Reference Manual

Allen-Bradley

Micro800 Programmable Controllers General Instructions

Catalog Numbers 2080-LC10, 2080-LC20, 2080-LC30, 2080-LC50

Allen-Bradley • Rockwell Software

Rockwell Automation

Important user information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
Important:	Identifies information that is critical for successful application and understanding of the product.

Chapter 5

Arithmetic instructions

Chapter 6

ASCII serial port instructions

Chapter 7

Binary instructions

Chapter 8

Boolean instructions

Chapter 9

Communication instructions

Chapter 10

Compare instructions

Chapter 11

Counter instructions

Chapter 12

Data conversion instructions

Chapter 13

Data manipulation instructions

Chapter 14

High-Speed Counter (HSC) instructions

Chapter 15

Input/Output instructions

Chapter 16

Interrupt instructions

Chapter 17

Motion control instructions

Chapter 18

Process control instructions

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Program control instruction

Chapter 20

Proportional Integral Derivative (PID) instruction

Chapter 21

Real Time Clock (RTC) instructions

Chapter 22

String manipulation instructions

Chapter 23

Timer instructions

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In This Manual

This guide provides reference information about the instruction set available for developing programs for use in Micro800 control systems. The instruction set includes Structured Text (ST), Ladder Diagram (LD) Function Block Diagram (FBD) programming language support. Additionally, the ladder elements supported in Connected Components Workbench development environment are defined.

Supported Controllers

Connected Components Workbench™ includes configuration support for the following Micro800™ controllers.

- 2080-LC10-12AWA
- 2080-LC10-12DWD
- 2080-LC10-12QBB
- 2080-LC10-12QWB
- 2080-LC20-20AWB
- 2080-LC20-20QBB
- 2080-LC20-20QWB
- 2080-LC30-10QVB
- 2080-LC30-10QWB
- 2080-LC30-16AWB
- 2080-LC30-16QVB
- 2080-LC30-16QWB
- 2080-LC30-24QBB
- 2080-LC30-24QVB
- 2080-LC30-24QWB
- 2080-LC30-48AWB
- 2080-LC30-48QBB
- 2080-LC30-48QVB
- 2080-LC30-48QWB
- 2080-LC50-24AWB
- 2080-LC50-24QBB
- 2080-LC50-24QVB
- 2080-LC50-24QWB
- 2080-LC50-48AWB
- 2080-LC50-48QBB
- 2080-LC50-48QVB
- 2080-LC50-48QWB

Additional Resources

These documents contain additional information concerning related Rockwell Automation products.

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1 available at http://literature.rockwellautomation.com/idc/groups/literature/documents/in/1770-in041_-en-p.pdf	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

Finding information about instructions and ladder elements

Connected Components Workbench™ includes a comprehensive instruction set with structures and arrays, development environments for ladder logic, structured text, function block diagram, and user-defined function block programs.

Additionally, Connected Components Workbench includes user-interface configuration tools for Micro800™ controllers, PowerFlex® drives, a Safety Relay device, PanelView™ Component graphic terminals, and serial and network connectivity options.

Instruction set

For information about a specific instruction, including a description, parameter details, and language examples, locate the instruction from the table of contents, or from the following reference topics.

Ladder Diagram elements

For a description of the ladder elements used in Connected Components Workbench, see the following section:

Instruction blocks

The Connected Components Workbench instruction set includes IEC 61131-3 compliant instruction blocks. Instruction blocks collectively include operators, functions and function blocks.

- Operators (on page 15)
- Functions (on page 16)
- Function blocks (on page 17)

Operators

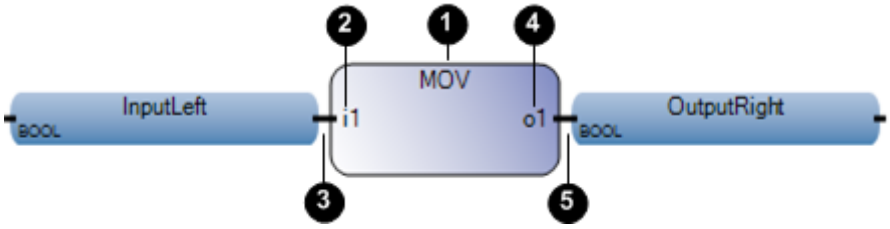
An operator is a basic logical operation such as arithmetic, boolean, comparator, or data conversion.

Functions

Functions have one or more input parameters and one output parameter.

Instruction block format

An instruction block is represented by a single rectangle, and has a fixed number of input connection points and output connection points. An elementary instruction block performs a single function.

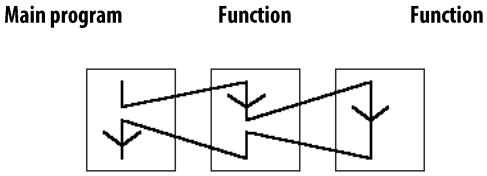


Item No.	Item	Description
1	Block name	The name of the function to be performed by the instruction block is written inside its rectangle shape (at the top).
2	Input	Each input of an instruction block is labeled and has a defined type.
3	Input connection	Inputs are connected on the left border.
4	Output	Each output of an instruction block is labeled and has a defined type.
5	Output connection	Outputs are connected on the right border.

Calling a function

Connected Components Workbench™ does not support recursive function calls. When a function of the Functions section is called by itself or one of its called functions, a run-time error occurs. Furthermore, functions do not store the local values of their local variables. Since functions are not instantiated, they cannot call function blocks.

- A function can be called by a program, by a function, or by a function block.
- Any program of any section can call one or more functions. A function can have local variables.
- A function has no instance meaning local data is not stored and so is usually lost from one call to the other.
- Because the execution of a function is driven by its parent program, the execution of the parent program is suspended until the function ends.



Defining function and parameter names

The interface of a function must be explicitly defined with a type and a unique name for each of its calling (input) parameters or return (output) parameters. A function has one return parameter. The value of a return parameter for a function block is different for each programming language (FBD, LD, ST).

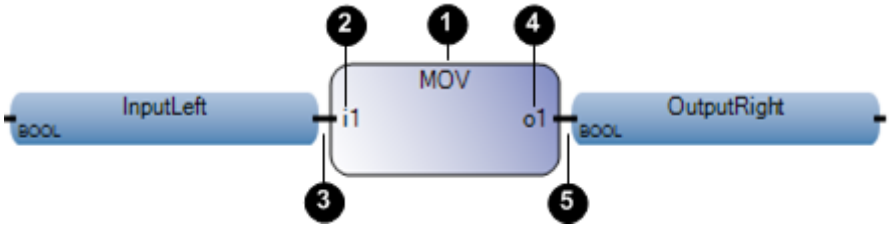
Function names and function parameter names can use up to 128 characters. Function parameter names can begin with a letter or an underscore followed by letters, numbers, and single underscores.

Function blocks

A function block is an instruction block that has input and output parameters and works on internal data (parameters). It can be written in Structured Text, Ladder Diagram, or Function Block Diagram languages.

Instruction block format

An instruction block is represented by a single rectangle, and has a fixed number of input connection points and output connection points. An elementary instruction block performs a single function.



Item No.	Item	Description
1	Block name	The name of the function to be performed by the instruction block is written inside its rectangle shape (at the top).
2	Input	Each input of an instruction block is labeled and has a defined type.
3	Input connection	Inputs are connected on the left border.
4	Output	Each output of an instruction block is labeled and has a defined type.
5	Output connection	Outputs are connected on the right border.

Calling a function block

When a function block is called in a program, an instance of the block is actually called. The instance uses the same code, but the input and output parameters are instantiated, which means local variables are copied for each instance of the function block. The values of the variables of a function block instance are stored from one cycle to the other.

A function block can be called by a program, or by another function block. They cannot be called by functions because functions are not instantiated.

Defining function block and parameter names

The interface of a function block must be explicitly defined with a type and a unique name for each of its calling (input) parameters or return (output) parameters. Function blocks can have more than one output parameter. The value of a return parameter for a function block is different for each programming language (FBD, LD, ST).

Function block names and function block parameter names can use up to 128 characters. Function block parameter names can begin with a letter or an underscore followed by letters, numbers, and single underscores.

Instruction set in alphabetical order

The following table lists the instruction set available in Connected Components workbench in alphabetical order.

Instruction	Instruction block type
ABL (on page 110)	Function block
ABS (on page 62)	Function
ACB (on page 112)	Function block
ACL (on page 114)	Function block
ACOS (on page 64)	Function
ACOS_LREAL (on page 66)	Function
Addition (on page 68)	Operator
AHL (on page 116)	Function block
AND (on page 159)	Operator
AND_MASK (on page 134)	Function
ANY_TO_BOOL (on page 276)	Function
ANY_TO_BYTE (on page 277)	Function
ANY_TO_DATE (on page 278)	Function
ANY_TO_DINT (on page 279)	Function
ANY_TO_DWORD (on page 280)	Function
ANY_TO_INT (on page 281)	Function
ANY_TO_LINT (on page 282)	Function
ANY_TO_LREAL (on page 283)	Function
ANY_TO_LWORD (on page 284)	Function
ANY_TO_REAL (on page 285)	Function
ANY_TO_SINT (on page 286)	Function
ANY_TO_STRING (on page 287)	Function
ANY_TO_TIME (on page 288)	Function
ANY_TO_UDINT (on page 289)	Function
ANY_TO_UINT (on page 290)	Function
ANY_TO_ULINT (on page 291)	Function
ANY_TO_USINT (on page 292)	Function

ANY_TO_WORD (on page 293)	Function
ARD (on page 118)	Function block
ARL (on page 121)	Function block
ASCII (on page 584)	Function
ASIN (on page 69)	Function
ASIN_LREAL (on page 71)	Function
ATAN (on page 73)	Function
ATAN_LREAL (on page 75)	Function
AVERAGE (on page 296)	Function block
AWA (on page 124)	Function
AWT (on page 126)	Function
CHAR (on page 586)	Function
COP (on page 298)	Function block
COS (on page 77)	Function
COS_LREAL (on page 79)	Function
CTD (on page 268)	Function
CTU (on page 270)	Function
CTUD (on page 272)	Function
DELETE (on page 588)	Function
DERIVATE (on page 516)	Function block
Division (on page 81)	Operator
DOY (on page 626)	Function
Equal (on page 260)	Operator
EXPT (on page 82)	Function
FIND (on page 591)	Function
F_TRIG (on page 152)	Function block
Greater Than (on page 262)	Operator
Greater Than or Equal (on page 263)	Operator
HSC (on page 309)	Function block
HSC_SET_STS (on page 330)	Function block
HYSTER (on page 518)	Function block
IIM (on page 375)	Function block
INSERT (on page 593)	Function
INTEGRAL (on page 520)	Function block
IOM (on page 378)	Function block
IPIDCONTROLLER (on page 551)	Function block
KEY_READ (on page 381)	Function block
LCD (on page 356)	Function
LEFT (on page 596)	Function
Less Than (on page 264)	Operator
Less Than or Equal (on page 265)	Operator

LIM_ALRM (on page 58)	Function block
LIMIT (on page 540)	Function
LOG (on page 84)	Function
MAX (on page 305)	Function
MC_AbortTrigger (on page 441)	Function block
MC_Halt (on page 444)	Function block
MC_Home (on page 448)	Function block
MC_MoveAbsolute (on page 453)	Function block
MC_MoveRelative (on page 458)	Function block
MC_MoveVelocity (on page 463)	Function block
MC_Power (on page 469)	Function block
MC_ReadAxisError (on page 473)	Function block
MC_ReadBoolParameter (on page 479)	Function block
MC_ReadParameter (on page 482)	Function block
MC_ReadStatus (on page 485)	Function block
MC_Reset (on page 490)	Function block
MC_SetPosition (on page 493)	Function block
MC_Stop (on page 497)	Function block
MC_TouchProbe (on page 501)	Function block
MC_WriteBoolParameter (on page 506)	Function block
MC_WriteParameter (on page 510)	Function block
MID (on page 598)	Function
MIN (on page 303)	Function
MLEN (on page 600)	Function
MM_INFO (on page 389)	Function block
MOD (on page 86)	Function
MOV (on page 88)	Operator
MSG_CIPGENERIC (on page 178)	Function
MSG_CIPSYMBOLIC (on page 187)	Function
MSG_MODBUS (on page 199)	Function
MSG_MODBUS2 (on page 206)	Function
Multiplication (on page 89)	Operator
MUX4B (on page 174)	Function
MUX8B (on page 168)	Function
NOT (on page 161)	Operator
Not Equal (on page 266)	Operator
Neg (on page 90)	Operator
NOT_MASK (on page 136)	Function
OR_MASK (on page 138)	Function
OR (on page 158)	Operator
PLUGIN_INFO (on page 392)	Function block

PLUGIN_READ (on page 395)	Function block
PLUGIN_RESET (on page 398)	Function block
PLUGIN_WRITE (on page 400)	Function block
POW (on page 91)	Function
R_TRIG (on page 154)	Function block
RAND (on page 93)	Function
REPLACE (on page 605)	Function
RHC (on page 368)	Function
RIGHT (on page 602)	Function
ROL (on page 140)	Function
ROR (on page 142)	Function
RPC (on page 370)	Function
RS (on page 156)	Function block
RTC_READ (on page 405)	Function block
RTC_SET (on page 408)	Function block
SCALER (on page 532)	Function block
SHL (on page 144)	Function
SHR (on page 146)	Function
SIN (on page 95)	Function
SIN_LREAL (on page 97)	Function
SQRT (on page 99)	Function
SR (on page 162)	Function block
STACKINT (on page 535)	Function block
STIS (on page 418)	Function
Subtraction (on page 101)	Operator
SUS (on page 544)	Function block
SYS_INFO (on page 411)	Function block
TAN (on page 102)	Function
TAN_LREAL (on page 104)	Function
TDF (on page 629)	Function
TND (on page 538)	Function
TOF (on page 611)	Function block
TON (on page 614)	Function block
TONOFF (on page 617)	Function block
TOW (on page 631)	Function
TP (on page 620)	Function block
TRIMPOT_READ (on page 413)	Function block
TRUNC (on page 106)	Function
TTABLE (on page 164)	Function
UIC (on page 420)	Function
UID (on page 422)	Function

UIE (on page 424)	Function
UIF (on page 426)	Function
XOR_MASK (on page 148)	Function
XOR (on page 160)	Operator

Instruction set by type and function

Function blocks

The following table lists the function blocks by functional category.

Instruction	Functional category
ABL (on page 110)	ASCII serial port instructions (on page 109)
ACB (on page 112)	
ACL (on page 114)	
AHL (on page 116)	
ARD (on page 118)	
ARL (on page 121)	
AWA (on page 124)	
AWT (on page 126)	
AVERAGE (on page 296)	Data manipulation instructions (on page 295)
COP (on page 298)	
CTD (on page 268)	Counter instructions (on page 267)
CTU (on page 270)	
CTUD (on page 272)	
DERIVATE (on page 516)	Process control instructions (on page 515)
F_TRIG (on page 152)	Boolean instructions (on page 151)
HSC (on page 309)	Input/Output instructions (on page 355)
HSC_SET_STS (on page 330)	
HYSTER (on page 518)	Process control instructions (on page 515)
IIM (on page 375)	Input/Output instructions (on page 355)
INTEGRAL (on page 520)	Process control instructions (on page 515)
IOM (on page 378)	Input/Output instructions (on page 355)
IPIDCONTROLLER (on page 551)	Proportional Integral Derivative (PID) instruction (on page 547)
KEY_READ (on page 381)	Input/Output instructions (on page 355)
LIM_ALRM (on page 58)	Alarm instruction (on page 57)
MC_AbortTrigger (on page 441)	Motion control instructions (on page 429)
MC_Halt (on page 444)	
MC_Home (on page 448)	
MC_MoveAbsolute (on page 453)	
MC_MoveRelative (on page 458)	
MC_MoveVelocity (on page 463)	
MC_Power (on page 469)	

Instruction	Functional category
MC_ReadAxisError (on page 473)	
MC_ReadBoolParameter (on page 479)	
MC_ReadParameter (on page 482)	
MC_ReadStatus (on page 485)	
MC_Reset (on page 490)	
MC_SetPosition (on page 493)	
MC_Stop (on page 497)	
MC_TouchProbe (on page 501)	
MC_WriteBoolParameter (on page 506)	
MC_WriteParameter (on page 510)	
MM_INFO (on page 389)	Input/Output instructions (on page 355)
MSG_CIPGENERIC (on page 178)	Communication instructions (on page 177)
MSG_CIPSYMBOLIC (on page 187)	
MSG_MODBUS (on page 199)	
MSG_MODBUS2 (on page 206)	
PLUGIN_INFO (on page 392)	Input/Output instructions (on page 355)
PLUGIN_READ (on page 395)	
PLUGIN_RESET (on page 398)	
PLUGIN_WRITE (on page 400)	
R_TRIG (on page 154)	Boolean instructions (on page 151)
RS (on page 156)	
RTC_READ (on page 405)	Input/Output instructions (on page 355)
RTC_SET (on page 408)	
SCALER (on page 532)	Process control instructions (on page 515)
SR (on page 162)	Boolean instructions (on page 151)
STACKINT (on page 535)	Process control instructions (on page 515)
SUS (on page 544)	Program control instruction (on page 543)
SYS_INFO (on page 411)	Input/Output instructions (on page 355)
TOF (on page 611)	Timer instructions (on page 609)
RTO (on page 623)	
TON (on page 614)	
TONOFF (on page 617)	
TP (on page 620)	
TRIMPOT_READ (on page 413)	Input/Output instructions (on page 355)

Functions

The following table lists the functions by functional category.

Instruction	Functional category
ABS (on page 62)	Arithmetic instructions (on page 61)
ACOS (on page 64)	
ACOS_LREAL (on page 66)	
AND_MASK (on page 134)	Binary instructions (on page 133)
ASCII (on page 584)	String manipulation instructions (on page 583)
ASIN (on page 69)	Arithmetic instructions (on page 61)
ASIN_LREAL (on page 71)	
ATAN (on page 73)	
ATAN_LREAL (on page 75)	
CHAR (on page 586)	String manipulation instructions (on page 583)
COS (on page 77)	Arithmetic instructions (on page 61)
COS_LREAL (on page 79)	
DELETE (on page 588)	String manipulation instructions (on page 583)
DOY (on page 626)	Timer instructions (on page 609)
EXPT (on page 82)	Arithmetic instructions (on page 61)
FIND (on page 591)	String manipulation instructions (on page 583)
INSERT (on page 593)	
LCD (on page 356)	Input/Output instructions (on page 355)
LEFT (on page 596)	String manipulation instructions (on page 583)
LIMIT (on page 540)	Process control instructions (on page 515)
LOG (on page 84)	Arithmetic instructions (on page 61)
MAX (on page 305)	Data manipulation instructions (on page 295)
MID (on page 598)	String manipulation instructions (on page 583)
MIN (on page 303)	Data manipulation instructions (on page 295)
MLEN (on page 600)	String manipulation instructions (on page 583)
MOD (on page 86)	Arithmetic instructions (on page 61)
MUX4B (on page 174)	Boolean instructions (on page 151)
MUX8B (on page 168)	
NOT_MASK (on page 136)	Binary instructions (on page 133)
OR_MASK (on page 138)	
POW (on page 91)	Arithmetic instructions (on page 61)
RAND (on page 93)	
REPLACE (on page 605)	String manipulation instructions (on page 583)
RHC (on page 368)	Input/Output instructions (on page 355)
RIGHT (on page 602)	String manipulation instructions (on page 583)

Instruction	Functional category
ROL (on page 140)	Binary instructions (on page 133)
ROR (on page 142)	
RPC (on page 370)	Input/Output instructions (on page 355)
SHL (on page 144)	Binary instructions (on page 133)
SHR (on page 146)	
SIN (on page 95)	Arithmetic instructions (on page 61)
SIN_LREAL (on page 97)	
SQRT (on page 99)	
STIS (on page 418)	Interrupt instructions (on page 417)
TAN (on page 102)	Arithmetic instructions (on page 61)
TAN_LREAL (on page 104)	
TDF (on page 629)	Timer instructions (on page 609)
TND (on page 538)	Process control instructions (on page 515)
TOW (on page 631)	Timer instructions (on page 609)
TRUNC (on page 106)	Arithmetic instructions (on page 61)
TTABLE (on page 164)	Boolean instructions (on page 151)
UIC (on page 420)	Interrupt instructions (on page 417)
UID (on page 422)	
UIE (on page 424)	
UIF (on page 426)	
XOR_MASK (on page 148)	Binary instructions (on page 133)

Operators

The following table lists the operators by functional category.

Instruction	Functional category
Addition (on page 68)	Arithmetic instructions (on page 61)
AND (on page 159)	Boolean instructions (on page 151)
ANY_TO_BOOL (on page 276)	Data conversion instructions (on page 275)
ANY_TO_BYTE (on page 277)	
ANY_TO_DATE (on page 278)	
ANY_TO_DINT (on page 279)	
ANY_TO_DWORD (on page 280)	
ANY_TO_INT (on page 281)	
ANY_TO_LINT (on page 282)	
ANY_TO_LREAL (on page 283)	
ANY_TO_LWORD (on page 284)	
ANY_TO_REAL (on page 285)	
ANY_TO_SINT (on page 286)	
ANY_TO_STRING (on page 287)	
ANY_TO_TIME (on page 288)	
ANY_TO_UDINT (on page 289)	
ANY_TO_UINT (on page 290)	
ANY_TO_ULINT (on page 291)	
ANY_TO_USINT (on page 292)	
ANY_TO_WORD (on page 293)	
Division (on page 81)	Arithmetic instructions (on page 61)
Equal (on page 260)	Compare instructions (on page 259)
Greater Than (on page 262)	
Greater Than or Equal (on page 263)	
Less Than (on page 264)	
Less Than or Equal (on page 265)	
MOV (on page 88)	Arithmetic instructions (on page 61)
Multiplication (on page 89)	
Neg (on page 90)	
NOT (on page 161)	Boolean instructions (on page 151)
Not Equal (on page 266)	Compare instructions (on page 259)
OR (on page 158)	Boolean instructions (on page 151)
Subtraction (on page 101)	Arithmetic instructions (on page 61)
XOR (on page 160)	Boolean instructions (on page 151)

Ladder Diagram (LD) language

Ladder diagram language reference.

Element	Description
LD program (on page 29)	Graphical representation of Boolean equations which combines contacts (input arguments) with coils (output results) using graphic symbols.
LD program development environment (on page 30)	Example showing the language editor for an Ladder Diagram (LD) program.
Ladder Diagram (LD) elements (on page 31)	Components used to build a Ladder Diagram program.
Instruction blocks in LD programs (on page 49)	IEC 61131-3 compliant instruction blocks collectively include function blocks, functions and operators.
Working in the LD language editor (on page 50)	Adding elements to a LD program.
Ladder Diagram (LD) program examples (on page 51)	Examples of Ladder Diagram (LD) programs.
LD Keyboard shortcuts (on page 53)	Keyboard shortcuts available for the Ladder Diagram (LD) language.

LD program

A Ladder Diagram (LD) is a graphical representation of Boolean equations that combines contacts (input arguments) with coils (output results). Using graphic symbols in a program chart (organized like a relay ladder wiring diagram), the LD language describes the tests and modifications of Boolean data.

LD graphic symbols are organized within the chart as an electrical contact diagram. The term "ladder" comes from the concept of rungs connected to vertical power rails at both ends where each rung represents an individual circuit.

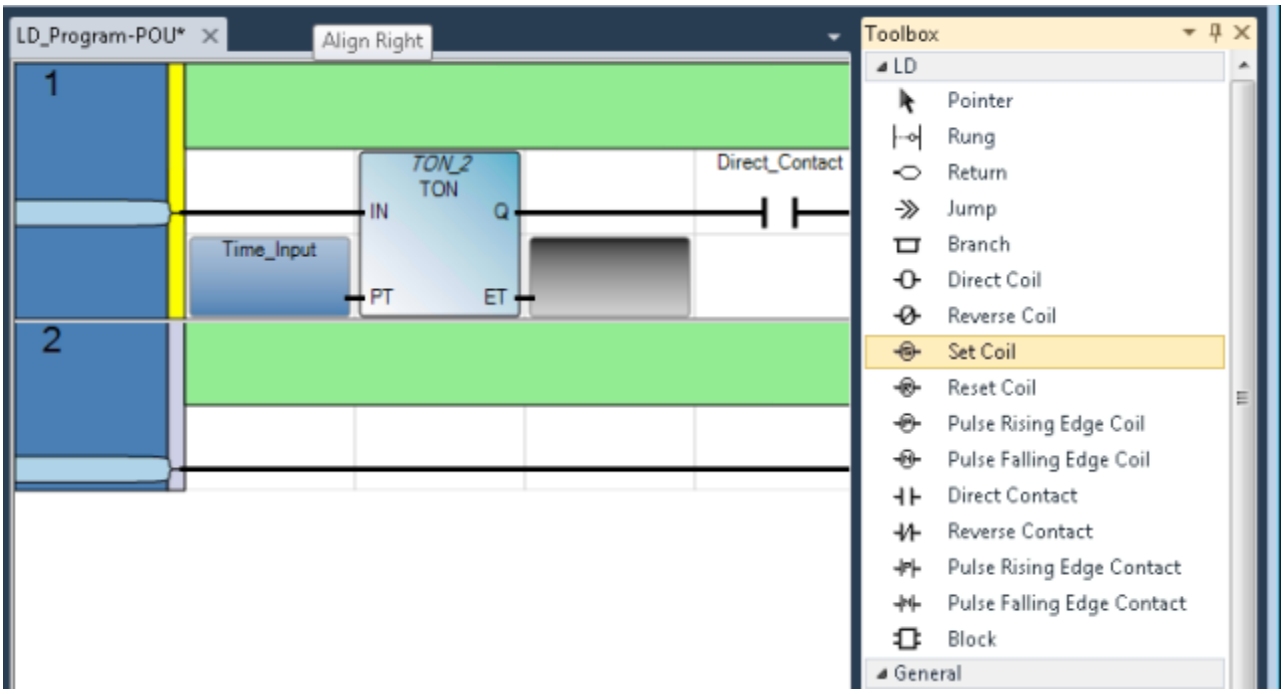
Connected Components Workbench™ support for Ladder Diagram (LD)

Connected Components Workbench™ provide

s an LD language editor and supports the elements and instructions that are supplied with the Connected Components Workbench software only.

LD program development environment

The following illustration shows the language editor for an LD program where you develop an LD Program Organizational Unit (POU). Use the LD Toolbox or LD keyboard shortcuts to add elements to your LD POU.



Ladder Diagram (LD) elements

Ladder diagram elements are the components that you use to build a ladder diagram program. All the elements listed in the following table can be added to your ladder diagram from the LD Toolbox within Connected Components Workbench.

Element	Description
Rung (on page 31)	Represents a group of circuit elements that lead to the activation of a coil.
Instruction Block (LD) (on page 34)	Instructions include operators, functions, and function blocks including user-defined function blocks.
Branch (on page 33)	Two or more instructions in parallel.
Coil (on page 39)	Represents the assignment of outputs or internal variables. In an LD program, a coil represents an action.
Contact (on page 44)	Represents the value or function of an input or internal variable.
Return (on page 48)	Represents the conditional end of a diagram output.
Jump (on page 49)	Represents the conditional and unconditional logic in the LD program that control the control the execution of diagrams.

Rung

Rungs are graphic components of an LD diagram that represent a group of circuit elements that lead to the activation of a coil. Rungs can have labels to identify them within the diagram. Labels, along with jumps, control the execution of a diagram. You can enter comments (free-format text) above the rung for documentation purposes.

Change the default width of rungs

Follow these steps to use a new width for rungs. You cannot adjust the width of existing rungs within a project.

1. From the **Tools** menu, select **Options**.
2. Click **IEC Languages**, and then **Ladder Diagram**.
3. Under **Container Settings**, click **Cell Width**.
4. Increase the cell width value, and then click **OK**.

5. Create and open a new LD program.

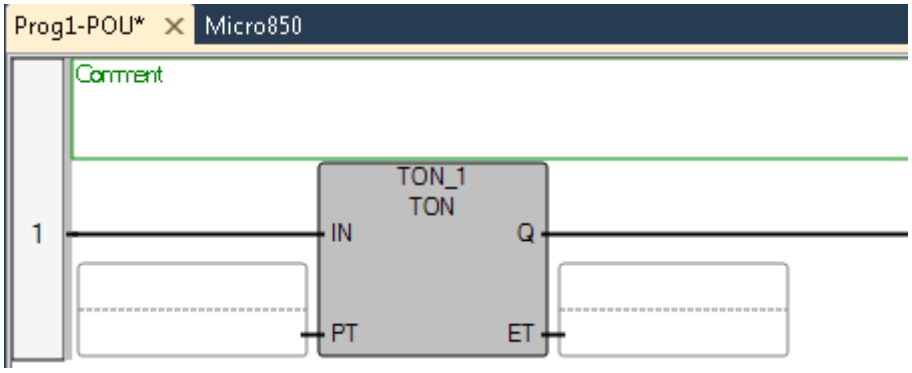
6. Hold down the **Ctrl** key while rolling the thumb wheel down on your mouse until the entire rung is visible on your computer.

Rung comments

Comments you enter in the space above the rung are saved in rich text format and stored in the controller.

1. In the **Language Editor**, double-click the rectangular area above the rung, then type comments.
   Tip: If the **Comment** is not showing, right-click the left rectangle area of the rung and select **Display Comment.**

2. Click anywhere in the **Language Editor** workspace to save the comments.



Add a label to a rung

Labels are optional additions for every rung in the **Language Editor.**

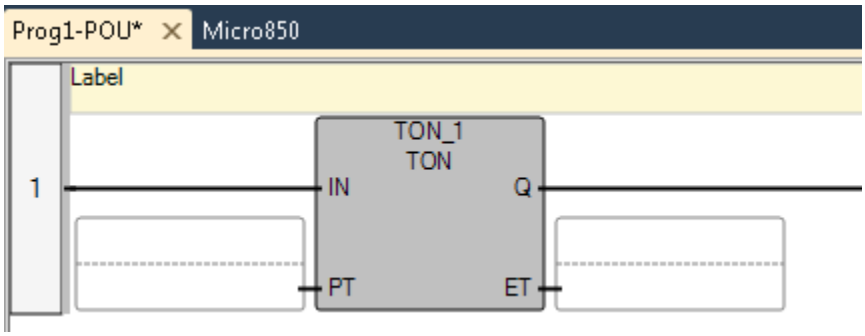
Label name requirements

Labels can be an unlimited number of characters, beginning with a letter or underscore character followed by letters, numbers, and underscore characters. Labels cannot have spaces or special characters (for example, '+', '-', or '\').

To add a label for a rung

1. Right-click the area to the left of the rung, and select **Add Label**.
2. Select the **Label**, and type a description for the rung.

Example: Label



To add an element to an LD program

To add a rung to the LD language editor, do one of the following:

- From the **Toolbox**, drag the rung element into the language editor, or
- From the **Toolbox**, double-click the rung element to add it to the language editor, or
- Right-click and existing rung, select **Copy** and then paste a copy of the rung into the language editor.

Tip:	A plus sign (+) appears on top of a Toolbox element when you hover over a valid target. Release the mouse button to add the element.
Tip:	You can use keyboard shortcut keys to add elements to your LD program. See LD Keyboard shortcuts (on page 53).
Tip:	If your ladder diagram contains more than 355 rungs, use the down triangle rather than the scroll bar to view additional rungs. 

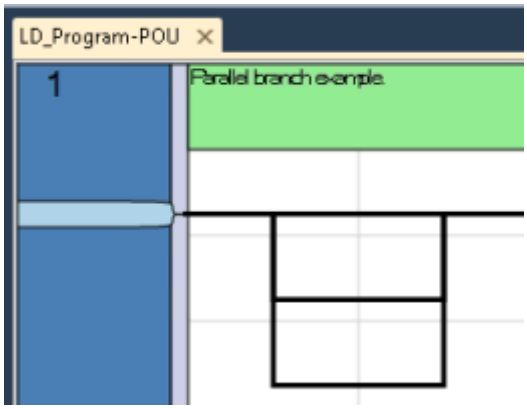
Branch

Branches create alternative routing for connections. You can add parallel branches to elements on a rung.

Add a branch

From the **Toolbox**, drag the branch element onto an existing element within the language editor.

Example: Branches



Add a label to a rung

Labels are optional additions for every rung in the **Language Editor**.

Label name requirements

Labels can be an unlimited number of characters, beginning with a letter or underscore character followed by letters, numbers, and underscore characters. Labels cannot have spaces or special characters (for example, '+', '-', or '\').

To add a label for a rung

1. Right-click the area to the left of the rung, and select **Add Label**.
2. Select the **Label**, and type a description for the rung.

Instruction Block (LD)

A LD instruction block element is a functional element in a LD diagram that can be a function block, a function, a user-defined function block, or an operator.

LD instruction blocks

The Connected Components Workbench instruction set includes IEC 61131-3 compliant instruction blocks. Instruction blocks collectively include operators, functions and function blocks.

Add an Instruction Block to an LD program

Use the LD Toolbox to add an Instruction Block element to an LD program. After you add the instruction block, you can configure its variables from the **Instruction Block Selector** or from the **Variable Selector**.

Follow these steps to add an Instruction Block element to an LD program, or change an existing instruction block to a different type.

Add an instruction block element to a program

1. From the **Toolbox**, drag the instruction block element into the language editor and place it in the correct location to display the **Instruction Block Selector**.
2. In Search type the name of the instruction block you want to add or sort and scroll through the list to find it.
3. Double-click the instruction block to add it to the program.

Change the block element type

1. In the language editor, double-click the block to display the **Instruction Block Selector**.
2. In Search type the name of the instruction block or sort and scroll through the list to find it.
3. Double-click the instruction block to update it.

Enable EN/ENO

You can enable the EN input parameter and ENO output parameter so they will always be added with the instruction block even when there is an available boolean input or output.

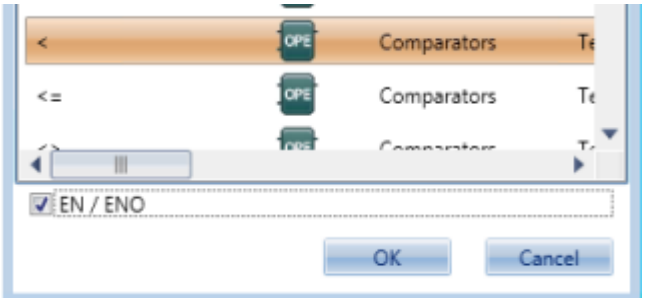
Note: The EN and ENO parameters will only be added to instruction blocks you add after you enable the setting - instructions blocks already in the LD program will not be affected.

To enable EN/ENO for all blocks added to LD program

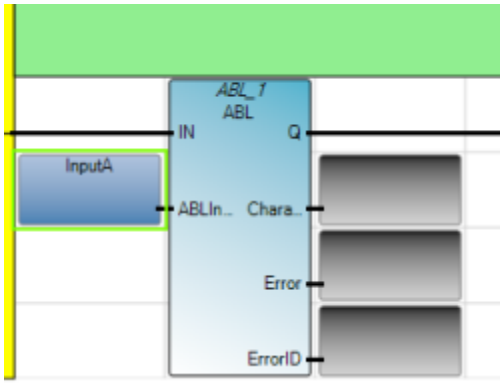
1. On the **Tool** menu, click **Options**.
2. Select IEC Languages > Ladder Diagram (LD) to display the language editor properties.
3. In **Block Settings**, set **Enable EN/ENO** to **True**.
4. Click **OK**.

To enable EN/ENO for the block

1. After selecting a block in the Block Selector, select EN/ENO (located at the bottom of the list).
2. In the Block Selector, after selecting at the bottom of the list of instructions, select EN/ENO.



Example: Instruction Block (LD)



Use of enable inputs and enable outputs in LD instruction blocks

The rung state in an LD diagram is always boolean, and a block's first input and first output is connected to the rung.

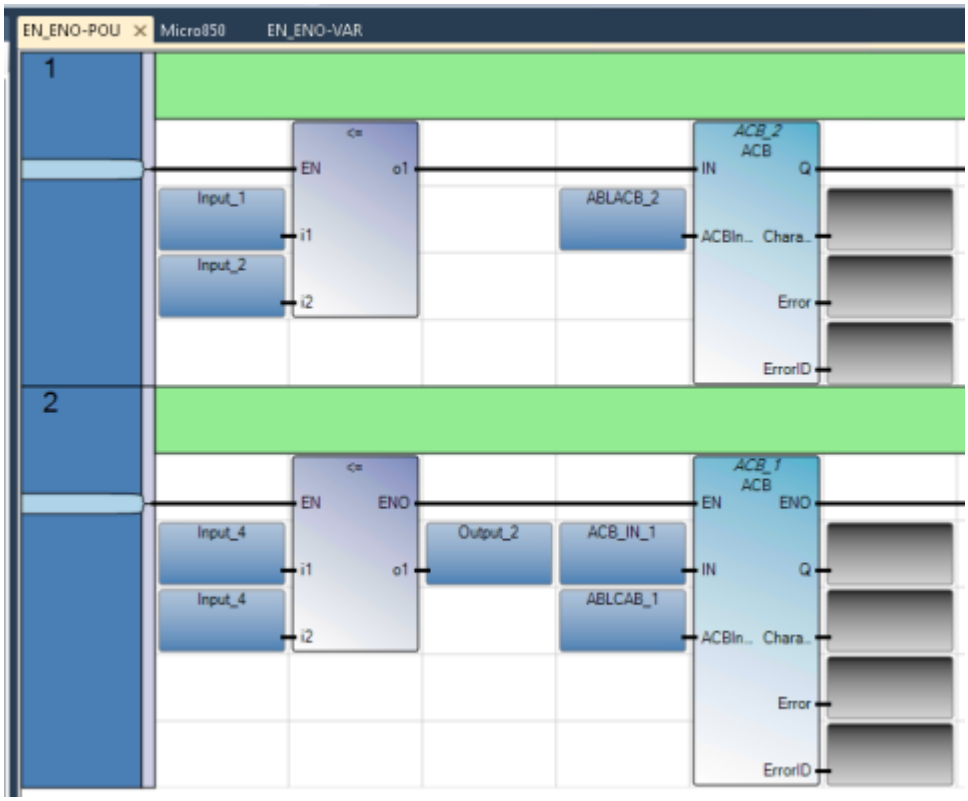
EN input/EN output

If a first boolean input or output is not present, an EN and/or an ENO parameter will be added to the block.

- If the first block input is not boolean, an EN input parameter is added to the block. The instruction block is executed only when the EN input is TRUE.
- If the first block output is not boolean, an ENO output parameter is added to the block. The ENO output always has the same state as the first input of the instruction block.

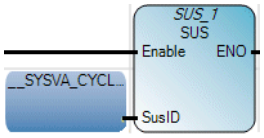
You can enable/disable the EN/ENO block settings for an individual instruction block in the Block Selector, or in Block Settings for the Ladder Diagram (LD) program. The following table describes the results of enabling and disabling the EN/ENO parameters in the blocks shown in the illustration.

Rung	EN/ENO	Block	1st boolean input	EN input added?	1st boolean output	ENO output added?
1	False	<=	No	Yes	Yes	No
		ACB	Yes	No	Yes	No
2	True	<=	No	Yes	Yes	Yes
		ACB	Yes	Yes	Yes	Yes



Example: Enable input

In some cases, Enable parameters are required for instruction blocks that execute on call. The following example shows an SUS instruction block with an Enable input.



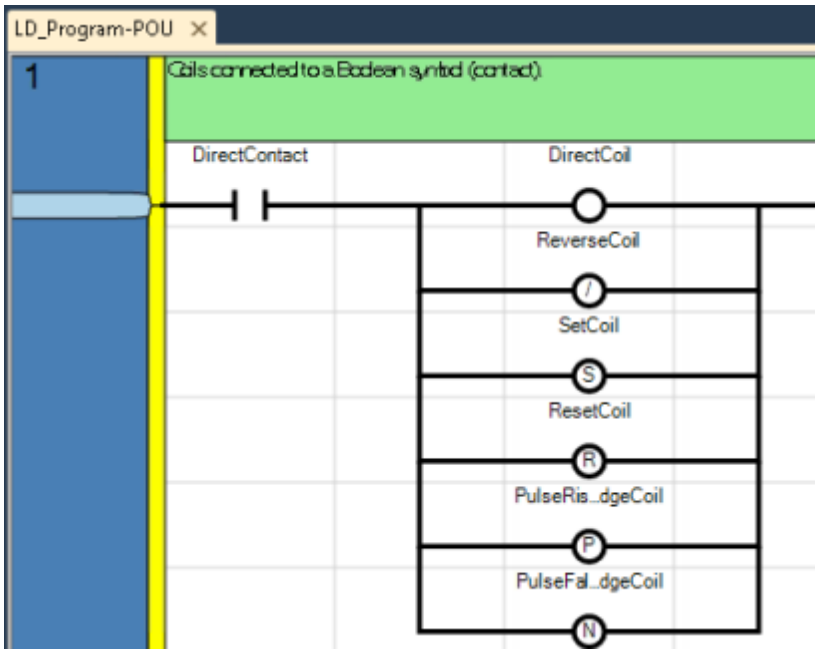
Coil

Coils are graphic components of an LD diagram that represent the assignment of an output or of an internal variable. In an LD diagram, a coil represents an action. A coil must be connected on the left to a Boolean symbol, such as a contact, or to a Boolean output of an instruction block. Consequently, coils can only be added to a defined rung in the LD language editor. After a coil is added, its definition can be modified.

You can add the following coil element types to your LD program from the Toolbox.

Coil element	Description
Direct coil (on page 41)	Direct coils support a Boolean output of a connection line Boolean state.
Reverse coil (on page 41)	Reverse coils support a Boolean output according to the Boolean negation of a connection line state.
Pulse rising edge coil (on page 42)	Pulse rising edge (or positive) coils support a Boolean output of a connection line Boolean state.
Pulse falling edge coil (on page 42)	Pulse falling edge (or negative) coils support a Boolean output of a connection line Boolean state.
Set coil (on page 43)	Set coils support a Boolean output of a connection line Boolean state.
Reset coil (on page 44)	Reset coils support a Boolean output of a connection line Boolean state.

Example: Coils



Adding coil elements

Follow these steps to add and modify coil elements.

Add a coil element

1. Verify the LD program has a defined rung for the coil.
2. From the **Toolbox**, drag the coil into the LD language editor to the right of a Boolean symbol or of a Boolean output.
3. Assign a variable to the coil.

Tip:	A plus sign (+) appears on top of a Toolbox element when you hover over a valid target. Release the mouse button to add the element.
Tip:	You can use keyboard shortcut keys to add elements to your LD program. See LD Keyboard shortcuts (on page 53).

Insert a parallel coil

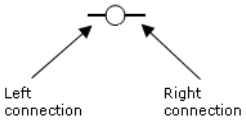
1. From the **Toolbox**, drag the branch element into the language editor, and place it just slightly above the rung element.
2. From the **Toolbox**, drag a coil element into the language editor, and place it on the branch element to display the coil on the branch.

Change the type of coil

In the language editor, select the coil, then press the **space bar** until the new coil type is available. Every time the **space bar** is pressed the type changes from direct, to reverse, to set, to reset, to pulse rising edge, to pulse falling edge.

Direct Coil

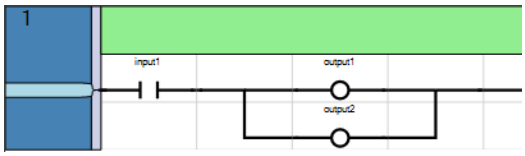
A direct coil supports a Boolean output of a connection line Boolean state.



The associated variable is assigned with the Boolean state of the left connection. The state of the left connection is propagated into the right connection. The right connection must be connected to the right vertical power rail (unless you have parallel coils, where only the upper coil must be connected to the right vertical power rail).

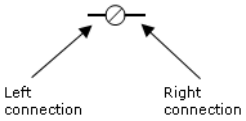
The associated Boolean variable must be an output or it must be user-defined.

Example: Direct coil



Reverse Coil

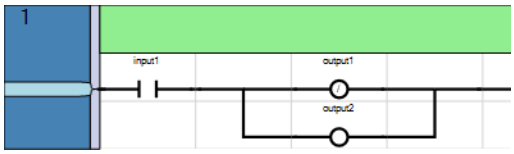
A reverse coil element supports a Boolean output according to the Boolean negation of a connection line state.



The associated variable is assigned with the Boolean negation of the state of the left connection. The state of the left connection is propagated into the right connection. The right connection must be connected to the right vertical power rail (unless you have parallel coils, where only the upper coil must be connected to the right vertical power rail).

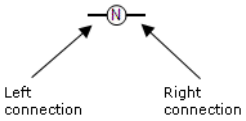
The associated Boolean variable must be output or it must be user-defined.

Example: Reverse Coil



Pulse Falling Edge Coil

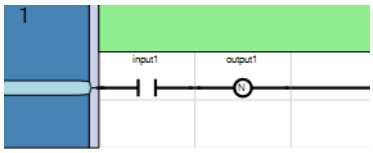
Pulse falling edge (or negative) coils support a Boolean output of a connection line Boolean state.



The associated variable is set to TRUE when the Boolean state of the left connection falls from TRUE to FALSE. The output variable resets to FALSE in all other cases. The state of the left connection is propagated into the right connection. The right connection must be connected to the right vertical power rail (unless you have parallel coils, where only the upper coil must be connected to the right vertical power rail).

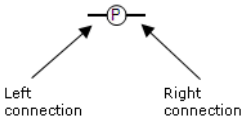
The associated Boolean variable must be output or it must be user-defined.

Example: Pulse Falling Edge Coil



Pulse Rising Edge Coil

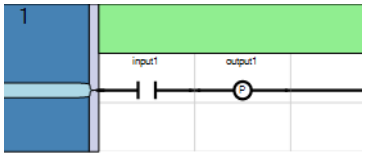
Pulse rising edge (or positive) coils support a Boolean output of a connection line Boolean state.



The associated variable is set to TRUE when the Boolean state of the left connection rises from FALSE to TRUE. The output variable resets to FALSE in all other cases. The state of the left connection is propagated into the right connection. The right connection must be connected to the right vertical power rail (unless you have parallel coils, where only the upper coil must be connected to the right vertical power rail).

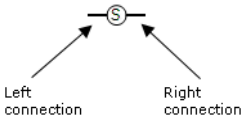
The associated Boolean variable must be output or user-defined.

Example: Pulse Rising Edge Coil



Set Coil

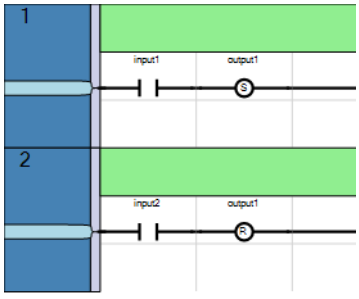
Set coils support a Boolean output of a connection line Boolean state.



The associated variable is set to TRUE when the Boolean state of the left connection becomes TRUE. The output variable keeps this value until an inverse order is made by a Reset coil. The state of the left connection is propagated into the right connection. The right connection must be connected to the right vertical power rail (unless you have parallel coils, where only the upper coil must be connected to the right vertical power rail).

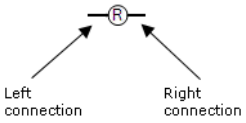
The associated Boolean variable must be output or it must be user-defined.

Example: Set Coil



Reset Coil

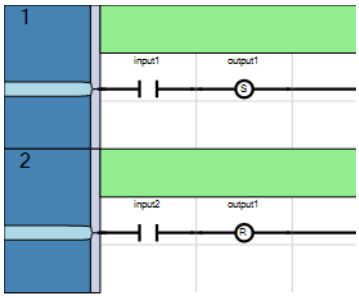
Reset coils support a Boolean output of a connection line Boolean state.



The associated variable is reset to FALSE when the Boolean state of the left connection becomes TRUE. The output variable keeps this value until an inverse order is made by a Set coil. The state of the left connection is propagated into the right connection. The right connection must be connected to the right vertical power rail (unless you have parallel coils, where only the upper coil must be connected to the right vertical power rail).

The associated Boolean variable must be output or user-defined.

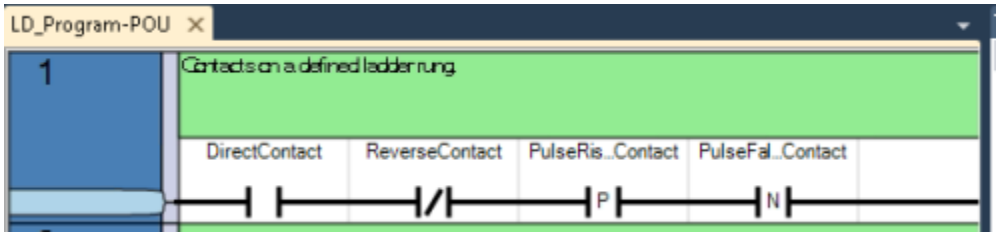
Example: Reset Coil



Contact

Contacts are graphic components of an LD diagram. Depending on the type, a contact represents the value or function of an input or of an internal variable. Contacts can only be added to a defined rung in the LD language editor. After a contact is added, its definition can be modified.

Example: Contacts



You can add the following contact element types to your LD program from the LD Toolbox in Connected Components Workbench.

Contact element	Description
Direct contact (on page 46)	Direct contacts support a Boolean operation between a connection line state and a Boolean variable.
Reverse contact (on page 46)	Reverse contacts support a Boolean operation between a connection line state and the Boolean negation of a Boolean variable.
Pulse rising edge contact (on page 47)	Pulse rising edge (or positive) contacts support a Boolean operation between a connection line state and the rising edge of a Boolean variable.
Pulse falling edge contact (on page 46)	Pulse falling edge (negative) contacts enable a Boolean operation between a connection line state and the falling edge of a Boolean variable.

Adding contact elements

Follow these steps to add a contact element to the ladder rung or change the type of contact used.

Add a contact element

1. Verify the LD program has a defined rung for the contact.
2. From the **Toolbox**, drag the contact element into the language editor and position it on the rung.

Tip:	A plus sign (+) appears on top of a Toolbox element when you hover over a valid target. Release the mouse button to add the element.
Tip:	You can use keyboard shortcut keys to add elements to your LD program. See LD Keyboard shortcuts (on page 53).

Insert a parallel contact

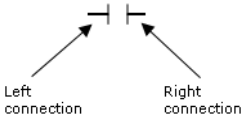
1. From the **Toolbox**, drag the branch element into the language editor, and place it on the existing contact.
2. From the **Toolbox**, drag a contact element into the language editor, and place it on the branch.

Change the type of contact

In the language editor, select the contact, then press the **space bar** until the contact type you want to use is displayed in the language editor.

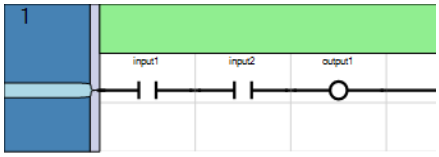
Direct Contact

Direct contacts support a Boolean operation between a connection line state and a Boolean variable.



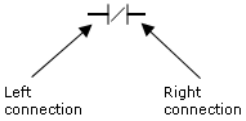
The state of the connection line on the right of the contact is the logical AND between the state of the left connection line and the value of the variable associated with the contact.

Example: Direct Contact



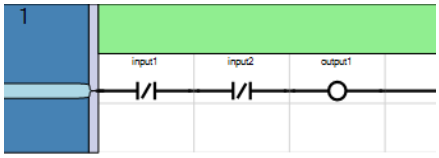
Reverse Contact

Reverse contacts support a Boolean operation between a connection line state and the Boolean negation of a Boolean variable.



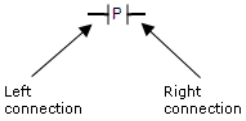
The state of the connection line on the right of the contact is the logical AND between the state of the left connection line and the Boolean negation of the value of the variable associated with the contact.

Example: Reverse Contact



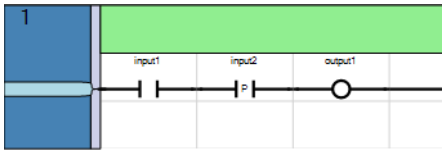
Pulse Rising Edge Contact

Pulse rising edge (or positive) contacts support a Boolean operation between a connection line state and the rising edge of a Boolean variable.



The state of the connection line on the right of the contact is set to TRUE when the state of the connection line on the left is TRUE, and the state of the associated variable rises from FALSE to TRUE. The state is reset to FALSE in all other cases.

Example: Pulse Rising Edge Contact

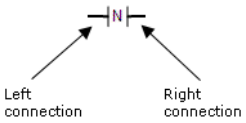


Recommendation: Restrict the use of output variables with edge contacts

We recommend you do not use outputs or variables with a Pulse rising edge contact (positive) or a Pulse falling edge contact (negative). These contacts are for physical inputs in a ladder diagram. If you need to detect the edge of a variable or an output, we recommend you use the R_TRIG/F_TRIG function block, which is supported and works in any language at any location in your program.

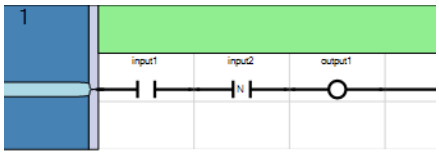
Pulse Falling Edge Contact

Pulse falling edge (or negative) contacts support a Boolean operation between a connection line state and the falling edge of a Boolean variable.



The state of the connection line on the right of the contact is set to TRUE when the state of the connection line on the left is TRUE, and the state of the associated variable falls from TRUE to FALSE. The state is reset to FALSE in all other cases.

Example: Pulse Falling Edge Contact



Recommendation: Restrict the use of output variables with edge contacts

We recommend you do not use outputs or variables with a Pulse rising edge contact (positive) or a Pulse falling edge contact (negative). These contacts are for physical inputs in a ladder diagram. If you need to detect the edge of a variable or an output, we recommend you use the R_TRIG/F_TRIG function block, which is supported and works in any language at any location in your program.

Return

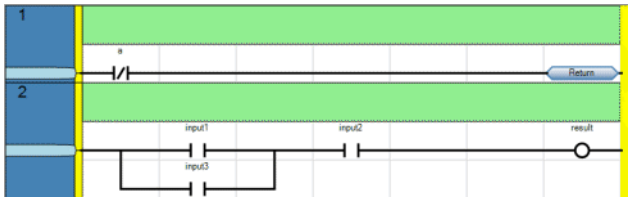
Returns are outputs that represent a conditional end of an LD diagram.

Note: You cannot place connections to the right of a return element.

When the left connection line has the TRUE Boolean state, the diagram ends without executing the instructions located on the next lines of the diagram.

When the LD diagram is a function, its name is associated with an output coil to set the return value (returned to the calling diagram).

Example: Return



Insert a return

From the **Toolbox**, drag the return element into the language editor and place it on the rung.

Jump

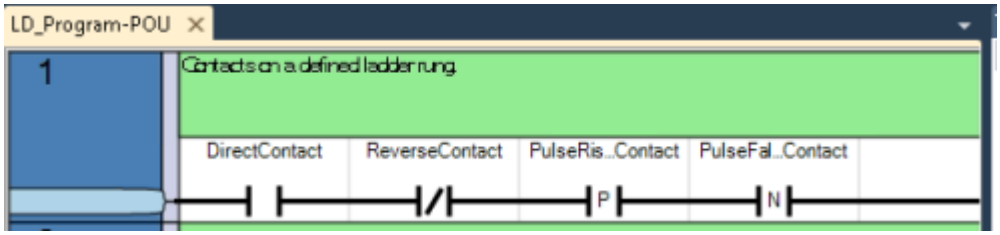
Jumps are conditional or unconditional elements that control the execution of an LD diagram.

Jump notation

The following notation indicates a jump to the LAB label:

>>LAB - Jump to a label where the label name is "LAB"

Example: Jump



Instruction blocks in LD programs

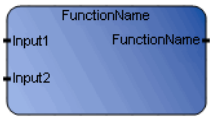
The Connected Components Workbench instruction set includes IEC 61131-3 compliant instruction blocks. Instruction blocks collectively include function blocks, functions and operators. You can connect instruction block inputs and outputs to variables, contacts, coils, or other instruction block inputs and outputs.

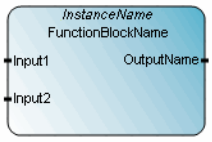
Instruction block conventions

The IEC61131-3 programming language specification addresses numerous aspects of programmable controllers including the operating system execution, data definitions, programming languages, and instruction sets. The IEC61131-3 specification provides a minimum set of functionality that can be extended to meet end user applications.

Instruction block names

Functions and function blocks are represented by a box that displays the name of the instruction, and the short version of the parameter names. For function blocks, the instance name is displayed in italics.





Instruction block return parameters

- The return parameter of a function has the same name as the function. The return parameter is the only output.
- The return parameters of a function block can have any name. Multiple return parameters can provide multiple outputs.
- You can define the parameters of programs for multiple devices by navigating the tabs for individual devices displayed in the Parameter view.

Working in the LD language editor

How elements are added to a ladder diagram

When you add items to a rung in the LD program, they are added according to the following criteria.

- The first element on a rung is inserted at the position you select in the ladder diagram.
- Subsequent elements are inserted to the right of the selected item on the rung.
- If the element is too large for the current rung, the element is placed on the next rung.

Add an element to an LD program

From the **LD Toolbox**, drag the element into the LD language editor, and place it on a rung.

Tip:	A plus sign (+) appears on top of a Toolbox element when you hover over a valid target. Release the mouse button to add the element.
Tip:	You can use keyboard shortcut keys to add elements to your LD program. See LD Keyboard shortcuts (on page 53).

Replace a variable assigned to an element

You can replace an assigned variable directly from the language editor, or from the Variable Selector.

To modify a variable from the language editor

1. In the language editor, click the variable name to display a drop-down list of global and local variables.

Do one of the following:

- Type a new variable name in the text box.
  -Or-
- Select a different variable name from the drop-down list.

To modify a variable from the Variable Selector

1. In the language editor, double-click the variable to open the **Variable Selector**.
2. Click the variable name, then select a different variable from the drop-down list of global and local variables.
3. Click an existing variable, then type constant values in the text box provided.

Ladder Diagram (LD) program examples

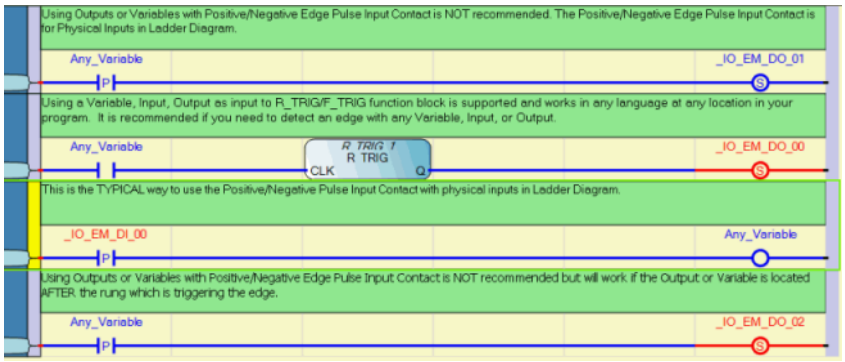
See the following examples of Ladder Diagram (LD) programs.

Example: R_TRIG function block (on page 52)

Example: Comparing Real Values using Subtraction (-) ABS, and Less than (<) (on page 52)

Example: R_TRIG function block

The following is an example program in debug mode that shows the recommended usage of an R_TRIG function block being used to detect an edge.

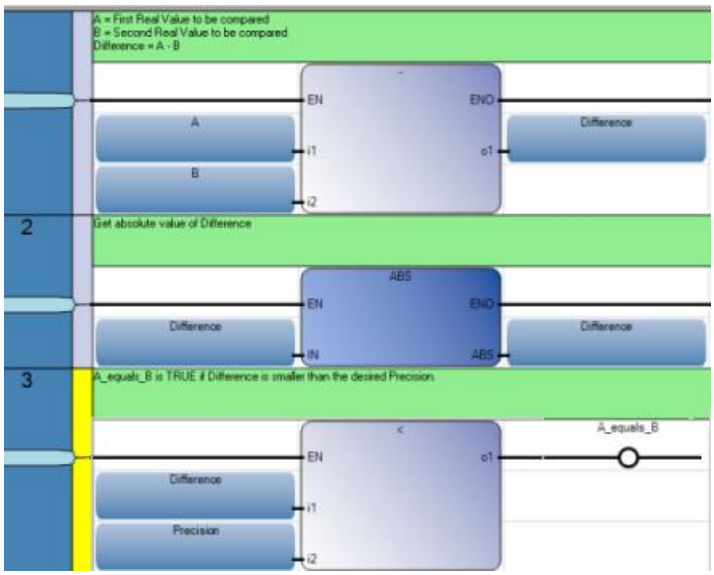


Example: Comparing Real Values using Subtraction (-) ABS, and Less than (<)

The Real data type is not recommended when comparing values for equality because of differences in the way numbers are rounded. Two output values may appear equal in a Connected Components Workbench display, but will evaluate as false.

For example, 23.500001 compared to 23.499999 will both display as 23.5 in the variable input display, but will not be equal in the controller.

To test whether two Real data type values are equal, you can use a Subtraction instruction to get the difference between the values and then determine if the difference is Less Than an established precision value. See the following LD program example for comparing two Real data type values.



LD Keyboard shortcuts

The following keyboard shortcuts are available for use with the LD language.

Shortcut	Description
Ctrl+0	Inserts a rung after a selected rung.[1]
Ctrl+Alt+0	Inserts a rung before a selected rung.[1]
Ctrl+ 1	Inserts a branch after a selected element.
Ctrl+Alt+ 1	Inserts a branch before a selected element.
Ctrl+2	Inserts an instruction block after a selected element.[2]
Ctrl+Alt+2	Inserts an instruction block before a selected element.[2]
Ctrl+3	Inserts a contact after a selected element.[2]
Ctrl+Alt+3	Inserts a contact before a selected element.[2]
Ctrl+4	Inserts a coil after a selected element**.
Ctrl+Alt+4	Inserts a coil after a selected element**.
Ctrl+5	Inserts a jump after a selected element**.
Ctrl+Alt+5	Inserts a jump after a selected element**.
Ctrl+6	Inserts a return after a selected element**.
Ctrl+Alt+6	Inserts a return after a selected element**.
Space bar	For coils or contacts, toggles between the available types.
Shift+Ctrl+Alt+G	Selects/clears the grid in the Language Editor workspace.
Ctrl+Down Arrow	Moves to the next rung. When an element is selected on a rung, moves to the next rung containing the selected element.
Ctrl+R	Opens the block selector.
Ctrl+Up Arrow	Moves to the previous rung. When an element is selected on a rung, moves to the previous rung containing the selected element.
Down, Up, Right, Left	Moves between branches and sub-.
Delete	Removes a selected rung or element.
Enter	Calls the Variable/ Block Selector (depending on the selected element).
Shift+Enter	Inserts a line break
Ctrl+Enter	Opens a line above the current line
Ctrl+Shift+Enter	Opens a line below the current line
Ctrl+Shift+L	Removes the current line
Ctrl+Delete	Removes the next word in the current line
Backspace	Removes the character on the left
Ctrl+Backspace	Removes the previous word in the current line
Ctrl+C	Copies the selected text to the clipboard
Ctrl+Insert	Copies the selected text to the clipboard
Ctrl+L	Cuts the current line to the clipboard
Ctrl+X	Cuts the selected text to the clipboard

Shortcut	Description
Shift+Delete	Cuts the selected text to the clipboard
Ctrl+V	Pastes text saved on the clipboard to the insertion point
Shift+Insert	Pastes text saved on the clipboard to the insertion point
Ctrl+Z	Undoes the previous command
Ctrl+Y	Redoes the previous command
Ctrl+Shift+Z	Redoes the previous command
Ctrl+Left	Moves to the previous statement or word
Ctrl+Right	Moves to the next statement or word
Home	Moves to the start of the line
End	Moves to the end of the line
Ctrl+Home	Moves to the start of the document
Ctrl+End	Moves to the end of the document
Page Up	Moves to the top of the visible code
Page Down	Moves to the bottom of the visible code
Ctrl+Page Up	Moves to the top of the visible code
Ctrl+Page Down	Moves to the bottom of the visible code
Ctrl+J	moves to the matching bracket
Ctrl+Down	Scrolls down
Ctrl+Up	Scrolls up
Shift+Down	Selects down
Shift+Up	Selects up
Shift+Left	Selects left
Shift+Right	Selects right
Ctrl+Shift+Left	Selects to the previous statement or word
Ctrl+Shift+Right	Selects to the next statement or word
Shift+Home	Selects from the insertion point until the start of the line
Shift+End	Selects from the insertion point until the end of the line
Ctrl+Shift+Home	Selects from the insertion point until the start of the document
Ctrl+Shift+End	Selects from the insertion point until the end of the document
Shift+Page Up	Selects from the insertion point until the top of the visible code
Shift+Page Down	Selects from the insertion point until the end of the visible code
Ctrl+Shift+Page Up	Selects from the insertion point until the top of the visible code
Ctrl+Shift+Page Down	Selects from the insertion point until the end of the visible code
Ctrl+A	Selects the entire document
Ctrl+Shift+W	Selects the next word
Ctrl+Shift+J	Selects to the matching bracket
Shift+Alt+Down	Selects the current and next lines
Shift+Alt+Up	Selects the current and previous lines

Shortcut	Description
Shift+Alt+Left	Selects left on the current line
Shift+Alt+Right	Selects right on the current line
Ctrl+Shift+Alt+ Left	Selects available columns in lines of code from the left to right
Ctrl+Shift+Alt+Right	Selects available columns in lines of code from the right to left
Ctrl+Space	Accesses the autocomplete function
Ctrl+Shift+Space	Accesses the autocomplete function
Ctrl+Shift+U	Changes the selected text into uppercase
Ctrl+U	Changes the selected text into lowercase
Esc	Deselects the selected text
Ctrl+I	Opens the variable selector
Ctrl+Shift+I	Opens the variable selector
Ctrl+Alt+R	Opens the block selector
Ctrl+Shift+Alt+R	Opens the block selector
Insert	Toggles between the overwrite/insert typing mode
Ctrl+Shift+T	Transposes the current and previous word
Ctrl+Shift+Alt+T	Transposes the current and next line

[1] When no rung is selected, a rung is added at the end of the rung list.
[2] When a branch is selected, an element is inserted at the end of the branch.

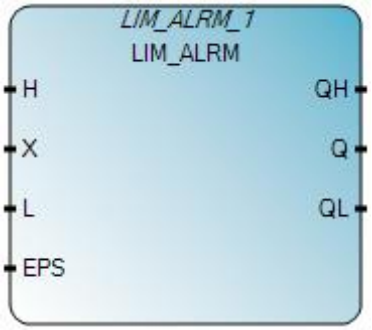
Alarm instruction

Alarm instruction is used to provide alerts when a configured high or a configured low limit has been reached.

Function block	Description
LIM_ALRM (on page 58)	Hysteresis on a real value for high and low limits.

LIM_ALRM

LIM_ALRM is an alarm with hysteresis on a Real value for high and low limits.



LIM_ALRM operation

A hysteresis is applied on high and low limits. The hysteresis delta used for either high or low limit is one half of the EPS parameter.

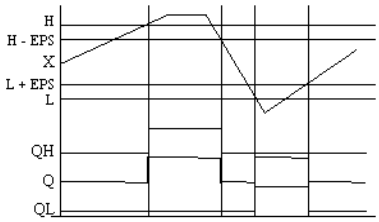
Process alarms

An alarm occurs when a fault is received and processed by the controller. Process level alarms alert you when the module has exceeded the configured high or configured low limits for each channel.

Arguments

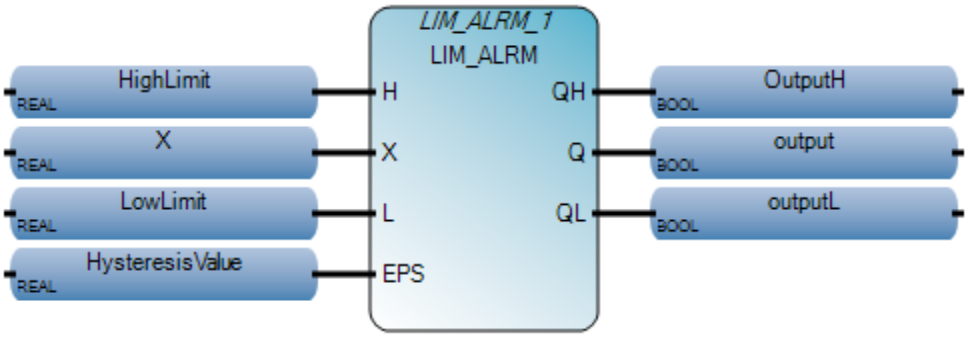
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current LIM_ALRM computation. When EN = FALSE, there is no computation. Applies only to LD programs.
H	Input	REAL	High limit value.
X	Input	REAL	Input: any real value.
L	Input	REAL	Low limit value.
EPS	Input	REAL	Hysteresis value (must be greater than zero).
QH	Output	BOOL	High alarm: TRUE if X above high limit H.
Q	Output	BOOL	Alarm output: TRUE if X out of limits.
QL	Output	BOOL	Low alarm: TRUE if X below low limit L.

LIM_ALRM timing diagram example

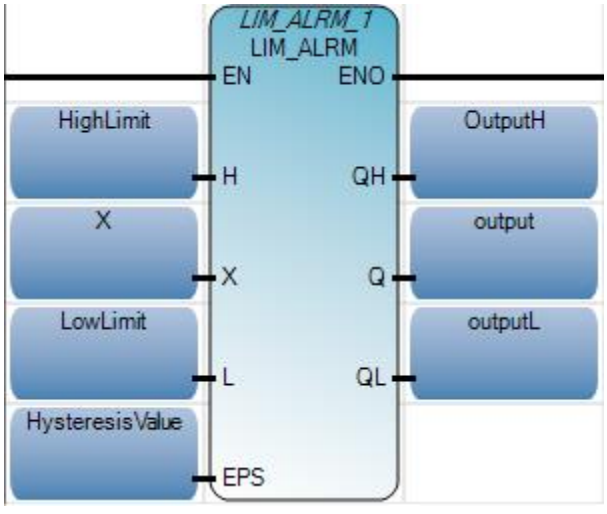


LIM_ALRM function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



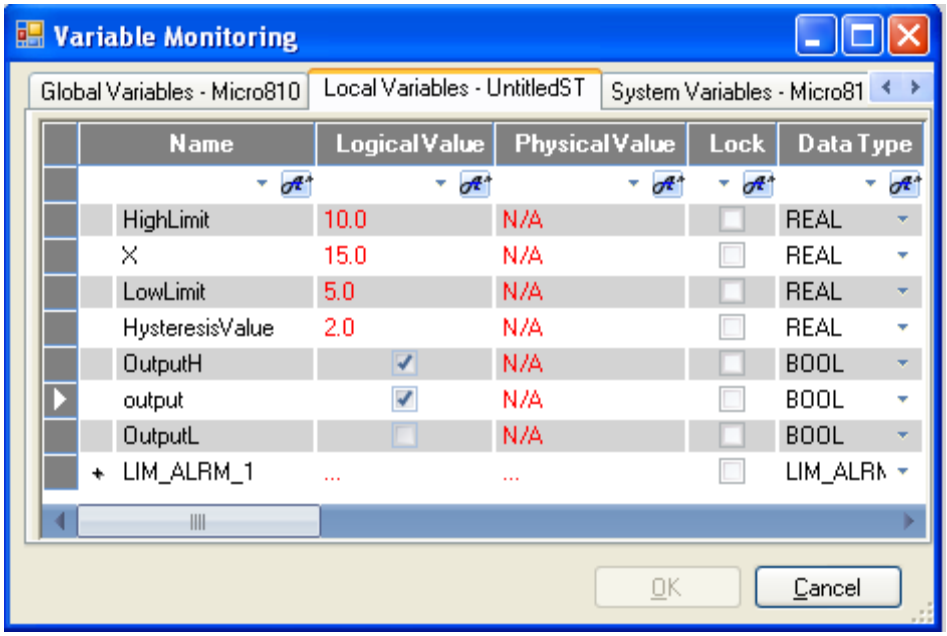
Structured Text (ST)

```
1  HighLimit := 10.0;
2  X := 15.0;
3  LowLimit := 5.0;
4  HysteresisValue := 2.0;
5  LIM_ALRM_1(HighLimit, X, LowLimit, HysteresisValue);
6  OutputH := LIM_ALRM_1.QH;
7  OutputL := LIM_ALRM_1.QL;
8  output := LIM_ALRM_1.Q;
```

```
LIM_ALRM_1(
```

void **LIM_ALRM_1**(REAL H, REAL X, REAL L, REAL EPS)
Type : LIM_ALRM, High/low limit alarm with hysteresis

Results



Chapter 5

Arithmetic instructions

Arithmetic instructions give a controller the ability to perform mathematical functions, such as addition, subtraction, multiplication, and division on data.

Function	Description
ABS (on page 62)	Absolute value of a Real value
ACOS (on page 64)	Arc cosine of a Real value
ACOS_LREAL (on page 66)	Perform 64-bit real arc-cosine calculation
Addition (on page 68)	Add a value
ASIN (on page 69)	Arc sine of a Real value
ASIN_LREAL (on page 71)	Perform 64-bit real arc-sine calculation
ATAN (on page 73)	Arc tangent of a Real value
ATAN_LREAL (on page 75)	Perform 64-bit Real arc-tangent calculation
COS (on page 77)	Cosine of a Real value
COS_LREAL (on page 79)	Perform 64-bit Real cosine calculation
Division (on page 81)	Divide Integer or Real value
EXPT (on page 82)	Exponent calculation of Real values
LOG (on page 84)	Logarithm of a Real value
MOD (on page 86)	Module
MOV (on page 88)	Move a copy of a value
Multiplication (on page 89)	Multiply an Integer or Real value
Neg (on page 90)	Negate a value
POW (on page 91)	Power calculation of Real values
RAND (on page 93)	Random value
SIN (on page 95)	Sine of a Real value
SIN_LREAL (on page 97)	Perform 64-bit real sine calculation
SQRT (on page 99)	Square root of a Real value
Subtraction (on page 101)	Subtract a value
TAN (on page 102)	Tangent of a Real value
TAN_LREAL (on page 104)	Perform 64-bit real tangent calculation
TRUNC (on page 106)	Truncates Real values, leaving just the integer.

ABS

ABS yields the absolute (positive) value of a Real value.

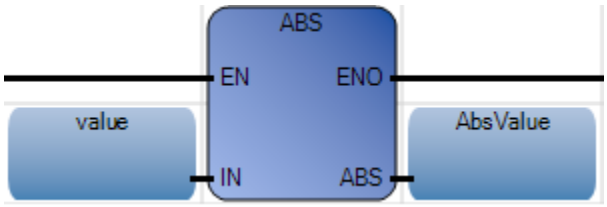
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current absolute computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Any signed Real value.
ENO	Output	BOOL	Enable out.
ABS	Output	REAL	Absolute value (always positive).

ABS function language examples

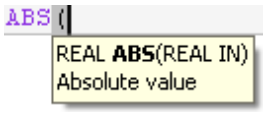
Function block diagram

Ladder diagram



Structured text diagram

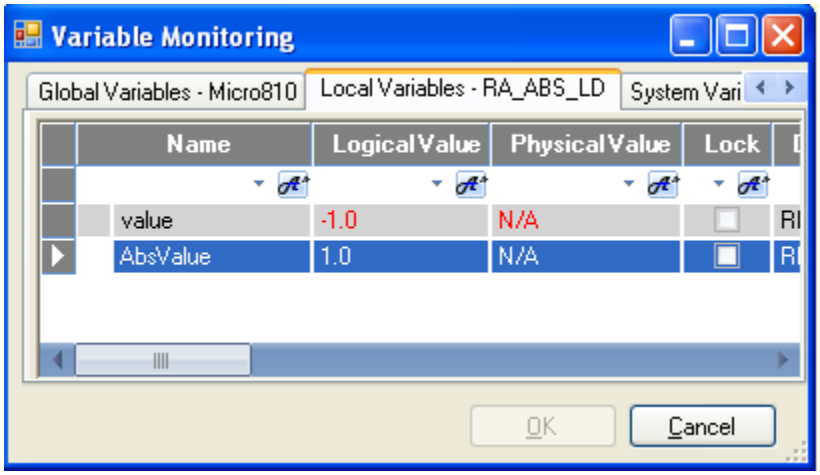
```
1  value := -1.0;
2  AbsValue := ABS(value);
```



(* ST Equivalence: *)

over := (ABS (delta) > range);

Results



ACOS

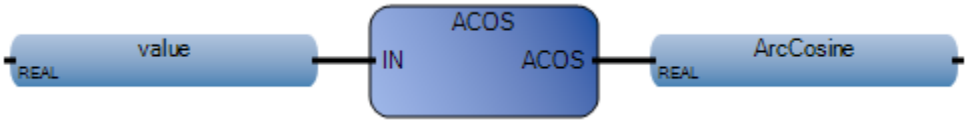
ACOS yields the Arc Cosine of a Real value. Input and output values are in radians.

Arguments

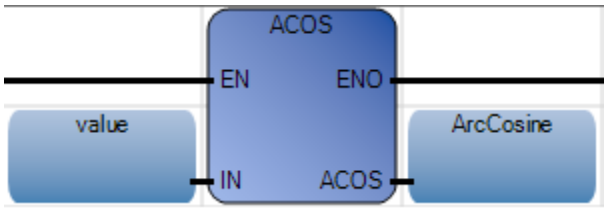
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current arc-cosine computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Must be in set [-1.0 .. +1.0].
ENO	Output	BOOL	Enable out.
ACOS	Output	REAL	Arc-cosine of the input value(in set [-p1/2..+p1/2])=0 for invalid input

ACOS function language examples

Function block diagram

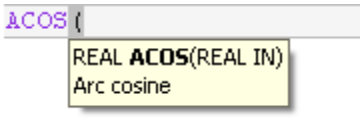


Ladder diagram



Structured text

```
1  value := 0.5;
2  ArcCosine := ACOS(value);
```

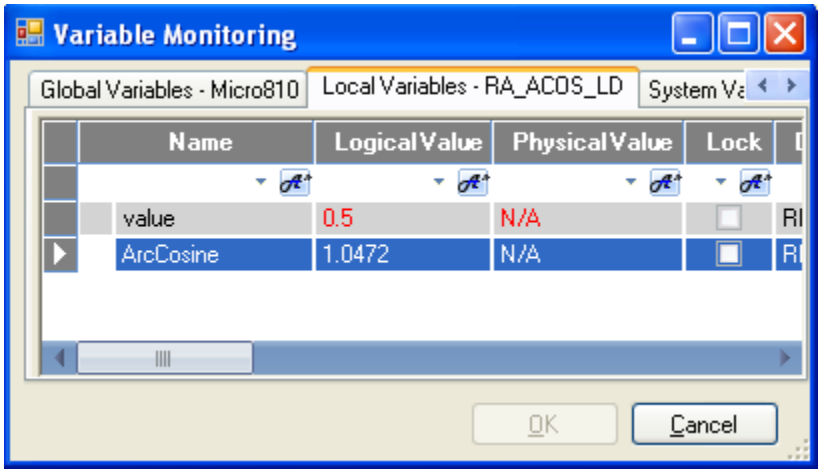


(* ST Equivalence: *)

cosine := COS (angle);

result := ACOS (cosine); (* result is equal to angle *)

Results



ACOS_LREAL

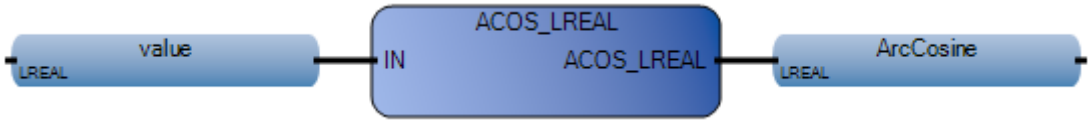
ACOS_LREAL calculates the Arc cosine of a Long Real value.

Arguments

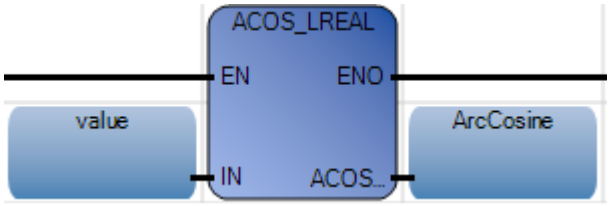
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current computation. When EN = FALSE, there is no computation.
IN	Input	LREAL	Must be in set [-1.0 .. +1.0].
ENO	Output	BOOL	Enable out.
ACOS_LREAL	Output	LREAL	Arc-cosine of the input value (in set [0.0 .. PI]) = 0.0 for invalid input.

ACOS_LREAL function language examples

Function block diagram



Ladder diagram



Structured text

```
1  value := 0.5;
2  ArcCosine := ACOS_LREAL(value);
```

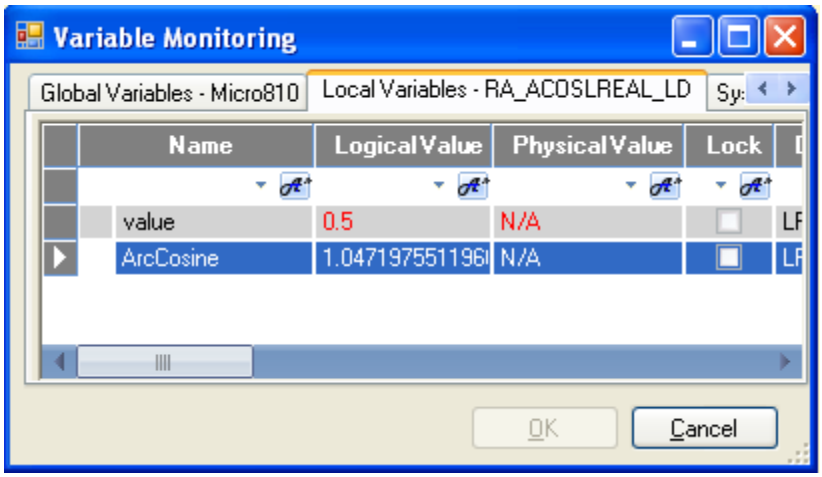
```
ACOS_LREAL(
LREAL ACOS_LREAL(LREAL IN)
Perform 64-bit real arccosine calculation.
```

(* ST Equivalence: *)

cosine := COS_LREAL (angle);

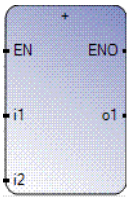
result := ACOS_LREAL (cosine); (* result is equal to angle *)

Results



Addition

Addition adds two or more Integer, Real, Time, or String values.



Addition operation

The Addition function supports additional inputs.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute current addition computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - STRING	Addend in Real, Time, or String data type. All inputs must be the same data type.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - STRING	Addend in Real, Time, or String data type. All inputs must be the same data type.
o1	Output	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - STRING	Sum of the input values in Real, Time, or String format. Input and output must use the same data type.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

Example

(* ST equivalence: *)

```
ao10 := ai101 + ai102;
ao5 := (ai51 + ai52) + ai53;
```

ASIN

ASIN yields the Arc sine of a Real value. Input and output values are in radians.

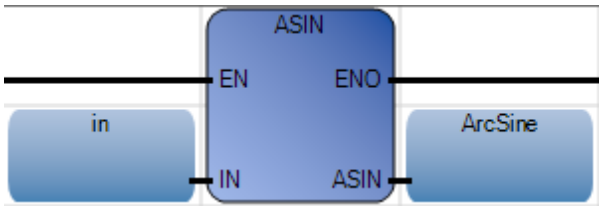
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current arc sine computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Must be in set [-1.0 .. +1.0].
ASIN	Output	REAL	Arc-sine of the input value (in set [-p1/2..+p1/2])=0 for invalid input.
ENO	Output	BOOL	Enable out.

ASIN function language examples

Function block diagram

Ladder diagram



Structured text

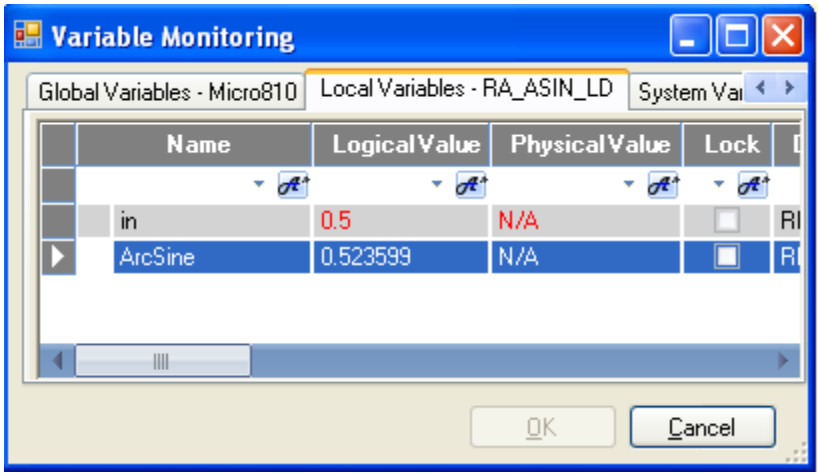
```
1  in := 0.5;
2  ArcSine := ASIN(in);
```

(* ST Equivalence: *)

sine := SIN (angle);

result := ASIN (sine); (* result is equal to angle *)

Results



ASIN_LREAL

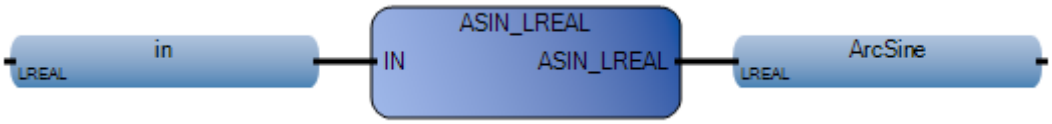
ASIN_LREAL calculates the Arc sine of a Long Real value.

Arguments

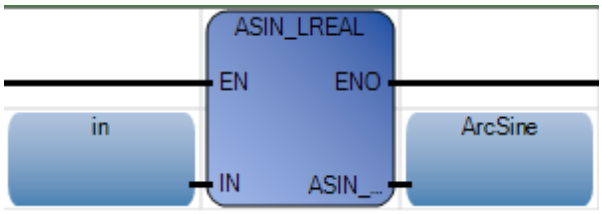
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current computation. When EN = FALSE, there is no computation.
IN	Input	LREAL	Must be in set [-1.0 .. +1.0].
ASIN_LREAL	Output	LREAL	Arc-sine of the input value (in set [-PI/2 .. +PI/2]) = 0.0 for invalid input.
ENO	Output	BOOL	Enable out.

ASIN_LREAL function language examples

Function block diagram



Ladder diagram



Structured text

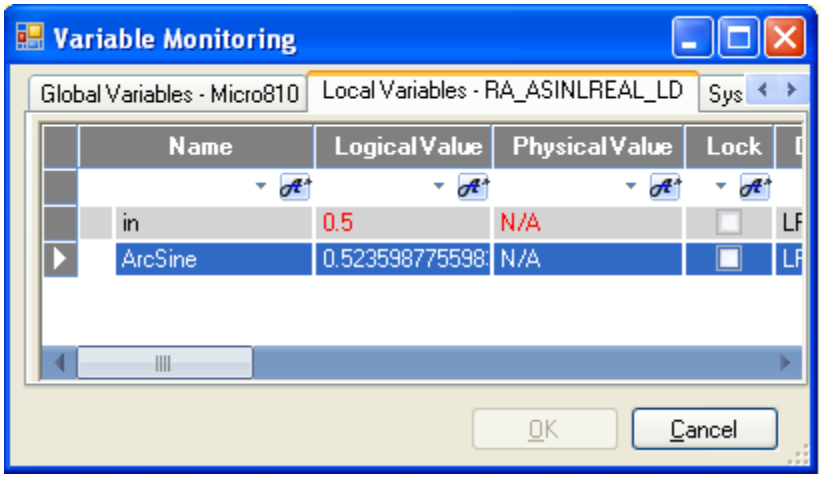
```
1  in := 0.5;
2  ArcSine := ASIN_LREAL(in);
```

(* ST Equivalence: *)

sine := SIN_LREAL (angle);

result := ASIN_LREAL (sine); (* result is equal to angle *)

Results



ATAN

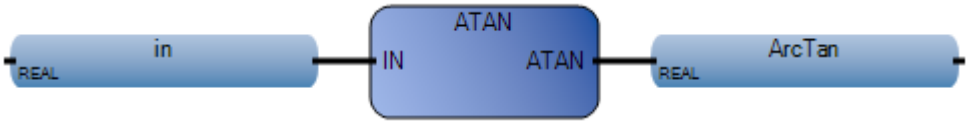
ATAN yields the Arc Tangent of a Real value.

Arguments

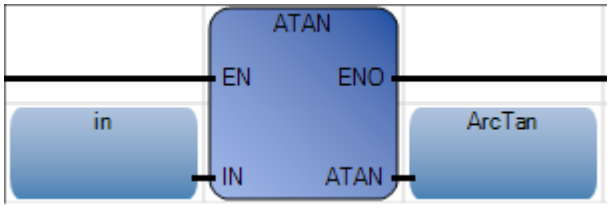
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current arc-tangent computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Any Real value.
ATAN	Output	REAL	Arc-tangent of the input value (in set [-PI/2 .. +PI/2]) = 0.0 for invalid input.
ENO	Output	BOOL	Enable out.

ATAN function language examples

Function block diagram



Ladder diagram



Structured text

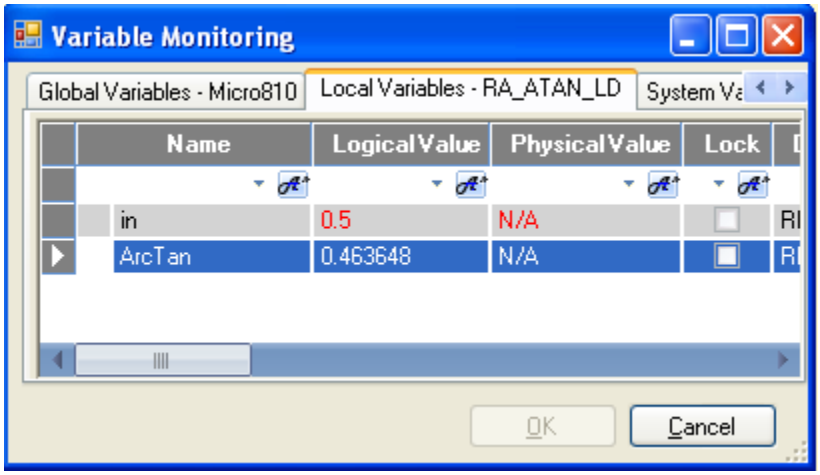
```
1  in := 0.5;
2  ArcTan := ATAN(in);
```

(* ST Equivalence: *)

tangent := TAN (angle);

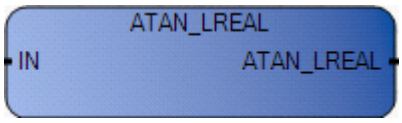
result := ATAN (tangent); (* result is equal to angle*)

Results



ATAN_LREAL

ATAN_LREAL calculates the Arc tangent of a Long Real value.

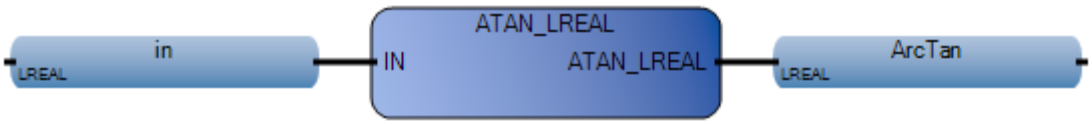


Arguments

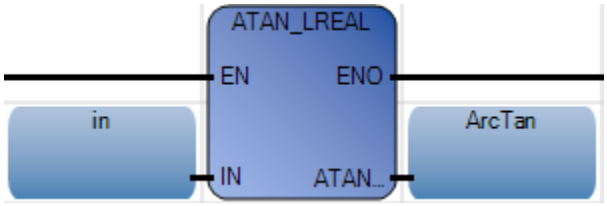
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current computation. When EN = FALSE, there is no computation.
IN	Input	LREAL	Any Long Real value.
ATAN_LREAL	Output	LREAL	Arc-tangent of the input value (in set [-PI/2 .. +PI/2]) = 0.0 for invalid input.
ENO	Output	BOOL	Enable out.

ATAN_LREAL function language examples

Function block diagram



Ladder diagram



Structured text

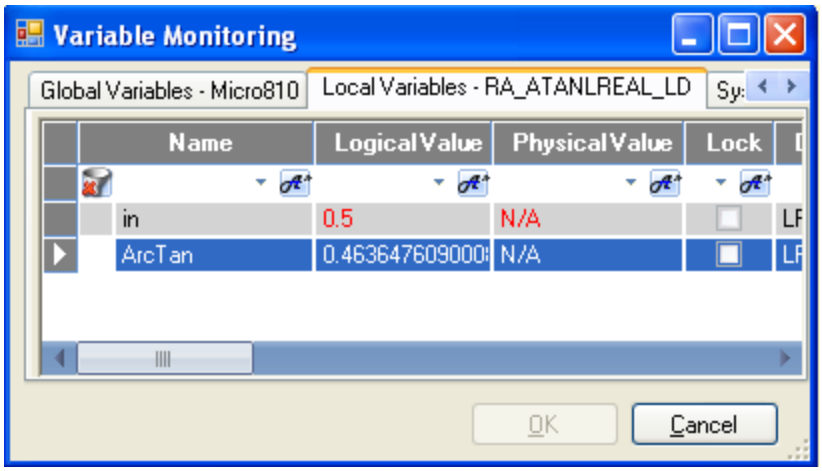
```
1  in := 0.5;
2  ArcTan := ATAN_LREAL(in);
```

(* ST Equivalence: *)

tangent := TAN_LREAL (angle);

result := ATAN_LREAL (tangent); (* result is equal to angle*)

Results



COS

COS yields the Cosine of a Real value.

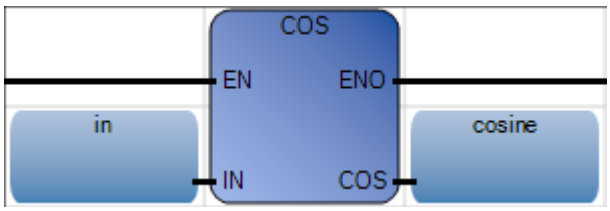
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current cosine computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Any Real value.
COS	Output	REAL	Cosine of the input value (in set [-1.0 .. +1.0]).
ENO	Output	BOOL	Enable out.

COS function language examples

Function block diagram

Ladder diagram



Structured text

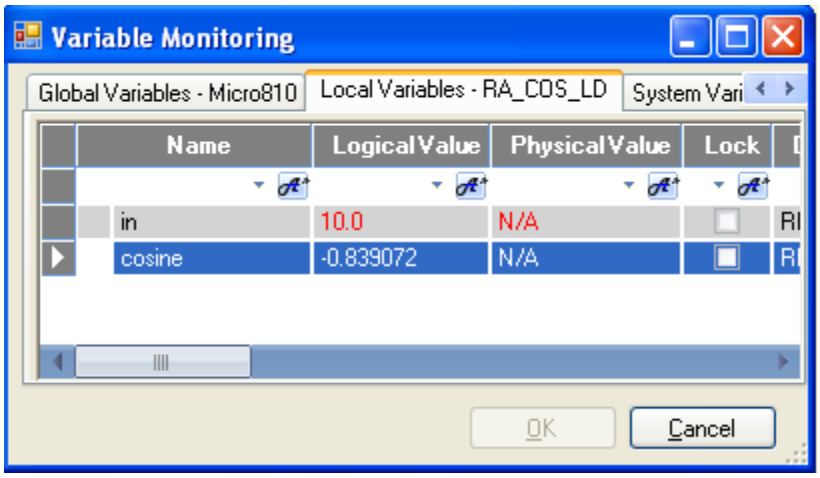
```
1  in := 10.0;
2  cosine := COS(in);
```

(* ST Equivalence: *)

cosine := COS (angle);

result := ACOS (cosine); (* result is equal to angle *)

Results



COS_LREAL

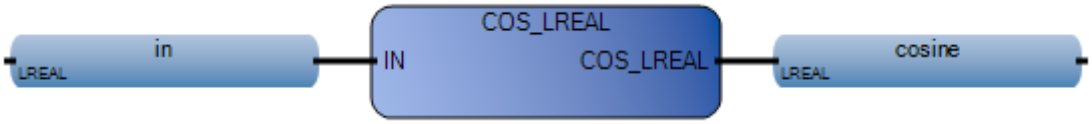
COS_LREAL calculates the cosine of a Long Real value.

Arguments

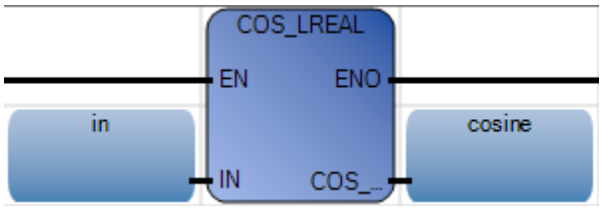
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current computation. When EN = FALSE, there is no computation.
IN	Input	LREAL	Any Long Real value.
COS_LREAL	Output	LREAL	Cosine of the input value (in set [-1.0 .. +1.0]).
ENO	Output	BOOL	Enable out.

COS_LREAL function language example

Function block diagram



Ladder diagram



Structured text

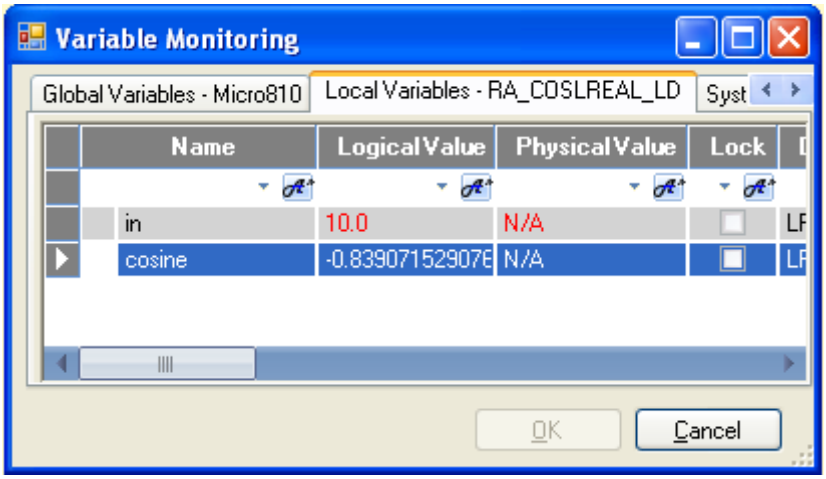
```
1  in := 10.0;
2  cosine := COS_LREAL(in);
```

(* ST Equivalence: *)

cosine := COS_LREAL (angle);

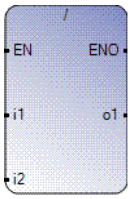
result := ACOS_LREAL (cosine); (* result is equal to angle *)

Results



Division

Division divides the first Integer or Real input value by the second Integer or Real input value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute current division computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL	Dividend in non-zero Integer or Real data type. All inputs must be the same data type.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL	Divisor in non-zero Integer or Real data type. All inputs must be the same data type.
o1	Output	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL	Quotient of the inputs in non-zero Integer or Real data type. Input and output must use the same data type.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

Example

(* ST Equivalence: *)

```
ao10 := ai101 / ai102;
ao5 := (ai5 / 2) / ai53;
```

EXPT

Where 'base' is the first argument and 'exponent' is the second argument, EXPT yields the Real result of the following operation: (base exponent).

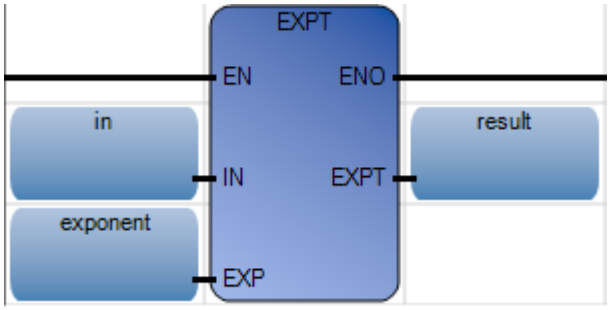
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current exponent computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Any signed Real value.
EXP	Input	DINT	Integer exponent.
EXPT	Output	REAL	(IN EXP).
ENO	Output	BOOL	Enable out.

EXPT function language examples

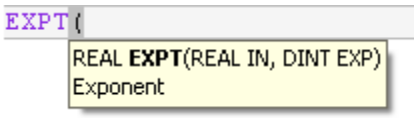
Function block diagram

Ladder diagram



Structured text

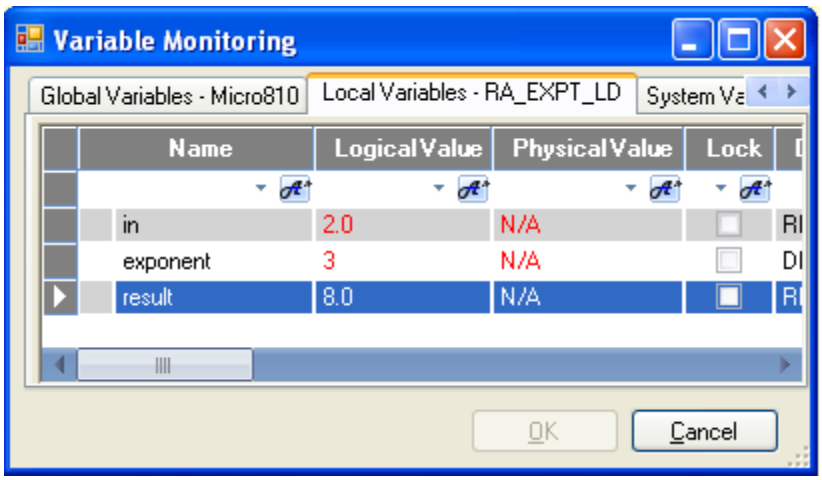
```
1  in := 2.0;
2  exponent := 3;
3  result := EXPT(in, exponent);
```



(* ST Equivalence: *)

tb_size := ANY_TO_DINT (EXPT (2.0, range));

Results



LOG

LOG yields the logarithm (base 10) of a Real value.

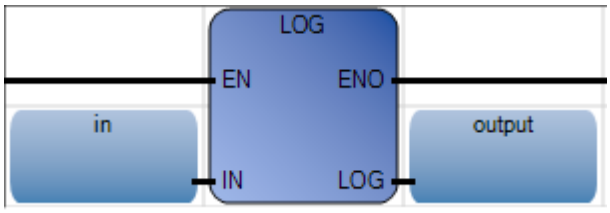
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current logarithm computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Must be greater than zero.
LOG	Output	REAL	Logarithm (base 10) of the input value. The returned result is -3.4E+38 for a zero IN value and negative IN value.
ENO	Output	BOOL	Enable out.

LOG function language examples

Function block diagram

Ladder diagram



Structured text

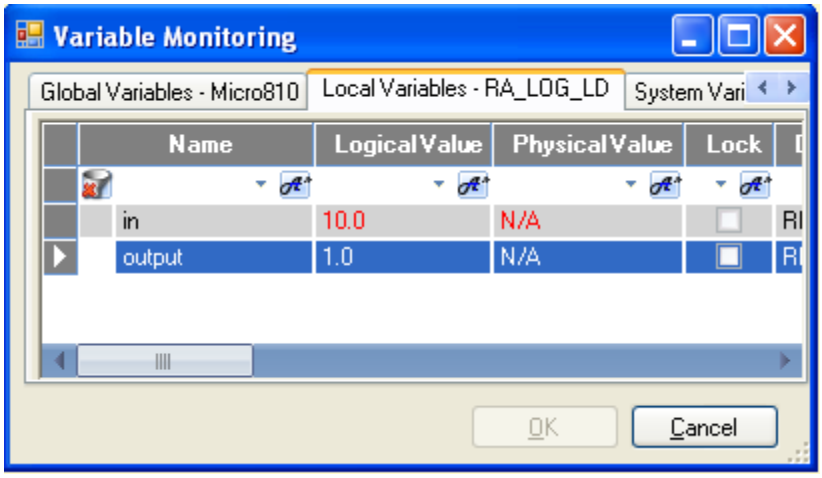
```
1  in := 10.0;
2  output := LOG(in);
```

(* ST Equivalence: *)

xpos := ABS (xval);

xlog := LOG (xpos);

Results



MOD

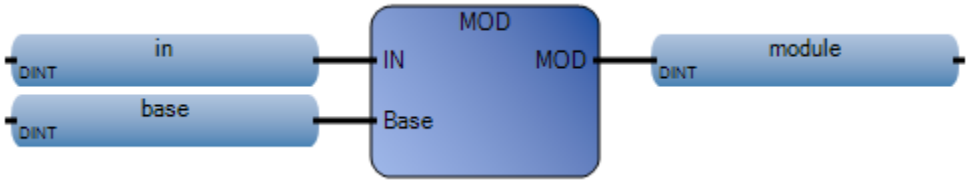
MOD yields the module of an integer value.

Arguments

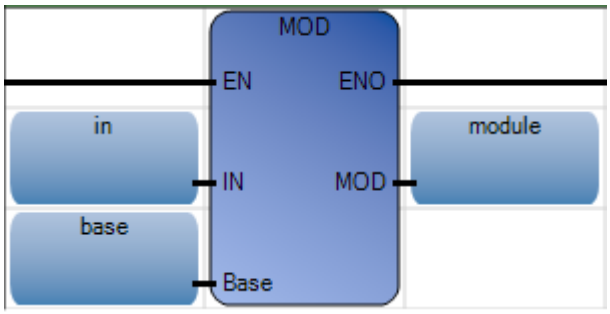
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the module computation. When EN = FALSE, there is no computation.
IN	Input	DINT	Any signed integer value.
Base	Input	DINT	Must be greater than zero.
MOD	Output	DINT	Module calculation (input MOD base) / returns -1 if Base <= 0.
ENO	Output	BOOL	Enable out.

MOD function language examples

Function block diagram

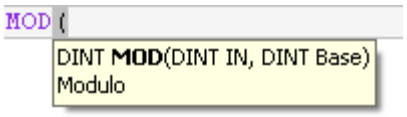


Ladder diagram



Structured text

```
1  in := 5;
2  base := 3;
3  module := MOD(in, base);
```

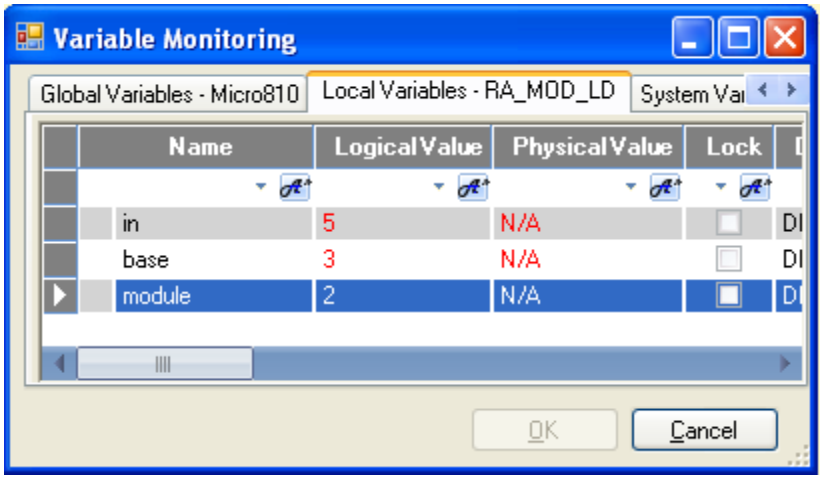


(* ST Equivalence: *)

division_result := (value / divider); (* integer division *)

rest_of_division := MOD (value, divider); (* rest of the division *)

Results



MOV

MOV moves a copy of the value in input (i1) to the output (o1).

Tip: The MOV instruction displays in the Block Selector when it is launched from a Ladder Diagram POU or a Function Block Diagram POU, but it does not display in a Structured Text POU. Structured Text programs use the "=" assignment operator instead of the MOV function.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the direct link to an output computation. When EN = FALSE, there is no computation. Applies only to LD programs. Applies only to LD programs.
i1	Input	BOOL - DINT - REAL - TIME - STRING - SINT - USINT - INT - UINT - UDINT - LINT - ULINT - DATE - LREAL - BYTE - WORD - DWORD - LWORD	Input and output must use the same data type.
o1	Output	BOOL - DINT - REAL - TIME - STRING - SINT - USINT - INT - UINT - UDINT - LINT - ULINT - DATE - LREAL - BYTE - WORD - DWORD - LWORD	Input and output must use the same data type.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

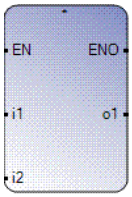
Example

(* ST equivalence: *)

```
ao23 := ai10;
```

Multiplication

Multiplication multiplies two or more Integer or Real values. The Multiplication function supports additional inputs.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute current multiplication computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL	Factor in Integer or Real data type. All inputs must be the same data type.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL	Factor in Integer or Real data type. All inputs must be the same data type.
o1	Output	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL	Product of the inputs in Integer or Real data type. Input and output must use the same data type.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

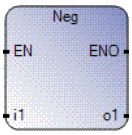
Example

(* ST equivalence *)

```
ao10 := ai101 * ai102;
ao5 := (ai51 * ai52) * ai53;
```

Neg

Neg converts a value to a negated value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute current convert to negative computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	SINT - INT - DINT - LINT - REAL - LREAL	Input and output must be the same data type.
o1	Output	SINT - INT - DINT - LINT - REAL - LREAL	Input and output must be the same data type.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

Example

(* ST equivalence: *)

```
ao23 := - (ai10);
ro100 := - (ri1 + ri2);
```

POW

When the first argument is 'base' and the second argument is 'exponent', POW yields the Real result of the following: (base exponent).

POW operation

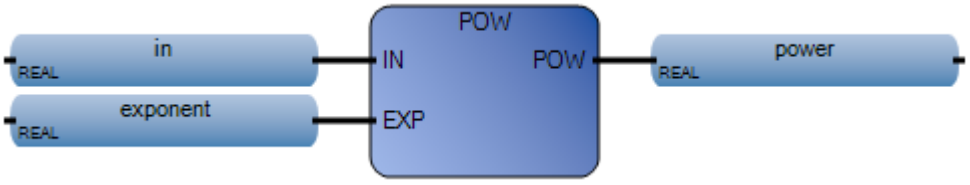
The Exponent is a real value.

Arguments

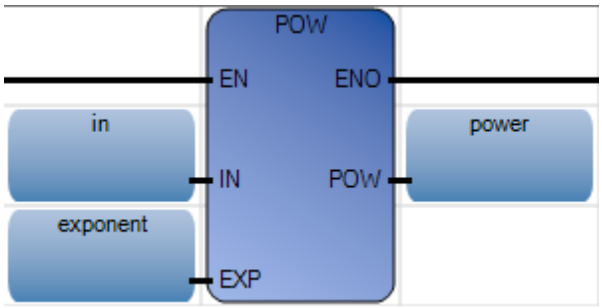
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current exponent computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Real number to be raised.
EXP	Input	REAL	Power (exponent).
POW	Output	REAL	(IN EXP) 1.0 if IN is not 0.0 and EXP is 0.0 0.0 if IN is 0.0 and EXP is negative 0.0 if both IN and EXP are 0.0 0.0 if IN is negative and EXP does not correspond to an integer.
ENO	Output	BOOL	Enable out.

POW function language examples

Function block diagram

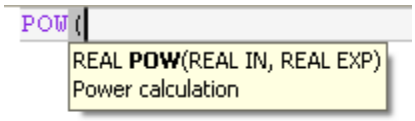


Ladder diagram



Structured text

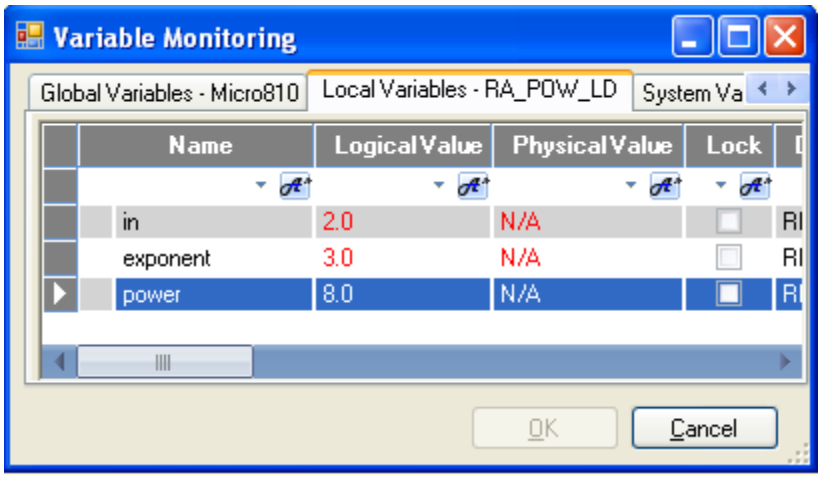
```
1  in := 2.0;
2  exponent := 3.0;
3  power := POW(in, exponent);
```



(* ST Equivalence: *)

result := POW (xval, power);

Results



RAND

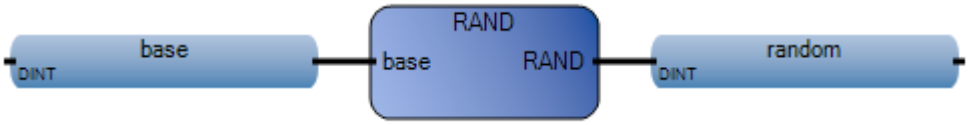
From a defined range, RAND yields random integer values.

Arguments

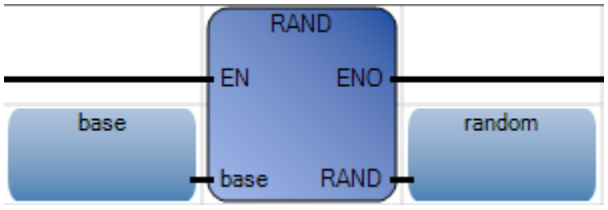
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the random integer value computation When EN = FALSE, there is no computation.
base	Input	DINT	Defines the supported set of numbers.
RAND	Output	DINT	Random value in set [0..base-1].
ENO	Output	BOOL	Enable out.

RAND function language examples

Function block diagram



Ladder diagram



Structured text

```
1  base := 10;
2  random := RAND(base);
```

- (* ST Equivalence: *)

selected := MUX4 (RAND (4), 1, 4, 8, 16);

(*

random selection of 1 of 4 pre-defined values

the value issued of RAND call is in set [0..3],

so 'selected' issued from MUX4, will get 'randomly' the value

1 if 0 is issued from RAND,

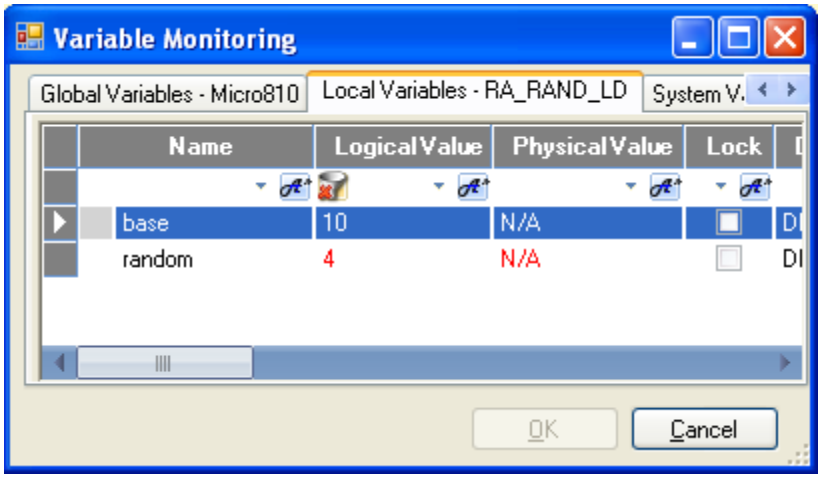
or 4 if 1 is issued from RAND,

or 8 if 2 is issued from RAND,

or 16 if 3 is issued from RAND,

*)

Results



SIN

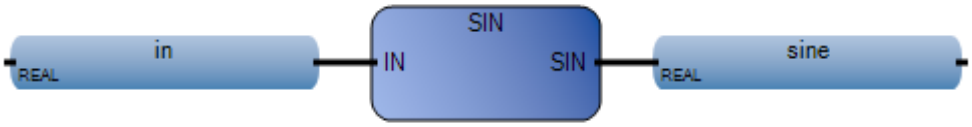
SIN yields the Sine of a Real value.

Arguments

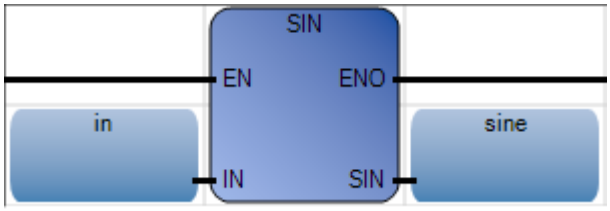
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current sine computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Any Real value.
SIN	Output	REAL	Sine of the input value (in set [-1.0 .. +1.0]).
ENO	Output	BOOL	Enable out.

SIN function language examples

Function block diagram

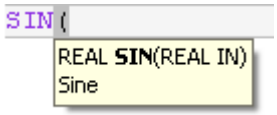


Ladder diagram



Structured text

```
1  in := 0.5;
2  sine := SIN(in);
```

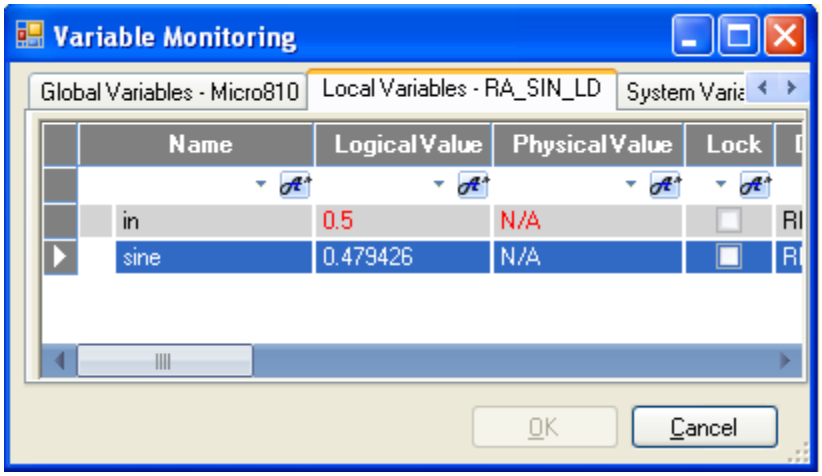


(* ST Equivalence: *)

sine := SIN (angle);

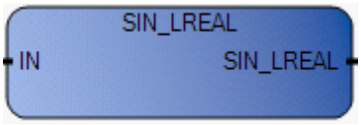
result := ASIN (sine); (* result is equal to angle *)

Results



SIN_LREAL

SIN_LREAL calculates the sine of a Long Real value.

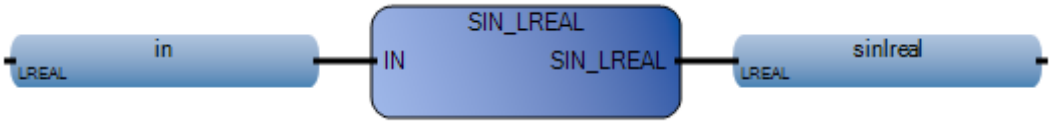


Arguments

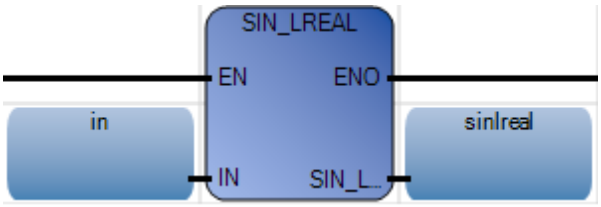
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current computation. When EN = FALSE, there is no computation.
IN	Input	LREAL	Any Long Real value.
SIN_LREAL	Output	LREAL	Sine of the input value (in set [-1.0 .. +1.0]).
ENO	Output	BOOL	Enable out.

SIN_LREAL function language examples

Function block diagram



Ladder diagram



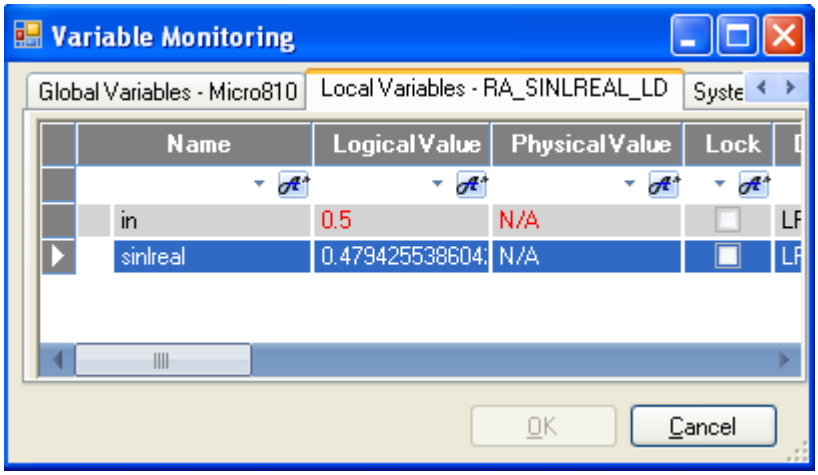
Structured text

```
1  in := 0.5;
2  sinlreal := SIN_LREAL(in);
```

(* ST Equivalence: *)

TESTOUTPUT1 := SIN_LREAL(TESTINPUT1) ;

Results



SQRT

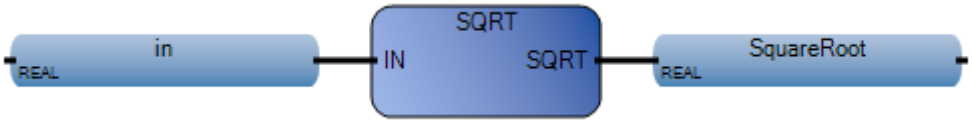
SQRT yields the square root of a Real value.

Arguments

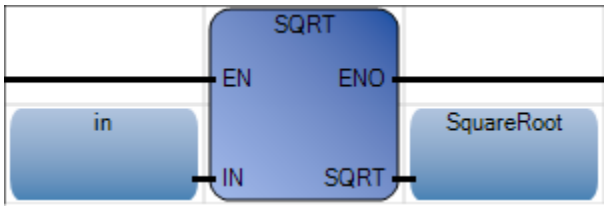
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current square root computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Must be greater than or equal to zero.
SQRT	Output	REAL	Square root of the input value. The returned result is 0 for a negative IN value.
ENO	Output	BOOL	Enable out.

SQRT function language examples

Function block diagram



Ladder diagram



Structured text

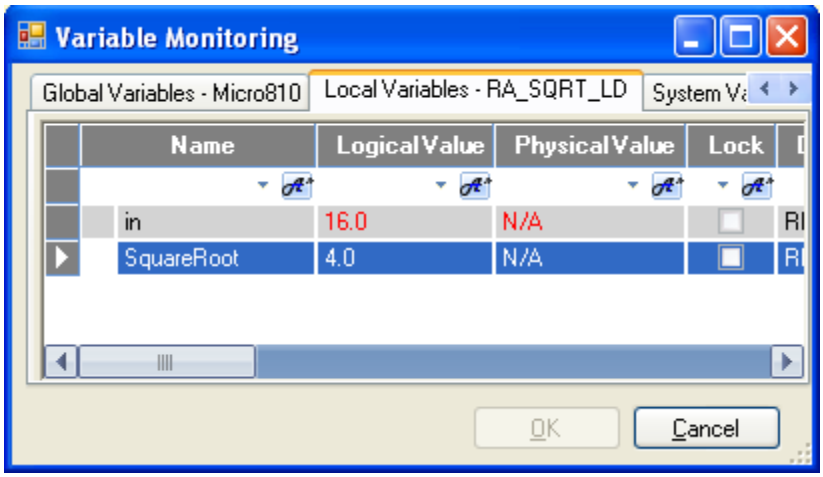
```
1  in := 16.0;
2  SquareRoot := SQRT(in);
```

(* ST Equivalence: *)

xpos := ABS (xval);

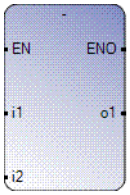
xroot := SQRT (xpos);

Results



Subtraction

Subtraction subtracts an Integer, Real, or Time value from another Integer, Real or Time value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute current addition computation. When Enable= FALSE, there is no computation. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME	Minuend in any Integer, Real or Time data type. All inputs must be the same data type.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME	Subtrahend in any Integer, Real or Time data type. All inputs must be the same data type.
o1	Output	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME	Difference of the minuend and the subtrahend in any Integer, Real or Time data type. Output must be the same data type as inputs.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

Example

(* ST equivalence: *)

```
ao10 := ai101 - ai102;
ao5 := (ai51 - 1) - ai53;
```

TAN

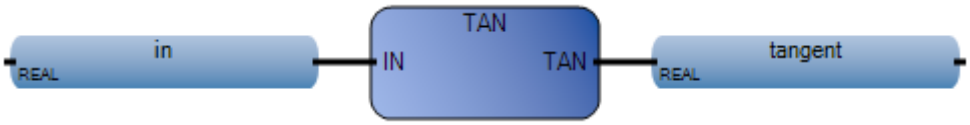
TAN yields the tangent of a Real value.

Arguments

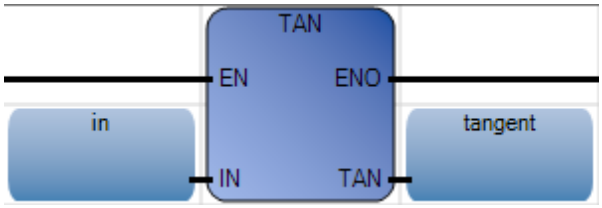
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, perform current tangent computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Cannot be equal to PI/2 modulo PI.
TAN	Output	REAL	Tangent of the input value = 1E+38 for invalid input.
ENO	Output	BOOL	Enable out.

