INOVANCE

CNC solutions

For milling machines

· Integrated hardware and software solution
· Ready-to-use HMI
· Simple and fast integration

CNC solutions
By Inovance

Inovance Technology Europe's headquarters in Stuttgart, Germany

Inovance Technology Europe is the European division of global industrial automation group Inovance. Formerly known as Power Automation, Inovance Technology Europe has more than 20 years of extensive CNC expertise across milling and cutting applications. The company specialises at delivering real-time machine control, and at helping OEMs to improve machine performance and productivity.

With its network of offices and R&D facilities in Germany, France, Italy, Spain and Turkey, Inovance Technology Europe is able to offer local service and support right across the European continent. Inovance has invested heavily in its European CNC R&D centre, and the company has a large engineering research team based in Germany, supported by a network of technical experts based across Europe.

To learn more about Inovance Technology Europe and about Inovance – a $2.7bn+ global industrial automation company offering the full range of industrial automation products from variable speed and servo drives, to PLCs to industrial IoT solutions – visit www.inovance.eu

Inovance Technology Europe - CNC Technology Centre

Milling with
Inovance

Inovance offers a perfectly suited solution of hardware and software for all kinds of milling and routing machines. All relevant milling functions are included - no additional options are required to run a milling machine. The Inovance solution consists of all necessary components and functions for easy machine setup:

- Easy-to-use HMI interface with multi-touch gestures
- 3D real-time visualization of the tool, the workpiece and the machine
- Tool management via high performance PostgreSQL database
- Easily customizable HMI
- Ready to use PLC and PLC App library with multiple functions and peripherals
- Various cycles available, including drilling, pocket and advanced cycles
- CNC path optimization functions
- Various axes transformations

Your advantages

- All relevant milling functions are included
- Simple and fast integration
- Freedom to extend or change our standard package according to your needs and requirements
- Generic PLC included
- Easy operation
- High performance
- Rapid machine start-up
- Predictable start-up and running costs
- Rapid time to market
- A one stop shop

General NC functions
- NC program manipulations like block skip, optional stop, G0/G1 override...
- NC cycle programming based on IEC1131 ST language
- Call up subroutines in an NC program
- Linear interpolations (G0/G1)
- Circular interpolation (G2, G3, G12, G13)
- Plane selection (G17, G18, G19, G20)
- Spline interpolations

- Path corrections (D-Corr)
- Length corrections (H-Corr)
- Tool frame offsets
- Part offsets and frame-offsets
- Homing cycles
- Different axis offsets (G92, G99)
- Mirroring and rotation of part
- NC interrupt by external signals

General machine options
- Position/lag monitoring
- Standstill monitoring
- Measuring system monitoring
- Angled wheel
- Dynamic axis allocation
- Gantry axis

- Positioning axis
- Parallel axis
- Feed rate override via external analogue signal
- Interrupt programming
- Backward on the contour

5-axes transformation*
The software package for 5-axes transformation is used for machines which have two round axes in addition to the usual three linear axes (X, Y and Z). These round axes make it possible to orient a rotation-symmetrical tool to any point relative to the workpiece. Active transformation allows programming of Cartesian workpiece coordinates without regard to the round axis. The workpiece coordinate system may be shifted and rotated to the machine coordinate system.

The orientation of the tool can be made by programming the round axis or the tool direction vector. In addition to the 5 mentioned axes, the machine can have further axes (e. g. loading axes or axes of tool changes) which are not involved in the transformation.

The 5-axes transformation allows changes of tool programs in the CNC control without changing the NC program.

