CNCelite

8060
8065

EASYPLANE.

Ref: 2508

FAGOR
AUTOMATION

TRANSLATION OF THE ORIGINAL MANUAL

This manual is a translation of the original manual. This manual, as well as the documents derived from it, have been drafted in Spanish. In the event of any contradictions between the document in Spanish and its translations, the wording in the Spanish version shall prevail. The original manual will be labeled with the text "ORIGINAL MANUAL".

MACHINE SAFETY

It is up to the machine manufacturer to make sure that the safety of the machine is enabled in order to prevent personal injury and damage to the CNC or to the products connected to it. On start-up and while validating CNC parameters, it checks the status of the following safety elements. If any of them is disabled, the CNC shows the following warning message.

- Feedback alarm for analog axes.
- Software limits for analog and sercos linear axes.
- Following error monitoring for analog and sercos axes (except the spindle) both at the CNC and at the drives.
- Tendency test on analog axes.

FAGOR AUTOMATION shall not be held responsible for any personal injuries or physical damage caused or suffered by the CNC resulting from any of the safety elements being disabled.

HARDWARE EXPANSIONS

FAGOR AUTOMATION shall not be held responsible for any personal injuries or physical damage caused or suffered by the CNC resulting from any hardware manipulation by personnel unauthorized by Fagor Automation.

If the CNC hardware is modified by personnel unauthorized by Fagor Automation, it will no longer be under warranty.

COMPUTER VIRUSES

FAGOR AUTOMATION guarantees that the software installed contains no computer viruses. It is up to the user to keep the unit virus free in order to guarantee its proper operation. Computer viruses at the CNC may cause it to malfunction.

FAGOR AUTOMATION shall not be held responsible for any personal injuries or physical damage caused or suffered by the CNC due a computer virus in the system.

If a computer virus is found in the system, the unit will no longer be under warranty.

DUAL-USE PRODUCTS

Products manufactured by FAGOR AUTOMATION since April 1st 2014 will include "-MDU" in their identification if they are included on the list of dual-use products according to regulation UE 428/2009 and require an export license depending on destination.

FAGOR AUTOMATION

It is possible that CNC can execute more functions than those described in its associated documentation; however, Fagor Automation does not guarantee the validity of those applications. Therefore, except under the express permission from Fagor Automation, any CNC application that is not described in the documentation must be considered as "impossible". In any case, Fagor Automation shall not be held responsible for any personal injuries or physical damage caused or suffered by the CNC if it is used in any way other than as explained in the related documentation.

The content of this manual and its validity for the product described here has been verified. Even so, involuntary errors are possible, hence no absolute match is guaranteed. However, the contents of this document are regularly checked and updated implementing the necessary corrections in a later edition. We appreciate your suggestions for improvement.

The examples described in this manual are for learning purposes. Before using them in industrial applications, they must be properly adapted making sure that the safety regulations are fully met.

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ABOUT THIS MANUAL.

Title.	EASYPLANE.
Models.	CNCelite 8060 8065
Type of documentation.	End user manual. This manual describes how to work with EASYPLANE for 5-axis or 3+2 machining. **Remarks.** Always use the manual reference associated with the software version or a later manual reference. You can download the latest manual reference from the download section on our website. **Limitations.** The availability of some of the features described in this manual are dependent on the acquired software options. Moreover, the machine manufacturer (OEM) customizes the CNC performance of each machine using the machine parameters and the PLC. Because of this, the manual may describe features that are not available for the CNC or the machine. Consult the machine manufacturer for the available features.
Electronic document.	man_elite_60_65_easyplane.pdf. Manual available from the download section of our website.
Language.	English [EN]. Refer to our website, download area, the languages available for each manual.
Date of publication.	Août, 2025
Manual reference	Ref: 2508
Associated version.	v2.50.05
Responsibility exemption.	The information described in this manual may be subject to changes due to technical modifications. Fagor Automation reserves the right to change the contents of this manual without prior notice.
Trademarks.	This manual may contain third-party trademarks or trade names, however, they do not have them associated ® or ™ symbols. All the trade marks appearing in the manual belong to the corresponding owners. The use of these marks by third parties for their own purpose could violate the rights of the owners.
Website / Email.	http://www.fagorautomation.com Email: contact@fagorautomation.es

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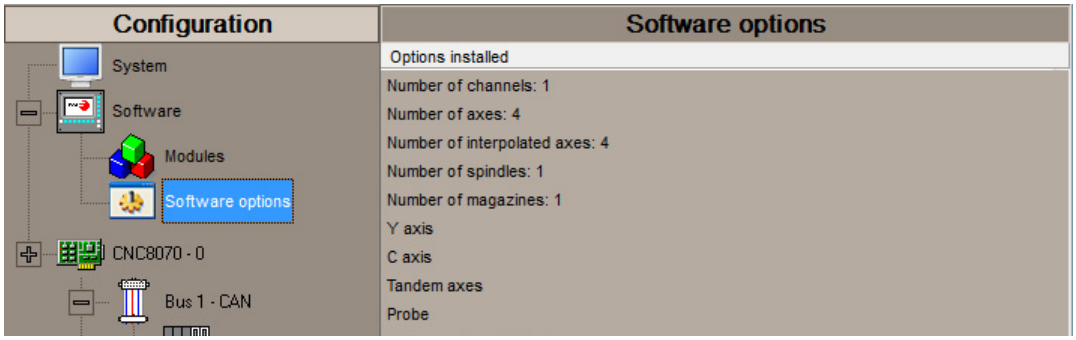
About the product.

SOFTWARE OPTIONS.

Some of the features described in this manual are dependent on the acquired software options. The active software options for the CNC can be consulted in the diagnostics mode (accessible from the task window by pressing [CTRL] [A]), under software options. Consult Fagor Automation regarding the software options available for your model.



Software option	Description.
SOFT ADDIT AXES	Option to add axes to the default configuration.
SOFT ADDIT SPINDLES	Option to add spindles to the default configuration.
SOFT ADDIT TOOL MAGAZ	Option to add magazines to the default configuration.
SOFT ADDIT CHANNELS	Option to add channels to the default configuration.
SOFT 4 AXES INTERPOLATION LIMIT	Limited to 4 interpolated axes.
SOFT DIGITAL SERCOS	Option for a Sercos digital bus.
SOFT THIRD PARTY DRIVES	Option to use EtherCAT third party drives.
SOFT THIRD PARTY I/Os	Option to use third party I/O modules.
THIRD PARTY FEEDBACK	Option to use third-party encoders (BiSS and EnDat protocol). Encoders associated with simulated axes do not require this option.
SOFT OPEN SYSTEM	Option for open systems. The CNC is a closed system that offers all the features needed to machine parts. Nevertheless, at times there are some customers who use third-party applications to take measurements, perform statistics or other tasks apart from machining a part. This feature must be active when installing this type of application, even if they are Office files. Once the application has been installed, it is recommended to close the CNC in order to prevent the operators from installing other kinds of applications that could slow the system down and affect the machining operations.

Software option	Description.
SOFT i4.0 CONNECTIVITY PACK	Options for Industry 4.0 connectivity. This option provides various data exchange standards (for example, OPC UA), which allows the CNC (and therefore the machine tool) to be integrated into a data acquisition network or into a MES or SCADA system.
SOFT EDIT/SIMUL	Option to enable edisimu mode (edition and simulation) on the CNC, which can edit, modify and simulate part programs.
SOFT DUAL-PURPOSE (M-T)	Option to enable the dual-purpose machine, which allows milling and turning cycles. On Y-axis lathes, this option allows for pockets, bosses and even irregular pockets with islands to be made during milling cycles. On a C-axis mill, this option allows turning cycles to be used.
SOFT TOOL RADIUS COMP	Option to enable radius compensation. This compensation programs the contour to be machined based on part dimensions without taking into account the dimensions of the tool that will be used later on. This avoids having to calculate and define the tool paths based on the tool radius.
SOFT PROFILE EDITOR	Option to enable the profile editor in edisimu mode and in the cycle editor. This editor can graphically, and in a guided way, define rectangular, circular profiles or any profile made up of straight and circular sections an it can also import dxf files. After defining the profile, the CNC generates the required blocks and add them to the program.
SOFT HD GRAPHICS In a multi-channel system, this feature requires the MP-PLUS (83700201) processor.	High definition solid 3D graphics for the execution and simulation of part-programs and canned cycles of the editor. During machining, the HD graphics display, in real time, the tool removing the material from the part, allowing the condition of the part to be seen at all times. These graphics are required for the collision control (FCAS).
SOFT IIP CONVERSATIONAL	The IIP (Interactive Icon-based Pages) mode, or conversational mode, works with the CNC in a graphical and guided way based on predefined cycles. There is no need to work with part programs, have any previous programming knowledge or be familiar with Fagor CNCs. Working in conversational mode is easier than in ISO mode, as it ensures proper data entry and minimizes the number of operations to be defined.
SOFT RTCP This feature requires the MP-PLUS (83700201) processor.	Option to enable dynamic RTCP (Rotating Tool Center Point) required to machine with 4, 5 and 6 axis kinematics; for example, angular and orthogonal spindles, tilting tables, etc. The RTCP orientation of the tool may be changed without modifying the position occupied by the tool tip on the part.
SOFT C AXIS	Option to enable C-axis kinematics and associated canned cycles. The machine parameters of each axis or spindle indicate whether it can operate as a C axis or not. For this reason, it is not necessary to add specific axes to the configuration.
SOFT Y AXIS	Option to enable lathe Y-axis kinematics and associated canned cycles.
SOFT TANDEM AXES	Option to enable tandem axle control. A tandem axis consists of two motors mechanically coupled to each other forming a single transmission system (axis or spindle). A tandem axis helps provide the necessary torque to move an axis when a single motor is not capable of supplying enough torque to do it. When activating this feature, it should be kept in mind that for each tandem axis of the machine, another axis must be added to the entire configuration. For example, on a large 3-axis lathe (X Z and tailstock), if the tailstock is a tandem axis, the final purchase order for the machine must indicate 4 axes.

Software option	Description.
SOFT SYNCHRONISM	Option to enable the synchronization of paired axes and spindles, in speed or position, and through a given ratio.
SOFT KINEMATIC CALIBRATION	Option to enable tool calibration. For the first time, this kinematics calibration allows for the kinematics offsets to be calculated using various approximate data and, also, from time to time to correct any possible deviations caused by day-to-day machining operations.
SOFT 60 HSSA I MACHINING SYSTEM	Option to enable the HSSA-I (High Speed Surface Accuracy) algorithm for high speed machining (HSC). This new HSSA algorithm allows for high speed machining optimization, where higher cutting speeds, smoother contours, a better surface finishing and greater precision are achieved.
SOFT HSSA II MACHINING SYSTEM	Option to enable the HSSA-II (High Speed Surface Accuracy) algorithm for high speed machining (HSC). This new HSSA algorithm allows for high speed machining optimization, where higher cutting speeds, smoother contours, a better surface finishing and greater precision are achieved. The HSSA-II algorithm has the following advantages compared to the HSSA-I algorithm. • Advanced algorithm for point preprocessing in real time. • Extended curvature algorithm with dynamic limitations. Improved acceleration and jerk control. • Greater number of pre-processed points. • Filters to smooth out the dynamic machine behavior.
SOFT TANGENTIAL CONTROL	Option to enable tangential control. "Tangential Control" maintains a rotary axis always in the same orientation with respect to the programmed tool path. The machining path is defined on the axes of the active plane and the CNC maintains the orientation of the rotary axis along the entire tool path.
SOFT PROBE	Option to enable functions G100, G103 and G104 (for probe movements) and probe canned cycles (which help to measure part surfaces and to calibrate tools). For the laser model, it only activates the non-cycle function G100. The CNC may have two probes; usually a tabletop probe to calibrate tools and a measuring probe to measure the part.
SOFT FVC STANDARD **SOFT FVC UP TO 10m3** **SOFT FVC MORE TO 10m3**	Options to enable volumetric compensation. The precision of the parts is limited by the machine manufacturing tolerances, wear, the effect of temperature, etc., especially on 5-axis machines. Volumetric compensation corrects these geometric errors to a larger extent, thus improving the precision of the positioning. The volume to be compensated is defined by a point cloud and for each point the error to be corrected is measured. When mapping the total work volume of the machine, the CNC knows the exact position of the tool at all times. There are 3 options, which depend on the size of the machine. • FVC STANDARD: Compensation for 15625 points (maximum 1000 points per axis). Quick calibration (time), but less precise than the other two, but sufficient for the desired tolerances. • FVC UP TO 10m3: Volume compensation up to 10 m³. More accurate than FVC STANDARD, but requires a more accurate calibration using a Tracer or Tracker laser). • FVC MORE TO 10m3: Volume compensation greater than 10 m³. More accurate than FVC STANDARD, but requires a more accurate calibration using a Tracer or Tracker laser.

Software option	Description.
SOFT CONV USER CYCLES	Option to enable user conversational cycles. The user and the OEM can add their own canned cycles (user cycles) using the FGUIM application that comes installed on the CNC. The application offers a guided way to define a new component and its softkey menu without having to be familiar with script languages. User cycles work in a similar way as Fagor canned cycles.
SOFT PROGTL3	Option to enable the ProGTL3 programming language (ISO language extension), allowing profiles to be programmed using a geometric language and without the need to use an external CAD system. This language can program lines and circles where the end point is defined as the intersection of 2 other sections, pockets, ruled surfaces, etc.
SOFT PPTRANS	Option to enable the program translator, which can convert programs written in other languages to Fagor ISO code.
SOFT DMC	Option to enable the DMC (Dynamic Machining Control). DMC adapts the feedrate during machining to maintain the cutting power as close as possible to ideal machining conditions.
SOFT FMC	Option to enable the FMC (Fagor Machining Calculator). The FMC application consists of a database of materials to be machined and machining operations, with an interface to choose suitable cutting conditions for these operations.
SOFT FFC	Option to enable the FFC (Fagor Feed Control). During the execution of a canned cycle of the editor, the FFC function makes it possible to replace the feedrate and speed programmed in the cycle with the active values of the execution, which are acted upon by the feed override and speed override.
SOFT 60/65/70 OPERATING TERMS	Option to enable a temporary user license for the CNC, which is valid until the date set by the OEM. While the license is valid, the CNC will be fully operational (according to the purchased software options).
SOFT FCAS	Option to enable the FCAS (Fagor Collision Avoidance System). The FCAS option, within the system limitations, monitors the automatic, MDI/MDA, manual and tool inspection movements in real time, so as to avoid collisions between the tool and the machine. The FCAS option requires that the HD graphics to be active and that there is a defined a model configuration of the machine adjusted to reality (.xca file), which includes all its moving parts.
SOFT GENERATE ISO CODE	ISO generation converts canned cycles, calls to subroutines, loops, etc. into their equivalent ISO code (G, F, S, etc functions), so the user can modify it and adapt it to his needs (eliminate unwanted movements, etc.). The CNC generates the new ISO code while simulating the program, either from the DISIMU mode or from the conversational mode.
SOFT PWM CONTROL	Option to enable PWM (Pulse - Width Modulation) control on laser machines. This feature is essential for cutting very thick sheets, where the CNC must create a series of PWM pulses to control laser power when drilling the initial point. This function is only available for Sercos bus control systems and must also use one of the two fast digital outputs available from the central unit.
SOFT GAP CONTROL	Option to enable gap control, which makes it possible to set a fixed distance between the laser nozzle and the sheet surface with the use of a sensor. The CNC compensates the difference between the distance measured by the sensor and the programmed distance with additional movements on the axis programmed for the gap.