TAN function language examples

Function block diagram



Ladder diagram



Structured text

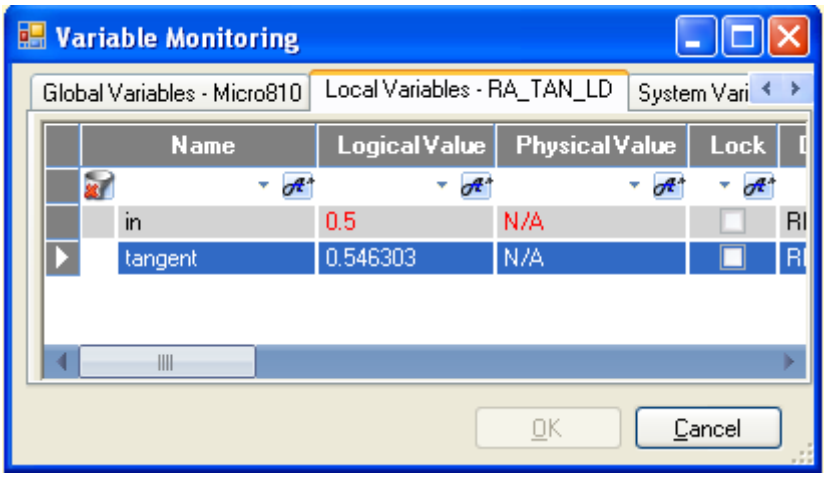
```
1  in := 0.5;
2  tangent := TAN(in);
```

(* ST Equivalence: *)

tangent := TAN (angle);

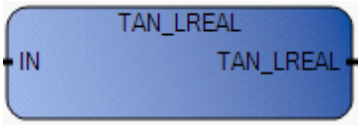
result := ATAN (tangent); (* result is equal to angle*)

Results



TAN_LREAL

TAN_LREAL calculates the tangent of a Long Real value.

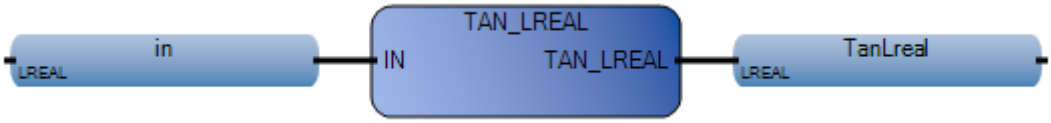


Arguments

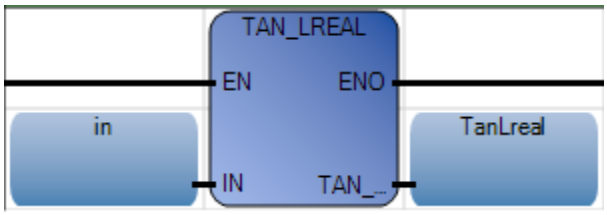
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, perform current computation. When EN = FALSE, there is no computation.
IN	Input	LREAL	Cannot be equal to PI/2 modulo PI.
TAN_LREAL	Output	LREAL	Tangent of the input value = 1E+38 for invalid input.
ENO	Output	BOOL	Enable out.

TAN_LREAL function language examples

Function block diagram



Ladder diagram



Structured text

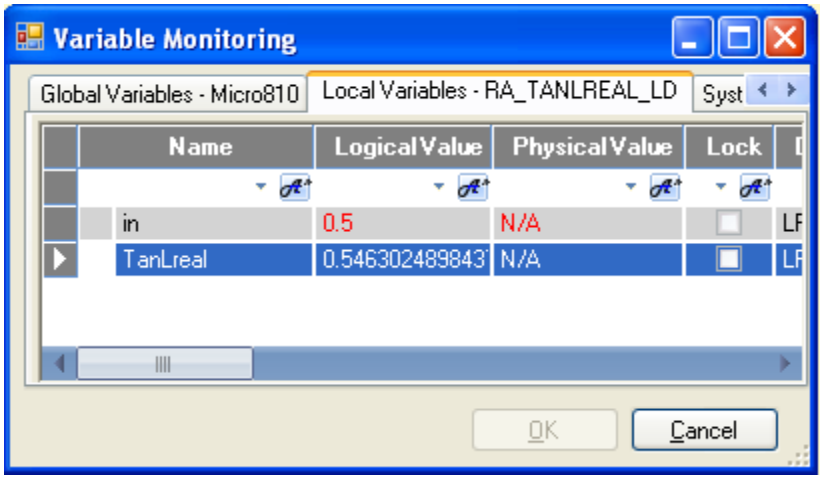
```
1  in := 0.5;
2  TanLreal := TAN_LREAL(in);
```

(* ST Equivalence: *)

tangent := TAN_LREAL (angle);

result := ATAN_LREAL (tangent); (* result is equal to angle*)

Results



TRUNC

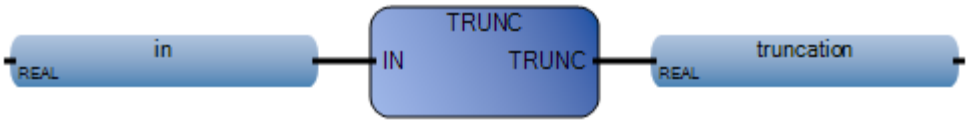
TRUNC truncates Real values, leaving just the integer.

Arguments

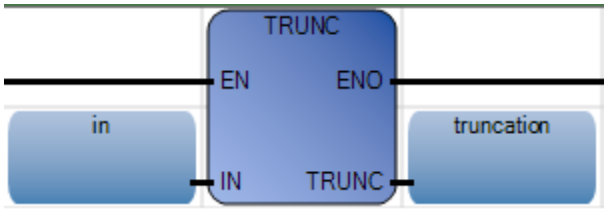
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, perform the truncation of Real value computation. When EN = FALSE, there is no computation.
IN	Input	REAL	Any Real value.
TRUNC	Output	REAL	If IN>0, biggest integer less or equal to the input. If IN<0, least integer greater or equal to the input.
ENO	Output	BOOL	Enable out.

TRUNC function language examples

Function block diagram



Ladder diagram



Structured text

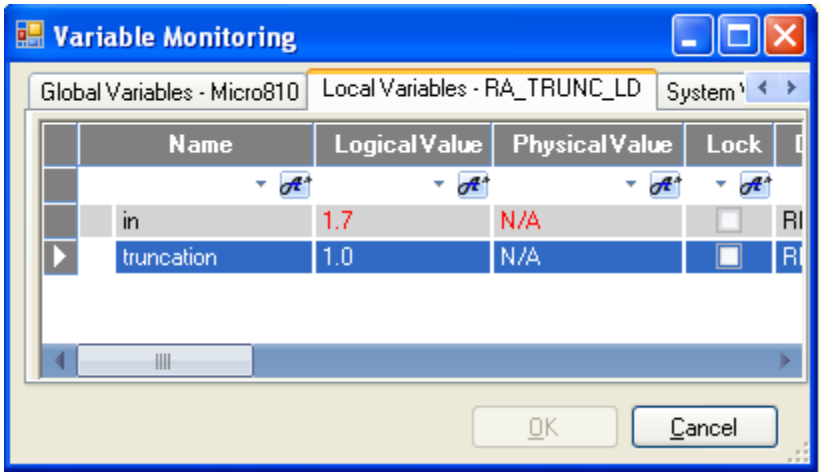
```
1  in := 1.7;
2  truncation := TRUNC(in);
```

(* ST Equivalence: *)

result := TRUNC (+2.67) + TRUNC (-2.0891);

(* means: result := 2.0 + (-2.0) := 0.0; *)

Results



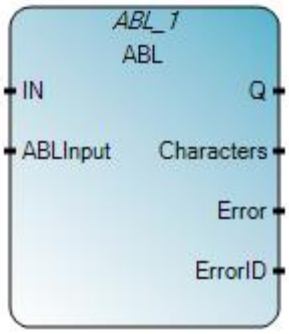
ASCII serial port instructions

ASCII serial port instructions are communication instructions that use or alter the communication channel for receiving or transmitting data.

Function block	Description
ABL (on page 110)	Determine number of characters in buffer (up to and including end of line character)
ACB (on page 112)	Determine total number of characters in buffer
ACL (on page 114)	Clear the receive and transmit buffers
AHL (on page 116)	Set or reset modem handshake lines
ARD (on page 118)	Read characters from the input buffer and place them into a string
ARL (on page 121)	Read one line of characters from the input buffer and place them into a string
AWA (on page 124)	Write a string with user-configured characters appended to an external device
AWT (on page 126)	Write characters from a source string to an external device

ABL

ABL counts the total number of characters in the input buffer up to and including the end-of-line termination character.

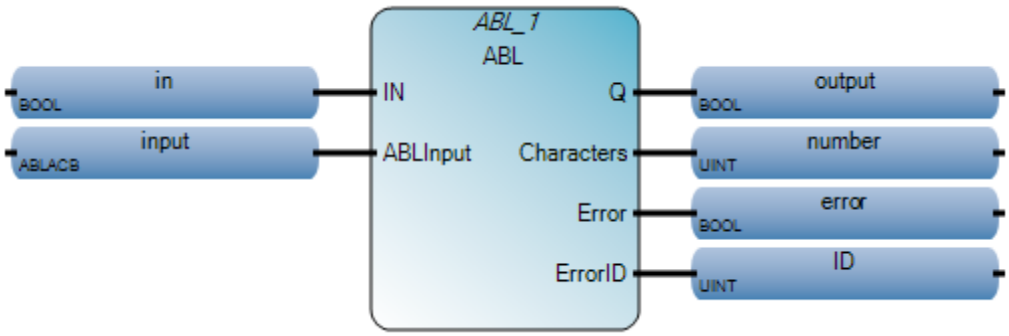


Arguments

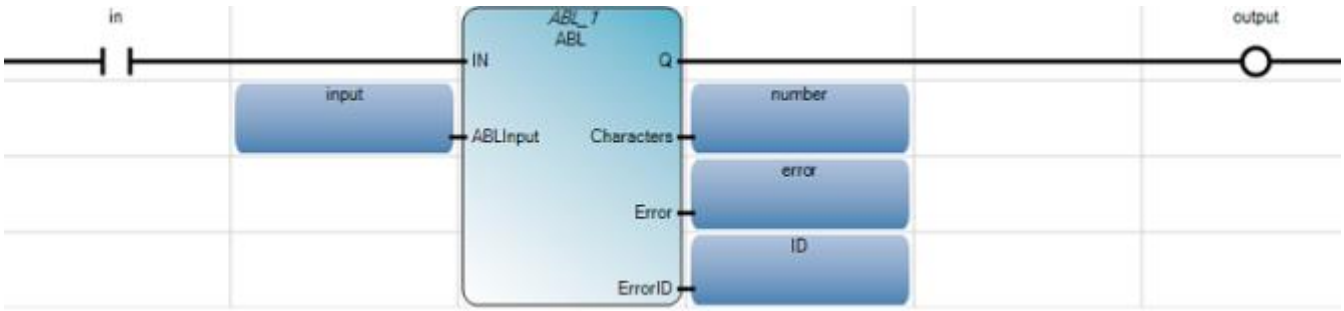
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN) turns from FALSE to TRUE, start the function block with the precondition that the last operation has been completed.
ABLInput	Input	ABLACB	The channel to be operated. See ABLACB data type (on page 128).
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
Characters	Output	UINT	The number of characters displayed in the buffer up to 82 characters.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

ABL function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

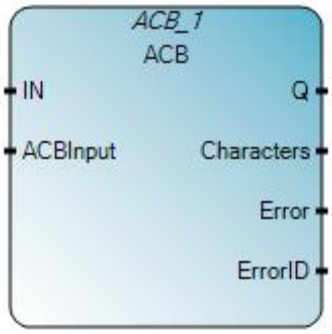
```
1  ABL_1(in, input);
2  output := ABL_1.Q;
3  number := ABL_1.Characters;
4  error := ABL_1.Error;
5  ID := ABL_1.ErrorID;
```

```
ABL_1(
```

void **ABL_1**(BOOL IN, ABLACB ABLInput)
Type : ABL, Specify number of characters in buffer (including end of line).

ACB

ACB determines the total characters in the buffer.

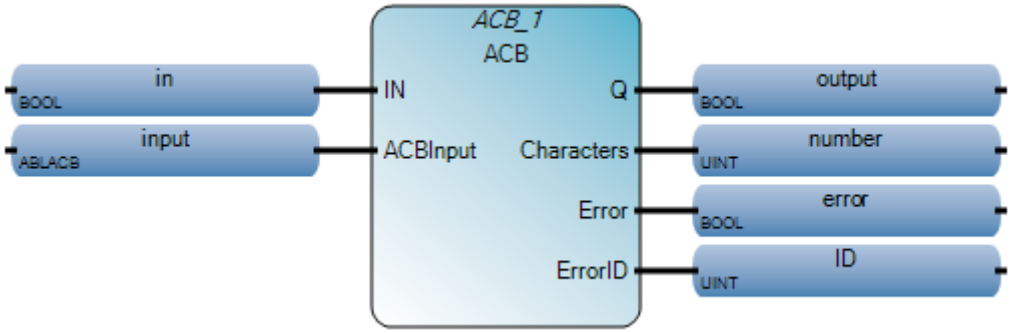


Arguments

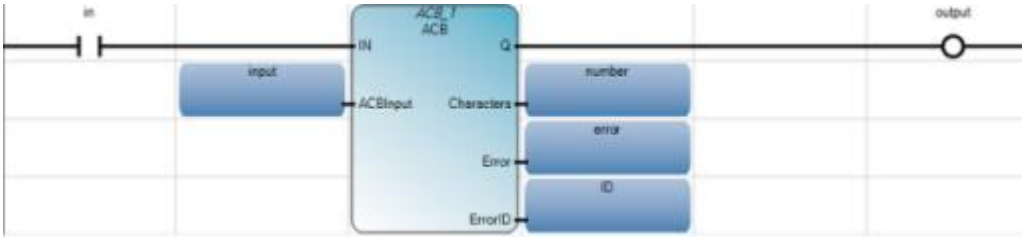
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
ACBInput	Input	ABLACB	The channel to be operated. See ABLACB data type (on page 128).
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
Characters	Output	UINT	The number of characters.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

ACB function block language examples

Function Block Diagram (FBD)

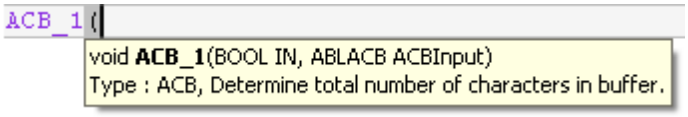


Ladder Diagram (LD)



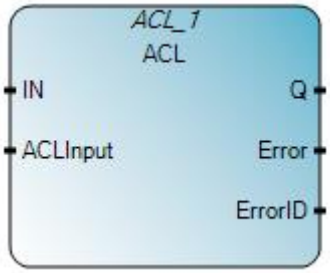
Structured Text (ST)

```
1  ACB_1(in, input);
2  output := ACB_1.Q;
3  number := ACB_1.Characters;
4  error := ACB_1.Error;
5  ID := ACB_1.ErrorID;
```



ACL

ACL clears the Receive and Transmit buffer(s), and removes instructions from the ASCII queue.

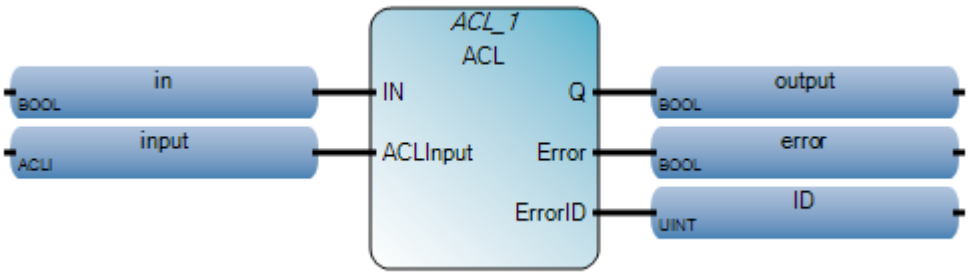


Arguments

Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
ACLInput	Input	ACL	The state of the transmit and receive buffers. See ACL data type (on page 129)
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

ACL function block language examples

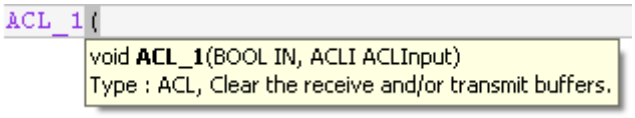
Function Block Diagram (FBD)



Ladder Diagram (LD)

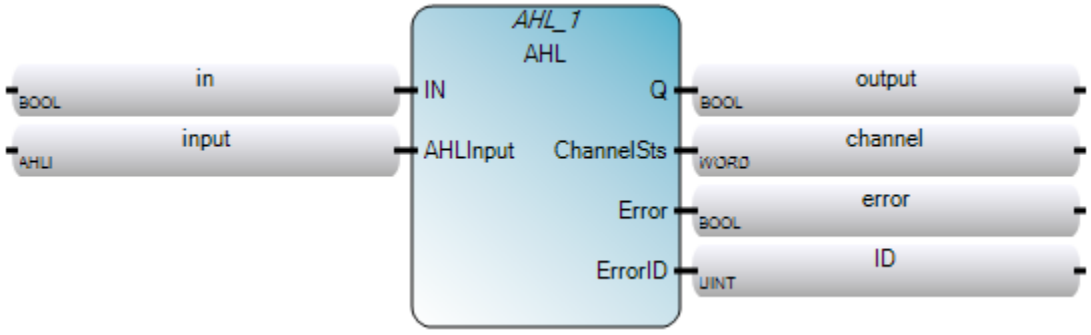
Structured Text (ST)

```
1  ACL_1(in, input);
2  output := ACL_1.Q;
3  error := ACL_1.Error;
4  ID := ACL_1.ErrorID;
```



AHL

AHL sets or resets the RS-232 Request to Send (RTS) handshake control lines for your modem.

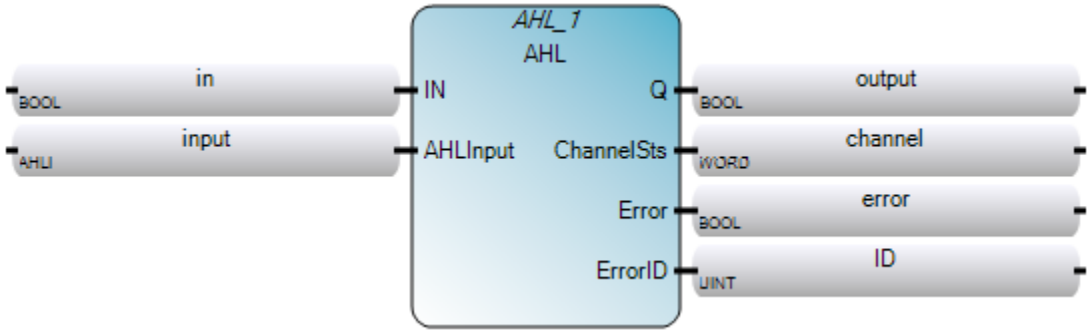


Arguments

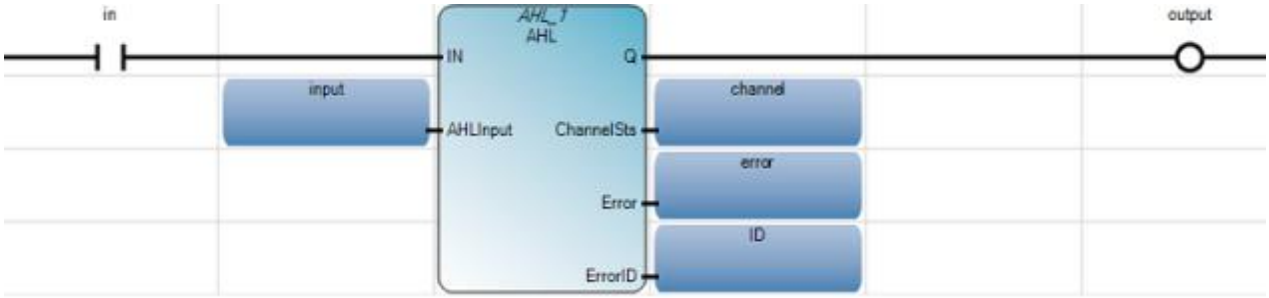
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
AHLInput	Input	AHLI	Set or reset the RTS control line for the modem. See AHLI data type (on page 130).
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
ChannelSts	Output	WORD	Displays the current status (0000 to 001F) of the handshake lines for the channel specified. See AHL ChannelSts data type (on page 129).
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

AHL function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

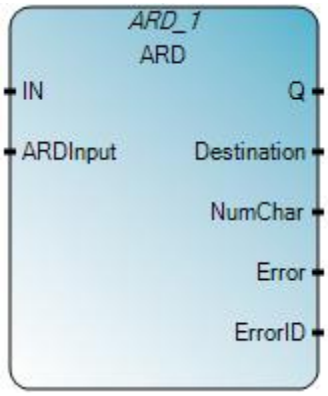
```
1  AHL_1(in, input);
2  output := AHL_1.Q;
3  channel := AHL_1.ChannelSts;
4  error := AHL_1.Error;
5  ID := AHL_1.ErrorID;
```

```
AHL_1(
```

void **AHL_1**(BOOL IN, AHLI AHLInput)
Type : AHL, Set or reset modem handshake lines.

ARD

ARD reads characters from the buffer and stores them in a string.



ARD operations

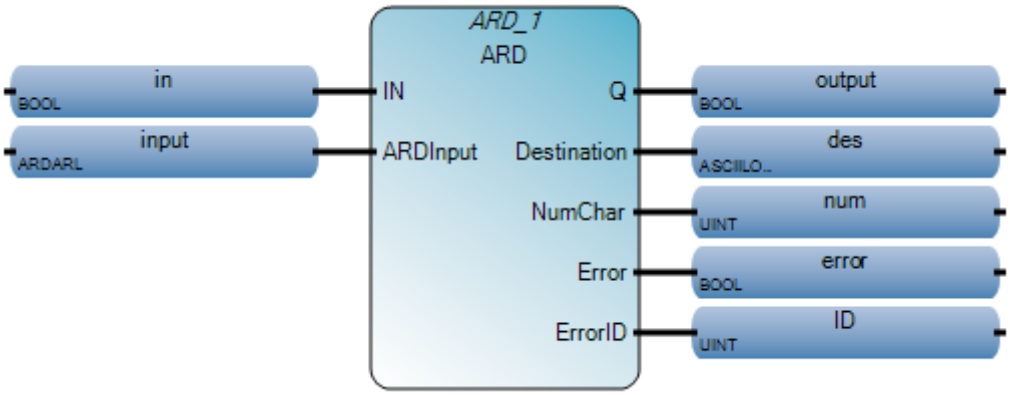
- ARD will be executed until all characters are received. If another ASCII command is executed, it will be queued until ARD is finished. An ACL (on page 114) instruction can be executed in order to abort the ARD instruction.
- Use the results of an ACB (on page 112) instruction to trigger the ARD instruction. This prevents the ARD instruction from holding up the ASCII queue while it waits for the required number of characters.
- Status of the instruction can be extracted from the control bit of the instruction instance (e.g. ARD_1.controlbit). This shows if the instruction is blocking the ASCII instruction queue waiting for more characters:
  - 7th bit = Instruction is enabled.
  - 6th bit = Instruction is in the queue.
  - 5th bit = Instruction is done.
  - 3rd bit = Instruction has an error.

Arguments

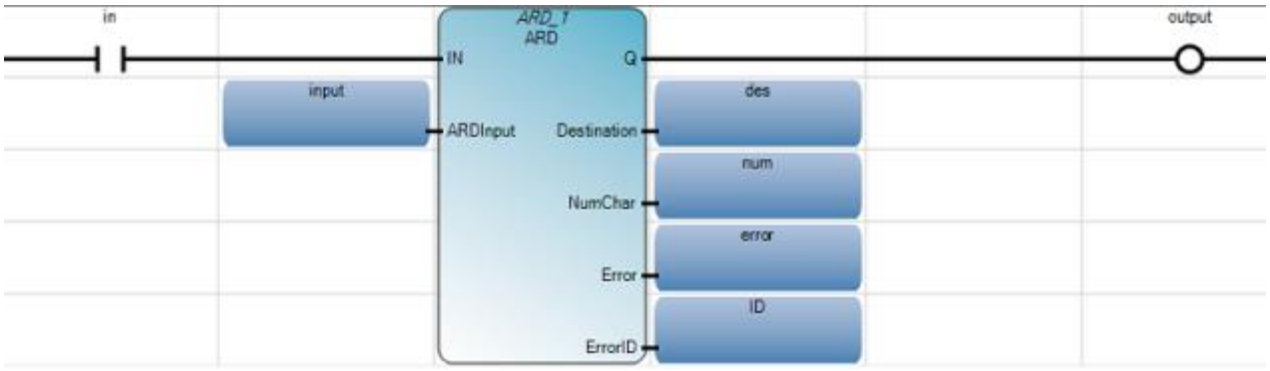
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
ARDInput	Input	ARDARL	Read characters from the buffer (maximum is 82). See ARDARL data type (on page 130).
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
Destination	Output	ASCIILOCADDR	The string element where you want the characters stored.
NumChar	Output	UINT	The number of characters.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

ARD function block language examples

Function Block Diagram (FBD)

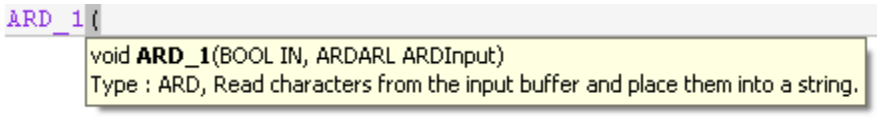


Ladder Diagram (LD)



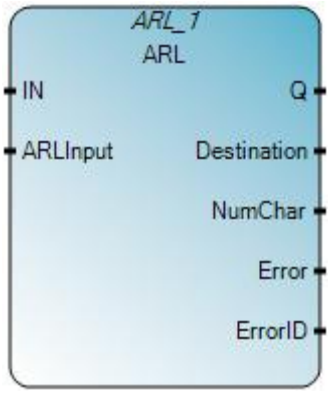
Structured Text (ST)

```
1  ARD_1(in, input);
2  output := ARD_1.Q;
3  des := ARD_1.Destination;
4  num := ARD_1.NumChar;
5  error := ARD_1.Error;
6  ID := ARD_1.ErrorID;
```



ARL

ARL reads characters from the buffer (up to and including the termination characters) and stores them in a string.

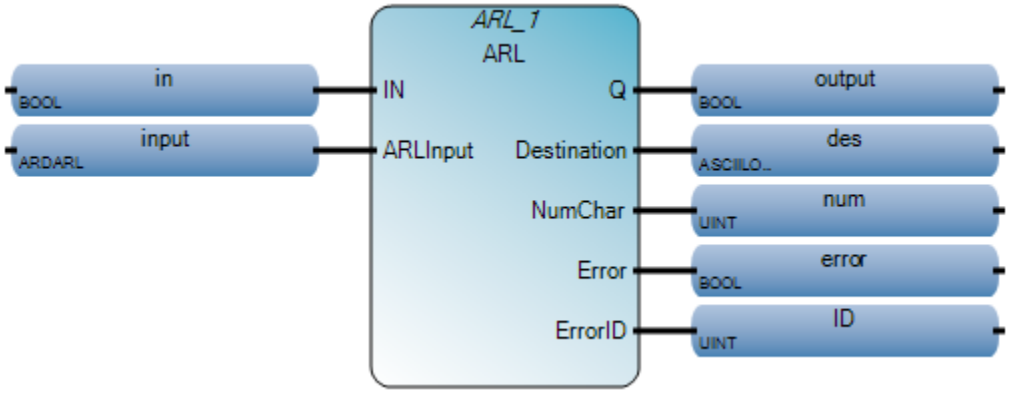


Arguments

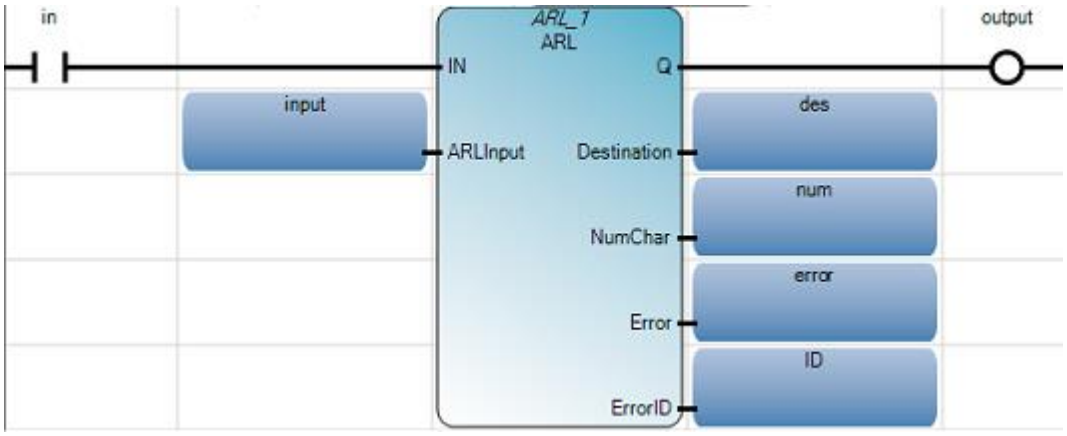
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
ARLInput	Input	ARDARL	Read characters from the buffer (maximum is 82). See ARDARL data type (on page 130).
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
Destination	Output	ASCIILOCADDR	The string element where you want the characters stored.
NumChar	Output	UINT	The number of characters.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

ARL function block language examples

Function Block Diagram (FBD)

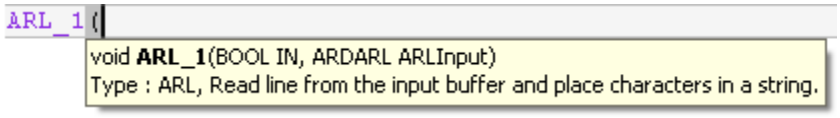


Ladder Diagram (LD)



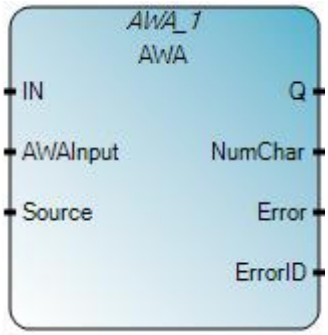
Structured Text (ST)

```
1  ARL_1(in, input);
2  output := ARL_1.Q;
3  des := ARL_1.Destination;
4  num := ARL_1.NumChar;
5  error := ARL_1.Error;
6  ID := ARL_1.ErrorID;
```



AWA

AWA writes characters from a source string to an external device. This instruction adds the two appended characters that you configure on the configuration dialog box.

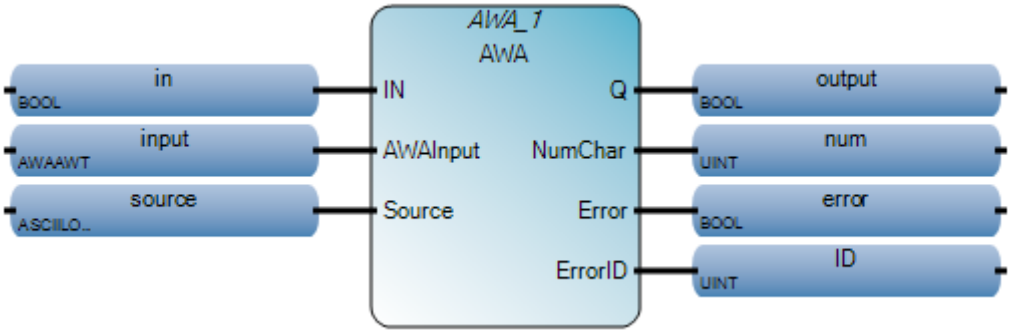


Arguments

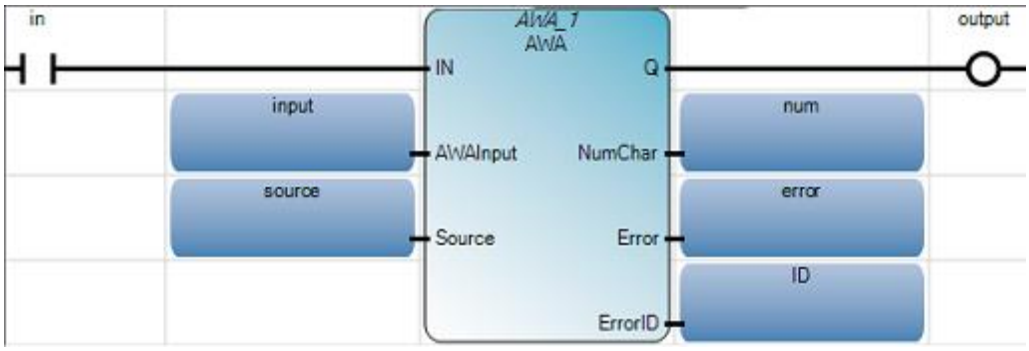
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
AWAInput	Input	AWAAWT	The channel and length to be operated. See AWAAWT data type (on page 131).
Source	Input	ASCIILOCADDR	The source string: char array.
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
NumChar	Output	UINT	The number of characters.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

AWA function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

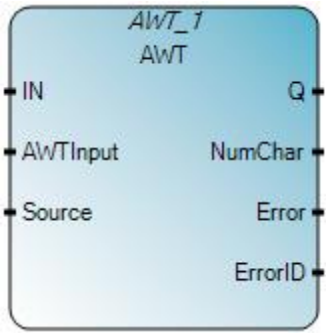
```
1  AWA_1(in, input, source);
2  output := AWA_1.Q;
3  num := AWA_1.NumChar;
4  error := AWA_1.Error;
5  ID := AWA_1.ErrorID;
```

```
AWA_1(
```

void **AWA_1**(BOOL IN, AWAAWT AWAInput, ASCIILOCADDR Source, UINT __ADI_Source)
Type : AWA, Write a string with characters appended to an external device.

AWT

AWT writes characters from a source string to an external device.

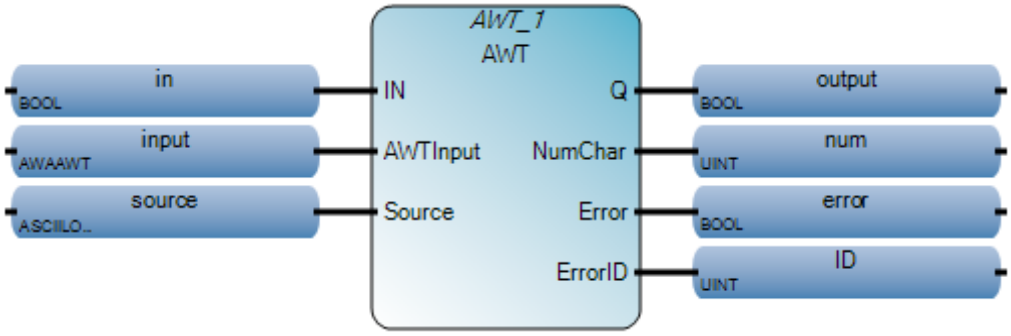


Arguments

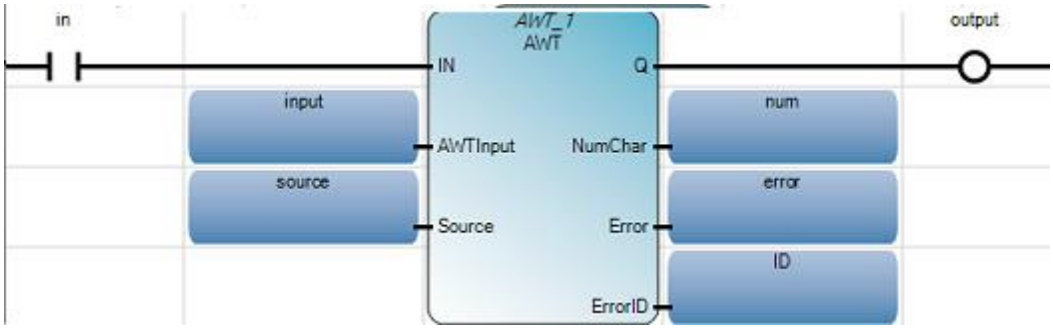
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
AWTInput	Input	AWAAWT	The channel and length to be operated. See AWAAWT data type (on page 131).
Source	Input	ASCIILOCADDR	The source string: char array.
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
NumChar	Output	UINT	Indicates the number of characters transmitted. Updates when the transmission is complete and Q is TRUE. NumChar may be less than the Length requested to be transmitted if the length of the Source String is shorter than the requested Length.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	See ABL error codes (on page 128).

AWT function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  AWT_1(in, input, source);
2  output := AWT_1.Q;
3  num := AWT_1.NumChar;
4  error := AWT_1.Error;
5  ID := AWT_1.ErrorID;
```

```
AWT_1(
```

void **AWT_1**(BOOL IN, AWAAWT AWTInput, ASCIILOCADDR Source, UINT __ADI_Source)
Type : AWT, Write characters from a source string to an external device.

ASCII parameter details

The following topics provide additional details for ASCII parameters and structured data types.

ABL error codes

The following table describes ABL error codes.

Error code	Error description
02	Operation cannot be completed because the modem went offline.
03	Transmission cannot be completed because the Clear-to-Send signal was lost.
05	While attempting to complete an ASCII transmission, System Mode (DF1) communication was detected.
06	Illegal parameter was detected.
07	Cannot complete ASCII send or receive because channel configuration has been shut down via the channel configuration dialog box.
08	Cannot complete ASCII Write due to an ASCII transmission already in progress.
09	ASCII communication requested is not supported by current channel configuration.
10	The Cancel was set, stopping instruction execution. No action required.
11	The requested length for the string is either invalid, a negative number, greater than 82, or 0. Applies to ARD (on page 118) and ARL (on page 121) function blocks.
13	The requested (.LEN) in the control block is a negative number or a value greater than the string size stored with the source string. Applies to AWA (on page 124) and AWT (on page 126) function blocks.
14	The ACL (on page 114) function block was aborted.
15	The channel configuration mode was changed.

ABLACB data type

The following table describes the ABLACB data type.

Parameter	Data type	Description
Channel	UINT	Serial port number: • 2 for the embedded serial port, or • 5-9 for serial port plug-ins installed in slots 1 through 5: • 5 for slot 1 • 6 for slot 2 • 7 for slot 3 • 8 for slot 4 • 9 for slot 5
TriggerType	USINT	Represents one of the following: • 0: Msg Triggered Once (when IN goes from False to True) • 1: Msg triggered continuously when IN is True • Other value: Reserved
Cancel	BOOL	When this input is set to TRUE, this function block does not execute.

ACL data type

The following table describes the ACL data type.

Parameter	Data type	Description
Channel	UINT	Serial port number: • 2 for the embedded serial port, or • 5-9 for serial port plug-ins installed in slots 1 through 5: • 5 for slot 1 • 6 for slot 2 • 7 for slot 3 • 8 for slot 4 • 9 for slot 5
RXBuffer	BOOL	Clears the receive buffer when set to TRUE and removes the receive ASCII function blocks (ARL and ARD) from the ASCII queue.
TXBuffer	BOOL	Clears the transmit buffer when set TRUE and removes the transmit ASCII function blocks (AWA and AWT) from the ASCII queue.

AHL ChannelSts data type

The following table describes the AHL ChannelSts data type.

Parameter	Data type	Description
DTRstatus	UINT	Used for the DTR signal (reserved)
DCDstatus	UINT	Used for the DCD signal (bit 3 of word) 1 indicates active
DSRstatus	UINT	Used for the DSR signal (reserved)
RTSstatus	UINT	Used for the RTS signal (bit 1 of word) 1 indicates active
CTSstatus	UINT	Used for the CTS signal (bit 0 of word) 1 indicates active

AHLI data type

The following table describes the AHL data type.

Parameter	Data type	Description
Channel	UINT	Serial port number: • 2 for the embedded serial port, or • 5-9 for serial port plug-ins installed in slots 1 through 5: • 5 for slot 1 • 6 for slot 2 • 7 for slot 3 • 8 for slot 4 • 9 for slot 5
ClrRts	BOOL	Used to reset the RTS control line.
SetRts	BOOL	Used to set the RTS control line.
Cancel	BOOL	When this input is set to TRUE, this function block does not execute.

ARDARL data type

The following table describes the ARDARL data type.

Parameter	Data type	Description
Channel	UINT	Serial port number: • 2 for the embedded serial port, or • 5-9 for serial port plug-ins installed in slots 1 through 5: • 5 for slot 1 • 6 for slot 2 • 7 for slot 3 • 8 for slot 4 • 9 for slot 5
Length	UINT	The number of characters that you want to read from the buffer (maximum is 82).
Cancel	BOOL	When this input is set to TRUE, this function block does not execute. If already executing, operation ceases.

AWAAWT data type

The following table describes the AWAAWT data type.

Parameter	Data type	Description
Channel	UINT	Serial port number: • 2 for the embedded serial port, or • 5-9 for serial port plug-ins installed in slots 1 through 5: • 5 for slot 1 • 6 for slot 2 • 7 for slot 3 • 8 for slot 4 • 9 for slot 5
Length	UINT	The number of characters that you want to write to the buffer (maximum is 82). **Note:** If you set the Length to 0, AWA sends 0 bytes of user data and 2 bytes of appended characters to the buffer.
Cancel	BOOL	When this input is set to TRUE, this function block does not execute. If already executing, operation ceases.

Binary instructions

Binary instructions perform mathematical operations in which two elements are combined to yield a single result.

Operator	Description
AND_MASK (on page 134)	Integer bit-to-bit AND_MASK
NOT_MASK (on page 136)	Integer bit-to-bit negation NOT_MASK
OR_MASK (on page 138)	Integer bit-to-bit OR_MASK
ROL (on page 140)	Rotate Left an integer value
ROR (on page 142)	Rotate Right an integer value
SHL (on page 144)	Shift Left an integer value
SHR (on page 146)	Shift Right an integer value
XOR_MASK (on page 148)	Integer bit-to-bit Exclusive OR mask

AND_MASK

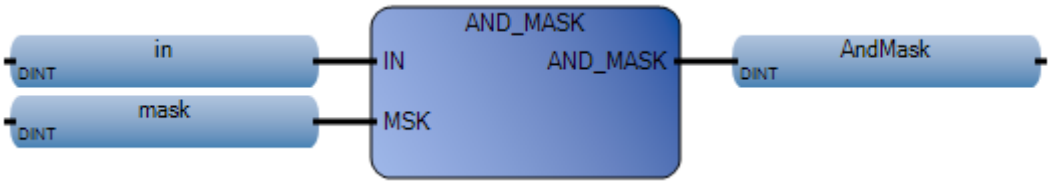
Integer bit-to-bit AND mask.

Arguments

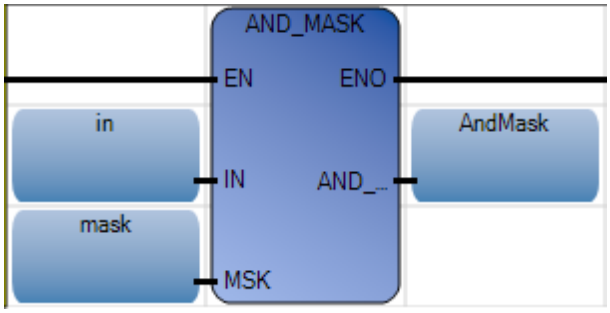
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the Integer AND bit-to-bit mask computation. When EN = FALSE, there is no computation.
IN	Input	DINT	Must have integer format.
MSK	Input	DINT	Must have integer format.
AND_MASK	Output	DINT	Bit-to-bit logical AND between IN and MSK.
ENO	Output	BOOL	Enable out.

AND_MASK function language examples

Function block diagram



Ladder diagram



Structured text

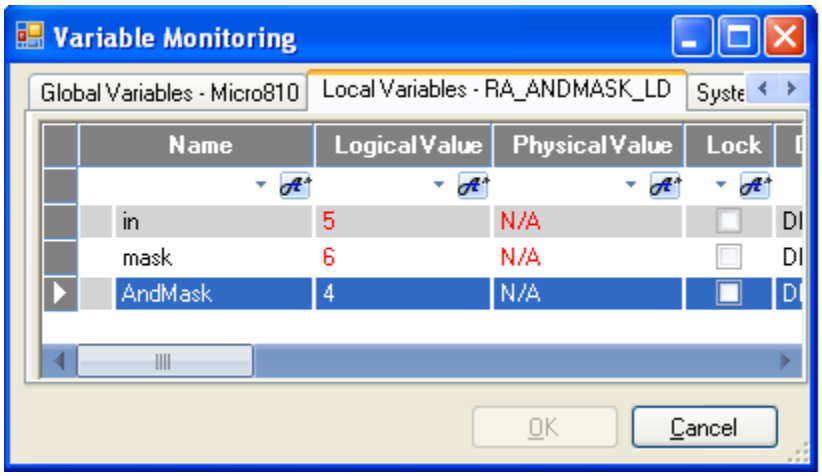
```
1  in := 5;
2  mask := 6;
3  AndMask := AND_MASK(in, mask);
```

(* ST Equivalence: *)

parity := AND_MASK (xvalue, 1); (* 1 if xvalue is odd *)

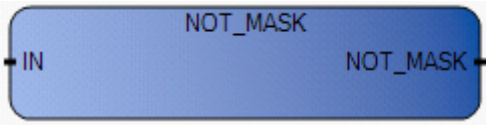
result := AND_MASK (16#abc, 16#f0f); (* equals 16#a0c *)

Results



NOT_MASK

Integer bit-to-bit negation mask, NOT_MASK inverts a parameter value.

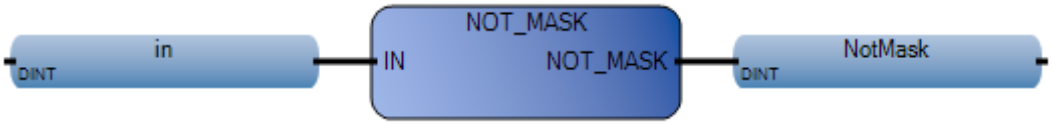


Arguments

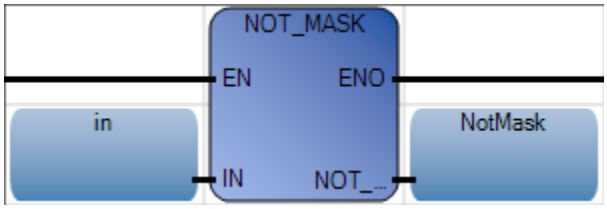
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the bit-to-bit negation mask computation. When EN = FALSE, there is no computation.
IN	Input	DINT	Must have integer format.
NOT_MASK	Output	DINT	Bit-to-bit negation on 32 bits of IN.
ENO	Output	BOOL	Enable out.

NOT_MASK function language example

Function block diagram



Ladder diagram



Structured text

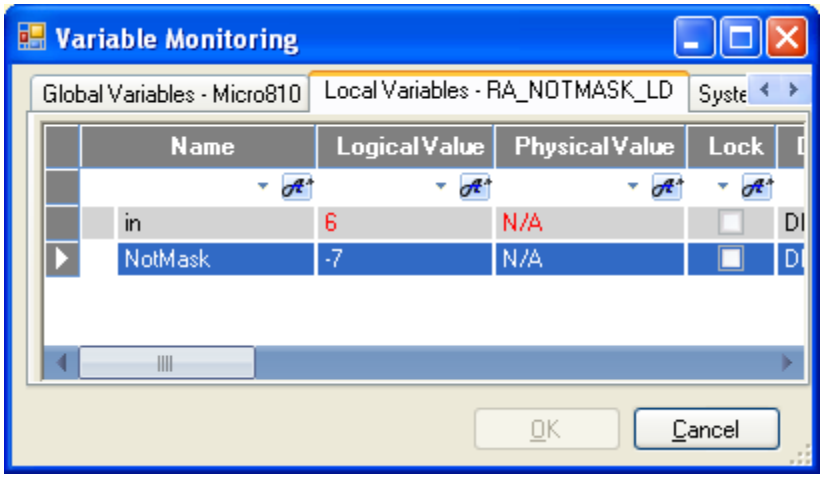
```
1  in := 6;
2  NotMask := NOT_MASK(in);
```

(*ST equivalence: *)

result := NOT_MASK (16#1234);

(* result is 16#FFFF_EDCB *)

Results



OR_MASK

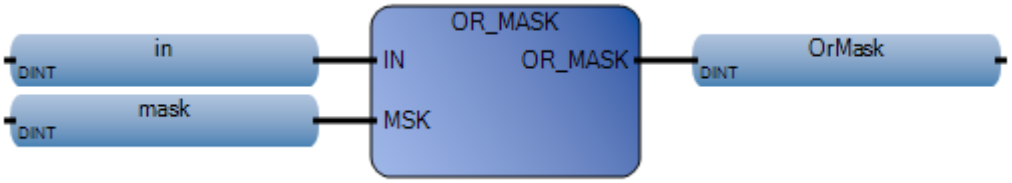
Integer OR bit-to-bit mask, OR_MASK turns bits on.

Arguments

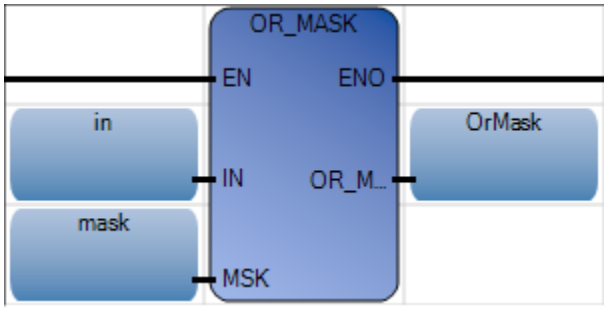
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the Integer OR bit-to-bit mask computation. When EN = FALSE, there is no computation.
IN	Input	DINT	Must have integer format.
MSK	Input	DINT	Must have integer format.
OR_MASK	Output	DINT	Bit-to-bit logical OR between IN and MSK.
ENO	Output	BOOL	Enable out.

OR_MASK function language examples

Function block diagram



Ladder diagram



Structured text

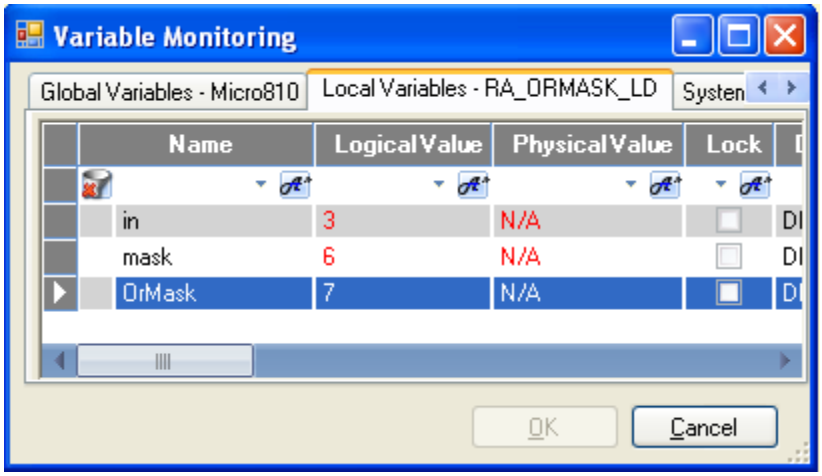
```
1  in := 3;
2  mask := 6;
3  OrMask := OR_MASK(in, mask);
```

(* ST Equivalence: *)

parity := OR_MASK (xvalue, 1); (* makes value always odd *)

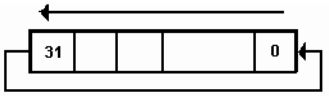
result := OR_MASK (16#abc, 16#f0f); (* equals 16#fbf *)

Results



ROL

For 32-bit integers, ROL rotates integer bits to the left.

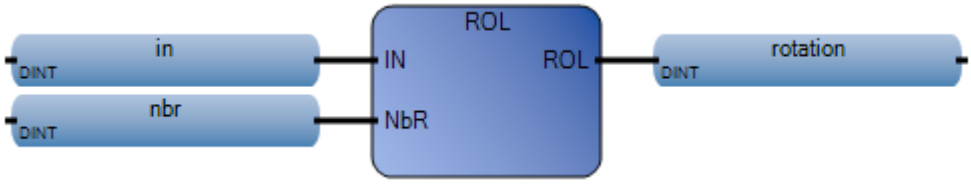


Arguments

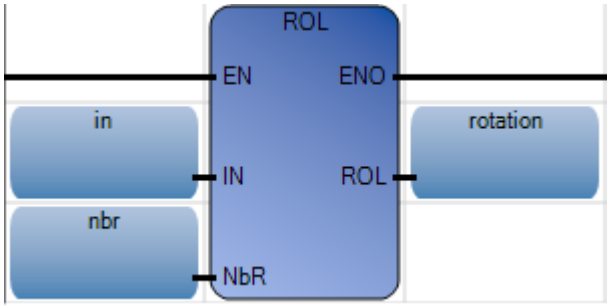
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the rotate bits left integer value computation. When EN = FALSE, there is no computation.
IN	Input	DINT	Integer value.
NbR	Input	DINT	Number of 1-bit rotations (in set [1..31]).
ROL	Output	DINT	Left rotated value. When NbR <= 0, no change occurs.
ENO	Output	BOOL	Enable out.

ROL function language examples

Function block diagram



Ladder diagram



Structured text

```
1  in := 123;
2  nbr := 2;
3  rotation := ROL(in, nbr);
```

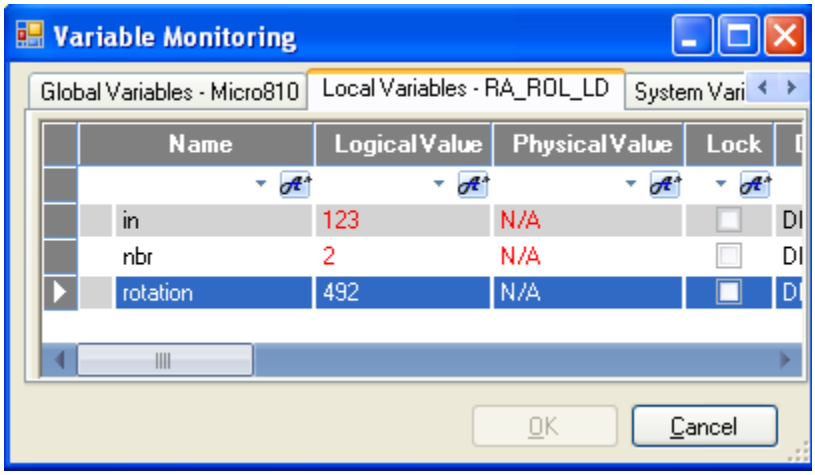
(* ST Equivalence: *)

result := ROL (register, 1);

(* register = 2#0100_1101_0011_0101*)

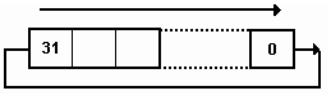
(* result = 2#1001_1010_0110_1010*)

Results



ROR

For 32-bit integers, ROR rotates integer bits to the right.

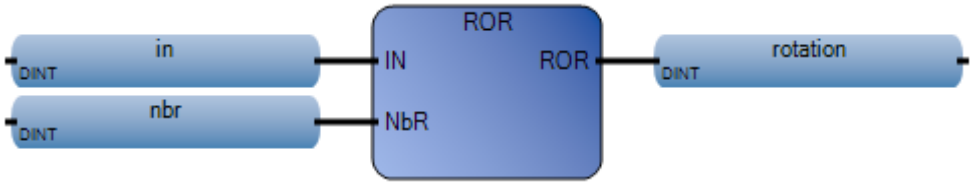


Arguments

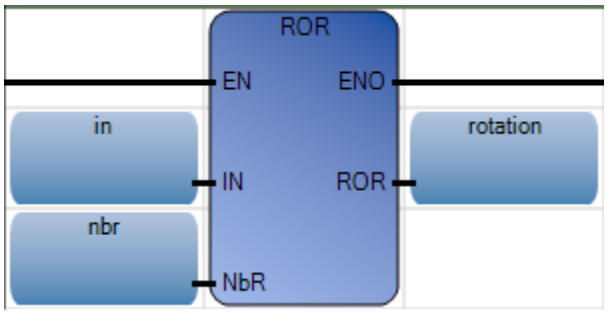
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the rotate bit right integer value computation. When EN = FALSE, there is no computation.
IN	Input	DINT	Any integer value.
NbR	Input	DINT	Number of 1-bit rotations (in set [1..31]).
ROR	Output	DINT	Right rotated value. There is no effect if NbR <= 0.
ENO	Output	BOOL	Enable out.

ROR function language examples

Function block diagram



Ladder diagram



Structured text

```
1  in := 123;
2  nbr := 2;
3  rotation := ROR(in, nbr);
```

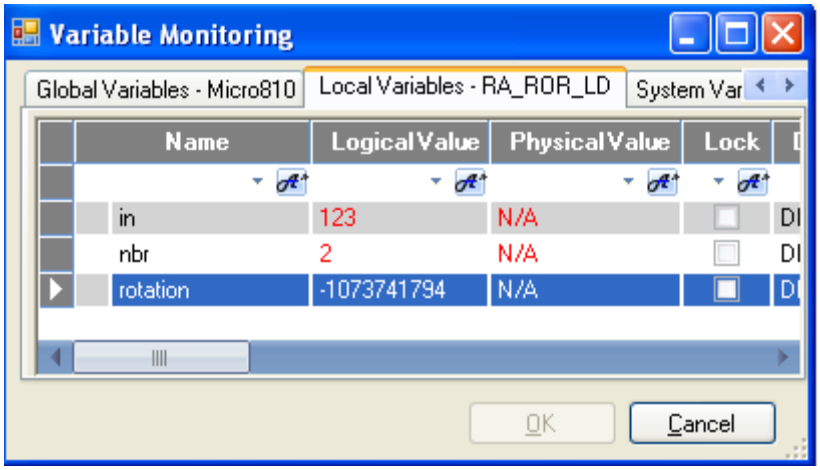
(* ST Equivalence: *)

result := ROR (register, 1);

(* register = 2#0100_1101_0011_0101 *)

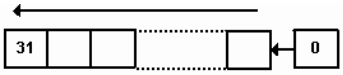
(* result = 2#1010_0110_1001_1010 *)

Results



SHL

For 32-bit integers, SHL moves integers to the left and places 0 in the least significant bit.

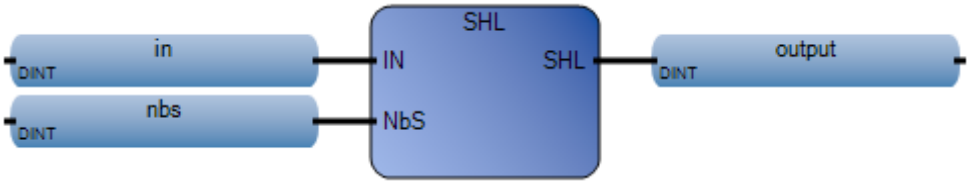


Arguments

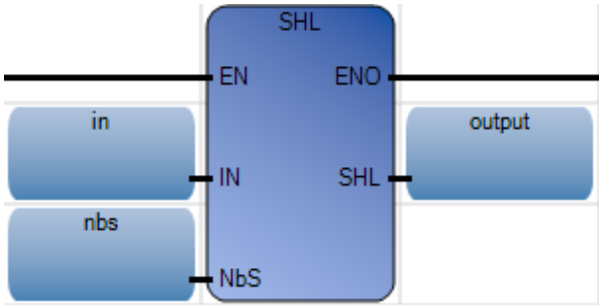
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, move integers to the left. When EN = FALSE, there is no integer movement.
IN	Input	DINT	Any integer value.
NbS	Input	DINT	Number of 1 bit shifts (in set [1..31]).
SHL	Output	DINT	Left shifted value. There is no effect if NbS <= 0. If a value of 0, replaces the least significant bit.
ENO	Output	BOOL	Enable out.

SHL function language examples

Function block diagram



Ladder diagram



Structured text

```
1  in := 123;
2  nbs := 2;
3  output := SHL(in, nbs);
```

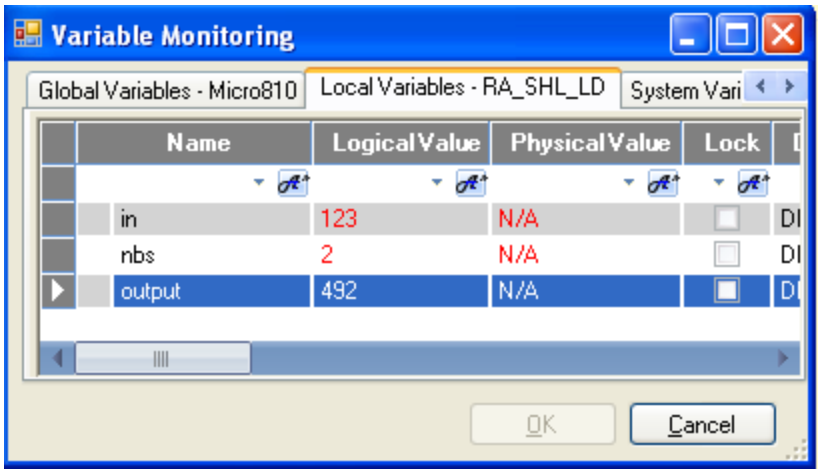
(* ST Equivalence: *)

result := SHL (register,1);

(* register = 2#0100_1101_0011_0101 *)

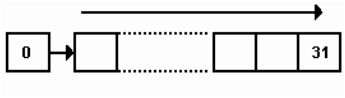
(* result = 2#1001_1010_0110_1010 *)

Results



SHR

For 32-bit integers, SHR moves integers to the right and places 0 in the most significant bit.

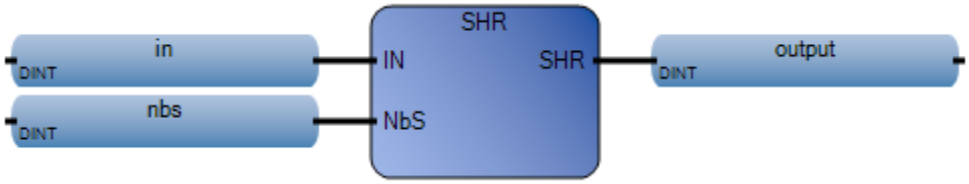


Arguments

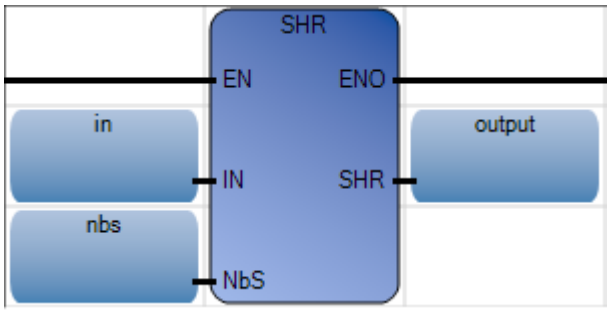
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, move integers to the right. When EN = FALSE, there is no integer movement.
IN	Input	DINT	Any integer value.
NbS	Input	DINT	Number of 1 bit shifts (in set [1..31]).
SHR	Output	DINT	Right shifted value. There is no effect if NbS <= 0. If a value of 0, replaces the most significant bit.
ENO	Output	BOOL	Enable out.

SHR function language examples

Function block diagram

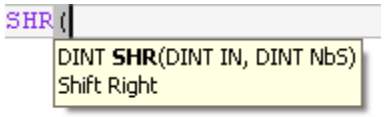


Ladder diagram



Structured text

```
1  in := 123;
2  nbs := 2;
3  output := SHR(in, nbs);
```



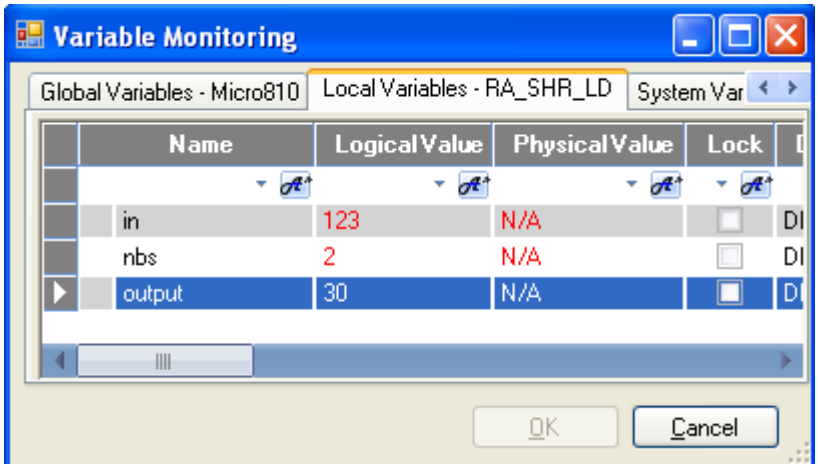
(* ST Equivalence: *)

result := SHR (register,1);

(* register = 2#1100_1101_0011_0101 *)

(* result = 2#0110_0110_1001_1010 *)

Results



XOR_MASK

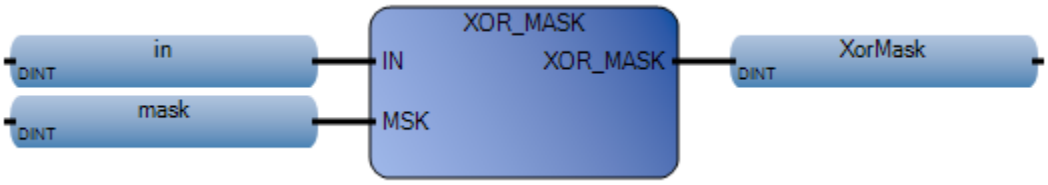
Integer exclusive OR bit-to-bit mask, XOR_MASK returns inverted bit values.

Arguments

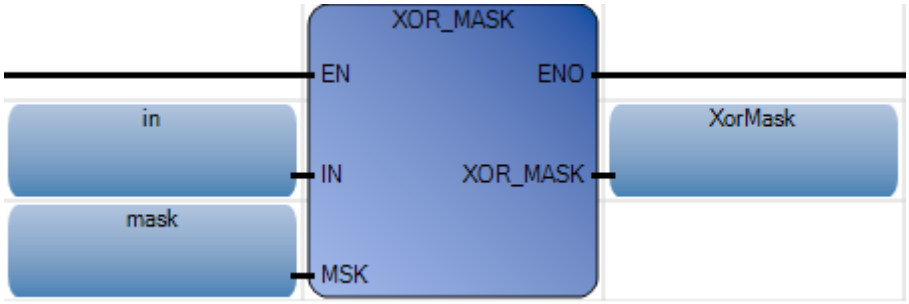
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, perform the exclusive OR bit-to-bit mask computation. When EN = FALSE, there is no computation.
IN	Input	DINT	Must have integer format.
MSK	Input	DINT	Must have integer format.
XOR_MASK	Output	DINT	Bit-to-bit logical Exclusive OR between IN and MSK.
ENO	Output	BOOL	Enable out.

XOR_MASK language examples

Function block diagram



Ladder diagram



Structured text

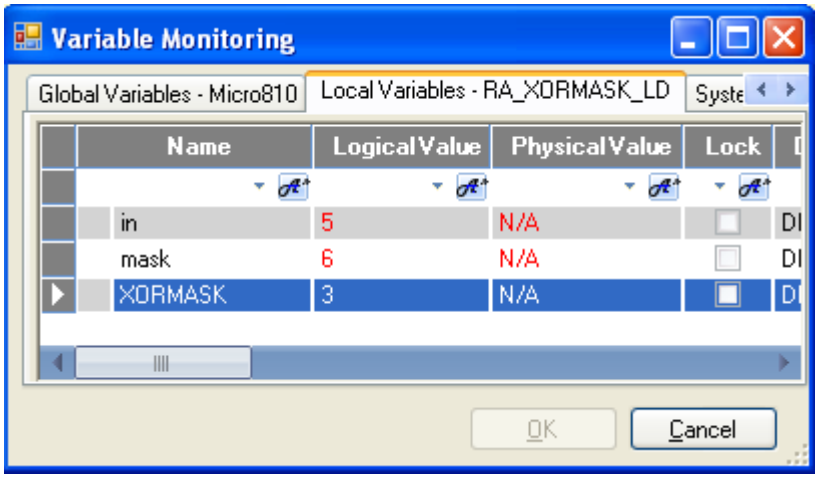
```
1  in := 5;
2  mask := 6;
3  XorMask := XOR_MASK(in, mask);
```

(* ST Equivalence: *)

crc32 := XOR_MASK (prevcrc, nextc);

result := XOR_MASK (16#012, 16#011); (* equals 16#003 *)

Results



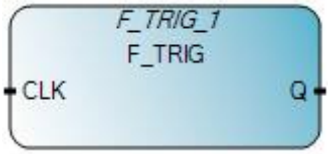
Boolean instructions

Boolean instructions determine a value output based on some logical calculation from inputs. The module outputs can be directly controlled from the program or independently controlled by the module using the Boolean instructions.

Function	Description
MUX4B (on page 174)	Similar to MUX4, but can accept BOOL type input and output BOOL type value
MUX8B (on page 168)	Similar to MUX8, but can accept BOOL type input and output BOOL type value
TTABLE (on page 164)	Provides the value of the output according to the combination of inputs
Function block	**Description**
F_TRIG (on page 152)	Falling edge detection
RS (on page 156)	Reset dominant bistable
R_TRIG (on page 154)	Rising edge detection
SR (on page 162)	Set dominant bistable
Operator	**Description**
AND (on page 159)	Performs a boolean AND operation between two or more values.
NOT (on page 161)	For Boolean expressions, converts values to negated values.
XOR (on page 160)	Boolean exclusive OR of two values.
OR (on page 158)	Boolean OR of two or more values.

F_TRIG

F_TRIG detects a falling edge of a Boolean variable.

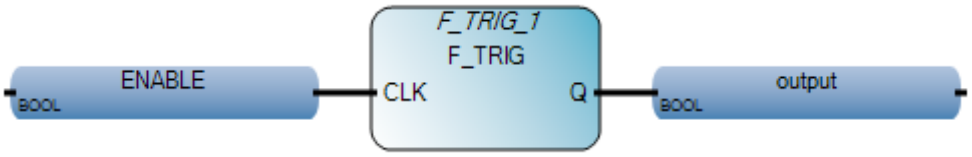


Arguments

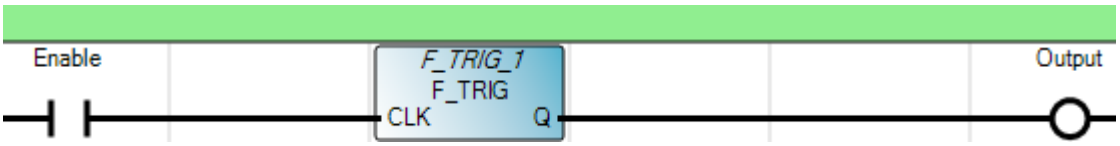
Parameter	Parameter type	Data type	Description
CLK	Input	BOOL	Any Boolean variable.
Q	Output	BOOL	TRUE when CLK changes from TRUE to FALSE. FALSE in all other cases.

F_TRIG function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

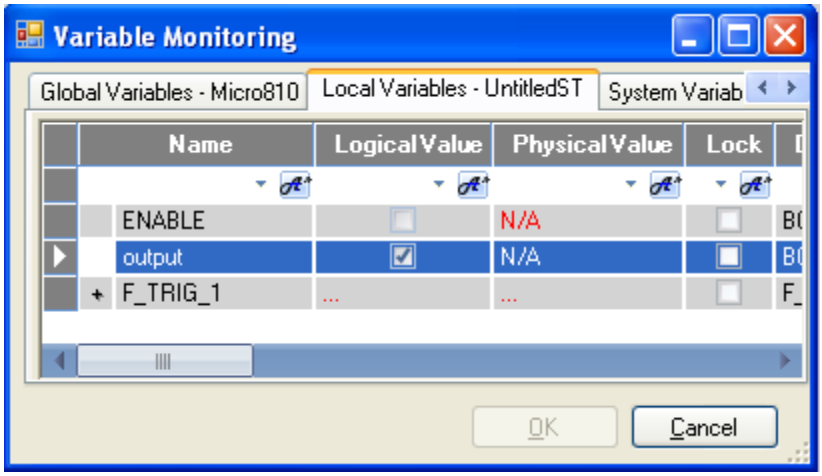
```
1  F_TRIG_1(ENABLE);
2  IF F_TRIG_1.Q THEN
3     output := TRUE;
4  END_IF;
```

```
F_TRIG_1(
        void F_TRIG_1(BOOL CLK)
        Type : F_TRIG, Falling edge detection
```

(* ST Equivalence: F_TRIG1 is an instance of a F_TRIG block *)

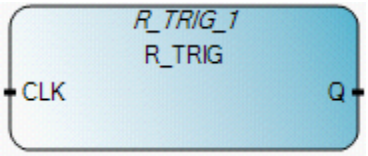
```
F_TRIG1(cmd);
nb_edge := ANY_TO_DINT(F_TRIG1.Q) + nb_edge;
```

Results



R_TRIG

R_TRIG detects a rising edge of a Boolean variable.

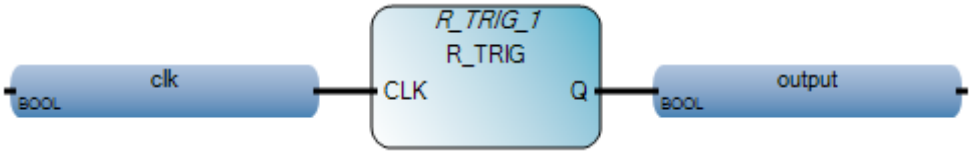


Arguments

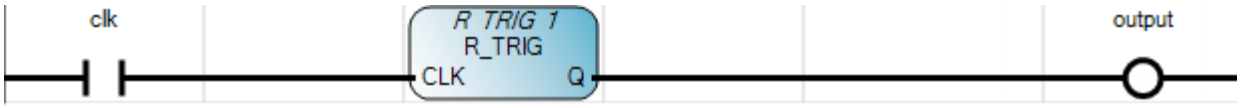
Parameter	Parameter type	Data type	Description
CLK	Input	BOOL	Any Boolean variable.
Q	Output	BOOL	TRUE when CLK rises from FALSE to TRUE. FALSE in all other cases.

R_TRIG function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



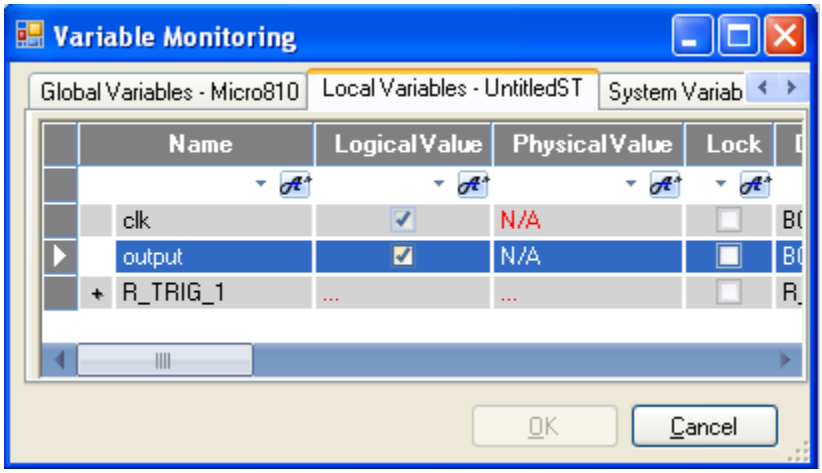
Structured Text (ST)

```
1  R_TRIG_1(clk);
2  output := R_TRIG_1.Q;
```

(* ST Equivalence: R_TRIG1 is an instance of a R_TRIG block *)

```
R_TRIG1(cmd);
nb_edge := ANY_TO_DINT(R_TRIG1.Q) + nb_edge;
```

Results



RS

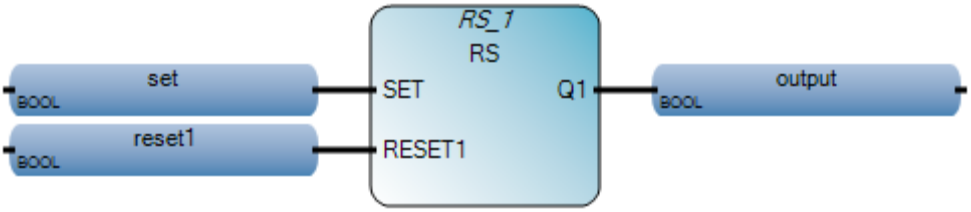
RS resets dominant bistable.

Arguments

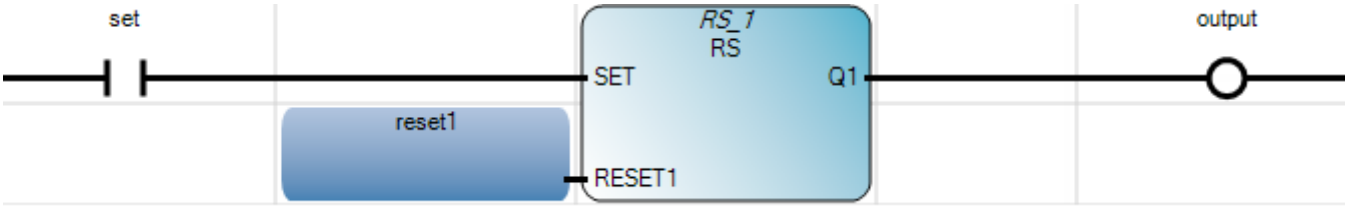
Parameter	Parameter type	Data type	Description
SET	Input	BOOL	If TRUE, sets Q1 to TRUE.
RESET1	Input	BOOL	If TRUE, resets Q1 to FALSE (dominant).
Q1	Output	BOOL	Boolean memory state.

RS function block language examples

Function Block Diagram (FBD)

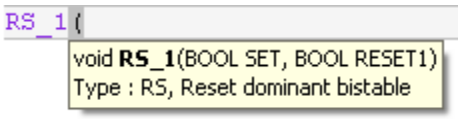


Ladder Diagram (LD)



Structured Text (ST)

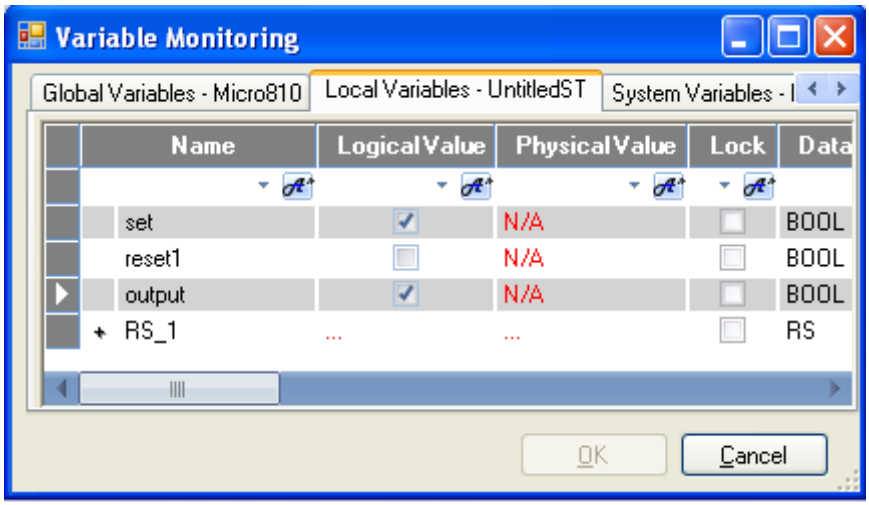
```
1  set := TRUE;
2  reset1 := FALSE;
3  RS_1(set, reset1);
4  output := RS_1.Q1;
```



(* ST Equivalence: RS1 is an instance of a RS block *)

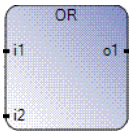
```
RS1(start_cmd, (stop_cmd OR alarm));
command := RS1.Q1;
```

Results



OR

Boolean OR of two or more values.



OR operation

The OR operator supports additional inputs.

Arguments

Parameter	Parameter Type	Data Type	Description
i1	Input	BOOL	
i2	Input	BOOL	
o1	Output	BOOL	Boolean OR of the input terms.

OR operator ST language example

(* ST equivalence: *)

```
bo10 := bi101 OR NOT (bi102);
bo5 := (bi51 OR bi52) OR bi53;
```

AND

AND performs a boolean AND operation between two or more values.

AND operation

The AND operator supports additional inputs.

Arguments

Parameter	Parameter Type	Data Type	Description
i1	Input	BOOL	Value in Boolean data type.
i2	Input	BOOL	Value in Boolean data type.
o1	Output	BOOL	Result of the Boolean AND operation of the input values.

AND operator ST language example

(* ST equivalence: *)

```
bo10 := bi101 AND NOT (bi102);
bo5 := (bi51 AND bi52) AND bi53;
```

XOR

Boolean exclusive OR of two values.

Arguments

Parameter	Parameter Type	Data Type	Description
i1	Input	BOOL	
i2	Input	BOOL	
o1	Output	BOOL	Boolean exclusive OR of the two input terms.

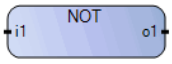
XOR operator ST language example

(* ST equivalence: *)

```
bo10 := bi101 XOR NOT (bi102);
bo5 := (bi51 XOR bi52) XOR bi53;
```

NOT

For Boolean expressions, NOT converts values to negated values.



Arguments

Parameter	Parameter Type	Data Type	Description
i1	Input	BOOL	Any Boolean value or complex expression.
o1	Output	BOOL	TRUE when IN is FALSE. FALSE when IN is TRUE.

NOT operator ST language example

(* ST equivalence: *)

```
bo10 := NOT (bi101);
```

SR

SR sets dominant bistable.

Arguments

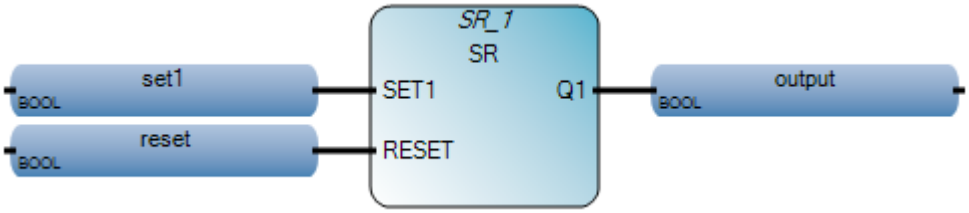
Parameter	Parameter type	Data type	Description
SET1	Input	BOOL	If TRUE, sets Q1 to TRUE (dominant).
RESET	Input	BOOL	If TRUE, resets Q1 to FALSE.
Q1	Output	BOOL	Boolean memory state.

Dominant bistable example

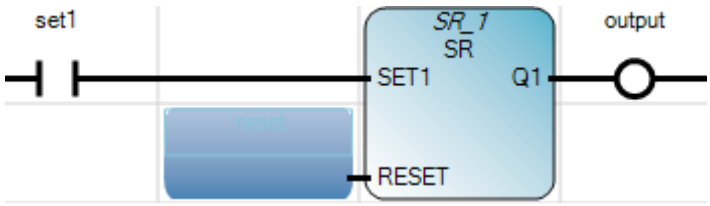
Set1	Reset	Q1	Result Q1
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

SR function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



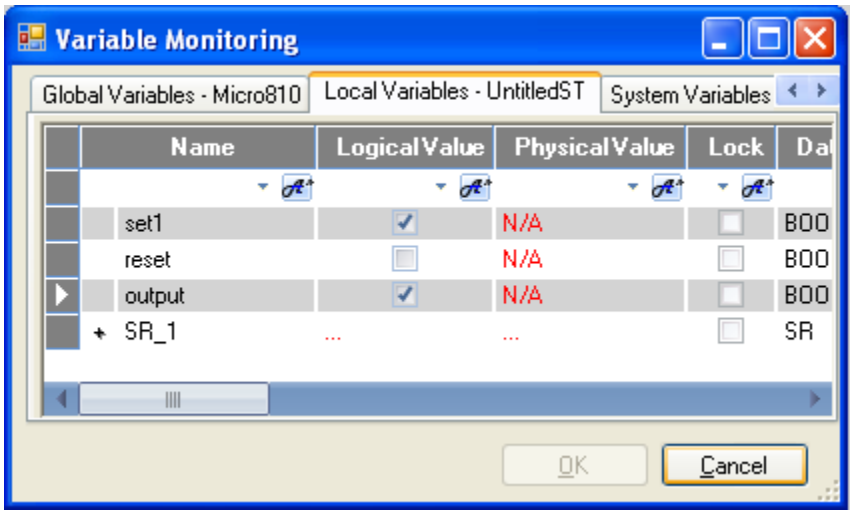
Structured Text (ST)

```
1  set1 := TRUE;
2  reset := FALSE;
3  SR_1(set1, reset);
4  output := SR_1.Q1;
```

(* ST Equivalence: SR1 is an instance of a SR block *)

```
SR1((auto_mode & start_cmd), stop_cmd);
command := SR1.Q1;
```

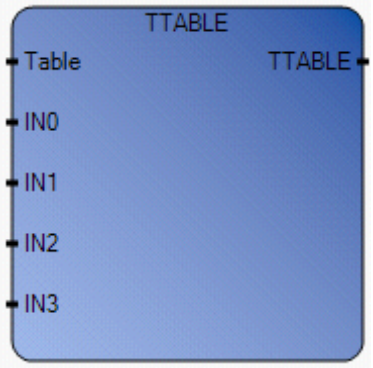
Results



TTABLE

The TTABLE function gives the value of the output according to the combination of inputs.

If the value is 0xABCD and In3 through In0 corresponds to the number 7, then TTABLE is the value of bit 7 in the table (which is 1). The least significant bit in the table is bit 0.



Arguments

Parameter	Parameter Type	Data Type	Description
Table	Input	UINT	Truth table of BOOLEAN function.
IN0	Input	BOOL	Any BOOL input value.
IN1	Input	BOOL	Any BOOL input value.
IN2	Input	BOOL	Any BOOL input value.
IN3	Input	BOOL	Any BOOL input value.
TTABLE	Output	BOOL	The value of the output according to the combination of inputs. See TTABLE input combinations (on page 167).

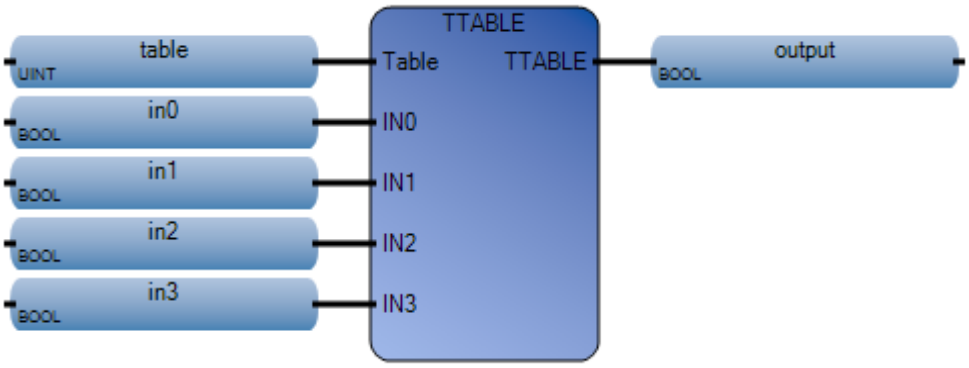
TTABLE input combinations

The function has four inputs, and therefore 16 combinations. These combinations can be found in a truth table; for each combination, the output value can be adjusted. The number of configurable combinations depends on the number of inputs connected to the function. For example:

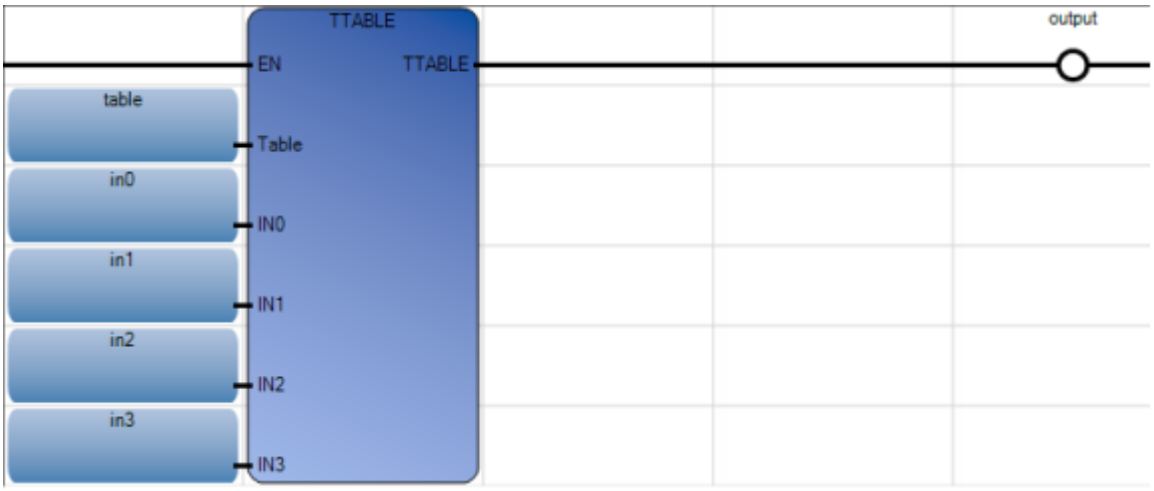
Number	In3	In2	In1	In0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

TTABLE function language examples

Function block diagram



Ladder diagram

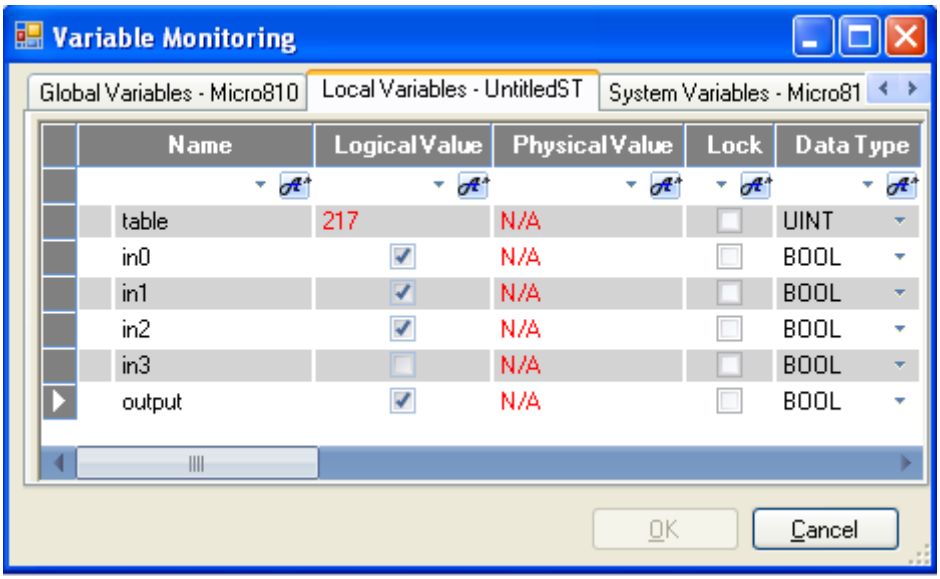


Structured text

```
1  table := 217;
2  in0 := TRUE;
3  in1 := TRUE;
4  in2 := TRUE;
5  in3 := FALSE;
6  output := TTABLE(table, in0, in1, in2, in3);
```

```
TTABLE(
BOOL TTABLE(UINT Table, BOOL IN0, BOOL IN1, BOOL IN2, BOOL IN3)
Provide the value output based on the combination of inputs.
```

Results



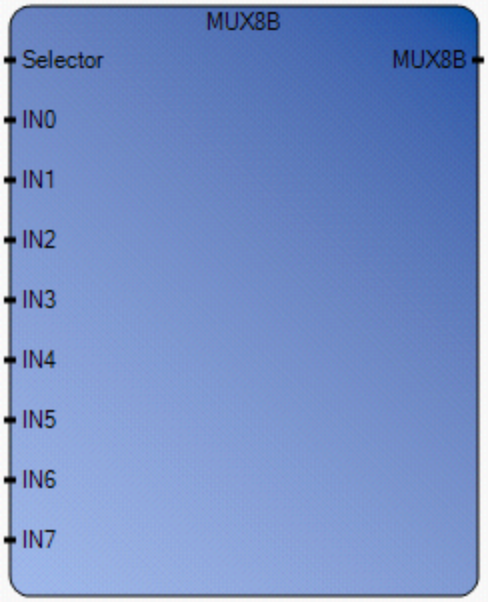
TTABLE input combinations

The function has four inputs, and therefore 16 combinations. These combinations can be found in a truth table; for each combination, the output value can be adjusted. The number of configurable combinations depends on the number of inputs connected to the function. For example:

Number	In3	In2	In1	In0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

MUX8B

MUX8B yields a value between eight BOOL type input and output values.

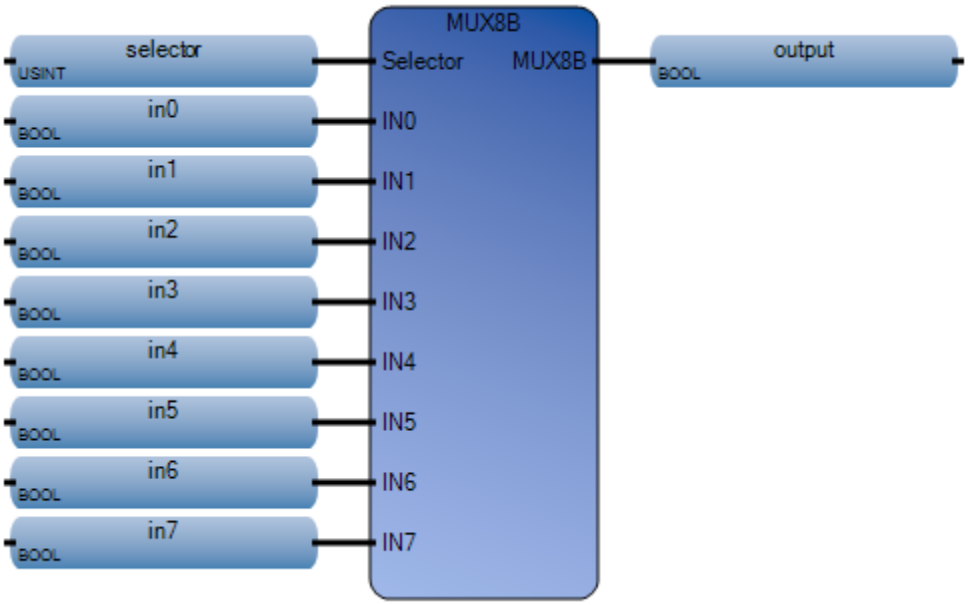


Arguments

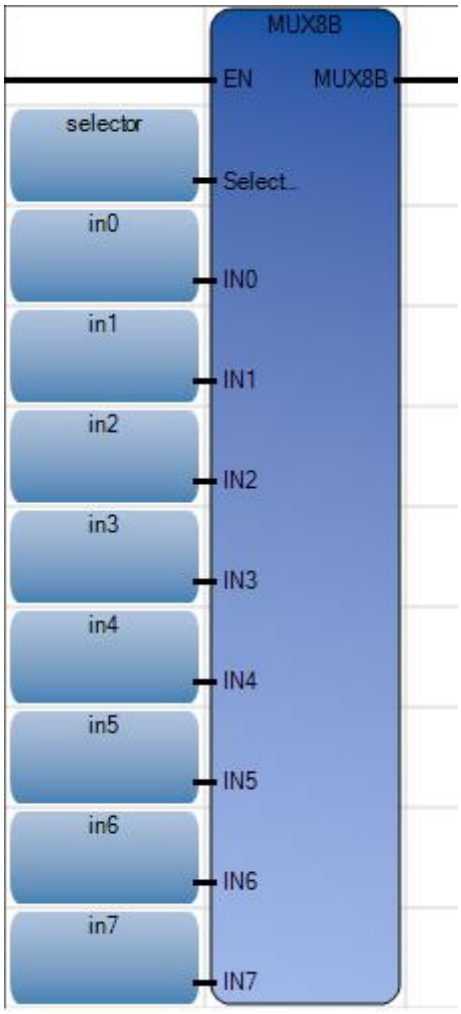
Parameter	Parameter Type	Data Type	Description
Selector	Input	USINT	Selector integer value, must be in set [0...7].
IN0	Input	BOOL	Any BOOL input value.
IN1	Input	BOOL	Any BOOL input value.
IN2	Input	BOOL	Any BOOL input value.
IN3	Input	BOOL	Any BOOL input value.
IN4	Input	BOOL	Any BOOL input value.
IN5	Input	BOOL	Any BOOL input value.
IN6	Input	BOOL	Any BOOL input value.
IN7	Input	BOOL	Any BOOL input value.
MUX8B	Output	BOOL	Can be: • In0 if Selector = 0 • In1 if Selector = 1 • In2 if Selector = 2 • In3 if Selector = 3 • In4 if Selector = 4 • In5 if Selector = 5 • In6 if Selector = 6 • In7 if Selector = 7 Will be FALSE for all other values of the selector.

MUX8B function language examples

Function block diagram



Ladder diagram



Structured text

```
1  selector := 7;
2  in0 := FALSE;
3  in1 := FALSE;
4  in2 := FALSE;
5  in3 := FALSE;
6  in4 := FALSE;
7  in5 := FALSE;
8  in6 := FALSE;
9  in7 := TRUE;
10 output := MUX8B(selector, in0, in1, in2, in3, in4, in5, in6, in7);
```

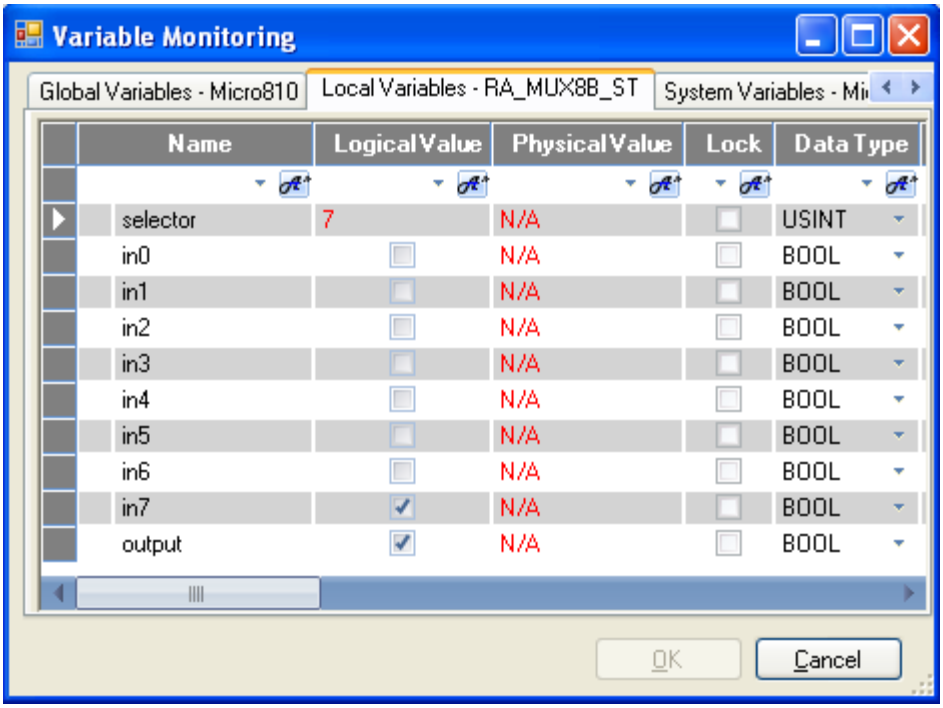
```
MUX8B(
BOOL MUX8B(USINT Selector, BOOL IN0, BOOL IN1, BOOL IN2, BOOL IN3, BOOL IN4, BOOL IN5, BOOL IN6, BOOL IN7)
Multiplexer(8 entries) - accepts BOOL inputs and output value.
```

(* ST Equivalence: *)

range := MUX8 (choice, 1, 5, 10, 50, 100, 500, 1000, 5000);

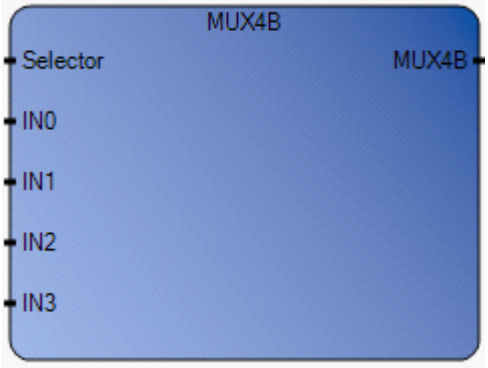
(* select from 8 predefined ranges, for example, if choice is 3, range will be 50 *)

Results


Variable Monitoring
Global Variables - Micro810
Local Variables - RA_MUX8B_ST
System Variables - Mi
Name
Logical Value
Physical Value
Lock
Data Type
selector
7
N/A
USINT
in0
N/A
BOOL
in1
N/A
BOOL
in2
N/A
BOOL
in3
N/A
BOOL
in4
N/A
BOOL
in5
N/A
BOOL
in6
N/A
BOOL
in7
N/A
BOOL
output
N/A
BOOL
OK
Cancel

MUX4B

MUX4B yields a value between four BOOL type input and output values.

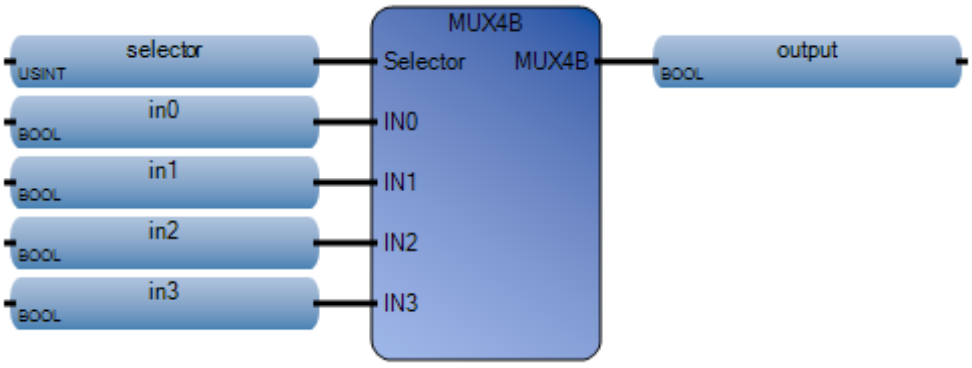


Arguments

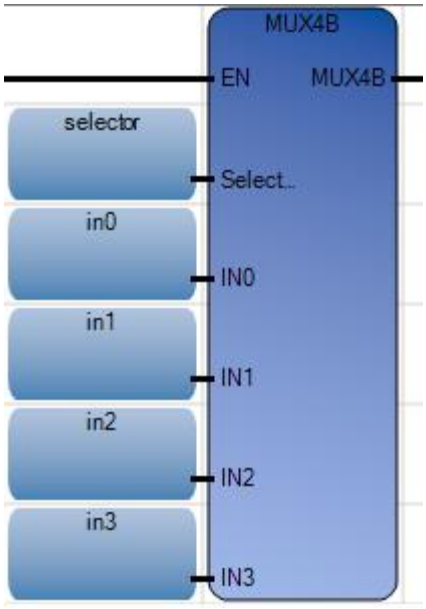
Parameter	Parameter Type	Data Type	Description
Selector	Input	USINT	Selector integer value, must be in set [0...3].
IN0	Input	BOOL	Any BOOL input value.
IN1	Input	BOOL	Any BOOL input value.
IN2	Input	BOOL	Any BOOL input value.
IN3	Input	BOOL	Any BOOL input value.
MUX4B	Output	BOOL	Can be: • In0 if Selector = 0 • In1 if Selector = 1 • In2 if Selector = 2 • In3 if Selector = 3 Will be FALSE for all other values of the selector.

MUX4B function language examples

Function block diagram

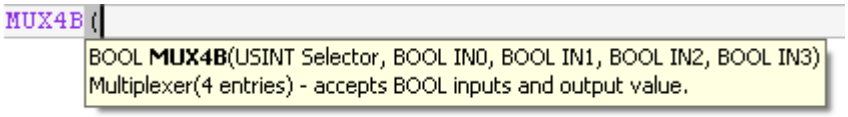


Ladder diagram



Structured text

```
1  selector := 1;
2  in0 := FALSE;
3  in1 := TRUE;
4  in2 := FALSE;
5  in3 := FALSE;
6  output := MUX4B(selector, in0, in1, in2, in3);
```

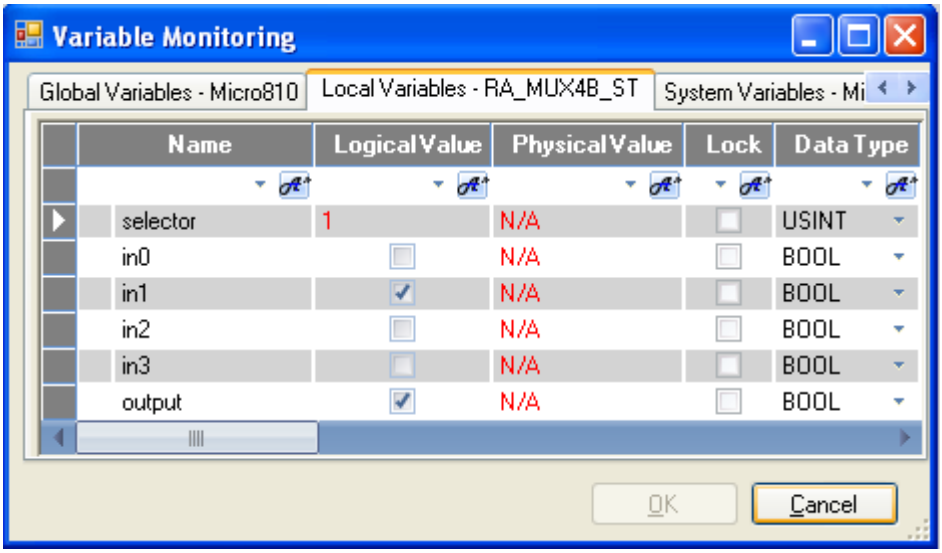


(* ST Equivalence: *)

range := MUX4 (choice, 1, 10, 100, 1000);

(* select from 4 predefined ranges, for example, if choice is 1, range will be 10 *)

Results



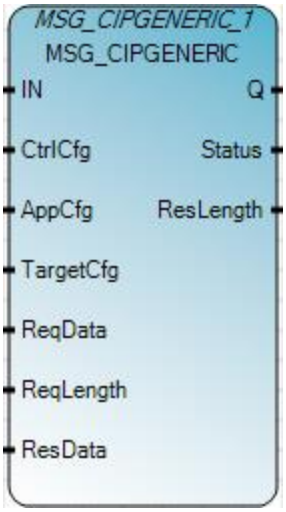
Communication instructions

Communication instructions read, write, compare, and convert communication strings.

Function block	Description
MSG_CIPGENERIC (on page 178)	Send a CIP generic explicit message
MSG_CIPSYMBOLIC (on page 187)	Send a CIP symbolic explicit message
MSG_MODBUS (on page 199)	Send a Modbus message
MSG_MODBUS2 (on page 206)	Send a MODBUS/TCP message over an Ethernet Channel

MSG_CIPGENERIC

MSG_CIPGENERIC sends a common industrial protocol (CIP) explicit message over an Ethernet channel or a serial port.



MSG_CIPGENERIC operation

A maximum of four message requests per channel can be processed in one scan. For Ladder Diagram programs, message requests are executed at the end of a ladder scan.

Arguments

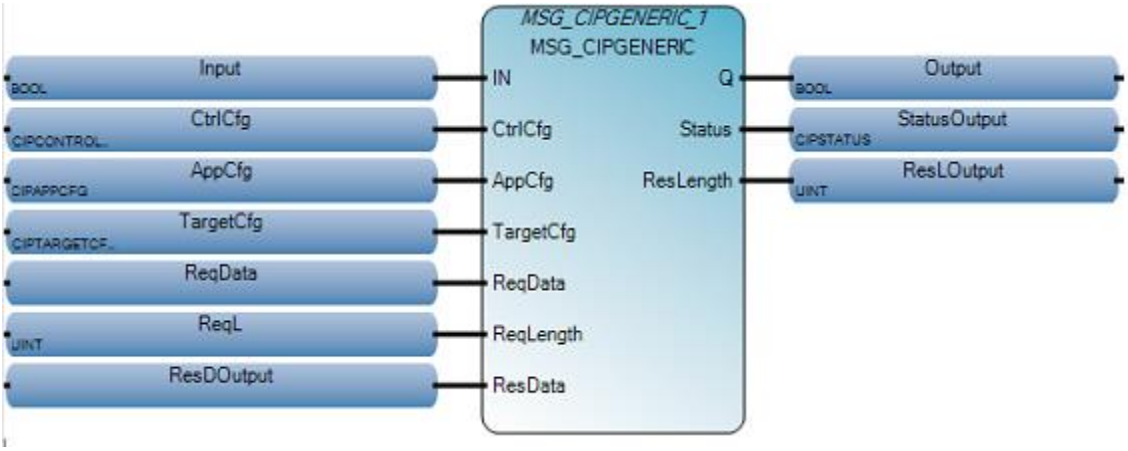
When the MSG_CIPGENERIC function block is enabled, the receive buffers for Read operations are cleared on the rising edge of Enable.

Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
CtrlCfg	Input	CIPCONTROLCFG	Function block execution control configuration See CIPCONTROLCFG data type (on page 181).
AppCfg	Input	CIPAPPCFG	CIP service and application path (EPATH) configuration See CIPAPPCFG data type (on page 180).
TargetCfg	Input	CIPTARGETCFG	Target device configuration See CIPTARGETCFG data type (on page 184).
ReqData	Input	USINT[1..1]	CIP message request data. The array size should not be less than the 'ReqLength' size See MSG_CIPGENERIC message behavior.
ReqLength	Input	UINT	CIP message request data length: • 0 - 490

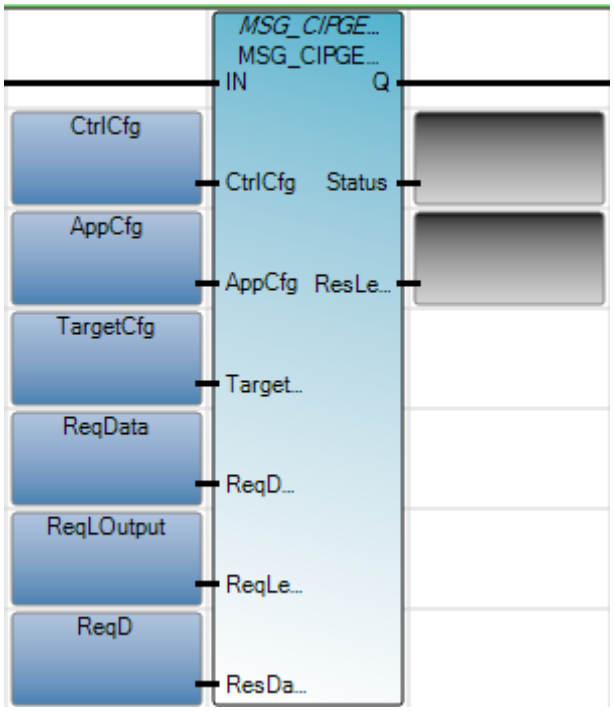
Parameter	Parameter type	Data type	Description
ResData	Input	USINT[1..1]	CIP message response data. The array size should not be less than the 'ResLength' size. When a MSG is triggered or re-triggered, data in the ResData array is cleared.
Q	Output	BOOL	TRUE - MSG instruction is finished. FALSE - MSG instruction is not finished.
Status	Output	CIPSTATUS	Function block execution status When a MSG is triggered, or re-triggered, all elements inside Status are reset. See CIPSTATUS data type (on page 182).
ResLength	Output	UINT	CIP message response data length: • 0 - 490 When a MSG is triggered, or re-triggered, ResLength is reset to 0.

MSG_CIPGENERIC function language examples

Function block diagram



Ladder diagram



CIPAPPCFG data type

The following table describes the CIPAPPCFG data type.

Parameter	Data type	Description
Service	USINT	Service code: 1 – 127
Class	UINT	Logical segment's Class ID value: 1 – 65535
Instance	UDINT	Logical segment's Instance ID value: 0 – 4294967295
Attribute	UINT	Logical segment's Attribute ID value: 1 - 65535, 0 - No Attribute ID used
MemberCnt	USINT	Members ID count. Maximum Member ID values used: 1 - 3, 0 - No Member ID used
MemberId	UINT[3]	Member ID values: 0 - 65535

CIPCONTROLCFG data type

The following table describes the CIPCONTROLCFG data type.

Parameter	Data type	Description
Cancel	BOOL	TRUE - Cancel the execution of the function block. Bit is cleared when the message is enabled.
TriggerType	USINT	Represents one of the following: • 0: Msg Triggered Once (when IN goes from False to True) • 1 to 65535: Cyclic trigger value in milliseconds. Msg is triggered periodically when IN is True. Set the value to 1 to trigger the MSG as quickly as possible.
StrMode	USINT	Reserved for future use.

Message cancellation

If the Cancel parameter is set, and the message is enabled (EN bit is set) and not done (DN bit is not set), then the message execution is aborted and the ER bit is set.

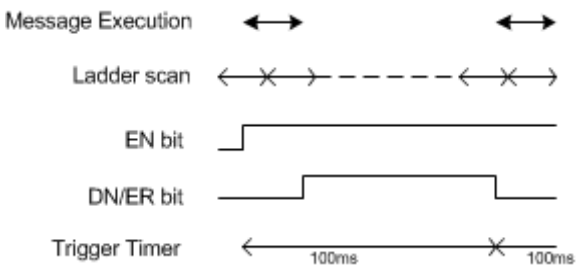
CIP message triggering

A CIP message can be triggered periodically by setting a non-zero value to the TriggerType parameter. The following table describes what happens when the TriggerType parameter is used.

Action	Results
Message is enabled	Trigger timer starts
Trigger timer expires before the message completes	Message is immediately triggered in the next ladder scan cycle.
Message completes before the trigger time expires	Message is triggered when the trigger time expires.

Example: message triggering

In the following example, the TriggerType value is set to 100.



CIPSTATUS data type

The following table describes the CIPSTATUS data type.

Parameter	Data type	Description
Error	BOOL	This bit is set to TRUE when the function block execution encounters an error condition.
ErrorID	UINT	Error code value. See CIPSTATUS error codes (on page 182).
SubErrorID	UINT	Sub Error code value. See CIPSTATUS error codes (on page 182).
ExtErrorID	UINT	CIP extended status error code value.
StatusBits	UINT	This parameter can be used to verify control bits: • Bit 0: EN – Enable • Bit 1: EW – Enable Wait • Bit 2: ST – Start • Bit 3: ER – Error • Bit 4: DN – Done • Other bits are reserved • See CIPSTATUS status bits (on page 182).

CIPSTATUS status bits

The CIPSTATUS status bits are set based on the status of the message execution, the communication buffers, and the rung conditions.

-	-	-	-	-	-	-	-	-	-	-	4	3	2	1	0

Bit	Name	Description	Behavior
0	EN	Enable	Set when the rung goes true and remains set until either the DN bit or the ER bit is set and the rung goes false.
1	EW	Enable Waiting	Set when the communication buffer is allocated for the message request. Cleared when the ST bit is set.
2	ST	Start	Set when the message has been transmitted and is waiting for a reply. Cleared when the DN bit is set.
3	ER	Error	Set when message transmission fails. An error code is written to ErrorID. The ER bit and error code values are cleared the next time the rung goes from false to true.
4	DN	Done	Set when the message is transmitted successfully. The DN bit is cleared the next time the rung goes from false to true. When the Done bit is set, all other bits are cleared to indicate the MSG completed successfully. When an error is detected and the Error bit is set, the other status bits (EN/EW/ST) are not cleared.

CIPSTATUS error codes

The following table describes the error codes that are displayed in the ErrorID and SubErrorID fields of the CIPSTATUS parameter when the ER bit is set.

ErrorID code	SubErrorID	Error code description
33	Parameter configuration related errors	
	32	Bad Channel number.
	36	Unsupported CIP connection type.
	40	Unsupported CIP symbolic data type.
	41	Invalid CIP symbol name.
	43	Unsupported CIP Class value or MemberID count.
	48	The instruction block's input data array size is not sufficient.
	49	Invalid target path.
	50	Bad service code.
	51	The instruction block's transmit data array size is too big for CIP communication. **Note**: The maximum length for the user data to be transmitted varies for different message configurations. If the total CIP message payload (including user data and CIP message overload) is beyond 504 bytes, an error 0x21 (subError 0x33) is reported.
55	Timeout related errors	
	112	Message timed out while waiting in the message wait queue.
	113	Message timed out while waiting for a connection to the link layer to be established.
	114	Message timed out while waiting to transmit to the link layer.
	115	Message timed out while waiting for a response from the link layer.
69	Server response format related error codes	
	65	Message reply does not match request.
	68	Message reply data type not valid/supported. (MSG_CIPSYMBOLIC).
208	No IP address configured for the network.	
209	Maximum number of connections used – no connections available.	
210	Invalid internet address or node address.	
217	Message execution was canceled by user. (Cancel parameter was set to TRUE).	
218	No network buffer space available.	
222	Reserved.	
224	CIP response error code. SubErrorID specifies the CIP status and ExtErrorID specifies the CIP extended status value. Refer to the CIP specification for possible error code values.	
255	Channel is shutdown or reconfiguration is in progress. Error code occurs immediately after power on until a connection is established, and is normal behavior. It may also occur in one of the following situations: • An Ethernet cable is disconnected • An IP address cannot be detected • A serial port plugin is present but not configured	

CIPTARGETCFG data type

The following table describes the CIPTARGETCFG data type.

Parameter	Data type	Description
Path	STRING[80]	Path for the target. A maximum of two hops can be specified. The path syntax is: • {"<port>,<node/slot address>"}2 See also Target path for CIP messaging (on page 184).
CipConnMode	USINT	CIP Connection type. • 0 - Unconnected (default) • 1 - Class3 connection See also CIP/EIP message connections (on page 185)
UcmmTimeout	UDINT	Unconnected message timeout (in milliseconds). The amount of time to wait for a reply for unconnected messages, including connection establishment for connected message. • Valid values: 250-10,000. • Set to 0 to use the default value of 3000. • A value set to less than 250 will be set to 250 (minimum). • A value set to greater than 10,000 will be set to 10,000 (maximum). See also CIP message timeout timers (on page 186).
ConnMsgTimeout	UDINT	Class3 Connection timeout (in milliseconds). The amount of time to wait for a reply for connected messages. The connection closes when the timeout expires. • Valid values: 800-10,000 • Set to 0 to use the default value of 3000 • A value set to less than 800 will be set to 800 (minimum) • A value set to greater than 10,000 will be set to 10,000 (maximum) See also CIP message timeout timers (on page 186).
ConnClose	BOOL	Connection closing behavior: • TRUE - Close the connection when the message completes. • FALSE - Do not close the connection when the message completed (default). • See also CIP/EIP message connections (on page 185).

Target path for CIP messaging

The target path for CIP messaging contains parameters which determine the path and destination of the of the CIP message.

Target path syntax

The target path string parameter uses the following syntax:

- "<local port>, <1st target's address>, [<1st target's local port>, <2nd target's address>]"

The 1st hop must be present; the 2nd hop is optional.

String element	Description
Local port	Local port used to send out the message. The port should be an active EtherNet/IP or CIP Serial port - USB ports are not supported.
1st Target address	Target address of the 1st hop. • For EIP, specify the target's IP address. The IP address should be a unicast address and should not be 0, multicast, broadcast, local address or a loop back (127.x.x.x) address. • For CIP Serial, specify the target's node address. The supported value is 1.
Local port of the 1st Target	Local port used to send out the message.
2nd Target address	Target address of the 2nd hop.

Target path example

The following table lists example values used in a target path string and describes the results for each string.

String example	Results
"0,0"	The target device is the local device.
"6,1"	Through Port 6 (Micro830 UPM Serial port) reach the Node at 1.
"4,192.168.1.100"	Through Port 4 (Micro850 embedded Ethernet port) reach the Node at 192.168.1.100.
"4,192.168.1.100,1,0"	Through Port 4 (Micro850 embedded Ethernet port) reach the Node at 192.168.0.100 (Logix ENET module). From ENET module, through the Backplane port (Port 1) reach the Logix controller at Slot 0.

CIP/EIP message connections

A maximum of 16 CIP (class 3) and 16 EIP connections are supported for client message execution. The following table describes the CIP/EIP connection behavior.

Scenario	Results
Message request is enabled and CipConnMode=1.	If a connection to the target does not exist, a CIP connection is established. If a connection to the target already exists, the existing CIP connection is used.
Message request is enabled, CipConnMode=1, and the message's local port is Ethernet.	If an EIP connection to the target does not exist, an EIP connection is established prior to establishing a CIP connection.
Message request is enabled, CipConnMode=0, and the message's local port is Ethernet.	If an EIP connection to the target does not exist, an EIP connection is established.
Message execution is completed, and ConnClose is set to True.	If there is only one connection to the target, the connection is closed. If there is more than one connection to the target, the connection is closed when the last message execution is completed. When a CIP connection is closed, any associated EIP connection is also closed. If more than one CIP connection uses the same EIP connection, the EIP connection will be closed after all associated CIP connections are closed.
Message execution is completed, and ConnClose is set to False.	The connection is not closed.
Connection is not associated with an active message, and remains idle for the amount of time specified in ConnTimeOut parameter.	The connection is closed.
Controller transitions from an executing mode (Run, Remote Run, Remote Test Single Scan and Remote Single Rung) to a non-executing mode.	All active connections are forcibly closed.

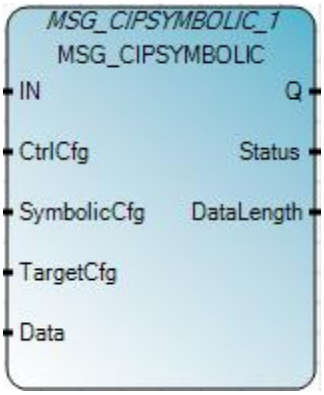
CIP message timeout timers

The following table describes how timers for CIPTARGETCFG timeout parameters (UcmmTimeout and ConnMsgTimeout) behave based on message requests and status.

Action	Results
Message is enabled	UcmmTimeout timer is activated
Connection is requested	ConnMsgTimeout timer is activated
ConnMsgTimeout timer is active	UcmmTimeout timer is disabled
Connection request is completed	UcmmTimeout timer is reactivated

MSG_CIPSYMBOLIC

MSG_CIPSYMBOLIC sends a common industrial protocol (CIP) symbolic message over an Ethernet channel or a serial port.



MSG_CIPSYMBOLIC operation

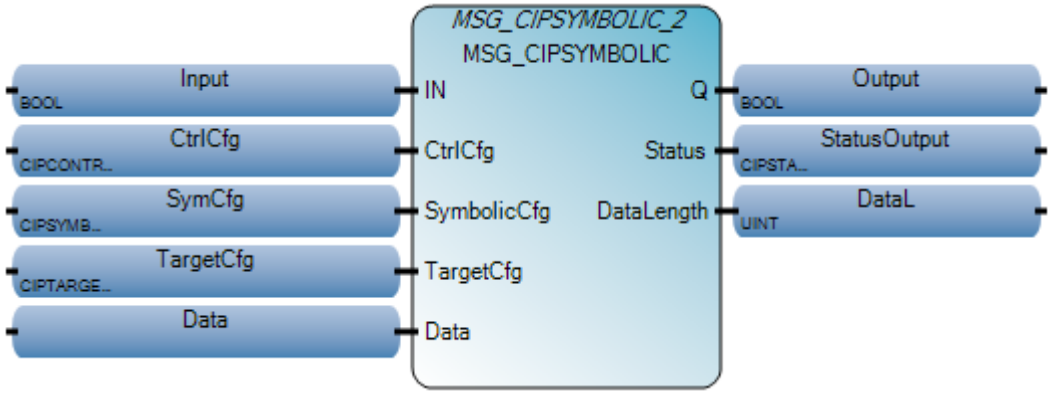
When the function block is enabled, the receive buffers for the Read operations are cleared on the rising edge of Enable. See the Message execution processes and timing diagrams (on page 214) for examples.

Arguments

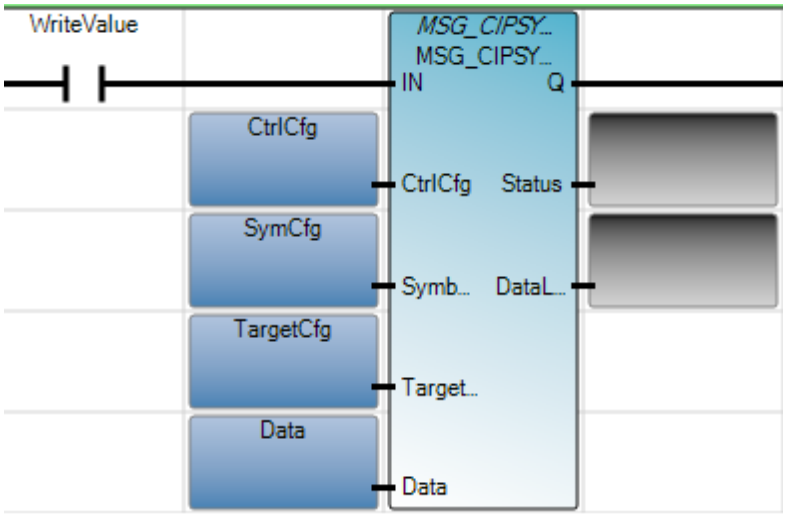
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
CtrlCfg	Input	CIPCONTROLCFG	Function block execution control configuration. See CIPCONTROLCFG data type (on page 181).
SymbolicCfg	Input	CIPSYMBOLICCFG	Information for the symbol to Read/Write. See CIPSYMBOLICCFG data type (on page 189).
TargetCfg	Input	CIPTARGETCFG	Target device configuration. See CIPTARGETCFG data type (on page 184).
Data	Input	USINT[490]	Read command stores the data returned from the server. Write command buffers the data to be sent to the server. When a MSG is triggered or retriggered, Data is cleared for the MSG Read command.
Q	Output	BOOL	FALSE - The function block is not done. TRUE - The function block is done.
Status	Output	CIPSTATUS	Function block execution status When a MSG is triggered, or re-triggered, all elements inside Status are reset. See CIPSTATUS data type (on page 182).
DataLength	Output	UDINT	Number of data bytes Read/Written. When a MSG is triggered or retriggered, DataLength is reset to 0 for MSG Read command.

MSG_CIPSYMBOLIC function language examples

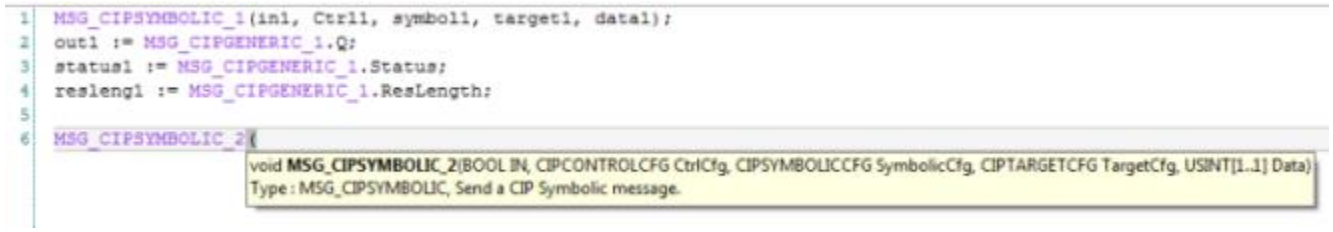
Function block diagram



Ladder diagram



Structured Text (ST)



CIPSYMBOLICCFG data type

The following table describes the CIPSYMBOLICCFG data type.

Parameter	Data type	Description
Service	USINT	Service code: • 0 - Read (default) • 1 - Write
Symbol	STRING	Name of the variable to Read/Write. • Maximum of 80 characters. • Field cannot be empty. See Symbolic Read/Write syntax (on page 191).
Count	UINT	Number of variable elements to Read/Write: • Valid values: 1 - 490 • 1 is used if the value is set to 0.
Type	User-defined	User-defined data type for the target variable. See Symbolic data type support (on page 190).
Offset	USINT	Reserved for future use. A byte offset of Read/Write variable used to Read/Write a large size variable that cannot be processed in one message. • 0 – 0xFF

Reserved for future use.

Symbolic data type support

The following table lists the data types that the MSG_CIPSYMBOLIC function block supports.

Data type	Data type value (hexadecimal)	Description
BOOL	193 (0xC1)	Logical Boolean with values TRUE (1) and FALSE (0)
SINT	194 (0xC2)	Signed 8–bit integer value
INT	195 (0xC3)	Signed 16–bit integer value
DINT	196 (0xC4)	Signed 32–bit integer value
LINT	197 (0xC5)	Signed 64–bit integer value
USINT	198 (0xC6)	Unsigned 8–bit integer value
UINT	199 (0xC7)	Unsigned 16–bit integer value
UDINT	200 (0xC8)	Unsigned 32–bit integer value
ULINT	201 (0xC9)	Unsigned 64–bit integer value
REAL	202 (0xCA)	32–bit floating point value
LREAL	203 (0xCB)	64–bit floating point value

Symbolic Read/Write syntax

Syntax is the set of rules that defines the combinations of symbols that comprise a valid read/write function block.

Valid symbol names

To be valid, each symbol name must meet the following requirements.

- Begin with a letter or underscore character followed by a letter, digit, or single underscore character.
- Be 40 characters or less.
- Not contain two consecutive underscore characters.
- Use special characters [ ] . , as separators.

Symbol syntax

The following table defines the valid syntax for symbols.

Note: Only global variables are supported.

Symbol	Syntax	Example
Variable	PROGRAM:<program name>,<symbol name>	PROGRAM:POU1.MyTag
Array	<symbol name>[dim3, dim2, dim1] (Maximum supported dimension is 3.	MyTag1[0] MyTag2[3,6] MyTag3[1,0,4]
Structure	<symbol name>.<symbol name of struct field>	MyTag4.time.year MyTag5.local.time[1].year

CIPAPPCFG data type

The following table describes the CIPAPPCFG data type.

Parameter	Data type	Description
Service	USINT	Service code: 1 – 127
Class	UINT	Logical segment's Class ID value: 1 – 65535
Instance	UDINT	Logical segment's Instance ID value: 0 – 4294967295
Attribute	UINT	Logical segment's Attribute ID value: 1 - 65535, 0 - No Attribute ID used
MemberCnt	USINT	Members ID count. Maximum Member ID values used: 1 - 3, 0 - No Member ID used
MemberId	UINT[3]	Member ID values: 0 - 65535

CIPCONTROLCFG data type

The following table describes the CIPCONTROLCFG data type.

Parameter	Data type	Description
Cancel	BOOL	TRUE - Cancel the execution of the function block. Bit is cleared when the message is enabled.
TriggerType	USINT	Represents one of the following: • 0: Msg Triggered Once (when IN goes from False to True) • 1 to 65535: Cyclic trigger value in milliseconds. Msg is triggered periodically when IN is True. Set the value to 1 to trigger the MSG as quickly as possible.
StrMode	USINT	Reserved for future use.

Message cancellation

If the Cancel parameter is set, and the message is enabled (EN bit is set) and not done (DN bit is not set), then the message execution is aborted and the ER bit is set.

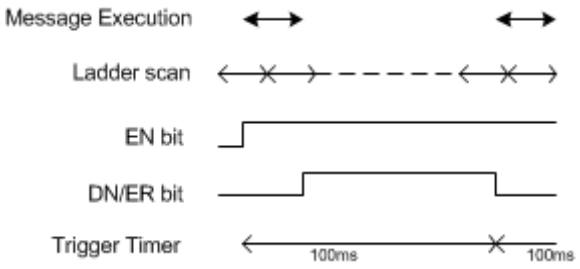
CIP message triggering

A CIP message can be triggered periodically by setting a non-zero value to the TriggerType parameter. The following table describes what happens when the TriggerType parameter is used.

Action	Results
Message is enabled	Trigger timer starts
Trigger timer expires before the message completes	Message is immediately triggered in the next ladder scan cycle.
Message completes before the trigger time expires	Message is triggered when the trigger time expires.

Example: message triggering

In the following example, the TriggerType value is set to 100.



CIPSTATUS data type

The following table describes the CIPSTATUS data type.

Parameter	Data type	Description
Error	BOOL	This bit is set to TRUE when the function block execution encounters an error condition.
ErrorID	UINT	Error code value. See CIPSTATUS error codes (on page 182).
SubErrorID	UINT	Sub Error code value. See CIPSTATUS error codes (on page 182).
ExtErrorID	UINT	CIP extended status error code value.
StatusBits	UINT	This parameter can be used to verify control bits: • Bit 0: EN – Enable • Bit 1: EW – Enable Wait • Bit 2: ST – Start • Bit 3: ER – Error • Bit 4: DN – Done • Other bits are reserved • See CIPSTATUS status bits (on page 182).

CIPSTATUS status bits

The CIPSTATUS status bits are set based on the status of the message execution, the communication buffers, and the rung conditions.

-	-	-	-	-	-	-	-	-	-	-	4	3	2	1	0

Bit	Name	Description	Behavior
0	EN	Enable	Set when the rung goes true and remains set until either the DN bit or the ER bit is set and the rung goes false.
1	EW	Enable Waiting	Set when the communication buffer is allocated for the message request. Cleared when the ST bit is set.
2	ST	Start	Set when the message has been transmitted and is waiting for a reply. Cleared when the DN bit is set.
3	ER	Error	Set when message transmission fails. An error code is written to ErrorID. The ER bit and error code values are cleared the next time the rung goes from false to true.
4	DN	Done	Set when the message is transmitted successfully. The DN bit is cleared the next time the rung goes from false to true. When the Done bit is set, all other bits are cleared to indicate the MSG completed successfully. When an error is detected and the Error bit is set, the other status bits (EN/EW/ST) are not cleared.

CIPSTATUS error codes

The following table describes the error codes that are displayed in the ErrorID and SubErrorID fields of the CIPSTATUS parameter when the ER bit is set.

ErrorID code	SubErrorID	Error code description
33	Parameter configuration related errors	
	32	Bad Channel number.
	36	Unsupported CIP connection type.
	40	Unsupported CIP symbolic data type.
	41	Invalid CIP symbol name.
	43	Unsupported CIP Class value or MemberID count.
	48	The instruction block's input data array size is not sufficient.
	49	Invalid target path.
	50	Bad service code.
	51	The instruction block's transmit data array size is too big for CIP communication. **Note**: The maximum length for the user data to be transmitted varies for different message configurations. If the total CIP message payload (including user data and CIP message overload) is beyond 504 bytes, an error 0x21 (subError 0x33) is reported.
55	Timeout related errors	
	112	Message timed out while waiting in the message wait queue.
	113	Message timed out while waiting for a connection to the link layer to be established.
	114	Message timed out while waiting to transmit to the link layer.
	115	Message timed out while waiting for a response from the link layer.
69	Server response format related error codes	
	65	Message reply does not match request.
	68	Message reply data type not valid/supported. (MSG_CIPSYMBOLIC).
208	No IP address configured for the network.	
209	Maximum number of connections used – no connections available.	
210	Invalid internet address or node address.	
217	Message execution was canceled by user. (Cancel parameter was set to TRUE).	
218	No network buffer space available.	
222	Reserved.	
224	CIP response error code. SubErrorID specifies the CIP status and ExtErrorID specifies the CIP extended status value. Refer to the CIP specification for possible error code values.	
255	Channel is shutdown or reconfiguration is in progress. Error code occurs immediately after power on until a connection is established, and is normal behavior. It may also occur in one of the following situations: • An Ethernet cable is disconnected • An IP address cannot be detected • A serial port plugin is present but not configured	

CIPTARGETCFG data type

The following table describes the CIPTARGETCFG data type.

Parameter	Data type	Description
Path	STRING[80]	Path for the target. A maximum of two hops can be specified. The path syntax is: • {"<port>,<node/slot address>"}2 See also Target path for CIP messaging (on page 184).
CipConnMode	USINT	CIP Connection type. • 0 - Unconnected (default) • 1 - Class3 connection See also CIP/EIP message connections (on page 185)
UcmmTimeout	UDINT	Unconnected message timeout (in milliseconds). The amount of time to wait for a reply for unconnected messages, including connection establishment for connected message. • Valid values: 250-10,000. • Set to 0 to use the default value of 3000. • A value set to less than 250 will be set to 250 (minimum). • A value set to greater than 10,000 will be set to 10,000 (maximum). See also CIP message timeout timers (on page 186).
ConnMsgTimeout	UDINT	Class3 Connection timeout (in milliseconds). The amount of time to wait for a reply for connected messages. The connection closes when the timeout expires. • Valid values: 800-10,000 • Set to 0 to use the default value of 3000 • A value set to less than 800 will be set to 800 (minimum) • A value set to greater than 10,000 will be set to 10,000 (maximum) See also CIP message timeout timers (on page 186).
ConnClose	BOOL	Connection closing behavior: • TRUE - Close the connection when the message completes. • FALSE - Do not close the connection when the message completed (default). • See also CIP/EIP message connections (on page 185).

Target path for CIP messaging

The target path for CIP messaging contains parameters which determine the path and destination of the of the CIP message.

Target path syntax

The target path string parameter uses the following syntax:

- "<local port>, <1st target's address>, [<1st target's local port>, <2nd target's address>]"

The 1st hop must be present; the 2nd hop is optional.

String element	Description
Local port	Local port used to send out the message. The port should be an active EtherNet/IP or CIP Serial port - USB ports are not supported.
1st Target address	Target address of the 1st hop. • For EIP, specify the target's IP address. The IP address should be a unicast address and should not be 0, multicast, broadcast, local address or a loop back (127.x.x.x) address. • For CIP Serial, specify the target's node address. The supported value is 1.
Local port of the 1st Target	Local port used to send out the message.
2nd Target address	Target address of the 2nd hop.

Target path example

The following table lists example values used in a target path string and describes the results for each string.

String example	Results
"0,0"	The target device is the local device.
"6,1"	Through Port 6 (Micro830 UPM Serial port) reach the Node at 1.
"4,192.168.1.100"	Through Port 4 (Micro850 embedded Ethernet port) reach the Node at 192.168.1.100.
"4,192.168.1.100,1,0"	Through Port 4 (Micro850 embedded Ethernet port) reach the Node at 192.168.0.100 (Logix ENET module). From ENET module, through the Backplane port (Port 1) reach the Logix controller at Slot 0.

CIP/EIP message connections

A maximum of 16 CIP (class 3) and 16 EIP connections are supported for client message execution. The following table describes the CIP/EIP connection behavior.

Scenario	Results
Message request is enabled and CipConnMode=1.	If a connection to the target does not exist, a CIP connection is established. If a connection to the target already exists, the existing CIP connection is used.
Message request is enabled, CipConnMode=1, and the message's local port is Ethernet.	If an EIP connection to the target does not exist, an EIP connection is established prior to establishing a CIP connection.
Message request is enabled, CipConnMode=0, and the message's local port is Ethernet.	If an EIP connection to the target does not exist, an EIP connection is established.
Message execution is completed, and ConnClose is set to True.	If there is only one connection to the target, the connection is closed. If there is more than one connection to the target, the connection is closed when the last message execution is completed. When a CIP connection is closed, any associated EIP connection is also closed. If more than one CIP connection uses the same EIP connection, the EIP connection will be closed after all associated CIP connections are closed.
Message execution is completed, and ConnClose is set to False.	The connection is not closed.
Connection is not associated with an active message, and remains idle for the amount of time specified in ConnTimeOut parameter.	The connection is closed.
Controller transitions from an executing mode (Run, Remote Run, Remote Test Single Scan and Remote Single Rung) to a non-executing mode.	All active connections are forcibly closed.

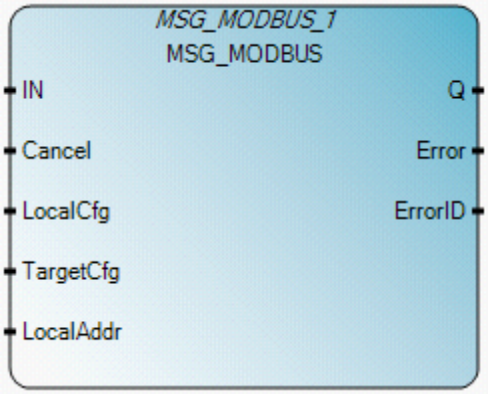
CIP message timeout timers

The following table describes how timers for CIPTARGETCFG timeout parameters (UcmmTimeout and ConnMsgTimeout) behave based on message requests and status.

Action	Results
Message is enabled	UcmmTimeout timer is activated
Connection is requested	ConnMsgTimeout timer is activated
ConnMsgTimeout timer is active	UcmmTimeout timer is disabled
Connection request is completed	UcmmTimeout timer is reactivated

MSG_MODBUS

MSG_MODBUS sends a Modbus message over a serial port.



MSG_MODBUS operation

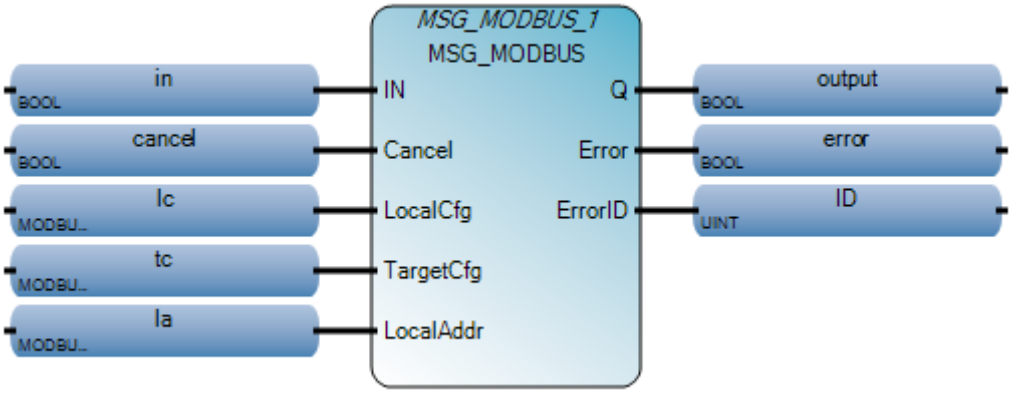
A maximum of four message requests per channel can be processed in one scan. For Ladder Diagram programs, message requests are executed at the end of a ladder scan.

Arguments

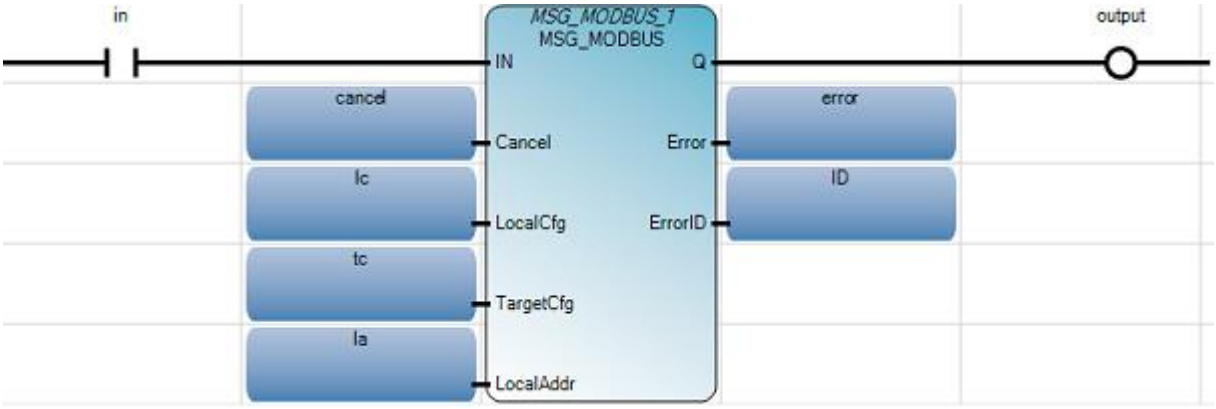
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
Cancel	Input	BOOL	TRUE - Cancel the execution of the function block.
LocalCfg	Input	MODBUSLOCPARA	Define structure input (local device). Defines the input structure for the local device. See MODBUSLOCPARA data type (on page 202).
TargetCfg	Input	MODBUSTARPARA	Define structure input (target device). Defines the input structure for the target device. See MODBUSTARPARA data type (on page 205).
LocalAddr	Input	MODBUSLOCADDR	MODBUSLOCADDR is a 125 Word array that is used by Read commands to store the data (1-125 words) returned by the Modbus slave and by Write commands to buffer the data (1-125 words) to be sent to the Modbus slave.
Q	Output	BOOL	TRUE - MSG instruction is finished. FALSE - MSG instruction is not finished.
Error	Output	BOOL	TRUE - When error occurs. FALSE - No error.
ErrorID	Output	UINT	Show the error code when message transfer failed. If a trigger is set to continuous, error codes are also continuously cleared. To view error codes, add a rung before the MSG_MODBUS instruction. See Modbus error codes (on page 201).

MSG_MODBUS function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  MSG_MODBUS_1(in, cancel, lc, tc, la);
2  output := MSG_MODBUS_1.Q;
3  error := MSG_MODBUS_1.Error;
4  ID := MSG_MODBUS_1.ErrorID;
```

Modbus error codes

The following table describes error codes for the MSG_MODBUS function block.