*Subject to official export approvals if exported outside of the European Union

Cartesian machines
The machine kinematics must correspond to the following requirements:
The three linear X, Y and Z axes must form a clockwise cartesian coordinate system. Each of the round axes rotates around one linear axis. That means the turning vector will be parallel to the according linear axis. Both round axes must be oriented perpendicular to one other. The round axis can be used either to turn the tool or to turn the workpiece. A situation where one of the round axes moves the tool and the other one moves the workpiece is also permitted.
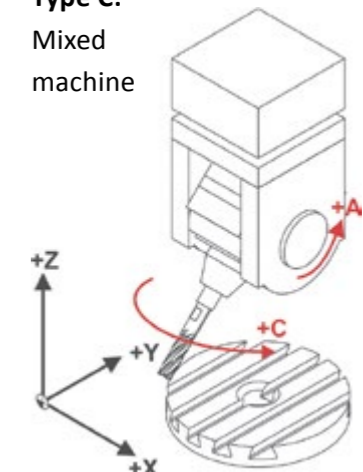
Type A:
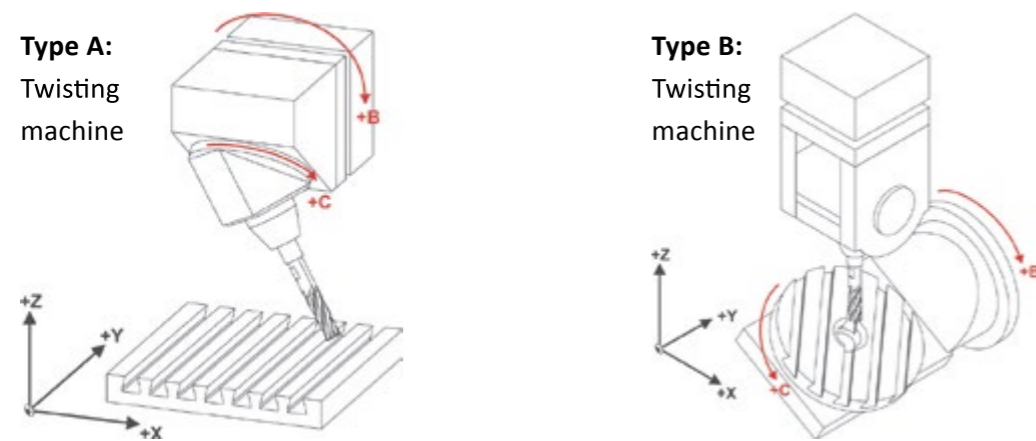Twisting machine
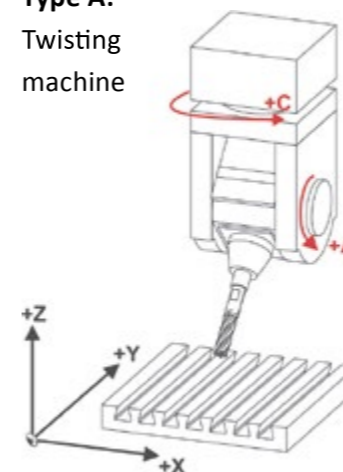
Type B:
Tilting machine
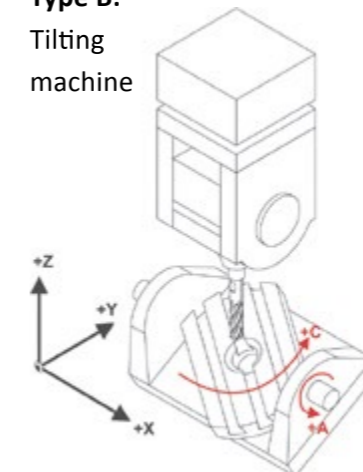
Type C:
Mixed machine

Nutator machines

There is a special type of "5-axes-transformation" for nutator machines, where one of the turning axes is not parallel to the linear axis.

Type A:
Twisting
machine

Type B:
Twisting
machine

4- and 3- axes transformation

4- and 3-axes transformation corresponds to 5-axes transformation.
4-axes transformation: 3 linear axes and 1 round axis.
3-axes transformation: 2 linear axes and 1 round axis.

Barrel transformation

The barrel cam transformation allows easier programming of a program path on a cylindrical part. The cylindrical part will be moved for the machining process around its centre of rotation, interpolated with the longitudinal axis.

The programming is done on an "unwrapped" (or "developed") plane surface, which serves as interpolation plane for compensations and feed rate calculations. In this developed plane, almost the complete range of geometric control options is available.
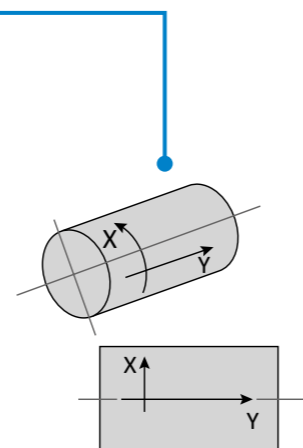
Polar transformation

Polar transformation allows programming of a polar machine with cartesian coordinates. However, programming in polar coordinates is selectable as well if required.
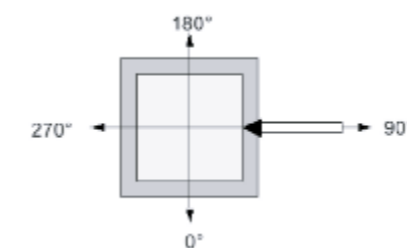
A polar machine is a machine constituted from a minimum of one rotary axis (1st axis) and one radial axis (2nd axis).
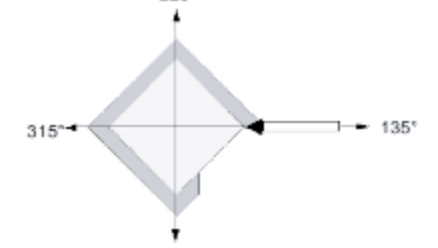
G101
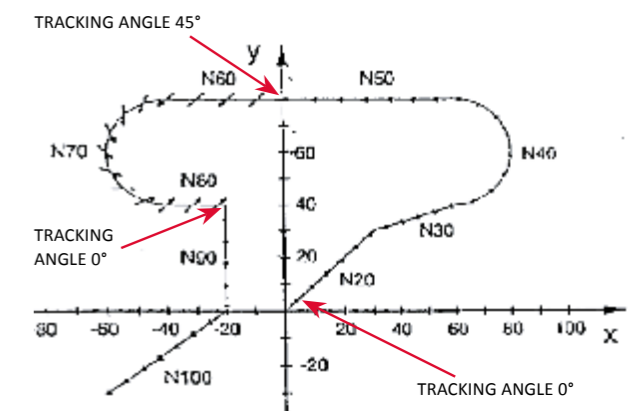**(polar transformation on)**
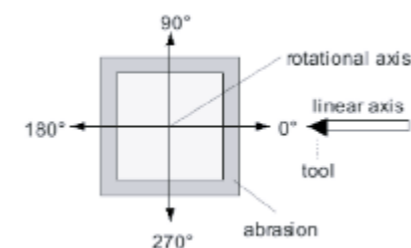
X0 Y20

X-20

Tangential tracking

The tangential tracking function enables a rotational axis to be oriented automatically, so that the rotational axis position matches the actual path tangent, or a defined offset to this tangent.

