

Festo_Positioning_Basic library – CNC

Commissioning of a selected system with the Festo_Positioning_Basic library is explained step by step, so that it's successfully integrated into the user program.

FPosB

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Users of this document (application note) must verify that all functions described here also work correctly in the application. By reading this document and adhering to the specifications contained therein, users are also solely responsible for their own application.

Table of contents

1 CNC..... 5

1.1 Internal CNC Mode..... 5

1.2 External CNC Mode..... 15

1.3 xNoAbortByEMCYErr function..... 16

1 CNC

The prerequisite for this section is a configured, enabled and homed system.
The operating mode is selected for the desired function.

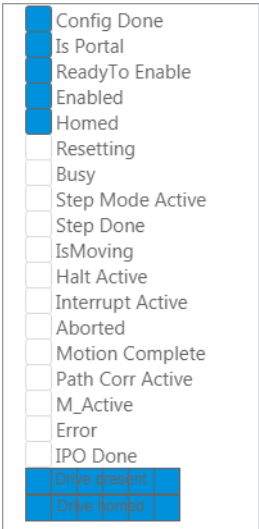
Visualisation	Codesys
 ☒ Config Done ☒ Is Portal ☒ ReadyTo Enable ☒ Enabled ☒ Homed ☐ Resetting ☐ Busy ☐ Step Mode Active ☐ Step Done ☐ IsMoving ☐ Halt Active ☐ Interrupt Active ☐ Aborted ☐ Motion Complete ☐ Path Corr Active ☐ M_Active ☐ Error ☐ IPO Done ☒ Drive Present ☒ Drive Homed	<pre> g_stOut.stSW.xError = FALSE; g_stOut.stSW.xConfigDone = TRUE; g_stOut.stSW.xIsPortal = TRUE; g_stOut.stSW.xReadyToEnable = TRUE; g_stOut.stSW.xEnabled = TRUE; g_stOut.stSW.xHomed = TRUE; g_stOut.stSW.arxMotorPresent[0] = 1; g_stOut.stSW.arxMotorPresent[1] = 1; g_stOut.stSW.arxMotorPresent[2] = 1; </pre>

Table 1: Labelling

The procedure used to this end can be found in sections/ApplicationNotes XXX.

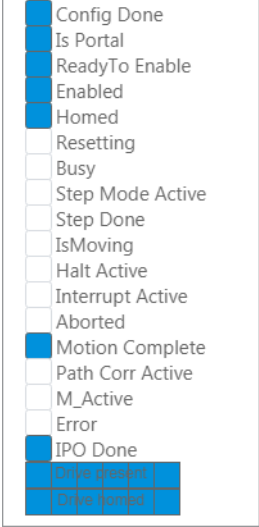
This mode provides the user with the opportunity of starting CNCs in the application which are directly integrated into the Codesys project and have been loaded to the controller.

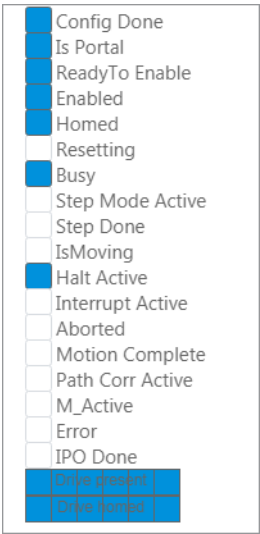
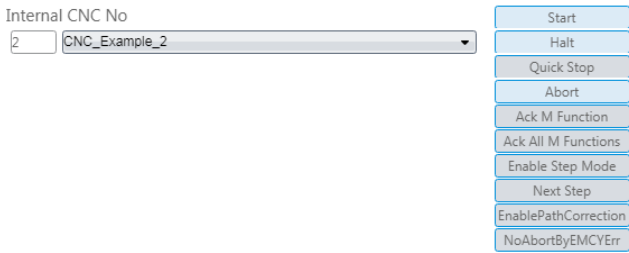
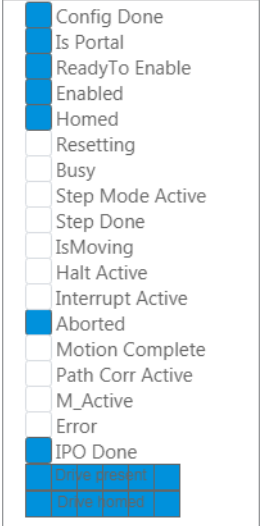
How these CNCs can be integrated into Codesys and the user project is described in the Application Note 03 Configuration H-/T-/XY-Gantry and in the onlinehelp of the library.

