

Synchronizing Several Slave Axes at Standstill with Cam Synchronization

TIA Portal V14 SP1 / V15.1, SIMATIC S7-1500T

<https://support.industry.siemens.com/cs/ww/en/view/109745764>

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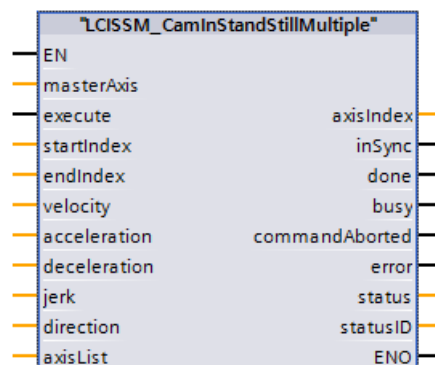
1 Introduction

This application example shows how to couple the master axis and several slave axes in standstill via the setpoints using the "MC_CamIn" instruction during cam synchronism at standstill. Using the "LCISSM_CamInStandStillMultiple" function block (FB), you can move several slave axes to the respective synchronous position and then couple them.

1.1 Overview

This application example describes how to synchronize several slave axes to a master axis with a S7-1500T. The individual steps of the coupling via dynamic response parameters are programmed in the "LCISSM_CamInStandStillMultiple" function block (FB).

Figure 1-1: FB "LCISSM_CamInStandStillMultiple"



1.2 Mode of operation

The "LCISSM_CamInStandStillMultiple" FB calculates the setpoint positions of several slave axes and moves them to the calculated positions. Then, the slave axes are coupled to the master axis using the "MC_CamIn" instruction.

In "LCISSM_CamInStandStillMultiple" FB, the following work steps are programmed:

1. Reduce the decimal places of the input parameters "masterOffset", "slaveOffset", "masterScaling" and "slaveScaling" to three decimal places.
2. Check that all axes are in position-controlled operation and that the slave axes are ready. To do this, the state ("StatusWord") of the slave axes is read out using the "LCISSM_GetStatusWordSyncAxis" function.
3. Position the master axis to the current absolute setpoint position. (only in project TIA V14 SP1)
4. Determine the subsequent position of the slave axes for the master position in the master/slave coordinate system as follows:
 - The respective conductances are calculated from the current master position in relation to the cams used.
 - The "MC_GetCamFollowingValue" motion control instruction is used to read out the corresponding subsequent value for the respective conductance from the cams used.
 - The positions of the slave axes in the master/slave coordinate system are calculated from the subsequent values read.

5. Move the slave axes to the calculated setpoint positions with the "LCISSM_MoveAbsSyncAxis" FB.
6. Calculate the parameters for each slave axis for the "MC_CamIn" motion control instruction. To do this, the start value of the cam ("StartLeadingValue") is read out using the "LCISSM_GetCamStartLeadingValue" function.
7. Synchronize the slave axes with the "MC_CamIn" motion control instruction.

Restrictions

The following restrictions apply to the "CamInStandStill" FB:

- The master axis must already be in the synchronous position.
- The setpoint position of the master axis has to be located in the area of the cam.
- Only three decimal places of the input parameters "masterOffset", "slaveOffset", "masterScaling" and "slaveScaling" will be taken into account.
- Position-controlled operation must be enabled on all axes.
Non-position-controlled operation is indicated by <TO>.StatusWord.X28 (NonPositionControlled) = TRUE.

1.3 Components used

This application example was created with the following hardware and software components:

Table 1-1

Component	Number	Article number	Note
SIMATIC Field PG M5	1	6ES7717-.....-0...	Alternatively, a different computer with TIA Portal can also be used.
STEP 7 Professional V14 SP1	1	6ES7822-1..04-..	-
S7-1500T (firmware V2.1)	1	6ES7 515-2TM01-0AB0	-
STEP 7 Professional V15.1	1	6ES7822-1..05-..	-
S7-1500T (firmware V2.5)	1	6ES7 515-2TM01-0AB0	-

This application example consists of the following components:

Table 1-2

Component	File name	Note
Documentation	109745764_CISSMultiple_DOC_v11_en.docx	-
STEP 7 project TIA V14 SP1	109745764_CISSMultiple_TIAV14SP1_PROJ_v10.zip	Test project and library
STEP 7 project TIA V15.1	109745764_CISSMultiple_TIAV15.1_PROJ_v11.zip	Test project and library

