3 axis controller
User manual

Twintec controller user manual

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Contents

1 Introduction

1.1 Controller manual

This manual, destinated to the controller users is divided in 4 sections to make more easy the arguments reading. We choose to not limit the manual to the simple thecnical description of the controller but to explain any argument, providing, where possible, examples and pictures than can give to the reader further informations for a correct use of the controller and a better understanding of it functionality.

Further informations can be found on our web site: http://www.twintec.it

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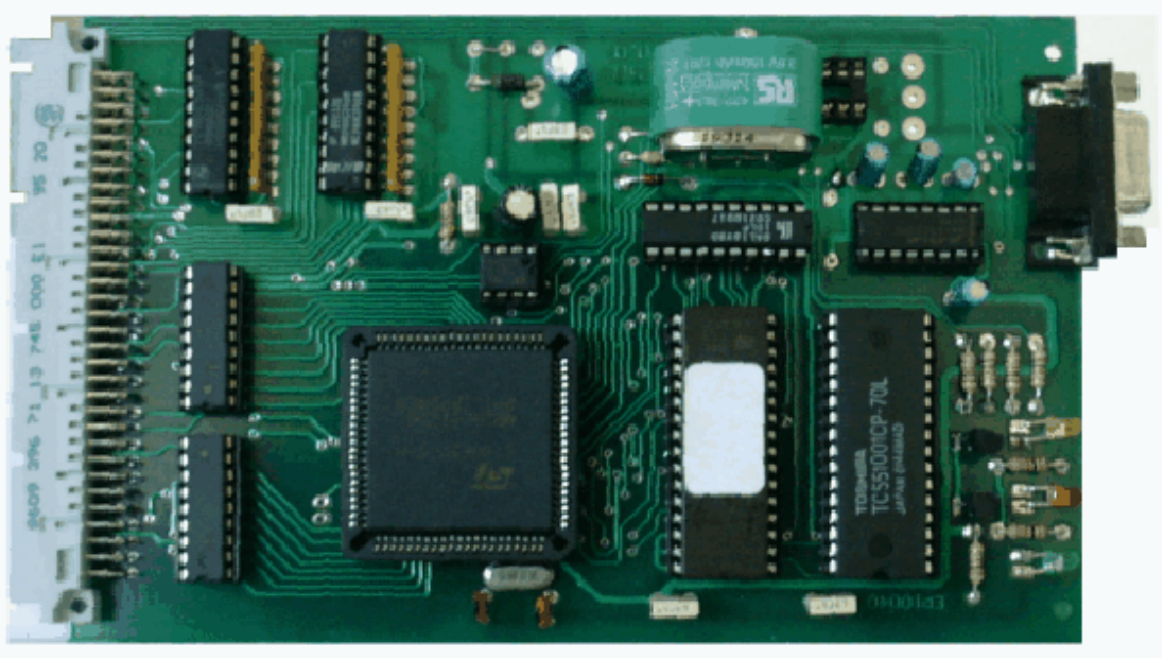
2 Hardware