Error code	Error description
3	The value of the TriggerType has been changed from 2 - 255.
20	The local communication driver is incompatible with the MSG instruction.
21	A local channel configuration parameter error exists.
22	The Target or Local Bridge address is higher than the maximum node address.
33	A bad MSG file parameter exists.
54	A lost modem.
55	The message timed out in the local processor. A link layer timeout.
217	The user cancelled the message.
129	An illegal function.
130	An illegal data address.
131	An illegal data value.
132	A slave device failure.
133	Acknowledge.
134	The slave device is busy.
135	Negative acknowledge.
136	A memory parity error.
137	A non-standard reply.
255	The channel has been shut down.

MODBUSLOCPARA data type

The following table describes the MODBUSLOCPARA data type parameters.

Parameter	Data type	Description
Channel	UINT	Micro800 PLC serial port number: • 2 for the embedded serial port, or • 5-9 for serial port plug-ins installed in slots 1 through • 5 for slot 1 • 6 for slot 2 • 7 for slot 3 • 8 for slot 4 • 9 for slot 5
TriggerType	USINT	Represents one of the following: • 0: Msg Triggered Once (when IN goes from False to True) • 1: Msg triggered continuously when IN is True • Other value: Reserved
Cmd	USINT	Represents one of the following: • 01: Read Coil Status (0xxxx) • 02: Read Input Status (1xxxx) • 03: Read Holding Registers (4xxxx) • 04: Read Input Registers (3xxxx) • 05: Write Single Coil (0xxxx) • 06: Write Single Register (4xxxx) • 15: Write Multiple Coils (0xxxx) • 16: Write Multiple Registers (4xxxx) • Others: See MODBUSLOCPARA custom command support.
ElementCnt	UINT	Limits • For Read Coil/Discrete inputs: 2000 bits • For Read Register: 125 words • For Write Coil: 1968 bits • For Write Register: 123 words

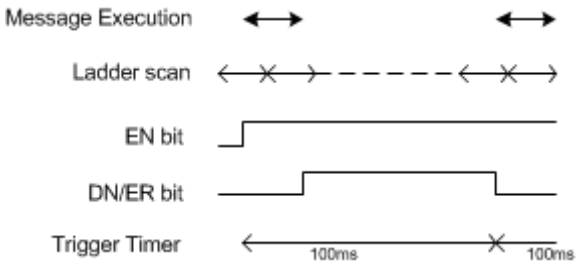
MSG_MODBUS message triggering

A Modbus message can be triggered periodically by setting a non-zero value to the TriggerType parameter. The following table describes what happens when the TriggerType parameter is used with the MSG_MODBUS function block.

Action	Results
Message is enabled	Trigger timer starts
Trigger timer expires before the message completes	Message is immediately triggered in the next ladder scan cycle.
Message completes before the trigger time expires	Message is triggered when the trigger time expires.

Example: message triggering

In the following example, the TriggerType value is set to 100.



MODBUSLOCPARA custom command support

Custom Commands in the range of 0-255 that are not already assigned to a Modbus command are also supported. If a custom command is used then the LocalCfg:ElementCnt contains the number of bytes received.

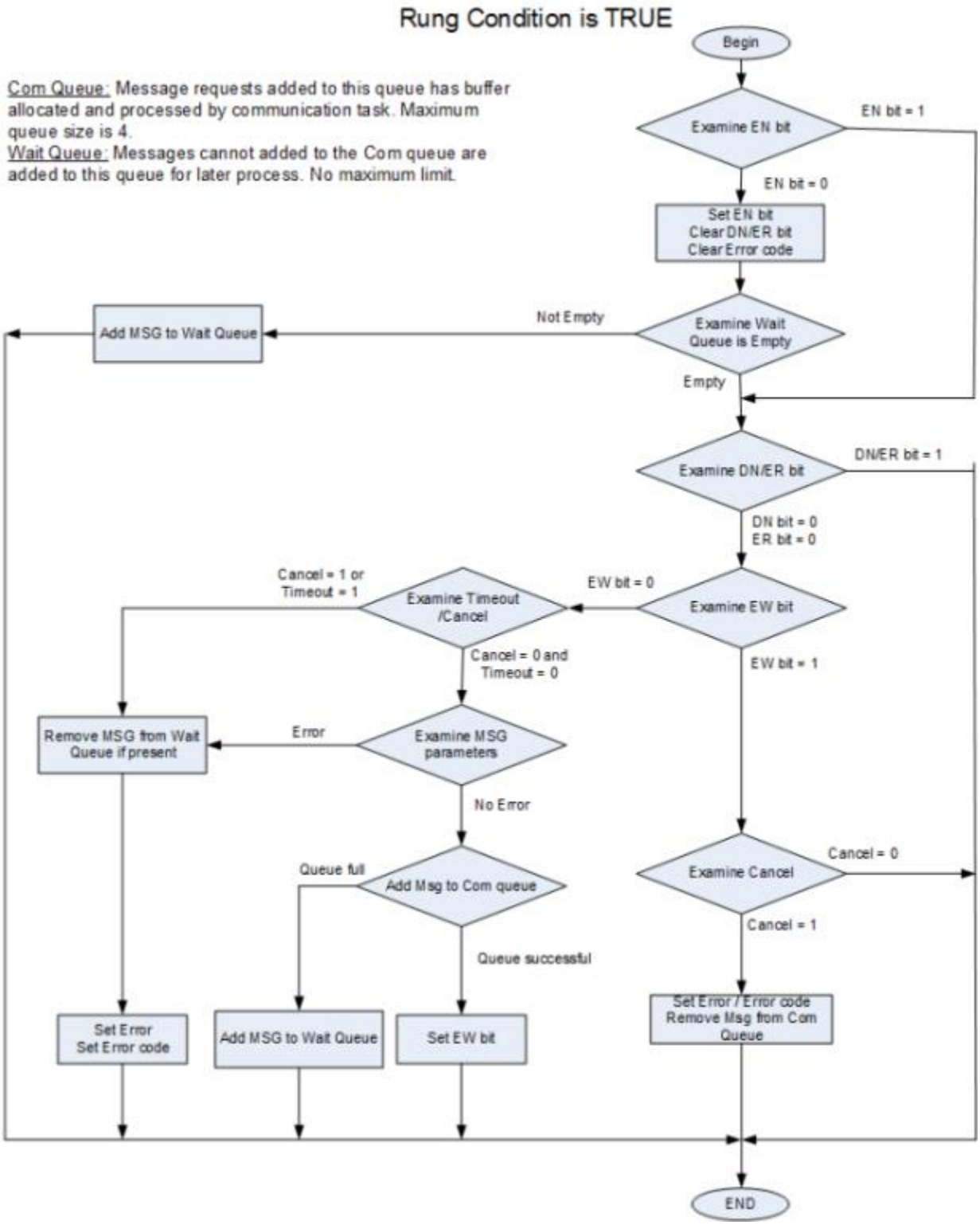
The response is received into the Local Address Data and overwrites the request data.

Example for CMD=0x2B

- Local Address Data 1:0x0E, READ_DEVICE_ID_MEI
- Local Address Data 2:0x01, READ_DEV_ID_BASIC
- Local Address Data 3:0x00, Read Vendor Object

Message execution process (Rung = TRUE)

The following process diagram describes the message instruction events that occur when the Rung condition is True.


Rung Condition is TRUE
Com Queue: Message requests added to this queue has buffer allocated and processed by communication task. Maximum queue size is 4.
Wait Queue: Messages cannot added to the Com queue are added to this queue for later process. No maximum limit.
Begin
Examine EN bit
EN bit = 1
EN bit = 0
Set EN bit
Clear DN/ER bit
Clear Error code
Examine Wait Queue is Empty
Not Empty
Add MSG to Wait Queue
Empty
Examine DN/ER bit
DN/ER bit = 1
DN bit = 0
ER bit = 0
Examine EW bit
EW bit = 0
Examine Timeout /Cancel
Cancel = 1 or Timeout = 1
Cancel = 0 and Timeout = 0
EW bit = 1
Examine MSG parameters
Error
Remove MSG from Wait Queue if present
No Error
Examine Cancel
Cancel = 0
Cancel = 1
Add Msg to Com queue
Queue full
Queue successful
Set Error / Error code
Remove Msg from Com Queue
Set Error
Set Error code
Add MSG to Wait Queue
Set EW bit
END

Com queue: Message requests added to the Com queue have a buffer allocated and processed by the communication task. The maximum queue size limit is 4.

Wait queue: Messages that cannot be added to the Com queue are added to the Wait queue to be processed at a later time. The Wait queue does not have a maximum size limit.

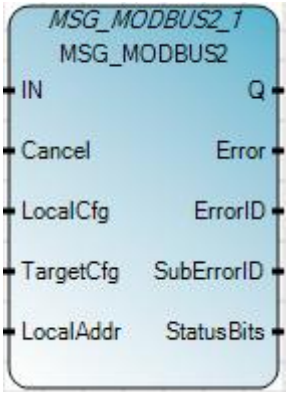
MODBUSTARPARA data type

The following table describes the MODBUSTARPARA data type.

Parameter	Data type	Description
Addr	UDINT	Target data address (1 - 65536). Decreases by one when sending.
Node	USINT	The default slave node address is 1. The range is 1- 247. Zero is the Modbus broadcast address and is only valid for Modbus write commands (for example, 5, 6, 15 and 16).

MSG_MODBUS2

MSG_MODBUS2 sends a MODBUS/TCP message over an Ethernet Channel.



MSG_MODBUS2 operation

A maximum of four message requests per channel can be processed in one scan. For Ladder Diagram programs, message requests are executed at the end of a ladder scan.

Arguments

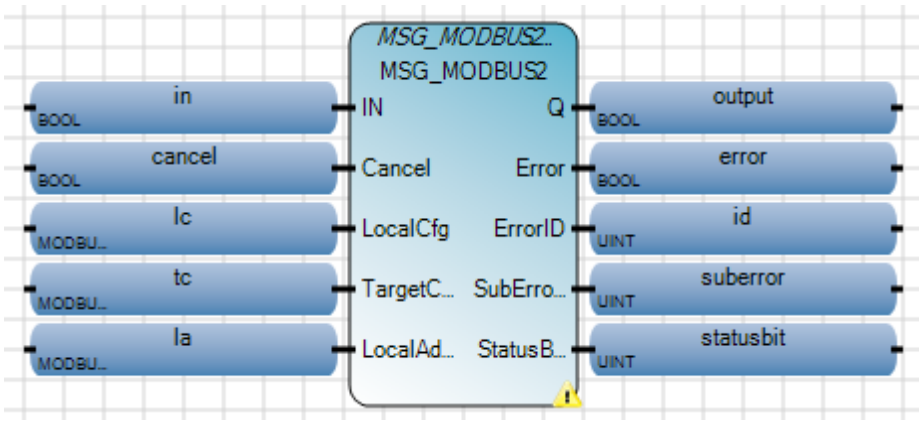
When the MSG_MODBUS2 function block is enabled, the receive buffers for Read operations are cleared on the rising edge of Enable.

Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN turns from FALSE to TRUE), start the function block with the precondition that the last operation has been completed.
Cancel	Input	BOOL	TRUE - Cancel the execution of the function block.
LocalCfg	Input	MODBUS2LOCPARA	Define structure input (local device). Defines the input structure for the local device. See MODBUS2LOCPARA data type (on page 209).
TargetCfg	Input	MODBUS2TARPARA	Define structure input (target device). Defines the input structure for the target device. See MODBUS2TARPARA data type (on page 211).
LocalAddr	Input	MODBUSLOCADDR	MODBUSLOCADDR data type is a 125 Word array that is used by Read commands to store the data (1-125 words) returned by the Modbus slave and by Write commands to buffer the data (1-125 words) to be sent to the Modbus slave.
Q	Output	BOOL	TRUE - MSG instruction is finished. FALSE - MSG instruction is not finished.
Error	Output	BOOL	TRUE - When error occurs. FALSE - No error.

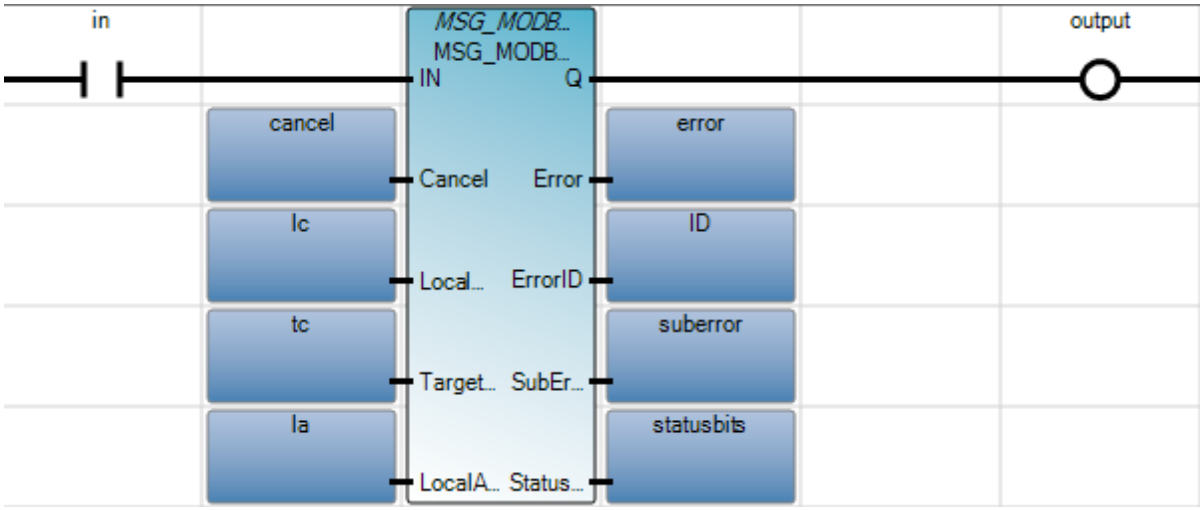
Parameter	Parameter type	Data type	Description
ErrorID	Output	UINT	Show the error code when message transfer failed. See Modbus2 error codes (on page 208).
SuberrorID	Output	UINT	Used to verify status bits: • Bit 0: EN – Enable • Bit 1: EW – Enable Wait • Bit 2: ST – Start • Bit 3: ER – Error • Bit 4: DN – Done Other bits are reserved.
StatusBits	Output	UINT	Sub Error code value when Error is TRUE. When a MSG is triggered, or re-triggered, a previously set SubErrorID is cleared.

MSG_MODBUS2 function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  MSG_MODBUS2_1(in, cancel, lc, tc, la);
2  output := MSG_MODBUS2_1.Q;
3  error := MSG_MODBUS2_1.Error;
4  ID := MSG_MODBUS2_1.ErrorID;
```

```
MSG_MODBUS2_1(
void MSG_MODBUS2_1(BOOL IN, BOOL Cancel, MODBUS2LOCPARA LocalCfg, MODBUSZTARPARA TargetCfg, MODBUSLOCADDR LocalAddr)
Type : MSG_MODBUS2, Send a modbus message.
```

Modbus2 error codes

The following table describes error codes for the MSG_MODBUS2 function block.

Error code	Error description
3	The value of the TriggerType has been changed from 2 - 255.
20	The local communication driver is incompatible with the MSG instruction.
21	A local channel configuration parameter error exists.
22	The Target or Local Bridge address is higher than the maximum node address.
33	A bad MSG file parameter exists.
54	A lost modem.
55	The message timed out in the local processor. A link layer timeout.
217	The user cancelled the message.
129	An illegal function.
130	An illegal data address.
131	An illegal data value.
132	A slave device failure.
133	Acknowledge.
134	The slave device is busy.
135	Negative acknowledge.
136	A memory parity error.
137	A non-standard reply.
255	The channel has been shut down.

MODBUS2LOCPARA data type

The following table describes the MODBUSLOCPARA data type parameters.

Parameter	Data type	Description
Channel	UINT	Local Ethernet port number: • 4 for Micro850 & Micro820 embedded Ethernet port
TriggerType	UDINT	Message trigger type: • 0: Msg Triggered Once (when IN goes from False to True) • 1 to 65535 - Cyclic trigger value in milliseconds. Message triggered periodically when IN is true and the previous message execution completes. • Set the value to 1 to trigger messages as quickly as possible.
Cmd	USINT	Modbus command: • 01: Read Coil Status (0xxxx) • 02: Read Input Status (1xxxx) • 03: Read Holding Registers (4xxxx) • 04: Read Input Registers (3xxxx) • 05: Write Single Coil (0xxxx) • 06: Write Single Register (4xxxx) • 15: Write Multiple Coils (0xxxx) • 16: Write Multiple Registers (4xxxx) • Others: See MODBUS2LOCPARA custom command support
ElementCnt	UINT	Limits • For Read Coil/Discrete inputs: 2000 bits • For Read Register: 125 words • For Write Coil: 1968 bits • For Write Register: 123 words

MSG_MODBUS2 message triggering

A Modbus message can be triggered periodically by setting a non-zero value to the TriggerType parameter. The following table describes what happens when the TriggerType parameter is used with the MSG_MODBUS2 function block.

Action	Results
Message is enabled	Trigger timer starts
Trigger timer expires before the message completes	Message is immediately triggered in the next ladder scan cycle.
Message completes before the trigger time expires	Message is triggered when the trigger time expires.

MODBUS2LOCPARA custom command support

Custom Commands in the range of 0-255 that are not already assigned to a Modbus command are also supported. If a custom command is used then the LocalCfg:ElementCnt contains the number of bytes received.

The response is received into the Local Address Data and overwrites the request data.

Example for CMD=0x2B

- Local Address Data 1:0x0E, READ_DEVICE_ID_MEI
- Local Address Data 2:0x01, READ_DEV_ID_BASIC
- Local Address Data 3:0x00, Read Vendor Object

MODBUS2TARPARA data type

The following table describes the MODBUSTARPARA data type parameters.

Parameter	Data type	Description
Addr	UDINT	Target device's Modbus data address: • 1 - 65536. • Decreases by one when sending. • Firmware uses low-word of address if the address value is greater than 65536.
NodeAddress[4]	USINT	Target device's IP address. The IP address should be a valid unicast address and cannot be 0, multicast, broadcast, local address or loop back address (127.x.x.x). For example, to specify 192.168.2.100: • NodeAddress[0]=192 • NodeAddress[1]=168 • NodeAddress[2]=2 • NodeAddress[3]=100
Port	UINT	Target TCP port number. Standard Modbus/TCP port is 502. 1 - 65535 Set to 0 to use the default value 502
UnitId	USINT	Unit Identifier. Used to communicate with slave devices through a Modbus bridge. Refer Modbus specification for more details. Note that Micro800 shall not attempt to validate this value. 0 - 255 Set to 255 if Target device is not a bridge.

Parameter	Data type	Description
MsgTimeOut	UDINT	Message timeout (in milliseconds). Amount of time to wait for a reply for an initiated command. • 250-10,000 • Set to 0 to use the default value 3000. • A value less than 250 (minimum) will be set to 250. • A value greater than 10,000 (maximum) will be set to 10,000. See also Modbus/TCP message timeout timers (on page 212).
ConnTimeOut	UDINT	TCP Connection establishment timeout (in milliseconds). Amount of time to wait for establishing successful TCP connection to the Target device. • 250-10,000 • Set to 0 to use the default value 3000. • A value less than 250 (minimum) will be set to 250. • A value greater than 10,000 (maximum) will be set to 10,000. See also Modbus/TCP message timeout timers (on page 212).
ConnClose	BOOL	TCP connection closing behavior. • True: Close the TCP connection upon message completion. • False: Do not close the TCP connection upon message completion [Default]. See also Modbus/TCP message connections (on page 212).

Modbus/TCP message timeout timers

The following table describes how timers for MODBUS2TARPARA timeout parameters (UcmmTimeout and ConnMsgTimeout) behave based on message requests and status.

Action	Results
Message is enabled	UcmmTimeout timer is activated
Connection is requested	ConnMsgTimeout timer is activated
ConnMsgTimeout timer is active	UcmmTimeout timer is disabled
Connection request is completed	UcmmTimeout timer is reactivated

Modbus/TCP message connections

Modbus/TCP client supports a maximum of 16 connections. The following table describes Modbus/TCP connection behavior.

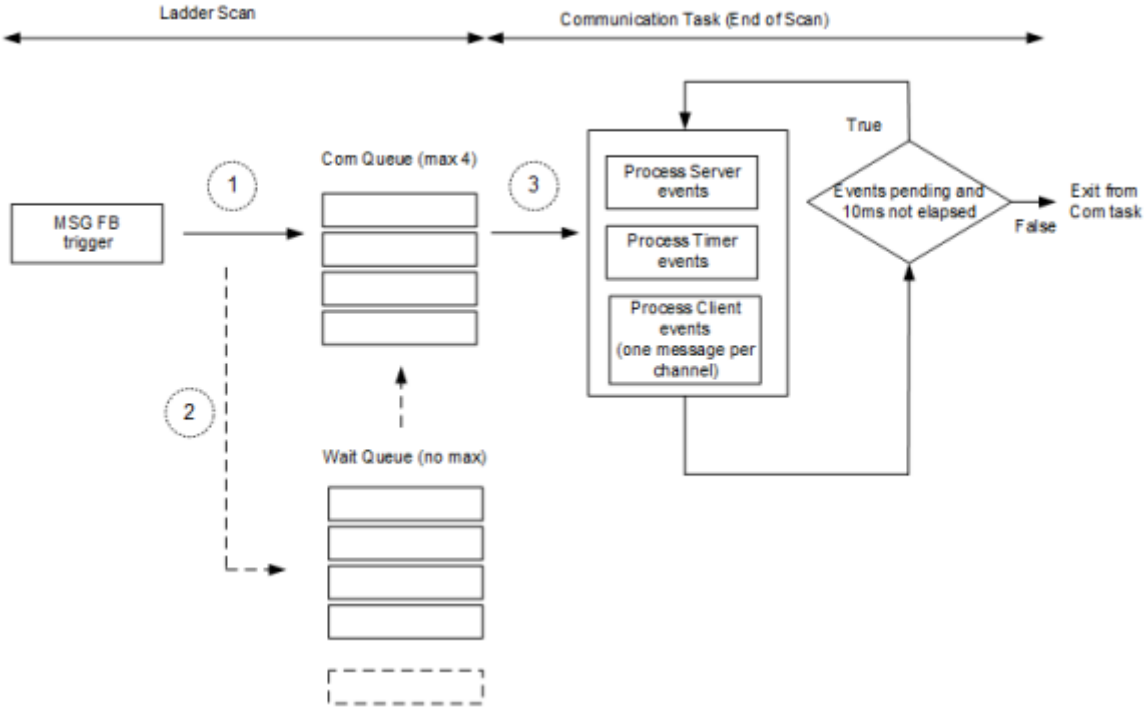
Scenario	Results
Message request is enabled, and a connection to the target does not exist. .	If a connection to the target does not exist, a new connection is established. If a connection to the target already exists, the existing connection is used.
Message execution is completed, and ConnClose is set to True.	If there is only one connection to the target, the connection is closed. If there is more than one connection to the target, the connection is closed when the last message execution is completed.
Message execution is completed, and ConnClose is set to False.	The connection is not closed.
Connection is not associated with an active message, and remains idle for the amount of time specified in ConnTimeOut parameter.	The connection is closed.
Controller transitions from an executing mode (Run, Remote Run, Remote Test Single Scan and Remote Single Rung) to a non-executing mode.	All active connections are forcibly closed.

Message execution processes and timing diagrams

The following topics describe how and when MSG_CIPGENERIC, MSG_CIPSYMBOLIC and MSG_MODBUS2 message instructions execute based on their bit and rung conditions.

Message execution process (general)

The following diagram shows how and when messages execute based on the status of the Com queue. See the table below for a detailed description of each the sequence.



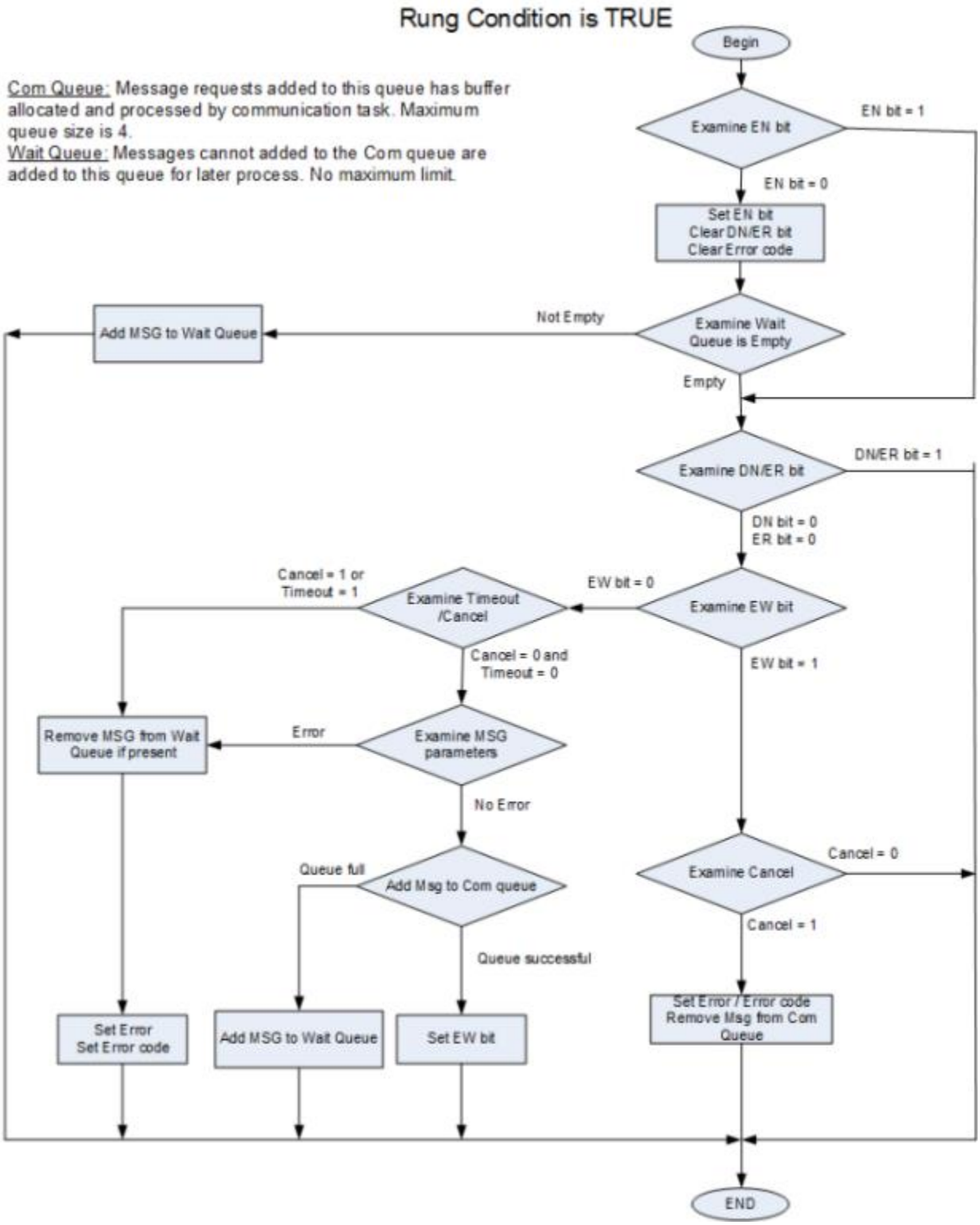
Message execution sequence (general)

The following table describes the sequence of events identified in the preceding diagram.

No.	Description of events
1	The message is enabled. If the Com queue is empty, the buffer is allocated for the message and the message is added to the Com queue for transmission. The Com queue size is 4 and each channel has a separate queue.
2	If the Com queue is full, the message is added to the Wait Queue. When the Com queue is empty, the message in the Wait queue is added to the Com queue. There is no size limit for the Wait Queue and each channel has a separate queue.
3	The communication task executes the messages in the Com queue on every End-of-Scan for transmission. Each channel's queue is processed one by one in a round robin fashion. One message from each channel is executed, and the process continues until all messages are executed or the communication schedule (10ms) expires. The channel next to the last processed channel is scheduled to appear first in the next End-of-Scan.

Message execution process (Rung = TRUE)

The following process diagram describes the message instruction events that occur when the Rung condition is True.


Rung Condition is TRUE
Com Queue: Message requests added to this queue has buffer allocated and processed by communication task. Maximum queue size is 4.
Wait Queue: Messages cannot added to the Com queue are added to this queue for later process. No maximum limit.
Begin
Examine EN bit
EN bit = 1
EN bit = 0
Set EN bit
Clear DN/ER bit
Clear Error code
Examine Wait Queue is Empty
Not Empty
Add MSG to Wait Queue
Empty
Examine DN/ER bit
DN/ER bit = 1
DN bit = 0
ER bit = 0
Examine EW bit
EW bit = 0
Examine Timeout /Cancel
Cancel = 1 or Timeout = 1
Cancel = 0 and Timeout = 0
EW bit = 1
Examine MSG parameters
Error
Remove MSG from Wait Queue if present
No Error
Examine Cancel
Cancel = 0
Cancel = 1
Add Msg to Com queue
Queue full
Queue successful
Set Error / Error code
Remove Msg from Com Queue
Set Error
Set Error code
Add MSG to Wait Queue
Set EW bit
END

Com queue: Message requests added to the Com queue have a buffer allocated and processed by the communication task. The maximum queue size limit is 4.

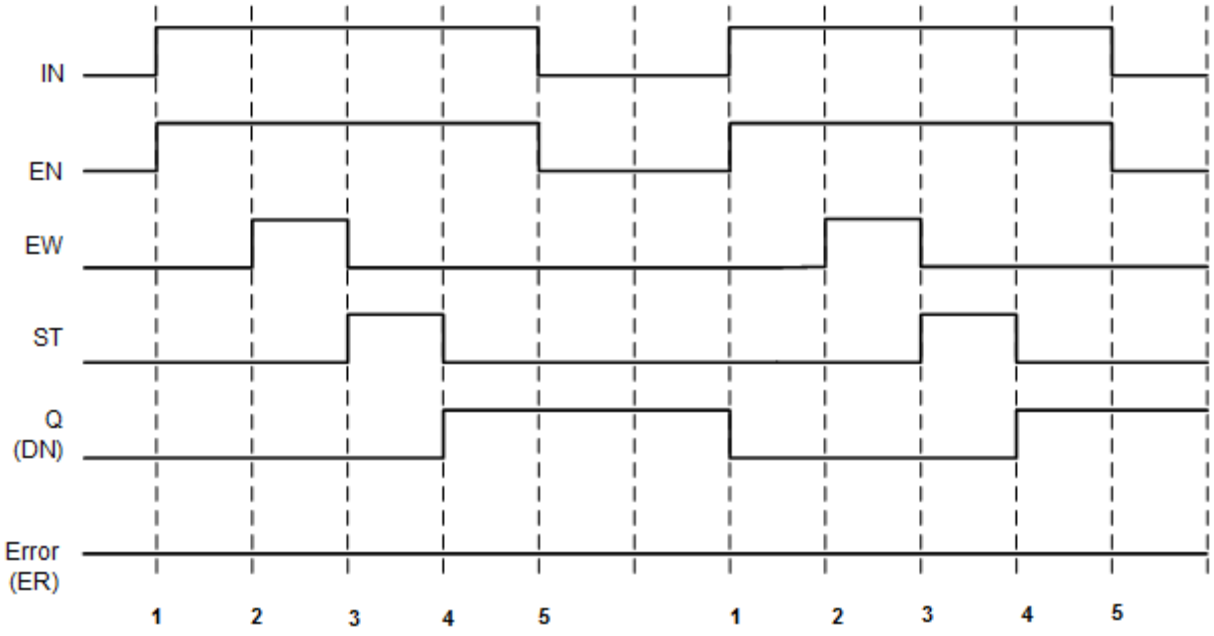
Wait queue: Messages that cannot be added to the Com queue are added to the Wait queue to be processed at a later time. The Wait queue does not have a maximum size limit.

Message execution timing diagram (Rung = TRUE)

The following table describes the message conditions and bit status for each execution step identified in the timing diagram while the rung condition remains true.

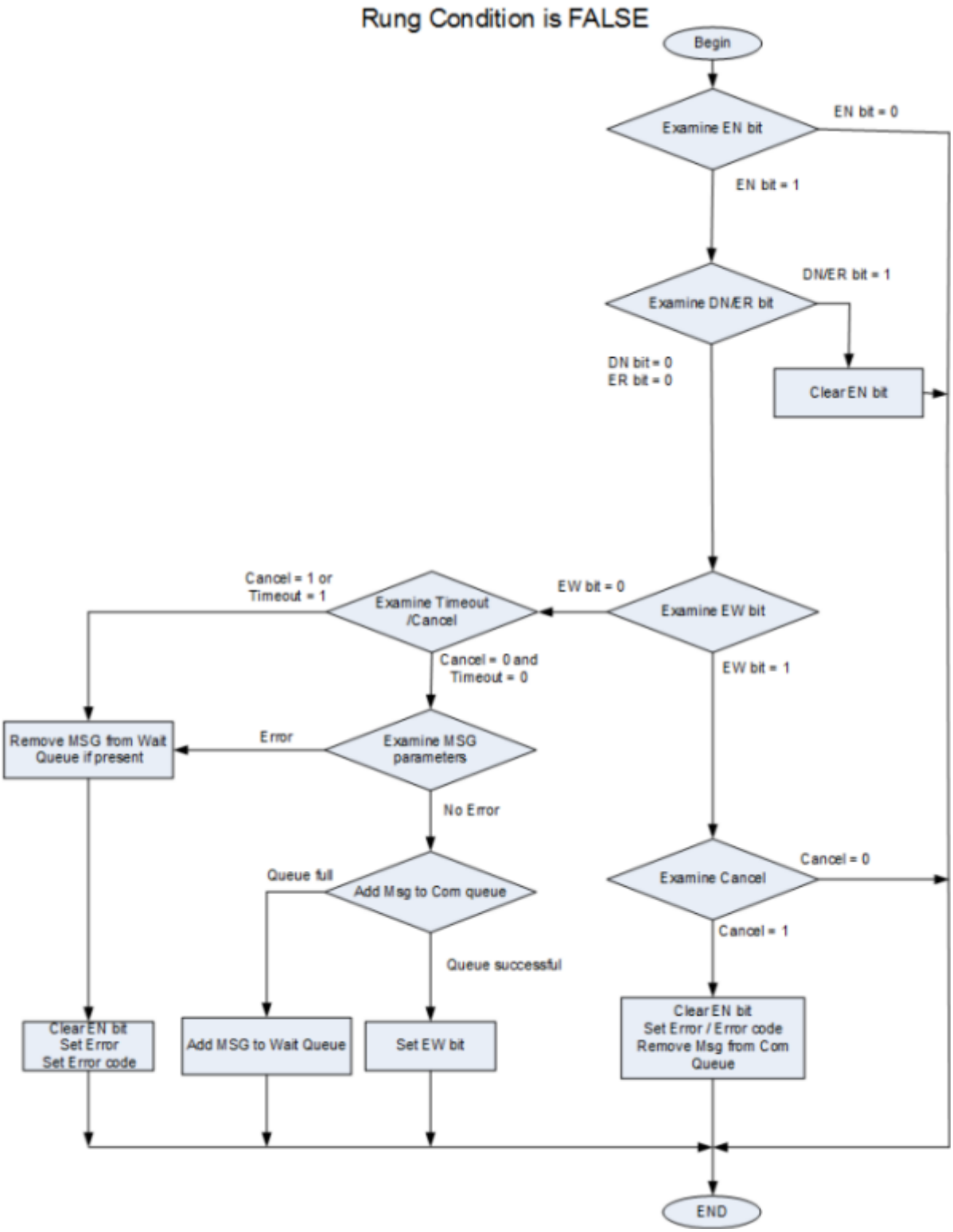
Step	Message description	Bit status
1	Rung condition goes TRUE. Message execution is enabled.	EN bit is set. All other bits are cleared.
2	Message control buffer is acquired. At this time, input data (that is, the "data" parameter for write messages) is copied for transmission. Subsequent changes to the input data will not be reflected in the transmitted message.	EW bit is set.
3	Message transmission starts.	EW bit is cleared. ST bit is set.
4	Message response is received.	ST bit is cleared. DN bit is set.
5	Rung condition goes FALSE.	EN bit is cleared.

Timing diagram for (Rung = TRUE)



Message execution process (Rung = FALSE)

The following process diagram describes the message instruction events that occur when the Rung condition is True.

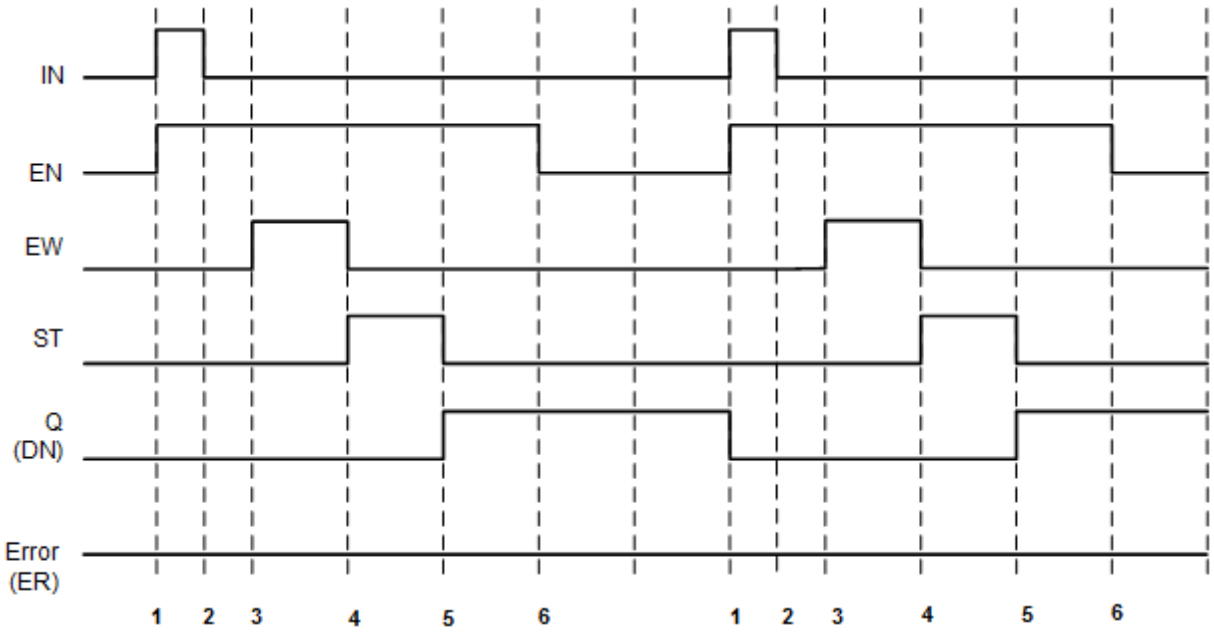

Rung Condition is FALSE
Begin
Examine EN bit
EN bit = 0
EN bit = 1
Examine DN/ER bit
DN/ER bit = 1
DN bit = 0
ER bit = 0
Clear EN bit
Examine EW bit
EW bit = 0
Examine Timeout /Cancel
Cancel = 1 or Timeout = 1
Cancel = 0 and Timeout = 0
EW bit = 1
Examine MSG parameters
Error
Remove MSG from Wait Queue if present
No Error
Examine Cancel
Cancel = 0
Cancel = 1
Add Msg to Com queue
Queue full
Queue successful
Clear EN bit Set Error Set Error code
Add MSG to Wait Queue
Set EW bit
Clear EN bit Set Error / Error code Remove Msg from Com Queue
END

Message execution timing diagram (Rung = FALSE)

The following table describes the message conditions and bit status for each execution step identified in the timing diagram when the rung goes to FALSE during execution.

Step	Message description	Bit status
1	Rung condition goes TRUE. Message execution is enabled.	EN bit is set. All other bits are cleared.
2	Rung condition goes FALSE. Message execution continues.	
3	Message buffer is acquired. At this time, input data (that is, the "data" parameter for write messages) is copied for transmission. Subsequent changes to the input data will not be reflected in the transmitted message.	EW bit is set.
4	Message transmission starts.	EW bit is cleared. ST bit is set.
5	Message response is received.	ST bit is cleared. DN bit is set.
6	Message is scanned again after step 5.	EN bit is cleared.

Timing diagram for (Rung = FALSE)



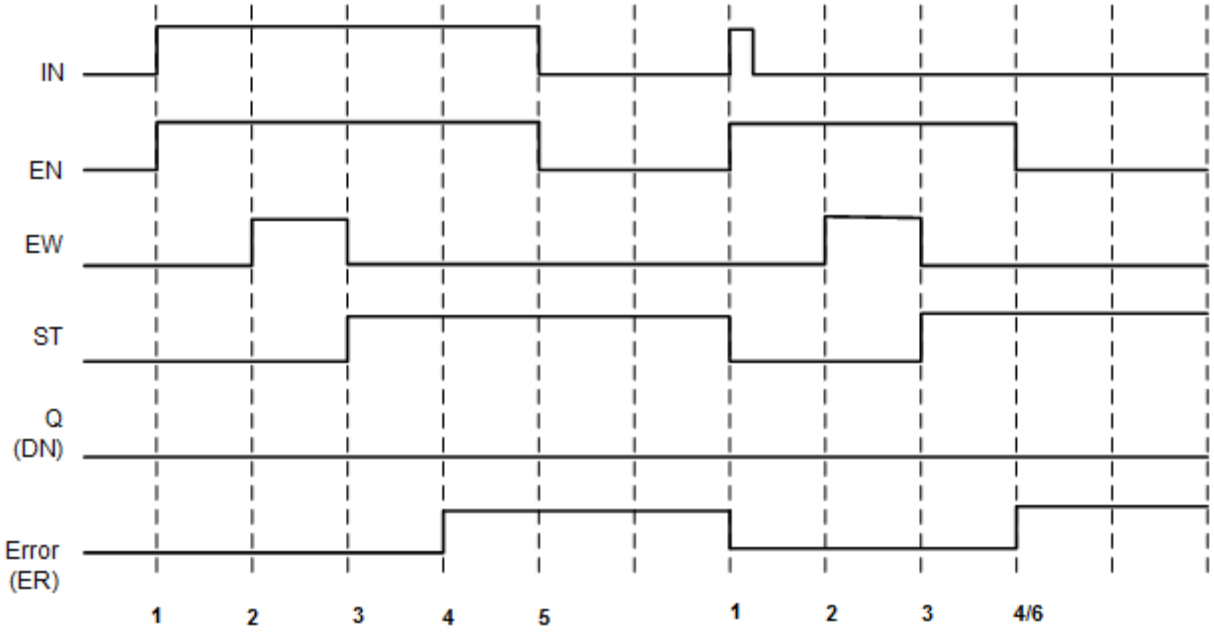
Message execution process (Error)

The following table describes the message conditions and bit status for each execution step identified in the timing diagram when an error occurs during execution.

Step	Message description	Bit status
1	Rung condition goes TRUE. Message execution is enabled.	EN bit is set. All other bits are cleared.
2	Message buffer is acquired.	EW bit is set.
3	Message transmission starts.	EW bit is cleared. ST bit is set.
4	Message transmission times out.	EW and ST bits do not change.
4-6	As rung condition goes FALSE.	EN bit is cleared. ER bit is set.

Message execution timing diagram (Error)

The following timing diagram shows a typical pattern when an error occurs during execution.



Using the communication (message) function blocks

This section provides specific details and examples for using communication instructions in logic programs. See the following topics for details of and examples for using the MSG_CIPGENERIC and MSG_CIPSYMBOLIC function blocks to create programs.

Configuring object data values for explicit messaging (MSG_CIPGENERIC)

To use the MSG_CIPGENERIC function block for explicit messaging, you will need to configure the AppCfg parameter with the correct values.

For additional information about message communication

There are several sources of information covering the implementation and use of message communication, including Connected Components Workbench Help, user manuals and the Rockwell Automation Literature Library.

Information sources for message communication

The following table lists additional sources of information relevant to message communication.

Information source	Description	How to find the information
User manual for your specific communication device	Contains important information about messaging and specific information for configuring message function blocks.	Connected Components Workbench Help menu
EtherNet/IP Adapter 22-COMM-E FRN 1.xxx, Appendix C	Provides information about the EtherNet/IP objects that can be accessed using Explicit Messages.	Connected Components Workbench Help menu
EtherNet/IP specification	Defines the objects to be included in every CIP device: Identity object, Messsage Router object and the Network object.	ODVA web site (http://www.odva.org)
Micro800 Programmable Controllers: Getting Started with CIP Client Messaging	Provides quickstart instructions for using CIP GENERIC and CIP Symbolic Messaging in Micro830 and Micro850 programmable logic controllers (PLC).	Rockwell Automation Literature Library

Accessing user manuals and quickstart guides

To access quickstart guide from the Help Menu

1. On the **Help** menu, click **View Help**.
2. Double-click on **Connected Components Workbench**.
3. Double-click on **Getting Started with Connected Components Workbench**.

To access drive manuals from the Help menu

1. On the **Help** menu, click **User Manuals** to display the Manuals dialog box.
2. Click the plus (+) sign next to Drives to expand the category, and then expand the class until you locate your manual.
3. Double-click the manual name to open the pdf file.

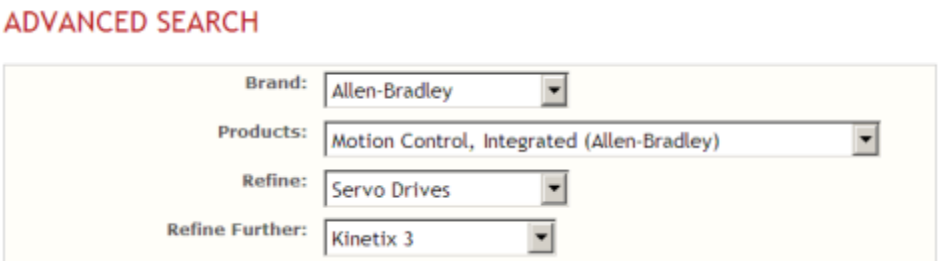
To access the EtherNet/IP manual from the Help menu

1. On the **Help** menu, click **User Manuals** to display the Manuals dialog box.
2. Click the plus (+) sign next to **Drives** to expand the category, and then expand the PowerFlex 4-class Peripherals class.
3. Double-click the 22-COMM-E EtherNet/IP Adapter User Manual to open the pdf file.

To access manuals from the Rockwell Automation Literature Library

1. Go to http://literature.rockwellautomation.com.
2. Click **Advanced Search**.

3. Enter the product information and other search criteria. This example shows search criteria for Kinetix manuals:



4. Click **Search**.

To access non-English language versions of user manuals

1. Select the language from the Publication Language drop-down box (right corner).

2. Enter the full or partial device catalog number in the **Search** box. For example, enter 2080-LC30 to view Micro830 user manuals.

CIP Register object data

MSG_CIPGENERIC function blocks use the CIP Register object data in the AppCfg parameter. The object data includes the following:

- Class Code
- Instance
- Instance Attribute
- Service

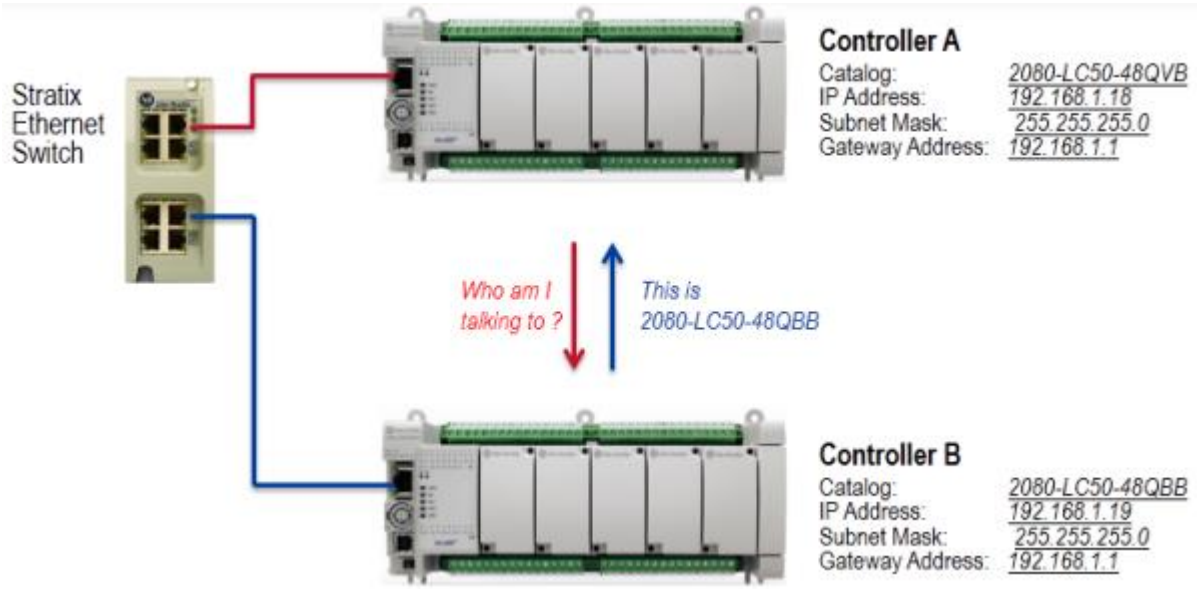
Values for the MSG_CIPGENERIC AppCfg parameter

Use the values from the CIP register object in your input variables to configure the MSG_CIPGENERIC function block parameters. The following image shows how the CIP register object data values are used in the MSG_CIPGENERIC function block parameters.

Name	Alias	Data Type	Dimen	Project Val	Initial Val
MSG_ReadDrive		MSG_CIPGENERIC		...	...
MyAppCfg		CIPAPPCFG		...	...
MyAppCfg.Service		USINT			14
MyAppCfg.Class		UINT			7
MyAppCfg.Instance		UDINT			4
MyAppCfg.Attribute		UINT			4
MyAppCfg.MemberC		USINT			

Example: How to create a MSG_CIPGENERIC messaging program to read data from a controller

This example shows you how to create a message program to retrieve Controller B's catalog information from Controller A using a MSG_CIPGENERIC function block and a COP function block.



Creating a MSG_CIPGENERIC messaging program

Perform the following tasks to create a MSG_CIPGENERIC messaging program that can be used to read information from a different controller.

No	Task
1	Identify initial values for the input variables (MSG_CIPGENERIC) (on page 227)
2	Add a MSG_CIPGENERIC function block and variables (on page 227)
3	Configure initial values for variables (on page 229)
4	Add a contact and a coil (on page 233)
5	Add a COP function block, variables and contact (MSG_CIPGENERIC) (on page 235)
6	Verify correct IP configuration on Controller B (on page 236)

Identify initial values for the input variables (MSG_CIPGENERIC)

Follow these general steps to obtain the Identity Object values to use for configuring the AppCfg parameter initial values.

To add input variables and initial values

1. From the Help menu, click **User Manuals.**
2. Expand the Drives selection and locate the user manual for the type of communication adapter you are using (EtherNet/IP Adapter User Manual).
3. Double- click the manual to open it.
4. Review the Appendix headings to locate the section that provides information about the EtherNet/IP objects that can be accessed using Explicit Messages (Appendix C).
5. Go to the Appendix section and identify the object type related to your explicit message (Identity object).
6. Identify the initial values for the AppCfg parameters based on the type information you will be retrieving.

Ethernet/IP object data and AppCfg parameters example

The following table identifies the specific Ethernet/IP object data that will be used to read catalog information from a controller.

Input variable example	AppCfg parameter	Ethernet/IP object data option	Description	Initial value
MyAppCfg.Service	Service	Service code	Implement for class = Yes Implement for Instance = Yes Get attribute single	14 (0x0E in hexadecimal)
MyAppCfg.Class	Class	Class code	EtherNet/IP object class = Identity object	01
MyAppCfg.Instance	Instance	Instances	22-COMM-E	01
MyAppCfg.Attribute	Attribute	Instance attribute	Get product name and rating as SHORT STRING	07

Add a MSG_CIPGENERIC function block and variables

Follow these steps to start a project, add a MSG_CIPGENERIC function block to a ladder diagram program and then add input variables to the function block.

Add a MSG_CIPGENERIC function block

1. Add a controller:
   - Expand the **Controllers** folder and the Micro850 folder to view all Micro850 controllers.
   - Double-click a controller (2080-LC50-48QVB) to add it to the Project Organizer.
2. Add a ladder diagram program:
   - In the Project Organizer, right-click **Programs**, click **Add**, and then click **New LD: Ladder Diagram**.
   - Right-click the ladder diagram icon in the Project Organizer, click **Rename** and type CIPExplicitMessage.
   - Double-click the ladder diagram program in the Project Organizer to display the LD POU in the language editor.
3. Add the MSG_CIPGENERIC function block:
   - In the Toolbox, select **Instruction Block** and drag and drop it onto the ladder rung to display the Block Selector.
   - In Search, type **MSG** to display the message function blocks.
   - Type **MSG_ReadDrive** in the **Instance** field.
   - Double-click **MSG_CIPGENERIC** to add an instance of the function block to the ladder diagram.

Add MSG_CIPGENERIC variables

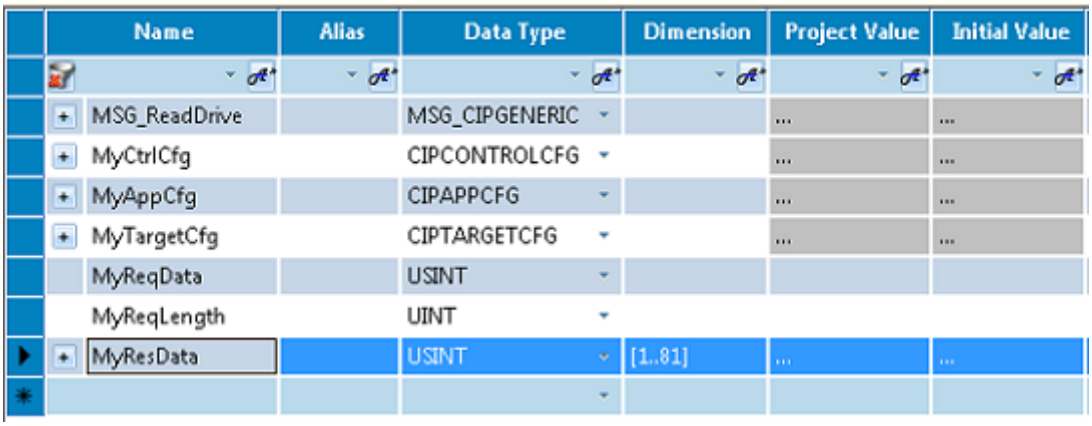
1. Add local input variables:
   - In the Project Organizer, double-click **Local Variables** to display the Local Variables page.
   - In the Variables page, add the variables and data types listed in the table.

Parameter	Variable Name	Data Type
CtrlCfg	MyCtrlCfg	CIPCONTROLCFG
AppCfg	MyAppCfg	CIPAPPCFG
TargetCfg	MyTargetCfg	CIPTARGETCFG
ReqData	MyReqData	USINT
ReqLength	MyReqLength	UINT
ResData	MyResData	USINT (array)

2. For the MyResData variable, double click **Dimension** and change the array size to [1..81].

Result

The Variables page should look similar to the following image.



Configure initial values for variables

Follow these steps to add initial values to the input variables you previously created and then assign the variables to the correct MSG_CIPGENERIC function block input parameter.

To configure initial values for the MyCtrlCfg input variable

1. From the **Local Variables** page, expand MyCtrlCfg to view its parameters.
2. Enter the following values in the **Initial Value** column for each parameter.

Parameter	Initial value	Comments
MyCtrlCfg.Cancel	Leave blank	Not needed.
MyCtrlCfg.TriggerType	0	We only need to retrieve the catalog number once.
MyCtrlcfg.StrMode	Leave blank	Not needed.

To configure initial values for the MyAppCfg input variable

1. From the **Local Variables** page, expand MyAppCfg to view its parameters.
2. Enter the following values in the **Initial Value** column for each parameter.

Parameter	Initial value
MyAppCfg.Service	14
MyAppCfg.Class	01
MyAppCfg.Instance	01
MyAppCfg.Attribute	07

To configure initial values for the MyTargetCfg input variable

1. From the **Local Variables** page, expand MyTargetCfg to view its parameters.
2. Enter the following values in the **Initial Value** column for each parameter.

Parameter	Initial Value	Comments
MyTargetCfg.Path	'4,192.168.100.4'	The first '4' indicates the message is being sent out of the embedded Ethernet port. 192.168.100.4 is the IP address of the drive Ethernet interface.
MyTargetCfg.CipConnMode	0	Unconnected is preferred for CIP messages.
MyTargetCfg.UcmmTimeout	blank	Unconnected messages have a timeout default of 3000 milliseconds if their Initial Values are blank.
MyTargetCfg.ConnMsgTimeout	blank	Connected messages have a timeout default of 3000 milliseconds if their Initial Values are blank.
MyTargetCfg.ConnClose	FALSE	For Connected messaging, the CIP connection could be closed immediately after completion of the message instruction by setting the Initial Value to TRUE.

Result

The parameters in the Variables page should look similar to the following image.

Name	Alias	Data Type	Dimension	Project Value	Initial Value
MSG_ReadDrive		MSG_CIPGENERIC		...	...
MyCtrlCfg		CIPCONTROLCFG		...	...
MyCtrlCfg.Cancel		BOOL			
MyCtrlCfg.TriggerType		UDINT			0
MyCtrlCfg.StrMode		USINT			
MyAppCfg		CIPAPPCFG		...	...
MyAppCfg.Service		USINT			14
MyAppCfg.Class		UINT			01
MyAppCfg.Instance		UDINT			01
MyAppCfg.Attribute		UINT			07
MyAppCfg.MemberCnt		USINT			
MyAppCfg.MemberId		CIPMEMBERID		...	...
MyTargetCfg		CIPTARGETCFG		...	...
MyTargetCfg.Path		STRING			'4,192.168.100.4'
MyTargetCfg.CipConnMode		USINT			0
MyTargetCfg.UcmmTimeout		UDINT			
MyTargetCfg.ConnMsgTime		UDINT			
MyTargetCfg.ConnClose		BOOL			FALSE
MyReqData		USINT			
MyReqLength		UINT			
MyResData		USINT	[1..81]	...	...
MyResData[1]		USINT			

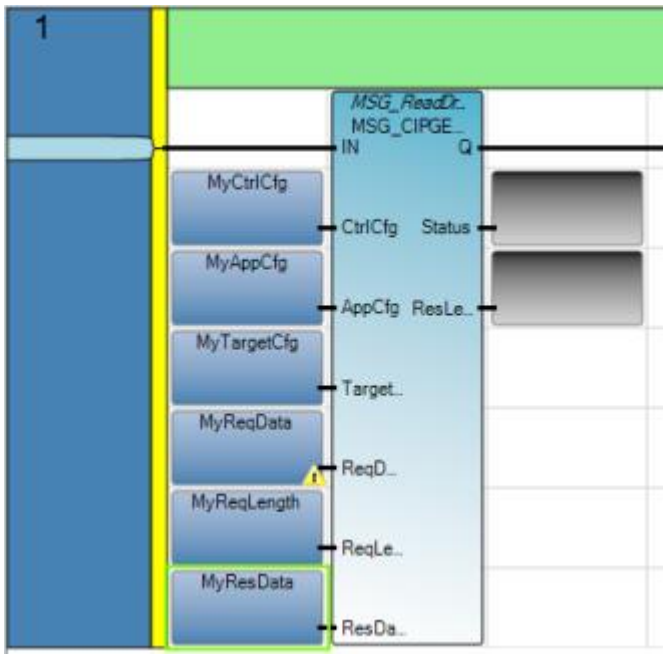
To assign the variables to the parameters

1. In the ladder diagram POU, click the top portion of the variable input block to display the variable drop-down list.
2. From the list, assign each input parameter to its correct input variable as identified in the following table.

Parameter	Input variable	Comments
CtrlCfg	MyCtrlCfg	The catalog number must only be retrieved one time so the MyCtrlCfg.TriggerType initial value is set to 0.
AppCfg	MyAppCfg	The initial values were determined by looking up the object data values for Service, Class, Instance and Attribute.
Target	MyTargetCfg	The initial values are for target device configuration.
ReqData	MyReqData	Because this is a Read message, there is no request data so the ReqData parameters is not used.
ReqLength	MyReqLength	Because this is a Read message, there is no request data so the ReqLength parameters is not used.
ResData	MyResData	The catalog number string is stored in the array in the ODVA short string format. The first array element defines the strength length and the rest store the string character's hexadecimal value. The maximum number of characters is 80, plus the length element so MyResData is defined as a 1 dimension array with 81 elements.

Result

Your instance of the MSG_CIPGENERIC function block should look similar to the following image.



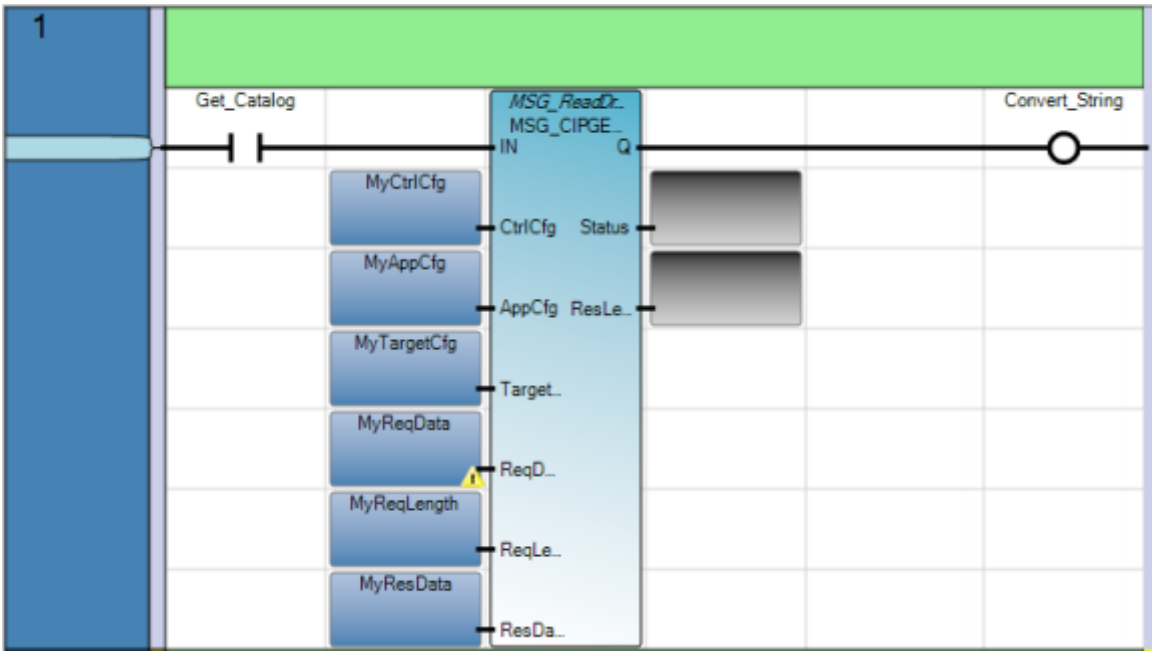
Add a contact and a coil

Follow these steps to add a coil and a contact to the MSG_CIPGENERIC function block, which will be used to convert the catalog information to a human readable string.

1. In the Toolbox, select **Direct Contact** and drag and drop it to the left of the MSG_CIPGENERIC function block input on the first ladder rung.
2. In the Variable Selector, type **Get_Catalog** in the Name field for the contact.
3. In the Toolbox, select **Direct Coil** and drag and drop it to the right of the MSG_CIPGENERIC function block output on the first ladder rung.
4. In the Variable Selector, type **Convert_String** in the Name field for the coil.

Result

The first rung of your ladder diagram program for MSG_CIPGENERIC messaging should look similar to the following image.



Add a COP function block, variables and contact (MSG_CIPGENERIC)

Follow these steps to add a COP function block, variables and a contact. The COP instruction is used to convert data from the source data type (for example, DINT or REAL) to the destination data type. In this example, the catalog information will be converted to a human readable string.

Add a COP function block

1. In the Toolbox, select **Rung** and drag and drop it directly under the first ladder rung to add a second rung.
2. Add the COP function block:
   - In the Toolbox, select **Block** and drag and drop it onto the second ladder rung to display the Block Selector.
   - Double-click **COP** to add an instance of the function block to the ladder diagram.

Add COP variables

1. Add local input variables:
   - In the Project Organizer, double-click **Local Variables** to display the Local Variables page.
   - In the Variables page, add the variables and data types listed in the following table.

Parameter	Variable name	Data type
Src	MyResData	Array USINT
SrcOffset	0	UINT
Dest	CatalogID	Array STRING
DestOffset	0	UINT
Length	1	UINT
Swap	FALSE	BOOLEAN

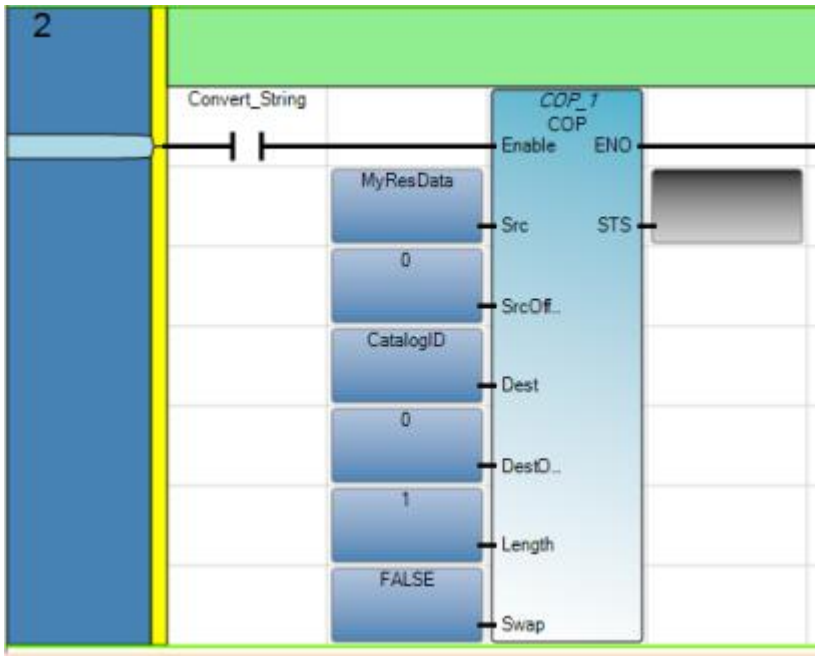
2. For the CatalogID variable, double click in **Dimension** and change the array size to [1..1]

Add a contact

1. In the Toolbox, select **Direct Contact** and drag and drop it to the left of the COP function block input on the second ladder rung.
2. In the Variable Selector, select the **Convert_String** variable for the contact.

Result

The second rung of your ladder diagram program for MSG_CIPGENERIC messaging should look similar to the following image.



Verify correct IP configuration on Controller B

Follow these steps to verify the IP address settings are correct on Controller B.

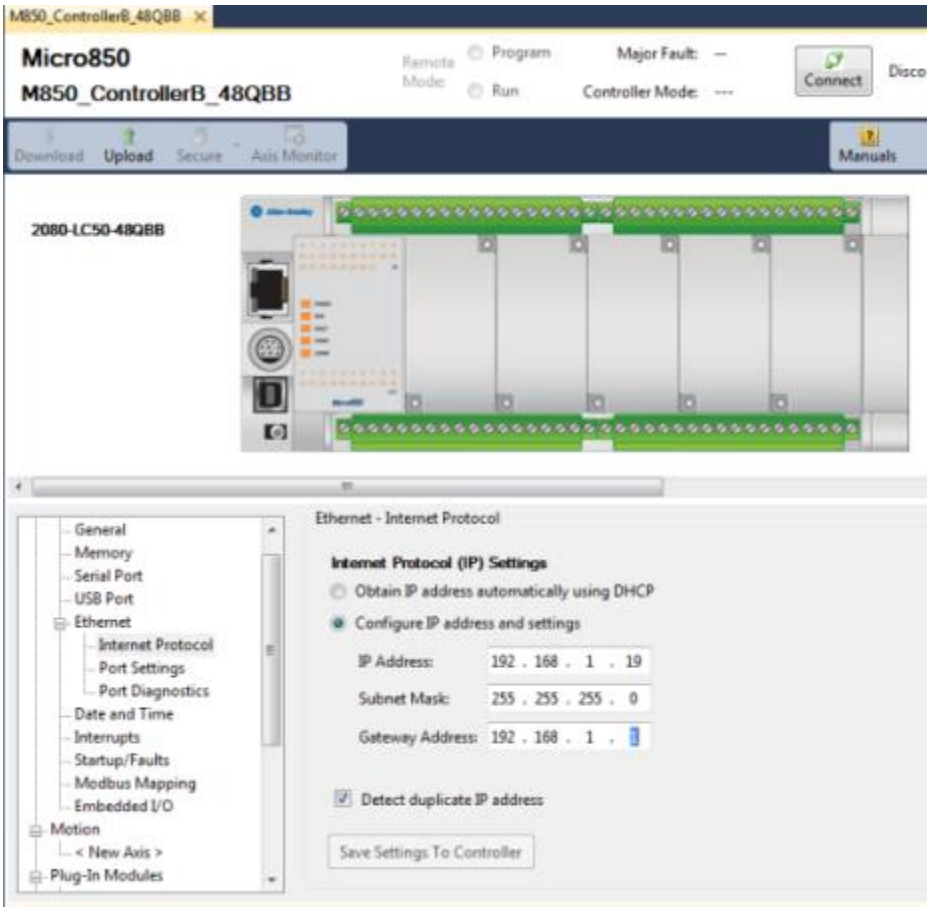
1. Open the application workspace for the controller:
2. From the Project Organizer, double-click the controller to display it in the application workspace.
3. In the controller configuration workspace, expand Ethernet in the controller tree and then click Internet Protocol to display the controller configuration page.

4. Verify the IP address settings are correct as identified in the following table.

IP configuration option	Value
IP address	192.168.1.19
Subnet Mask	255.255.255.0
Gateway address	192.168.1.1

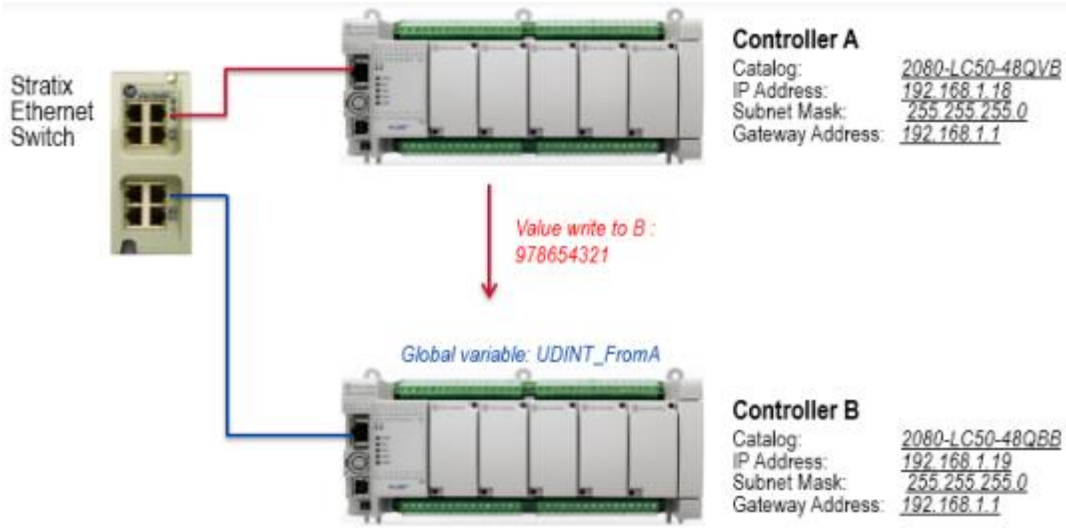
Results

The Internet Protocol options in your controller configuration page should look similar to the following image.



Example: How to create a MSG_CIPSYMBOLIC messaging program to write a value to a variable

This example shows you how to create a message program to write a value to a Controller B global variable from Controller A.



Creating a MSG_CIPSYMBOLIC messaging program

Perform the following tasks to create a MSG_CIPSYMBOLIC messaging program that can be used to write a value to a global variable on another controller.

No	Task
1	Add a COP function block, variables and a contact (MSG_CIPSYMBOLIC) (on page 239)
2	Add an Equal operator and a coil (on page 241)
3	Add a MSG_CIPSYMBOLIC function block, variables and a contact (on page 243)
4	Verify correct IP configuration on Controller B (on page 236)
5	Create global variable for Controller B (on page 248)
6	Review the complete program results (on page 249)

Add a COP function block, variables and a contact (MSG_CIPSYMBOLIC)

Follow these steps to add a COP function block, variables and a contact. The COP instruction is used to convert the data you enter to the destination data type so it will be compatible with the controller variable.

Add a COP function block

1. Add a controller:
   - Expand the **Controllers** folder and the Micro850 folder to view all Micro850 controllers.
   - Double-click a controller (2080-LC50-48QVB) to add it to the Project Organizer.
2. Add a ladder diagram program:
   - In the Project Organizer, right-click **Programs**, click **Add**, and then click **New LD: Ladder Diagram**.
   - Right-click the ladder diagram icon in the Project Organizer, click **Rename** and type **CIPSymbolicMessage.**
   - Double-click the ladder diagram program in the Project Organizer to display the LD POU in the language editor.
3. Add a COP function block:
   - In the Toolbox, select **Block** and drag and drop it onto the first ladder rung to display the Block Selector.
   - In Search, type **COP**, and double-click **COP** to add an instance of the function block to the ladder diagram.

Add COP variables and initial values

1. Add variables:
   - In the ladder diagram POU, double-click **Local Variables** to display the Local Variables page.
   - In the Variables page, add the variables and data types listed in the table below.
2. Create Arrays:
   - For ValueToWrite, double-click in **Dimension** and change the array size to [1..1].
   - For A_Data, double-click in **Dimension** and change the array size to [1..4].
3. Enter the data from the **Value** column of the table below into the **Initial Value** field for each variable.

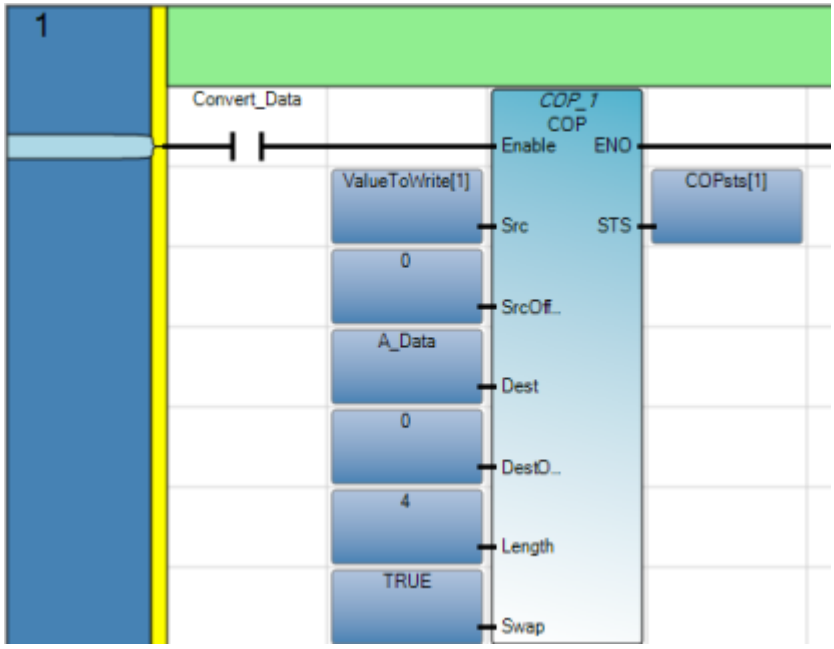
Parameter	Variable name	Data type
Src	ValueToWrite	Array UINT
SrcOffset	0	UINT
Dest	A_Data	Array USINT
DestOffset	0	UINT
Length	4	UINT
Swap	TRUE	BOOLEAN
STS	COPsts	Array UINT

Add a contact

1. In the Toolbox, select **Direct Contact** and drag and drop it to the left of the COP function block input on the first ladder rung.
2. In the Variable Selector, assign a variable named **Convert_Data** to contact.

Result

The first rung of your ladder diagram program for MSG_CIPSYMBOLIC messaging should look similar to the following image.



Add an Equal operator and a coil

Follow these steps to add an Equal (=) operator, variables and a coil. The Equal instruction is used to trigger writing a value if the data type conversion was successful.

To add an Equal operator

1. In the Toolbox, select **Rung** and drag and drop it directly under the first ladder rung to add a second rung.
2. Add an Equal operator:
   - In the Toolbox, select **Block** and drag and drop it onto the second ladder rung to display the Block Selector.
   - In Search, type the '=' sign and double-click **'='** to add an instance of the operator to the ladder diagram.

To add Equal variables

1. In the ladder diagram POU, double-click a variable to display the Variable Selector.
2. In the Variable Selector, assign variable names as listed in the following table.

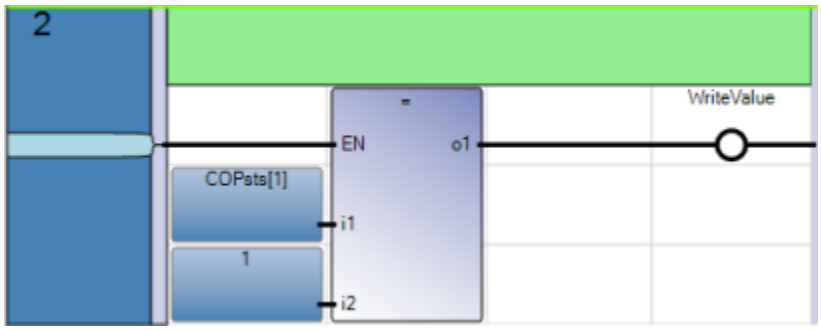
Parameter	Variable name
i1	COPsts
i2	1

To add a coil to the Equal operator

1. In the Toolbox, select **Direct Coil** and drag and drop it to the right of the Equal operator output on the second ladder rung.
2. In the Variable Selector, type **WriteValue** in the Name field for the coil.

Result

The second rung of your ladder diagram program for MSG_CIPGENERIC messaging should look similar to the following image.



Add a MSG_CIPSYMBOLIC function block, variables and a contact

Follow these steps to add a MSG_CIPSYMBOLIC function block, input variables and a contact to a ladder diagram.

Add function block and variables

1. In the **Toolbox**, select **Rung** and drag and drop it directly under the second ladder rung to add a third rung.
2. Add the MSG_CIPSYMBOLIC function block:
   - In the **Toolbox**, select **Instruction Block** and drag and drop it onto the ladder rung to display the **Instruction Block Selector**.
   - In Search, type **MSG** to display the message function blocks.
   - Type **MSG_WriteVariable** in the **Instance** field.
   - Double-click **MSG_CIPSYMBOLIC** to add an instance of the function block called MSG_WriteVariable to the ladder diagram.
3. Assign variable names:
   - In the ladder diagram POU, double-click a variable to display the **Variable Selector**.
   - In the **Variable Selector**, assign variable names as listed in the following table.
4. For the Data variable, double click **Dimension** and change the array size to [1..4].

Configure initial values for the local variables

1. Add CtrlCfg initial values:
   - From the Local Variables page, expand the CtrlCfg parameter to view additional parameters.
   - Enter the following values in the Initial Value column for each parameter.

Parameter	Initial value
A_CtrlCfg.Cancel	Leave blank
A_CtrlCfg.TriggerType	300
A_Ctrlcfg.StrMode	Leave blank

2. Add SymCfg initial values:

   - From the Local Variables page, expand the SymCfg parameter to view additional parameters.
   - Enter the following values in the Initial Value column for each parameter.

Parameter	Initial value
A_SymCfg.Service	1
A_SymCfg.Symbol	'UDINT_FromA'
A_SymCfg.Count	Leave blank
A_SymCfg.DataType	200
A_SymCfg.Offset	Leave blank

Results

The Local Variables selector should look similar to the following image.

Name	Alias	Data Type	Dimension	Project Value	Initial Value
+ MSG_CIPSYMBOLIC_1		MSG_CIPSYMBOL		...	...
- A_CtrlCfg		CIPCONTROLCFG		...	...
A_CtrlCfg.Cancel		BOOL			
A_CtrlCfg.TriggerType		UDINT			300
A_CtrlCfg.StrMode		USINT			
- A_SymCfg		CIPSYMBOLICCFG		...	...
A_SymCfg.Service		USINT			1
A_SymCfg.Symbol		STRING			'UDINT_FromA'
A_SymCfg.Count		UINT			
A_SymCfg.DataType		USINT			200
A_SymCfg.Offset		USINT			

Configure initial values for TargetCfg

1. From the ladder diagram POU, double-click the A_TarCfg variable to open the global variables selector.
2. Expand the TargetCfg parameter to view additional parameters.
3. Enter the following values in the Initial Value column for each parameter.

Parameter	Initial value
A_TarCfg.Path	'4,192.168.1.19'
A_TarCfg.CipConnMode	1
A_TarCfg.UcmmTimeout	0
A_TarCfg.ConnMsgTimeout	0
A_TarCfg.ConnClose	Leave blank

Results

The User Global Variables selector should similar to the following image.

Name	Alias	Data Type	Dimension	Project Value	Initial Value
		CIPTARG			
A_TarCfg		CIPTARGETCFG		...	...
A_TarCfg.Path		STRING			'4,192.168.1.19'
A_TarCfg.CipConnMode		USINT			1
A_TarCfg.UcmmTimeout		UDINT			0
A_TarCfg.ConnMsgTimeout		UDINT			0
A_TarCfg.ConnClose		BOOL			

Values for the Data parameter

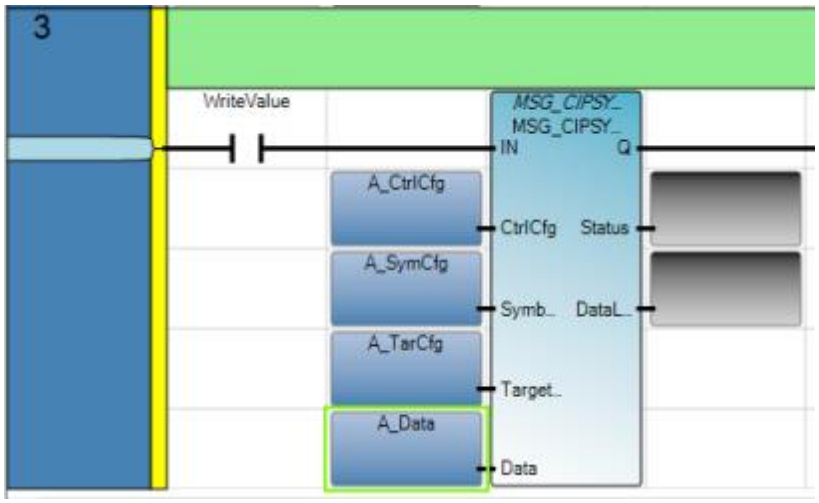
The values for A_Data will be automatically obtained from the COP function block on Rung 1. Also, notice that A UDINT is 32 bit data, USINT is 8 bit data, so A_Data is a one dimension array with 4 elements

Add a contact

1. In the Toolbox, select **Direct Contact** and drag and drop it to the left of the MSG_CIPSYMBOLIC function block input on the third ladder rung.
2. In the Variable Selector, assign the **WriteValue** variable to the contact.

Result

The third rung of your ladder diagram program for MSG_CIPSYMBOLIC messaging should look similar to the following image.



Verify correct IP configuration on Controller B

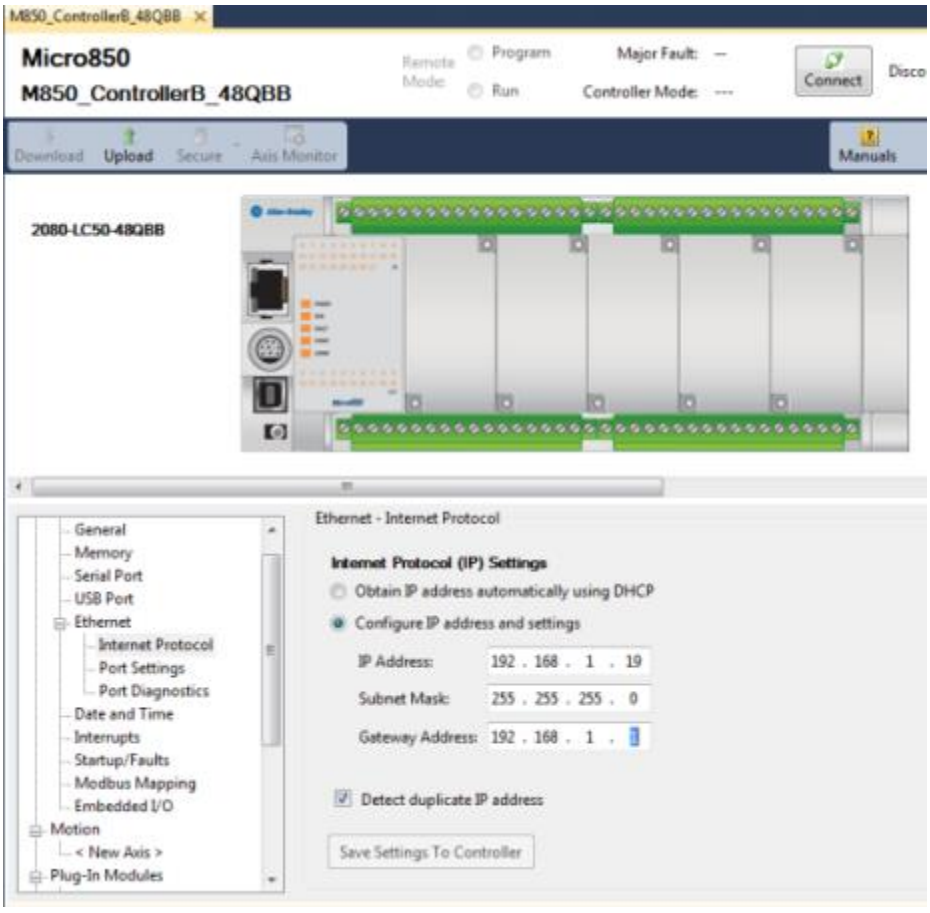
Follow these steps to verify the IP address settings are correct on Controller B.

1. Open the application workspace for the controller:
2. From the Project Organizer, double-click the controller to display it in the application workspace.
3. In the controller configuration workspace, expand Ethernet in the controller tree and then click Internet Protocol to display the controller configuration page.
4. Verify the IP address settings are correct as identified in the following table.

IP configuration option	Value
IP address	192.168.1.19
Subnet Mask	255.255.255.0
Gateway address	192.168.1.1

Results

The Internet Protocol options in your controller configuration page should look similar to the following image.



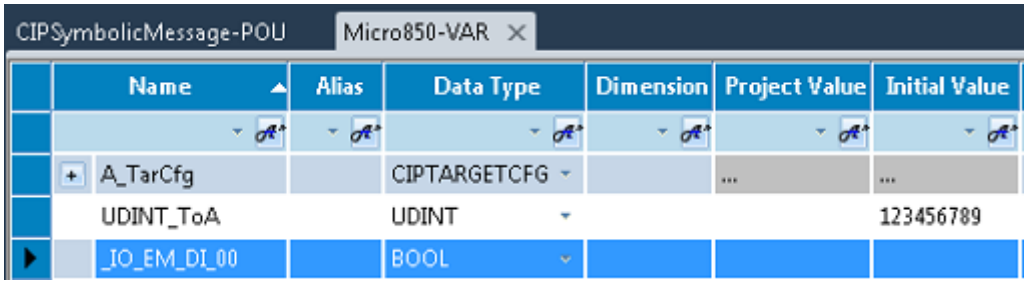
Create global variable for Controller B

Follow these steps to create a Global variable for controller B.

1. In the Project Organizer, double-click **Global Variables** to display the global variables selector.
2. Type UDINT_ToA in the **Name** column.
3. Configure the remaining parameters:
   - Verify the data type is UDINT.
   - Type 123456789 in the **Initial Value** field.
   - Verify the **Read/Write** attribute is selected.

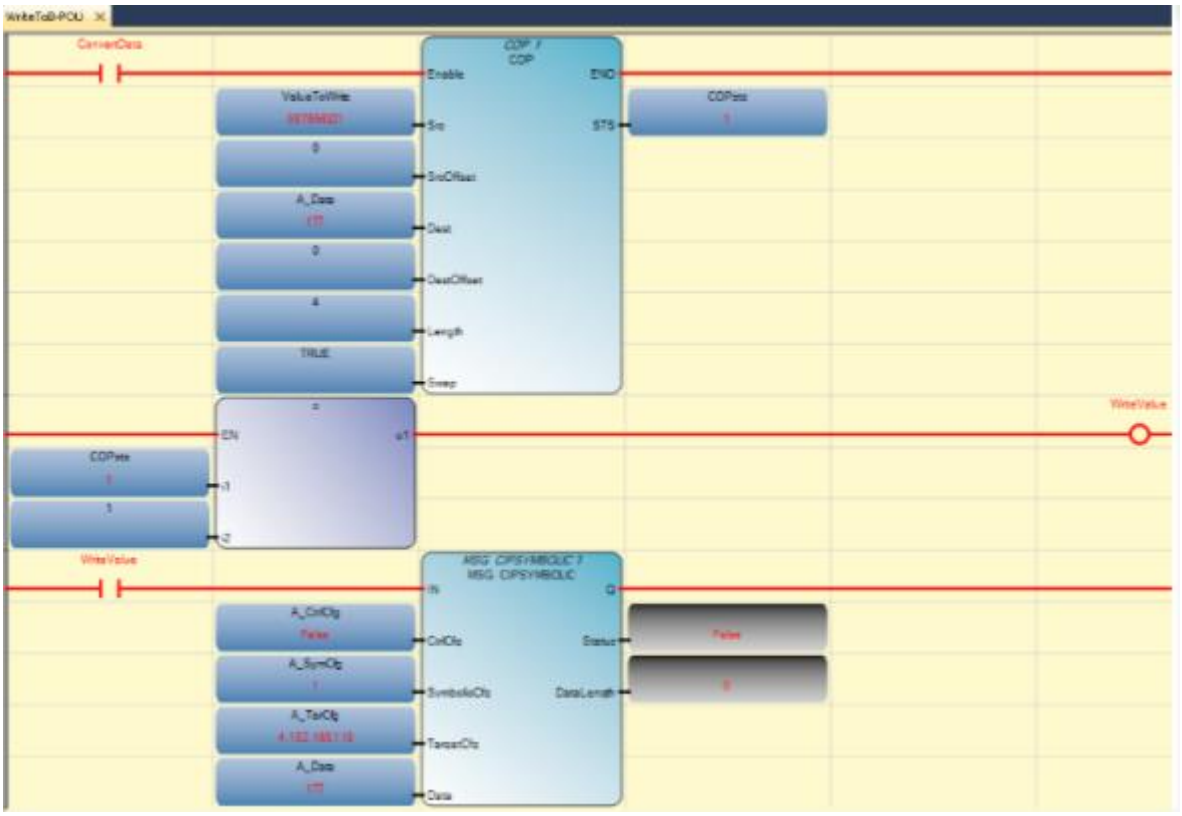
Results

The Global Variables selector should look similar to the following image.



Review the complete program results

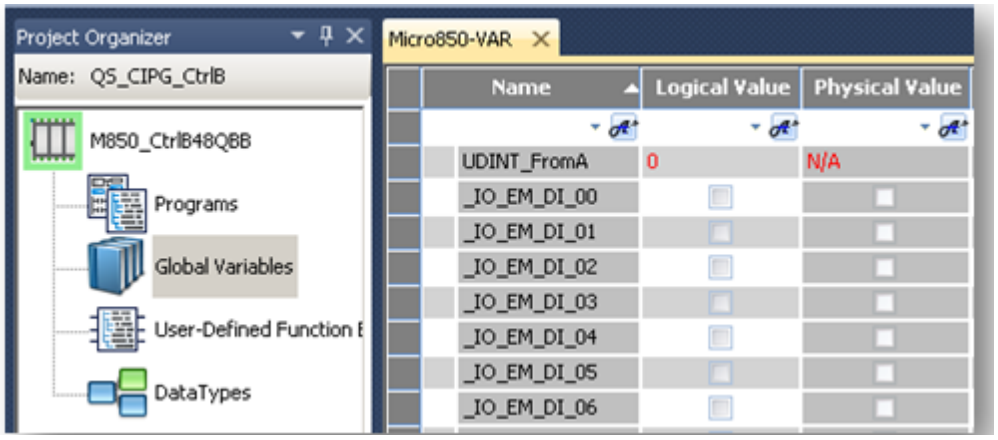
The following example shows the complete MSG_CIPSYMBOLIC messaging program after it has executed.



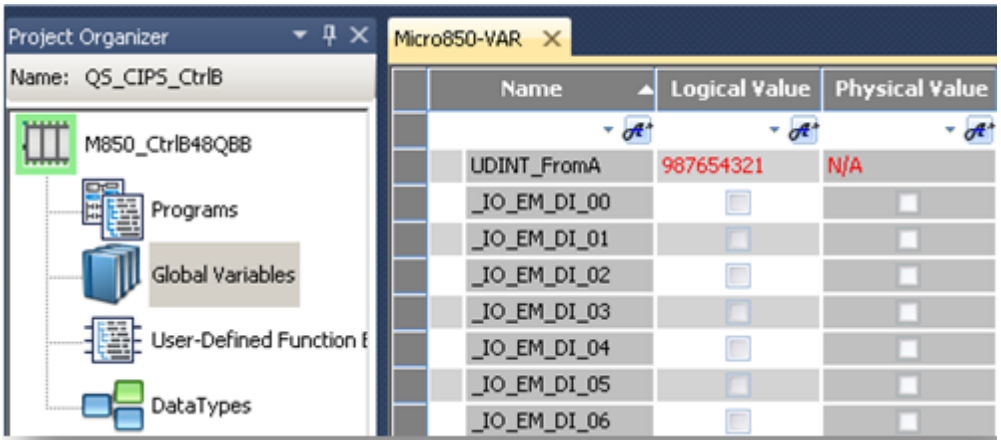
Controller B results

The following two images show the values for Controller B before and after the messaging program is executed.

Before the program is executed



After the program is executed

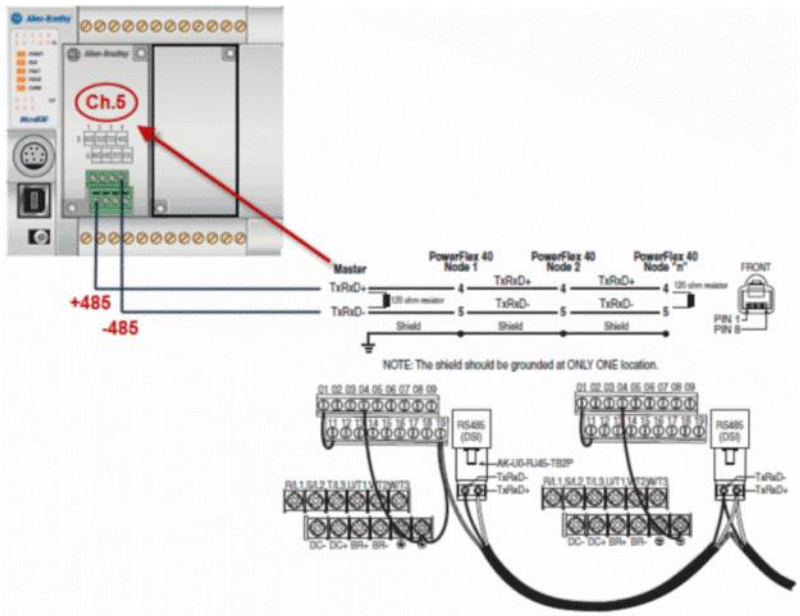


Example: How to configure Modbus communication to read from and write to a drive

These examples show you how to configure Modbus communication to read status data from and write control data to a PowerFlex 4 drive using the MSG_MODBUS function block.

Micro830 wiring

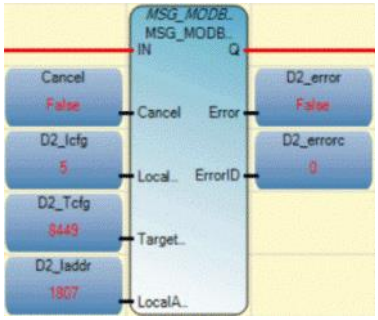
This example uses a Micro830 controller with a SERIALISOL module plugged into the first slot (Channel 5). A single PowerFlex 40 is connected, but the diagram below shows how to wire for multi-drop. Refer to the user manual for additional wiring information.



AK-U0-RJ45-TB2P is an RJ45 connector with 2 terminal blocks for RS485 communications

Modbus Read example

The following MSG_MODBUS instruction can be used to read status data from the PowerFlex 40 drive.



Drive status

An "1807" indicates the drive is

- Ready (bit 0 ON),
- Active (bit 1 ON)
- Commanded Forward (bit 2 ON)
- Rotating Forward (bit 3 ON)
- Status of some digital inputs on the drive

A "278" indicates 27.8Hz.

Refer to the PowerFlex user manual for additional information about Logic Status word bits, error code descriptions, commanded and actual speeds, and other status codes.

MSG_MODBUS Read configuration

The following image shows the variable options for the MSG_MODBUS instruction block used to read status data from a PowerFlex 40 drive.

Name	Data Type	Direction	Dimension
MSG_MODBUS_1	MSG_MODI	Var	
D2_lcfg	MODBUSLC	Var	
D2_lcfg.Channel	UINT	Var	
D2_lcfg.TriggerType	USINT	Var	
D2_lcfg.Cmd	USINT	Var	
D2_lcfg.ElementCnt	UINT	Var	
D2_Tcfg	MODBUSTA	Var	
D2_Tcfg.Addr	UDINT	Var	
D2_Tcfg.Node	USINT	Var	
D2_laddr	MODBUSLC	Var	
D2_laddr[1]	WORD	Var	
D2_laddr[2]	WORD	Var	
D2_laddr[3]	WORD	Var	
D2_laddr[4]	WORD	Var	
D2_laddr[5]	WORD	Var	

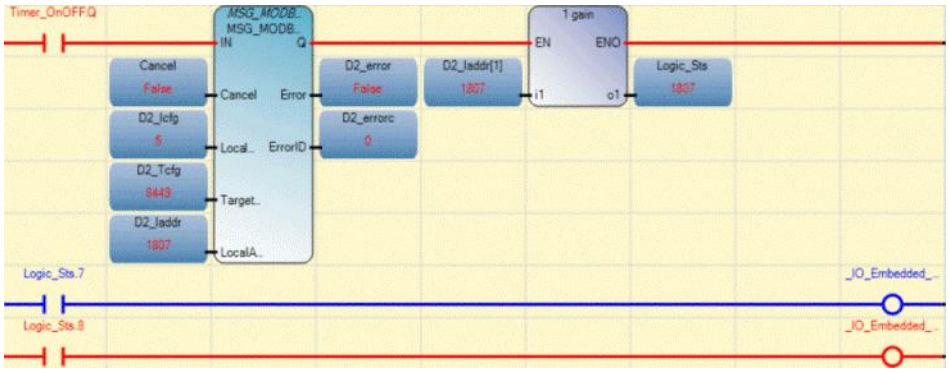
MSG_MODBUS Read variables

The following table identifies the variables and the values used to configure the MSG_MODBUS instruction to read status data from a PowerFlex 4 drive.

Variable	Value	Description
*.Channel	5	Channel 5 - location of SERIALISOL module
*.TriggerType	0	Trigger on False-to-True transition
*.Cmd	3	Modbus Function Code "03" - Read Holding Registers
*.ElementCnt	4	Length
*.Addr	8449	PowerFlex Logic Status word address + 1
*.Node	2	PowerFlex Node address
*_laddr[1]	{data}	PowerFlex Logic Status word
*_laddr[2]	{data}	PowerFlex Error Code
*_laddr[3]	{data}	PowerFlex Commanded Speed (Speed Reference)
*_laddr[4]	{data}	PowerFlex Speed Feedback (Actual Speed)

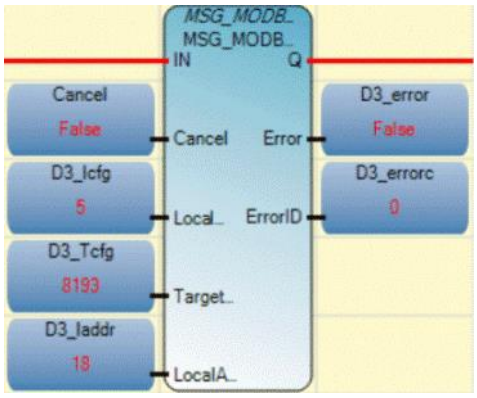
MOV instruction example

The following images shows an example of using the MOV instruction to move the *_l[1] array value to a Word, which allows you to directly access the individual bits.



Modbus Write example

The following MSG_MODBUS instruction is used to write control data to a PowerFlex 40 drive.



MSG_MODBUS Write configuration

The following image shows the variables and the values used to configure the MSG_MODBUS instruction to write control data to a PowerFlex 4 drive.

Name	Data Type	Direction	Dimension
D3_lcfg	MODBUSLC	Var	
D3_lcfg.Channel	UINT	Var	
D3_lcfg.TriggerType	USINT	Var	
D3_lcfg.Cmd	USINT	Var	
D3_lcfg.ElementCnt	UINT	Var	
D3_Tcfg	MODBUST/	Var	
D3_Tcfg.Addr	UDINT	Var	
D3_Tcfg.Node	USINT	Var	
D3_laddr	MODBUSLC	Var	
D3_laddr[1]	WORD	Var	
D3_laddr[2]	WORD	Var	
D3_laddr[3]	WORD	Var	

MSG_MODBUS Write variables

The following table lists the variables, values and describes the purpose of each variable.

Variable	Value	Description
*.Channel	5	Channel 5 - location of SERIALISOL module
*.TriggerType	0	Trigger on False-to-True transition
*.Cmd	16	Modbus Function Code "16" - Write Holding Registers
*.ElementCnt	2	Length
*.Addr	8193	PowerFlex Logic Status word address + 1
*.Node	2	PowerFlex Node address
*_laddr[1]	{data}	PowerFlex Logic Command word
*_laddr[2]	{data}	PowerFlex Speed Reference word

Communication protocol support

The MSG_CIP function blocks support different communication protocols as described in this section.

Function block support for message communication protocols

The following table lists the communication protocols supported by the Modbus and CIP message function blocks.

Messaging Protocol	Communication media	Use this function block
Modbus/RTU client and server	Through a Serial port configured as Modbus RTU	MSG_MODBUS (on page 199)
Modbus/TCP client and server	Over the Ethernet instead of through a serial port	MSG_MODBUS2 (on page 206)
Ethernet IP client and server	Through an embedded Ethernet channel	MSG_CIPSYMBOLIC (on page 187) MSG_CIPGENERIC (on page 178)
CIP Serial client and server	Ethernet cable or Serial cable	MSG_CIPSYMBOLIC (on page 187)
ASCII	Through an RS-232 port configured with an ASCII driver	See ASCII serial port instructions (on page 109)

Modbus RTU

Modbus is a half-duplex, master-slave communications protocol that allows a single master to communicate with a maximum of 247 slave devices. The Modbus network master reads and writes bits and registers. Modbus RTU is supported by configuring the Serial port as Modbus RTU.

For more information about the Modbus protocol, refer to the Modbus Protocol Specifications (available from http://www.modbus.org).

Modbus/TCP

The Modbus/TCP Server communication protocol uses the same Modbus mapping features as Modbus RTU, but it is supported over the Ethernet instead of through a Serial port.

The Micro850 controller supports up to 16 simultaneous Modbus TCP Server connections. No protocol configuration is required other than configuring the Modbus mapping table.

EtherNet/IP

Micro850 controllers support up to 16 simultaneous EtherNet/IP server connections through an embedded Ethernet communication channel. The channel can be used to connect a Micro850 controller to various devices through a local area network using a 10 Mbps/100 Mbps transfer rate.

Common Industrial Protocol (CIP)

CIP Serial

CIP serial uses DF1 Full Duplex protocol, and provides point-to-point connection between two devices. It combines data transparency (American National Standards Institute ANSI - X3.28-1976 specification subcategory D1) and 2-way simultaneous transmission with embedded responses (subcategory F1)

Micro830 and Micro850 controllers support CIP Serial through an RS-232 connection to external devices, such as computers running RSLinx Classic software, PanelView Component terminals (firmware revisions 1.70 and above), or other controllers that support CIP Serial over DF1 Full-Duplex, such as ControlLogix and CompactLogix controllers that have embedded serial ports.

The Serial Port driver can be configured as CIP Serial, Modbus RTU, ASCII or Shutdown through the device configuration tree.

Embedded communication channels

The Micro830 and Micro850 controllers have the following additional embedded communication channels:

- A non-isolated RS-232/485 combo port
- A non-isolated USB programming port
- An RJ-45 ethernet port (Micro850 only)

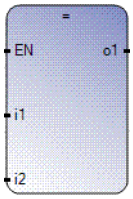
Compare instructions

Compare instructions compare values using an expression or a specific compare instruction.

Operator	Description
(=) Equal (on page 260)	Compares the first input to the second input to determine equality for Integer, Real, Time, Date, and String data types.
(>) Greater Than (on page 262)	For Integer, Real, Time, Date, and String values, compares input values to determine whether the first is greater than the second.
(>=) Greater Than or Equal (on page 263)	For Integer, Real, Time, Date, and String values, compares input values to determine whether the first is greater than or equal to the second.
(<) Less Than (on page 264)	For Integer, Real, Time, Date, and String values, compares input values to determine whether the first is less than the second.
(<=) Less Than or Equal (on page 265)	For Integer, Real, Time, Date, and String values, compares input values to determine whether the first is less than or equal to the second.
(<>) Not Equal (on page 266)	For Integer, Real, Time, Date, and String values, compares input values to determine whether the first is not equal to the second.

Equal

Equal (=) compares the first input to the second input to determine equality for Integer, Real, Time, Date, and String data types.



Recommendation: Using the Equal (=) operator

Equality testing of Time values is not recommended for TON, TP, and TOF functions.

The Real data type is not recommended when comparing values for equality because numbers in the math operation are rounded differently than those that appear in the variable output display. Consequently, two output values may appear equal in the display, but will still evaluate as false. For example, 23.500001 compared to 23.499999 will both display as 23.5 in the variable input display, but will not be equal in the controller. For an alternative method to determine equality, see the following topic.

Arguments

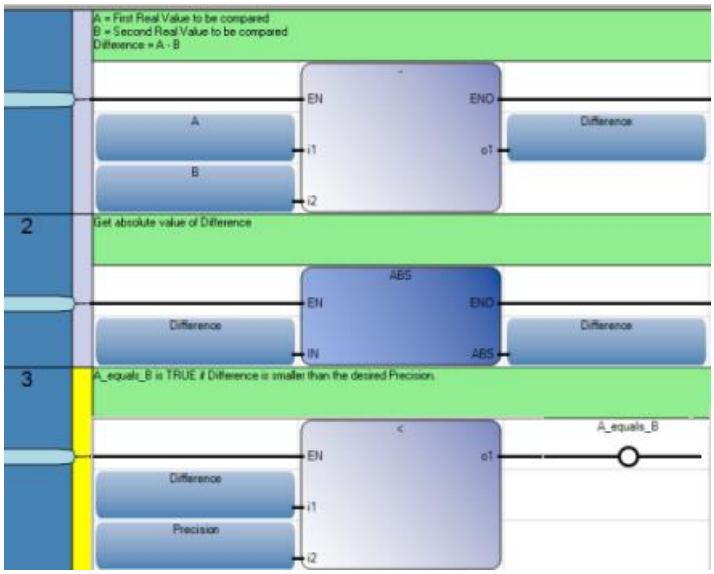
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the equality comparison. When Enable = FALSE, there is no comparison. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	All inputs must be the same data type. The Time input applies to the ST, LD and FBD languages. **Note**: The Real data type is not recommended.
i2	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	
o1	Output	BOOL	TRUE if i1 = i2.

Example: Comparing Real Values using Subtraction (-) ABS, and Less than (<)

The Real data type is not recommended when comparing values for equality because of differences in the way numbers are rounded. Two output values may appear equal in a Connected Components Workbench display, but will evaluate as false.

For example, 23.500001 compared to 23.499999 will both display as 23.5 in the variable input display, but will not be equal in the controller.

To test whether two Real data type values are equal, you can use a Subtraction instruction to get the difference between the values and then determine if the difference is Less Than an established precision value. See the following LD program example for comparing two Real data type values.



Equal (=) operator ST language example

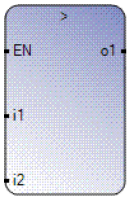
Example

(* ST Equivalence: *)

