

**CNC**

**8070**

Monographic subjects

(Ref: 1304)



**FAGOR AUTOMATION**

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## 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 a 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. An antivirus software is highly recommended if the CNC is connected directly to another PC, it is part of a computer network or floppy disks or other computer media is used to transmit data.

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.

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The information described in this manual may be changed due to technical modifications. Fagor Automation reserves the right to make any changes to the contents of this manual without prior notice.

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.

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, thus no absolute match is guaranteed. Anyway, the contents of the manual is periodically checked making and including the necessary corrections in a future 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 THE PRODUCT

## BASIC CHARACTERISTICS.

Basic characteristics.	.BL.	.OL.	.M. / .T.
PC-based system.	Closed system	Open system	
Operating system.	Windows XP		
Number of axes.	3 to 7	3 to 28	
Number of spindles.	1	1 to 4	
Number of tool magazines.	1	1 to 4	
Number of execution channels.	1	1 to 4	
Number of handwheels.	1 to 12		
Type of servo system.	Analog / Digital Sercos / Digital Mechatrolink		
Communications.	RS485 / RS422 / RS232 Ethernet		
PCI expansion.	No	Option	No
Integrated PLC.			
PLC execution time.	< 1ms/K		
Digital inputs / Digital outputs.	1024 / 1024		
Marks / Registers.	8192 / 1024		
Timers / Counters.	512 / 256		
Symbols.	Unlimited		
Block processing time.	< 1 ms		

Remote modules.	RIOW	RIO5	RIO70
Communication with the remote modules.	CANopen	CANopen	CANfagor
Digital inputs per module.	8	16 or 32	16
Digital outputs per module.	8	24 or 48	16
Analog inputs per module.	4	4	8
Analog outputs per module.	4	4	4
Inputs for PT100 temperature sensors.	2	2	---
Feedback inputs.	---	---	4 Differential TTL Sinusoidal 1 Vpp

### Customizing.

PC-based open system, fully customizable.  
 INI configuration files.  
 FGUIM visual configuration tool.  
 Visual Basic®, Visual C++®, etc.  
 Internal databases in Microsoft® Access.  
 OPC compatible interface



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## SOFTWARE OPTIONS.

Bear in mind that some of the features described in this manual depend on the software options that are installed. The information of the following table is informative only; when purchasing the software options, only the information provided in the ordering handbook is valid.

	<b>-BL- model</b>	<b>-OL- model</b>	<b>-M- model</b>	<b>-T- model</b>
Open system. Access to the administrator mode.	---	Option	---	---
Editing and simulation environment.	---	Standard	Standard	Standard
Number of execution channels	1	1 to 4	1 to 4	1 to 4
Number of axes	3 to 7	3 to 28	3 to 28	3 to 28
Number of spindles	1	1 to 4	1 to 4	1 to 4
Number of tool magazines	1	1 to 4	1 to 4	1 to 4
Number of interpolated axes (maximum)	4	28	---	---
Limited to 4 interpolated axes	Option	Option	Option	Option
IEC 61131 language	Option	Option	---	---
HD graphics	---	Option	Option	Option
Conversational IIP	---	---	Option	Option
Non-Fagor digital drive	Option	Option	---	---
Tool radius compensation	Option	Option	Standard	Standard
"C" axis	Option	Option	Standard	Standard
Dynamic RTCP	Option	Option	---	Option
HSSA machining system.	Option	Option	Standard	Standard
Probing canned cycles	---	---	Option	Standard
Profile editor	---	---	Standard	Standard
Drilling ISO cycles for the OL model. (G80, G81, G82, G83).	---	Option	---	---
Tandem axes	---	Option	---	Option
Synchronism and cams	Option	Option	---	---
Tangential control	Option	Option	---	Standard
Volumetric compensation (up to 10 m <sup>3</sup> ).	Option	Option	Option	Option
Volumetric compensation (more than 10 m <sup>3</sup> ).	Option	Option	Option	Option



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# DECLARATION OF CONFORMITY

**The manufacturer:**

Fagor Automation S. Coop.  
Barrio de San Andrés Nº 19, C.P.20500, Mondragón -Guipúzcoa- (Spain).

**Declares:**

The manufacturer declares under their exclusive responsibility the conformity of the product:

## 8070 CNC

Consisting of the following modules and accessories:

**8070-M-ICU, 8070-T-ICU, 8070-OL-ICU, 8070-BL-ICU**  
**8070-M-MCU, 8070-T-MCU, 8070-OL-MCU, 8070-BL-MCU, 8070-OL-MCU-PCI**  
**8070-LCD-10, 8070-LCD-15, LCD-15-SVGA**  
**JOG PANEL, KEYBOARD PANEL, OP PANEL**  
**HORIZONTAL-KEYB, VERTICAL-KEYB, OP-PANEL**  
**BATTERY, MOUSE UNIT**  
**Remote Modules RIOW, RIO5, RIO70**

**Note.** Some additional characters may follow the model references indicated above. They all comply with the directives listed here. However, compliance may be verified on the label of the unit itself.

Referred to by this declaration with following directives:

**Low-voltage regulations.**

EN 60204-1: 2006 Electrical equipment on machines — Part1. General requirements.

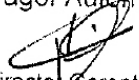
**Regulation on electromagnetic compatibility.**

EN 61131-2: 2007 PLC — Part 2. Equipment requirements and tests.

According to the European Community Directives 2006/95/EC on Low Voltage and 2004/108/EC on Electromagnetic Compatibility and their updates.

In Mondragón, May 10th, 2013.

Fagor Automation, S. Coop.

  
Director Gerente  
Pedro Ruiz de Aguirre



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# VERSION HISTORY

Here is a list of the features added to each manual reference.

## Ref. 0502

Software V02.02	
First version.	
<ul style="list-style-type: none"> <li>• Electronic cam.</li> <li>• Independent axis.</li> <li>• Axis synchronization.</li> </ul>	

## Ref. 0811

Software V03.21 (features not included in version V04.00)	
Electronic cam. Load a file cam from the CNC.	<ul style="list-style-type: none"> <li>• Instructions: #CAM SELECT #CAM DESELECT.</li> </ul>

## Ref. 1010

Software V04.02 (features not included in version V04.10)	
Electronic cam. Load a file cam from the PLC.	<ul style="list-style-type: none"> <li>• PLC command: CAM SELECT CAM DESELECT</li> </ul>
Electronic cam. Variable to modify the data of the cam	<ul style="list-style-type: none"> <li>• Variable: (V.)G.CAM[cam][index]</li> </ul>
Electronic cam. Variable to check the status of the cam.	<ul style="list-style-type: none"> <li>• Variable: (V.)G.CAMST[cam]</li> </ul>

## Ref. 1304

Software V04.25	
Update.	



# 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 damage or defective unit resulting from not complying with these basic safety regulations.



*Before start-up, verify that the machine that integrates this CNC meets the 89/392/CEE Directive.*

## PRECAUTIONS BEFORE CLEANING THE UNIT

If the CNC does not turn on when actuating the start-up switch, verify the connections.

- Do not get into the inside of the unit.** Only personnel authorized by Fagor Automation may manipulate the inside of this unit.
- Do not handle the connectors with the unit connected to AC power.** Before manipulating the connectors (inputs/outputs, feedback, etc.) make sure that the unit is not connected to AC power.

## PRECAUTIONS DURING REPAIR

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 manipulate the inside of this unit.
- Do not handle the connectors with the unit connected to AC power.** Before manipulating the connectors (inputs/outputs, feedback, etc.) make sure that the unit is not connected to AC power.

## PRECAUTIONS AGAINST PERSONAL DAMAGE

- Interconnection of modules.** Use the connection cables provided with the unit.
- Use proper cables.** To prevent risks, use the proper cables for mains, Sercos and Bus CAN recommended for this unit.  
In order to avoid electrical shock at the central unit, use the proper power (mains) cable. Use 3-wire power cables (one for ground connection).
- Avoid electrical overloads.** In order to avoid electrical discharges and fire hazards, do not apply electrical voltage outside the range selected on the rear panel of the central unit.
- Ground connection.** In order to avoid electrical discharges, connect the ground terminals of all the modules to the main ground terminal. Before connecting the inputs and outputs of this unit, make sure that all the grounding connections are properly made.  
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 under 90% of relative humidity (non-condensing) and 45 °C (113 °F).
- Do not work in explosive environments.** In order to avoid risks or damages, do no work in explosive environments.



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## PRECAUTIONS AGAINST PRODUCT DAMAGE

<b>Working environment.</b>	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 or homes).
<b>Install the unit in the right place.</b>	It is recommended, whenever possible, to install the CNC away from coolants, chemical product, blows, etc. that could damage it. This unit complies with the European directives on electromagnetic compatibility. Nevertheless, it is recommended to keep it away from sources of electromagnetic disturbance such as: <ul style="list-style-type: none"> <li>Powerful loads connected to the same AC power line as this equipment.</li> <li>Nearby portable transmitters (Radio-telephones, Ham radio transmitters).</li> <li>Nearby radio/TV transmitters.</li> <li>Nearby arc welding machines.</li> <li>Nearby High Voltage power lines.</li> </ul>
<b>Enclosures.</b>	The manufacturer is responsible of assuring that the enclosure involving the equipment meets all the currently effective directives of the European Community.
<b>Avoid disturbances coming from the machine.</b>	The machine must have all the interference generating elements (relay coils, contactors, motors, etc.) uncoupled.
<b>Use the proper power supply.</b>	Use an external regulated 24 Vdc power supply for the keyboard and the remote modules.
<b>Grounding of the power supply.</b>	The zero volt point of the external power supply must be connected to the main ground point of the machine.
<b>Analog inputs and outputs connection.</b>	Use shielded cables connecting all their meshes to the corresponding pin.
<b>Ambient conditions.</b>	The storage temperature must be between +5 °C and +45 °C (41 °F and 113 °F). The storage temperature must be between -25 °C and 70 °C (-13 °F and 158 °F).
<b>Central unit enclosure.</b>	Make sure that the needed gap is kept between the central unit and each wall of the enclosure. Use a DC fan to improve enclosure ventilation.
<b>Main AC power switch.</b>	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.

## PROTECTIONS OF THE UNIT ITSELF

<b>Remote modules.</b>	All the digital inputs and outputs have galvanic isolation via optocouplers between the CNC circuitry and the outside.
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## SAFETY SYMBOLS

### Symbols that may appear on the manual.



*Danger or prohibition symbol.*

*It indicates actions or operations that may hurt people or damage products.*



*Warning symbol.*

*It indicates situations that certain operations could cause and the suggested actions to prevent them.*



*Obligation symbol.*

*It indicates actions and operations that must be carried out.*



*Information symbol.*

*It indicates notes, warnings and advises.*

### Symbols that the product may carry.



*Ground protection symbol.*

*It indicates that that point must be under voltage.*



# WARRANTY TERMS

## INITIAL WARRANTY

All products manufactured or marketed by FAGOR carry a 12-month warranty for the end user which could be controlled by the our service network by means of the warranty control system established by FAGOR for this purpose.

In order to prevent the possibility of having the time period from the time a product leaves our warehouse until the end user actually receives it run against this 12-month warranty, FAGOR has set up a warranty control system based on having the manufacturer or agent inform FAGOR of the destination, identification and on-machine installation date, by filling out the document accompanying each FAGOR product in the warranty envelope. This system, besides assuring a full year of warranty to the end user, enables our service network to know about FAGOR equipment coming from other countries into their area of responsibility.

The warranty starting date will be the one appearing as the installation date on the above mentioned document. FAGOR offers the manufacturer or agent 12 months to sell and install the product. This means that the warranty starting date may be up to one year after the product has left our warehouse so long as the warranty control sheet has been sent back to us. This translates into the extension of warranty period to two years since the product left our warehouse. If this sheet has not been sent to us, the warranty period ends 15 months from when the product left our warehouse.

This warranty covers all costs of material and labour involved in repairs at FAGOR carried out to correct malfunctions in the equipment. FAGOR undertakes to repair or replace their products within the period from the moment manufacture begins until 8 years after the date on which it disappears from the catalogue.

It is entirely up to FAGOR to determine whether the repair is or not under warranty.

## EXCLUDING CLAUSES

Repairs will be carried out on our premises. Therefore, all expenses incurred as a result of trips made by technical personnel to carry out equipment repairs, despite these being within the above-mentioned period of warranty, are not covered by the warranty.

Said warranty will be applied whenever the equipment has been installed in accordance with instructions, has not be mistreated, has not been damaged by accident or by negligence and has not been tampered with by personnel not authorised by FAGOR. If, once servicing or repairs have been made, the cause of the malfunction cannot be attributed to said elements, the customer is obliged to cover the expenses incurred, in accordance with the tariffs in force.

Other warranties, implicit or explicit, are not covered and FAGOR AUTOMATION cannot be held responsible for other damages which may occur.



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## WARRANTY ON REPAIRS

In a similar way to the initial warranty, FAGOR offers a warranty on standard repairs according to the following conditions:

PERIOD	12 months.
CONCEPT	Covers parts and labor for repairs (or replacements) at the network's own facilities.
EXCLUDING CLAUSES	The same as those applied regarding the chapter on initial warranty. If the repair is carried out within the warranty period, the warranty extension has no effect.