1.1 Internal CNC Mode

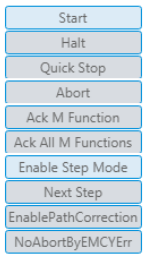
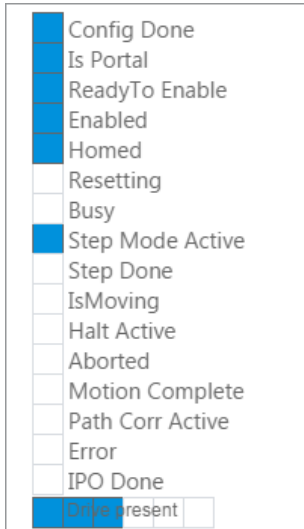
	Visualisation	Codesys
1	The desired CNC is selected. Selection is numerically dependent on the order in which the CNCs have been integrated into the project. Speed can be influenced by means of the override function.	
	Internal CNC No 2 CNC_Example_2 Start Halt Quick Stop Abort Ack M Function Ack All M Functions Enable Step Mode Next Step EnablePathCorrection NoAbortByEMCYErr	<pre>g_stIn.uiUserCNCNo := 2; g_stIn.uiOverride := 100;</pre>
2	The CNC can be checked – as a number as well as in text format.	
	CNC Prg Name: CNC_Example_2	<pre>g_stOut.stActiveCncSource.sCNCName = 'CNC_Example_2';</pre>
3	The CNC is started by means of a rising edge applied to “Start”.	
	Internal CNC No 2 CNC_Example_2 Start Halt Quick Stop Abort Ack M Function Ack All M Functions Enable Step Mode Next Step EnablePathCorrection NoAbortByEMCYErr	<pre>g_stIn.stCW.xStart := TRUE;</pre>

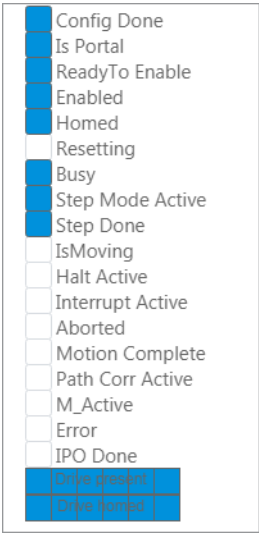
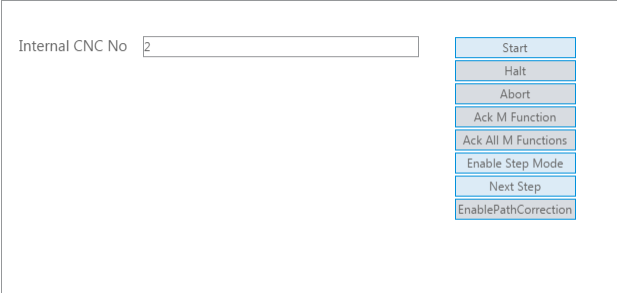
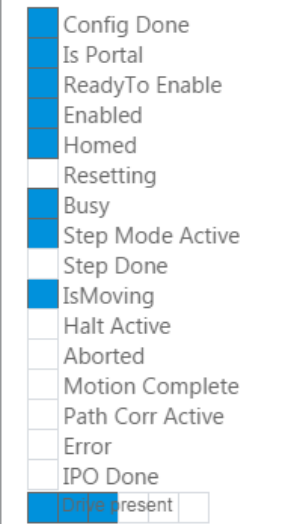
	Visualisation	Codesys
4	The “isMoving” and “Busy” outputs are active as long as motion is in progress. Whereas “isMoving” indicates active positioning motion, the “Busy” status indicates an active internal module. Config Done Is Portal ReadyTo Enable Enabled Homed Resetting Busy Step Mode Active Step Done IsMoving Halt Active Interrupt Active Aborted Motion Complete Path Corr Active M_Active Error IPO Done Drive Present Drive Locked	<pre>g_stOut.stSW.xIsMoving = TRUE; g_stOut.stSW.xBusy = TRUE;</pre>