Software option	Description.
SOFT MANUAL NESTING	Option to enable nesting in the automatic option. Nesting consists of creating a pattern on the sheet material using previously defined figures (in dxf, dwg or parametric files), so as to use most of the sheet as possible. Once the pattern has been defined, the CNC creates a program. During manual nesting, the operator distributes the parts on top of the sheet material.
SOFT AUTO NESTING	Option to enable nesting in the automatic option. Nesting consists of creating a pattern on the sheet material using previously defined figures (in dxf, dwg or parametric files), so as to use most of the sheet as possible. Once the pattern has been defined, the CNC creates a program. During automatic nesting, the application distributes the figures on the sheet material and optimizes the spaces.
SOFT DRILL CYCL OL	Option to enable ISO drilling cycles (G80, G81, G82, G83).

EC DECLARATION OF CONFORMITY, WARRANTY CONDITIONS AND QUALITY CERTIFICATES.

EC-DECLARATION OF CONFORMITY

The declaration of conformity is available from the downloads section of the Fagor Automation corporate website.

https://www.fagorautomation.com/en/downloads/

Type of file: Declaration of conformity.

NRTL CERTIFICATE FOR USA AND CANADA

The quality certificates are available from ·the company· label on the Fagor Automation corporate website.

https://www.fagorautomation.com/en/sections/quality/

WARRANTY TERMS

The sales and warranty conditions are available from the downloads section of the Fagor Automation corporate website.

https://www.fagorautomation.com/en/downloads/

Type of file: General sales - warranty conditions.

SAFETY CONDITIONS.

Read the following safety measures in order to prevent harming people or damage to this product and those products connected to it. Fagor Automation shall not be held responsible of any physical or material damage originated from not complying with these basic safety rules.

Before start-up, verify that the machine that integrates this CNC meets the 2006/42/EC Directive.

PRECAUTIONS BEFORE CLEANING THE UNIT

Do not get into the inside of the unit.	Only personnel authorized by Fagor Automation may access the interior of this unit.
Do not handle the connectors with the unit connected to AC power.	Before handling these connectors (I/O, feedback, etc.), make sure that the unit is not powered.

PRECAUTIONS DURING REPAIRS

In case of a malfunction or failure, disconnect it and call the technical service.

Do not get into the inside of the unit.	Only personnel authorized by Fagor Automation may access the interior of this unit.
Do not handle the connectors with the unit connected to AC power.	Before handling these connectors (I/O, feedback, etc.), make sure that the unit is not powered.

PRECAUTIONS AGAINST PERSONAL HARM

Interconnection of modules.	Use the connection cables provided with the unit.
Use proper cables.	To prevent risks, only use cables and Sercos fiber recommended for this unit. To prevent a risk of electrical shock at the central unit, use the proper connector (supplied by Fagor); use a three-prong power cable (one of them being ground).
Avoid electric shocks.	To prevent electrical shock and fire risk, do not apply electrical voltage out of the indicated range.
Ground connection.	In order to avoid electrical discharges, connect the ground terminals of all the modules to the main ground terminal. Also, before connecting the inputs and outputs of this product, make sure that the ground connection has been done. In order to avoid electrical shock, before turning the unit on verify that the ground connection is properly made.
Do not work in humid environments.	In order to avoid electrical discharges, always work with a relative humidity (non-condensing).
Do not work in explosive environments.	In order to avoid risks, harm or damages, do not work in explosive environments.

PRECAUTIONS AGAINST DAMAGE TO THE PRODUCT

Work environment.

This unit is ready to be used in industrial environments complying with the directives and regulations effective in the European Community.

Fagor Automation shall not be held responsible for any damage suffered or caused by the CNC when installed in other environments (residential, homes, etc.).

Install this unit in the proper place.

It is recommended, whenever possible, to install the CNC away from coolants, chemical product, blows, etc. that could damage it.

This unit meets the European directives on electromagnetic compatibility. Nevertheless, it is recommended to keep it away from sources of electromagnetic disturbance such as:

- Powerful loads connected to the same mains as the unit.
- Nearby portable transmitters (radio-telephones, Ham radio transmitters).
- Nearby radio / TC transmitters.
- Nearby arc welding machines.
- Nearby high voltage lines.

Enclosures.

It is up to the manufacturer to guarantee that the enclosure where the unit has been installed meets all the relevant directives of the European Union.

Avoid disturbances coming from the machine.

The machine must have all the interference generating elements (relay coils, contactors, motors, etc.) uncoupled.

Use the proper power supply.

Use an external regulated 24 Vdc power supply for the keyboard, operator panel and the remote modules.

Connecting the power supply to ground.

The zero Volt point of the external power supply must be connected to the main ground point of the machine.

Analog inputs and outputs connection.

Use shielded cables connecting all their meshes to the corresponding pin.

Ambient conditions.

Maintain the CNC within the recommended temperature range, both when running and not running. See the corresponding chapter in the hardware manual.

Central unit enclosure.

To maintain the right ambient conditions in the enclosure of the central unit, it must meet the requirements indicated by Fagor. See the corresponding chapter in the hardware manual.

Power switch.

This switch must be easy to access and at a distance between 0.7 and 1.7 m (2.3 and 5.6 ft) off the floor.

SAFETY SYMBOLS

Symbols that may appear in the manual.

Danger or prohibition symbol.
This symbol indicates actions or operations that may hurt people or damage products.

Warning or caution symbol.
This symbol indicates situations that certain operations could cause and the suggested actions to prevent them.

Obligation symbol.
This symbol indicates actions and operations that must be carried out.

Information symbol.
This symbol indicates notes, warnings and advises.

Symbol for additional documentation.
This symbol indicates that there is another document with more detailed and specific information.

Symbols that the product may carry.

Ground symbol.
This symbol indicates that that point must be under voltage.

ESD components.
This symbol identifies the cards as ESD components (sensitive to electrostatic discharges).

RETURNING CONDITIONS.

Pack it in its original package along with its original packaging material. If you do not have the original packaging material, pack it as follows:

1. Get a cardboard box whose 3 inside dimensions are at least 15 cm (6 inches) larger than those of the unit itself. The cardboard being used to make the box must have a resistance of 170 Kg (375 lb.).
2. Attach a label to the device indicating the owner of the device along with contact information (address, telephone number, email, name of the person to contact, type of device, serial number, etc.). In case of malfunction also indicate symptom and a brief description of the problem.
3. Protect the unit wrapping it up with a roll of polyethylene or with similar material. When sending a central unit with monitor, protect especially the screen.
4. Pad the unit inside the cardboard box with polyurethane foam on all sides.
5. Seal the cardboard box with packaging tape or with industrial staples.

CNC MAINTENANCE.

CLEANING

The accumulated dirt inside the unit may act as a screen preventing the proper dissipation of the heat generated by the internal circuitry which could result in a harmful overheating of the unit and, consequently, possible malfunctions. Accumulated dirt can sometimes act as an electrical conductor and short-circuit the internal circuitry, especially under high humidity conditions.

To clean the operator panel and the monitor, a smooth cloth should be used which has been dipped into de-ionized water and /or non abrasive dish-washer soap (liquid, never powder) or 75º alcohol. Never use air compressed at high pressure to clean the unit because it could cause the accumulation of electrostatic charges that could result in electrostatic shocks.

The plastics used on the front panel are resistant to grease and mineral oils, bases and bleach, dissolved detergents and alcohol. Avoid the action of solvents such as chlorine hydrocarbons, venzole, esters and ether which can damage the plastics used to make the unit's front panel.

PRECAUTIONS BEFORE CLEANING THE UNIT

Fagor Automation shall not be held responsible for any material or physical damage derived from the violation of these basic safety requirements.

- Do not handle the connectors with the unit supplied with power. Before handling these connectors (I/O, feedback, etc.), make sure that the unit is not powered.
- Do not get into the inside of the unit. Only personnel authorized by Fagor Automation may access the interior of this unit.

NEW FEATURES.

Manual reference:	Ref: 2508
Date of publication:	Août, 2025
Associated software:	v2.50.05

Below is a list of the features added in this software version and the manuals that describe them.

List of features.	Manual
New software option "THIRD PARTY FEEDBACK". • Option to use third-party encoders (BiSS and EnDat protocol). • Encoders associated with simulated axes do not require this option.	
Simulator. • CNC simulator with support for 64-bit Elkhart Lake. • Single setup for free simulator, paid simulator and CNC. The same setup works for CNC (if the Hardware ID exists), paid simulator (if the license file exists) or free simulator (if there is no Hardware ID or license file).	
The PLC comes with the _EMERGEN signal at 0, so that a restore can be done as soon as you receive the CNC without having to modify the PLC.	
PLC Offset. Apply the offset active on the virtual axis to the trihedron axes.	[INST]
Configuring the SSI protocol. • Configuration of start of reading on an SSI encoder. - Machine parameters: SSIGAPCLK	[INST]
Multi-axis: Verification of loop directions. • To facilitate setup, the CNC allows you to close the position loop with the first feedback (SPEEDFBID) and view the second feedback count (POSITIONFBID) with the A.POS2NC.xn variable. This is controlled using the FBMIXTIME=-1 parameter. - Machine parameter: FBMIXTIME	[INST]
The number of global user variables (V.S.) increases from 118 to 250.	[PRG] [VAR]
Change of permissions of the following variables. Variable that can be read and written via program and interface. - Variable: (V.)MPCMP.POSERROR[point].table Error to be compensated at each point, for positive displacements. - Variable: (V.)MPCMP.NEGERROR[point].table Error to be compensated at each point, for negative displacements.	[VAR]
The Operating Terms page shows the Hardware ID of the CNC.	

[CYC-M]..... Machining canned cycles (·M· model).
[EASY]..... Easyplane.
[ERR]..... Solución de errores.
[INST]..... Installation manual.
[PRG]..... Programming manual.
[PROGTL3]..... Lenguaje ProGTL3.
[VAR]..... CNC variables.

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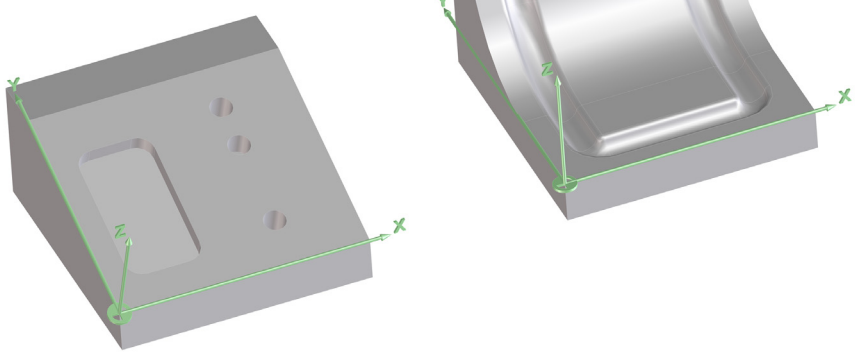
1 5-axis machining.

In 5-axis (or 3+2) machining, the main X-Y-Z axes define the working trihedron and the two rotary axes of the kinematics (on the table and/or spindle) guide the tool. This allows the tool to approach the part from any direction.

- In 3+2 axis machining, the work plane is inclined at a fixed angle to the machine axes (#CS/#ACS). With the tool perpendicular to this plane (#TOOL ORI), machining is carried out on the X-Y-Z axes of the inclined plane. 3+2 machining allows 2D machining to be carried out in any direction of the tool. Activating the kinematics (#KIN ID) with the "TIP=1" option allows you to control the tool tip coordinates.
- In 5-axis continuous machining, the X-Y-Z axes and the rotary axes can be moved simultaneously by pivoting the tool on its tip (#RTCP). The tool tip stays in the programmed tool path while the tool direction changes. 5-axis machining allows 3D surfaces and shapes to be machined, always keeping the tool perpendicular to the tool path.



3+2-axis machining (left) and 5-axis machining (right).

Manual kinematics.

In this type of kinematics, the user must manually move the rotary axes of the kinematics and then define the new position in the CNC. This position is defined by writing the following variables.

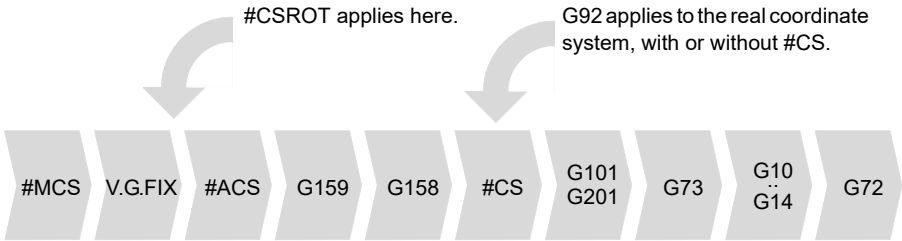
Variables.	Meaning.
V.G.POSROTF	Current position of the first rotary axis of the kinematics.
V.G.POSROTS	Current position of the second rotary axis of the kinematics.
V.G.POSROTT	Current position of the third rotary axis of the kinematics.
V.G.POSROTO	Current position of the fourth rotary axis of the kinematics.

