Motion Coordinated Change Dynamics (MCCD)

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.

The Motion Coordinated Change Dynamics (MCCD) instruction starts a change in the path dynamics of the specified coordinate system. Based upon the Motion Type, the MCCD changes the coordinated motion profile that is currently active on the system.

Important: Tags used for the motion control attribute of instructions should only be used once. Re-use of the motion control tag in other instructions can cause unintended operation. This may result in damage to equipment or personal injury.

Important: Risk of Velocity and/or End Position Overshoot

If you change move parameters dynamically by any method, that is by changing move dynamics (MCD or MCCD) or by starting a new instruction before the last one has completed, be aware of the risk of velocity and/or end position overshoot.

A Trapezoidal velocity profile can overshoot if maximum deceleration is decreased while the move is decelerating or is close to the deceleration point.

An S-curve velocity profile can overshoot if:

maximum deceleration is decreased while the move is decelerating or close to the deceleration point; or

maximum acceleration jerk is decreased and the axis is accelerating. Keep in mind, however, that jerk can be changed indirectly if it is specified in % of time

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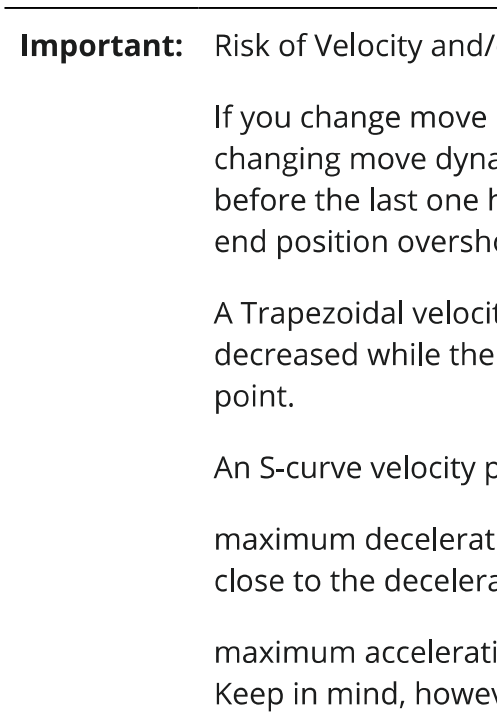
Available Languages

Ladder Diagram



Function Block

This instruction is not available in function block.

Structured Text

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Structured Text

MCCD(CoordinateSystem, MotionControl, MotionType, ChangeSpeed, Speed, SpeedUnits, ChangeAccel, AccelRate, AccelUnits, ChangeDecel, DecelRate, DecelUnits, ChangeAccelJerk, AccelJerk, ChangeDecelJerk, DecelJerk, JerkUnits, Scope);

Operands

There are data conversion rules for mixed data types within an instruction. See *Data Conversion*.

Inputs

The following table explains the instruction inputs.

Operand	Type	Format	Description
Coordinate System	COORDINATE_SYSTEM	tag	Coordinated group of axes.
Motion Control	MOTION_INSTRUCTION	tag	Structure used to access instruction status parameters.
Motion Type	DINT	immediate	1 = Coordinated Move
Change Speed	DINT	immediate	0 = No 1 =Yes
Speed	SINT, INT, DINT, or REAL	immediate tag	[coordinate units]
Speed Units	DINT	immediate	0 = Units per Sec 1 = % of Maximum 4 = Units per MasterUnit
Change Accel	DINT	immediate	0 = No 1 = Yes
Accel Rate	SINT, INT, DINT, or REAL	immediate tag	[coordinate units]
Accel Units	DINT	immediate	0 = Units per Sec^2 1 = % of Maximum 4 = Units per $MasterUnit^2$
Change Decel	DINT	immediate	0 = No 1 =Yes
Decel Rate	SINT, INT, DINT, or REAL	immediate tag	[coordinate units]
Decel Units	DINT	immediate	0 = Units per Sec^2 1 = % of Maximum 4 = Units per $MasterUnit^2$