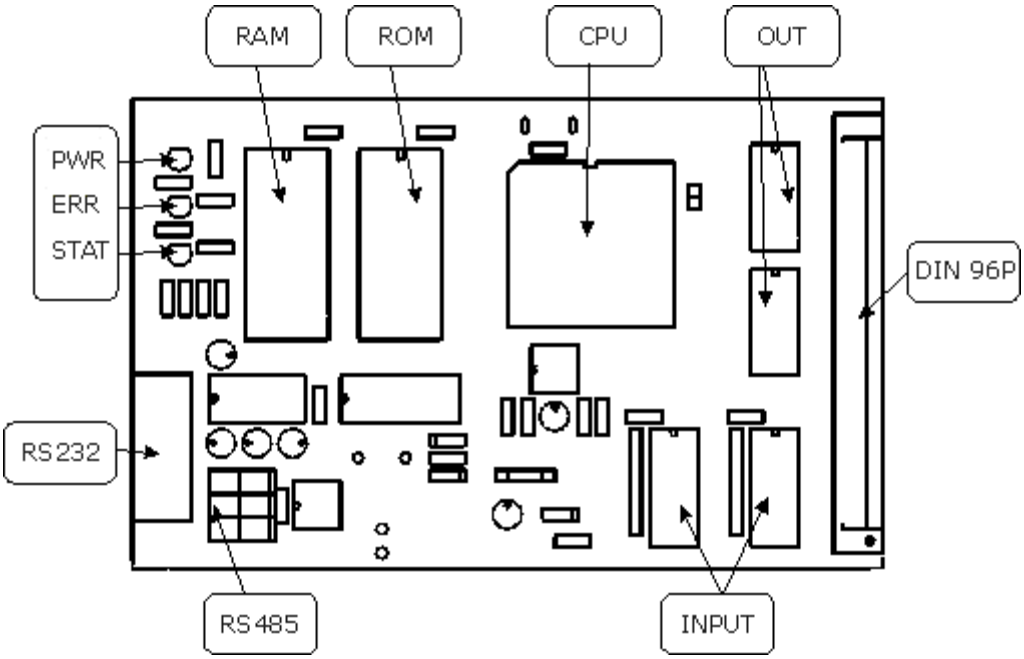
2.1 General description

3 axis controller



- Eurocard board 100X160 mm. connector DIN 96 poles.
- LED indicators for power, execution and error.
- Power supply 5V 200 mA.
- 3 AXIS interpolated.
- 2 serial port: Rs232 19200-38400 BPS. e RS 485 19200 a 38400.
- Communication protocol: RS232 Hardware Handshake via CTS-RTS..
- 8 user input CMOS 5V.
- 8 user output OPEN COLLECTOR max 100 mA.
- Inputs for HOME and LIMIT for all axis.
- STOP input.
- STOP with deceleration and acceleration at restart.
- CONTOURING with adjustable angle.
- Battery for data retention (6 month).
- Configuration buffer for startup.
- Input and output commands.
- Timing commands.

Drawing of the controller.



Led indicators descripition:

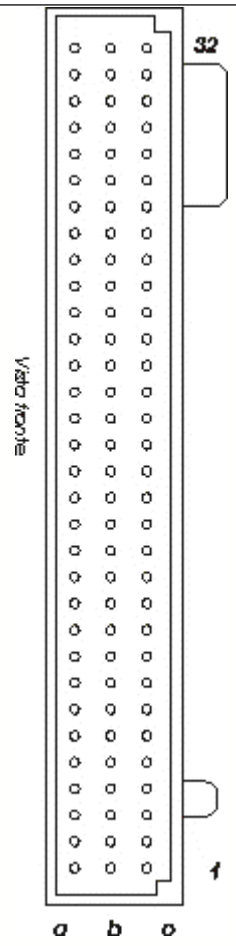
- PWR=POWER LED
- ERR=ERROR AND STOP LED
- STAT=STATUS LED

2.2 Connections description

In the following table the name of the signals.

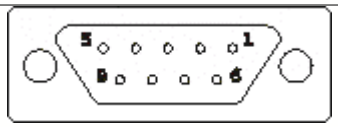
VCC	5V supply.
GND	Ground.
PULSE0	Step output X
PULSE1	Step output Y
PULSE2	Step output Z
DIR0	Direction output X
DIR1	Direction output Y
DIR2	Direction output Z
UI0.. UI7	User inputs.
UO0..UO7	User outputs.
UO Com.	Common snubber for outputs
HOME0	
HOME1	Home input X.
HOME2	Home inputY.
LIM0	Home input Z.
LIM1	Limit Input X.
LIM2	Limit input Y.
	Limit input Z.
RXD	
TXD	Data input rs232
CTS	Data output rs232
RTS	Clear to send rs232
	Request to send 232
ANA1	
ANA2	Analogic input 0-5V
	Analogic input 0-5V
PULSE3	
DIR3	Step output (optional).
	Direction output (optional).

The following table show the drawing of the connector front view and the coresponding pin and signal.