After defining the position, activate RTCP (#RTCP ON) or kinematics (#KIN ID [{id},TIP=1]) so that the CNC can update the coordinates of the tool tip.

```
#MSG["Rotate the kinematics axes and press [START]"]
    (Message to rotate the kinematics axes)
M0
    (Interruption of the execution)

#MSG[""]
V.G.POSROTF=V.G.TOOLORIF2
V.G.POSROTS=V.G.TOOLORIS2
    (Confirmation of the position occupied by the rotating axes)
    (Tool perpendicular to the inclined plane)

#KIN ID [1,TIP=1]
    (Update the tool tip coordinates)
```

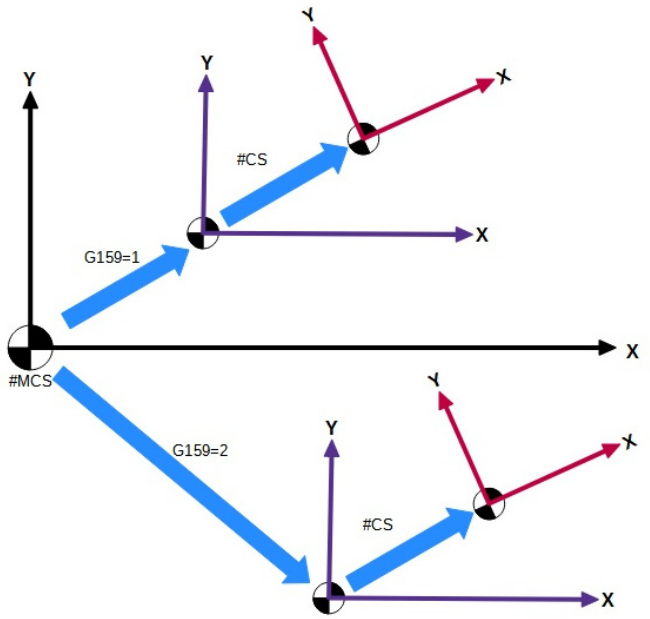
1.1 Construction of the coordinate system.

EASYPLANE simplifies the coordinate system programming for 3+2 or 5 axes (zero offsets + RTCP + inclined planes). When performing the coordinate transformation, each instruction has a priority index and it is always the same, regardless of the programming order.



Instruction.	Meaning.
#MCS	Programming in the machine coordinate system.
V.G.FIX	Zero offset of the fixture.
#ACS	Fixture coordinate system (inclined plane).
G159	Absolute part zero offset.
G158	Incremental part zero offset.
#CS	Part coordinate system (inclined plane).
G101	Probe measuring error.
G201	Additive manual intervention.
G73	Rotation of the coordinate system.
G10..G14	Mirror image.
G72	Scaling factor.

If one of the instructions is modified, the new value replaces the previous one in the coordinate transformation. This means that the resulting plane is the same, regardless of the order in which the instructions are programmed.



#MCS represents the origin of the machine coordinate system, G159 the zero offset and #CS the definition of an inclined plane.

1.2 Behavior of the coordinate systems.

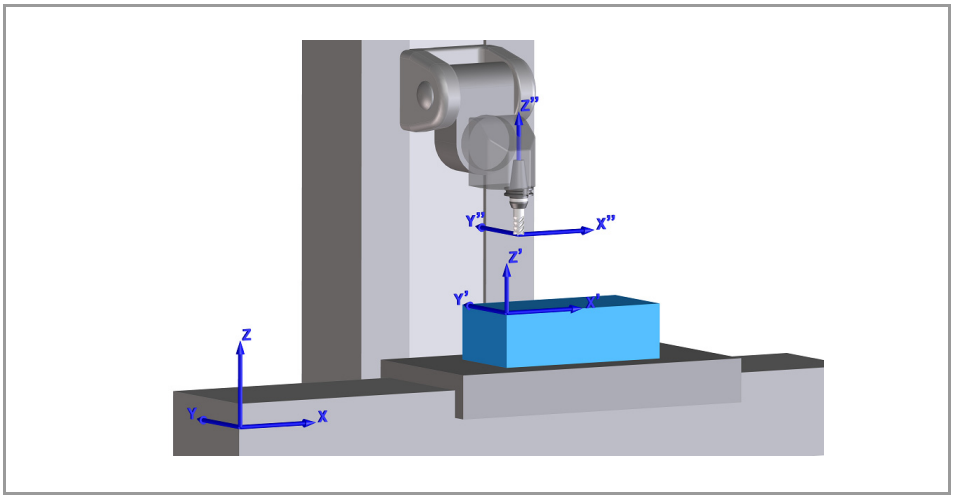
1.2.1 Spindle kinematics.

When the kinematics is at rest, and there is no active transformation, the following 3 coordinate systems coincide.

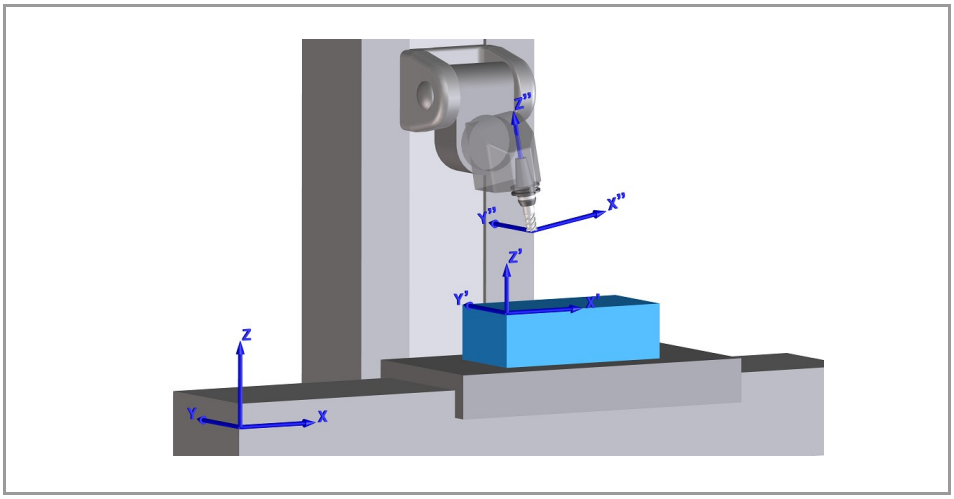
X Y Z Machine coordinate system.

X' Y' Z' Part coordinate system.

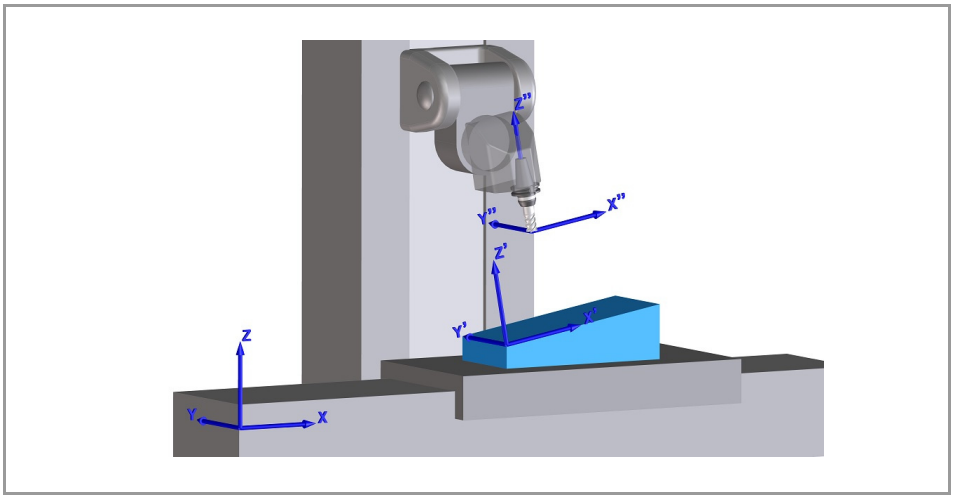
X" Y" Z" Tool coordinate system.



The spindle movement changes the direction of the tool coordinate system (X" Y" Z").



The activation of an inclined plane (#ACS/#CS), changes the coordinate system of the part (X' Y' Z').



1.2.2 Table kinematics.

When the kinematics is at rest, and there is no active transformation, the following 3 coordinate systems coincide.

X Y Z	Machine coordinate system.
X' Y' Z'	Part coordinate system.
X" Y" Z"	Tool coordinate system.

Since the kinematics are located on the table, the tool coordinate system is always fixed.

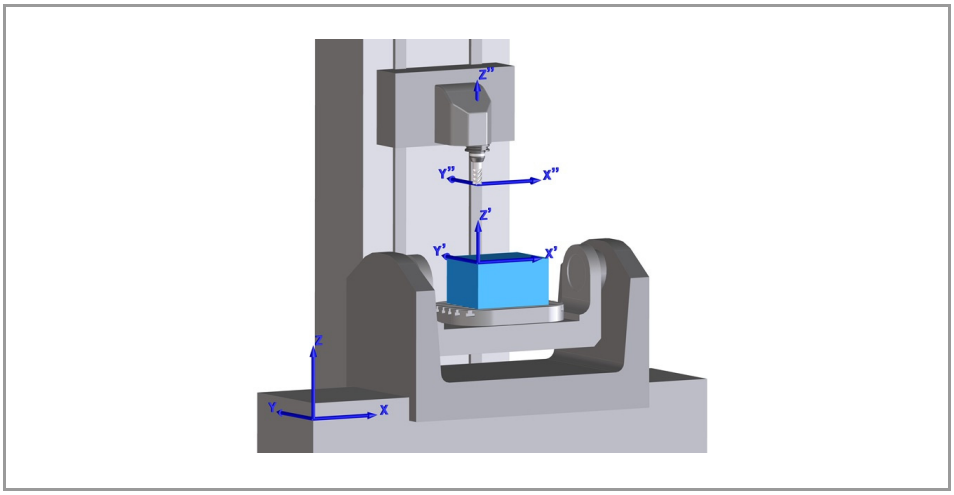


Table movement without RTCP enabled does not change the direction of the coordinate system of the part (X' Y' Z').

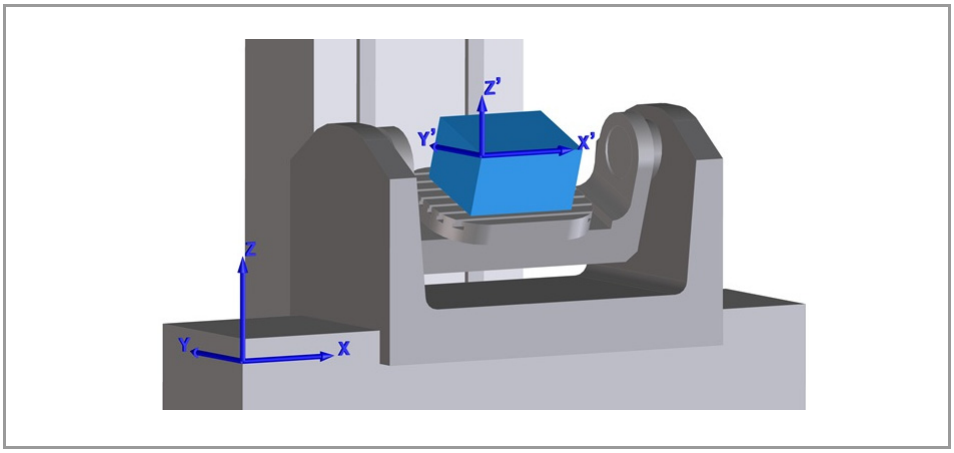
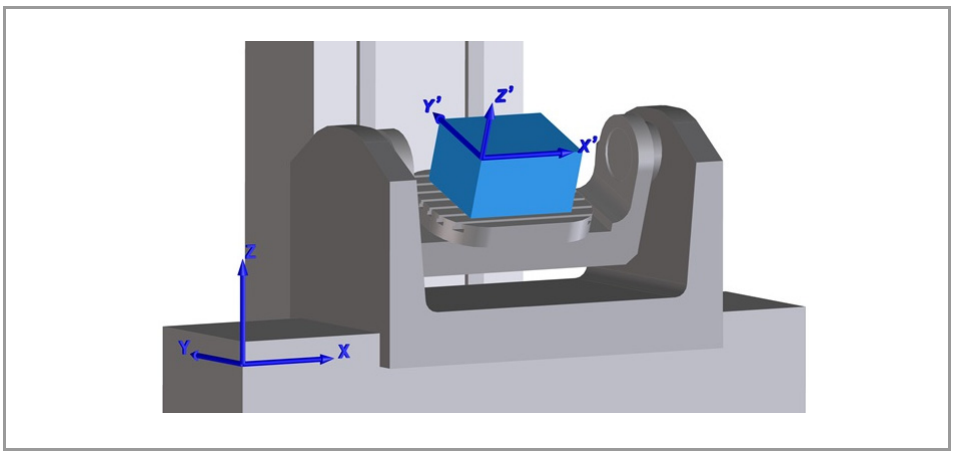
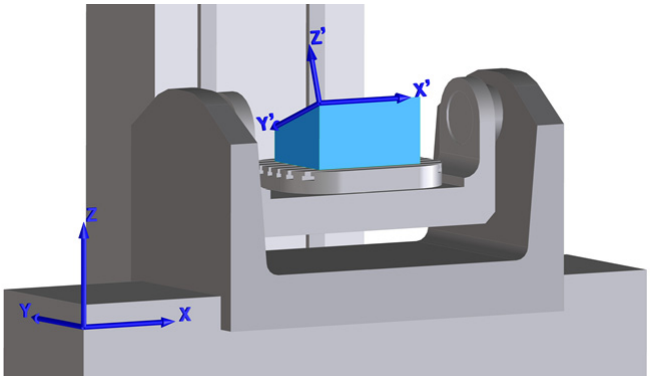


Table movement with RTCP enabled changes the direction of the coordinate system of the part (X' Y' Z').



The activation of an inclined plane (#ACS/#CS), changes the coordinate system of the part (X' Y' Z').