2 Engineering

2.1 Interface description

The FB "LCISSM_CamInStandStillMultiple" of the application example takes over the complete synchronization of several slave axes. The FB has the following interface:

Figure 2-1: Interfaces of FB "LCISSM_CamInStandStillMultiple"

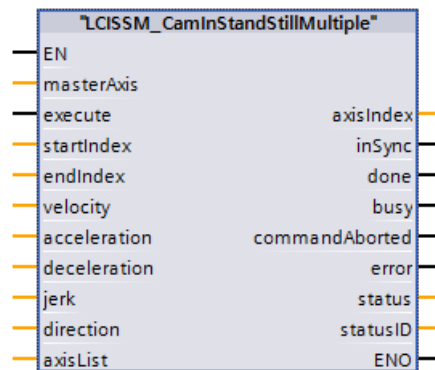


Table 2-1: Parameters of the block interface

Parameter	Data type	Start value	Description
Input parameters			
masterAxis	TO_PositioningAxis	-	Technology object of the master axis
execute	BOOL	False	Synchronization starts with a positive edge at this input.
startIndex	INT	-	Start index axis list
endIndex	INT	-	End index axis list
velocity	LREAL	-1.0	Speed of master axis
acceleration	LREAL	-1.0	Acceleration of master axis
deceleration	LREAL	-1.0	Deceleration of master axis
jerk	LREAL	-1.0	Jerk master axis
direction	DINT	1	Direction of movement of master axis
Input/output parameters			
axisList	Array [1..63] of LCISSM_typeAxisListData	-	Axis list with parameters of slave axes
Output parameters			
axisIndex	INT	-	Index of slave axis in the event of an error
inSync	BOOL	-	Synchronism achieved. The slave axes are synchronized.
done	BOOL	-	Synchronization completed
busy	BOOL	-	The FB is busy processing.

Parameter	Data type	Start value	Description
commandAborted	BOOL	-	The motion control instructions used in the FB, and consequently the FB itself, have been replaced by a motion control instruction outside the FB.
error	BOOL	-	An error occurred while processing the FB. Further information on localizing the cause of the error is available via the "status" and "statusID" outputs.
status	WORD	-	Error code of the FB or of a motion control instruction that has been called internally. In addition, it is possible to locate the error within the FB via the "statusID" output.
statusID	WORD	-	Specification of an additional error code for localizing the error cause within the FB

axisList [LCISSM_typeAxisListData]

The following table describes the parameters of a slave axis for synchronizing with the master axis.

Table 2-2: Parameter data of a slave axis

Parameter	Data type	Start value	Description
enableSync	BOOL	-	Enable synchronization of slave axis.
axisNr	DB_ANY	-	DB number of the "TO_SynchronousAxis" slave axis
camNr	DB_ANY	-	DB number of the "TO_SynchronousAxis" cam
masterOffset	LREAL	0.0	Offset of the conductances of the cam to the position range of the master/slave coordinate system.
slaveOffset	LREAL	0.0	Offset of the conductances of the cam to the position range of the master/slave coordinate system
masterScaling	LREAL	1.0	Scaling the conductance of the cam disk
slaveScaling	LREAL	1.0	Scaling the conductance of the cam.
syncProfile Reference	DINT	2	Synchronization profile 0: Synchronization via dynamic parameter 1: Synchronization via conductance path 2: Set directly synchronously

Parameter	Data type	Start value	Description
masterStart Distance	LREAL	0.0	Conductance path (path of the master axis during synchronization) (for "syncProfileReference" = 1)
applicationMode	DINT	2	Use of cam 0: once/non-cyclic 1: cyclic 2: cyclically appending
syncDirection	DINT	3	Synchronization direction 1: Positive direction 2: Negative direction 3: Shortest path
velocity	LREAL	-1.0	Velocity for move absolute.
acceleration	LREAL	-1.0	Acceleration for move absolute.
deceleration	LREAL	-1.0	Deceleration for move absolute.
jerk	LREAL	-1.0	Jerk for move absolute.
direction	DINT	3	Direction of movement for move absolute.

