# CNC872 - iTD/iTQ

Multi-support continuous CNC device by MEFI for controlling milling cutters, lathes, carousels, turning machines, flame-cutting machines, grinders and water and laser beam cutters.

**Use**

CNC872 iTD (and iTQ) systems are continuous multi-support control systems with integrated PLC, designed for controlling milling, turning, drilling and flame-cutting machinery, as well as industrial manipulators, and water and laser beam cutters. CNC872 iTD systems rank among the new range of control systems MEFI, running under MS Windows family computer operating systems. They fulfil the needs of demanding applications of high-speed machining requiring CNC control with the possibility of execution of part-programmes of extreme lengths, with emphasis on smooth movement and "anticipation" of machining speed. They are also suitable for equipment requiring multi-support (i.e. independent) control.
The systems are also suitable as a replacement for older control systems when overhauling equipment. They are designed for machinery with direct-current or alternating-current servomotors, with digital, analogue or pulse control modes.

**Basic description**

The control system CNC872 iTD or CNC872 iTQ is based on an industrial PC motherboard, fitted with a Core 2 Duo or Core 2 Quad processor. One processor controls the user interface, i.e. manages the interaction with the operator via a touch-screen, processes and displays various user information, prepares part-programme blocks and input/output operations and processes other data files. Other processors compute the processing track in real time and control servo-loops and the PLC, adjusting the system to the particular controlled machinery. All processors interact via a shared memory bank.
The motheboard is fitted with a MCAN unit providing a connection interface for peripherals and drives over the CAN-BUS, via the CANopen communicating protocol, plus another optional unit for analogue and/or pulse control of drives, and reception of data from incremental sensors.
The motherboard also includes USB and serial ports and an Ethernet link.

CNC872 iTD control systems are delivered with a separate touch-screen, connecting to the control unit via VGA, CAN-BUS and USB cables.

**Operation**

Operation of the control system using the touch screen is intuitive and user-friendly. It utilises a user interface developed by the PLC programme designer in line with submitted requirements. Various screen formats can be easily selected at any time, e.g. listing, graphic interpretation, corrections, inputs and outputs, user dialogues or diagnostic screens.
Development and editing of part-programmes is just as comfortable as using the MS Windows operating system. Input and output for part-programmes as well as other files is possible via a Windows network or a USB Flash disk. The operator can utilise a graphic interpretation of the selected part-programme with continuous zooming, sliding, and turning, selection of displayed planes, including radius corrections and analyses of continuous transport for the envelope velocity.

**NC programming**

Programming is done according to ISO standards with the possibility of utilising part-programmes, macro-cycles, fixed cycles and default shapes. Part-programmes can utilise predefined parameter macros for simpler and clearer programming, parametric programming, including arithmetic operations with parameters of real or integer values. Technological part-programmes can also be developed using any higher programming tools of CAD/CAM.

**Workshop programming**
Workshop programming is based on graphic dialogues. Any desired CAD/CAM design systems running under MS Windows XP can be implemented into the system upon request. A design system is available even during machining.

**Integrated PLC**

The integrated PLC controls all functions of the connected machinery via twin-value inputs and outputs. The PLC programme relies on positioning units and interfaces for controlling servo-loops dynamics. The software design reflects utilisation of the personal computer standard. A user PLC programme can be created and uploaded into the system via the integrated development environment WinTechnol.
Various required user dialogues and display elements can be created in the HTML format. That allows the creation of a customised user interface, in line with the customer's needs. The system is equipped for data transfer between the user interface and the PLC and NC parts. The PLC is designed using development tools of WinTechnol SETUP, containing all necessary components for the final version of the system.