When the customer does not choose the standard repair and just the faulty material has been replaced, the warranty will cover just the replaced parts or components within 12 months.

For sold parts the warranty is 12 months length.

## SERVICE CONTRACTS

The SERVICE CONTRACT is available for the distributor or manufacturer who buys and installs our CNC systems.



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## MATERIAL RETURNING TERMS

When sending the central nit or the remote modules, pack them in its original package and packaging material. If the original packaging material is not available, pack it as follows:

- 1 Get a cardboard box whose three inside dimensions are at least 15 cm (6 inches) larger than those of the unit. The cardboard being used to make the box must have a resistance of 170 Kg (375 lb.).
- 2 Attach a label indicating the owner of the unit, person to contact, type of unit and serial number. In case of malfunction also indicate symptom and a brief description of the problem.
- 3 Wrap the unit in a polyethylene roll or similar material to protect it. When sending a central unit with monitor, protect especially the screen.
- 4 Pad the unit inside the cardboard box with poly-utherane foam on all sides.
- 5 Seal the cardboard box with packing tape or 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 75° alcohol. Do not use highly compressed air to clean the unit because it could generate electrostatic discharges.

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, benzole, 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 connected to AC power. Before handling these connectors (I/O, feedback, etc.), make sure that the unit is not connected to main AC power.
- Do not get into the inside of the unit. Only personnel authorized by Fagor Automation may manipulate the inside of this unit.
- If the CNC does not turn on when actuating the start-up switch, verify the connections.



## RELATED DOCUMENTATION

Here is a list of the manuals available for your CNC and all the languages in which they are available. All the manuals are available on our corporate website and some of them may be found in the CD-Rom that comes with the product. Some of these manuals are also available in paper upon request.

Name and description.	WEB		
<b>Hardware configuration (-M- / -T- / -BL- / -OL- model)</b> This manual describes the hardware configuration and the technical data of each element.	Spanish / English		---
<b>Installation manual (-M- / -T- / -BL- / -OL- model)</b> This manual describes how to install and set the CNC up.	Spanish / English		
<b>Operating manual (-M- / -T- / -BL- / -OL- model)</b> This manual describes how to operate the CNC.	Spanish / English Italian / French German/Brasilian		
<b>Programming manual (-M- / -T- / -BL- / -OL- model)</b> This manual describes how to program the CNC.	Spanish / English Italian / French German/Brasilian		
<b>Probing (-M-model)</b> This manual describes how to program probing movements and probing canned cycles. Milling model.	Spanish / English Italian / French German/Brasilian		---
<b>Probing (-T-model)</b> This manual describes how to program probing movements and probing canned cycles. Lathe model.	Spanish / English Italian / French German		---
<b>Machining canned cycles (-M- / -OL- model )</b> This manual describes how to program the machining canned cycles. Milling model.	Spanish / English Italian / French German/Brasilian		
<b>Machining canned cycles (-T- model)</b> This manual describes how to program the machining canned cycles. Lathe model.	Spanish / English Italian / French / German		
<b>Quick reference (-M- / -T- model)</b> Summary guide of the PLC programming language.	Spanish / English Italian / French German		---
<b>Programming examples (-M- model)</b> Manual with programming examples for the mill model.	Spanish / English		---
<b>Programming examples (-T- model)</b> Manual with programming examples for the lathe model.	Spanish / English		---
<b>Error solving manual (-M- / -T- / -BL- / -OL- model)</b> This manual offers a description of some error messages that may appear on the CNC indicating the probable causes that originate them and how to solve them.	Spanish / English		---
<b>Execution channels (-M- / -T- / -OL- model)</b> This manual describes how to configure and work in a multi-channel system.	Spanish / English Italian / French German/Brasilian		
<b>Monographic subjects (-M- / -T- / -BL- / -OL- model)</b> This manual describes how to configure and work with some CNC features.	Spanish / English Italian / French German		

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# ELECTRONIC CAM

I





The electronic cam mode may be used to move a slave axis based on a positions-table or on a cam profile. There are two types of cam movement; position-position cam and position-time cam. In either case, the CNC is in charge of generating the necessary position commands to reach the cam's movement profile.

- Position - position cam. On this type of cam, it is possible to obtain non-linear electronic synchronization ratios between two axes. Thus, the position of the slave axis is synchronized with the position of the master axis using a cam profile.
- Position - time cam. On this type of cam, it is possible to obtain other movement profiles different from trapezoidal or S-shaped ones.

If while executing a cam profile, a second cam profile is executed, the second one gets ready and waiting for the current execution to be over. Once the current cam profile has ended, the CNC starts executing the second cam blending both profiles like when blending (joining) two positioning blocks. Executing the cam synchronization ending command will end the current cam, but not immediately, it will do so the next time it goes through the end of the cam profile.

After executing the synchronization of the cam, no positioning moves of the independent axis (MOVE) are possible. It makes no sense to add another movement to the cam synchronization movement that would brake the synchronization already achieved.

1.

INTRODUCTION



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The cam editor is a graphic help element that makes designing cams very flexible. At the same time, this editor offers friendly assistance to analyze the behavior of the cam projected through graphically assisted data entry for speed, acceleration and jerk.

It is up to the user to select the parameters and the functions to design an electronic cam and must make sure that his design is coherent with the required specifications.

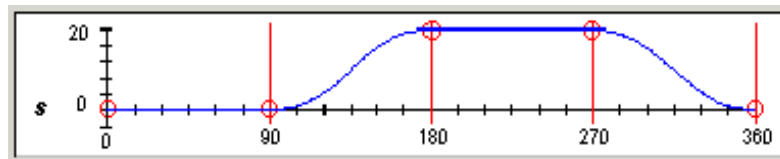
## 2.1 Initial designing approach

The first thing the cam designer must do is select the math functions that define the movement of the slave axis. Thus, the cam is designed with a number of separate functions, each of which defines the movement of the slave along a particular segment of the cam.

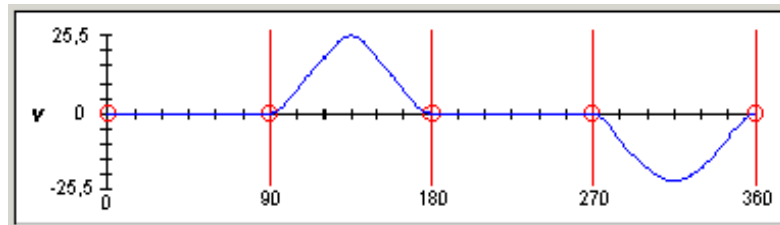
The simplest and most common approach to do this, is to "linearize" the cam, i.e. "to unroll it" from its original shape and represent it as a graphic function on the Cartesian axes. This graphic function coincides with the slave's movement (s).

Once the graphic function that defines the cam (distance function (s) of the slave) is known, it also represents its first derivative or velocity function (v), its second derivative or acceleration function (a) and its third derivative or jerk function (j) (acceleration speed).

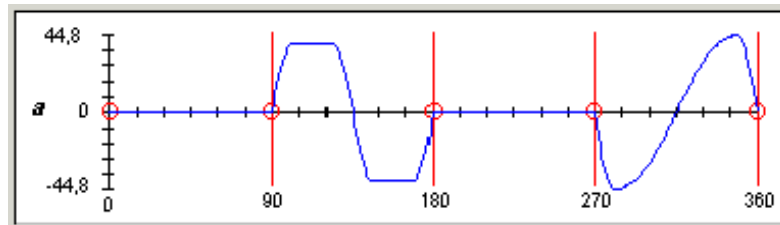
All these functions are represented as an angle function  $\theta$  of the camshaft between the limits of the abscissa axis ( $0^\circ$ - $360^\circ$ ) and on aligned axes. The time t can also be considered as a variable of the axis.



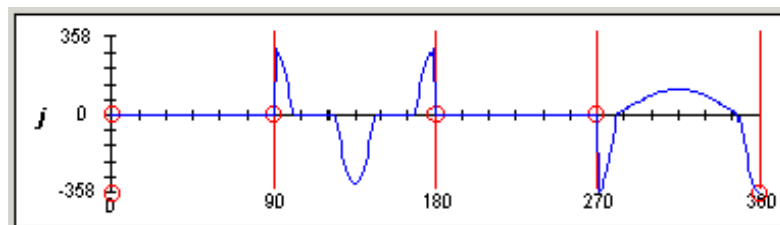
(s) Distance function



(v) velocity function



(a) Acceleration function



(j) Jerk function

2.

ELECTRONIC-CAM EDITOR  
Initial designing approach



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## 2.2 Design conditions

The basic rule to design cams states the following conditions.

- The cam function must be continuous in the first and second derivatives of the distance throughout the whole interval ( $0^\circ$ -  $360^\circ$ ).
- The acceleration speed (jerk) function must be finite throughout the whole interval ( $0^\circ$ -  $360^\circ$ ).

In all of the cams, even in the simplest cam, its movement is not defined by a simple mathematical expression, but with several separate functions, each one defining the movement of the follower/slave along a segment of the cam. These functions must have a third degree continuity (the function plus two derivatives) at all the borders.

The distance, velocity and acceleration functions must not be discontinued at the borders. The overall procedure to design the movement of the follower (slave axis) of the cam is based on the VDI (Verein Deutscher Ingenieure) regulation 2143. The purpose of this regulation is to avoid defective path designs that may generate high stress on the cam when it is working and make it deteriorate faster.

For that, starting with extreme positions or with given paths, the full travel of the cam is divided into several segments or intervals and the movement characteristics are set for each of them. The following classification sets the type of movement assigned to the border points of each defined interval according to the pair of values (velocity-acceleration) reached in them. Each movement type is shown by its associated symbol.

Pair of values. velocity (v) - acceleration (a)	Type of movement.	Symbol.
$v = 0, a = 0$	Rest	R
$v \neq 0, a = 0$	Constant velocity	V
$v = 0, a \neq 0$	Withdrawal	A
$v \neq 0, a \neq 0$	Movement	M

There are 16 possible transitions or combinations per interval:

R - R	V - R	A - R	M - R
R - V	V - V	A - V	M - V
R - A	V - A	A - A	M - A
R - M	V - M	A - M	M - M



*The "VDI 2143" regulation sets the rules for the possible movements for each interval to meet the continuity conditions at their borders according to the type of transition to apply in that interval.*

# 2.

ELECTRONIC-CAM EDITOR  
Design conditions

The following classification attends to the type of function (mathematical law) of transitions for each border point specified by the "VDI 2143" regulation:

Function.	Description.	Contouring condition (*).
SYNC	Synchronous movement with constant transmission ratio between the master and the slave axes.	$v = \text{constant}$ $a = 0$
AUTO	Automatic adaptation to the contouring conditions.	
POLY5	5th degree polynomial for the R-R case.	$v = 0, a = 0$
SIN	Sinusoidal for the R-R case.	$v = 0, a = 0$
SIN_M	Modified sinusoidal for the R-R case.	$v = 0, a = 0$
SIN_AA	Sinusoidal between points A-A.	
CYCLO	Cycloidal for the R-R case.	$v = 0, a = 0$
TRAP	Modified trapezoidal acceleration for the R-R case.	$v = 0, a = 0$
SIN_M_VV	Modified sinusoidal for the V-V case.	$a = 0$
COMBI_AA	Synchronous sinusoidal combination for the A-A case.	$v = 0$
TRAP_RA	Modified trapezoidal acceleration for the R-A case.	$v = 0,$ start: $a = 0$
TRAP_AR	Modified trapezoidal acceleration for the A-R case.	$v = 0,$ final: $a = 0$
HARM_RA	Harmonics combination in the R-A case.	
HARM_AR	Harmonics combination in the A-R case.	
SPL	Cubic spline.	
SPL_NAT	Natural cubic spline.	$a = 0$
SPL_TAN	Tangential cubic spline.	

(\*)  $v$  = velocity    $a$  = acceleration.

# 2.

ELECTRONIC-CAM EDITOR  
Design conditions

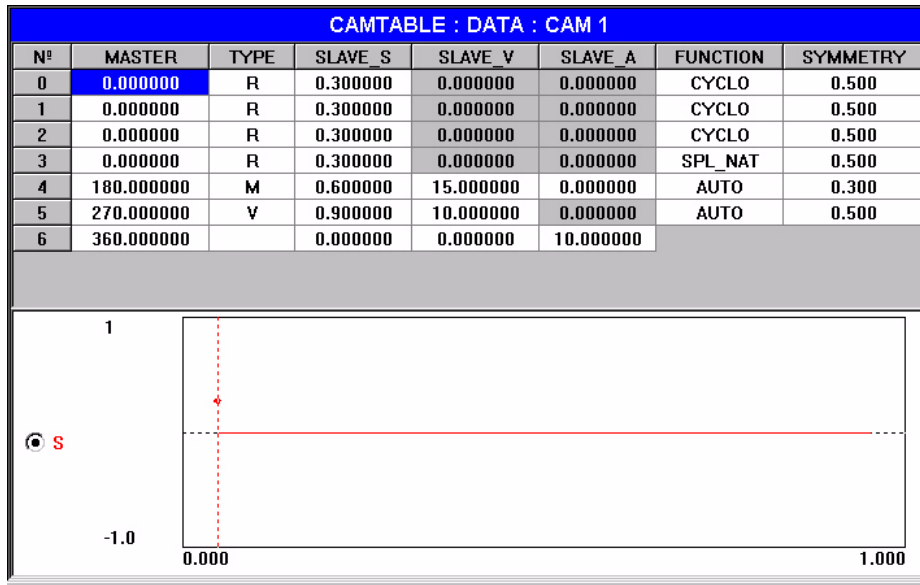


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## 2.3 User interface

The cam editor looks like this:



2.

