

Sommario

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DEVICE JOINT

1. Introduction

The internal device JOINT is achieved to manage multiple axes (max. 3) in linear interpolation connected. The interpolation is done through tiny movements determined by programmed points.

You can also move the axes individually and execute the homing procedure. The placement of axes runs under a P.I.D. reaction control that guarantees the accuracy by reducing the tracking error.

1.1 Device declaration

In the configuration unit, the BUS section must be declared so that you have the hardware resources necessary for the use of the JOINT device.

There must be at least a bi-directional counter and an analog output implemented with 16-bit resolution DAC. The device can also use a digital input and a digital input for interruption for homing operation.

In the INTDEVICE section of the configuration unit must be add the following definition:

```

-----
; Internal device declaration
-----
INTDEVICE
<device_name> JOINT TCamp NAxis Buffer
                  IContX IntLX IAZeroX IoutAX
                  IContY IntLY IAZeroY IoutAY
                  IContZ IntLZ IAZeroZ IoutAZ
                  IOut1  IOut2 IOut3 IOut4

```

Where:

<device_name>	the name assigned to the device
JOINT	keyword that identifies the device,
TCamp	sample time device (1÷255 ms)
NAxis	number of axes enabled to the interpolation (2÷3) Note: the number of axes is going to affect both the performance and on the amount of memory used
Buffer	step number available in the buffer (3÷30000)
Axis X	
IContX	bidirectional counter input (to prevent the device uses this resource enter the X.X characters)
IntLX	number of digital input for dedicated encoder zero pulse break during the research phase of presets. (to prevent the device uses this resource enter the X character)
IAZeroX	enable input for transducer zero pulse acquisition during homing research phase (to prevent the device uses this resource enter the X.X characters)
IoutAX	hardware address of the analog output (to prevent the device uses this resource enter the X.X characters)
Axis Y	
IContY	bidirectional counter input (to prevent the device uses this resource enter the X.X characters)
IntLY	number of digital input for dedicated encoder zero pulse break during the research phase of presets. (to prevent the device uses this resource enter the X character)
IAZeroY	enable input for transducer zero pulse acquisition during homing research phase (to prevent the device uses this resource enter the X.X characters)
IoutAY	hardware address of the analog output (to prevent the device uses this resource enter the X.X characters)
Axis Z	
IContZ	bidirectional counter input (to prevent the device uses this resource enter the X.X characters)
IntLZ	number of digital input for dedicated encoder zero pulse break during the research phase of presets. (to prevent the device uses this resource enter the X character)
IAZeroZ	enable input for transducer zero pulse acquisition during homing research phase (to prevent the device uses this resource enter the X.X characters)
IoutAZ	hardware address of the analog output (to prevent the device uses this resource enter the X.X characters)
Digital outputs	
IOut1	hardware address of the digital output OUT1
IOut2	hardware address of the digital output OUT2
IOut3	hardware address of the digital output OUT3
IOut4	hardware address of the digital output OUT4



Attention:

It is necessary that each definition are present on the same line.

In case you do not want to assign a resource, such as IAZeroX, you must enter in the appropriate field the X.X string

1.2 Operation

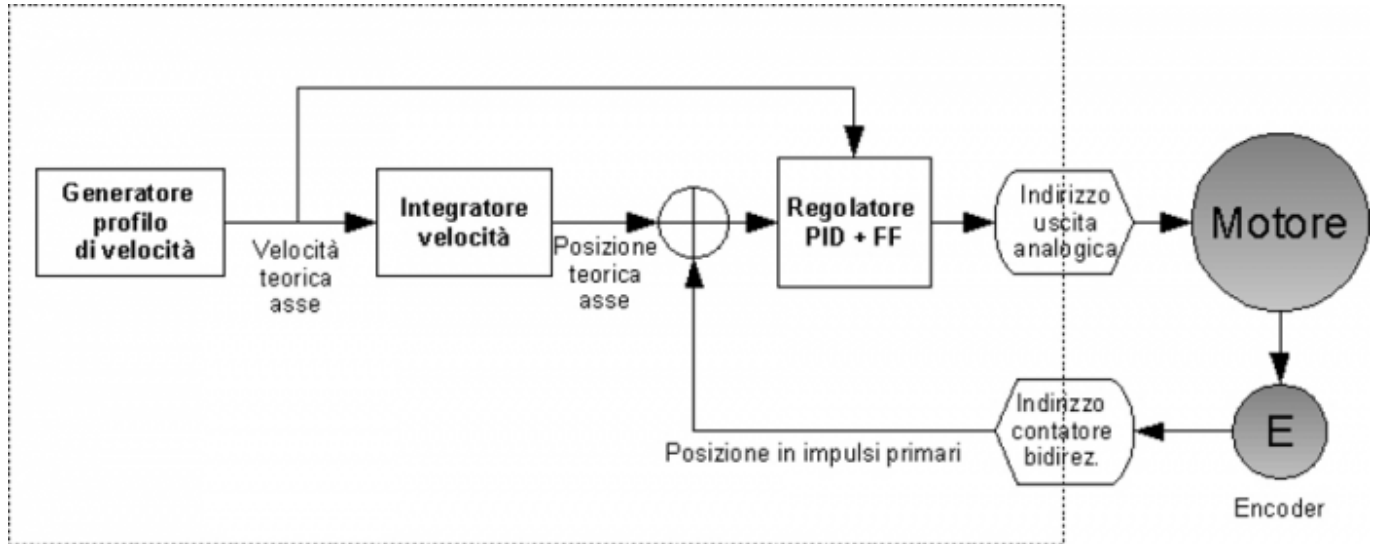
The JOINT device adds to the capabilities of analog positioner EANPOS (see see the documentation for more details) the possibility to make a movement interpolated axes (max. 3). By this we mean that you get a chance, using the axes, to execute

a movement from one point in space (3 dimensions) to another along a line (not necessarily straight line) or a preset path. Moreover, the device can calculate a fillet between two lines with different slopes according to some programmable modes.

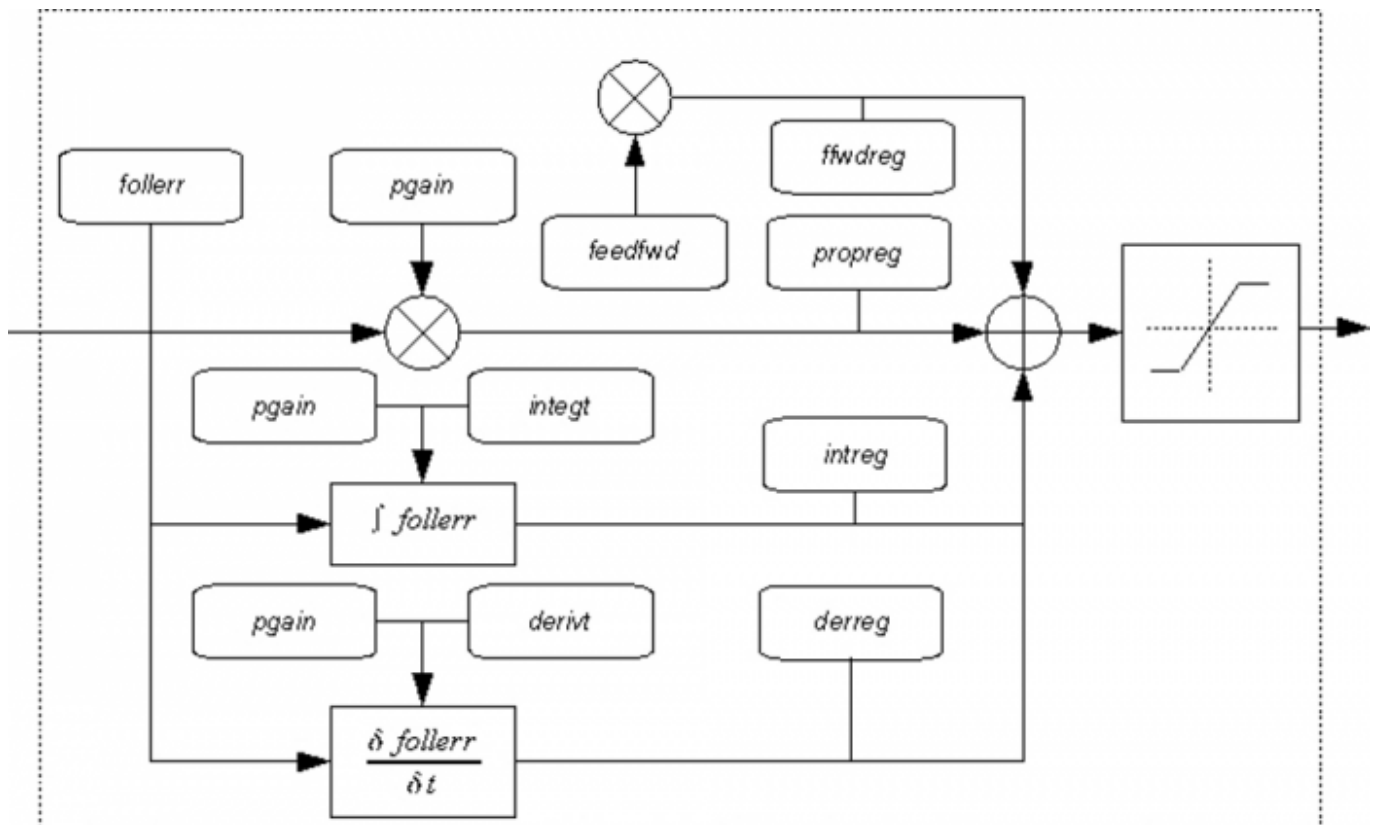
1.2.1 PID regulator

The device includes a trajectory-generating function (also called velocity profile). This generates a piece of information that is appropriately converted to a proportional voltage signal via the analog output to operate the motor and therefore the axis connected to bring it to the desired position.

