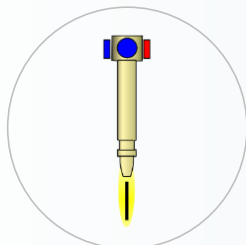


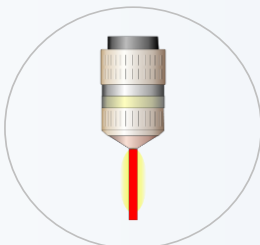
# MEFI CNC 872 series control systems

Applications for cutting machines

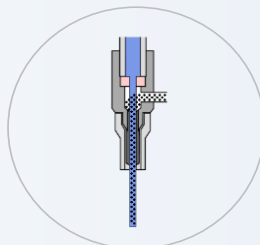
Oxy-fuel



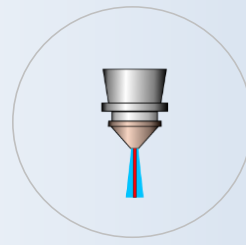
Plasma



Water-jet



Laser



**meffi**

## MEFI CNC 872 Cutting – solution for cutting machines

### Complete solution

We will provide full support to ensure that your machine will actually work.

### Ready to use

Ready for immediate use. This makes it possible to deploy in a very short time.

### Durability

All components are ready for use in a demanding industrial environment, individual components are adapted for the use of specific technology.

### Independence

The ability to connect equipment from many manufacturers, whether it be servo drives, I/O modules, plasma sources, high pressure water pumps, lasers and more.

**Long-term support and service** By using industrial components, we are able to provide service for a minimum of 10 years. However, even after this period, we will offer the optimal solution to extend the life of the machine without the need to replace other components.

## Podporované technologie

### Oxy-fuel

Fully automated oxy-fuel cutting.

### Water-jet

High pressure water-jet cutting and marking.

### Drilling

Pre-drilling holes with a drill.

### All in one

A complete solution including both hardware and software needed to control the cutting machine.

### Consistency and scalability

A unified solution for all types of cutting machines. The supported technologies can be freely combined on one machine.

### Extensibility and customisability

At the customer's request, we are ready to add support for additional functions and additional devices, modify the user interface or customize the operator panel.

### For both new and older machines

On a new machine, we will help optimise the entire machine concept, on an older machine we will adapt to the existing situation so that the maximum number of existing components can be retained and the replacement of the control system can be carried out quickly and at low cost.

### Plasma

Plasma cutting and marking, plasma drilling.

### Laser

Laser cutting and marking.

### Marking and labeling

Marking with pneumatic punch (texts) or inkjet print head (texts, barcodes, ...).