```
aresult := (10 = 25); (* aresult is FALSE *)
mresult := ('ab' = 'ab'); (* mresult is TRUE *)
```

Greater than

For Integer, Real, Time, Date, and String values, Greater Than compares input values to determine whether the first is greater than the second.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the input comparison. When Enable = FALSE, there is no comparison. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	All inputs must be the same data type.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	
o1	Output	BOOL	TRUE if i1 > i2.

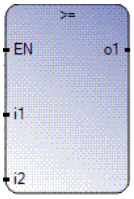
Greater than (>) operator ST language example

(* ST Equivalence: *)

```
aresult := (10 > 25); (* aresult is FALSE *)
mresult := ('ab' > 'a'); (* mresult is TRUE *)
```

Greater than or equal

For Integer, Real, Time, Date, and String values, Greater Than or Equal compares input values to determine whether the first is greater than or equal to the second.



Special recommendations for >= operator

For TON, TP, and TOF, equality testing of Time values is not recommended.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the input comparison. When Enable = FALSE, there is no comparison. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	All inputs must be the same data type. The Time input applies to the ST, LD and FBD languages.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	
o1	Output	BOOL	TRUE if i1 >= i2.

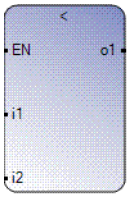
>= operator ST language example

(* ST Equivalence: *)

```
aresult := (10 >= 25); (* aresult is FALSE *)
mresult := ('ab' >= 'ab'); (* mresult is TRUE *)
```

Less than

For Integer, Real, Time, Date, and String values, Less Than compares input values to determine whether the first is less than the second.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the input comparison. When Enable = FALSE, there is no comparison. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	All inputs must be the same data type.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	
o1	Output	BOOL	TRUE if i1 < i2.

Less than (<) operator ST language example

(* ST Equivalence: *)

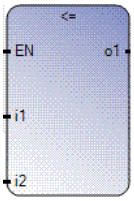
```
aresult := (10 < 25); (* aresult is TRUE *)
mresult := ('z' < 'B'); (* mresult is FALSE *)
```

(* IL equivalence: *)

```
LD      10
LT      25
ST      aresult
LD      'z'
LT      'B'
ST      mresult
```

Less than or equal

For Integer, Real, Time, Date, and String values, Less Than or Equal compares input values to determine whether the first is less than or equal to the second.



Special recommendations

For TON, TP, and TOF, equality testing of Time values is not recommended.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the input comparison. When Enable = FALSE, there is no comparison. Applies only to LD programs.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	All inputs must be the same data type. The Time input applies to the ST, LD and FBD languages.
i2	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	
o1	Output	BOOL	TRUE if i1 <= i2.

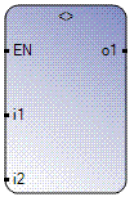
Less than or equal (<=) operator ST language example

(* ST Equivalence: *)

```
aresult := (10 <= 25); (* aresult is TRUE *)
mresult := ('ab' <= 'ab'); (* mresult is TRUE *)
```

Not equal

For Integer, Real, Time, Date, and String values, Not Equal compares input values to determine whether the first is not equal to the second.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute current compare computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	All inputs must be the same data type.
i2	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	
o1	Output	BOOL	TRUE if first <> second

Not equal (<>) operator ST language example

(* ST Equivalence: *)

```
aresult := (10 <> 25); (* aresult is TRUE *)
mresult := ('ab' <> 'ab'); (* mresult is FALSE *)
```

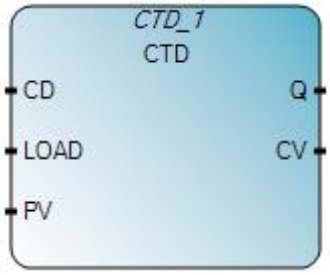
Counter instructions

Counter instructions are used to control operations based on the number of events.

Function	Description
CTD (on page 268)	Block counts (integers) from a given value down to 0, 1 by 1.
CTU (on page 270)	Counts (integers) from 0 up to a given value, 1 by 1.
CTUD (on page 272)	Counts (integers) from 0 up to a given value, 1 by 1, or from a given value down to 0 (1 by 1).

CTD

CTD counts (integers) from a given value down to 0, 1 by 1.

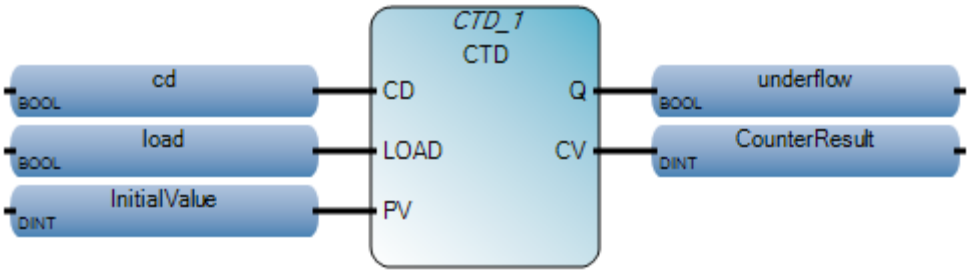


Arguments

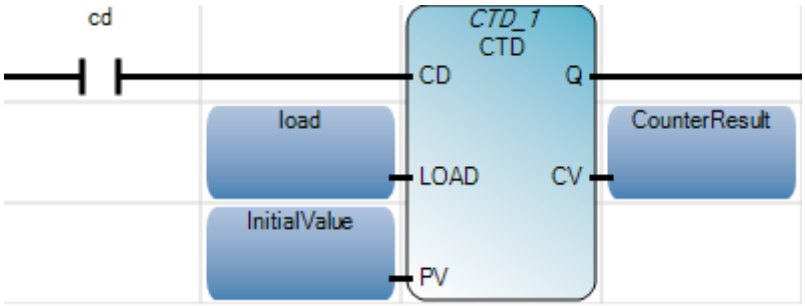
Parameter	Parameter type	Data type	Description
CD	Input	BOOL	Counting input (down-counting when CD is a rising edge).
LOAD	Input	BOOL	Load command (dominant) (CV = PV when LOAD is TRUE).
PV	Input	DINT	Programmed initial value.
Q	Output	BOOL	Underflow: TRUE when CV <= 0.
CV	Output	DINT	Counter result.

CTD function block language examples

Function Block Diagram (FBD)

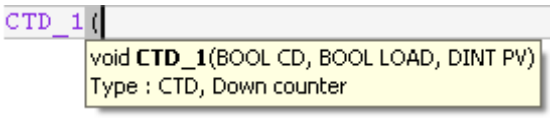


Ladder Diagram (LD)



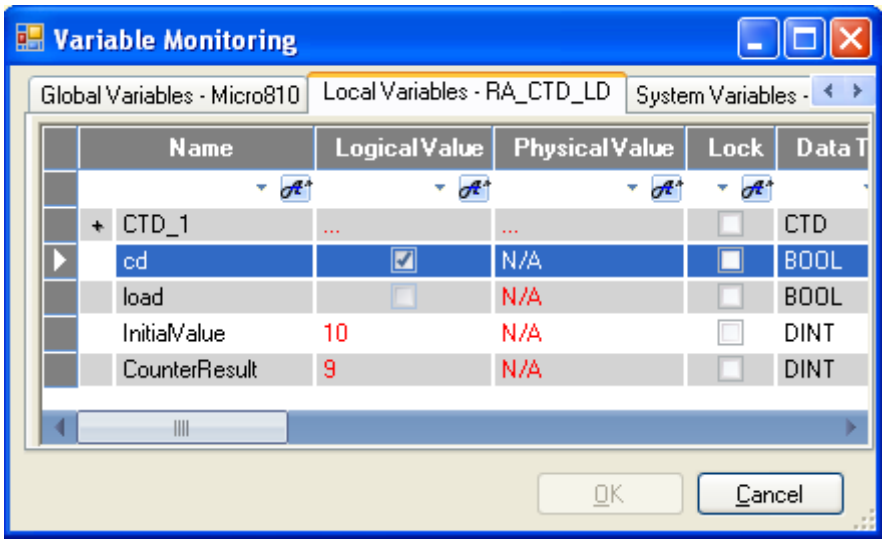
Structured Text (ST)

```
1  InitialValue := 10;
2  CTD_1(cd, load, InitialValue);
```



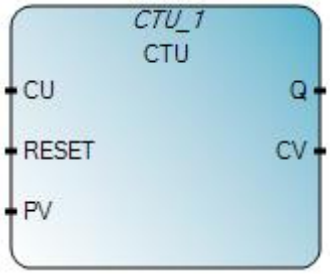

```
(*ST Equivalence: CTD1 is an instance of block *)
CTD1(trigger,load_cmd,100);
underflow := CTD1.Q;
result := CTD1.CV;
```

Results



CTU

CTU counts (integers) from 0 up to a given value, 1 by 1.

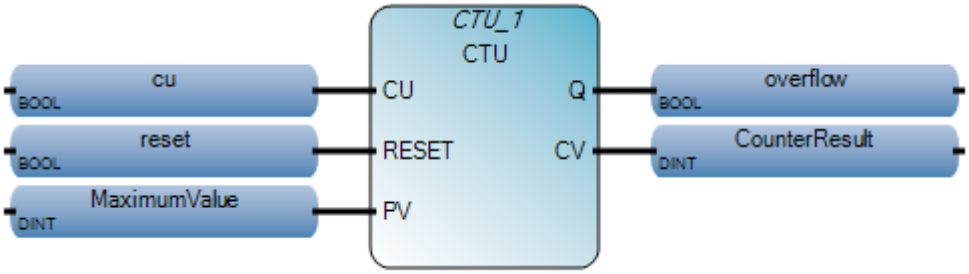


Arguments

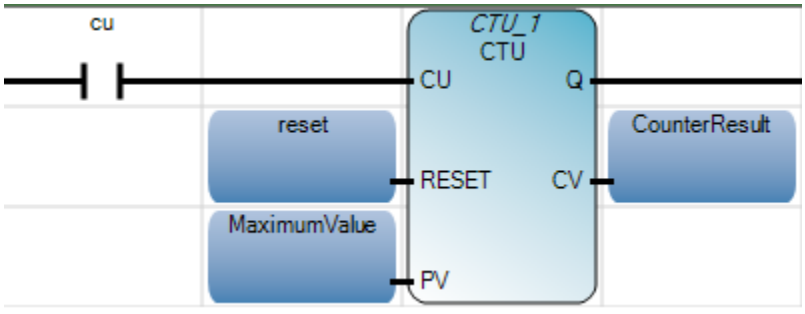
Parameter	Parameter type	Data type	Description
CU	Input	BOOL	Counting input (counting when CU is a rising edge).
RESET	Input	BOOL	Reset dominant command.
PV	Input	DINT	Programmed maximum value.
Q	Output	BOOL	Overflow: TRUE when CV >= PV.
CV	Output	DINT	Counter result.

CTU function block language examples

Function Block Diagram (FBD)

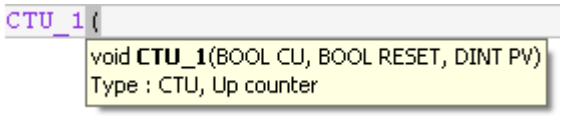


Ladder Diagram (LD)



Structure Text

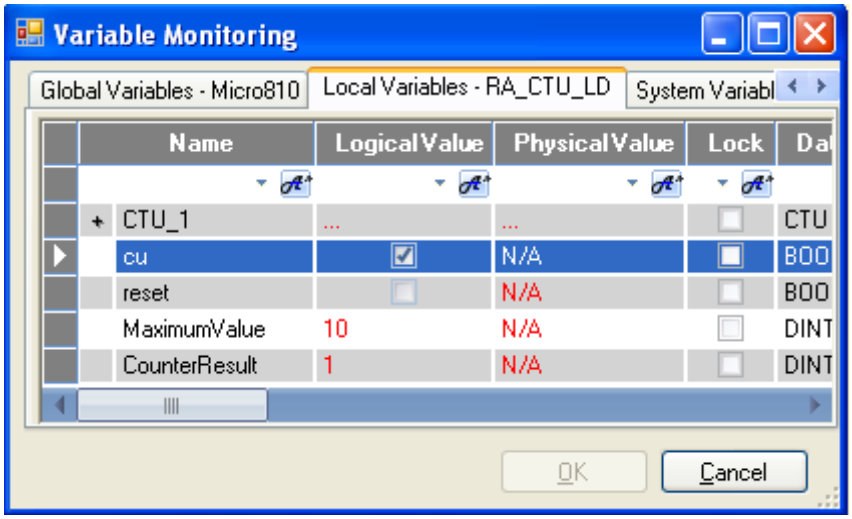
```
1  MaximumValue := 10;
2  CTU_1(cu, reset, MaximumValue);
```



(* ST Equivalence: CTU1 is an instance of CTU block*)

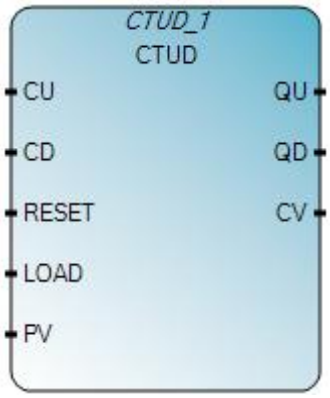
```
CTU1(trigger,NOT(auto_mode),100);
overflow := CTU1.Q;
result := CTU1.CV;
```

Results



CTUD

CTUD counts (integers) from 0 up to a given value, 1 by 1, or from a given value down to 0 (1 by 1).

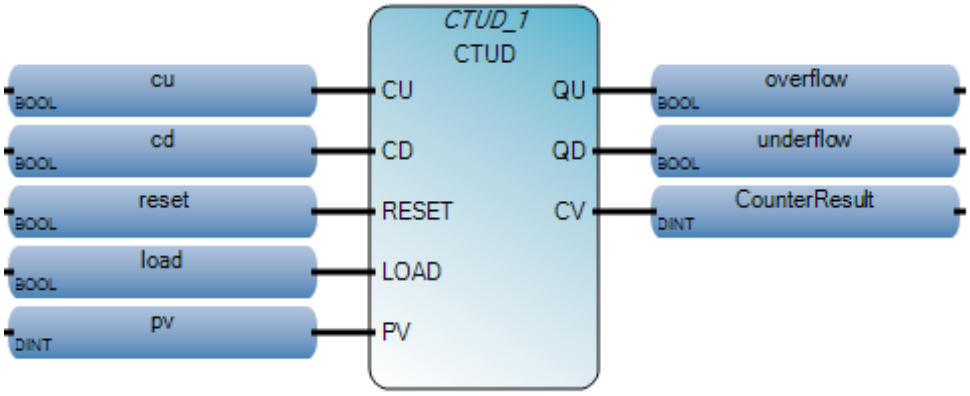


Arguments

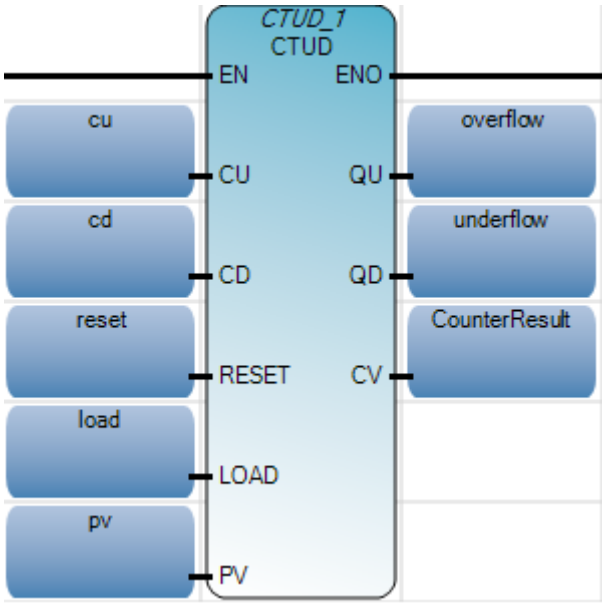
Parameter	Parameter type	Data type	Description
CU	Input	BOOL	Up-counting (when CU is a rising edge).
CD	Input	BOOL	Down-counting (when CD is a rising edge).
RESET	Input	BOOL	Reset dominant command. (CV = 0 when RESET is TRUE).
LOAD	Input	BOOL	Load command (CV = PV when LOAD is TRUE).
PV	Input	DINT	Programmed maximum value.
QU	Output	BOOL	Overflow: TRUE when CV >= PV.
QD	Output	BOOL	Underflow: TRUE when CV <= 0.
CV	Output	DINT	Counter result.

CTUD function block language examples

Function Block Diagram (FBD)

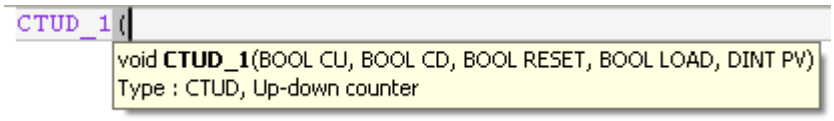


Ladder Diagram (LD)



Structured Text (ST)

```
1  cu := TRUE;
2  cd := TRUE;
3  reset := FALSE;
4  load := FALSE;
5  pv := 10;
6  CTUD_1(cu, cd, reset, load, pv);
```




```
(* ST Equivalence: We suppose CTUD1 is an instance of block*)
CTUD1(trigger1, trigger2, reset_cmd, load_cmd,100);
full := CTUD1.QU;
empty := CTUD1.QD;
nb_elt := CTUD1.CV;
```

Data conversion instructions

Data conversion instructions are used to convert the data type of a variable to a different data type.

Operator	Description
ANY_TO_BOOL (on page 276)	Converts to Boolean
ANY_TO_BYTE (on page 277)	Converts to BYTE
ANY_TO_DATE (on page 278)	Converts to Date
ANY_TO_DINT (on page 279)	Converts to Double Integer
ANY_TO_DWORD (on page 280)	Converts to Double Word
ANY_TO_INT (on page 281)	Converts to Integer
ANY_TO_LINT (on page 282)	Converts to Long Integer
ANY_TO_LREAL (on page 283)	Converts to Long real
ANY_TO_LWORD (on page 284)	Converts to Long Word
ANY_TO_REAL (on page 285)	Converts to Real
ANY_TO_SINT (on page 286)	Converts to Short Integer
ANY_TO_STRING (on page 287)	Converts to String
ANY_TO_TIME (on page 288)	Converts to Time
ANY_TO_UDINT (on page 289)	Converts to Unsigned Double Integer
ANY_TO_UINT (on page 290)	Converts to Unsigned Integer
ANY_TO_ULINT (on page 291)	Converts to Unsigned Long Integer
ANY_TO_USINT (on page 292)	Converts to Unsigned Short Integer
ANY_TO_WORD (on page 293)	Converts to Word

ANY_TO_BOOL

ANY_TO_BOOL converts a value to a Boolean value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to BOOLEAN computation. When Enable = FALSE, there is no computation.
i1	Input	SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any non-Boolean value.
o1	Output	BOOL	Boolean value.

ANY_TO_BOOL operator ST language example

(* ST Equivalence: *)

```
ares := ANY_TO_BOOL (10);          (* ares is TRUE *)
tres := ANY_TO_BOOL (t#0s);        (* tres is FALSE *)
mres := ANY_TO_BOOL ('FALSE');     (* mres is FALSE *)
```

ANY_TO_BYTE

ANY_TO_BYTE converts a value to an 8-bit Byte value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 8-bit BYTE computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT -USINT - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any non-Byte value.
o1	Output	BYTE	An 8-bit Byte value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_BYTE operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_BYTE (true);         (* bres is 1 *)
tres := ANY_TO_BYTE (t#0s46ms);     (* tres is 46 *)
mres := ANY_TO_BYTE ('0198');       (* mres is 198 *)
```

ANY_TO_DATE

ANY_TO_DATE converts a value to a Date value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the Date computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - STRING	Any value other than Date.
o1	Output	DATE	Date represented by IN. A value of -1 indicates an invalid date.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_DATE operator ST language example

(* ST Equivalence: *)

```
ares := ANY_TO_DATE (1109110199);          (* ares := d#2005-02-22 *)
rres := ANY_TO_DATE (1109110199.3);        (*rres := d#2005-02-22 *)
```

ANY_TO_DINT

ANY_TO_DINT converts a value to 32-bit Double Integer value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 32-bit Double Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any value other than a Double Integer.
o1	Output	DINT	A 32-bit Double Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_DINT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_DINT (true);          (* bres is 1 *)
tres := ANY_TO_DINT (t#1s46ms);      (* tres is 1046 *)
mres := ANY_TO_DINT ('0198');        (* mres is 198 *)
```

ANY_TO_DWORD

ANY_TO_DWORD converts a value to a 32-bit double Word value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 32-bit double Word computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any value other than a double word.
o1	Output	DWORD	A 32-bit double Word value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_DWORD operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_DWORD (true);        (* bres is 1 *)
tres := ANY_TO_DWORD (t#1s46ms);    (* tres is 1046 *)
mres := ANY_TO_DWORD ('0198');      (* mres is 198 *)
```

ANY_TO_INT

ANY_TO_INT converts a value to a 16-bit Integer value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 16-bit Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any non-16-bit Integer value.
o1	Output	INT	A 16-bit Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

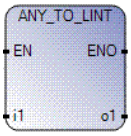
ANY_TO_INT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_INT (true);          (* bres is 1 *)
tres := ANY_TO_INT (t#0s46ms);      (* tres is 46 *)
mres := ANY_TO_INT ('0198');        (* mres is 198 *)
```

ANY_TO_LINT

ANY_TO_LINT converts a value to a 64-bit Long Integer value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 64-bit Long Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any value other than a Long Integer.
o1	Output	LINT	A 64-bit Long Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_LINT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_LINT (true);          (* bres is 1 *)
tres := ANY_TO_LINT (t#0s46ms);      (* tres is 46 *)
mres := ANY_TO_LINT ('0198');        (* mres is 198 *)
```

ANY_TO_LREAL

ANY_TO_LREAL converts any value to a Long Real value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the long Real computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - TIME - DATE - STRING	Any value other than a long Real.
o1	Output	LREAL	A long real value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_LREAL operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_LREAL (true);          (* bres is 1.0 *)
tres := ANY_TO_LREAL (t#1s46ms);      (* tres is 1046.0 *)
ares := ANY_TO_LREAL (198);           (* ares is 198.0 *)
```

ANY_TO_LWORD

ANY_TO_LWORD converts a value to a 64-bit Long Word value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 64-bit long Word computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - REAL - LREAL - TIME - DATE - STRING	Any value other than a long Word.
o1	Output	LWORD	A 64-bit long Word value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

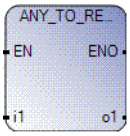
ANY_TO_LWORD operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_LWORD (true);          (* bres is 1 *)
tres := ANY_TO_LWORD (t#0s46ms);      (* tres is 46 *)
mres := ANY_TO_LWORD ('0198');        (* mres is 198 *)
```

ANY_TO_REAL

ANY_TO_REAL converts a value to a Real value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the Real computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - LREAL - TIME - DATE - STRING	Any value other than Real.
o1	Output	REAL	A real value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

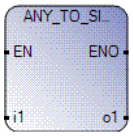
ANY_TO_REAL operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_REAL (true);            (* bres is 1.0 *)
tres := ANY_TO_REAL (t#1s46ms);        (* tres is 1046.0 *)
ares := ANY_TO_REAL (198);             (* ares is 198.0 *)
```

ANY_TO_SINT

ANY_TO_SINT converts a value to a Short Integer value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 8-bit Short Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any non-Short Integer value.
o1	Output	SINT	A Short Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_SINT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_SINT (true);           (* bres is 1 *)
tres := ANY_TO_SINT (t#0s46ms);       (* tres is 46 *)
mres := ANY_TO_SINT ('0198');         (* mres is 198 *)
```

ANY_TO_STRING

ANY_TO_STRING converts a value to a String value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	C Function enable. When Enable = TRUE, execute the conversion to String computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE	Any value other than String.

o1	Output	STRING	If IN is a Boolean, 'FALSE' or 'TRUE'.
			If IN is an Integer or a real, a decimal representation.
			If IN is a TIME, can be:
			TIME time1
			STRING s1
			time1 :=13 ms;
			s1:=ANY_TO_STRING(time1);
			(* s1 = '0s13' *).

ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_STRING operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_STRING (TRUE);       (* bres is 'TRUE' *)
ares := ANY_TO_STRING (125);        (* ares is '125' *)
```

ANY_TO_TIME

ANY_TO_TIME converts a non-Time or non-Date value to a Time value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the Time computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - STRING	Any positive value other than a Time or Date data type. IN (or integer part of IN if it is real) is the number of milliseconds. STRING (number of milliseconds, for example, a value of 300032 represents 5 minutes and 32 milliseconds).
o1	Output	TIME	Time value represented by IN. A value of 1193h2m47s295ms indicates an invalid time.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_TIME operator ST language example

(* ST Equivalence: *)

```
ares := ANY_TO_TIME (1256);          (* ares := t#1s256ms *)
rres := ANY_TO_TIME (1256.3);        (* rres := t#1s256ms *)
```

ANY_TO_UDINT

ANY_TO_UDINT converts a value to a 32-bit Unsigned Double Integer value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 32-bit Double Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any value other than an Unsigned Double Integer.
o1	Output	UDINT	A 32-bit Unsigned Double Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_UDINT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_UDINT (true);          (* bres is 1 *)
tres := ANY_TO_UDINT (t#1s46ms);      (* tres is 1046 *)
mres := ANY_TO_UDINT ('0198');        (* mres is 198 *)
```

ANY_TO_UINT

ANY_TO_UINT converts a value to an Unsigned Integer value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 16-bit Unsigned Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any non-Unsigned Integer value.
o1	Output	UINT	An Unsigned Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

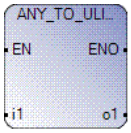
ANY_TO_UINT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_UINT (true);          (* bres is 1 *)
tres := ANY_TO_UINT (t#0s46ms);      (* tres is 46 *)
mres := ANY_TO_UINT ('0198');        (* mres is 198 *)
```

ANY_TO_ULINT

ANY_TO_ULINT converts a value to a 64-bit Unsigned Long Integer value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 64-bit Unsigned Long Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any value other than an Unsigned Long Integer.
o1	Output	ULINT	A 64-bit Unsigned Long Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_ULINT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_ULINT (true);          (* bres is 1 *)
tres := ANY_TO_ULINT (t#0s46ms);      (* tres is 46 *)
mres := ANY_TO_ULINT ('0198');        (* mres is 198 *)
```

ANY_TO_USINT

ANY_TO_USINT converts a value to an Unsigned Short Integer value.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 8-bit Unsigned Short Integer computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - BYTE - INT - UINT - WORD - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any non-Short Integer value.
o1	Output	USINT	An Unsigned Short Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

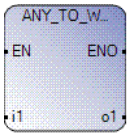
ANY_TO_USINT operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_USINT (true);          (* bres is 1 *)
tres := ANY_TO_USINT (t#0s46ms);      (* tres is 46 *)
mres := ANY_TO_USINT ('0198');        (* mres is 198 *)
```

ANY_TO_WORD

ANY_TO_WORD converts a value to a 16-bit Word value.



Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When Enable = TRUE, execute the conversion to the 16-bit Word computation. When Enable = FALSE, there is no computation. Applies only to LD programs.
i1	Input	BOOL - SINT - USINT - BYTE - INT - - DINT - UDINT - DWORD - LINT - ULINT - LWORD - REAL - LREAL - TIME - DATE - STRING	Any non-Unsigned Integer value.
o1	Output	WORD	An Unsigned Integer value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

ANY_TO_WORD operator ST language example

(* ST Equivalence: *)

```
bres := ANY_TO_WORD (true);          (* bres is 1 *)
tres := ANY_TO_WORD (t#0s46ms);      (* tres is 46 *)
mres := ANY_TO_WORD ('0198');        (* mres is 198 *)
```

Data manipulation instructions

Data manipulation instructions are used to alter the output data to change the status without altering the program.

Function block	Description
AVERAGE (on page 296)	Running average over N samples.
COP (on page 298)	Copy binary data in the Source (Src) to the Destination (Dest).
Function	**Description**
MAX (on page 305)	Maximum
MIN (on page 303)	Minimum

AVERAGE

AVERAGE stores a value at each cycle and calculates the average value of all already stored values. Only the N last values are stored.

Average function block operation

- The number of samples (N) cannot exceed 128.
- If the RUN command is FALSE (reset mode), the output value is equal to the input value.
- When the maximum number of stored values is reached, the first stored value is erased by the last one.

Arguments

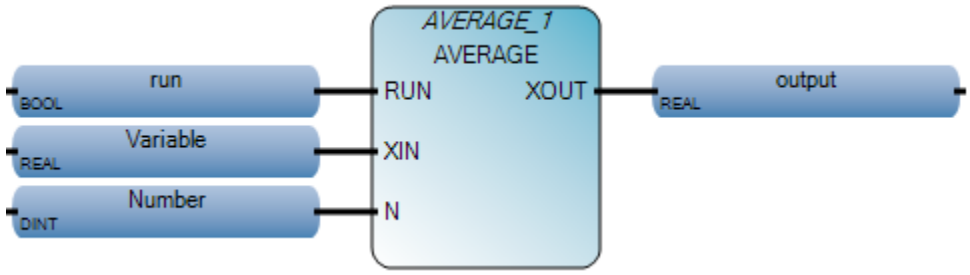
Parameter	Parameter type	Data type	Description
RUN	Input	BOOL	TRUE = run/FALSE = reset.
XIN	Input	REAL	Any real variable.
N	Input	DINT	Application defined number of samples.
XOUT	Output	REAL	Running average of XIN value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

Note: Using floating-point data types could result in inaccurate calculations due to the rounding limitations inherent in floating-point mathematics.

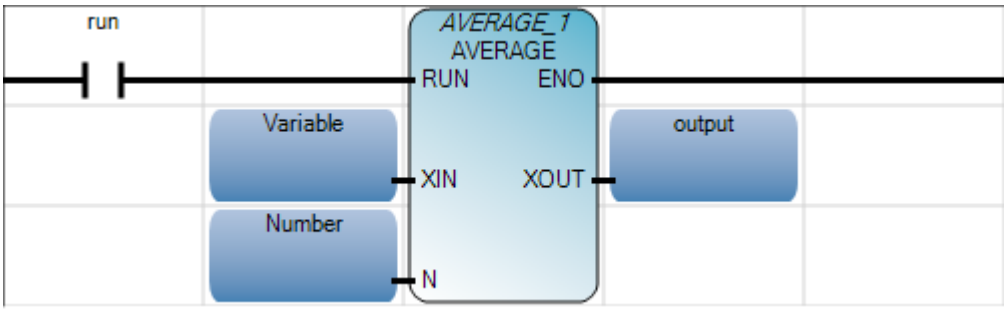
Note: When setting or changing the value for N, you need to set RUN to FALSE, then set it back to TRUE.

AVERAGE function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

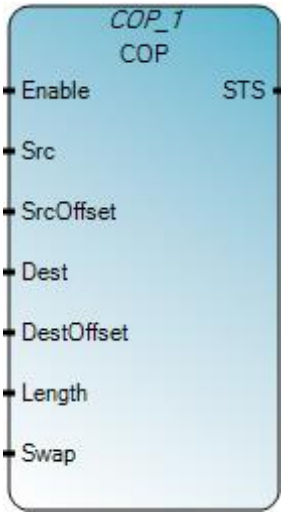
```
1  AVERAGE_1(run, Variable, Number);
2  output := AVERAGE_1.XOUT;
```

```
AVERAGE_1(
          void AVERAGE_1(BOOL RUN, REAL XIN, DINT N)
          Type : AVERAGE, Running average over N samples
```

```
(* ST Equivalence: AVERAGE1 an instance of an AVERAGE block *)
AVERAGE1((auto_mode & store_cmd), sensor_value, 100);
ave_value := AVERAGE1.XOUT;
```

COP

COP copies the binary data in the Source to the Destination, and leaves the source value unchanged.



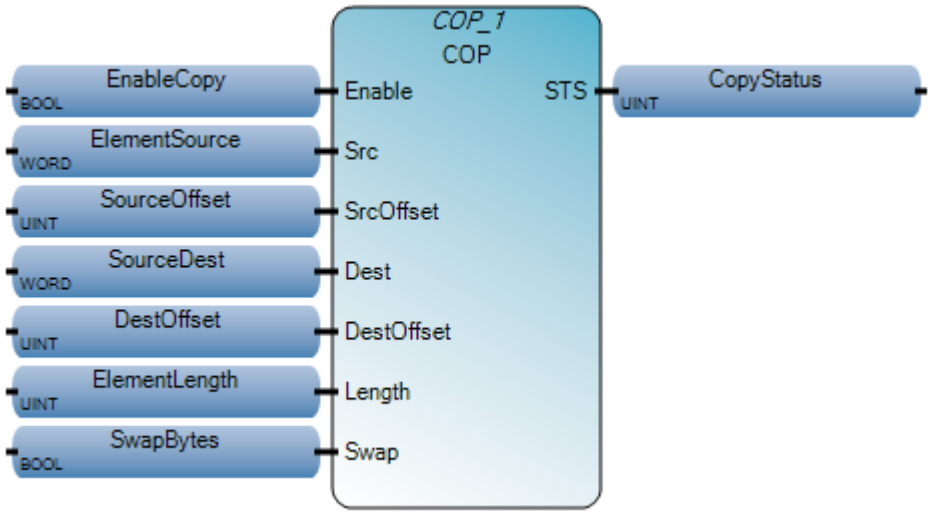
Arguments

Parameter	Parameter type	Data type		Description
Enable	Input	BOOL		Function block enable. This FB is level triggered. When Enable=TRUE, perform copy. When Enable=FALSE, the function block will not be executed.
Src	Input	BOOL SINT USINT BYTE INT UINT WORD DINT UDINT	DWORD REAL TIME DATE STRING LWORD ULINT LINT LREAL	Initial element to copy. If the source or destination is a String data type, the other party must also be a String data type, or a USINT (UCHAR and BYTE) data type. If it is not, a data type mismatch will be reported. See also Copying to a different data type (on page 302).
SrcOffset	Input	UINT		Source element offset. The element offset if the source is an array data type. Set the offset to 0 if: • If it is not an array data type, or • To copy from the first element for an array data type.

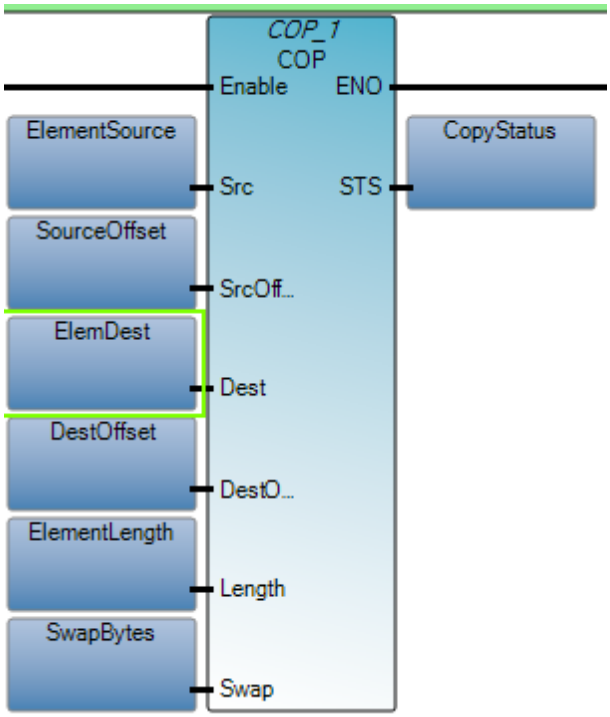
Parameter	Parameter type	Data type		Description
Dest	Input	BOOL SINT USINT BYTE INT UINT WORD DINT UDINT	DWORD REAL TIME DATE STRING LWORD ULINT LINT	Initial element to be overwritten by the source.
DestOffset	Input	UINT		Destination element offset. The element offset if the destination is an array data type. Set the offset to 0 if: • If it is not an array data type, or • To copy from the first element for an array data type.
Length	Input	UINT		Number of Destination Elements to copy. When the destination is a String data type, it indicates the number of strings to be copied.
Swap	Input	BOOL		TRUE: Swap bytes according to the Data Type. A swap operation will not occur if: • The source data type or the destination data type is a String, or • If both the source and the destination are 1-byte length data.
Sts	Output	UINT		Status of the copy operation. See COP operation status values (on page 301)
ENO	Output	BOOL		Enable out. Applies only to LD programs.

COP function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  COP_1(EnableCopy, ElementSource, SourceOffset, SourceDest,
2    DestOffset, ElementLength, SwapBytes);
3  output :=COP_1.STS;
```

COP operation status values

The following table describes COP operation status values:

COP Status value	Status description
0x00	No action taken (not enabled).
0x01	COP function block success.
0x02	Destination has spare bytes when copying from String.
0x03	Source data are truncated.
0x04	Copy length is invalid.
0x05	Data type mismatch when there is String Data type as either source or destination.
0x06	Source data size is too small for copy.
0x07	Destination data size is too small for copy.
0x08	Source Data offset is invalid.
0x09	Destination Data offset is invalid.
0x0A	Data is invalid in either source or destination.

Copying to a different data type

When a copy to or from a String data type is performed, the ODVA short String format is used for data in the USINT array.

When COP is used between any other pair of data types, the copy operation is valid, even if the data type in the source is not the same as the data type in the destination, and even when they are not in a valid format. The logic must be validated at the application level.

From a USINT array to a String array

To copy a USINT array to a String array, the data in the USINT array must be in this format:

- Byte1: Length of first String
- Byte2: First Byte Character
- Byte3: Second Byte Character
- Byte n: Last Byte Character
- Byte (n+1): Length of second String
- Byte (n+2): First Byte Character for second String
- Etc.

MIN

MIN yields the minimum of two integer values.

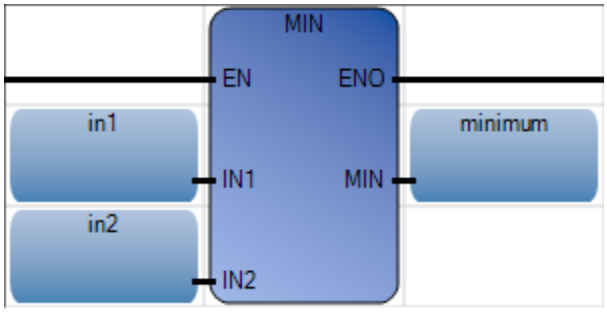
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute the minimum integer value computation When EN = FALSE, there is no computation.
IN1	Input	DINT	Any signed integer value.
IN2	Input	DINT	Cannot be Real.
MIN	Output	DINT	Minimum of both input values.
ENO	Output	BOOL	Enable out.

MIN function language examples

Function block diagram

Ladder diagram



Structured text

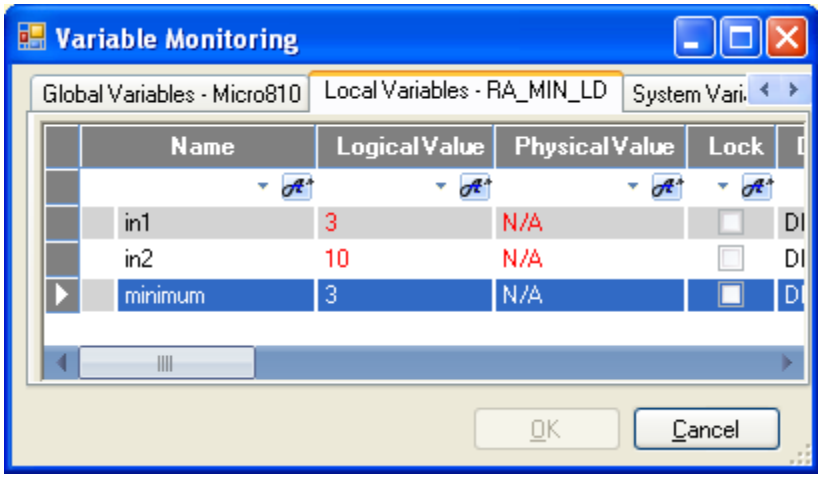
```
1  in1 := 3;
2  in2 := 10;
3  minimum := MIN(in1, in2);
```

(* ST Equivalence: *)

new_value := MAX (MIN (max_value, value), min_value);

(* bounds the value to the [min_value..max_value] set *)

Results



MAX

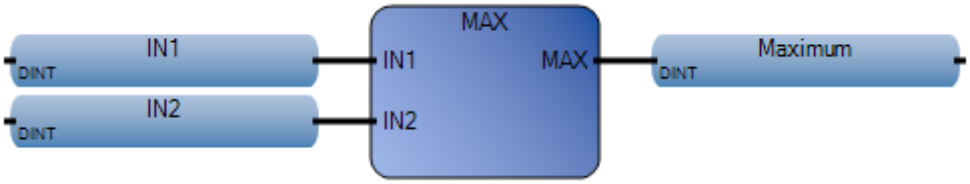
MAX yields the maximum of two integer values.

Arguments

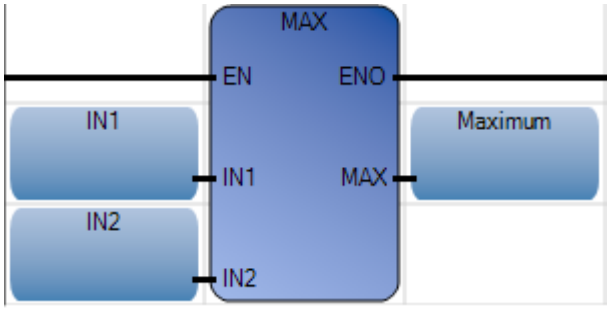
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute maximum integer value computation. When EN = FALSE, there is no computation.
IN1	Input	DINT	Any signed integer value.
IN2	Input	DINT	Cannot be Real.
MAX	Output	DINT	Maximum of both input values.
ENO	Output	BOOL	Enable out.

MAX function language examples

Function block diagram



Ladder diagram



Structured text

```
1  IN1 := 3;
2  IN2 := 10;
3  Maximum := MAX(IN1, IN2);
```

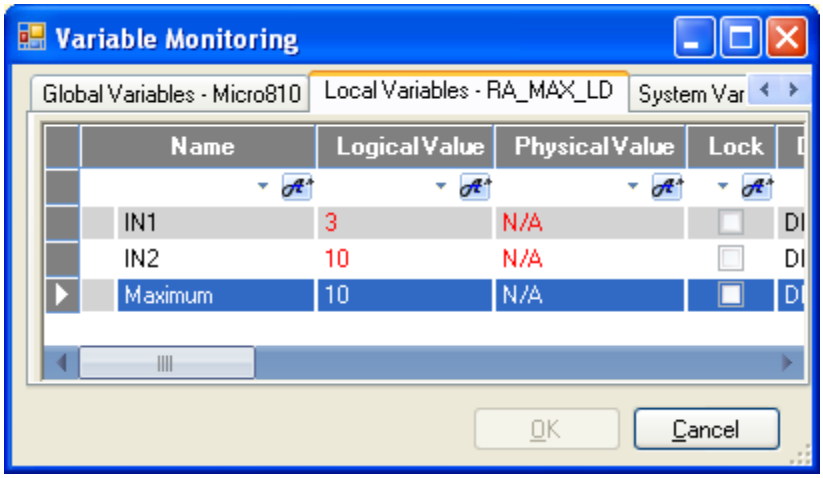
```
MAX(
    DINT MAX(DINT IN1, DINT IN2)
    Maximum
```

(* ST Equivalence: *)

new_value := MAX (MIN (max_value, value), min_value);

(* bounds the value to the [min_value..max_value] set *)

Results



High-Speed Counter (HSC) instructions

High-speed counter instructions are used to monitor and control the high-speed counter.

Function block	Description
HSC (on page 309)	HSC applies high presets, low presets and output source values to the high-speed counter.
HSC_SET_STS (on page 330)	HSC_SET_STS manually sets or resets the HSC counting status.

What is a High-Speed Counter?

A high-speed counter detects and counts narrow (fast) pulses and then issues specialized instructions to initiate control operations when the detected counts reach their preset values. Control operations include the automatic and immediate execution of the high-speed counter interrupt routine and the immediate update of outputs based on the configured source and mask pattern.

High-speed counter capabilities

Because HSC instructions have high-performance requirements, their operation is performed by custom circuitry that runs in parallel with the main system processor. Enhanced capabilities of High-Speed Counters include:

- 100 kHz operation high-speed direct control of outputs
- 32-bit signed integer data (count range of ± 2,147,483,647)
- Programmable high and low presets
- Overflow and underflow setpoints
- Automatic interrupt processing based on accumulated count
- Run-time editable parameters (from the user control program) HSC instruction operation

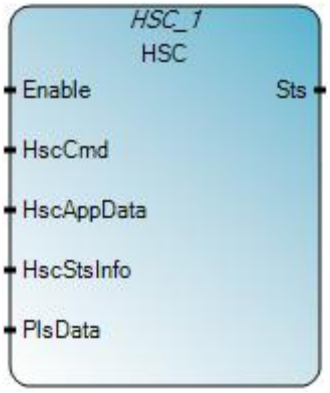
Micro800 controller support for HSC

All Micro830 and Micro850 controllers, except for 2080-LCxx-AWB, support up to six HSC inputs. HSC functionality is implemented in Micro800 controllers using high-speed counter hardware (embedded inputs in the controller), and the HSC instruction in the application. The HSC instruction configures the high-speed counter hardware and updates the image accumulator.

Important:	The HSC function can only be used with the controller's embedded I/O. It cannot be used with expansion I/O modules.

HSC

HSC applies high presets, low presets and output source values to the high-speed counter.

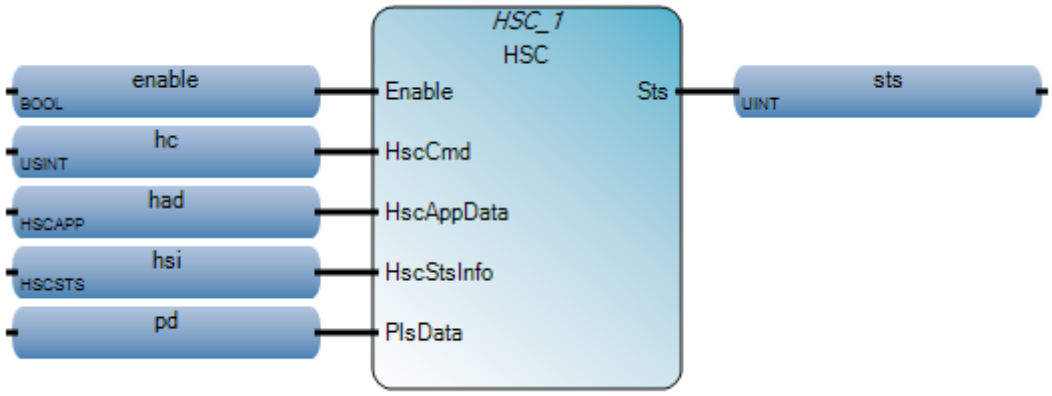


Arguments

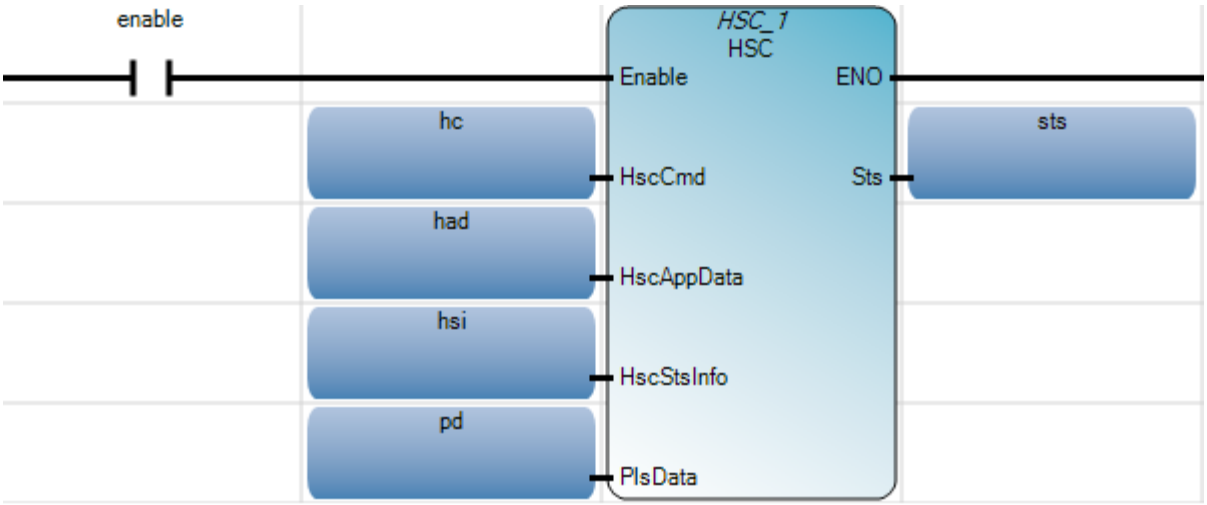
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute the HSC operation specified in the HSC command parameter. When Enable = FALSE, no HSC commands are issued.
HscCmd	Input	USINT	Issues commands to the HSC. See HSCCmd values (on page 311).
HSCAppData	Input	HSCAPP	HSC application configuration, which is usually only needed once. See HSCAPP data type (on page 312).
HSCStsInfo	Input	HSCSTS	HSC dynamic status, which is continuously updated during HSC counting. See HSCSTS data type (on page 318).
PlsData	Input	DINT UDINT	Programmable Limit Switch (PLS) data structure. See PLS data type (on page 327)
Sts	Output	UINT	HSC execution status. See HSC status codes (Sts) (on page 329).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

HSC function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  HSC_1(enable, hc, had, hsi, pd);
2  sts := HSC_1.Sts;
```

```
HSC_1(
```

```
void HSC_1(BOOL Enable, USINT HscCmd, HSCAPP HscAppData, HSCSTS HscStsInfo, PLS[1..1] PlsData, UINT __ADI_PlsData)
Type : HSC, Apply high/low presets and output source to high-speed counter.
```

HSCCmd values

The following table describes the HSC commands for each HSC command value.

HSC command	Command description
0x01	HSC RUN • Start HSC (if HSC is in Idle mode and the rung is enabled). • Update HSC Status Information only (if HSC in Run mode and the rung is enabled).
0x02	HSC Stop: Stop a HSC counting (if HSC is in Run mode and the rung is enabled).
0x03	HSC Load/Set: reload the HSC Application Data (if rung is enabled) for 6 input elements: HPSetting, LPSetting, HPOutput, LPOutput, OFSetting, and UFSetting. **Note:** This command does not re-load the following input element: HSC accumulator.
0x04	HSC Accumulator Reset (if rung is enabled).

HSC command results

The following table describes the results of issuing HSC commands in different situations.

Command value	Result	Conditions
HscCmd =1	Starts the HSC mechanism, and the HSC transitions to running mode.	Setting the Enable input parameter to False does not stop counting while in running mode. HscCmd =2 must be issued to stop counting.
	The HSC mechanism automatically updates values.	HSC AppData.Accumalator is updated with HSC Sts.Accumulator
HscCmd =4 (reset)	Sets the HSC Acc value to the HSC AppData.Accumalator value.	HscCmd =4 does not stop HSC counting. If HSC is counting when HscCmd =4 is issued, some counting may be lost
		To set a specific value to HSC Acc while counting, write the value to HSC AppData.Accumalator immediately before HscCmd =4 is issued.

HSCAPP data type

HSCAppData (data type HSCAPP) is used to configure the HSC application.

HSCAppData parameters

The following table lists the HSCAppData parameters.

Parameter	Data type	Data format	User program access	Description
PLSEnable	BOOL	bit	read/write	Enable or disable the Programmable Limit Switch (PLS).
HSCID	UINT	word	read/write	Defines the HSC.
HSCMode	UINT	word	read/write	Defines the HSC mode.
Accumulator	DINT	long word	read/write	Initial accumulator value.
HPSetting	DINT	long word	read/write	High preset setting.
LPSetting	DINT	long word	read/write	Low preset setting.
OFSetting	DINT	long word	read/write	Overflow setting.
UFSetting	DINT	long word	read/write	Underflow setting.
OutputMask	UDINT	word	read/write	Out mask for output.
HPOutput	UDINT	long word	read/write	32-bit output setting for High preset reaching.
LPOutput	UDINT	long word	read/write	32-bit output setting for Low preset reaching.

HSCAppData parameter details

HSCApp data type parameters are used to define HSC configuration data.

PLSEnable

Parameter	Data type	Data format	User program access
HSCApp.PLSEnable	BOOL	bit	read/write

Enables and disables the High-Speed Counter Programmable Limit Switch (PLS) function.

HSCApp settings versus PLSData settings

When the PLS function is enabled, relevant HSCApp settings are superseded by the corresponding PLSData settings as shown in the following table.

HSCApp setting	PLSData setting
HSCAPP.HpSetting	HSCHP
HSCAPP.LpSetting	HSCLP
HSCAPP.HPOutput	HSCHPOutput
HSCAPP.LPOutput	HSCLPOutput

HSCID

Parameter	Data type	Data format	User program access
HSCApp.HSCID	UINT	word	read/write

Identifies the High-Speed Counter to be used. The following table lists the values for defining the HSC ID:

Output Selection	Bit	Description
First word of HSC Function Data	15-13	Module type of HSC: • 0x00 - Embedded. • 0x01 - Expansion. • 0x02 - Plug-in Port.
	12-8	Slot ID of the module: • 0x00 - Embedded. • 0x01-0x1F - ID of Expansion Module. • 0x01-0x05 - ID of Plug-in Port.
	7-0	HSC ID inside the module: • 0x00-0x0F - Embedded. • 0x00-0x07 - ID of HSC for Expansion. • 0x00-0x07 - ID of HSC for Plug-in Port. **Note**: For the initial version of Connected Components Workbench, only IDs 0x00-0x05 are supported.

HSCMode

Parameter	Data type	User program access
HSCApp.HSCMode	UINT	read/write

Sets the High-Speed Counter to one of 10 types of counting modes. The mode value is configured through the programming device and is accessible in the control program.

HSC operating modes

The main HSC and sub HSC support different modes.

- The main high-speed counters support 10 types of operation modes.
- Sub high-speed counters support 5 types of operation modes (mode 0, 2, 4, 6, 8).
- If the main high-speed counter is set to mode 1, 3, 5, 7 or 9, then the sub high-speed counter will be disabled.

HSCMode	Counting mode
0	Up counter. The accumulator is immediately cleared (0) when it reaches the high preset. A low preset cannot be defined in this mode.
1	Up counter with external reset and hold. The accumulator is immediately cleared (0) when it reaches the high preset. A low preset cannot be defined in this mode.
2	Counter with external direction.
3	Counter with external direction, reset and hold.
4	Two input counter (up and down).
5	Two input counter (up and down) with external reset and hold.
6	Quadrature counter (phased inputs A and B).
7	Quadrature counter (phased inputs A and B) with external reset and hold.
8	Quadrature X4 counter (phased inputs A and B).
9	Quadrature X4 counter (phased inputs A and B) with external reset and hold.

For additional information on HSC operating modes and input assignments, see HSC Inputs and Wiring Mapping in the *Micro830 and Micro850 Programmable Controllers User Manual*.

1. In the **Help** menu, click **User Manuals**, expand **Controllers** and then the controller category.
2. Double-click the controller user manual in the controller category to open a pdf of the manual.

Accumulator

Parameter	Data type	User program access
HSCApp.Accumulator	DINT	read/write

Sets the initial accumulator value when the High-Speed Counter starts. When the HSC is in Counting mode, the Accumulator is automatically updated by the HSC sub-system to reflect the actual HSC accumulator value.

HPSetting

Parameter	Data type	User program access
HSCApp.HPSetting	DINT	read/write

Upper setpoint (in counts) that defines when the HSC sub-system generates an interrupt.

The data loaded into the high preset must be less than or equal to the data resident in the overflow (HSCAPP.OFSetting) parameter or an HSC error is generated.

LPSetting

Parameter	Data type	User program access
HSCApp.LPSetting	DINT	read/write

Lower setpoint (in counts) that defines when the HSC sub-system generates an interrupt.

- The data loaded into the low preset must be greater than or equal to the data resident in the underflow (HSCAPP.UFSetting) parameter or an HSC error is generated.
- If the underflow and low preset values are negative numbers, the low preset must be a number with an absolute value smaller than the underflow.

OFSetting

Parameter	Data type	User program access
HSCApp.OFSetting	DINT	read/write

Overflow setting that defines the upper count limit for the counter.

- If the counter's accumulated value increments above the value specified in OFSetting, an overflow interrupt is generated.
- When the overflow interrupt is generated, the HSC sub-system resets the accumulator value to the underflow value and the counter continues counting from the underflow value (counts are not lost in this transition).

OFSetting values must be:

- Between -2,147,483,648 and 2,147,483,647.
- Greater than the underflow value.
- Greater than or equal to the data resident in the high preset (HSCAPP.HPSetting) or an HSC error is generated.

UFSetting

Parameter	Data type	User program access
HSCApp.UFSetting	DINT	read/write

Underflow setting that defines the lower count limit for the counter.

- If the counter's accumulated value decrements below the value specified in UFSetting, an underflow interrupt is generated.
- When the underflow interrupt is generated, the HSC sub-system resets the accumulated value to the overflow value and the counter starts counting from the overflow value (counts are not lost in the transition).

UFSetting values must be:

- Between -2,147,483,648 and 2,147,483,647.
- Less than the overflow value.
- Less than or equal to the data resident in the low preset (HSCAPP.LPSetting) or an HSC error is generated.

OutputMask

Parameter	Data type	User program access
HSCApp.OutputMask	UDINT	read/write

Defines the embedded outputs on the controller that the High-Speed Counter can directly control. The HSC sub-system can, without control program interaction, turn outputs ON or OFF based on the High or Low presets of the HSC accumulator.

OutputMask bit patterns

The bit pattern stored in HSCApp.OutputMask defines which outputs are controlled by the HSC and which outputs are not controlled by the HSC.

The HSCAPP.OutputMask bit pattern corresponds to the output bits on the controller, and can only be configured during initial setup.

- Bits that are set (1) are enabled and can be turned on or off by the HSC sub-system.
- Bits that are set (0) cannot be turned on or off by the HSC sub-system.

For example, to use the HSC to control outputs 0, 1, 3, assign:

- HscAppData.OutputMask = 2#1011, or
- HscAppData.OutputMask = 11

HPOutput

Parameter	Data type	User program access
HSCApp.HPOutput	UDINT	read/write

Defines the state (1 = ON or 0 = OFF) of the outputs on the controller when the high preset is reached. For more information on how to directly turn outputs on or off based on the high preset, see OutputMask.

You can configure the high output bit pattern during initial setup, or you can use the HSC function block to load the new parameters while the controller is operating.

LPOutput

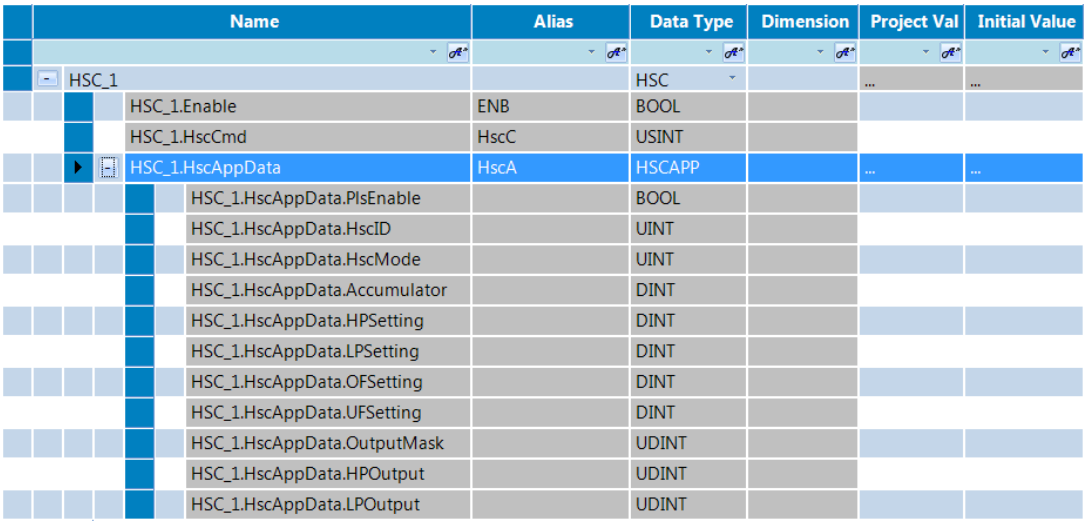
Parameter	Data type	User program access
HSCApp.LPOutput	UDINT	read/write

LPOutput (HSCApp.LPOutput) defines the state (1 = "on", 0 = "off") of the outputs on the controller when the low preset is reached. For more information on how to directly turn outputs on or off based on the low preset, see OutputMask.

You can configure the low output bit pattern during initial setup, or you can use the HSC function block to load the new parameters while the controller is operating.

HSCAppData parameters example

The following image shows the HSCAppData parameters in the **Variable Selector**.



Name	Alias	Data Type	Dimension	Project Val	Initial Value
HSC_1		HSC		...	...
HSC_1.Enable	ENB	BOOL			
HSC_1.HscCmd	HscC	USINT			
HSC_1.HscAppData	HscA	HSCAPP		...	...
HSC_1.HscAppData.PlsEnable		BOOL			
HSC_1.HscAppData.HscID		UINT			
HSC_1.HscAppData.HscMode		UINT			
HSC_1.HscAppData.Accumulator		DINT			
HSC_1.HscAppData.HPSetting		DINT			
HSC_1.HscAppData.LPSetting		DINT			
HSC_1.HscAppData.OFSetting		DINT			
HSC_1.HscAppData.UFSetting		DINT			
HSC_1.HscAppData.OutputMask		UDINT			
HSC_1.HscAppData.HPOutput		UDINT			
HSC_1.HscAppData.LPOutput		UDINT			

HSCSTS data type

HSCSTSInfo (data type HSCSTS) displays the status of the High-Speed Counter.

HSCSTSInfo status actions

During HSC counting, the following HSC status actions occur.

- If the HSC function block is counting with command 0x01, the HSC status is continuously updated.
- If an error occurs, the Error_Detected flag is turned on and an error code is set.

HSCSTSInfo parameters

The following table describes the HSCSTSInfo parameters.

Parameter	Data type	HSC mode	User program access	Description
CountEnable	BOOL	0...9	read only	Counting enabled.
ErrorDetected	BOOL	0...9	read/write	Non-zero means error detected.
CountUpFlag	BOOL	0...9	read only	Count up flag.
CountDwnFlag	BOOL	2...9	read only	Count down flag.
Mode1Done	BOOL	0 or 1	read/write	HSC is Mode 1A or Mode 1B; accumulator counts up to the HP value.
OVF	BOOL	0...9	read/write	Overflow is detected.
UNF	BOOL	0...9	read/write	Underflow is detected.
CountDir	BOOL	0...9	read only	1: count up; 0: count down.
HPReached	BOOL	2...9	read/write	High preset reached.
LPReached	BOOL	2...9	read only	Low preset reached.
OFCauseInter	BOOL	0...9	read/write	Overflow caused a HSC interrupt.
UFCauseInter	BOOL	2...9	read/write	Underflow caused a HSC. interrupt.
HPCauseInter	BOOL	0...9	read/write	High preset reached, causing a HSC interrupt.
LPCauseInter	BOOL	2...9	read/write	Low Preset reached, causing a HSC interrupt.
PlsPosition	UINT	0...9	read only	Position of the Programmable Limit Switch (PLS).
ErrorCode	UINT	0...9	read/write	Displays the error codes detected by the HSC sub-system.
Accumulator	DINT		read/write	Actual accumulator reading.
HP	DINT		read only	Last high preset setting.
LP	DINT		read only	Last low preset setting.
HPOutput	UDINT		read/write	Last high preset output setting.
LPOutput	UDINT		read/write	Last low preset output setting.

HSCSTSInfo parameter details

HSCSTSInfo (data type HSCSTS) parameters are used to determine the status of the High-Speed Counter.

CountEnable

Parameter	Data type	HSC mode	User program access
HSCSTS.CountEnable	BOOL	0...9	read only

Indicates the status of the High-Speed Counter, whether counting is enabled (1) or disabled (0, default).

ErrorDetected

Parameter	Data type	HSC mode	User program access
HSCSTS.ErrorDetected	BOOL	0...9	read/write

Detects if an error is present in the HSC sub-system. Configuration errors are the most common types of error represented by the ErrorDetectedr. When the bit is set (1), look at the specific error code in parameter HSCSTS.ErrorCode, which is maintained by the controller. You can clear the ErrorDetected bit when necessary.

CountUpFlag

Parameter	Data type	HSC mode	User program access
HSCSTS.CountUpFlag	BOOL	0...9	read only

Used with all of the HSCs (modes 0...9). If the HSCSTS.CountEnable bit is set, the Count Up bit is set (1). If the HSCSTS.CountEnable is cleared, the Count Up bit is cleared (0).

CountDownFlag

Parameter	Data type	HSC mode	User program access
HSCSTS.CountDownFlag	BOOL	2...9	read only

Used with the bidirectional counters (modes 2...9). If the HSCSTS.CountEnable bit is set, the Count Down bit is set (1). If the HSCSTS.CountEnable bit is clear, the Count Down bit is cleared (0).

Mode1Done

Parameter	Data type	HSC mode	User program access
HSCSTS.Mode1Done	BOOL	0 or 1	read/write

The HSC sub-system sets the HSCSTS.Mode1Done status flag to (1) when the HSC is configured for Mode 0 or Mode 1 behavior, and the accumulator counts up to the High Preset value.

OVF

Parameter	Data type	HSC mode	User program access
HSCSTS.OVF	BOOL	0...9	read/write

The HSC sub-system sets the HSCSTS.OVF status flag to (1) whenever the accumulated value (HSCSTS.Accumulator) has counted through the overflow variable (HSCAPP.OFSetting). This bit is transitional and is set by the HSC sub-system. It is up to the control program to use, track, and clear (0) the overflow condition.

Overflow conditions do not generate a controller fault.

UNF

Parameter	Data type	HSC mode	User program access
HSCSTS.UNF	BOOL	0...9	read/write

The HSC sub-system sets the HSCSTS.UNF status flag to (1) whenever the accumulated value (HSCSTS.Accumulator) has counted through the underflow variable (HSCAPP.UFSetting). This bit is transitional and is set by the HSC sub-system. It is up to the control program to use, track, and clear (0) the underflow condition.

Underflow conditions do not generate a controller fault.

CountDir

Parameter	Data type	HSC mode	User program access
HSCSTS.CountDir	BOOL	0...9	read only

The HSC sub-system controls the HSCSTS.CountDir status flag. When the HSC accumulator counts up, the direction flag is set to (1). Whenever the HSC accumulator counts down, the direction flag is cleared (0).

If the accumulated value stops, the direction bit retains its value. The only time the direction flag changes is when the accumulated count reverses.

This bit is updated continuously by the HSC sub-system whenever the controller is in a run mode.

HPReached

Parameter	Data type	HSC mode	User program access
HSCSTS.HPReached	BOOL	2...9	read/write

The HSC sub-system sets the HSCSTS.HPReached status flag to (1) whenever the accumulated value (HSCSTS.Accumulator) is greater than or equal to the high preset variable (HSCAPP.HPSetting).

This bit is updated continuously by the HSC sub-system whenever the controller is in an executing mode. Writing to this element is not recommended.

LPReached

Parameter	Data type	HSC mode	User program access
HSCSTS.LPReached	BOOL	2...9	read only

The HSC sub-system sets the HSCSTS.LPReached status flag to (1) whenever the accumulated value (HSCSTS.Accumulator) is less than or equal to the low preset variable (HSCAPP.LPSetting).

This bit is updated continuously by the HSC sub-system whenever the controller is in an executing mode. Writing to this element is not recommended.

OFCauseInter

Parameter	Data type	HSC mode	User program access
HSCSTS.OFCauseInter	BOOL	0...9	read/write

The Overflow Interrupt status bit sets (1) when the HSC accumulator counts through the overflow value and the HSC interrupt is triggered. This bit can be used in the control program to identify that the overflow variable caused the HSC interrupt. If the control program needs to perform any specific control action based on the overflow, this bit is used as conditional logic.

This bit can be cleared (0) by the control program and is also cleared by the HSC sub-system whenever these conditions are detected:

- Low Preset Interrupt executes
- High Preset Interrupt executes
- Underflow Interrupt executes

UFCauseInter

Parameter	Data type	HSC mode	User program access
HSCSTS.UFCauseInter	BOOL	2...9	read/write

The Underflow Interrupt status bit sets (1) when the HSC accumulator counts through the underflow value and the HSC interrupt is triggered. This bit can be used in the control program to identify that the underflow condition caused the HSC interrupt. If the control program needs to perform any specific control action based on the underflow, this bit is used as conditional logic.

This bit can be cleared (0) by the control program and is also cleared by the HSC sub-system whenever these conditions are detected:

- Low Preset Interrupt occurs
- High Preset Interrupt occurs
- Overflow Interrupt occurs

HPCauseInter

Parameter	Data type	HSC mode	User program access
HSCSTS.HPCauseInter	BOOL	0...9	read/write

The High Preset Interrupt status bit sets (1) when the HSC accumulator reaches the high preset value and the HSC interrupt is triggered. This bit can be used in the control program to identify that the high preset condition caused the HSC interrupt. If the control program needs to perform any specific control action based on the high preset, this bit is used as conditional logic.

This bit can be cleared (0) by the control program and is also cleared by the HSC sub-system whenever these conditions are detected:

- Low Preset Interrupt occurs
- Underflow Interrupt occurs
- Overflow Interrupt occurs

LPCauseInter

Parameter	Data type	HSC mode	User program access
HSCSTS.LPCauseInter	BOOL	2...9	read/write

The Low Preset Interrupt status bit sets (1) when the HSC accumulator reaches the low preset value and the HSC interrupt is triggered. This bit can be used in the control program to identify that the low preset condition caused the HSC interrupt. If the control program needs to perform any specific control action based on the low preset, this bit is used as conditional logic.

This bit can be cleared (0) by the control program and is also cleared by the HSC sub-system whenever these conditions are detected:

- High Preset Interrupt occurs
- Underflow Interrupt occurs
- Overflow Interrupt occurs

PlsPosition

Parameter	Data type	HSC mode	User program access
HSCSTS.PLSPosition	UINT	0...9	read only

When the HSC is in Counting mode, and PLS is enabled, this parameter indicates which PLS element is used for the current HSC configuration.

ErrorCode

Parameter	Data type	HSC mode	User program access
HSCSTS.ErrorCode	BOOL	0...9	read only

Displays the error codes detected by the HSC sub-system.

Error code sub-element	HSC counting error code	Error description
Bit 15-8 (high byte)	0-255	The non-zero value for the high byte indicates that the HSC error is due to the PLS data setting. The value of the high byte indicates which element of the PLS data triggers the error.
Bit 7-0 (low byte)	0x00	No error occurring.
	0x01	Invalid HSC counting mode.
	0x02	Invalid high preset.

Error code sub-element	HSC counting error code	Error description
	0x03	Invalid overflow.
	0x04	Invalid underflow.
	0x05	No PLS data.

Accumulator

Parameter	Data type	User program access
HSCApp.Accumulator	DINT	read/write

Sets the initial accumulator value when the High-Speed Counter starts. When the HSC is in Counting mode, the Accumulator is automatically updated by the HSC sub-system to reflect the actual HSC accumulator value.

HP

Parameter	Data type	User program access
HSCSTS.HP	DINT	read only

The HSCSTS.HP is the upper setpoint (in counts) that defines when the HSC sub-system generates an interrupt.

The data loaded into the high preset must be less than or equal to the data resident in the overflow (HSCAPP.OFSetting) parameter or an HSC error is generated.

This is the latest high preset setting, which may be updated by PLS function from the PLS data block.

LP

Parameter	Data type	HSC mode	User program access
HSCSTS.LP	DINT		read only

The HSCSTS.LP is the lower setpoint (in counts) that defines when the HSC sub-system generates an interrupt.

The data loaded into the low preset must be greater than or equal to the data resident in the underflow (HSCAPP.UFSetting) parameter or an HSC error is generated. If the underflow and low preset values are negative numbers, the low preset must be a number with a smaller absolute value. This is the latest low preset setting, which may be updated by PLS function from the PLS data block.

HPOutput

Parameter	Data type	User program access
HSCApp.HPOutput	UDINT	read/write

Defines the state (1 = ON or 0 = OFF) of the outputs on the controller when the high preset is reached. For more information on how to directly turn outputs on or off based on the high preset, see OutputMask.

You can configure the high output bit pattern during initial setup, or you can use the HSC function block to load the new parameters while the controller is operating.

LPOutput

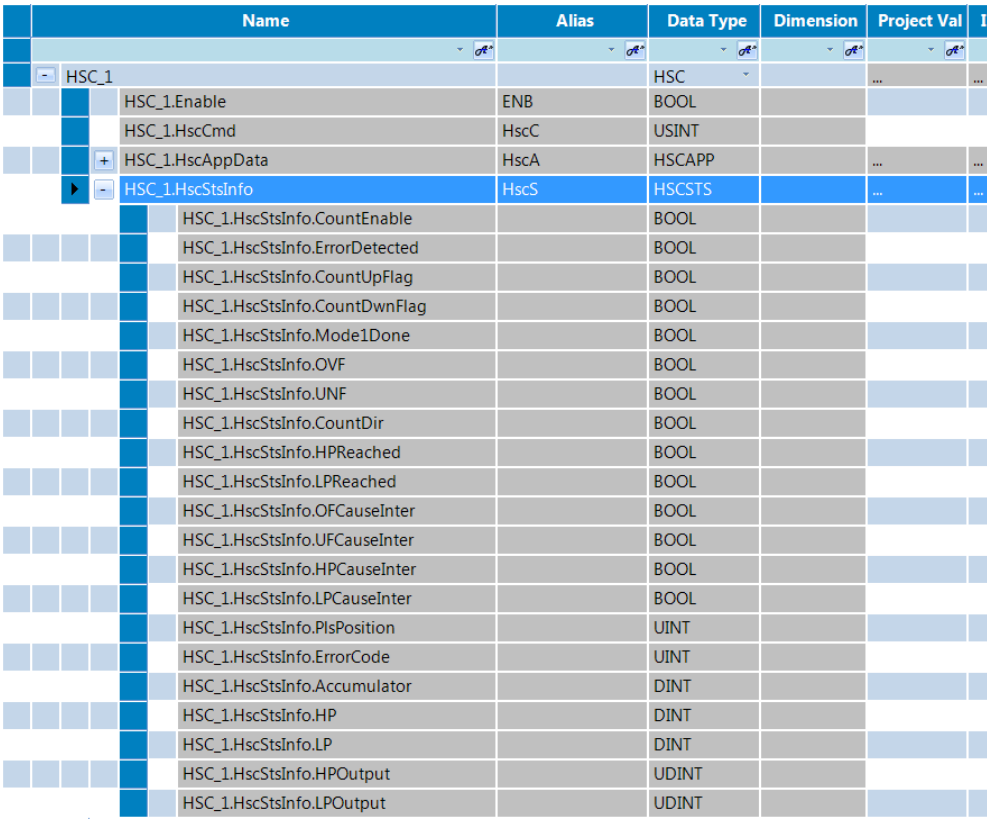
Parameter	Data type	User program access
HSCApp.LPOutput	UDINT	read/write

LPOutput (HSCApp.LPOutput) defines the state (1 = "on", 0 = "off") of the outputs on the controller when the low preset is reached. For more information on how to directly turn outputs on or off based on the low preset, see OutputMask.

You can configure the low output bit pattern during initial setup, or you can use the HSC function block to load the new parameters while the controller is operating.

HSCSTSInfo parameters example

The following image shows the HSCStsInfo parameters in the **Variable Selector.**



Name	Alias	Data Type	Dimension	Project Val
HSC_1		HSC		
HSC_1.Enable	ENB	BOOL		
HSC_1.HscCmd	HscC	USINT		
HSC_1.HscAppData	HscA	HSCAPP		
HSC_1.HscStsInfo	HscS	HSCSTS		
HSC_1.HscStsInfo.CountEnable		BOOL		
HSC_1.HscStsInfo.ErrorDetected		BOOL		
HSC_1.HscStsInfo.CountUpFlag		BOOL		
HSC_1.HscStsInfo.CountDwnFlag		BOOL		
HSC_1.HscStsInfo.Mode1Done		BOOL		
HSC_1.HscStsInfo.OVF		BOOL		
HSC_1.HscStsInfo.UNF		BOOL		
HSC_1.HscStsInfo.CountDir		BOOL		
HSC_1.HscStsInfo.HPReached		BOOL		
HSC_1.HscStsInfo.LPReached		BOOL		
HSC_1.HscStsInfo.OFCauseInter		BOOL		
HSC_1.HscStsInfo.UFCauseInter		BOOL		
HSC_1.HscStsInfo.HPCauseInter		BOOL		
HSC_1.HscStsInfo.LPCauseInter		BOOL		
HSC_1.HscStsInfo.PlsPosition		UINT		
HSC_1.HscStsInfo.ErrorCode		UINT		
HSC_1.HscStsInfo.Accumulator		DINT		
HSC_1.HscStsInfo.HP		DINT		
HSC_1.HscStsInfo.LP		DINT		
HSC_1.HscStsInfo.HPOutput		UDINT		
HSC_1.HscStsInfo.LPOutput		UDINT		

PLS data type

PLSData (data type PLS) is used to configure the programmable limit switch.

PLSData structure elements

The PLS data structure is a flexible array with the following elements.

Element	Element order	Data type	Element description
HSCHP	Word 0...1	DINT	High preset
HSCLP	Word 2...3	DINT	Low preset
HSCHPOutput	Word 4...5	UDINT	Output high data
HSCLPOutput	Word 6...7	UDINT	Output low data

The total number of elements for one PLS data structure should not exceed 255.

PLSData parameters

The following table lists the PLSData parameter details.

Parameter	Data type	Data format	HSC mode	User program access	Description
HSCHP	DINT	32-bit signed integer	0	read/writer	High preset
HSCLP	DINT	32-bit signed integer	0	read/write	Low preset
HSCHPOutput	UDINT	32-bit binary	0	read/write	Output high data
HSCLPOutput	UDINT	32-bit binary	0	read/write	Output low data

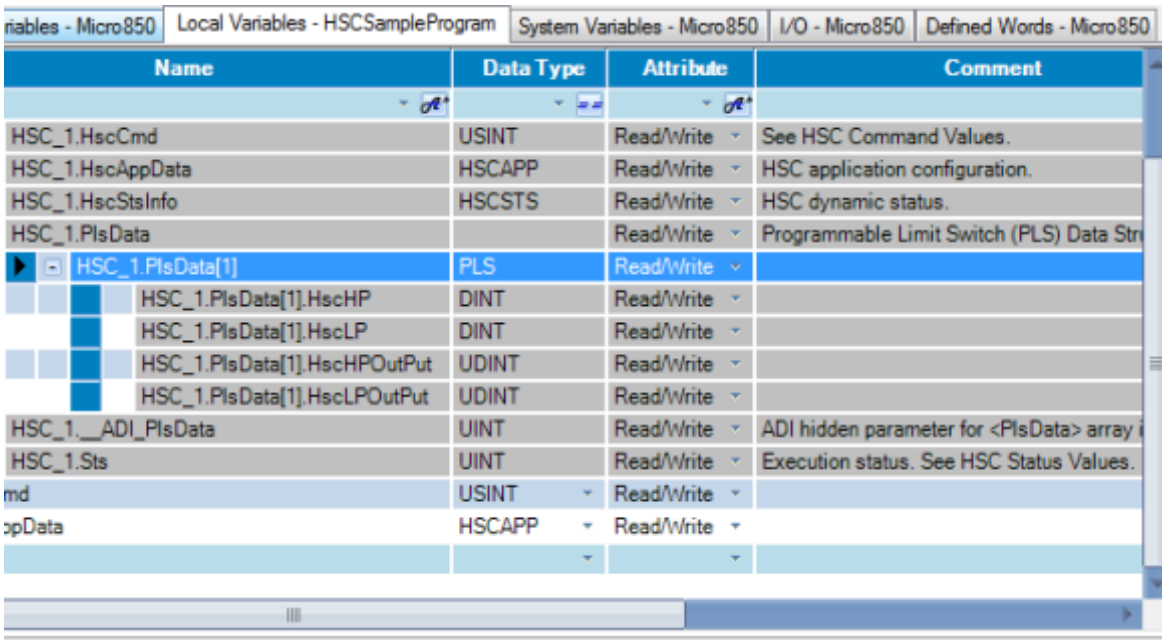
HSCApp settings versus PLSData settings

When the PLS function is enabled, relevant HSCApp settings are superseded by the corresponding PLSData settings as shown in the following table.

HSCApp setting	PLSData setting
HSCAPP.HpSetting	HSCHP
HSCAPP.LpSetting	HSCLP
HSCAPP.HPOutput	HSCHPOutput
HSCAPP.LPOutput	HSCLPOutput

PLSData parameters example

The following figure shows the PLSData parameters in the **Variable Selector.**



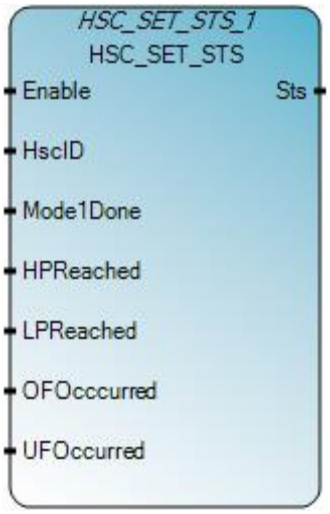
HSC status codes (STS)

The following table describes the codes that are used to indicate the execution status of the HSC function block.

Status code	Status description
0x00	No action taken (not enabled).
0x01	HSC execution successful.
0x02	HSC command invalid.
0x03	HSC ID out of range.
0x04	HSC configure error.

HSC_SET_STS

HSC_SET_STS manually sets or resets the HSC counting status.



HSC_SET_STS function block operation

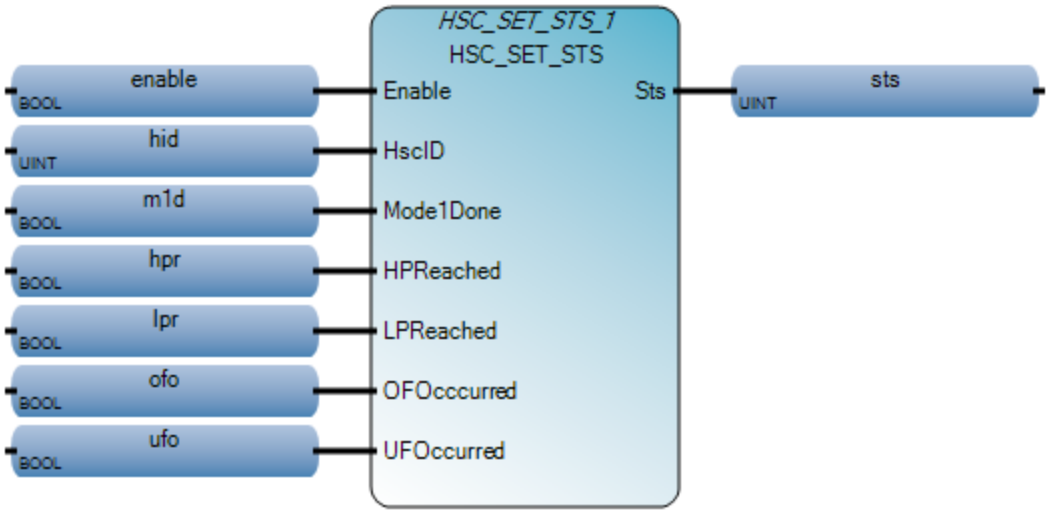
The HSC function block must be stopped (not counting) for the HSC_SET_STC function block to set or reset its HTS status. If the HSC function block is not stopped, the input parameters will continue to update and any changes made using the HSC_SET_STS function block will be ignored.

Arguments

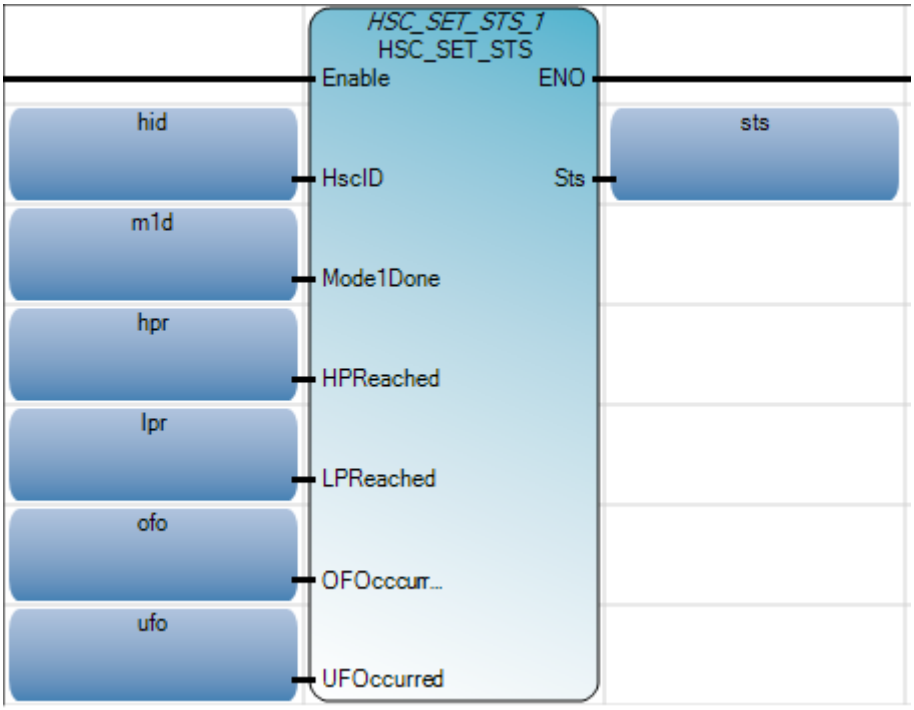
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, set/reset the HSC status. When Enable = FALSE, there is no HSC status change.
HscID	Input	UINT	Manually sets ore resets the HSC status.
Mode1Done	Input	BOOL	Mode 1A or 1B counting is done.
HPReached	Input	BOOL	High preset reached. This bit can be reset to FALSE when HSC is not counting.
LPReached	Input	BOOL	Low preset reached. This bit can be reset to FALSE when HSC is not counting.
OFOccurred	Input	BOOL	Overflow occurred. This bit can be reset to FALSE when necessary.
UFOccurred	Input	BOOL	Underflow occurred. This bit can be reset to FALSE when necessary.
Sts	Output	UINT	See HSC Status codes (STS) (on page 329).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

HSC_SET_STS function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  HSC_SET_STS_1(enable, hid, m1d, hpr, lpr, ofo, ufo);
2  sts := HSC_SET_STS_1.Sts;
```

```
HSC_SET_STS_1(
```

void **HSC_SET_STS_1**(BOOL Enable, UINT HscID, BOOL Mode1Done, BOOL HPReached, BOOL LPReached, BOOL OFOccurred, BOOL UFOccurred)
Type : HSC_SET_STS, Manually set/reset HSC status.

Using the High-Speed Counter instructions

This section provides specific details and examples for using high-speed counter instructions in logic programs, including the following:

Updating HSC application data

HSC configuration is defined in the HSC application data, and is usually only configured once before programming the HSC instruction. Changes made to the HSC application data (HSCAppData parameter) are ignored while the HSC is counting.

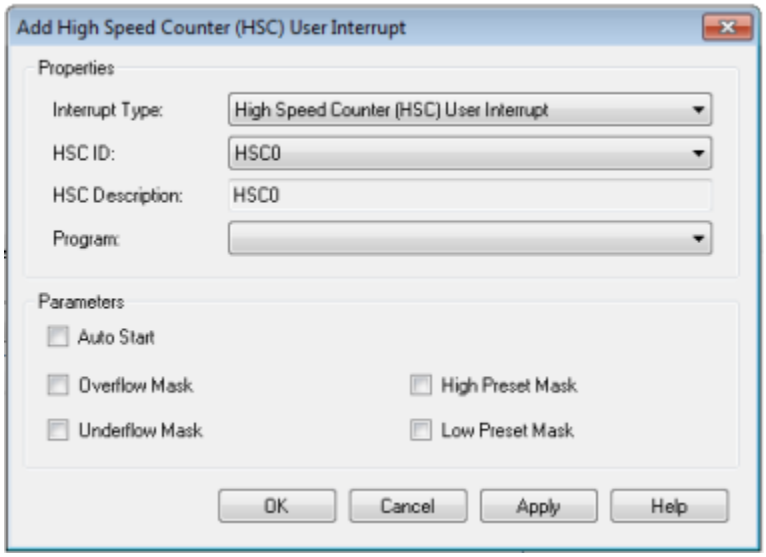
To update the HSC configuration

- Update HSCAppData.
- Call the HSC instruction with command 0x03 (set/reload).

High-Speed Counter (HSC) User Interrupt dialog box

Use the HSC interrupt dialog box to:

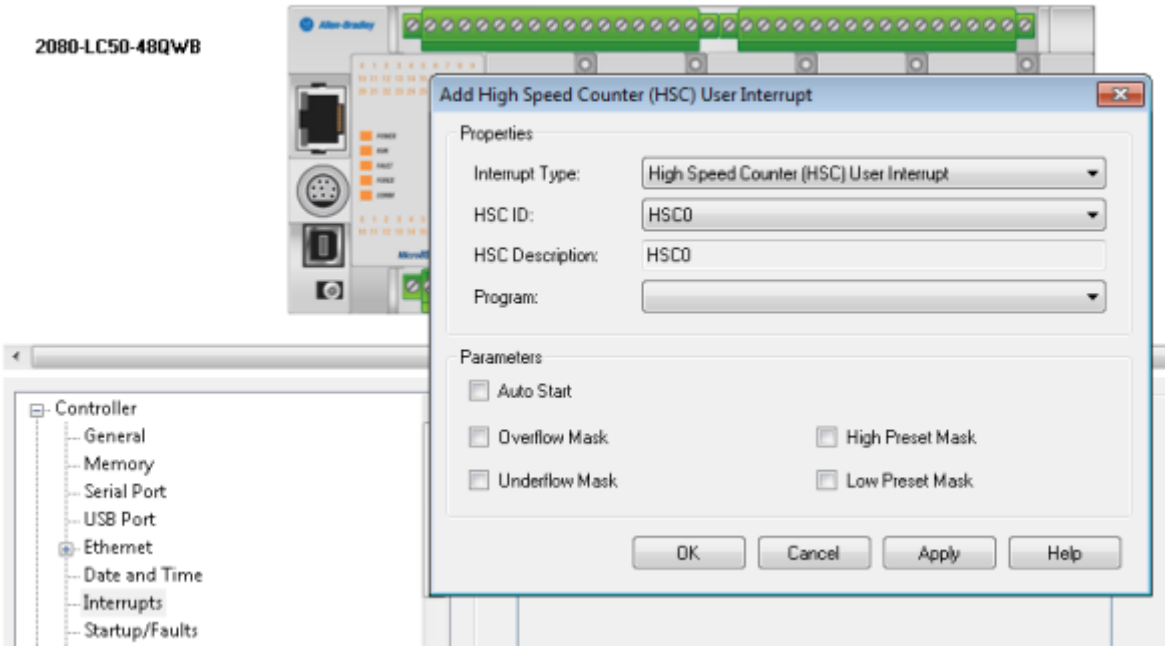
- Configure the interrupt properties, such as ID and the program to use it in.
- Configure the interrupt parameters.
- In Interrupt Type, select **High-Speed Counter (HSC) User Interrupt**.



Configuring High-Speed Counter (HSC) user interrupts

A user interrupt causes the controller to suspend the task it is currently performing, perform a different task, and then return to the suspended task at the point where the task was suspended.

Micro830 and Micro850 controllers support up to six HSC User Interrupts that can be used to execute selected user logic at a pre-configured event.



Add and configure a High-Speed Counter (HSC) User Interrupt

Follow these steps to add and configure a HSC interrupt from the controller's configuration workspace.

To add an HSC interrupt

1. Double-click the controller to open the controller configuration workspace.
2. In the controller tree, click **Interrupts** to display the Interrupt configuration page.
3. Right-click an empty row, and click **Add** to display the Interrupt properties dialog box.

To configure an HSC interrupt

1. In Interrupt Type, select **High-Speed Counter (HSC) User Interrupt**.
2. Select the properties:

   HSC Interrupt properties (on page 335)

3. Select the parameters:

   HSC Interrupt parameters (on page 336).

HSC Interrupt properties

The HSC Interrupt properties status bits indicate the enabled/disabled status, the execution status, and whether or not the interrupt condition is lost.

User Interrupt Enable (HSC0.Enabled)

Parameter	Data format	HSC modes	User program access
HSC0.Enabled	bit	0...9	read only

Enabled bit is used to indicate HSC interrupt enable or disable status.

User Interrupt Executing (HSC0.EX)

Parameter	Data format	HSC modes	User program access
HSC0.Ex	bit	0...9	read only

The EX (User Interrupt Executing) bit is set (1) whenever the HSC sub-system begins processing the HSC subroutine due to any of the following conditions:

- Low preset reached
- High preset reached
- Overflow condition - count up through the overflow value
- Underflow condition - count down through the underflow value

The HSC EX bit can be used in the control program as conditional logic to detect if an HSC interrupt is executing.

The HSC sub-system will clear (0) the EX bit when the controller completes its processing of the HSC subroutine.

User Interrupt Pending (HSC0.PE)

Parameter	Data format	HSC modes	User program access
HSC0.PE	bit	0...9	read only

The PE (User Interrupt Pending) status flag indicates an interrupt is pending. The PE status bit can be monitored or used for logic purposes in the control program if you need to determine when a subroutine cannot be immediately executed. The PE bit is maintained by the controller and is set and cleared automatically.

User Interrupt Lost (HSC0.LS)

Parameter	Data format	HSC modes	User program access
HSC0.LS	bit	0...9	read only

The LS (User Interrupt Lost) is a status flag that indicates an interrupt has been lost. The controller can process 1 active user interrupt condition and maintain 1 pending user interrupt condition before it sets the lost bit.

The LS bit is set by the controller. It is up to the control program to use and monitor a lost condition.

HSC Interrupt parameters

The HSC interrupt parameters are used to configure the start and mask options.

Auto Start (HSC0.AS)

Parameter	Data format	HSC modes	User program access
HSC0.AS	bit	0...9	read only

Auto Start is configured with the programming device and stored as part of the user program. The auto start bit defines if the HSC interrupt function automatically starts whenever the controller enters any run or test mode.

Overflow Mask (HSC0.MV)

Parameter	Data format	HSC modes	User program access
HSC0.MV	bit	0...9	read only

The MV (Overflow Mask) control bit is used to enable (allow) or disable (not allow) an overflow interrupt from occurring. If the bit is clear (0), and an Overflow Reached condition is detected by the HSC, the HSC user interrupt is not executed.

The MV bit is controlled by the user program and retains its value through a power cycle. The user program must set and clear the MV bit.

Underflow Mask (HSC0.MN)

Parameter	Data format	HSC modes	User program access
HSC0.MN	bit	2...9	read only

The MN (Underflow Mask) control bit is used to enable (allow) or disable (not allow) an underflow interrupt from occurring. If the bit is clear (0), and an Underflow Reached condition is detected by the HSC, the HSC user interrupt is not executed.

The MN bit is controlled by the user program and retains its value through a power cycle. The user program must set and clear the MN bit.

High Preset Mask (HSC0.MH)

Parameter	Data format	HSC modes	User program access
HSC0.MH	bit	0...9	read only

The MH (High Preset Mask) control bit is used to enable (allow) or disable (not allow) a high preset interrupt from occurring. If this bit is clear (0), and a High Preset Reached condition is detected by the HSC, the HSC user interrupt is not executed.

The MH bit is controlled by the user program and retains its value through a power cycle. The user program must set and clear the MH bit.

Low Preset Mask (HSC0.ML)

Parameter	Data format	HSC modes	User program access
HSC0.ML	bit	2...9	read only

The ML (Low Preset Mask) control bit is used to enable (allow) or disable (not allow) a low preset interrupt from occurring. If this bit is clear (0), and a Low Preset Reached condition is detected by the HSC, the HSC user interrupt is not executed.

The ML bit is controlled by the user program and retains its value through a power cycle. The user program must set and clear the ML bit.

Configuring a Programmable Limit Switch (PLS)

The high-speed counter has additional operating modes for implementing a Programmable Limit Switch (PLS). The PLS function is used to configure the High-Speed Counter to operate as a PLS or as a rotary cam switch. The PLS function supports up to 255 pairs of high and low presets, and can be used when you need more than one pair of high and low presets.

Enabling PLS in the HSC

The PLS mode only operates in tandem with the HSC of the Micro800 controller, and must be enabled in the HSC by setting the HSCAppData.PLSEnable parameter to True.

HSC operation when PLS is enabled

The PLS function can operate with all other HSC capabilities, including the ability to select which HSC events generate a user interrupt. When the PLS function is enabled, and the controller is in run mode, the HSC counts incoming pulses, and the following events occur.

- When the count reaches the first preset (HSCHP or HSCLP) defined in the PLS data, the output source data (HSCHPOutput or HSCLPOutput) is written through the HSC mask (HSCAPP.OutputMask).
- At that point, the next presets (HSCHP and HSCLP) defined in the PLS data become active.
- When the HSC counts to the new preset, the new output data is written through the HSC mask.
- This process continues until the last element within the PLS data block is loaded.
- At that point the active element within the PLS data block is reset to zero.
- This behavior is referred to as circular operation

Example: How to create a High-Speed Counter (HSC) program

This example shows you how to create a High-Speed Counter (HSC) program that uses a quadrature encoder and includes a Programmable Limit Switch (PLS) function.

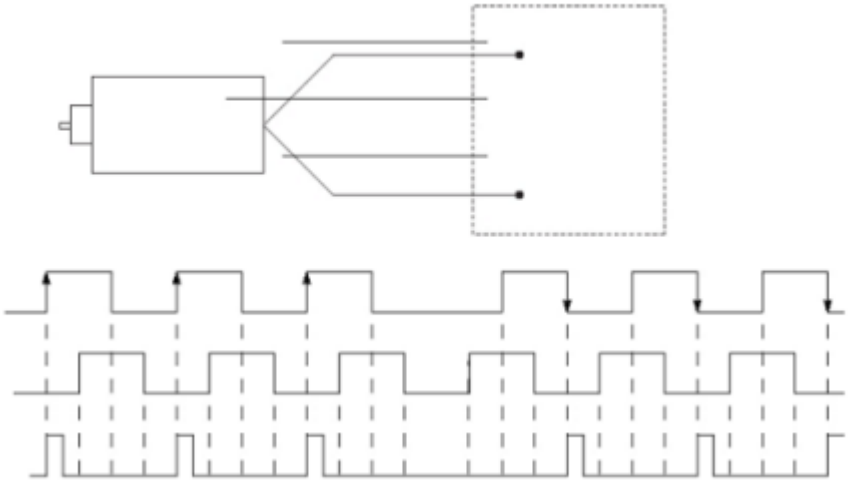
Quadrature encoder used in the example

The High Speed Counter program example uses an HSC function block and a quadrature counter with phased inputs A and B. The quadrature encoder

determines the direction of rotation and the position for rotating equipment, such as a lathe. The Bidirectional Counter counts the rotation of the quadrature encoder.

The following quadrature encoder is connected to inputs 0 and 1. The count direction is determined by the phase angle between A and B:

- If A leads B, the counter increments.
- If B leads A, the counter decrements.



Creating a High-Speed Counter (HSC) program

Perform the following tasks for to create, build, and test the HSC program, and then add a PLS function.

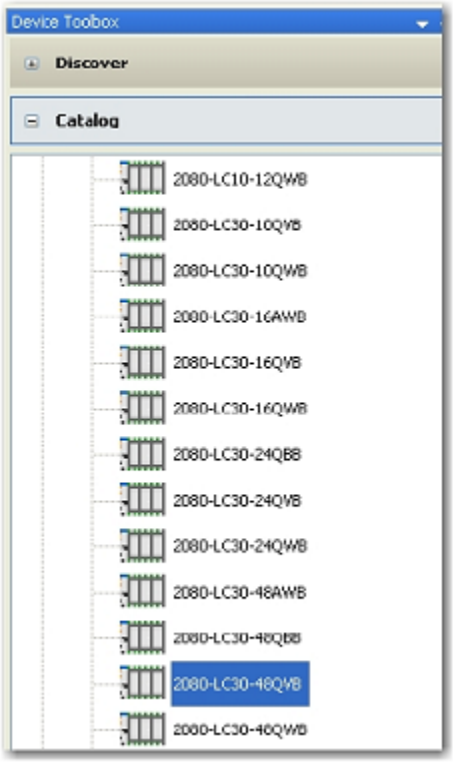
No	Task
1	Create a ladder diagram and add variables (on page 340)
2	Assign values to the HSC variables (on page 343)
3	Assign variables and build the program (on page 344)
4	Test the program and run the High-Speed Counter (on page 346)
5	Add a Programmable Limit Switch (PLS) function (on page 349)

Create a ladder diagram and add variables

Follow these steps to create a ladder diagram and then add local variables to the rung. This sample program uses a 2080-LC50-24QVB controller. The HSC is supported on all Micro830 and Micro850 controllers except 2080-LCxx-xxAWB controller types.

To create a ladder diagram and add variables

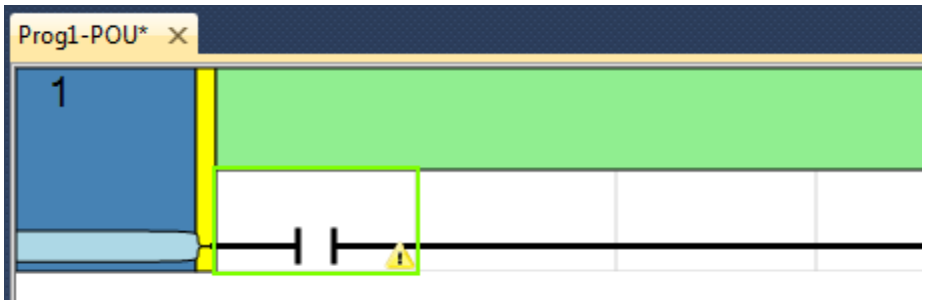
1. In the **Device Toolbox**, expand the **Catalog** tab to view the device folders.
2. Expand the Controllers folder and the Micro830 folder to view all Micro830 controllers. Double-click a controller (2080-LC50-24QVB) to add it to the **Project Organizer**.



3. In the **Project Organizer**, right-click **Programs**, click **Add,** and then click **New LD: Ladder Diagram** to add a new ladder logic program.
4. Right-click **UntitledLD** and select **Open.**

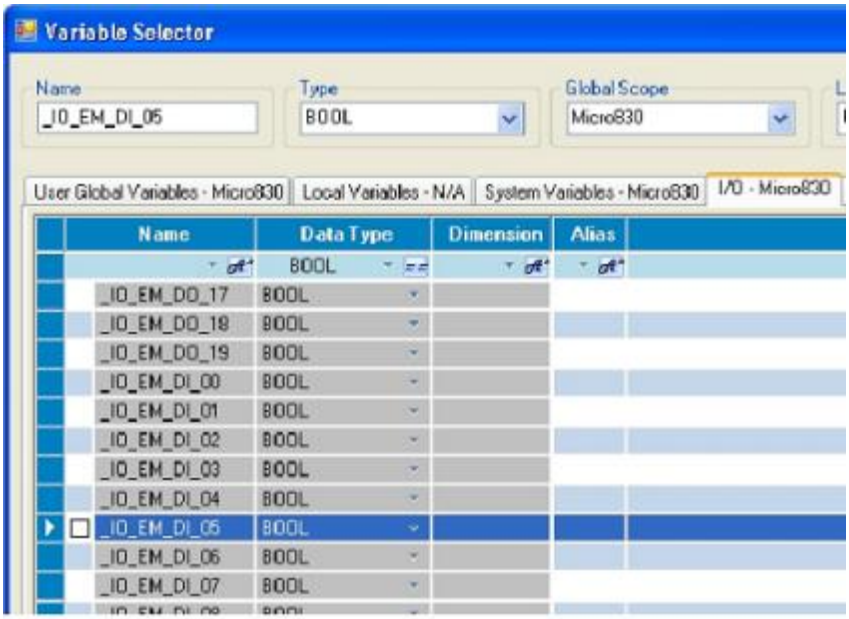
5. In the Toolbox:

   - Double-click **Direct Contact** to add it to the rung, or
   - Drag and drop a **Direct Contact** onto the rung.

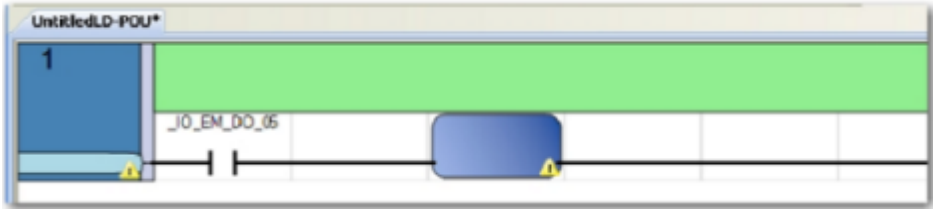


6. Assign a variable to the direct contact:

   - Double-click on the direct contact to display the **Variable Selector**, and then click the **I/O - Micro830** tab.
   - Click **_IO_EM_DI_05**, and then click **OK** to assign the direct contact to input 5.



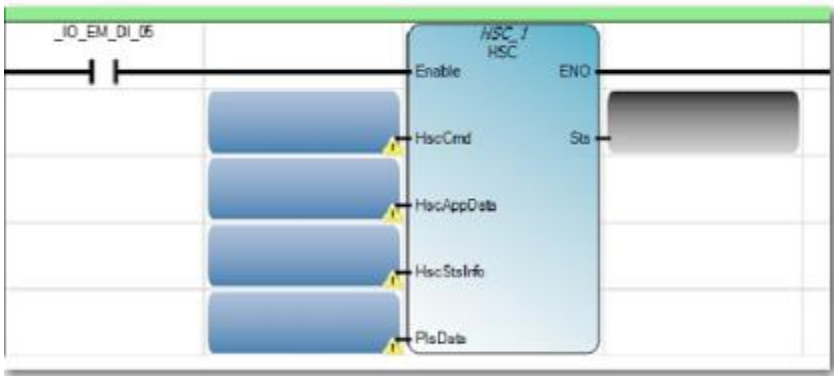
7. In the Toolbox, select a function block and drag it to the right of the direct contact as shown in the following image.



8. Double-click the function block to display the **Block Selector**.
9. In the **Block Selector**, select **HSC** and click **OK**.

   Tip: Type HSC in **Search** to display all HSC function blocks.

10. Verify the ladder rung looks similar to the following figure.



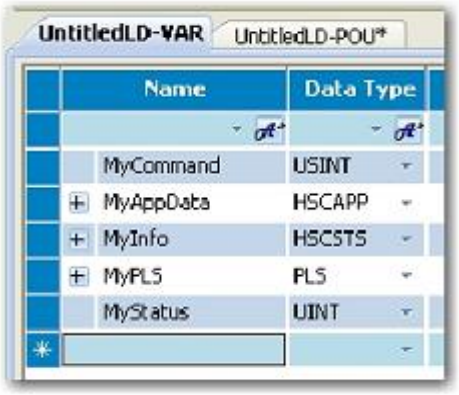
11. In the **Project Organizer**, double-click **Local Variables** to display the **Variables** page.

12. In the Variables page, add the following variables and data types.

Variable Name	Data Type
MyCommand	USINT
MyAppData	HSCAPP
MyInfo	HSCSTS
MyPLS	PLS
MyStatus	UINT

Result

The **Variables** page should look similar to the following image.



Assign values to the HSC variables

After you add variables, follow these steps to add values to the variables using the Initial Value column in the Variable Selector. A standard program usually uses a routine to assign values to the variables.

To assign values to the HSC variables

1. Expand **MyAppData** to view all variables.
2. Assign the HSC mode value:
   - In the Initial Value field for the MyAppData.HSCMode variable, type 6.
   - See HSCMode in HSCAPP data type (on page 312) for more information on the description for each value.

3. Assign the rest of the values to the MyAppData variables as shown in the following figure.

   - In the Initial Value field, enter the value.
   - See HSCAPP data type (on page 312) for more information on the description for each value

Name	Alias	Data Type	Dimension	Project Value	Initial Value
MyAppData		HSCAPP		...	...
MyAppData.PIsEnable		BOOL			FALSE
MyAppData.HscID		UINT			0
MyAppData.HscMode		UINT			6
MyAppData.Accumulator		DINT			
MyAppData.HPSetting		DINT			40
MyAppData.LPSetting		DINT			-40
MyAppData.OFSetting		DINT			50
MyAppData.UFSetting		DINT			-50
MyAppData.OutputMask		UDINT			3
MyAppData.HPOutput		UDINT			1
MyAppData.LPOutput		UDINT			2

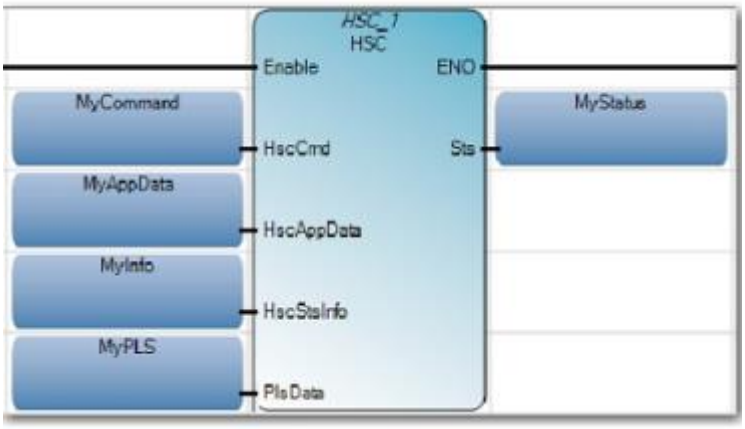
4. Assign the HSC command value:

   - In the Initial Value field for the MyCommand variable, type 1.
   - See HSCCmd values (on page 311) for more information on command values.

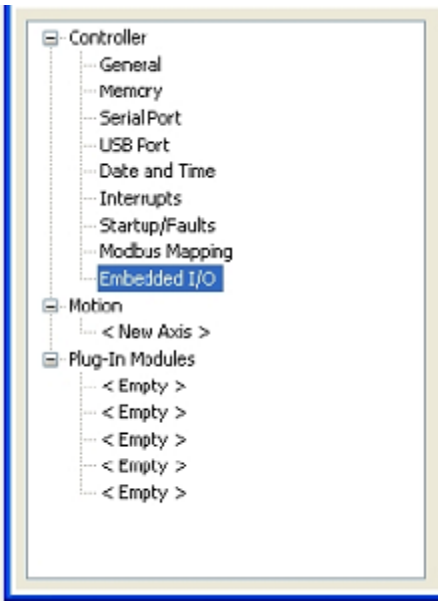
Assign variables and build the program

After you enter values in the HSC variables, follow these steps to assign the variables to the function block, and build the program.

1. From the ladder diagram, assign each variable to its HSC function block element as shown in the following figure.



2. From the **Project Organizer**, click the controller to display the controller tree.



3. From the controller tree, click **Embedded I/O**, and select input filters for your encoder.

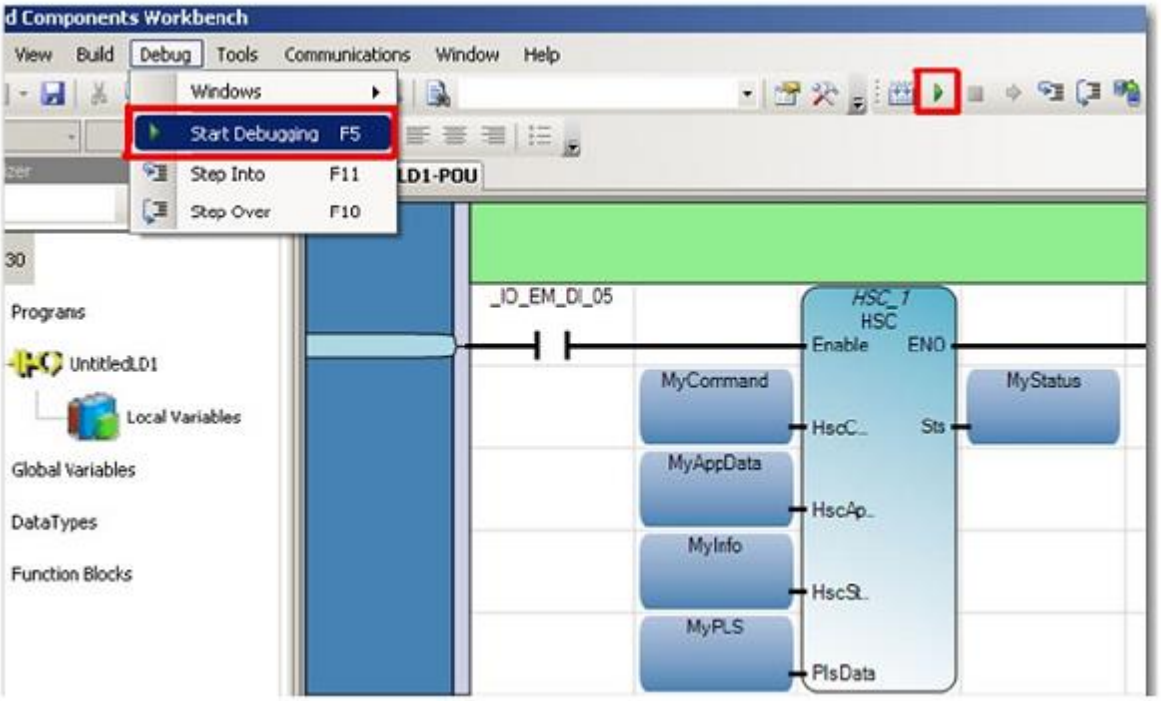
4. Verify the encoder is connected to the Micro830 controller.
5. Start the Micro830 controller and connect it to your computer.
6. Build the program and then download it to the controller.

Test the program and run the High-Speed Counter

After you download the HSC program to the controller, you can test it and then run the High-Speed Counter.

To test the program

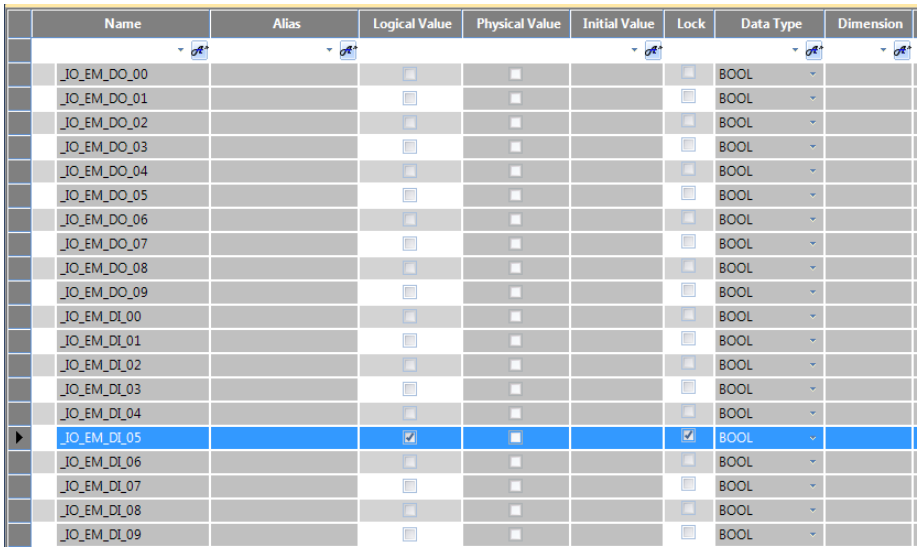
1. Enter debug mode by performing one of the following:
   - From the **Debug** menu, click **Start Debugging**, or
   - Click the green play button below the menu bar, or
   - Press the F5 key.



While in debug mode, you can see the values of the two HSC outputs: STS (MyStatus) and HSCSTS (MyInfo).

1. Double-click the _IO_EM_DI_05 direct contact to display the **Variable Selector** window.
2. Click the **I/O Micro830** tab, and then click the **_IO_EM_DI_05** row.

3. Select **Lock** and Logical Value to force the input to the ON position.



Name	Alias	Logical Value	Physical Value	Initial Value	Lock	Data Type	Dimension
_IO_EM_DO_00						BOOL	
_IO_EM_DO_01						BOOL	
_IO_EM_DO_02						BOOL	
_IO_EM_DO_03						BOOL	
_IO_EM_DO_04						BOOL	
_IO_EM_DO_05						BOOL	
_IO_EM_DO_06						BOOL	
_IO_EM_DO_07						BOOL	
_IO_EM_DO_08						BOOL	
_IO_EM_DO_09						BOOL	
_IO_EM_DI_00						BOOL	
_IO_EM_DI_01						BOOL	
_IO_EM_DI_02						BOOL	
_IO_EM_DI_03						BOOL	
_IO_EM_DI_04						BOOL	
_IO_EM_DI_05		☑	☐		☑	BOOL	
_IO_EM_DI_06						BOOL	
_IO_EM_DI_07						BOOL	
_IO_EM_DI_08						BOOL	
_IO_EM_DI_09						BOOL	

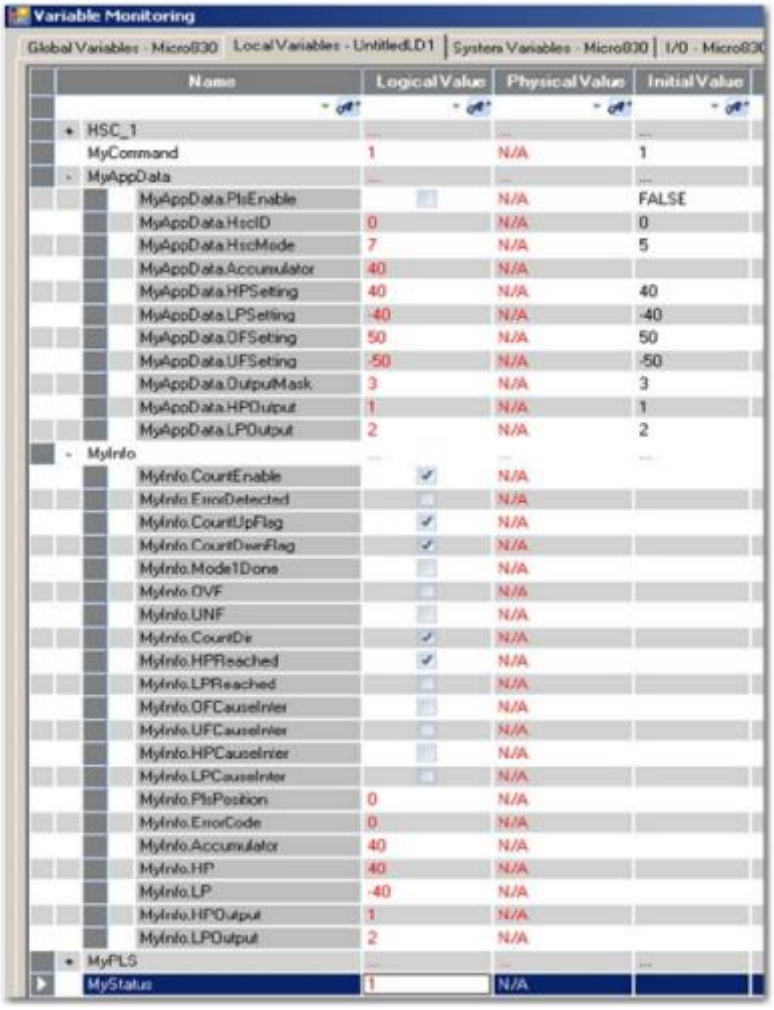
To view results

1. Click the **Local Variables** tab to view variable changes.
2. Expand **MyAppData** and **MyInfo** variable list.
3. Turn on the encoder to see the counter count up/down. For example, if the encoder is attached to a motor shaft, then turn on the motor to trigger the HSC count.
4. Verify the Logical Value of in the MyStatus variable is 1, which indicates the HSC is running.
5. View the counter value in MyInfo.Accumulator.

   Tip: See HSC status codes (STS) (on page 329) for the complete list of status codes.

Results

In this example, once MyInfo.Accumulator reaches a High Preset value of 40, output 0 turns on and the HPReached flag turns on. If MyInfo.Accumulator reaches a Low Preset value of -40, output 1 turns on and the LPReached flag turns on as well.



Add a Programmable Limit Switch (PLS) function

This example shows you how to add a Programmable Limit Switch (PLS) function to the HSC program.

Variable values for the counter settings

- **MyAppData.PlsEnable** is used to enable or disable the PLS settings. It should be set to FALSE (disabled) if the MyAppData variable is used.
- **MyAppData.HscID** is used to specify which embedded inputs will be used based on the mode and application type. See HSC Inputs and Wiring Mapping to know the different IDs that can be used as well as the embedded inputs and its characteristics.
- If ID 0 is used, ID 1 cannot be used on the same controller because the inputs are used by Reset and Hold.
- **MyAppData.HscMode** is used to specify the type of operation the HSC will use to count. See HSC Mode (HSCAPP.HSCMode).

To enable PLS

1. In the **Project Organizer**, double-click **Local Variables** to display the **Variables** page.
2. Enable the PLS function:
   - In the Initial Value field for the MyAppData.PlsEnable variable, select TRUE.
3. Configure the underflow and overflow settings:
   - In the Initial Value field for MyAppData.OFSetting, type 50.
   - In the Initial Value field for MyAppData.UFSetting, type -50.
4. Configure the output mask if an output is to be used.

Results

In this example, the PLS variable has a dimension of [1..4]. This means that the HSC can have four pairs of High and Low Presets.

- High Presets should always be set lower than the OFSetting and the Low Preset should always be greater than the UFSetting.
- The HscHPOutPut and HscLPOutPut values will determine which outputs will be turned on when a High Preset or Low Preset is reached.

Name	Alias	Data Type	Dimension	Project Val	Initial Value
MyPLS		PLS	[1..4]	...	...
MyPLS[1]		PLS		...	...
MyPLS[1].HscHP		DINT			10
MyPLS[1].HscLP		DINT			-10
MyPLS[1].HscHPOutPut		UDINT			1
MyPLS[1].HscLPOutPut		UDINT			16
MyPLS[2]		PLS		...	...
MyPLS[2].HscHP		DINT			20
MyPLS[2].HscLP		DINT			-20
MyPLS[2].HscHPOutPut		UDINT			2
MyPLS[2].HscLPOutPut		UDINT			32
MyPLS[3]		PLS		...	...
MyPLS[3].HscHP		DINT			30
MyPLS[3].HscLP		DINT			-30
MyPLS[3].HscHPOutPut		UDINT			4
MyPLS[3].HscLPOutPut		UDINT			64
MyPLS[4]		PLS		...	...
MyPLS[4].HscHP		DINT			40
MyPLS[4].HscLP		DINT			-40
MyPLS[4].HscHPOutPut		UDINT			8
MyPLS[4].HscLPOutPut		UDINT			128

Example: Programmable Limit Switch (PLS) enabled

This topic describes the results when PLS is enabled using specific HSC and PLSData parameter values.

HSC parameter values

This example assumes the following HSC parameters use these values.

- HSCApp.OutputMask = 31
- HSCApp.HSCMode = 0
- HSC controls Embedded Output 0...4 only

PLSData parameter values

This example assumes the PLSData parameters for the variable (HSC_PLS) are configured as shown in the following figure.

Name	Alias	Data Type	Dimension	Project Value	Initial Value
HSC_1		HSC		...	...
HSC_PLS		PLS	[1..4]	...	...
HSC_PLS[1]		PLS		...	...
HSC_PLS[1].HscHP		DINT			250
HSC_PLS[1].HscLP		DINT			-2
HSC_PLS[1].HscHPOutPut		UDINT			3
HSC_PLS[1].HscLPOutPut		UDINT			0
HSC_PLS[2]		PLS		...	...
HSC_PLS[2].HscHP		DINT			500
HSC_PLS[2].HscLP		DINT			-2
HSC_PLS[2].HscHPOutPut		UDINT			7
HSC_PLS[2].HscLPOutPut		UDINT			0
HSC_PLS[3]		PLS		...	...
HSC_PLS[3].HscHP		DINT			750
HSC_PLS[3].HscLP		DINT			-2
HSC_PLS[3].HscHPOutPut		UDINT			15
HSC_PLS[3].HscLPOutPut		UDINT			0
HSC_PLS[4]		PLS		...	...
HSC_PLS[4].HscHP		DINT			1000
HSC_PLS[4].HscLP		DINT			-2
HSC_PLS[4].HscHPOutPut		UDINT			31
HSC_PLS[4].HscLPOutPut		UDINT			0

PLS enabled results

For this example, the following events will occur.

- When the ladder logic first runs: HSCSTS.Accumulator = 1, which means all the outputs are turned off.
- When HSCSTS.Accumulator = 250, HSC_PLS[1].HSCHPOutput is sent through the HSCAPP.OutputMask, and energizes outputs 0 and 1.
- Sending the high preset output throught the output mask repeats as the HSCSTS.Accumulator reaches 500, 750, and 1000, and the controller energizes outputs 0...2, 0...3, and 0...4 respectively.
- After the full operation completes, the cycle resets and repeats from HSCSTS.HP = 250.

Input/Output instructions

Input/Output instructions read or write data to or from a controller or a module using signals sent to a device that is physically connected to a programmable logic controller. Input relays transfer signals to the internal relays, and output relays transfer signals to external output devices.

Function	Description
LCD (on page 356)	Display string or number (Micro810™ only)
LCD_BKLT_REM (on page 359)	Change remote LCD backlight color and mode
LCD_REM (on page 363)	Display messages on remote LCD
RHC (on page 368)	Read high-speed clock
RPC (on page 370)	Reads user program checksum
Function block	**Description**
DLG (on page 372)	Save data and global/local variables to an SD Card Data Log file
IIM (on page 375)	Update inputs prior to normal output scan
IOM (on page 378)	Update outputs prior to normal output scan
KEY_READ (on page 381)	Read key status on the optional LCD module (Micro810™ only)
KEY_READ_REM (on page 385)	Read key status on remote LCD
MM_INFO (on page 389)	Read memory module header information
PLUGIN_INFO (on page 392)	Get module information from a generic plug-in module (excluding Memory Module)
PLUGIN_READ (on page 395)	Read data from a generic plug-in module
PLUGIN_RESET (on page 398)	Reset a generic plug-in module (hardware reset)
PLUGIN_WRITE (on page 400)	Write data to a generic plug-in module
RCP (on page 402)	Read/write recipe data to and from an SD memory card
RTC_READ (on page 405)	Read real-time clock (RTC) module information
RTC_SET (on page 408)	Set real-time clock data to real-time clock module
SYS_INFO (on page 411)	Read Micro800™ system status
TRIMPOT_READ (on page 413)	Read the trimpot value from a specific trimpot

LCD

LCD displays a string or a number on the optional LCD module.

