**"MC_CamIn":
Direct Synchronous
Setting of a Master
Axis and a Slave Axis**

SIMATIC S7-1500T / TIA Portal V15

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1 "MC_CamIn" motion control instruction

1.1 Functionality

The "MC_CamIn" motion control instruction starts camming between a master axis and a slave axis.

Figure 1-1 "MC_CamIn" motion control function
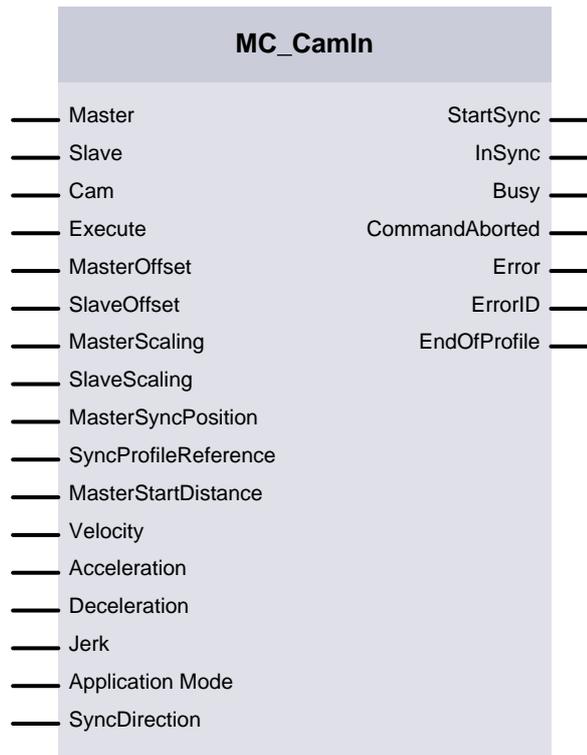
1.2 Parameter settings

1.2.1 Synchronization behavior

The synchronization behavior of the "MC_CamIn" motion control instruction can be influenced using the following input parameters:

- "SyncProfileReference"
  - 0: Synchronization using the specified dynamic response parameters ("Velocity", "Acceleration", "Deceleration" and "Jerk")
  - 1: Synchronization using the specified master value distance ("MasterStartDistance")
  - 2: Direct synchronous setting of the two axes

- "MasterSyncPosition"
  Final position of the synchronization process relative to the cam start. The value must be within the cam's master value range.

Note	The "SyncProfileReference" = 2 setting is particularly suited for synchronizing a slave axis with a master axis when both axes are at a standstill.

1.2.2 Synchronization process

Synchronous operation with "SyncProfileReference" = 0 or 1: leading synchronization with the synchronous position of the master axis. The synchronous position of the master axis starting from which master axis and slave axis move synchronously results from the cam's start position and the "MasterSyncPosition" and "MasterOffset" parameters.

Synchronous operation with "SyncProfileReference" = 2 causes an immediate synchronous setting of the two axes, which is particularly suited for synchronizing a slave axis with a master axis at a standstill.

The "MasterSyncPosition" parameter defines the synchronization position in the cam.

With the "MasterOffset" parameter, you can offset the cam's master values when "SyncProfileReference" = 0 or 1. This defines the cam's position relative to the master value of the synchronous operation function and moves the curve defined in an absolute manner to the required position range of the application.

The "MasterSyncPosition" parameter specifies the synchronization position in the cam relative to the curve's start position within the definition range ("StartLeadingValue"). When the synchronization position is reached, synchronization is complete. If you want to run the entire cam, specify the value 0.0 (default value) in "MasterSyncPosition".

Figure 1-2 Example of a cam's synchronization process
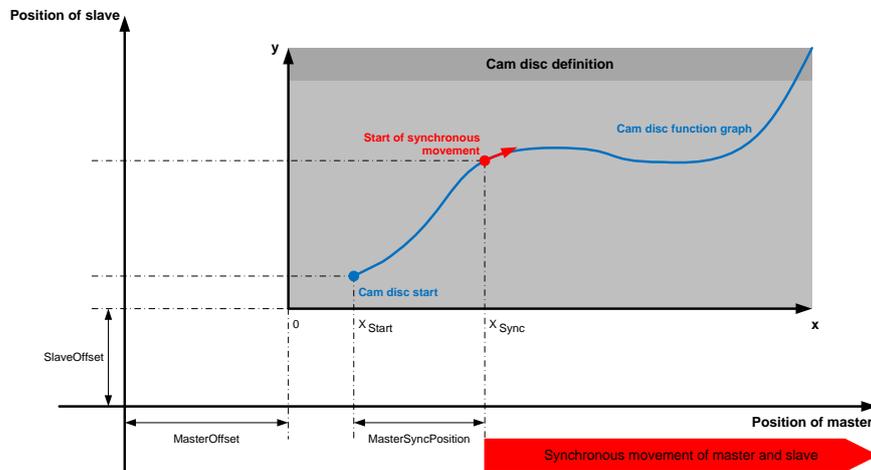
By default, the "MasterSyncPosition" parameter is set to 0.0 so that the synchronization process is complete with the cam start. Modifying the "MasterSyncPosition" value allows you to specifically move the synchronous position within the cam without changing the cam's position.