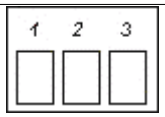


a32		b32		c32		
a31		b31		c31		
a30	GND	b30	GND	c30	GND	
a29		b29		c29		
a28		b28	ANA 1	c28	ANA2	
a27		b27		c27		
a26	LIM0	b26		c26	HOME0	
a25	STOP	b25	LIM 1	c25		
a24	LIM2	b24	HOME1	c24		
a23		b23		c23	HOME2	
a22	CTS	b22		c22		
a21	TXD	b21	RTS	c21	UI0	
a20	RXD	b20	UI1	c20	UI6	
a19	UI7	b19	UI5	c19	UI3	
a18	UI2	b18		c18	UI4	
a17		b17	GND	c17	GND	
a16		b16	GND	c16		
a15	Dir 0	b15	Dir 1	c15	Dir 2	
a14	Pulse0	b14	Pulse1	c14	Pulse2	
a13		b13		c13	GND	
a12	GND	b12	GND	c12		
a11	GND	b11		c11	Pulse3	
a10		b10		c10	Dir3	
a9		b9		c9		
a8		b8		c8		
a7		b7		c7		
a6	UO2	b6	UO1	c6	UO0	
a5	UO5	b5	UO4	c5	UO3	
a4	UO Com.	b4	UO7	c4	UO6	
a3	GND	b3	GND	c3	GND	
a2	VCC	b2	VCC	c2	VCC	
a1	VCC	b1	VCC	c1	VCC	

Here the serial connector.

Connettore DB9 RS 232	Related signals	
	2 RXD	Data receive (PC)
	3 TXD	Data transmit (PC)
	4-----6	Shortened (DTR DSR)
	5 GND	Ground
	7 CTS	Clear to send (PC)
	8 RTS	Request to send (PC)

and the RS 485 connector

RS 485 connector	Related signals
	1 GROUND 2 BUS A 3 BUS B

2.3 Electrical characteristics

Power supply: 5V 200 mA max.
Input home and limits: Normaly closed CMOS 5 V with pull-up da 10 KOhm.
User input: pull-up 10KOhm.
User output: Open collector max 100 mA.
Step and dir output: Open collector without pull-up.

Ouput IC: ULN2803;
Input IC: 74HC244;

2.4 Status indicators

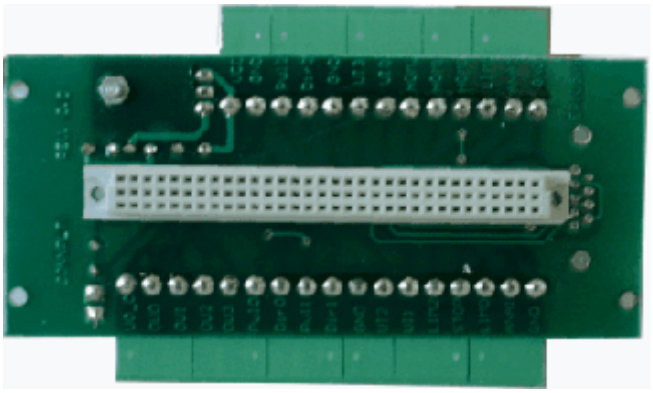
The LED indicators are three:

1. GREEN LED: indicate the power is on.
2. RED LED: Have three states:
   - OFF: nessun errore.
   - FLASHING: The STOP is Pressed.
   - ON: A limit have benn reached.
3. YELLOW LED: have two states:
   - 1 sec. Flashing: The controller is in the stand-by state.
   - 1/2 sec. flashing: The controller is executing commands.

2.5 Accessory

2.5.1 Controller connector

This board allow the connection of the controller with detachable connectors. It comprise a 5V stabilized power so the input can be 9~15 V cc.. On the back there is a LED that indicate the power presence and is possible to add a DB9 connector whenever the one on the controller will result in an unfavorable position.



Power supply 9~15 V CC. 200 mA.

Nota: Not all the signals are disponible on that connector
Signals present:

UO common
UO 0..3
UI 0..3
PULSE 0,1,2
DIR 0,1,2
LIM 0,1,2
STOP
HOME 0,1,2
GND
VCC
ANA 1,2

3 Software

3.1 Command syntax

All commands are of two characters and a list of parameters delimited by a comma, the command terminator is the semi-colon ";".