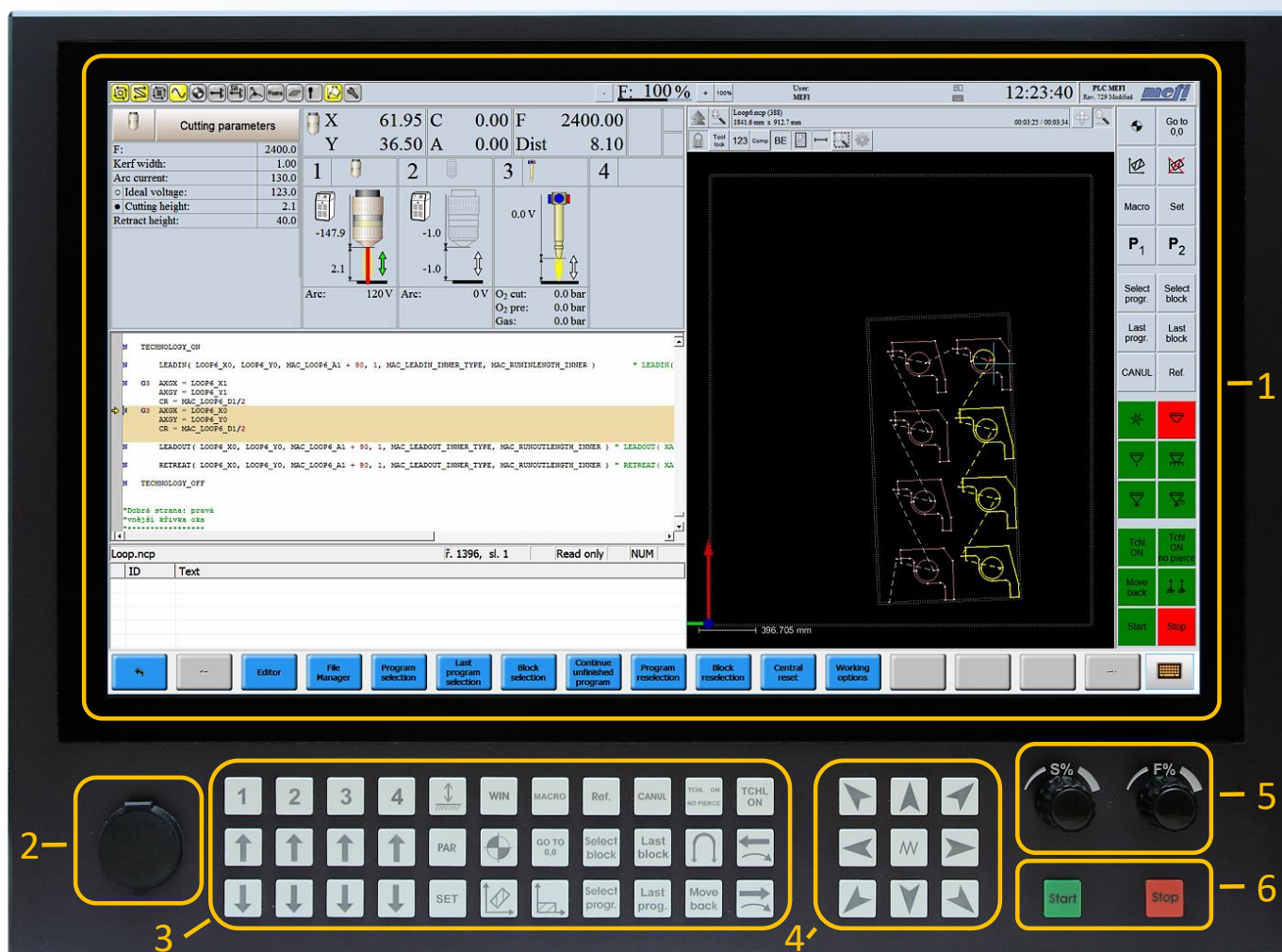
## Basic characteristics

- - Customizability and scalability
  - Any combination of technologies and attachments on one machine.
  - Up to 8 separate supports with any combination of technologies (e.g. plasma + 3 x oxy-fuel or plasma + water-jet).
  - Combination of multiple technologies on one support (e.g. plasma and autogenous).
  - Independent positioning of up to 6 supports in the X/Y axis. Allows simultaneous cutting of several identical parts, cutting of mirror contours, etc.
- Versatility
  - No link to proprietary technologies. Possibility to connect servo drives, I/O modules, plasma sources, high pressure water pumps, height control modules, etc. from various manufacturers.
  - Database of cutting parameters with the possibility of modification on the machine. Easy preparation of databases on computer in Microsoft Excel.
- Advanced cutting options
  - Bevel cutting by oxy-fue, plasma, waterjet and laser. Prepared for the most used 3D head geometries.
  - Cutting of tubes and rectangular profiles (square and rectangular hollow sections) with the possibility of programming the unfolding.
  - Cut virtually any workpiece using direct programming of all axes.
- Easy to use, advanced features
  - Possibility to continue the interrupted program.
  - Move forward/backward along the contour.
  - Manual or automatic adjustment of the workpiece (rotation, displacement, size ...) with the possibility of storage.
  - Easy selection of starting point.
  - Fast workshop programming using dialog input.
- Integration into a corporate environment
  - Monitoring of job parameters (total time, length of cut, number of piercings ...).
  - Detailed machine usage statistics - monitoring machine time, working time, cut length and number of piercings for each technology and support.
  - Automatic or manual generation of machine usage reports.
  - Support of OPC-UA.
  - Estimation of cutting time before starting work.
  - Ability to run the software in simulation mode on a regular PC - easy training and testing.
- Improving machine precision
  - Compensation for machine backlash.
  - Non-linear compensation - correction of axis nonlinearity, slope, sag, etc.
  - Compensation of 3D head tolerances.
- Maintenance and troubleshooting
  - Wear and tear monitoring of consumable parts.
  - Remote support and diagnostics.
  - Error and event logging for diagnostic purposes.
  - Service plan - alerts user when a part needs to be replaced, maintained or serviced on a regular basis.

## Common features

### Operator panel

The operator panel is designed for fast and intuitive operation. It is equipped with a multi-touch display that makes all control system functions easily accessible. At the same time, it offers considerable flexibility by allowing only those controls that are needed on the machine to be displayed. Physical buttons below the display are dedicated to controlling machine movements. The tactile response makes it easier to operate the machine. A part of the physical buttons is also dedicated to control the most used machine functions.