2 Activation of kinematics (#KIN ID).

The #KIN ID statement activates the kinematics that allows the tool to be aligned for 3+2 or 5-axis machining operations. The OEM may have associated a subroutine to the #KIN ID instruction, which the CNC executes together with the command. When this subroutine exists, the #KIN ID instruction can initialize local arithmetic parameters.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

```
#KIN ID [{kinematics} <,TIP/TIP={mode}>] <P0..Pn={value}>
```

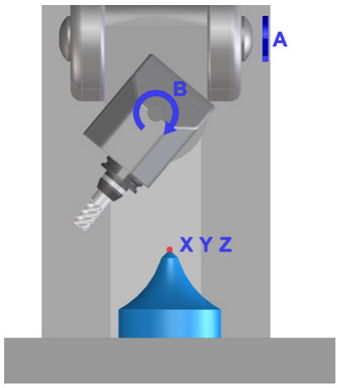
{kinematics}	Kinematics number. 0: Deactivating the kinematics. 1..6: Kinematics number.
TIP	Activation of kinematics equivalent to TIP=1.
TIP={mode}	How to display the coordinates when rotating the axes of the kinematics. 0: Do not update the tool tip coordinates. 1: Update the tool tip coordinates. Optional; if not programmed, value 0.
P0..Pn={value}	Initializing of local parameters. Optional; program only if there is a subroutine associated to #KIN ID.

```
#KIN ID [2]
    (Activate kinematics number 2)
    (Do not update the tool tip coordinates)
    (Equivalent to program #KIN ID [2, TIP=0])

#KIN ID [2, TIP]
    (Activate kinematics number 2)
    (Update the tool tip coordinates)
    (Equivalent to program #KIN ID [2, TIP=1])

#KIN ID [2, TIP=0] P0=3 P5=4
    (Activate kinematics number 2)
    (Do not update the tool tip coordinates)
    (Initialization of P0 and P5 parameters)

#KIN ID [0]
    (Deactivating the kinematics)
```

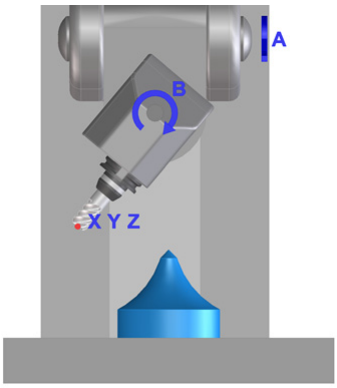
Kinematics activation mode (TIP command).

TIP=0 When the kinematics is rotated, the CNC does not update the tool tip coordinates. To display the tip coordinates, it is necessary to activate RTCP. With the RTCP active, operations of C axis are not permitted (#FACE, #CYL).

TIP=1 When rotating the kinematics, the CNC updates the tool tip coordinates, so it is not necessary to activate the RTCP. As RTCP is not active, C-axis operations are allowed (#FACE, #CYL).



#KIN ID [1, TIP=0]



#KIN ID [1, TIP=1]

Considerations.

- With TIP=1, for safety, it is not permitted to program the rotary axes of the kinematics together with the linear axes. After positioning the rotary axes, the three linear axes of the trihedron should be programmed.
- Activate table kinematics with the option TIP=1, view the coordinates of the tool tip without coordinate system rotation; that is, with axes parallel to the machine reference system.
- Functions #RTCP, #TLC and #TOOL ORI must always be activated after selecting a kinematics.
- The kinematics cannot be changed while function #RTCP or #TLC is active.
- The kinematics adopted by the CNC by default (on start-up, after running M02, M30 or after reset) depends on the OEM configuration (KINID parameter).
- The TIP command that the CNC adopts by default (on start-up, after running M02, M30 or after reset) depends on the OEM configuration (KINTIP parameter).

2.1 Summary of the variables.

The following variables may be accessed from (PRG) the part-program and from the MDI/MDA mode, PLC and (INT) from an external application. For each variable, the table indicates whether the access is reading (R) or writing (W). PLC access to the variables, for both reading and writing, will be synchronous. Access to the variables from the part program returns the value for the block preparation (it does not stop the preparation), except when indicated otherwise.

Variables.	PRG	PLC	INT
(V.)[ch].G.KINTYPE Type of the active kinematics. If no kinematics is active, the variable will return a ·0· value. Units: -.	R	R	R
(V.)[ch].G.KINIDMODE Value of the TIP command of the active kinematics. This variable returns one of the following values. 0: TIP=0. 1: TIP=1. Units: -.	R(*)	R	R
(V.)[ch].G.NKINAX Number of axes of the active kinematics. Units: -.	R	R	R

(*) The CNC evaluates the variable during execution (it stops the block preparation).

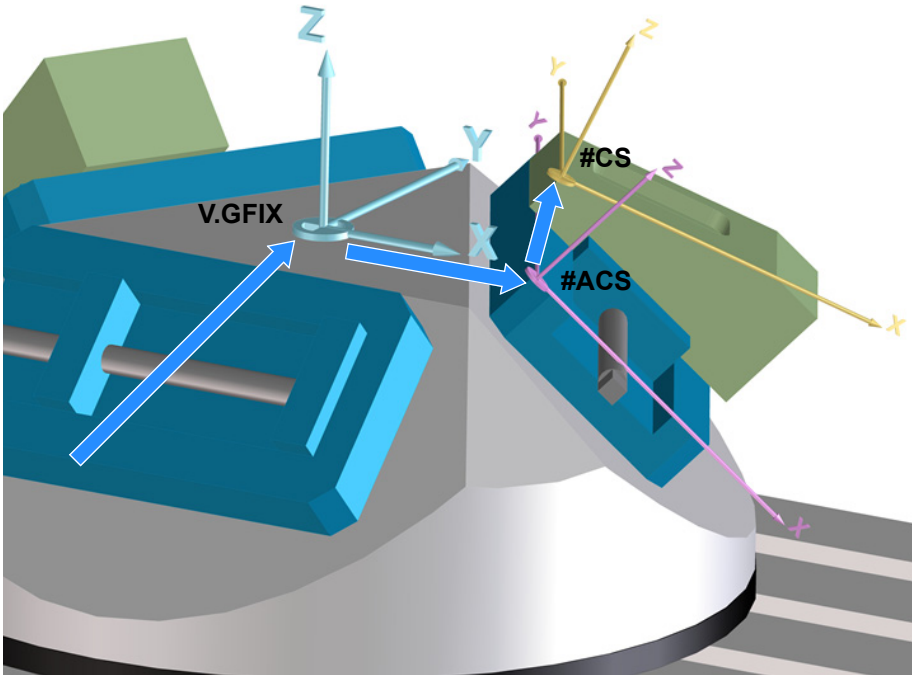
Syntax.

·ch· Channel number.

V.[2].G.KINTYPE	Type of the active kinematics.
V.[2].G.KINIDMODE	Value of the TIP command of the active kinematics.

3 Definition of inclined planes (#CS / #ACS).

There are two types of coordinate systems: the machining one (#CS) and the clamping one (#ACS). Both instructions use the same programming format and may be used together or separately.



Programming options.

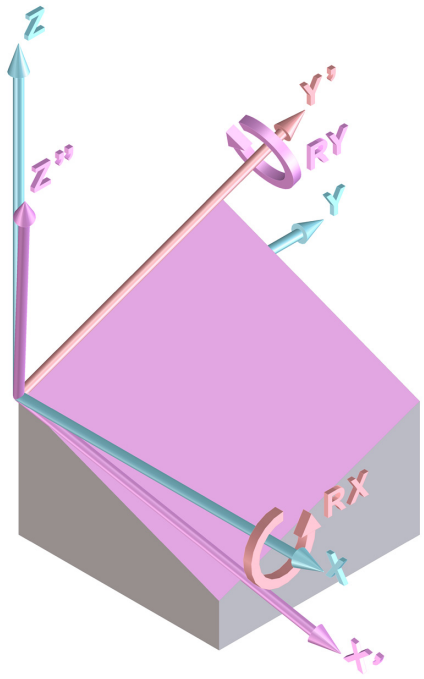
Instruction.	Meaning.
#ACS {parameters} #CS {parameters}	Define a new inclined plane (replaces the active plane).
#ACS ADD {parameters} #CS ADD {parameters}	Add the new inclined plane to the active plane.
#ACS OFF #CS OFF	Delete the active inclined plane.
#ACS{id} SAVE #CS{id} SAVE	Save the active inclined plane.
#ACS{id} ON #CS{id} ON	Load a saved inclined plane.

Considerations for the two functions.

With Easyplane active (parameter EASYPLANE), the inclined plane remains active after a reset and after executing M02 or M30. At start-up, the CNC maintains or cancels the coordinate system according to that defined by the OEM (CSCANCEL parameter).

3.1 Rotation about the coordinate axes.

Mode for defining an inclined plane by means of rotations about a coordinate system. The definition of the plane allows a maximum of three rotations. The programming order of the rotations (RX, RY and RZ) defines the rotation order of the plane. It is possible to program a number of rotations on the same axis.



Plane generated with two rotations; first on the X axis and then on the new Y axis.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

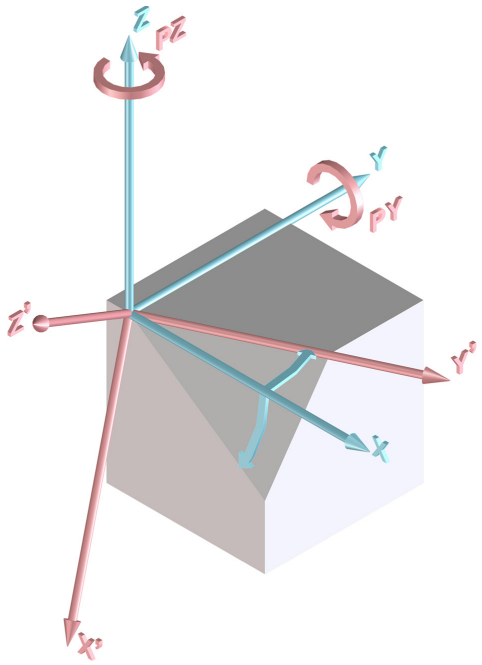
```
#CS
  <ADD>
  <X{origin}> <Y{origin}> <Z{origin}>
  <RX{rotation}> <RY{rotation}> <RZ{rotation}>
```

ADD	Add the new plane to the active one. Optional; if not programmed, the new plane replaces the previous one.
X{origin} Y{origin} Z{origin}	Origin of the plane in the first three axes of the channel; X for the first axis (abscissa), Y for the second axis (ordinate) and Z for the third axis (perpendicular to the plane). Optional; only program the required coordinates.
RX{rotation} RY{rotation} RZ{rotation}	Rotation of the axes; RX on the X axis, RY on the Y axis and RZ on the Z axis. The programming order defines the rotation order of the axes. It is possible to repeat the axis of rotation. Optional; only program the required rotations.

```
#CS X20 Z-70 RX45 RY10
    (Origin of the plane in X20 Y-70)
    (First rotation of 45º about the X-axis)
    (Second rotation of 10º about the new Y' axis)

#CS ADD Z40 RZ30 RY10 RZ20
    (Change active plane)
    (Origin of the plane in Z40)
    (First rotation of 30º about the Z-axis)
    (Second rotation of 10º about the new Y' axis)
    (Third rotation of 20º about the Z' axis)

#CS ADD X100
    (Add an offset in X)

#CS ADD RY30
    (Add a Y rotation)
```

3.2 Angles of the plane projection about the axes.

Mode for defining an inclined plane by projecting its angles on the coordinate axes. The definition of the plane allows two of the three possible projection angles to be programmed (PX, PY and PZ).



Projection of angles on the Y and Z axes. Alignment of the Y-axis with the corner.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

```
#CS
  <ADD>
  <X{origin}> <Y{origin}> <Z{origin}>
  <PX{angle}> <PY{angle}> <PZ{angle}>
  <Q{rotación}>
  <ALIGNX/ALIGNY>
```

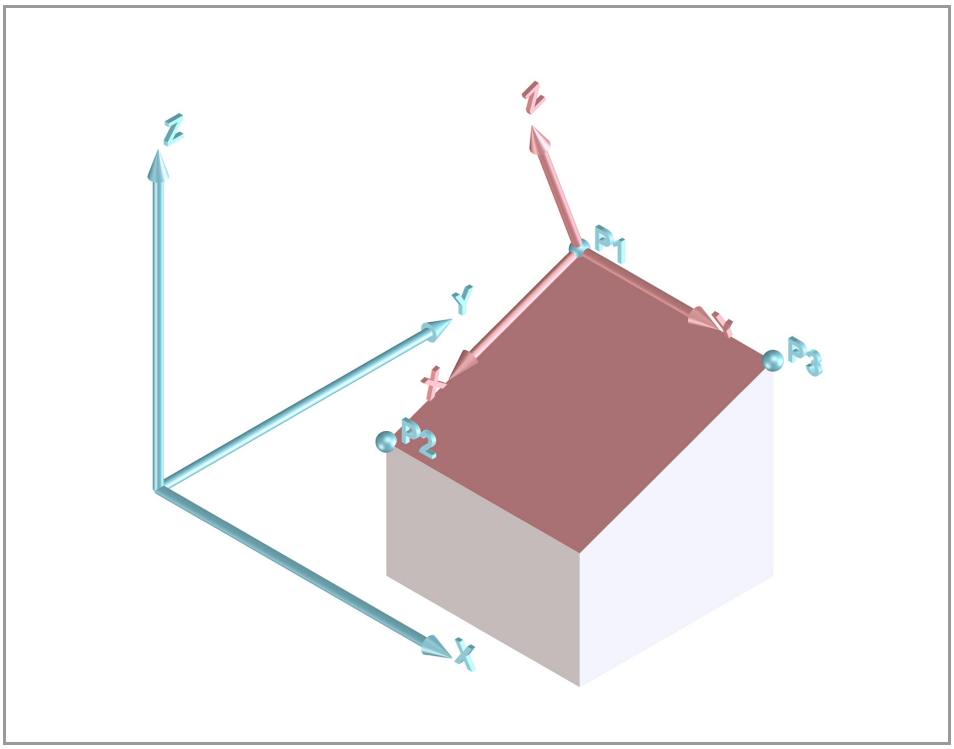
ADD	Add the new plane to the active one. Optional; if not programmed, the new plane replaces the previous one.
X{origin} Y{origin} Z{origin}	Origin of the plane in the first three axes of the channel; X for the first axis (abscissa), Y for the second axis (ordinate) and Z for the third axis (perpendicular to the plane). Optional; only program the required coordinates.
PX{angle} PY{angle} PZ{angle}	Angles of the plane projection; PX on the X axis, PY on the Y axis and PZ on the Z axis. Optional; only program the required projections (maximum 2).
Q{rotación}	Coordinate rotation about Z' of the plane. Optional; by default, 0.
ALIGNX ALIGNY	Axis of the (X' Y') plane that is aligned with the corner. Use the following commands. ALIGNX: Alignment of the X' axis. ALIGNY: Alignment of the Y' axis. Optional; by default, ALIGNX.

```
#CS X100 PX20 PY30
    (Origin of the plane in X100)
    (20º angle on the X axis)
    (30º angle on the Y axis)
```

3.3 Plane defined by three points.

Mode for defining a plane through three points. First the three points that determine the plane must be programmed and then the plane must be activated.