ELECTRONIC-CAM EDITOR  
User interface

### Data table

This table helps the user design the cam. The data table consists of 8 columns labeled by all the elements to be considered in the design. Each label appearing in the data table has the following meaning:

Label.	Description.
Nº	Number of border points that set the whole total path of the cam/follower (slave) into intervals. (Meaning cam = master axis, follower = slave axis). It admits up to 1024 points.
Master	Position of the master axis. It admits values between 0 and 360 (if the range is from 0 to 360) or between 0 and 1 (of the range is from 0 to 1).
Type	Type of movement; rest (R), constant speed (V), withdrawal (A) o movement (M). See "2.2 Design conditions" on page 29.
Slave_S	Position of the slave axis relative to that of the master axis. It admits values between -1 and 1.
Slave_V	Slave axis velocity relative to that of the master axis. It admits any value.
Slave_A	Acceleration of the slave axis relative to the square of the velocity of the master axis. It admits any value.
Function	Mathematical law of the path applied at each border point. See "2.2 Design conditions" on page 29.
Symmetry	Value of the symmetry of the movement law at each border point. It admits values between 0 and 1.

There is a drop menu to set the type of movement and the mathematical function; this menu appears when activating the text box associated with each point.

Nº	MASTER	TYPE
0	0.000000	A
1	90.000000	M
2	180.000000	R
3	270.000000	V
4	360.000000	A

SLAVE_A	FUNCTION	SYMM
0.000000	AUTO	0.5
2.000000	SPL_NAT	0.5
0.000000	SPL_TAN	0.5
0.000000	SIN_AA	0.5
0.000000		

Each line of the table refers to a border point of the interval and all the values entered in the line only correspond to it. The joining mathematical function sets the type of joint between the point of the current line and the point of the next line.



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## Graphics window

This window lets the user display the behavior of the cam (master) and that of the follower (slave) with graphics showing the distance traveled, velocity, acceleration and jerk of the slave axis after entering the design parameters in the editing table mentioned earlier.

Up to 4 graphics may be displayed showing the movement (s), velocity (v), acceleration (a), and jerk (j) functions. They are selected from the softkey menu. When using a mouse, click on the right button of the mouse to show the selection menu.

## Horizontal softkey menu

The following softkey menu is displayed.

### Views

This softkey may be used to select the graphics to be displayed in the graphic window and to display the cam editing table. Select S, SV, SVA, SVAJ to display the graphics of 1, 2, 3 or 4 functions individually.

The "Change mode" option shows the graphics of the four functions superimposed on the same graphics.

### Zoom

The zoom option may be used to select one of the graphics currently displayed to enlarge a portion of it. The enlargement takes place on the graphic itself. When selecting the zoom option, the softkey menu shows a number of options to select and activate the zoom.

The "Next channel" option may be used to select the graphics been zoomed. Every time this softkey is pressed, it selects a different graphics. The selection box to the left of the graphics indicates which one is currently selected.

The "Zoom on" option may be used to define and apply the desired zoom. There are two different ways to apply the zoom to the selected graphics.

- The graphics may be zoomed in (enlarged) or out (shrunk) using the "+" and "-" keys of the numeric keyboard.
- It is possible to define the maximum and minimum position to be displayed, both on the abscissa axis and on the ordinate axis. In this case, Xmin/Xmax define the minimum and maximum coordinates to display on the abscissa axis and Ymin/Ymax define the minimum and maximum coordinate to display on the ordinate axis.

The "Zoom off" option closes the zoom defining screen.

### Editing

The edit option may be used to edit the cam table adding or removing points to the table and calculating the new graphics.

The "Add point" option adds a new point to the cam. This adds a new segment to the travel length of the cam.

The "Delete point" option removes a point from the cam. This removes a segment from the path of the cam.

The "Recalculate" option refreshes the graphics of the functions after adding, removing or modifying any point of the path.

### 0 - 360 / 0 - 1

This softkey may be used to set the coordinate boundaries for the abscissa axis that will contain the graphics. The boundaries may be between 0-360 degrees or between 0-1 units.

# 2.



## Vertical softkey menu



### Initialize table.

Reset all the table data to "0". The CNC will request confirmation of the command.



### Save tool.

Save the values of the table into a file. The file extension is cpj.



### Recall table.

Restore the values of the table previously saved into a file.

2.

2.

**ELECTRONIC-CAM EDITOR**  
User interface



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## 3.1 Activating and canceling the electronic cam

The electronic cam may be activated and canceled from the part-program as well as from the PLC program.

### Activating and canceling the electronic cam from the part-program

The activation and cancellation of the electronic cam is programmed with the following instructions.

- #CAM ON - Activate the synchronization movement.
- #CAM OFF - Cancel the synchronization movement.

The programming format for each of them is the following. Optional parameters are indicated between the <> characters.

```
#CAM ON [cam, master/"TIME", slave, master_off, slave_off, range_master,  
range_slave <,type>]  
#CAM OFF [slave]
```

Executing the #CAM OFF instruction involves eliminating the synchronization of the cam. Once this instruction has been programmed, the cam ends when reaching the end of its profile.

### Activating and canceling the electronic cam from the PLC program

The activation and cancellation of the electronic cam is programmed with the following commands.

- CAM ON - Activate the synchronization movement.
- CAM OFF - Cancel the synchronization movement.

The programming format for each of them is the following.

```
CAM ON (cam, master/"TIME", slave, master_off, slave_off, range_master,  
range_slave, type)  
CAM OFF (slave)
```

Executing the CAMOFF command involves eliminating the synchronization of the cam. Once this command has been programmed, the cam ends when reaching the end of its profile.

### Description of the call-parameters.

Parameter.	Meaning.
cam	Cam number.
master	Name of the master axis.
TIME	Time cam. When programming "TIME" instead of an axis name, the cam is interpreted as being a time cam.
slave	Name of the slave axis.
master_off	Offset for the master axis.

## 3.

Parameter.	Meaning.
slave_off	Offset for the slave axis.
range_master	Master axis activation scale or range.
range_slave	Slave axis activation scale or range.
type	It defines the type of cam; periodic or not periodic. It is programmed using parameters "ONCE" (non-periodic cam) or "CONT" (periodic cam). Optional from the part-program. If not programmed, it assumes the "ONCE" value (non-periodic cam).

**Example from the part-program.**

```
#CAM ON [1, X, Y, 30, 0, 100, 100]
#CAM ON [1, TIME, A2, 0, 0, 6, 3, ONCE]
#CAM OFF [Y]
```

**Example from the PLC program.**

```
CAM ON (1, Y, U2, 0, 0, 100, 100, CONT)
CAM ON (1, TIME, Y, 10, 0, 3, 3, ONCE)
CAM OFF (U2)
```

**Cam mode.**

Two types of cams may be activated; cams in time or cams according to the position of the master axis. The activation instruction is the same and it is selected by the call-parameters.

**Cam number.**

To activate a cam, it must have been previously defined at the cam editor, within the machine parameters.

**Master axis activation range.**

The cam is activated when the master axis is between the positions "master\_off" and "master\_off + range\_master".

**Range for the slave axis.**

The cam applies it to the slave axis when the slave axis is between "slave\_off" and "slave\_off + range\_slave".

**Cam type.**

Depending on the execution mode, the time cams and the position cams may be of two different types; i.e. periodic or non-periodic. It is selected with the type parameter.

Not periodic                      It is defined by assigning the "ONCE" value to the type parameter.

This mode maintains the synchronization for the range defined for the master axis. If the master axis moves backwards or if it is a module, the slave axis will keep on executing the cam profile until the cancellation is programmed.

Periodic                              It is defined by assigning the "CONT" value to the type parameter.

In this mode, when reaching the end of the range of the master axis, it calculates the offset to execute the cam again shifted in the amount of that range. In other words, identical cams are executed along the path of the master axis.

If the master axis is a rotary module and the cam definition range is that module, the two execution modes are equivalent.

Either mode maintains synchronization until the #CAM OFF instruction is executed. When reaching that instruction, the execution of the cam will end the next time the end of the cam profile is reached.

## 3.2 Execute cams defined in a file.

The data of a cam may be defined in a file that may be loaded from the CNC or from the PLC. When executing a cam from a file, the CNC reads its data dynamically and, consequently, the number of points to define the cam is unlimited.

The following instructions and commands only define the location of the cam; to activate it, use the instruction #CAM ON (from the CNC) or the command CAM ON (from the PLC).

It is up to the user to select the parameters and the functions to design an electronic cam and must make sure that his design is coherent with the required specifications.

### Activating and canceling the file cam from the part-program

To select or cancel a file cam, use the following instructions.

#CAM SELECT - Select a file cam.

#CAM DESELECT - Cancel the cam of a file.

The programming format for each of them is the following.

#CAM SELECT [cam, file]

#CAM DESELECT [cam]

After selecting a file cam, it stays available until the cam table of the machine parameters is validated or the CNC is turned off.

### Activating and canceling the file cam from the PLC

To select or cancel a file cam, use the following commands.

CAM SELECT - Select a file cam.

CAM DESELECT - Cancel the cam of a file.

The programming format for each of them is the following.

CAM SELECT (cam, file)

CAM DESELECT (cam)

After selecting a file cam, it stays available until the cam table of the machine parameters is validated or the CNC is turned off.

### Description of the call-parameters.

Parameter.	Meaning.
cam	Cam number.
path/file	Name and path of the file containing the cam data.

#### Example from the part-program.

```
#CAM SELECT [6, "C:\USERCAM\cam.txt"]
```

(The CNC uses for cam ·6· the data defined in the cam.txt file)

```
#CAM DESELECT [6]
```

(The CNC stops using for cam ·6· the data defined in the cam.txt file)

# 3.

PROGRAMMING AND EXECUTING THE ELECTRONIC CAM

Execute cams defined in a file.

**FAGOR** 

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## Modify the data of the cam

Cam data may be modified from the CNC and from the PLC using the following variable.

Variable.	Meaning.
(V.)G.CAM[cam][index]	Cam status.

### (V.)G.CAM[cam][index]

*Variable that can be read and written via program, PLC and interface.*

*The variable returns the execution value; reading it interrupts block preparation.*

Factor to be applied to the range of the slave axis when activating the cam.

#### Syntax.

- cam· Cam number (between 1 and 16).
- index· Point of the cam. For the cams defined in the machine parameters, a value between 1 and 1024. For the file cams, the line number.

V.G.CAM[2]	Cam ·2·.
------------	----------

# 3.

PROGRAMMING AND EXECUTING THE ELECTRONIC CAM  
Execute cams defined in a file.

### 3.3 Check the status of the cam.

The status of the cam may be consulted using the following variable.

Variable.	Meaning.
(V.)G.CAMST[cam]	Cam status.

#### (V.)G.CAMST[cam]

Variable that can only be read from the program, PLC and interface.

The variable returns the execution value; reading it interrupts block preparation.

Cam status. Use this variable in the PLC routine to condition the cam operations to the right status and consequently prevent execution errors. The operations of the cam from the part-program stay in execution, without issuing an error message, waiting for the right cam status.

#### Syntax.

·cam· Cam number.

V.G.CAMST[2] Cam ·2·.

