Motion Axis Position Cam (MAPC)

This information applies to the CompactLogix 5370, ControlLogix 5570, Compact GuardLogix 5370, GuardLogix 5570, Compact GuardLogix 5380, CompactLogix 5380, CompactLogix 5480, ControlLogix 5580, and GuardLogix 5580 controllers. Controller differences are noted where applicable.

The Motion Axis Position Cam (MAPC) instruction provides electronic camming between any two axes according to the specified Cam Profile.

When executed, the specified Slave Axis is synchronized to the designated Master Axis using a position Cam Profile established by the Logix Designer application Cam Profile Editor, or by a previously executed Motion Calculate Cam Profile (MCCP) instruction. The direction of Slave Axis motion relative to the Master Axis is defined by a flexible Direction input parameter. The camming Direction, as applied to the slave, may be explicitly set as the Same or Opposite or set relative to the current camming direction as Reverse or Unchanged.

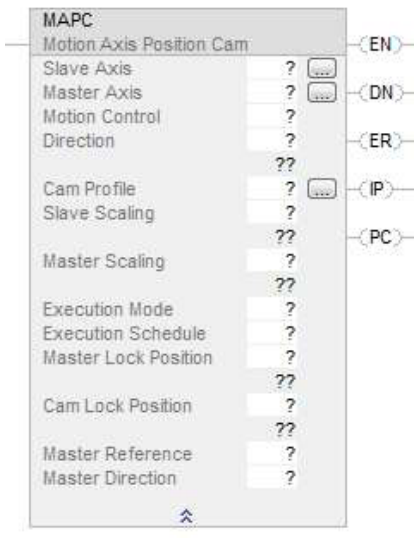
To accurately synchronize the slave axis position to master axis position, an Execution Schedule setting and an associated Master Lock Position can be specified for the master axis. When the master axis travels past the Master Lock Position in the direction specified by the Execution Schedule parameter, the slave axis is locked to the master axis position according to the specified Cam Profile beginning at the Cam Lock Position.

The cam profile can also be configured via the Execution Schedule parameter to execute Immediately or Pending completion of a currently executing position cam profile. The cam profile can also be executed Once or Continuously by specifying the desired Execution Mode. The Master Reference selection allows camming input from the master to be derived from either the Actual or Command position of the Master Axis.

To support applications which require unidirectional motion, a "slip clutch" feature is available, which prevents the slave from "backing-up" when the master axis reverses direction. This feature is controlled by the Master Direction parameter. Master and Slave Scaling functionality can be used to scale slave motion based on a standard cam profile without having to create a new cam table and calculate a new cam profile.

Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

MAPC (SlaveAxis,MasterAxis, MotionControl,Direction, CamProfile,SlaveScaling, MasterScaling,ExecutionMode, ExecutionSchedule, MasterLockPosition, CamLockPosition, MasterReference, MasterDirection);

Operands

Ladder Diagram and Structured Text

Operand	Type **CompactLogix 5370, Compact GuardLogix 5370, Compact GuardLogix 5380, CompactLogix 5380, CompactLogix 5480**	Type **ControlLogix 5570, GuardLogix 5570, ControlLogix 5580, and GuardLogix 5580 controllers**	Format	Description
Slave Axis	AXIS_CIP_DRIVE AXIS_VIRTUAL	AXIS_CIP_DRIVE AXIS_VIRTUAL AXIS_SERVO AXIS_SERVO_DRIVE	Tag	The name of the axis that the cam profile is applied to. Ellipsis launches Axis Properties dialog.
Master Axis	AXIS_CIP_DRIVE AXIS_CONSUMED AXIS_VIRTUAL AXIS_SERVO AXIS_SERVO_DRIVE **Tip:** AXIS_CONSUMED is supported by Compact GuardLogix 5580, CompactLogix 5380, and CompactLogix 5480 controllers only.	AXIS_CIP_DRIVE AXIS_CONSUMED AXIS_VIRTUAL AXIS_SERVO AXIS_SERVO_DRIVE	Tag	The axis that the slave axis follows according to the cam profile. Ellipsis launches Axis Properties dialog. If Pending is selected as the Execution Schedule, then Master Axis is ignored.
Motion Control	MOTION_INSTRUCTION	MOTION_INSTRUCTION	Tag	Structure used to access block status parameters.
Direction	UINT32	UINT32	Immediate or Tag	Relative direction of the slave axis to the master axis: 0 = Same The slave axis position values are in the same sense as the master's. When Same is selected or entered as the Direction for the MAPC instruction, the slave axis position values computed from the cam profile are added to the command position of the slave axis. This is the most common operation. The profile position values are used as entered in the original cam table. Consecutive increasing profile values result in axis motion in the positive direction and vice-versa. 1 = Opposite The slave axis position values are in the opposite sense of the master's. When Opposite is selected or

				entered as the Direction, the slave axis position values computed from the cam profile are subtracted from the command position of the slave axis. Axis motion is in the opposite direction from that implied by the original cam table. Consecutive increasing profile values result in axis motion in the negative direction and vice-versa. Or relative to the current or previous camming direction: 2 = Reverse The current or previous direction of the position cam is reversed on execution. When executed for the first time with Reverse selected, the control defaults the direction to Opposite. 3 = Unchanged This allows other cam parameters to be changed without altering the current or previous camming direction. When executed for the first time with Unchanged selected, the control defaults the direction to Same.
Cam Profile	CAM_PROFILE	CAM_PROFILE	Array	Tag name of the calculated cam profile array used to establish the master/slave position relationship. Only the zero array element ([0]) is allowed for the Cam Profile array. Ellipsis launches Cam Profile Editor.
Slave Scaling	REAL	REAL	Immediate or Tag	Scales the total distance covered by the slave axis through the cam profile.
Master Scaling	REAL	REAL	Immediate or Tag	Scales the total distance covered by the master axis through the cam profile.