If the motor system was ideal would follow perfectly the velocity profile created and you would bring to the position given by the integral of the velocity profile. Actually this doesn't happen and you need to top it all with a chain of feedback. The transducer that detects the position of the axis is typically digital, typically an encoder (we'll call it always bi-directional meter).



The information provided by the transducer is used to make a comparison between the current position and the theoretical position. This comparison allows to know the current error and the PID controller can use this information to modify the output and get the error condition zero. The regulator used implements four types of actions. The block diagram of the regulator is as follows:



The output PID + FF controller is a value between -32768 and 32767. This is used by the analogue output to generate the adjusting voltage. Typically the analogue output is implemented by a DAC device that converts the digital information in a tension between -10 Volt and +10 Volt. For every action the regulator calculates a coefficient inside to ensure that the value generated has a significant for the analog output.

1.2.1.1 Proportional action

This control action establishes a relationship of direct proportionality between the tracking error (*folterr*) and the output value to the controller. The parameter proportional gain *pgain* (user-settable) defines the degree of proportional controller; It is expressed in milliseconds for which to set a gain of 0.5 you should enter the value 500. The rule establishing the output value (*propreg*) is: with unitarian gain (*pgain*), the control output will be maximum when the tracking error is equal to the space that is executing the axis at the maximum speed in a sampling time of the device. It is important to note that due to the rule that you just described, there is a link between the proportional and the sampling time of the device. Also note that when the error is null even proportional control output is nothing.

1.2.1.2 Integral action

The integral controller of PID controller calculates the integral of position error on a time interval user-settable with *integt* parameter (expressed in ms). The output signal is updated in a particular way: whenever the supplement from an output value that is added to the value that is on the register, then it will continue to increase or decrease (depending on the sign of the error). The output value is calculated as follows: with unit proportional gain, the integration time (*integt*) is the time it takes for the output (*intreg*) reaches the proportional output value (*propreg*). From this last statement shows that the integral action is related to the proportional controller.

1.2.1.3 Derivative action

The derivative action “anticipates” the system behavior of the system being monitored. The output produced is proportional to the change of the input signal (that is the position error). The magnitude of the derivative effect is adjustable via the parameter time derivative *derivt*. Computing the derivative action is based on the following convention: the derivative time is the time it takes for error constant variation, the derivative output (*derreg* parameter) reaches a value equal to the proportional output. As for the integral action shows that even for the derivative action is there a link with the proportional action. More higher the time of derivation of error and more faster the transient error recovery system. It is evident that the derivative action may never be used alone because in the presence of constant mistakes its effect would be null.

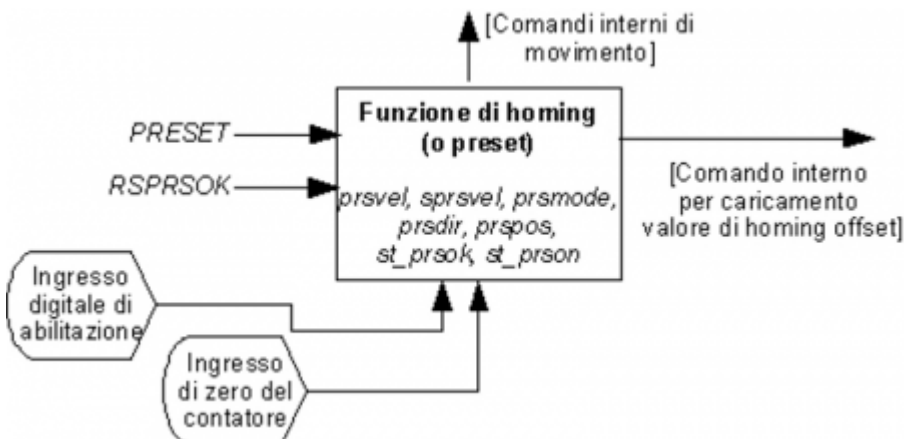
In summary: the proportional action has the effect of increasing the rate of reaction of the system, it also reduces, but does not completely eliminate, the error. The integral action leads to clear the error, but lengthens the transitional times. Derivative control increases the stability of the system, reducing overshoot and reducing transitional times.

1.2.1.4 Feed-forward action

In addition to the PID controller There is also then feed-forward actio: It generates an output proportional to the value of theoretical speed determined by the trajectory generator (as you can tell from the name doesn't exploit any tracking error feedback). Its function is to reduce the system response time by providing a release already nearby to that which provides the speed profile. The contribution of this action is adjustable via the *feedfw* parameter: This parameter is expressed as a portion of millesimal theoretical speed (so to introduce, for example, 98.5% it's necessary set the 985 value).

1.2.2 Homing (or preset) function description

This chapter describes the method by which the device searches the home position (also called zero axis or mark point). There are various ways to do this research and these use different movements and hardware resources.

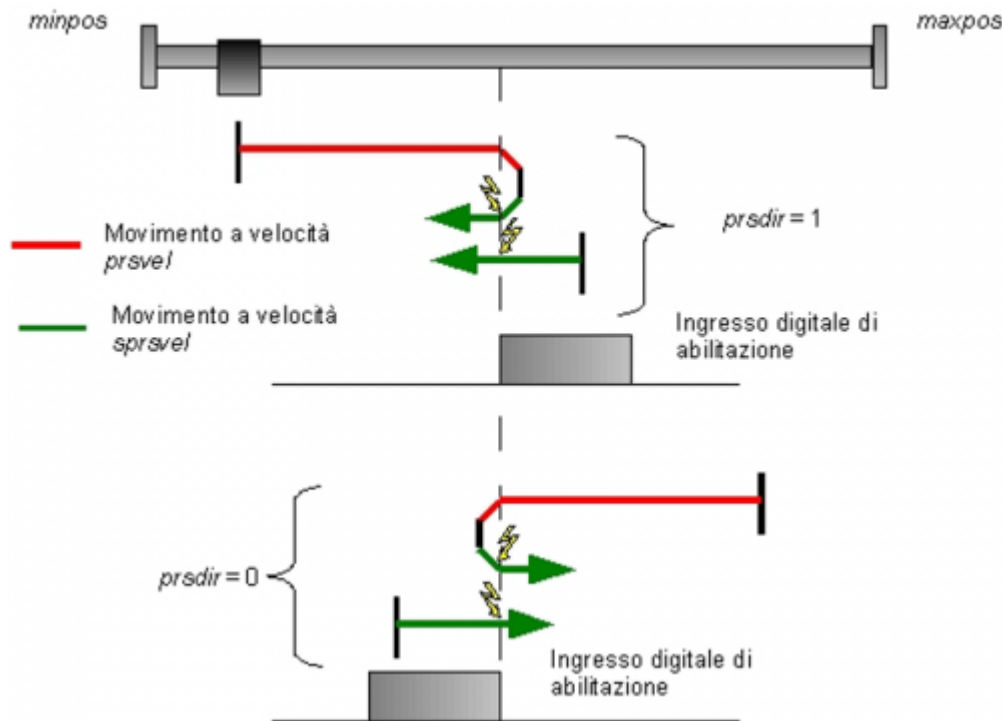


Homing function must be properly configured before it is used. In particular the *prsmode* parameter defines the way in which the device searches the home position. This parameter also defines the hardware resources necessary to search and how to

move. You must then configure the search speed. Typically an high speed (expressed from the *prsvcl* parameter) is used to search for the activation of the enable input and a lower speed (expressed from the *sprsvcl* parameter) is used to search the home position. Can be derived from the zero of the bi-directional counter or from the disable of the enable digital input.

