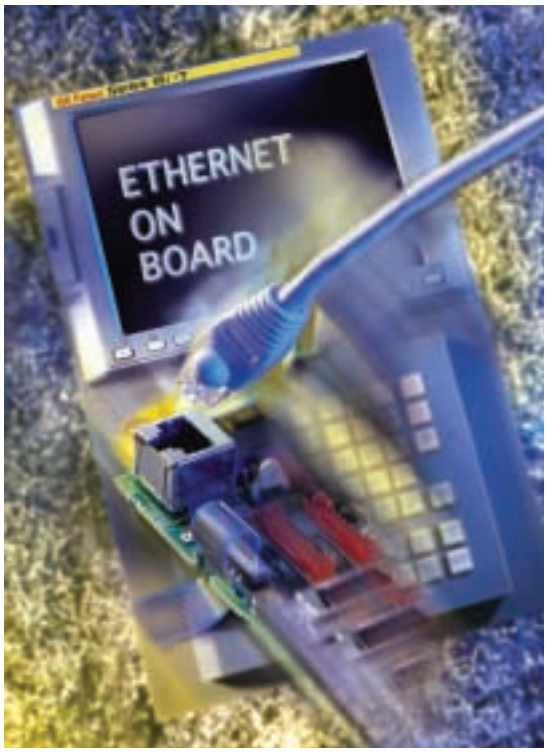
PMC programming: Machine tool manufacturers can also influence the machine control. For example, they can develop applications that are modelled on structured sequences of ladder logic.

Ethernet as standard

GE Fanuc has performed pioneer work in the field of the network capability of CNCs. Since 2001 the *i* Series MODEL B has been equipped with an Ethernet interface as standard. Network connection is available either via the integrated Ethernet interface or via a PCMCIA card.

The interchange of large volumes of data via Fast Ethernet (up to 100Mb/s) is possible simultaneously between several computers. This is of particular importance for data communication between production plants and the host computer of a manufacturing plant.

Large NC programs, used for the machining of free-formed surfaces, are transferred with Ethernet and are stored on a built-in ATA flash card or hard disk and are executed at a high processing speed.



Open CNC

The *i* Series Open CNC is what its name states. It is the optimum combination of a CNC and a computer via a serial high-speed interface, enabling the transfer of large volumes of data. With it, GE Fanuc supports individual applications on special machines that have to be matched to special customer requirements by the machine tool manufacturers.

The *i* Series Open CNC allows individual operator control of CNC machine tools via a graphic user interface (GUI), the interchange of large data volumes via networks, tool file management via a database, and a lot more.

The *i* Series Open CNC is available with two types of operating system, Windows® or Windows® CE.

The Series 160*i*/180*i*/210*i* CNC consist of a stand-alone CNC with a Windows® computer which is connected to the CNC display via a high-speed optical fibre interface (HSSB).

The Series 160*is*/180*is*/210*is* CNCs are open CNCs with Windows® CE. This compact operating system makes do without a hard disk and for this very reason provides extreme reliability in harsh deployment conditions. These controls are available either as an integrated CNC complete with a CNC display or as a stand-alone version. Here again the Windows® CE computer is connected to the CNC via a high-speed optical fibre interface (HSSB).

Open communication

The *i* Series CNC controls are open at field level. Many I/O components can be integrated via commonly available bus systems (FL-net, PROFIBUS-DP, DeviceNet, I/O Link II).

Safety inside

Dual Check Safety is the safety function integrated into the CNC in accordance with the European safety standard. A special processor for the monitoring of safety-related parameters tracks the actual position and speed of the servomotors, spindle motors and of the I/O interface, and by means of its redundancy ensures system of its safety.