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- Motion Event Instructions
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- Motion Move Instructions
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- Multi-Axis Coordinated Motion Instructions
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  - Motion Coordinated Circular Move (MCCM)
  - Motion Coordinated Transform with Orientation (MCTO)
  - Motion Coordinated Path Move (MCPM)
  - Motion Calculate Transform Position with Orientation (MCTPO)
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  - Motion Coordinated Shutdown Reset (MCSR)
  - Motion Coordinated Stop (MCS)
  - Motion Coordinated Transform (MCT)
  - Speed, acceleration, deceleration, and jerk enumerations for coordinated motion
  - Status Bits for Motion Instructions (MCLM, MCCM) when MDCC Is Active
  - Change between master driven and time driven modes for Coordinated Motion instructions
  - Choose a Termination Type
  - Common Action Table for Slave Coordinate System and Master Axis
  - Input and Output Parameters Structure for Coordinate System Motion Instructions
  - Returned Calculated Data Parameter for Coordinated System Motion Instruction

			4 = Units per MasterUnit
Change Accel Jerk	DINT	immediate	0 = No 1 = Yes
Accel Jerk	SINT, INT, DINT, or REAL	immediate tag	You must always enter a value for the Accel Jerk operand. This instruction only uses the value if the Profile is configured as S-curve. Accel Jerk is the acceleration jerk rate for the coordinate system. Use these values to get started. Accel Jerk = 100 (% of Time) Jerk Units = 2
Change Decel Jerk	DINT	immediate	0 = No 1 = Yes
Decel Jerk	SINT, INT, DINT, or REAL	immediate tag	You must always enter a value for the Decel Jerk operand. This instruction only uses the value if the Profile is configured as S-curve. Decel Jerk is the deceleration jerk rate for the coordinate system. Use these values to get started. Decel Jerk = 100 (% of Time) Jerk Units = 2
Jerk Units	DINT	immediate	0 = Units per sec^3 1 = % of Maximum 2 = % of Time (use this value to get started) 4 = Units per $MasterUnit^3$ 6 = % of Time Master Driven
Scope	DINT	immediate	0 = Active Motion 1 = Active and Pending Motion

Structured Text

When entering enumerations for the operand value in structured text, multiple word enumerations must be entered without spaces. For example: when entering Decel Units the value should be entered as $unitspersec^2$ rather than Units per Sec^2 as displayed in the ladder logic.

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

For the operands that have enumerated values, enter your selection as follows.

This	Has These Options Which You

- Logical and Move Instructions
- Program Control Instructions
- Sequencer Instructions
- Special Instructions
- Timer and Counter Instructions
- Trigonometric Instructions
- Process Control Instructions
- Select/Limit Instructions
- Sequential Function Chart (SFC) Instructions
- Statistical Instructions
- Safety Instructions

Studio 5000 Logix Designer Glossary

This Operand	Has These Options Which You	
	Enter as Text	**Or as**
Coordinate System	No enumeration	tag
Motion Control	No enumeration	tag
Motion Type	coordinatedmove	1 = Coordinated Move
Change Speed	no yes	0 = No 1 = Yes
Speed	No enumeration	immediate or tag
Speed Units	unitspersec %ofmaximum unitspermasterunit	0 1 4
Change Accel	no yes	0 = No 1 = Yes
Accel Rate	No enumeration	immediate or tag
Accel Units	unitspersec2 %ofmaximum unitspermasterunit2	0 1 4
Change Decel	no yes	0 = No 1 = Yes
Decel Rate	No enumeration	immediate or tag
Decel Units	unitspersec2 %ofmaximum unitspermasterunit2	0 1 4
Change Accel Jerk	no yes	0 = No 1 = Yes
Accel Jerk	No enumeration	immediate or tag You must always enter a value for the Accel operand. This instruction only uses the value if the Profile is configured as S-curve. Use this value to get started. Accel Jerk = 100 (% of Time)

Change Decel Jerk	no yes	0 = No 1 = Yes
Decel Jerk	No enumeration	immediate or tag You must always enter a value Decel Jerk operand. This instruction only uses the value if the Profile is configured as S-curve. Use this value to get started. Decel Jerk = 100 (% of Time) Jerk Units = 2
Jerk Units	unitspersec3 %ofmaximum %oftime unitspermasterunit3 %oftimemasterdriven	0 1 2 (use this value to get started) 3 6
Scope	activemotion activeandpendingmotion	0 = Active Motion 1 = Active and Pending Motion

Outputs

The following table explains the instruction outputs.