- Positive X' axis: Direction from P1 to P2.
- Positive Y' axis: Perpendicular to X' and in direction of P3.
- Positive Z' axis: Perpendicular to X' and Y', in the direction that defines a positive X'Y'Z' trihedron.



Programming.

Program each statement alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

```
#CS P1 X{position} Y{position} Z{position}
#CS P2 X{position} Y{position} Z{position}
#CS P3 X{position} Y{position} Z{position}
```

P1 P2 P3	Point to be defined. Use the following commands. P1: First point. P2: Second point. P3: Third point.
X{position} Y{position} Z{position}	Position of the point; X for the first axis (abscissa), Y for the second axis (ordinate) and Z for the third axis (perpendicular to the plane).

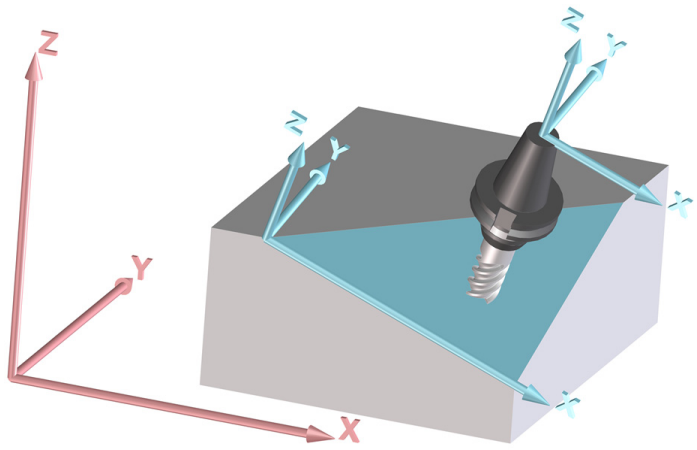
```
#CS <ADD> <X{origen}> <Y{origen}> <Z{origen}> M3P <Q{rotación}>
```

ADD	Add the new plane to the active one. Optional; if not programmed, the new plane replaces the previous one.
X{origin} Y{origin} Z{origin}	Origin of the plane in the first three axes of the channel; X for the first axis (abscissa), Y for the second axis (ordinate) and Z for the third axis (perpendicular to the plane). Optional; only program the required coordinates.
M3P	Plane defined by three points.
Q{rotación}	Coordinate rotation about Z' of the plane. Optional; by default, 0.

```
#CS P1 X100 Y0 Z-10
#CS P2 X45 Y15 Z20
#CS P3 X0 Y0 Z0
    (Definition of the three points that define the plane)
#CS M3P
    (Activation of the plan)
```

3.4 Plane perpendicular to the tool.

This mode defines an inclined plane perpendicular to the tool axis. The new work plane assumes the orientation of the tool's coordinate system.



Plane perpendicular to the tool, aligned with the X axis.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

```
#CS
  <ADD>
  <X{origin}> <Y{origin}> <Z{origin}>
  T
  <Q{rotación}>
  <ALIGNX/ALIGNY>
```

ADD	Add the new plane to the active one. Optional; if not programmed, the new plane replaces the previous one.
X{origin} Y{origin} Z{origin}	Origin of the plane in the first three axes of the channel; X for the first axis (abscissa), Y for the second axis (ordinate) and Z for the third axis (perpendicular to the plane). Optional; only program the required coordinates.
T	Plane perpendicular to the tool.
Q{rotación}	Coordinate rotation about Z' of the plane. Optional; by default, 0.
ALIGNX ALIGNY	Axis of the (X' Y') plane that is aligned with the machine. Use the following commands. ALIGNX: Alignment of the X'-axis with the X-axis of the machine. ALIGNY: Alignment of the Y'-axis with the Y-axis of the machine. Optional; by default, ALIGNX.

```
#CS X100 T
    (Origin of the plane in X100)
    (The T command indicates that the plane is perpendicular to the tool)
```

3.5 Cancel the active inclined plane.

When the inclined plane is cancelled, the CNC recovers the coordinate system parallel to the machine axes. The CNC does not modify the position of the part zero.

Programming.

Program each statement alone in the block.

Programming format.

The programming format is:

#CS OFF

```
#CS OFF
```

3.6 Save the active inclined plane.

The CNC allows the storage of up to five inclined planes. Stored planes are deleted after M30, reset or a shutdown.

Programming.

Program each statement alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets.

#CS{id} SAVE

{id}	Identifier or plane number (from 1 to 5).
SAVE	Save the inclined plane.

```
#CS1 SAVE
    (Save the active inclined plane with id=1)

#CS[P1] SAVE
    (Save the active inclined plane)
    (The value of P1 indicates the plane's ID)
```

3.7 Load a previously saved inclined plane.

Programming.

Program each statement alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets.

#CS{id}

{id}	Identifier or plane number (from 1 to 5).

```
#CS1
    (Load inclined plane stored with id=1)
```

3.8 Summary of the variables.

The following variables may be accessed from (PRG) the part-program and from the MDI/MDA mode, PLC and (INT) from an external application. For each variable, the table indicates whether the access is reading (R) or writing (W). PLC access to the variables, for both reading and writing, will be synchronous. Access to the variables from the part program returns the value for the block preparation (it does not stop the preparation), except when indicated otherwise.

Definition of inclined planes (#CS / #ACS).

Variable.	PRG	PLC	INT
(V.)[ch].G.ACSX **(V.)[ch].G.ACSY** **(V.)[ch].G.ACSZ** Translation of the active #ACS plane in the XYZ axes. Units (PRG): 1 (mm) | 1 (inch).	R	R	R
(V.)[ch].G.ACSRX **(V.)[ch].G.ACSRY** **(V.)[ch].G.ACSRZ** Rotation of the active #ACS plane in the XYZ axes. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.CSX **(V.)[ch].G.CSY** **(V.)[ch].G.CSZ** Translation of the active #CS plane in the XYZ axes. Units (PRG): 1 (mm) | 1 (inch).	R	R	R
(V.)[ch].G.CSRX **(V.)[ch].G.CSRY** **(V.)[ch].G.CSRZ** Rotation of the active #CS plane in the XYZ axes. Units (PRG): 1 (º).	R	R	R

Syntax.

·ch· Channel number.

Tool perpendicular to the inclined plane (#TOOL ORI).

Variable.	PRG	PLC	INT
(V.)[ch].G.TOOLORIERR1 Positioning error of the hirth axis (solution 1). Units (PRG): 1 (mm) | 1 (inch).	R	R	R
(V.)[ch].G.TOOLORIERR2 Positioning error of the hirth axis (solution 2). Units (PRG): 1 (mm) | 1 (inch).	R	R	R
(V.)[ch].G.TOOLORISOL1 Valid TOOLORI solution (solution 1). Units: -.	R	R	R
(V.)[ch].G.TOOLORISOL2 Valid TOOLORI solution (solution 2). Units: -.	R	R	R
(V.)[ch].G.ACTPOSLIM1 Positive limit coordinate of the first channel axis. Units (PRG): 1 (mm) | 1 (inch).	R	R	R
(V.)[ch].G.ACTPOSLIM2 Positive limit coordinate of the second channel axis. Units (PRG): 1 (mm) | 1 (inch).	R	R	R
(V.)[ch].G.ACTPOSLIM3 Positive limit coordinate of the third channel axis. Units (PRG): 1 (mm) | 1 (inch).	R	R	R

Syntax.

·ch· Channel number.

4 Tool perpendicular to the inclined plane (#TOOL ORI).

The #TOOL ORI statement has an associated subroutine (TOOLORISUB parameter), where the positioning strategy and movements to position the tool are defined. This subroutine can be configured by the OEM. This manual explains the programming to use the subroutine supplied by Fagor. Refer to the machine manual for OEM modifications related to the programming of this subroutine.

The #TOOL ORI instruction is used to position the tool perpendicular to the active inclined plane. The process of shaft orientation gives rise to two possible solutions for rotary shaft positioning. This statement allows you to select the solution to be applied.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

#TOOL ORI <O{solución}> <R{retroceso}> <S{selectOri}> <E{hirth}> <L{longitud}>

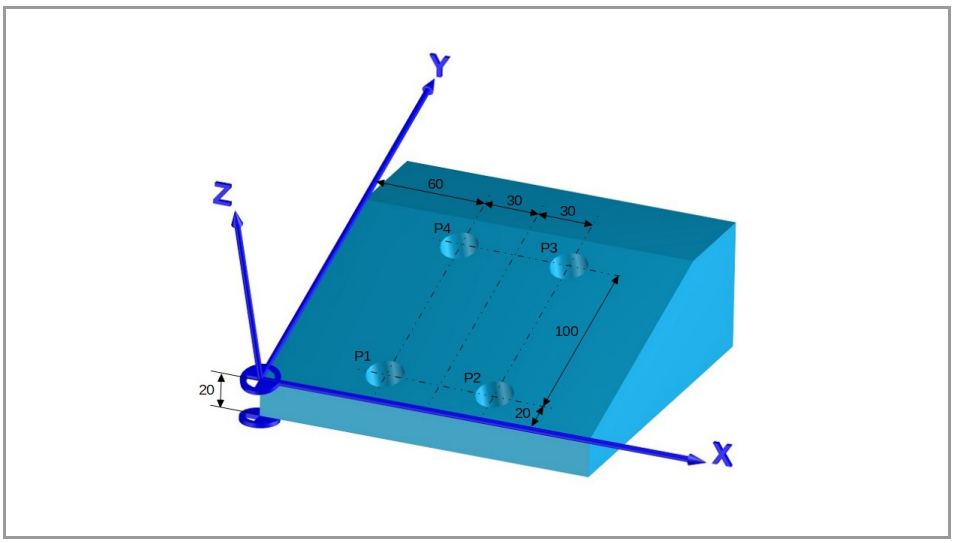
OR{solución}	Solution for positioning, based on the movement of the main rotary. Use the following values. 0: Via the shortest way. 1: Main rotary axis via the shortest path, in a positive direction. 2: Main rotary axis via the shortest path, in a negative direction. 3: Main rotary axis via the longest path, in a positive direction. 4: Main rotary axis via the longest path, in a negative direction. 5: First solution (less movement of the main rotary axis). 6: Second solution (greater movement of the main rotary axis). Optional; if not programmed, value 0.
R{retroceso}	Distance to retract the tool before orienting it, when there is no RTCP. With value 0, movement up to the travel limit. If only R is programed, value 0. Optional; if not programmed, there's no withdrawal.
S{selectOri}	Select the rotary axes that guide the tool. 0: Both spindle axes. 1: First axis of the spindle / First axis of the table. 2: First axis of the spindle / Second axis of the table. 3: Second axis of the spindle / First axis of the table. 4: Second axis of the spindle / Second axis of the table. 5: Both table axes. 6: Both spindle axes, taking into account the position of the table. Optional; if not programmed, value 0.
E{hirth}	Positioning error for Hirth axes. Optional; if not programmed, 0.015 mm.
L{length}	Increase in tool length, so that the RTCP pivots at that distance from the tool tip. With value 0, the tool pivots on its tip. Optional; if not programmed, value 0.

```
#TOOL ORI R20
    (Tool perpendicular to the inclined plane)
    (Tool retracts 20 mm before orientation)
```

Select the rotary axes that guide the tool (command S).

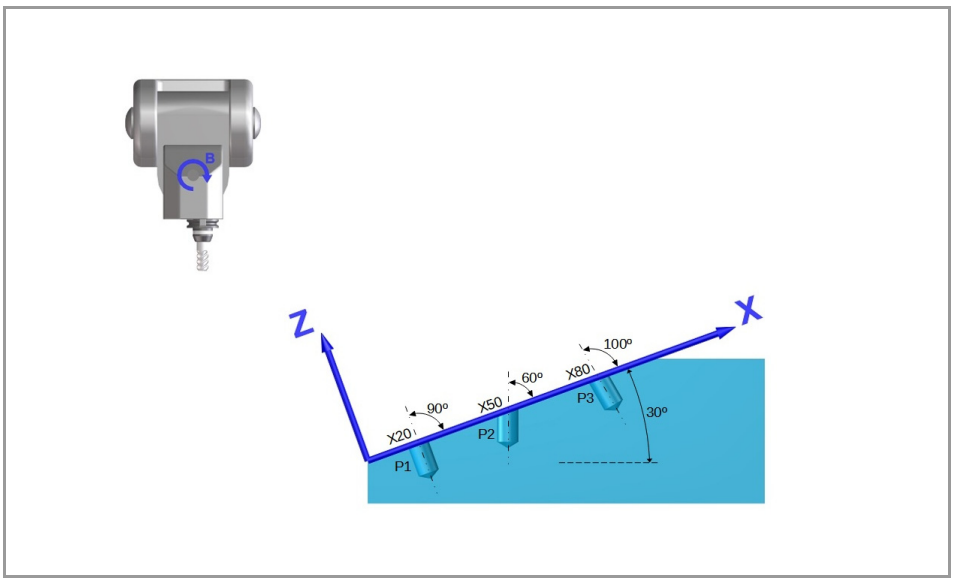
Kinematics 52 has at the most 2 rotary axes on the spindle and two rotary axes on the table, which means that there may be up to 4 rotary axes to orient the tool on the work piece. This statement allows you to choose which rotary axes to be used to guide the tool.

Programming example (1)




```
#CS X0 Y0 Z20 RX30
    (Define the inclined plane)
#TOOL ORI R20
    (Tool perpendicular to the inclined plane)
G90 G0 X60 Y20 Z3
    (Position at point P1)
F1000 S300 M3
G81 Z5 I13
    (Drilling canned cycle)
G0 G90 X120 Y20
    (Position at point P2)
    (Drilling)
G0 G90 X120 Y120
    (Position at point P3)
    (Drilling)
G0 G90 X60 Y120
    (Position at point P4)
    (Drilling)
G80
G0 Z50
    (Withdrawal)
M30
```

Programming example (2)




```
F1000 S300 M3
;
; *** Drilling P1 ***
#CS X0 Y0 Z20 RY-30
    (Define the inclined plane)
#TOOL ORI R20
    (Tool perpendicular to the inclined plane)
    (The tool retracts 20 mm)
G1 G90 X20 Y20 Z25
    (Movement to point P1 and Z25)
G81 Z5 I-18
    (Drilling canned cycle)
G80
    (Cancel canned cycle)
;
; *** Drilling P2 ***
#CS ADD X50 RY30
    (Define the incremental inclined plane)
#TOOL ORI R20
    (Tool perpendicular to the inclined plane)
    (The tool retracts 20 mm)
G1 G90 X0 Z25
    (Movement to point P2 and Z25)
G81 Z5 I-18
G80
;
; *** Drilling P3 ***
#CS ADD RY-30
#CS ADD X30 RY-10
(Define the incremental inclined plane)
#TOOL ORI R20
    (Tool perpendicular to the inclined plane)
    (The tool retracts 20 mm)
G1 G90 X0 Z25
    (Movement to point P3 and Z25)
G81 Z5 I-18
G80
;
#CS OFF
    (Cancel the inclined plane)
M30
```

4.1 Summary of the variables.

The following variables may be accessed from (PRG) the part-program and from the MDI/MDA mode, PLC and (INT) from an external application. For each variable, the table indicates whether the access is reading (R) or writing (W). PLC access to the variables, for both reading and writing, will be synchronous. Access to the variables from the part program returns the value for the block preparation (it does not stop the preparation).