Execution Mode	UINT32	UINT32	Immediate	Determines if the cam profile is executed only one time or repeatedly: 0 = Once – cam motion of slave axis starts only when the master axis moves into the range defined by the start and end points of the cam profile. When the master axis moves beyond the defined range cam motion on the slave axis stops and the Process Complete bit is set. Slave motion does not resume if the master axis moves back into the cam profile range. 1 = Continuous – Once started the cam profile is executed indefinitely. This feature is useful in rotary applications where it is necessary that the cam position run continuously in a rotary or reciprocating fashion. 2 = Persistent - When the Master Axis moves beyond the defined range, cam motion on the Slave Axis stops and the PositionCamLockStatus bit is cleared. Slave motion resumes in the opposite direction when the Master Axis reverses and moves back into the cam profile range, at which time the PositionCamLockStatus bit is set.

Execution Schedule	UINT32	UINT32	Immediate	Selects the method used to execute the cam profile. Options are: 0 = Immediate – The slave axis is immediately locked to the master axis and the position camming process begins. 1 = Pending – lets you blend a new position cam execution after an in process position cam is finished. When Pending is selected the following parameters are ignored: Master Axis, Master Lock Position, and Master Reference. 2 = Forward only – the cam profile starts when the master position crosses the Master Lock Position in the forward direction. 3 = Reverse only – the cam profile starts when the master position crosses the Master Lock Position in the reverse direction. 4 = Bi-directional – the cam profile starts when the master position crosses the Master Lock Position in either direction.

Master Lock Position	REAL	REAL	Immediate or Tag	When the Master Offset = 0.0, the Master Lock Position is the Master axis absolute position where the slave axis locks to the master axis. If the Master Offset is X, then the Slave axis will lock to the Master axis at the absolute master position value of Master Lock Position –X. For example: Assume a Master Lock Position = 50 and a Master Offset Move = 10. Also assume that the Master axis move (MAM) and Master offset move (MOM) start at the same time. Then the Slave will lock to the Master at an absolute Master axis position of 40. This in effect shifts the Cam profile 10 units to the left. If Pending is selected as the Execution Schedule value, then Master Lock Position is ignored.
Cam Lock Position	REAL	REAL	Immediate or Tag	This determines the starting location in the cam profile.
Master Reference	UINT32	UINT32	Immediate	Sets the master position reference to either Command position or Actual position. If Pending is selected for the Execution Schedule value, then Master Reference is ignored. 0 = Actual – slave axis motion is generated from the current position of the master axis as measured by its encoder or other feedback device. 1 = Command – slave axis motion is generated from the desired or commanded position of the master axis.

Master Direction	UINT32	UINT32	Immediate	This determines the direction of the master axis that generates slave motion according to the cam profile. Options are: 0 = Bi-directional – slave axis can track the master axis in either direction. 1 = Forward only – slave axis tracks the master axis in the forward direction of the master axis. 2 = Reverse only – slave axis tracks the master axis in the opposite direction of the master axis.

For the array operands, you do not have to include the array index. If you do not include the index, the instruction starts with the first element in the array ([0]).

See Structured Text Syntax for more information on the syntax of expressions within structured text.

For the operands that require you to select from available options, enter your selection as:

This Operand	**Has These Options Which You**	
	Enter as Text	**Or Enter as a Number**
ExecutionMode	once continuous persistent	0 1 2
ExecutionSchedule	immediate pending forwardonly reverseonly bidirectional	0 1 2 3 4
MasterReference	actual command	0 1
MasterDirection	bidirectional forwardonly reverseonly	0 1 2

MOTION_INSTRUCTION Structure

Mnemonic	**Description**
.EN (Enable) Bit 31	It is set when the rung makes a false-to-true transition and remains set until the rung goes false.
.DN (Done) Bit 29	It is set when the axis' position cam has been successfully redefined.

.ER (Error) Bit 28	It is set to indicate that the instruction detected an error, such as if you specified an unconfigured axis.
.IP (In Process) Bit 26	It is set on positive rung transition and cleared if either superseded by another Motion Axis Position Cam command, or terminated by a stop command, merge, shutdown, or servo fault.
.PC (Process Complete) Bit 27	It is cleared on positive rung transition. It is set when the position of the master axis leaves the master position range defined by the currently active cam profile if Execution Mode = Once.

Description

The MAPC instruction executes a position cam profile set up by a previous Motion Calculate Cam Profile (MCCP) instruction or, alternatively, by the Logix Designer application Cam Profile Editor. Position cams, in effect, provide the capability of implementing non-linear electronic gearing relationships between two axes. No maximum velocity, acceleration, or deceleration limits are used. The speed, acceleration, and deceleration of the slave axis are completely determined by the motion of the master axis and the designated cam profile derived from the associated cam table.

The maximum velocity, acceleration, or deceleration limits established during axis configuration do not apply to electronic camming.

The direction of Slave Axis motion relative to the Master Axis is defined by a flexible Direction input parameter. The camming direction, as applied to the slave, may be explicitly set as the Same or Opposite or set relative to the current camming direction as Reverse or Unchanged.

To accurately synchronize the slave axis position to master axis position, an Execution Schedule setting and an associated Master Lock Position can be specified for the master axis. When the master axis travels past the Master Lock Position in the direction specified by the Execution Schedule parameter, the slave axis is locked to the master axis position according to the specified Cam Profile beginning at the Cam Lock Position.

The cam profile can also be configured to execute Immediately or Pending completion of a currently executing position cam profile via the Execution Schedule parameter. The cam profile can be executed:

- once
- continuous
- in a persistent mode

by specifying the desired Execution Mode.

The Master Reference selection allows camming input from the master to be derived from either the Actual or Command position of the Master Axis. To support applications which require unidirectional motion, a slip clutch feature is available which prevents the slave from backing-up when the master axis reverses direction. This feature is controlled by the Master Direction parameter.

Master and Slave Scaling functionality can be used to scale slave motion based on a standard cam profile without having to create a new cam table and calculate a new cam profile.