Control system panel

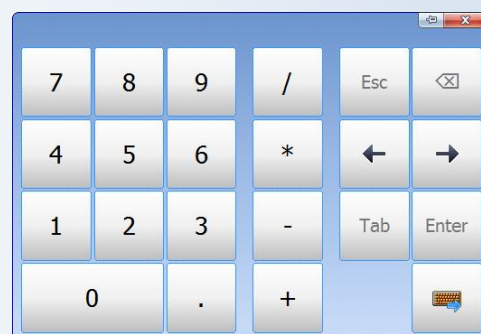
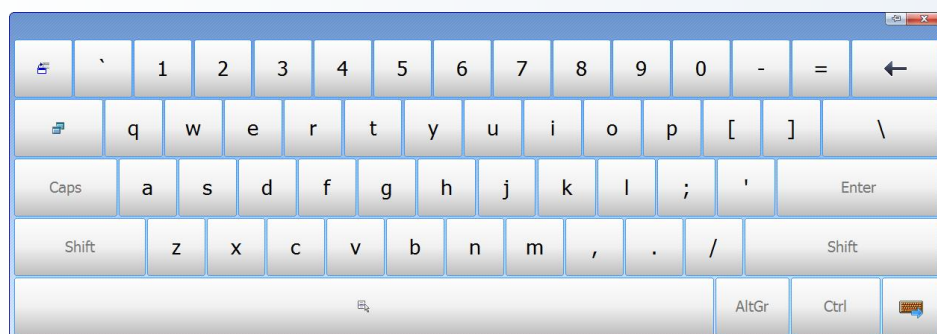
1. Multi-touch display.
2. Dual USB connector for connecting flash memory, keyboard or other peripherals.
3. Buttons for controlling the supports and the most used functions of the control system. The layout can be adapted to a specific machine line
4. Buttons to control movements.
5. Potentiometers for adjusting the speed compared to the programmed one, or other technological parameters (e.g. cutting height).
6. Start and Stop buttons.

## User interface

The user interface is fully adapted to touch control. The main screen shows the status of the machine and other connected devices and information about the program being executed in an intuitive way, while the most used functions are easily accessible.

Control system user interface main screen

1. Machine status indication.
2. Feed override, current user and current time.
3. Software and revision information
4. Cutting parameters - access to settings, summary of the most important parameters for the current technology
5. Position and speed information, status of individual tools, status of suction and other equipment. Click on each area to display a dialog with additional options.
6. NC program or edited file.
7. Persistent messages window.
8. Graphical preview of the NC program, name of the executed program, execution time, estimate of the total execution time.
9. Buttons to access the most used functions.
10. Software menu.
11. Button to display the software keyboard.



### Software keyboard (different variants)

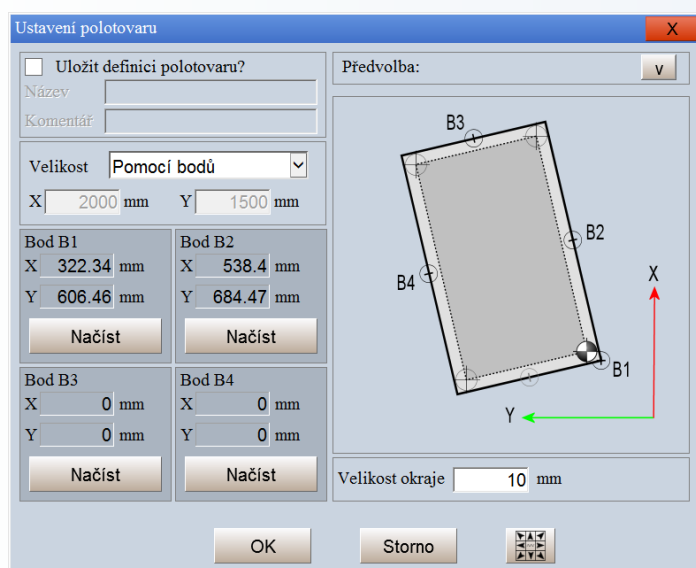
## Localization

The software is fully localized into the following languages (partial localization is available for other languages, where only the most important parts of the software are translated):

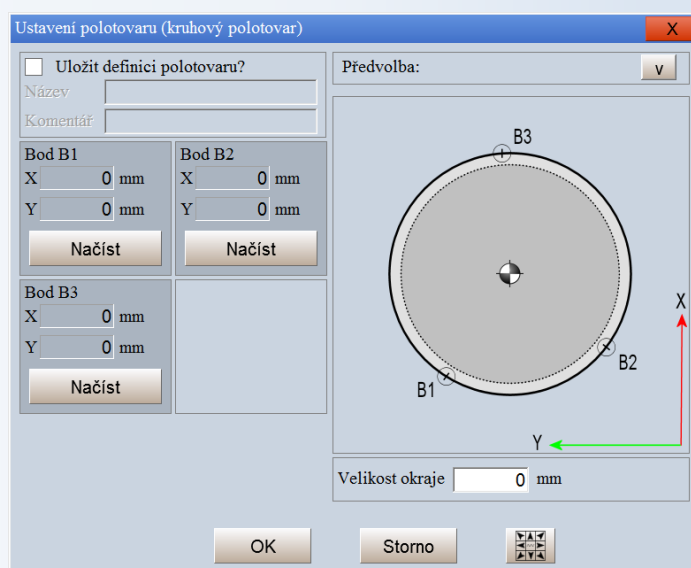
- Czech
- English
- German
- Polish
- Russian

## Workpiece adjustment

- Automatic adjustment (machine must be equipped with a suitable sensor).
- Manual alignment (typically using a laser pointer).
- Circular workpiece
- The adjustment can be saved for later use.
- Possibility to prepare multiple workpieces and select a separate NC program for each of them, the following cutting can be done autonomously.