This function maybe used for automatic orientation of non-symmetrical tools (such as cutting and welding tools).

The tangential tracking angle can be changed during the process:
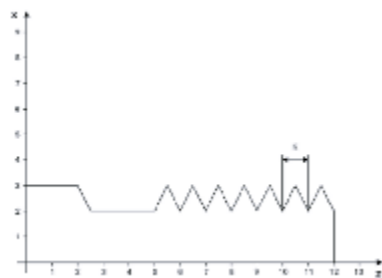
For milling

Thread cutting

Thread cutting requires synchronization between the spindle's rotation and a cutting axis (usually Z-axis). Therefore, during thread cuts, the programmed feed rate has no effect.
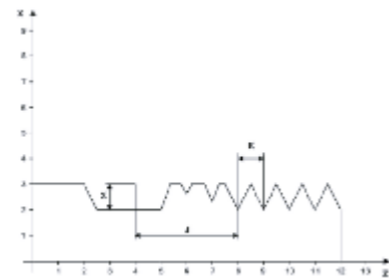
The spindle speed controls movement and the longitudinal axis moves along with the spindle in accordance with the programmed thread pitch.
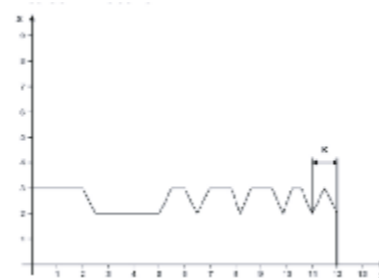As threads can be cut in several strokes if necessary, the axis will not move until the spindle marker (the 0-position of the spindle) is detected.
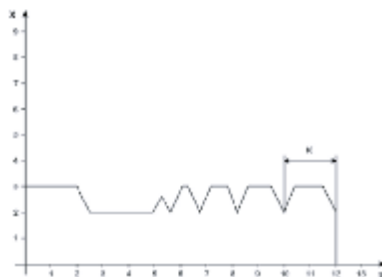
Cylindrical basic thread cut
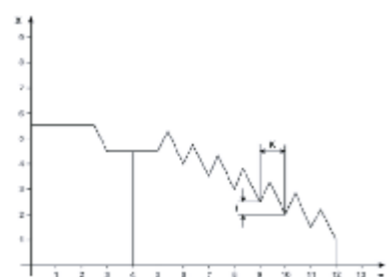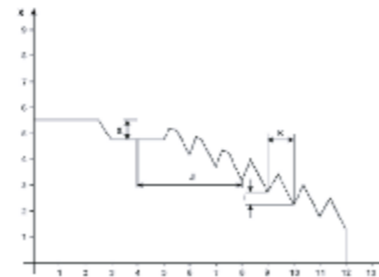
Cylindrical thread cut with runout

Cylindrical thread cut with increasing pitch

Cylindrical thread cut with decreasing pitch

Conical basic thread cut

Conical thread cut with run-out

For milling

S-Curve for jerk control

S-Curve is the classic solution for jerk limited axis movement. The jerk, i.e. the change of the acceleration per time is limited to an axis specific value. The following graphic shows the standard movement profile for a positioning command with defined maximum velocity, acceleration and jerk.

— jerk
— acceleration
— velocity
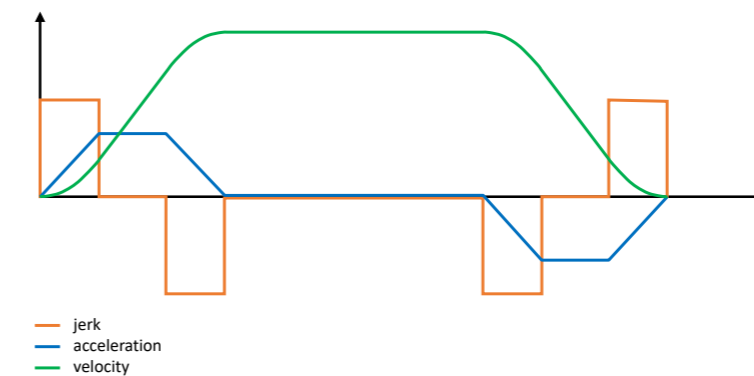
The implemented solution provides maximum productivity by fully utilizing the dynamic possibilities of the machine. For further enhancement of the productivity the functions corner smoothing and path smoothing should be used.

Path smoothing

Path smoothing function is used for processing digitized NC-Programs from CAD/CAM – systems. Path smoothing calculates a C2 – continuous path and based on this path, calculates a homogeneous movement that is adapted to the course of the workpiece surface.

Path smoothing bundles a number of CNC functions for intelligent motion control. They result in a workpiece surface that is optimal according to the state of the art and at the same time the highest processing speed.