#### Values of the variable.

Value.	Meaning.
0	<p><b>CAM_NULL</b></p> <p>The cam does not exist. The cam is not defined in the machine parameters and there is no file cam available, the CNC or the PLC have not selected it (SELECT) or they have deselected it (DESELECT).</p> <ul style="list-style-type: none"> <li>• This state only allows loading one file cam from the CNC or PLC.</li> <li>• This status does not allow activating the cam, either from the CNC or from the PLC.</li> </ul>
1	<p><b>CAM_LOADING</b></p> <p>The CNC or the PLC is loading the file that defines the cam.</p> <ul style="list-style-type: none"> <li>• This state only allows activating the cam from the CNC, where the CNC will remain in execution until the cam reaches the CAM_READY state. The cam cannot be activated from the PLC.</li> </ul>
2	<p><b>CAM_READY</b></p> <p>Cam ready. The CNC has validated the cam defined in the machine parameters or is done loading the cam from a file.</p> <ul style="list-style-type: none"> <li>• This state allows any cam operation, either from the CNC or from the PLC.</li> </ul>
3	<p><b>CAM_START</b></p> <p>The cam is activated, but it has not entered the range of the master axis yet. In this situation, if the CNC or the PLC cancels the cam, the cam will not reach the CAM_READY state as long as it does not go into and out of the range of the master axis at least once.</p> <ul style="list-style-type: none"> <li>• This state allows canceling the cam, either from the CNC or from the PLC.</li> <li>• This state allows deselecting the cam, but only from the CNC.</li> </ul>
4	<p><b>CAM_RUNNING_OUTSIDE</b></p> <p>The cam is active and in execution out of the range of the master axis. In this state, the cam has been inside the range of the master axis at least once. If the CNC or the PLC cancel the cam, the cam will go into CAM_READY state.</p> <ul style="list-style-type: none"> <li>• This state allows canceling the cam, either from the CNC or from the PLC.</li> <li>• This state allows deselecting the cam, but only from the CNC.</li> </ul>
5	<p><b>CAM_RUNNING_INSIDE</b></p> <p>The cam is active and in execution inside the range of the master axis. If the CNC or the PLC cancel the cam, the cam will go into CAM_FINISH state.</p> <ul style="list-style-type: none"> <li>• This state allows canceling the cam, either from the CNC or from the PLC.</li> <li>• This state allows deselecting the cam, but only from the CNC.</li> </ul>
6	<p><b>CAM_FINISH</b></p> <p>The CNC or the PLC has canceled the cam, but it keeps executing until the cam goes out of the range of the master axis. This situation occurs when the CNC or the PLC cancel a cam that was in CAM_RUNNING_INSIDE state; if they cancel a cam that was in CAM_RUNNING_OUTSIDE state, the cam reaches the CAM_READY state.</p> <ul style="list-style-type: none"> <li>• This state only allows deselecting the cam, but only from the CNC.</li> </ul>

# 3.

PROGRAMMING AND EXECUTING THE ELECTRONIC CAM

Check the status of the cam.

FAGOR 

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**Remarks.**

To switch from CAM\_READY to CAM\_NULL, just deselect the file cam and make sure that the cam is not in the machine parameters. If the cam is defined in the machine parameters, it maintains the CAM\_READY state, but the cam data will be defined in the machine parameters.

- To select a file cam, the cam status (state) must be either CAM\_NULL or CAM\_READY.
- To select a file cam from the PLC, preventing execution errors, the cam status (state) must be CAM\_READY. If the cam is activated from the CNC, the channel will remain in execution until the cam reaches the CAM\_READY state.
- To deselect a file cam from the PLC, preventing execution errors, the cam status (state) must be CAM\_READY. If the cam is deselected from the CNC, the channel will remain in execution until the cam reaches the CAM\_READY state.

**3.****PROGRAMMING AND EXECUTING THE ELECTRONIC CAM**

Check the status of the cam.

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### 3.4 "Position - position" type cams

The ratio set between the master axis and the slave axis for synchronizing "position - position" type cams is the following:

$$Y = K_S \times CAM \left[ \frac{X - X_{off}}{K_M} \right] + Y_{off}$$

Parameter.	Meaning.
Y	Position of the slave axis.
Ks	Position scale of the slave axis.
CAM[i]	Normalized table of the electronic cam.
X	Position of the master axis.
Xoff	Position offset of the master axis.
Km	Position scale of the master axis.
Yoff	Position offset of the slave axis.

#### Normalized table of the electronic cam.

The table of the electronic cam must be properly defined within the machine parameter table.

#### Range of action of the electronic cam.

The Xoff and Km values define the position range of the master axis where the cam acts. The cam only regulates the slave axis position within this range.

The Xoff value is subtracted from the master axis position to calculate the entry position of the cam table.

#### Origin of the range of action of the electronic cam.

The Yoff and Ks values allow moving the slave axis positions outside the range of values set by the cam function.

# 3.

PROGRAMMING AND EXECUTING THE ELECTRONIC CAM  
"Position - position" type cams

### 3.5 "Position - time" type cams

The ratio set between the master axis and the slave axis for synchronizing "position - time" type cams is the following:

$$Y = K_S \times CAM \left[ \frac{T - T_{off}}{K_T} \right] + Y_{off}$$

Parameter.	Meaning.
Y	Position of the slave axis.
Ks	Position scale of the slave axis.
CAM[i]	Normalized table of the electronic cam.
T	Time elapsed since the beginning of the cam (in each cycle).
Toff	Time offset.
Kt	Time range (duration of the cam profile).
Yoff	Position offset of the slave axis.

#### Normalized table of the electronic cam.

The table of the electronic cam must be properly defined within the machine parameter table.

#### Range of action of the electronic cam.

The Kt value sets the time range or total duration of the cam function.

#### Beginning of the cam.

The Toff value sets a time for the cam trigger.

#### Origin of the range of action of the electronic cam.

The Yoff and Ks values allow moving the slave axis positions outside the range of values set by the cam function.

# 3.

PROGRAMMING AND EXECUTING THE ELECTRONIC CAM  
"Position - time" type cams

### 3.6 Synchronizing the electronic cam

When starting the electronic-cam synchronization mode, the system calculates the synchronization position of the slave axis according to the ratios described in the previous two sections.

There are two stages to reach synchronization. The first one is to adapt the velocity and the second one to adapt the position. Synchronization is canceled with the relevant command.

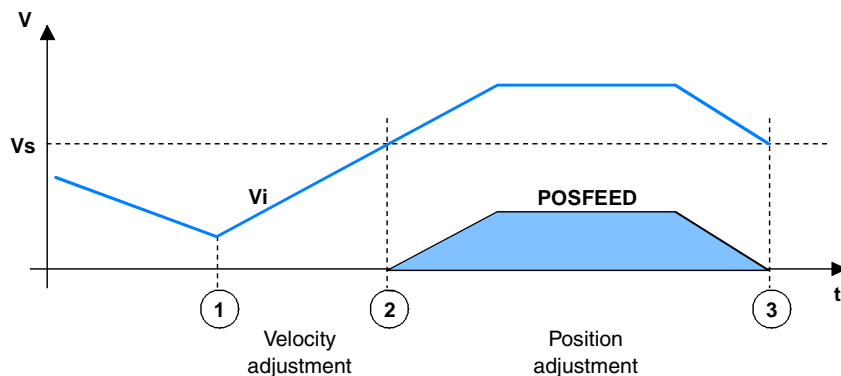
#### Velocity adaptation stage.

The first stage adapts the current slave axis speed to the synchronism speed. The velocity adapting process is carried out at the linear acceleration of the axis when activating the instruction. Once the velocity has been adapted, there will be a difference between the generated position instruction and the synchronization position of the slave axis.

#### Position adaptation stage.

This second stage of the synchronization generates the position adjustment, thus eliminating the position error generated at the end of the previous stage. To adjust the position, an additional movement is added to the synchronization velocity that will originate an increase or decrease of the velocity already reached. The velocity for the additional movement is set by parameter POSFEED. This process ends when the generated position instruction coincides with the calculated position.

- 1 Beginning of the synchronization.
- 2 Adjustment of the velocity adaptation. The internal speed ( $V_i$ ) reaches the synchronism speed ( $V_s$ ).
- 3 Adjustment of the position adaptation. Reach of the synchronization.



The shaded area indicates the position error at the end of the velocity adaptation stage.

Synchronism is maintained until programming the opposite; the #CAM OFF instruction from the part-program or the CAMOFF command from the PLC program. After executing one of these instructions, the execution of the cam ends the next time the end of its profile is reached.

#### Monitoring during cam synchronization

The synchronization process must be successful in a specific amount of time. The monitoring of the time needed to reach the synchronization state begins when activating the cam and ends when reaching this state.

# 3.

PROGRAMMING AND EXECUTING THE ELECTRONIC CAM  
Synchronizing the electronic cam

**FAGOR** 

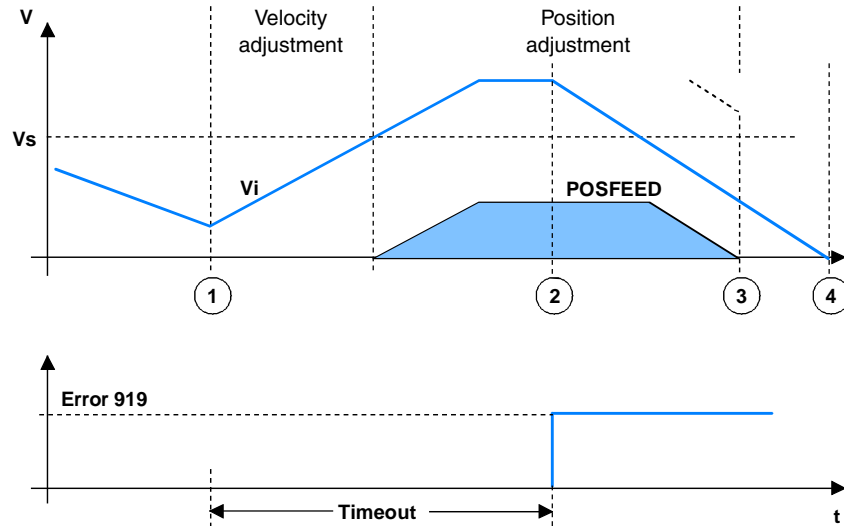
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The time elapsed cannot be indefinite. The variable SYNCTOUT may be used to set the maximum time (timeout) it takes to achieve synchronization. An error is issued if the timeout value is exceeded before reaching synchronization.

**3.**

- 1 Starting the test.
- 2 Activating the error.
- 3 Theoretical activation of the synchronization, if no error has been detected.
- 4 Once the error has been detected, it switches to zero velocity command.

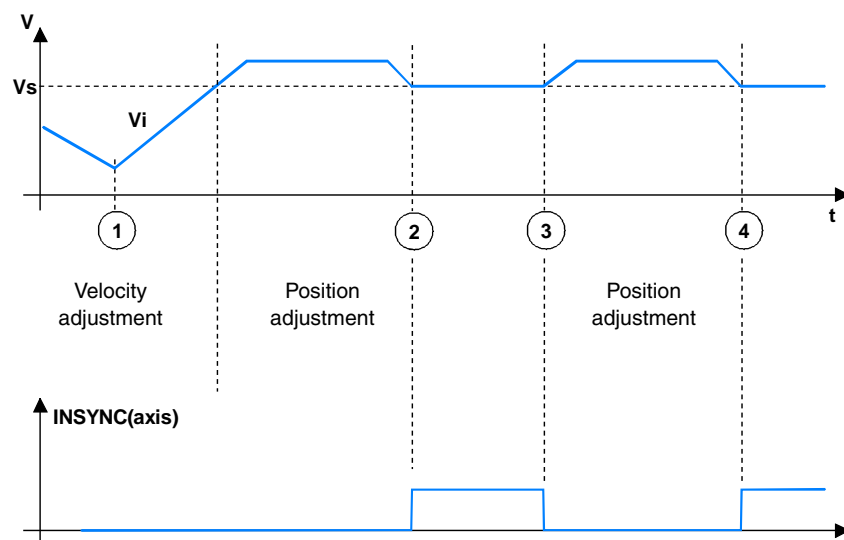


The shaded area indicates the position error at the end of the velocity adaptation stage.

**Adjustment during cam synchronization**

Once synchronization has been reached, if the position offset is modified, it restarts monitoring the synchronization timeout. This monitoring ends when the new synchronism is reached.

- 1 Beginning of the position synchronization.
- 2 Reach the position synchronization.
- 3 Beginning of the synchronization after modifying the position offset of the slave axis.
- 4 Reach the new position synchronization.



Behavior of the INSYNC mark of the slave axis during synchronization and later modification of the offset.



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### 3.7 Effect of the control signals on the electronic cam

The execution of the application will be affected by different control signals (INHIBIT(axis) and IRESET(axis)).

The names of the signals are generic. Replace the text (axis) with the name or logic number of the axis.

#### Modifiable signals

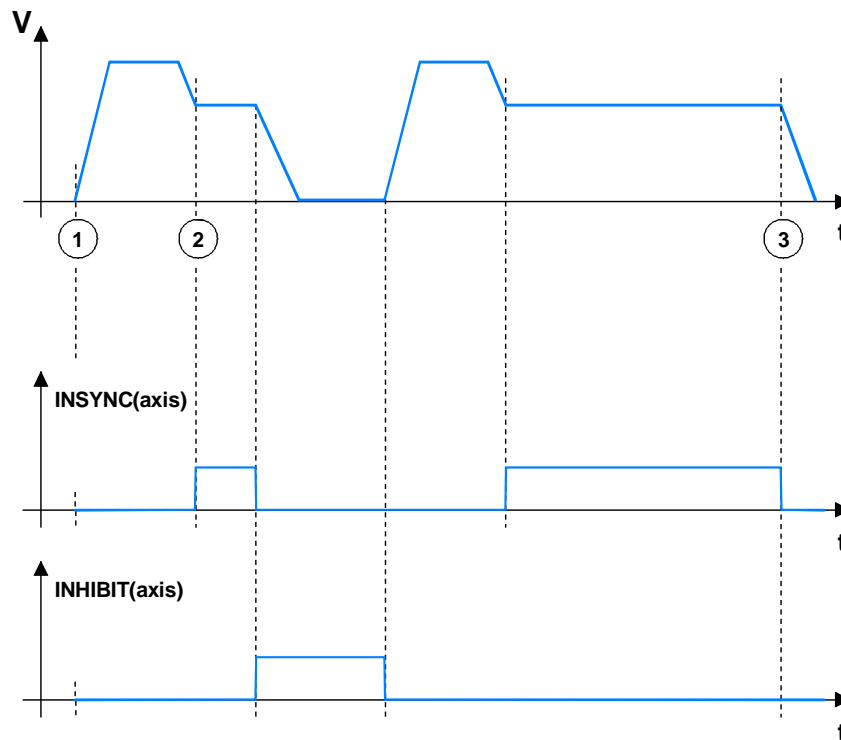
##### INHIBIT(axis)

If the PLC activates this mark, it interrupts the synchronization movement of the cam switching to zero speed. The system waits for the signal to deactivate before resuming the execution and the movement from the interruption point.