We illustrate now the various ways to search for the location of home:

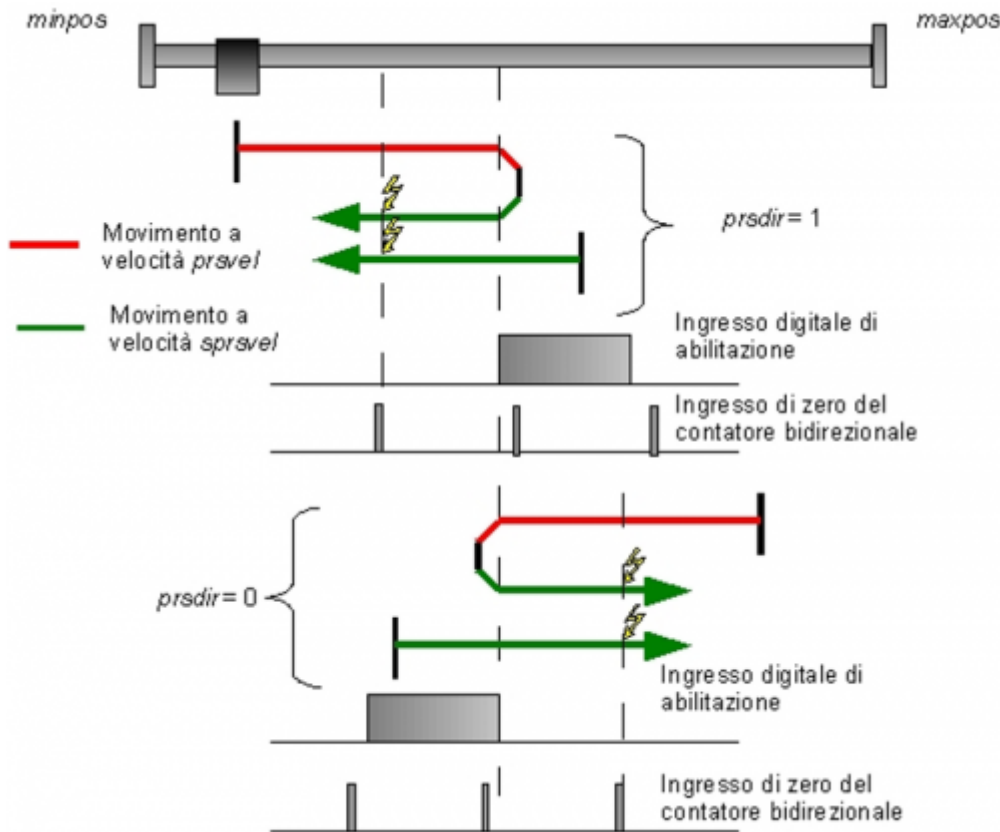
1.2.2.1 Mode 0, without zero input of bi-directional counter



This mode involves the movement of axis and only enabling digital input. To the deactivation of the digital input the location of the axis takes the value in the *prspos* parameter. You later disable the *st_prson* state and enable the *st_prsok* state to report the end of search. This state remains active until launching a new search procedure.

In the picture it was shown the function pirnciple highlighting the differences in the case of opposite directions of motion.

1.2.2.2 Mode 1, with zero input of bi-directional counter





This mode involves the movement of the axis and the additional use of the bidirectional counter zero. To the deactivated of the enable digital input is enable the reading of the first enable of the zero input and on this signal the position of the axis takes the value in the *prspos* parameter. You later disable the *st_prson* status and is active the *st_prsok* state to signal the end of search. This state remains active until launching a new search procedure.

In the picture is shown the operating principle of highlighting the differences in the case of opposite directions of motion

1.2.2.3 Mode 2, homing in current position

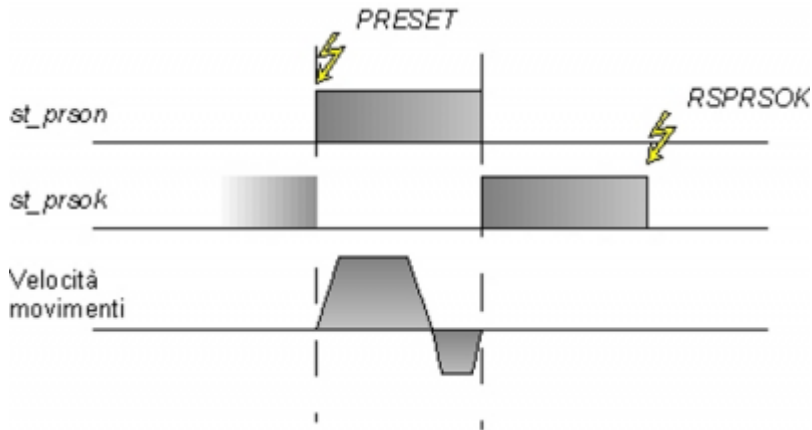
This mode does not provide for the moving of the axis and uses only the enabling digital input. If the input is activated, the position of the axis takes the value in the *prspos* parameter.

	<ul style="list-style-type: none"> • When you set the search speed of the zero (<i>sprsvcl</i> parameter) we must consider that the mode 0 the input has a hardware filter that delays the acquisition and so this delay affects the accuracy of the loading. In mode 1 instead acquiring execute on digital input for interruption and the speed of the movement is not determinative. But we must ensure that the operating time of the zero-pulse is sufficient to be acquired from the input. To know the times of acquisition of digital inputs and the minimum time zero pulse signal refer to the technical documentation of the used cards. • If during the first movement of research of the enable input (executed at the <i>prsvcl</i> speed) is given again the PRESET command, the direction of movement is inverted. • After loading the homing offset in the current position, automatically commanded a placement at the homing offset quota.
	<p>When moving home positioning the <i>maxpos</i> and <i>minpos</i> software limits aren't enabled.</p>

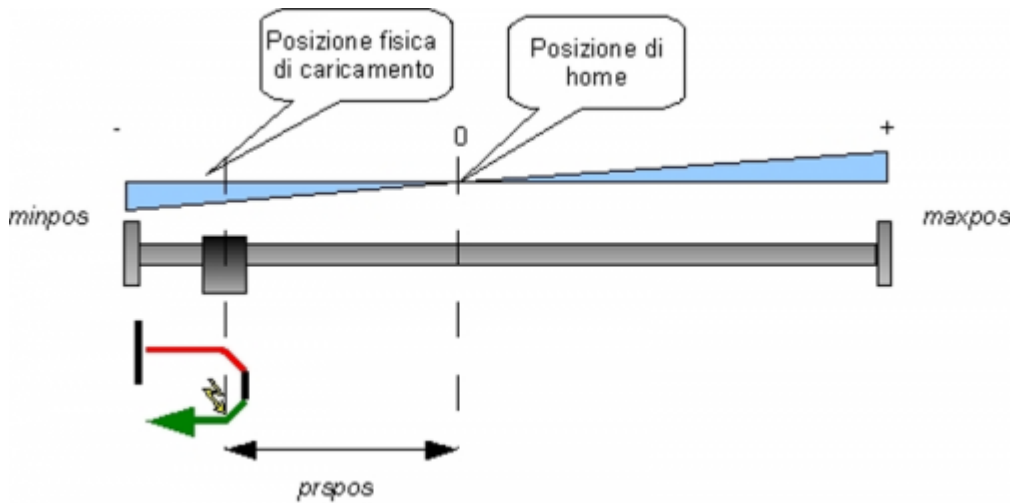
The **PRESET** and **RSPRSOK** commands manage the homing function. The first must be used to initiate a search of the home position or to reverse the direction of research during the first movement at *prsvcl* speed. The second command should be used instead to clear the *st_prsok* state. This state can be used by the application to know if a homing function has been completed successfully. The **RSPRSOK** command it can be used in the case that intervening events that invalidate the current position value (for example a break of the bi-directional counter, manual introduction of a value in the current position). The application (that monitorize the *st_prsok* state) will require a new homing search.

The *st_prson* state should be used to determine if the function is active homing. The *st_still* state cannot be used because the movement is composed of multiple placements and this state would indicate stationary axis at the end of each movement.

See the states chart:



The *prspos* parameter should be used to express the distance between home and the location where the homing function. If they match then the parameter should be set to zero. See a chart:



1.2.3 Delta current position

Normally the *posit* and *encoder* parameters represent the absolute position of the axis. There are some applications where these parameters must represent a relative information. These can be for example circular axes (*posit* must express an angular size) or a valve controller to the respective quotas. To make *posit* information relating you must edit its value; Although there is the possibility of writing to that parameter, the operation is not recommended for two reasons:

- because the actual position of the axis is always influenced by tracking error
- because the current location can be one of the many intermediate positions between a unit of measure and the subsequent

To do this there is the *DELCONT* command that allows you to change the *posit* a value that can be set with *delcnt* parameter. For example, suppose you have configured *pulse* and *measure* so that the location is expressed in tenths of a degree. If *posit* expresses the angular position and we want this is always between zero and 360 degrees we should add the following code:

```
IF Axis:posit GE 3600
  Axis:delcnt = -3600
  DELCNT Axis
ENDIF
```

It is wrong to use the following code:

```
IF Axis:posit GE 3600
  Axis:posit = Axis:posit - 3600
ENDIF
```

For the conditions of execution of the command, see the descriptions.

The *DELCONT* command function is assured even in the event that a unit of measure is not expressible in a finite number of impulses. For example with the *measure* = 1000 and *pulse* = 1024 parameters, the value 3600 in the preceding example corresponds to 3686.4 pulses. Thanks to a sophisticated algorithm inside the device fails to consider the fractional part of this value and through internal batteries it becomes part of the information used to change the *posit* value.