An optimized Look Ahead is used for motion control with path smoothing. It contributes to perfect surface quality through reproducible results, accuracy and increased speed.

Path smoothing ensures exact contour accuracy and maximum processing speeds. An intelligent jerk limitation protects the mechanics of the machine. It enables the axes to be accelerated and decelerated gently despite all the dynamics, thus extending the service life of the machine.

— programmed path
— smoothened path
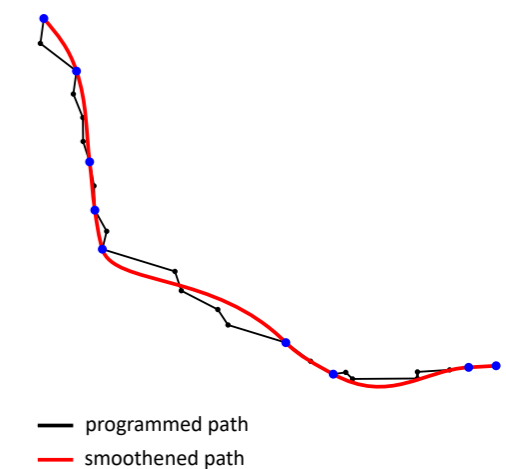
For milling

PA9000 milling HMI

The PA9000 Milling HMI is a user-friendly HMI which has all standard functionalities for operating a milling machine based on the programming language QT.

Product benefits:
- Intuitive and easy to use
- Touch screen operation
- Customization of virtual MCP via SETUP page
- Modular system allows to arrange single screens to fit the customer needs
- Open interface for adding new parts or substituting existing components on the HMI
- Various QT libraries available that allows communication with CNC, NC, PLC and database

Automatic mode

Options:
- Select NC program for execution
- Select single or sequential blocks for execution
- Optional halt (M01)
- Block delete (/)
- G01 override
- Test with or without movement
- Backward operation
- Manual movements in automatic mode, and automatic return to last programmed position
- Feed/spindle override control
- Start at selected NC block
- NC file view of entire NC program

Manual mode

Options:
- Jog axis (incremental/continuous mode)
- Control of feed override (G1) and rapid override (G0)
- Set zero position (G92 offset)
- Selection of different modes to visualize axes' positions: tool coordinate position/zero position/absolute position
- Hand release mode
- Switch on/off handwheel
- Redefine homing position

Data

Options:
- Length correction table editor (H1...H128)
- Path correction table editor (D1...D128)
- Zero offset table editor (G54...G59)
- Cycle parameter table editor
- NC program editor

For milling

Info

Options:
- View of actual active messages
- Interface display for CNC-PLC interface variables, PLC I/O variables
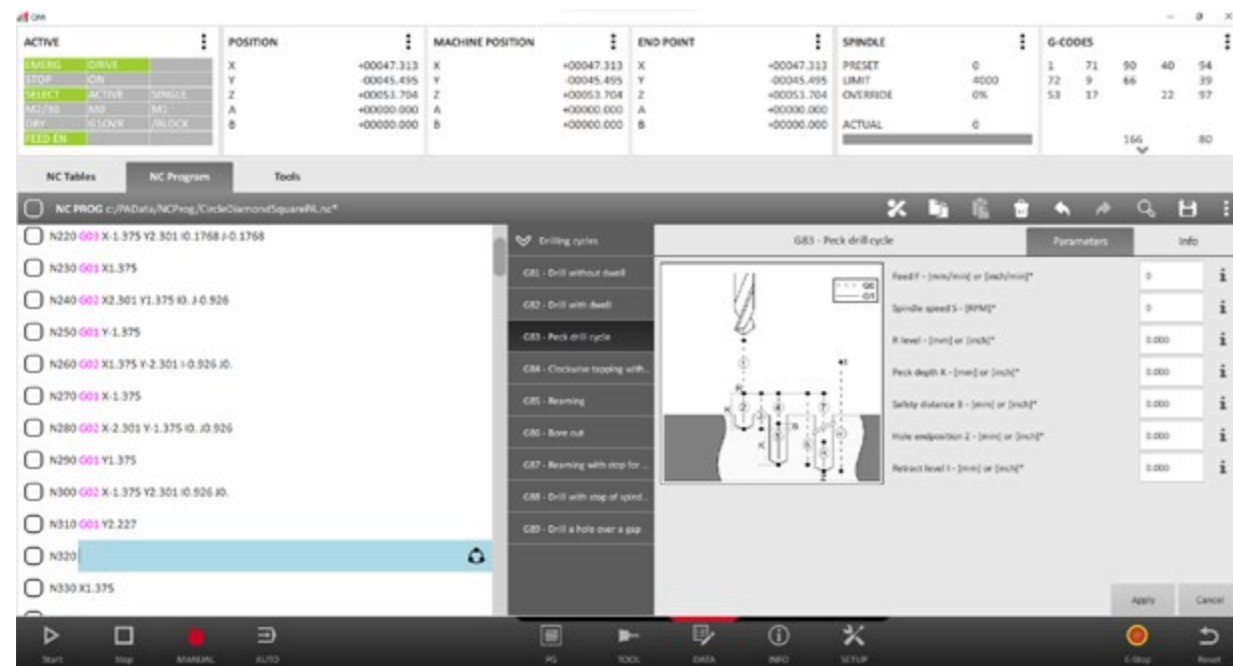

Setup

Options:
- Shutdown CNC or OS
- PLC editor
- Editor for machine parameters
- Logic analyser
- Logout/login and change password
- CNC configuration info
- Main menu settings for hiding/unhiding buttons/options on HMI
- QMI settings for resolution and sizing of HMI

Status bar & zoom info screen

Status bar has multiple display options, dependent on user preferences.

