Modicon M100/M200 Logic Controller

Programming Guide

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Legal Information

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Safety Information

Important Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER
DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

WARNING
WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

CAUTION
CAUTION indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

NOTICE
NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Book

Document Scope

This document describes the configuration and programming of the Modicon M100/M200 Logic Controller for EcoStruxure Machine Expert-Basic. For further information, refer to the separate documents provided in the EcoStruxure Machine Expert-Basic online help.

Validity Note

This document has been updated for the release of EcoStruxure Machine Expert-Basic V1.3.

Related Documents

Title of Documentation	Reference Number
EcoStruxure Machine Expert-Basic - Operating Guide	EIO0000003281 (ENG) EIO0000003282 (FRA) EIO0000003283 (GER) EIO0000003284 (SPA) EIO0000003285 (ITA) EIO0000003286 (CHS) EIO0000003287 (POR) EIO0000003288 (TUR)
EcoStruxure Machine Expert-Basic Generic Functions - Library Guide	EIO0000003289 (ENG) EIO0000003290 (FRE) EIO0000003291 (GER) EIO0000003292 (SPA) EIO0000003293 (ITA) EIO0000003294 (CHS) EIO0000003295 (POR) EIO0000003296 (TUR)
Modicon M100/M200 Logic Controller - Hardware Guide	EIO0000002023 (ENG) EIO0000002024 (CHS)

Title of Documentation	Reference Number
Modicon TM3 Expansion Modules Configuration - Programming Guide	EIO0000003345 (ENG) EIO0000003346 (FRE) EIO0000003347 (GER) EIO0000003348 (SPA) EIO0000003349 (ITA) EIO0000003350 (CHS) EIO0000003351 (POR) EIO0000003352 (TUR)
Modicon TM2 Expansion Modules Configuration - Programming Guide	EIO0000003432 (ENG) EIO0000003433 (FRE) EIO0000003434 (GER) EIO0000003435 (SPA) EIO0000003436 (ITA) EIO0000003437 (CHS)

You can download these technical publications and other technical information from our website at www.se.com/ww/en/download/ .

The characteristics that are described in the present document, as well as other related documents, should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the document and online information, use the online information as your reference.

Product Related Information

⚠WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Introduction

What’s in This Part

Overview

This part provides general information about the Modicon M100/M200 Logic Controller and its configuration and programming features.

About the Modicon M100/M200 Logic Controller

What’s in This Chapter

M100/M200 Logic Controller Description

Overview

The M100/M200 Logic Controller has various powerful features and can service a wide range of applications.

Software configuration, programming, and commissioning are accomplished with the EcoStruxure Machine Expert-Basic software described in the (see EcoStruxure Machine Expert - Basic, Operating Guide and the EcoStruxure Machine Expert - Basic, Generic Functions Library Guide).

Programming Languages

The M100/M200 Logic Controller is configured and programmed with the EcoStruxure Machine Expert-Basic software, which supports the following IEC 61131-3 programming languages:

- IL: Instruction List
- LD: Ladder Diagram
- Grafcet (List)
- Grafcet (SFC)

Power Supply

The power supply of the M100 Logic Controller is 100...240 Vac.

The power supply of the M200 Logic Controller is 24 Vdc or 100...240 Vac.

Real Time Clock

The M200 Logic Controller includes a Real Time Clock (RTC) system (see Modicon M100/M200 Logic Controller, Hardware Guide).

Run/Stop

The M100/M200 Logic Controller can be operated externally by the following:

- A hardware Run/Stop switch (see Modicon M100/M200 Logic Controller, Hardware Guide)
- A Run/Stop (see Modicon M100/M200 Logic Controller, Hardware Guide) operation by a dedicated digital input, defined in the software configuration. For more information, refer to Configuring Digital Inputs, page 51.
- EcoStruxure Machine Expert-Basic software. For more information, refer to the EcoStruxure Machine Expert - Basic, Operating Guide.

Memory

This table describes the different types of memory:

Memory Type		Size	Used to...
RAM	For TM100C••RN	128 Kbytes RAM memory: 32 Kbytes for internal variables and 96 Kbytes for application and data.	execute the application and contain data.
	For TM100C••R and TM200C•••	512 Kbytes RAM memory: 256 Kbytes for internal variables and 256 Kbytes for application and data.	
Flash		1 Mbyte, of which 256 Kbytes is used to back up the application and data in case of power outage.	save the application.

Embedded Inputs/Outputs

The following embedded I/O types are available, depending on the controller reference:

- Regular inputs
- Fast inputs associated with counters
- Regular sink transistor outputs (PMW/PLS/PTO/FREQGEN)
- Fast sink transistor outputs associated with pulse generators
- Relay outputs

Removable Storage

The M100/M200 Logic Controller includes an embedded micro SD card slot.

The M100/M200 Logic Controller allows the following types of file management with an micro SD card:

- Clone management, page 140: back up the application, firmware, and post configuration (if it exists) of the logic controller
- Firmware management, page 142: download firmware updates directly to the logic controller or to TM3R expansion modules
- Application management, page 145: back up and restore the logic controller application, or copy it to another logic controller of the same reference
- Post configuration management, page 148: add, change, or delete the post configuration file of the logic controller
- Error log management, page 153: back up or delete the error log file of the logic controller
- Memory management, page 157: backup/restore of memory bits and words from a controller

Embedded Communication Features

The following types of communication ports are available depending on the controller reference:

- Ethernet (see Modicon M100/M200 Logic Controller, Hardware Guide)
- USB Mini-B (see Modicon M100/M200 Logic Controller, Hardware Guide)
- Serial Line 1 (see Modicon M100/M200 Logic Controller, Hardware Guide)