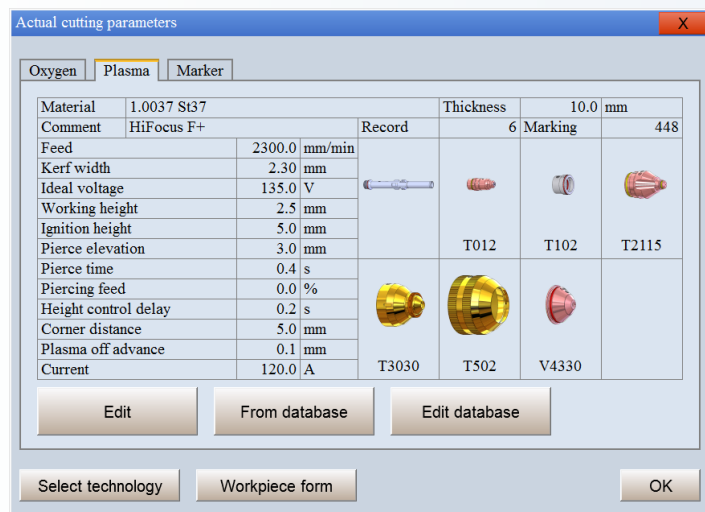
Dialog for manual adjustment of the workpiece - the user enters two, or four, points (typically using a laser pointer), which defines the location and rotation of the material, and its size.



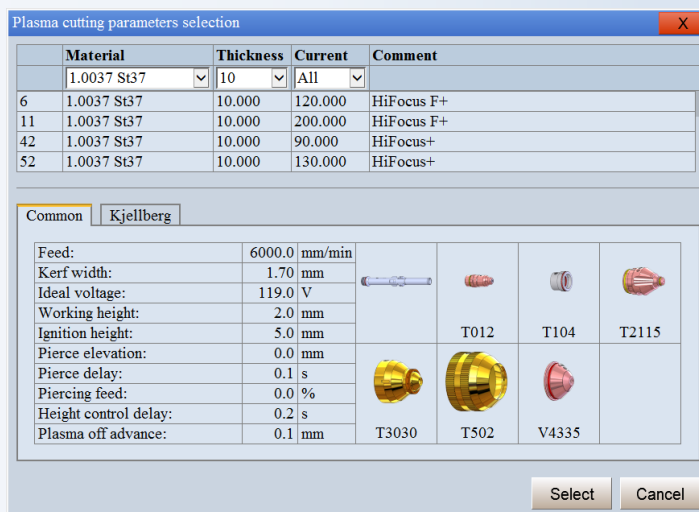
Dialogue for manual adjustment of the circular workpiece.

## Cutting parameters database

- Database preparation in Excel.
- Possibility to edit the database on the control system.
- The user selects parameters from the database based on the material to be cut, its thickness and the desired process.
- Options for temporary modification of selected parameters.
- Simplified / full parameter display.



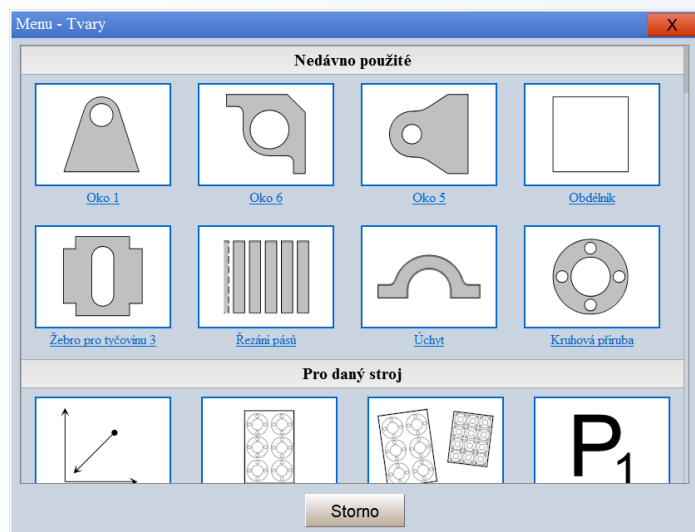
Dialog with an overview of the current cutting parameters.