1.2.3.1 Example:

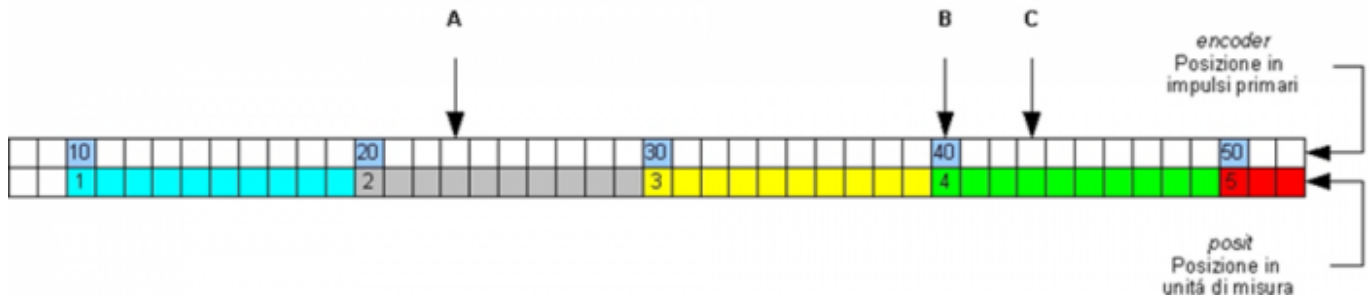
For example, the following setting: *pulse* = 10, *measure* = 1. For example the reading of the position of the axis is 2 and you are at point A. You want to add to the position posit two units of measure. With instructions:

```
Axis:posit = Axis:posit + 2
```

the axis takes the new position B.
With instructions:

```
Axis:delta = 2  
DELCNT Axis
```

C position is reached.



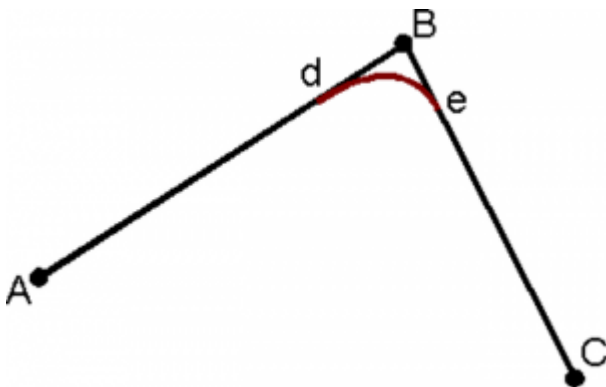
Note that if you change it directly the *posit* without using the delta function (as in the first example) an error is introduced.

Se si devono inviare comandi *DELCNT* in successione, è conveniente calcolare la grandezza da sommare ed inviare una sola volta il comando. Se ciò non fosse possibile bisogna prestare attenzione a non inviare comandi successivi senza interporre una istruzione di lettura su parametro device. Esempio:

```
Axis:delta = 3  
DELCNT Axis WAIT  
Axis:delta  
Axis:delta = 40  
DELCNT Axis
```

1.2.4 Smooth interpolation

The device allows a positioning by connecting pairs of points with fees and making the connection by changing the slope of the first line to reach the slope of the second line. Doing it this way you will calculate a curve that join without being hard moved and trajectories of two lines. An example is shown in picture.



The device in this situation generates two trajectories that will merge together between a line and the other. To obtain a greater homogeneity of the resulting movement was chosen to keep the acceleration and deceleration time equal to each axis, programmable with a single variable. Otherwise it could happen that the resulting trajectory is what you want. If the coordinates exceed maximum and minimum dimensions set as the limit of the axes, the system will position itself on these limits.

If you make the connections so you get circular figures, It is good to set *mx/rvelASSE* variables equal to prevent various interpolation between the limits of speed *mx/rvel* of any axes.

Note: What has been described is also valid for three-axis movement.

1.2.4.1 Interpolation speed change

When positioning you can vary the speed of interpolation without affecting the location to get to. This operation can lead to an

increase or a decrease in the speed of each axis: If an axis reaches its maximum limit, then the overall speed of interpolation may not exceed.

The change of speed is not said to occur immediately, but only when all conditions are met.

Also the acceleration/deceleration time of the interpolation (*tacci*) is subject to the limits imposed by the various axes: It must be equal to or greater than the maximum acceleration and deceleration time of all axes.

1.2.4.2 Using of passcodes interpolation

The device, When enable make a movement interpolation using the *STARTPRG* command, uses the program Buffer containing axes coordinates for points that need to be connected.

The introduction of quotas can occur both in absolute or incremental forms, compared to the previous position (*setpos*AXIS), depending on the choice of the *prgmode* parameter.

For each program step is also a code variable whose values are between 0 and 65536.

The meaning of the variable code is shown in the following table:

Value	Description																																																																																																					
0	No operation																																																																																																					
1÷1000	Speed override (expressed in tenths of percentage points setveli)																																																																																																					
2000÷6999	Performs a shutdown of positioning (using a deceleration ramp) then waits for an interval of time (in milliseconds) equal to the value of the code - 2000 field, then resumes the placement with an acceleration toward the next point.																																																																																																					
10000÷100015	Shows the status of the OUT1, OUT2, OUT3, OUT4 outputs The resulting value of subtracting 10000 to the <i>code</i> variable is a value between 0 and 15 indicating the status of 4 outputs as to the following diagram:																																																																																																					
	OUT4	OUT3	OUT2	OUT1	code- 10000	code	0	0	0	0	0	10000	0	0	0	1	1	10001	0	0	1	0	2	10002	0	0	1	1	3	10003	0	1	0	0	4	10004	0	1	0	1	5	10005	0	1	1	0	6	10006	0	1	1	1	7	10007	1	0	0	0	8	10008	1	0	0	1	9	10009	1	0	1	0	10	10010	1	0	1	1	11	10011	1	1	0	0	12	10012	1	1	0	1	13	10013	1	1	1	0	14	10014	1	1	1	1	15	10015
	OUT4	OUT3	OUT2	OUT1	code- 10000	code																																																																																																
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	1	1	1	0	14	10014																																																																																																
	1	1	1	1	15	10015																																																																																																

1.2.4.3 Conditions for the execution of an interpolation

For start interpolation, use the *STARTI* or *STARTPRG* commands, requires that the following conditions are met by departure:

- the *unitvelASSE* and *decptAXIS* parameters to interpolate axes must be equal
- the axes should not be in an emergency: *st_emrgAXIS* = 0
- the axes must be in stop: *st_stillAXIS* = 1
- the axes not be in calibration: *st_calAXIS* = 0
- the axes should not be looking for homing: *st_prsonAXIS* = 0

1.3 Parameters table

Name	Dimensions	Default value	Access type	Unit of measure	Valid range	Write conditions	Description
prgmode	Byte	Retentive	RW	-	0÷1	st_ipolar=0	How to setup program quotas Defines how to setup program memory: 0 : the quotas are expressed as absolute value, 1 : dimensions are referred to as incremental value.

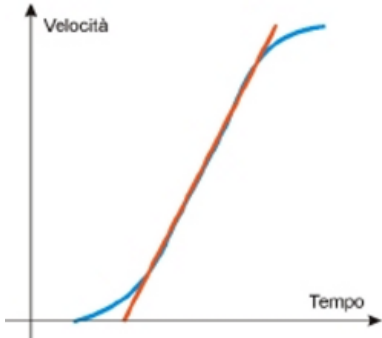
Name	Dimensions	Default value	Access type	Unit of measure	Valid range	Write conditions	Description
maxveli	Long	0	R	Uv	0÷999999	-	Maximum speed in interpolation Defines the maximum speed of interpolation in the speed unit set. The value is calculated automatically depending on the maximum speeds of the X, Y and Z axes.
tacci	Word	Retentive	RW	hundredths of a second	0÷999	st_ipolar=0	Acceleration and deceleration time in interpolation Defines the time taken by the interpolated axis to move when stationary to maximum speed and from the maximum speed to zero (condizione di asse fermo). Is only used when interpolated movements.
setveli	Long	Retentive	RW	Uv	1÷maxveli	-	Setting the interpolation speed Defines the interpolation speed and can be changed during the interpolation. This value should not exceed <i>maxvelx</i> or <i>maxvely</i> or <i>maxvelz</i> . If during calculations a component exceeds the maximum re-calculable value (<i>mxrlvelx</i> or <i>mxrlvely</i> or <i>mxrlvelz</i>), interpolation speed reduction it's executed in order to meet this requirement.
minspINT	Long	0	R	Um	-	-	Minimum space in constant speed interpolation (integer part) Indicates the minimum space and can be networked in interpolation, this value is calculated as a function of speed (<i>setveli</i>) and the acceleration and deceleration time (<i>tacci</i>) of the interpolation. The value is expressed in the <i>minspINT</i> variable (integer part) and <i>minspFRAC</i> (fractional part).
minspFRAC	Word	0	R	-	-	-	Minimum space in constant speed interpolation (fractional part) Represents the fractional part of the <i>minspINT</i> parameter, is expressed as the fractional part * 65535.
mxrlvelx	Long	Retentive	RW	Uv	0÷maxvelx	st_ipolar = 0	Maximum speed X axis for movements with interpolation In the case of movements with interpolation defines the maximum speed from the X axis. In case the axis speed exceeds this value is subject to a reduction in the rate of reported easing <i>st_rvel</i> state activation.
mxrlvely	Long	Retentive	RW	Uv	0÷maxvelx	st_ipolar = 0	Maximum speed Y axis for movements with interpolation In the case of movements with interpolation defines the maximum speed from the Y axis.
mxrlvelz	Long	Retentive	RW	Uv	0÷maxvelx	st_ipolar = 0	Maximum speed Z axis for movements with interpolation In the case of movements with interpolation defines the maximum speed from the Z axis.
stepbeg	Word	0	RW	-	0÷30000	-	Step number of start interpolation program Indicates the number of step which will begin easing the program with the <i>STARTPRG</i> command. If set to 0, the device will loop continuously from 1 to <i>stepend</i> . By changing from 0 to 1 the value during the interpolation, it will end when <i>stepexe</i> will reach <i>stepend</i> .
stepend	Word	0	RW	-	1÷30000	-	Step number of end interpolation program Indicates the number of step that will end the easing programme started with the <i>STARTPRG</i> command.
stepexe	Word	0	R	-	1÷30000	-	Step number in execution of interpolation program Indicates the number of the step executing during the interpolation started with the <i>STARTPRG</i> command.
stepin	Word	0	RW	-	1÷30000	-	Step number to memorize Indicates the number of the step to be stored with the <i>WRITESTEP</i> command or read with the <i>READSTEP</i> command.