LCD function operation

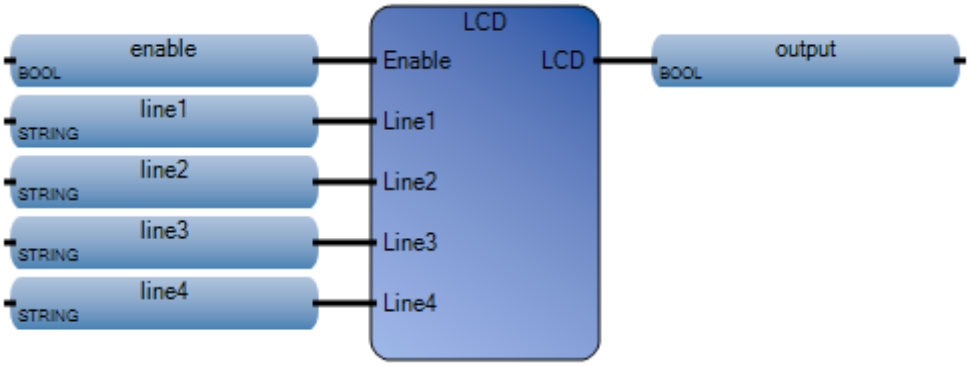
The LCD function is only supported by the Micro810 controller.

Arguments

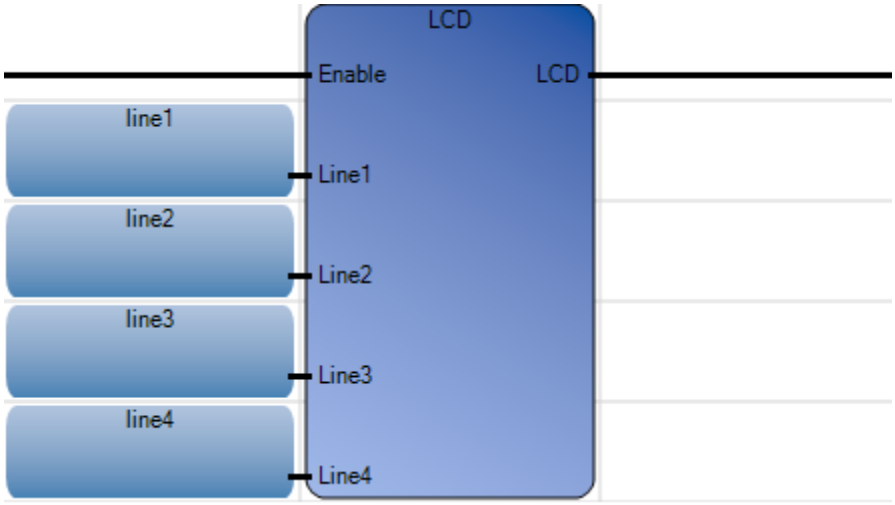
Parameter	Parameter Type	Data Type	Description
Enable	Input	BOOL	Function enable. When Enable = TRUE, the LCD switches to the user-defined screen (strings displayed on the LCD) from the I/O status screen. When Enable = FALSE, the LCD displays the contents of the I/O status screen.
Line1	Input	STRING	String to be displayed on line 1 of the LCD.
Line2	Input	STRING	String to be displayed on line 2 of the LCD.
Line3	Input	STRING	String to be displayed on line 3 of the LCD.
Line4	Input	STRING	String to be displayed on line 4 of the LCD.
LCD	Output	BOOL	When TRUE, function is enabled.

LCD function language examples

Function block diagram

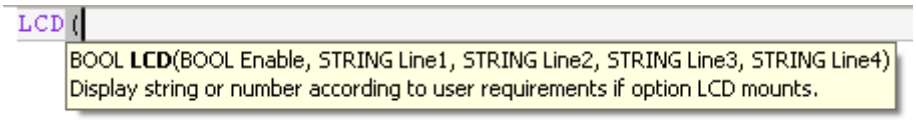


Ladder diagram



Structured text

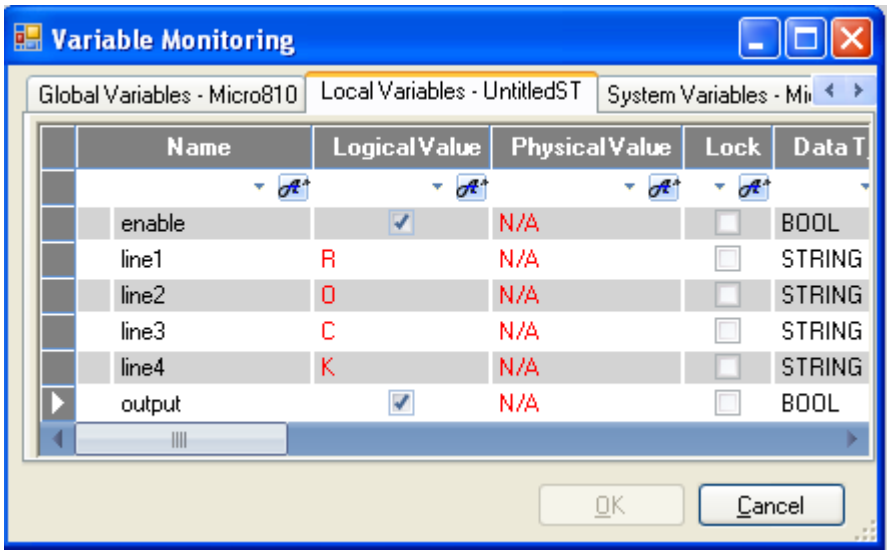
```
1  enable := TRUE;
2  line1 := 'R';
3  line2 := 'O';
4  line3 := 'C';
5  line4 := 'K';
6  output := LCD(enable, line1, line2, line3, line4);
```



(* ST Equivalence: *)

TESTOUTPUT := LCD(LCDENABLE, LINE1, LINE2, LINE3, LINE4) ;

Results

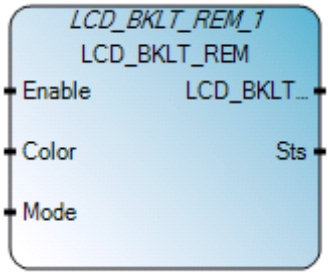


LCD_BKLT_REM

LCD_BKLT_REM sets the Remote LCD backlight parameters in a user program.

LCD_BKLT_REM function block can be used in a user program to set the Remote LCD backlight parameters. The function is only supported by Micro 820.

LCD_BKLT_REM is only effective when Remote LCD is displaying either the User defined screen (by using LCD_REM FB) or default IO Status screen. For all other screens, backlight parameter settings done through menu will take effect. When Enable input goes False, last menu settings will take effect



LCD_BKLT_REM operation

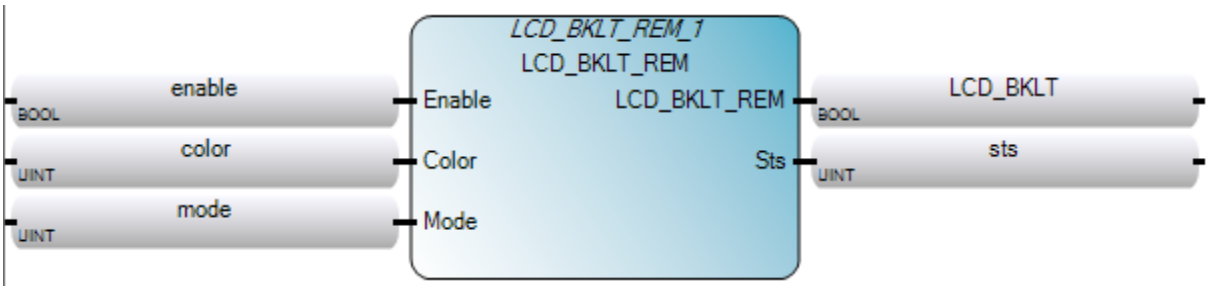
- LCD_BKLT_REM is supported for Micro820 controllers only.
- LCD_BKLT_REM is only effective when Remote LCD is displaying either the user-defined screen (by using the LCD_REM function block) or default I/O Status screen. For all other screens, backlight parameter settings configured through the menu will take effect.
- When the Enable Input goes false the last menu settings will take effect.

LCD_BKLT_REM arguments

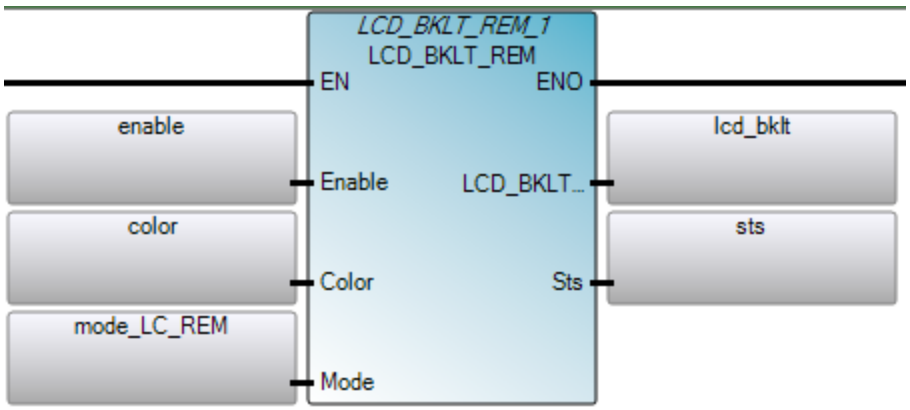
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute REM_LCD_BKLT function, overwriting any current backlight settings. When Enable = FALSE, REM_LCD_BKLT will be disabled.
Color	Input	UINT	Backlight Color Code • 0: White • 1: Blue • 2: Red • 3: Green • 4-65535: Reserved
Mode	Input	UINT	• 0 : Permanently OFF • 1: Permanently ON • 2: Flash (1 sec interval) • 3-65535: Reserved
LCD_BKLT_REM	Output	BOOL	When TRUE: Instruction executed successfully. When FALSE: Error occurred during instruction execution.
Sts	Output	UINT	Status of the remote LCD operation. See LCD_BKLT_REM status codes (on page 362)

LCD_BKLT_REM function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  LCD_BKLT_REM_1 (EN, Enable, Color, Mode);
2  output := LCD_BKLT_REM_1.ENO
3  LCD_BKLT_REM_1 := LCD_BKLT_REM_1.LCD_BKLT_REM
4  sts_lcd_rem := LCD_REM_1.Sts
```

```
LCD_BKLT_REM_4(
```

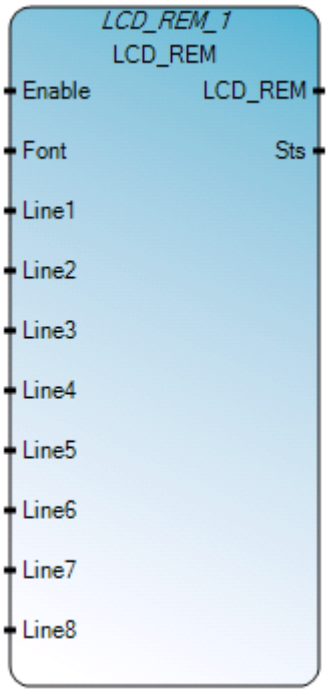
void **LCD_BKLT_REM_4**(BOOL Enable, UINT Color, UINT Mode)
Type : LCD_BKLT_REM, Set the remote LCD backlight parameters.

LCD_BKLT_REM status codes

Status code	Description
0	Enable input is false.
1	Success.
2	Remote LCD not detected. May occur when: • Remote LCD is not physically connected to the controller (or the wiring is incorrect). • Serial port settings are other than what is required for the Remote LCD.
3	Connection error. May occur when there is an internal state machine error. (Possibly caused by an incompatibility between Controller FW version and RLCD FW version.
4	Invalid color code.
5	Invalid mode.
6-65535	Reserved.

LCD_REM

LCD_REM function block can be used in a program to display user strings on the Remote LCD when it is present and connected. This function block is only supported by the Micro820.



LCD_REM operation

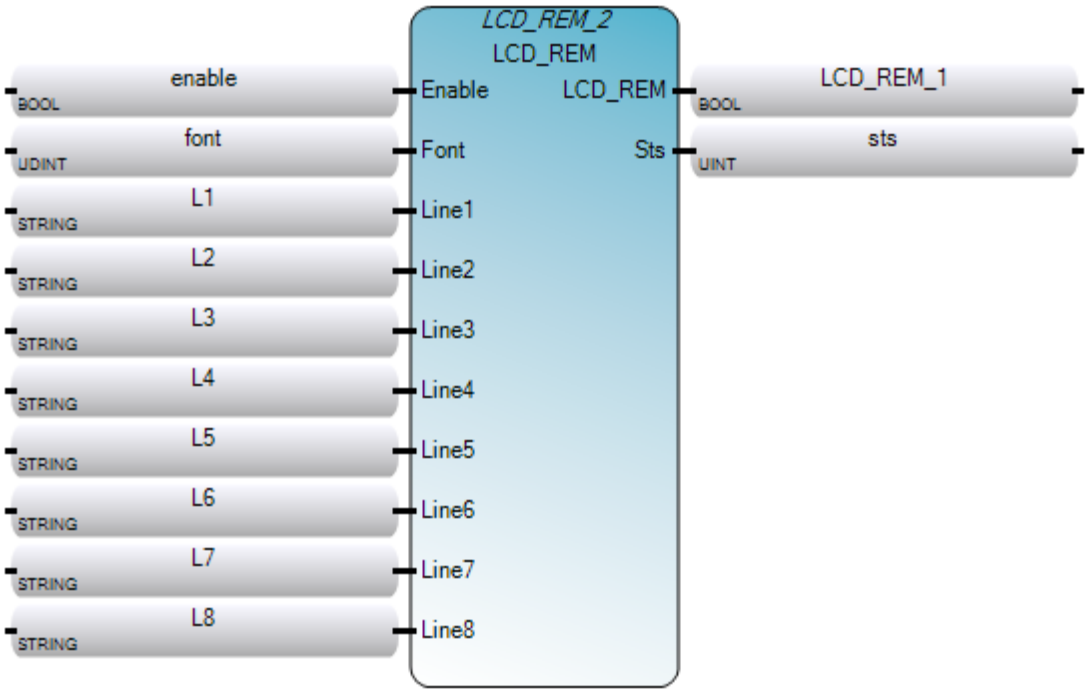
- LCD_REM is supported for Micro820 controllers only.

LCD_REM arguments

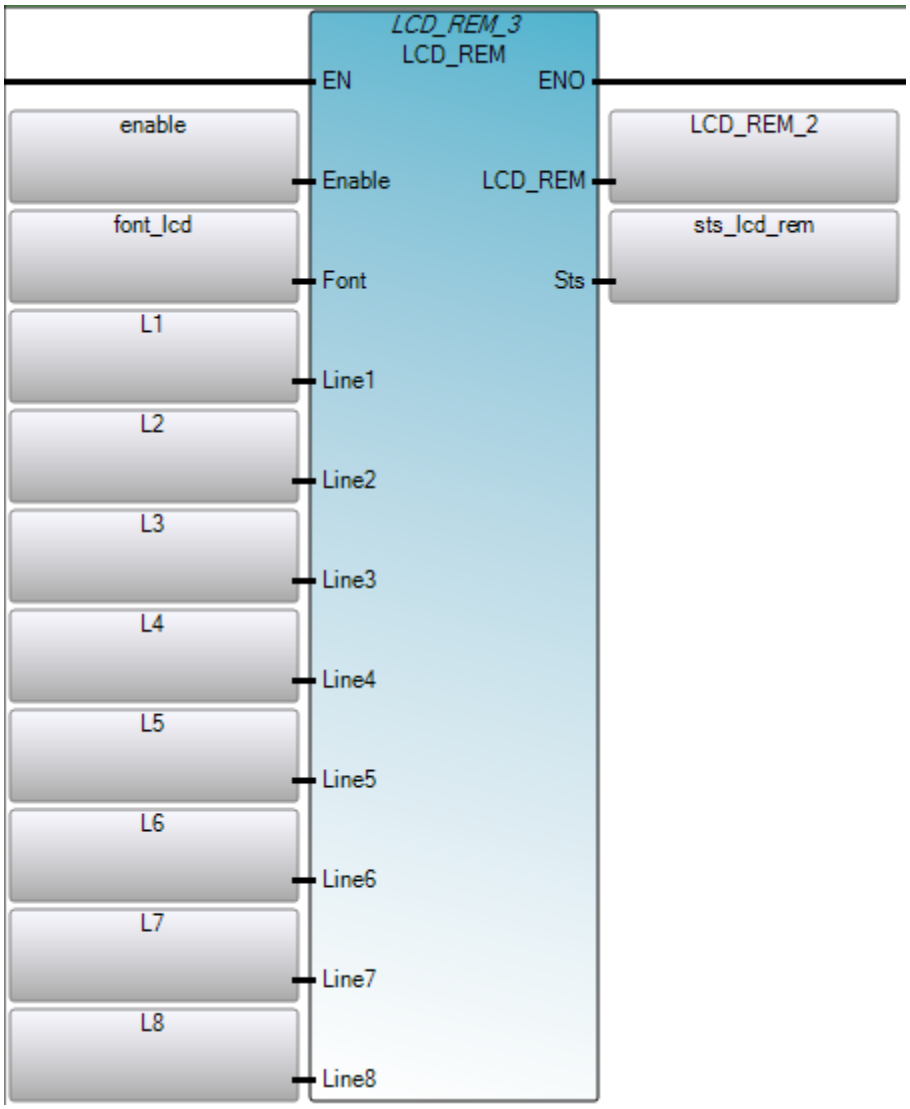
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, remote LCD switches to user-defined screen from I/O status screen. When Enable = FALSE, remote LCD switches back to I/O status screen.
Font	Input	UDINT	Value of the startup message font size. Valid values: • 0: Default (Large – 8x16) • 1: Small (8x8) • 2: Large (8x16) • 3: Extra Large (16x16) • 4 onward: Reserved Remote LCD Size is 192x64 pixels. When large or extra-large font is selected, Remote LCD only displays Line1 to Line4 strings. Line5 to Line 8 string inputs are ignored in this case. Remote LCD can display maximum 24 characters per line when small or large font is selected. For extra large fonts, remote LCD can display maximum 12 characters per line.
Line1	Input	String	String to be displayed on line 1 of the LCD. Maximum 24 characters.
Line2	Input	String	String to be displayed on line 2 of the LCD. Maximum 24 characters.
Line3	Input	String	String to be displayed on line 3 of the LCD. Maximum 24 characters.
Line4	Input	String	String to be displayed on line 4 of the LCD. Maximum 24 characters.
Line5	Input	String	String to be displayed on line 5 of the LCD. Maximum 24 characters.
Line6	Input	String	String to be displayed on line 6 of the LCD. Maximum 24 characters.
Line7	Input	String	String to be displayed on line 7 of the LCD. Maximum 24 characters.
Line8	Input	String	String to be displayed on line 8 of the LCD. Maximum 24 characters.
LCD_REM	Output	BOOL	Function block enable. When Enable = TRUE, user display is active. When Enable = FALSE, IO Status/Menu display is active.
Sts	Output	UINT	Status of the remote LCD operation. See LCD_REM status codes. (see "LCD_REM status codes" on page 367)

LCD_REM function block language examples

Function Block Diagram (FBD)

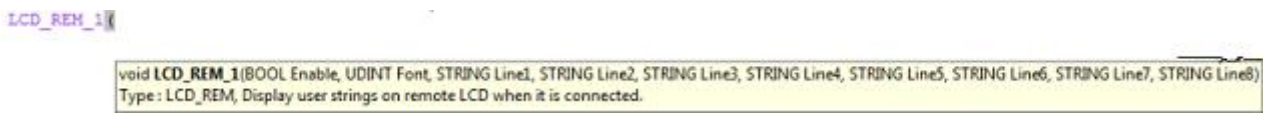


Ladder Diagram (LD)



Structured Text (ST)

```
1  LCD_REM_1 (EN, Enable, Font, Line1, Line2, Line3, Line4, Line5, Line6, Line7, Line8);
2  output := LCD_REM_1.ENO
3  LCD_REM_1 := LCD_REM_1.LCD_REM
4  sts_lcd_rem := LCD_REM_1.Sts
```



LCD_REM status codes

Status code	Description
0	Enable input is false.
1	User Message displayed successfully.
2	Remote LCD not detected. May occur when: • Remote LCD is not physically connected to the controller (or the wiring is incorrect). • Serial port settings are other than what is required for the Remote LCD.
3	Connection error. May occur when there is an internal state machine error. (Possibly caused by an incompatibility between Controller FW version and RLCD FW version.
4	Invalid font code.
5-65535	Reserved.

RHC

RHC reads a high-speed clock value in the Micro800™ controller.

Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, replace parts of strings with new characters. When EN = FALSE, no operation.
ENO	Output	BOOL	Enable out.
RHC	Output	UDINT	The value of the high-speed clock.

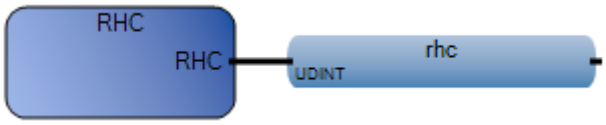
High-speed clock resolution

The resolution for the high-speed clock instruction differs depending on the controller type:

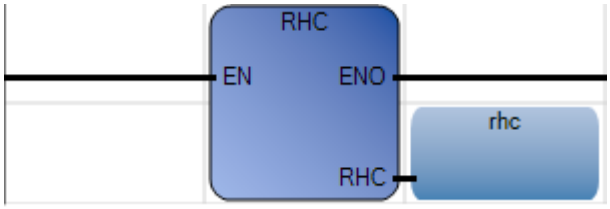
Controller Type	Increments	Timebase	Resolution
Micro810	4 every 40 µs	10 µs	40 µs
Micro820 Micro830 Micro850	1 every 10 µs	10 µs	10 µs

RHC function language examples

Function block diagram



Ladder diagram



Structured text

```
1  rhc := RHC();
```

(* ST Equivalence: *)

TESTOUTPUT2 := RHC() ;

RPC

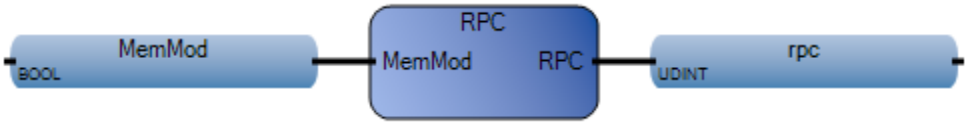
RPC reads the user program checksum, either from the controller or Memory Module.

Arguments

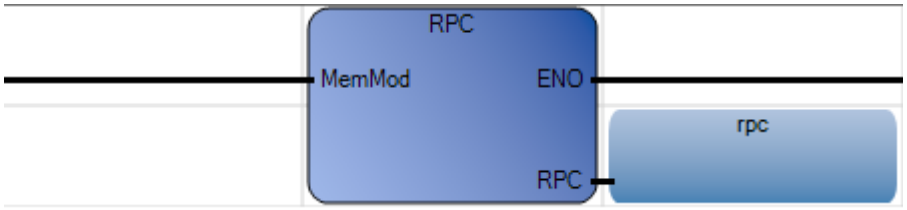
Parameter	Parameter Type	Data Type	Description
MemMod	Input	BOOL	If true, the value is taken from the memory module. If false, the value is taken from the Micro800 controller.
ENO	Output	BOOL	Enable out.
RPC	Output	UDINT	The checksum value of the specified user program.

RPC function language examples

Function block diagram

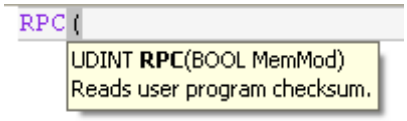


Ladder diagram



Structured text

```
1  MemMod := TRUE;
2  rpc := RPC(MemMod);
```



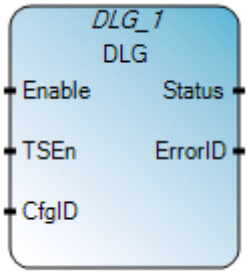
(* ST Equivalence: *)

TESTOUTPUT2 := RPC(TESTINPUT) ;

DLG

The Data Logging Function Block can be used to write variable values from the run-time engine into a Data Logging File on an SD Card.

Important: When writing to a data log a maximum of 50 group folders are allowed per day. Each group folder has a maximum of 50 files with a file size of 4k-8k.



DLG operation

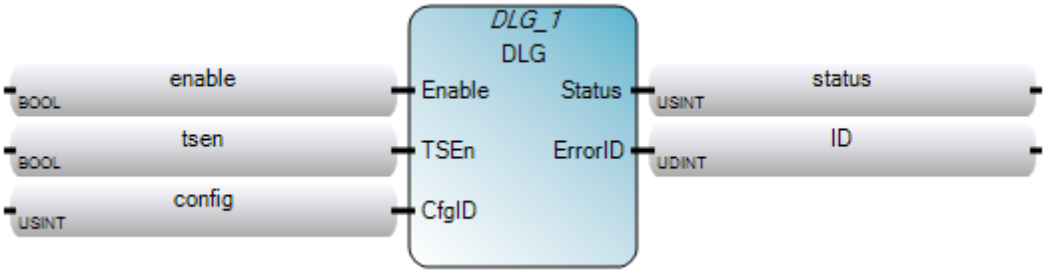
- DLG is supported for Micro820 controllers only.

DLG arguments

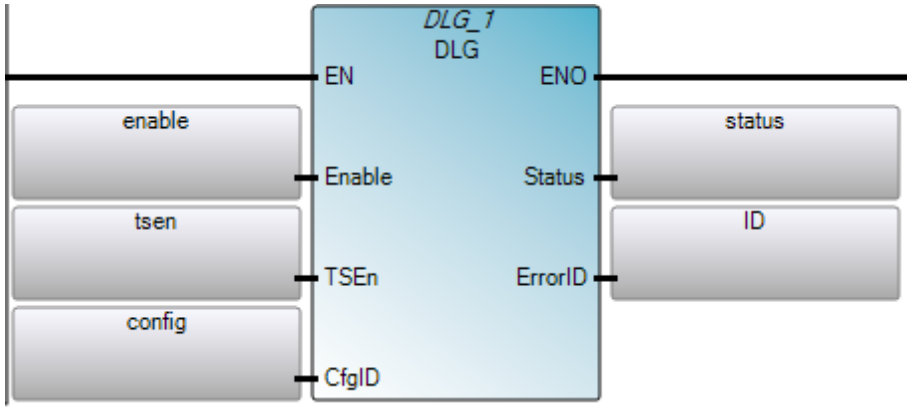
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Datalogging write enable. If Rising Edge Enable is triggered from "False" to "True," data logging function block will execute if the previous FB operation is completed.
TSEnable	Input	BOOL	Date and time stamp logging enable flag.
CfgID	Input	USINT	Data logging configuration VA ID number from 1-10.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Status	Output	USINT	Data logging function block current status. See DLG status codes (on page 374).
ErrorID	Output	UDINT	FB error code, refer to Data logging FB error ID. See DLG error codes (on page 374).

DLG function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  DLG_1 (EN, Enable, TSEn, CfgID);
2  output := DLG_1.ENO
3  status := DLG_1.Status
4  ID := DLG_1.ErrorID
```

```
DLG_1(
```

void **DLG_1**(BOOL Enable, BOOL TSEn, USINT CfgID)
Type : DLG, Save list of data to SD Card Data Log file.

DLG status codes

Status code	Description
0	Data logging "Idle" status.
1	Data logging "Doing" status.
2	Data logging Complete - "Succeed" status.
3	Data logging Complete "Error" status.

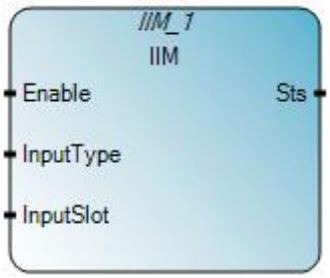
DLG error codes

The following table describes DLG error codes.

Error code	Error Name	Comments
0	DLG_ERR_NONE	No error.
1	DLG_ERR_NO_SDCARD	SD card is absent.
2	DLG_ERR_RESERVED	Reserved.
3	DLG_ERR_DATAFILE_ACCESS	Access Data logging file error.
4	DLG_ERR_CFG_ABSENT	Data logging configuration file is absent.
5	DLG_ERR_CFG_ID	Configure ID is absent in data logging configuration file
6	DLG_ERR_RESOURCE_BUSY	The Data logging operation linked to this Data logging ID is used by another FB operation.
7	DLG_ERR_CFG_FORMAT	Data logging configuration file format is invalid.
8	DLG_ERR_RTC	Real time clock is invalid.
9	DLG_ERR_UNKNOWN	Unspecified error has occurred.

IIM

IIM executes an immediate input instruction to update the input data without having to wait until the beginning of the next input scan.

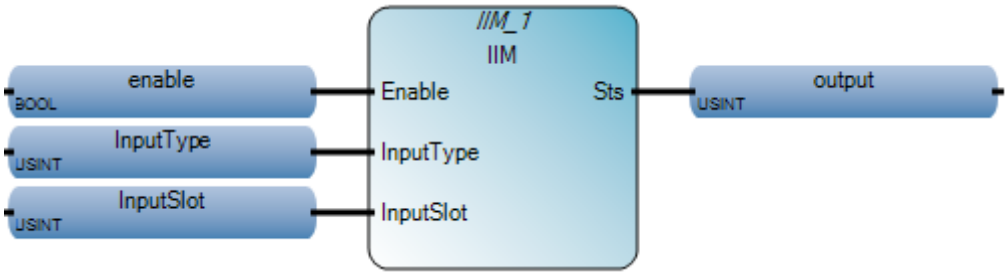


Arguments

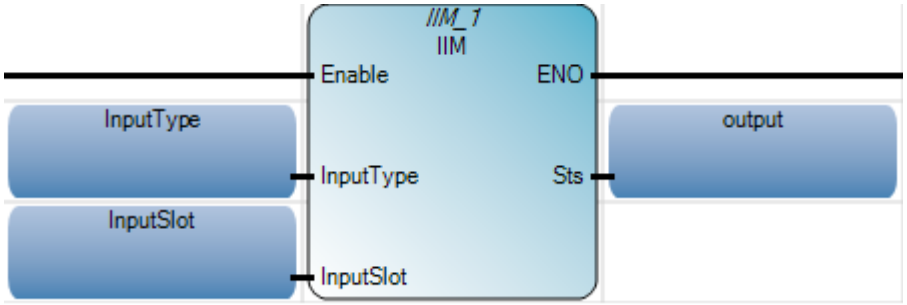
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute function. When Enable = FALSE, do not execute function.
InputType	Input	USINT	Type of input: 0 - Embedded input. 1 - Plug-in input.
InputSlot	Input	USINT	Input slot: Used to effectively select or mask which inputs are immediately scanned. IIM is typically used at the beginning of an interrupt program to get the current inputs. For embedded input, always 0. For Plug-in input, input slot is 1,2,3,4,5 (Plug-in slot number, starting with left-most slot = 1).
Sts	Output	USINT	Immediate input scan status. See IIM status codes (on page 377).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

IIM function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



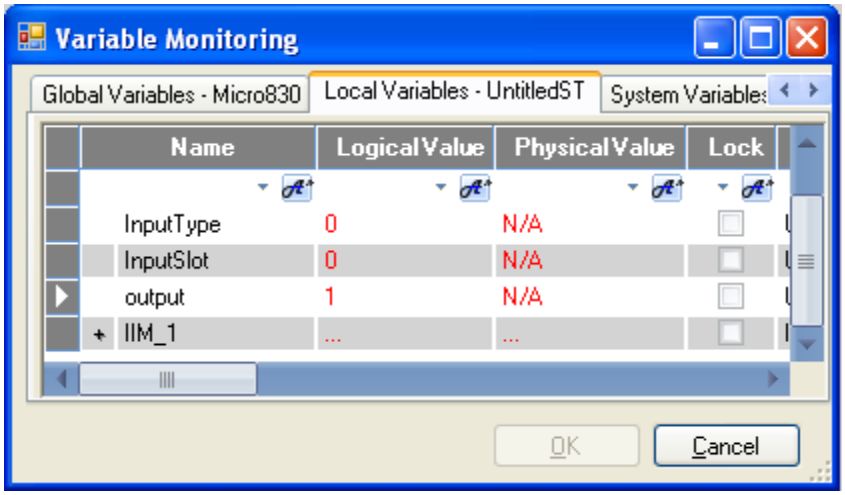
Structured Text (ST)

```
1  enable := TRUE;
2  InputType := 0;
3  InputSlot := 0;
4  IIM_1(enable, InputType, InputSlot);
5  output := IIM_1.Sts;
```

```
IIM_1(
```

void **IIM_1**(BOOL Enable, USINT InputType, USINT InputSlot)
Type : IIM, Update inputs prior to normal input scan.

Results



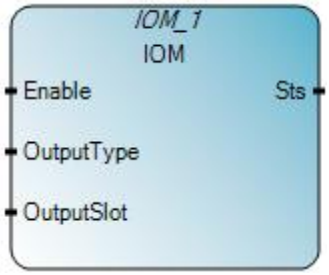
IIM status codes

The following table describes the codes that are used to indicate the input scan status of the IIM function block.

Status code	Description
0x00	Not enabled (no action taken).
0x01	Input/output scan success.
0x02	Input/output type invalid.
0x03	Input/output slot invalid.

IOM

IOM executes an immediate embedded output data update without waiting for the automatic output scan.

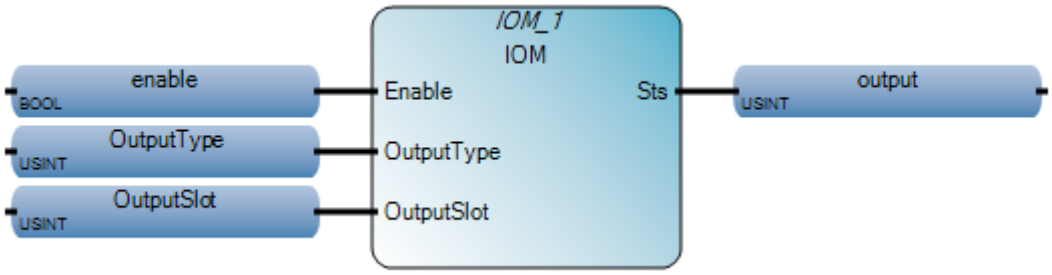


Arguments

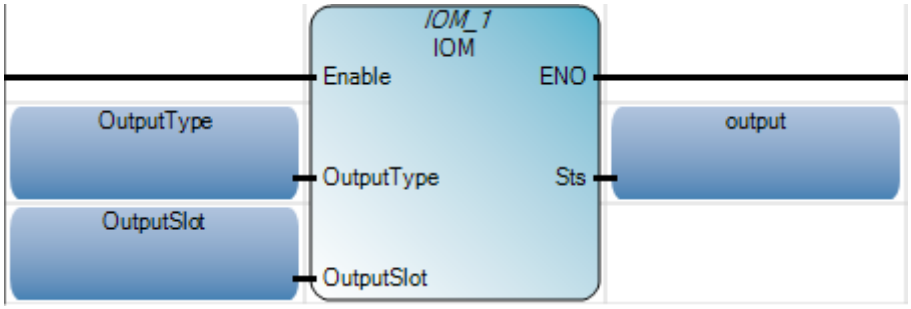
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute function. When Enable = FALSE, do not execute function.
OutputType	Input	USINT	Type of output: 0 - Embedded output. 1 - Plug-in output.
OutputSlot	Input	USINT	Output slot: Used to effectively select or mask which output is immediately scanned. IOM is typically used at the end of an interrupt program to immediately update outputs. For embedded output, always 0. For Plug-in output, output slot is 1,2,3,4,5 (Plug-in slot number, starting with left-most slot = 1).
Sts	Output	USINT	Immediate output scan status. See IOM status codes (on page 380).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

IOM function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)

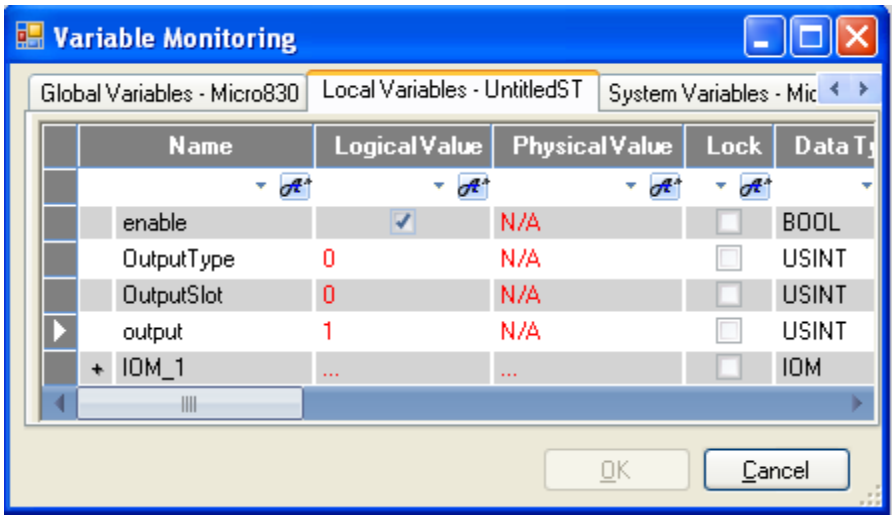


Structured Text (ST)

```
1  enable := TRUE;
2  OutputType := 0;
3  OutputSlot := 0;
4  IOM_1(enable, OutputType, OutputSlot);
5  output := IOM_1.Sts;
```

```
IOM_1(
    void IOM_1(BOOL Enable, USINT OutputType, USINT OutputSlot)
    Type : IOM, Update outputs prior to normal output scan.
```

Results



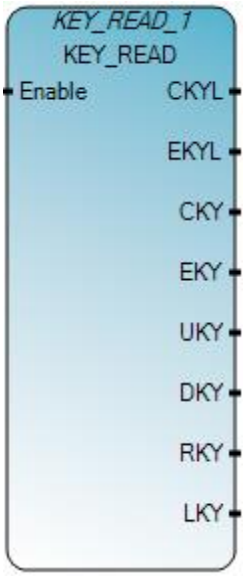
IOM status codes

The following table describes the codes that are used to indicate the output scan status of the IOM function block.

Status code	Description
0x00	Not enabled (no action taken).
0x01	Input/output scan success.
0x02	Input/output type invalid.
0x03	Input/output slot invalid.

KEY_READ

KEY_READ checks Key status on the optional LCD module when the user display is active. This is only available for the Micro810.



KEY_READ operation

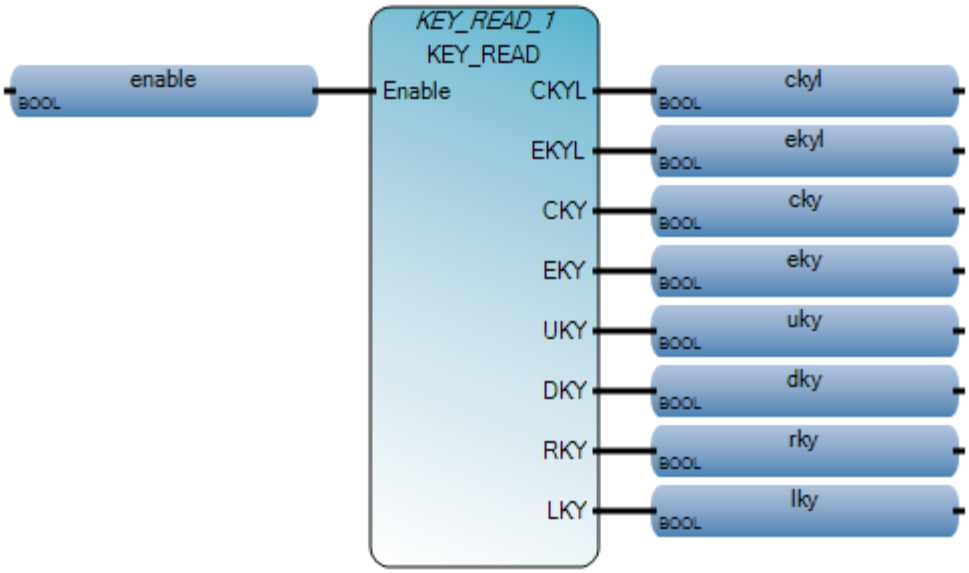
The KEY_READ function block is available for Micro810 controllers only.

Arguments

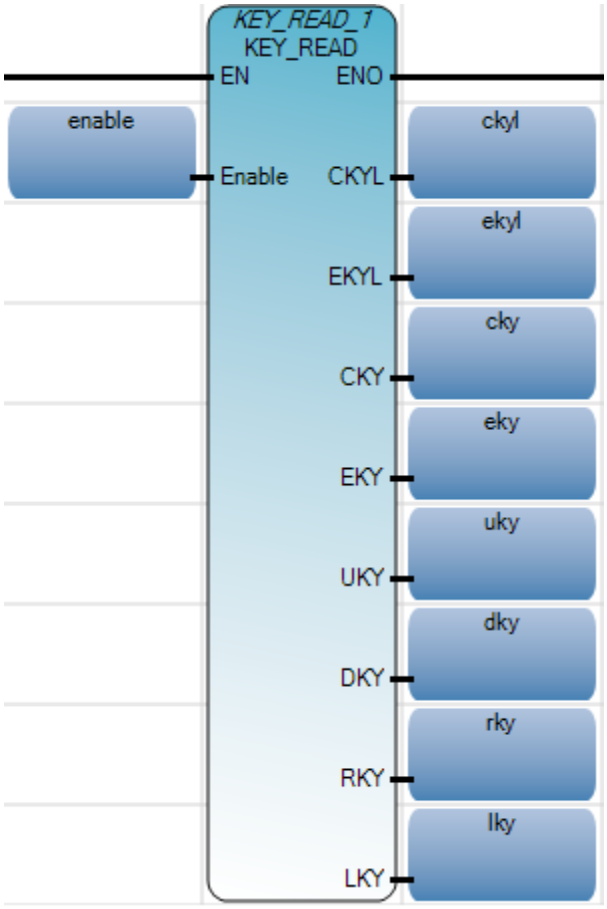
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute LCD read. When Enable = FALSE, there is no read operation.
CKYL	Output	BOOL	TRUE: ESC key pressed for more than 2 seconds.
EKYL	Output	BOOL	TRUE: OK key pressed for more than 2 seconds.
CKY	Output	BOOL	TRUE: ESC key pressed.
EKY	Output	BOOL	TRUE: OK key pressed.
UKY	Output	BOOL	TRUE: Up key pressed.
DKY	Output	BOOL	TRUE: Down key pressed.
LKY	Output	BOOL	TRUE: Left key pressed.
RKY	Output	BOOL	TRUE: Right key pressed.

KEY_READ function block language examples

Function Block Diagram (FBD)

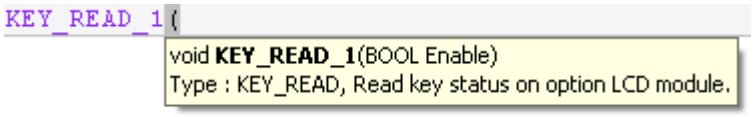


Ladder Diagram (LD)



Structured Text (ST)

```
1  KEY_READ_1(enable);
2  ckyl := KEY_READ_1.CKYL;
3  ekyl := KEY_READ_1.EKYL;
4  cky := KEY_READ_1.CKY;
5  eky := KEY_READ_1.EKY;
6  uky := KEY_READ_1.UKY;
7  dky := KEY_READ_1.DKY;
8  lky := KEY_READ_1.LKY;
9  rky := KEY_READ_1.RKY;
```

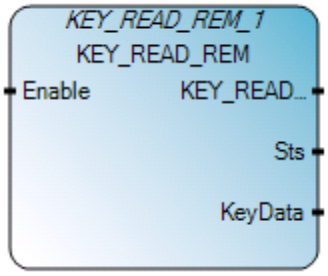


(* ST Equivalence: *)

```
KEY_READ_1(KEYENABLE) ;
KEY_EKYL := KEY_READ_1.EKYL ;
KEY_CKY := KEY_READ_1.CKY ;
KEY_EKY := KEY_READ_1.EKY ;
KEY_UKY := KEY_READ_1.UKY ;
KEY_DKY := KEY_READ_1.DKY ;
KEY_RKY := KEY_READ_1.RKY ;
KEY_LKY := KEY_READ_1.LKY ;
```

KEY_READ_REM

KEY_READ_REM checks Key status on a Remote LCD module when the user display is active. This is only available for the Micro820.



KEY_READ_REM operation

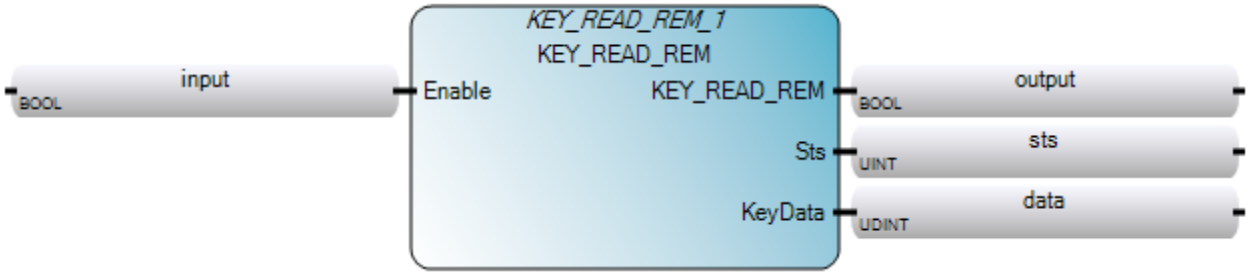
- KEY_READ_REM is supported for Micro820 controllers only.
- This function block can be used to check Key status on Remote LCD module when user display is active (LCD_REM instruction is used to make User Display Active). When User display is not active, KEY_READ_REM instruction flags an error.
- P-BUTTON property in LCD Function File shall be activated; otherwise all key status will be FALSE.
- Only single key presses are supported for the KEY_READ_REAM instruction; two-key press combinations are not supported.

KEY_READ_REM arguments

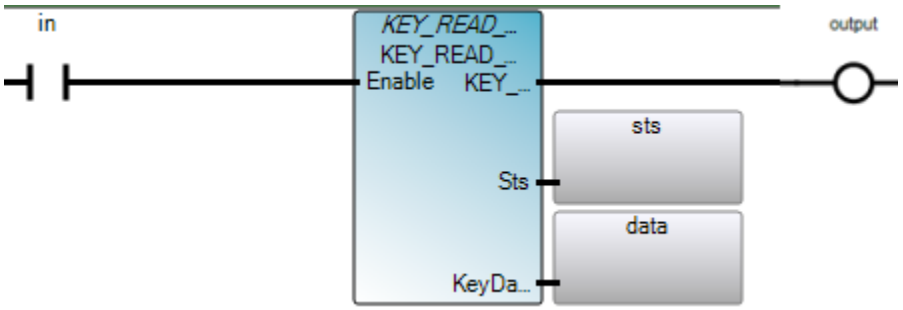
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function enabled. TRUE = Enable FALSE = Disable
KEY_READ_REM	Output	BOOL	TRUE: Remote LCD Key data is read successfully. FALSE: Enable is false, there is an error reading. Remote LCD Key Data or User Display is not active.
Sts	Output	UINT	Status of the KEY_READ_REM operation. See KEY_READ_REM status codes (on page 387).
KeyData	Output	UDINT	Remote LCD KeyPad Data. See KeyData bitfields table (on page 387).

KEY_READ_REM function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  KEY_READ_REM (Enable);
2  output := KEY_READ_REM.ENO
3  sts := KEY_READ_REM.Sts
4  data := KEY_READ_REM.KeyData

KEY_READ_REM_2(
```

void **KEY_READ_REM_2**(BOOL Enable)
Type : KEY_READ_REM, Check key status on remote LCD.

KEY_READ_REM operation

- KEY_READ_REM is supported for Micro820 controllers only.
- This function block can be used to check Key status on Remote LCD module when user display is active (LCD_REM instruction is used to make User Display Active). When User display is not active, KEY_READ_REM instruction flags an error.
- P-BUTTON property in LCD Function File shall be activated; otherwise all key status will be FALSE.
- Only single key presses are supported for the KEY_READ_REAM instruction; two-key press combinations are not supported.

KEY_READ_REM status codes

Status code	Description
0	Enable Input is False.
1	Key data read successfully.
2	Remote LCD not detected. May occur when: • Remote LCD is not physically connected to the controller (or the wiring is incorrect). • Serial port settings are other than what is required for the Remote LCD.
3	Connection Error. May occur when there is an internal state machine error. (Possibly caused by an incompatibility between Controller FW version and RLCD FW version.)
4	User Display is not active.
5-65535	Reserved.

KeyData bitfields table

Bit No. in KeyData	Name	Parameter Description
0	UKY	TRUE = Up key pressed.
1	DKY	TRUE = Down key pressed.
2	LKY	TRUE = Left key pressed.
3	RKY	TRUE = Right key pressed.
4	F1KY	TRUE = F1 key pressed.
5	F2KY	TRUE = F2 key pressed.
6	F3KY	TRUE = F3 key pressed.
7	F4KY	TRUE = F4 key pressed.
8	F5KY	TRUE = F5 key pressed.
9	F6KY	TRUE = F6 key pressed.
10	EKY	TRUE = Enter key pressed.
11	CKY	TRUE = Cancel key pressed.
12	EKYL	TRUE = Enter key pressed for more than 2 seconds.
13	CKYL	TRUE = Cancel key pressed for more than 2 seconds.
14-31	--	Reserved.

MM_INFO

MM_INFO checks Memory Module information. When a Memory Module is not present, all values return zero (0).

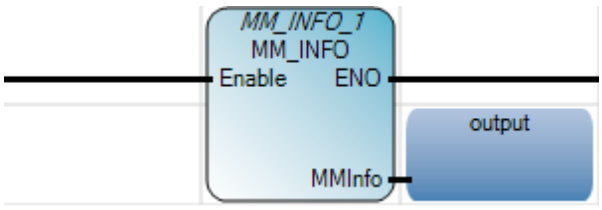
Arguments

Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, read Memory Module header information. When Enable = FALSE, there is no read operation, and the output Memory Module information is invalid.
MMInfo	Output	MMINFO	Memory Module Information. See MMINFO data type (on page 390).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

MM_INFO function block language examples

Function Block Diagram (FBD)

Ladder Diagram (LD)



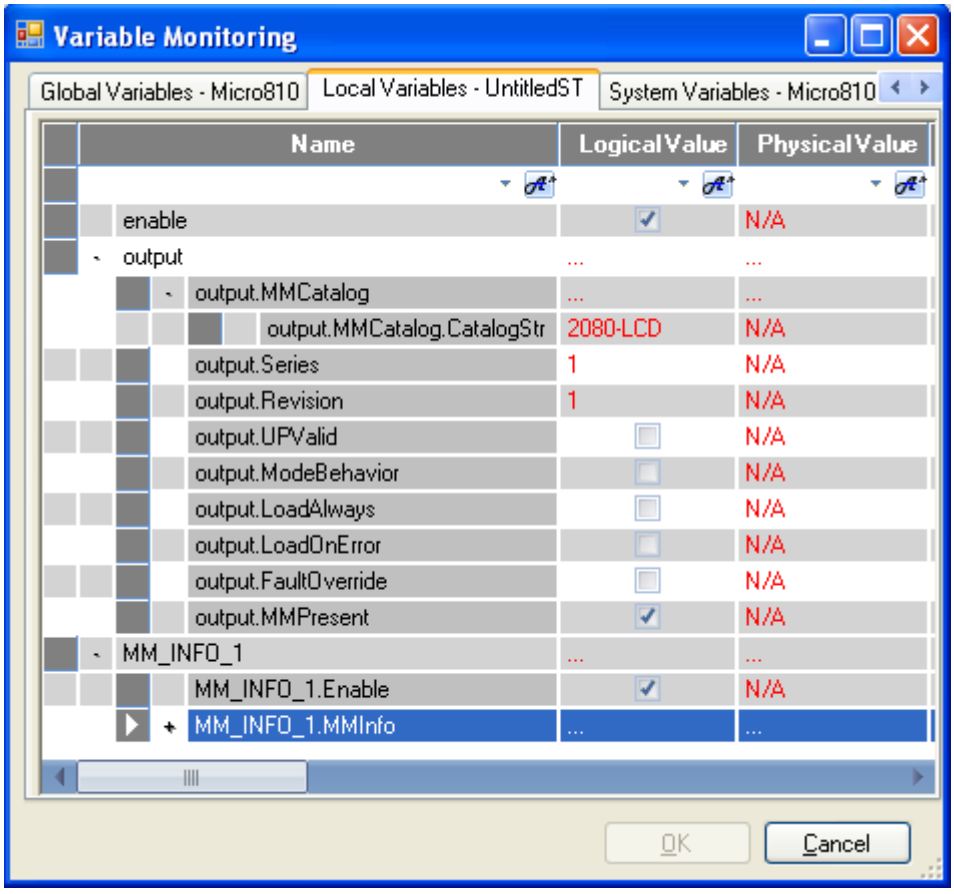
Structured Text (ST)

```
1  MM_INFO_1(enable);
2  output := MM_INFO_1.MMInfo;
```

```
MM_INFO_1(
```

void **MM_INFO_1**(BOOL Enable)
Type : MM_INFO, Read memory module header information.

Results



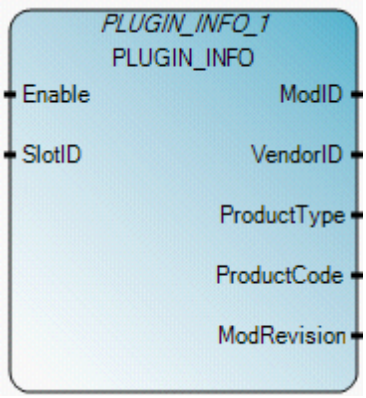
MMINFO data type

The following table describes the MMINFO data type parameters.

Parameter	Data type	Description
MMCatalog	MMCATNUM	The catalog number of the Memory Module. **Note**: When using the MM_INFO instruction on controllers with an SD card, the MMCatalog is "SD CARD".
Series	UINT	The series of the Memory Module. **Note**: When using the MM_INFO instruction on controllers with an SD card, the series is 0.
Revision	UINT	The revision of the Memory Module. **Note**: When using the MM_INFO on controllers with an SD card, the revision is 0.
UPValid	BOOL	User program valid (TRUE: Valid).
ModeBehavior	BOOL	Mode behavior (TRUE: Go to RUN on power up).
LoadAlways	BOOL	Memory Module restore to controller always on power up.
LoadOnError	BOOL	Memory Module restore to controller if power up with error.
FaultOverride	BOOL	Override fault on power up.
MMPresent	BOOL	Memory Module is present.

PLUGIN_INFO

PLUGIN_INFO reads the Plug-in Generic Module Information. It can read any Plug-in module information except for 2080-MEMBAK-RTC modules. When a Plug-in Generic Module is not present, all values return to zero (0).

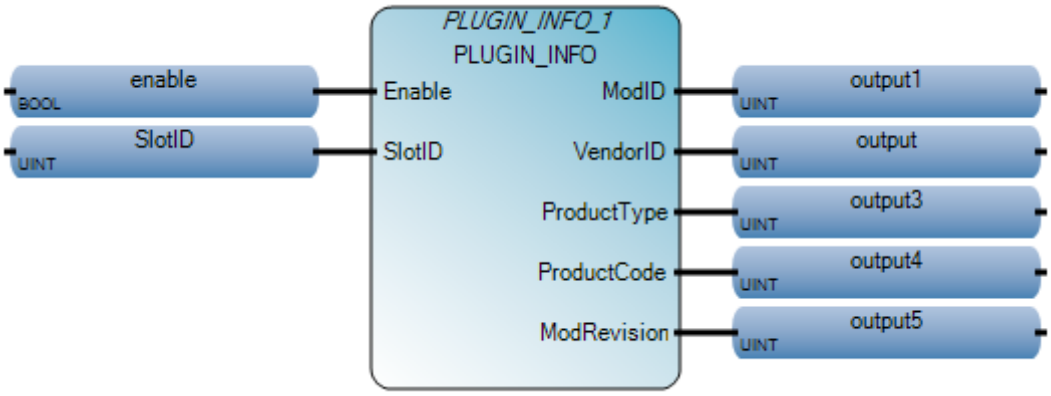


Arguments

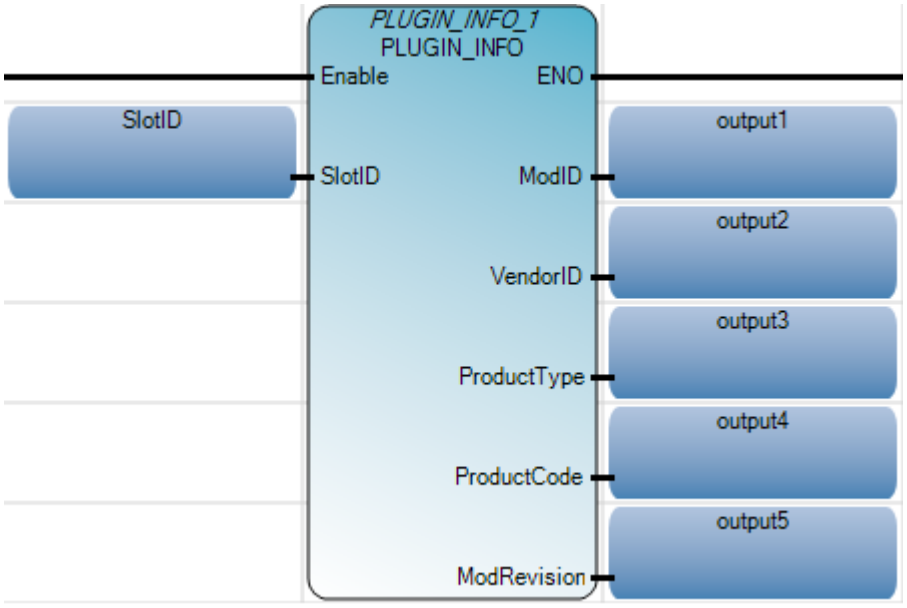
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute P_IM information read. When Enable = FALSE, the function block is not executed. All output data values are reset to 0.
SlotID	Input	UINT	Plug-in slot number. Slot ID = 1,2,3,4,5 (starting with far left slot = 1).
ModID	Output	UINT	Plug-in Generic Module physical ID.
VendorID	Output	UINT	Plug-in Generic Module vendor ID. For Allen Bradley products, the vendor ID = 1.
ProductType	Output	UINT	Plug-in Generic Module product type.
ProductCode	Output	UINT	Plug-in Generic Module product code.
ModRevision	Output	UINT	Plug-in Generic Module revision information.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

PLUGIN_INFO function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



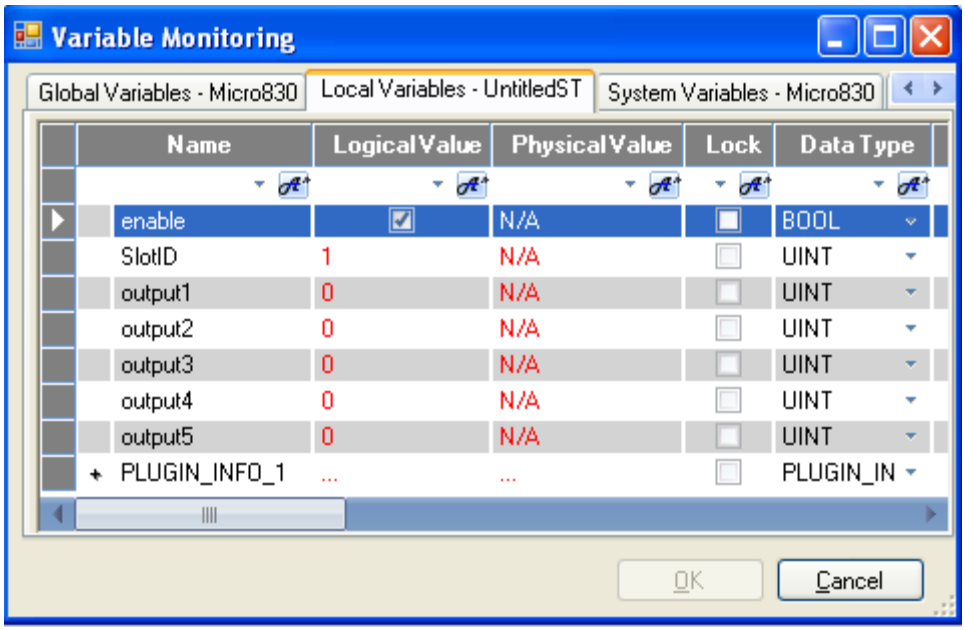
Structured Text (ST)

```
1  SlotID := 1;
2  PLUGIN_INFO_1(enable, SlotID);
3  output1 := PLUGIN_INFO_1.ModID;
4  output2 := PLUGIN_INFO_1.VendorID;
5  output3 := PLUGIN_INFO_1.ProductType;
6  output4 := PLUGIN_INFO_1.ProductCode;
7  output5 := PLUGIN_INFO_1.ModRevision;
```

```
PLUGIN_INFO_1(
```

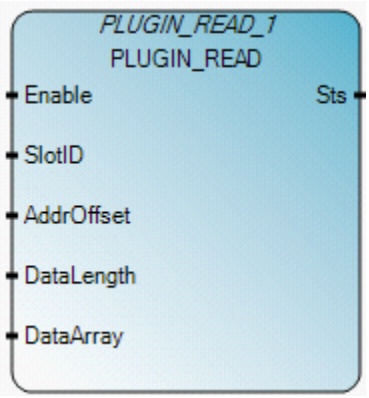
void **PLUGIN_INFO_1**(BOOL Enable, UINT SlotID)
Type : PLUGIN_INFO, Get module information from a generic plug-in module.

Results



PLUGIN_READ

PLUGIN_READ reads a block of data from any Plug-in Generic Module hardware except for 2080-MEMBAK-RTC modules. When a Plug-in Generic Module is not present, all values return to zero (0).

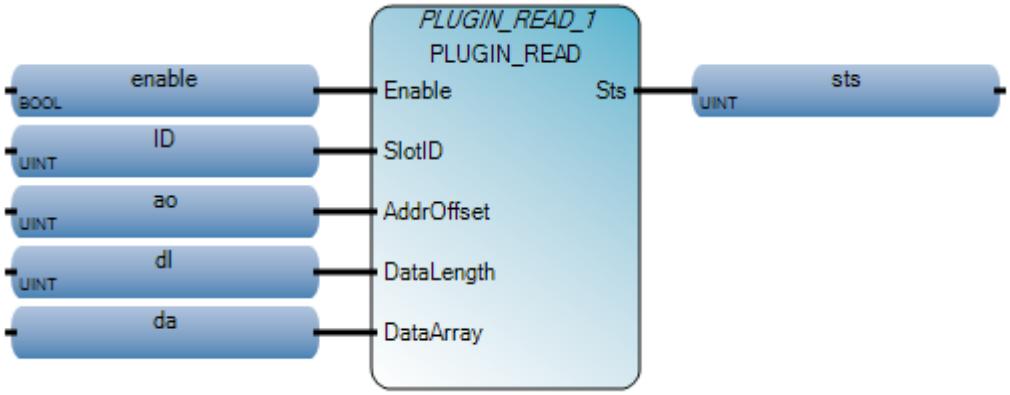


Arguments

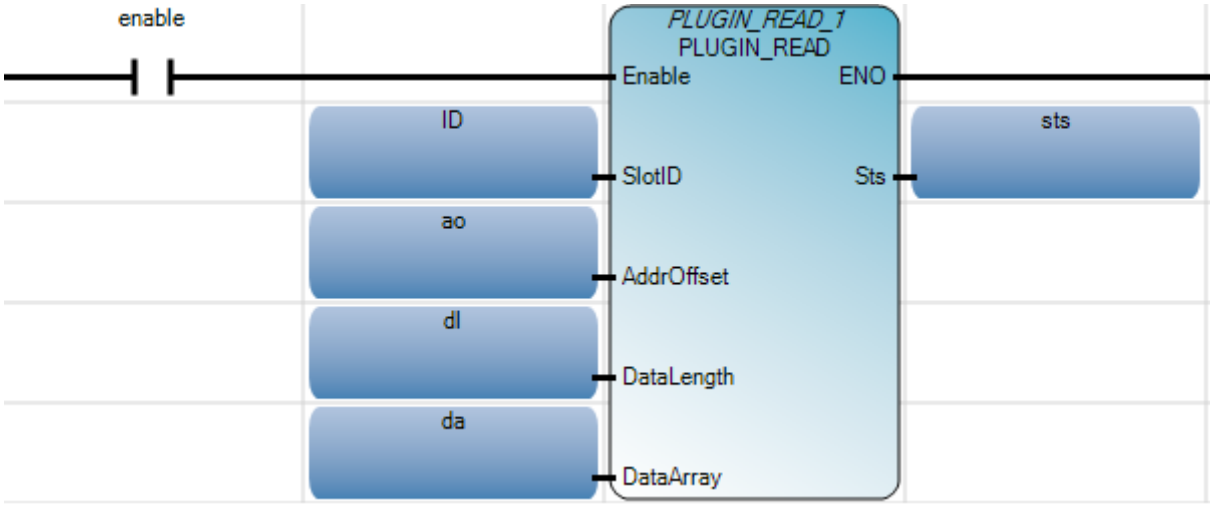
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute UPM read. When Enable = FALSE, there is no read operation and the data inside the data array is invalid.
SlotID	Input	UINT	Plug-in slot number. Slot ID = 1,2,3,4,5 (starting with the far left slot = 1).
Offset	Input	UINT	Address offset of the first data to be read, calculating from the first byte of the Plug-in Generic Module.
DataLength	Input	UINT	The number of bytes to be read.
DataArray	Input	USINT	An array used to store the data read from the Plug-in Generic Module.
Sts	Output	UINT	See PLUGIN_READ status codes (on page 397).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

PLUGIN_READ function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  PLUGIN_READ_1(enable, ID, ao, dl, da);
2  sts := PLUGIN_READ_1.Sts;
```

```
PLUGIN_READ_1(
```

void **PLUGIN_READ_1**(BOOL Enable, UINT SlotID, UINT AddrOffset, UINT DataLength, USINT[1..1] DataArray, UINT __ADI_DataArray)
Type : PLUGIN_READ, Read data from a generic PLUGIN module.

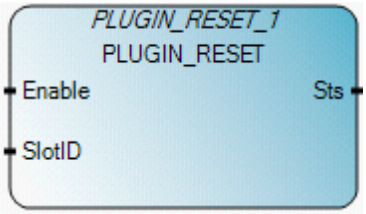
PLUGIN_READ status codes

The following table describes status codes for the PLUGIN_READ function block.

Status code	Status description
0x00	Function block not enabled (no operation).
0x01	Plug-in operation success.
0x02	Plug-in operation fails due to an invalid Slot ID.
0x03	Plug-in operation fails since it is not a valid Plug-in Generic module.
0x04	Plug-in operation fails due to data operated out of range.
0x05	Plug-in operation fails due to a data access parity error.

PLUGIN_RESET

PLUGIN_RESET resets any Plug-in Generic Module hardware except 2080-MEMBAK-RTC modules. After the hardware reset, the Plug-in Generic Module is ready for configuration and operation.

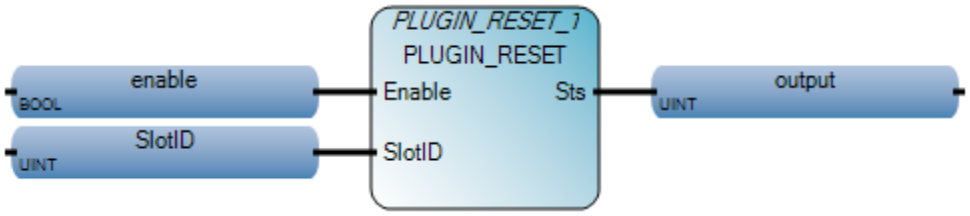


Arguments

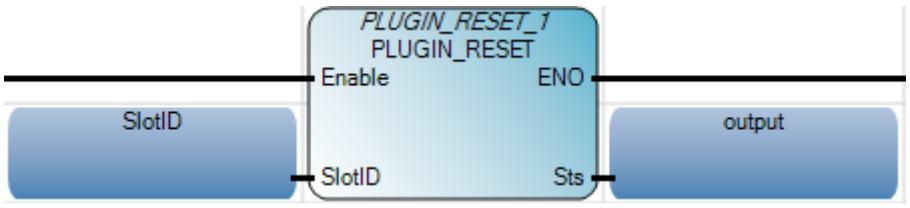
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute Plug-in reset. When Enable = FALSE, there is no reset operation.
SlotID	Input	UINT	Plug-in slot number. Slot ID = 1,2,3,4,5 (starting with the far left slot = 1).
Sts	Output	UINT	See PLUGIN_READ status codes (on page 397).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

PLUGIN_RESET function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



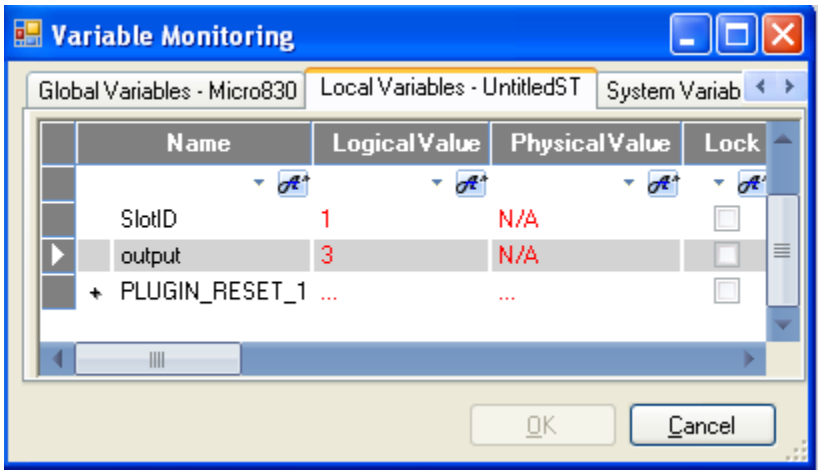
Structured Text (ST)

```
1  SlotID := 1;
2  PLUGIN_RESET_1(enable, SlotID);
3  output := PLUGIN_RESET_1.Sts;
```

```
PLUGIN_RESET_1(
```

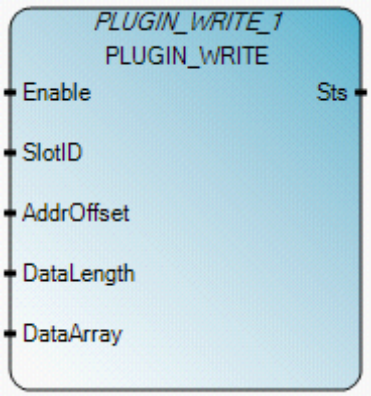
void **PLUGIN_RESET_1**(BOOL Enable, UINT SlotID)
Type : PLUGIN_RESET, Reset a generic PLUGIN module(hardware reset).

Results



PLUGIN_WRITE

PLUGIN_WRITE writes a block of data to any Plug-in Generic Module hardware except 2080-MEMBAK-RTC modules.

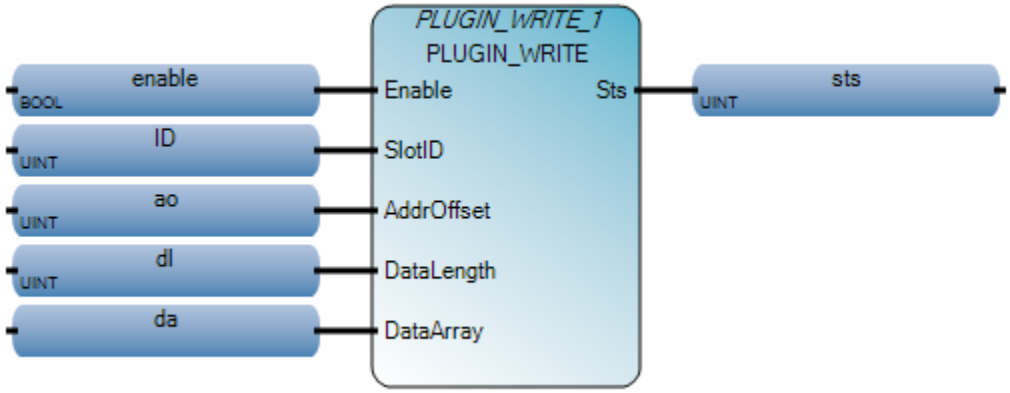


Arguments

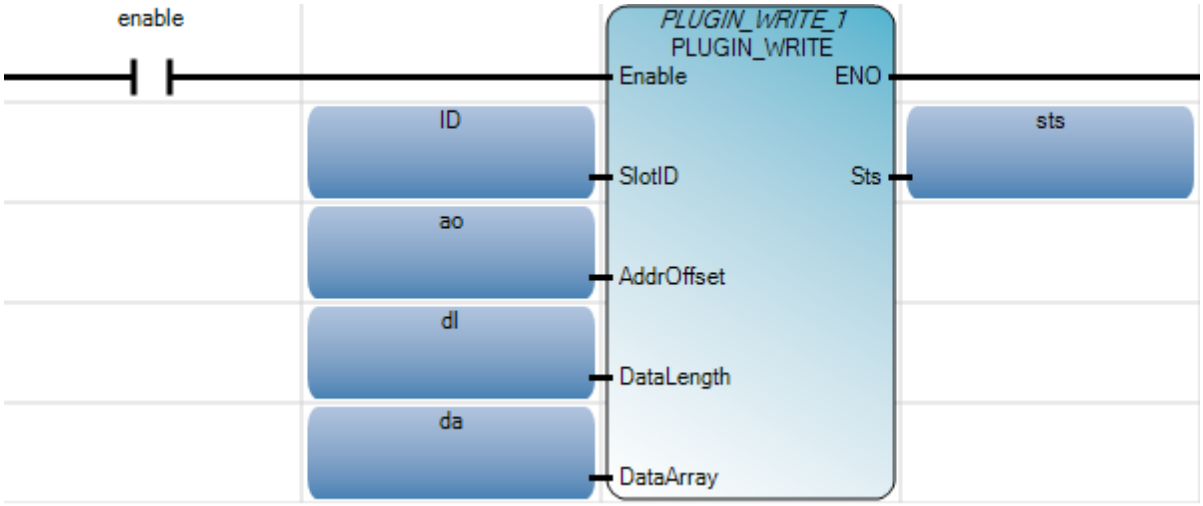
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute Plug-in write. When Enable = FALSE, there is no data write operation.
SlotID	Input	UINT	Plug-in slot number. Slot ID = 1,2,3,4,5 (starting with the far left slot = 1).
Offset	Input	UINT	Address offset of the first data to be written, calculating from the first byte of the Plug-in Generic Module.
DataLength	Input	UINT	The number of bytes to be written.
DataArray	Input	USINT	Data to be written to the Plug-in Generic Module.
Sts	Output	UINT	See PLUGIN_READ status codes (on page 397).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

PLUGIN_WRITE function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



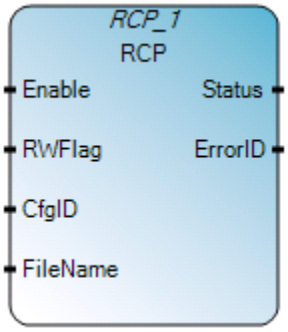
Structured Text (ST)

```
1  PLUGIN_WRITE_1(enable, ID, ao, dl, da);
2  sts := PLUGIN_WRITE_1.Sts;
```

```
PLUGIN_WRITE_1(
void PLUGIN_WRITE_1(BOOL Enable, UINT SlotID, UINT AddrOffset, UINT DataLength, USINT[1..1] DataArray, UINT __ADI_DataArray)
Type : PLUGIN_WRITE, Write data to a generic PLUGIN module.
```

RCP

Recipe C Function Block can be used to read a variable's data value from the recipe data file which exists in the recipe data file folder of SD card and update the value to the run-time engine. The Recipe C Function Block can be used to write the variable value with the run time engine into the recipe data file in the SD card.



RCP operation

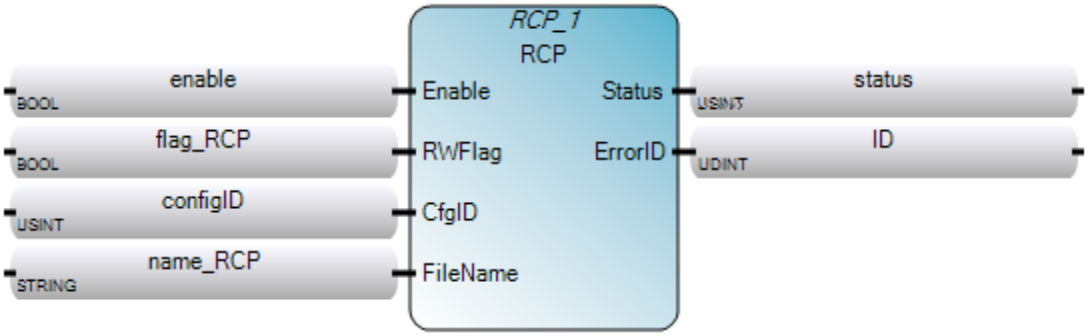
- RCP is supported for Micro820 controllers only.

RCP arguments

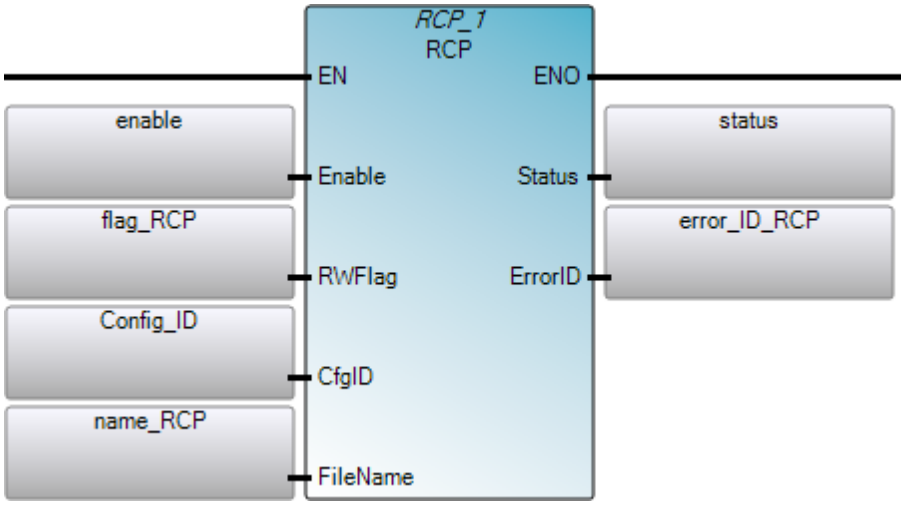
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current RCP computation. When EN = FALSE, there is no computation. Applies only to LD programs.
Enable	Input	BOOL	Function block read/write enable. On Rising Edge (Enable switches from 0 to 1), the function block executes with the precondition that the last operation has completed.
RWFlag	Input	BOOL	TRUE = write to SD Card. FALSE = Recipe read from SD Card.
CfgID	Input	USINT	Recipe configuration VA ID index.
RcpName	Input	STRING	Recipe data file name which is operated in the recipe folder in SD card (maximum 30 characters length).
Status	Output	USINT	Recipe function block current status. See RCP status codes (on page 404).
ErrorID	Output	UDINT	Error ID if RCP Read/Write fails. See RCP error codes (on page 404).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

RCP function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  RCP_1 (EN, Enable, RWFlag, CfgID, FileName);
2  output := RCP_1.ENO
3  status := RCP_1.Status
4  error_ID_RCP := RCP_1.ErrorID
```

```
RCP_1(
```

void **RCP_1**(BOOL Enable, BOOL RWFlag, USINT CfgID, STRING FileName)
Type : RCP, Save/Restore list of data to/from SD Card Recipe file.

RCP status codes

Status code	Description
0	Recipe "Idle" status.
1	Recipe "Doing" status.
2	Recipe Complete - "Succeed" status.
3	Recipe Complete - "Error" status.

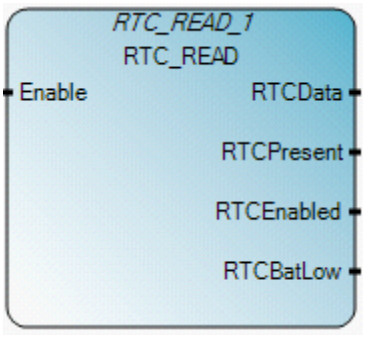
RCP error codes

The following table describes RCP error codes.

Error code	Error Name
0	RCP_ERR_NONE
1	RCP_ERR_NO_SDCARD
2	RCP_ERR_DATAFILE_FULL
3	RCP_ERR_DATAFILE_ACCESS SD card may be identified as a) broken; b) full; or c) read only.
4	RCP_ERR_CFG_ABSENT
5	RCP_ERR_CFG_ID
6	RCP_ERR_RESOURCE_BUSY
7	RCP_ERR_CFG_FORMAT
8	RCP_ERR_RESERVED Reserved for future possible expansion.
9	RCP_ERR_UNKNOWN
10	RCP_ERR_DATAFILE_NAME
11	RCP_ERR_DATAFOLDER_INVALID
12	RCP_ERR_DATAFILE_ABSENT
13	RCP_ERR_DATAFILE_FORMAT
14	RCP_ERR_DATAFILE_SIZE Recipe data file size is too big (>4kb).

RTC_READ

RTC_READ reads the RTC preset and RTC information.



RTC_READ operation

When used with a Micro810 or Micro820 controller with embedded RTC:

- RTCBatLow is always set to zero (0).
- RTCEnabled is always set to one (1).

When the embedded RTC has lost its charge/memory due to loss of power:

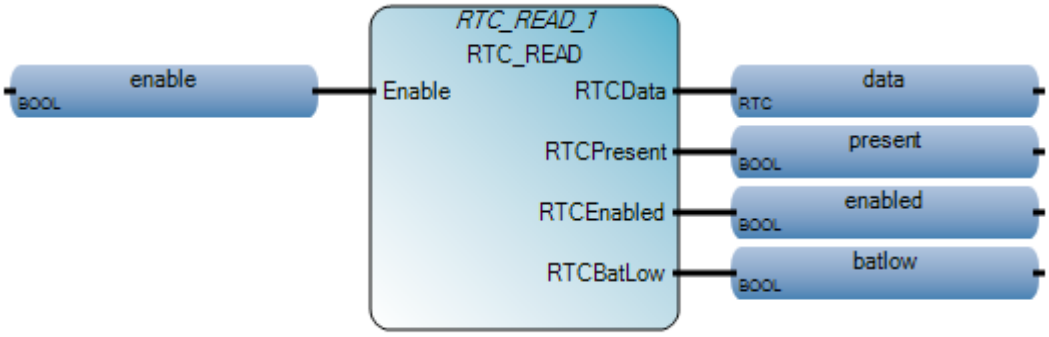
- RTCData is set to 2000/1/1/0/0/0.
- RTCEnabled is always set to one (1).

Arguments

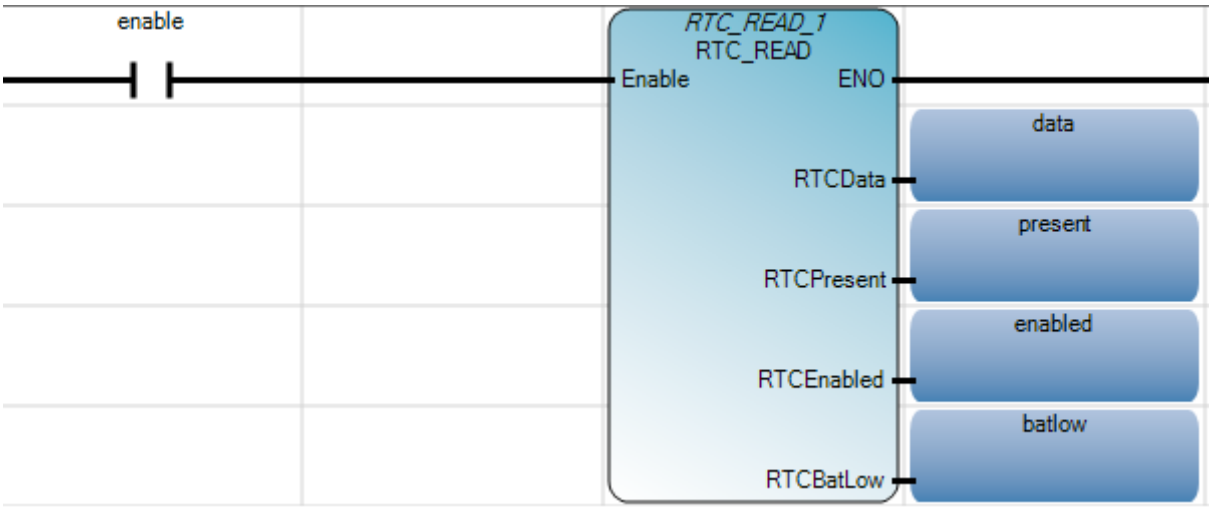
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute RTC information read. When Enable = FALSE, there is no read operation and output RTC data is invalid.
RTCData	Output	RTC	RTC data information: yy/mm/dd, hh/mm/ss, week. See RTC data type (on page 407).
RTCPresent	Output	BOOL	TRUE - RTC hardware is plugged in. FALSE - RTC hardware is not plugged in.
RTCEnabled	Output	BOOL	TRUE - RTC hardware is enabled (timing). FALSE - RTC hardware is disabled (not timing).
RTCBatLow	Output	BOOL	TRUE - RTC battery is low. FALSE - RTC battery is not low.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

RTC_READ function block language examples

Function Block Diagram (FBD)

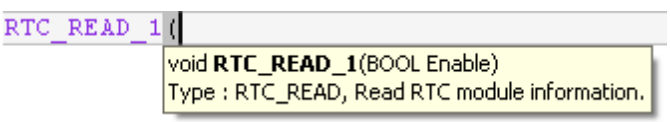


Ladder Diagram (LD)



Structured Text

```
1  RTC_READ_1(enable);
2  data := RTC_READ_1.RTCData;
3  present := RTC_READ_1.RTCPresent;
4  enabled := RTC_READ_1.RTCEnabled;
5  batlow := RTC_READ_1.RTCBatLow;
```



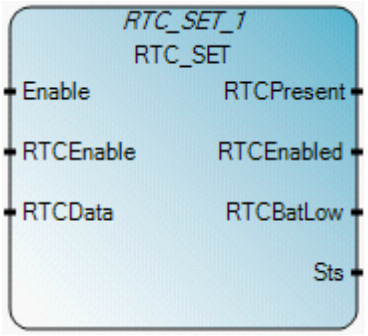
RTC data type

The following table describes the RTC data type.

Parameter	Data type	Description
Year	UINT	The year setting for the RTC. 16-bit value, and the valid range is from 2000 (Jan 01, 00:00:00) to 2098 (Dec. 31, 23:59:59)
Month	UINT	The month setting for the RTC.
Day	UINT	The day setting for the RTC.
Hour	UINT	The hour setting for the RTC.
Minute	UINT	The minute setting for the RTC.
Second	UINT	The second setting for the RTC.
DayOfWeek	UINT	The day of the week setting for the RTC. This parameter is ignored for RTC_SET.

RTC_SET

RTC_SET sets RTC status or write RTC information.

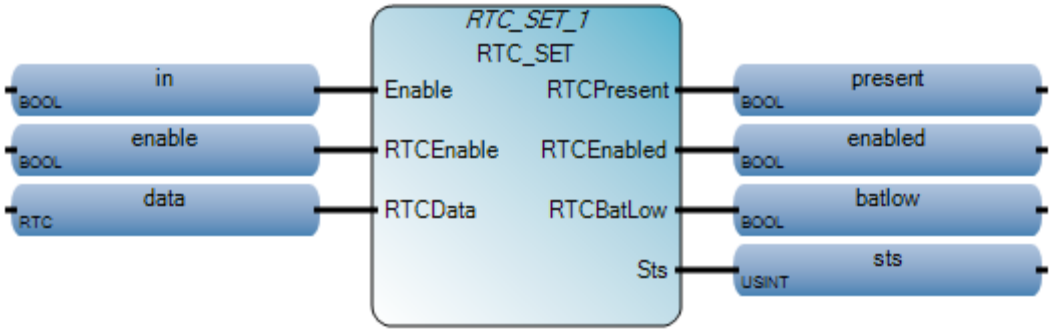


Arguments

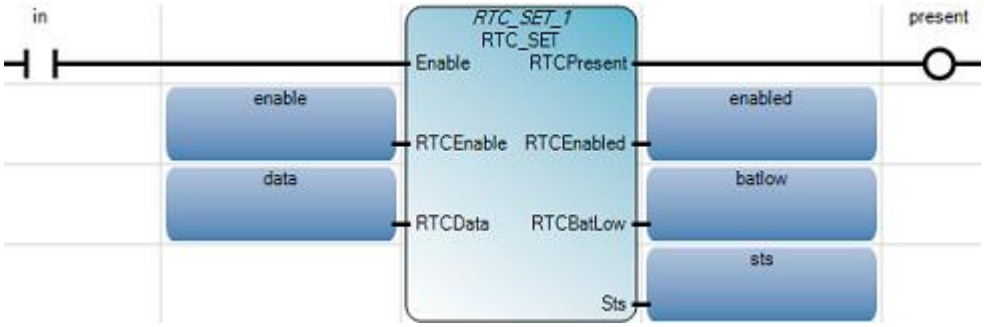
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute RTC set with the RTC info from input. When Enable = FALSE, there is no read operation and output RTC data is invalid.
RTCEnable	Input	BOOL	TRUE - To enable RTC with the RTC data specified. FALSE - To disable RTC. **Note:** This is ignored by Micro810 controllers.
RTCData	Input	RTC	RTC data information: yy/mm/dd, hh/mm/ss, week. This RTC data are ignored when RTCEnable = 0. See RTC data type (on page 407).
RTCPresent	Output	BOOL	TRUE - RTC hardware is plugged in. FALSE - RTC hardware is not plugged in.
RTCEnabled	Output	BOOL	TRUE - RTC hardware is enabled (timing). FALSE - RTC hardware is disabled (not timing).
RTCBatLow	Output	BOOL	TRUE - RTC battery is low. FALSE - RTC battery is not low.
Sts	Output	USINT	The read operation status. See RTC Set Status values (on page 409)

RTC_SET function block language examples

Function Block Diagram (FBD)

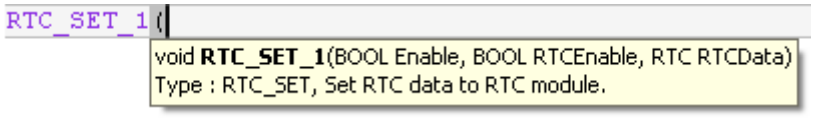


Ladder Diagram (LD)



Structured Text (ST)

```
1  RTC_SET_1(in, enable, data);
2  present := RTC_SET_1.RTCPresent;
3  enabled := RTC_SET_1.RTCEnabled;
4  batlow := RTC_SET_1.RTCBatLow;
5  sts := RTC_SET_1.Sts;
```



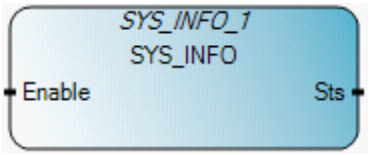
RTC Set status values

The following table describes RTCSet values:

Status value	Status description
0x00	Function block not enabled (no operation).
0x01	RTC set operation success.
0x02	RTC set operation fails.

SYS_INFO

SYS_INFO reads the status data block.

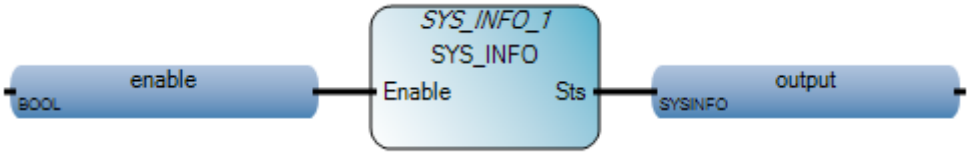


Arguments

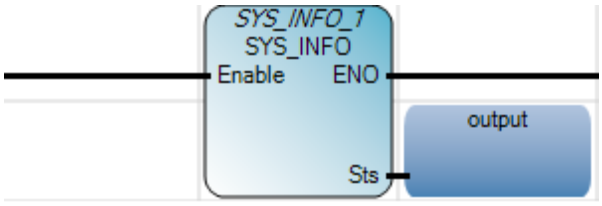
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute function. When Enable = FALSE, do not execute function.
Sts	Output	SYSINFO	System status data block. See SYS_INFO data type (on page 413).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

SYS_INFO function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



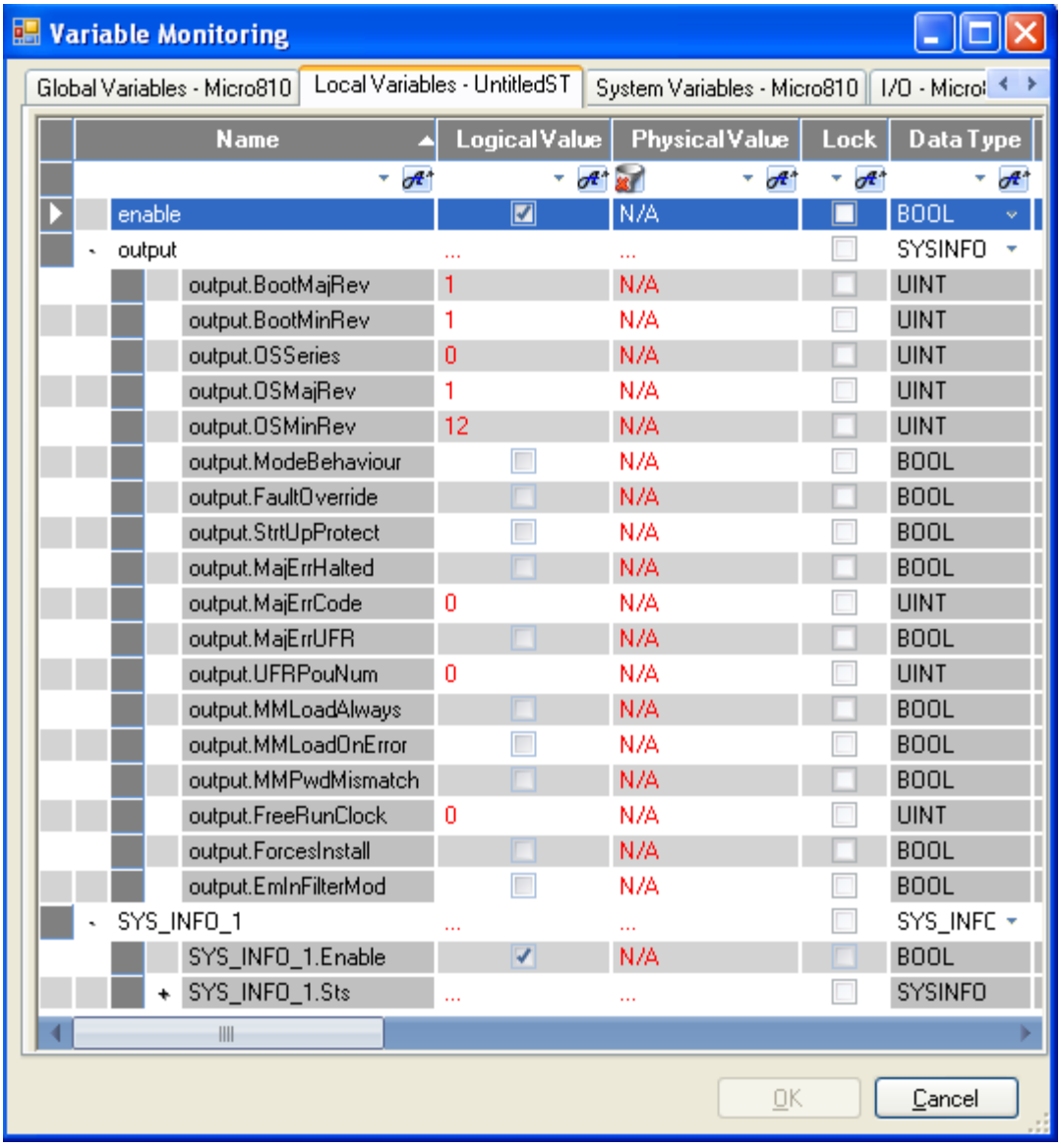
Structured Text (ST)

```
1  SYS_INFO_1(enable);
2  output := SYS_INFO_1.Sts;
```

```
SYS_INFO_1(
```

void **SYS_INFO_1**(BOOL Enable)
Type : SYS_INFO, Read Micro800 system status.

Results



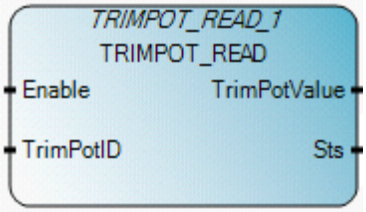
SYS_INFO data type

The following table describes the SYSINFO data type.

Parameter	Data type	Description
BootMajRev	UINT	Boot Major Revision.
BootMinRev	UINT	Boot Minor Revision.
Operating System Series	UINT	Operating System Series: 0 indicates a series A device 1 indicates a series B device
OSMajRev	UINT	OS Major Revision.
OSMinRev	UINT	OS Minor Revision.
ModeBehaviour	BOOL	Mode Behavior (TRUE: Go to RUN on power up).
FaultOverride	BOOL	Fault Override (TRUE: Override error on power up).
StrtUpProtect	BOOL	Startup Protection (TRUE: Run startup protection program on power up). **Note:** For future release
MajErrHalted	BOOL	Major error halted (TRUE: Major error halted).
MajErrCode	UINT	Major error code.
MajErrUFR	BOOL	Major error during user fault routine. **Note:** For future release
UFRPouNum	UINT	User fault routine program number.
MMLoadAlways	BOOL	Memory Module restore to controller always on power up (TRUE: Restore).
MMLoadOnError	BOOL	Memory Module restore to controller if power up with error (TRUE: Restore).
MMPwdMismatch	BOOL	Memory Module password mismatch (TRUE: Controller and Memory Module password mismatch).
FreeRunClock	UINT	Free running clock that increments every 100 microseconds from 0 to 65535 and then returns to 0. You can use the Clock, which is globally accessible, if you need more resolution than the standard 1 millisecond timer. **Note:** Only supported for Micro830 and Micro850 controllers. Value for Micro810 controllers remains 0.
ForcesInstall	BOOL	Forces enabled (TRUE: Enabled).
EMINFilterMod	BOOL	Embedded filter modified (TRUE: Modified).

TRIMPOT_READ

TRIMPOT_READ reads one Trimpot current value.

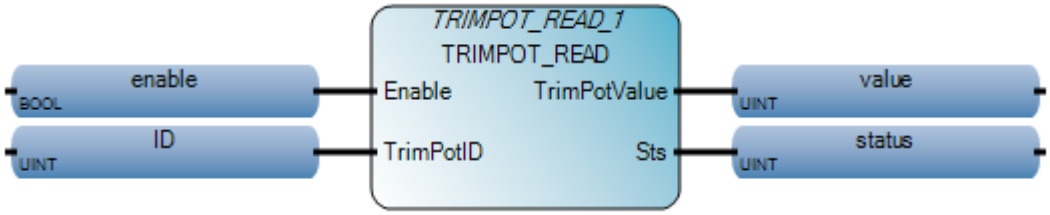


Arguments

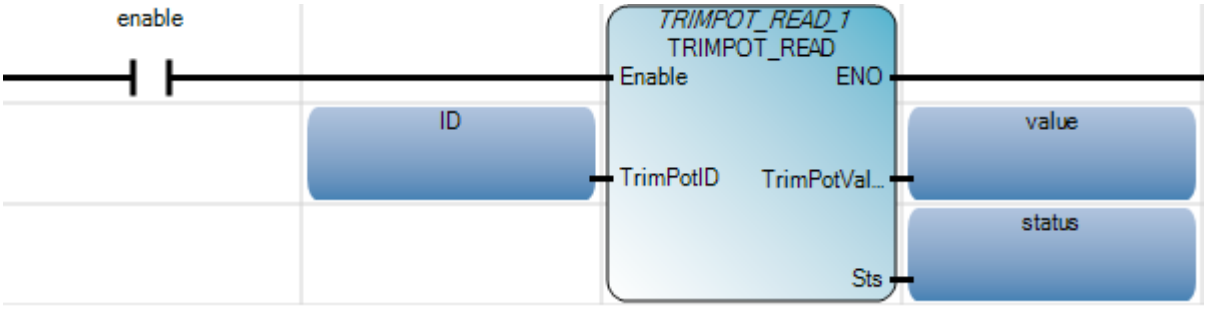
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute Trimpot read. When Enable = FALSE, there is no read operation and output Trimpot value is invalid.
TrimPotID	Input	UINT	The ID of the Trimpot to be read. See Trimpot ID definition (on page 415).
TrimPotValue	Output	UINT	Current trimpot value.
Sts	Output	UINT	The read operation status. See Trimpot operation status values (on page 416).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

TRIMPOT function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  TRIMPOT_READ_1(enable, ID);
2  value := TRIMPOT_READ_1.TrimPotValue;
3  status := TRIMPOT_READ_1.Sts;
```

```
TRIMPOT_READ_1(
```

void **TRIMPOT_READ_1**(BOOL Enable, UINT TrimPotID)
Type : TRIMPOT_READ, Read the Trimpot value from a specific Trimpot.

Trimpot ID definition

The following table describes the Trimpot ID definition.

Output selection	Bit	Description
Trimpot ID definition	15 - 13	Module type of trimpot: • 0x00 - Embedded. • 0x01 - Expansion. • 0x02 - Plug-in Port.
	12 - 8	Slot ID of the module: • 0x00 - Embedded. • 0x01-0x1F - ID of Expansion Module. • 0x01-0x05 - ID of Plug-in Port.
	7 - 4	Trimpot type: • 0x00 - Reserved. • 0x01 - Digital Trimpot Type 1 (LCD Module 1). • 0x02 - Mechanical Trimpot Module 1.
	3 - 0	Trimpot ID inside the module: • 0x00-0x0F - Embedded. • 0x00-0x07 - ID of Trimpot for Expansion. • 0x00-0x07 - ID of Trimpot for Plug-in Port. The trimpot ID starts from 0.

Trimpot operation status values

The following table describes Trimpot operation status values.

Status value	Status description
0x00	Function block not enabled (no read/write operation).
0x01	Read/write operation success.
0x02	Read/write operation fails due to an invalid Trimpot ID.
0x03	Write operation fails due to an out of range value.

Interrupt instructions

Interrupt instructions are used to signal the processor that an event needs attention. Usually, the interrupt signal is used for high-priority conditions that require interruption of the current code the processor is executing.

Function	Description
STIS (on page 418)	Start the STI timer from the control program rather than starting automatically
UIC (on page 420)	Clears specific user interrupt
UID (on page 422)	Disable specific user interrupt
UIE (on page 424)	Enable specific user input
UIF (on page 426)	Flush specific user input

STIS

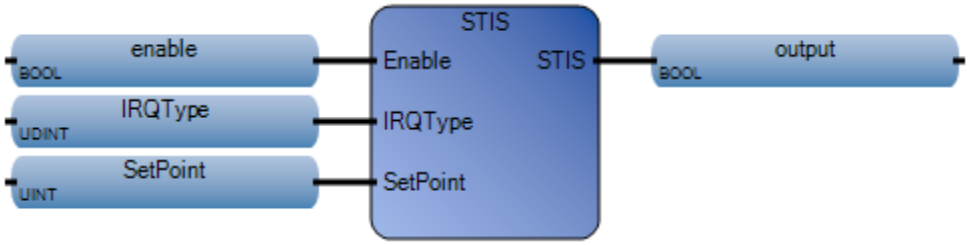
STIS starts a selectable timed (timer) user interrupt.

Arguments

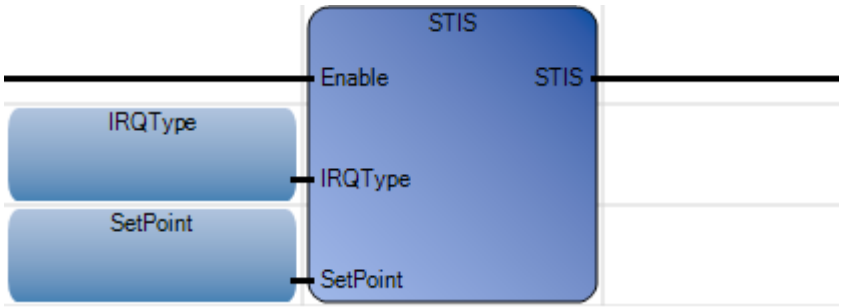
Parameter	Parameter Type	Data Type	Description
Enable	Input	BOOL	Function enable. When Enable = TRUE, perform function. When Enable = FALSE, do not perform function.
IRQType	Input	UDINT	Use the STI defined words. - IRQ_STI0 - IRQ_STI1 - IRQ_STI2 - IRQ_STI3
SetPoint	Input	UINT	This is the amount of time (in ms) which must expire prior to executing the selectable timed interrupt. A value of 0 disables the STIS function. A value between 1 and 65535 enables the STIS function.
STIS	Output	BOOL	Rung status (same as Enable).

STIS function language examples

Function block diagram



Ladder diagram



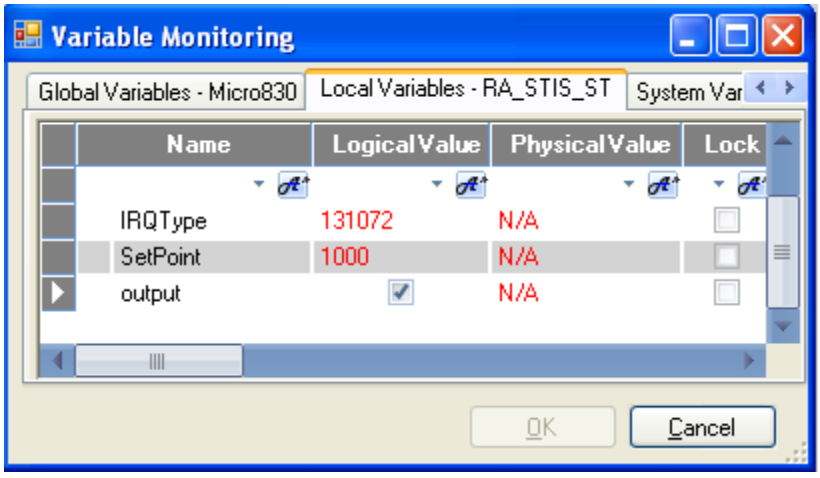
Structured text

```
1  enable := TRUE;
2  IRQType := IRQ_STI2;
3  SetPoint := 1000;
4  output := STIS(enable, IRQType, SetPoint);
```

(* ST Equivalence: *)

TESTOUTPUT := STIS(TESTENABLE, 2, 1000) ;

Results



UIC

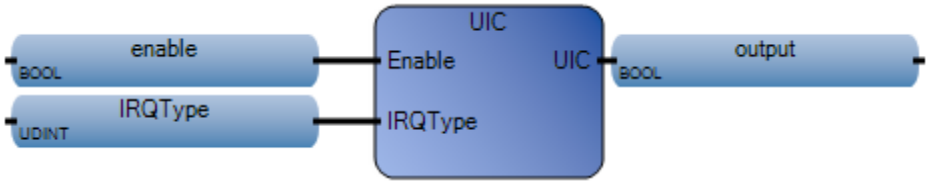
UIC clears Interrupt Lost bit for the selected User Interrupt(s).

Arguments

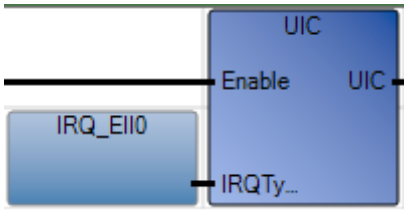
Parameter	Parameter Type	Data Type	Description	
Enable	Input	BOOL	Function enable. When Enable = TRUE, perform function. When Enable = FALSE, do not perform function.	
IRQType	Input	UDINT	Use the STI defined words. - IRQ_EII0 - IRQ_EII1 - IRQ_EII2 - IRQ_EII3 - IRQ_EII4 - IRQ_EII5 - IRQ_EII6 - IRQ_EII7 - IRQ_HSC0 - IRQ_HSC1 - IRQ_HSC2	- IRQ_HSC3 - IRQ_HSC4 - IRQ_HSC5 - IRQ_STI0 - IRQ_STI1 - IRQ_STI2 - IRQ_STI3 - IRQ_UFR - IRQ_UPM0 - IRQ_UPM1 - IRQ_UPM2 - IRQ_UPM3 - IRQ_UPM4
UIC	Output	BOOL	Rung status (same as Enable).	

UIC function language examples

Function block diagram



Ladder diagram



Structure text

```
1  enable := TRUE;
2  IRQType := 2;
3  output := UIC (enable, IRQType);
```

Results

User Global Variables - Micro850 | Local Variables - Prog3 | System Varial

	Name	Initial Value	Data Type	
	enable		BOOL	Rea
	output		BOOL	Rea
	IRQType	2	UINT	Rea

UID

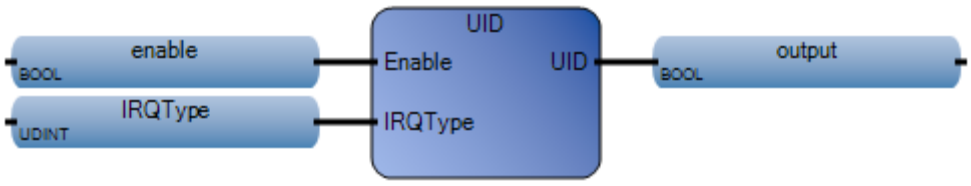
UID disables selected user interrupt(s).

Arguments

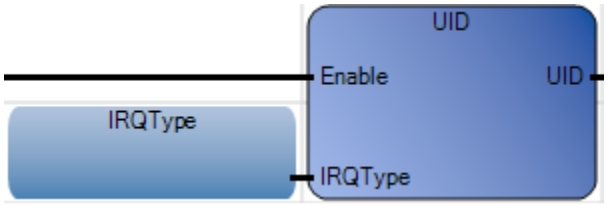
Parameter	Parameter Type	Data Type	Description	
Enable	Input	BOOL	Function enable. When Enable = TRUE, perform function. When Enable = FALSE, do not perform function.	
IRQType	Input	UDINT	Use the STI defined words. - IRQ_EII0 - IRQ_EII1 - IRQ_EII2 - IRQ_EII3 - IRQ_EII4 - IRQ_EII5 - IRQ_EII6 - IRQ_EII7 - IRQ_HSC0 - IRQ_HSC1 - IRQ_HSC2	- IRQ_HSC3 - IRQ_HSC4 - IRQ_HSC5 - IRQ_STI0 - IRQ_STI1 - IRQ_STI2 - IRQ_STI3 - IRQ_UFR - IRQ_UPM0 - IRQ_UPM1 - IRQ_UPM2 - IRQ_UPM3 - IRQ_UPM4
UID	Output	BOOL	Rung status (same as Enable).	

UID function language examples

Function block diagram

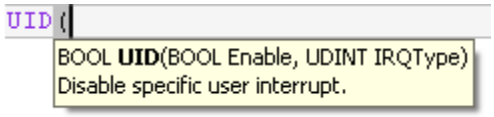


Ladder diagram



Structured text

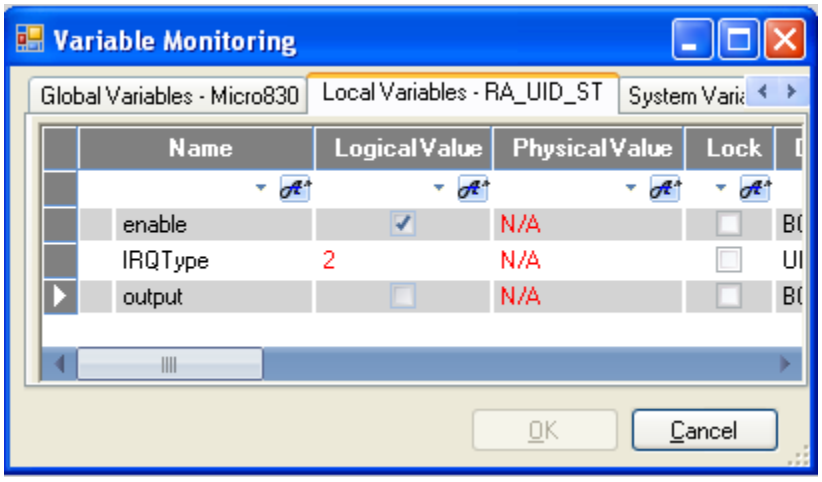
```
1  enable := TRUE;
2  IRQType := 2;
3  output := UID(enable, IRQType);
```



(* ST Equivalence: *)

TESTOUTPUT := UID(TESTENABLE, 2) ;

Results



UIE

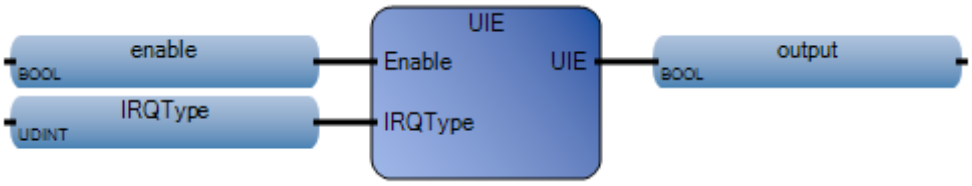
UIE enables a user interrupt.

Arguments

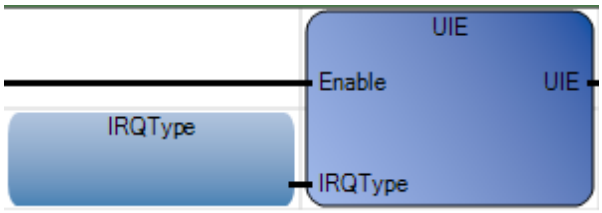
Parameter	Parameter Type	Data Type	Description	
Enable	Input	BOOL	Function enable. When Enable = TRUE, perform function. When Enable = FALSE, do not perform function.	
IRQType	Input	UDINT	Use the STI defined words. - IRQ_EII0 - IRQ_EII1 - IRQ_EII2 - IRQ_EII3 - IRQ_EII4 - IRQ_EII5 - IRQ_EII6 - IRQ_EII7 - IRQ_HSC0 - IRQ_HSC1 - IRQ_HSC2	- IRQ_HSC3 - IRQ_HSC4 - IRQ_HSC5 - IRQ_STI0 - IRQ_STI1 - IRQ_STI2 - IRQ_STI3 - IRQ_UFR - IRQ_UPM0 - IRQ_UPM1 - IRQ_UPM2 - IRQ_UPM3 - IRQ_UPM4
UIE	Output	BOOL	Rung status (same as Enable).	

UIE function language examples

Function block diagram

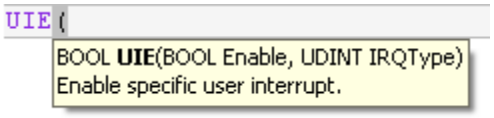


Ladder diagram



Structured text

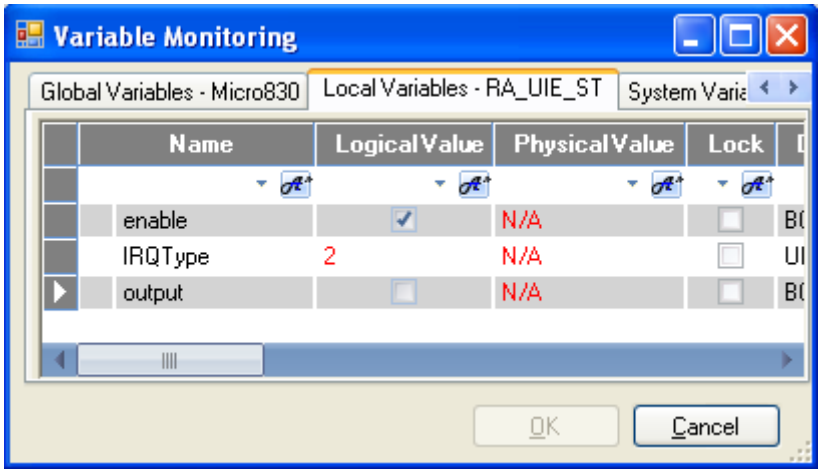
```
1  enable := TRUE;
2  IRQType := 2;
3  output := UIE(enable, IRQType);
```



(* ST Equivalence: *)

TESTOUTPUT := UIE(TESTENABLE, 2) ;

Results



UIF

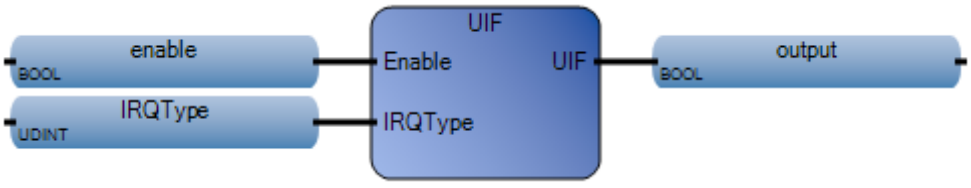
UIF flushes (removes) a pending user interrupt for selected user interrupt(s).

Arguments

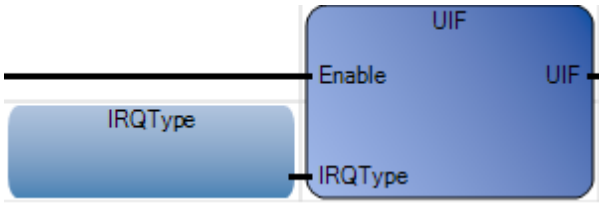
Parameter	Parameter Type	Data Type	Description	
Enable	Input	BOOL	Function enable. When Enable = TRUE, perform function. When Enable = FALSE, do not perform function.	
IRQType	Input	UDINT	Use the STI defined words. - IRQ_EII0 - IRQ_EII1 - IRQ_EII2 - IRQ_EII3 - IRQ_EII4 - IRQ_EII5 - IRQ_EII6 - IRQ_EII7 - IRQ_HSC0 - IRQ_HSC1 - IRQ_HSC2	- IRQ_HSC3 - IRQ_HSC4 - IRQ_HSC5 - IRQ_STI0 - IRQ_STI1 - IRQ_STI2 - IRQ_STI3 - IRQ_UFR - IRQ_UPM0 - IRQ_UPM1 - IRQ_UPM2 - IRQ_UPM3 - IRQ_UPM4
UIF	Output	BOOL	Rung status (same as Enable).	

UIF function language examples

Function block diagram

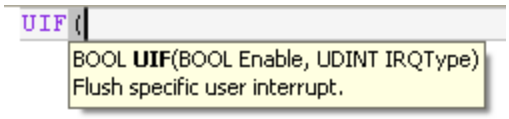


Ladder diagram



Structured text

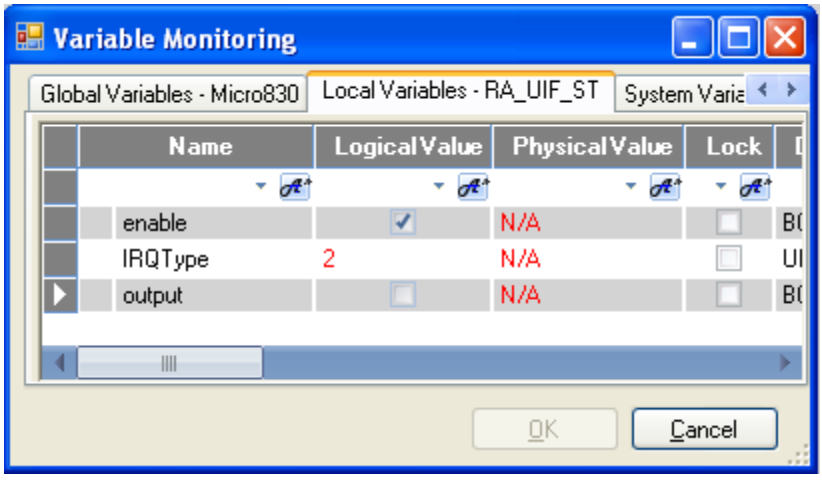
```
1  enable := TRUE;
2  IRQType := 2;
3  output := UIF(enable, IRQType);
```



(* ST Equivalence: *)

TESTOUTPUT := UIF(TESTENABLE, 2) ;

Results



Motion control instructions

Connected Components Workbench 2.0 and later includes a set of instructions for programming and designing the motion of a particular axis using motion control function blocks.

Function block	Description
Administrative	
MC_AbortTrigger (on page 441)	Abort function blocks which are connected to trigger events.
MC_Power (on page 469)	Controls the power stage (ON or OFF)
MC_ReadAxisError (on page 473)	Describes general axis errors
MC_ReadBoolParameter (on page 479)	Returns the value of a vendor specific parameter of type BOOL
MC_ReadParameter (on page 482)	Returns the value of a vendor specific parameter
MC_ReadStatus (on page 485)	Returns the status of the axis
MC_Reset (on page 490)	Resets all internal axis-related errors
MC_SetPosition (on page 493)	Shifts the coordinate system of an axis by manipulating the actual position
MC_TouchProbe (on page 501)	Records the axis position at a trigger event
MC_WriteBoolParameter (on page 506)	Modifies the value of a vendor specific parameter of type BOOL
MC_WriteParameter (on page 510)	Modifies the value of a vendor specific parameter
Motion	
MC_Halt (on page 444)	Stop the axis under normal operating conditions
MC_Home (on page 448)	Commands the axis to perform the <*search home*> sequence
MC_MoveAbsolute (on page 453)	Commands a controlled motion to a specified absolute position
MC_MoveRelative (on page 458)	Commands a controlled motion of a specified distance relative to the actual position at the time of the execution
MC_MoveVelocity (on page 463)	Commands a never ending controlled motion at a specified velocity
MC_Stop (on page 497)	Commands a controlled motion stop

General rules for motion control function blocks

The general rules for the Micro800 motion control function blocks follow the PLCopen Motion control specifications. The following table provides general rules about the interface of motion control function blocks.

Rule applies to	Rule
Input parameters	**With Execute**: The parameters are used with the rising edge of the execute input. To modify any parameter, change the input parameter(s) and trigger the motion again. **Note:** If an instance of a function block receives a new Execute before it finishes (as a series of commands on the same instance), the new Execute is ignored, and the previously issued instruction continues with its execution. **With Enable**: The parameters are used with the rising edge of the enable input and can be modified continuously.
Missing input parameters	Missing input is captured during User Application compilation. There is no missing input error handling at the controller level.
Inputs exceeding application limits	If a function block is commanded with parameters that result in a violation of application limits, the instance of the function block generates an error. In this case, the Error output is flagged On, and error information is indicated by the output ErrorID. The controller, in most cases, remains in Run mode, and there is no Motion Error reported as a major controller fault.
Sign rules for inputs	The Acceleration, Deceleration, and Jerk inputs are always positive values. Velocity, Position and Distance inputs can have positive and negative values.
Position versus Distance	Position is a value defined within a coordinate system. Distance is a relative measure related to technical units. Distance is the difference between two positions.
Position/Distance input	Only linear motion is supported on Micro800 controllers. For MC_MoveAbsolute function block, the position input is the absolute location to be commanded to the axis. For MC_MoveRelative, the distance input is the relative location (considering current axis position is 0) from current position.
Velocity input	Velocity can be a signed value, but it can also use Direction input to define the sign of the velocity (negative velocity x negative direction = positive velocity). The E parameter "Direction" refers to the velocity input and output for compatibility reasons.
Direction input	For distance (position) motion, with the target position (either absolute, or relative) defined, the motion direction is unique. The direction input for distance move is ignored. For velocity motion, direction input value can be 1 (positive direction), 0 (current direction) or -1 (negative direction). For any other value, only the sign is considered. For example, -3 denotes negative direction, +2 denotes positive direction, and so on. For velocity move (MC_MoveVelocity), the sign (velocity x direction) determines the actual motion direction if the value is not 0. For example, if velocity x direction = +300, then direction is positive.
Acceleration, Deceleration and Jerk inputs	• Deceleration or Acceleration inputs should have a positive value. If Deceleration or Acceleration is set to a non-positive value, the function block reports an error (Error ID: MC_FB_ERR_RANGE). • Jerk input should have a non-negative value. If Jerk is set to a negative value, the function block reports an error (Error ID: MC_FB_ERR_RANGE). • If Maximum Jerk is set to zero, all jerk parameters for the motion control function block, including jerk setting for MC_Stop have to be set to zero. If they are not, the function block reports an error (Error ID: MC_FB_ERR_RANGE). • If Jerk is set to a non-zero value, S-Curve profile is generated; if Jerk is set to 0, trapezoidal profile is generated. • Home Jerk configuration is not limited to Max Jerk configuration. • If the motion engine fails to generate the motion profile prescribed by the dynamic input parameters, the function block reports an error (Error ID: MC_FB_ERR_PROFILE).

Rule applies to	Rule
Output exclusivity	**With Execute**: When Execute is TRUE, one of the Busy, Done, Error, or CommandAborted outputs must also be TRUE. The outputs are mutually exclusive: only one output on one function block can be TRUE. Only one of the outputs Active, Error, Done and CommandAborted is set at one time. **With Enable**: The Valid and Error outputs are mutually exclusive: only one output on one function block can be TRUE.
Output status	**With Execute**: The Done, Error, ErrorID and CommandAborted outputs are reset with the falling edge of Execute instruction. However, the falling edge of Execute does not stop or influence the execution of the actual function block. Even if Execute is reset before the function block completes, the corresponding outputs are set for at least one cycle. If an instance of a function block receives a new Execute command before it completes (as a series of commands on the same instance), the new Execute command is ignored, and the previously issued instruction continues with execution. **With Enable**: Valid, Enabled, Busy, Error, and ErrorID outputs are reset with the falling edge of Enable as soon as possible.
Behavior of Done output	The Done output is set when the commanded action has successfully completed. When multiple function blocks are working on the same axis in a sequence, the following applies: • When one movement on an axis is interrupted with another movement on the same axis without having reached the final goal, Done on the first function block will not be set.
Behavior of Busy output	Every function block can have a Busy output, indicating the function block is not finished (for function blocks with an Execute input) or is not working and new output values can be expected (in case of Enable input). Busy is set at the rising edge of Execute and reset when one of the outputs Done, Aborted, or Error is set. The function block should be kept in the active loop of the application program for at least as long as Busy is TRUE because the outputs may change. Function blocks with the same instance that are busy cannot execute until it is no longer busy. Function blocks with different instances can abort the currently executing function block.
Behavior of CommandAborted output	The CommandAborted output is set when a commanded motion is interrupted by another motion command. The reset behavior of CommandAborted output is similar to Done output. When CommandAborted occurs, other output signals such as InVelocity are reset.
Output Active	The Active output is required on buffered function blocks, and is set at the moment the function block takes control of the motion of the according axis. For unbuffered mode, the Active and Busy outputs can have the same value.
Enable and Valid status	The Enable input is coupled to a Valid output. Enable is level sensitive, and Valid shows that a valid set of outputs is available at the function block. The Valid output is TRUE as long as a valid output value is available and the Enable input is TRUE. The relevant output value can be refreshed as long as the input Enable is TRUE. If there is a function block error, the output is not valid (Valid set to FALSE). When the error condition disappears, the values reappear and Valid output is set again.
Output error handling	**Outputs used to define errors** All blocks have the following two outputs that are used for errors that occur during execution: • Error – Rising edge of "Error" informs that an error occurred during the execution of the function block. • ErrorID – Error number. **Note**: Done and InVelocity outputs are used for successful completion so they are logically exclusive to Error. Instance errors do not always result in an axis error (bringing the axis to ErrorStop).
	How the error outputs are reset • Error outputs of the relevant function blocks are reset with tje falling edge of Execute and Enable. • The error outputs of a function block with Enable can be reset during operation without having to reset Enable.