Variables.	PRG	PLC	INT
(V.)[ch].G.POSROTF Current position of the first rotary axis of the kinematics. Units (PRG): 1 (º).	R/W	R/W	R/W
(V.)[ch].G.POSROTS Current position of the second rotary axis of the kinematics. Units (PRG): 1 (º).	R/W	R/W	R/W
(V.)[ch].G.POSROTT Current position of the third rotary axis of the kinematics. Units (PRG): 1 (º).	R/W	R/W	R/W
(V.)[ch].G.POSROTO Current position of the fourth rotary axis of the kinematics. Units (PRG): 1 (º).	R/W	R/W	R/W
(V.)[ch].G.TOOLORIF1 Position (machine coordinates) to be occupied by the first rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 1. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.TOOLORIS1 Position (machine coordinates) to be occupied by the second rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 1. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.TOOLORIT1 Position (machine coordinates) to be occupied by the third rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 1. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.TOOLORIO1 Position (machine coordinates) to be occupied by the fourth rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 1. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.TOOLORIF2 Position (machine coordinates) to be occupied by the first rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 2. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.TOOLORIS2 Position (machine coordinates) to be occupied by the second rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 2. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.TOOLORIT2 Position (machine coordinates) to be occupied by the third rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 2. Units (PRG): 1 (º).	R	R	R
(V.)[ch].G.TOOLORIO2 Position (machine coordinates) to be occupied by the fourth rotary axis in order to position the tool perpendicular to the inclined plane, according to solution 2. Units (PRG): 1 (º).	R	R	R

Syntax.

·ch· Channel number.

5 5-axis machining with RTCP (Rotating Tool Center Point).

The RTCP represents a compensation of length in space, which allows you to know the position of the tool tip at any position of the kinematics. The CNC has two types of RTCP.

- The dynamic RTCP executes the kinematic movements on the tool tip. The CNC interpolates the axes required to maintain the position of the tool tip on the part.
- The static RTCP executes the kinematic movements without taking into account the tool tip or interpolating the other axes. The CNC updates the coordinates of the tool tip, taking into account the position of the rotary axes. If the position of the rotary axes is modified from the kinematics, the RTCP must be reprogrammed to update the coordinates.

Considerations about the RTCP transformation.

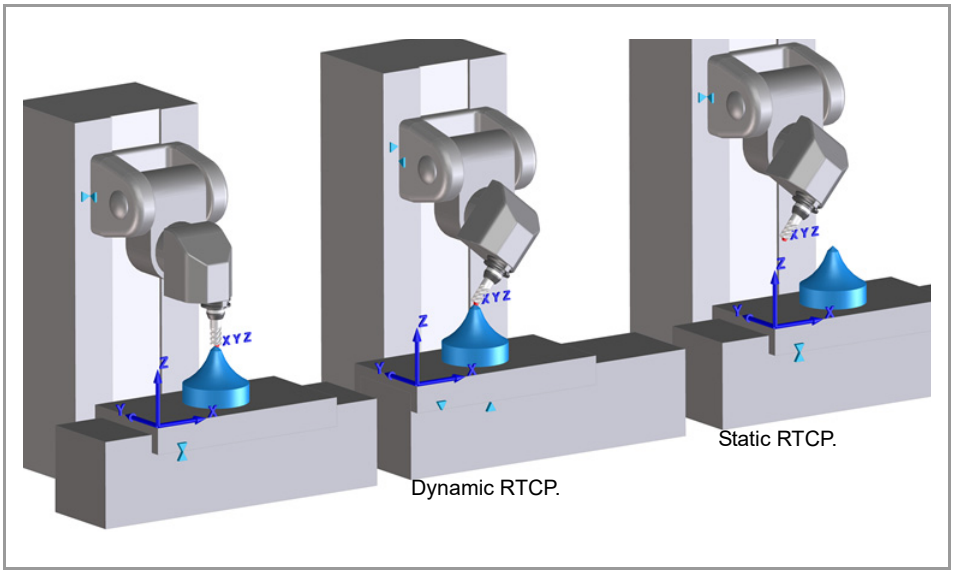
- In order to work with RTCP transformation, the first three axes of the channel (for example X, Y, Z) must be defined, they must form a trihedron and be linear. These axes may be GANTRY axes.
- Being RTCP transformation active, it is possible to apply zero offsets (G54-G59, G159) and preset coordinates (G92).
- Being RTCP transformation active, it is possible to carry out movements in continuous job, incremental jog and handwheel mode.
- RTCP transformation being active, the CNC only allows home search (G74) on the axes not involved in RTCP .
- The RTCP transformation cannot be selected while the TLC compensation is active.
- RTCP transformation being active, the CNC does not allow modifying the active kinematics (#KIN ID).
- RTCP transformation being active, the CNC does not allow modifying the software limits (G198/G199).
- The RTCP does not allow C-axis operations (#FACE, #CYL).

Recommended programming order.

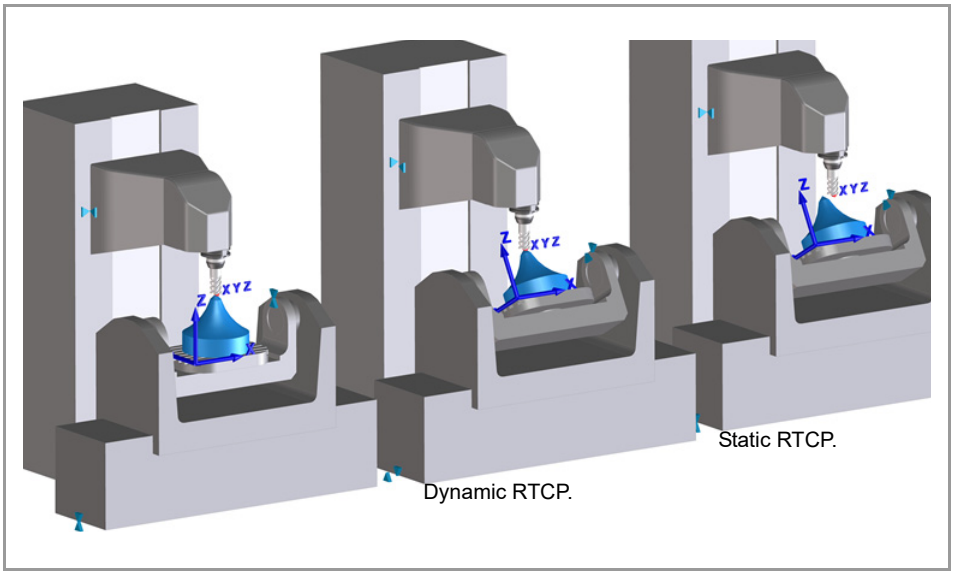
When working with inclined planes and RTCP transformation, it is recommended to follow this programming order (sequence). RTCP should be turned on first because it allows orienting the tool without modifying the tool tip position.

```
#RTCP ON
    (Turn RTCP on)
#CS ON
    (Activate the inclined plane)
#TOOL ORI
    (Position the tool perpendicular to the plane)
G_ X_ Y_ Z_
    (Machine on the inclined plane)
    .
    .
    .
#CS OFF
    (Cancel the inclined plane)
#RTCP OFF
    (Turn RTCP off)
M30
    (End of part-program)
```

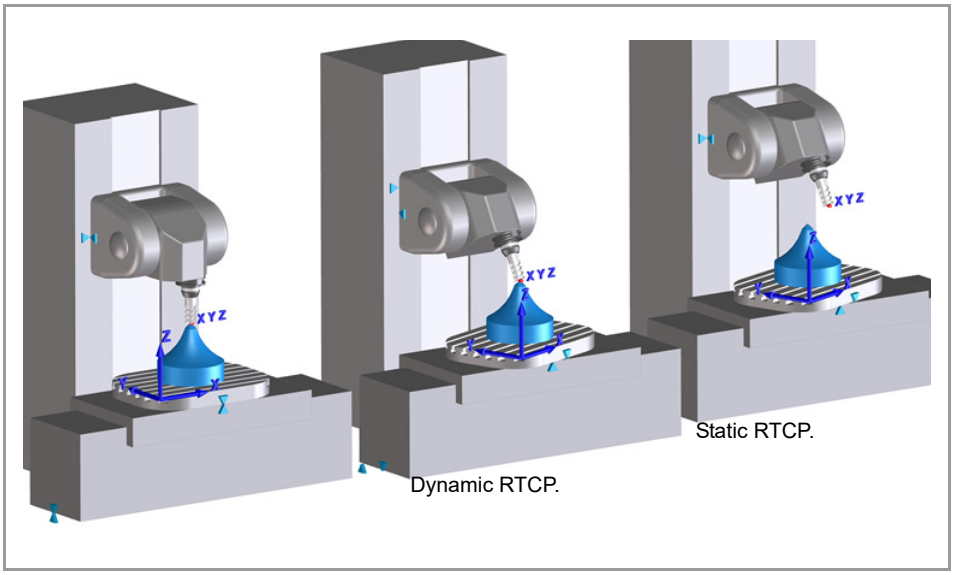
Dynamic/static RTCP in spindle kinematics.



Dynamic/static RTCP in table kinematics.



Dynamic/static RTCP in mixed kinematics.



5.1 Activate the static/dynamic RTCP.

The #RTCP ON statement activates the RTCP. In spindle+table kinematics, this statement defines the part of the kinematics (table or spindle) to be used and the type of RTCP (static or dynamic).

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

#RTCP ON
#RTCP ON [CLEAR]
#RTCP ON [<HEAD=ST/DYN/OFF><, TABLE=ST/DYN/OFF><, COROT=ROT/FIX>]

CLEAR	Activation of the RTCP according to the values defined in the machine parameters (TDATA).
HEAD	Treatment of the spindle kinematics. HEAD=ST: Treatment of the static RTCP with the position of the rotary axes of the spindle at the time of programming. HEAD=DYN: Treatment of dynamic RTCP, maintaining the tip of the tool on the part, when orienting the spindle. HEAD=OFF: Disregard the position of the spindle.
TABLE	Treatment of the table kinematics. TABLE=ST: Treatment of the static RTCP with the position of the rotary axes of the table at the time of programming. TABLE=DYN: Treatment of dynamic RTCP, maintaining the tip of the tool on the part, when orienting the table. TABLE=OFF: Disregard the position of the table.
COROT	COROT=ROT (or 1): Rotate the part coordinate system when rotating the table. COROT=FIX (or 0): Do not rotate the part coordinate system when rotating the table.

```
#RTCP ON
    (Activate the RTCP)
    (The CNC maintains the latest programming)
#RTCP ON [CLEAR]
    (Activation of the RTCP according to the values defined in the machine parameters)
#RTCP ON [HEAD=DYN, TABLE=OFF]
    (Treatment of dynamic RTCP in the spindle kinematics)
    (Disregard the position of the table)
```

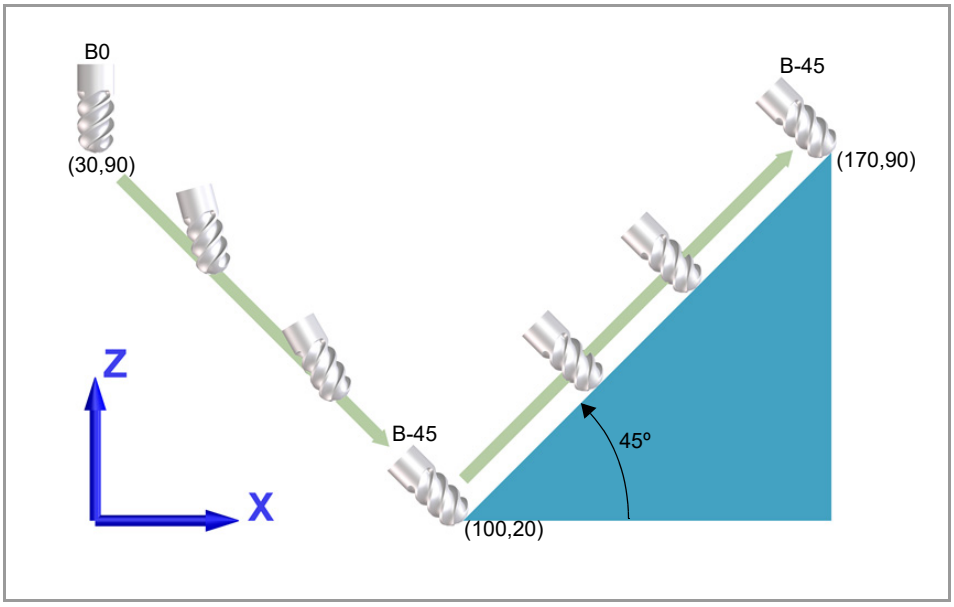
Remarks.

- The kinematics may be activated with parked axes, if they are not involved in the programmed RTCP parameters.
- With static RTCP, the CNC only updates the coordinates of the tip and, after orienting the kinematics, returns to program the RTCP.
- In the event of activating the kinematics with #KIN ID [TIP], it is only necessary to reprogram the #KIN ID [TIP] if the rotary axes, after turning them, are manual.

Properties of the function and Influence of the reset, turning the CNC off and of the M30 function.