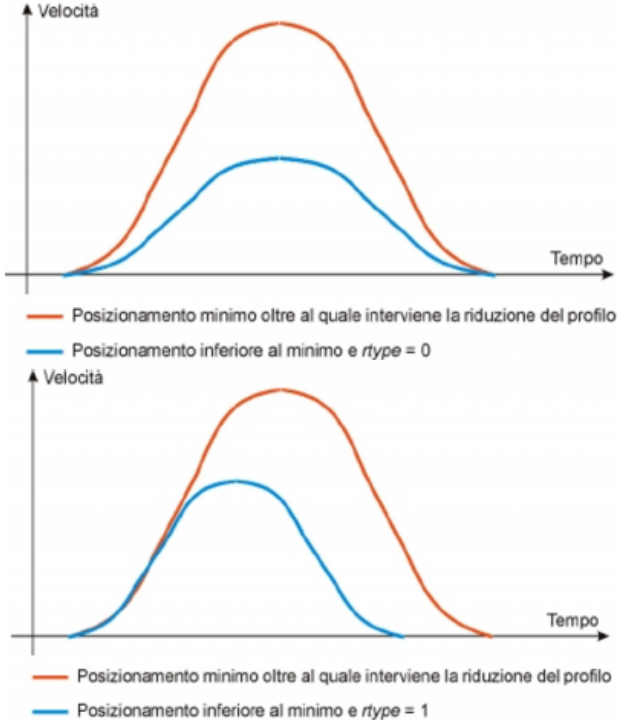
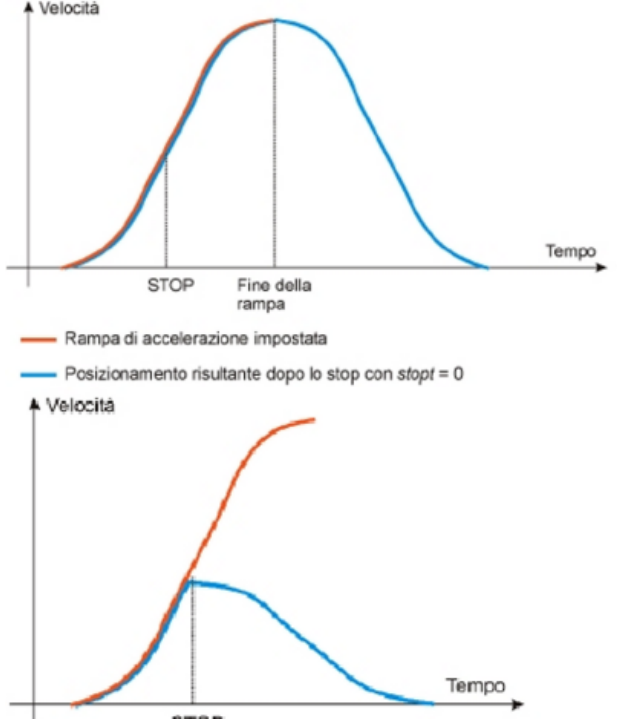
Name	Dimensions	Default value	Access type	Unit of measure	Valid range	Write conditions	Description	
stepout	Word	0	RW	-	1÷30000	-	Outcome of reading or writing step procedure When the execution of the <i>WRITESTEP</i> or <i>READSTEP</i> commands was successful stepout will have the same value as <i>stepin</i> .	
stepnum	Word	0	RW	-	1÷4	-	Number of steps considered by READSTEP or WRITESTEP Indicates the number of steps that are read or written by the <i>READSTEP</i> or <i>WRITESTEP</i> commands.	
codexl	Long	0	RW	-	0÷10015	-	Code X axis for the step I Indicates the X axis coordinate in read or write step number I (I = 1÷8).	
codeyl	Long	0	RW	-	0÷10015	-	Code Y axis for the step I Indicates the Y axis coordinate in read or write step number I (I = 1÷8).	
codezl	Long	0	RW	-	0÷10015	-	Code Z axis for the step I Indicates the Z axis coordinate in read or write step number I (I = 1÷8).	
codestpl	Word	0	RW	-	0÷10015	-	Code step I number Indicates the value for the code I number (I = 1÷8). If zero, the value is ignored.	
errcode	Byte	0	RW	-	0÷100	-	Error identification code Indicates the type of failure intervened in the system. When <i>st_error</i> = 1 is present on the <i>errcode</i> variable the type of failure intervened and in the <i>errvalue</i> variable an indication on the cause of the error. If the device goes wrong, to start cut you have to clear the <i>st_error</i> state through the <i>RSERR</i> command. The following table specifies the values from the <i>errcode</i> variable:	
							Code	Description
							1	Encountered an error in calculations during the interpolation. When this condition occurs, the interpolation is immediately interrupted.

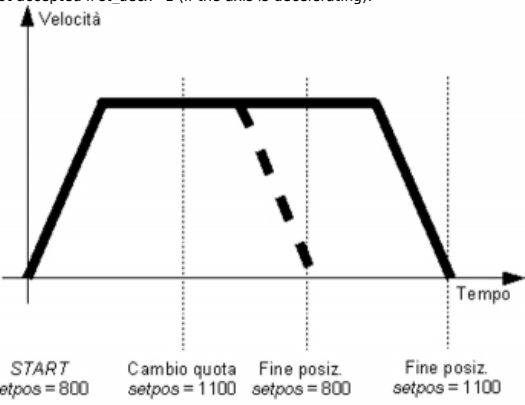
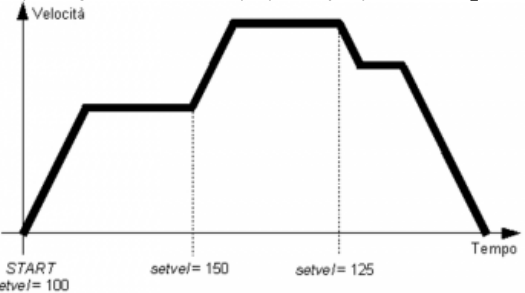

Name	Dimensions	Default value	Access type	Unit of measure	Valid range	Write conditions	Description	
errvalue	Byte	0	RW	-	0÷100	-	Identifying code of the cause of the error Through the <i>errvalue</i> variableYou can get more detailed information about the error reported. The following table specifies the values from the <i>errvalue</i> variable:	
							Code	Description
							1	This error is reported when for 5 consecutive steps moving the interpolation point proved 0.
							2	An invalid operation has been requested.
							3	During the calculating of the interpolation point movement was an overflow.
							10	Exceeding maximum quota X axis. Placement quota calculated, is greater than the maximum quota set.
							11	Exceeding maximum quota Y axis. Placement quota calculated, is greater than the maximum quota set.
							12	Exceeding maximum quota Z axis. Placement quota calculated, is greater than the maximum quota set.
							13	Exceeding minimum quota X axis. Calculated placement quota is less than the minimum amount set.
							14	Exceeding minimum quota Y axis. Calculated placement quota is less than the minimum amount set.
							15	Exceeding minimum quota Z axis. Calculated placement quota is less than the minimum amount set.
							wrncode	Byte
Code	Description							
1	Command not executed							
2	You cannot perform writing parameter because it active the interpolation.							
16÷31	Code related to X axis							
32÷47	Code related to Y axis							
48÷63	Code related to Z axis							
wrnvalue	Byte	0	RW	-	0÷100	-		