Mnemonic	Description
.EN (Enable) Bit 31	The Enable bit is set when the rung transitions from false to true. It resets when the rung transitions from true to false.
.DN (Done) Bit 29	The Done bit resets when the rung transitions from false to true. It sets when target position is calculated successfully.
.ER (Error) Bit 28	The Error bit resets when the rung transitions from false to true. It sets when target position fails to calculate successfully.

Description

MCCD is a transitional instruction:

- In relay ladder, toggle the Rung-condition-in from false to true each time the instruction should execute.
- In structured text, condition the instruction so that it only executes on a transition.

Coordinate System

The Coordinate System operand specifies the set of motion axes that define the dimensions of a coordinate system. The coordinate system supports up to three (3) primary axes.

Motion Type

The motion type operand determines which motion profile to change. Currently

Coordinated Move is the only available option.

Coordinated Move - when selected, the Coordinated Move option changes the motion of the currently active move in the coordinate system.

Change Speed

The Change Speed operand determines whether or not to change the speed of the coordinated motion profile.

- No - no change is made to the speed of the coordinated motion.
- Yes - the speed of the coordinated motion is changed by the value defined in the Speed and Speed Units operands.

Speed

The Speed operand defines the maximum speed along the path of the coordinated move.

Speed Units

The Speed Units operand defines the units applied to the Speed operand either directly in coordinate units of the specified coordinate system or as a percentage of the maximum values defined in the coordinate system.

Change Accel

The Change Accel operand determines whether or not to change the acceleration of the coordinated motion profile.

- No - no change is made to the acceleration of the coordinated motion.
- Yes - the acceleration of the coordinated motion is changed by the value defined in the Accel Rate and Accel Units operands.

Accel Rate

The Accel Rate operand defines the maximum acceleration along the path of the coordinated move.

Accel Units

The Accel Units operand defines the units applied to the Accel Rate operand either directly in coordinate units of the specified coordinate system or as a percentage of the maximum values defined in the coordinate system.

Change Decel

The Change Decel operand determines whether or not to change the deceleration of the coordinated motion profile.

- No - no change is made to the deceleration of the coordinated motion.
- Yes - the deceleration of the coordinated motion is changed by the value defined in the Decel Rate and Decel Units operands.

Decel Rate

The Decel Rate operand defines the maximum deceleration along the path of the coordinated move.

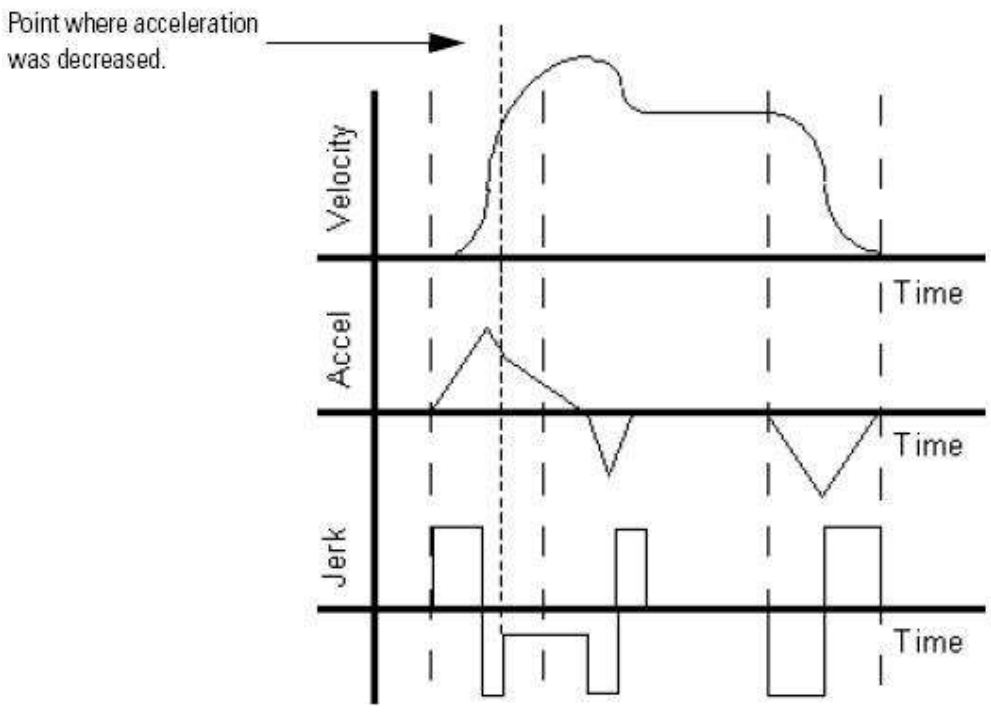
Decel Units

The Decel Units operand defines the units applied to the Decel Rate operand either directly in coordinate units of the specified coordinate system or as a percentage of the maximum values defined in the coordinate system.