Technical Data

Model Available	16*i*/160*i*/160*is* MB/TB/LB/PB/LPB/WB	18*i*/180*i*/180*is* MB/MB5/TB/LB/PB/WB
Max. Controlled Axes (Machine Axes x Paths + Loader)	20	20
Machine Controlled Axes	8	8
Simultaneous Controlled Axes	6	4 (5 for MB5)
Controlled Path	3	2
Loader Control Axes	4	4
Max. Spindle Control	4	3
Power Mate CNC Manager for additional Axes on I/O LINK	●	●
PMC Systems	SB7 or SD7	SB7 or SD7
µs per Step	0,0033	0,0033
Max. Steps	64 000	64 000
Max. DI/DO Points	2,048/2,048	2,048/2,048
Panel Mount I/O Modules	●	●
Decentralized Fieldbus I/O Modules	●	●
Part Program Storage Length	2,048 KB (5,120m)	1,024 KB (2,560m)
Maximum Resolution 0.0001mm, 0.0001deg, 0.00001inch	●	●
Maximum Resolution 0.00001mm, 0.00001deg, 0.000001inch	●	●
Number of Expansion Slots Available (LCD Mounted Version)	0, 2, 3 or 4	0, 2, 3 or 4
Number of Expansion Slots Available (Standalone Version)	1 or 3	1 or 3
Expansion Slot Option Boards Available	64 Bit RISC Processor RISC Processor/Data Server Sub-CPU PMC C Language Loader Control Data Server/ATA Interface HSSB PROFIBUS DP DeviceNet Fast Ethernet I/O Link II FL-Net Serial Communication Analogue Input Board	64 Bit RISC Processor RISC Processor/Data Server Sub-CPU PMC C Language Loader Control Data Server/ATA Interface HSSB PROFIBUS DP DeviceNet Fast Ethernet I/O Link II FL-Net Serial Communication Analogue Input Board
Ethernet on Board	●	●
Open CNC System	● (160*i*/160*is*)	● (180*i*/180*is*)
Communications	RS232 DNC1, DNC2 Ethernet PROFIBUS-DP DeviceNet I/O Link II FL-Net	RS232 DNC1, DNC2 Ethernet PROFIBUS-DP DeviceNet I/O Link II FL-Net
Front Access PCMCIA Slot	Memory Card Ethernet Card Modem Card	Memory Card Ethernet Card Modem Card
Standard Display		
Monochrome LCD Screen	7.2" or 9.5"	7.2" or 9.5"
Color TFT LCD Screen	8.4" or 10.4"	8.4" or 10.4"
Front Access PCMCIA	●	●
CNC Display with Windows® (160*i*/180*i*/210*i* only)		
Processor	Intel® Celeron™ / Pentium®	Intel® Celeron™ / Pentium®
Memory	Up to 512MB	Up to 512MB
Min Hard Disk Size	40 GB	40 GB
Operating System	Windows® 2000/XP	Windows® 2000/XP
USB Ports	●	●
Serial Ports	●	●
Front Access PCMCIA	●	●
Ethernet Port (100BASE-TX)	●	●
Front Access PCMCIA	●	●
Color TFT LCD Screen	10.4", 12.1" or 15.0"	10.4", 12.1" or 15.0"
Screen Resolution	Up to 1,024 X 768	Up to 1,024 X 768

Some functions listed above are optional. They depend on the CNC configuration and cannot be used in combination with other functions. Check with your sales representative for availability and compatibility. For a detailed list of functions, refer to the i-Series MODEL B specifications GFTE-525 or the manual B-63522.