1.3.1 X axis parameters

Name	Dimension	Default value	Access type	Unit of measure	Valid range	Write conditions	Description
measurex	Long	Retentive	RW	Um	1÷999999	st_ipolar = 0, st_prsonx = 0, st_stillx = 1	Reference measure for calculating the conversion factor between primary impulses and units for X axis Indicates the space, in unit of measure, covered by the X axis to obtain primary pulses set in <i>pulsex</i> parameter. This parameter is used to calculate the conversion factor between primary pulses and units of measure. $positx = encoderx * measurex / pulsex$ The relationship <i>measurex/pulsex</i> must have a value between 0.00935 and 1.
pulsex	Long	Retentive	RW	-	1÷999999	st_ipolar = 0, st_prsonx = 0, st_stillx = 1	Number of pulses for calculating the conversion factor between primary pulses and units of measure for X axis Indicates the number of pulses that will generate the bidirectional transducer to get a movement of <i>measurex</i> . This parameter is used to calculate the conversion factor between primary pulses and units of measure. $positx = encoderx * measurex / pulsex$ The relationship <i>measurex/pulsex</i> must be a value between 0.00935 and 1.
decptx	Byte	Retentive	RW	-	0÷3	st_ipolar = 0, st_prsonx = 0, st_stillx = 1	Choice of the unit of measurement of the speed of the X axis The speed unit depends on the <i>unitvelx</i> and <i>decptx</i> parameters. Through <i>decptx</i> determines whether setting the values of speed in multiples of the fundamental units Um. For example, if the fundamental unit of measure Um=mm, and unitvel=1 you get the speed indicator in the <i>vel</i> variable in: mm/s (with <i>decpt</i> = 0), cm/s (with <i>decpt</i> = 1), dm/s (with <i>decpt</i> = 2), m/s (with <i>decpt</i> = 3).
unitvelx	Byte	Retentive	RW	-	0÷1	st_ipolar = 0, st_prsonx = 0, st_stillx = 1	The time unit for the speed calculation Defines the speed unit: 0: Um/min, 1: Um/sec.
maxposx	Long	Retentive	RW	Um	-999999÷999999	st_stillx=1	Maximum quota reached by the X axis Defines the maximum quota reached by the X axis: the set value is considered also as an upper limit for the introduction of quotas of program.
minposx	Long	Retentive	RW	Um	-999999÷999999	st_stillx=1	Minimum quota reached by the X axis Defines the minimum quota reached by the X axis: the set value is considered also as the lower limit for the introduction of quotas of program.
prspox	Long	Retentive	RW	Um	minpos÷maxpos	st_stillx=1, st_prsonx=0	Homing offset X axis Represents the homing offset that is the distance between the location of home and location where ends the homing function for X axis.
maxvelx	Long	Retentive	RW	Uv	0÷999999	st_ipolar = 0, st_prsonx = 0, st_stillx = 1	Maximum speed X axis Defines the maximum speed of the X axis, or that is the speed assumed when the output voltage is $\pm 10V$. The input value is measured in the units that are set using the <i>unitvelx</i> parameter.
prsvlax	Long	Retentive	RW	Uv	0÷maxvelx	st_stillx=1, st_prsonx=0	Speed for the search of the activation for X axis enable digital input Speed to search the digital input is activated by enabling. The input value is measured in the units that are set using the <i>unitvelx</i> parameter.
sprsvlax	Long	Retentive	RW	Uv	0÷maxvelx	st_stillx=1, st_prsonx=0	Speed used for the search the X axis home position Defines the speed used to search up the location of home. This can be given by the input of zero of the bi-directional counter or from the disable of enable digital input (depends on the value of the <i>prsmodex</i> parameter). The input value is measured in the units that are set using the <i>unitvelx</i> parameter.
tollix	Long	Retentive	RW	Um	-999999÷999999	-	X axis tolerance Define a tolerance band around the positioning quotas. When the placement ends within this band then is placed to 1 the <i>st_tollix</i> state. Is there a time of check to ensure that the axis has assumed a stable position within the range. This time is expressed by the <i>toldlyx</i> parameter.
maxfollerrx	Long	Retentive	RW	Primary pulses	0÷2147483648	-	Maximum following error X for axis Defines the maximum acceptable deviation between the theoretical position and the current position of the X axis. It is used for the management of <i>st_follerrx</i> .
mxrlvelx	Long	Retentive	RW	Uv	0÷maxvelx	-	Maximum speed X axis in interpolation In the case of placements with interpolation, defines the maximum speed reached by the X axis.
rampmodex	Byte	Retentive	RW	-	0÷1	-	Choice between acceleration ramps and deceleration for the X axis Used when choosing between equal acceleration and deceleration ramps (usage of <i>taccdecx</i> parameter) or differentiated (usage of two <i>taccx</i> and <i>tdecx</i> parameters). 0: equal ramp, 1: differentiated ramps.  Note: if <i>st_stillx</i>=1 the writing is always enabled, otherwise the value is processed only if the new acceleration and deceleration time can reach the pre-set quota.

Name	Dimension	Default value	Access type	Unit of measure	Valid range	Write conditions	Description
ramptypex	Byte	Retentive	RW	-	0÷3	st_stillx=1	<p>Ramp type X axis Defines the ramp type to execute for X axis: 0: trapezoidal acceleration and deceleration, 1: acceleration and deceleration of epicycloidal type, 2: trapezoidal acceleration and epicycloidal deceleration type, 3: epicycloidal acceleration and trapezoidal deceleration.</p> <p>Description of epicycloidal motion The epicycloidal motion (<i>ramptypex=1</i>) is used to move the axes without sudden variations of speed. The time of positioning of an axis moved by trapezoidal ramps will be less, but the mechanical wear increases. For comparison shows the difference of the time of acceleration in the two cases with constant maximum gradient acceleration (deceleration ramp behavior is the same).</p>  <p>Epicycloidal movement has the ability to behave in different ways in the event of a reduction in profile (<i>rtypex</i>) and in the case of stop during the acceleration ramp (<i>stoptx</i>).</p>
taccdecx	Word	Retentive	RW	hundredths of a second	0÷999	st_ipolar = 0, st_prsonx = 0, st_stillx = 1	<p>Acceleration and deceleration time X axis Is the time it takes to go from speed 0 to maximum speed (<i>maxvelx</i>) and vice versa; the parameter is used if <i>rampmodex</i> = 0.</p> <p>Change ramp time in motion When positioning can be varied acceleration and deceleration times. For example, the device can start a placement with a long ramp and, reach the target speed, is changed the deceleration time and executed a speed change with a very long ramp. For special applications and with trapezoidal ramps, the time can be changed even during a speed change, in this case, the new time is used immediately. Writing to acceleration and deceleration parameters is always enabled but the new value will be used only if the generator profile can reach the location set. Otherwise, the new value will be put into execution to the next positioning.</p>
taccx	Word	Retentive	RW	hundredths of a second	0÷999	-	<p>Acceleration time X axis Is the time to go from 0 speed to maximum speed. Is used when <i>rampmodex=1</i>.</p> <p>Moving ramp time change When positioning can be varied acceleration and deceleration times. For example, the device can start a placement with a very long ramp and, reach the target speed, is changed the deceleration time and execute a speed change gearbox with very long ramp ramp. For special applications and with trapezoidal ramps, the time can be changed even during a change in speed, in this case, the new time is used immediately. The writing to acceleration and deceleration parameters is always enabled but the new value will be used only if the generator listing can reach the location set. Otherwise, the new value will be put into execution the next positioning.</p>
tdecx	Word	Retentive	RW	hundredths of a second	0÷999	-	<p>Deceleration time X axis Is the time to go from maximum speed to 0 speed. Is used when <i>rampmodex=1</i>.</p> <p>Moving ramp time change When positioning can be varied acceleration and deceleration times. For example, the device can start a placement with a very long ramp and, reach the target speed, is changed the deceleration time and execute a speed change gearbox with very long ramp ramp. For special applications and with trapezoidal ramps, the time can be changed even during a change in speed, in this case, the new time is used immediately. The writing to acceleration and deceleration parameters is always enabled but the new value will be used only if the generator listing can reach the location set. Otherwise, the new value will be put into execution the next positioning.</p>

Name	Dimension	Default value	Access type	Unit of measure	Valid range	Write conditions	Description
rtypex	Byte	Retentive	RW	-	0÷1	ramtypex=1	<p>Profile reduction type X axis This parameter indicates the behavior of the profile generator in the case of positioning with epicycloidal ramps in conditions of not reached of the constant speed. The behavior is: 0: the acceleration and deceleration times remain those already calculated and is decreased proportionally speed. 1: acceleration, deceleration times and the speed are decreased.</p>  <p>— Posizionamento minimo oltre al quale interviene la riduzione del profilo — Posizionamento inferiore al minimo e rtype = 0 — Posizionamento minimo oltre al quale interviene la riduzione del profilo — Posizionamento inferiore al minimo e rtype = 1</p> <p>With the rtypex = 0 parameter extend considerably the time needed to placements small. If the parameter is set to 1 you have a short time in case of short placements, but keeping the constant gradient you will lose the benefits of using an epicycloidal ramp.</p>
stoptx	Byte	Retentive	RW	-	0÷1	ramtypex=1	<p>Stop mode X axis In case you are using epicycloidal ramps and we should curb the X axis during acceleration ramp with the STOPX command you can choose whether to complete the ramp or interrupt. This option will change the stoptx parameter: 0: the acceleration ramp is completed, and then it starts the deceleration ramp, 1: the acceleration ramp stops and start the deceleration ramp of epicycloidal type.</p>  <p>— Rampa di accelerazione impostata — Posizionamento risultante dopo lo stop con stopt = 0 — Rampa di accelerazione impostata — Posizionamento risultante dopo lo stop con stopt = 1</p>