##### I RESET(axis)

The system behaves similarly to when activating INHIBIT (axis). It differs in that after interrupting the movement, it initializes the independent interpolator.

- 1 Beginning of the position synchronization.
- 2 Reach the position synchronization.
- 3 Beginning of the synchronization after modifying the position offset of the slave axis.
- 4 Reach the new position synchronization.



- ① #CAM ON [1, . . . ]
- ② #TIME 100
- ③ #CAM OFF [...]

It shows a cam synchronization in continuous mode, executed the same profile several times until executing the #CAM OFF instruction.

# 3.

## PROGRAMMING AND EXECUTING THE ELECTRONIC CAM

Effect of the control signals on the electronic cam



CNC 8070

(REF: 1304)

# INDEPENDENT AXES

II





# OVERVIEW ON THE INDEPENDENT MOVEMENTS OF THE AXES.

# 4

The CNC has the possibility of executing independent axis positioning and synchronization. For this type of movements, each CNC axis has an independent interpolator that keeps track of the current position on its own without depending on the tracking of the general interpolator of the CNC.

The CNC allows executing an independent movement and general movement simultaneously. The result will be the sum of the two interpolators.

## Restrictions of the axes to make independent movements

Any axis of the channel may be moved independently using the associated instructions. However, this function presents the following restrictions.

- Un cabezal únicamente podrá moverse de manera independiente si mediante una instrucción #CAX se activa como eje C. Sin embargo, siempre podrá ejercer de eje maestro de una sincronización o de una leva electrónica.
- A rotary axis may be of any module, but the lower limit must always be zero.  
AXISMODE = module.  
MODLOWLIM= 0.  
MODUPLIM = any value.
- A Hirth axis cannot move independently.

## Movement programming

The commands may be executed from the part-program as well as from the PLC program. The CNC stores up to a maximum of two motion instructions per axis. The rest of instructions sent when there are two pending execution imply a wait from the part-program or cause an error via PLC.

Independent movements may be programmed indistinctly from the CNC or from the PLC, although the results may be different. Thus, from the PLC, the instruction is included immediately in the table of blocks of independent movements, whereas from the part-program, it is included as it is executed. It is up to the user to assure proper synchronization.

## Influence of the active functions in the independent movements

The absolute movements programmed from the part-program are carried out referred to the active zero offset in the channel; i.e. they will be applied the offset active at the time. The coordinate will also be affected by mirror image, the radius/diameter option and the mm/inches option. But it will not be affected by the scaling factor nor by the pattern (coordinate) rotation.

If these movements are programmed from the PLC, the coordinate origin, the mirror image and the radius/diameter option will be ignored. The mm/inches option will be treated according to the setting of the machine parameters.

As a single origin, the V.A.IORG.Xn variable may be written from the PLC and when used from the part-program, it will become additive to the value active at the time in the channel.

## Influence of the independent movements in block preparation

None of these blocks interrupt block preparation, but they do interrupt the interpolation. Therefore, it will not blend two blocks, there will be an intermediate one.



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### Influence of the movements in the inclined planes

The CNC allows programming an independent movement of axes involved in an incline plane or in a transformation. The movement is carried out referred to machine zero when programming from the PLC as well as from the CNC.



*It is up to the user to control the position of the machine.*

### Movement execution

It is possible to execute an independent movement and general movement simultaneously. The result will be the sum of the two interpolators.



*Executing both movements at the same time may exceed the dynamic parameters for acceleration and jerk (e.g. if they both accelerate at the same time or reverse their moving direction). It is up to the user to control the simultaneity of both movements.*

The independent interpolator keeps track of the current position on its own without depending on the tracking of the general interpolator of the CNC. The incremental movements programmed by each interpolator are calculated from each absolute position.

If blocks of independent motion are inserted between other motion blocks, neither rounding nor path blending is carried out from the part-program in the program's motion blocks.

### Feedrate override percentage selection

The position of the feedrate selector of the operator panel does not affect the movement of the independent axis. The feedrate override percentage of the axis involved in the independent movement may be varied using the axis variable (V).A.FRO.Xn.

### Acceleration and jerk

The acceleration and jerk values used to generate the independent movement are the same as those of the general interpolator; in other words, those of the machine parameters or the ones programmed with CNC variables or instructions and that are active at the time.

### Channel status

The channel status will not be affected when having channel axes moving independently. The program or MDI block will be completed even if the axis is moving independently.

### Synchronizing the interpolators

In order for the incremental movements to take the real coordinate of the machine into account, each interpolator must be synchronized with that real coordinate. The synchronization is done from the part-program using the instruction #SYNC POS. The independent interpolator is also synchronized with the real coordinate with the signal IRESET(axis).

Resetting the CNC synchronizes the theoretical coordinates of both interpolators with the real coordinate. These synchronizations will only be necessary when inserting instructions of both types of interpolators.

Every time the program is initiated or an MDI block is executed, the coordinate of the general interpolator of the CNC is synchronized and every new independent instruction (without any one pending) also synchronizes the coordinate of the independent interpolator.

# 4.

## OVERVIEW ON THE INDEPENDENT MOVEMENTS OF THE

## Influence of the independent movements onto PLC signals

Any axis of the channel may be moved independently by simply programming the instructions for independent movement. This independent movement does not affect the following typical signals of the channel. Signal names are generic; replace the word (axis) with the spindle name or with the name or logic number of the axis.

Mnemoni.	Meaning.
INPOSI	The CNC channel activates this mark to indicate that all its active axes and spindles have reached position, except the independent axes programmed from the PLC. This mark remains active during the movement of independent axes.
ADVINPOS	The CNC channel sets this signal high for some time before the axes reach position. This mark is not affected by the independent movement because it is an anticipation of the INPOS mark of the channel.
_STOP	Si el PLC activa esta marca (nivel lógico bajo), el CNC detiene la ejecución del programa pieza, manteniendo el giro del cabezal. El movimiento independiente de los ejes no se ve afectado por esta marcas.
_FEEDHOL	If the PLC activates this mark (=0), the CNC channel interrupts momentarily the movement of the axes; but keeping the spindle turning. El movimiento independiente de los ejes no se ve afectado por esta marcas.
INHIBIT(axis)	If the PLC turns this mark on, the CNC inhibits any movement of the corresponding axis or spindle. For independent movement of the axes, if the PLC turns activates this mark, the CNC interrupts the synchronization movement switching to zero speed. The system waits for the signal to deactivate before resuming the execution and the movement from the interruption point. For independent axes, this signal also stops the monitoring of the synchronization.
ENABLE(axis)	The CNC activates this mark to indicate to the PLC that it is going to move the corresponding axis or spindle in closed loop, so the PLC enables it if necessary. This PLC also activates this mark in the movements of the independent axis and remains active until the synchronization is deactivated.

The mnemonics that begin with a "\_" sign indicate that the signal is active low (0 V).

4.

OVERVIEW ON THE INDEPENDENT MOVEMENTS OF THE

# 4.

## OVERVIEW ON THE INDEPENDENT MOVEMENTS OF THE



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The movements may be programmed either from a part-program or from the PLC. The CNC executes the positioning movements with the acceleration and jerk values active on the axis. There are three types of positioning moves.

- Absolute positioning move.  
The positioning coordinates are defined in absolute coordinates.
- Incremental positioning move.  
The positioning coordinates are defined in incremental coordinates.
- Positioning movement in the indicated direction.  
The positioning coordinate is not defined and the axis makes a movement in the indicated direction until the axis limits are reached or until the movement is interrupted.

## 5.1 Activation and cancellation of the positioning movement

The synchronization movement may be activated and canceled from the part-program as well as from the PLC program.

### Activation and cancellation from the part-program

The various types of positioning are programmed with the following instructions.

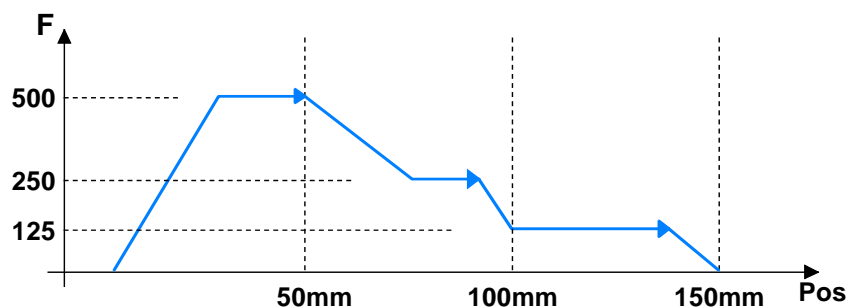
- #MOVE - Absolute positioning move.
- #MOVE ADD - Incremental positioning move.
- #MOVE INF - Positioning movement in the indicated direction.

The programming format for each of them is the following. Optional parameters are indicated between the <> characters.

- #MOVE <ABS> [Xpos <,Ffeed> <,blend>]
- #MOVE ADD [Xpos <,Ffeed> <,blend>]
- #MOVE INF [X+/- <,Ffeed> <,blend>]

Parameter.	Meaning.
Xpos	Axis and position to reach.
X+/-	Axis (without coordinates) to position and moving direction.
Ffeed	Optional. Positioning feedrate
blend	Optional. Dynamic blend with the next block

```
P100 = 500 (feedrate)
#MOVE [X50, FP100, PRESENT]
#MOVE [X100, F[P100/2], NEXT]
#MOVE [X150, F[P100/4], NULL]
```



#### Axis and position to reach

With #MOVE ABS the position to be reached will be defined in absolute coordinates whereas with #MOVE ADD it will be defined in incremental coordinates.

The moving direction is determined by the coordinate or the increment programmed. For rotary axes, the moving direction is determined by the type of axis. If it is unidirectional, it positions in the preset direction; otherwise, it positions via the shortest path.

#### Axis and moving direction

It is used with #MOVE INF to execute a movement in the indicated direction until the axis limit is reached or until the movement is interrupted.

The moving direction is determined by the programmed sign. "+" sign to move in the positive direction and "-" to move in the negative direction.

5.

POSITIONING MOVE  
Activation and cancellation of the positioning movement

### Positioning feedrate

The feedrate is programmed with the "F" code followed by the desired feedrate value according to the active units (mm/min, inch/min or degrees/min).

This parameter is optional. If not defined, it assumes the feedrate set by machine parameter POSFEED.

### Dynamic blend with the next block

It sets the feedrate used to reach the position (dynamic blend with the next block). It is programmed with one of the following parameters.

- PRESENT The axis reaches the indicated position at the feedrate indicated by the block itself.
- NEXT The axis reaches the indicated position at the feedrate indicated in the next block.
- NULL The axis reaches the indicated position at zero feedrate.
- WAITINPOS The axis reaches the indicated position at zero feedrate and it waits to be in position before executing the next block.

Programming this parameter is optional. If not programmed, the dynamic blend is carried out according to machine parameter ICORNER as follows.

ICORNER	Type of dynamic blend
G5	According to the setting for the PRESENT value.
G50	According to the setting for the NULL value.
G7	According to the setting for the WAITINPOS value.

### Activation and cancellation from the PLC program

The various types of positioning are programmed with the following commands.

- MOVE ABS - Absolute positioning move.
- MOVE ADD - Incremental positioning move.
- MOVE INF - Positioning movement in the indicated direction.

The programming format for each of them is the following.

- MOVE ABS (axis, pos, feed, blend)
- MOVE ADD (axis, pos, feed, blend)
- MOVE INF (axis, direction, feed, blend)

### Programming units

The programming units are the standard PLC units.

- The coordinates will be given in ten-thousandths if they are in mm or hundred-thousandths if they are in inches.
  - For 1 mm it is defined as 10000.
  - For 25.40 mm it is defined as 100000.
  - For 1° it is defined as 10000.
- The feedrate of the axes is given in tenth-thousandths if mm or in hundred-thousandths if inches.
  - For 1 mm/min it is defined as 10000.
  - For 25.40 mm/min it is defined as 100000.
  - For 1°/min it is defined as 10000.

5.