The following options can be chosen:
- Active signals
- Actual absolute axis position
- Axis endpoints
- Axis remaining path
- Active G-codes
- Axis corrections
- Axis KV
- Axis Lag
- Axis direction
- Axis out value
- Active compensations
- Actual feeds
- Spindle information
- Machine status
- Active BCD
- NC program information
- Axis speed

Instead of the 2D graphic, a zoom of 2 status views can be shown. The status view content can be defined by the user.

For milling

For milling

NC editor

An NC editor with a programming assistant is integrated in the HMI.

Create your customized HMIs by using the modular PA HMI system!

For a smaller screen (12" to 14") an extended virtual MCP was added as a new menu entry.

Programming with QT makes it easy to create new content, like this virtual MCP.

Options:
- Add NC codes as plane text
- Add NC code via PA NC wizard with explanations for each parameter
- Add NC code via "teach" function which will enter the current axes positions as a NC block
- Add machine dependent G / M – Codes to the PA NC wizard by xml-based files
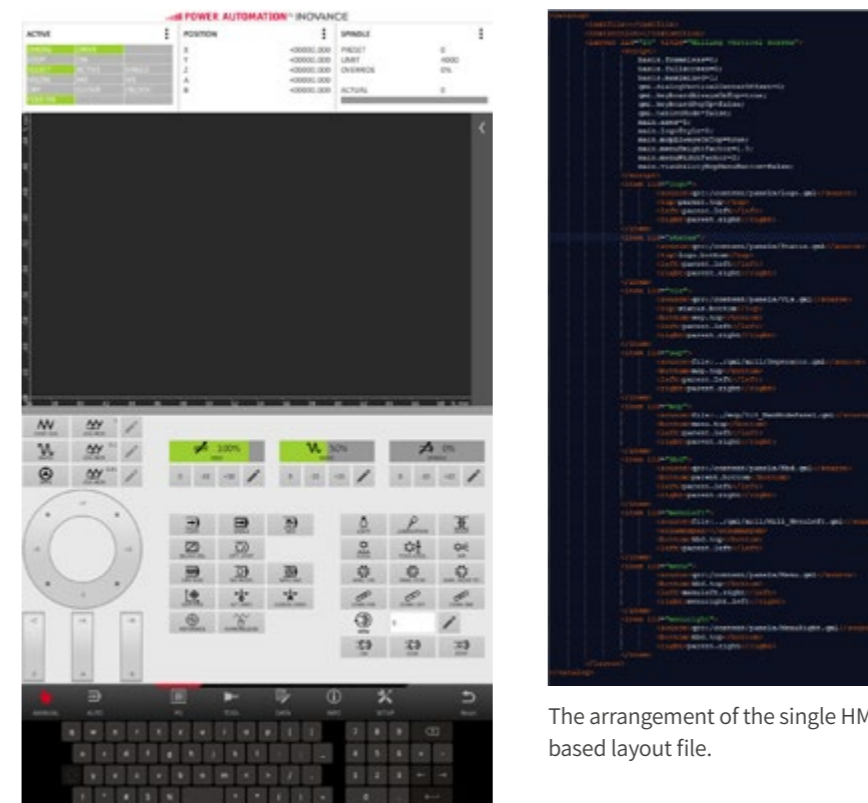
The arrangement of the single HMI modules is defined by a xml-based layout file.

For a 21" HD vertical screen the virtual keyboard and an extended virtual MCP is shown always on top.