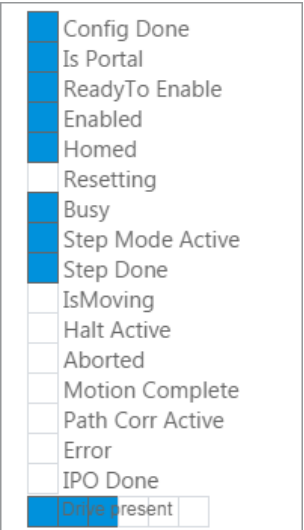
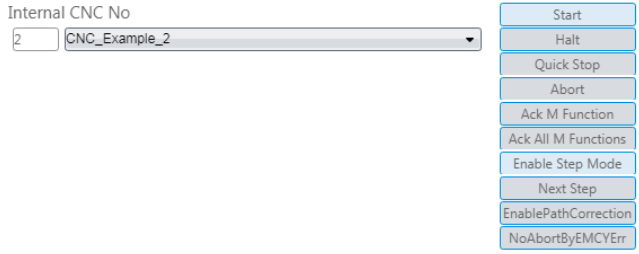
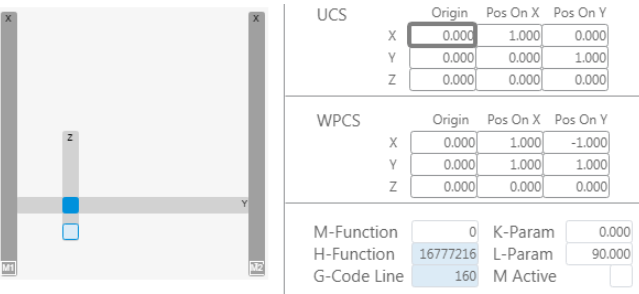
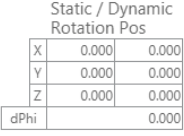
5	Positioning has been successfully completed when Motion Complete is reported back, as long as no errors have occurred. The “isMoving” and “Busy” outputs are inactive.	
		<pre> g_stOut.xError = FALSE; g_stOut.stSW.xIsMoving = FALSE; g_stOut.stSW.xBusy = FALSE; g_stOut.stSW.xMotionComplete = TRUE; </pre>
5	The start command is reset.	
6	During the course of travel, positioning motion can be suspended with the “Halt” command. The position set is still active. As soon as the halt command is deactivated, positioning is continued.	
		<pre> g_stIn.stCW.xStart := FALSE; g_stIn.stCW.xHalt := TRUE; </pre>

7	If “Halt” is active during positioning, the system is in the “Busy” status with active “HaltActive”. “IsMoving” is inactive. “Motion Complete” is not reported back.	
		<pre>g_stOut.stSW.xBusy = TRUE; g_stOut.stSW.xIsMoving = FALSE; g_stOut.stSW.xHaltActive = TRUE; g_stOut.stSW.xMotionComplete = FALSE;</pre>
8	A travel command can also be aborted. As opposed to the “Halt” command, the CNC is aborted in this case. However, the position set should first be suspended with the halt command if possible, and then aborted.	
		<pre>g_stIn.stCW.xStart := TRUE; g_stIn.stCW.xAbort := TRUE;</pre>
9	Abortion is reported back in the status display.	
		<pre>g_stOut.stSW.xAborted = TRUE;</pre>
10	M functions, for example, can be implemented in a CNC’s G code. At the same time, parameters (K/L parameters) can be added to these M functions which are further processed. An active M function is correspondingly indicated. In this case: M function no. 10 with a K parameter of 100.7 (G code: N008 M10 K100.7)	