1.3 Behavior during "Direct synchronous setting"

1.3.1 General behavior

When synchronous operation is started with "SyncProfileReference" = 2, the motion control function performs an immediate synchronization with the specified cam.

In this case, the cam is directly moved to the setpoint position of the master axis (master) specified in "MasterSyncPos". In addition, the cam is moved in the direction of the slave axis in such a way that the slave axis (slave) position of the cam at "MasterSyncPos" matches the setpoint position of the slave axis. For the offset, refer to the "<TO>.StatusSynchronizedMotion.SlaveOffset" variable.

Chapter 2 shows this behavior for different parameter settings of the "MC_CamIn" motion control instruction.

Note	If you want to perform 'direct synchronous setting' for the slave axis at an exactly defined position using the "MC_CamIn" motion control function, you must move the slave axis to the desired position before performing 'direct synchronous setting'.

1.3.2 Use when the master axis is not at a standstill

During a synchronous motion, the dynamic limits of the slave axis set on the technology object are ignored so that the synchronous operation can be maintained as long as possible. The only value that is complied with is the drive's maximum speed ("<TO>.Actor.DriveParameter.MaxSpeed") set on the technology object.

When the "Direct synchronous setting" function is used for a master axis that is not at a standstill and the cam curve is unfavorable, violations of the dynamic limits of the slave axis set in the technology object may occur.

Note	Synchronizing a slave axis with the motions of a master axis complies with the dynamic limits set on the technology object of the slave axis.
	However, when starting a synchronous operation with "SyncProfileReference" = 2 (Direct synchronous setting), this synchronization phase does not take place. The synchronized state is immediately established by moving the cam at the current position of master axis and slave axis. The slave axis immediately moves synchronously; as a result, the dynamic limits set in the technology object of the slave axis are ignored.

Note	Protection of the mechanical system of an axis, in this case especially the slave axis, should always be implemented by reducing the torque in the axis drive and not using the dynamic limit settings in the technology object of the axis.

1.4 Monitoring and diagnostics

When the cam is synchronized, active scaling and active offset of the cam for master axis (master) and slave axis (slave) can be viewed in the slave axis data.

To do this, open, for example, the Slave Axis technology object in the DB editor and view the "StatusSynchronizedMotion" entries in Monitoring mode.

Figure 1-3 Monitoring and diagnosing the cam synchronization

SynchronousAxis

		Name	Data type	Start value
1	▶	Base	TO_PositioningAxis	
2		Input		
3		Output		
4		InOut		
5	▼	Static		
6	▼	StatusSynchronizedMotion	TO_Struct_StatusSynchronizedMotion	
7		FunctionState	DInt	0
8		PhaseShift	LReal	0.0
9		ActualMaster	DB_ANY	0
10		ActualCam	DB_ANY	0
11		MasterOffset	LReal	0.0
12		MasterScaling	LReal	0.0
13		SlaveOffset	LReal	0.0
14		SlaveScaling	LReal	0.0
15		StatusWord	DWord	16#0

2 "Direct Synchronous Setting" – Examples

2.1 Cam used in the example

For the following examples, the below cam is defined and used in TIA Portal.

Figure 2-1 Cam used in the examples
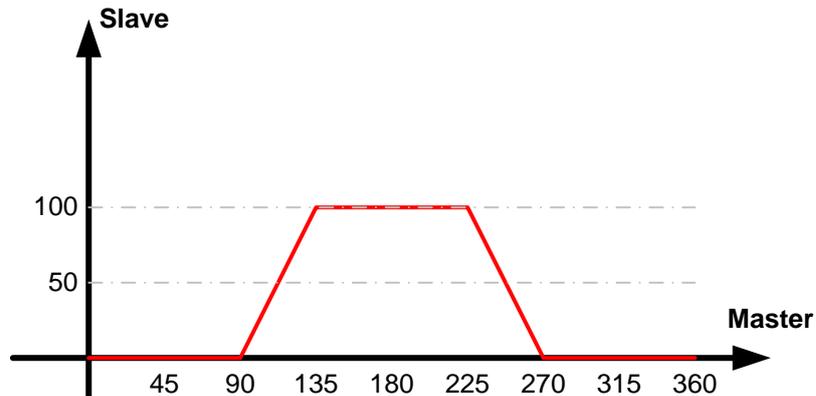
The cam is defined in the following ranges:

- Master axis range (master): 0…360
- Slave axis range (slave): 0...100

2.2 Motion control instruction behavior

Synchronizing the cam using the "MC_CamIn" motion control instruction with direct synchronous setting ("SyncProfileReference" = 2) is shown depending on the following parameters:

- Setpoint position of master axis (MasterPos)
- Current position of slave axis (SlavePos)
- Synchronous position in master axis range of cam (MasterSyncPos).