21*i*/210*i*/210*is* MB/TB	Model Available	16*i*/160*i*/160*is* MB/TB/LB/PB/LPB/WB	18*i*/180*i*/180*is* MB/MB5/TB/LB/PB/WB	21*i*/210*i*/210*is* MB/TB
	CNC Display with Windows® CE 3.0 (160*is*/180*is*/210*is* only)			
9	Processor	HITACHI SH-4	HITACHI SH-4	HITACHI SH-4
5	Memory	64MB	64MB	64MB
4	File Memory	CompactFlash™ Card	CompactFlash™ Card	CompactFlash™ Card
1	Color TFT LCD Screen	10.4" or 12.1"	10.4" or 12.1"	10.4" or 12.1"
4	Screen Resolution	Up to 800 X 600	Up to 800 X 600	Up to 800 X 600
2	USB Port	●	●	●
●	Ethernet Port (100BASE-TX)	●	●	●
SB7 or SD7	Front Access PCMCIA	●	●	●
0,0033	Touch Screen	Optional	Optional	Optional
64 000	Handy Machine Operator Panel	Optional	Optional	Optional
2,048/2,048	PMC C Language	●	●	●
●	CNC Macro Executor	●	●	●
●	CNC Custom Macro	●	●	●
512 KB (1,280m)	CNC C Language Executor	●	●	●
●	Conversational Programming	●	●	●
	Display			
0, 2, 3 or 4	Graphic Display	●	●	●
1 or 3	Status/Program/Parameters	●	●	●
	Ladder Monitoring/Editing	●	●	●
PMC C Language	Servo/Spindle Setup	●	●	●
Loader Control	Alarm/Operation History	●	●	●
Data Server/ATA Interface	Remote Diagnostic	●	●	●
HSSB	Multi-Language Support	●	●	●
PROFIBUS DP	Customization	●	●	●
DeviceNet	Milling Functions	●	●	●
Fast Ethernet	Turning Functions	●	●	●
I/O Link II	Compound Machining Function	●	●	
FL-Net	Electronic Gear Box /Hobbing Functions	●	●	
Serial Communication	Grinding Functions	●	●	●
Analogue Input Board	Punching Functions	● (PB)	● (PB)	
	Laser Function	● (LB)	● (LB)	
	EDM Functions	● (WB)	● (WB)	
●	Tool Functions	●	●	●
● (210*i*/210*is*)	Measurement Functions	●	●	●
RS232	Guidance for Machine Preparation Functions	●	●	●
DNC1, DNC2	Accuracy Compensation Functions	●	●	●
Ethernet	Linear/Circular Interpolation	●	●	●
PROFIBUS-DP	Exponential Interpolation	●	●	
DeviceNet	Helical Interpolation	●	●	●
I/O Link II	Involute Interpolation	●	●	
FL-Net	Cylindrical Interpolation	●	●	●
Memory Card	Polar Coordinate Interpolation	●	●	●
Ethernet Card	Hypothetical Interpolation	●	●	
Modem Card	Conical/Spiral Interpolation	●	●	
	Smooth Interpolation	●	●	
7.2" or 9.5"	Nano Interpolation	●	●	
8.4" or 10.4"	NURBS Interpolation	●	●	
●	5 Axis Machining Functions	●	● (MB5)	
	3D Circular Interpolation	●	● (MB5)	
Intel® Celeron™ / Pentium®	Nano Smoothing	●	●	
Up to 512MB	Advanced Preview Control	●	●	●
40 GB	AI Contour Control	●	●	●
Windows® 2000/XP	AI Nano Contour Control	●	●	●
●	High Precision Contour Control	●	●	
●	AI High Precision Contour Control	●	●	
●	AI Nano High Precision Contour Control	●	●	
●	Jerk Control	●	●	●
●	Rigid Tapping	●	●	●
10.4", 12.1" or 15.0"	Synchronous Control	●	●	●
Up to 1,024 X 768	Tandem Control	●	●	●
	Advanced Tandem Control Functions	●	●	
	Torque Control	●	●	
	Advanced Acceleration/Deceleration Control Functions	●	●	●

The CNC Package – Automation from One Stop Shop

CNC controls are not everything. GE Fanuc offers what an automated machine tool needs – amplifiers, servomotors, spindle motors, I/O modules, stationary and mobile operator control terminals and the relevant cables for them. All of its CNC products are designed from the outset as a system and are optimally matched as a CNC package.

To support our customers, we have created an extensive global support and service network. We offer a variety of support services and programs to help you get your GE Fanuc CNC up and running and keep it at maximum productivity.

GE Fanuc Automation

For the location of your nearest GE Fanuc sales representative or authorized distributor contact:

Europe:
GE Fanuc Automation Europe S.A., Zone Industrielle, 6468 Echternach, Luxembourg
Tel.: (+352) 72 79 79 1, Fax: (+352) 72 79 79 214, www.gefanuc-europe.com

America:
GE Fanuc Automation Americas Inc., P.O. Box 8106, Charlottesville, VA - 22906, USA
Tel.: (+1) 434 978 5000, Fax: (+1) 434 978 5035, www.gefanuc.com

Asia/Pacific:
FANUC Ltd., Oshino-mura, Yamanashi Prefecture, 410-0597, Japan
Tel.: (+81) 555-84-5555, Fax: (+81) 555-84-5512, www.fanuc.co.jp

04/03 3C GFTE-560-EN

Specifications are subject to change without notice. All rights reserved.

©2003 GE Fanuc Automation Europe S.A.