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Tool management

The PA9000 Milling HMI uses a PostgreSQL database for tool management.
The database is fully integrated in the system with accessibility from PLC, HMI,
CNC and NC programs. The tool management includes lists of tools, various tool
correction tables, tool types, tool holders, spindles, grippers and magazines.
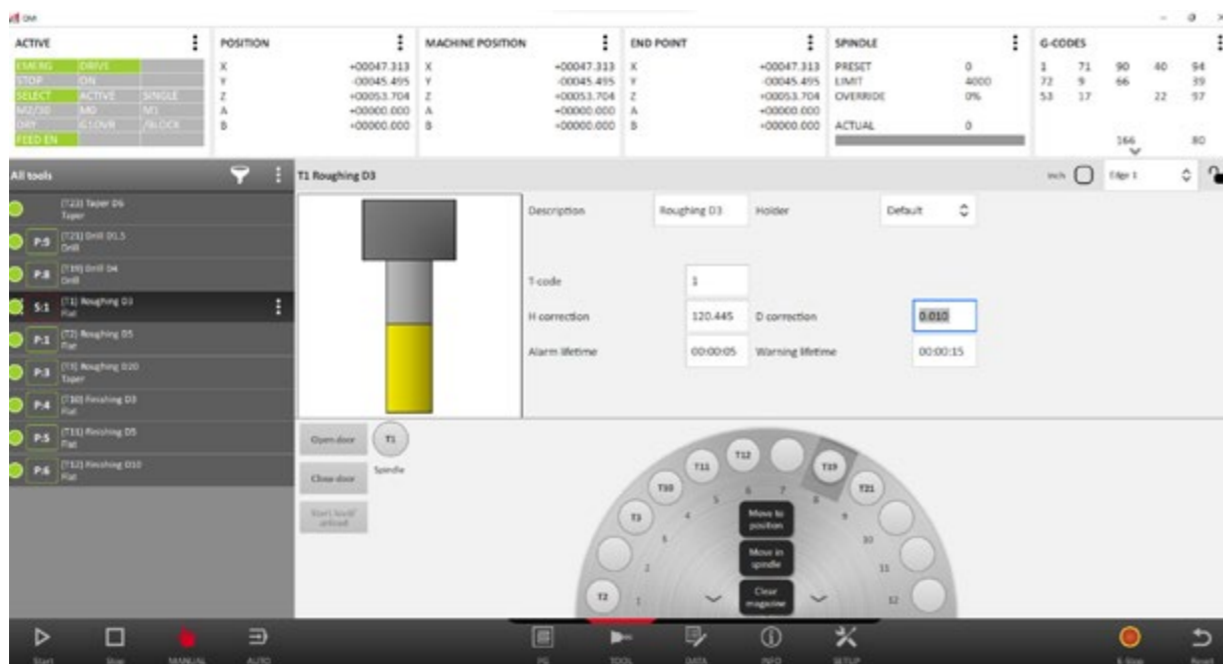
Tool management options

- Tools can be created and defined in different positions as:
  - in stock
  - in magazine
  - in spindle or
  - in gripper
- Each tool can be combined with a tool holder
- Master and sister tool option available
- Tool can be defined as a "big" tool which blocks magazine pockets on left and right
- Magazine pockets can be defined as pockets for "big" tools
- Option of dynamic tool places and fix tool places available
- Each tool can be defined with up to 128 edges
- For each edge of a tool it is possible to define frame, height and diameter corrections
- Each tool edge can be set to different states as for example: blocked, broken, measured etc.
- For each tool edge a lifetime can be defined
- Shown tool parameters on tool editor are adjustable

For milling

In every PA9000 CNC, Inovance provides a ready to use standard PLC program.
With the PA Kernel PLC, you can easily implement your own functions
and peripherals.

PLC app library
Inovance also offers a PLC app library for many of the functions and peripherals that
are regularly used in milling machines. The apps are programmed for use with the
PA Kernel PLC, but because of the fixed defined input/output interface of every app,
they can be used in any PLC.

Examples of PLC apps

PA tool management app
This app can be used to work with the PA tool management database. All data
about active and new tools can be read and written. Tool change processes and tool
time handling are integrated. Documentation assists in understanding how to create
an NC-subprogram for a tool change if the existing one will not fit.

Analog/ETC spindle app
App for control an analog spindle drive or an ethercat spindle drive via PLC

Coolant app
App which can be used to switch on/off coolants via M-Code/HMI and hardware
button

Conveyor app
App which can be used to switch on/off conveyor via M-Code/HMI and hardware
button

MPG app (handwheel)
App for use of different MPGs

Hardware feed override app (G0 and G1)
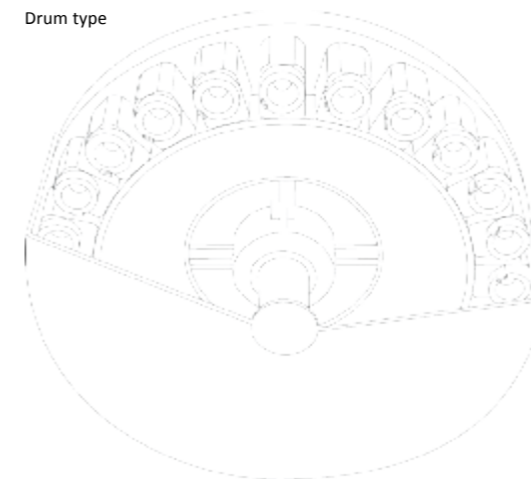Freely definable hardware switch for up to 64 feed override steps

Hardware spindle override app
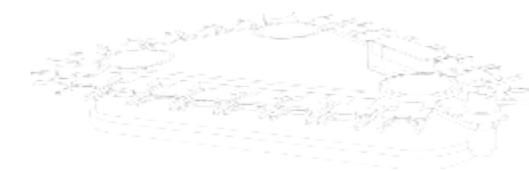Freely definable hardware switch for up to 64 spindle override steps