Camming Direction

Cams can be configured to add or subtract their incremental contribution to the slave axis command position. Control over this behavior is via the Direction parameter.

Camming in the Same Direction

When Same is selected or entered as the Direction for the MAPC instruction, the slave axis position values computed from the cam profile are added to the command position of the slave axis. This is the most common operation, as the profile position values are used just as entered in the original cam table. That is, consecutive increasing profile values result in axis motion in the positive direction and vice-versa.

Camming in the Opposite Direction

When Opposite is selected or entered as the Direction, the slave axis position values computed from the cam profile are subtracted from the command position of the slave axis. Thus, axis motion is in the opposite direction from that implied by the original cam table. That is, consecutive increasing profile values result in axis motion in the negative direction and vice-versa.

Preserving the Current Camming Direction

When Unchanged is selected or entered as the Direction, other position cam parameters may be changed while preserving the current or previous camming direction (same or opposite). This is useful when the current direction is not known or not important. For first time execution of a cam with Unchanged selected, the control defaults the direction to Same.

Reversing the Current Camming Direction

When Reverse is selected the current or previous direction of the position cam is changed from Same to Opposite or from Opposite to Same. For first time execution of a cam with Reverse selected, the control defaults the direction to Opposite.

Specifying the Cam Profile

To execute a MAPC instruction, a calculated Cam Profile data array tag must be specified. Cam Profile array tags may be created by the Logix Designer application tag editor or the MAPC instruction using the built-in Cam Profile Editor, or by executing an Motion Calculate Cam Profile (MCCP) instruction on an existing Cam array.

The data within the Cam Profile array can be modified at compile time using the Cam Profile Editor, or at run-time with the Motion Calculate Cam Profile (MCCP) instruction. In the case of run-time changes, a Cam array must be created in order to use the MCCP instruction. Refer to the MCCP instruction specification for more detail on converting Cam arrays.

All but the status element of this Cam Profile array structure element are hidden from the Logix Designer application tag editor. These elements are of no value to the user. The Status member is used to indicate that the corresponding Cam Profile array element has been calculated. If execution of a camming instruction is attempted with any uncalculated elements in a cam profile, the instruction errors. The type parameter determines the type of interpolation applied between this cam array element and the next cam element, (for example, linear or cubic).

Cam Profile Array Checks

The Status member of the first element in the cam profile array is special and used for data integrity checks. For this reason, the MAPC must always specify the cam profile with the starting index set to 0.

This first cam profile element Status member can have the following values.

Status Variables	**Description**
0	Cam profile element has not been calculated.
1	Cam profile element is being calculated.
2	Cam profile element has been calculated
n	Cam profile element has been calculated and is currently being used by (*n*-2) MAPC or MATC instructions.

Before starting a cam on a specified axis, the MAPC instructions checks if the cam profile array has been calculated by checking the value of the first cam profile element's Status member. If Status is 0 or 1 then the cam profile has not been calculated yet and the MAPC instruction errors. If the cam profile array has been completely calculated (Status > 1), the instruction then increments the Status member indicating that it is in use by this axis.

When the cam completes, or terminates, the Status member of the first cam profile array element is decremented to maintain track of the number of cams actively using the associated cam profile.

Linear and Cubic Interpolation

Position cams are fully interpolated. This means that if the current Master Axis position does not correspond exactly with a point in the cam table associated with the cam profile, the slave axis position is determined by linear or cubic interpolation between the adjacent points. In this way, the smoothest possible slave motion is provided.

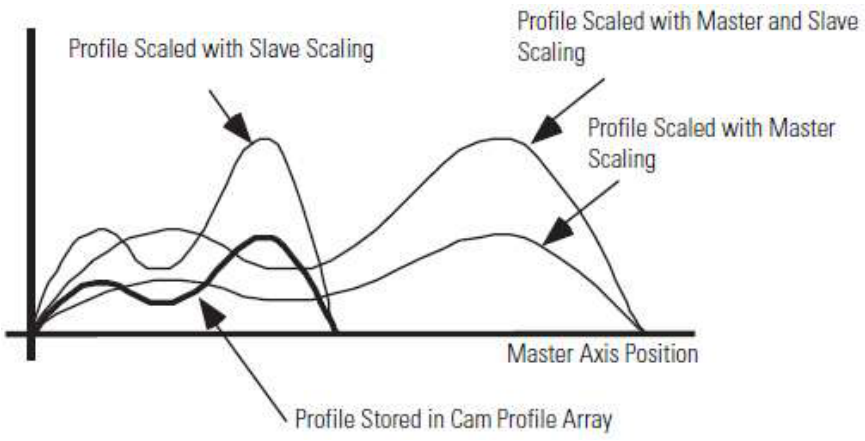
Each point in the Cam array that was used to generate the Cam Profile can be configured for linear or cubic interpolation.

Electronic camming remains active through any subsequent execution of jog, or move processes for the slave axis. This allows electronic camming motions to be superimposed with jog, or move profiles to create complex motion and synchronization.

Scaling Position Cams

A position cam profile can be scaled in both the master dimension and slave dimension when it is executed. This scaling feature is useful to allow the stored cam profile to be used to determine the general form of the motion profile. The scaling parameters are then used to define the total master or slave travel over which the profile is executed, as shown in the illustration below. In this way, one standard cam profile can be used to generate a whole family of specific cam profiles.

When a cam profile array is specified by an MAPC instruction, the master and slave values defined by the cam profile array take on the position units of the master and slave axes respectively. By contrast, the Master and Slave Scaling parameters are unitless values that are simply used as multipliers to the cam profile.



By default, both the Master Scaling and Slave Scaling parameters are set to 1. To scale a position cam profile, enter a Master Scaling or Slave Scaling value other than 1.