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13	If the CNC should not stop at each M function, the M functions can be permanently acknowledged. The K/L parameters are still updated.	
		<pre>g_stIn.stCW.xAckAllM := TRUE;</pre>
14	As a rule, a CNC consists of several lines of code. Each line corresponds to a certain action. These individual elements can be run one after the other. The step mode is activated to this end.	
	Internal CNC No 2 CNC_Example_2 	<pre>g_stIn.stCW.xEnableStepMode := TRUE;</pre>
15	The active step mode is reported back in the status display.	
		<pre>g_stOut.stSW.xStepModeActive = TRUE;</pre>

16	A soon as the step mode is active and the CNC has been started, the “Busy” output becomes active.	
		<pre> g_stIn.stCW.xStart := TRUE; g_stOut.stSW.xBusy = TRUE; g_stOut.stSW.xIsMoving = FALSE; g_stOut.stSW.xStepDone= TRUE; </pre>
17	The CNC’s path elements can be processed one after the other by applying a rising edge to “Next Step”.	
		<pre> g_stIn.stCW.xNextStep := TRUE; </pre>
18	As long as motion is taking place along a path element, the “IsMoving” output is active.	
		<pre> g_stOut.stSW.xIsMoving = TRUE; g_stOut.stSW.xStepDone= FALSE; </pre>

19	After a path element has been completed, the “IsMoving” output becomes inactive and the “StepDone” status is reported back. 	<pre>g_stOut.stSW.xIsMoving = FALSE; g_stOut.stSW.xStepDone = TRUE;</pre>
20	During the next cycle, the input signal to “NextStep” can be cancelled. 	<pre>g_stIn.stCW.xNextStep := FALSE;</pre>
21	The point within the CNC code at which the system is currently located can be correspondingly read out. The number obtained in this way corresponds to the line in the CNC and makes no reference to the numbering with N000, N010 ... 	<pre>g_stOut.stCncFunctions.diActGCODELine = 160;</pre>
22	Path correction can be activated. Offset and angle of rotation are determined at a reference mark by means of suitable measuring equipment (e.g. a camera). 	<pre>g_stIn.stCW.xEnablePathCorrection := TRUE;</pre>
23	As soon as it's active, it appears at the status display.	

☒	Config Done
☒	Is Portal
☒	ReadyTo Enable
☒	Enabled
☒	Homed
☐	Resetting
☐	Busy
☐	Step Mode Active
☐	Step Done
☐	IsMoving
☐	Halt Active
☐	Aborted
☐	Motion Complete
☒	Path Corr Active
☐	Error
☐	IPO Done
☒	Drive present

g_stOut.stSW.xPathCorrActive = TRUE;

1.2 External CNC Mode

The functions of the “External CNC Mode” are the same as those of the “Internal CNC Mode”.

Only the difference is pointed out here, which has to do with the source of the CNC data. The data are not loaded to the controller along with the Codesys project, and instead are saved to the controller as a file.

	Visualisation	Codesys
1	You can choose the complete path of the file directly, which will open the selected one. OR You can put your CNC files in a specific folder on the PLC. PLC: //ffx/codesys/_cnc/ (default CNC Folder for CODESYS, therefore “/_cnc/CNC_PathSmall_File.cnc” is also possible) Soft_PLC: C:_cnc All CNC files in this folder will be automatically added to your list and can be activated just by their name. Please take care of “/” and “\” because of SoftPLC (Windows) and PLC (Linux) CNC File Path /_cnc/CNC_PathSmall_File.cnc Start Halt Quick Stop Abort Ack M Function Ack All M Functions Enable Step Mode Next Step EnablePathCorrection NoAbortByEMCYErr Default Path for External CNCs PLC : //ffx/codesys/_cnc/ SoftPLC : C:_cnc	<pre>g_stIn.sCNCFilePath := '/specific folder/CNC_PathSmall_File.cnc'; or g_stIn.sCNCFilePath := '/_cnc/CNC_PathSmall_File.cnc';</pre>
2	The selected CNC can be checked as a name in text format. CNC Prg Name: //ffx/codesys/_cnc/CNC_PathSmall_File.cnc	<pre>g_stOut.stActiveCncSource.sCNCName = '//ffx/codesys/_cnc/CNC_PathSmall_File.cnc';</pre>

1.3 xNoAbortByEMCYErr function

This input is just used now for one specific situation: You like to stop an ongoing CNC and activate the safety functionality of a device to check something in the machine. Afterwards you like to proceed from that point.