POSITIONING MOVE  
Activation and cancellation of the positioning movement



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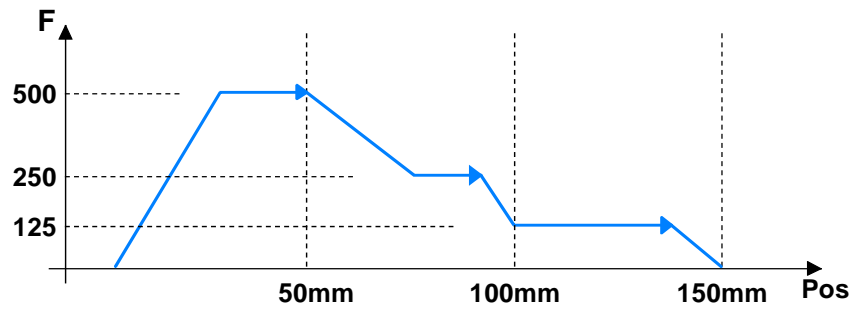
## 5.

## POSITIONING MOVE

Activation and cancellation of the positioning movement

Parameter.	Meaning.
axis	Axis to position.
pos	Position to reach.
direction	Moving direction.
feed	Positioning feedrate
blend	Dynamic blend with the next block

```
.. = MOVE ABS (X, 50, 500, PRESENT)
.. = MOVE ABS (X, 100, 250, NEXT)
.. = MOVE ABS (X, 150, 125, NULL)
```

**Position to reach**

With MOVE ABS the position to be reached will be defined in absolute coordinates whereas with MOVE ADD it will be defined in incremental coordinates.

The moving direction is determined by the coordinate or the increment programmed. For rotary axes, the moving direction is determined by the type of axis. If it is unidirectional, it positions in the preset direction; otherwise, it positions via the shortest path.

For positioning, the zero offset active in the channel is ignored.

**Moving direction**

It is used with MOVE INF to execute a movement in the indicated direction until the axis limit is reached or until the movement is interrupted.

The moving direction is programmed with parameters "DIRPOS" (positive direction) or "NEGPOS" (negative direction).

**Dynamic blend with the next block**

It sets the feedrate used to reach the position (dynamic blend with the next block). It is programmed with one of the following parameters.

- PRESENT The axis reaches the indicated position at the feedrate indicated by the block itself.
- NEXT The axis reaches the indicated position at the feedrate indicated in the next block.
- NULL The axis reaches the indicated position at zero feedrate.
- WAITINPOS The axis reaches the indicated position at zero feedrate and it waits to be in position before executing the next block.



## 5.2 Resolution of the conflicts with the programmed feedrate

Sometimes, it is impossible to obtain the feedrate requested or to blend it dynamically with the next block. When having this type of conflicts, the order of priorities is the following:

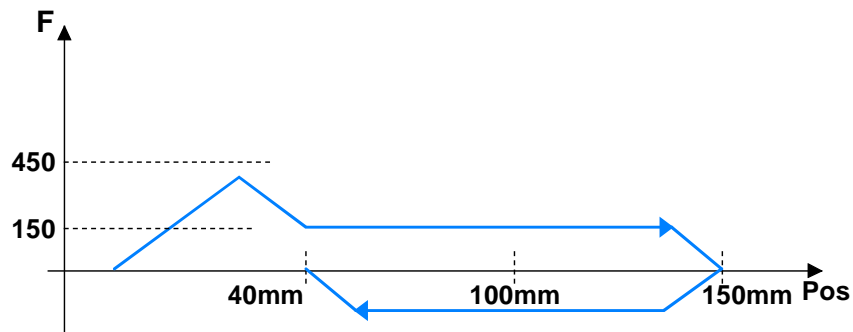
- 1 Reach the coordinate requested in the instruction.
- 2 Carry out the dynamic blend with the next motion block MOVE in the desired mode.
- 3 Make the move as long as possible at the requested feedrate.

### Example. Generic behavior with conflicts.

The first part shows a conflict feedrate - blend where the system attends to the dynamic blending mode even if the requested feedrate is not reached at any time.

The second part shows a conflict position - blend where the system does not allow overshooting the target coordinate.

```
P100 = 450 (feedrate)
#MOVE [X40, FP100, NEXT]
#MOVE [X150, F[P100/3], PRESENT]
#MOVE [X40, F[P100/3], NULL]
```



# 5.

**POSITIONING MOVE**  
Resolution of the conflicts with the programmed feedrate

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### 5.3 Consulting variables associated with positioning

The following variables may be accessed from the part-program, via MDI/MDA, via PLC and from an external application or interface. Each of them indicates whether it may be read (R) or written (W).

Variable.	R/W	Meaning.
(V.)[ch].G.IBUSY	R	Some axis of the channel is busy with an independent movement.
(V.)[ch].A.IORG.xn	R/W	Zero offset (origin) for the independent interpolator of the axis. From the PLC, it will be applied as a single part-zero whereas from the part-program it will be applied as an additive offset to the rest of the active zero offsets.
(V.)[ch].A.IPPOS.xn	R	Coordinate programmed for the independent axis. Final position for the current block.
(V.)[ch].A.ITPOS.xn	R	Current theoretical coordinate of the independent interpolator, without synchronization.
(V.)[ch].A.IPRGF.xn	R	Feedrate programmed for the independent movement in progress.
(V.)[ch].A.FRO.xn	R/W	Feedrate percentage active on the axis.

When accessing from a part program, the variable returns the execution value; reading it interrupts block preparation. The axis variables are valid for linear and rotary axes.

#### Syntax of the variables.

- ch· Channel number. The first channel is identified with the number 1, "0" is not a valid number.
- xn· Name, logic number or index in the channel of the axis.

V.[2].G.IBUSY	Channel -2.
V.A.IORG.Z	Z axis.
V.A.IPPOS.4	Axis with logic number -4.
V.[2].A.FRO.1	Axis with index -1. in the channel -2.

# 5.

POSITIONING MOVE  
Consulting variables associated with positioning



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## 5.4 Consulting the PLC marks associated with positioning

The following marks are generated by the independent interpolator. Signal names are generic; replace the word (axis) with the name or logic number of the axis.

### Consultation signals of the independent interpolator.

Mnemoni.	Meaning.
IBUSY(axis)	The independent interpolator of the axis activates this mark when there is an instruction pending to be executed.
IFREE(axis)	The independent interpolator of the axis, activates this mark when it is ready to accept a new motion block. The independent interpolator of the axis can activate this mark even if there is block in execution, so it can join both blocks at the joining feedrate indicated in the first block.
IFHOUT(axis)	The independent interpolator of the axis activates this mark when the execution is interrupted.
IEND(axis)	The independent interpolator of the axis activates this mark when it is done generating the theoretical movement.

### Modifiable signals of the independent interpolator.

Mnemoni.	Meaning.
_IXFERINH(axis)	<p>If the PLC activates this mark (=0), the movement of the independent axis ends and remains waiting for the PLC to activate this mark again. To manage the transfer inhibit in an independent movement, the PLC also has a general mark per channel (_XFERINH mark). The CNC evaluates both marks as follows.</p> <ul style="list-style-type: none"> <li>In independent movements programmed from the CNC, it first evaluates the transfer inhibit of the channel (_XFERINH mark) and then the particular one of the axis (_IXFERINH(axis) mark).</li> <li>In independent movements programmed from the PLC, the transfer inhibit of the channel is evaluated depending on parameter XFITOIND. The CNC always evaluates the particular transfer inhibit of the axis.</li> </ul>
IRESET(axis)	For independent movements of the axis, if the PLC activates this mark, it interrupts the instruction in execution and eliminates the instructions pending execution. The CNC sets the initial conditions at the independent interpolator of the axis.
IABORT(axis)	<p>For independent movements of the axis, if the PLC activates this mark, the positioning block being executed (if any) stops, without eliminating also the rest of the positioning blocks pending execution. The CNC goes on with the next instruction.</p> <p>It only affects positioning blocks; neither the pending instructions nor the synchronization movement are eliminated.</p>

The mnemonics that begin with a "\_" sign indicate that the signal is active low (0 V).

# 5.

**POSITIONING MOVE**  
Consulting the PLC marks associated with positioning

**FAGOR** 

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(REF: 1304)

# 5.

## POSITIONING MOVE

Consulting the PLC marks associated with positioning



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(REF: 1304)

# AXIS SYNCHRONIZATION

III



This mode may be used to set the movement of an axis or spindle (slave) synchronized with that of another axis or spindle (master) through a given ratio. There are two types of synchronization movements:

- Velocity synchronization (by default).
- Position synchronization.

## 6.1 Activation and cancellation of the synchronization movement

The synchronization movement may be activated and canceled from the part-program as well as from the PLC program.

### Activation and cancellation from the part-program

The activation and cancellation of the different types of synchronization are programmed with the following instructions.

- #FOLLOW ON - Activates the synchronization movement.
- #FOLLOW OFF - Cancels the synchronization movement.

The programming format for each of them is the following. Optional parameters are indicated between the <> characters.

- #FOLLOW ON [master, slave, nratio, dratio <,synctype>]
- #FOLLOW OFF [slave]

Executing the #FOLLOW OFF instruction involves eliminating the synchronization speed of the slave. The axis will take some time to brake and the instruction will stay in execution during that time.

### Activation and cancellation from the PLC program

The activation and cancellation of the different types of synchronization are programmed with the following commands.

- FOLLOW ON - Activates the synchronization movement.
- FOLLOW OFF - Cancels the synchronization movement.

The programming format for each of them is the following.

- FOLLOW ON (master, slave, nratio, dratio, synctype)
- FOLLOW OFF (slave)

### Programming units

The programming units are the standard PLC units.

- The coordinates will be given in ten-thousandths if they are in mm or hundred-thousandths if they are in inches.

For 1 mm it is defined as 10000.

For 25.40 mm it is defined as 100000.

For 1<sup>o</sup> it is defined as 10000.

- The feedrate of the axes is given in tenth-thousandths if mm or in hundred-thousandths if inches.

For 1 mm/min it is defined as 10000.

For 25.40 mm/min it is defined as 100000.

For 1<sup>o</sup>/min it is defined as 10000.

### Description of the call-parameters.

Parameter	Meaning
master	Name of the master axis.
slave	Name of the slave axis.
nratio	Numerator of the gear ratio. Turns of the slave axis.
dratio	Denominator of the gear ratio. Rotations of the master axis.
synctype	Type of synchronization; in position or in velocity. It is programmed with parameters "POS" (position) or "VEL" (velocity). Optional from the part-program. If not programmed, it assumes "VEL" (velocity).

6.

SYNCHRONIZATION MOVEMENT  
Activation and cancellation of the synchronization movement



**Example from the part-program.**

```
#FOLLOW ON [X, Y, 1, 1, POS]  
#FOLLOW OFF [Y]
```

**Example from the PLC program.**

```
FOLLOW ON (A1, Z, 3, 1, VEL)  
FOLLOW OFF (Z)
```

# 6.

## SYNCHRONIZATION MOVEMENT

Activation and cancellation of the synchronization movement



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(REF: 1304)

## 6.2 Variables associated with the synchronization movement

The following variables may be accessed from the part-program, via MDI/MDA, via PLC and from an external application or interface. Each of them indicates whether it may be read (R) or written (W).

Variable.	R/W	Meaning.
(V.)[ch].A.GEARADJ.xn	R/W	Fine adjustment of the gear ratio during synchronization. The variable is programmed as a percentage of the original adjustment value. The PLC reading comes in hundredths (x100)
(V.)[ch].A.SYNCTOUT.xn	R/W	Maximum time to establish synchronism. An error will be issued if the axis is not synchronized in this period of time. The units are milliseconds and its default value is 0 (zero).
(V.)[ch].A.SYNCVELW.xn	R/W	Velocity window for synchronization. Allowed velocity margin in which synchronization is considered to be OK. Its default value is that of machine parameter DSYNCVELW.
(V.)[ch].A.SYNCVELOFF.xn	R/W	Velocity offset to be applied to the slave axis of the synchronization.
(V.)[ch].A.SYNCPOSW.xn	R/W	Position window for synchronization. Allowed position margin in which synchronization is considered to be OK. Its default value is that of machine parameter DSYNCPOSW.
(V.)[ch].A.SYNCPOSOFF.xn	R/W	Position offset to be applied to the slave axis of the synchronization.

When accessing from a part program, the variable returns the execution value; reading it interrupts block preparation. The axis variables are valid for linear and rotary axes.

### Syntax of the variables.

- ch· Channel number. The first channel is identified with the number 1, "0" is not a valid number.
- xn· Name, logic number or index in the channel of the axis.

V.A.GEARADJ.Z	Z axis.
V.A.SYNCTOUT.Z	Z axis.
V.A.SYNCVELW.4	Axis with logic number -4.
V.A.SYNCVELOFF.4	Axis with logic number -4.
V.[2].A.SYNCPOSW.1	Axis with index -1 in the channel -2.
V.[2].A.SYNCPOSOFF.1	Axis with index -1 in the channel -2.

### 6.3 Velocity synchronization

In velocity synchronization mode, the ratio set between the master axis speed and that of the slave axis is the following.

$$V_S = \left( V_M \times \frac{N_{slave}}{N_{master}} \times \left[ 1 + \frac{GEARADJ}{100} \right] \right) + V_o$$

Parameter	Meaning
Vs	Velocity of the slave axis.
Vm	Speed of the master axis. It is calculated as the difference between the current position and the previous position of the master axis.
Vo	Velocity offset.
Nslave	Turns of the slave axis for the gear ratio
Nmaster	Turns of the master axis for the gear ratio.
GEARADJ	Fine adjustment of the gear ratio.