Note that increasing the master scaling value of a cam profile decreases the velocities and accelerations of the profile, while increasing the slave scaling value increases the velocities and accelerations of the profile. To maintain the velocities and accelerations of the scaled profile approximately equal to those of the unscaled profile, the master scaling and slave scaling values should be equal. For example, if the slave scaling value of a profile is 2, the master scaling value should also be 2 to maintain approximately equal velocities and accelerations during execution of the scaled position cam.

Decreasing the Master Scaling value or increasing the Slave Scaling value of a position cam increases the required velocities and accelerations of the profile. This can cause a motion fault if the capabilities of the drive system are exceeded.

Cam Profile Execution Modes

Execution Modes of Once or Continuous can be selected to determine how the cam motion behaves when the master position moves beyond the start and end points of the profile defined by the original cam table.

If Once is selected (default), the cam motion of the slave axis starts only when the master axis moves into the range defined by the start and end points of the cam profile. When the master axis moves outside the range of the profile, cam motion on the slave axis stops and the Process Complete bit of the MAPC instruction is set. Note that, contrary to the current S Class practice, slave motion **does not resume** when and if the master moves back into the profile range specified by the start and end points.

When Continuous mode is selected, the specified cam profile, once started, is executed indefinitely. With continuous operation, the profile's master and slave positions are unwound when the position of the master axis moves outside the profile range, causing the cam profile to repeat. This feature is particularly useful in rotary applications where it is necessary that the position cam run continuously in a rotary or reciprocating fashion. To generate smooth continuous motion using this technique, however, care must be taken in designing the cam points of the cam table to ensure that there are no position, velocity, or acceleration discontinuities between the start and end points of the calculated cam profile.

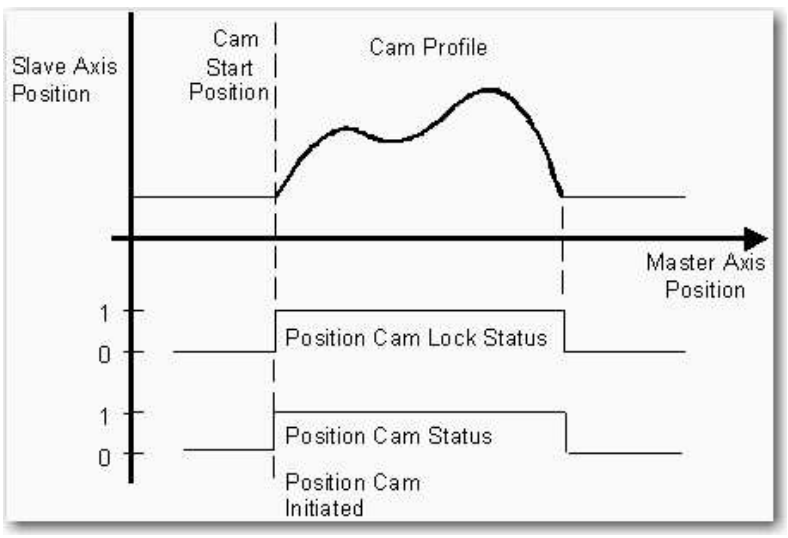
Execution Schedule

Control over the MAPC instruction's execution is via the Execution Schedule parameter.

Immediate Execution

By default, the MAPC instruction is scheduled to execute Immediately. In this case, there is no delay to the enabling of the position camming process and the Master Lock Position parameter is irrelevant. The slave axis is immediately locked to the master axis beginning at the Cam Lock Position of the specific cam profile.

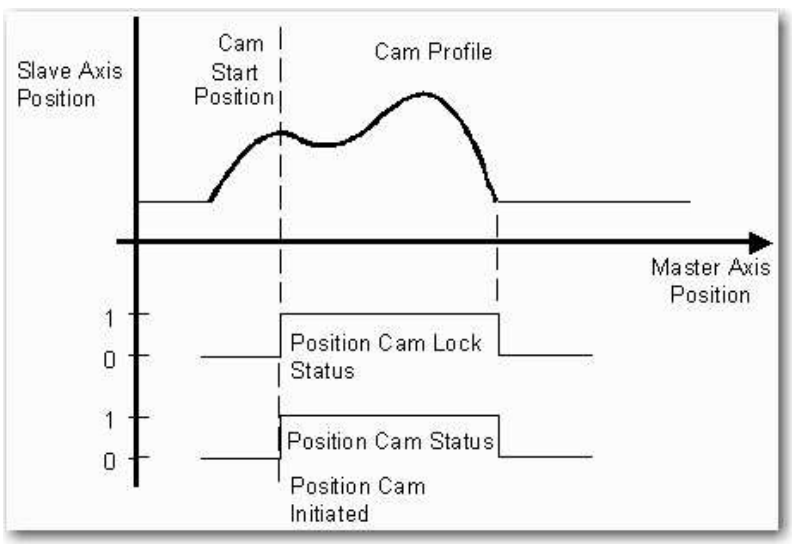
As illustrated in the diagram below, when the MAPC instruction is executed, the camming process is initiated on the specified slave axis and the Position Cam Status bit in the slave axis' Motion Status word is set. If the Execution Schedule parameter is set to Immediate, the slave axis is immediately locked to the master according to the specified Cam Profile. This is indicated by the fact that the Position Cam Lock Status bit for the specified slave axis is also set.



Changing the Cam Lock Position

The Cam Lock Position parameter of the MAPC instruction determines the starting location within the cam profile when the slave locks to the master. Typically, the Cam Lock Position is set to the beginning of the cam profile as shown in the above illustration. Since the starting point of most cam tables is 0, the Cam Lock Position is typically set to 0. Alternatively, the Cam Lock Position can be set to any position within the master range of the cam profile. If a Cam Lock Position is specified that is out of this range, the MAPC instruction errors.