Impact of Changes to Acceleration and Deceleration Values on Motion Profile

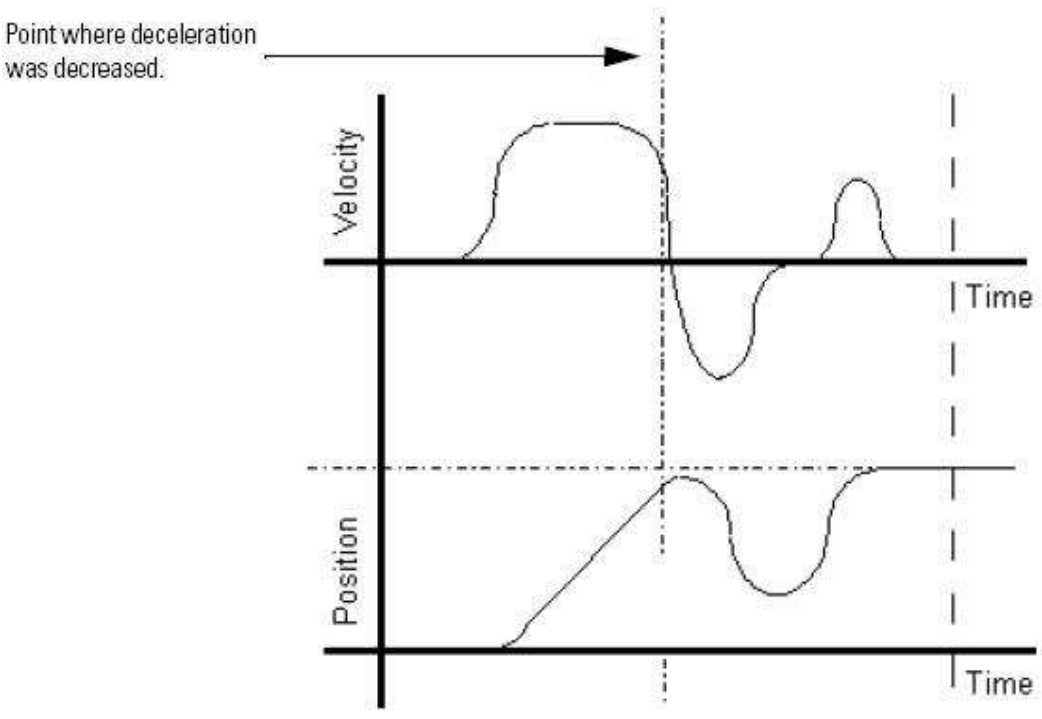
The following graph illustrates what could happen when a MCCD instruction is used to reduce the acceleration as velocity approaches maximum. The new acceleration Jerk Rate becomes smaller, further limiting the maximum change in acceleration. Velocity overshoot occurs due to the additional time required for acceleration to reach zero. Another profile is generated to bring velocity back to the programmed maximum.

Effect of Change to Acceleration



The following graph illustrates what could happen when an MCCD instruction is used to reduce the deceleration as velocity and position approach their target endpoints. The new deceleration Jerk Rate becomes smaller. The time required to decelerate to zero causes velocity to undershoot, passing through zero and becoming negative. Axis motion also reverses direction until velocity returns to zero. An additional profile is generated to bring position back to the programmed target.

Effect of Change to Deceleration



Change Accel Jerk

The Change Accel Jerk operand determines whether or not to change the acceleration jerk of the coordinated motion profile.

- No - no change is made to the acceleration jerk of the coordinated motion.
- Yes - the acceleration of the coordinated motion is changed by the value defined in the Accel Jerk Rate and Jerk Units operands.

Accel Jerk

Accel Jerk defines the maximum acceleration jerk for the programmed move. For more information on calculating Accel Jerk, refer to the Jerk Units below.

information on calculating Accel Jerk, refer to the Jerk Units below.

Change Decel Jerk

The Change Decel Jerk operand determines whether or not to change the deceleration jerk of the coordinated motion profile.