#### Velocity offset

It may be used to vary the speed of the slave axis independently from that of the master axis. It is set with the variable SYNCVELOFF.

#### Gear ratio

Ratio (Nslave/Nmaster) between the number of turns of the slave axis (Nslave) and the number of turns of the master axis (Nmaster).

#### Fine adjustment of the gear ratio

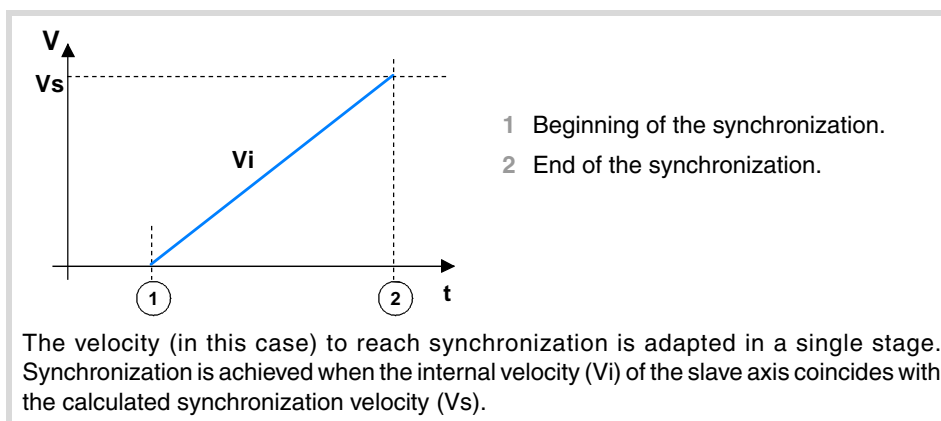
The gear ratio is determined when programming the instruction and its value remains constant during the whole operation. However, and even if the synchronization is in progress, this ratio may be modified by fine-adjusting it.

The fine adjustment of the ratio is defined with the variable GEARADJ.

### Velocity synchronization

When initiating the synchronization mode, the system calculates the velocity that the slave axis must reach depending on the velocity of the master axis, according to the previous expression.

The velocities of the slave axis before and after synchronization mode are adapted assuming as synchronization acceleration the linear acceleration of the axis before initiating this mode. This acceleration is applied without jerk.



# 6.

**SYNCHRONIZATION MOVEMENT**  
 Velocity synchronization



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## Testing during velocity synchronization

### Synchronization speed

The synchronization window is the velocity margin admitted within which the axes are considered to be synchronized. The velocity window for synchronization is determined with the variable SYNCVELW.

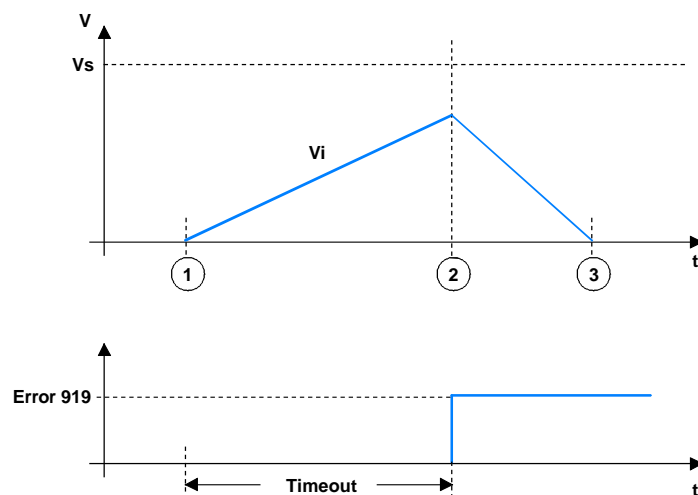
If the difference between the synchronization speed calculated for the slave axis and its actual speed is within the synchronization window, it is assumed that it is synchronized. It activates the PLC mark INSYNC of the slave axis.

### Time for synchronization

The synchronization process must be successful in a specific amount of time. The time it takes to reach the synchronization state is monitored when initiating the synchronization mode until that state is reached (it activates the PLC mark INSYNC).

The time elapsed cannot be indefinite. The variable SYNCTOUT may be used to set the maximum time (timeout) it takes to achieve synchronization. An error is issued if the timeout value is exceeded before reaching synchronization. If the value of this variable is zero, the synchronization time is not monitored. By default, this variable takes a zero value and it is also initialized after a reset.

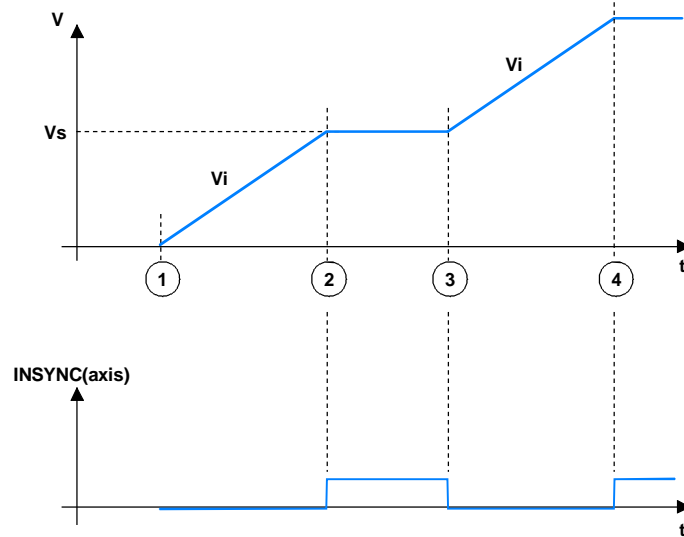
- 1 Starting the test.
- 2 Activating the error.
- 3 Once the error has been detected, it switches to zero velocity command.



### Adjustment after velocity synchronization

Once velocity synchronization has been achieved, if the gear ratio adjustment (variable GEARADJ) or the velocity offset of the slave axis is changed (variable SYNCVELOFF), the synchronization velocity must be recalculated. Thus, a new adaptation stage is required to reach the new synchronization speed after the changes made.

- 1 Beginning of the velocity synchronization. The ( $V_i$ ) speed of the slave axis increases to reach the synchronization speed ( $V_s$ ).
- 2 It reaches velocity synchronism.
- 3 Beginning of the velocity synchronization after modifying the gear ratio or the offset.
- 4 Velocity synchronism reached.



It shows the behavior of the INSYNC mark of the slave axis during synchronization and later modification of the adjustment of the gear ratio or velocity offset.

The variations of the gear ratio or velocity offset adjustment during the synchronization process restart the monitoring of the synchronization timeout. This monitoring ends when synchronization has been reached after the changes.

# 6.

## SYNCHRONIZATION MOVEMENT Velocity synchronization

## 6.4 Position (phase) synchronization

In the position synchronization mode (also known as "phase synchronization"), the ratio set between the master axis position and the slave axis is the following.

$$X_S = \left( X_M \times \frac{N_{slave}}{N_{master}} \right) + X_o$$

Parameter	Meaning
Xs	Position of the slave axis.
Xm	Position of the master axis.
Xo	Position offset.
Nslave	Turns of the slave axis for the gear ratio
Nmaster	Turns of the master axis for the gear ratio.

### Position offset

It may be used to vary the position of the slave axis independently from that of the master axis. It is set with the variable SYNCPOSOFF.

### Gear ratio

Ratio (Nslave/Nmaster) between the number of turns of the slave axis (Nslave) and the number of turns of the master axis (Nmaster).

The gear ratio is determined when programming the instruction and its value remains constant during the whole operation. In this synchronization mode, it is not possible to change this value while the system is running, because this behavior is more for an electronic cam than for an electronic gear. To solve this matter, an electronic cam may be programmed instead.

## Position synchronization

In position synchronization, there are two stages to reach synchronism. The first one is to adapt the velocity and the second one to adapt the position.

### Velocity adaptation stage

When initiating the position synchronization mode, in the first stage, it adapts the velocity of the slave axis in that instant to the synchronization velocity according to the expression given earlier.

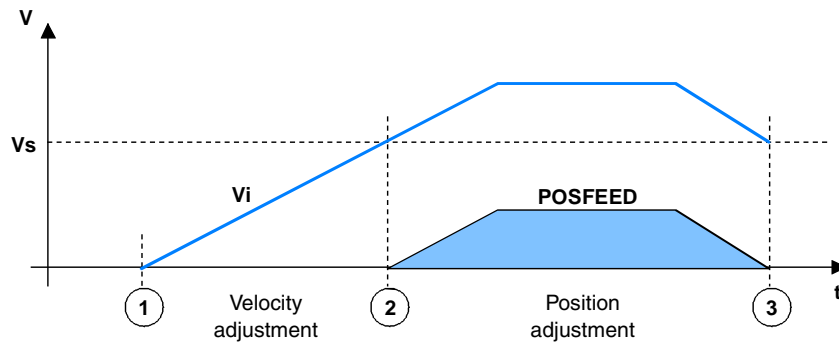
The velocity adapting process is carried out at the linear acceleration of the axis when activating the instruction. Once the velocity has been adapted, there will be a difference between the generated position instruction and the synchronization position of the slave axis.

# 6.

### Position adaptation stage

This second stage of the synchronization generates the position adjustment, thus eliminating the position error generated at the end of the previous stage. To adjust the position, an additional movement is added to the synchronization velocity that will originate an increase or decrease of the velocity already reached. The velocity for the additional movement is set by parameter POSFEED. This process ends when the generated position instruction coincides with the calculated position.

- 1 Beginning of the synchronization.
- 2 Adjustment of the velocity adaptation.
- 3 Adjustment of the position adaptation. Reach of the synchronization.



The shaded area indicates the position error at the end of the velocity adaptation stage. After the position adaptation stage, the ( $V_i$ ) speed of the slave axis is the same as the synchronism velocity ( $V_s$ ).

### Testing during position synchronization

#### Synchronization position

The synchronization window is the position margin admitted within which the axes are considered to be synchronized. The position window for synchronization is determined with the variable SYNCPOSW.

If the difference between the synchronization position calculated for the slave axis and its position feedback is within the synchronization window, it is assumed that it is synchronized (the interpolator activates the PLC mark INSYNC of the slave axis). This test is ignored during the first velocity adaptation stage.

#### Time for synchronization

The synchronization process must be successful in a specific amount of time. The time it takes to reach the synchronization state is monitored when initiating the synchronization mode until that state is reached (PLC mark INSYNC). This timeout monitoring is activated again if the INSYNC mark drops.

The time elapsed cannot be indefinite. The variable SYNCTOUT may be used to set the maximum time (timeout) it takes to achieve synchronization. An error is issued if the timeout value is exceeded before reaching synchronization.

If the value of this variable is zero, the synchronization time is not monitored. By default, this variable takes a zero value and it is also initialized after a reset.

6.

**SYNCHRONIZATION MOVEMENT**  
 Position (phase) synchronization

**FAGOR** 

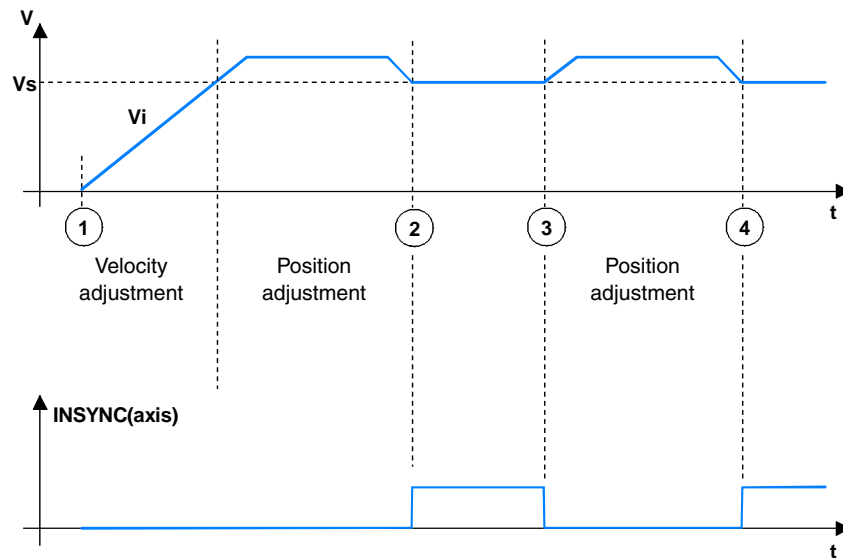
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## Adjustment during position synchronization

Once position synchronization is achieved, if the position offset of the slave axis (variable SYNCPOSOFF) is modified, the synchronization position of the slave axis must be recalculated. Thus, a new adaptation stage is required to reach the new synchronization position after the changes made.

- 1 Beginning of the position synchronization.
- 2 Reach the position synchronization.
- 3 Beginning of the synchronization after modifying the position offset.
- 4 Reach the new position synchronization.



Behavior of the INSYNC mark of the slave axis during synchronization and later modification of the velocity offset.