To realize this, you have to follow a certain order step by step.

1. Activate the NoAbortByEMCYErr Bit

Festo_Positioning_Basic_3

Operation Mode
 No Mode
 Configuration Mode
 Homing Mode
 Jogging Mode
 Stepping Mode
 PTP Mode
Internal CNC Mode
 External CNC Mode

UCS
 X 0.000 1.000 0.000
 Y 0.000 0.000 1.000
 Z 0.000 0.000 0.000
 WPCS
 X 0.000 1.000 -1.000
 Y 0.000 1.000 1.000
 Z 0.000 0.000 0.000
 M-Function 0 K-Param 0.000
 H-Function 0 L-Param 0.000
 G-Code Line -1 M Active

Enable System
 Reset System
 Ack Error

Select Coordinate System
 MCS
 UCS
 WPCS

Override 100

Internal CNC No 2 CNC_Example_1

Start
 Halt
 Quick Stop
 Abort
 Ack M Function
 Ack All M Functions
 Enable Step Mode
 Next Step
 EnablePathCorrection
NoAbortByEMCYErr

GVL_Motion_INOUT x		
Device_1.Application.GVL_Motion_INOUT		
Expression	Type	Value
vOrigin1	SMC_VECTOR3D	
vPointOnX1	SMC_Vector3D	
vPointOnY1	SMC_Vector3D	
vOrigin2	SMC_VECTOR3D	
vPointOnX2	SMC_Vector3D	
vPointOnY2	SMC_Vector3D	
garSingleVar	ARRAY [0..3] OF SM3_CNC.SMC_SingleVar	
g_stIn	FPosB.FPB_INPUT_DATA	
eMOP	OP_MODE	eInternalCncMode
stCW	CONTROL_WORD	
xEnable	BOOL	FALSE
xReset	BOOL	FALSE
xMovePositive	BOOL	FALSE
xMoveNegative	BOOL	FALSE
xStart	BOOL	FALSE
xHalt	BOOL	FALSE
xQuickStop	BOOL	FALSE
xAbsort	BOOL	FALSE
xEnablePathCorrection	BOOL	FALSE
xAckM	BOOL	FALSE
xAckAllM	BOOL	FALSE
xEnableStepMode	BOOL	FALSE
xNextStep	BOOL	FALSE
xAckError	BOOL	FALSE
xSetOpMode	BOOL	FALSE
xNoAbortByEMCYErr	BOOL	TRUE
xReadDriveError	BOOL	FALSE
eSetCS	COORDINATE_SYSTEM	eMCS

2. While your CNC is running, you like to stop and to check something.
Activate Halt

Festo_Positioning_Basic_3

Operation Mode				UCS		
				Origin	Pos On X	Pos On Y
No Mode		X	0.000	1.000	0.000	
Configuration Mode		Y	0.000	0.000	1.000	
Homing Mode		Z	0.000	0.000	0.000	
Jogging Mode		WPCS				
Stepping Mode		X	0.000	1.000	-1.000	
PTP Mode		Y	0.000	1.000	1.000	
Internal CNC Mode		Z	0.000	0.000	0.000	
External CNC Mode		M-Function	0	K-Param	0.000	
		H-Function	0	L-Param	0.000	
		G-Code Line	70	M Active	☐	