Rule applies to	Rule
	Types of errors • Function blocks logics (for example, parameters out of range, state machine violation attempted, and so on) • HW Limit or SW Limit • Mechanism/Motor • Drive
Naming conventions ENUM types	Due to the naming constraints in the IEC standard on the uniqueness of variable names, the 'mc' reference to the PLCopen Motion Control namespace is used for the ENUMs. In this way we avoid the conflict that using the ENUM types 'positive' and 'negative' for instance with variables with these names throughout the rest of the project since they are called mcPositive and mcNegative respectively.

Motion control function block parameter details

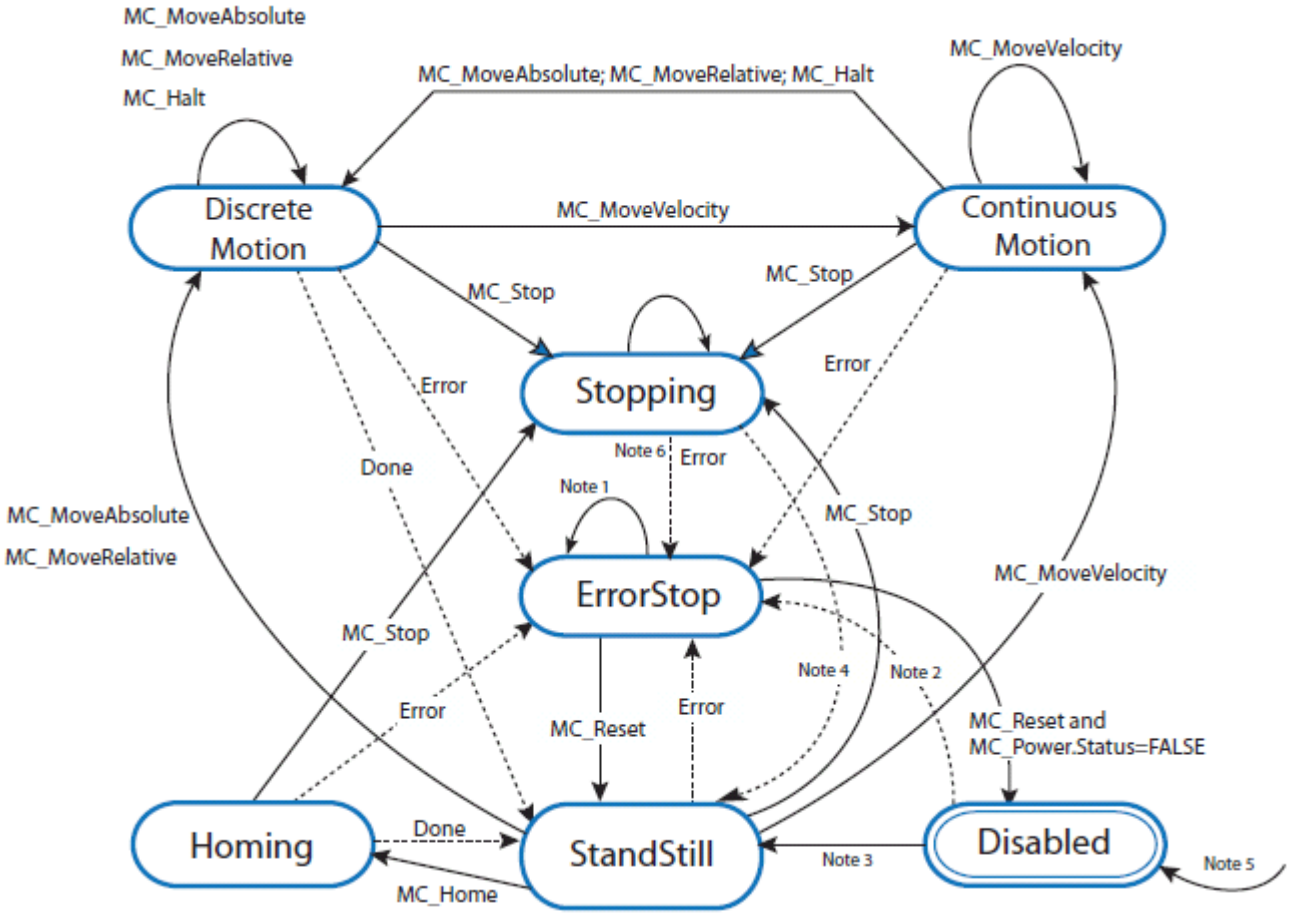
The following topics provide details for motion control parameters that are relevant to all motion control function blocks.

Motion control axis states

The basic rule for the behavior of the axis at a high level when multiple motion control function blocks are activated is that motion commands are always taken sequentially, even if the controller has the capability of real parallel processing. Any motion command is a transition that changes the state of the axis and, as a consequence, modifies the way the current motion is computed.

Motion control axis state diagram

The axis is always in one of the defined states as shown in the following diagram.



Motion control axis state behavior

The following table describes motion control axis states and parameters.

No.	Note
1	In the ErrorStop and Stopping states, all function blocks (except MC_Reset), can be called although they will not be executed. MC_Reset generates a transition to the Standstill state. If an error occurs while the state machine is in the Stopping state, a transition to the ErrorStop state is generated.
2	Power.Enable = TRUE and there is an error in the axis.
3	Power.Enable = TRUE and there is no error in the axis
4	MC_Stop.Done AND NOT MC_Stop.Execute.
5	When MC_Power is called with Enable = False, the axis goes to the Disabled state for every state including ErrorStop.
6	If an error occurs while the state machine is in Stopping state, a transition to the ErrorStop state is generated.

Motion control axis state code values

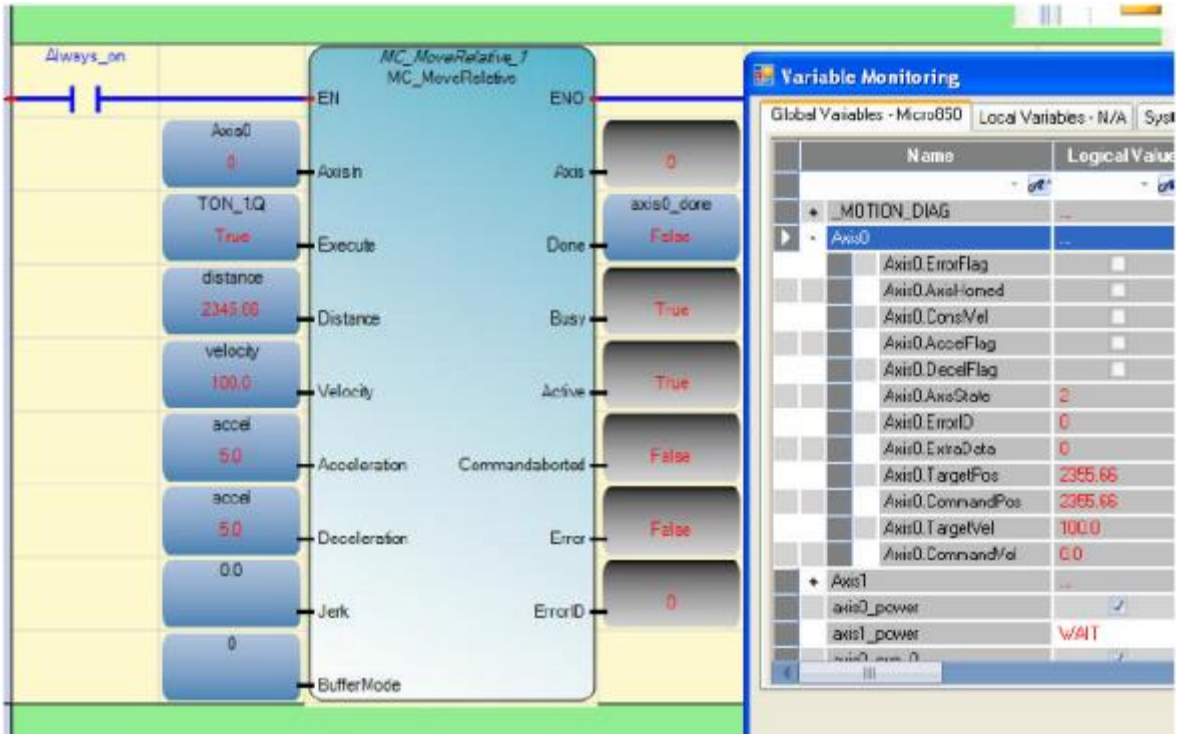
You can monitor the axis state using the Axis Monitor feature. The following table identifies the values used to define each of the predefined axis states.

State value	State name
0x00	Disabled
0x01	Standstill
0x02	Discrete Motion
0x03	Continuous Motion
0x04	Homing
0x06	Stopping
0x07	Error Stop

Axis state updates

On motion execution, the axis state update is dependent on when the relevant motion function block is called by the POU scan. This is the case even though the motion profile is controlled by the Motion Engine as a background task, and is independent from the POU scan.

For example, on a moving axis on a Ladder POU (state of a rung=true), an MC_MoveRelative function block in the rung is scanned and the axis starts to move. Before MC_MoveRelative completes, the state of the rung becomes False, and MC_MoveRelative is no longer scanned. In this case, the state of the axis cannot switch from Discrete Motion to StandStill, even after the axis fully stops, and the velocity comes to 0.



Motion control function block parameter numbers

The following function blocks use specific parameter numbers when the function blocks are programmed.

- MC_ReadParameter
- MC_ReadBoolParameter
- MC_WriteParameter
- MC_WriteBoolParameter

Parameter number identification

Parameter numbers between 0 and 999 are reserved for standard parameters. Extensions by a supplier or user are also allowed, although using them can affect portability between different platforms. If the parameter number is greater than 999, the parameter is supplier-specific.

Parameter number	Parameter Name	Data type	R/W	Description
1	Commanded Position	REAL	R	Commanded position.
2	SWLimitPos	REAL	R/W	Positive software limit switch position.
3	SWLimitNeg	REAL	R/W	Negative software limit switch position.
4	EnableLimitPos	BOOL	R/W	Enable positive software limit switch.
5	EnableLimitNeg	BOOL	R/W	Enable negative software limit switch.
8	MaxVelocitySystem	REAL	R	Maximal allowed velocity of the axis in the motion system.
9	MaxVelocityAppl	REAL	R/W	Maximal allowed velocity of the axis in the application.
11	CommandedVelocity	REAL	R	Commanded velocity.
12	MaxAccelerationSystem	REAL	R	Maximal allowed acceleration of the axis in the motion system.
13	MaxAccelerationAppl	REAL	R/W	Maximal allowed acceleration of the axis in the application.
14	MaxDecelerationSystem	REAL	R	Maximal allowed deceleration of the axis in the system.
15	MaxDecelerationAppl	REAL	R/W	Maximal allowed deceleration of the axis in the application.
16	MaxJerk	REAL	R/W	Maximal allowed jerk of the axis.
1001	TargetPosition	REAL	R	The final target position for current active moving function block
1002	TargetVelocity1	REAL	R	The final target velocity for current active moving function block.
1005	Duty Cycle	REAL	R/W	The pulse duty cycle for one pulse. The valid value is 0 – 100, indicating 0% - 100%. (PWM function can be realized by adjusting this value). This parameter is configurable only using this Function Block. The default value is set 50.0 by the controller. **Note**: For Duty Cycle, the value will be overwritten by the default setting, 50.0 when the controller is switched from RUN mode to PRG and RUN again, or when the controller power is cycled.
1006	PulsePerRevolution	REAL	R	The Pulse per Revolution setting input by user in CCW GUI.
1007	TravelPerRevolution	REAL	R	The Travel per Revolution setting input by user in CCW GUI.

Motion control function block error IDs

When a motion control function block ends with an error, and the axis state is ErrorStop, in most cases, MC_Reset function block (or, MC_Power Off/On and MC_Reset) can be used to recover the axis. The axis can be reset to normal motion operation without stopping the controller operation.

Value	MACRO ID	Description
00	MC_FB_ERR_NO	The function block execution is successful.
01	MC_FB_ERR_ WRONG_STATE	The function block cannot execute because the axis is not in the correct state. Check the axis state.
02	MC_FB_ERR_RANGE	The function block cannot execute because there is invalid axis dynamic parameter(s) (velocity, acceleration, deceleration, or jerk) set in the function block. Correct the setting for the dynamic parameters in the function block against Axis Dynamics configuration page.
03	MC_FB_ERR_PARAM	The function block cannot execute because there is invalid parameter other than velocity, acceleration, deceleration, or jerk, set in the function block. Correct the setting for the parameters (for example, mode or position) for the function block.
04	MC_FB_ERR_AXISNUM	The function block cannot execute because the axis does not exist, the axis configuration data is corrupted, or the axis is not correctly configured.
05	MC_FB_ERR_MECHAN	The function block cannot execute because this axis gets a fault due to drive or mechanical issues. Check the connection between the drive and the controller (Drive Ready and In-Position signals), and ensure the drive is operating normally.
06	MC_FB_ERR_NOPOWER	The function block cannot execute because the axis is not powered on. Power on the axis using MC_Power function block.
07	MC_FB_ERR_RESOURCE	The function block cannot execute because the resource required by the function block is controlled by some other function block or it is not available. Ensure the resource required by the function block is available for use. Examples: • MC_Power try to control the same axis. • MC_Stop are executed against the same axis at the same time. • MC_TouchProbe are executed against the same axis at the same time.) • MC_TouchProbe is executed, while touch probe input is not enabled in Motion Configuration.
08	MC_FB_ERR_PROFILE	The function block cannot execute because the motion profile defined in the function block cannot be achieved. Correct the profile in the function block.
09	MC_FB_ERR_VELOCITY	The function block cannot execute because the motion profile requested in the function block cannot be achieved due to current axis velocity. Examples: • The function block requests the axis to reverse the direction while the axis is moving. • The required motion profile cannot be achieved due to current velocity too low or too high. Check the motion profile setting in the function block, and correct the profile, or re-execute the function block when the axis velocity is compatible with the requested motion profile.
0A	MC_FB_ERR_SOFT_LIMIT	This function block cannot execute as it will end up moving beyond the Soft Limit, or the function block is aborted as the Soft Limit has been reached. Check the velocity or target position settings in the function block, or adjust Soft Limit setting.

Value	MACRO ID	Description
0B	MC_FB_ERR_HARD_LIMIT	This function block is aborted as the Hard Limit switch active state has been detected during axis movement, or aborted as the Hard Limit switch active state has been detected before axis movement starts. Move the axis away from the Hard Limit switch in the opposite direction.
0C	MC_FB_ERR_LOG_LIMIT	This function block cannot execute as it will end up moving beyond the PTO Accumulator logic limit, or the function block is aborted as the PTO Accumulator logic limit has been reached. Check the velocity or target position settings for the function block. Or use MC_SetPosition function block to adjust the axis coordinate system.
0D	MC_FB_ERR_ ERR_ENGINE	A motion engine execution error is detected during the execution of this function block. Power cycle the whole motion setup, including controller, drives and actuators, and re-download the User Application. If the fault persists, call Tech support.
10	MC_FB_ERR_ NOT_HOMED	The function block cannot execute because the axis need to be homed first. Execute homing against the axis using MC_Home function block.
80	MC_FB_ERR_ PARAM_MODIFIED	**Warning**: The requested velocity for the axis has been adjusted to a lower value. The function block executes successfully at a lower velocity.

Axis error scenarios

In most cases, when a movement function block instruction issued to an axis results in a function block error, the axis is also flagged as being in an Error state, and the corresponding ErrorID element is set on the AXIS_REF data for the axis. However, in the following situations, an axis error may not always be flagged, and it is still possible for the user application to issue a successful movement function block to the axis after the axis state changes.

Scenario	Example
A movement function block instructs an axis, but the axis is in a state in which the function block cannot be executed properly.	The axis has no power, or the axis is in a Homing sequence, or in an Error Stop state.
A movement function block instructs an axis, but the axis is still controlled by another movement function block. The axis cannot allow the motion to be controlled by the new function block without going to a full stop.	The new function block commands the axis to change motion direction.
When one movement function block tries to control an axis, but the axis is still controlled by another movement function block, and the newly-defined motion profile cannot be realized by the controller.	User Application issues an S-Curve MC_MoveAbsolute function block to an axis with too short a distance given when the axis is moving.

AXIS_REF data type

The AXIS_REF data type is a data structure that contains information for a motion axis. It is used as an input and output variable in all motion control function blocks. An instance of an AXIS_REF data type is automatically created when you add a motion axis to the configuration.

Parameter	Data type	Description
Axis_ID	AXIS_REF	The logic axis ID automatically assigned by Connected Components Workbench. It cannot be edited or viewed by user.
Error Flag	BOOL	Indicates whether an error is present in the axis.
AxisHomed	BOOL	Indicates whether homing operation is successfully executed for the axis or not. When the user tries to redo homing for an axis with AxisHomed already set (homing performed successfully), and the result is not successful, the AxisHomed status is cleared.
ConstVel	BOOL	Indicates whether the axis is in Constant Velocity movement or not. Stationary axis is not considered in Constant Velocity.
AccFlag	BOOL	Indicates whether the axis is in an Accelerating movement or not.
DecelFlag	BOOL	Indicates whether the axis is in an Decelerating movement or not.
AxisState	USINT	Indicates the current state of the axis.
ErrorID	UINT	Indicates the cause for axis error when error is indicated by ErrorFlag. This error usually results from motion control function block execution failure.
ExtraData	UINT	Reserved.
TargetPos	REAL	Indicates the final target position of the axis for MoveAbsolute and MoveRelative function blocks. For MoveVelocity, Stop, and Halt function blocks, TargetPos is 0 except when the TargetPos set by previous position function blocks is not cleared.
CommandPos	REAL	During motion, this is the current position the controller commands the axis to take. There may be a slight delay between the axis actual position and this CommandPos.
TargetVel	REAL	The maximum target velocity instructed to the axis for a moving function block. The value of TargetVel in current function block, or smaller than it, depending on the other parameters in the same function block.
CommandVel	REAL	During motion, this element indicates the current velocity the controller instructs the axis to use. Note that there may be a slight difference between the axis actual velocity and CommandVel, due to the drive delay or drive adjustment overshoot.

Important: Once an axis is flagged with and error, and the error ID is not zero, the axis must be reset using MC_Reset before issuing any other movement function block.

Axis variables

Axis variables are used to control position, speed, acceleration, and error for a given motion control axis.

Assigning a variable to an Axis output parameter

In a Function Block Diagram

You can graphically connect the Axis output parameter of a motion control function block to the AxisIn input parameter of another motion control function block for convenience. For example, connect MC_POWER Axis output parameter to MC_HOME AxisIn input parameter. j

In a Ladder Diagram

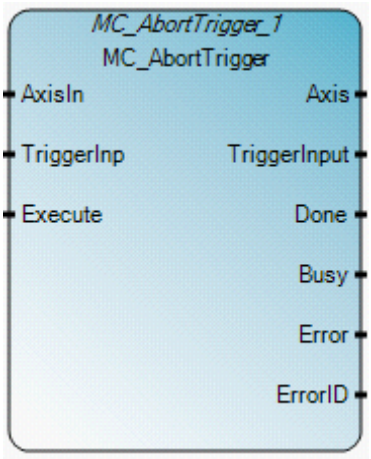
You cannot assign a variable to the Axis output parameter of a motion control function block because it is read-only.

Monitoring an AXIS_REF variable

You can monitor an AXIS_REF variable in the software while in the controller debug mode when the motion engine is active, or in the user application as part of user logic. You can also monitor the AXIS_REF variable remotely through various communication channels.

MC_AbortTrigger

MC_AbortTrigger aborts other function blocks that are connected to trigger events. For example, MC_TouchProbe.



MC_AbortTrigger operation

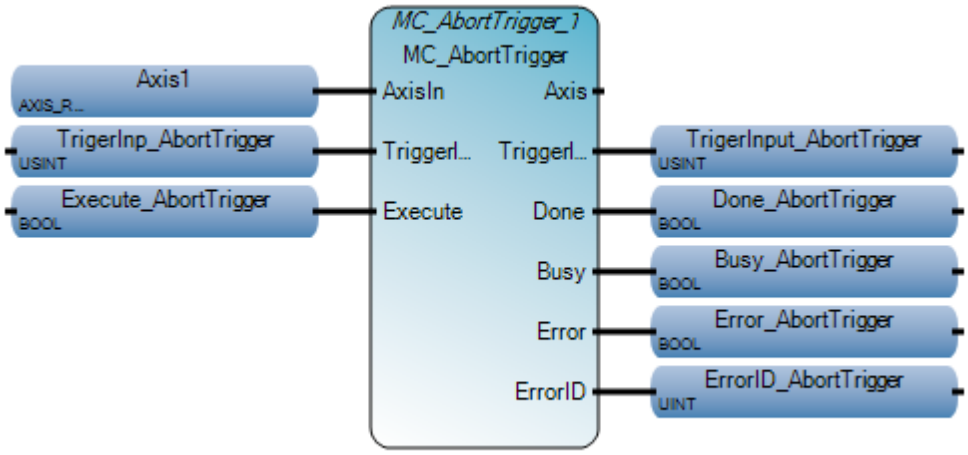
- The MC_AbortTrigger function block only executes when it is assigned to an axis that is controlled by MC_TouchProbe.

Arguments

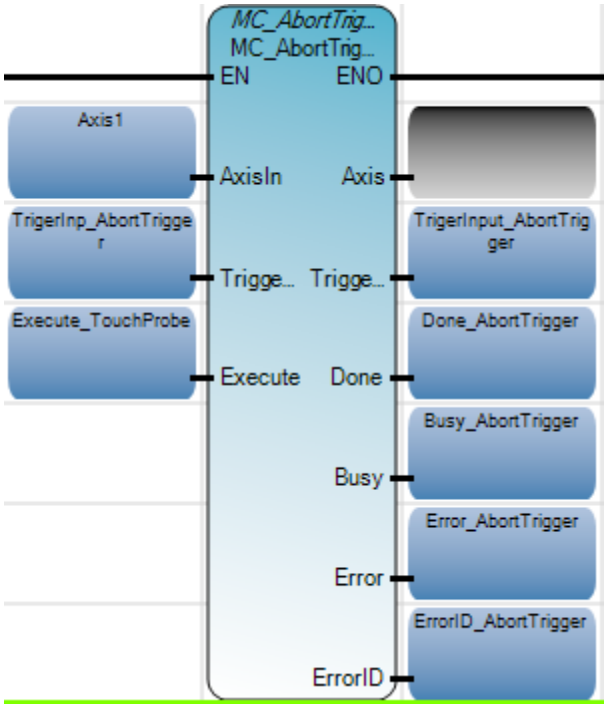
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_AbortTrigger computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
TriggerInp	Input	USINT	This parameter is ignored.
Execute	Input	BOOL	When TRUE, aborts the trigger event at the rising edge.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
TriggerInput	Output	USINT	This parameter is ignored.
Done	Output	BOOL	TRUE when the trigger event is aborted.
Busy	Output	BOOL	TRUE when the function block is not finished.
Error	Output	BOOL	TRUE when an error is detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_AbortTrigger function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



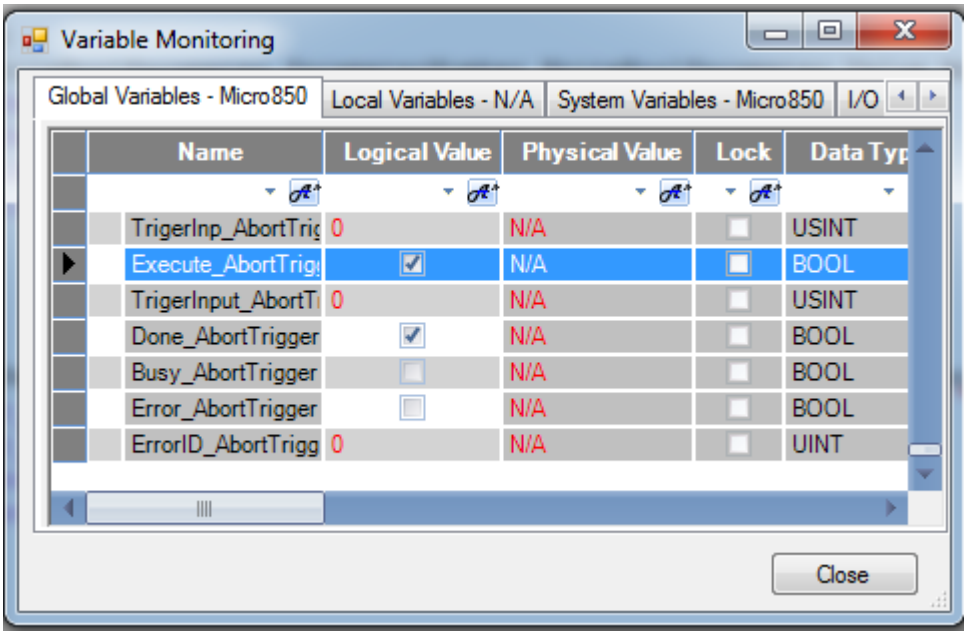
Structured Text (ST)

```
MC_AbortTrigger_1(Axis1,TrigerInp_AbortTrigger,Execute_AbortTrigger);
Done_AbortTrigger := MC_AbortTrigger_1.Done;
Busy_AbortTrigger := MC_AbortTrigger_1.Busy;
Error_AbortTrigger := MC_AbortTrigger_1.Error;
ErrorID_AbortTrigger := MC_AbortTrigger_1.ErrorID;
```

```
MC_AbortTrigger_1(
```

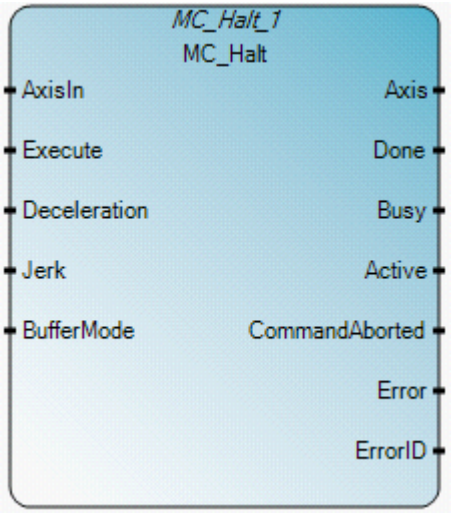
void **MC_AbortTrigger_1**(AXIS_REF AxisIn, USINT TriggerInp, BOOL Execute)
Type : MC_AbortTrigger, Abort Function Blocks connected to trigger events (e.g. MC_TouchProbe)

Results



MC_Halt

MC_Halt commands a controlled motion stop. Use MC_Halt to stop the axis under normal operating conditions. The axis state changes to DiscreteMotion, until velocity is zero. When velocity reaches zero, Done is set to True and the axis state changes to StandStill.



MC_Halt operation

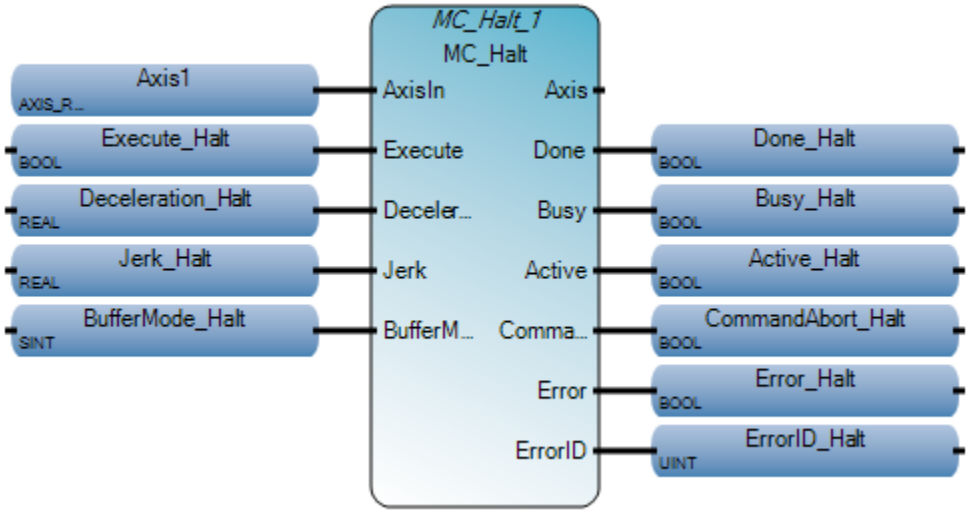
- It is possible to execute another motion command during deceleration of the axis, which aborts the MC_Halt function block.
- If an MC_Halt function block is issued when the axis state is Homing, the function block reports an error, and the homing process is not interrupted.

Arguments

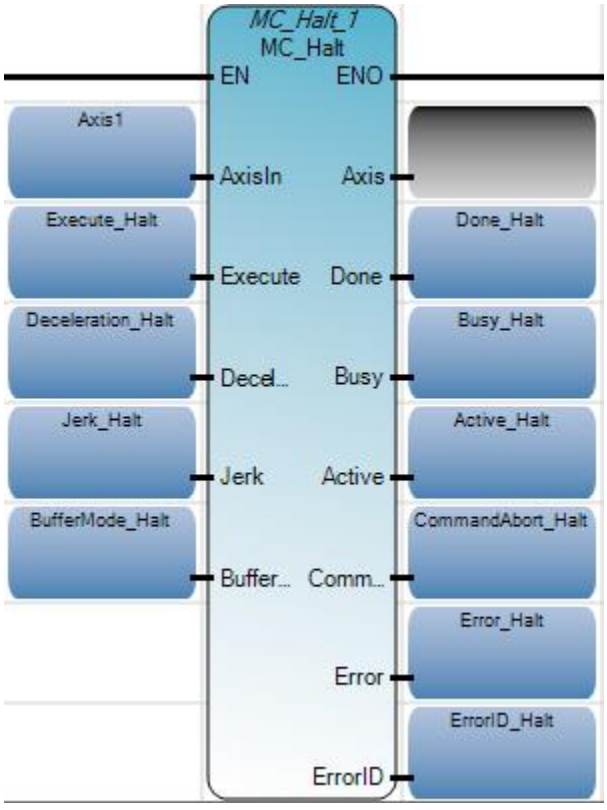
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_Halt computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, start the motion at rising edge. Note: Executing MC_Halt during homing, MC_Halt is set to MC_FB_ERR_STATE and the homing process continues.
Deceleration	Input	REAL	Value of the deceleration (always positive) (decreasing energy of the motor). Note: If Deceleration <= 0 and the axis state is not Standstill, MC_Halt is set to MC_FB_ERR_RANGE.
Jerk	Input	REAL	Value of the Jerk (always positive). Note: If Jerk < 0 and the axis state is Standstill, MC_Halt is set to MC_FB_ERR_RANGE.
BufferMode	Input	SINT	Not used. The mode is always MC_Aborting.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	Zero velocity reached.
Busy	Output	BOOL	The function block is not finished.
Active	Output	BOOL	Indicates that the function block has control on the axis.
CommandAborted	Output	BOOL	Command is aborted by another command, or error stop.
Error	Output	BOOL	FALSE - No error. TRUE - An error is detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_Halt function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



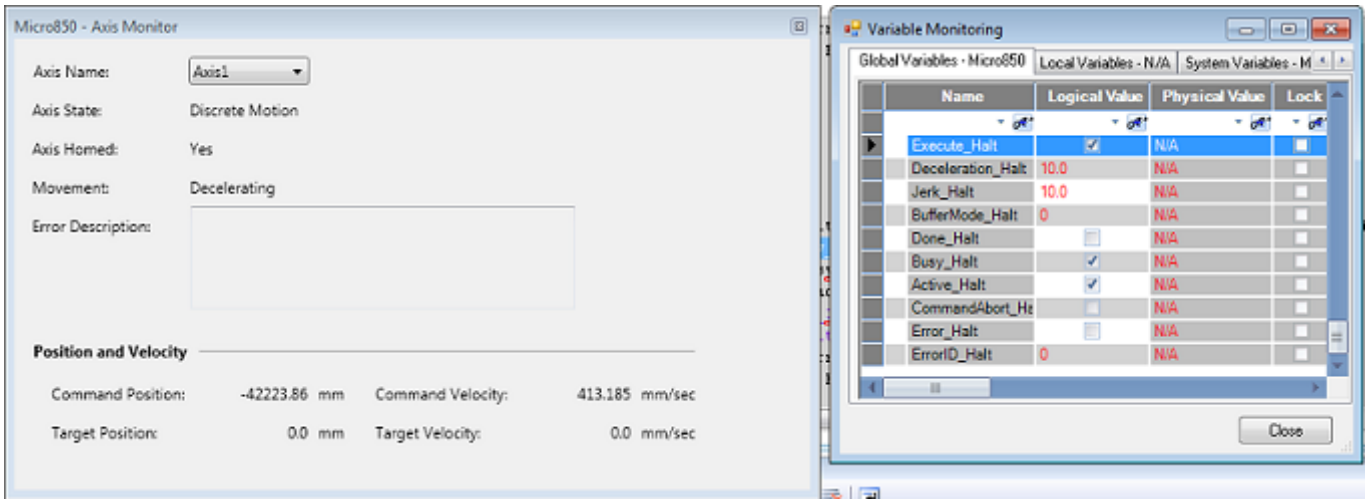
Structured Text (ST)

```
Deceleration_Halt := 10.0;
Jerk_Halt := 10.0;
MC_Halt_1(Axis1,Execute_Halt,Deceleration_Halt,Jerk_Halt,BufferMode_Halt);
Done_Halt := MC_Halt_1.Done;
Busy_Halt := MC_Halt_1.Busy;
Active_Halt := MC_Halt_1.Active;
CommandAbort_Halt := MC_Halt_1.CommandAborted;
Error_Halt := MC_Halt_1.Error;
ErrorID_Halt := MC_Halt_1.ErrorID;
```

```
MC_Halt_1(
```

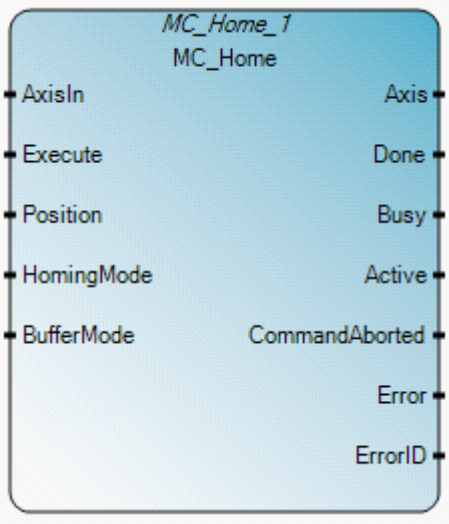
void **MC_Halt_1**(AXIS_REF AxisIn, BOOL Execute, REAL Deceleration, REAL Jerk, SINT BufferMode)
Type : MC_Halt, Commands a controlled motion stop. The axis is moved to the state Discrete Motion, until the velocity is zero.

Results



MC_Home

MC_Power commands the axis to perform the <*search home*> sequence. The details of this sequence are manufacturer dependent and can be set by the axis parameters. The "Position" input is used to set the absolute position when a reference signal is detected, and the configured Home offset is reached.



MC_Home operation

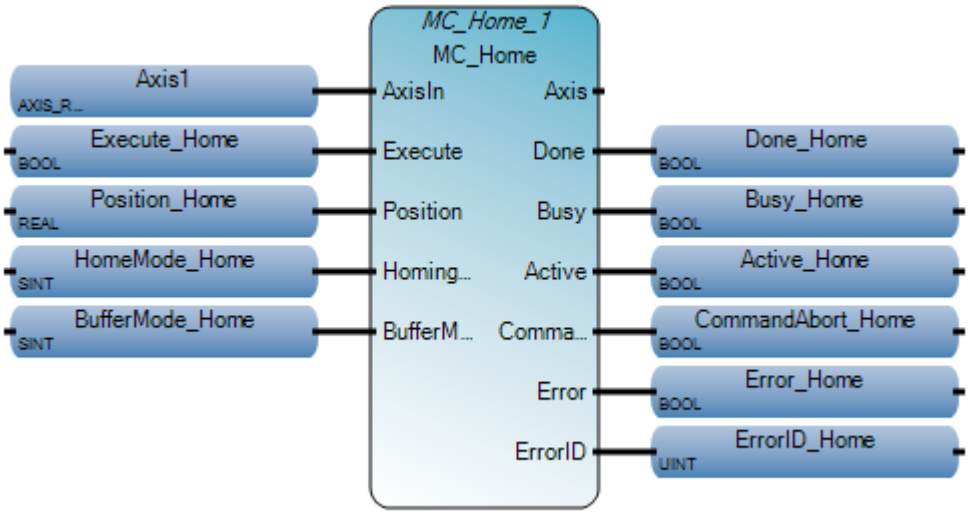
- After MC_Power is issued, the axis Homed status is reset to 0 (not homed). In most cases, after the axis is powered on, the MC_Home function block needs to be executed to calibrate the axis position and the Home reference.
- The MC_Home function block can only be aborted using a MC_Stop or a MC_Power function block. If it is aborted before it completes, the previously searched Home position is considered invalid and the axis Homed status is cleared.

Arguments

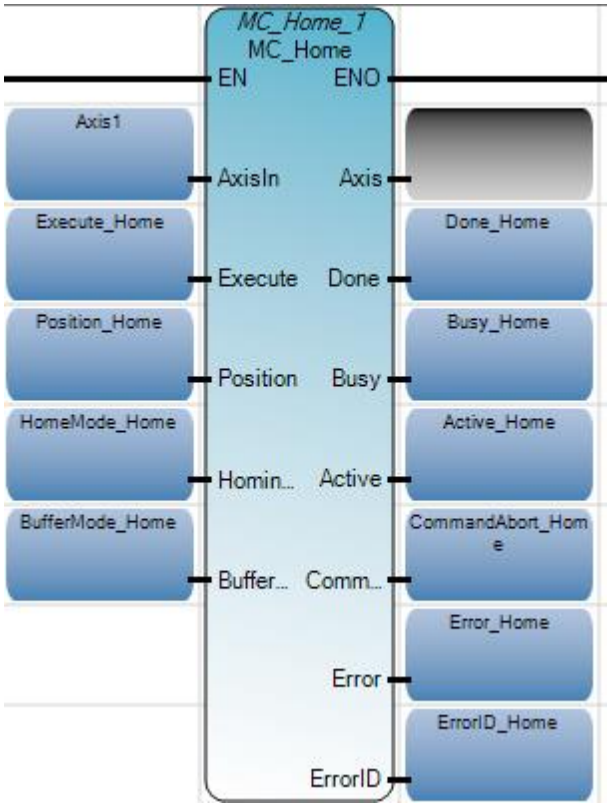
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_Home computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, starts the motion at the rising edge.
Position	Input	REAL	Absolute position is set when the reference signal is detected and configured Home offset is reached. The value range for this input is -0x40000000 – 0x40000000 physical pulse after the position is converted from user position unit to PTO pulse. Set the Position value within the Soft Limit. An invalid input value results in an error. Error ID = **MC_FB_ERR_PARAM**.
HomingMode	Input	SINT	Enum input for Homing mode See Homing modes (on page 452).
BufferMode	Input	SINT	Not used. The mode is always mcAborting.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, the Homing operation completed successfully and the axis state is set to StandStill.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Active	Output	BOOL	When TRUE, indicates that the function block has control on the axis.
CommandAborted	Output	BOOL	When TRUE, command was aborted by another command, or error stop.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UNIT	Error identification. See also Motion control function block error IDs (on page 436).

MC_Home function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



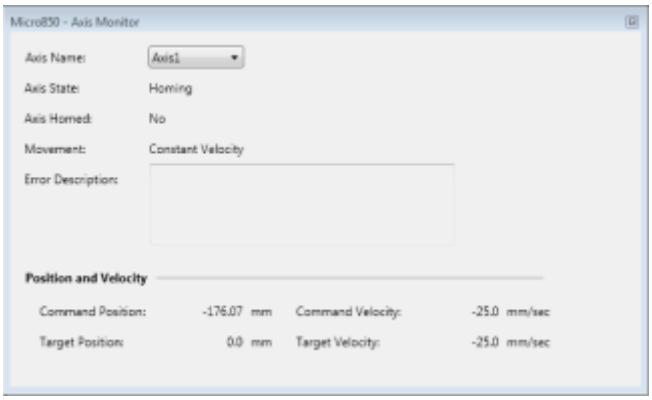
Structured Text (ST)

```
MC_Home_1(
```

void **MC_Home_1**(AXIS_REF AxisIn, BOOL Execute, REAL Position, SINT HomingMode, SINT BufferMode)
Type : MC_Home, Commands the axis to perform the home searching sequence

```
Position_Home := -50000.0;
HomeMode_Home := 4;  (*1*)
MC_Home_1(Axis1,Execute_Home,Position_Home,HomeMode_Home,BufferMode_Home);
Done_Home := MC_Home_1.Done;
Busy_Home := MC_Home_1.Busy;
Active_Home := MC_Home_1.Active;
CommandAbort_Home := MC_Home_1.CommandAborted;
Error_Home := MC_Home_1.Error;
ErrorID_Home := MC_Home_1.ErrorID;
```

Results



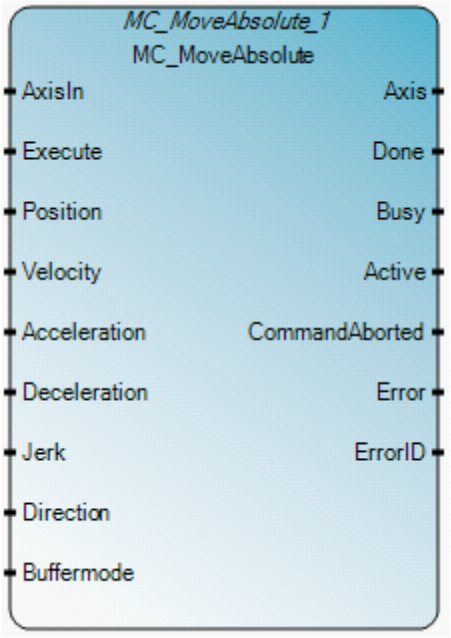
Name	Alias	Logical Value	Physical Value	Initial Value	Lock	Data T
Execute_Home		☑	N/A		☐	BOOL
Position_Home		-50000.0	N/A		☐	REAL
HomeMode_Home		1	N/A		☐	SINT
BufferMode_Home		0	N/A		☐	SINT
Done_Home		☐	N/A		☐	BOOL
Busy_Home		☑	N/A		☐	BOOL
Active_Home		☑	N/A		☐	BOOL
CommandAbort_Hc		☐	N/A		☐	BOOL
Error_Home		☐	N/A		☐	BOOL
ErrorID_Home		0	N/A		☐	UINT

Homing modes

Value	Name	Description
0x00	MC_HOME_ABS_SWITCH	Homing process by searching Home Absolute switch
0x01	MC_HOME_LIMIT_SWITCH	Homing process by searching limit switch
0x02	MC_HOME_REF_WITH_ABS	Homing process by searching Home Absolute switch plus using encoder reference pulse
0x03	MC_HOME_REF_PULSE	Homing process by searching limit switch plus using encoder reference pulse
0x04	MC_HOME_DIRECT	Static homing process with direct forcing a home position from user reference. The function block will set current position the mechanism is in as home position, with its position determined by the input parameter, "Position"

MC_MoveAbsolute

MC_MoveAbsolute commands a controlled motion to a specified absolute position.



MC_MoveAbsolute operation

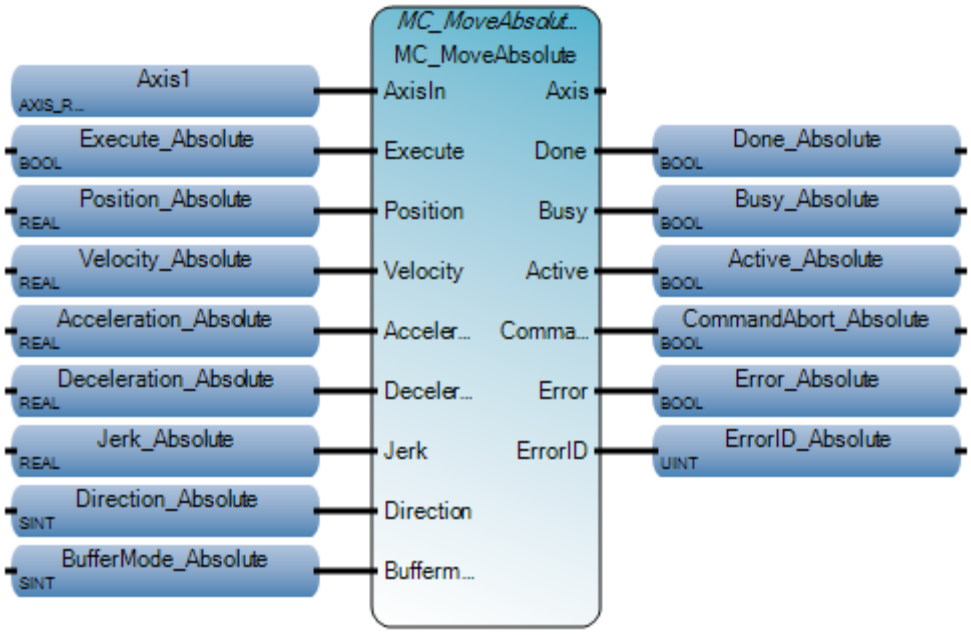
- For a Micro800 controller, the sign of the input Velocity for a MC_MoveAbsolute function block is ignored because the motion direction is determined by the Current position and the Target position.
- For a Micro800 controller, the input Direction for a MC_MoveAbsolute function block is ignored because there is only one mathematical solution to reach the Target position.
- If the MC_MoveAbsolute function block is issued when the Micro800 controller axis state is StandStill and the relative distance to move is zero, the execution of the function block is immediately reported as Done.
- If a MC_MoveAbsolute function block is issued to an axis that is not in the Homed, position, the function block reports an error.
- The MoveAbsolute function block completes with Velocity zero if it is not aborted by another function block.

Arguments

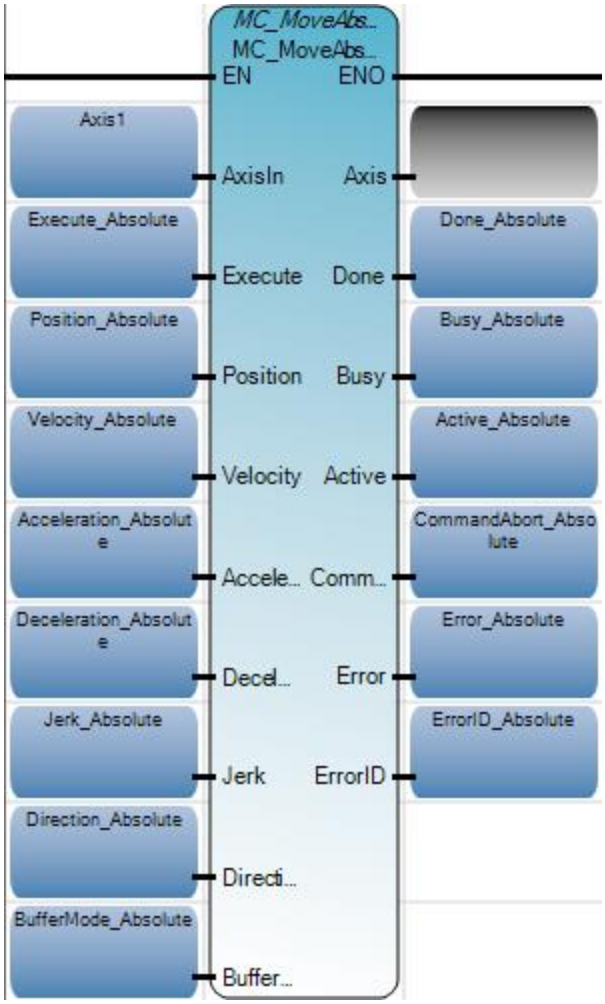
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_MoveAbsolute computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, starts the motion at rising edge. The axis should be in the home position when this execute command is issued or an error occurs, MC_FB_ERR_NOT_HOMED.
Position	Input	REAL	Target position for the motion in technical unit (negative or positive). **Note**: The technical unit is defined in the Motion - General configuration page for an axis.
Velocity	Input	REAL	Value of the maximum velocity. The maximum velocity may not be reached when Jerk = 0. The sign of Velocity is ignored, the motion direction is determined by the input Position.
Acceleration	Input	REAL	Value of the acceleration (always positive - increasing energy to the motor.) user unit/sec^2
Deceleration	Input	REAL	Value of the deceleration (always positive - decreasing energy to the motor). u/sec^2
Jerk	Input	REAL	Value of the Jerk (always positive). u/sec^3 **Note**: When the value of the input Jerk = 0, the Trapezoid profile is calculated by Motion Engine. When Jerk > 0, the S-Curve profile is calculated.
Direction	Input	SINT	This parameter is not used.
BufferMode	Input	SINT	This parameter is not used.
ENO	Output	BOOL	Enable out Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, command position reached. When the In-Position Input is configured as Enabled for this axis, the drive needs to set In-Position Input signal active before this Done bit goes to True. This action completes with velocity zero unless it is aborted.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Active	Output	BOOL	When TRUE, indicates that the function block has control of the axis
CommandAborted	Output	BOOL	When TRUE, the Command was aborted by another command, or error stop.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_MoveAbsolute function block language examples

Function Block Diagram (FBD)

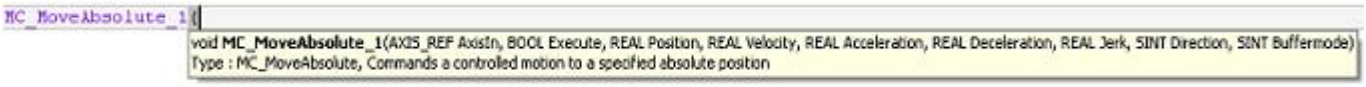


Ladder Diagram (LD)

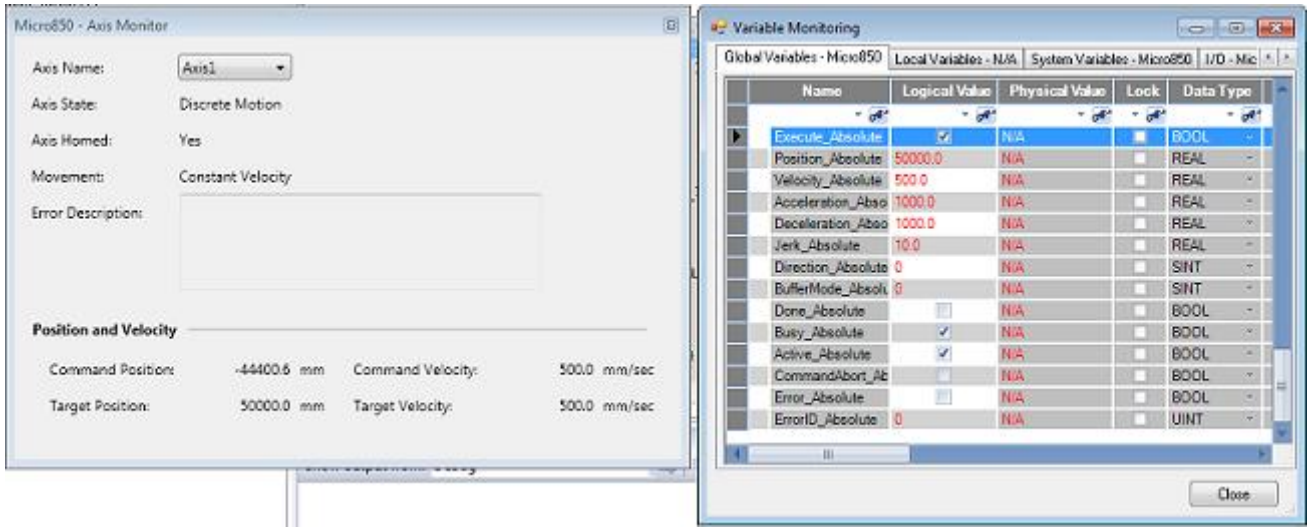


Structured Text (ST)

```
Position_Absolute := 50000.0;
Velocity_Absolute := 500.0;
Acceleration_Absolute := 1000.0;
Deceleration_Absolute := 1000.0;
Jerk_Absolute := 10.0;
MC_MoveAbsolute_1(Axis1,Execute_Absolute,Position_Absolute,Velocity_Absolute,
Acceleration_Absolute,Deceleration_Absolute,Jerk_Absolute,Direction_Absolute,BufferMode_Absolute);
Done_Absolute := MC_MoveAbsolute_1.Done;
Busy_Absolute := MC_MoveAbsolute_1.Busy;
Active_Absolute := MC_MoveAbsolute_1.Active;
CommandAbort_Absolute := MC_MoveAbsolute_1.CommandAborted;
Error_Absolute := MC_MoveAbsolute_1.Error;
ErrorID_Absolute := MC_MoveAbsolute_1.ErrorID;
```

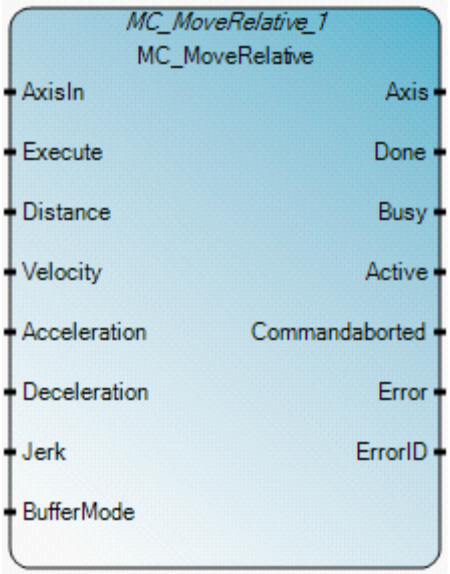


Results



MC_MoveRelative

MC_MoveRelative commands a controlled motion of a specified distance relative to the actual position at the time of the execution.



MC_MoveRelative operation

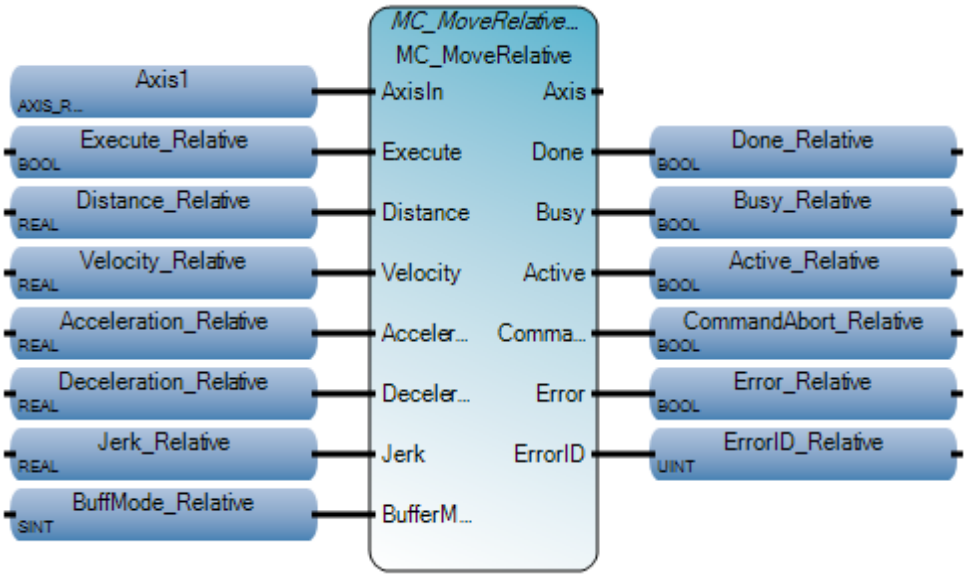
- Because the motion direction for a MC_MoveRelative function block is determined by the current position and the target position, the sign of the Velocity is ignored.
- The MoveRelative function block completes with Velocity zero if it is not aborted by another function block.
- If the MC_MoveRelative function block is issued when the Micro800 controller axis state is StandStill and the relative distance to move is zero, the execution of the function block is immediately reported as Done.
- For a Micro800 controller, the sign of the input Velocity for a MC_MoveRelative function block is ignored because the motion direction is determined by the Current position and the Target position.

Arguments

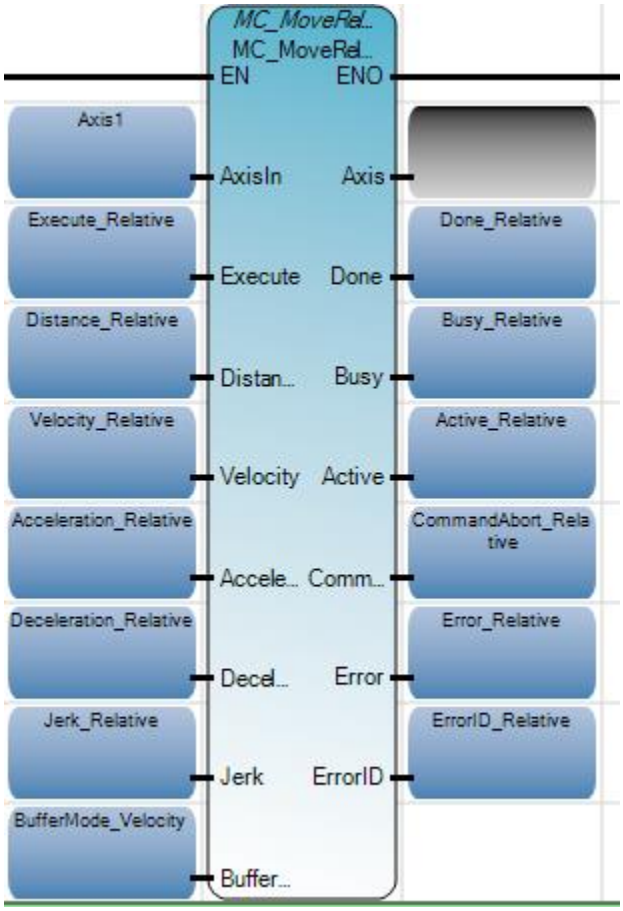
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_MoveRelative computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, starts the motion at rising edge.
Distance	Input	REAL	Relative distance for the motion (in technical unit [u]).
Velocity	Input	REAL	Value of the maximum velocity (not necessarily reached) [u/s]. As the motion direction is determined by input Position, the sign of Velocity is ignored by the function block. **Note:** The maximum velocity may not be reached when Jerk = 0.
Acceleration	Input	REAL	Value of the acceleration (increasing energy of the motor) [u/s**2**]
Deceleration	Input	REAL	Value of the deceleration (decreasing energy of the motor) [u/s**2**]
Jerk	Input	REAL	Value of the Jerk [u/s^3]
BufferMode	Input	SINT	This parameter is not used.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, commanded distance reached. When the In-Position input is enabled for an axis, the In-Position signal must be set to active before Done = True.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Active	Output	BOOL	When TRUE, indicates that the function block has control on the axis
CommandAborted	Output	BOOL	Command is aborted by another command, or Error Stop.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_MoveRelative function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



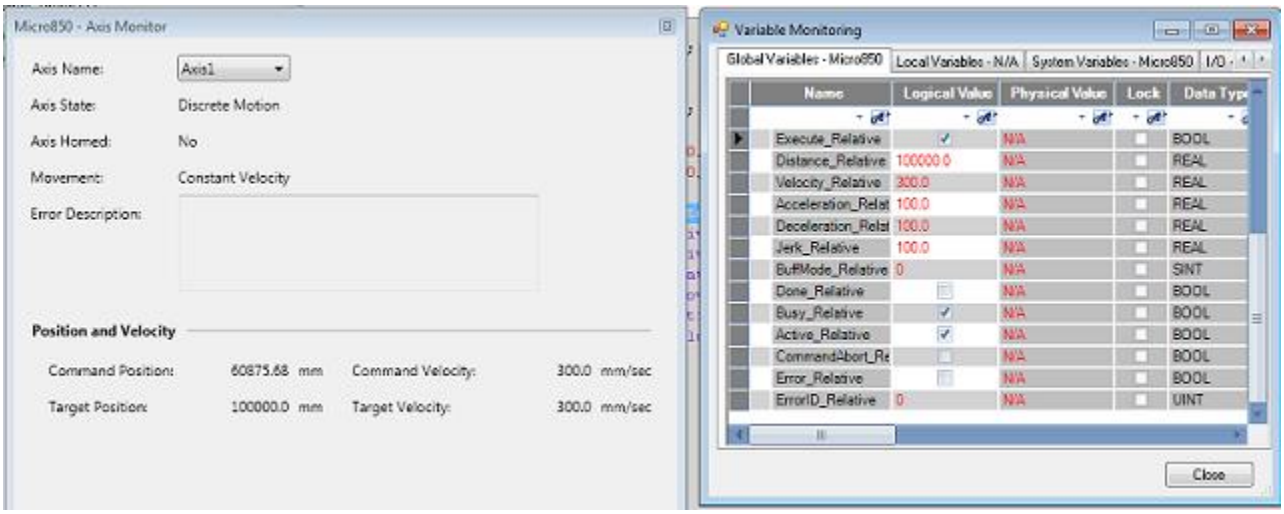
Structured Text (ST)

```
Distance_Relative := 100000.0;
Velocity_Relative := 300.0;
Acceleration_Relative := 100.0;
Deceleration_Relative := 100.0;
Jerk_Relative := 100.0;
MC_MoveRelative_1(Axis1,Execute_Relative,Distance_Relative,
Velocity_Relative,Acceleration_Relative,Deceleration_Relative,Jerk_Relative,BuffMode_Relative);
Done_Relative := MC_MoveRelative_1.Done;
Busy_Relative := MC_MoveRelative_1.Busy;
Active_Relative := MC_MoveRelative_1.Active;
CommandAbort_Relative := MC_MoveRelative_1.Commandaborted;
Error_Relative := MC_MoveRelative_1.Error;
ErrorID_Relative := MC_MoveRelative_1.ErrorID;
```

```
MC_MoveRelative_1(
```

void **MC_MoveRelative_1**(AXIS_REF AxisIn, BOOL Execute, REAL Distance, REAL Velocity, REAL Acceleration, REAL Deceleration, REAL Jerk, SINT BufferMode)
Type : MC_MoveRelative, Commands a controlled motion of a specified distance relative to the actual position at the time of the execution.

Results



MC_MoveVelocity

MC_MoveVelocity commands a never ending controlled motion at a specified velocity.

MC_MoveVelocity operation

- If the MC_MoveVelocity function block DirectionIn input is equal to 0 and the axis is in a moving state, the sign of the Velocity input is ignored, the axis continues to move in its current direction, and new dynamic parameters are applied.
- If the MC_MoveVelocity function block DirectionIn input is equal to 0 and the axis is not in a moving state, the function block reports an error.
- If the PTO Pulse limit is reached during execution of the MC_MoveVelocity function block, the PTO Accumulator value is rolled over to 0 (or to the opposite Soft Limit if the limit is activated) and the execution of the function block continues.
- If the axis is in a moving state, and the MC_MoveVelocity function block issues a motion in which the direction (the sign of Velocity * Direction) is the opposite of the current motion direction, the function block reports an error.
- Once the signal 'InVelocity' is set, it indicates the MC_MoveVelocity function block has completed. Any subsequent motion event has no effect on the function block outputs except the signal 'InVelocity'.
- The InVelocity output of the MC_MoveVelocity function block stays True once the Velocity of the axis reaches the commanded Velocity until the function block is aborted.

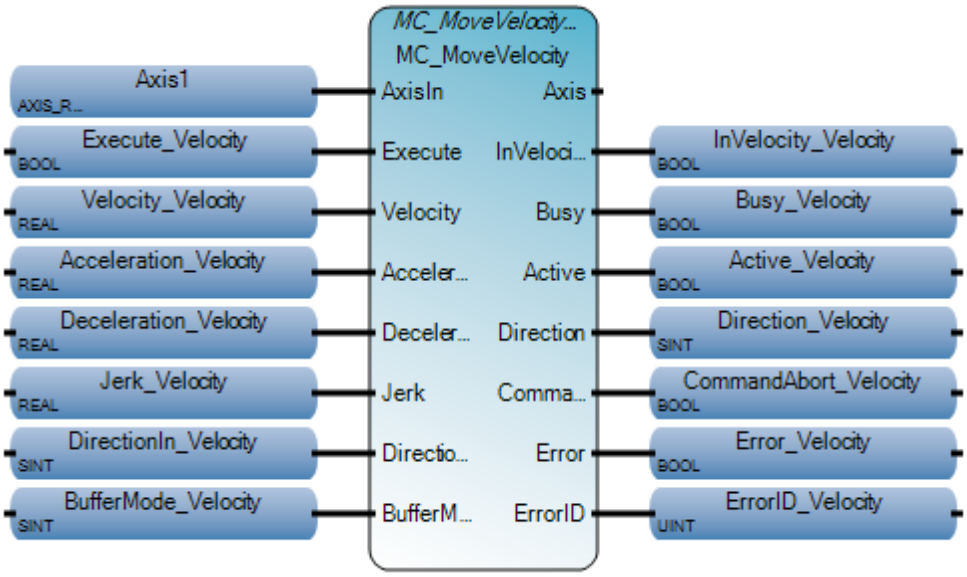
- The sign of (Velocity * Direction) determines the motion direction for a MC_MoveVelocity function block. If the Velocity sign and the Direction sign are the same, positive motion is issued. If the Velocity sign and the Direction sign are different, negative motion is issued.
- The signal 'InVelocity' is reset when the MC_MoveVelocity is aborted by another function block/Motion event, or at the falling edge of 'Execute'.
- To stop or change the motion initiated by the MC_MoveVelocity function block, the function block must be interrupted or aborted by another function block, which includes executing the MC_MoveVelocity function block again with different parameters.
- If the MC_MoveVelocity function block is issued with the axis state in StandStill (not controlled by another function block) and a function block error occurs, the axis state goes to ErrorStop.

Arguments

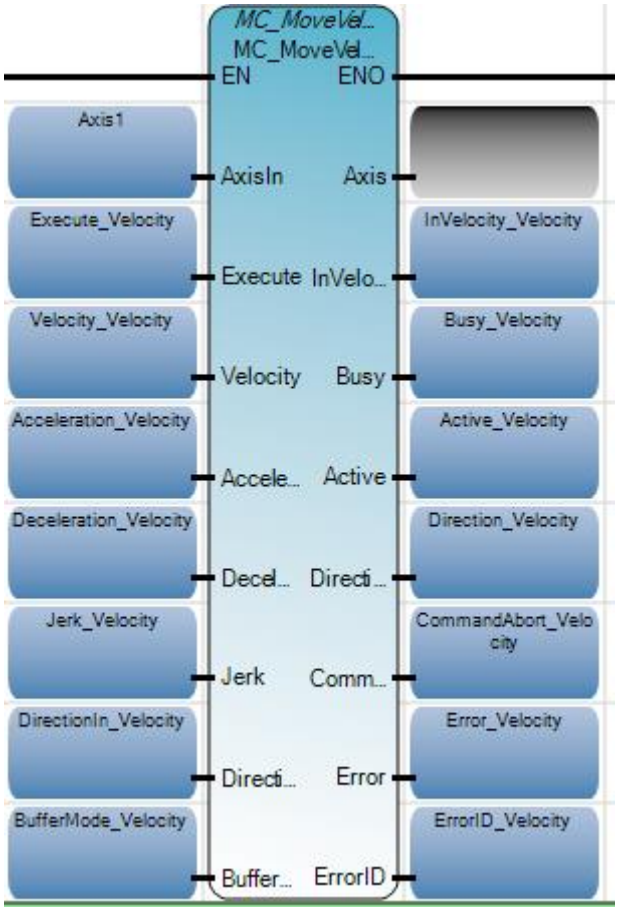
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_MoveVelocity computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, starts the motion at rising edge.
Velocity	Input	REAL	Value of the maximum velocity [u/s].
Acceleration	Input	REAL	Value of the acceleration (increasing energy of the motor) [u/s^2]
Deceleration	Input	REAL	Value of the deceleration (decreasing energy of the motor) [u/s^2]
Jerk	Input	REAL	Value of the Jerk [u/s^3]
DirectionIn	Input	SINT	The valid values are: -1, 0, 1.
BufferMode	Input	SINT	This parameter is not used.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
InVelocity	Output	BOOL	When TRUE, commanded velocity was reached (first time).
Busy	Output	BOOL	When TRUE, the function block is not finished.
Active	Output	BOOL	When TRUE, indicates that the function block has control on the axis.
Direction	Output	SINT	The valid values are: -1, 0, 1.
CommandAborted	Output	BOOL	When TRUE, command was aborted by another command, or Error Stop.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_MoveVelocity function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



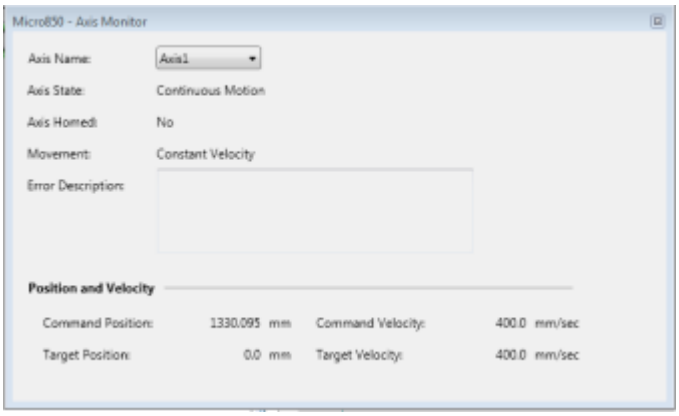
Structured Text (ST)

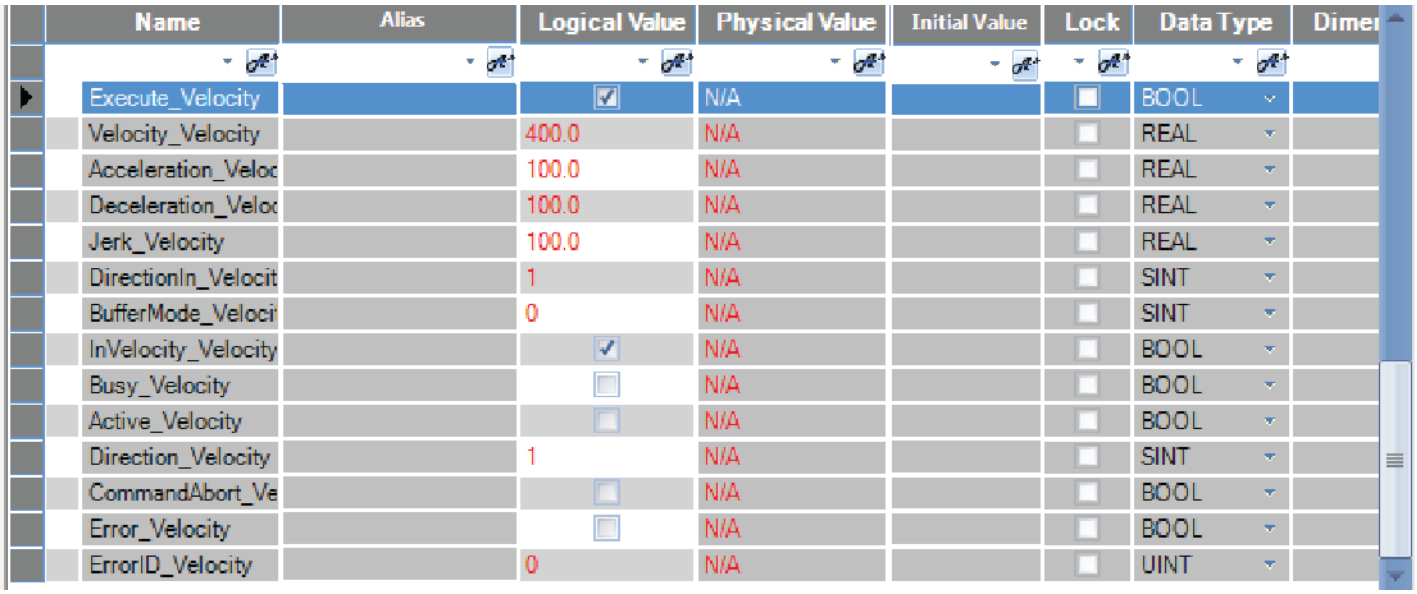
```
Velocity_Velocity := 400.0;
Acceleration_Velocity := 100.0;
Deceleration_Velocity := 100.0;
Jerk_Velocity := 100.0;
DirectionIn_Velocity := 1;
MC_MoveVelocity_1(Axis1,Execute_Velocity,Velocity_Velocity,
Acceleration_Velocity,Deceleration_Velocity,Jerk_Velocity,DirectionIn_Velocity,BufferMode_Velocity);
InVelocity_Velocity := MC_MoveVelocity_1.InVelocity;
Busy_Velocity := MC_MoveVelocity_1.Busy;
Active_Velocity := MC_MoveVelocity_1.Active;
Direction_Velocity := MC_MoveVelocity_1.Direction;
CommandAbort_Velocity := MC_MoveVelocity_1.CommandAborted;
Error_Velocity := MC_MoveVelocity_1.Error;
ErrorID_Velocity := MC_MoveVelocity_1.ErrorID;
```

```
MC_MoveVelocity_1(
```

void **MC_MoveVelocity_1**(AXIS_REF AxisIn, BOOL Execute, REAL Velocity, REAL Acceleration, REAL Deceleration, REAL Jerk, SINT DirectionIn, SINT BufferMode)
Type : MC_MoveVelocity, Commands a never ending controlled motion at a specified velocity.

Results

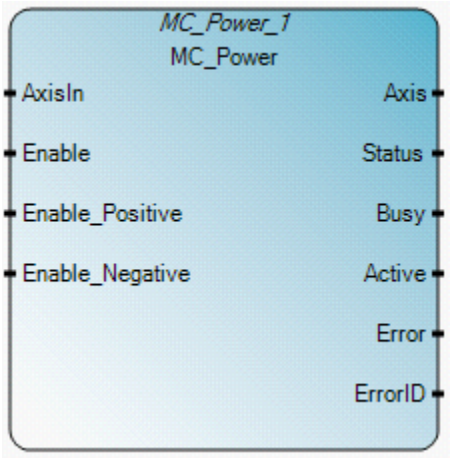




Name	Alias	Logical Value	Physical Value	Initial Value	Lock	Data Type	Dimer
Execute_Velocity		☑	N/A		☐	BOOL	
Velocity_Velocity		400.0	N/A		☐	REAL	
Acceleration_Veloc		100.0	N/A		☐	REAL	
Deceleration_Veloc		100.0	N/A		☐	REAL	
Jerk_Velocity		100.0	N/A		☐	REAL	
DirectionIn_Velocit		1	N/A		☐	SINT	
BufferMode_Velocit		0	N/A		☐	SINT	
InVelocity_Velocity		☑	N/A		☐	BOOL	
Busy_Velocity		☐	N/A		☐	BOOL	
Active_Velocity		☐	N/A		☐	BOOL	
Direction_Velocity		1	N/A		☐	SINT	
CommandAbort_Ve		☐	N/A		☐	BOOL	
Error_Velocity		☐	N/A		☐	BOOL	
ErrorID_Velocity		0	N/A		☐	UINT	

MC_Power

MC_Power controls the power stage (ON or OFF).



MC_Power operation

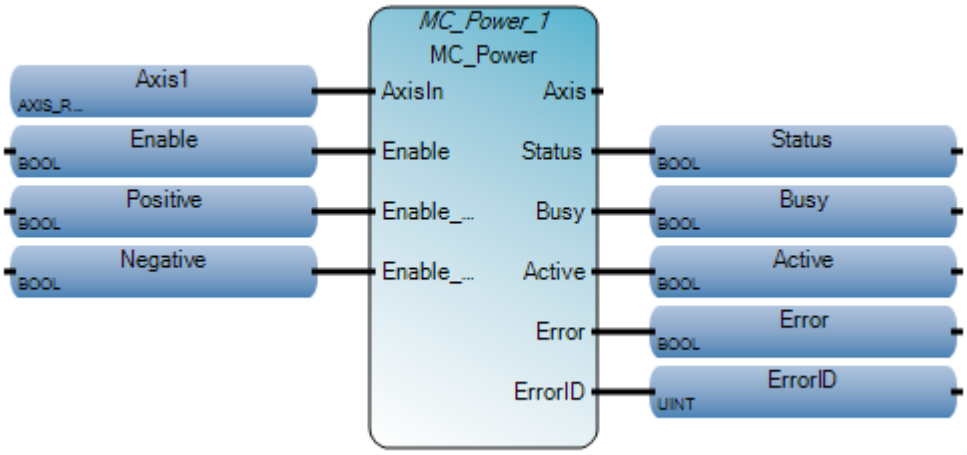
- After axis power On completes, the axis Homed status is reset to 0 (not homed).
- The Enable_Positive input and the Enable_Negative input of the MC_Power function block are both level triggered; they are checked when the Enable input changes from OFF to ON. The on-the-fly change for the Enable_Positive input and the Enable_Negative input without Enable input toggling is not checked.
- If power fails during operation (when Servo ready has been detected) the axis state goes to ErrorStop.
- If the MC_Power function block with Enable set to True is called while the axis state is Disabled, the axis state goes to StandStill if there is not an error, or the axis state goes to ErrorStop if there is an error.
- Only one MC_Power function block should be issued per axis. Using a different MC_ Power function block to control the same axis simultaneously will be rejected by the Motion Engine.
- When there is a Power On/Off state switch for an axis, the absolute axis position is not reset.
- If the MC_Power function block with Enable set to False is called, the axis state goes to Disabled for every state including ErrorStop. The MC_Power function block can do the following:
- Power on the axis if Enable is set to True; Power off the axis if Enable is set to False.

Arguments

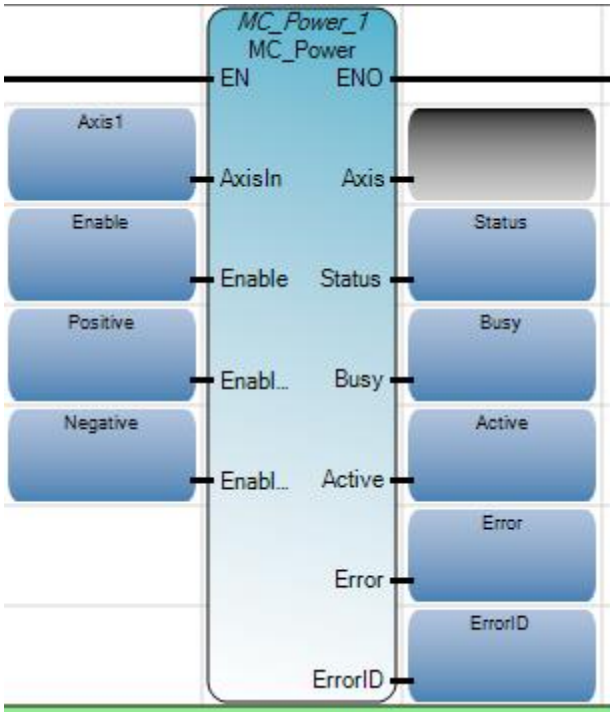
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_Power computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Enable	Input	BOOL	When TRUE, power is ON.
Enable_Positive	Input	BOOL	When TRUE, motion direction is positive only.
Enable_Negative	Input	BOOL	When TRUE, motion direction is negative only.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Status	Output	BOOL	State of the power stage: • When TRUE, drive power on is done
Busy	Output	BOOL	When TRUE, the function block is not finished.
Active	Output	BOOL	When TRUE, indicates that the function block has control on the axis.
Error	Output	BOOL	When TRUE, an error is detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_Power function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



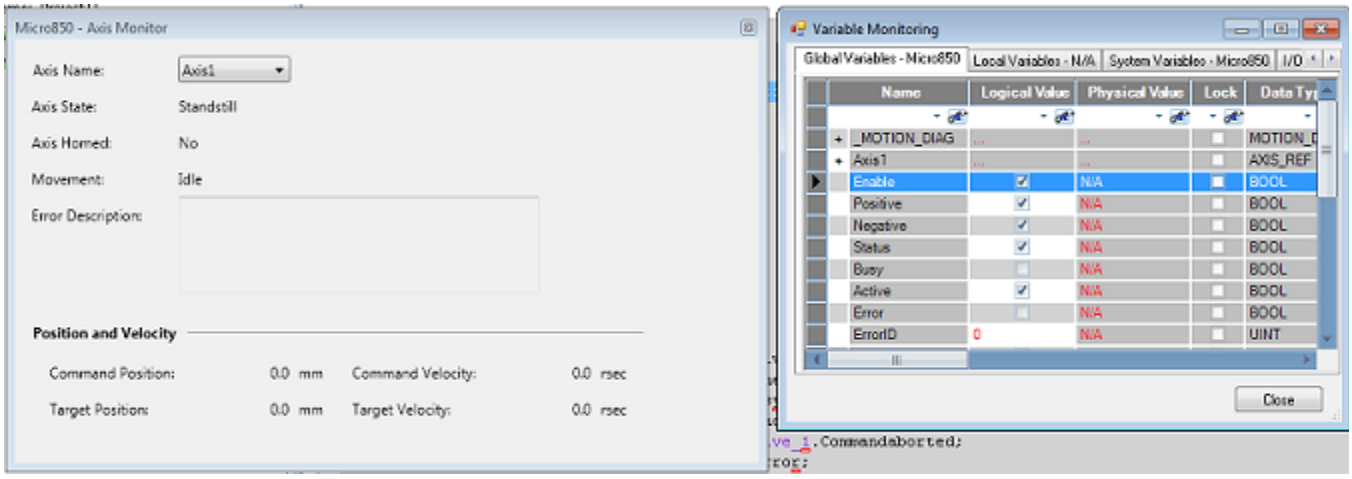
Structured Text (ST)

```
Positive := True;
Negative := True;
MC_Power_1(Axis1,Enable,Positive,Negative);
Status := MC_Power_1.Status;
Busy := MC_Power_1.Busy;
Active := MC_Power_1.Active;
Error := MC_Power_1.Error;
ErrorID := MC_Power_1.ErrorID;
```

```
MC_Power_1(
```

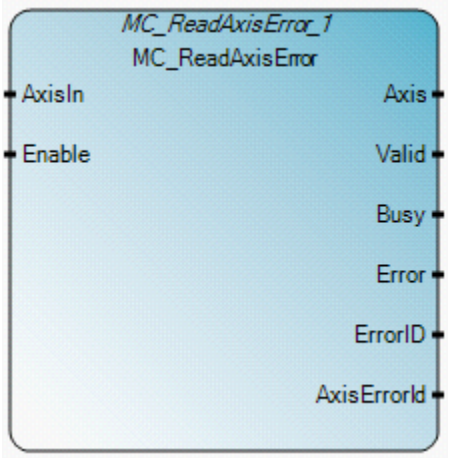
void **MC_Power_1**(AXIS_REF AxisIn, BOOL Enable, BOOL Enable_Positive, BOOL Enable_Negative)
Type : MC_Power, Controls the power stage (On or Off)

Results



MC_ReadAxisError

MC_ReadAxisError describes general axis errors not related to the Motion control function blocks.



MC_ReadAxisError operation

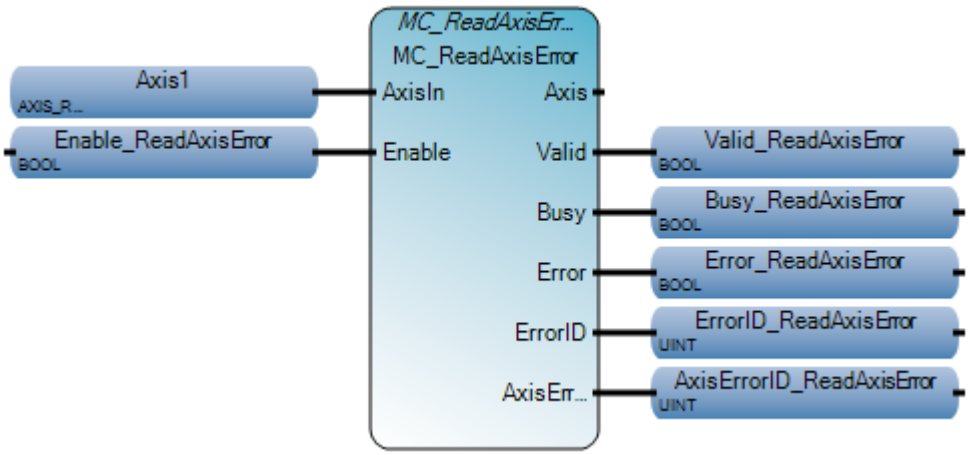
- When an axis is in a Disabled state, the MC_ReadAxisError function block may or may not get a non-zero Error ID for the axis as a Disabled axis can contain errors or be error-free.
- When the Enable input of the MC_ReadAxisError function block is set to False, the Error, ErrorID, and AxisErrorID outputs are all reset to False or 0.

Arguments

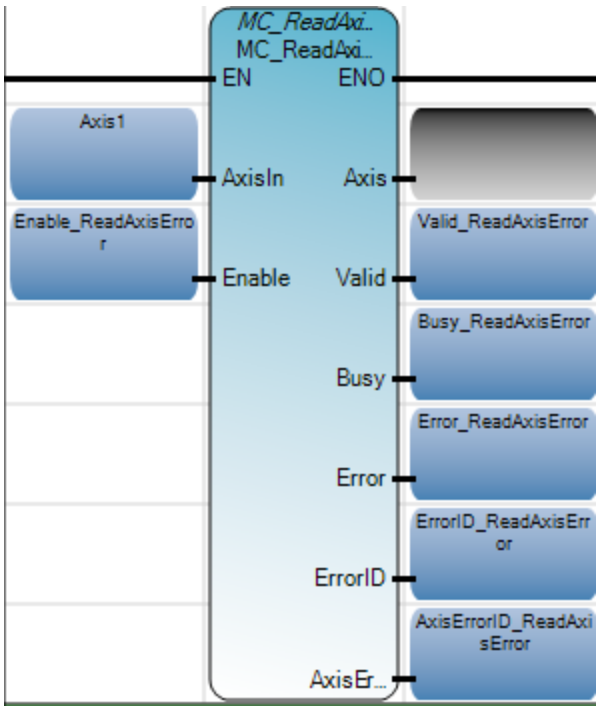
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_ReadAxisError computation. When EN = FALSE, Error, ErrorID, and AxisErrorID are reset to False (or 0). Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Enable	Input	BOOL	When TRUE, gets the value of the parameter continuously.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Valid	Output	BOOL	When TRUE, indicates the function block is active and new output values are expected.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).
AxisErrorID	Output	UINT	Error identification. See AxisErrorID error codes (on page 476).

MC_ReadAxisError function block language examples

Function Block Diagram (FBD)

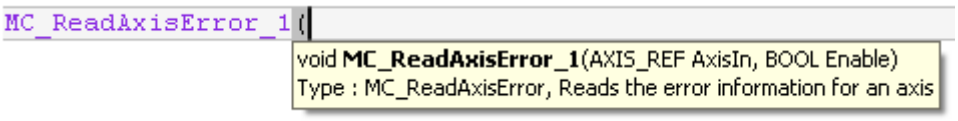


Ladder Diagram (LD)

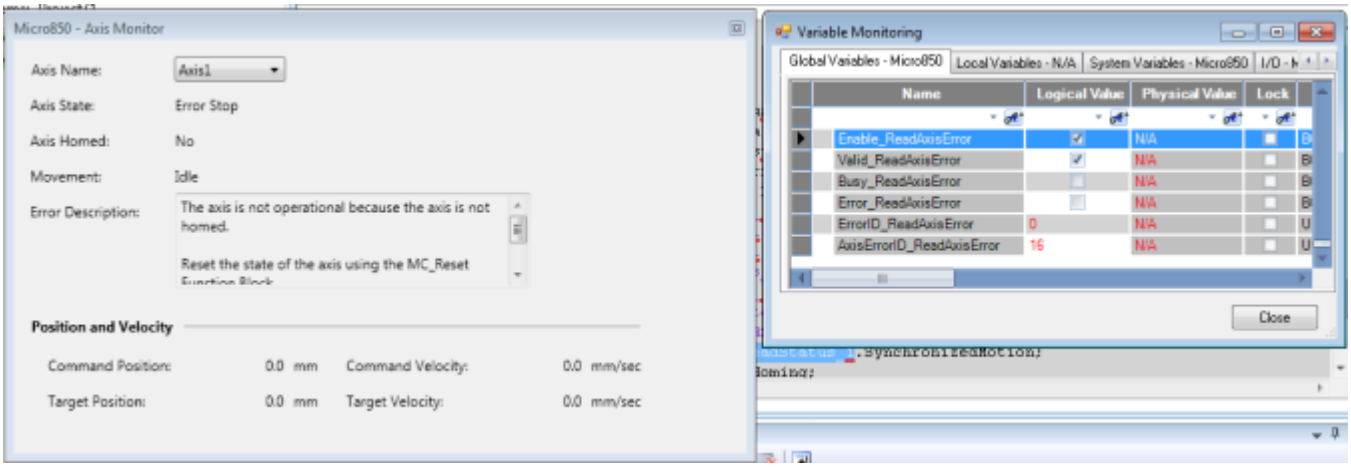


Structured Text (ST)

```
MC_ReadAxisError_1(Axis1,Enable_ReadAxisError);
Valid_ReadAxisError := MC_ReadAxisError_1.Valid;
Busy_ReadAxisError := MC_ReadAxisError_1.Busy;
Error_ReadAxisError := MC_ReadAxisError_1.Error;
ErrorID_ReadAxisError := MC_ReadAxisError_1.ErrorID;
AxisErrorID_ReadAxisError := MC_ReadAxisError_1.AxisErrorId;
```



Results



AxisErrorID error codes

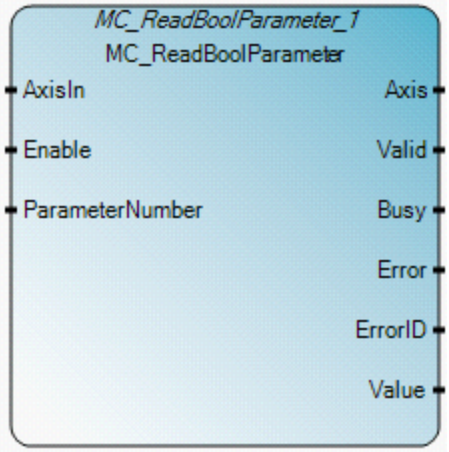
The following table describes the Axis error codes identified in the AxisErrorID for the MC_ReadAxis Error.

Value	MACRO ID	Description
00	MC_FB_ERR_NO	The axis is in an operational state (nothing to display).
01	MC_FB_ERR_WRONG_STATE	The axis is not operational because an incorrect axis state was detected during a function block execution. Reset the state of the axis using the MC_Reset function block.
02	MC_FB_ERR_RANGE	The axis is not operational because an invalid axis dynamic parameter (velocity, acceleration, deceleration, or jerk) is set in a function block. Reset the state of the axis using the MC_Reset function block. In the function block, correct any setting for the dynamic parameters that conflict with the settings on the Axis Dynamics configuration page.
03	MC_FB_ERR_PARAM	The axis is not operational because an invalid parameter, (other than velocity, acceleration, deceleration, or jerk), is set in a function block. Reset the state of the axis using the MC_Reset function block. In the function block, correct the settings for the parameters, such as mode or position.
04	MC_FB_ERR_AXISNUM	Motion internal Fault, Error ID = 0x04. Contact your local Rockwell Automation technical support representative. For contact information, see: http://www.rockwellautomation.com/support
05	MC_FB_ERR_MECHAN	The axis is not operational because a drive or mechanical issue was detected. Check the connection between the drive and the controller (Drive Ready and In-Position signals), and ensure the drive is operating normally. Reset the state of the axis using the MC_Reset function block.
06	MC_FB_ERR_NOPOWER	The axis is not powered on. Power on the axis using MC_Power function block. Reset the state of the axis using the MC_Reset function block.
07	MC_FB_ERR_RESOURCE	The axis is not operational because it or its related resources required by a function block are under the control of other function block, or not available. Ensure the axis or its related resources required by the function block are available for use. Reset the state of the axis using the MC_Reset function block. Review and correct the application if there are multiple instances of the same function block trying to control the axis at the same time.
08	MC_FB_ERR_PROFILE	The axis is not operational because the motion profile defined in a function block is invalid. Reset the state of the axis using the MC_Reset function block. Correct the profile in the function block.

Value	MACRO ID	Description
09	MC_FB_ERR_VELOCITY	The axis is not operational because the motion profile requested in a function block conflicts with the current axis velocity. Possible causes: • The function block requests the axis to reverse the direction while the axis is moving. • The current velocity is too low or too high for the requested motion profile. Reset the state of the axis using the MC_Reset function block. Correct the motion profile in the function block, or re-execute the function block when the axis velocity is compatible with the requested motion profile.
10	MC_FB_ERR_SOFT_LIMIT	The axis is not operational because a Soft Limit error was detected, or executing the function block would cause a Soft Limit error. Reset the state of the axis using the MC_Reset function block. Check the velocity or target position settings for the function block, or adjust Soft Limit setting.
11	MC_FB_ERR_HARD_LIMIT	The axis is not operational because a Hard Limit error was detected. Reset the state of the axis using the MC_Reset function block, and then move the axis away from the Hard Limit switch in the opposite direction.
12	MC_FB_ERR_LOG_LIMIT	The axis is not operational because a PTO Accumulator logic limit error was detected, or executing the function block would cause a PTO Accumulator logic limit error. Reset the state of the axis using the MC_Reset function block. Check the velocity or target position settings for the function block. Use the MC_SetPosition function block to adjust the axis coordinate system.
13	MC_FB_ERR_ERR_ENGINE	The axis is not operational because a motion engine execution error was detected. Power cycle the entire machine and download the User Application to the controller again. If the fault persists, contact your local Rockwell Automation technical support representative. For contact information, see: http://www.rockwellautomation.com/support.
16	MC_FB_ERR_NOT_HOMED	The axis is not operational because the axis is not homed. Reset the state of the axis using the MC_Reset function block. Execute homing against the axis using MC_Home function block.
128	MC_FB_ERR_PARAM_MODIFIED	Motion internal warning, Warning ID = 0x80. Contact your local Rockwell Automation technical support representative. For contact information, see: http://www.rockwellautomation.com/support.

MC_ReadBoolParameter

MC_ReadBoolParameter returns the value of a vendor specific parameter with data type BOOL.



MC_ReadBoolParameter operation

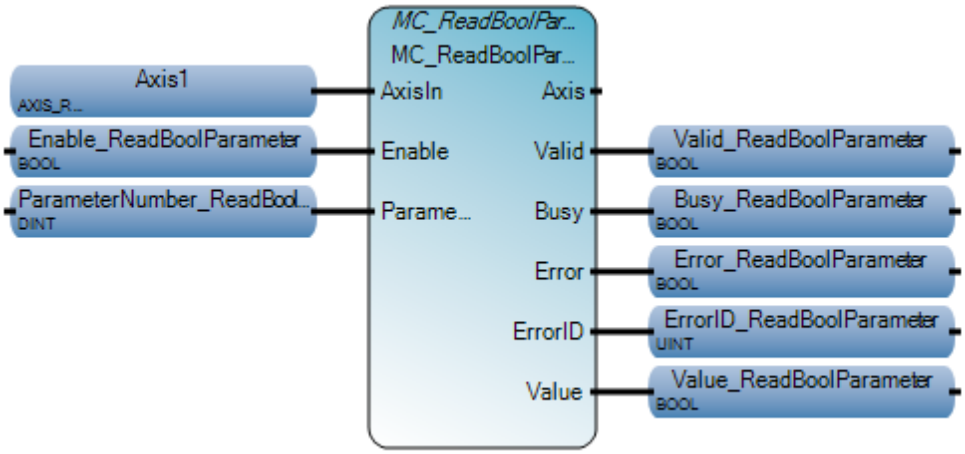
When the MC_ReadBoolParameter function block Enable input is set to False, the Value output is reset to 0.

Arguments

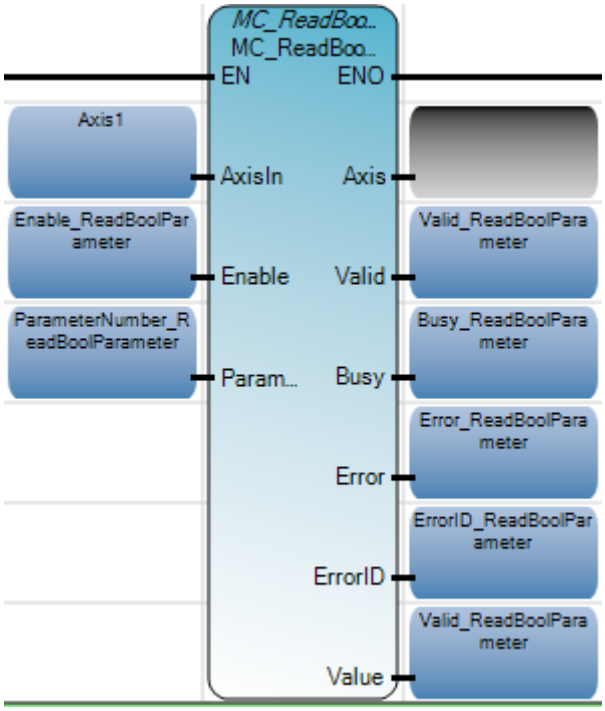
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_ReadBoolParameter computation. When EN = FALSE, the Value output is reset to 0. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Enable	Input	BOOL	When TRUE, gets the value of the parameter continuously.
ParameterNumber	Input	DINT	Parameter identification. See also Motion control function block parameter numbers (on page 435).
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Valid	Output	BOOL	When TRUE, parameter available.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).
Value	Output	BOOL	Value of the specified parameter in the data type, as specified by the vendor.

MC_ReadBoolParameter function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



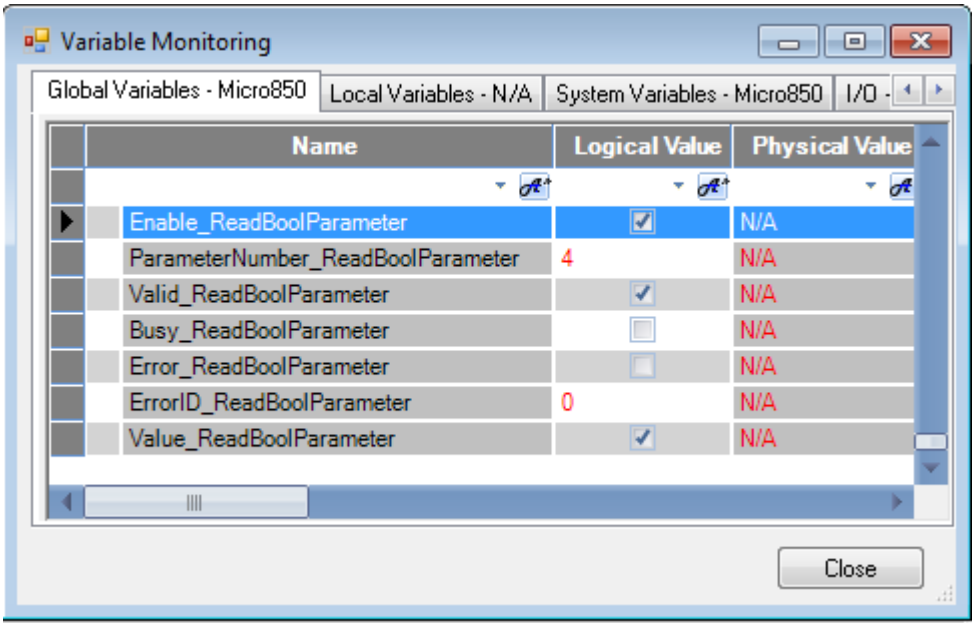
Structured Text (ST)

```
ParameterNumber_ReadBoolParameter := 4;
MC_ReadBoolParameter_1(Axis1,Enable_ReadBoolParameter,ParameterNumber_ReadBoolParameter);
Valid_ReadBoolParameter := MC_ReadBoolParameter_1.Valid;
Busy_ReadBoolParameter := MC_ReadBoolParameter_1.Busy;
Error_ReadBoolParameter := MC_ReadBoolParameter_1.Error;
ErrorID_ReadBoolParameter := MC_ReadBoolParameter_1.ErrorID;
Value_ReadBoolParameter := MC_ReadBoolParameter_1.Value;
```

```
MC_ReadBoolParameter_1(
```

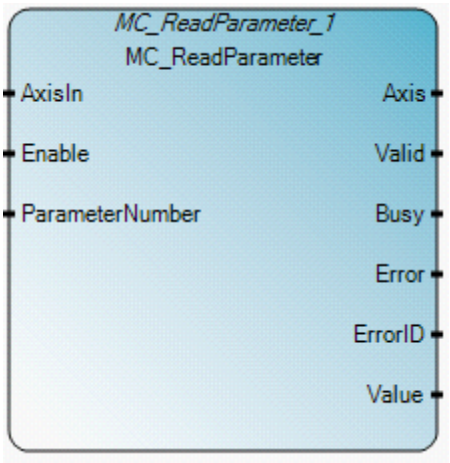
void **MC_ReadBoolParameter_1**(AXIS_REF AxisIn, BOOL Enable, DINT ParameterNumber)
Type : MC_ReadBoolParameter, Returns the value of a motion specific BOOL parameter.

Results



MC_ReadParameter

MC_ReadParameter returns the value of a vendor specific parameter.



MC_ReadParameter operation

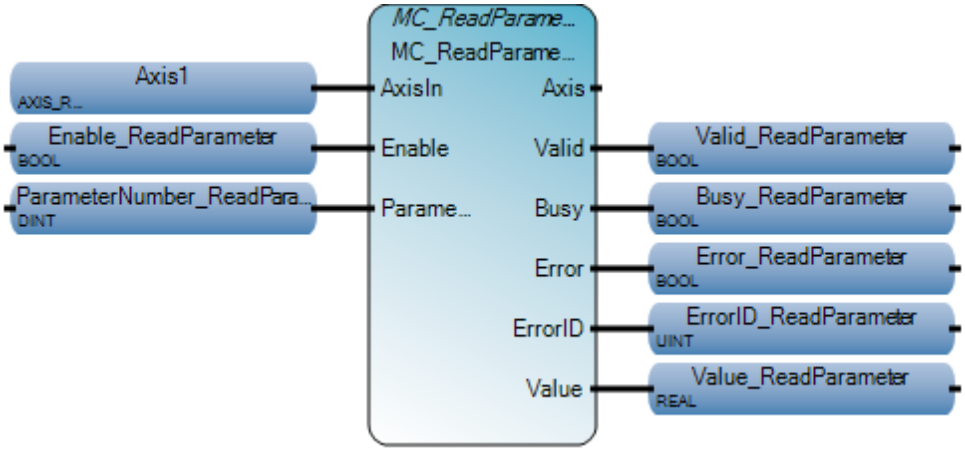
- When the MC_ReadParameter function block Enable input is set to False, the Value output is reset to 0.
- Only supports the REAL data type.

Arguments

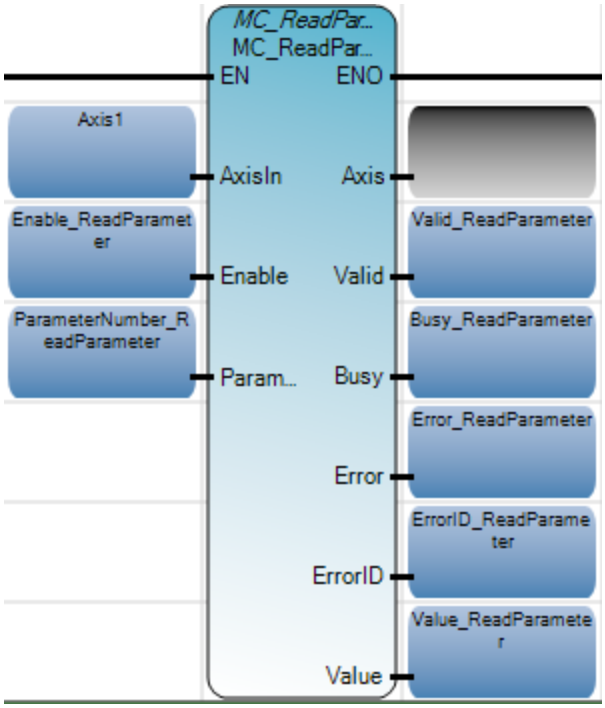
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_ReadParameter computation. When EN = FALSE, the Value output is reset to 0. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Enable	Input	BOOL	When TRUE, gets the value of the parameter continuously.
ParameterNumber	Input	DINT	Parameter identification. See also Motion control function block parameter numbers (on page 435).
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Valid	Output	BOOL	When TRUE, parameter available.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).
Value	Output	REAL	Value of the specified parameter in the data type, as specified by the vendor.

MC_ReadParameter function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



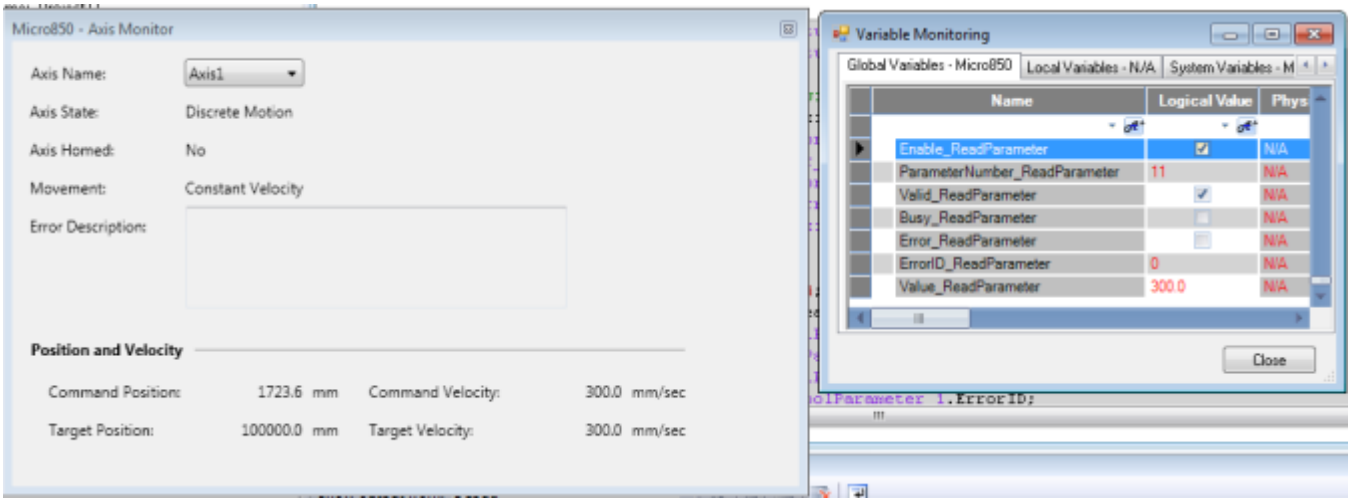
Structured Text (ST)

```
ParameterNumber_ReadParameter := 11;
MC_ReadParameter_1(Axis1,Enable_ReadParameter,ParameterNumber_ReadParameter);
Valid_ReadParameter := MC_ReadParameter_1.Valid;
Busy_ReadParameter := MC_ReadParameter_1.Busy;
Error_ReadParameter := MC_ReadParameter_1.Error;
ErrorID_ReadParameter := MC_ReadParameter_1.ErrorID;
Value_ReadParameter := MC_ReadParameter_1.Value;
```

```
MC_ReadParameter_1(
```

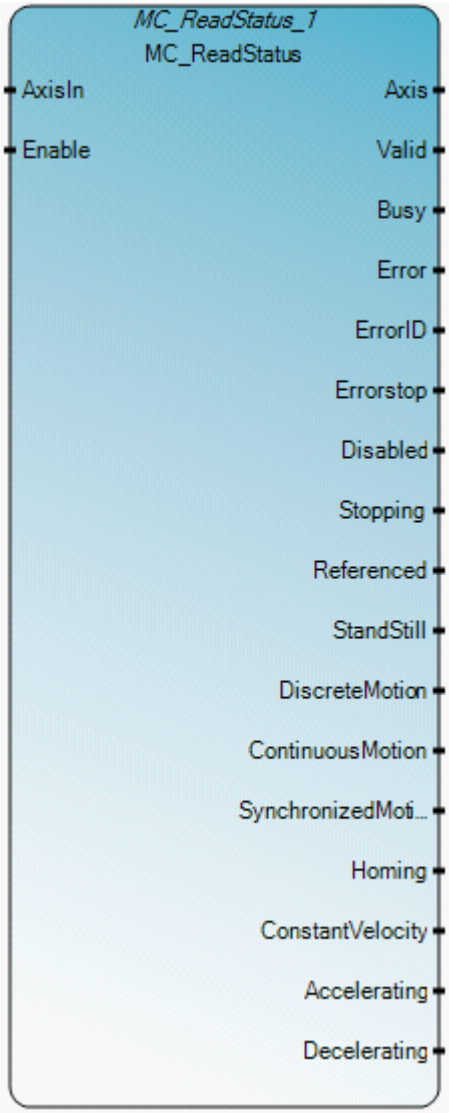
void **MC_ReadParameter_1**(AXIS_REF AxisIn, BOOL Enable, DINT ParameterNumber)
Type : MC_ReadParameter, Returns the value of a motion specific REAL parameter.

Results



MC_ReadStatus

MC_ReadStatus returns the status of the axis with respect to the motion currently in progress.



MC_ReadStatus operation

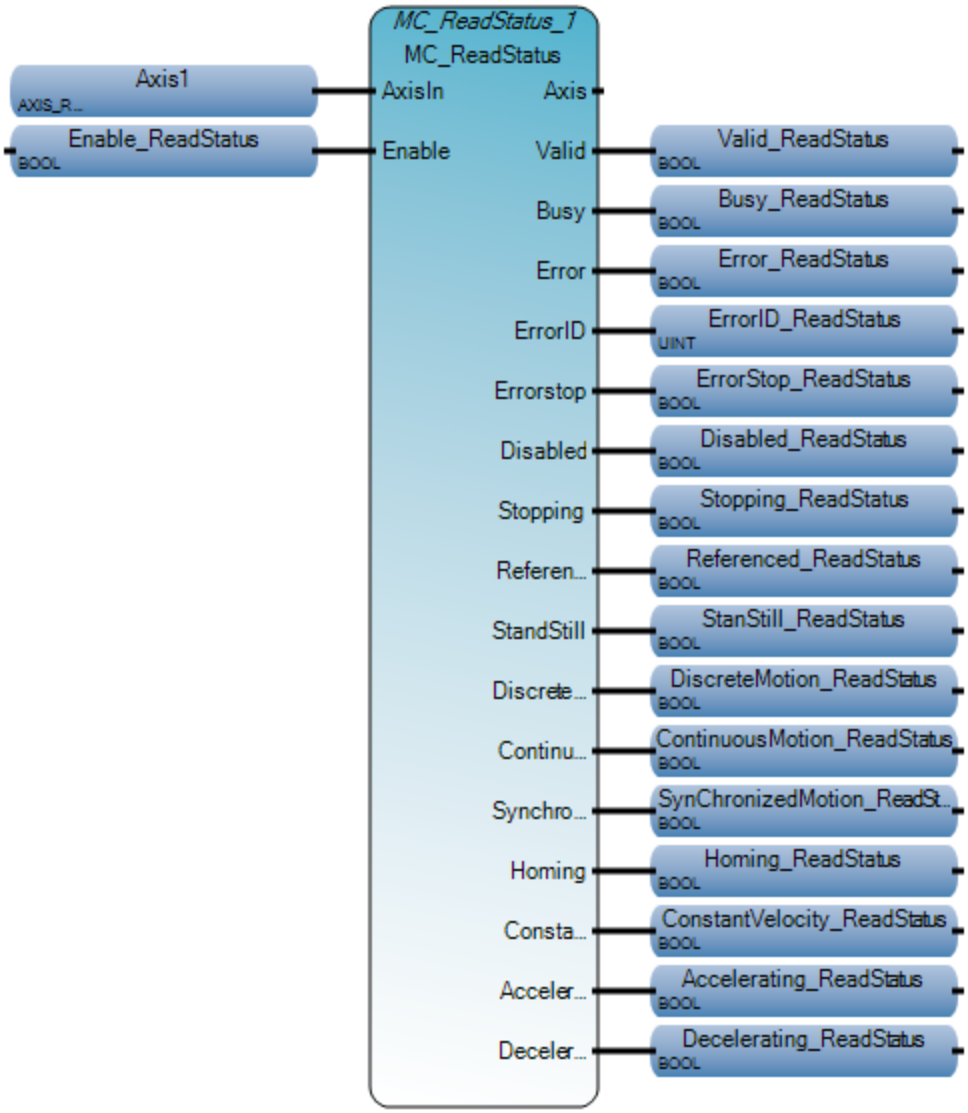
When the MC_ReadStatus function block Enable is set to False, all status outputs are reset to False or 0.

Arguments

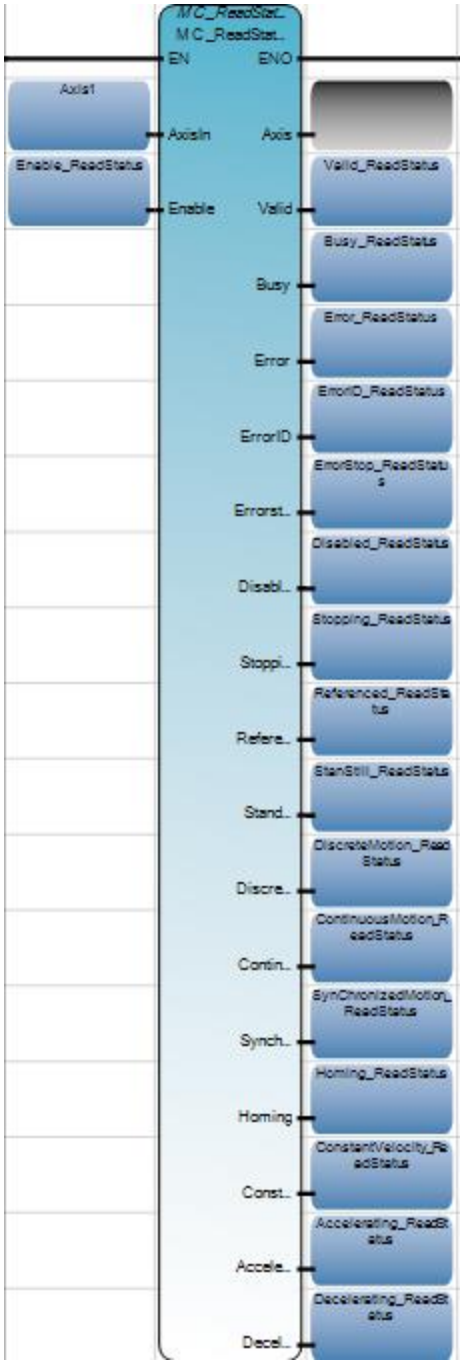
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_ReadStatus computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Enable	Input	BOOL	When TRUE, gets the value of the parameter continuously.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Valid	Output	BOOL	When TRUE, valid outputs are available.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. For Error ID numbers and descriptions, see Motion control function block error IDs (on page 436).
ErrorStop	Output	BOOL	When TRUE, the axis state is ErrorStop. See Motion control axis state values and names.
Disabled	Output	BOOL	When TRUE, the axis state is Disabled.
Stopping	Output	BOOL	When TRUE, the axis state is Stopping. See Motion control axis state values and names.
Referenced	Output	BOOL	When TRUE, the absolute reference position is known for the axis (axis is homed).
StandStill	Output	BOOL	When TRUE, the axis state is StandStill. See Motion control axis state values and names.
DiscreteMotion	Output	BOOL	When TRUE, the axis state is DiscreteMotion. See Motion control axis state values and names.
ContinuousMotion	Output	BOOL	When TRUE, the axis state is ContinuousMotion. See Motion control axis state values and names.
SynchronizedMotion	Output	BOOL	This output is always FALSE. Synchronized motion is not supported in Micro800 controllers.
Homing	Output	BOOL	When TRUE, the axis state is Homing. See Motion control axis state values and names.
ConstantVelocity	Output	BOOL	When TRUE, the velocity for the motor is constant.
Accelerating	Output	BOOL	When TRUE, increasing energy to the motor.
Decelerating	Output	BOOL	When TRUE, decreasing energy to the motor.

MC_ReadStatus function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



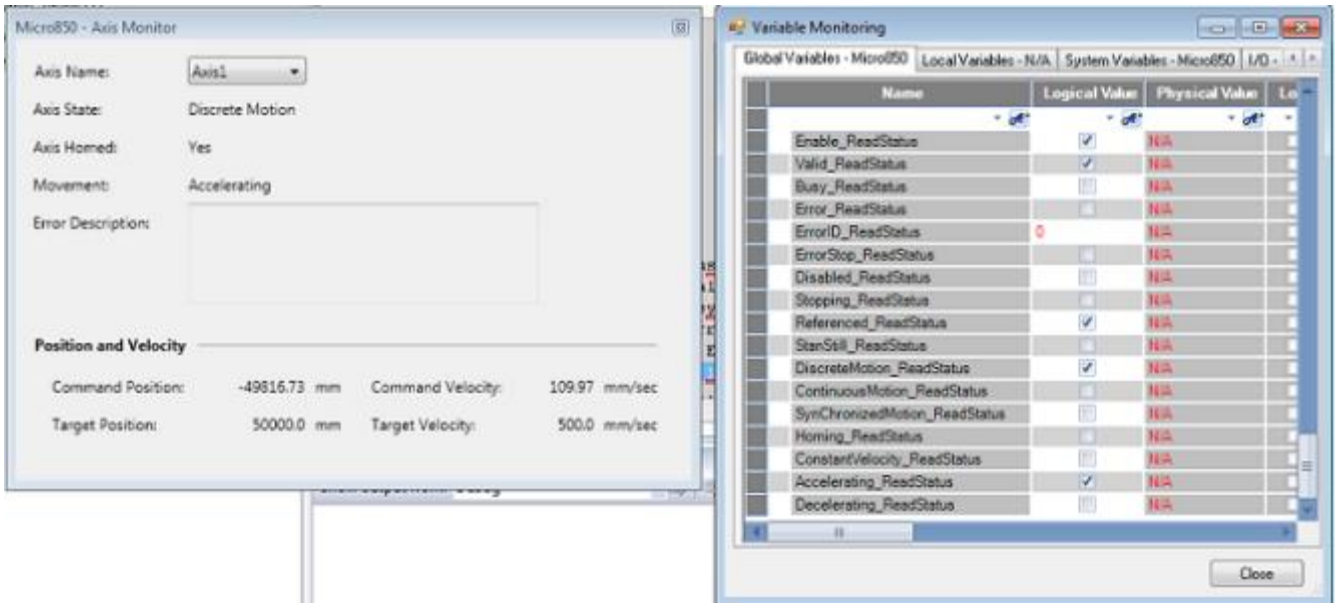
Structured Text (ST)

```
MC_ReadStatus_1(Axis1,Enable_ReadStatus);
Valid_ReadStatus := MC_ReadStatus_1.Valid;
Busy_ReadStatus := MC_ReadStatus_1.Busy;
Error_ReadStatus := MC_ReadStatus_1.Error;
ErrorID_ReadStatus := MC_ReadStatus_1.ErrorID;
ErrorStop_ReadStatus := MC_ReadStatus_1.Errorstop;
Disabled_ReadStatus := MC_ReadStatus_1.Disabled;
Stopping_ReadStatus := MC_ReadStatus_1.Stopping;
Referenced_ReadStatus := MC_ReadStatus_1.Referenced;
StanStill_ReadStatus := MC_ReadStatus_1.StandStill;
DiscreteMotion_ReadStatus := MC_ReadStatus_1.DiscreteMotion;
ContinuousMotion_ReadStatus := MC_ReadStatus_1.ContinuousMotion;
SynChronizedMotion_ReadStatus := MC_ReadStatus_1.SynchronizedMotion;
Homing_ReadStatus := MC_ReadStatus_1.Homing;
ConstantVelocity_ReadStatus := MC_ReadStatus_1.ConstantVelocity;
Accelerating_ReadStatus := MC_ReadStatus_1.Accelerating;
Decelerating_ReadStatus := MC_ReadStatus_1.Decelerating;
```

```
MC_ReadStatus_1(
```

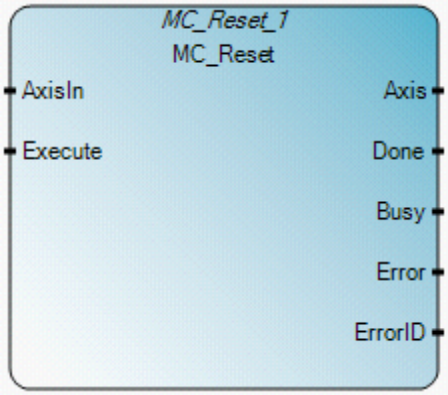
void **MC_ReadStatus_1**(AXIS_REF AxisIn, BOOL Enable)
Type : MC_ReadStatus, Returns in detail the status of the axis with respect to the motion currently in progress.

Results



MC_Reset

MC_Reset transitions the axis state from ErrorStop to StandStill by resetting all internal axis-related errors. The outputs of the function block instances are not changed.



MC_Reset operation

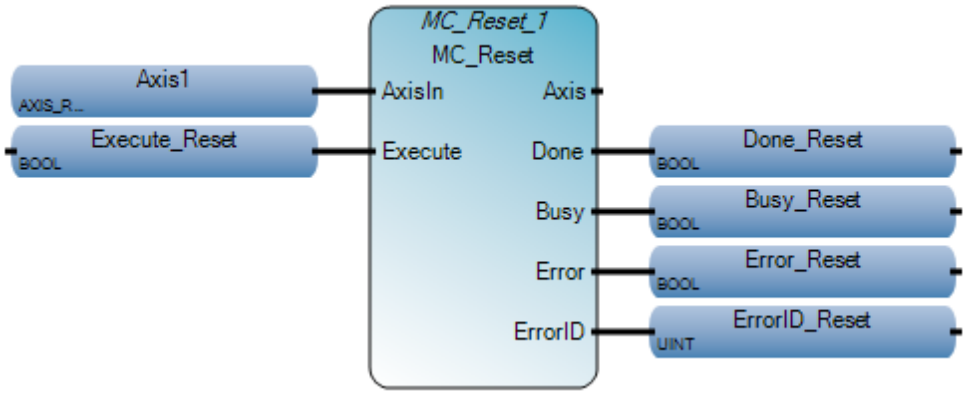
The MC_Reset function block only resets the axis state from ErrorStop to StandStill. The application of MC_Reset function block in other states, including Disabled, results in an error, and has no impact on on-going motion or the status of the axis.

Arguments

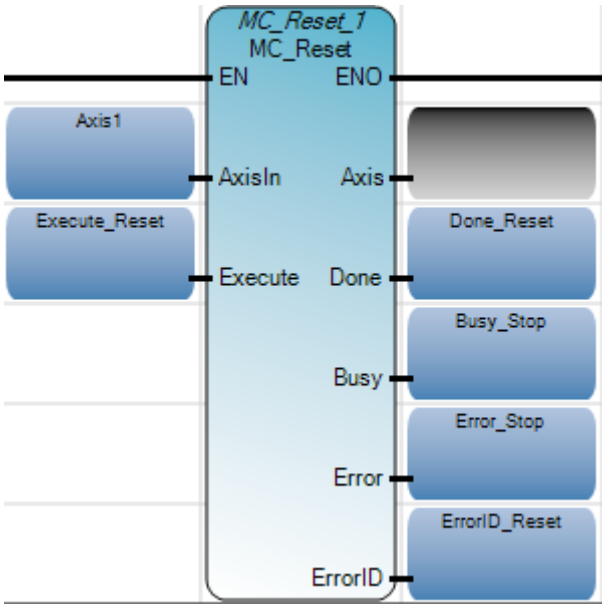
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_Reset computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, resets the axis to the rising edge.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, the axis state is StandStill.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Error	Output	BOOL	When TRUE, an error is detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_Reset function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



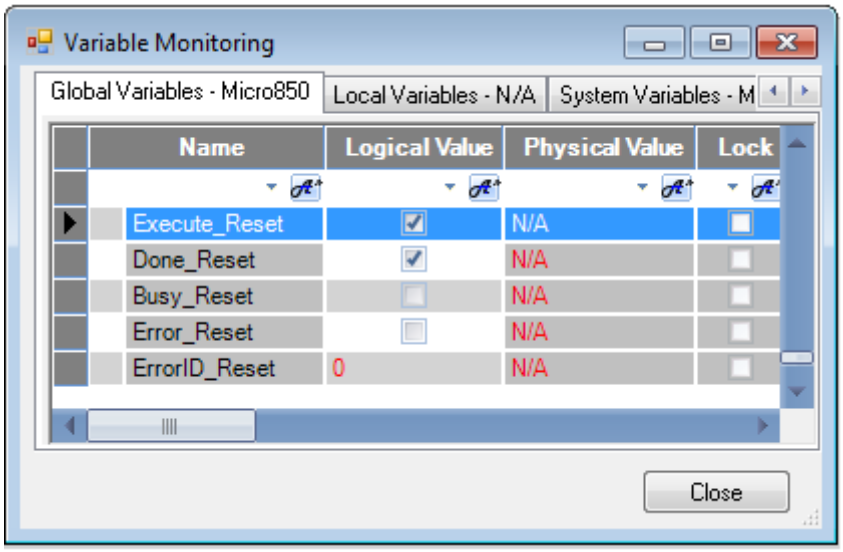
Structured Text (ST)

```
MC_Reset_1(Axis1,Execute_Reset);
Done_Reset := MC_Reset_1.Done;
Busy_Reset := MC_Reset_1.Busy;
Error_Reset := MC_Reset_1.Error;
ErrorID_Reset := MC_Reset_1.ErrorID;
```

```
MC_Reset_1(
```

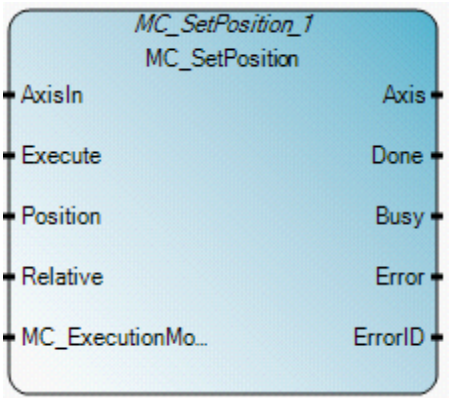
void **MC_Reset_1**(AXIS_REF AxisIn, BOOL Execute)
Type : MC_Reset, Resets all internal axis-related errors

Results



MC_SetPosition

MC_SetPostion shifts the coordinate system of an axis by manipulating the actual position of an axis with the same value without causing any movement.