MC100,100,100;

Spaced are discarded by the controller.
MC 100, 100, 100;

The interpreter is case insensitive;
mc 100,100,100;

Follow the description of the commands, the syntax, limits and error condition.

3.2 List of commands

3.2.1 Move

Syntax: **MV X,Y,Z;**

Purpose: Move the axis at the specified position with acceleration and deceleration.

Parameters: X,Y and Z.

Example: MV 100, 100, 400;

Limits: 8388608÷ -8388608

Errors: Missing parrameter, parameter out of limit.

Note: The position are in step and are absolute.

3.2.2 Move contour

Syntax: **MC X,Y,Z;**

Purpose: Move the axis at the specified position inside a path. If the angle between the vector and the previous one is greater than the angle of contour the controller will decelerate if in move and then accelerate to begin this position motion

(see the paragraph for the vector execution).

Parameters: X,Y e Z.

Example: MC 100, 100, 400;

Limits: 8388608÷ -8388608

Errors: Missing parrameter, parameter out of limit.

Note: The position are in step and are absolute.

3.2.3 Set the contour angle

Syntax: **SI A;**

Purpose: Set the contour angle (see the paragraph for the vector execution).

Parameters: A. Contour angle in degree;

Example: SI 25;

Limits: 0-360;

Errors: Missing parrameter, parameter out of limit.

3.2.4 Set the speed

Syntax: **SV V;**

Purpose: Set the speed for the next vectors (see paragraph Speed and acceleration).

Parameters: V. Speed in cm/s.

Example: SV 2.5;

Limits: 1.2-20;

Errors: Missing parrameter, parameter out of limit.

3.2.5 Set the acceleration

Syntax: **SA A;**

Purpose: Set the acceleration in cm/s² (see paragraph Speed and acceleration).

Parameters: A. acceleration in cm/s².

Example: SA 5.5;

Limits: 1.2-40;

Errors: Missing parrameter, parameter out of limit.

3.2.6 Activate output

Syntax: **EO bit,value;**

Purpose: Set the user output at the specified value.

Parameters: bit: number 0..7, value 0-1.

Example: EO 7,1;

Limits: 0..7, 0-1;

Errors: Missing parrameter, parameter out of limit.

3.2.7 Wait an input

Syntax: **WI bit,valore;**

Purpose: Wait a specified value on a user input bit.

Parameters: bit: number 0..7, value 0-1.

Example: WI 7,1;

Limits: 0..7, 0-1;

Errors: Missing parrameter, parameter out of limit.

3.2.8 Wait a time

Syntax: **EW tempo;**

Purpose: Wait for the specified time in ms.

Parameters: time in ms.

Example: EW 1000; wait a second

Limits: 10-65536;

Errors: Missing parrameter, parameter out of limit.

3.2.9 Execute home

Syntax: **EH x,y,z;**

Purpose: Bring the axis at the home position seeking the specified switch. At the end of the command the internal position is 0,0,0.

Parameters: x,y,z. 0 mean no seek 1 mean seek the switch.

Example: EH 1,1,0; Seek the home switch for the x and y axis.

Limits: 0-1;

Errors: Missing parrameter, parameter out of limit.

3.2.10 Set the position

Syntax: **SP x,y,z;**

Purpose: Set the logical position without making any move.

Parameters: x,y,z.

Example: SP 1000,1000,0;

Limits:

Errors: Missing parrameter, parameter out of limit, command received in excecution phase.

Note: This command have to be executed carefully, the command will be refused if the controller is excecuting vectors.

3.2.11 Configure

Syntax: **CF tipo, p1[, p2][, p2];**

These commands are for configuration that are retained even when the controller power is not present.

Configure HOME:

Syntax: **CF 1,x,y,z;**

Purpose: Set how the controller search the Home switch at the reset.

Parameters: x,y,z.