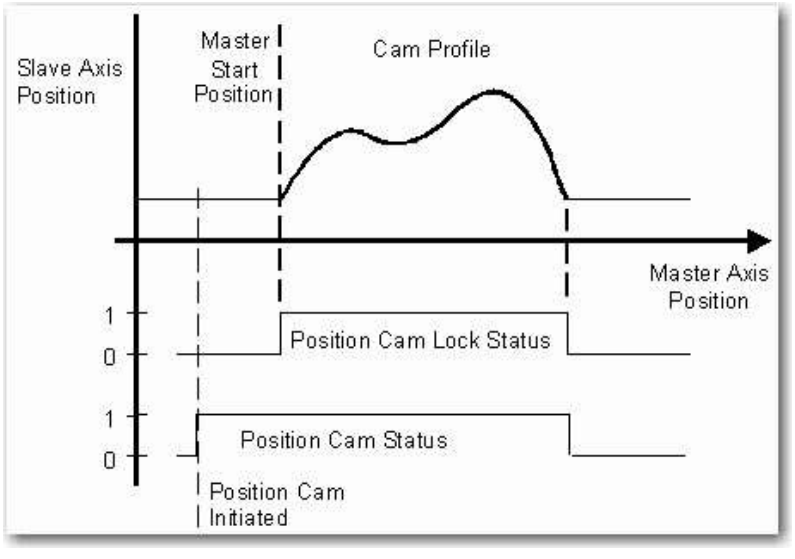
The diagram Changing the Cam Lock Position below shows the effect of specifying a Cam Lock Position value other than the starting point of the cam table, in this case, a position within the cam profile itself. Care must be taken not to define a Cam Start Point that results in a velocity or acceleration discontinuity to the slave axis if the master axis is currently moving.



Forward Only, Reverse Only, or Bi-directional Execution

In the case where the Execution Schedule parameter of the instruction is set to Forward Only, Reverse Only, or Bi-directional, the slave axis is not locked to the master until the master axis satisfies the specified condition. In this case, the master axis is monitored by the camming process to determine when the master axis passes the specified Master Lock Position in the specified direction. In a rotary axis configuration, this lock criterion is still valid, independent of the turns count.

Important: If the position reference of the master axis is redefined (for example an MRP instruction) after the MAPC instruction executes but before the lock condition is satisfied, the cam profile generator monitors the master axis based on the absolute position reference system in effect prior to the redefine position operation.



When the absolute position of the master axis passes the specified Master Lock Position in the specified direction (Forward Only direction in the illustration below), the Position Cam Status bit of the Motion Status word for specified slave axis is set. Slave axis motion is then initiated according to the specified cam profile starting at the specified Cam Lock Position of the cam profile. From this point on, only the incremental change in the master axis position is used to determine the corresponding slave axis position from the defined cam profile. This is important for applications where the master axis is a rotary axis since the position cam is then unaffected by the position unwind process.

When the master axis moves out of the range defined by the cam profile (assuming Execution Mode configured for Once), both the Position Cam Lock Status and the Position Cam Status bits of the Motion Status word are cleared. This Motion Status bit condition indicates that the cam process has completed. This fact is also reflected in the bit leg behavior of the associated MAPC instruction, PC bit set and IP bit clear.

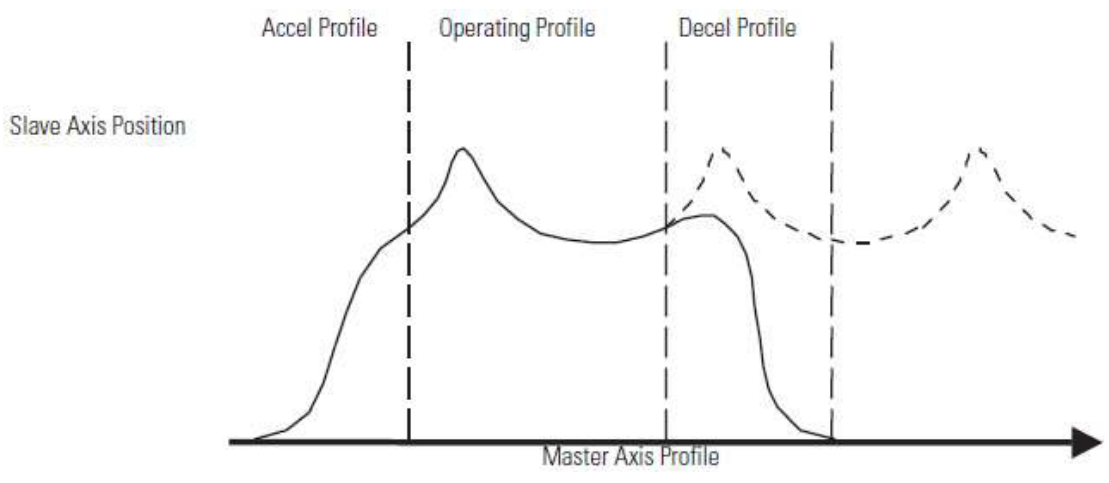
After position cam motion is started when the master axis passes the specified Master Lock Position in either the Forward Only or Reverse Only direction, the master axis can change direction and the slave axis reverses accordingly.

If an MAPC instruction is executed on a slave axis that is already actively position camming, an Illegal Dynamic Change error is generated (error code 23). The only exception for this is if the Execution Schedule is specified as pending.

Pending Cam Execution

Alternatively, the MAPC instruction's execution can be deferred pending completion of a currently executing position cam. An Execution Schedule selection of Pending can thus be used to seamlessly blend two position cam profiles together without stopping motion.

The Pending execution feature is particularly useful in applications like high-speed packaging when a slave axis must be locked onto a moving master axis and accelerate using a specific profile to the proper speed. When this acceleration profile is done, it must be smoothly blended into the operating profile, which is typically executed continuously. To stop the slave axis, the operating profile is smoothly blended into a deceleration profile such that the axis stops at a known location as shown in graphic Pending Cam Execution.