**Input and output peripherals**
The system utilises distributed peripherals for the necessary inputs, outputs and analogue inputs, controlled via the CAN-BUS, using the CANopen protocol, compliant with the DS401 and DS402 standards. Standard CAN-BUS peripherals supplied by the manufacturer include the INOUT08 and KLA50 units. The system can accommodate CAN-BUS peripherals by other manufacturers as well. The INOUT08 unit can transfer data at speed up to 1 MBd with operation cycle as short as 1 ms. The unit contains four input ports, three 100 mA output ports and four analogue inputs.

**Drive control and measuring**
Drives connect to the system via the CAN-BUS or over an analogue or pulse link. CAN-BUS connection can operate in a "Trajectory mode" or "Speed control mode". Basic types of CAN-BUS drives are implemented in the system, other types can be controlled via special instructions of a PLC programme. The system supports incremental or coded measurements, as well as "spliced" rulers. Measurements can also make use of the CAN-BUS.

**Parabolic velocity curve**
Implementing the parabolic velocity curve is a way to limit the reaction forces as well as an increase in acceleration. Acceleration then does not change in abruptly as when linear velocity ramps are used, but changes linearly with a slope determined by the acceleration derivative. Limitation of acceleration growth to linear curve results in parabolic curve for the velocity. The driving power impulse in time is comparably smaller than in the case of linear velocity curve. That manifests in lower reaction force acting on the machine frame, resulting in significant decrease of resonance vibrations of the machine.

**Dynamic velocity control with upcoming block analysis (look- ahead)**
The CNC system offers smooth transitions between blocks without affecting the velocity of movement and predicts the future velocity based on specified criteria, such as dynamic accuracy, up to 500 blocks ahead. The system processes individual blocks continuously while attempting to maintain the pre-programmed velocity over several blocks. Essential criteria of velocity control include the dynamic criterion and the accuracy criterion. The dynamics aspect is based on centrifugal acceleration and the maximum permissible overload of the drives-machine assembly. The accuracy criterion limits velocity sufficiently in advance to ensure the deviation from the ideal track below the set margin.

**Wireless remote control**
Wireless remote control simplifies settings of the control system. The operator often needs to be in places where the standard control panel cannot reach due to design reason (e.g. in close vicinity of the workpiece). A wireless remote control can be used to operate several machines once communication parameters are set.

The remote control is based on a small pocket computer technology PDA (Personal Digital Assistant) with a touch screen. Additional peripherals enhance the remote control with numerous further functions (buttons, display, dials, etc.).

Wireless data transfer from an Ethernet network to the remote control is secured via a Wi-Fi (Wireless Fidelity) technology.

Data from the CNC system are made available to the remote control by a plug-in (a functional addition to the standard system) integrated into the system.

Communication between the plug-in and the system takes place over a COM technology interface. The WinCNC application employs this interface to provide read/write access to internal variables of the system (e.g. positional data, velocity, START/STOP instructions, etc.).

**COM (Component Object Model)**
The COM technology provides a description of various components and the manner of their mutual communication. The technology has been designed and developed into a standard by Microsoft.

The COM technology provides a link to other applications supporting the technology, such as other Microsoft products. The technology thus enables gaining control e.g. over the Internet Explorer browser. The COM technology has become a standard for other software developers.

Component utilisation is independent of the programming language used as the components are always distributed in binary code, corresponding to the standard. The COM technology also defines the component interface and the manner of use of components.

The COM technology is not a programming language in itself, it consists a set of instructions for the creation of components in order to meet the standard.

An interface is a set of methods used to manipulate an object. In traditional object-oriented languages, the interface forms a part of an object, it consists a separate class in COM. In the C++ language, interface represents an abstract class with purely virtual functions defined. It does not contain any variables or implemented functions.
An object is a class derived from an interface. The virtual methods of the interface are loaded and implemented only in an object. An object can provide several interfaces.

**User HTML page**
The use of a PDA remote control offers simple customisation of the user interface using standard HTML editors.

This solution enables the user to customise the PDA control panel for the particular application used. It provides a simple way to set what values and control elements should be displayed.