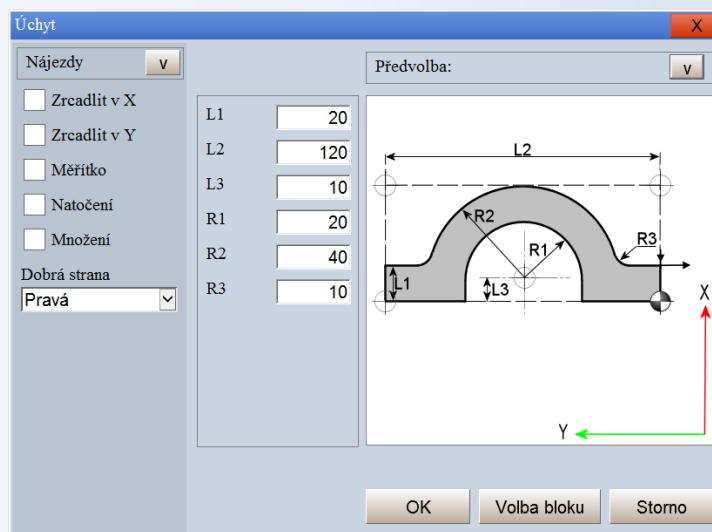
Dialog for selecting plasma cutting parameters from the database.

## Workshop programming

- Macros: nearly 100 basic shapes are available that can be cut directly from the control system environment without the need to create NC code. Simply select the desired shape and enter its parameters in the dialog.
- Presets: if necessary, the current shape parameters can be saved as a preset. The part can then be re-cut with the same parameters at any later time.
- On request, we can prepare customized macros or provide information for their preparation.



Dialog with macro selection



Example of macro dialog

## Common functions

- Cutting kerf compensation.
- Height control.
- Continuation of the program in progress, return to the trajectory, move forward / backward along the trajectory.
- Rotary axis for pipe and profile cutting.
- Cutting with multiple tools at the same time.
- Bevel cutting.
- Control of dust extraction section of the cutting table.

## Features to increase efficiency

- Automatic detection of material height with the possibility of skipping.
- Triangular traverses - after completing one cut, the tool retract only to a minimum height above the material, the rest of the retract is performed during the traverse above the material. The descent to the material then begins before reaching the point where the next cut is to begin.

## Additional devices

- Drill machine.
- Pneumatic puncher.
- Ink-jet printer.
- Dust and fume extraction and filtration unit.

## Technologies

### Oxy-fuel

Designed for controlling the process of thermal cutting of material by oxy-fuel torch.

- Selection of cutting parameters from a database with the possibility of further modification (the database is prepared by the machine manufacturer). The parameters are selected based on the material to be cut and its thickness.
- Fully autonomous cutting without the need for operator intervention (only on machines with suitable equipment - torch, gas console, height control ...).
- Direct control of manual or automatic gas console.
- Possibility of cutting with multiple torches simultaneously.
- Torch height control during cutting with an external unit or integrated height control using a capacitive sensor and servo motor.
- Advanced options for controlling gas pressure and torch height during preheating and piercing.

### Plasma

Designed for controlling the process of thermal cutting and marking of material by plasma arc

- Selection of cutting parameters from a database with the possibility of further modification (the database is prepared by the machine manufacturer, usually using recommended parameters from the plasma source manufacturer). The parameters are selected based on the material to be cut and its thickness.
- Support for plasma sources from all major manufacturers such as Kjellberg, Hypertherm, Thermal Dynamics and Formica. Includes communication with the plasma source via serial line or EtherCAT (depending on the type of plasma source). The parameters for the plasma source are included in the database of plasma cutting and marking parameters on the control system.
- Possibility to connect other plasma sources controlled only by digital signals.
- Possibility of cutting with multiple torches simultaneously.
- Integrated torch height control based on the plasma arc voltage allows full control of the process. For less demanding applications, an external height control unit can be used.
- Advanced control possibilities during piercing allow cutting of thick and difficult materials.
- Plasma "drilling" - preparation for subsequent manual drilling.
- Micro joints - by temporarily changing the cutting parameters, it is achieved that the material is not completely cut through at a given point and the cut part is fixed in its original place.

## Water-jet

Designed for controlling the process of cutting and marking with a high-pressure water jet with or without abrasive.

- Selection of cutting parameters from a database with the possibility of further modification (the database is prepared by the machine manufacturer - adaptation to the used high-pressure pump and other machine components). The parameters are selected on the basis of the material to be cut and its thickness, 5 cutting qualities are available.
- Virtually any high-pressure water pump can be connected.
- Multiple nozzles can cut simultaneously.
- Taper and stream lag compensation (only in conjunction with a suitable 3D head).
- Advanced piercing methods (circular, on the move ...).

## Laser

Designed to control the process of laser cutting and marking.