Enable System
 Reset System
 Ack Error

Select Coordinate System

MCS
UCS
WPCS

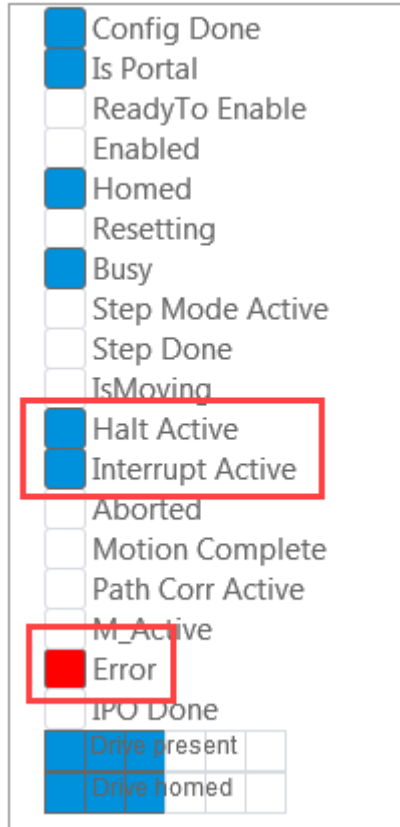
Override 100

Internal CNC No 2 CNC_Example_1

Start
 Halt
 Quick Stop
 Abort
 Ack M Function
 Ack All M Functions
 Enable Step Mode
 Next Step
 EnablePathCorrection
 NoAbortByEMCYErr

GVL_Motion_INOUT x		
Device_1.Application.GVL_Motion_INOUT		
Expression	Type	Value
vOrigin1	SMC_VECTOR3D	
vPointOnX1	SMC_Vector3D	
vPointOnY1	SMC_Vector3D	
vOrigin2	SMC_VECTOR3D	
vPointOnX2	SMC_Vector3D	
vPointOnY2	SMC_Vector3D	
garSingleVar	ARRAY [0..3] OF SM3_CNC.SMC_SingleVar	
g_stIn	FPosB.FPB_INPUT_DATA	
eMOP	OP_MODE	eInternalCncMode
stCW	CONTROL_WORD	
xEnable	BOOL	TRUE
xReset	BOOL	FALSE
xMovePositive	BOOL	FALSE
xMoveNegative	BOOL	FALSE
xStart	BOOL	TRUE
xHalt	BOOL	TRUE
xQuickStop	BOOL	FALSE
xAbort	BOOL	FALSE
xEnablePathCorrection	BOOL	FALSE
xAckM	BOOL	FALSE
xAckAllM	BOOL	FALSE
xEnableStepMode	BOOL	FALSE
xNextStep	BOOL	FALSE
xAckError	BOOL	FALSE
xSetOpMode	BOOL	FALSE
xNoAbortByEMCYErr	BOOL	TRUE
xReadDriveError	BOOL	FALSE

3. Release the STO. You will get an error, while Halt and Interrupt are active



GVL_Motion_INOUT x		
CPX_CEC.Application.GVL_Motion_INOUT		
Expression	Type	Value
vOrigin1	SMC_VECTOR3D	
vPointOnX1	SMC_Vector3D	
vPointOnY1	SMC_Vector3D	
vOrigin2	SMC_VECTOR3D	
vPointOnX2	SMC_Vector3D	
vPointOnY2	SMC_Vector3D	
garSingleVar	ARRAY [0..3] OF SM3_CNC.SMC_SingleVar	
g_stIn	FPosB.FPB_INPUT_DATA	
g_stOut	FPosB.FPB_OUTPUT_DATA	
stSW	STATUS_WORD	
xEnabled	BOOL	FALSE
xResetting	BOOL	FALSE
xIsMoving	BOOL	FALSE
xPathCorrActive	BOOL	FALSE
xBusy	BOOL	TRUE
xHaltActive	BOOL	TRUE
xAborted	BOOL	FALSE
xHomed	BOOL	TRUE
xReadyToEnable	BOOL	FALSE
xError	BOOL	TRUE
xMotionComplete	BOOL	FALSE
xStepModeActive	BOOL	FALSE
xStepDone	BOOL	FALSE
xConfigDone	BOOL	TRUE
xM_Active	BOOL	FALSE
axMotorHomed	ARRAY [1..6] OF BOOL	
xInterruptActive	BOOL	TRUE