MC_SetPosition operation

- The MC_SetPostion function block can successfully complete only when the axis state is StandStill, continuous Motion (MC_ExecutionMode = 0), or when the on-going motion completes, and ends with a StandStill state (MC_ExecutionMode = 1).
- The MC_SetPosition function block operates the same as MC_Home when the HomingMode = MC_HOME_DIRECT (0x04), except the MC_Home function block sets the Axis Homed status.
- When MC_ExecutionMode = 0 (mcImmediately), the execution of the MC_SetPosition function block reports an error if there is on-going non-continuous motion with the axis.
- When MC_ExecutionMode = 1 (mcQueued), the actual position setting occurs only when all previous on-going motion stops. That is, each previous function block must have at least one of the Done, Aborted, or Error outputs equal to True.

Arguments

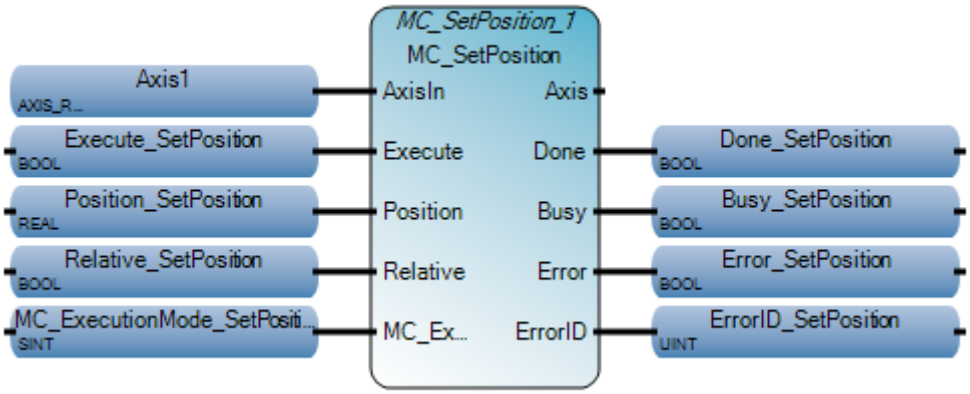
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_SetPosition computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, starts setting the axis position.
Position	Input	REAL	The absolute position or relative distance to be set for the axis.
Relative	Input	BOOL	When TRUE, set the relative distance for the axis. When FALSE, set the absolute position for the axis.

MC_ExecutionMode	Input	SINT	Values are:
			• 0 (*mcImmediately*) - The functionality is immediately valid.
			• 1 (*mcQueued*) - The new functionality becomes valid when:
			  • all previous motion commands set one of the following output parameters: Done, Aborted or Error.
			  • the axis is not in a moving state.
			For (MC_ExecutionMode = 0), this function block can only successfully complete when the axis state is Disabled or StandStill. The execution of this function block reports an error if there is on-going non-Continuous motion with the axis in this mode.
			For (MC_ExecutionMode = 1), this function block can only successfully complete when the axis state is Disabled, Standstill, or the on-going motion can complete, ending with a Standstill state.
			Other input values are reserved currently, and are considered as invalid parameters.

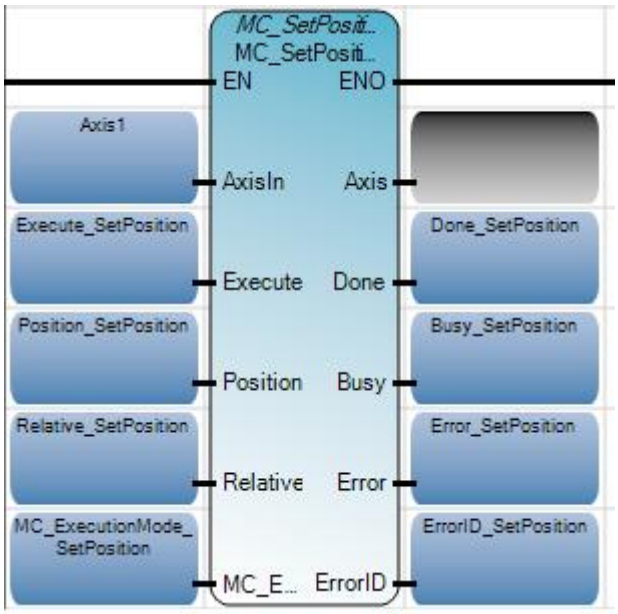
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, the Position has new value.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_SetPosition function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



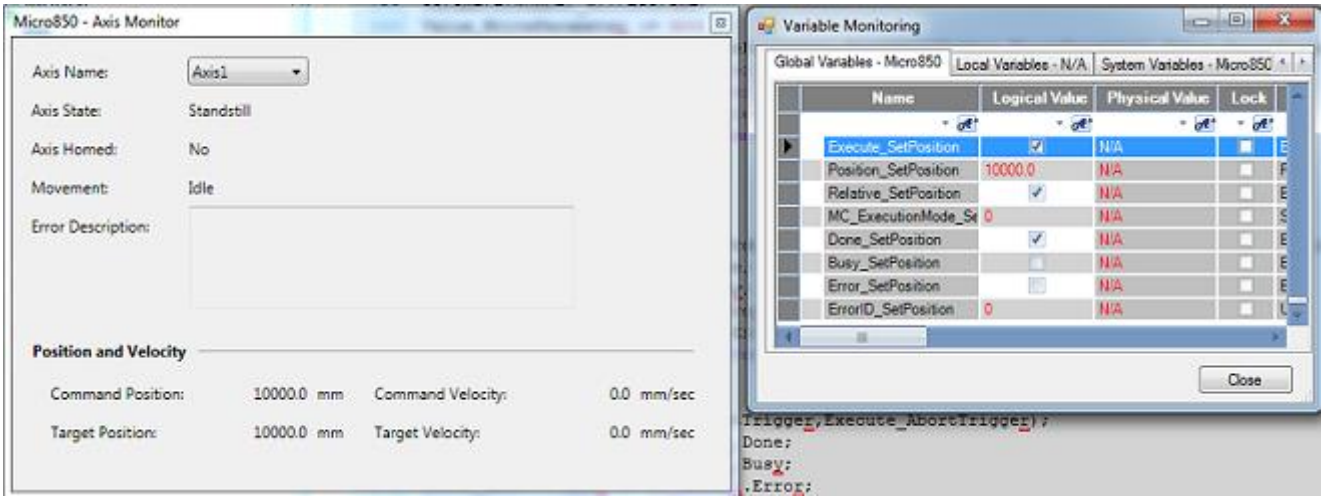
Structured Text (ST)

```
Position_SetPosition := 10000.0;
Relative_SetPosition := TRUE;
MC_ExecutionMode_SetPosition := 0;
MC_SetPosition_1(Axis1,Execute_SetPosition,Position_SetPosition,Relative_SetPosition,MC_ExecutionMode_SetPosition);
Done_SetPosition := MC_SetPosition_1.Done;
Busy_SetPosition := MC_SetPosition_1.Busy;
Error_SetPosition := MC_SetPosition_1.Error;
ErrorID_SetPosition := MC_SetPosition_1.ErrorID;
```

```
MC_SetPosition_1(
```

void **MC_SetPosition_1**(AXIS_REF AxisIn, BOOL Execute, REAL Position, BOOL Relative, SINT MC_ExecutionMode)
Type : MC_SetPosition, Shifts the coordinate system of an axis by manipulating the actual position of the axis with the same value without any movement caused

Results



MC_Stop

MC_Stop commands a controlled motion stop and transfers the axis state to Stopping. Any ongoing function block execution is aborted. All function block move commands are ignored until the axis state transitions to StandStill.

MC_Stop operation

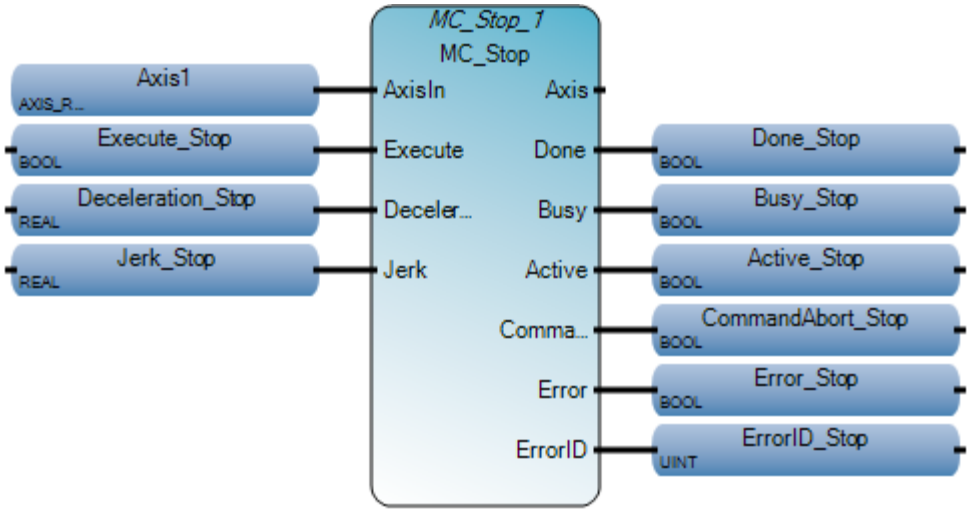
- As long as the Execute input is high, the axis remains in the Stopping state. While the axis is in the Stopping state, no other motion function block can perform any motion on the same axis.
- If Deceleration equals zero, the MC_Stop function block parameters are determined by the Axis configuration Emergency stop setting, including E-Stop type, E-stop Deceleration and E-stop Jerk.
- The axis goes to StandStill after the Done bit is SET and the Execute input is changed to False if there is no error detected during the stop sequence.
- The MC_Stop function block is primarily intended for emergency stop functionality or exception situations. For normal motion stop, MC_Halt function block is usually used.

Arguments

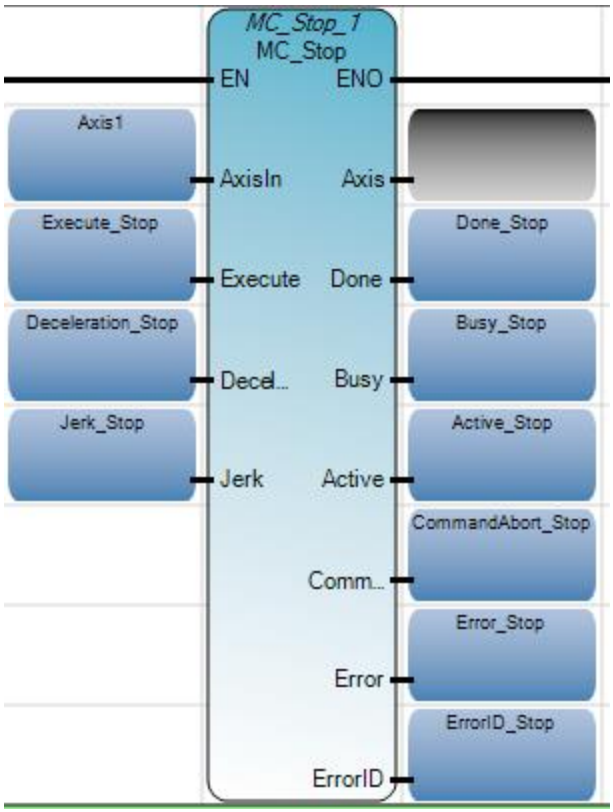
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_Stop computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, starts the action at the rising edge.
Deceleration	Input	REAL	Value of the deceleration [u/s^2].
Jerk	Input	REAL	Value of the Jerk [u/s^3].
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, zero velocity was reached, without error during the stop sequence.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Active	Output	BOOL	When TRUE, indicates the function block has control on the axis.
CommandAborted	Output	BOOL	When TRUE, command was aborted by MC_Power(OFF) function block, or ErrorStop.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_Stop function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



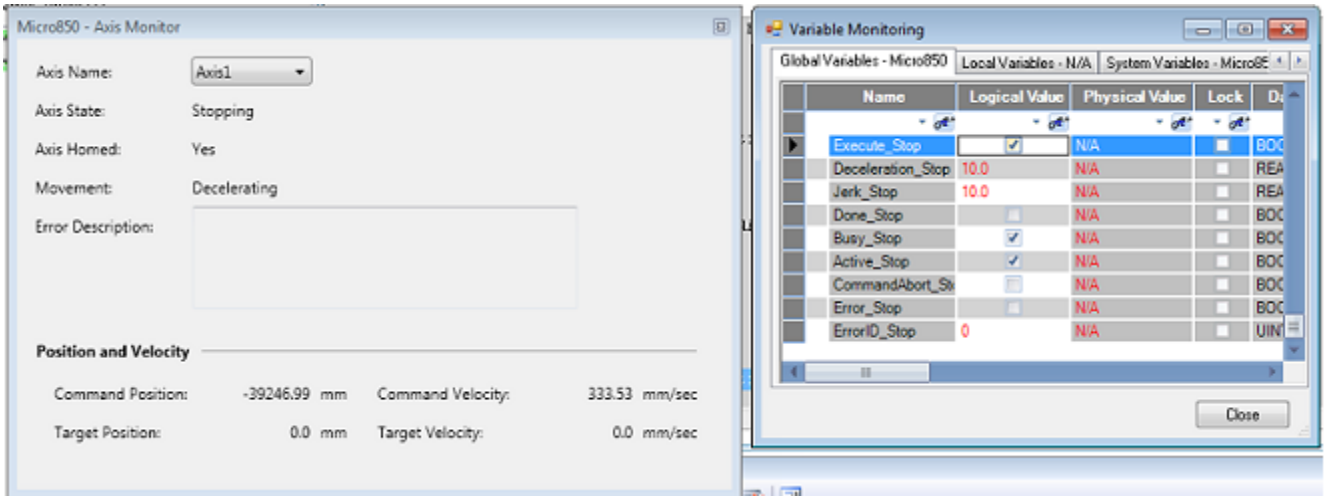
Structured Text (ST)

```
Deceleration_Stop := 10.0;
Jerk_Stop := 10.0;
MC_Stop_1(Axis1,Execute_Stop,Deceleration_Stop,Jerk_Stop);
Done_Stop := MC_Stop_1.Done;
Busy_Stop := MC_Stop_1.Busy;
Active_Stop := MC_Stop_1.Active;
CommandAbort_Stop := MC_Stop_1.CommandAborted;
Error_Stop := MC_Stop_1.Error;
ErrorID_Stop := MC_Stop_1.ErrorID;
```

```
MC_Stop_1(
```

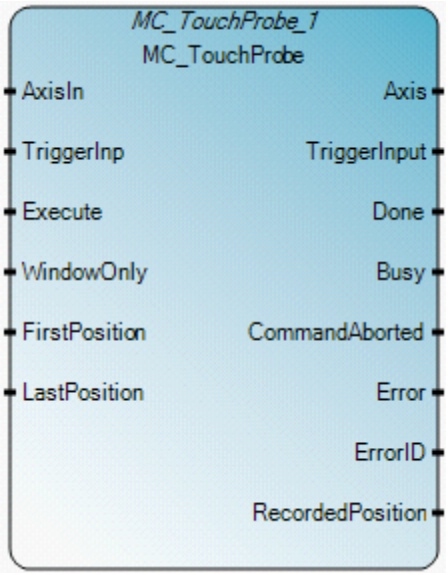
void **MC_Stop_1**(AXIS_REF AxisIn, BOOL Execute, REAL Deceleration, REAL Jerk)
Type : MC_Stop, Commands a controlled motion stop and transfers the axis to the state Stopping.

Results



MC_TouchProbe

MC_TouchProbe records an axis position at a trigger event.



MC_TouchProbe operation

- If the window direction (first position --> last position) is in the opposite direction of the motion direction, the touch probe window will not be activated.
- If the window setting (FirstPosition or LastPosition) is invalid, the MC_TouchProbe function block reports an error.
- If a second instance of the MC_TouchProbe function block is issued on the same axis, and the first function block instance is in a Busy state, the second function block instance reports an error.
- Only one MC_TouchProbe function block instance should be issued to one axis.

Arguments

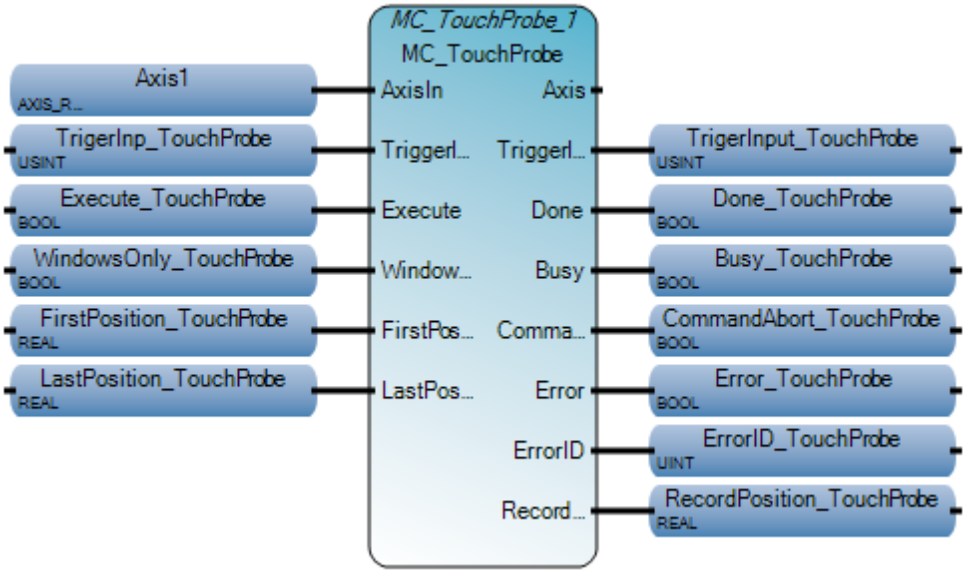
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_TouchProbe computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
TriggerInp	Input	USINT	Only embedded motion supported.
Execute	Input	BOOL	When TRUE, starts touch probe recording at the rising edge.
WindowOnly	Input	BOOL	When TRUE, only use the window (defined here) to accept trigger events. Motion resolution is limited to the Motion Engine interval configured by the user. For WindowOnly TouchProbe functionality, there is a maximum response time delay that is equal to the Motion Engine interval for both FirstPosition and LastPosition activation. The maximum possible lag in the triggering position (both FirstPosition and LastPosition) can be calculated by (Motion Engine interval * moving velocity).
FirstPosition	Input	REAL	Start position of the window from where trigger events are accepted (in technical units [u]). Value included in window.
LastPosition	Input	REAL	Stop position of the window from where trigger events are not accepted (in technical units [u]). Value included in window.
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
TriggerInput	Output	USINT	Only embedded motion supported.
Done	Output	BOOL	When TRUE, trigger event was recorded.
Busy	Output	BOOL	When TRUE, the function block is not finished.
CommandAborted	Output	BOOL	When TRUE, the command was aborted by the MC_Power(OFF), or Error Stop function block.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).
RecordedPosition	Output	REAL	Position where trigger event occurred (in technical units [u]) Motion is an open-loop motion. The axis position at the time the trigger event occurs. If the axis motion is an open-loop motion, the commanded position (not an actual position) at the time the trigger event occurs, assuming there is no motion delay between the drive and the motor.

Motion fixed input/output

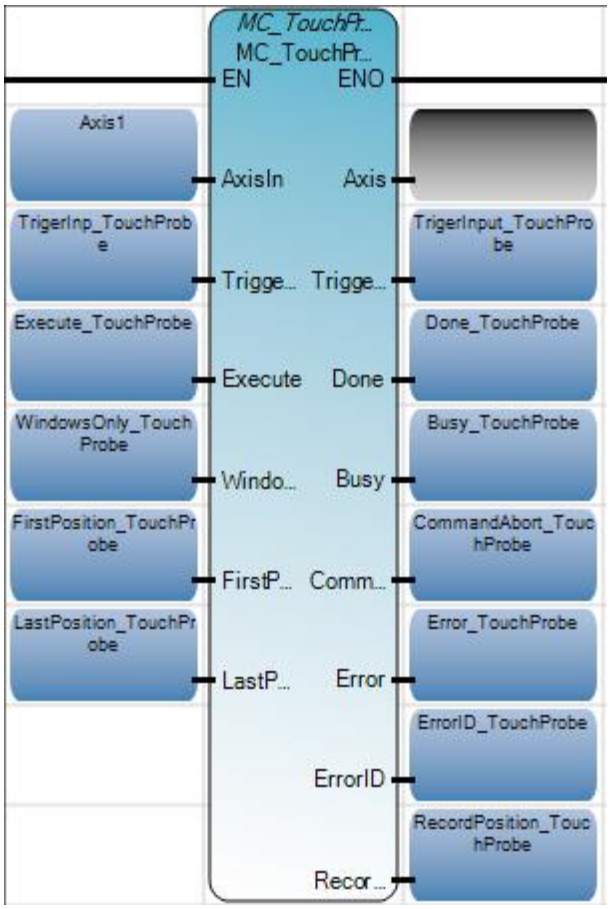
Motion Signals	PT00	PT01	PT02
PTO pulse	Output_0	Output_1	Output2
PTO direction	Output_3	Output_4	Output_5
Lower (Negative) Limit switch	Input_0	Input_4	Input_8
Upper (Positive) Limit switch	Input_1	Input_5	Input_9
Absolute Home switch	Input_2	Input_6	Input_10
Touch Probe Input switch	Input_3	Input_7	Input_11

MC_TouchProbe function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



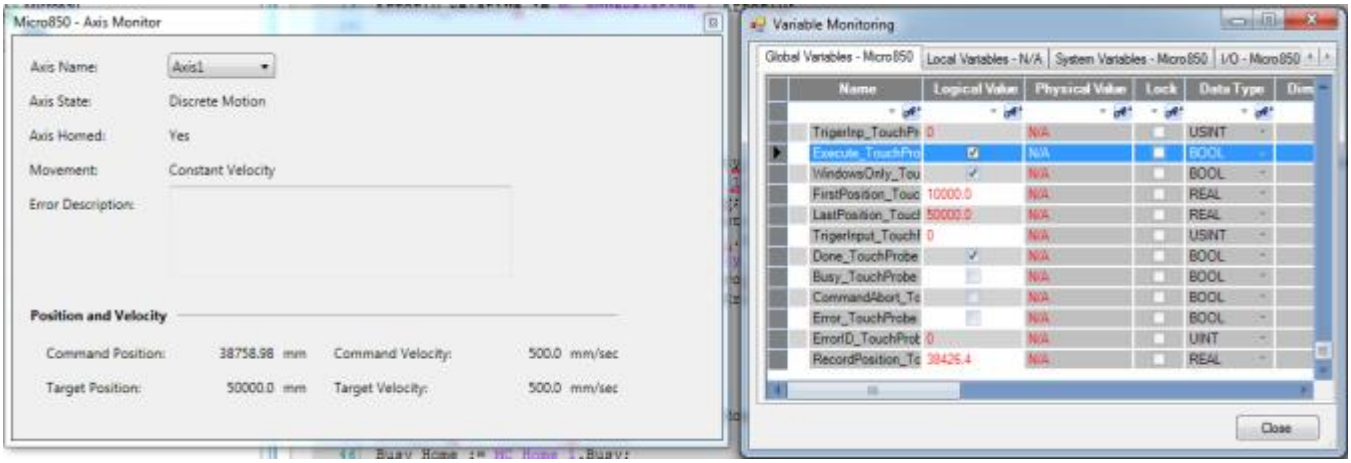
Structured Text (ST)

```
FirstPosition_TouchProbe := 10000.0;
LastPosition_TouchProbe := 50000.0;
MC_TouchProbe_1(Axis1,TrigerInp_TouchProbe,Execute_TouchProbe,WindowsOnly_TouchProbe,
FirstPosition_TouchProbe,LastPosition_TouchProbe);
Done_TouchProbe := MC_TouchProbe_1.Done;
Busy_TouchProbe := MC_TouchProbe_1.Busy;
Error_TouchProbe := MC_TouchProbe_1.Error;
ErrorID_TouchProbe := MC_TouchProbe_1.ErrorID;
RecordPosition_TouchProbe := MC_TouchProbe_1.RecordedPosition;
```

```
MC_TouchProbe_1(
```

void **MC_TouchProbe_1**(AXIS_REF AxisIn, USINT TriggerInp, BOOL Execute, BOOL WindowOnly, REAL FirstPosition, REAL LastPosition)
Type : MC_TouchProbe, Records an axis position at a trigger event

Results

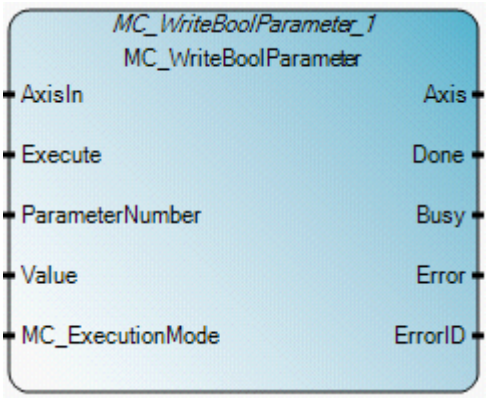


Motion fixed input/output

Motion Signals	PTO0	PTO1	PTO2
PTO pulse	Output_0	Output_1	Output2
PTO direction	Output_3	Output_4	Output_5
Lower (Negative) Limit switch	Input_0	Input_4	Input_8
Upper (Positive) Limit switch	Input_1	Input_5	Input_9
Absolute Home switch	Input_2	Input_6	Input_10
Touch Probe Input switch	Input_3	Input_7	Input_11

MC_WriteBoolParameter

MC_WriteBoolParameter modifies the value of a vendor specific parameter of type BOOL.



MC_WriteBoolParameter operation

The parameters set by the MC_WriteBoolParameter function block are only applied to the application temporarily. They are overwritten by the permanent settings, which are configured by the user in Connect Component Workbench Motion Configuration, when the controller is switched from PRG to RUN, or when the controller power is cycled.

Arguments

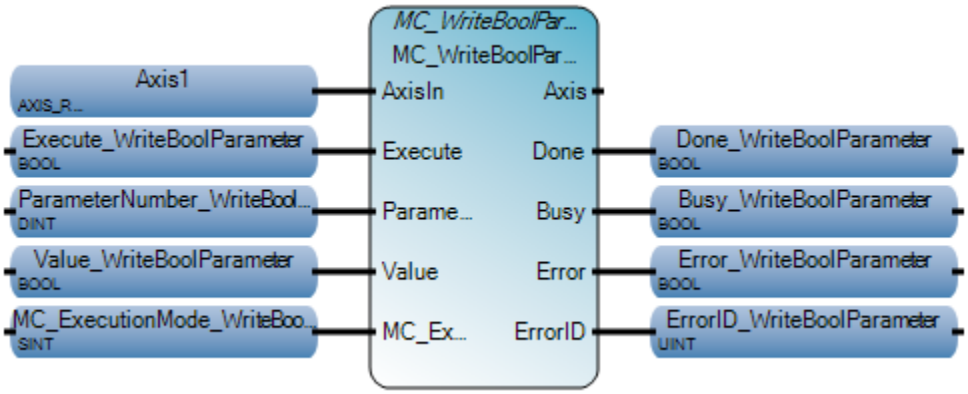
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_WriteBoolParameter computation. When EN = FALSE, the Value output is reset to 0. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, writes the value of the parameter at the rising edge.
ParameterNumber	Input	DINT	Parameter ID. See additional topics in 'See also' below.
Value	Input	BOOL	When TRUE, the specified parameter has a new value.

MC_ExecutionMode	Input	SINT	Values are:
			• 0 (*mcImmediately*) - The functionality is immediately valid.
			• 1 (*mcQueued*) - The new functionality becomes valid when:
			  • all previous motion commands set one of the following output parameters: Done, Aborted or Error
			  • the axis is not in a moving state.
			Note: When (MC_ExecutionMode = 0), for all parameters except Duty Cycle (1005), this FB can be completed successfully only when the axis state is Disabled or StandStill,
			When (MC_ExecutionMode = 0), for Parameter Duty Cycle (1005), this FB can be completed successfully except the axis is in Homing or ErrorStop state.
			For (MC_ExecutionMode = 1), this function block can be successfully completed only when the axis state is Disabled, Standstill, or the on-going motion can complete, ending with Standstill state
			Other input values are reserved currently, and are considered as invalid parameters.

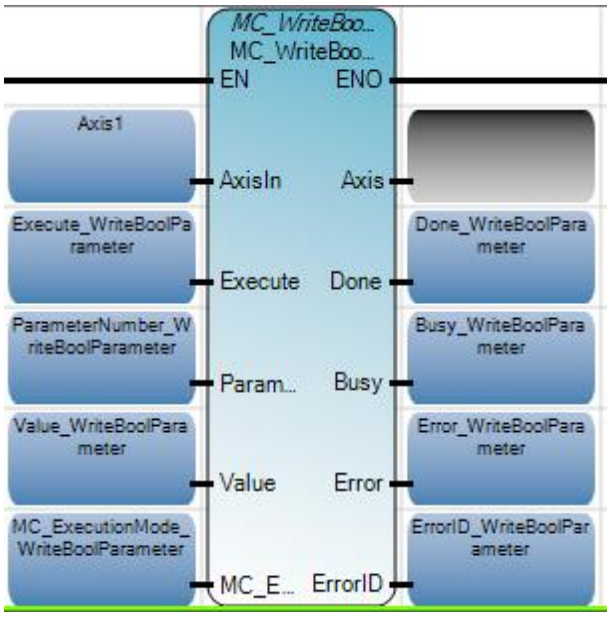
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, the parameter was successfully written.
Busy	Output	BOOL	When TRUE, the function block is not finished.
Error	Output	BOOL	When TRUE, an error is detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_WriteBoolParameter function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



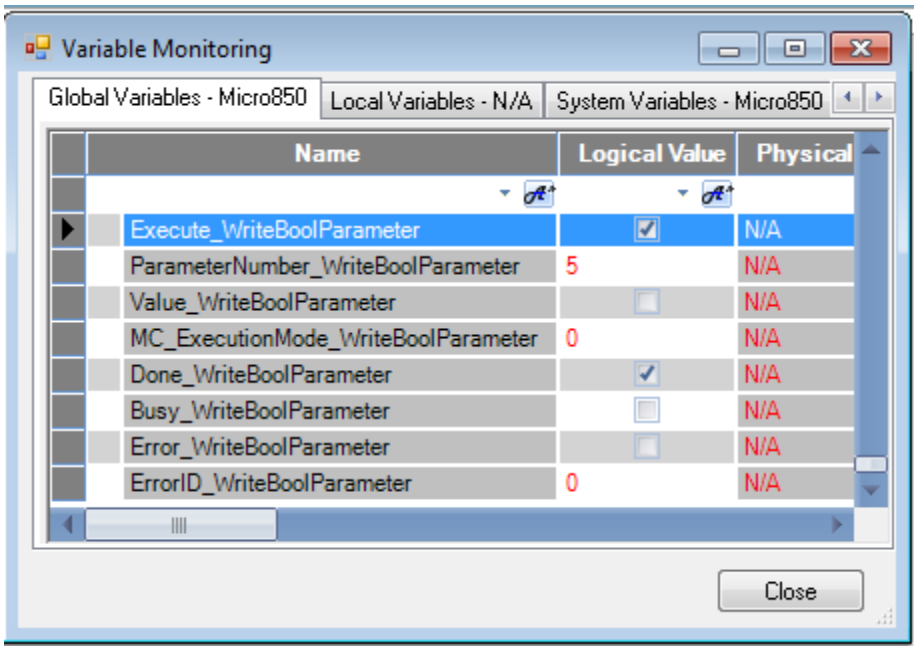
Structured Text (ST)

```
ParameterNumber_WriteBoolParameter := 5;
MC_WriteBoolParameter_1(Axis1,Execute_WriteBoolParameter,ParameterNumber_WriteBoolParameter,
Value_WriteBoolParameter,MC_ExecutionMode_WriteBoolParameter);
Done_WriteBoolParameter := MC_WriteBoolParameter_1.Done;
Busy_WriteBoolParameter := MC_WriteBoolParameter_1.Busy;
Error_WriteBoolParameter := MC_WriteBoolParameter_1.Error;
ErrorID_WriteBoolParameter := MC_WriteBoolParameter_1.ErrorID;
```

```
MC_WriteBoolParameter_1(
```

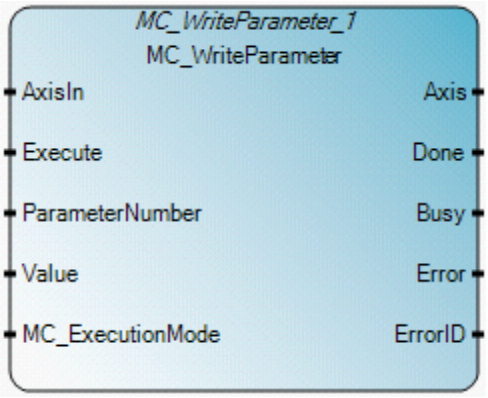
void **MC_WriteBoolParameter_1**(AXIS_REF AxisIn, BOOL Execute, DINT ParameterNumber, BOOL Value, SINT MC_ExecutionMode)
Type : MC_WriteBoolParameter, Modifies the value of a motion specific BOOL parameter

Results



MC_WriteParameter

MC_WriteParameter modifies the value of a vendor specific parameter.



MC_WriteParameter operation

The parameters set by the MC_WriteParameter function block are only applied to the application temporarily. They are overwritten by the permanent settings, which are configured by the user in Connect Component Workbench Motion Configuration, when the controller is switched from PRG to RUN, or when the controller power is cycled.

Arguments

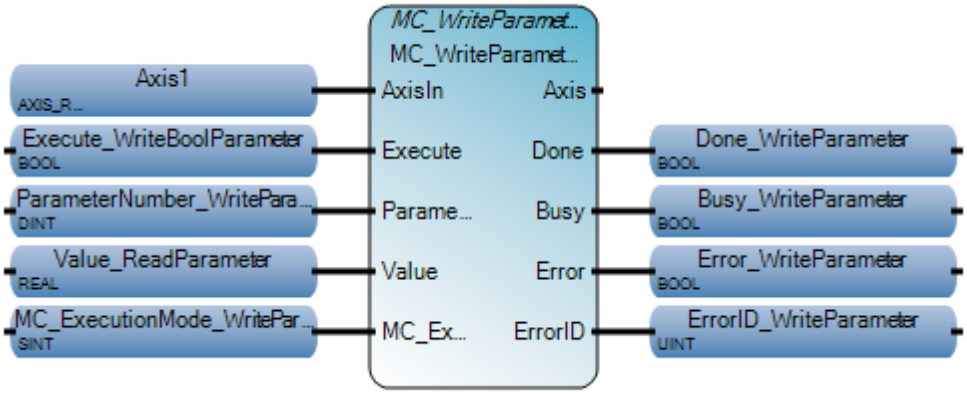
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute current MC_WriteParameter computation. When EN = FALSE, there is no computation. Applies only to LD programs.
AxisIn	Input	AXIS_REF	See also AXIS_REF data type (on page 438).
Execute	Input	BOOL	When TRUE, writes the value of the parameter at the rising edge.
ParameterNumber	Input	DINT	Parameter identification. See also Motion control function block parameter numbers (on page 435).
Value	Input	REAL	New value of the specified parameter.

MC_ExecutionMode	Input	SINT	Values are:
			• 0 (*mcImmediately*) - The functionality is immediately valid.
			• 1 (*mcQueued*) - The new functionality becomes valid when:
			  • all previous motion commands set one of the following output parameters: Done, Aborted or Error
			  • the axis is not in a moving state
			  • implies that the output parameter Busy is set to FALSE.
			Note: When (MC_ExecutionMode = 0), for all parameters except Duty Cycle (1005), this FB can be completed successfully only when the axis state is Disabled or StandStill,
			When (MC_ExecutionMode = 0), for Parameter Duty Cycle (1005), this FB can be completed successfully except the axis is in Homing or ErrorStop state.
			For (MC_ExecutionMode = 1), this function block can be successfully completed only when the axis state is Disabled, Standstill, or the on-going motion can complete, ending with Standstill state
			Other input values are reserved currently, and are considered as invalid parameters.

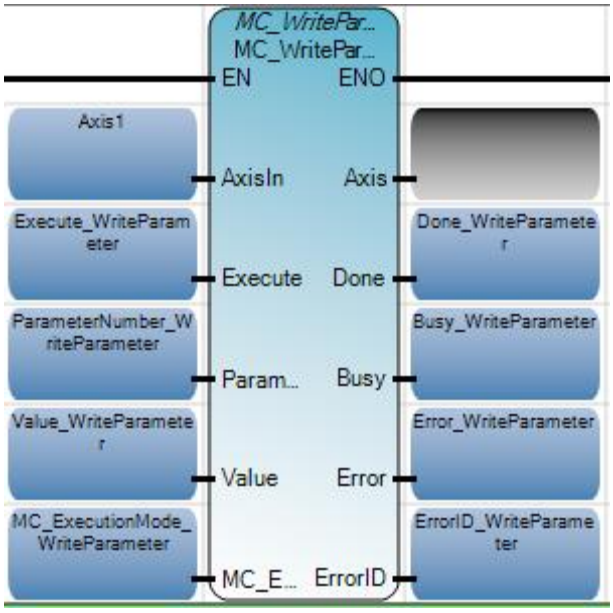
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Axis	Output	AXIS_REF	Axis output is read-only in LD programs. See also AXIS_REF data type (on page 438).
Done	Output	BOOL	When TRUE, the parameter was successfully written.
Busy	Output	BOOL	When TRUE, indicates the function block has control of the axis.
Error	Output	BOOL	When TRUE, an error was detected.
ErrorID	Output	UINT	Error identification. See also Motion control function block error IDs (on page 436).

MC_WriteParameter function block language examples

Function Block Diagram (FBD)

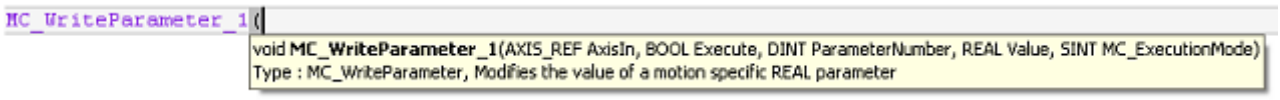


Ladder Diagram (LD)

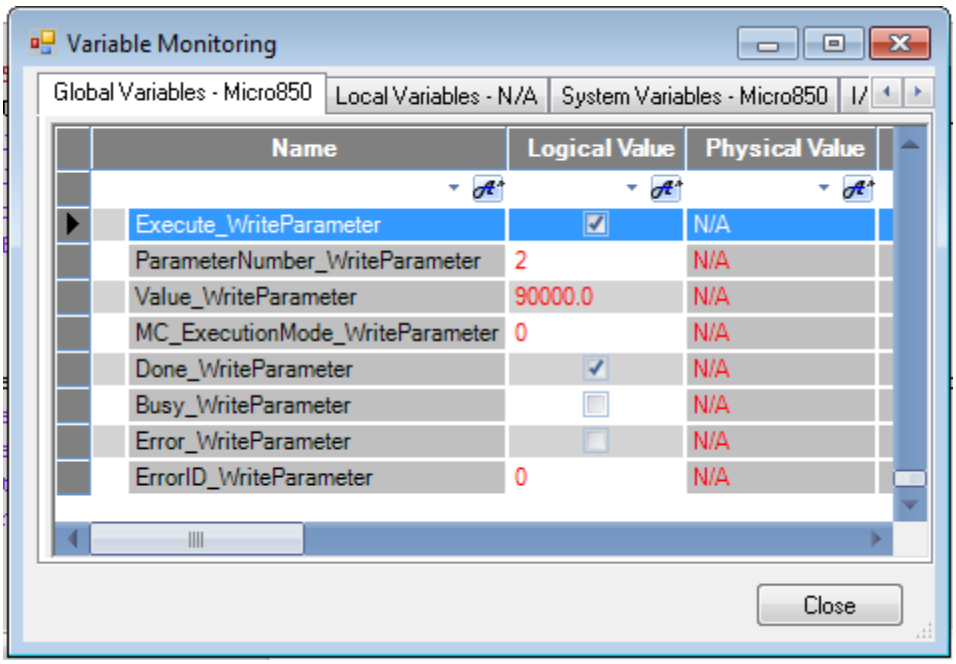


Structured Text (ST)

```
ParameterNumber_WriteParameter := 2;
Value_WriteParameter := 90000.0;
MC_WriteParameter_1(Axis1,Execute_WriteParameter,ParameterNumber_WriteParameter,
Value_WriteParameter,MC_ExecutionMode_WriteParameter);
Done_WriteParameter := MC_WriteParameter_1.Done;
Busy_WriteParameter := MC_WriteParameter_1.Busy;
Error_WriteParameter := MC_WriteParameter_1.Error;
ErrorID_WriteParameter := MC_WriteParameter_1.ErrorID;
```



Results



Process control instructions

Process control instructions are used to monitor and maintain process loops for quantities such as pressure, temperature, flow rate, and fluid level. Process controls regulate the course by sending an output signal to the control valve.

Function block	Description
DERIVATE (on page 516)	Differentiation of a real value
HYSTER (on page 518)	Boolean hysteresis on difference of reals
INTEGRAL (on page 520)	Integration over time
PWM (on page 527)	Turns the output for a configured channel on or off
SCALER (on page 532)	Scale input value according to output range
STACKINT (on page 535)	Stack of integer
Function	**Description**
LIMIT (on page 540)	Limit
TND (on page 538)	Stops the current cycle of the user program scan

DERIVATE

DERIVATE differentiates a Real value. If the CYCLE parameter value is less than the cycle timing of the execution of the device, the sampling period is forced to this cycle timing.

Derivate operation

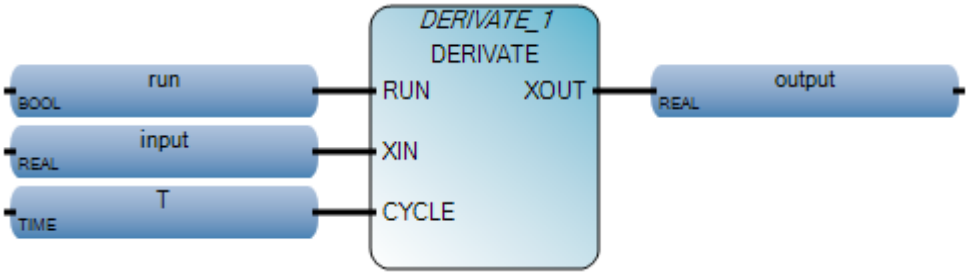
The derivation is performed with a time base of milliseconds (that is, the derivation of an input of 1000 that changes to 2000 over a time period of 1 second results in a value of 1). To convert the output of the instruction to units of seconds, the output must be multiplied by 1000.

Arguments

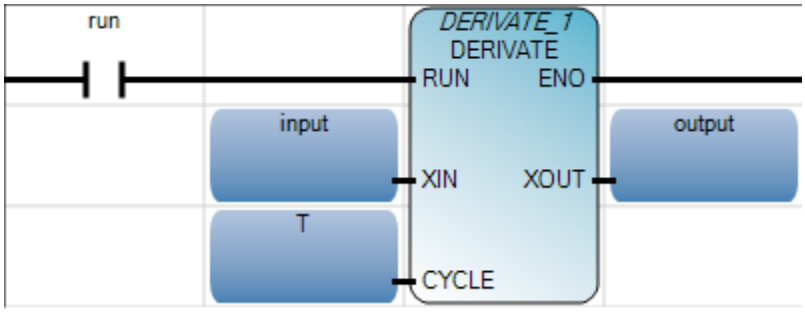
Parameter	Parameter type	Data type	Description
RUN	Input	BOOL	Mode: TRUE = normal / FALSE = reset.
XIN	Input	REAL	Input: any real value.
CYCLE	Input	TIME	Sampling period. Possible values range from 0ms to 23h59m59s999ms.
XOUT	Output	REAL	Differentiated output.
ENO	Output	BOOL	Enable out Applies only to LD programs.

DERIVATE function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  DERIVATE_1(run, input, T);
2  output := DERIVATE_1.XOUT;
```

```
DERIVATE_1(
```

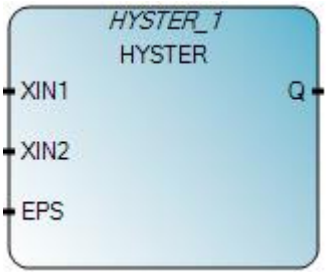
void **DERIVATE_1**(BOOL RUN, REAL XIN, TIME CYCLE)
Type : DERIVATE, Differentiation according to time

(* ST Equivalence: DERIVATE1 is an instance of a DERIVATE block *)

```
DERIVATE1(manual_mode, sensor_value, t#100ms);
derivated_value := DERIVATE1.XOUT;
```

HYSTER

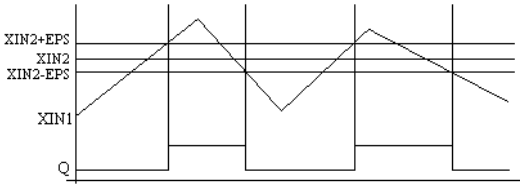
HYSTER performs hysteresis on a Real value for a high limit.



Arguments

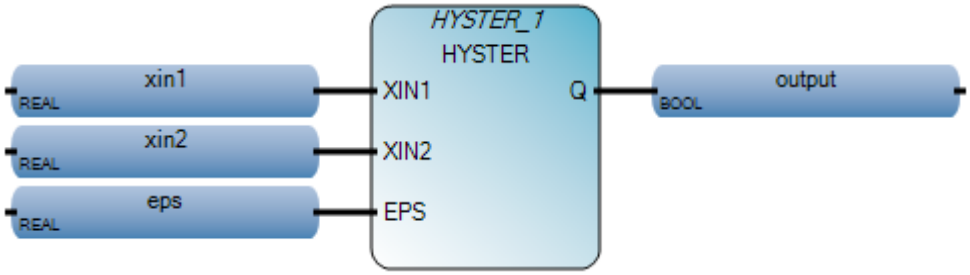
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute function. When EN = FALSE, do not execute function. Applies only to LD programs.
XIN1	Input	REAL	Any real value.
XIN2	Input	REAL	To test if XIN1 has overpassed XIN2 + EPS.
EPS	Input	REAL	Hysteresis value (must be greater than zero).
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Q	Output	BOOL	TRUE if XIN1 has overpassed XIN2 + EPS and is not yet below XIN2 - EPS.

Hyster timing diagram example

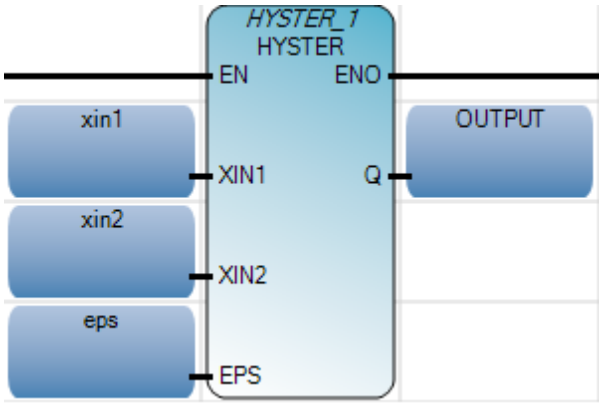


HYSTER function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

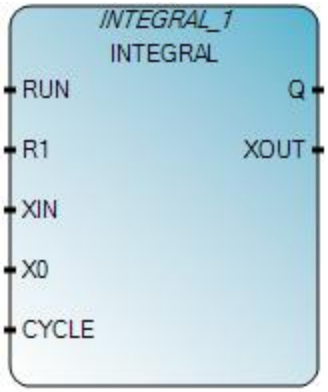
```
1  xin1 := 10.0;
2  xin2 := 1.0;
3  eps := 1.0;
4  HYSTER_1(xin1, xin2, eps);
5  output := HYSTER_1.Q;
```

```
HYSTER_1(
```

void **HYSTER_1**(REAL XIN1, REAL XIN2, REAL EPS)
Type : HYSTER, Boolean hysteresis on difference of reals

INTEGRAL

INTEGRAL integrates a real value.



INTEGRAL operation

- When the INTEGRAL function block is first initialized, its initial values are not considered. Use the R1 parameter to set the initial values for a calculation.
- To prevent loss of the integrated value, the integration value is not cleared automatically when the controller transitions from PROGRAM to RUN or when the RUN parameter transitions from FALSE to TRUE. Use the R1 parameter to clear the integral value when first transitioning the controller from PROGRAM to RUN mode and when starting a new integration.
- We recommend you do not use the EN or ENO parameters with this function block because the cycle time calculation will be disrupted when EN is FALSE, resulting in an incorrect integration. If you choose to use the EN or ENO parameters, toggle the R1 parameter with EN equal to TRUE to clear the current result and ensure correct integration.
- Integration is performed with a time base of milliseconds (that is, integrating an input of 1 with an initial value of 0 for 1 second will result in a value of 1000). To convert the output of the instruction to units of seconds, divide the output by 1000.
- If the CYCLE parameter value is less than the cycle timing of the execution of the device, the sampling period is forced to the cycle timing.
- XIN sampling and function block executions occur every cycle time + Scan Time Jitter.
- For a given user program, Scan Time Jitter varies from controller to controller.

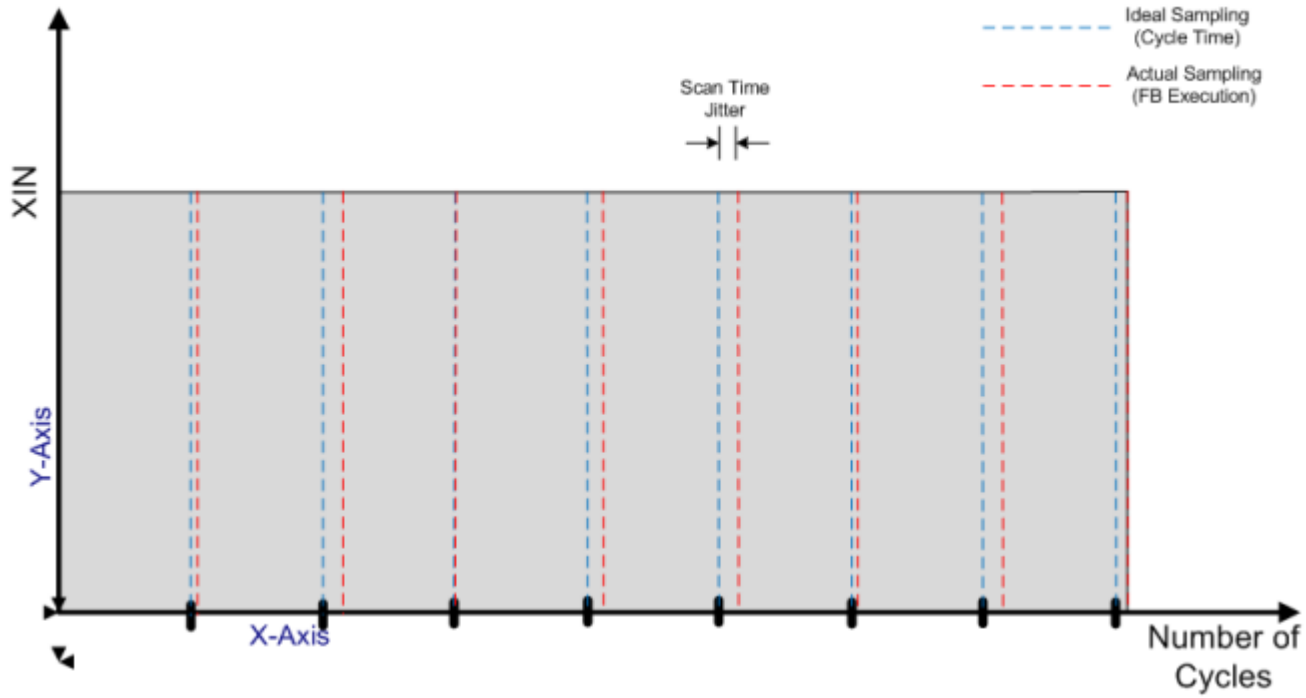
- The cycle time determines the sensitivity of the Integral function block. Changes occurring in XIN between two samplings (or within the cycle time) are not taken into account when the integral XOUT value is calculated.
- Cycle time and Scan Time Jitter both contribute to the overall inaccuracy of Integral output.
- See also XIN in sync with function block execution example and XIN not in sync with function block execution example.

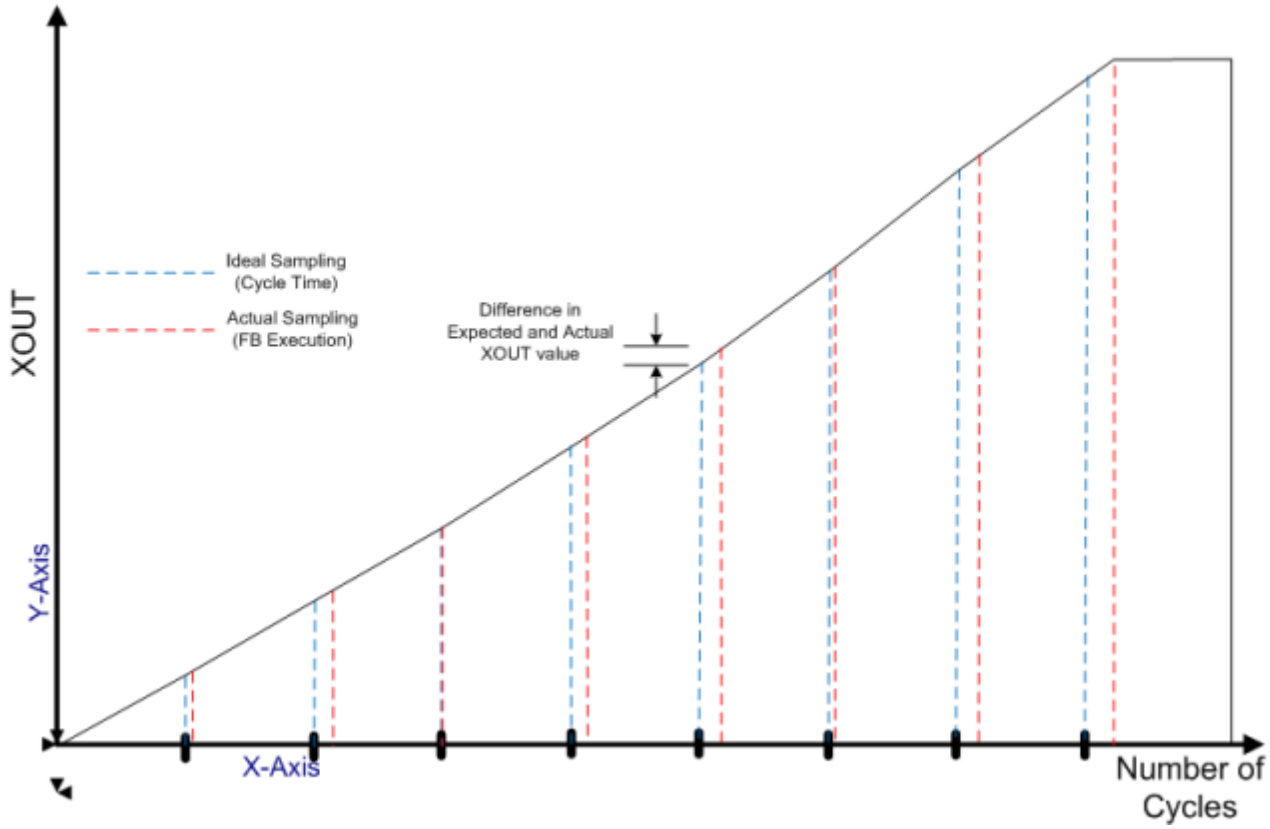
Arguments

Parameter	Parameter type	Data type	Description
RUN	Input	BOOL	Mode: TRUE = integrate / FALSE = hold.
R1	Input	BOOL	Overriding reset.
XIN	Input	REAL	Input: any real value.
X0	Input	REAL	Initial value.
CYCLE	Input	TIME	Sampling period. Possible values range from 0ms to 23h59m59s999ms.
Q	Output	BOOL	Not R1.
XOUT	Output	REAL	Integrated output.

Example: XIN in sync with function block execution

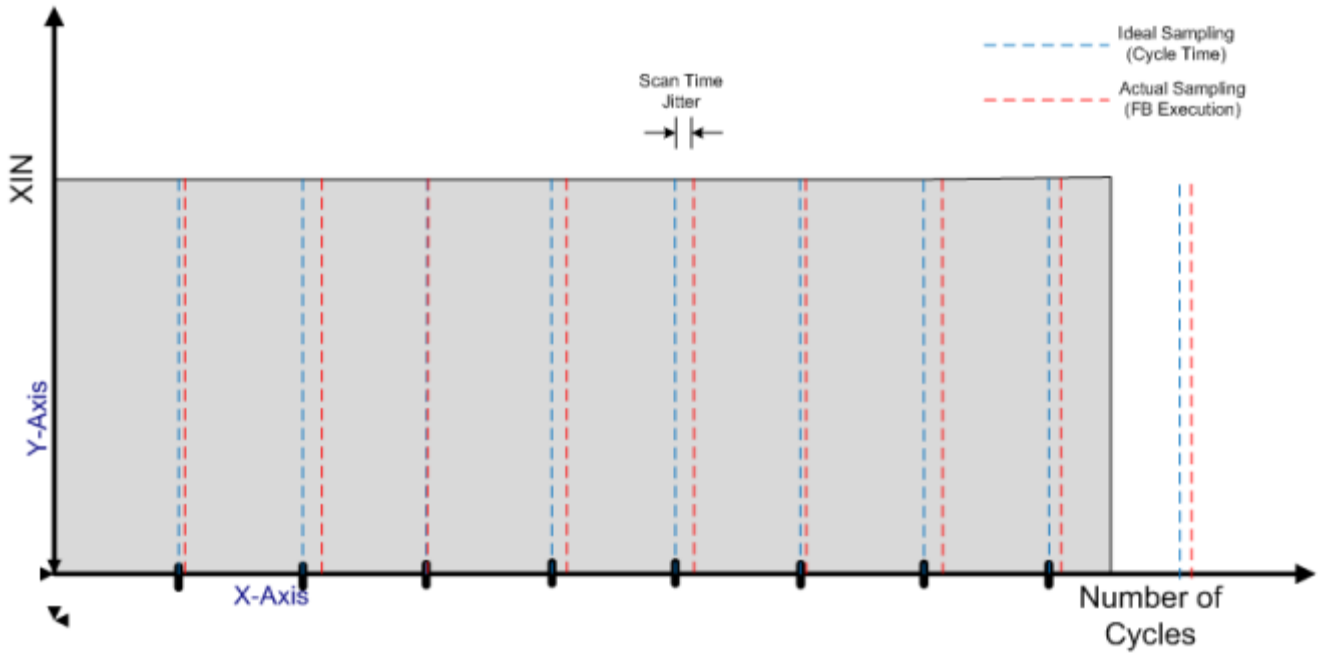
The following pictures show the effect of Scan Time Jitter on the XOUT value:

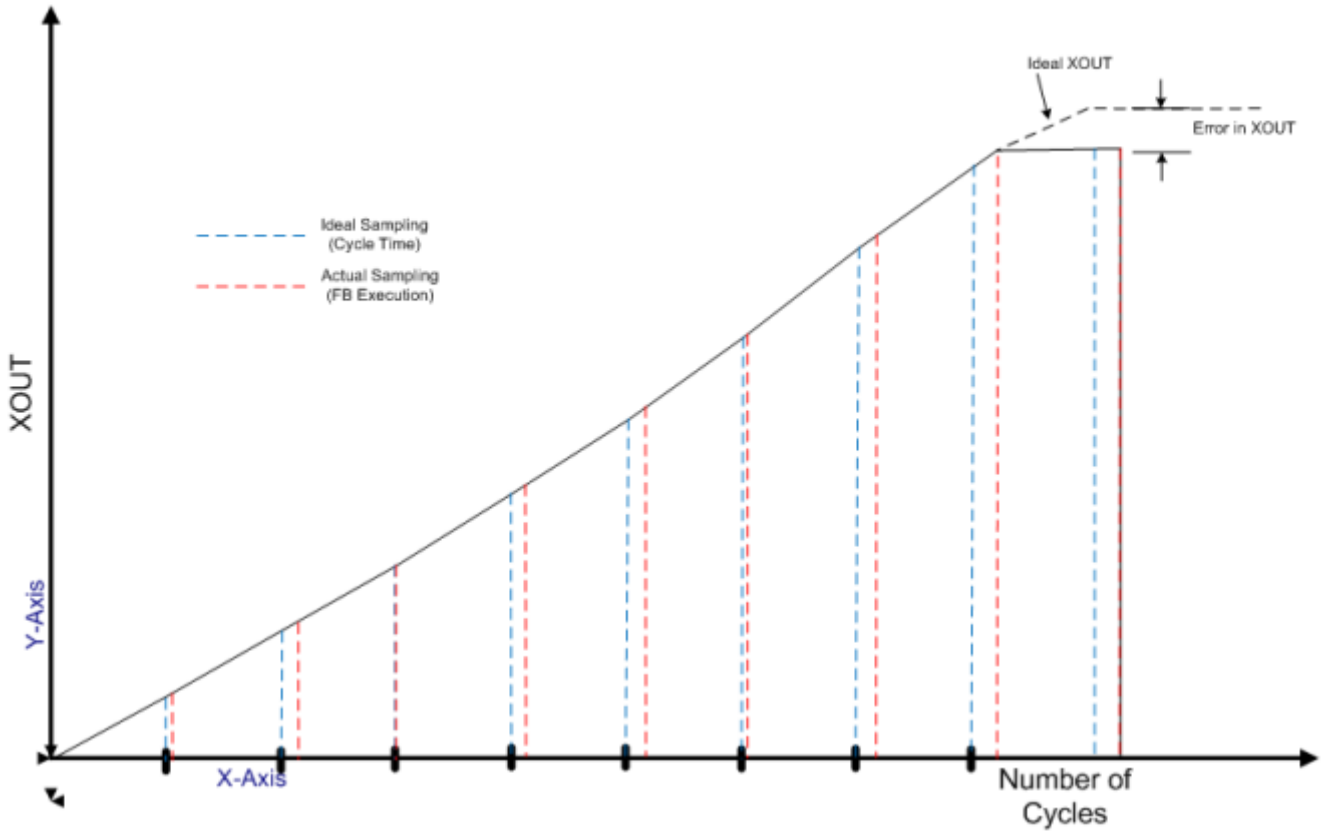

Ideal Sampling
(Cycle Time)
Actual Sampling
(FB Execution)
Scan Time
Jitter
XIN
Y-Axis
X-Axis
Number of
Cycles


Ideal Sampling
(Cycle Time)
Actual Sampling
(FB Execution)
Difference in
Expected and Actual
XOUT value
XOUT
Y-Axis
X-Axis
Number of
Cycles

Example: XIN not in sync with function block execution

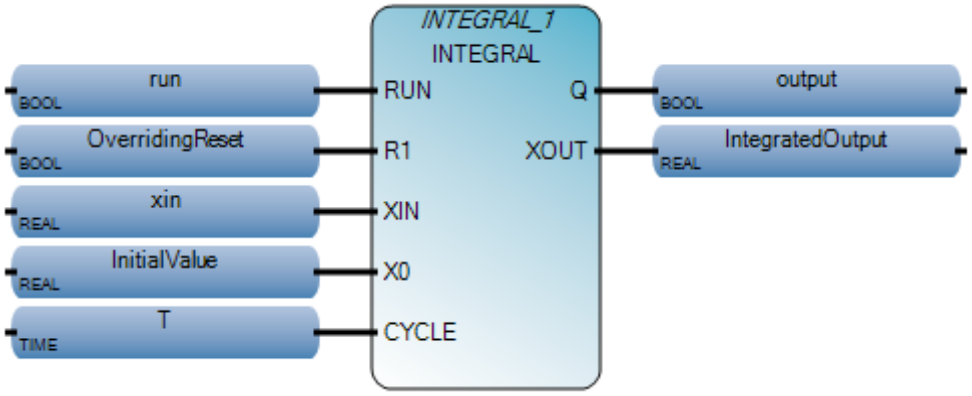
The following pictures show an example in which an error is introduced in the XOUT value of an Integral function block:



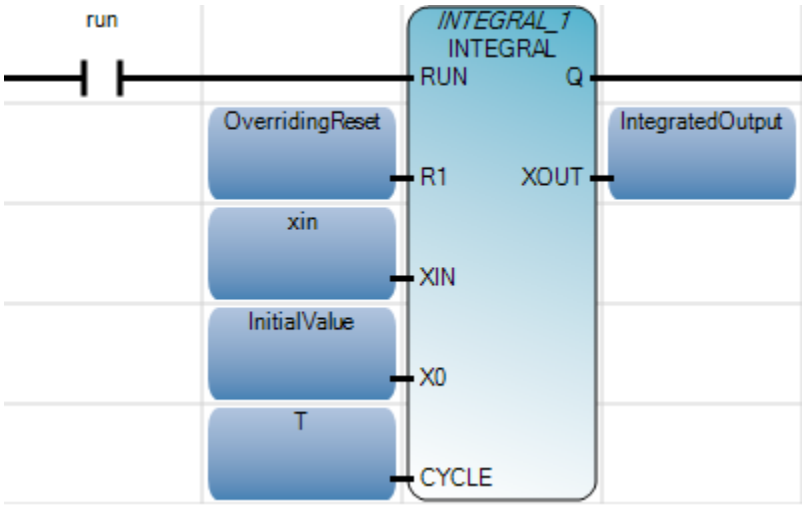


INTEGRAL function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  run := TRUE;
2  xin := 10.0;
3  InitialValue := 5.0;
4  T := T#10s;
5  INTEGRAL_1(run, OverridingReset, xin, InitialValue, T);
6  output := NOT OverridingReset;
7  IntegratedOutput := INTEGRAL_1.XOUT;
```

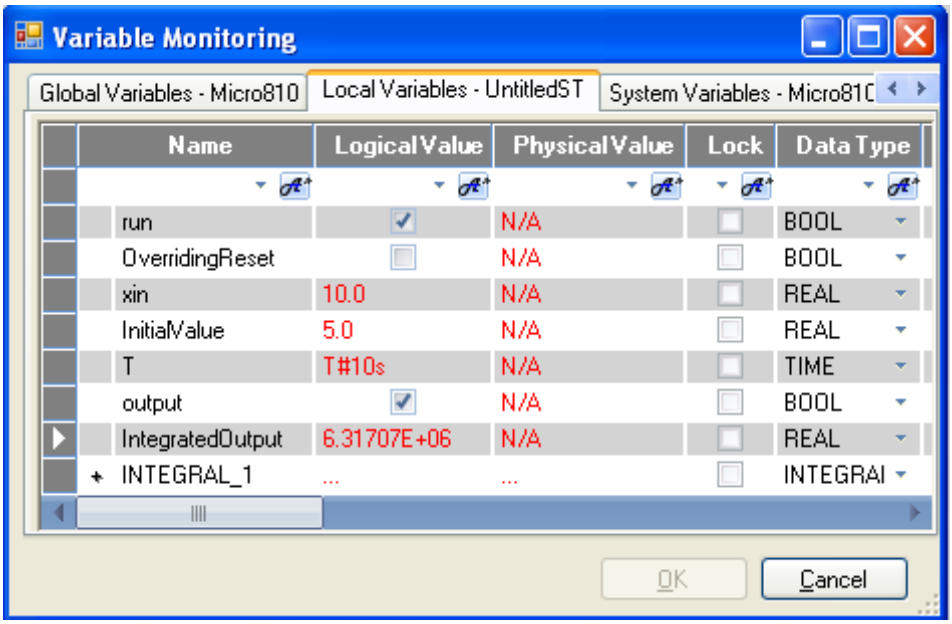
```
INTEGRAL_1(
```

void **INTEGRAL_1**(BOOL RUN, BOOL R1, REAL XIN, REAL X0, TIME CYCLE)
Type : INTEGRAL, Integration over time

(* ST Equivalence: INTEGRAL1 is an instance of a INTEGRAL block *)

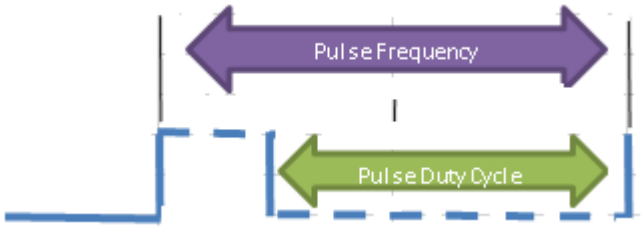
```
INTEGRAL1(manual_mode, NOT(manual_mode), sensor_value,
init_value, t#100ms);
controlled_value := INTEGRAL1.XOUT;
```

Results


Variable Monitoring
Global Variables - Micro810
Local Variables - UntitledST
System Variables - Micro81C
Name
LogicalValue
PhysicalValue
Lock
DataType
run
N/A
BOOL
OverridingReset
N/A
BOOL
xin
10.0
N/A
REAL
InitialValue
5.0
N/A
REAL
T
T#10s
N/A
TIME
output
N/A
BOOL
IntegratedOutput
6.31707E+06
N/A
REAL
INTEGRAL_1
...
...
INTEGRAI
OK
Cancel

PWM

PWM (Pulse Width Modulation) turns the PWM output for a configured PWM channel on or off. This instruction block is used with Micro820 2080-LC20-20QBB controllers and supports one PWM channel (using the embedded output channel 6).



PWM operation

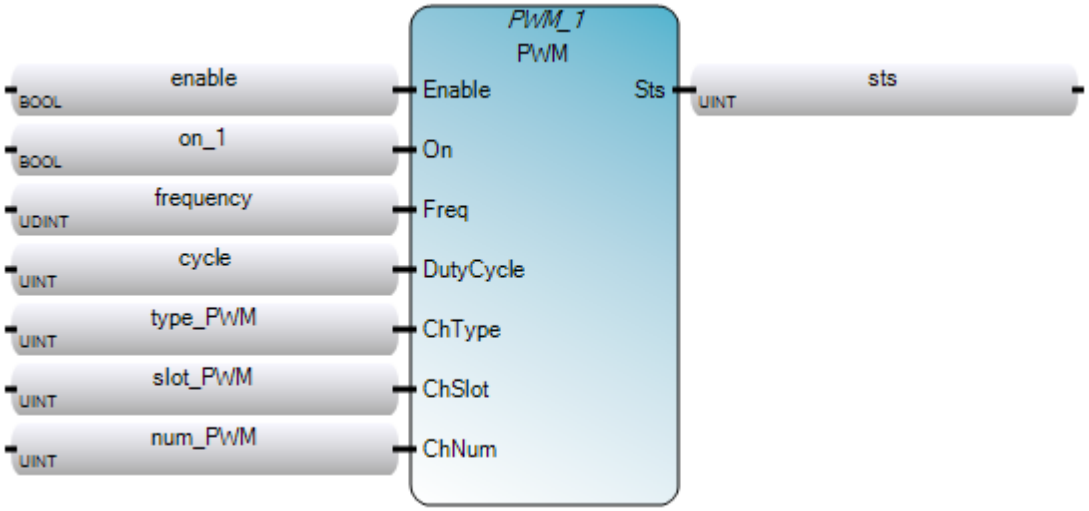
- PWM is supported for Micro820 controllers only.

PWM arguments

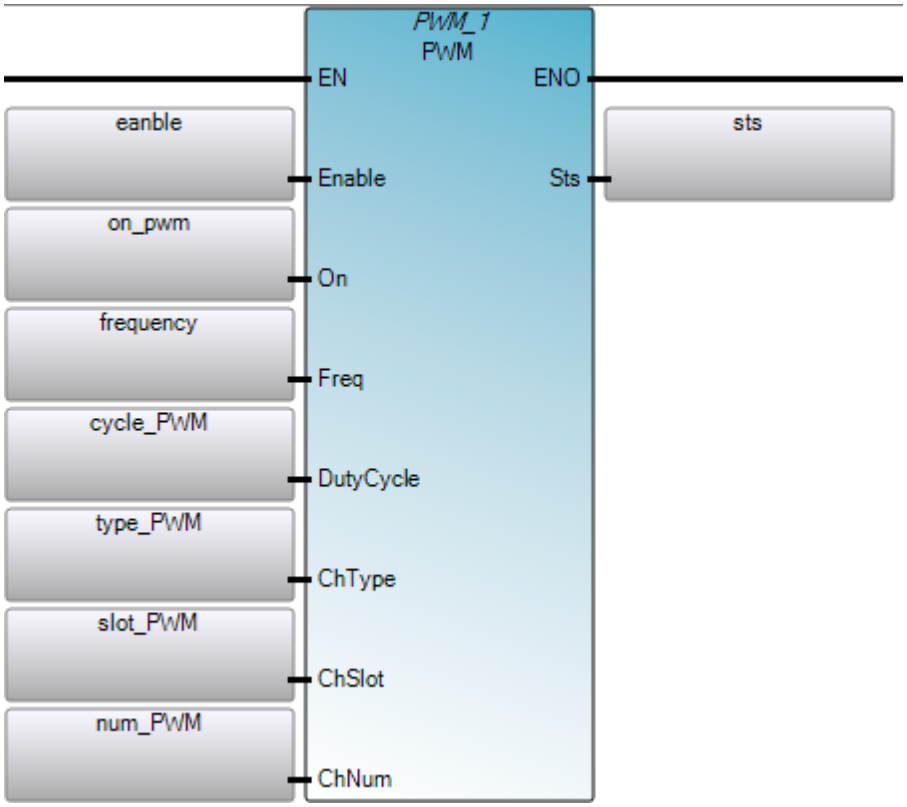
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. This level is FB triggered. When EN = TRUE, **Sts** is updated. PWM is made active or inactive depending on the On input parameter and valid configuration. When EN = FALSE, **Sts** is only updated. PWM state (active or inactive) is not affected.
On	Input	BOOL	Turns the PWM output On/Active or Off/Inactive. TRUE = PWM output is made active or continues to be active with latest valid configuration. Output LED is ON when PWM is active, even if duty cycle is set to 0%. FALSE = PWM output is made inactive but only if configuration is also valid.
Freq	Input	UDINT	Frequency in Hz • 1 – 100000
DutyCycle	Input	UINT	Duty Cycle • 0 – 1000 (0% - 100%)
ChType	Input	UINT	Channel Type • 0 – Embedded • 1 – Plugin • 2 – Expansion
ChSlot	Input	UINT	Channel Slot • 0 – Embedded
ChNum	Input	UINT	Channel Number • 0 – PWM CH0
ENO	Output	BOOL	Enable out. Applies only to LD programs.
Sts	Output	UINT	Function block execution status. 00 - Function block not enabled (no operation.) 01 - PWM configuration successful. 02 - Invalid duty cycle. 03 - Invalid Frequency. 04 - Invalid Channel Type. 05 - Invalid Channel Slot. 06 - Invalid Channel Number. 07 - Invalid Catalog. PWM feature is not supported in the catalog being used.

PWM function block language examples

Function Block Diagram (FBD)

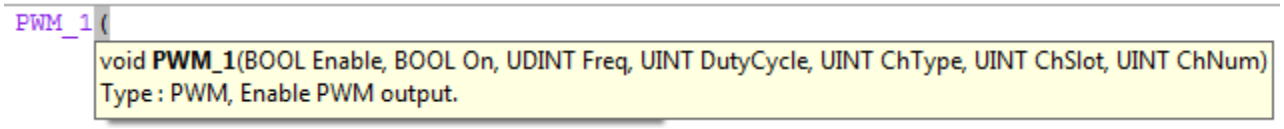


Ladder Diagram (LD)



Structured Text (ST)

```
1  PWM (EN, Enable, On, Freq, DutyCycle, ChType, ChSlot, ChNum);
2  output := PWM.ENO
3  sts := PWM.Sts
```

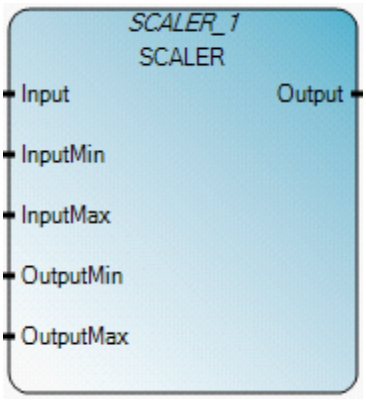


PWM status codes

Status code	Description
0	Function block not enabled (no operation).
1	PWM configuration successful.
2	Invalid Duty cycle.
3	Invalid Frequency.
4	Invalid Channel Type.
5	Invalid Channel Slot.
6	Invalid Channel Number.
7	Invalid Catalog. PWM feature is not supported in the catalog being used.

SCALER

SCALER scales the input value according to the output range.

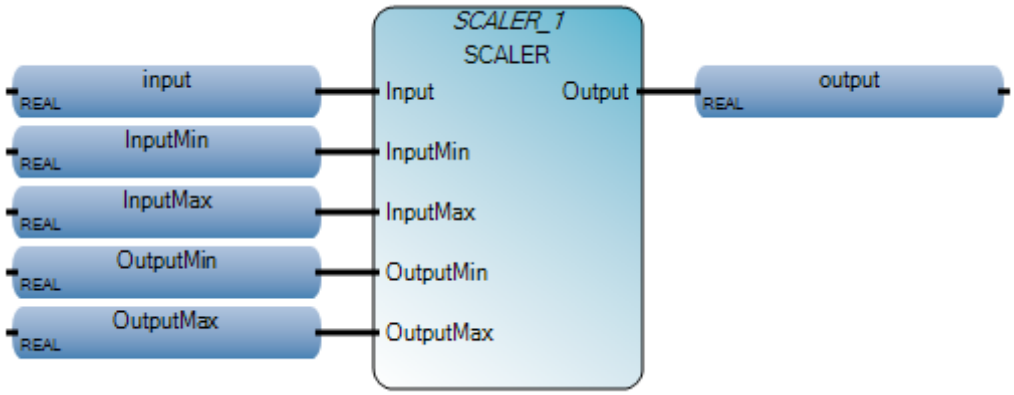


Arguments

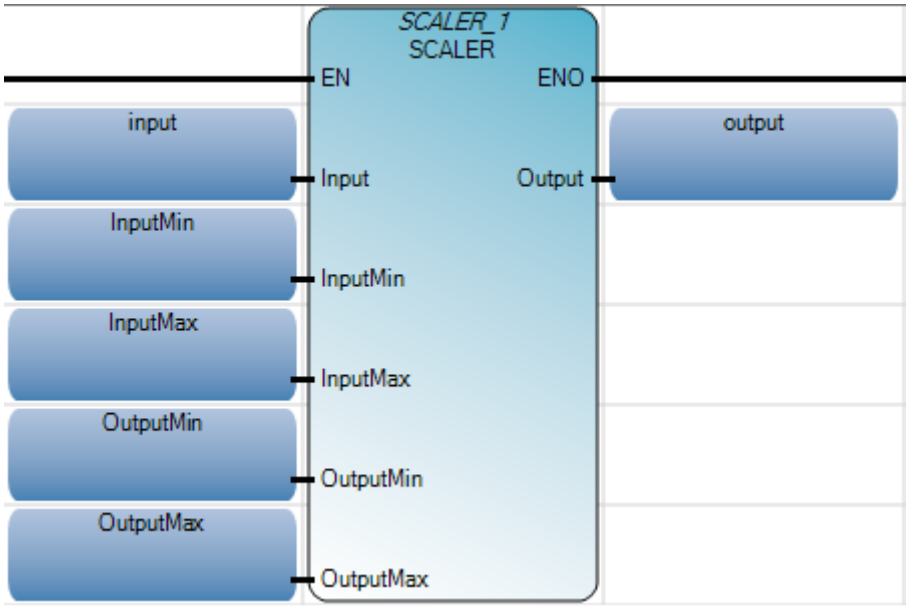
Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute the scaling equation. When EN = FALSE, there is no scaling equation. Applies only to LD programs.
Input	Input	REAL	Input signal.
InputMin	Input	REAL	Minimum value of Input.
InputMax	Input	REAL	Maximum value of Input.
OutputMin	Input	REAL	Minimum value of Output.
OutputMax	Input	REAL	Maximum value of Output.
Output	Output	REAL	Output value.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

SCALER function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  input := 10.0;
2  InputMin := 5.0;
3  InputMax := 15.0;
4  OutputMin := 1.0;
5  OutputMax := 10.0;
6  SCALER_1(input, InputMin, InputMax, OutputMin, OutputMax);
7  output := SCALER_1.Output;
```

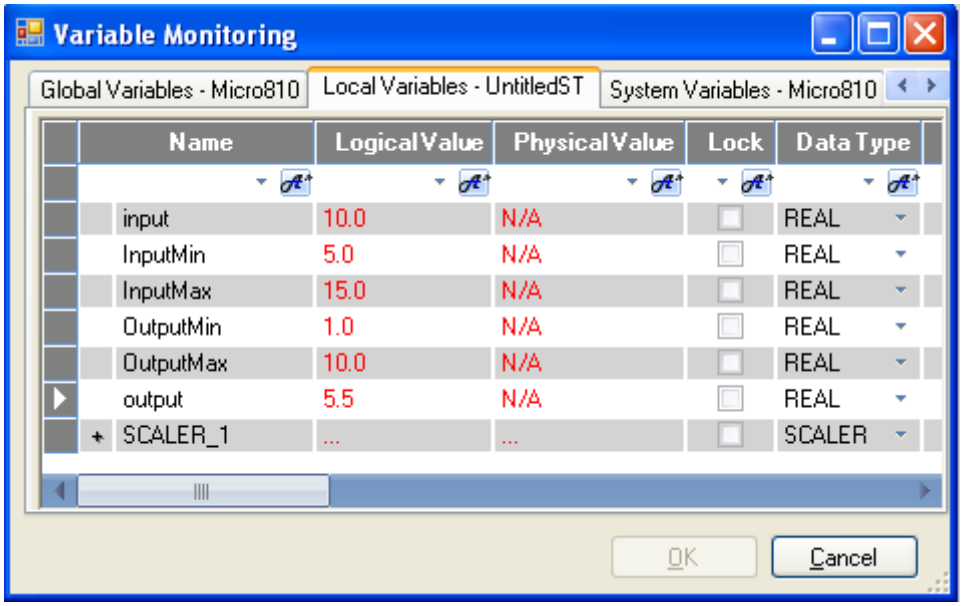
```
SCALER_1(
```

void **SCALER_1**(REAL Input, REAL InputMin, REAL InputMax, REAL OutputMin, REAL OutputMax)
Type : SCALER, Scale input value according to output range.

(* ST equivalence: SCALER1 is an instance of SCALER block *)

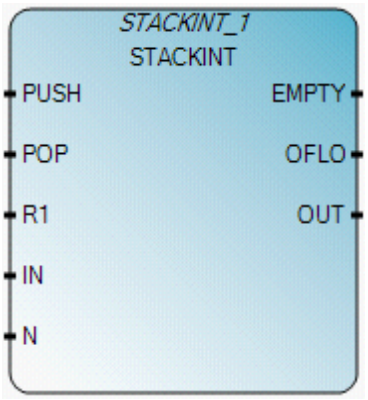
```
SCALER1(Signal_In, 4.0, 20.0 , 0.0 , 150.0 ) ;
Out_Temp := SCALER1.Output ;
```

Results



STACKINT

STACKINT manages a stack of integer values.



STACKINT operation

The STACKINT function block includes a rising edge detection for both PUSH and POP commands. The maximum size of the stack is 128. The OFLO value is valid only after a reset (R1 has been set to TRUE at least once and back to FALSE). The application defined stack size N cannot be less than 1 or greater than 128. STACKINT manages invalid values as follows:

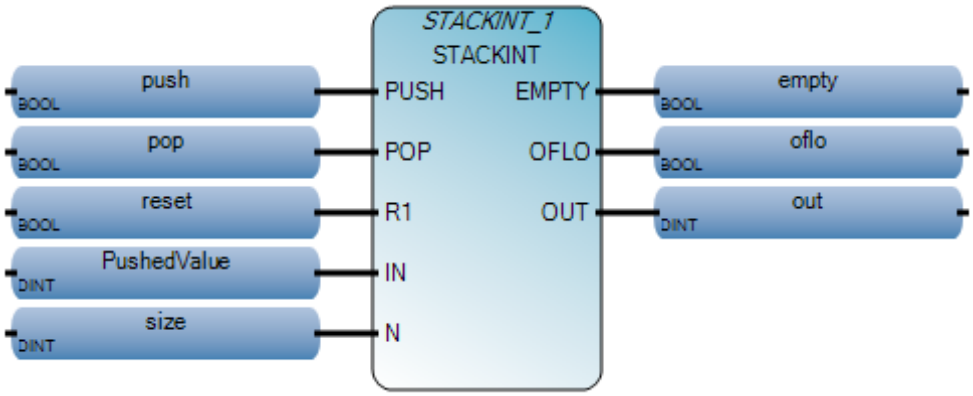
- if N < 1, STACKINT assumes a size of 1.
- if N > 128, STACKINT assumes a size of 128.

Arguments

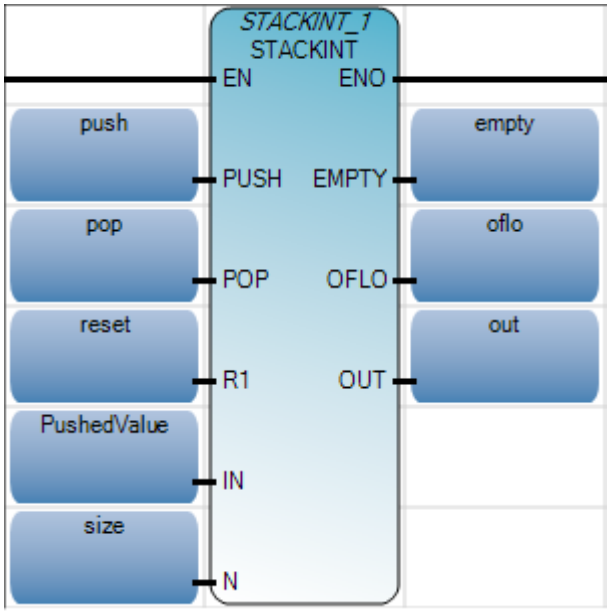
Parameter	Parameter type	Data type	Description
PUSH	Input	BOOL	Push command (on rising edge only). Adds the IN value on the top of the stack.
POP	Input	BOOL	Pop command (on rising edge only). Deletes the last value pushed to the top of the stack.
R1	Input	BOOL	Resets the stack to its empty state.
IN	Input	DINT	Pushed value.
N	Input	DINT	Application defined stack size.
EMPTY	Output	BOOL	TRUE if the stack is empty.
OFLO	Output	BOOL	Overflow: TRUE if the stack is full.
OUT	Output	DINT	Value at the top of the stack. OUT equals 0 when OFLO is TRUE.

STACKINT function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

```
1  PushedValue := 5;
2  size := 10;
3  STACKINT_1(push, pop, reset, PushedValue, size);
4  empty := STACKINT_1.EMPTY;
5  oflo := STACKINT_1.OFLO;
6  out := STACKINT_1.OUT;
```

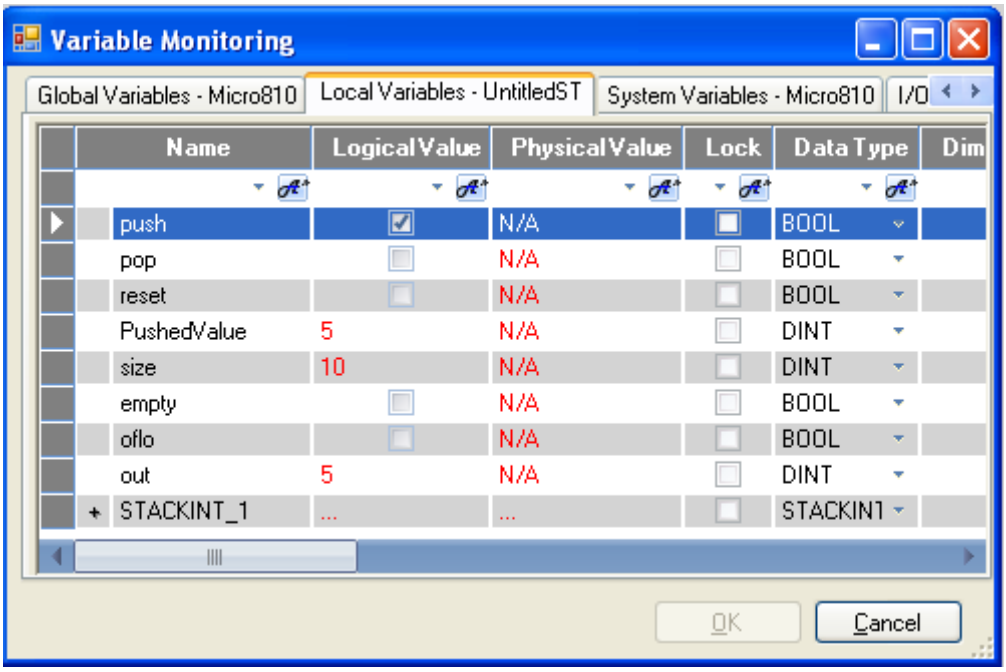
```
STACKINT_1(
```

void **STACKINT_1**(BOOL PUSH, BOOL POP, BOOL R1, DINT IN, DINT N)
Type : STACKINT, Stack of integer analogs

(* ST Equivalence: STACKINT1 is an instance of a STACKINT block *)

```
STACKINT1(err_detect, acknowledge, manual_mode, err_code,
max_err);
appli_alarm := auto_mode AND NOT(STACKINT1.EMPTY);
err_alarm := STACKINT1.OFLO;
last_error := STACKINT1.OUT;
```

Results



TND

TND stops the current cycle of user program scan. Then, after the output scan, input scan, and housekeeping, the user program will be re-executed from the start of the first routine.

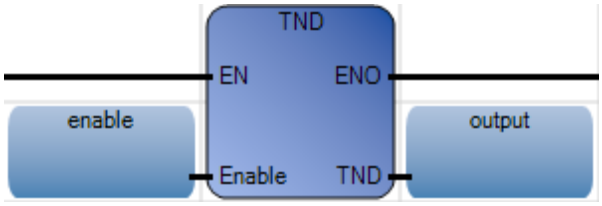
Arguments

Parameter	Parameter Type	Data Type	Description
Enable	Input	BOOL	Function enable. When Enable = TRUE, perform the function. When Enable = FALSE, do not perform the function.
TND	Output	BOOL	If true, function performed. **Note:** When variable monitoring is on, the monitoring variable's value is assigned to the block's output. When variable monitoring is off, the output variable's value is assigned to the block's output.

TND function language examples

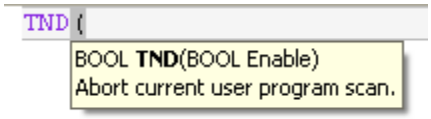
Function block diagram

Ladder diagram



Structured text

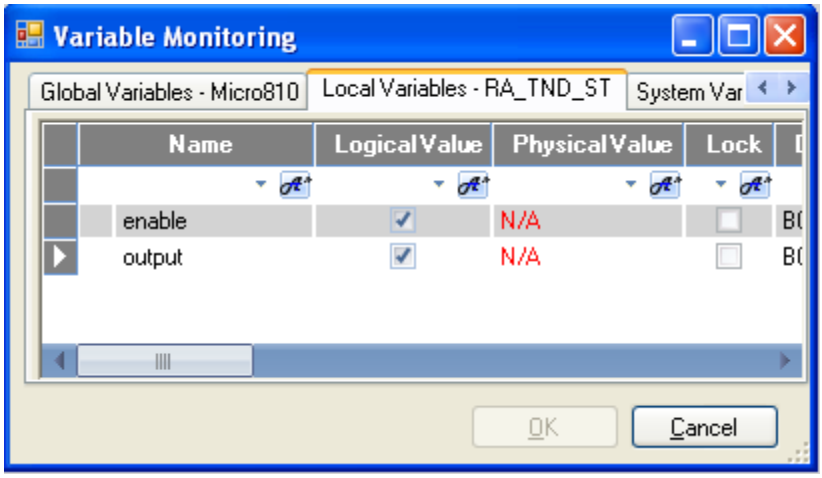
```
1  enable := TRUE;
2  output := TND(enable);
```



(* ST Equivalence: *)

TESTOUTPUT := TND(TESTENABLE) ;

Results



LIMIT

LIMIT restricts integer values to a given interval. Integer values between the minimum and maximum are unchanged. Integer values greater than the maximum are replaced with the maximum value. Integer values less than the minimum are replaced with the minimum value.

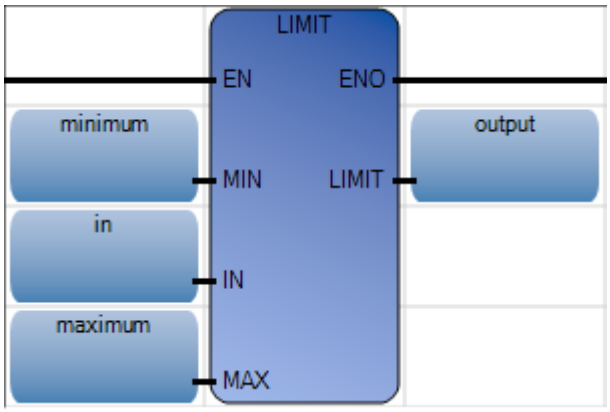
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, execute current LIMIT computation. When EN = FALSE, there is no computation.
MIN	Input	DINT	Minimum value supported.
IN	Input	DINT	Any signed integer value.
MAX	Input	DINT	Maximum value supported.
LIMIT	Output	DINT	Input value bounded to the supported range.
ENO	Output	BOOL	Enable out.

LIMIT function language examples

Function block diagram

Ladder diagram



Structured text

```
1  minimum := 2;
2  in := 5;
3  maximum := 10;
4  output := LIMIT(minimum, in, maximum);
```

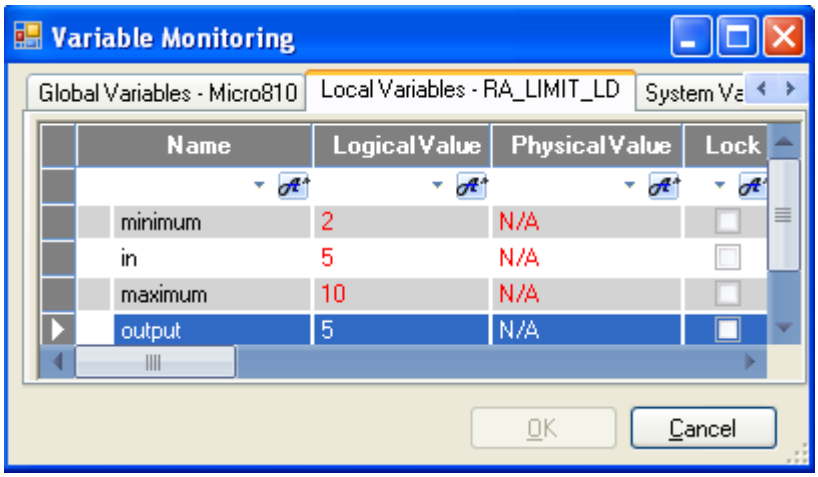
```
LIMIT(
    DINT LIMIT(DINT MIN, DINT IN, DINT MAX)
    Limit
```

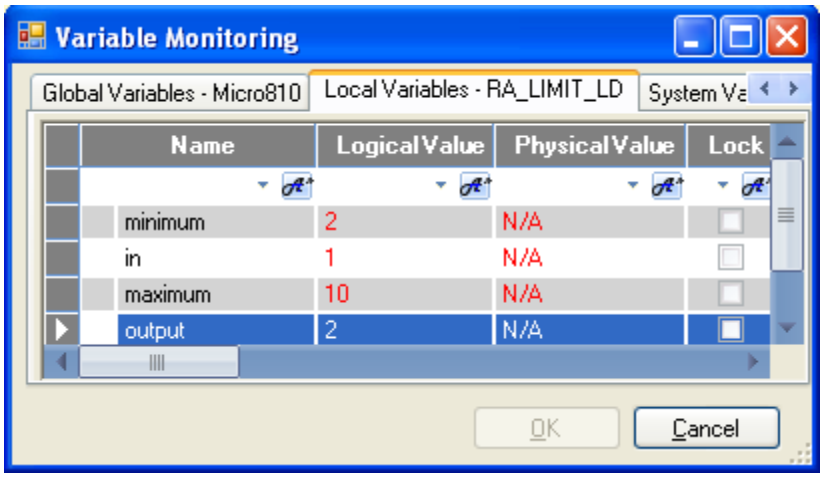
(* ST Equivalence: *)

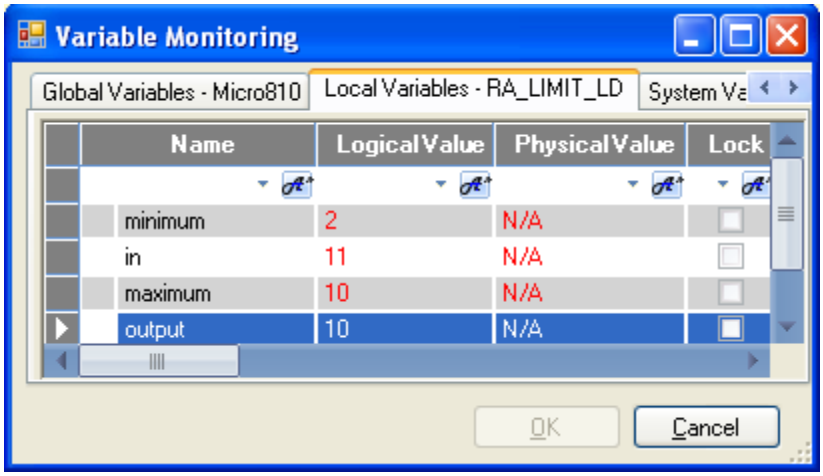
new_value := LIMIT (min_value, value, max_value);

(* bounds the value to the [min_value..max_value] set *)

Results


Variable Monitoring
Global Variables - Micro810
Local Variables - RA_LIMIT_LD
System Va
Name
LogicalValue
PhysicalValue
Lock
minimum 2 N/A
in 5 N/A
maximum 10 N/A
output 5 N/A
OK
Cancel


Variable Monitoring
Global Variables - Micro810
Local Variables - RA_LIMIT_LD
System Va
Name
LogicalValue
PhysicalValue
Lock
minimum 2 N/A
in 1 N/A
maximum 10 N/A
output 2 N/A
OK
Cancel


Variable Monitoring
Global Variables - Micro810
Local Variables - RA_LIMIT_LD
System Va
Name
LogicalValue
PhysicalValue
Lock
minimum 2 N/A
in 11 N/A
maximum 10 N/A
output 10 N/A
OK
Cancel

Program control instruction

Program control instructions are used to control instructions simultaneously from a user program and from an operator interface device.

Function block	Description
SUS (on page 544)	Suspend the execution of the application.

SUS

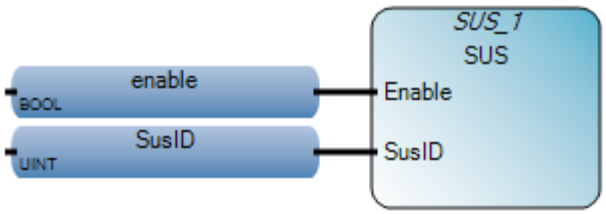
SUS suspends the execution of the Micro800 controller. The controller remains in RUN mode but execution is suspended indefinitely. Suspend catches User Program errors and aids in User Program debugging. Place the SUS instruction in User Program sections where you want to trap unusual conditions. In suspend mode, RUN LED is set to OFF to indicate the program scan is Idle.

Arguments

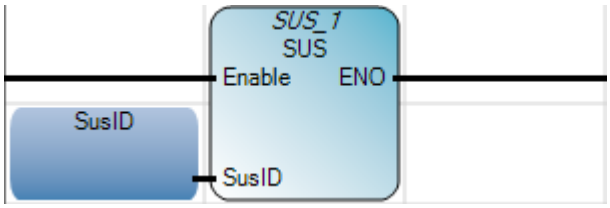
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute function. When Enable = FALSE, do not execute function.
SusID	Input	UINT	Suspension ID.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

SUS function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)

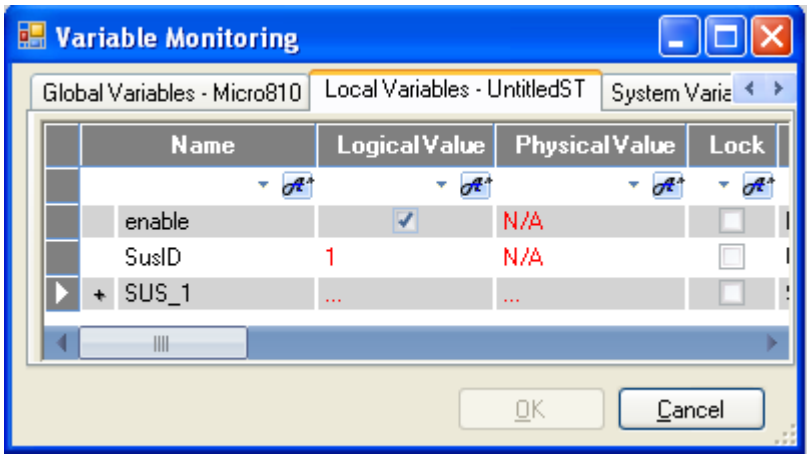


Structured Text (ST)

```
1  SusID := 1;
2  SUS_1(enable, SusID);
```

```
SUS_1(
    void SUS_1(BOOL Enable, UINT SusID)
    Type : SUS, Suspend the execution of the application.
```

Results



Proportional Integral Derivative (PID) instruction

The Proportional-Integral-Derivative (PID) instruction is used to control the process more accurately using PID functionality.

Function block	Description
IPIDCONTROLLER (on page 551)	Proportional Integral Derivative

What is Proportional Integral Derivative (PID) control?

Proportional-Integral-Derivative (PID) control allows the process control to accurately maintain the setpoint by adjusting the control outputs. A PID function block combines all of the necessary logic to perform proportional/integral/derivative (PID) control.

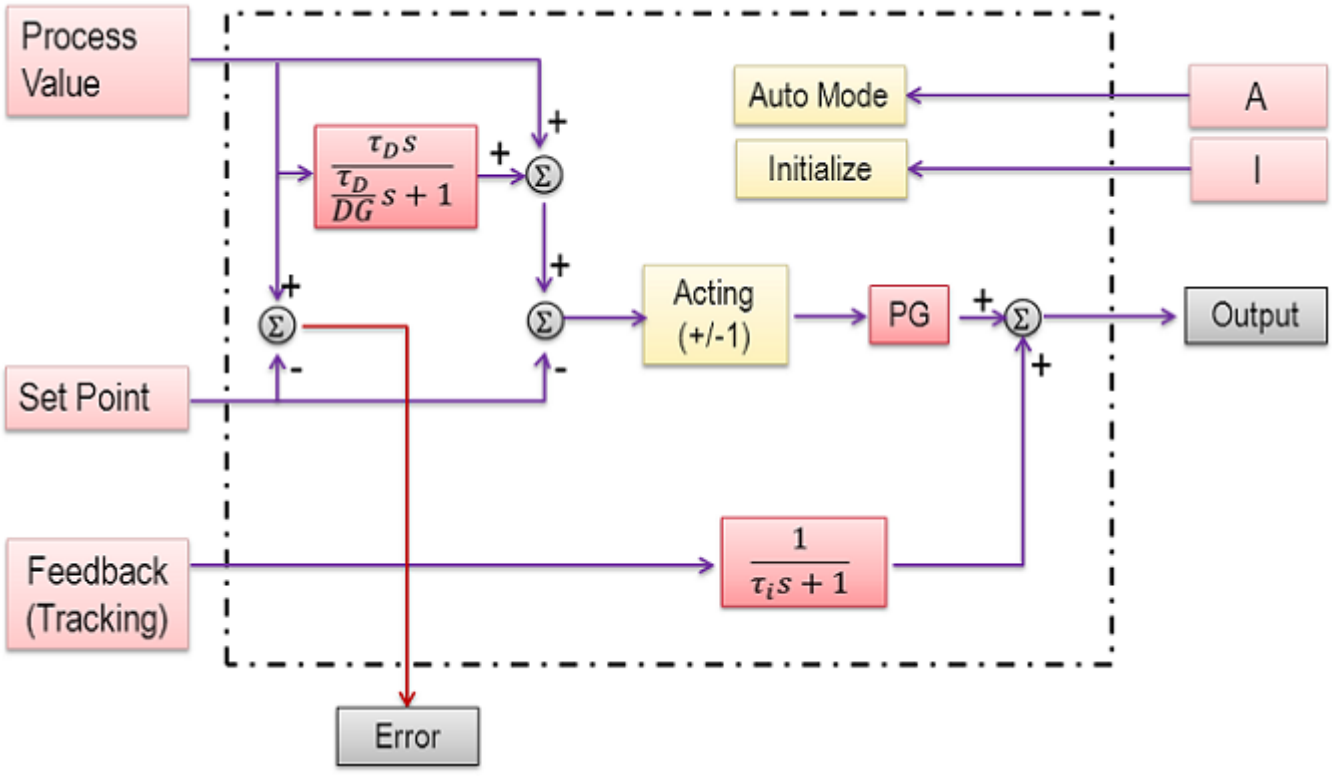
How the IPIDController function block implements PID control

The IPIDController function block, available in the Connected Components Workbench instruction set, is based on PID control theory and combines all of the necessary logic to perform analog input channel processing and proportional integral-derivative (PID) control. In the HMI, the IPID faceplate is available for use with the IPIDController function block.

IPIDController function block description

The IPIDController function block uses the following function block components:

- A: Acting (+/- 1)
- PG: Proportional Gain
- DG: Derivative Gain
- td: ãD
- ti: ãI



Preventing integral windup

If the difference between the setpoint value and the process value is great, the output value will increase significantly, and during the time it takes to decrease, the process will not be in control. The IPIDController function block interactively tracks feedback and prevents integral windup. When the output is saturated, the integral term in the controller is recomputed so that its new value provides an output at the saturation limit.

IPIDCONTROLLER

IPIDCONTROLLER is used for proportional integral-derivative (PID) logic, which controls physical properties such as temperature, pressure, liquid level, or flow rate using process loops.

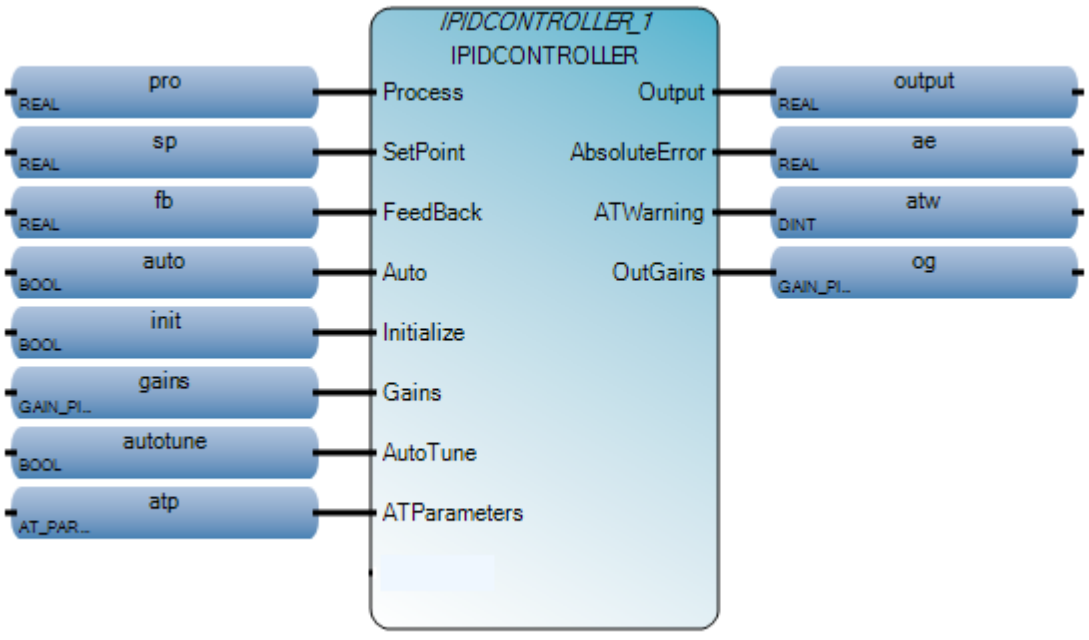
Arguments

Parameter	Parameter type	Data type	Description
EN	Input	BOOL	Function block enable. When EN = TRUE, execute function. When EN = FALSE, do not execute function. Applies only to LD programs.
Process	Input	REAL	Process value, which is the value measured from the process output.
SetPoint	Input	REAL	Set point.
FeedBack	Input	REAL	Feedback signal, which is the value of the control variable applied to the process. For example, the feedback can be IPIDCONTROLLER output.
Auto	Input	BOOL	The operation mode of the PID controller: • TRUE - controller runs in normal mode. • FALSE - controller causes reset R to track (F-GE).
Initialize	Input	BOOL	A change in value (TRUE to FALSE or FALSE to TRUE) causes the controller to eliminate any proportional gain during that cycle. Also initializes AutoTune sequences.
Gains	Input	GAIN_PID	Gains PID for IPIDController. See GAIN_PID data type (on page 555).
AutoTune	Input	BOOL	When set to TRUE and Auto and Initialize are FALSE, the AutoTune sequence is started.

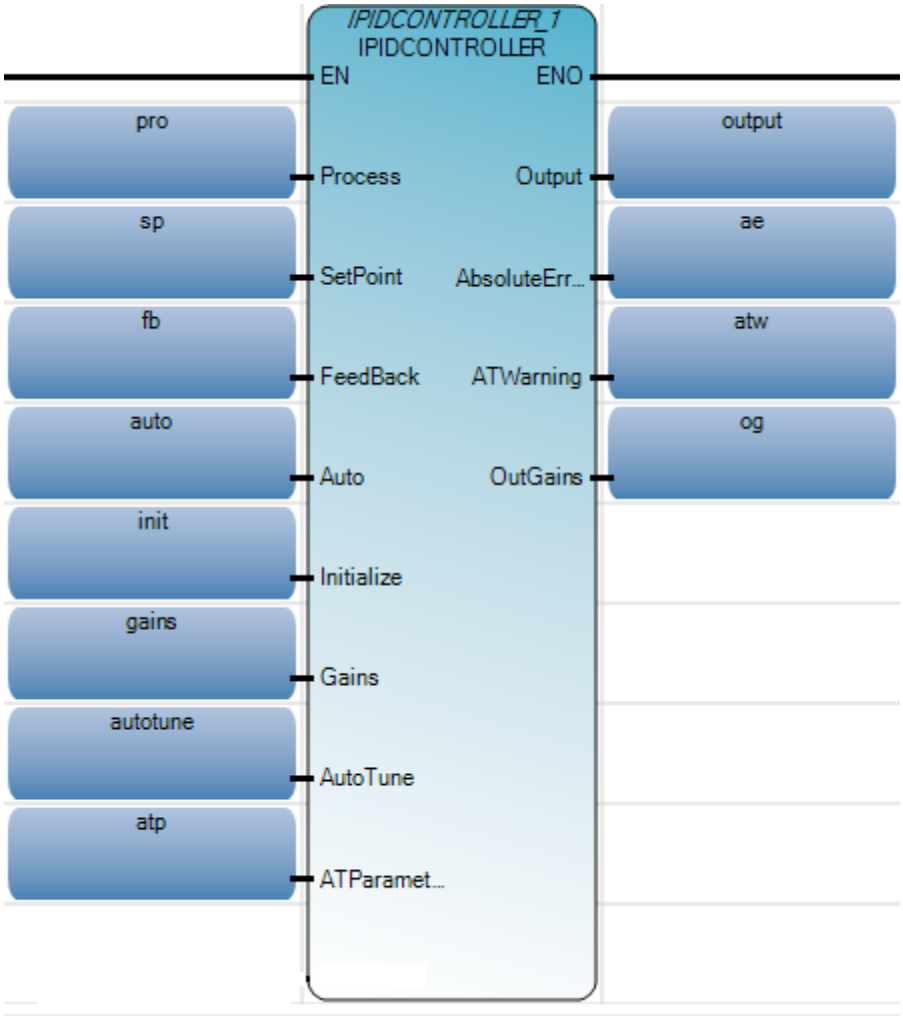
Parameter	Parameter type	Data type	Description
ATParameters	Input	AT_Param	Auto Tune Parameters. See AT_Param data type (on page 555).
Output	Output	REAL	Output value from the controller.
AbsoluteError	Output	REAL	Absolute error (Process – SetPoint) from the controller.
ATWarnings	Output	DINT	(ATWarning) Warning for the Auto Tune sequence. Possible values are: • 0 - no auto tune done. • 1 - in auto tune mode. • 2 - auto tune done. • -1 - ERROR 1 input automatically set to TRUE, no auto tune possible. • -2 - ERROR 2 auto tune error, ATDynaSet expired.
OutGains	Output	GAIN_PID	Gains calculated after AutoTune sequences. See GAIN_PID data type (on page 555).
ENO	Output	BOOL	Enable out. Applies only to LD programs.

IPIDCONTROLLER function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

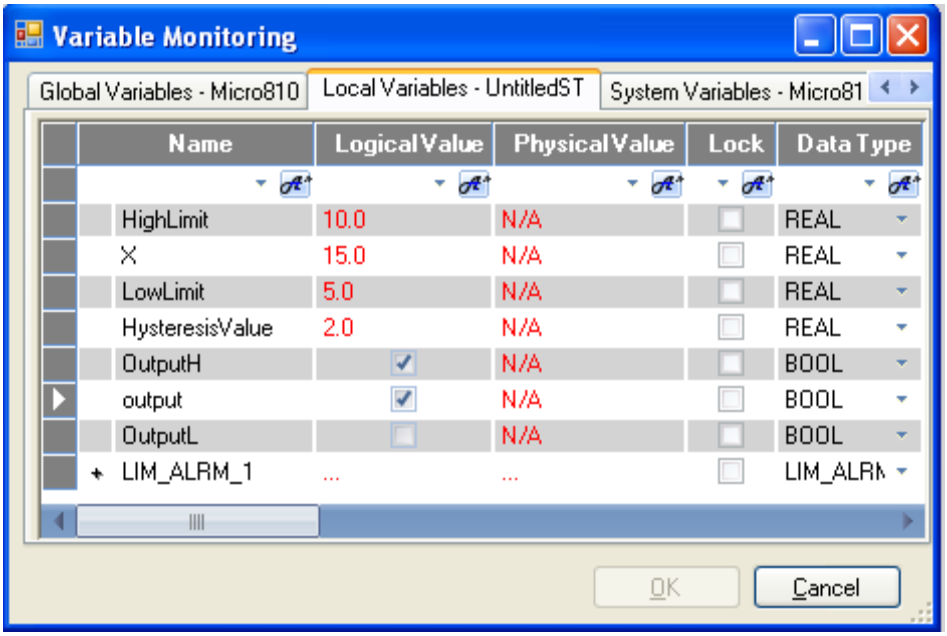
```
1  IPIDCONTROLLER_1(pro, sp, fb, auto, init, gains, autotune, atp, em);
2  output := IPIDCONTROLLER_1.Output;
3  ae := IPIDCONTROLLER_1.AbsoluteError;
4  atw := IPIDCONTROLLER_1.ATWarning;
5  og := IPIDCONTROLLER_1.OutGains;
```

```
IPIDCONTROLLER_1(
void IPIDCONTROLLER_1(REAL Process, REAL SetPoint, REAL FeedBack, BOOL Auto, BOOL Initialize, GAIN_PID Gains, BOOL AutoTune, AT_PARAM ATParameters, DINT ErrorMode)
Type : IPIDCONTROLLER, Proportional Integral Derivative.
```

```
(* ST equivalence: IPIDController1 is an instance of
IPIDController block *)