Name	Dimension	Default value	Access type	Unit of measure	Valid range	Write conditions	Description
tinvx	Word	Retentive	RW	hundredths of a second	0÷999	-	Late for reversing the direction of X axis Is a delay time introduced in the case of reversals of direction. Is used to avoid mechanical stress caused by too rapid reversals.
toldlyx	Word	Retentive	RW	hundredths of a second	0÷999	-	Tolerance signalling delay X axis Defines the time between the arrival of the axis in the tolerance range and its status report (<i>st_tolx</i>).
pgainx	Word	Retentive	RW	-	0÷32767	-	Proportional gain X axis Is the coefficient that allows you to change the amount of proportional in PID controller. Is placed in thousandths (therefore inserting 1000 the coefficient will be equal to 1).
feedfwx	Word	Retentive	RW	-	0÷32767	-	Coefficient of feed forward X axis Is the percentage coefficient that, multiplied by the theoretical speed, raises the portion of feed forward control output. The value is entered in tenths (therefore inserting 1000 the percentage will be 100.0%).
integtx	Word	Retentive	RW	milliseconds	0÷32767	-	Integration time of following error X axis Is the parameter that allows you to change the scale of the action integral PID controller PID.
derivtx	Word	Retentive	RW	milliseconds	0÷32767	-	Time for calculation of derivative coefficient of the following error X axis Is the parameter that allows you to change the amount of derivative action in PID controller.
prsmodex	Byte	Retentive	RW	-	0÷2	st_ipolar = 0, st_prsonx=0, st_stillx=1	Search mode of home position X axis Select the search mode of the home position. Possible values are: 0: without zero input of bi-directional counter, 1: with zero input of bi-directional counter, 2: homing in current location without moving.
prsdirex	Byte	Retentive	RW	-	0÷1	st_prsonx=0	Direction of movement for seeking the home position X axis Defines the direction of the first movement when searching the home position: 0: forward direction, 1: backward direction.
offsetx	Word	Retentive	RW	bit	-32768÷32767	-	Analog output offset X axis Defines the value in bits of the correction concerning the analogue output to compensate for any drift in the system.
setposx	Long	Retentive	RW	Um	minposx÷maxposx	-	Positioning quota X axis Defines the quota of positioning to achieve the <i>setvelx</i> speed. Setposx change in motion In some applications you are prompted to define the target quota during the placement, based on certain events. This means you can write in the <i>setposx</i> parameter even with ongoing positioning. Changing the quota is accepted only if the new location is accessible by the current direction of movement. In the case of using epicycloidal dimension change ramps is not accepted if <i>st_decx</i> =1 (if the axis is decelerating). 
setvelx	Long	Retentive	RW	Uv	0÷maxvelx	-	X axis positioning speed Sets the value of the positioning speed. Setvelx change in motion When positioning the axis speed can be changed without affecting the location to reach. This operation can also be done in several places of the same positioning simply by changing the <i>setvelx</i> parameter. The speed change is always available except during the deceleration ramp reported by a specific state (<i>st_decx</i> = 1).   Attention: the value is altered if you tell a homing with search function <i>prsmodex</i> = 0 or 1
voutx	Byte	0	RW	tenths of a Volt	-100÷100	st_init=1, st_calx=1, st_emrgx = 0	Output voltage X axis Typically indicates the voltage value provided by analog output, during the calibration phase can be modified to set a fixed value at exit.
velx	Long	0	R	Uv	0÷maxvelx	-	X axis speed Is the value of the instantaneous speed of X axis. The update is executed every 250 ms. The speed unit depends on the <i>unitvelx</i> and <i>decptx</i> parameters.

Name	Dimension	Default value	Access type	Unit of measure	Valid range	Write conditions	Description
frqx	Long	0	RW	Hz	-	-	Input signal frequency X axis It's the frequency value of the input signals on the bi-directional counter. The update is executed every 250 ms.
posit	Long	Retentive	RW	Um	minpos+maxpos	st_init=1	Current position in units of measurement Is the value of the instantaneous position of the axis. $positx = encoderx * measurex / pulsex$ Change current location in motion When positioning you can change the value of the current <i>positx</i> position. This function is usually used when a device must, under special conditions, continue a speed profile for a very long time, that exceeds the time axis takes to reach the quota limit (<i>maxposx</i> or <i>minposx</i>).
encoderx	Long	Retentive	RW	Primary pulses	st_init=1	-	Current position X axis in primary pulses Expresses the current position in the primary pulses.
folloerrx	Long	0	R	Primary pulses	-	-	X axis following error It's the instantaneous value of the following error.
ffwdregx	Long	0	R	bit	-	-	Output value feed forward X axis It's the instantaneous value of the feed forward output in PID controller.
propregx	Long	0	R	bit	-	-	Proportional output value X axis It's the instantaneous value of the proportional output in PID controller.
integrx	Long	0	R	bit	-	-	Integral output value X axis It's the instantaneous value of the integral PID controller output.
derregx	Long	0	R	bit	-	-	Derivative output value X axis Is the instantaneous value of the derivative in PID controller output.
deltax	Long	0	RW	Um	-999999+999999	-	Variation of the current position of the X axis to use the DELCNT command Is the value that is added to your current position when a <i>DELCNTX</i> command is sent.
errcodex	Byte	0	R	-	0÷100	-	Error identification code X axis Indicates the type of error intervened in the system. When <i>st_errorx</i> = 1 is present on the <i>errcodex</i> variable and the type of error intervened in the <i>errvaluex</i> variable is an indication of the cause of the error. If the device goes wrong, to start work you have to clear the <i>st_errorx</i> status through the <i>RSERRX</i> command.
errvaluex	Byte	0	R	-	0÷100	-	Identifying code of the cause of the error X axis Indicates the cause of the error in the system. The code is valid only if <i>st_error</i> = 1.
wrncodex	Byte	0	R	-	0÷100	-	Identification code warning X axis Indicates the type of warning in the system. The <i>st_warningx</i> state indicates a minor event that guarantees the operation of the device. When <i>st_warningx</i> is equal to 1, it's present on the <i>wrncodex</i> variable the type of warning intervened and in the <i>wrnvaluex</i> variable an indication as to the cause of the warning. To clear the <i>st_warningx</i> status must be send the <i>RSWRNX</i> command.
wrnvaluex	Byte	0	R	-	0÷100	-	Identification code of the cause of the warning X axis Indicates the cause of the warning in the system.

ATTENTION: The last letter of the name of the variable takes the value of the axis name.

1.3.2 Y axis parameters

See section [X axis parameters](#)

1.3.3 Z axis parameters


See section [X axis parameters](#)

1.4 States table

Name	Default value	Description
st_init	0	Initialization state Reporting of device initialized: 0: device is not initialized, 1: device initialized
st_ipolar	0	Interpolation in progress status Interpolation in progress: 0: interpolation not in progress, 1: interpolation in progress
st_rvel	0	State of speed reduction in interpolation When this flag is 1, indicates that there has been a reduction in speed of interpolation to retract the axis speed within the limits set by the <i>mxrlvel</i> / <i>ASSE</i> parameters. The state remains active at least for 200 msec.
st_undsp	0	Segment in interpolation executed without reach the target speed When this flag is to 1, indicates that the segment was executed without reaching the set speed.
st_error	0	There is an error Indicates the error state of the device, to recognize the type of error you must refer to <i>errcode</i> and <i>errvalue</i> variables: 0: error not present, 1: error present
st_warning	0	There is a warning Indicates the warning state of the device, to recognize the type of warning you must refer to <i>wrncode</i> and <i>wrnvalue</i> variables: 0: warning not present, 1: warning present

Name	Default value	Description
st_out0X	0	Output OUT0X state Indicates the output status OUT0X (where X=1÷4): 0 : disabled output, 1 : activated output.