4. Close the STO circuit again and quit the error(s) until there is no error anymore and the system is enabled again.

Festo_Positioning_Basic_3

Operation Mode

- No Mode
- Configuration Mode
- Homing Mode
- Jogging Mode
- Stepping Mode
- PTP Mode
- Internal CNC Mode
- External CNC Mode

Buttons: Enable System, Reset System, Ack Error

Select Coordinate System

- MCS
- UCS
- WPCS

Override: 100

Internal CNC No: 2 **CNC_Example_1**

Buttons: Start, Halt, Quick Stop, Abort, Ack M Function, Ack All M Functions, Enable Step Mode, Next Step, EnablePathCorrection, NoAbortByEMCYErr

UCS

	Origin	Pos On X	Pos On Y
X	0.000	1.000	0.000
Y	0.000	0.000	1.000
Z	0.000	0.000	0.000

WPCS

	Origin	Pos On X	Pos On Y
X	0.000	1.000	-1.000
Y	0.000	1.000	1.000
Z	0.000	0.000	0.000

M-Function: 0 **K-Param:** 0.000
H-Function: 0 **L-Param:** 0.000
G-Code Line: 70 **M Active:** ☐

Status: Config Done, Is Portal, ReadyTo Enable, Enabled, Homed, Resetting, Busy, Step Mode Active, Step Done, IsMoving, Halt Active, Interrupt Active, Aborted, Motion Complete, Path Corr Active, M Active, Error, IPO Done, Error (highlighted), Error (highlighted), Error (highlighted)

MCS | UCS | WPCS

	MCS	UCS	WPCS
X	50.000	50.000	70.711
Y	50.000	50.000	0.000
Z	27.349	27.349	27.349
U	10.000	10.000	10.000
V	0.000	0.000	0.000
W	0.000	0.000	0.000
CS Quality	1.000	1.000	
Act. Velocity			0.000
Act. Override			100

CNC Prg Name:

GVL_Motion_INOUT x

CPX_CECApplication.GVL_Motion_INOUT

Expression	Type	Value
vOrigin1	SMC_VECTOR3D	
vPointOnX1	SMC_Vector3D	
vPointOnY1	SMC_Vector3D	
vOrigin2	SMC_VECTOR3D	
vPointOnX2	SMC_Vector3D	
vPointOnY2	SMC_Vector3D	
garSingleVar	ARRAY [0..3] OF SM3_CNC.SMC_SingleVar	
g_stIn	FPosB.FPB_INPUT_DATA	
eMOP	OP_MODE	eInternalCncMode
stCW	CONTROL_WORD	
xEnable	BOOL	TRUE
xReset	BOOL	FALSE
xMovePositive	BOOL	FALSE
xMoveNegative	BOOL	FALSE
xStart	BOOL	TRUE
xHalt	BOOL	TRUE
xQuickStop	BOOL	FALSE
xAbort	BOOL	FALSE
xEnablePathCorrection	BOOL	FALSE
xAckM	BOOL	FALSE
xAckAllM	BOOL	FALSE
xEnableStepMode	BOOL	FALSE
xNextStep	BOOL	FALSE
xAckError	BOOL	FALSE
xSetOpMode	BOOL	FALSE
xAvoidAbortByError	BOOL	TRUE
xReadDriveError	BOOL	FALSE

GVL_Motion_INOUT x

CPX_CECApplication.GVL_Motion_INOUT

Expression	Type	Value
vOrigin1	SMC_VECTOR3D	
vPointOnX1	SMC_Vector3D	
vPointOnY1	SMC_Vector3D	
vOrigin2	SMC_VECTOR3D	
vPointOnX2	SMC_Vector3D	
vPointOnY2	SMC_Vector3D	
garSingleVar	ARRAY [0..3] OF SM3_CNC.SMC_SingleVar	
g_stIn	FPosB.FPB_INPUT_DATA	
g_stOut	FPosB.FPB_OUTPUT_DATA	
stSW	STATUS_WORD	
xEnabled	BOOL	TRUE
xResetting	BOOL	FALSE
xIsMoving	BOOL	FALSE
xPathCorrActive	BOOL	FALSE
xBusy	BOOL	TRUE
xHaltActive	BOOL	TRUE
xAborted	BOOL	FALSE
xHomed	BOOL	TRUE
xReadyToEnable	BOOL	TRUE
xError	BOOL	FALSE
xMotionComplete	BOOL	FALSE
xStepModeActive	BOOL	FALSE
xStepDone	BOOL	FALSE
xConfigDone	BOOL	TRUE
xM_Active	BOOL	FALSE
anxMotorHomed	ARRAY [1..6] OF BOOL	TRUE
xInterruptActive	BOOL	TRUE