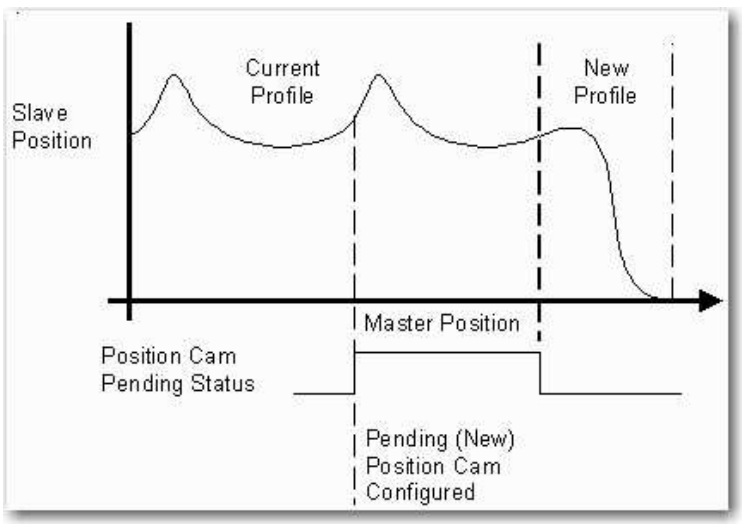
By executing the position cam profile as a Pending cam profile while the current profile is still executing, the appropriate cam profile parameters are set up ahead of time. This makes the transition from the current profile to the pending profile seamless; synchronization between the master and slave axes is maintained. To ensure smooth motion across the transition, however, the profiles must be designed such that no position, velocity, or acceleration discontinuities exist between the end of the current profile and the start of the new one. This is done using the Logix Designer application Cam Profile Editor.

Once a pending position cam instruction has been executed, the new cam profile takes effect automatically (and becomes the current profile) when the master axis passes through either the start or end point of the current profile. If the current cam is configured to execute once, the new profile is initiated at the completion of the pass through the current cam profile and the PC bit of the currently active MAPC instruction is set. If the current cam is configured to execute continuously, the new profile is initiated at the completion of the current pass through the current cam profile and the IP bit of the currently active MAPC instruction is cleared. The motion controller keeps track of the master axis and slave axis positions relative to the first profile at the time of the change and uses this information to maintain synchronization between the profiles.

If the Execution Schedule of an MAPC instruction is set to Immediate and a position cam profile is currently in process, the MAPC instruction errs. This is true even when the axis is waiting to lock onto the master axis.

If an Execution Schedule of Pending is selected without a corresponding position cam profile in progress, the MAPC instruction executes but no camming motion occurs until another MAPC instruction with a non-pending Execution Schedule is initiated. This allows pending cam profiles to be preloaded prior to executing the initial cam. This method addresses cases where immediate cams would finish before the pending cam could be reliably loaded.

After a Pending position cam has been configured, the Position Cam Pending Status bit of the Motion Status word for the specified slave axis is set to 1 (true). When the pending (new) profile is initiated and becomes the current profile, Position Cam Pending Status bit is immediately cleared as shown below.

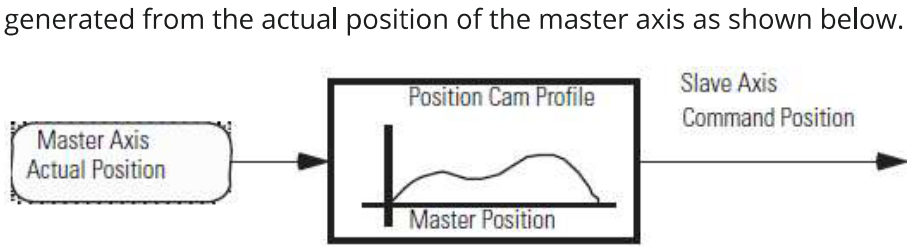


Master Reference

The Master Reference parameter determines the master position source to link to the cam generator. This source can be actual position or command position of the master axis. Smoother motion is derived from command position but in some cases, for example when a physical axis is not controlled by a ControlLogix motion module, actual position is the only practical option.

Slaving to the Actual Position

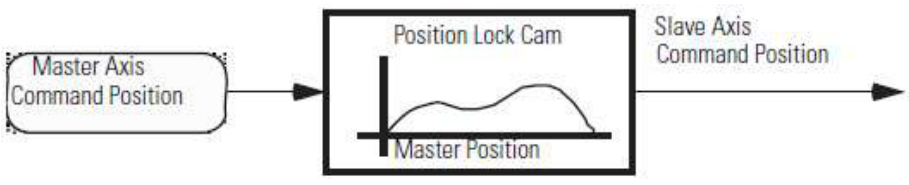
When Actual Position is entered or selected as the Master Reference source, the slave axis motion is generated from the actual position of the master axis as shown below.



Actual position is the current position of the master axis as measured by its encoder or other feedback device. This is the default selection and the only selection when the master Axis Type is configured as Feedback Only since it is often necessary to synchronize the actual positions of two axes.

Slaving to the Command Position

When Command Position is entered or selected as the Master Reference source, the slave axis motion is generated from the command position of the master axis as shown below.



Command position (only available when the master axis' Axis Type is a Servo or Virtual axis) is the desired or commanded position of the master axis.

Since the command position does not incorporate any associated following error or external position disturbances, it is a more accurate and stable reference for camming. When camming to the command position of the master, the master axis must be commanded to move to cause any motion on the slave axis.

Master Direction

Normally, the Master Direction parameter is set to Bi-directional (default). However, when Forward Only is selected for Master Direction, the slave axis tracks the master axis in the forward direction of the master axis. When Reverse Only is selected, the slave axis tracks the master axis in the reverse direction of the master axis. If the master axis changes direction, the slave axis does not reverse direction, but stays where it was when the master reversed. This Uni-directional feature of position cams is used to provide an electronic slip clutch, which prevents the cam motion generator from moving backward through the cam profile if the master reverses direction.

When the master axis again reverses, resuming motion in the desired direction, the slave axis picks up again when the master reaches the position where it initially reversed. In this way, the slave axis maintains synchronization with the master while motion in the wrong direction is inhibited. This is especially useful where motion in a certain direction can cause physical damage to the machine or to the product.