Position offset variations during the synchronization process restart the synchronization timeout monitoring. This monitoring ends when synchronization has been reached after the changes.

6.

**SYNCHRONIZATION MOVEMENT**  
 Position (phase) synchronization



## 6.5 Positioning programming (MOVE) after synchronization

Movement instructions (MOVE) are possible after executing the synchronization. These instructions generate a movement that overlaps with that of synchronization. This movement is carried out in a way similar to the one generated in the second stage of the position adaptation in order to travel the distance indicated in the positioning instruction.

The new programmed position is maintained as difference in position synchronization; i.e. it is not recovered because it is synchronized in position. Therefore, once synchronization has been achieved (in velocity or in position), the velocity component due to the positioning block is added to the synchronization velocity in that instant.

6.

**SYNCHRONIZATION MOVEMENT**  
Positioning programming (MOVE) after synchronization

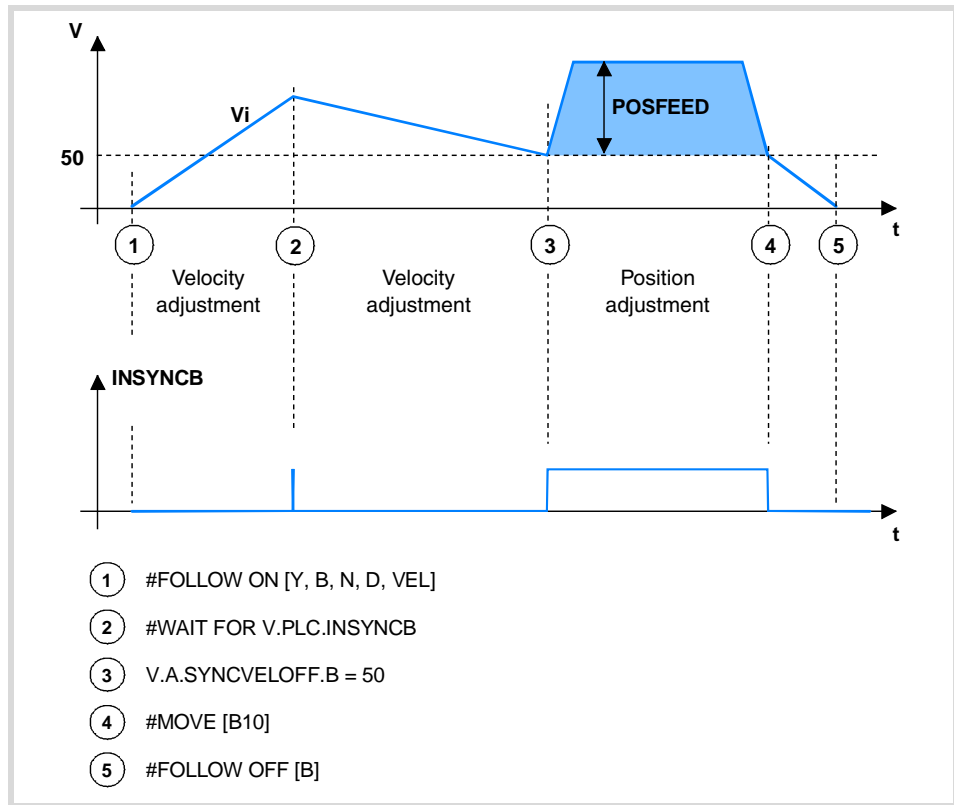


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### Example ·1· Positioning after velocity synchronization

The figure shows the execution sequence generated when operating in velocity synchronization according to the given part-program.



#FOLLOW ON [Y, B, N, D, VEL]  
 Velocity synchronization begins.

#WAIT FOR V.PLC.INSYNCB  
 The execution waits for INSYNCB to be activated indicating that velocity synchronization has been reached.

V.A.SYNCVELOFF.B = 50  
 This variable modifies the velocity offset and it forces to set the velocity synchronization again. While making this adjustment, the INSYNCB mark is deactivated until the internal velocity ( $V_i$ ) reaches the synchronization velocity ( $V_s$ ) again.  
 In the figure, it decreases the speed. The synchronization speed has been assumed as being greater than the one assigned to V.A.SYNCVELOFF.B.

#MOVE [B10]  
 Positioning block executed after reaching synchronization. The velocity of the slave axis has two components; one due to the synchronization movement and the other due to the positioning block (superimposed velocities). The shaded area corresponds to the distance given in the positioning block.  
 The mark INSYNCB remains activated while the slave axis is making this positioning movement.

#FOLLOW OFF [B]  
 End of the synchronization. The CNC waits for this previous positioning block to end before finishing the synchronization.

# 6.

**SYNCHRONIZATION MOVEMENT**  
 Positioning programming (MOVE) after synchronization

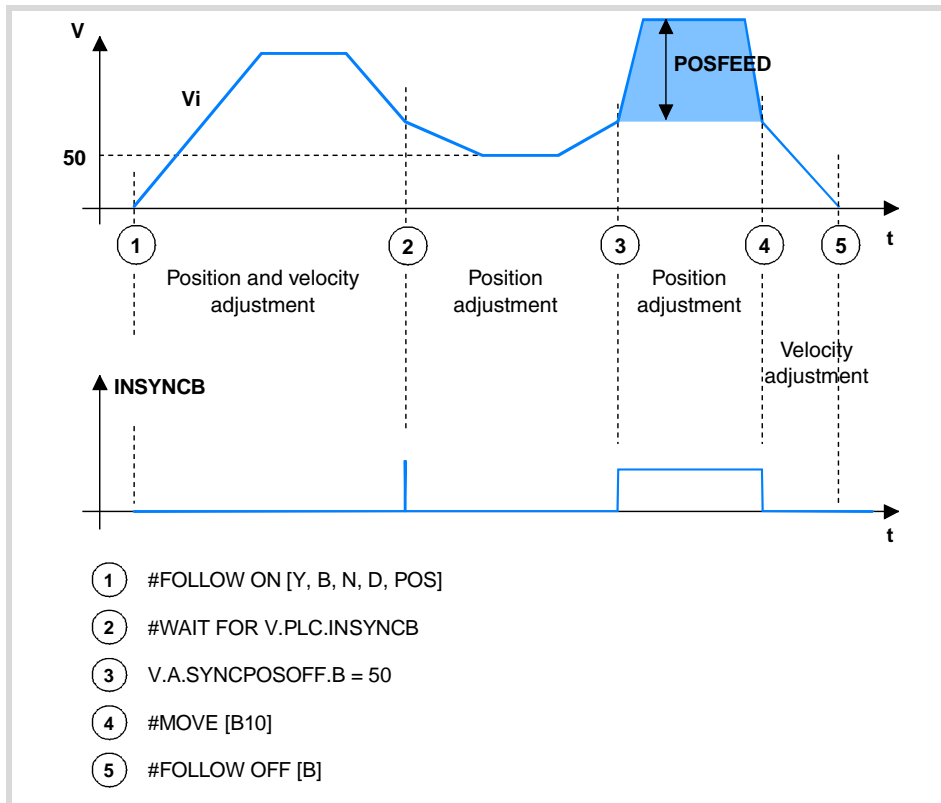


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## Example -2- Positioning after position synchronization

The figure shows the execution sequence generated when operating in position synchronization according to the given part-program.



#FOLLOW ON [Y, B, N, D, POS]

Position synchronization begins.

#WAIT FOR V.PLC.INSYNCB

The execution waits for INSYNCB to be activated indicating that position synchronization has been reached.

V.A.SYNCPOSOFF.B = 50

This variable modifies the position offset and it forces to set the position synchronization again. While making this adjustment, the INSYNCB mark is deactivated until the internal position reaches the synchronization position again.

#MOVE [B10]

Positioning block executed after reaching synchronization. The velocity of the slave axis has two components; one due to the synchronization movement and the other due to the positioning block. The shaded area corresponds to the distance given in the positioning block.

The mark INSYNCB remains activated while the slave axis is making this positioning movement.

#FOLLOW OFF [B]

End of the synchronization. The CNC waits for this previous positioning block to end before finishing the synchronization.

6.

SYNCHRONIZATION MOVEMENT  
Positioning programming (MOVE) after synchronization



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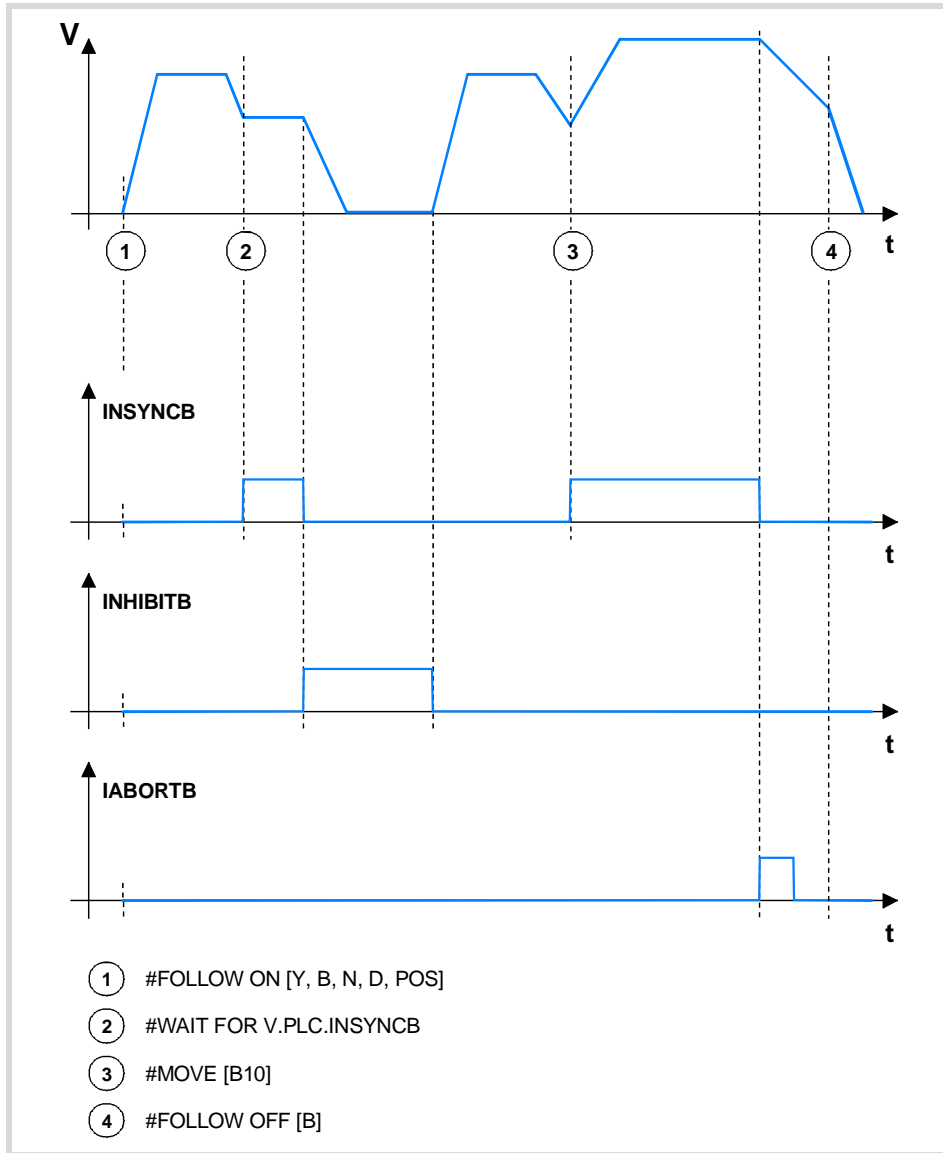
(REF: 1304)

## 6.6 Effect of the control signals on the synchronization

The execution of the application will be affected by the following PLC marks that will also affect the positioning blocks generated with MOVE instructions and the synchronization movements. Signal names are generic; replace the word (axis) with the name or logic number of the axis.

Mnemoni.	Meaning.
ENABLE(axis)	The CNC activates this mark to indicate to the PLC that it is going to move the corresponding axis or spindle in closed loop, so the PLC enables it if necessary. This PLC also activates this mark in the movements of the independent axis and remains active until the synchronization is deactivated.
INHIBIT(axis)	If the PLC turns this mark on, the CNC inhibits any movement of the corresponding axis or spindle. For independent movement of the axes, if the PLC turns activates this mark, the CNC interrupts the synchronization movement switching to zero speed. The system waits for the signal to deactivate before resuming the execution and the movement from the interruption point. For independent axes, this signal also stops the monitoring of the synchronization.
IRESET(axis)	For independent movements of the axis, if the PLC activates this mark, it interrupts the instruction in execution and eliminates the instructions pending execution. The CNC sets the initial conditions at the independent interpolator of the axis.
IABORT(axis)	For independent movements of the axis, if the PLC activates this mark, the positioning block being executed (if any) stops, without eliminating also the rest of the positioning blocks pending execution. The CNC goes on with the next instruction. It only affects positioning blocks; neither the pending instructions nor the synchronization movement are eliminated.

# 6.



# 6.

## SYNCHRONIZATION MOVEMENT

Effect of the control signals on the synchronization



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