- No - no change is made to the deceleration jerk of the coordinated motion.
- Yes - the deceleration of the coordinated motion is changed by the value defined in the Decel Jerk Rate and Jerk Units operands

Decel Jerk

Decel Jerk defines the maximum deceleration jerk for the programmed move. For more information on calculating Decel Jerk, refer to the Jerk Units below.

Jerk Units

The jerk units define the units that are applied to the values entered in the Accel Jerk and Decel Jerk operands. The values are entered directly in the position units of the specified coordinate system or as a percentage. When configured using % of Maximum, the jerk is applied as a percentage of the Maximum Acceleration Jerk and Maximum Deceleration Jerk operands specified in the coordinate system attributes. When configured using % of Time, the value is a percentage based on the Speed, Accel Rate, and Decel Rate specified in the instruction.

If you want to convert engineering units to % of Time, use these equations.

For Accel Jerk:

$$j_a\,[\mathrm{EU/s^3}] = \frac{a_{max}{}^2\,[\mathrm{EU/s^2}]}{v_{max}\,[\mathrm{EU/s}]}\left(\frac{200}{j_a\,[\%\ \mathrm{of\ time}]} - 1\right)$$

For Decel Jerk:

$$j_a\,[\mathrm{EU/s^3}] = \frac{a_{max}{}^2\,[\mathrm{EU/s^2}]}{v_{max}\,[\mathrm{EU/s}]}\left(\frac{200}{j_a\,[\%\ \mathrm{of\ time}]} - 1\right)$$

If you want to convert % of Time to engineering units, use these equations.

For Accel Jerk:

$$j_a\,[\%\ \mathrm{of\ time}] = \frac{2}{1 + \dfrac{j_a\,[\mathrm{EU/s^3}]\ v_{max}\,[\mathrm{EU/s}]}{a_{max}^2\,[\mathrm{EU/s^2}]}}\,100$$

For Decel Jerk:

$$j_d\,[\%\ \mathrm{of\ time}] = \frac{2}{1 + \dfrac{j_d\,[\mathrm{EU/s^3}]\ v_{max}\,[\mathrm{EU/s}]}{d_{max}^2\,[\mathrm{EU/s^2}]}}\,100$$

Scope

Choosing Active Motion for the Scope operand specifies that the changes affect only the motion dynamics of the active coordinated motion instruction. Choosing Active and Pending Motion specifies that the changes affect the motion dynamics of the active coordinated motion instruction and any pending coordinated motion instruction in the queue. Currently the queue size is limited to one instruction after the active instruction.

Changing Between MDSC and Time Driven Modes in Master Driven Speed Control (MDSC)

You cannot change from Master Driven Mode to Time Driven Mode or vice versa with an MCCD instruction. You receive a runtime error if you attempt to change modes.

Fault Codes

For the Master Driven Speed Control (MDSC) function, an error will occur at runtime if you attempt to change the mode of the system from Master Driven to Time Driven or from Time Driven to Master Driven.

Extended Error Codes

Extended Error codes help to further define the error message given for this particular instruction. Their behavior is dependent upon the Error Code with which they are associated.

The Extended Error Codes for Servo Off State (5), Shutdown State (7), Axis Type Not Servo (8), Axis Not Configured (11), Homing In Process Error (16), and Illegal Axis Data type (38) errors all function in the same fashion. A number between 0...n is displayed for the Extended Error Code. This number is the index to the Coordinate System indicating the axis that is in the error condition. See Motion Error Codes (ERR) for Motion Instructions.

For the MCCD instruction, Error Code 13 - Parameter Out of Range, Extended Errors return a number that indicates the offending parameter as listed on the faceplate in numerical order from top to bottom beginning with zero. For example, 2 indicates the parameter value for Move Type is in error.

Referenced Error Code and Number	Extended Error Numeric Indicator	Instruction Parameter	Description
Parameter Out Of Range (13)	2	Move Type	Move Type is either less than 0 or greater than 1.
Parameter Out Of Range (13)	4	Speed	Speed is less than 0.
Parameter Out of Range (13)	7	Accel Rate	Accel Rate is less than or equal to 0.
Parameter Out of Range (13)	10	Decal Rate	Decel Rate is less than or equal to 0.

For the Error Code 54 – Maximum Deceleration Value is Zero, if the Extended Error returns a positive number (0-n) it's 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.