Moving While Camming

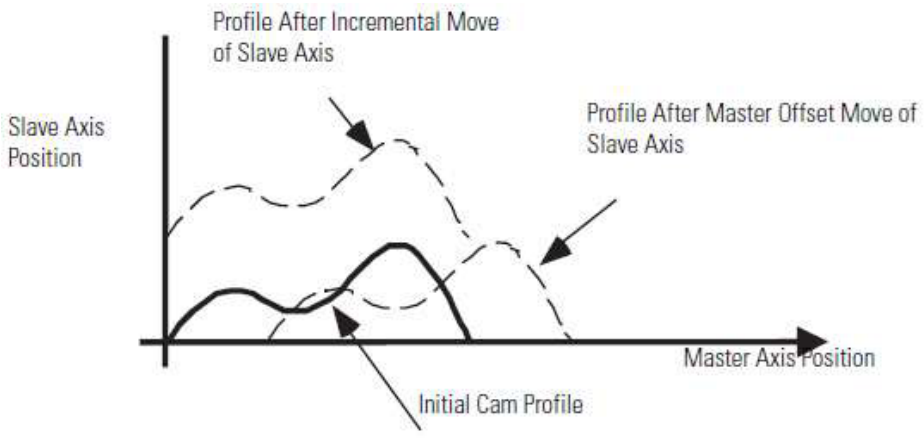
Motion Axis Moves may be performed while camming to provide sophisticated phase and offset control while the slave axis is running.

Incremental Moves

An Incremental Motion Axis Move (MAM) instruction may be used on the slave axis (or master axis if configured for Servo operation) while the position cam is operating. This is particularly useful to accomplish phase advance/retard control. The incremental move distance can be used to eliminate any phase error between the master and the slave, or to create an exact phase relationship.

Master Offset Moves

A MAM instruction can also be used while the position cam is operating to shift the master reference position of the cam on the fly. Unlike an incremental move on the slave axis, a master offset move on the slave axis shifts the cam profile relative to the master axis, as shown in graphic Master Offset Move below.



When the MAPC instruction (except pending) is initiated, the corresponding active Master Offset Move is disabled and the corresponding Master Offset, Strobe Offset, and Start Master Offset are reset to zero. In order to achieve the master reference position shift, the MAM instruction must be initiated after the MAPC is initiated.

See the Motion Axis Move (MAM) instruction for more information on Master Offset moves.

Stopping a Cam

Like other motion generators (jog, move, gear) active cams must be stopped by the various stop instructions, such as the Motion Axis Stop (MAS) or the Motion Group Stop (MGS). Cam motion must also stop when the ControlLogix processor changes OS modes. The MAS instruction, in particular, must be able to specifically stop the camming process. This behavior should be identical to the MAS functionality that specifically stops a gearing process.

Merging from a Cam

Like other motion generators (jog, move, gear) active cams must also be compliant with motion merge functionality. Moves and Jogs, in particular, must be able to merge from active camming. This behavior should be identical to the merge functionality applied to a gearing process.

Fault Recovery

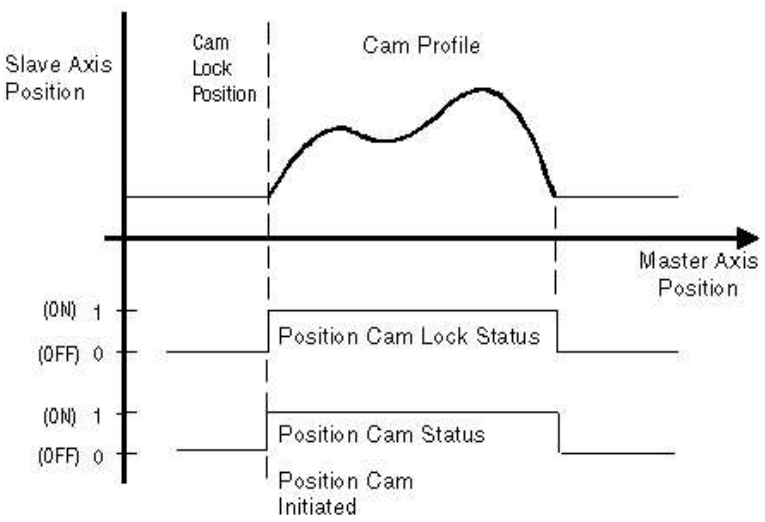
Sometimes it is necessary to respond to an axis fault condition without loosing synchronization between a master and slave axis that are locked in a cam relationship. With an active cam there are a couple ways to handle axis faults.

Create a virtual axis and cam everything to it and, if necessary, gear this virtual master axis to actual master axis of the machine. Set the various fault actions for all axes to Status Only. When an axis fault occurs (for example, a drive fault) an application program monitoring the axes fault status detects the fault and does a controlled stop of all active axes by stopping the virtual master axis. At the profiler level, everything is still fully synchronized. Use the following error on faulted axis to determine how far it is out of position. Reset the fault on the faulted axis, bring into position at a controlled speed using the MAM instruction and the computed following error. Finally, start moving virtual master axis.

Same configuration as above but, in this case, when the slave axis faults the axis fault action disables the drive. This, of course, would terminate the active cam process on the slave axis. At this point, the application program should stop all other axes via the virtual master axis. Next, reposition the faulted axis by determining where the master is, and then calculating where the slave axis should be had the fault not occurred. Finally, do an immediate lock MAPC to resynchronize with the Cam Lock Position set to the calculated value.

Important: The MAPC instruction execution completes in a single scan, thus the Done (.DN) bit and the In Process (.IP) bit are set immediately. The In Process (.IP) bit remains set until the initiated PCAM process completes, is superseded by another MAPC instruction, terminated by a Motion Axis Stop command, Merge operation, or Servo Fault Action. The Process Complete bit is cleared immediately when the MAPC executes and sets when the cam process completes when configured for Once Execution Mode.