Rotational tool magazine - digital control app
Rotates the magazine with digital signals place by place. Double arm logic integrated
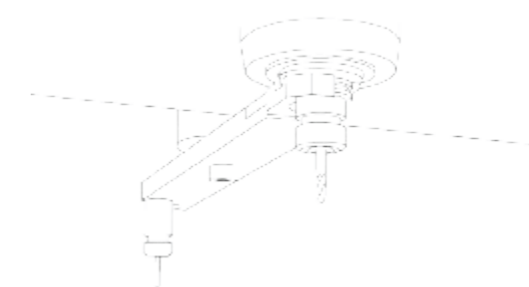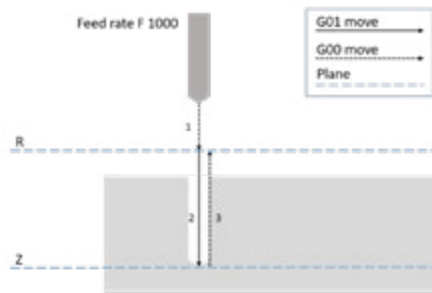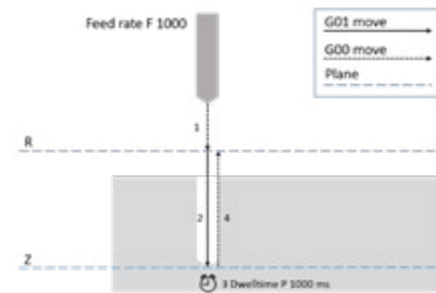
Drum type   Chain type

Double arm

Cycles
For milling

Drilling cycles

G81 Drilling to final depth
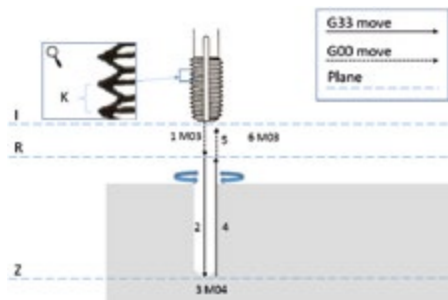

**G82** Spot facing with dwell time

Other cycles available:
- Deep hole drilling
- Thread cutting with balanced chuck
- Reaming
- Bore out
- Reaming with measuring stop
- Bore out with spindle stop
- Bore out with intermediate stop
- Deep hole with reducing peck

Rigid tap cycles

G720 Rigid tapping right handed (only possible at spindle with position feedback)

G721 Rigid tapping left handed (only possible at spindle with position feedback)
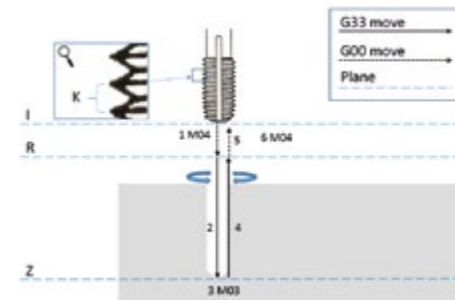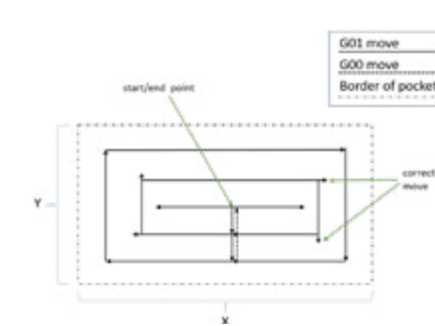

Other cycles available:
- Rigid tapping, right handed, self-reversing (needs special tool)
- Rigid tapping, right handed with variable retract feed (only possible at spindle with position feedback)
- Rigid tapping left handed with variable retract feed (only possible at spindle with position feedback)
- Rigid tapping, right handed, with variable retract feed without thread lead (needs special tool holder)
- Rigid tapping, left handed, with variable retract feed without thread lead (needs special tool holder)

Milling cycles

G711 Rectangular pocket counterclockwise
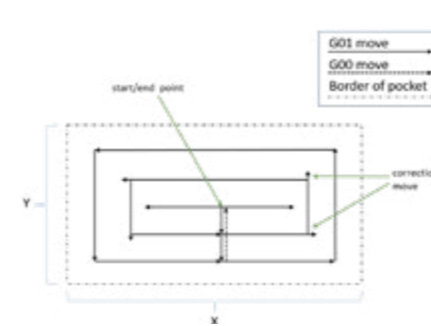
G712 Rectangular pocket clockwise
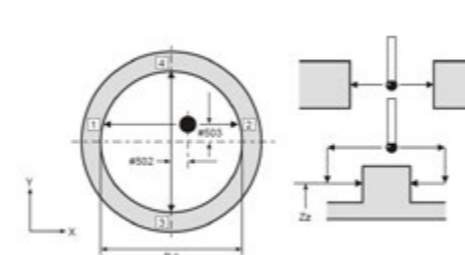