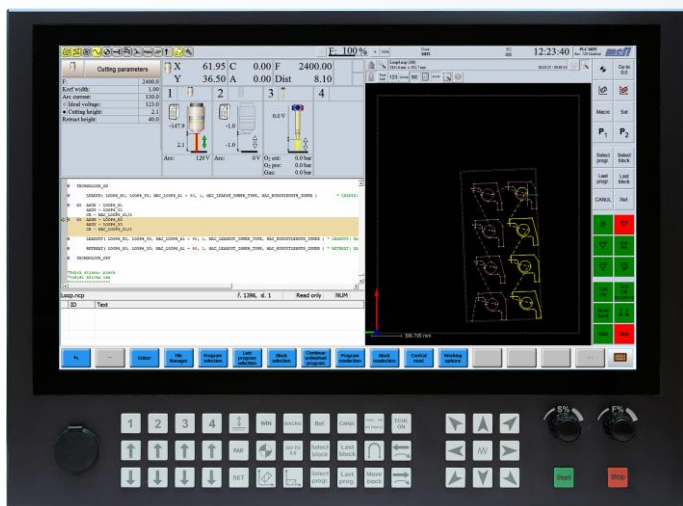
- Selection of cutting parameters from a database with the possibility of further modification (the database is prepared by the machine manufacturer - adaptation to the used laser, cutting head and other machine components). The parameters are selected based on the material to be cut, its thickness and the nozzle used. For each combination there can be several sets of parameters (e.g. several cutting qualities, several types of marking, evaporation of protective film, etc.).
- Integrated control of all components required for cutting and marking (laser source, laser cutting head, gas console ...).
- Laser power control using analogue output and PWM with the possibility of dynamic adjustment according to the current cutting speed (e.g. when passing through a "corner" the laser power is reduced).
- Control of the auxiliary gas pressure during piercing and cutting with the possibility of dynamic adjustment according to the actual cutting speed.
- Fly-cut - significant increase in the speed of marking or cutting thin materials. The individual cuts are connected so that they are as close as possible to each other and the given trajectory can be traversed with as little deceleration as possible. The laser beam is then switched on/off with very precise timing while moving.
- Advanced piercing possibilities. It is possible to change (interpolate) the laser power during the shot through the analogue output and PWM, the pressure of the auxiliary gas, the position of the focal point, the height of the cutting head above the material and other parameters.
- Control of exchange tables of several different designs.

## Hardware

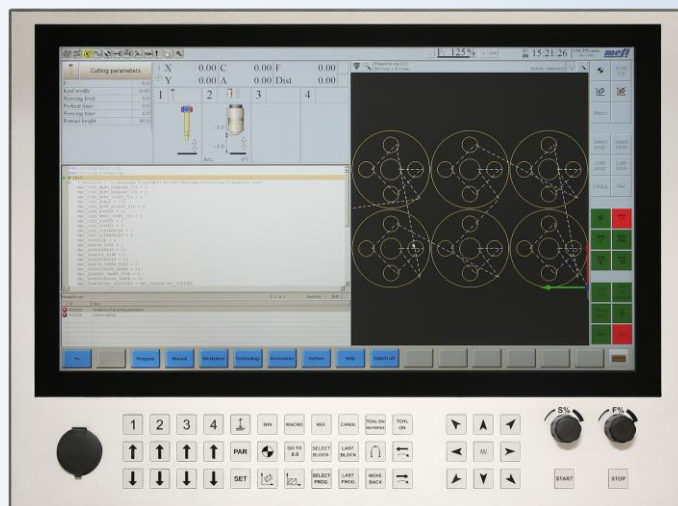
The basis of our production is our own control system in several variants. In addition, we also supply other accessories and electronic modules.

## Control system

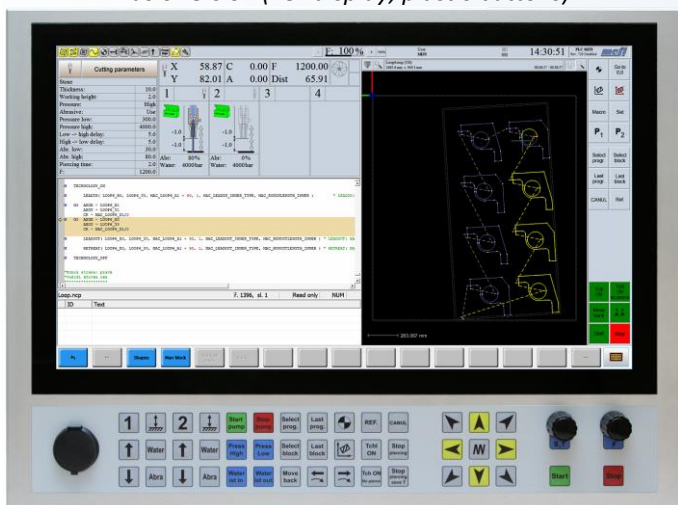
The control system, based on an industrial computer, is integrated in the operator panel, which is equipped with a multi-touch display, technology and motion control buttons, potentiometers and a dual USB connector. The control system is available in several variants:



Basic version (18" display, plastic buttons)



Silver variant (18" display, aluminum buttons)



Waterjet variant (18" display, foil keyboard)



Economy variant (15.6" display, reduced number of buttons)

## Remote control with joystick

A suitable accessory, especially for larger machines or machines where the control system is fixed (does not move with the gantry), is a remote control with joystick, which allows easy and precise control of movements. The arrangement of the buttons is chosen according to the type of machine and the customer's wishes. A foil keyboard version is also available for waterjet machines.



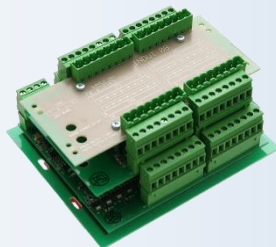


### Remote control with joystick


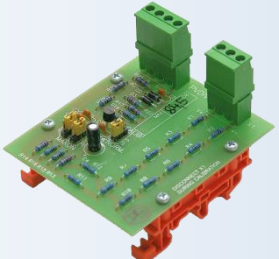



Remote control with joystick - variant for waterjet cutting machines

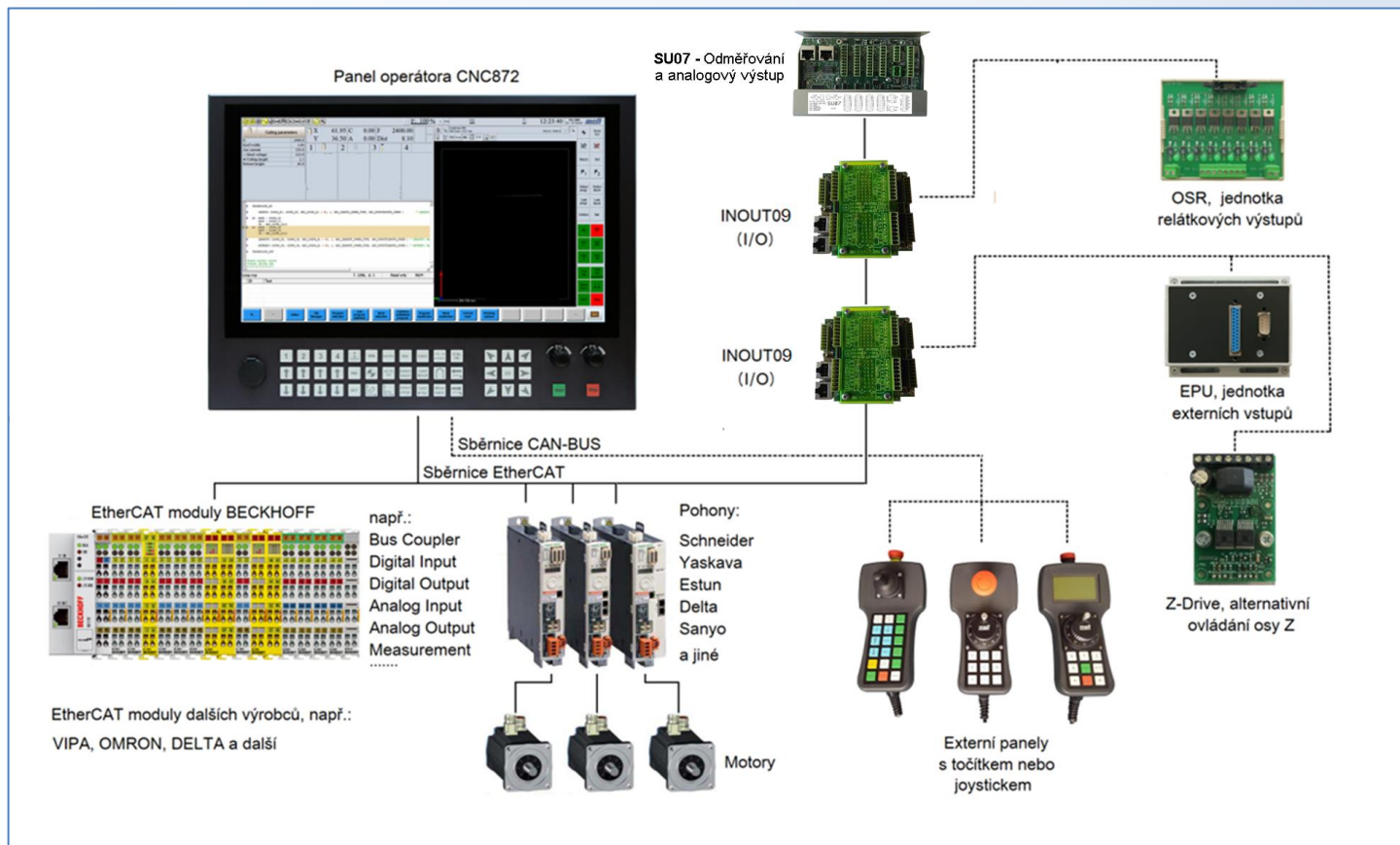
## Input and output modules and more

As accessories we supply modules from the following list:

<p>Input and output module INOUT 08</p> <ul style="list-style-type: none"> <li>• Communication via CAN bus</li> <li>• 32 digital inputs</li> <li>• 24 digital outputs</li> <li>• Optionally 4 differential analogue inputs (instead of 8 digital outputs).</li> <li>• Optionally 4 digital outputs with PWM signal generation.</li> </ul>	
<p>Input and output module INOUT 09</p> <ul style="list-style-type: none"> <li>• EtherCAT bus communication</li> <li>• 32 digital inputs 24V or up to 32 analog inputs <math>\pm 10</math> V</li> <li>• 16 digital outputs 24 V, 0.5 A</li> <li>• 4 digital outputs 24 V, 50 mA or up to 4 outputs with PWM signal generation</li> <li>• 4 digital outputs 24 V, 6 mA or up to 4 analogue outputs 0 - 10 V</li> </ul>	
<p>SU 07 (4 channel encoder interface board)</p> <ul style="list-style-type: none"> <li>• EtherCAT communication</li> <li>• 4 channels for connecting incremental encoders</li> <li>• 4 analog outputs <math>\pm 10</math> V</li> </ul>	

<p>Ohmic touch module ETOUCH2</p> <ul style="list-style-type: none"> <li>Interface for detecting electrical contact between the sheet and the plasma torch for material position detection.</li> </ul>	
<p>Voltage divider PVDIV2</p> <ul style="list-style-type: none"> <li>A voltage divider on the plasma arc allowing safe connection to the analog input of the INOUT 08 or INOUT 09.</li> </ul>	
<p>Z-DRIVE</p> <ul style="list-style-type: none"> <li>Module for DC motor control using PWM signal. Up to two modules can be connected to an INOUT 08 or INOUT 09 card.</li> </ul>	
<p>EPU</p> <ul style="list-style-type: none"> <li>“External Panel Unit“ allows connection of buttons for remote control of the machine.</li> </ul>	

## Application example



## Basic technical data

### Hardware

The exact specification varies according to the specific model of the control system, and also changes due to constant development. Here are the main common characteristics:

- An industrial computer equipped with a multi-core Intel processor and SSD drive.
- The control panel has a 15.6", 18.5" or 22" touchscreen display and buttons to control movement and the most frequently used functions.
- EtherCAT bus for connecting servo drives and other peripherals such as input and output modules, stepper motor control modules, proportional valves, etc.
- CAN bus for connecting older and less demanding peripherals.
- Remote control with joystick can be connected.

### Software

A single software is currently used for all control system models, but it is scalable and adaptable to a wide variety of applications.

- 1 ms base period, fast PLC loop up to 250  $\mu$ s.
- Minimum block duration for smooth speed transition is 4 ms.
- 20 interpolated axes.
- 20 servo loops. If a position control loop in the control system is use, it is possible to set 4 sets of position control parameters, use feed forward or use a digital filter (frequency band hold) to reduce resonances.
- Backlash compensation.
- Non-linear compensation - for each servo it is possible to activate position compensation depending on the position of up to 4 different axes and independently for both directions (compensation of linearity, tilt, sag, etc.).
- Thermal compensation.
- Kerf compensation - adjustment of the trajectory taking into account the width of the cutting kerf.
- Five-axis machining - simultaneous interpolation of XYZ and tool orientation vector. Depending on the machine geometry and tool length, the machine position in XYZ is compensated when tilting the tool so that the position of the tool tip remains unchanged.
- Coordinate system transformation - two independent linear coordinate system transformations (for geometric axes, "program transformation" and "workpiece transformation"), two independent offsets (for all axes).
- Ramps with acceleration and jerk limitation - S-ramps.
- Dynamic speed control with look ahead analysis.
- Logging of events for later processing (diagnostics, machine usage monitoring, etc.).
- Graphical preview of the NC program (2D or 3D), tool position and machining visualization.
- Simulation of machine movement and machining using a 3D model of the machine, workpiece and tool.
- Remote connection using TeamViewer or AnyDesk software - remote management, diagnostics, software upgrades or technical assistance.
- Languages: Czech, English, German, Polish, Russian, And French, in addition partial (only the most used parts of the user interface are translated): Hungarian, Romanian, Bulgarian, Croatian, Dutch, Ukrainian and Lithuanian.