Default value: 0,0,0;

Example: CF1,0,0;

Limits: 0-1;

Note: This command have no immediate effect, but it configure the controller to seek or not the home switch at the reset. If we send the command CF 1,1,1,0; at the next reset the controller will seek the switch that are set to one.

Configure Axis resolution:

Syntax: **CF 2,x,y,z;**

Purpose: Set the axis resolution for the three axis in step/mm.

Parameters: x,y,z.

Default value: 40,40,40;

Example: CF2,40,40,80;

Limits: 1-400;

Note: this command have effect on the speed calculation.

Configure Home Speed:

Syntax: **CF 3,f;**

Purpose: Set the home frequency.

Parameters: f: frequency.

Valore predefinito: 1000;

Example: CF2500;

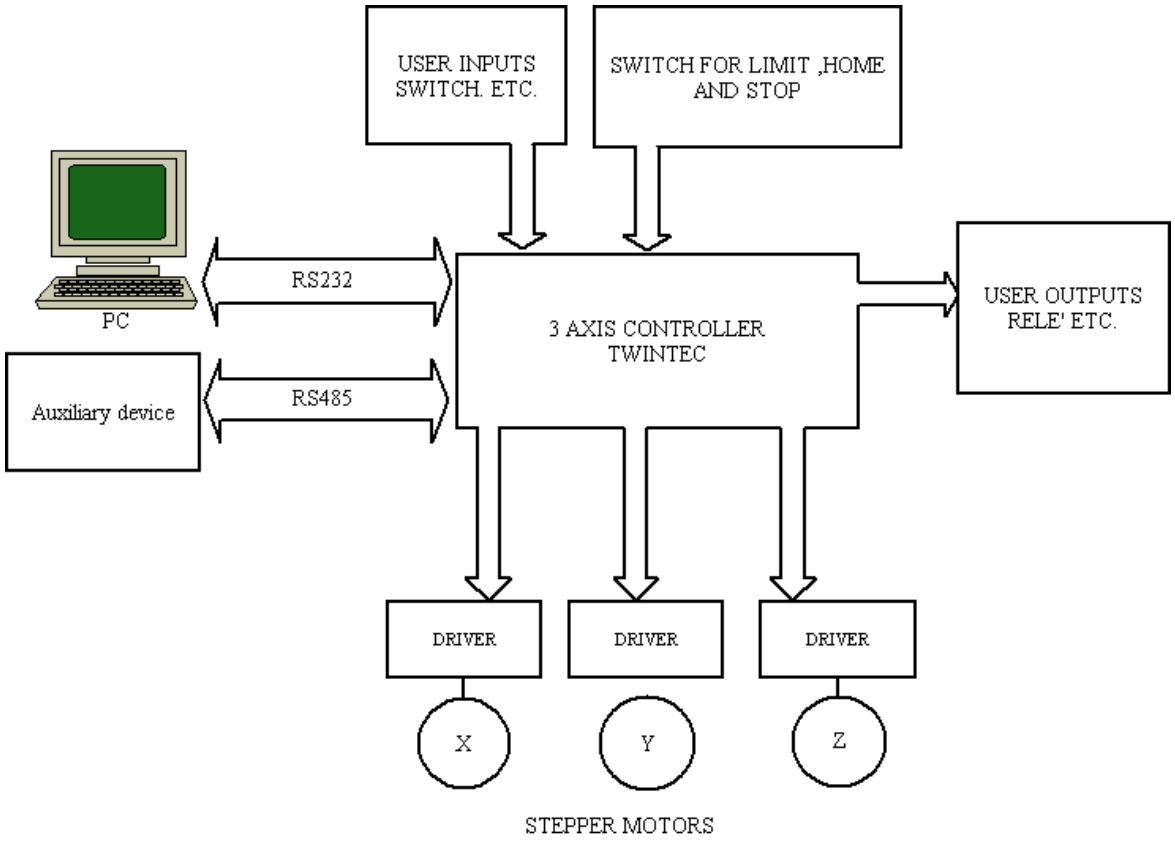
Limits: 100-10000;

4 Operation principles

This chapter describe the operation principle of a positioning system.