MCCD Changes to Status Bits:

For the Master Driven Speed Control (MDSC) function, when the MCCD is executed (goes IP), the CalculatedDataAvailable (CDA) status bit is cleared (as specified by the Scope variable of the MCCD instruction), in each MCLM and MCCM instruction tag, which indicates that the Event Distances has been computed. (The Scope variable specifies either the Active Motion instruction or Active Motion and Pending instruction (that is, all instructions, in the queue)).

After the MCCD is complete and the Event Distances have been recomputed, the CalculatedDataAvailable status bit is set again. Therefore, look at the CalculatedDataAvailable status bit after the MCCD instruction has been completed to determine when to use the recomputed Event Distances.

If a MCCD is executed (goes IP), the CDA bit is cleared. The Calculated Data for the move is recomputed using the new dynamics parameters. The CDA bit is set again when computations are complete. The Calculated Data that is recomputed is measured from the original Motion Start Point (MSP) to the Event Distance point using the new dynamics parameters as changed by the MCCD instruction - not from the point of the MCCD.

Note that if the MCCD changes the speed to 0, the Event Distance is not recomputed; the CDA bit is not set. The Event Distance is however recomputed if a second MCCD is issued to restart the motion. The recomputed Calculated Data includes the duration of the stopped motion.

If the Event Distance is set to 0, the Calculated Data is set to equal the position that equals the length of the move. This may be one or two coarse update periods before the PC bit is set because of an internal delay. The end position is typically achieved in the middle of a coarse update period, which adds up to one additional coarse update period to the delay. Therefore, if the master is moved a distance equal to the Calculated Data, you must wait up to 2 iterations more for the PC bit of the slave move to be set.

Affects Math Status Flags

No

Major/Minor Faults

None specific to this instruction. See *Index Through Arrays* for array-indexing faults.

Execution

Ladder Diagram

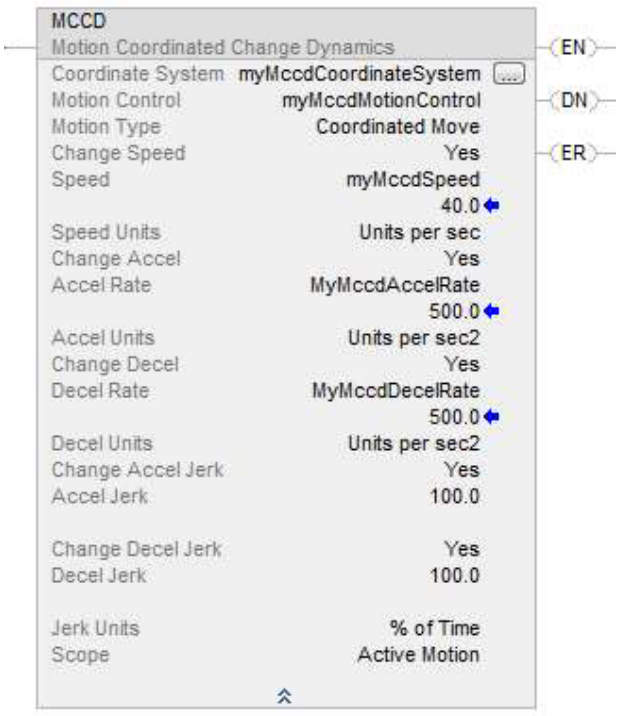
Condition/State	**Action Taken**
Prescan	The .EN, .DN, and .ER bits are cleared to false.
Rung-condition-in is false	The .EN bit is cleared to false if either the .DN or .ER bit is true.
Rung-condition-in is true	The .EN bit is set to true and the instruction executes.
Postscan	N/A

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-condition-in is true in the Ladder Diagram table.
Postscan	See Postscan in the Ladder Diagram table.

Example

Ladder Diagram



Structured Text

MCCD(myMccdCoordinateSystem, myMccdMotionControl, CoordinatedMove, Yes, MyMccdSpeed, Unitspersec, Yes, MyMsccdAccelRate, Unitspersec2, Yes, MyMccdDecelRate, Unitspersec2, Yes, 100.0, Yes, 100.0, %ofTime, ActiveMotion);

See also

Structured Text Syntax

Motion Error Codes (.ERR)

Multi-Axis Coordinated Motion Instructions

Index Through Arrays

Data Conversions

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How are we doing?