2.2 Integration into the user project

To be able to integrate the function into your STEP 7 project, the following technology objects must already have been created, configured and interconnected in the S7-1500T:

- Master axis (TO_PositioningAxis)
- One or more slave axis/es (TO_SynchronousAxis)
- One or more cam(s) (TO_Cam)

2.2.1 Integrating FB "LCCISM_CamInStandStillMultiple"

To transfer the function into your user program, proceed as follows:

1. Open the "LCCISM" library in the TIA Portal.
2. Move the "LCCISM_CamInStandStillMultiple" function block from the library into the "Program blocks" folder using drag-and-drop.
The following objects are automatically included in the project.
 - LCCISM_MoveAbsSyncAxis
 - LCCISM_GetStatusWordSyncAxis
 - LCCISM_GetCamStartLeadingValue
 - LCCISM_typeAxisListData

2.2.2 Creating axis list and entering parameters

To create an axis list, please proceed as follows:

1. Create an axis list by defining a tag of the data type "Array[1..63] of LCCISM_typeAxisListData".

2. Enter the parameters of your slave axes (see [Table 2-2](#)) into the axis list.
The following figure shows the parameters of the first slave axis.

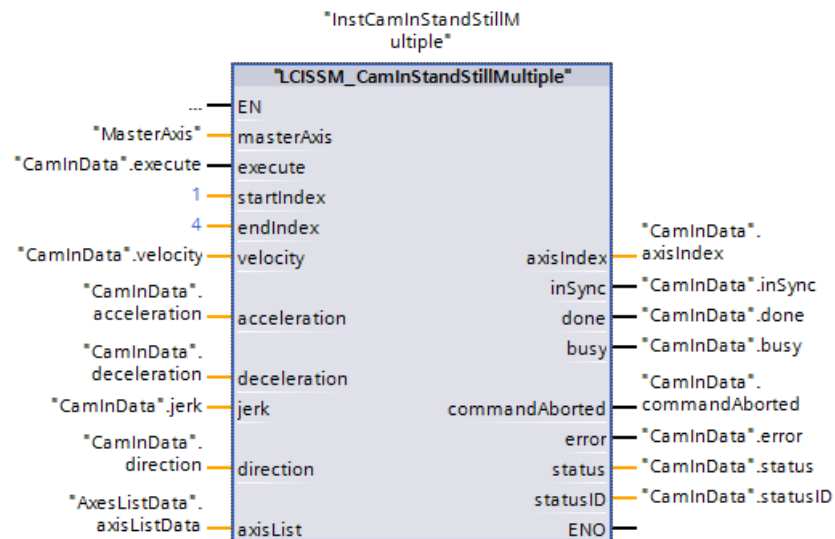
Figure 2-2: Axis list

AxesListData			
	Name	Data type	Start value
1	Static		
2	axisListData	Array[1..63] of "LCISSM_typeAxisListData"	
3	axisListData[1]	"LCISSM_typeAxisListData"	
4	enableSync	Bool	true
5	axisNr	DB_ANY	101
6	camNr	DB_ANY	201
7	masterOffset	LReal	0.0
8	slaveOffset	LReal	0.0
9	masterScaling	LReal	1.0
10	slaveScaling	LReal	1.0
11	syncProfileReference	DInt	2
12	masterStartDistance	LReal	0.0
13	applicationMode	DInt	2
14	syncDirection	DInt	3
15	velocity	LReal	-1.0
16	acceleration	LReal	-1.0
17	deceleration	LReal	-1.0
18	jerk	LReal	-1.0
19	direction	Int	3

2.2.3 Calling FB "LCISSM_CamInStandStillMultiple"

Call the "LCISSM_CamInStandStillMultiple" FB in a cyclically starting OB or FB in your user program and pass the required parameters to the FB.
Alternatively, you can call the FB in the cyclic interrupt OB (e.g. OB 35).

Figure 2-3: Calling FB "LCISSM_CamInStandStillMultiple"



The two tags "startIndex" and "endIndex" make it possible for you to select a range of the slave axes in the "AxesListData" axis list. In the axis list, you can also use the "enableSync = TRUE" parameter to determine which slave axes in the range are actually to be synchronized.

2.3 Operation

2.3.1 Test program

You can use the "ProjectCamInStandStillMultiple" project to test the functionality of the FB "LCISSM_CamInStandStillMultiple". Enter the values at the interface of the FB via a watch table. Thus, you can test the responses and options of the FB.

You do not need real machine axes for the test program. The program is instantly executable on a S7-1500T. The axes are simulated as virtual axes in the controller.