IPIDController1(Proc,
                SP,
                FBK,
                Auto,
                Init,
                G_In,
                A_Tune,
                A_TunePar,
                Err );
Out_process := IPIDController1.Output ;
A_Tune_Warn := IPIDController1.ATWarning ;
Gain_Out := IPIDController1.OutGains ;
```

Results



GAIN_PID data type

The following table describes the GAIN_PID data type.

Parameter	Data type	Description
DirectActing	BOOL	The type of acting: • TRUE - direct acting (output moves same direction as error). That is, the actual process value is greater than the SetPoint and the appropriate controller action is to increase the output (For example: Chilling). • FALSE - reverse acting (output moves opposite direction as error). That is, the actual process value is greater than the SetPoint and the appropriate controller action is to decrease the output (For example: Heating).
ProportionalGain	REAL	Proportional gain for PID (>= 0.0001).
TimeIntegral	REAL	Time integral value for PID (>= 0.0001).
TimeDerivative	REAL	Time derivative value for PID (> 0.0).
DerivativeGain	REAL	Derivative gain for PID (> 0.0).

AT_Param data type

The following table describes the AT_Param data type parameters.

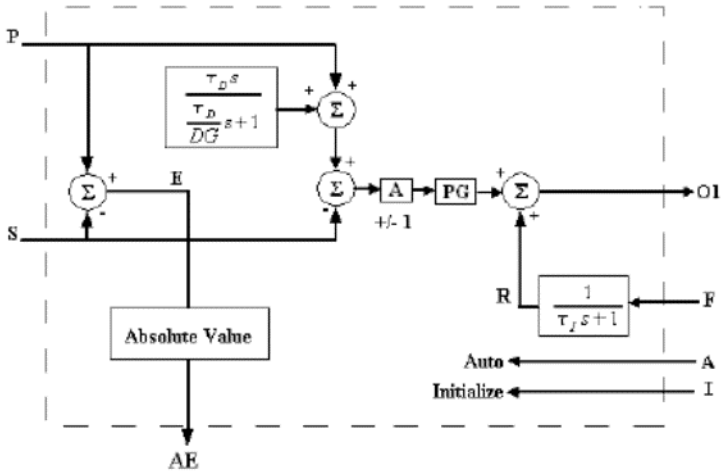
Parameter	Data type	Description
Load	REAL	Load parameter for auto tuning. This is the output value when starting AutoTune.
Deviation	REAL	Deviation for auto tuning. This is the standard deviation used to evaluate the noise band needed for AutoTune.
Step	REAL	Step value for AutoTune. Must be greater than noise band and less than ½ Load.
ATDynamSet	REAL	Waiting time in seconds before abandoning auto tune.
ATReset	BOOL	The indication of whether the output value is reset to zero after an AutoTune sequence: • TRUE - resets output to zero. • FALSE - leaves Output at Load value.

IPIDController function block operation

Input Auto

When **Input Auto is TRUE**, the IPIDController runs in normal auto mode.

When **Input Auto is FALSE**, it causes reset R to track (F-GE) forcing the IPIDController Output to track the Feedback within the IPIDController limits at which time the controller switches back to auto without incrementing the Output.



Input Initialize

For Input Initialize, changing from FALSE to TRUE or TRUE to FALSE when AutoTune is FALSE causes the IPIDController to eliminate any proportional gain action during that cycle (for example, Initialize). You can use this process to prevent bumping the Output when changes are made to the SetPoint using a switch function block.

To run an AutoTune sequence

To run an AutoTune sequence, the input ATParameters must be completed. The Input Gain and DirectActing parameters must be set according to the process and DerivativeGain set, (typically 0.1). The AutoTune sequence is started with the following sequence:

1. Set the input Initialize to TRUE.
2. Set the input Autotune to TRUE.
3. Change the input Initialize to FALSE.
4. Wait until the output ATWarning changes to 2.
5. Transfer the values for output OutGains to input Gains.

To finalize tuning

To finalize the tuning, some fine tuning may be needed depending on the processes and needs. When setting TimeDerivative to 0.0, the IPIDController forces DerivativeGain to 1.0 then works as a PI controller.

Using the Proportional Integral Derivative instruction

This section provides specific details and examples for using the proportional integral derivative instruction, including the following:

Using auto-tune with the IPIDController function block

You can use the AutoTune parameter of the IPIDController function block to implement auto-tuning in the control program.

Auto-tuning requirements and recommendations

Following is a summary of requirements and recommendations for implementing successful auto-tuning.

- Autotuning must cause the output of the control loop to oscillate, which means the IPIDController must be called frequently enough to adequately sample the oscillation.
- The IPIDController instruction block must be executed at a relatively constant time interval.
- Configure the scan time of the program to be than half of the oscillation period.
- Consider using a Structured Text Interrupt (STI) instruction block to control the IPIDController instruction block.

Auto-tune in first and second order systems

Auto-tune can be used in first order system, which uses a single element, or in a second order system, which uses two independent elements.

Auto-tune a first order system

A first order system uses a single independent energy storage element. Examples include:

- Cooling of a fluid tank, with heat energy as the storage unit.
- Flow of fluid from a tank, with potential energy as the storage unit.
- A motor with constant torque driving a disk flywheel, with rotational kinetic energy as the storage unit.
- An electric RC lead network, with capacitive storage energy as the storage unit.

In a first order system, the function may be written in a standard form such as $f(t) = \tau\, dy/dt + y(t)$

Where:

Variable	Description	Example: Cooling of a fluid tank using heat energy as the storage element
t	System time constant	Is equal to RC Where R = Thermal resistance of the walls of the tank C = Thermal capacitance of the fluid
f	Forcing function	Is the Ambient temperature
y	System state variable	Is the Fluid temperature

Auto-tune in a second order system

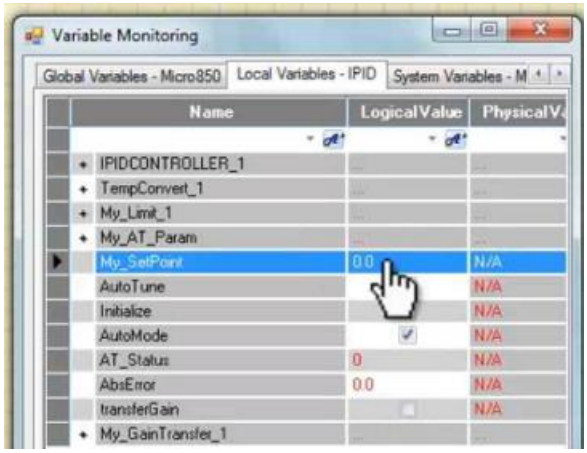
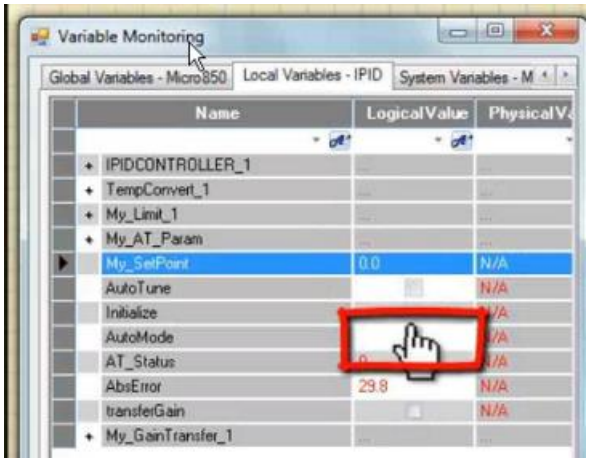
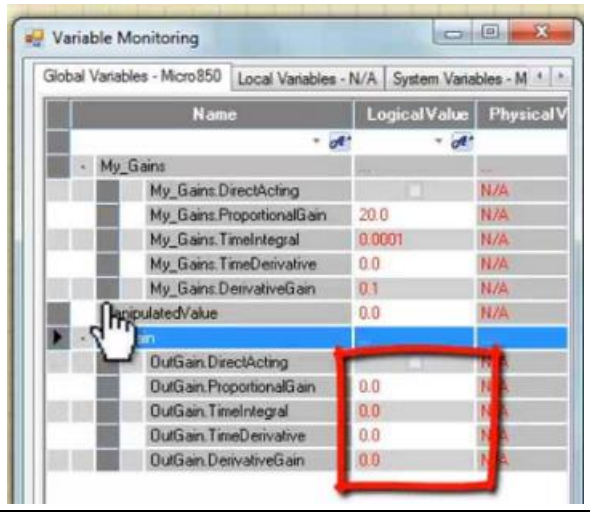
A second order system uses two independent energy storage elements that exchange stored energy. Examples include:

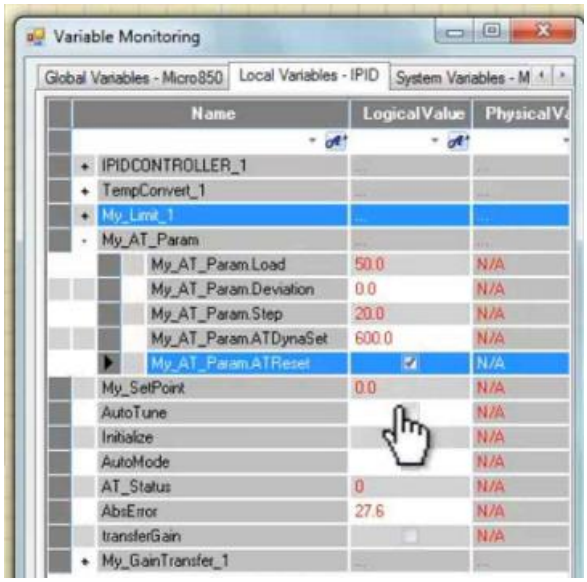
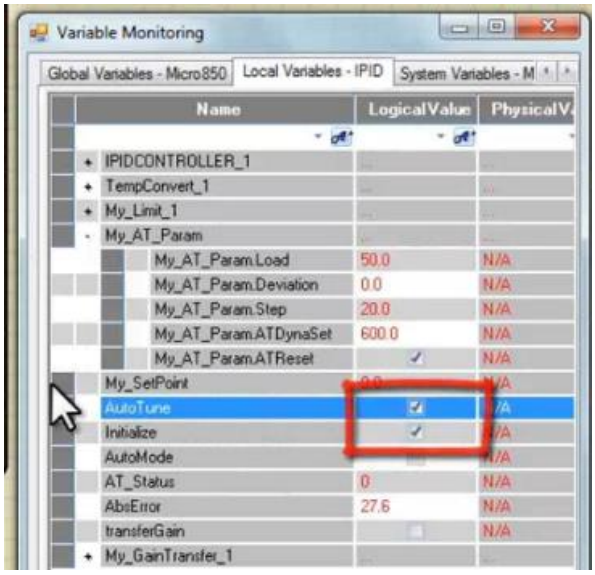
- A motor driving a disk flywheel with the motor coupled to the flywheel via a shaft with torsional stiffness; Rotational kinetic energy and torsion spring energy are the storage units.
- An electric circuit composed of a current source driving a series LR (inductor and resistor) with a shunt C (capacitor); Inductive energy and capacitive energy are the storage units.

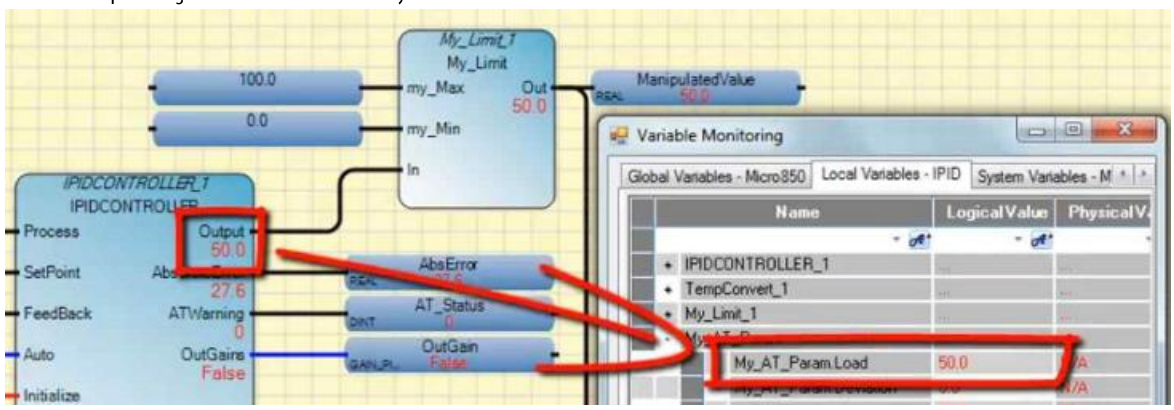
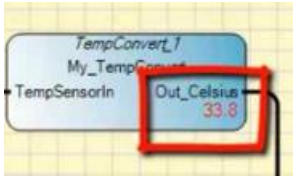
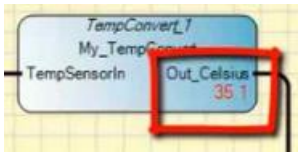
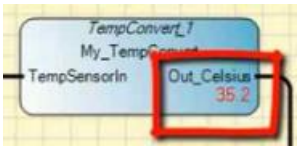
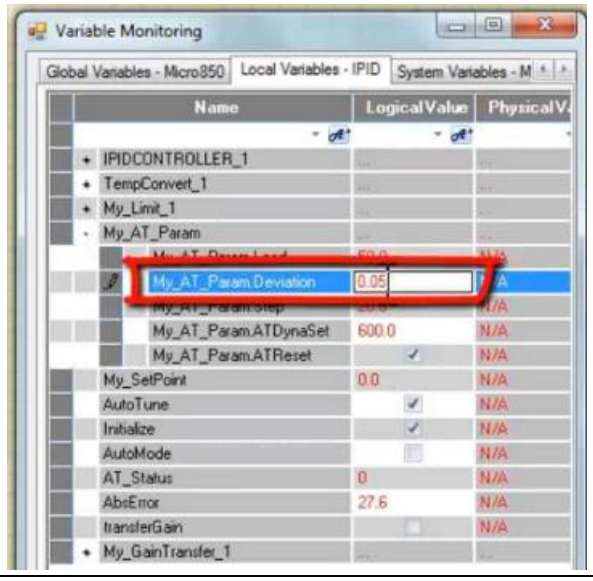
Motor driven systems and heating systems can typically be modeled by the LR and the C electric circuit.

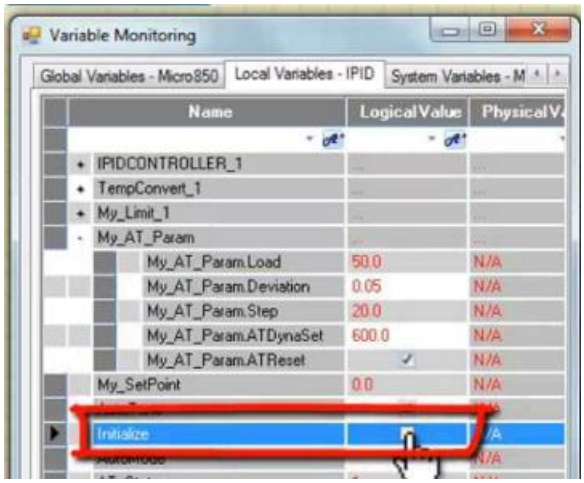
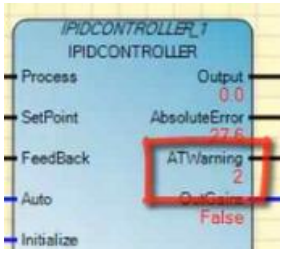
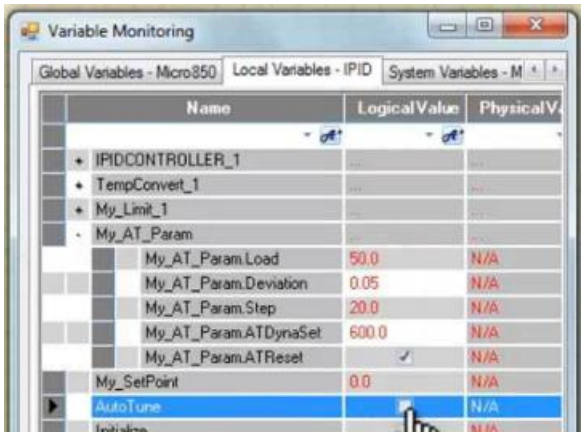
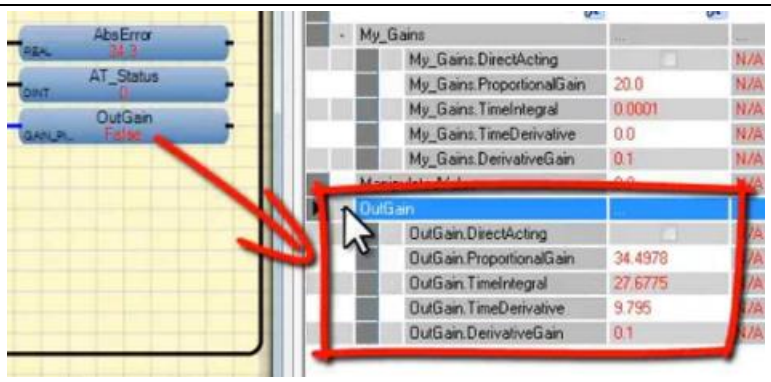
Configure auto-tuning

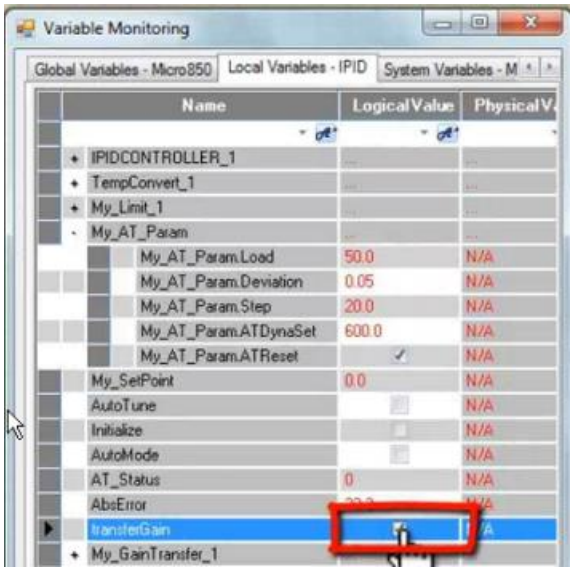
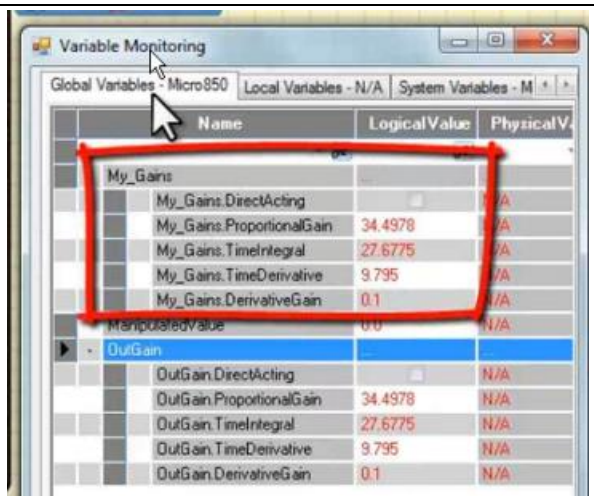
Following are the general steps for implementing auto-tuning using the IPIDController function.

No.	Step	Example
1	Reset setpoint to zero.	
2	Switch Auto mode to False	
3	Set Gains parameters.	

No.	Step	Example
4	Set Auto-Tune parameters.	Set auto-tune parameters including an initial load value, step change for the output, an estimated time to complete the auto tuning, and the auto-tune reset. 
5	Set Initialize and AutoTune to True.	

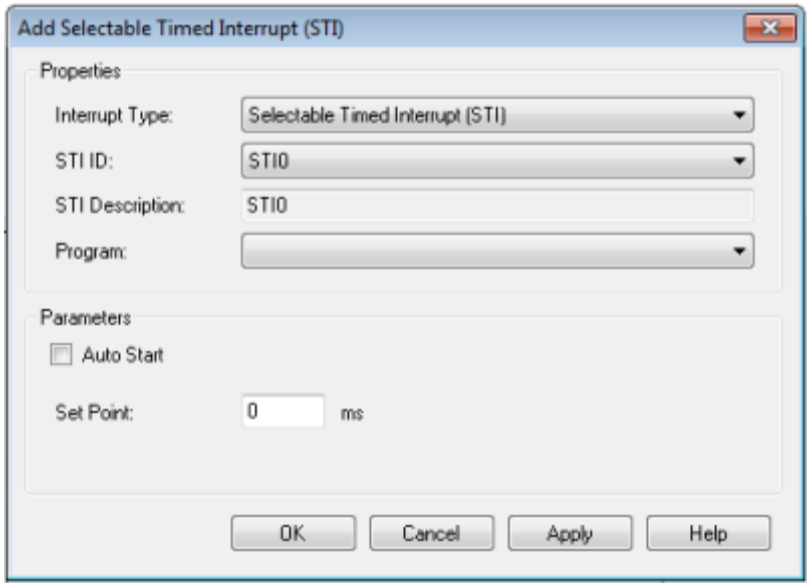
No.	Step	Example
6	Notice the Output changes to the value of Load when you set AutoTune to True.	
7	Observe the process value rises quickly until it gets closer to its saturation point.	
8	Observe the stabilization of the process value and its fluctuation.	 
9	Set the deviation.	

No.	Step	Example
10	Set Initialize to False.	
11	Controller starts auto-tuning. Wait for ATWarning to become 2.	
12	Set AutoTune to False.	
13	Observe the tuned values appear in OutGains.	

No.	Step	Example
14	Transfer parameter from OutGain to My_Gains.	
15	Observe the controller is updated with the with the tuned gain parameter.	

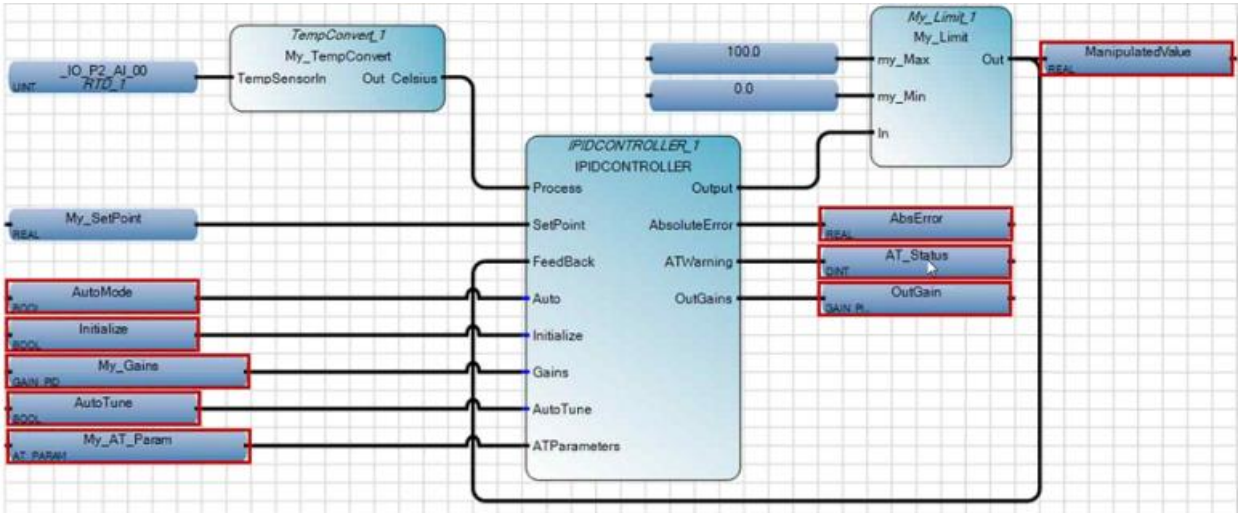
Using a Structured Timing Interrupt (STI) with auto-tuning

Although a PID instruction works if it is not controlled by a Structured Timing Interrupt (STI), using an STI increases the auto-tune success rate because the auto-tune will operate on a fixed cycle.



Example: IPIDController with auto-tune

The following example program is shows the variables used to configure the parameters for auto-tuning.



Auto-tune parameters

The following table describes the variables that are used with each parameter in the example to configure auto-tuning.

Input parameters		
Variable	**Parameter**	**Description**
AutoMode	Auto	The operation mode of the PID controller: TRUE - controller runs in normal mode. FALSE – derivative term is ignored forcing the controller output to track the feedback within the controller limits, and allowing the controller to switch back to auto without bumping the output
Initialize	Initialize	Initializes AutoTune sequence. A change in value from TRUE to FALSE or FALSE to TRUE causes the controller to eliminate any proportional gain during the cycle.
My_Gains	Gains	Establishes the Gains PID for IPIDController.
My_Gains.DirectActing	DirectActing	Defines the type of acting for the output. TRUE - direct acting in which the output moves in the same direction as the error. That is, the actual process value is greater than the SetPoint and the appropriate controller action is to increase the output. For example, chilling. FALSE - reverse acting in which the output moves in the opposite direction as the error. That is, the actual process value is greater than the SetPoint and the appropriate controller action is to decrease the output. For example: heating.
My_Gains.ProportionalGain	ProportionalGain	Proportional gain for PID (>= 0.0001).
My_Gains.TimeIntegral	TimeIntegral	Time integral value for PID (>= 0.0001). The tendency for oscillation increases with a decrease in ti.
My_Gains.TimeDerivative	TimeDerivative	Time derivative value for PID (> 0.0). Damping increases with an increase in derivative time, but decreases if the derivative time value is too large.
My_Gains.DerivativeGain	Derivative gain for PID (> 0.0).	
AutoTune	When set to TRUE and Auto and Initialize are FALSE, the AutoTune sequence is started.	
ATParameters		
Load	• Initial output value during auto-tuning. • Allows the process value to stabilize at the load	
Deviation	• The standard deviation for a series of stabilized process values. For example, if the process value stabilized between 31.4 to 32.0, then the deviation value would be (32.0-31.4)/2 = 0.3. • Some process values, such as temperature, take a very long time to stabilize.	
Step	• The auto-tune process considers how the process value reacts to the changes in step value and derives the Gain parameters.	
ATDynaSet	• Allocated time for the auto-tune to complete. It must be longer than what is required for the auto-tune process. • A common value for many systems is 600 seconds, but some systems may require more time.	
ATReset	• If TRUE, the output will be reset to "0" after auto-tune completes. • If FALSE, the output will remain at the load value after auto-tune completes.	
Output parameters		
Parameter	**Description**	
AbsoluteError	Absolute error (Process – SetPoint) from the controller.	

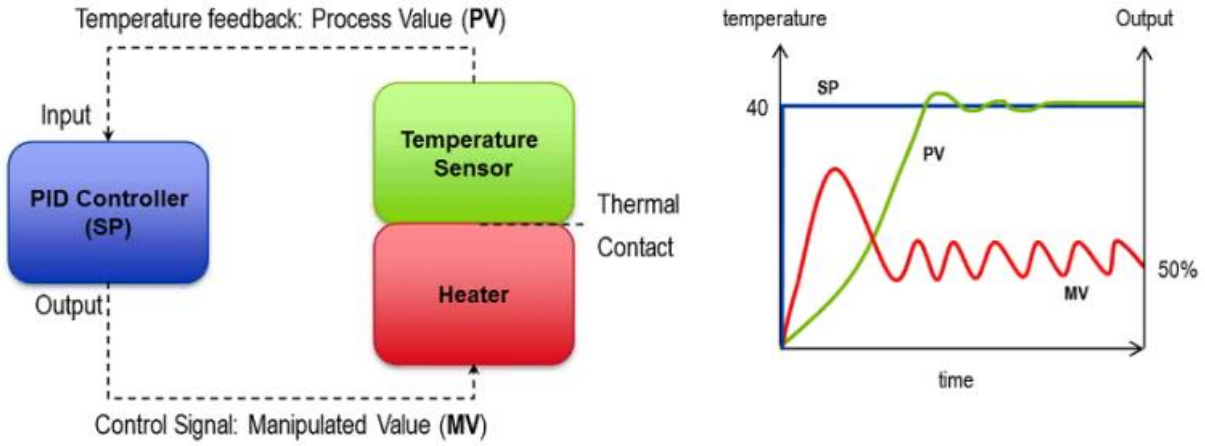
Input parameters	
ATWarning	Warning for the Auto Tune sequence. Possible values are: 0 - no auto tune done. 1 - in auto tune mode. 2 - auto tune done. -1 - ERROR 1 input automatically set to TRUE, no auto tune possible. -2 - ERROR 2 auto tune error, ATDynaSet expired
OutGains	Gains calculated after AutoTune sequences.

Example: How to create a feedback loop for the manipulated value

Adding a feedback loop for the manipulated value prevents excessive overshooting by providing a minimum and maximum value for the MV.

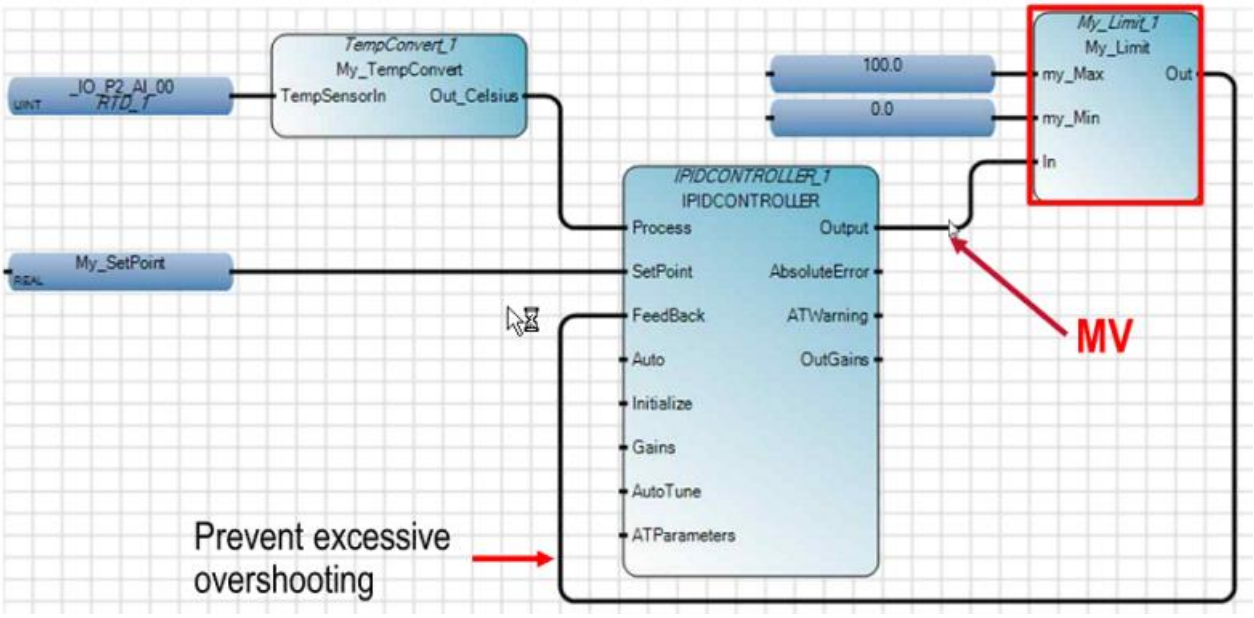
Temperature feedback loop example

At the beginning of the temperature control process, the difference between the process value (PV) and the setpoint value (SP) is large, as shown in the following graph. In this example of a temperature feedback loop, the PV starts at 0 degrees Celsius and moves towards the SP value of 40 degrees Celsius. Notice also that the fluctuation between the high and low manipulated value (MV) decreases and stabilizes with time. The behavior of the MV depends on the values used in each of the P, I, and D parameters.



IPIDController with a feedback loop

The following function block diagram includes a feedback loop for the manipulated value that prevents excessive overshooting by providing a minimum and maximum value for the MV.

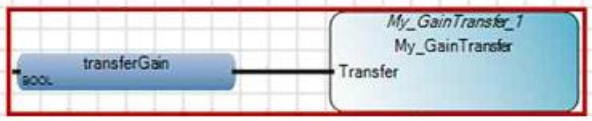


Example: How to add a UDFB to a PID program

You can add UDFBs outside the main program to perform specialized functions such as converting units or transferring values.

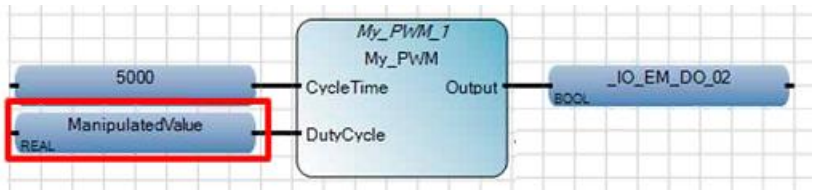
Transfer the auto-tune gain value

This UDFB transfers the Autotune gain value to My_GainTransfer so it can be used by the controller.



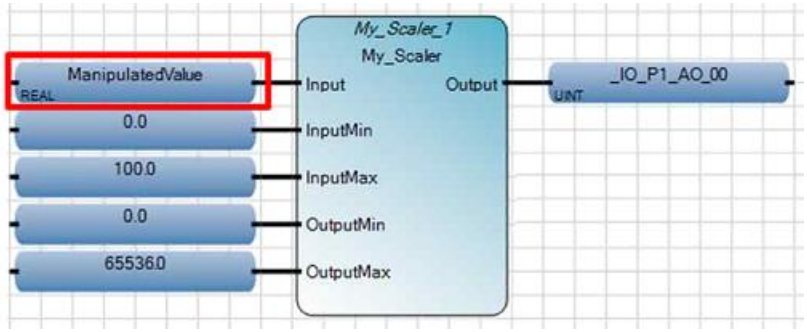
Convert a manipulated value to a digital output

This UDFB converts a manipulated value (MV) to a digital output (DO) so it can be used to control a digital input n(DI).



Converting a manipulated value to an analog output

This UDFB converts a manipulated value (MV) to an analog output (AO) so it can be used to control an analog input (AI).



Example: How to create an IPIDController program to control temperature

The temperature control program maintains the temperature within the control zone.

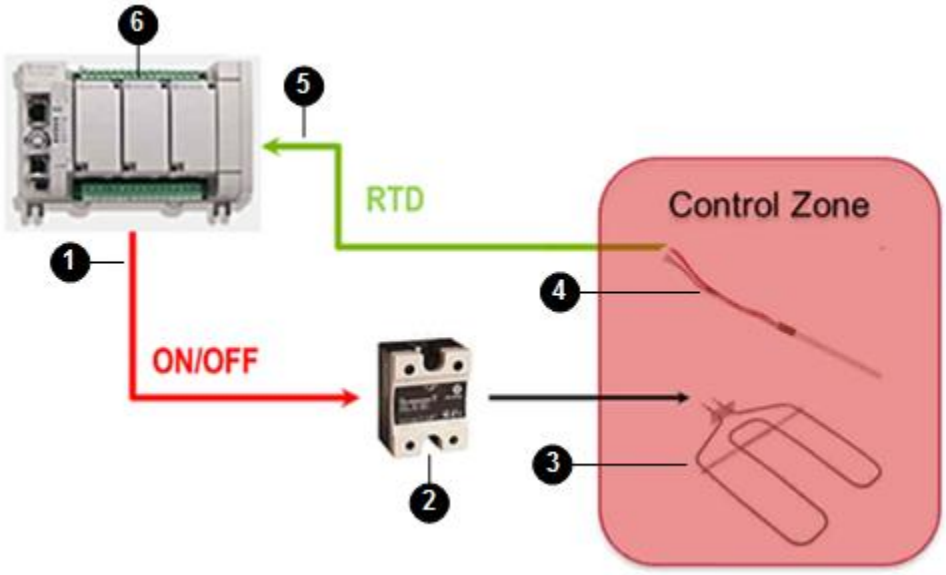
Setpoint, process and manipulated values

The following table defines how the SP, PV, and MV values are used in the temperature control program.

Item	Description
Setpoint (SP)	Measurement of temperature in degrees Celsius that defines the temperature for the control zone.
Process value (PV)	Must be converted to the same unit as the SP, which is a measurement of degrees Celsius.
Manipulated value (MV)	Must be converted to an analog value so it can be output to the PWM to control the heating element.

Temperature control system

The following diagram shows the components in the temperature control system that are controlled by the temperature control program. The table following the diagram describes the events that occur when the control program runs.



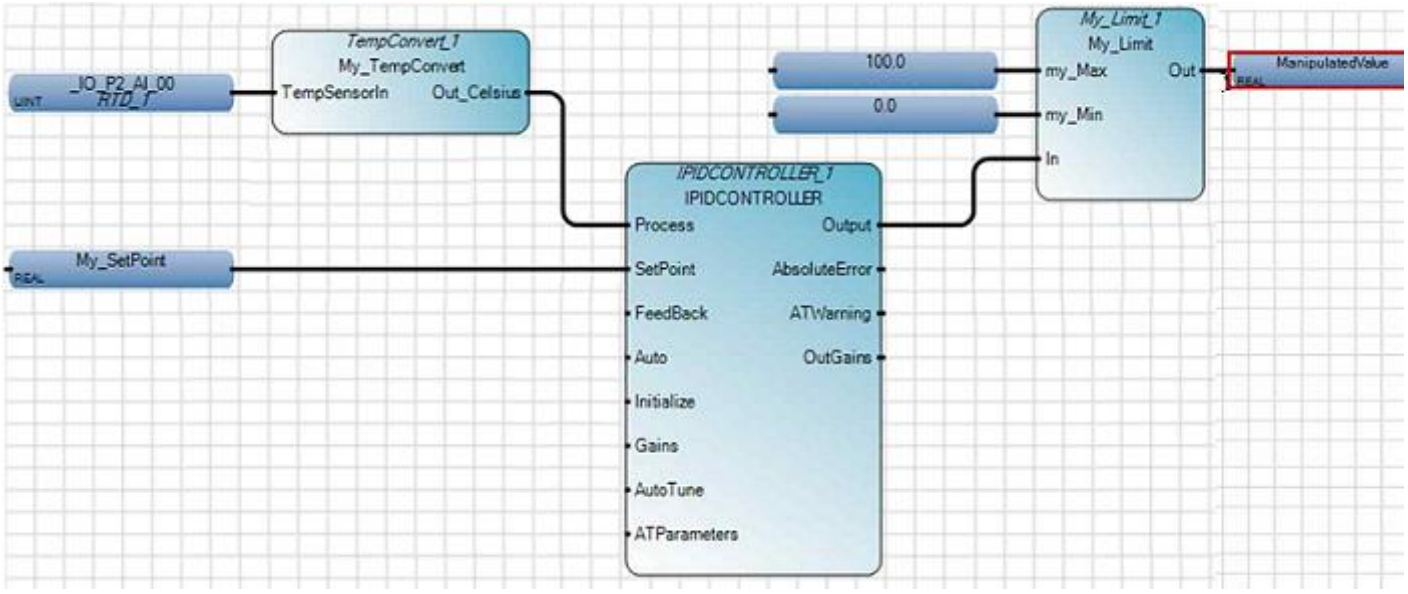
Sequence of events for temperature control program

The following table identifies the components in the temperature control system and describes, in sequence, the events that occur in the system when the temperature control program runs.

No	Item	Description
1	Controller output	Sends the MV to the PWM (On/Off).
2	Pulse Width Modulation (PWM temperature controller	Solid state relay that controls the heating element.
3	Heating element	Increases temperature in the control zone.
4	Resistance temperature detector (RTD)	Measures the temperature in the control zone and sends the PV (RTD signal) to the controller input.
5	Controller input	Receives the PV (RTD signal).
6	PLC program	Converts the PV (RTD signal) to the same unit as the SP (degrees Celsius) and determines the difference between the PV and the SP and adjusts the MV according to the parameter values defined in the P, I and D parameters.

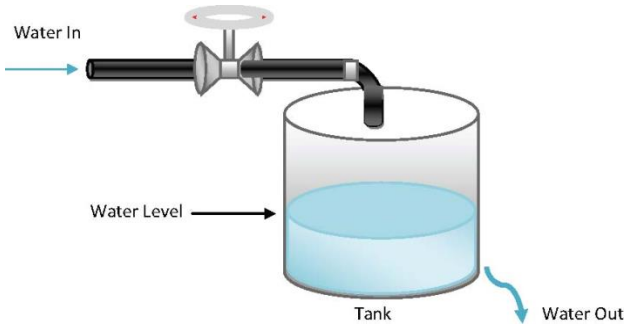
Example: Function block diagram to control temperature

This function block diagram shows the predefined and user-defined function blocks used in the application to control temperature in a control zone.



Example: How to create an IPIDController program to control water supply level

The water supply level control program example maintains sufficient water in a water supply tank that has an outflow. A solenoid valve controls incoming water and fills the tank at a preset rate; outflowing water is also controlled at a preset rate.



Program example information

The water supply level program example includes the following information.

- The sequence of events that occur in the control process
- How the setpoint, process and manipulated values are used in the control program
- An example function block diagram that shows the IPIDController and other instruction blocks

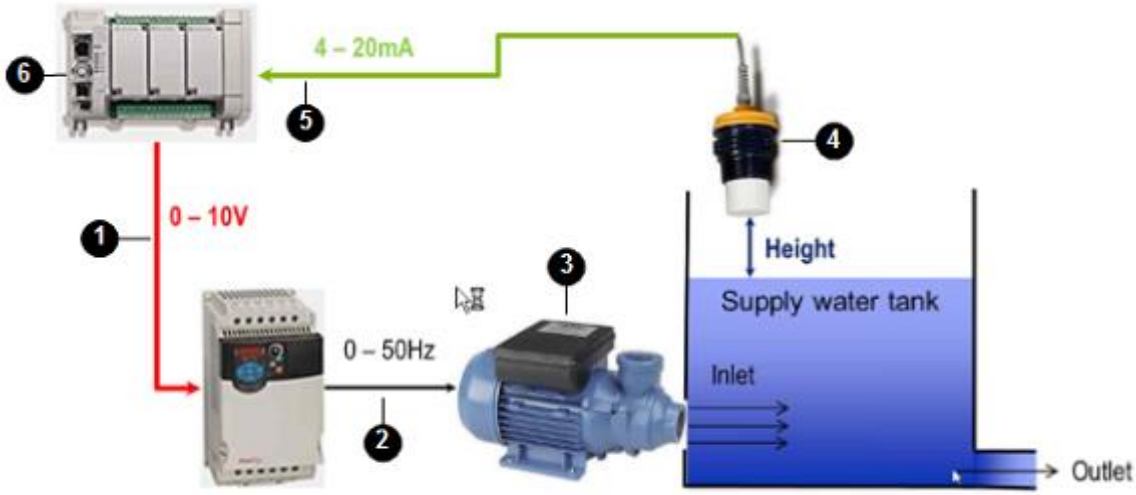
Setpoint, process and manipulated values

The following table defines how the SP, PV, and MV values are used in the water supply level program.

Item	Description
Setpoint (SP)	Measurement of height that defines the target water supply level.
Process value (PV)	The 4-20mA must be converted to the same unit as the SP, which is a measurement of height.
Manipulated value (MV)	Must be converted to an analog value so it can be output to the drive to control the pump.

Water supply level system

The following diagram shows the components in the water supply level system that are controlled by the water supply level program. The table following the diagram describes the events that occur when the control program runs.



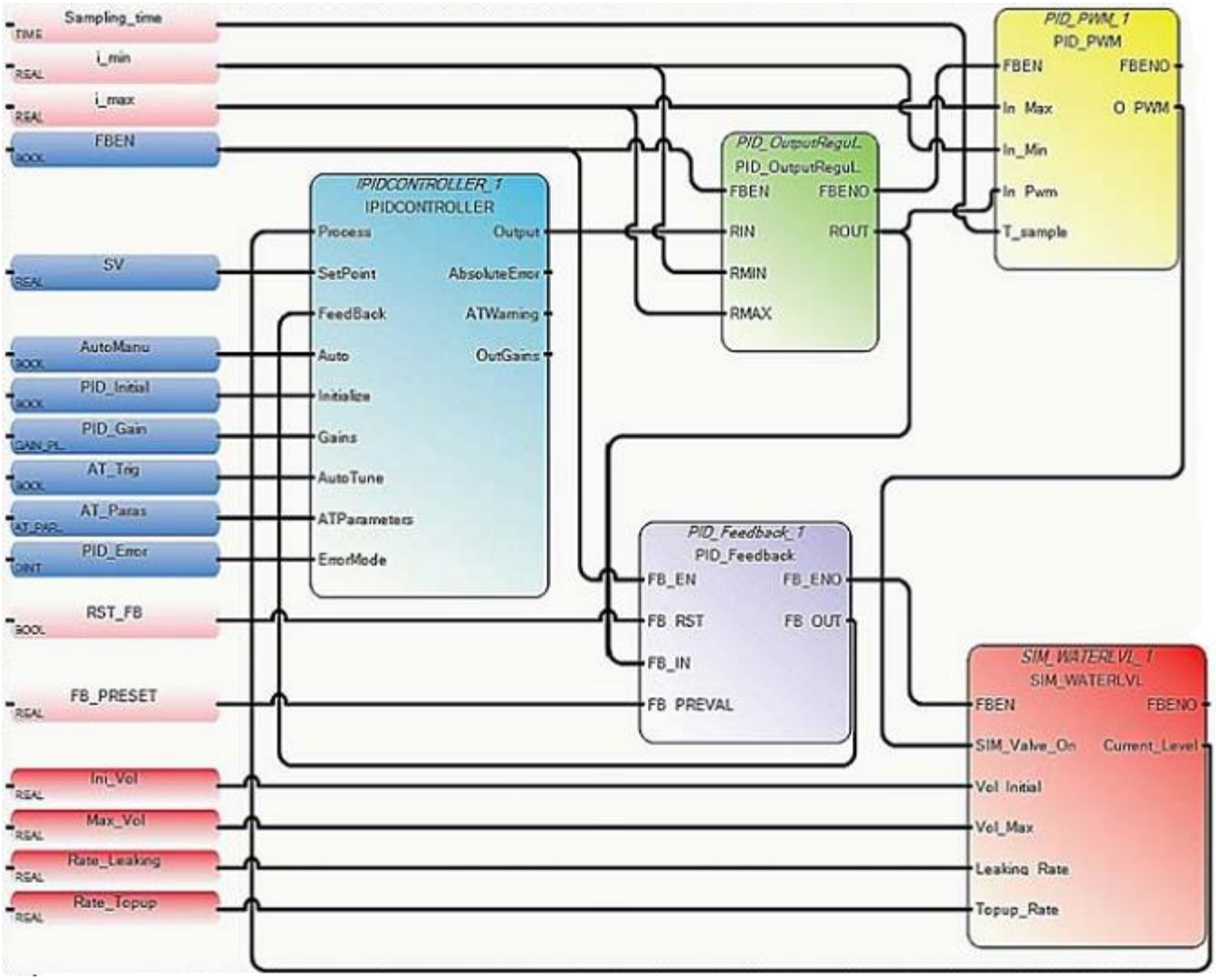
Sequence of events in water supply level system

The following table identifies the components in the water supply system and describes, in sequence, the events that occur in the system when the water supply level program runs.

No	Item	Description
1	Controller output	Sends the MV to the PowerFlex drive (0-10V).
2	PowerFlex drive	Controls the water pump (0-50Hz).
3	Water pump	Controls the water level in the supply tank.
4	Output transfer device	Measures the height of the water supply level (4-20mA) and sends the PV to the controller.
5	Controller input	Receives the PV (water supply level of 4-20mA).
6	PLC program	Converts the PV to the same unit as the SP (measurement of height) and determines the difference between the PV and SP and adjusts the MV according to the parameter values defined in the P, I and D parameters.

Example: Function block diagram to control water supply level

The following function block diagram shows the predefined and user-defined function blocks for the program to control the water supply level.



Function blocks and UDFBs used in the water level FBD

This application, developed in the Function Block Diagram (FBD) language, uses the function blocks described in the following table.

Function block	Description
IPIDController function block	Provides PID process control
PID_OutputRegulator UDFB	Regulates the output of the IPIDCONTROLLER within a safe range to ensure the hardware used in the process is not damaged **Sample code:** IF RMIN ≤ RIN ≤ RMAX, then ROUT = RIN, IF RIN < RMIN, then ROUT = RMIN, IF RIN > RMAX, then ROUT = RMAX
PID_Feedback UDFB	Acts as a multiplexer **Sample code:** IF "FB_RST" is false, FB_OUT=FB_IN; If "FB_RST" is true, then FB_OUT=FB_PREVAL.
PID_PWM UDFB	Provides a PWM function, converting a real value to a time related ON/OFF output
SIM_WATERLVL UDFB	Simulates the process in the application example

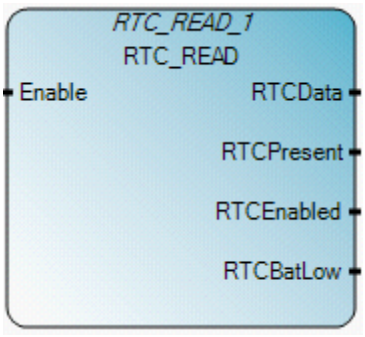
Real Time Clock (RTC) instructions

Real Time Clock instructions are used to configure the calendar and the clock.

Function block	Description
RTC_READ (on page 405)	RTC_READ reads the RTC preset and RTC information.
RTC_SET (on page 408)	RTC_SET sets RTC status or write RTC information.

RTC_READ

RTC_READ reads the RTC preset and RTC information.



RTC_READ operation

When used with a Micro810 or Micro820 controller with embedded RTC:

- RTCBatLow is always set to zero (0).
- RTCEnabled is always set to one (1).

When the embedded RTC has lost its charge/memory due to loss of power:

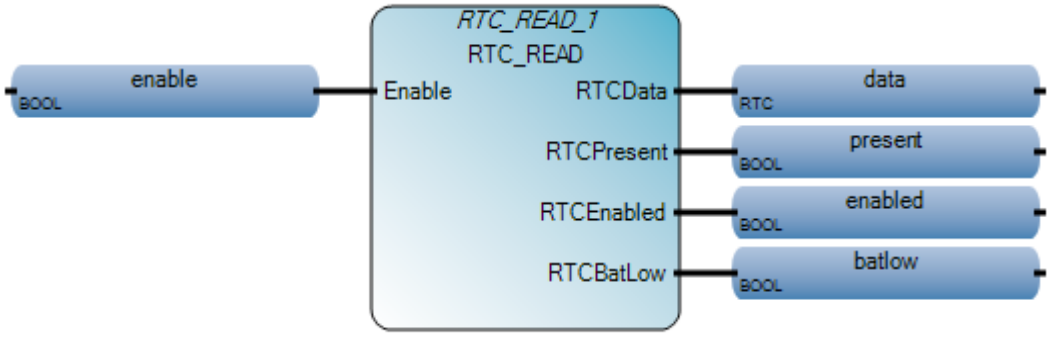
- RTCData is set to 2000/1/1/0/0/0.
- RTCEnabled is set to one (1).

Arguments

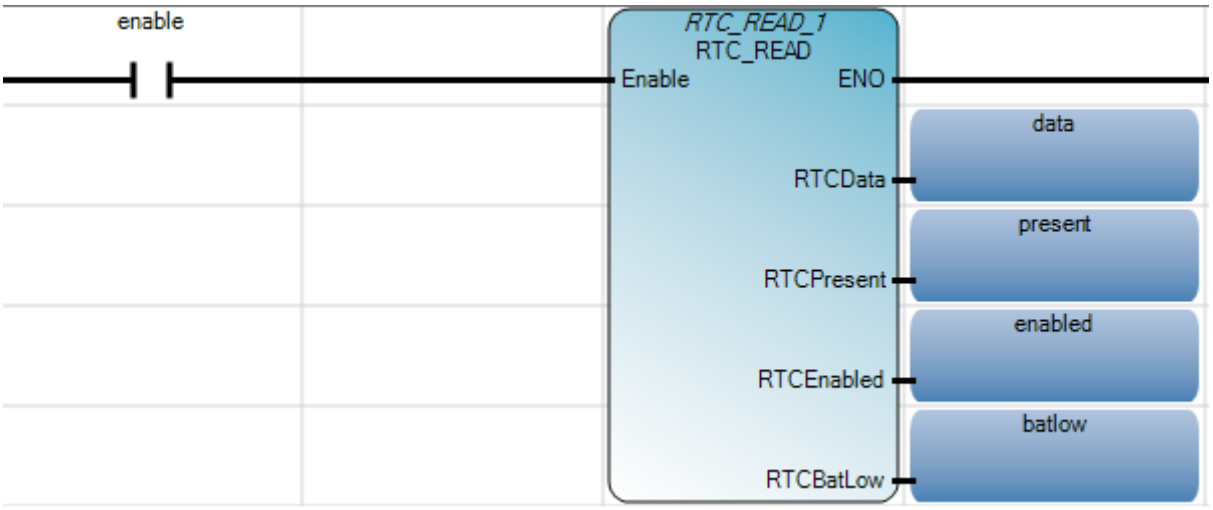
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute RTC information read. When Enable = FALSE, there is no read operation and output RTC data is invalid.
RTCData	Output	RTC	RTC data information: yy/mm/dd, hh/mm/ss, week. See RTC data type (on page 407).
RTCPresent	Output	BOOL	TRUE - RTC hardware is plugged in. FALSE - RTC hardware is not plugged in.
RTCEnabled	Output	BOOL	TRUE - RTC hardware is enabled (timing). FALSE - RTC hardware is disabled (not timing).
RTCBatLow	Output	BOOL	TRUE - RTC battery is low. FALSE - RTC battery is not low.
ENO	Output	BOOL	Enable out. Applies only to LD programs.

RTC_READ function block language examples

Function Block Diagram (FBD)

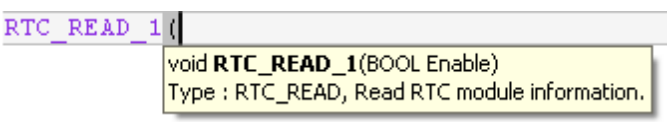


Ladder Diagram (LD)



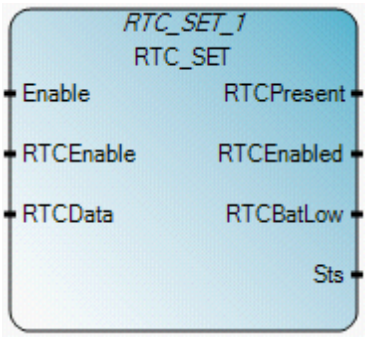
Structured Text

```
1  RTC_READ_1(enable);
2  data := RTC_READ_1.RTCData;
3  present := RTC_READ_1.RTCPresent;
4  enabled := RTC_READ_1.RTCEnabled;
5  batlow := RTC_READ_1.RTCBatLow;
```



RTC_SET

RTC_SET sets RTC status or write RTC information.

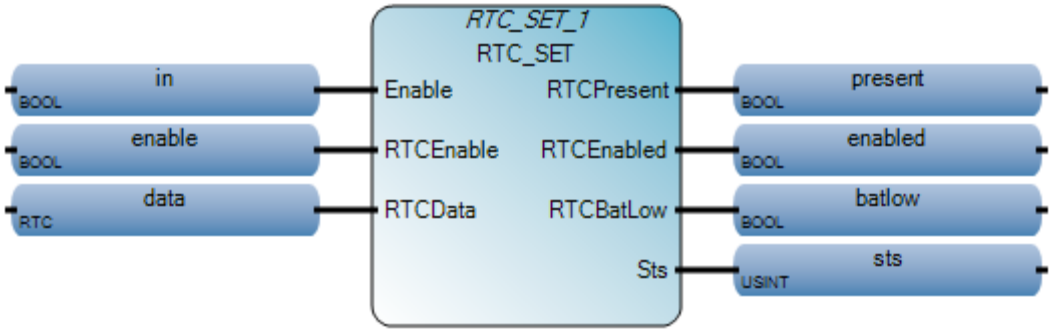


Arguments

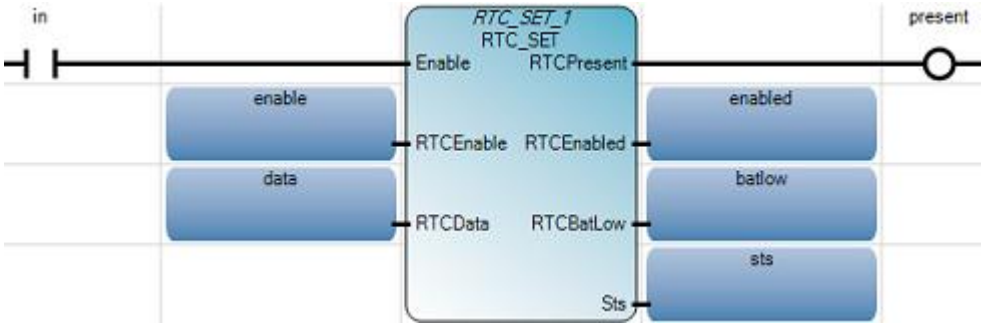
Parameter	Parameter type	Data type	Description
Enable	Input	BOOL	Function block enable. When Enable = TRUE, execute RTC set with the RTC info from input. When Enable = FALSE, there is no read operation and output RTC data is invalid.
RTCEnable	Input	BOOL	TRUE - To enable RTC with the RTC data specified. FALSE - To disable RTC. **Note:** This is ignored by Micro810 and Micro820 controllers.
RTCData	Input	RTC	RTC data information: yy/mm/dd, hh/mm/ss, week. This RTC data are ignored when RTCEnable = 0. See RTC data type (on page 407).
RTCPresent	Output	BOOL	TRUE - RTC hardware is plugged in. FALSE - RTC hardware is not plugged in.
RTCEnabled	Output	BOOL	TRUE - RTC hardware is enabled (timing). FALSE - RTC hardware is disabled (not timing).
RTCBatLow	Output	BOOL	TRUE - RTC battery is low. FALSE - RTC battery is not low.
Sts	Output	USINT	The read operation status. See RTC Set Status values (on page 409)

RTC_SET function block language examples

Function Block Diagram (FBD)

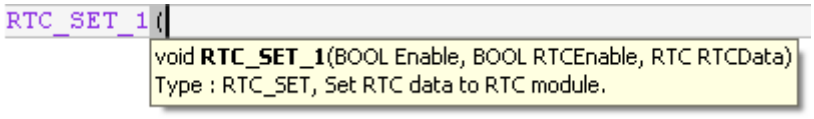


Ladder Diagram (LD)



Structured Text (ST)

```
1  RTC_SET_1(in, enable, data);
2  present := RTC_SET_1.RTCPresent;
3  enabled := RTC_SET_1.RTCEnabled;
4  batlow := RTC_SET_1.RTCBatLow;
5  sts := RTC_SET_1.Sts;
```



RTC data type

The following table describes the RTC data type.

Parameter	Data type	Description
Year	UINT	The year setting for the RTC. 16-bit value, and the valid range is from 2000 (Jan 01, 00:00:00) to 2098 (Dec. 31, 23:59:59)
Month	UINT	The month setting for the RTC.
Day	UINT	The day setting for the RTC.
Hour	UINT	The hour setting for the RTC.
Minute	UINT	The minute setting for the RTC.
Second	UINT	The second setting for the RTC.
DayOfWeek	UINT	The day of the week setting for the RTC. This parameter is ignored for RTC_SET.

RTC Set status values

The following table describes RTCSet values:

Status value	Status description
0x00	Function block not enabled (no operation).
0x01	RTC set operation success.
0x02	RTC set operation fails.

String manipulation instructions

String manipulation instructions are used to alter a sequence of symbols that are chosen from a set or alphabet to change the output status.

Note: To read input strings containing special characters correctly, input the string characters after the program containing the function block instance is online.

Function	Description
ASCII (on page 584)	Character -> ASCII code
CHAR (on page 586)	ASCII code -> Character
DELETE (on page 588)	Delete sub-string
FIND (on page 591)	Find sub-string
INSERT (on page 593)	Insert string
LEFT (on page 596)	Extract left of a string
MID (on page 598)	Extract middle of a string
MLEN (on page 600)	Get string length
REPLACE (on page 605)	Replace sub-string
RIGHT (on page 602)	Extract right of a string

ASCII

ASCII yields the ASCII code for characters in strings.

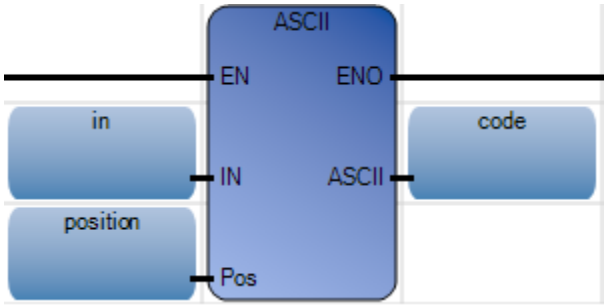
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, display the ASCII code for characters. When EN = FALSE, no display operation.
IN	Input	STRING	Any non-empty string.
Pos	Input	DINT	Position of the selected character in set [1.. len] (len is the length of the IN string).
ASCII	Output	DINT	Code of the selected character (in set [0 .. 255]) yields 0 is Pos is out of the string.
ENO	Output	BOOL	Enable out.

ASCII function language examples

Function block diagram

Ladder diagram



Structured text

```
1  position := 1;
2  code := ASCII(in, position);
```

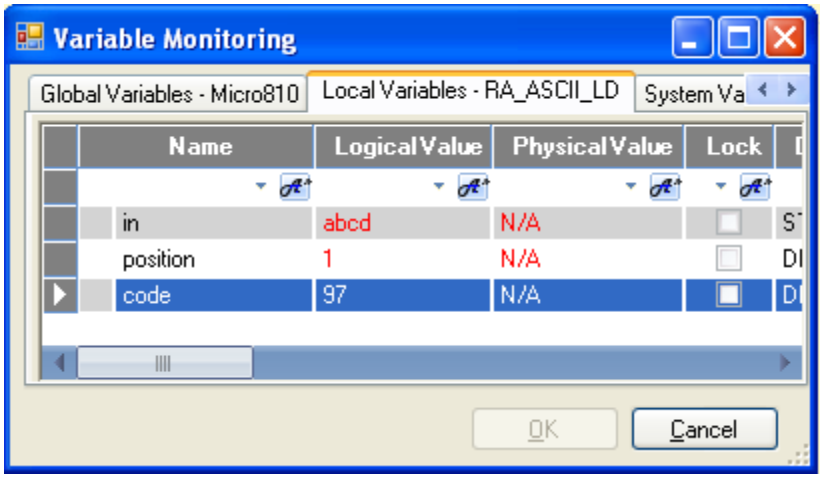
```
ASCII(
      DINT ASCII(STRING IN, DINT Pos)
      Character -> ASCII code
```

(* ST Equivalence: *)

FirstChr := ASCII (message, 1);

(* FirstChr is the ASCII code of the first character of the string *)

Results



CHAR

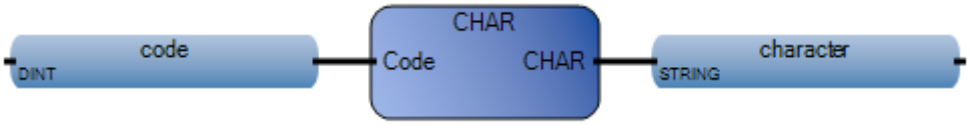
For a given ASCII code, CHAR provides a string containing one character.

Arguments

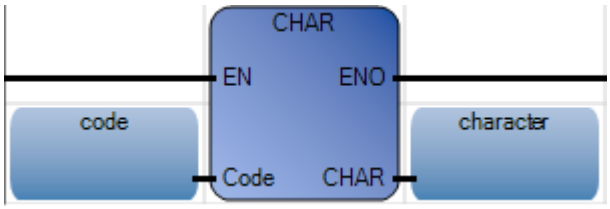
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, provide a single character string. When EN = FALSE, no operation.
Code	Input	DINT	Code in set [0 .. 255].
CHAR	Output	STRING	One character string. The character has the ASCII code given in input code.
ENO	Output	BOOL	Enable out.

CHAR function language examples

Function block diagram



Ladder diagram



Structured text

```
1  code := 97;
2  character := CHAR(code);
```

(* ST Equivalence: *)

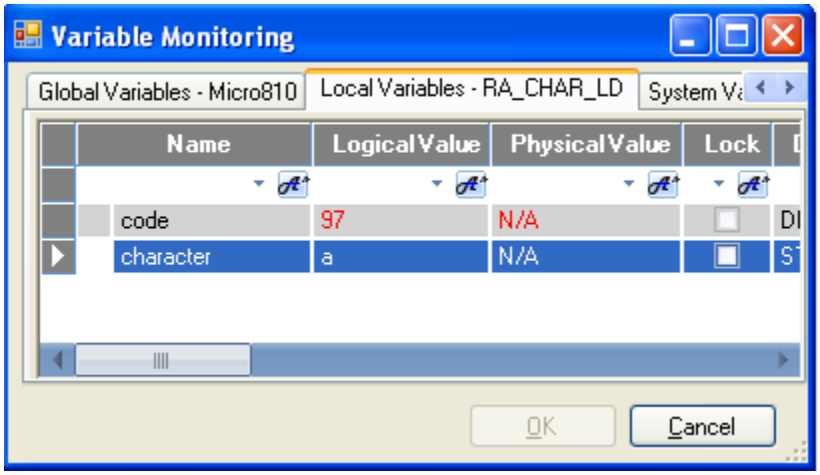
Display := CHAR (value + 48);

(* value is in set [0..9] *)

(* 48 is the ascii code of '0' *)

(* result is one character string from '0' to '9' *)

Results



DELETE

DELETE deletes part of a string.

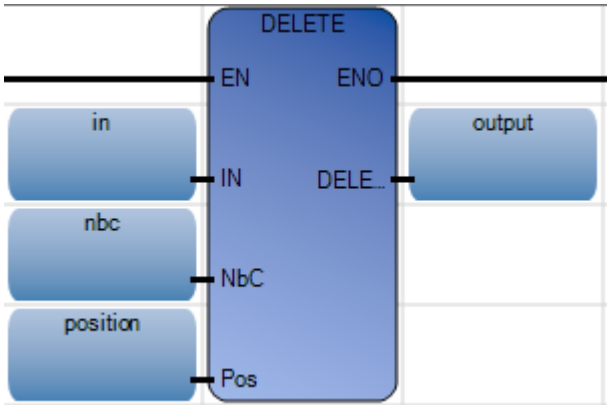
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, delete specified part of a string. When EN = FALSE, no operation.
IN	Input	STRING	Any non-empty string.
NbC	Input	DINT	Number of characters to be deleted.
Pos	Input	DINT	Position of the first deleted character. (first character of the string has position 1).
DELETE	Output	STRING	Can be a(n): • modified string • empty string (if Pos < 1) • initial string (if Pos > IN string length) • initial string (if NbC <= 0)
ENO	Output	BOOL	Enable out.

DELETE function language examples

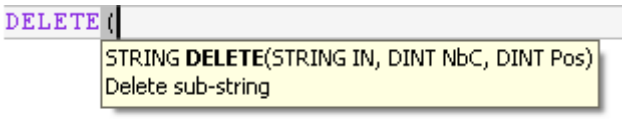
Function block diagram

Ladder diagram



Structured text

```
1  nbc := 3;
2  position := 2;
3  output := DELETE(in, nbc, position);
```

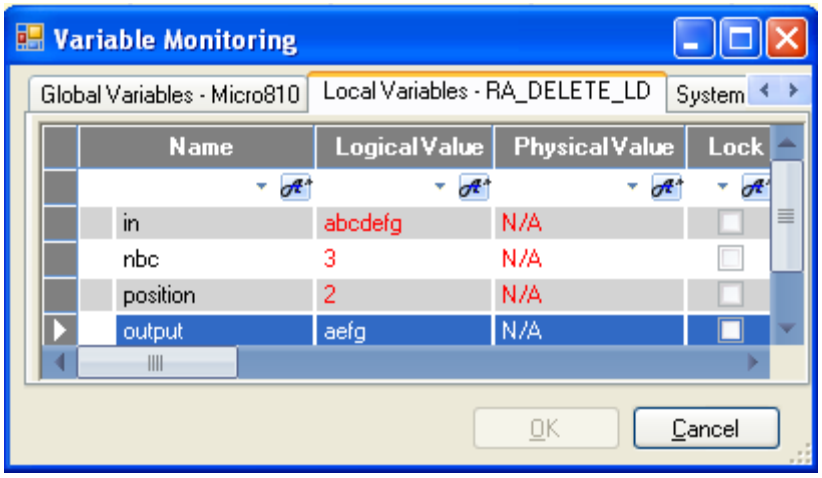


(* ST Equivalence: *)

complete_string := INSERT ('ABCD ', 'EFGH', 5); (* complete_string is 'ABCDEFGH ' *)

sub_string := DELETE (complete_string, 4, 3); (* sub_string is 'ABGH '*)

Results



FIND

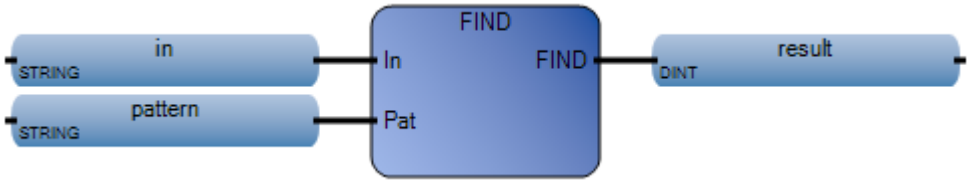
FIND locates and provides the position of sub-strings within strings.

Arguments

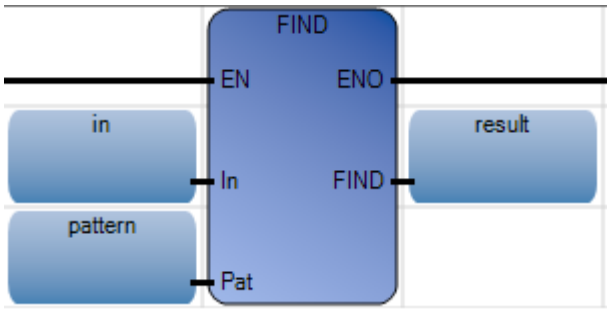
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, locate position within strings. When EN = FALSE, no locate operation.
In	Input	STRING	Any non-empty string.
Pat	Input	STRING	Any non-empty string (Pattern).
FIND	Output	DINT	Can be: • 0 if the sub string Pat not found • the position of the first character of the first occurrence of the sub-string Pat (first position is 1) **Note:** This function is case sensitive.
ENO	Output	BOOL	Enable out.

FIND function language examples

Function block diagram

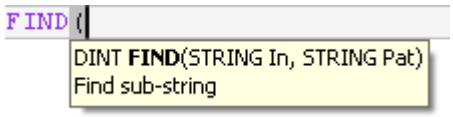


Ladder diagram



Structured text

```
1  result := FIND(in, pattern);
```

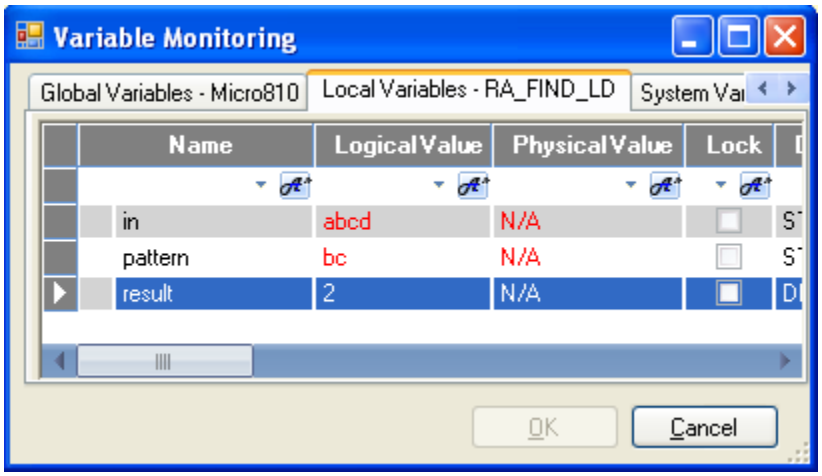


(* ST Equivalence: *)

complete_string := 'ABCD' + 'EFGH'; (* complete_string is 'ABCDEFGH ' *)

found := FIND (complete_string, 'CDEF'); (* found is 3 *)

Results



INSERT

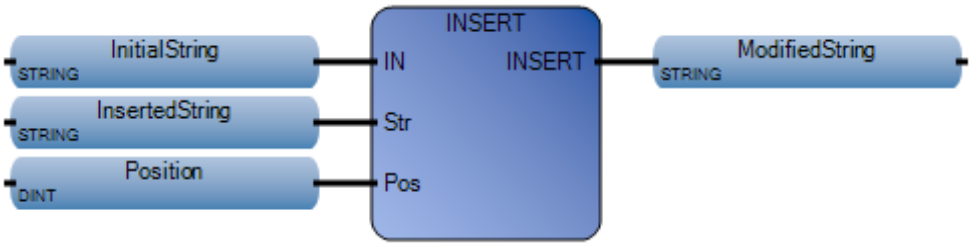
INSERT inserts sub-strings at user-defined positions within strings.

Arguments

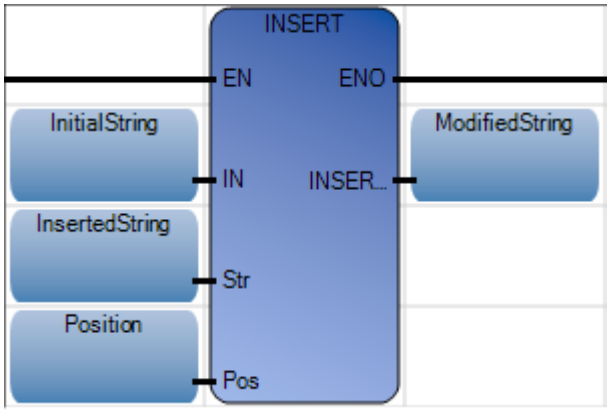
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, insert sub-strings in a string. When EN = FALSE, no operation.
IN	Input	STRING	Initial string.
Str	Input	STRING	String to be inserted.
Pos	Input	DINT	Position of the insertion the insertion is done before the position (first valid position is 1).
INSERT	Output	STRING	Modified string. Can be: • empty string if Pos <= 0 • concatenation of both strings if Pos is greater than the length of the IN string
ENO	Output	BOOL	Enable out.

INSERT function language examples

Function block diagram



Ladder diagram



Structured text

```
1  Position := 3;
2  ModifiedString := INSERT(InitialString, InsertedString, Position);
```

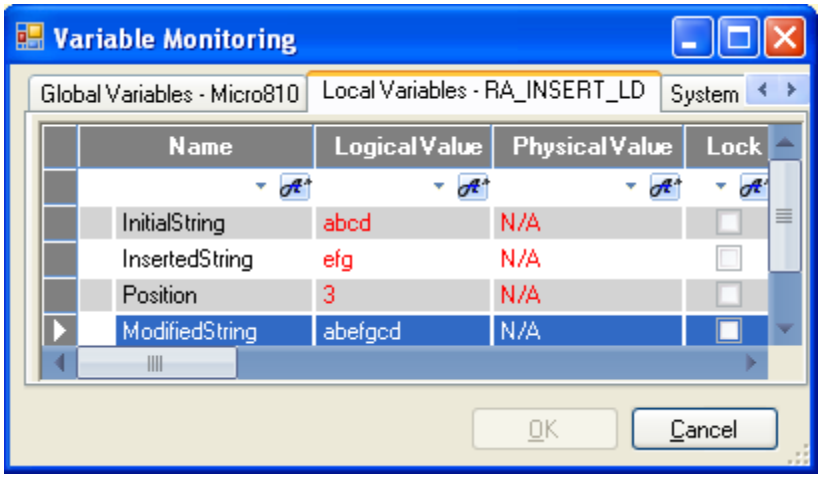
```
INSERT(
    STRING INSERT(STRING IN, STRING Str, DINT Pos)
    Insert string
```

(* ST Equivalence: *)

MyName := INSERT ('Mr JONES', 'Frank ', 4);

(* MyName is 'Mr Frank JONES' *)

Results



LEFT

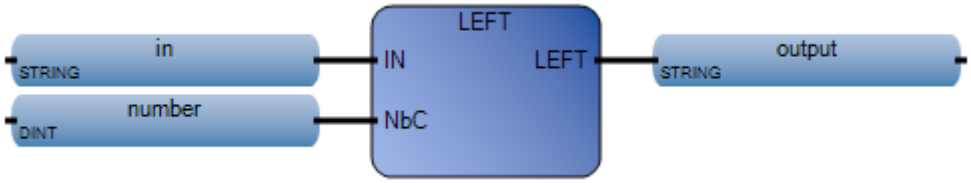
From the left end of strings, LEFT yields the number of characters defined.

Arguments

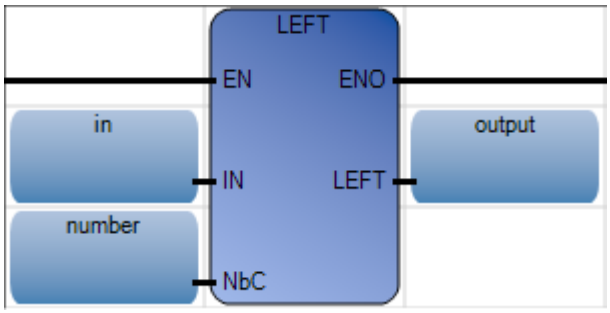
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, yield number of characters from left side of string. When EN = FALSE, no operation.
IN	Input	STRING	Any non-empty string.
NbC	Input	DINT	Number of characters to be extracted. This number cannot be greater than the length of the IN string.
LEFT	Output	STRING	Left part of the IN string (its length = NbC). Can be: • empty string if NbC <= 0 • complete IN string if NbC >= IN string length
ENO	Output	BOOL	Enable out.

LEFT function language examples

Function block diagram

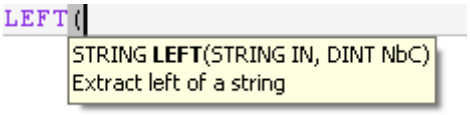


Ladder diagram



Structured text

```
1  number := 3;
2  output := LEFT(in, number);
```



(* ST Equivalence: *)

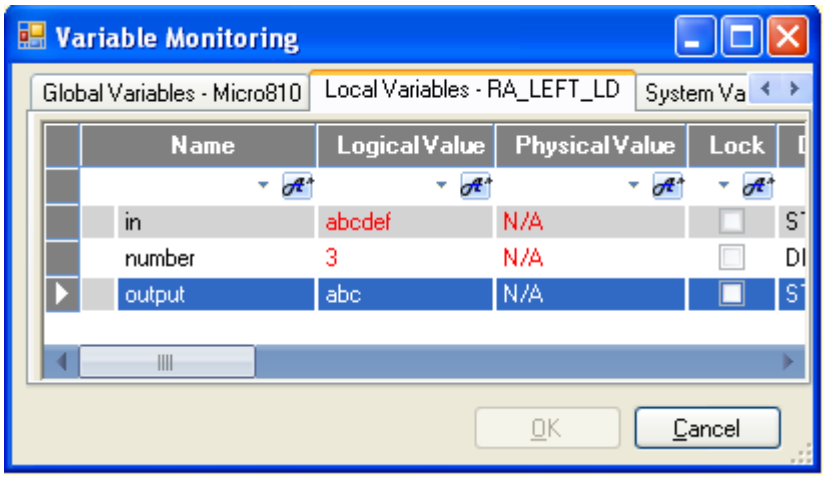
complete_string := RIGHT ('12345678', 4), LEFT ('12345678', 4), 5;

(* complete_string is '56781234'

the value issued from RIGHT call is '5678'

the value issued from LEFT call is '1234'*)

Results



MID

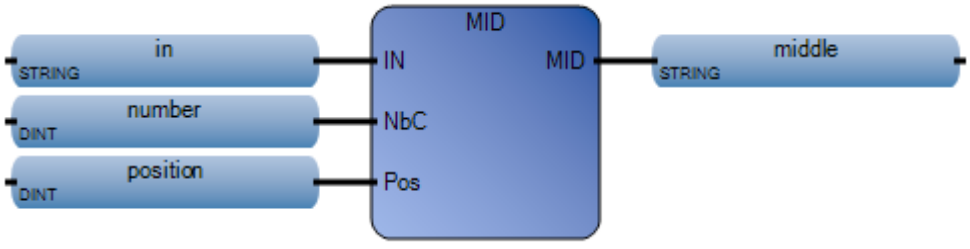
Using the position and number of characters provided, MID yields required parts of strings.

Arguments

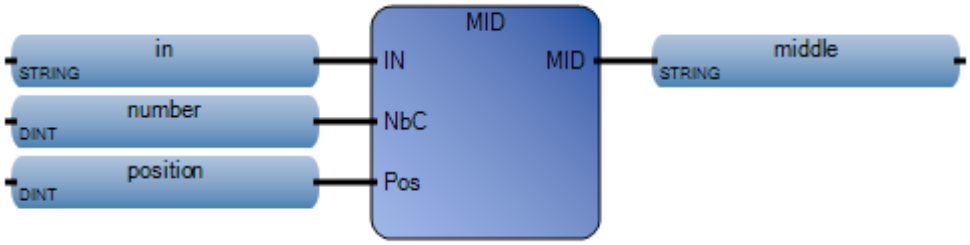
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, generate portion of a string. When EN = FALSE, no generate operation.
IN	Input	STRING	Any non-empty string.
NbC	Input	DINT	Number of characters to be extracted cannot be greater than the length of the IN string.
Pos	Input	DINT	Position of the sub-string. The sub-string first character will be the one pointed to by Pos (first valid position is 1).
MID	Output	STRING	Middle part of the string (its length = NbC). When the number of characters to extract exceeds the length of the IN string, NbC is automatically recalculated to get the remainder of the string only. When NbC or Pos are zero or negative numbers, an empty string is returned.
ENO	Output	BOOL	Enable out.

MID function language examples

Function block diagram

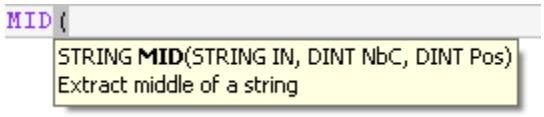


Ladder diagram



Structured text

```
1  number := 3;
2  position := 2;
3  middle := MID(in, number, position);
```

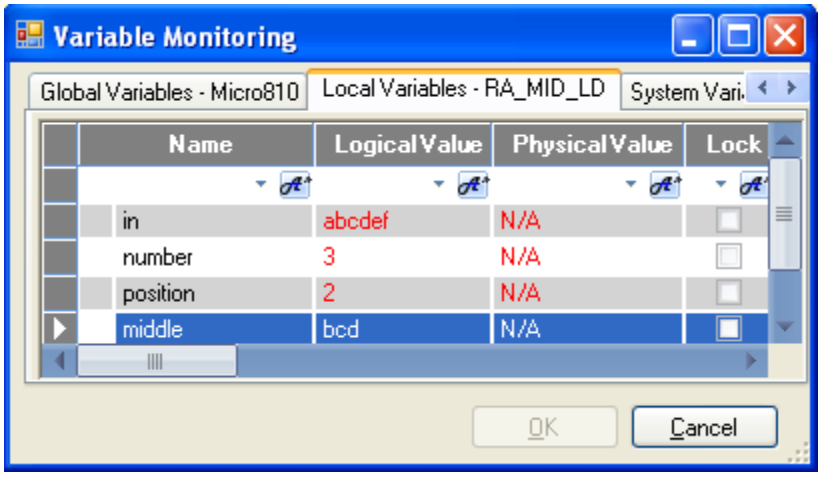


(* ST Equivalence: *)

sub_string := MID ('abcdefgh', 2, 4);

(* sub_string is 'de' *)

Results



MLEN

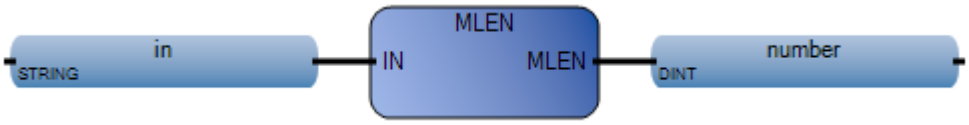
MLEN yields the length of strings.

Arguments

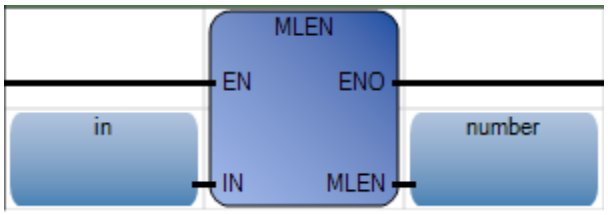
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, yield length of strings. When EN = FALSE, no operation.
IN	Input	STRING	Any string.
MLEN	Output	DINT	Number of characters in the IN string.
ENO	Output	BOOL	Enable out.

MLEN function language examples

Function block diagram



Ladder diagram



Structured text

```
1  number := MLEN(in);
```

```
MLEN(
    DINT MLEN(STRING IN)
    Get string length
```

(* ST Equivalence: *)

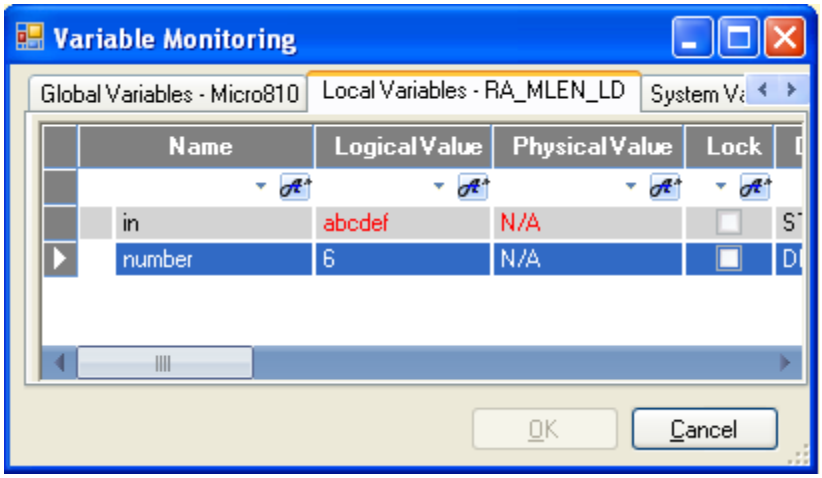
nbchar := MLEN (complete_string);

If (nbchar < 3) Then Return; End_if;

prefix := LEFT (complete_string, 3);

(* this program extracts the 3 characters on the left of the string and puts the result in the prefix string variable. Nothing is done if the string length is less than 3 characters *)

Results



RIGHT

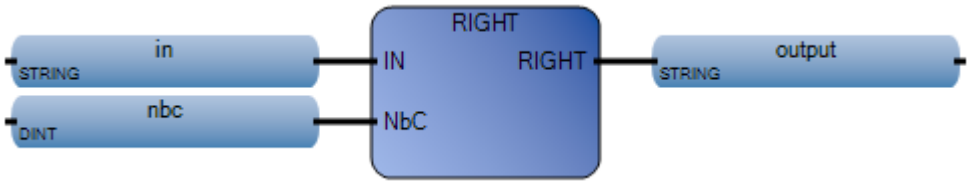
From the right ends of strings, RIGHT yields the number of characters defined.

Arguments

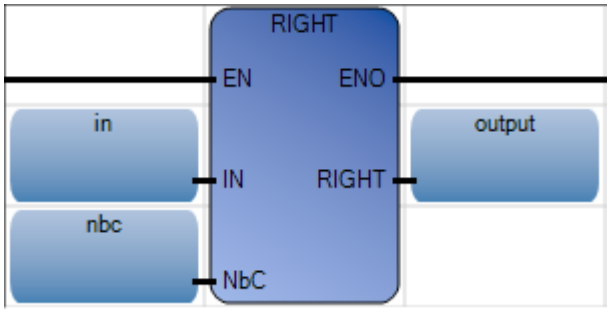
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, yield specified number of characters from the right end of the string. When EN = FALSE, no operation.
IN	Input	STRING	Any non-empty string.
NbC	Input	DINT	Number of characters to be extracted. This number cannot be greater than the length of the IN string.
RIGHT	Output	STRING	Right part of the string (length = NbC). Can be: • empty string if NbC <= 0 • complete string if NbC >= string length
ENO	Output	BOOL	Enable out.

RIGHT function language examples

Function block diagram



Ladder diagram



Structured text

```
1  nbc := 2;
2  output := RIGHT(in, nbc);
```

(* ST Equivalence: *)

complete_string := RIGHT ('12345678', 4), LEFT ('12345678', 4),5;

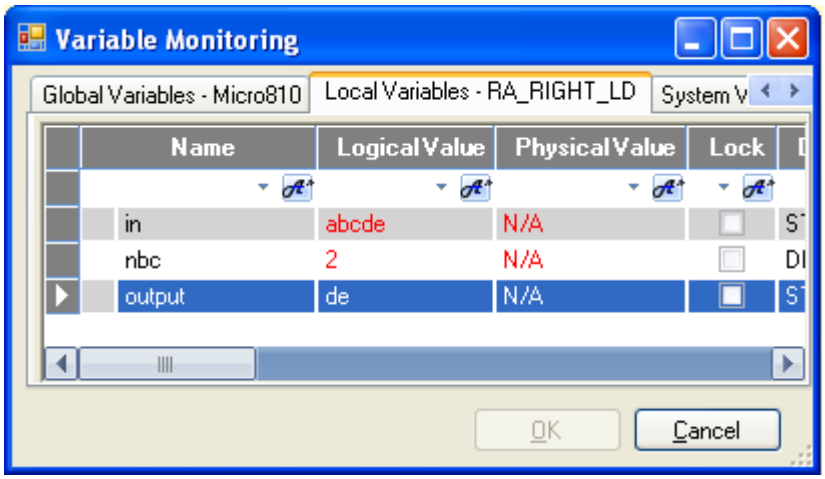
(* complete_string is '56781234'

the value issued from RIGHT call is '5678'

the value issued from LEFT call is '1234'

*)

Results



REPLACE

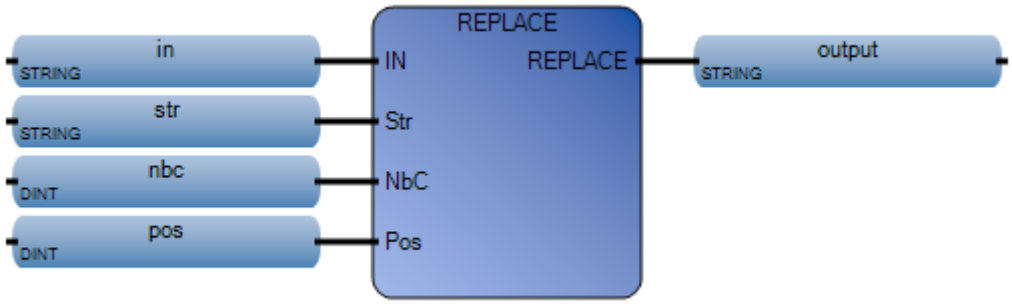
REPLACE replaces parts of a string with new sets of characters.

Arguments

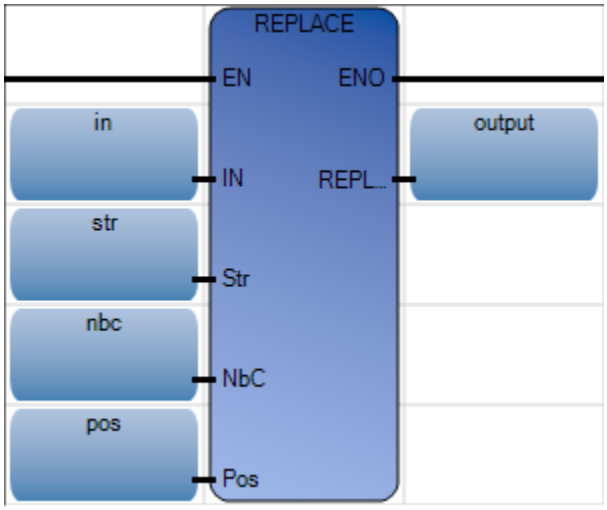
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, replace parts of strings with new characters. When EN = FALSE, no operation.
IN	Input	STRING	Any string.
Str	Input	STRING	String to be inserted (to replace NbC chars).
NbC	Input	DINT	Number of characters to be deleted.
Pos	Input	DINT	Position of the first modified character. (first valid position is 1).
REPLACE	Output	STRING	Modified string. The NbC characters are deleted at position Pos, then the substring Str is inserted at this position. Can be: • empty string if Pos <= 0 • strings concatenation (IN+Str) if Pos is greater than the length of the IN string • initial string IN if NbC <= 0
ENO	Output	BOOL	Enable out.

REPLACE function language examples

Function block diagram



Ladder diagram



Structured text

```
1  nbc := 4;
2  pos := 2;
3  output := REPLACE(in, str, nbc, pos);
```

```
REPLACE(
        STRING REPLACE(STRING IN, STRING Str, DINT NbC, DINT Pos)
        Replace sub-string
```

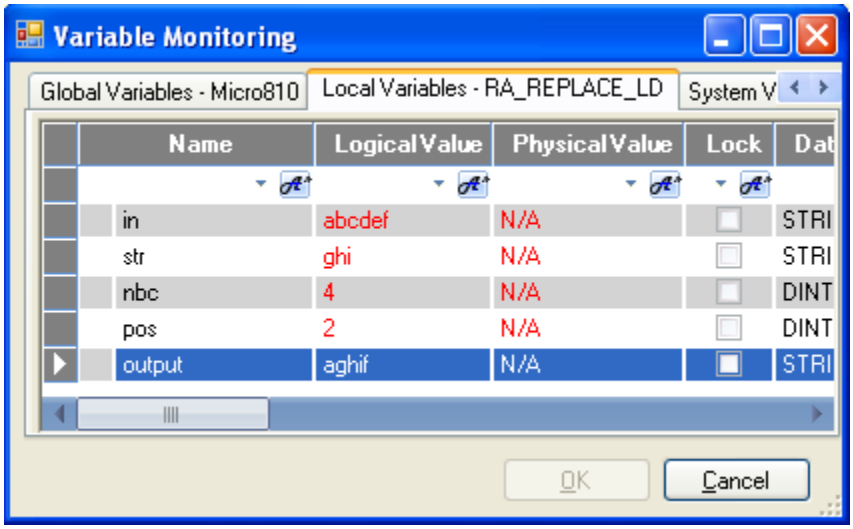
Replacing a part of a string with a new set of characters.

(* ST Equivalence: *)

MyName := REPLACE ('Mr X JONES, 'Frank', 1, 4);

(* MyName is 'Mr Frank JONES' *)

Results



Timer instructions

Timer instructions are used to control operations based on time.

Function block	Description
TOF (on page 611)	Off-delay timing
TON (on page 614)	On-delay timing
TONOFF (on page 617)	Delay turning on an output on a true rung, and then delay turning off the output on the false rung
TP (on page 620)	Pulse timing
RTO (on page 623)	Retentive timing. Saves accumulated time until reset instruction is active.
Function	**Description**
DOY (on page 626)	Turn on an output if the value of the real-time clock is in the range of the Year Time setting.
TDF (on page 629)	Compute the time difference.
TOW (on page 631)	Turn on an output if the value of the real-time clock is in the range of the Time of Week setting.

Timer instruction configuration

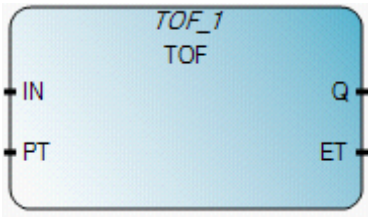
Time accuracy refers to the time between the moment the processor enables a timer instruction and the moment the processor completes the timed interval.

The processor uses the following information from the timer instruction:

- **Timer** - The timer control address in the timer area of data storage.
- **Time Base** - Determines how the timer operates.
- **Preset** - Specifies the value that the timer must reach before the processor sets the done bit.
- **Accumulated value** - The number of time increments the instruction has counted. When enabled, the timer updates this value continually.

TOF

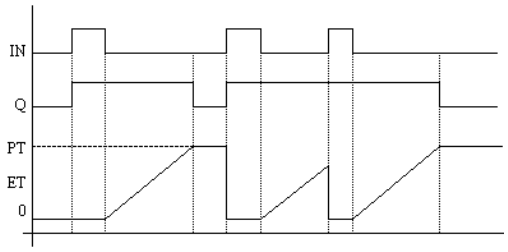
TOF increases an internal timer up to a given value.



Arguments

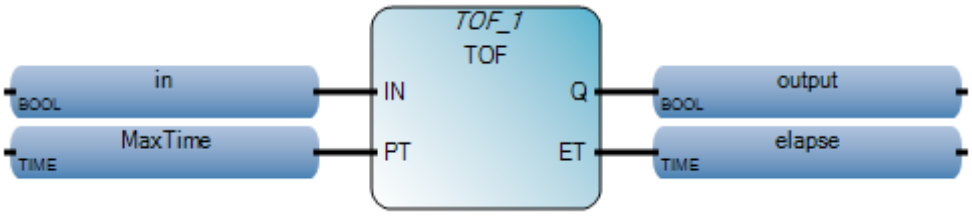
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If falling edge, starts increasing internal timer. If rising edge, stops and resets internal timer.
PT	Input	TIME	Maximum programmed time. See Time data type.
Q	Output	BOOL	If TRUE: total time is **not** elapsed.
ET	Output	TIME	Current elapsed time. Possible values range from 0ms to 1193h2m47s294ms. **Note:** If you use the EN parameter with this block, the timer starts incrementing when EN is set to TRUE, and continues to increment even if EN is set to FALSE. See Time data type.

TOF timing diagram

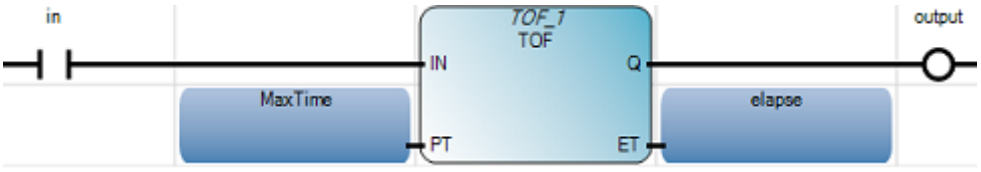


TOF function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)

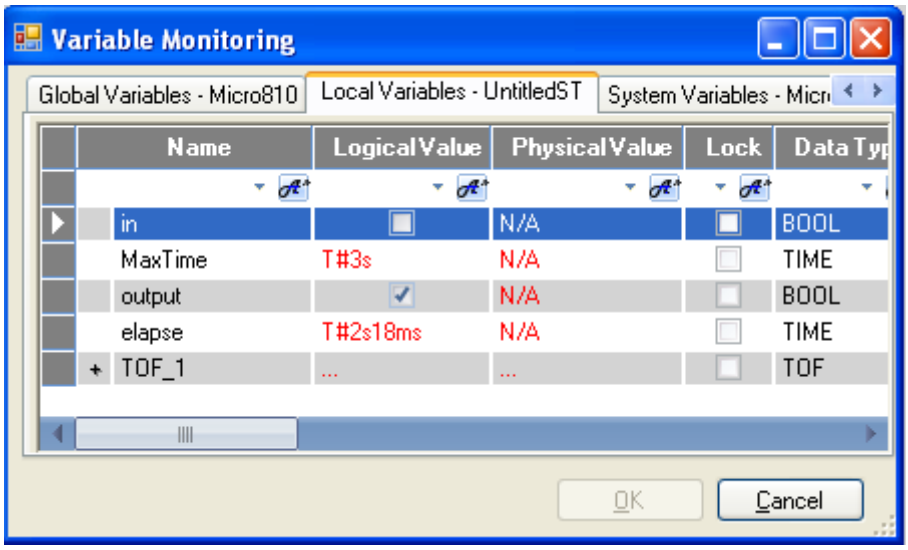


Structured Text (ST)

```
1  MaxTime := T#3s;
2  TOF_1(in, MaxTime);
3  output := TOF_1.Q;
4  elapse := TOF_1.ET;
```

```
TOF_1(
      void TOF_1(BOOL IN, TIME PT)
      Type : TOF, Off-delay timing
```

Results



TON

TON increases an internal timer up to a given value.

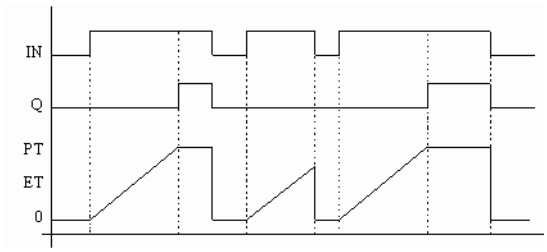
TON operation

- Do not use a jump to skip over a TON function block in a Ladder Diagram (LD). If you do, the TON timer will continue after the elapsed time.
- For example: Rung 1 contains a jump; rung 2 contains a TON function block with an elapsed time of 10 seconds; enable the jump from rung 1 to rung 3; disable the jump after 30 seconds; the elapsed time will be 30 seconds - not 10 seconds as defined in the elapsed time.

Arguments

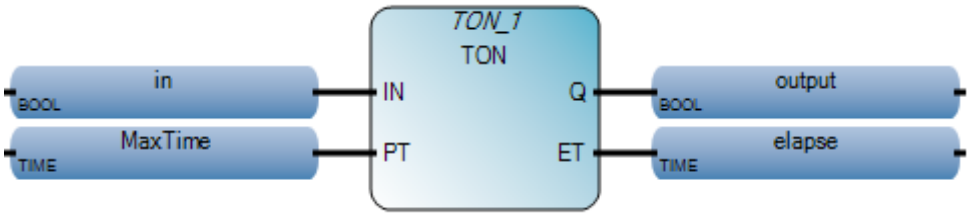
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If rising edge, starts increasing internal timer. If falling edge, stops and resets internal timer.
PT	Input	TIME	Maximum programmed time. See Time data type.
Q	Output	BOOL	If TRUE, programmed time is elapsed.
ET	Output	TIME	Current elapsed time. Possible values range from 0ms to 1193h2m47s294ms. **Note:** If you use the EN parameter with this block, the timer starts incrementing when EN is set to TRUE, and continues to increment even if EN is set to FALSE. See Time data type.

TON timing diagram

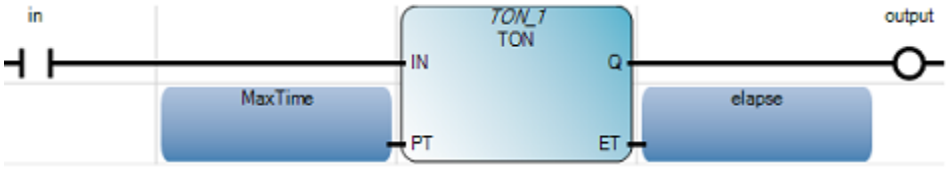


TON function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)

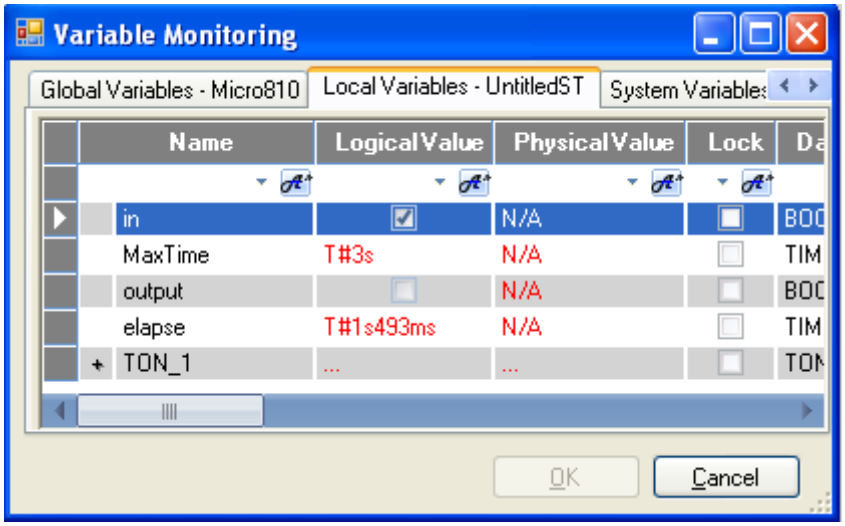


Structured Text (ST)

```
1  MaxTime := T#3s;
2  TON_1(in, MaxTime);
3  output := TON_1.Q;
4  elapse := TON_1.ET;
```

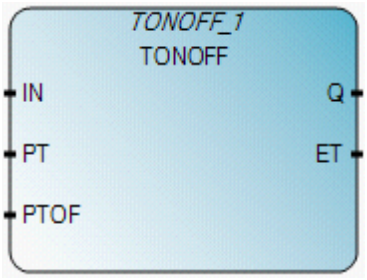
```
TON_1(
      void TON_1(BOOL IN, TIME PT)
      Type : TON, On-delay timing
```

Results



TONOFF

TONOFF delays turning on an output on a true rung, then delays turning off the output on the false rung.

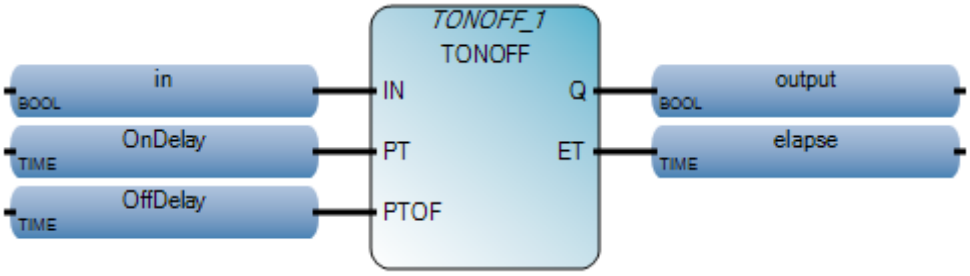


Arguments

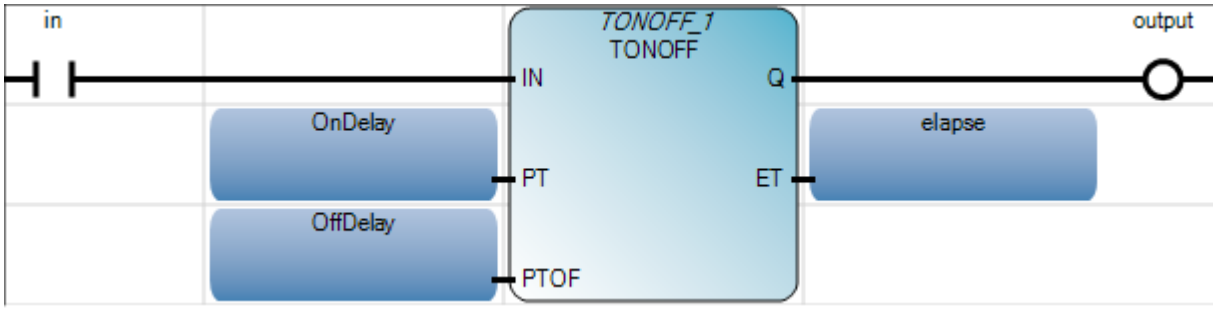
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If Rising Edge (IN) turns from 0 to 1, the On-delay timer starts. If the Programmed On-delay time is elapsed and the Falling Edge (IN) turns from 1 to 0, the Off-delay timer starts and resets the elapsed time (ET). If the Programmed On-delay time is elapsed and the Falling Edge (IN) turns from 1 to 0, the Off-delay timer starts. If the Programmed On-delay time is not elapsed and the Rising Edge (IN) turns from 0 to 1, the On-delay timer starts.
PT	Input	TIME	On-delay time setting. See Time data type.
PTOF	Input	TIME	Off-delay time setting. See Time data type.
Q	Output	BOOL	If TRUE, the Programmed On-delay time is elapsed and Programmed Off-delay time is not elapsed.
ET	Output	TIME	Current elapsed time. Possible values range from 0ms to 1193h2m47s294ms. If the Programmed On-delay time is elapsed and the Off-delay timer is not starting, the elapsed time (ET) remains at the on-delay (PT) value. If the Programmed Off-delay time is elapsed and the Off-delay timer is not starting, the elapsed time (ET) remains at the off-delay (PTOF) value until the rising edge occurs again. **Note:** If you use the EN parameter with this block, the timer starts incrementing when EN is set to TRUE, and continues to increment even if EN is set to FALSE. See Time data type.

TONOFF function block language examples

Function Block Diagram (FBD)

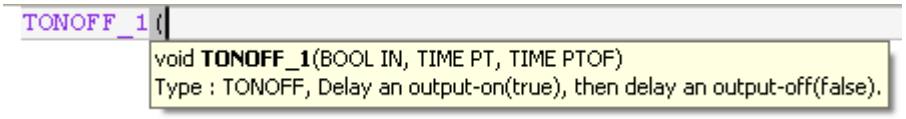


Ladder Diagram (LD)

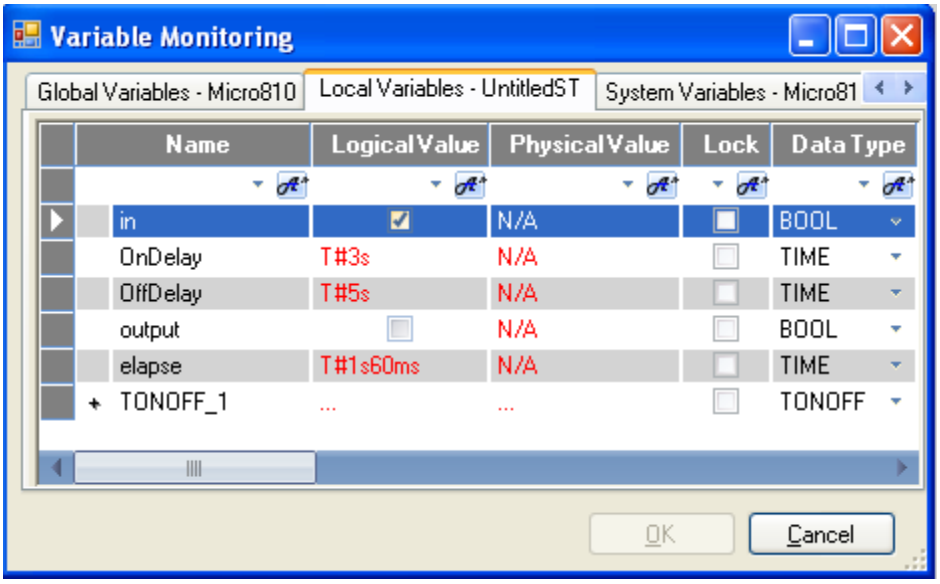


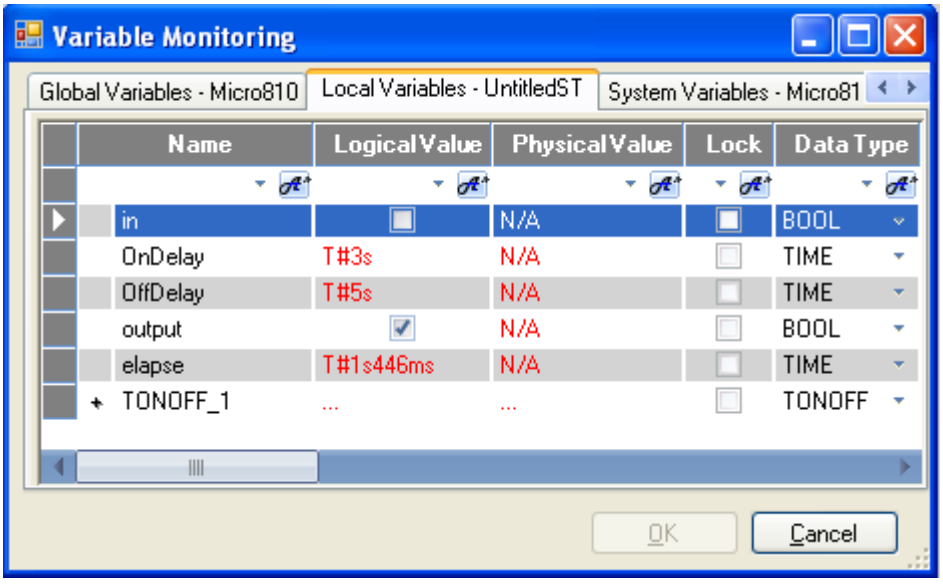
Structured Text (ST)

```
1  OnDelay := T#3s;
2  OffDelay := T#5s;
3  TONOFF_1(in, OnDelay, OffDelay);
4  output := TONOFF_1.Q;
5  elapse := TONOFF_1.ET;
```



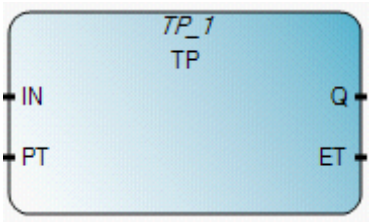
Results


Variable Monitoring
Global Variables - Micro810
Local Variables - UntitledST
System Variables - Micro81
Name
Logical Value
Physical Value
Lock
Data Type
in
N/A
BOOL
OnDelay
T#3s
N/A
TIME
OffDelay
T#5s
N/A
TIME
output
N/A
BOOL
elapse
T#1s60ms
N/A
TIME
TONOFF_1
...
...
TONOFF
OK
Cancel


Variable Monitoring
Global Variables - Micro810
Local Variables - UntitledST
System Variables - Micro81
Name
Logical Value
Physical Value
Lock
Data Type
in
N/A
BOOL
OnDelay
T#3s
N/A
TIME
OffDelay
T#5s
N/A
TIME
output
N/A
BOOL
elapse
T#1s446ms
N/A
TIME
TONOFF_1
...
...
TONOFF
OK
Cancel

TP

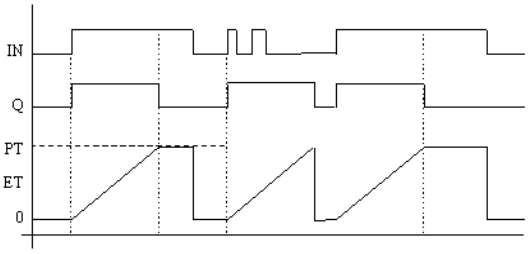
On a rising edge, TP increases an internal timer up to a given value. If the timer is elapsed, it resets the internal timer.



Arguments

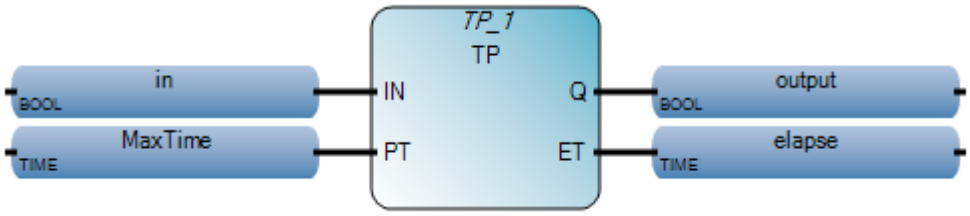
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If rising edge, starts increasing internal timer (if not already increasing). If FALSE and only if timer is elapsed, resets the internal timer. Any change on IN during counting has no effect.
PT	Input	TIME	Maximum programmed time. See Time data type.
Q	Output	BOOL	If TRUE: timer is counting.
ET	Output	TIME	Current elapsed time. Possible values range from 0ms to 1193h2m47s294ms. **Note:** If you use the EN parameter with this block, the timer starts incrementing when EN is set to TRUE, and continues to increment even if EN is set to FALSE. See Time data type.

TP timing diagram

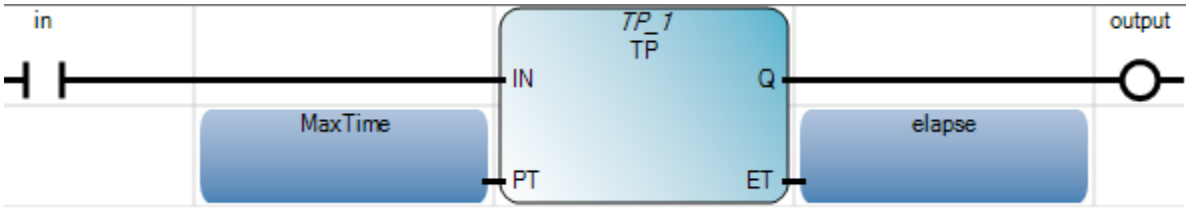


TP function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



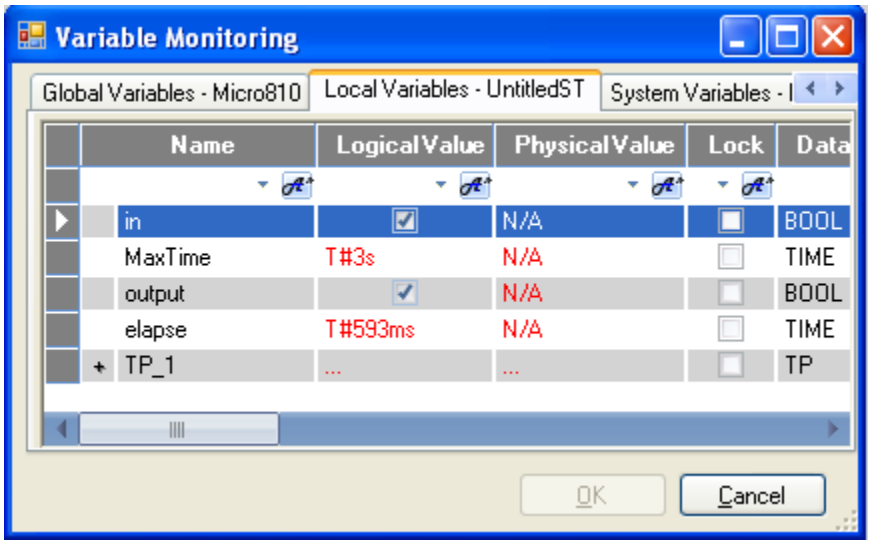
Structured Text (ST)

```
1  MaxTime := T#3s;
2  TP_1(in, MaxTime);
3  output := TP_1.Q;
4  elapse := TP_1.ET;
```

```
TP_1(
```

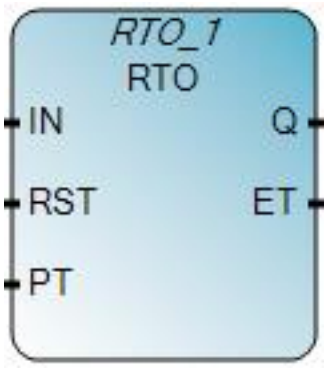
void **TP_1**(BOOL IN, TIME PT)
Type : TP, Pulse timing

Results



RTO

RTO increases an internal timer when its input is active, but does not reset its internal timer when its input changes to inactive.



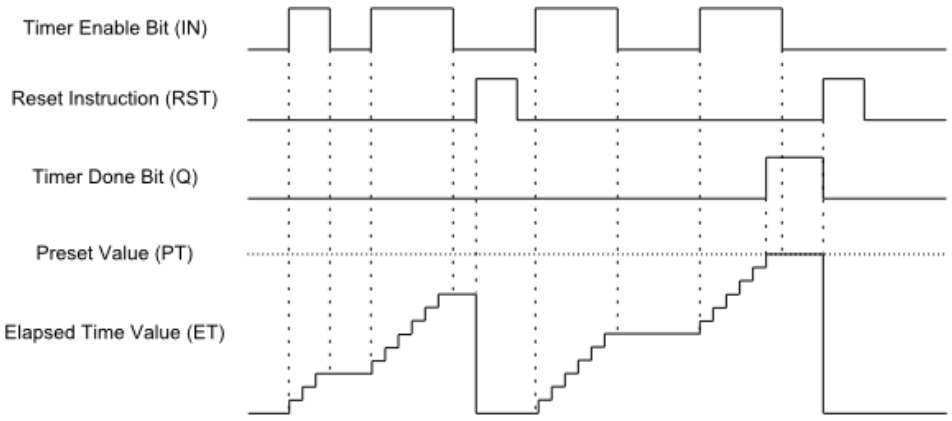
If using a Micro810 or Micro820 controller, the RTO internal timer does not persist through a power cycle by default. To persist the internal timer, set the **Retained** configuration parameter to true.

If using a Micro830 or Micro850 controller, the RTO internal timer will persist through a power cycle.

Arguments

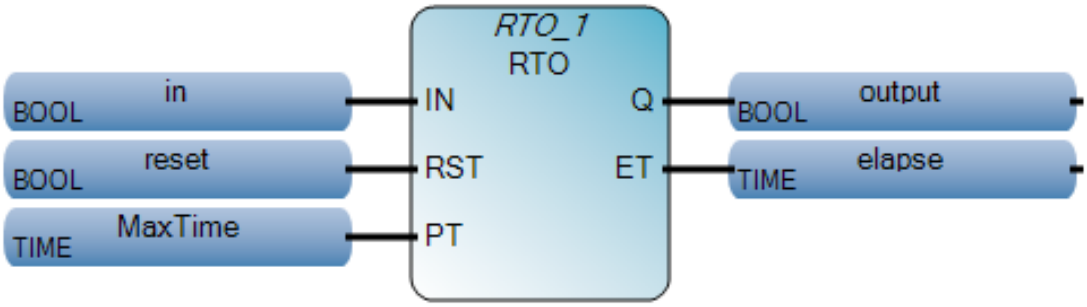
Parameter	Parameter type	Data type	Description
IN	Input	BOOL	If rising edge, starts increasing internal timer. If falling edge, stops and does not reset the internal timer.
RST	Input	BOOL	If rising edge, resets the internal timer.
PT	Input	TIME	Maximum programmed time. See Time data type.
Q	Output	BOOL	If TRUE, programmed time is elapsed.
ET	Output	TIME	Elapsed time. Possible values range from 0ms to 1193h2m47s294ms. See Time data type.

RTO timing diagram

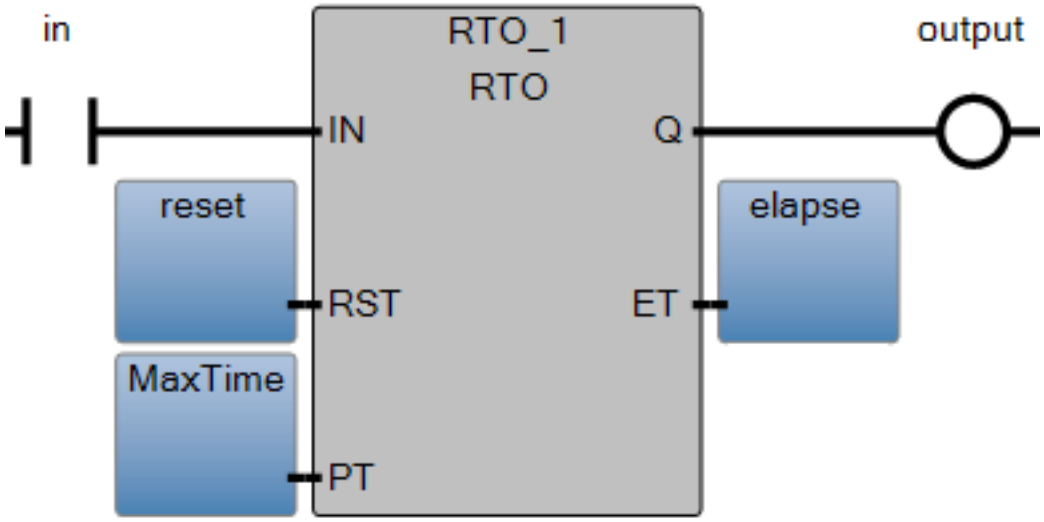


RTO function block language examples

Function Block Diagram (FBD)



Ladder Diagram (LD)



Structured Text (ST)

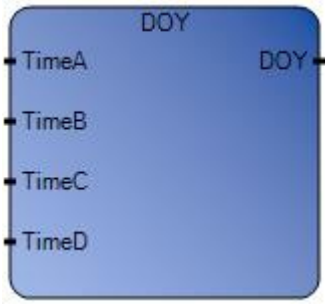
```
1  MaxTime := T#3s;
2  RTO_1(in, reset, MaxTime);
3  output := RTO_1.Q;
4  elapse := RTO_1.ET;
```

```
RTO_1(
```

void **RTO_1**(BOOL IN, BOOL RST, TIME PT)
Type : RTO, Delay an output-on(true). Retain elapsed time until reset.

DOY

The DOY function has four channel inputs; it turns on an output if the value of Real-Time Clock (RTC) is in the range of the Year Time setting of any one of four channels. If RTC is not present, the output is always off.



DOY operation

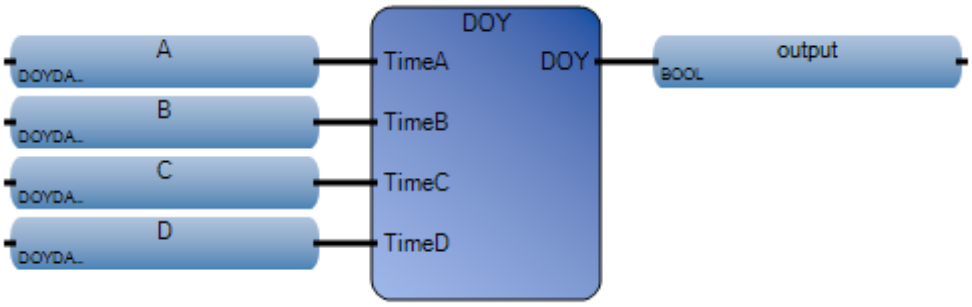
Configure any of the Time input parameters with valid ranges as specified in the DOYDATA Data Type table. If TimeX.Enable is set to TRUE and an RTC is present and enabled, an invalid value will fault the controller.

Arguments

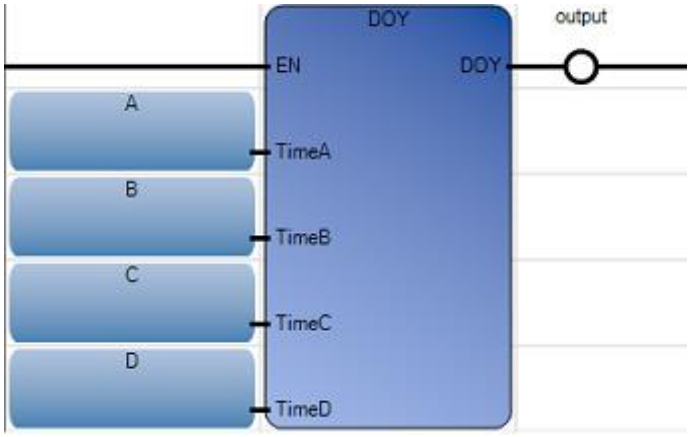
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, perform the function. When EN = FALSE, do not perform the function.
TimeA	Input	DOYDATA	Year Time Setting of Channel A. See DOYDATA data type (on page 628).
TimeB	Input	DOYDATA	Year Time Setting of Channel B. See DOYDATA data type (on page 628).
TimeC	Input	DOYDATA	Year Time Setting of Channel C. See DOYDATA data type (on page 628).
TimeD	Input	DOYDATA	Year Time Setting of Channel D. See DOYDATA data type (on page 628).
DOY	Output	BOOL	If TRUE, the value of the real-time clock is in the range of the Year Time setting of any one of the four channels.

DOY instruction language examples

Function block diagram

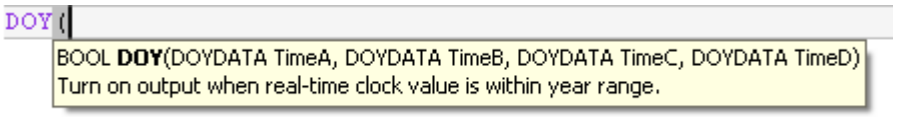


Ladder diagram



Structured text

```
1  output := DOY(A, B, C, D);
```



(* ST Equivalence: *)

TESTOUTPUT := DOY(TIMEA1, TIMEB1, TIMEC1, TIMED1) ;

DOYDATA data type

The following table describes the DOYDATA data type.

Parameter	Data Type	Description
Enable	BOOL	TRUE:Enable; FALSE:Disable
YearlyCenturial	BOOL	Type of timer (0:Yearly timer; 1:Centurial timer).
YearOn	UINT	Year On value (must be in set [2000...2098]).
MonthOn	USINT	Month On value (must be in set [1...12]).
DayOn	USINT	Day On value (must be in set [1...31], determined by "MonthOn" value).
YearOff	UINT	Year Off value (must be in set [2000...2098]).
MonthOff	USINT	Month Off value (must be in set [1...12]).
DayOff	USINT	Day Off value (must be in set [1...31], determined by "MonthOff" value).

TDF

TDF computes time difference.

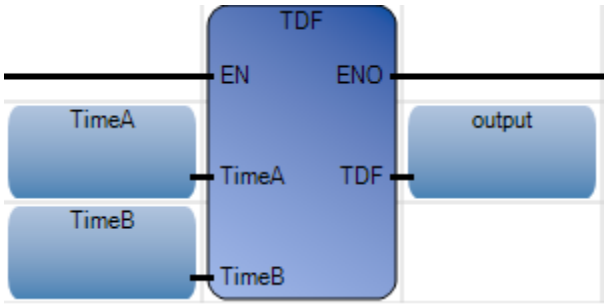
Arguments

Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, perform current computation. When EN = FALSE, there is no computation.
TimeA	Input	TIME	The start time for time difference computation.
TimeB	Input	TIME	The end time for time difference computation.
ENO	Output	BOOL	Enable out.
TDF or Q	Output	TIME	The time difference for the two time inputs. TDF is name or PIN ID Q is PIN ID

TDF function language examples

Function block diagram

Ladder diagram



Structured text

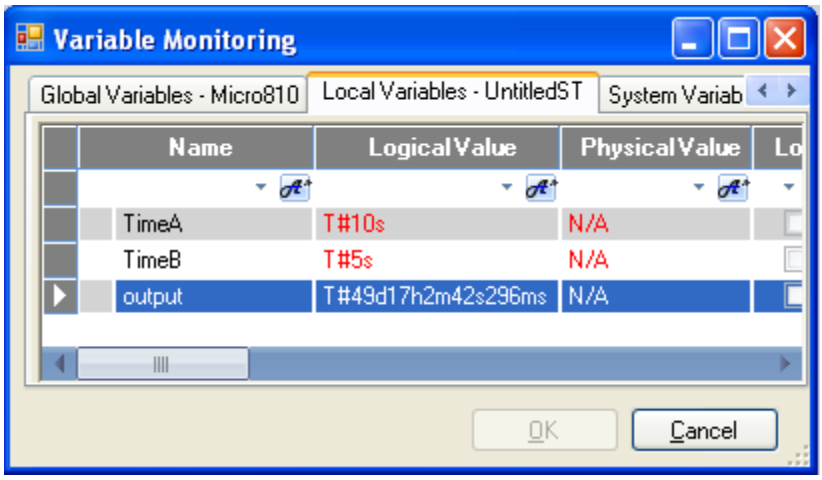
```
1  TimeA := T#10s;
2  TimeB := T#5s;
3  output := TDF(TimeA, TimeB);
```

```
TDF(
    TIME TDF(TIME TimeA, TIME TimeB)
    Compute time difference.
```

(* ST Equivalence: *)

TESTTIMEDIFF := TDF(TESTTIME1, TESTTIME2) ;

Results



TOW

The TOW function has four channel inputs; it turns on an output if the value of the real-time clock (RTC) is in the range of the Time of Week setting of any one of four channels. If an RTC is not present, the output is always off.

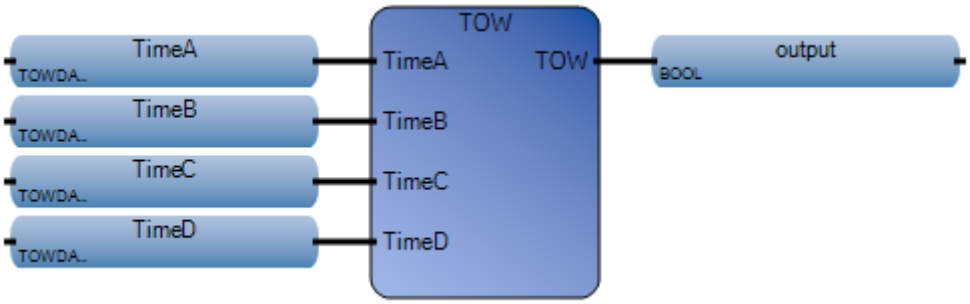
Note: Make sure you configure any TimeX input parameter with valid ranges as specified in the TOWDATA Data Type table. An invalid value will fault the controller if TimeX.Enable is set to TRUE and an RTC is present and enabled.

Arguments

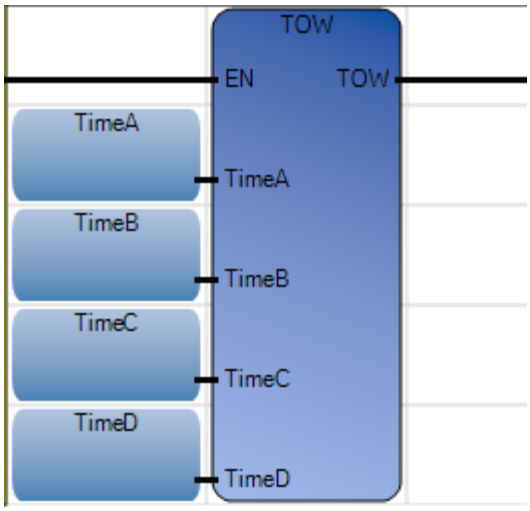
Parameter	Parameter Type	Data Type	Description
EN	Input	BOOL	Function enable. When EN = TRUE, perform the function. When EN = FALSE, do not perform the function.
TimeA	Input	TOWDATA	Day Time Setting of Channel A. See TOWDATA Data Type (on page 634).
TimeB	Input	TOWDATA	Day Time Setting of Channel B. See TOWDATA Data Type (on page 634).
TimeC	Input	TOWDATA	Day Time Setting of Channel C. See TOWDATA Data Type (on page 634).
TimeD	Input	TOWDATA	Day Time Setting of Channel D. See TOWDATA Data Type (on page 634).
TOW	Output	BOOL	If TRUE, the value of the real-time clock is in the range of the Day Time setting of any one of four channels.

TOW function language examples

Function block diagram



Ladder diagram



Structured text

```
1  output := TOW(TimeA, TimeB, TimeC, TimeD);
```

```
TOW(
    BOOL TOW(TOWDATA TimeA, TOWDATA TimeB, TOWDATA TimeC, TOWDATA TimeD)
    Turn on output when real-time clock value is within week range.
```

(* ST Equivalence: *)

TESTOUTPUT := TOW(TIMEA, TIMEB, TIMEC, TIMED) ;

Results

Name	Logical Value	Physical Value	Lock	Data Type
TimeA	...	...		TOWDAT
TimeA.Enable	✓	N/A		BOOL
TimeA.DailyWeekly	✓	N/A		BOOL
TimeA.DayOn	1	N/A		USINT
TimeA.HourOn	10	N/A		USINT
TimeA.MinOn	20	N/A		USINT
TimeA.DayOff	2	N/A		USINT
TimeA.HourOff	15	N/A		USINT
TimeA.MinOff	30	N/A		USINT
TimeB	...	...		TOWDAT
TimeB.Enable	✓	N/A		BOOL
TimeB.DailyWeekly	✓	N/A		BOOL
TimeB.DayOn	2	N/A		USINT
TimeB.HourOn	15	N/A		USINT
TimeB.MinOn	20	N/A		USINT
TimeB.DayOff	3	N/A		USINT
TimeB.HourOff	10	N/A		USINT
TimeB.MinOff	30	N/A		USINT
TimeC	...	...		TOWDAT
TimeC.Enable	✓	N/A		BOOL
TimeC.DailyWeekly	✓	N/A		BOOL
TimeC.DayOn	3	N/A		USINT
TimeC.HourOn	20	N/A		USINT
TimeC.MinOn	10	N/A		USINT
TimeC.DayOff	4	N/A		USINT
TimeC.HourOff	25	N/A		USINT
TimeC.MinOff	55	N/A		USINT
TimeD	...	...		TOWDAT
TimeD.Enable	✓	N/A		BOOL
TimeD.DailyWeekly	✓	N/A		BOOL
TimeD.DayOn	5	N/A		USINT
TimeD.HourOn	10	N/A		USINT
TimeD.MinOn	15	N/A		USINT
TimeD.DayOff	6	N/A		USINT
TimeD.HourOff	35	N/A		USINT
TimeD.MinOff	40	N/A		USINT
output	✓	N/A		BOOL

TOWDATA Data Type

The following table describes the TOWDATA data type:

Parameter	Data Type	Description
Enable	BOOL	TRUE: Enable; FALSE: Disable.
DailyWeekly	BOOL	Type of Timer (0:daily timer; 1:weekly timer).
DayOn	USINT	Day of Week On value (must be in set [0...6]).
HourOn	USINT	Hour On value (must be in set [0...23]).
MinOn	USINT	Minute On value (must be in set [0...59]).
DayOff	USINT	Weekday Off value (must be in set [0...6]).
HourOff	USINT	Hour Off value (must be in set [0...23]).
MinOff	USINT	Minute Off value (must be in set [0...59]).

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