In order to exactly specify the synchronization positions of master axis and slave axis, Figure 2-2 assumes that master axis and slave axis are at a standstill at the positions shown in the figure.

If at least one of the two axes is in motion, the basic behavior of the synchronized axes, too, corresponds to the travel paths shown below; however, the exact axis positions cannot be specified, but result from the "MC_CamIn" motion control function's time of execution.

Figure 2-2 shows the following six cases as examples:

Table 2-1 Travel paths shown as examples

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
MasterPos (actual position)	0	0	180	180	90	90
SlavePos (actual position)	100	225	300	350	50	200
MasterSyncPos	0	90	90	0	90	112.5

The dot in the curves specifies the "MasterSyncPos" defined relative to the cam and its offset to the current position of master axis (master) and slave axis (slave). The master axis is shown as a modulo axis with a modulo range from 0 to 360.

Figure 2-2 Travel paths depending on the specified parameters
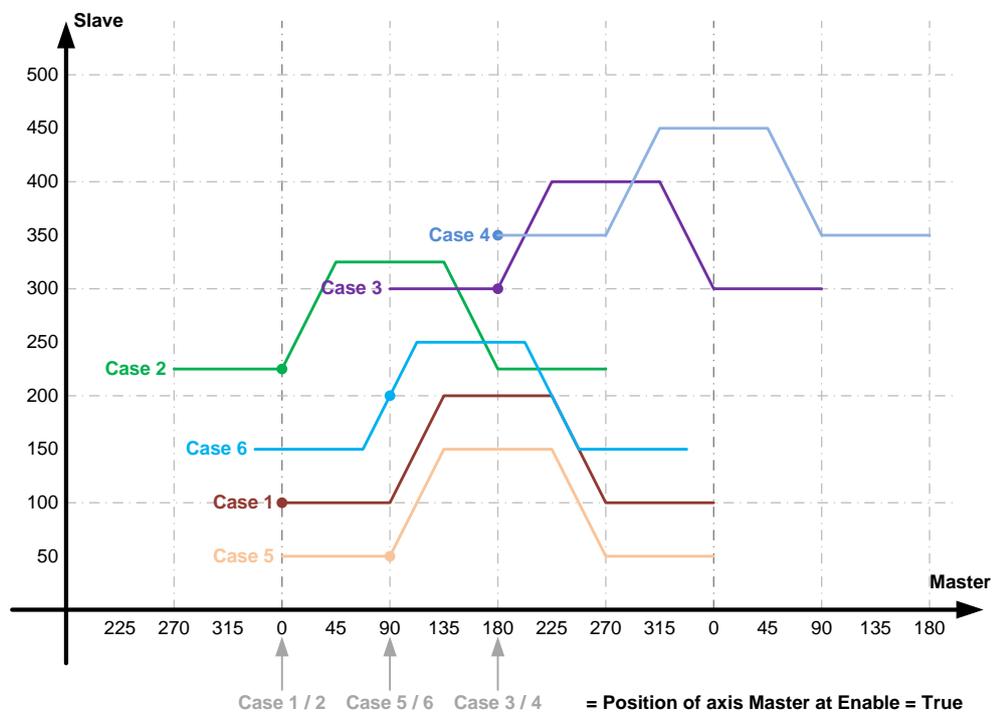
Direct synchronization moves the defined cam such that the "MasterSyncPos" specified in the cam's definition range is laid on the current master axis (master) position and the slave axis (slave) position resulting from the cam.

For the cam's active offset, refer to the variables specified in the table in "<TO>.StatusSynchronizedMotion. …".

Table 2-2 Resulting offsets of the cams

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
MasterOffset	0	-90	90	180	0	-22.5
SlaveOffset	100	225	300	350	50	150

3 Appendix

3.1 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/109758886
\3\	"SIMATIC Technology" topic page https://support.industry.siemens.com/cs/ww/en/view/109751049
\4\	FAQ S7-1500T: Set synchronization in simulation - Retain a synchronized connection when locking the slave axis, for example https://support.industry.siemens.com/cs/ww/en/view/109741930
\5\	FAQ Camming with "MC_CamIn" in the S7-1500T https://support.industry.siemens.com/cs/ww/en/view/109740188
\6\	Application example S7-1500T: Circular Motion on the Basis of Cam Disks "MoveCircle2D" https://support.industry.siemens.com/cs/ww/en/view/109742306
\7\	Application example Technology Objects of the SIMATIC S7-1500(T) https://support.industry.siemens.com/cs/ww/en/view/109743134
\8\	Application example S7-1500T: Synchronizing in Standstill "CamInStandStill" https://support.industry.siemens.com/cs/ww/en/view/109745764
\9\	Application example SIMATIC S7-1500 / S7-1500T: Standard application axis control https://support.industry.siemens.com/cs/ww/en/view/109749348
\10\	Application example SIMATIC/SIMOTION Library LCamHdl – Creation of cam disks at runtime https://support.industry.siemens.com/cs/ww/en/view/105644659

3.2 Change documentation

Table 3-2

Version	Date	Modifications
V1.0	07/09/2018	First version