The "ProjectCamInStandStillMultiple" project uses the function blocks from the application example

"LAxisBasics - Easy control of the "axis" TO in the SIMATIC S7-1500".

<https://support.industry.siemens.com/cs/ww/en/view/109749348>

NOTICE

The test program enables you to familiarize yourself with the principle of operation and the responses of the FB "CamInStandStill".

The test program is not intended for use in real machines and therefore not enabled.

The following technology objects have already been created in the test program:

Table 2-3: Technology objects

Technology object	Function	Note
"MasterAxis"	Positioning axis	Master axis
"SlaveAxis"	Synchronous axis	Slave axis 1
"SlaveAxis2"	Synchronous axis	Slave axis 2
"SlaveAxis3"	Synchronous axis	Slave axis 3
"SlaveAxis4"	Synchronous axis	Slave axis 4
"Cam1"	Cam	Cam 1
"Cam2"	Cam	Cam 2


2.3.2 Operating the test program with the watch table

Watch table

The following figure shows the watch table via which you can operate the test program.

Figure 2-4: Watch table of the test program

... PLC_1 [CPU 1515T-2 PN] ▶ Watch and force tables ▶ CamInStandStillMultiple

		Name	Address	Display format	Monitor value	Modify value
1		// Common axes functions				
2		"AxesCtrl".powerAll		Bool	<input checked="" type="checkbox"/> TRUE	TRUE
3		"AxesCtrl".resetAll		Bool	<input type="checkbox"/> FALSE	FALSE
4		"AxesCtrl".homeAll		Bool	<input type="checkbox"/> FALSE	FALSE
5		"AxesCtrl".interpolateAll		Bool	<input type="checkbox"/> FALSE	FALSE
6		"AxesCtrl".homePosMaster		Floating-point ...	66.6	66.6
7		"AxesCtrl".homePosSlave1		Floating-point ...	77.7	77.7
8		"AxesCtrl".homePosSlave2		Floating-point ...	88.8	88.8
9		"AxesCtrl".homePosSlave3		Floating-point ...	99.9	99.9
10		"AxesCtrl".homePosSlave4		Floating-point ...	55.5	55.5
11		// Start CamIn Multiple				
12		"CamInData".execute		Bool	<input checked="" type="checkbox"/> TRUE	TRUE
13		// Status				
14		"CamInData".inSync		Bool	<input checked="" type="checkbox"/> TRUE	
15		"CamInData".error		Bool	<input type="checkbox"/> FALSE	
16		"CamInData".status		Hex	16#0000	
17		"CamInData".statusID		DEC	0	
18		"CamInData".axisIndex		DEC+/-	0	
19		"InstCamInStandStillMultiple".done		Bool	<input checked="" type="checkbox"/> TRUE	
20		"InstCamInStandStillMultiple".statSequencer		DEC+/-	0	
21		// Actual Positions				
22		"MasterAxis".ActualPosition		Floating-point ...	66.6	
23		"SlaveAxis1".ActualPosition		Floating-point ...	12.251	
24		"SlaveAxis2".ActualPosition		Floating-point ...	12.251	
25		"SlaveAxis3".ActualPosition		Floating-point ...	347.747	
26		"SlaveAxis4".ActualPosition		Floating-point ...	347.748	

You can use the watch table to execute the following functions of the test program:

- Enabling the axes
 - Acknowledging errors
 - Setting axis positions to specified positions.
- Thus, you can define various starting positions and monitor the behavior of the FB for the specified axis constellation.

Testing "LCISSM_CamInStandStillMultiple" FB

The watch table and the test program allow you to test the "LCISSM_CamInStandStillMultiple" FB in the various initial positions.

To do this, proceed as follows:

1. Load the test program into the controller and set the controller to RUN.
2. Open the "CamInStandStillMultiple" watch table and enable "Monitor all".
3. In the "Modify value" column, specify the positions of the axes as well as the input parameters.