In this transitional instruction, the relay ladder, toggle the Rung-condition-in from cleared to set each time the instruction should execute.



Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See Common Attributes for operand-related instructions.

Execution

Ladder Diagram

Condition/State	Action Taken
Prescan	The .EN, .DN, .ER, and .IP bits are cleared to false.
Rung-condition-in is false	The .EN bit is cleared to false if either the .DN or .ER bit is true.
Rung-condition-in is true	The .EN bit is set to true and the instruction executes.
Postscan	N/A

Structured Text

Condition/State	Action Taken
Prescan	See Prescan in the Ladder Diagram table.
Normal execution	See Rung-condition-in is false, followed by rung is true in the Ladder Diagram table.
Postscan	See Postscan in the Ladder Diagram table.

Error Codes

See Motion Error Codes (.ERR) for motion instructions.

Extended Error Codes

Extended Error Codes provide additional instruction specific information for the Error Codes that are generic to many instructions.

Extended Error Codes for Axis Not Configured (11) error code are as follows:

- Extended Error Code 1 signifies that the Slave Axis is not configured.
- Extended Error Code 2 signifies that the Master Axis is not configured.

Extended Error codes for the Parameter Out of Range (13) error code lists a number that refers to the number of the operand as they are listed in the faceplate from top to bottom with the first operand being counted as zero. Therefore for the MAPC instruction, an extended error code of 5 would refer to the Slave Scaling operand's value. You would then have to check your value with the accepted range of values for the instruction.

For the Error Code 54 – Maximum Deceleration Value is Zero, if the Extended Error returns a positive number (0-n) it is referring to the offending axis in the coordinate system. Go to the Coordinate System Properties General Tab and look under the Brackets ([ ])column of the Axis Grid to determine which axis has a Maximum Deceleration value of 0. Click on the ellipsis button next to the offending axis to access the Axis Properties screen. Go to the Dynamics tab and make the appropriate change to the Maximum Deceleration Value. If the Extended Error number is -1, this means the Coordinate System has a Maximum Deceleration Value of 0. Go to the Coordinate System Properties Dynamics Tab to correct the Maximum Deceleration value. See Motion Error Codes (.ERR) for motion instructions.

Status Bits

MAPC Changes to Status Bits

If the Execution Schedule is set to Immediate, execution of the MAPC instruction simply sets both the Position Cam Status and the Position Cam Lock Status bits to True.

Bit Name	State	Meaning
Position Cam Status	TRUE	Position Camming is Enabled.
Position Cam Lock Status	TRUE	Slave Axis is Locked to the Master Axis according to the Cam Profile.
Position Cam Pending Status	Unchanged	No pending Position Cam.

If the Execution Schedule is set to Forward or Reverse, execution of the MAPC instruction initially sets the Position Cam Status bit to True and the Position Cam Lock Status bits to False. Position Cam Lock Status transitions to True when the Execution Schedule condition is satisfied.

Bit Name	State	Meaning
Position Cam Status	TRUE	Position Camming is Enabled.
Position Cam Lock Status	FALSE	Slave Axis is waiting for Master Axis to reach Lock Position.

Position Cam Pending Status	Unchanged	No pending Position Cam.

If the Execution Schedule is set to Pending, execution of the MAPC instruction does not affect the current state of either the Position Cam Status or Position Lock Status bits. Position Cam Pending Status bit is set to True immediately and transitions to False when the pending cam becomes the active cam.

Bit Name	**State**	**Meaning**
Position Cam Status	Unchanged	Position Camming is Enabled.
Position Cam Lock Status	Unchanged	Slave Axis is waiting for Master Axis to reach Lock Position.
Position Cam Pending Status	TRUE	Pending Position Cam.

Once the MAPC is executing, the state of Position Cam Lock Status is determined by the setting of MasterDirection, and the direction the Master Axis is moving.

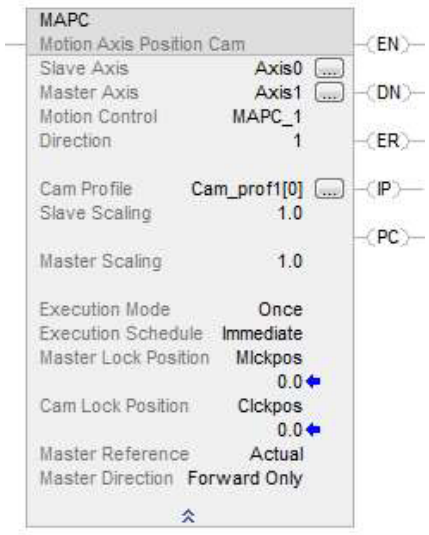
Bit Name	**State**	**Meaning**
Position Cam Status	TRUE	Position Camming is Enabled.
Position Cam Lock Status	TRUE	Slave Axis is Locked to the Master Axis according to the Cam Profile.
	FALSE	Slave Axis is waiting for the Master Axis to move in the direction specified by MasterDirection.
Position Cam Pending Status	Unchanged	

When ExecutionMode is set to Persistent, the Slave Axis will unlock whenever the Master Axis exceeds the Cam Profile range, and will lock when the Master Axis re-enters the Cam Profile range.

Bit Name	**State**	**Meaning**
Position Cam Status	TRUE	Position Camming is Enabled.
Position Cam Lock Status	TRUE	Slave Axis is Locked to the Master Axis according to the Cam Profile.
	FALSE	Slave Axis is waiting for the Master Axis to re-enter Cam Profile range.
Position Cam Pending Status	Unchanged	

Example

Ladder Diagram



Structured Text

MAPC (Axis0, Axis1, MAPC_1,1, Cam_pro1[0], 1.0,1.0, Once, immediate, Mlckpos, Clckpos, Actual, Forwardonly);

See also

Structured Text Syntax

MAPC Flow Chart (True)

Motion Error Codes (.ERR)

Motion Move Instructions

Common Attributes

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How are we doing?