1.4.1 X axis states

Name	Default value	Description
st_emrgx	0	Emergency X axis state Reporting of X axis in emergency: 0 : X axis not in emergency, 1 : X axis in emergency
st_tollx	0	Tolerance X axis state Reporting of X axis in tolerance than the placement quota set. Signaling axis in tolerance may be delayed through <i>toldlyx</i> parameter 0 : X axis not in tolerance, 1 : X axis in tolerance
st_prsokx	0	Outcome of the X axis homing function This state indicates whether the homing function for the X axis has been successfully concluded. The values are: 0 : function not executed or not properly completed, 1 : function executed and properly completed.
st_stillx	1	State of X axis movement Reporting of X axis stopped: 0 : axis moving, 1 : axis stopped
st_prsonx	0	Homing function X axis state Reporting of homing function X axis in progress: 0 : function not in progress, 1 : function in progress
st_movdirx	0	Direction of X axis movement Indication of the direction of X axis movement: 0 : forward, 1 : backward  Note: When the axis is stopped the status indicates the direction of the last entry executed.
st_looponx	0	Space reaction X axis activation Reporting of X axis in space reaction: 0 : axis not in space reaction, 1 : axis in space reaction
st_follerrx	0	Following error X axis state Reportin of folowing error X axis state. This state when switching from 0 to 1, remains the same for a minimum of 500 ms. 0 : axis not in following error, 1 : axis in following error
st_regoffx	0	Disabling update of X axis analog output State reporting if the upgrade of analog output is disabled 0 : the calibration is enabled, 1 : the calibration is disable.
st_calx	0	Calibration status Reporting of device in the X axis calibration (the output voltage can be adjusted): 0 : voltage generator disable, 1 : voltage generator enable
st_cntlockx	Retentive	Update X axis status position disabled Update reporting position X axis blocked: 0 : update position enabled, 1 : update position disabled
st_cntrevx	Retentive	Flip X axis position update state Invert X axis location update report: 0 : update position not reversed, 1 : update position inverted
st_accx	0	X axis acceleration state Reporting of X axis acceleration phase: 0 : axis not in acceleration, 1 : axis in acceleration
st_decx	0	X axis deceleration state \\Reporting of X axis when slowing down: 0 : axis does not decelerating, 1 : axis decelerating

Name	Default value	Description
st_vconstx	0	State of X axis constant speed Reports that the speed profile generator is performing a constant speed movement: 0: axis not in constant speed, 1: axis in constant speed
st_intx	0	Activation of a digital input for X axis stopping Indicates the status of the digital input for interruption: 0: digital input for stopping off, 1: digital input for stopping on
st_errorx	0	There is an X axis error Indicates the error status of the device, to recognize the type of error you must refer to <i>errcodex</i> to <i>errvaluex</i> variables: 0: error not present, 1: error present
st_warningx	0	There is of a X axis warning Indicates the warning state of the device, to recognize the type of warning you must refer to <i>wrmcodex</i> and <i>wrmvaluex</i> variables: 0: warning not present, 1: warning present

ATTENTION: The last letter of the name of the variable takes the value of the axis name.



1.4.2 Y axis states

See section [X axis states](#)

1.4.3 Z axis state

See section [X axis states](#)

1.5 Commands table

Name	Conditions	Description
INIT	st_init=0	Device initialization Device initialization command. If the device is not initialized does not execute the calculations related to the axis and then sits is idle. Activates the <i>st_init</i> state.
RSERR	-	Reset the error state Reset the <i>st_error</i> state.
RSWRN	-	Reset the thw warning state Reset the <i>st_warning</i> state.
READSTEP	-	Read the steps Allows the steps reading <i>numstep</i> starting from the selected step in <i>stepin</i> .  Note: Memory steps is not retentive WRITESTEP - Write the steps Allows the steps writing <i>numstep</i> starting from the selected step in <i>stepin</i>.  Note: Memory steps is not retentive
STARTI	st_init = 1, st_ipolar = 0	Start command of single interpolation Linearly interpolates quotas described in <i>setposx</i> , <i>setposy</i> and <i>setposz</i> depending on the number of axes that are enabled. Interpolation speed is <i>setveli</i> .
STARTPRG	st_init = 1, st_ipolar = 0, 0≤stepbeg<30000, 0<stepend<30000	Start command of interpolations program Start positioning coordinates set by interpolation from step <i>stepbeg</i> (including) up to <i>stepend</i> (including). The speed interpolation is <i>setveli</i> .
STOPI	st_init = 1, st_ipolar = 0	Interruption interpolation Stops any ongoing interpolation position in progress. The stopped of the axis are made by deceleration ramp and axes remain in reaction to space.

1.5.1 X axis commands

Name	Conditions	Description
EMRGX	st_init=1	Emergency command Put in emergency the X axis interrupting, without the deceleration ramp, any ongoing positioning. It also disabled the reaction of axis space. As a result <i>st_emrgx</i> is set to 1, in this state it will not be possible to move the axis.
RESUMEX	st_init=1, st_emrgx=1	Recovery from X axis emergency condition Recovery from X axis emergency condition, space reaction is reenabled if disabled. The acquisition of the <i>STARTX</i> command, the axis resumes the placement.
STARTX	st_init=1, st_regoffx=0, st_emrgx=0, st_stillx=1, st_ipolar=0, st_calx=0, st_prsonx=0	Beginning of the X axis positioning Controls the position of the X axis to the quota <i>setposx</i> and speed <i>setvelx</i> , the placement will run following to the acceleration and deceleration ramps that were set using <i>taccdecx</i> parameter or through the <i>taccx</i> and <i>tdecx</i> parameters (in the case of differentiated ramps). The type of used ramp (trapezoid or epicycloid) is choosing through the <i>ramptypex</i> parameter.
STOPX	st_init=1, st_regoffx=0, st_emrgx=0, st_stillx=0, st_ipolar=0	Interruption of the X axis positioning Stops any ongoing X axis positioning. The axis stop take place following the programmed deceleration ramp <i>tdecx</i> . The axis remains in reaction to space.
LOOPONX	st_init=1	Enabling of the X axis space reaction Enables the X axis reaction space: accordingly <i>st_looponx</i> is set to 1 and the axis is moved using all the functions of the PID controller. The analog output sharpen every external action that attempts to move the axis from the reached position (drift, user, ...). This action resets any following error (<i>folterr</i>).
LOOPOFFX	st_init=1	Disabling the X axis space reaction Disables the X axis reaction space. The <i>st_looponx</i> state is set to 0: in this state the axis accept anyway the axis movement commands. A placement executed without the reaction loop is comparable to a positioning run without proportional gain (is not guaranteed to arrive in position).
CNTLOCKX	st_init=1	Disabling the X axis actual position update Disables the updating of the current position. In this situation the possible displacement of the axis is not detected.
CNTUNLOCKX	st_init=1	Enabling the X axis actual position update Enable current location updating.
CNTREVX	st_init=1	Reversal the X axis position update Reverses the sign of the update location.
CNTDIRX	st_init=1	Updating the X axis position not inverted Turn a possible reversal of position update; the <i>st_cntrev</i> state is set to 0.
PRESETX	st_init=1, st_regoffx=0, st_emrgx=0, st_calx=0, st_ipolar=0	Start X axis homing function X axis homing function start with the manner set. If the process is already running, the command execute the reverse search. activates the <i>st_prsonx</i> state and disable the <i>st_prsokx</i> state.
CALONX	st_init=1, st_ipolar=0, st_prsonx=0, st_stillx=1	Enable X axis calibration state The X axis analog output is used as an analog voltage generator; in this case you cannot use it to execute a placement. The output value is settable with <i>voutx</i> parameter.
CALOFFX	st_init=1, st_ipolar=0, st_prsonx=0, st_stillx=1, st_calx=1	Disable the X axis calibration state The X axis analog output is not use as voltage generator, so it can be used for managing placements.
MANFWX	st_init=1, st_regoffx=0, st_prsonx=0, st_stillx=1, st_calx=0, st_emrgx=0, st_ipolar=0, st_ovrmxpx=0	Manual command of X axis forward movement (jog) Controls the manual forward positioning (towards <i>maxposx</i>) at the X axis set speed. If the current position exceeds <i>maxposx</i> , the axis will not move.
MANBW	st_init=1, st_regoffx=0, st_prsonx=0, st_stillx=1, st_calx=0, st_emrgx=0, st_ipolar=0, st_undmnpix=0	Manual command of X axis backward movement (jog) Controls the manual backward positioning (towards <i>minposx</i>) at the X axis set speed. If the current position is less <i>minposx</i> , the axis will not move.
REGOFFX	st_init=1, st_stillx=1	Disabling the X axis device intervention Disable X axis adjustment and updating of the analog output, and all movement commands.
REGONX	st_init=1, st_regoffx=1	Enabling the X axis device intervention X axis adjustment and updating of the analog output, and all movement commands.

Name	Conditions	Description
DELCNTX	st_initx=1, st_calx=0, st_prsonx=0	Positx editing command a value equal to deltax The current position (<i>positx</i>) is modified by algebraically adding the value specified in the <i>deltax</i> variable. This command can be given, except in the case that, with the moving axis, the command would reverse the direction. NIn the case of using epicycolidal deceleration ramps you cannot give the command if <i>st_decx</i> =1.
RSERRX	st_errorx=1	Reset X axis error state Reset the <i>st_errorx</i> state.
RSWRNX	st_warningx=1	Reset the X axis warning state Reset the <i>st_warningx</i> state.
RSPRSOKX	st_init=1, st_prsonx=0	Reset the X axis homing OK state Reset the <i>st_prsokx</i> state.

ATTENTION: The last letter of the name of the variable takes the value of the axis name.

1.5.2 Y axis commands

See section [X axis commands](#).

1.5.3 Z axis commands

See section [X axis commands](#).

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