4.1 General Principles

Block diagram of a positioning system:



The controller is the headt of a positioning system. It perform the following tasks:

- Generate the direction signals and step frequencies to the drivers to move the motors at the desired position.
- Activate the outputs.
- Wait a status at an input.
- Perform the timing between two command.
- Transmit informations about the position and the status.
- Acquire the Stop status.
- Acquire the Limits status.
- Seek the Home switch to put the axis in this position.

The actions above mentioned can be performed by comunicating, trhough the serial PC line, with defined commands than will be executed by the controller in the sequence that are been transmitted. In the controller there is a receive buffer that allow the same to execute work of hours without interruptions. The communication handshake is managed by the CTS and RTS control signals.

4.2 Communication

The communication with the controller is established with RS232: the line parameters are:

Bit:8
Stop bit: 1
Parity: None
Baud rate: 19200 bps.

The cable to use is a simple direct MF DB9.
The flow control signals are RTS and CTS. Note: in absence of those signals an overwriting of the buffer can occur with severe consequence for the correct excecution.

The RS 485 is optional and is reserved for future or custom usages.

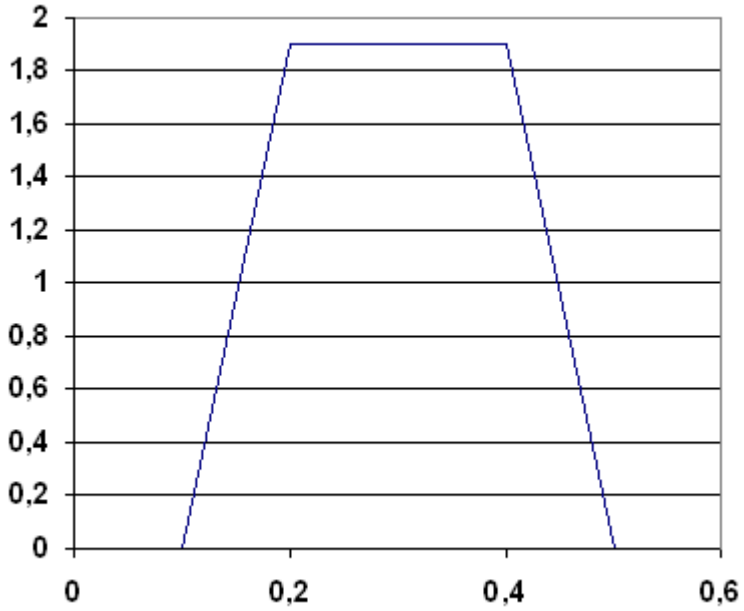
4.3 Speed and acceleration

The speed, in a system composed by three axis is done with the following formula: $V = \sqrt{Vx^2 + Vy^2 + Vz^2}$ here V is the speed and vx,vy, vx are the component speeds.The controller calculate the component speeds for any axis to make the final desired speed that can be set with the SVv; command where v is the speed in cm/s

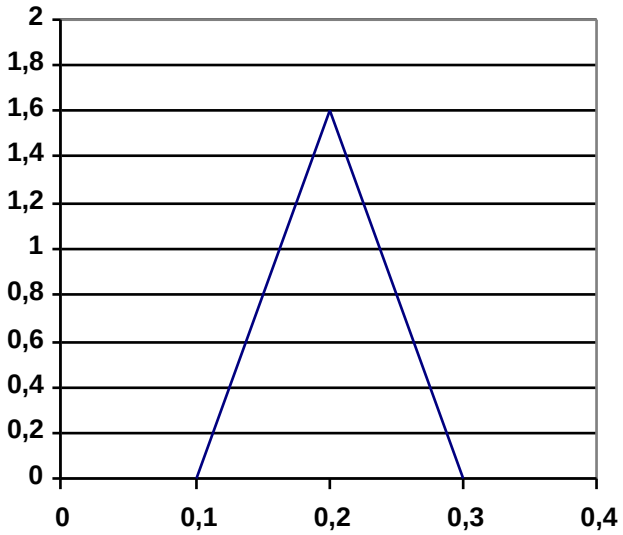
The acceleration of a system is the variation of the velocity with the time, this parameter is set in cm/s² in the controller.