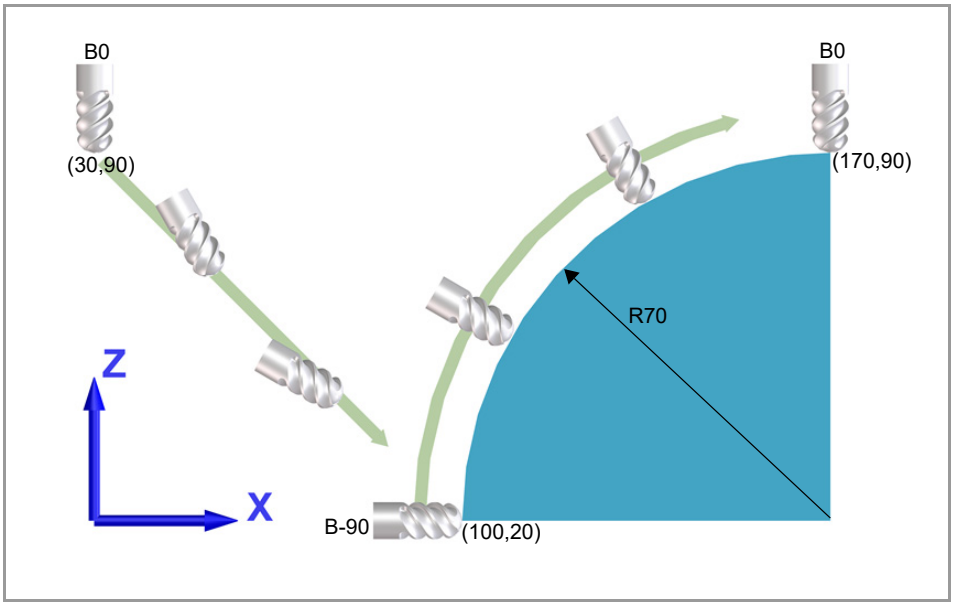
On poAt start-up, after executing M02 or M30 and after an emergency or a reset, the CNC keeps the RTCP active.

Example. Linear interpolation keeping the tool orientation fixed.



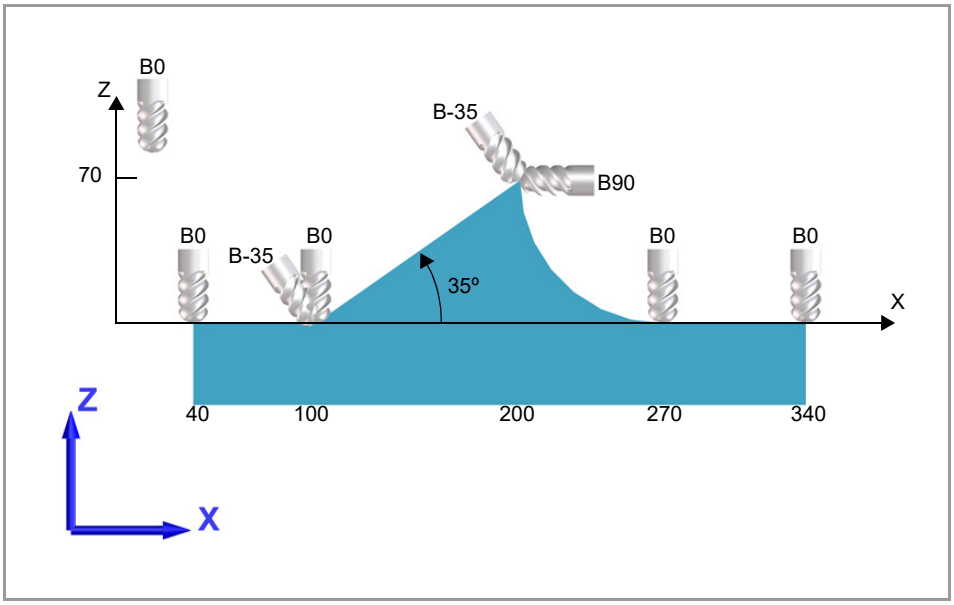

```
G90 G01 X30 Z90
#RTCP ON
    (RTCP activation)
G01 X100 Z20 B-60
    (Movement to point X100 Z20 and tool orientation at -45º)
    (The CNC interpolates the X, Z, B axes during movement)
G01 X170 Z90
    (Movement to X170 Y90)
    (The tool maintains the angle during the tool path)
G01 X170 Z120 B0
    (Retraction of the tool and orientation of the tool at 0°)
#RTCP OFF
    (RTCP cancellation)
```

Example. Circular interpolation with tool perpendicular to its path.




```
G18 G90 G01 X30 Z90
    (Selection of the ZX plane (G18))
#RTCP ON
    (RTCP activation)
G01 X100 Z20 B-90
    (Movement to point X100 Z20 and tool orientation at -90º)
    (The CNC interpolates the X, Z, B axes during movement)
G03 X170 Z90 I70 K0 B0
    (Circular interpolation to point X170 Z90)
    (Tool perpendicular to the tool path)
G01 X170 Z120
    (Retraction of the tool maintaining orientation of 0°)
#RTCP OFF
    (RTCP cancellation)
```

Example. Machining a profile.




```
G18 G90
    (Selection of the ZX plane (G18))
#RTCP ON
    (RTCP activation)
G01 X40 Z0 B0 F1000
    (Movement to point X40 Z0 with the tool oriented at 0º)
X100
    (Movement to point X100 with the tool oriented at 0º)
B-35
    (Tool orientation at -35º)
X200 Z70
    (Movement to point X200 Z70 with the tool oriented at -35º)
B90
    (Tool orientation at 90º)
G02 X270 Z0 R70 B0
    (Circular interpolation to point X270 Z0)
    (Tool perpendicular to the tool path)
G01 X340
    (Movement to point X340 with the tool oriented at 0º)
#RTCP OFF
    (RTCP cancellation)
```

5.2 Deactivating the RTCP.

The #RTCP OFF instruction deactivates RTCP.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is:

#RTCP OFF

```
#RTCP OFF
```

5.3 Summary of the variables.

The following variables may be accessed from (PRG) the part-program and from the MDI/MDA mode, PLC and (INT) from an external application. For each variable, the table indicates whether the access is reading (R) or writing (W). PLC access to the variables, for both reading and writing, will be synchronous. Accessing variables from the part-program returns the execution value (stops the preparation).

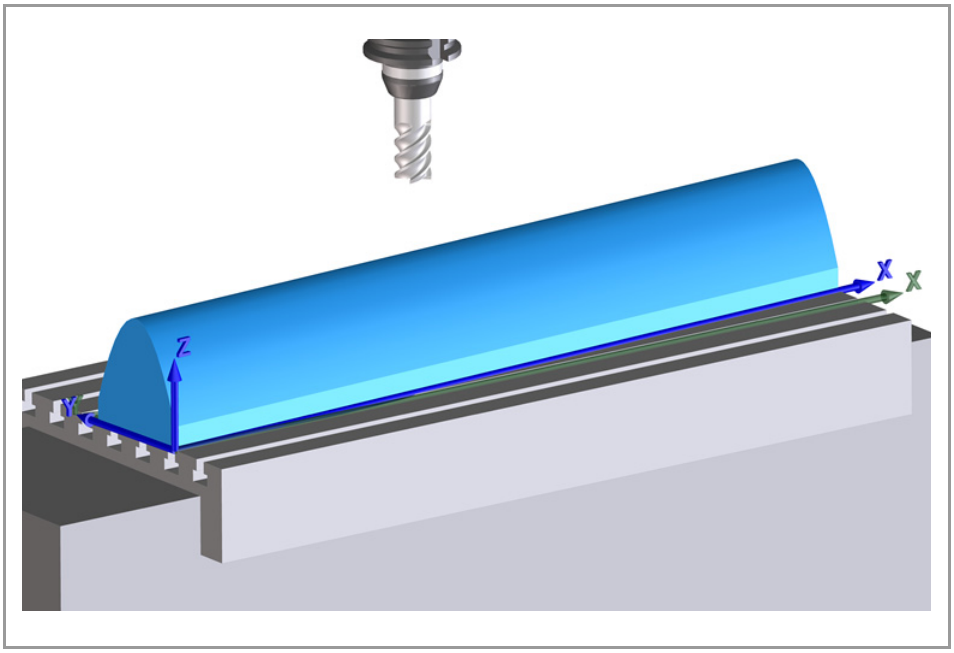
Variables.	PRG	PLC	INT
(V.)[ch].G.RTCPMODE Options programmed for the RTCP. This variable returns a binary value as follows. • Bit 0 and 1 indicate the option programmed for the spindle. 0: HEAD=OFF. 1: HEAD=ST. 2: HEAD=DYN (or not programmed). • Bit 2 and 3 indicate the option programmed for the table. 0: TABLE=OFF. 1: TABLE=ST. 2: TABLE=DYN (or not programmed). • Bit 4 and 5 indicate the option programmed for the coordinate system. 0: COROT=FIX. 1: COROT=ROT. 2: COROT=not programmed. Units: -.	R	R	R

Syntax.

·ch· Channel number.

6 Alignment of the machine coordinate system with the part (#CSROT).

The #CSROT statement aligns the machine coordinate system (ACS) with the part. For parts that, due to their characteristics (weight, size, etc.), are difficult to align mechanically with the machine axes, this function allows you to correct this misalignment from the program. After defining a machine coordinate system (#ACS) aligned with the part, the #CSROT statement aligns the kinematics with that coordinate system.



If the process for orientation of the axes has two solutions, the CNC applies the one that provides the shortest path with respect to the actual position. This option can be configured using the #DEFROT statement.

6.1 Activation of tool orientation.

The #CSROT statement activates the programming of the rotary axes of the kinematics in the active ACS coordinate system.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

#CSROT <ON> <[ROTATE]>

ON	Activate the kinematics orientation in the part coordinate system.
ROTATE	The CNC guides the kinematics in the new coordinate system together with the first movement block, even if the rotary axes are not programmed. Optional; if not programmed, the CNC orients the kinematics together with the first motion block in which the rotary axes are programmed.

```
#CSROT
    (Orientation of kinematics)
    (First motion block, even if the rotary axes are not programmed)

#CSROT ON
    (Orientation of kinematics)
    (First motion block, even if the rotary axes are not programmed)

#CSROT [ROTATE]
    (Orientation of kinematics)
    (First motion block in which the rotary axes are programmed)

#CSROT ON [ROTATE]
    (Orientation of kinematics)
    (First motion block in which the rotary axes are programmed)
```

Considerations.

This statement remains active until M02 or M30 is executed, a reset or is deactivated. (#CSROT OFF).

6.2 Cancel the tool orientation.

The #CSROT OFF statement deactivates the programming of the rotary axes of the kinematics in the active ACS coordinate system.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is:

#CSROT OFF

```
#CSROT OFF
```

6.3 Management of discontinuities in the orientation of rotary axes.

Usually, the axis orienting process provides two possible solution in the positioning of the rotary axes for a particular tool orientation. The CNC applies the one resulting in the shortest distance with respect to the current position.

A discontinuity means that a little change in the programmed angle results in a huge change of angle on the rotary axes due to the inclined plane. When the CNC detects a discontinuity, the instruction #DEFROT defines what the CNC must do depending on the angle difference between the one programmed and the one calculated.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets and the optional ones, between angle brackets.

#DEFROT [<{action},><{criterion},><Q{angle}>]

{action}	CNC action when it detects a discontinuity. Use the following commands. ERROR: Show an error and interrupt the execution. WARNING: Show a warning and interrupt the execution. NONE: Ignore the discontinuity and continue with the execution. Optional; if not programmed, last value programmed. The first time the program is run, after M30 and after a reset, WARNING.
{criterion}	Criterion to solve the discontinuity. Use the following commands. LOWF: The shortest way for the main rotary axis, then the secondary one. LOWS: The shortest way for the secondary rotary axis, then the main one. DPOSF: Positive direction of the main rotary axis. DPOSS: Positive direction of the secondary rotary axis. DNEGF: Negative direction of the main rotary axis. DNEGS: Negative direction of the secondary rotary axis. VPOSF: Positive value of the main rotary axis. VPOSS: Positive value of the secondary rotary axis. VNEGF: Negative value of the main rotary axis. VNEGS: Negative value of the secondary rotary axis. DIRF: Programmed direction of the main rotary axis. DIRS: Programmed direction of the secondary rotary axis. Optional; if not programmed, last value programmed. The first time the program is run, after M30 and after a reset, LOWF.
Q{angle}	Comparison angle. Optional; if not programmed, last value programmed. The first time the program is run, after M30 and after a reset, 5º.

```
#DEFROT
#DEFROT [ERROR, Q5]
#DEFROT [WARNING, DNEGF, Q10]
#DEFROT [NONE, LOWF]
```

CNC action when it detects a discontinuity.

These values define what the CNC must do when it detects a discontinuity.

Command.	Meaning.
ERROR	Show an error and interrupt the execution.
WARNING	Show a warning and interrupt the execution. The CNC displays a screen for selecting the solution to be applied.
NONE	Ignore the discontinuity and resume program execution. The CNC applies the solution programmed in the instruction (argument {criterion}), without showing to the user the screen to choose a solution. If no criterion has been programmed, the CNC applies the last one active.

Criterion to solve the discontinuity.

The possible criteria are:

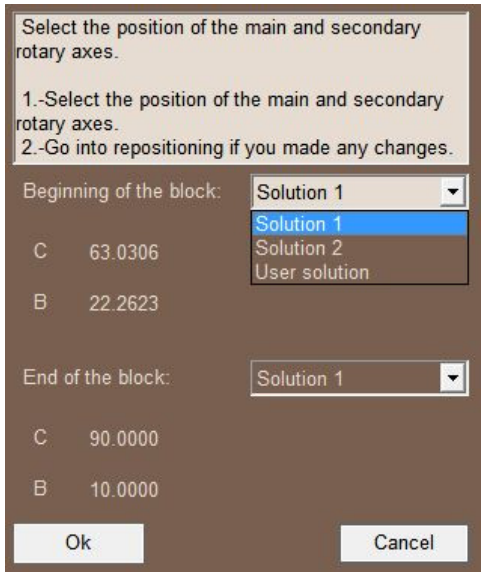
Command.	Meaning.
LOWF	The shortest way for the main rotary axis, then the secondary one.
LOWS	The shortest way for the secondary rotary axis, then the main one.
DPOSF	Positive direction of the main rotary axis.
DPOSS	Positive direction of the secondary rotary axis.
DNEGF	Negative direction of the main rotary axis.
DNEGS	Negative direction of the secondary rotary axis.
VPOSF	Positive value of the main rotary axis.
VPOSS	Positive value of the secondary rotary axis.
VNEGF	Negative value of the main rotary axis.
VNEGS	Negative value of the secondary rotary axis.
DIRF	Programmed direction of the main rotary axis.
DIRS	Programmed direction of the secondary rotary axis.

Comparison angle.

This value indicates the maximum travel difference between the programmed angle and the calculated angle, from which the actions and criteria are applied to choose the solution.