Other cycles available:
- Circular pocket, counterclockwise
- Circular pocket clockwise
- Mill boring circle counterclockwise
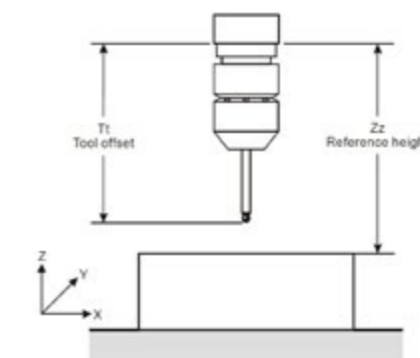- Mill boring circle clockwise
Advanced cycles available:
- Bolt circle
- Bolt grid
- Engraving letters
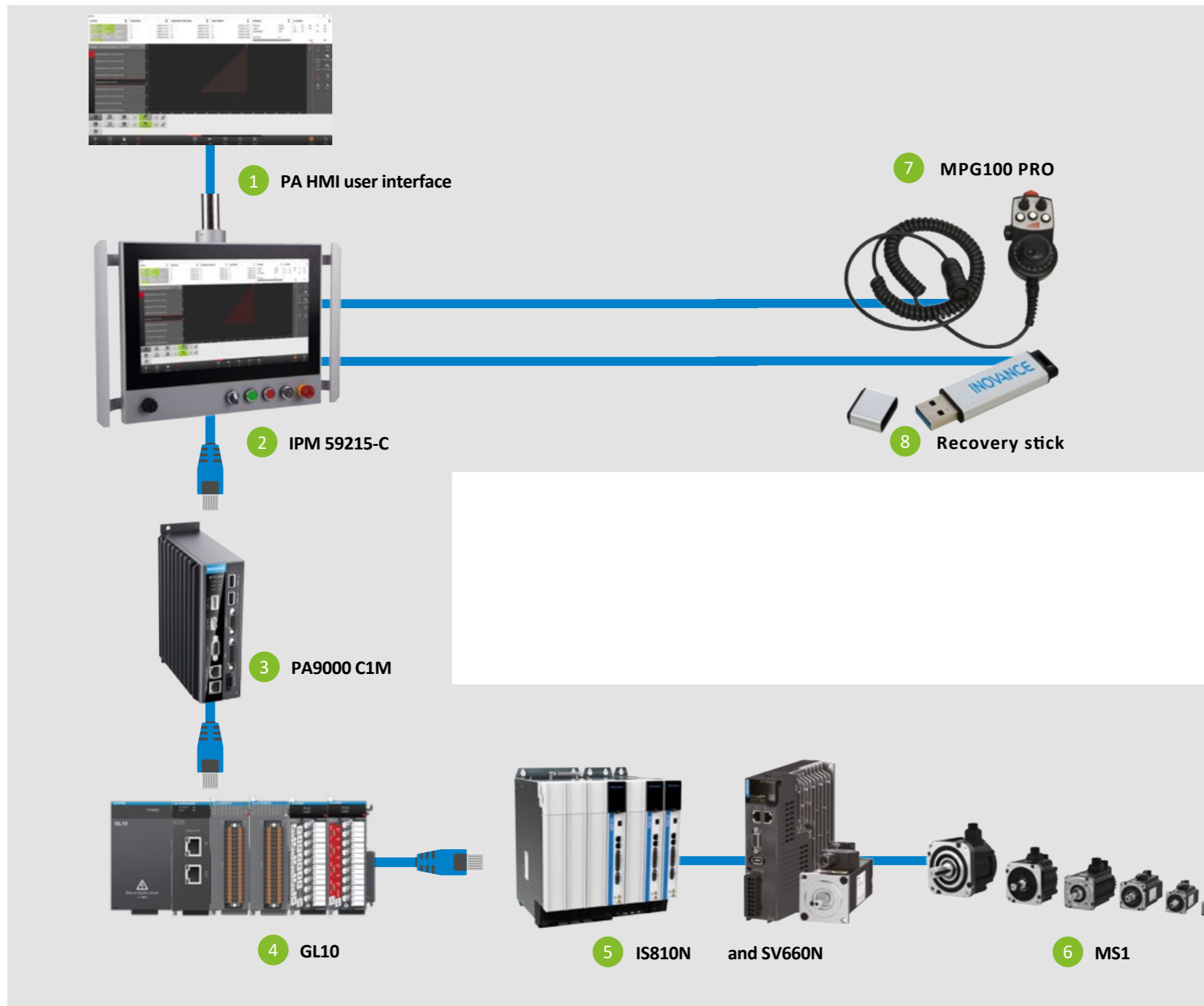
Measuring cycles

G850 Calibration

G851 Length calibration

Other cycles available:
- Measure in one direction
- Measure two points
- Measure four points
- Corner measure
- Angle measure

Configuration

① PA HMI user interface

⑦ MPG100 PRO

② IPM 59215-C

⑧ Recovery stick

③ PA9000 C1M

④ GL10

⑤ IS810N   and SV660N

⑥ MS1

① **PA HMI user interface**
State of the art design. Easy-to-use

② **IPM 59215-C**
Operating panel with touch screen,
freely definable emergency stop buttons,
and USB input

③ **PA9000 C1M**
Ultra compact, lightweight, EtherCAT CNC

④ **GL10**
Compact EtherCAT I/O modules

⑤ **IS810**
High performance EtherCAT servo drives
400 V series with common power supply
Single axis versions also available

⑥ **MS1**
Servo motors with excellent servo properties

⑦ **MPG100 PRO**
Ergonomic handheld pendant

⑧ **Recovery stick**
All-in-one solution for checking,
testing, recovering and restoring PA9000
CNC controls

Driven by Technology

AC Drives

AC MultiDrives

MV Drives

Single-Axis Servos

Multi-Axis Servos

EtherCAT

Robotics & Motion Controllers

PLCs & HMIs

CNC Machine Tool Solutions

EtherCAT

Electric Vehicle Inverters

For more information, please contact our local offices.