5. Now you can proceed with your CNC by deactivating the halt bit.

Festo_Positioning_Basic_3

Operation Mode No Mode Configuration Mode Homing Mode Jogging Mode Stepping Mode PTP Mode Internal CNC Mode External CNC Mode			UCS <table border="1"> <thead> <tr> <th></th> <th>Origin</th> <th>Pos On X</th> <th>Pos On Y</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>0.000</td> <td>1.000</td> <td>0.000</td> </tr> <tr> <td>Y</td> <td>0.000</td> <td>0.000</td> <td>1.000</td> </tr> <tr> <td>Z</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> </tr> </tbody> </table>				Origin	Pos On X	Pos On Y	X	0.000	1.000	0.000	Y	0.000	0.000	1.000	Z	0.000	0.000	0.000
	Origin		Pos On X	Pos On Y																	
X	0.000	1.000	0.000																		
Y	0.000	0.000	1.000																		
Z	0.000	0.000	0.000																		
Enable System Reset System Ack Error		WPCS <table border="1"> <thead> <tr> <th></th> <th>Origin</th> <th>Pos On X</th> <th>Pos On Y</th> </tr> </thead> <tbody> <tr> <td>X</td> <td>0.000</td> <td>1.000</td> <td>-1.000</td> </tr> <tr> <td>Y</td> <td>0.000</td> <td>1.000</td> <td>1.000</td> </tr> <tr> <td>Z</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> </tr> </tbody> </table>				Origin	Pos On X	Pos On Y	X	0.000	1.000	-1.000	Y	0.000	1.000	1.000	Z	0.000	0.000	0.000	
	Origin	Pos On X	Pos On Y																		
X	0.000	1.000	-1.000																		
Y	0.000	1.000	1.000																		
Z	0.000	0.000	0.000																		
Select Coordinate System MCS UCS WPCS		M-Function 0 K-Param 0.000 H-Function 0 L-Param 0.000 G-Code Line -1 M Active ☐																			
Override 100		Internal CNC No 5 Test Start Halt Quick Stop Abort Ack M Function Ack All M Functions Enable Step Mode Next Step EnablePathCorrection AvoidAbortByError																			

GVL_Motion_INOUT x		
CPX_CEC.Application.GVL_Motion_INOUT		
Expression	Type	Value
vOrigin1	SMC_VECTOR3D	
vPointOnX1	SMC_Vector3D	
vPointOnY1	SMC_Vector3D	
vOrigin2	SMC_VECTOR3D	
vPointOnX2	SMC_Vector3D	
vPointOnY2	SMC_Vector3D	
garSingleVar	ARRAY [0..3] OF SM3_CNC.SMC_SingleVar	
g_stin	FPosB.FPB_INPUT_DATA	
eMOP	OP_MODE	eInternalCncMode
stCW	CONTROL_WORD	
xEnable	BOOL	TRUE
xReset	BOOL	FALSE
xMovePositive	BOOL	FALSE
xMoveNegative	BOOL	FALSE
xStart	BOOL	TRUE
xHalt	BOOL	FALSE
xQuickStop	BOOL	FALSE
xAbort	BOOL	FALSE
xEnablePathCorrection	BOOL	FALSE
xAckM	BOOL	FALSE
xAckAllM	BOOL	FALSE
xEnableStepMode	BOOL	FALSE
xNextStep	BOOL	FALSE
xAckError	BOOL	FALSE
xSetOpMode	BOOL	FALSE
xAvoidAbortByError	BOOL	TRUE
xReadDriveError	BOOL	FALSE