The controller have two command for the setting of these parameters, read the

paragraphs set the speed e set the acceleration for a detailed esplanation of these commands. When the controller have to move at a defined position it start to send pulse with an increasing frequency until it reach the final speed and continue with this speed until it reach the position calculated for the deceleration. The following diagram show how the curve of the velocity for a single vector assume a trapeziodal form. The vertical axis represent the speed and the orizontal the time.



If the length of the vector is too small to reach the final velocity the form of the curve is a triangle.



The correct setting of these two parameters (speed and acceleration) allow to reache optimal performances relating the speed and the positioning accuracy. It is necessary to consider the kind of work to execute before set these two parameters. The step loss can be a consequence of the incorrect setting of a speed or an acceleration. It is a good practice to refer with the caracteristics of the motor to find the correct values.

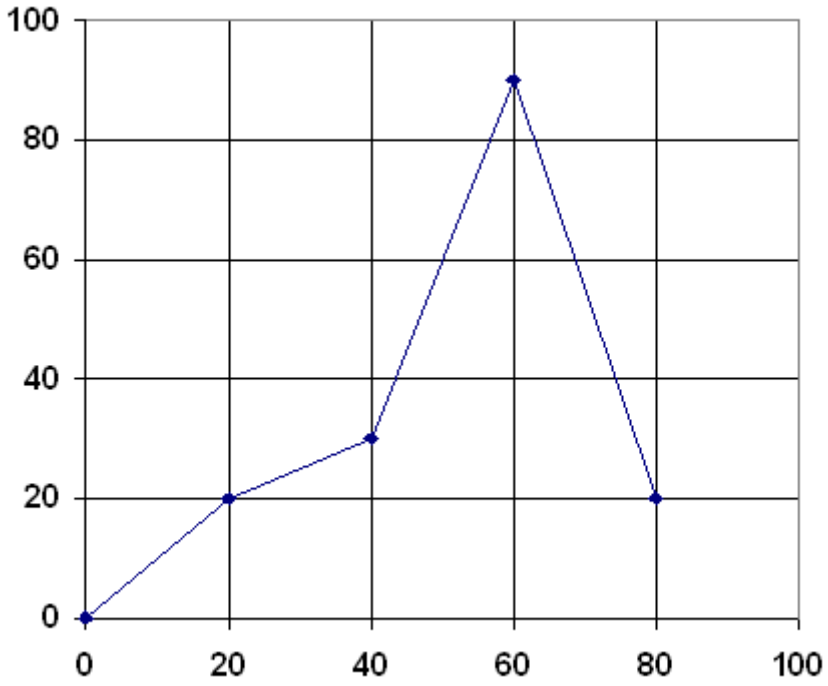
4.4 Vector's execution

To explain how the controller perform the axis positioning it is necessary to introduce the concept of a **vector** and the **path**.
In the following diagram we can see a path composed of 4 vectors. To make that path we have to send to the controller 4 position command. We suppose that the controller start from the position 0.0.0 and all vectors are on the same level so the Z value is 0.

List of commands:

MC20,20,0;
MC40,30,0;
MC60,90,0;
MC80,20,0;

Position diagram



If the contouring angle is set to 23° (default value) the execution of that path is done with 3 accelerations and 3 decelerations. This because the angle between the first and the second vector is less than 23° while the angle between the second and the third vector and between the third and the fourth is greater than 23°.
The sequence will be the following:

1. accelerate from the 0,0,0 position until reach the final speed.
2. reach the position 20,20,0 and it continue in the direction of the 40,30,0 position
3. decelerate until it reach teh 40,30,0 position.
4. accelerate in the direction of the 60,90,0 position
5. decelerate until it reache the 60,90,0 position
6. accelerate in the direction of the 80,20,0 position
7. decelerate until it reach the final position 80,20,0

f we want to execute the move with an acceleration and a deceleration every vector independently of the angle we have to use the MV command instead of the MC one.

Index

NOTE