Example see [Figure 2-4](#)

4. Click the "Modify once only and immediately" button to apply the values.
5. Switch on the axes by setting the "AxesCtrl".powerAll tag to "1".
6. Reference the axes by setting the "AxesCtrl".homeAll tag to "1". Then set "AxesCtrl".homeAll back to "0".
7. Interpolate the cams by setting the "AxesCtrl".interpolateAll tag to "1". Then, set "AxesCtrl".interpolateAll back to "0".
8. Start synchronizing (coupling) by setting the "CamInData".execute tag to "1". Synchronizing is started and the slave axes are moved to the respective synchronous position. The process is complete when the "CamInData".inSync tag assumes the value "TRUE".
If an error occurs, this error will be signaled by the "CamInData".error tag. Error handling is described in chapter [2.4](#).
9. Set "CamInData".execute back to "0".
10. Repeat steps 3 to 9 with different values for the input parameters.

Note

In case of errors occurring, set the "AxesCtrl".reset tag to "1". Then, set "AxesCtrl".resetAll back to "0".

Note

You can monitor the current positions of the axes via the tags "MasterAxis".ActualPosition and "SlaveAxisX".ActualPosition.

Note

You can uncouple the slave axes from the master axis again by setting the "AxesCtrl".powerAll tag to "0".

2.4 Error handling

2.4.1 Output of error messages

The outputs "error", "status" and "statusID" signal an error occurring within the FB "LCISSM_CamInStandStillMultiple". In order to be able to take suitable measures if necessary, the outputs pass on the information of the events that have occurred to the user program.

2.4.2 Error concept

The output of error messages is based on the following concept:

- **"axisIndex" output:**
If an error occurs, the index of the respective slave axis is output at the "axisIndex" output.
- **"error" output:**
If the "error" output is set, the occurred event is an error. The error cause is output at the "status" and "statusID" outputs.
- **"status" output:**
The "status" output outputs the error code. The following error codes are possible:
 - **Error at a technology function:**
If an error occurs while using a technology function within the FB, the error code of the technology function (ErrorID) is passed on directly to the "status" output of the FB "LCISSM_CamInStandStillMultiple".
The error codes of the technology functions and their remedy are described in the TIA Portal V14 SP1 online help.
 - **Error in FB "LCISSM_CamInStandStillMultiple":**
If an error occurs in the FB "LCISSM_CamInStandStillMultiple" which was not caused by the use of a technology function, the internal error code will be output.
- **"statusID" output:**
The "statusID" output outputs the associated error source of the error code at output "status". With this error code, you can localize the cause of the error.

The following table describes the possible error code at the "status" output:

Table 2-4: Error code at the "status" output

Error code	Description
16#0000	No error
16#80xx	Error (ErrorID) of the motion control instructions
16#8200	Internal error: Error during plausibility check of the block parameters
16#8201	Internal error: Timeout during cam synchronization
16#8202	Internal error: Master axis is not in position-controlled operation.
16#8203	Internal error: One or more slave axes are not in position-controlled operation or not ready.
16#8203	Internal error: No slave axis has been enabled for synchronization.

The following table describes the error sources for "statusID" output:

Table 2-5: Error source at the "statusID" output

statusID	Meaning	Note
0	No error	-
1	Internal error of FB	-
2	Error when moving the "MasterAxis"	"MC_MoveAbsolute"
3	Error when reading the subsequent values from the cam(s)	"MC_GetCamFollowingValue"
4	Error when moving the "SlaveAxis" slave axes.	"LCISSM_MoveAbsSyncAxis" or "MC_MoveAbsolute"
5	Error during the cam coupling of the axis	"MC_CamIn"

3 Appendix

3.1 Service and Support

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<https://support.industry.siemens.com/cs/ww/en/sc/2067>

3.2 Links and literature

Table 3-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the entry page of the application example https://support.industry.siemens.com/cs/ww/en/view/109745764
\3\	"LAxisBasics - Easy control of the "axis" TO in the SIMATIC S7-1500". https://support.industry.siemens.com/cs/ww/en/view/109749348
\4\	STEP 7 Professional V14.0 System Manual https://support.industry.siemens.com/cs/ww/en/view/109742272
\5\	FAQ: Camming with "MC_CamIn" in the S7-1500T https://support.industry.siemens.com/cs/ww/en/view/109740188
\6\	SIMATIC STEP 7 Basic/Professional V15.1 and SIMATIC WinCC V15.1 System Manual https://support.industry.siemens.com/cs/ww/en/view/109755202

3.3 Change documentation

Table 3-2

Version	Date	Modification
V1.0	06/2018	First version
V1.1	04/2019	New version for TIA Portal V15.1 Query "CommandAborted" for MoveMaster and MoveSlave added