Screen for choosing the desired solution.

When the instruction #DEFROT is programmed with the WARNING option (show a warning and interrupt the execution) the CNC shows the following screen for the user to choose the solution to be applied, both for the beginning of the block and for the end. The screen offers the two solution calculated by the CNC, plus a third one that lets program the posiion of the rotary axes on the screen itself. The position of the axes is given in machine coordinates.



By default, the CNC suggests one solution. If the user chooses the solution suggested by the CNC, it resumes execution. If the user chooses a solution other than the one suggested by the CNC, it goes into tool inspection to reposition the axes. Once in tool inspection, the process will be as follows.

1. Move the tool away from the part by moving the linear axes or the virtual tool axis if it is active.
2. Orient the rotary axes of the kinematics.
3. Reposition the tool by moving the linear axes or the virtual tool axis if it is active.

Execution example. Selecting a solution.

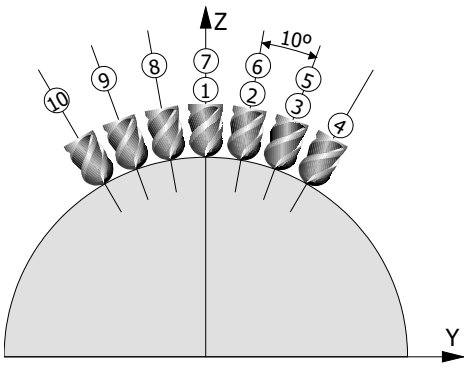
The example assumes a CB spindle type kinematics. The starting program will be a circle in the XZ plane.

```
N1 X.. Y.. Z.. C0 B0
N2 X.. Y.. Z.. C0 B10
N3 X.. Y.. Z.. C0 B20
N4 X.. Y.. Z.. C0 B30
N5 X.. Y.. Z.. C0 B20
N6 X.. Y.. Z.. C0 B10
N7 X.. Y.. Z.. C0 B0
N8 X.. Y.. Z.. C0 B-10
N9 X.. Y.. Z.. C0 B-20
N10 X.. Y.. Z.. C0 B-30
```

And specifically for a circle with a radius of 10.

```
N1 X0 Z10 C0 B0
N2 X1.736 Z9.8480 C0 B10
N3 X3.420 Z9.3969 C0 B20
N4 X5 Z8.660 C0 B30
...
```

If the part rotates 90º with respect to the C axis, the result will be a circle in the YZ plane.




```
#CS NEW[MODE1,0,0,0,0,0,90]
    ; 90º rotation on the C axis.
#CSROT ON
N1 X0 Z10 C0 B0
N2 X1.736 Z9.8480 C0 B10
    Discontinuity point.
    ; Solution 1: C90 B10.
    ; Solution 2: C-90 B-10.
N3 X3.420 Z9.3969 C0 B20
N4 X5 Z8.660 C0 B30
M30
```

In block N2 there is a path discontinuity greater than 5º between what has been programmed and what has been calculated which is the default value for the angle that may be programmed in the instruction DEFROT. Depending on the criterion chosen, one may select solution 1 or 2 and from there on keep positioning in the rest of the blocks.

- With #DEFROT [DPOSF] (positive direction of the main axis), solution 1 is chosen and the resulting positioning of the rotary axes will be the following.

  ```
  N2 C90 B10
  N3 C90 B20
  N4 C90 B30
  ```

- With #DEFROT [DNEF] (negative direction of the main axis), solution 2 is chosen and the resulting positioning of the rotary axes will be the following.

  ```
  N2 C-90 B-10
  N3 C-90 B-20
  N4 C-90 B-30
  ```

If WARNING (issue a warning and generate a stop) is chosen when defining the criterion in #DEFROT, the CNC will select the solution according to the chosen criterion. The CNC will also display an interactive screen offering the option to change from one solution to another in that motion block, both in its starting orientation and in the final one.

6.4 Summary of the variables.

The following variables may be accessed from (PRG) the part-program and from the MDI/MDA mode, PLC and (INT) from an external application. For each variable, the table indicates whether the access is reading (R) or writing (W). PLC access to the variables, for both reading and writing, will be synchronous. Access to the variables from the part program returns the value for the block preparation (it does not stop the preparation), except when indicated otherwise.

Variables.	PRG	PLC	INT
(V.)[ch].G.CSROTST Status of the #CSROT function. This variable returns one of the following values. 0: Off. 1: ON Units: -.	R	R	R
(V.)[ch].G.CSROTF1[1] Position (machine coordinates) calculated for the first rotary axis of the kinematics at the beginning of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTF1[2] Position (machine coordinates) calculated for the first rotary axis of the kinematics at the end of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTS1[1] Position (machine coordinates) calculated for the second rotary axis of the kinematics at the beginning of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTS1[2] Position (machine coordinates) calculated for the second rotary axis of the kinematics at the end of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTT1[1] Position (machine coordinates) calculated for the third rotary axis of the kinematics at the beginning of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTT1[2] Position (machine coordinates) calculated for the third rotary axis of the kinematics at the end of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTO1[1] Position (machine coordinates) calculated for the fourth rotary axis of the kinematics at the beginning of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTO1[2] Position (machine coordinates) calculated for the fourth rotary axis of the kinematics at the end of the block. Solution 1 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTF2[1] Position (machine coordinates) calculated for the first rotary axis of the kinematics at the beginning of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTF2[2] Position (machine coordinates) calculated for the first rotary axis of the kinematics at the end of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R

(*) The CNC evaluates the variable during execution (it stops the block preparation).

Variables.	PRG	PLC	INT
(V.)[ch].G.CSROTS2[1] Position (machine coordinates) calculated for the second rotary axis of the kinematics at the beginning of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTS2[2] Position (machine coordinates) calculated for the second rotary axis of the kinematics at the end of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTT2[1] Position (machine coordinates) calculated for the third rotary axis of the kinematics at the beginning of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTT2[2] Position (machine coordinates) calculated for the third rotary axis of the kinematics at the end of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTO2[1] Position (machine coordinates) calculated for the fourth rotary axis of the kinematics at the beginning of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTO2[2] Position (machine coordinates) calculated for the fourth rotary axis of the kinematics at the end of the block. Solution 2 of the #CSROT mode. Units (PRG): 1 (º).	R(*)	R	R
(V.)[ch].G.CSROTF[1] Position (machine coordinates) to be occupied by the first rotary axis of the kinematics at the beginning of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W
(V.)[ch].G.CSROTF[2] Position (machine coordinates) to be occupied by the first rotary axis of the kinematics at the end of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W
(V.)[ch].G.CSROTS[1] Position (machine coordinates) to be occupied by the second rotary axis at the beginning of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W
(V.)[ch].G.CSROTS[2] Position (machine coordinates) to be occupied by the second rotary axis at the end of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W
(V.)[ch].G.CSROTT[1] Position (machine coordinates) to be occupied by the third rotary axis at the beginning of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W
(V.)[ch].G.CSROTT[2] Position (machine coordinates) to be occupied by the third rotary axis at the end of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W
(V.)[ch].G.CSROTO[1] Position (machine coordinates) to be occupied by the fourth rotary axis at the beginning of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W
(V.)[ch].G.CSROTO[2] Position (machine coordinates) to be occupied by the fourth rotary axis at the end of the block, for the #CSROT mode. Units (PRG): 1 (º).	R/W(*)	R/W	R/W

(*) The CNC evaluates the variable during execution (it stops the block preparation).

Syntax.

·ch· Channel number.

6.5 Transform part zero taking into account the table position (#KINORG).

The instruction #KINORG may be used to transform the active part zero into a new part zero that considers the position of the table. On 7-axis kinematics (spindle-table) or 5-axis table kinematics, without coordinate system rotation, it may be necessary to get a part zero with the axes of the table in any position, to use it later on when activating the RTCP of the kinematics with the option to keep the part zero without coordinate system rotation.

The #KINORG statement saves the transformed part zero in the variables V.G.KINORG1 to V.G.KINORG3. Save the value of these variables in the zero offset table for later in order to have that part zero available and be able to activate it at any time.

Programming.

Program the instruction alone in the block.

Programming format.

The programming format is:

#KINORG

```
#KINORG
```

Sequence to transform the part zero.

Example of a possible sequence to transform the measured part zero into a new part zero taking into account the position of the table. Example with a vector kinematics of type 52 (spindle-table) defined as third kinematics. The sequence is similar for vector kinematics type 51 (table) and standard table kinematics with parameter TDATA17=1.

How to transform the part zero with the table in any position.

1 Activate the kinematics.

```
#KIN ID [3]
    (Activate kinematics number 3)
```

2 Optionally, activate the RTCP on the spindle to obtain the tool tip coordinates.

```
V.G.OFTDATA3[52]=1
    (Apply RTCP only to the spindle side)
#RTCP ON
```

3 Move the tool to the future part zero. If necessary, move the rotary axes of both the spindle (AB) and the table (UV) in order to measure the part zero in XYZ.

```
A_ B_ U_ V_
X_ Y_ Z_
```

4 Select the current position as part zero.

```
G92 X0 Y0 Z0
```

5 Transform the current part zero into a new set of values that consider the table position.

```
#KINORG
```

6 Save the calculated values in to the zero offset table; for example, in G55 (G159=2).

```
V.A.ORGT[2].X = V.G.KINORG1
V.A.ORGT[2].Y = V.G.KINORG2
V.A.ORGT[2].Z = V.G.KINORG3
```

How to activate the RTCP, maintaining the transformed part zero.

1 Activate the kinematics.

```
#KIN ID [3]
    (Activate kinematics number 3)
```

2 Activate the transformed part zero (in this case, G55).

```
G55
```

3 Activate the full RTCP, considering the spindle and the table and without rotating the coordinate system.

```
V.G.OFTDATA3[52]=0
    (Apply full RTCP; table and spindle)
V.G.OFTDATA3[51]=1
    (RTCP without rotation of the coordinate system)
#RTCP ON
```

6.6 Summary of the variables.

The following variables may be accessed from (PRG) the part-program and from the MDI/MDA mode, PLC and (INT) from an external application. For each variable, the table indicates whether the access is reading (R) or writing (W). PLC access to the variables, for both reading and writing, will be synchronous. Access to the variables from the part program returns the value for the block preparation (it does not stop the preparation), except when indicated otherwise.

Variable.	PRG	PLC	INT
(V.)[ch].G.KINORG1 Position of the part zero transformed by the instruction #KINORG, considering the table position, on the first axis of the channel. Units (PRG): 1 (mm) | 1 (inch).	R(*)	R	R
(V.)[ch].G.KINORG2 Position of the part zero transformed by the instruction #KINORG, considering the table position, on the second axis of the channel. Units (PRG): 1 (mm) | 1 (inch).	R(*)	R	R
(V.)[ch].G.KINORG3 Position of the part zero transformed by the instruction #KINORG, considering the table position, on the third axis of the channel. Units (PRG): 1 (mm) | 1 (inch).	R(*)	R	R

(*) The CNC evaluates the variable during execution (it stops the block preparation).

Syntax.

·ch· Channel number.

7 Correct the implicit tool length compensation of the program (#TLC).

The #TLC (Tool Length Compensation) statement compensates for the difference in length between the actual tool and the one used by CAD-CAM to generate the program. The programs generated by CAD-CAM packages take into account the length of the tool and generate the coordinates with respect to the tool base. The instruction #TLC must be used with CAD-CAM generated programs and the CNC does not have a tool with the same dimensions.

Programming (activation).

Program the instruction alone in the block.

Programming format.

The programming format is the following; the arguments appear between curly brackets.

#TLC ON [{length}]

{length}	Tool length difference (real - theoretical).

```
#TLC ON [1.5]
    (Compensation for a tool 1.5 mm longer)

#TLC ON [-2]
    (Compensation for a tool 2 mm shorter)
```

Programming (deactivation).

Program the instruction alone in the block.

Programming format.

The programming format is:

#TLC OFF

```
#TLC OFF
    (Deactivation of compensation)
```

Considerations about the TLC.

- TLC compensation being active, the CNC only allows home search (G74) on the axes not involved in TLC.
- TLC cannot be selected while the RTCP transformation is active.
- TLC compensation being active, the CNC does not allow modifying the active kinematics (#KIN ID).
- TLC compensation being active, the CNC does not allow modifying the software limits (G198/G199).

7.1 Summary of the variables.

The following variables may be accessed from (PRG) the part-program and from the MDI/MDA mode, PLC and (INT) from an external application. For each variable, the table indicates whether the access is reading (R) or writing (W). PLC access to the variables, for both reading and writing, will be synchronous. Access to the variables from the part program returns the value for the block preparation (it does not stop the preparation), except when indicated otherwise.

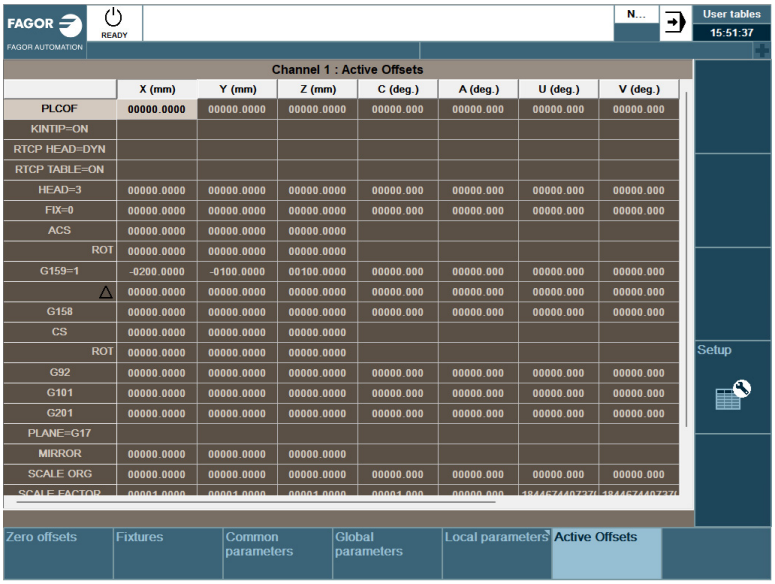
Variables.	PRG	PLC	INT
(V.)[ch].G.TOOLCOMP Longitudinal compensation function active. This variable returns one of the following values. 1: RTCP. 2: TLC. 3: None. Units: -.	R	R	R

Syntax.

·ch· Channel number.

8 Active zero offset table.

Within the user tables, the "Active zero offsets" table shows information relevant to the construction of the plane.



User notes:

User notes:

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