The HTML interface is a modern.NET technology-based component. Modification of the HTML page does not require re-translation of the application. Running the relevant application suffices to display the changes made. In order to modify the application control, without the need for translation, the used cannot use the standard MS Visual Studio resources. The user interface module employs Internet Explorer services (such as navigation, refresh, even control, etc.).

**Basic technical specification of CNC872 control systems**

**Hardware**

- Motherboard with a multi-core processor Intel Core 2 Duo or Core 2 Quad
- MCAN unit connecting drives and peripherals over the CAN BUS
- Stable memory - hard disk (e.g. 4 GB), or a flash disk
- Network connection to a MS Windows network (Ethernet)
- USB, COM ports
- Analogue drive control unit, and incremental sensor reader unit SU05 (optional)

**Software**

- Interpolation – classification of axes into geometric, synchronous and asynchronous
- 16 servo-loops with four sets of adjustable regulating parameters
- Positional spindle control
- Constant cutting speed
- Thread control with thread entry and exit
- Non-linear table corrections for both directions, including a dependency definition

- Instrument husbandry – separate definitions for individual and type-related instrument parameters
- Dynamic give compensation
- Coordinate system transformations: programmed transformation, intermediate product transformation, 5-axis transformation, machine transformation and various types of shifts and corrections
- Independent track shifts during movement using a dial
- Optional manual control via potentiometers along all axes
- Optional connection of a portable control panel with a dial and an LCD display
- Drive control via CAN-BUS, analogue voltage control or pulse outputs
- A filter for frequency band trap circuit for the servo-loops
- Adjustment of the servo-loops to high-speed machining (feed-forward, etc.)
- Measuring checks (phase, control counter, difference counter, interruption and conductor short circuit)
- Automatic system references for coded rulers
- Drive servo-loop cycle 1 ms, interpolator cycle 1 ms
- Minimum block duration necessary for continuous movement between blocks: 4 ms
- Parabolic velocity curve (limitation of acceleration leaps
- Servo-loops frequency band trap circuit to eliminate resonance
- Dynamic velocity control with upcoming block analysis (look-ahead)
- Thermal compensation
- Optional connection of a measuring probe
- Ethernet, Internet, TCP/IP, FTP connections with optional wireless link
- Even monitoring, even recording into a file, forwarding to an FTP server
- 3D graphic imaging of the machining track
- Diagnostic screens
- Text file output for system time utilisation
- Control panel language versions: Czech, English, Polish, Hungarian, Russian, French

**PLC part:**
- PLC programme size: 1 Mbyte of processor code (max. 16 modules)
- Optional programming of logical sequence units
- System control from PLC using a button sequence and format selection
- Optional connection of an external panel
- Drive regulation control and parameter setting
- Rotary coordinates positional control
- 16 single-axis positioning units for the use by PLC
- Optional development of technological, diagnostic and user dialogues, including images and animations in the HTML format
- Resources for utilisation of tables by PLC
- PLC tuning via an external computer, tuning instruments integrated in the implemented WinTechnol environment

| **Modernisation of MEFI system-equipped machines** | |
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| **Lathes:** | **SPRY16, SPRY25, SPR63, SPT16, SPT 32, SUI32, SUI63, SPS2, DST21, WEILER, SUT160, NDM** |
| **Carousels:** | **SKIQ12, SKIQ20, SKQ25, SKI16, SKI20, MCSK8** |
| **Milling cutters and horizontal cutters:** | **FV1000, FR50NC, FGS40NC, FCH63, FCR50, FQH50, WD160, WD160A, W200S, WFQ80NC, WHN9, WHN10, WHN11, WHN13A, WHN13B, WHN13C, MFCHD40, CINCINATI, COBURK, FCM25CNC** |
| **Drills:** | **VXR50NC, VR5** |
| **Special machinery:** | **Single-and double-spindle grinders, tool grinders, punching presses, flame cutting machines, water-beam cutters** |

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