M100 Logic Controller References

Reference	Digital inputs	Digital outputs	Communication ports	Power supply
TM100C16R	1 regular input[(1)] 4 fast inputs (FC)[(2)] 4 high-speed inputs (HSC)[(3)]	7 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM100C24R	6 regular inputs[(1)] 4 fast inputs (FC)[(2)] 4 high-speed inputs (HSC)[(3)]	10 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM100C40R	16 regular inputs[(1)] 4 fast inputs (FC)[(2)] 4 high-speed inputs (HSC)[(3)]	16 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM100C16RN	3 regular inputs[(1)] 4 fast inputs (FC)[(2)] 2 high-speed inputs (HSC)[(4)]	7 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM100C24RN	8 regular inputs[(1)] 4 fast inputs (FC)[(2)] 2 high-speed inputs (HSC)[(4)]	10 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM100C32RN	14 regular inputs[(1)] 4 fast inputs (FC)[(2)] 2 high-speed inputs (HSC)[(4)]	12 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM100C40RN	18 regular input[(1)] 4 fast inputs (FC)[(2)] 2 high-speed inputs (HSC)[(4)]	16 relay outputs	1 serial line port 1 USB programming port	100...240 Vac

(1) The regular inputs have a maximum frequency of 5 kHz.

(2) The fast inputs have a maximum frequency of 5 kHz. They can be used either as regular inputs or as fast inputs for counting or event functions.

(3) The high-speed inputs have a maximum frequency of 100 kHz.

(4) The high-speed inputs have a maximum frequency of 60 kHz.

M200 Logic Controller References

Reference	Digital inputs	Digital outputs	Communication ports	Power supply
TM200C16R	1 regular input[1] 4 fast inputs (FC)[2] 4 high-speed inputs (HSC)[3]	7 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM200C16T		Source outputs 5 regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)[4]	1 serial line port 1 USB programming port	24 Vdc
TM200C16U		Sink outputs 5 regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)[4]	1 serial line port 1 USB programming port	24 Vdc
TM200C24R	6 regular inputs[1] 4 fast inputs (FC)[2] 4 high-speed inputs (HSC)[3]	10 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM200CE24R			1 serial line port 1 USB programming port 1 Ethernet port	
TM200C24T		Source outputs 8 regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)[4]	1 serial line port 1 USB programming port	24 Vdc
TM200CE24T			1 serial line port 1 USB programming port 1 Ethernet port	
TM200C24U		Sink outputs 8 regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)[4]	1 serial line port 1 USB programming port	24 Vdc
TM200CE24U			1 serial line port 1 USB programming port 1 Ethernet port	
TM200C32R	12 regular inputs[1] 4 fast inputs (FC)[2] 4 high-speed inputs (HSC)[3]	12 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM200CE32R			1 serial line port 1 USB programming port 1 Ethernet port	

Reference	Digital inputs	Digital outputs	Communication ports	Power supply
TM200C32T	12 regular inputs (1) 4 fast inputs (FC) (2) 4 high-speed inputs (HSC)(3)	Source outputs 10regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)(4)	1 serial line port 1 USB programming port	24 Vdc
TM200C32U		Sink outputs 10 regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)(4)		
TM200C40R	16 regular inputs (1) 4 fast inputs (FC) (2) 4 high-speed inputs (HSC)(3)	16 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM200CE40R			1 serial line port 1 USB programming port 1 Ethernet port	
TM200C40T		Source outputs 14 regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)(4)	1 serial line port 1 USB programming port	24 Vdc
TM200CE40T			1 serial line port 1 USB programming port 1 Ethernet port	
TM200C40U		Sink outputs 14 regular transistor outputs 2 fast outputs (PWM / PLS / PTO / FREQGEN)(4)	1 serial line port 1 USB programming port	24 Vdc
TM200CE40U			1 serial line port 1 USB programming port 1 Ethernet port	
TM200C60R	28 regular inputs (1) 4 fast inputs (FC) (2) 4 high-speed inputs (HSC)(3)	24 relay outputs	1 serial line port 1 USB programming port	100...240 Vac
TM200CE60R			1 serial line port 1 USB programming port 1 Ethernet port	

(1) The regular inputs have a maximum frequency of 5 kHz.

(2) The fast inputs have a maximum frequency of 5 kHz. They can be used either as regular inputs or as fast inputs for counting or event functions.

(3) The high-speed inputs have a maximum frequency of 100 kHz.

(4) The fast transistor outputs can be used either as regular transistor outputs, or for PLS/PWM/PTO/FREQGEN functions.

Configuration Features

What's in This Chapter

Introduction

This chapter provides information related to M100/M200 Logic Controller memory mapping, task, states, behaviors, objects, and functions. The topics explained in this chapter allow the operator to understand the featured specifications of M100/ M200 Logic Controller that are primarily needed to configure and program the controller in EcoStruxure Machine Expert-Basic.

Objects

Overview of Objects

Definition

In EcoStruxure Machine Expert-Basic, the term *object* is used to represent an area of logic controller memory reserved for use by an application. Objects can be:

- Simple software variables, such as memory bits and words
- Addresses of digital and analog inputs and outputs
- Controller-internal variables, such as system words and system bits
- Predefined system functions or function blocks, such as timers and counters.

Controller memory is either pre-allocated for certain object types, or automatically allocated when an application is downloaded to the logic controller.

Objects can only be addressed by a program once memory has been allocated. Objects are addressed using the prefix %. For example, *%MW12* is the address of a memory word, *%Q0.3* is the address of an embedded digital output, and *%TM0* is the address of a *Timer* function block.

Object Types

Introduction

The language object types for the M100/M200 Logic Controller are described in the following table:

Object Type	Object	Object Function	Description
Memory objects	*%M*	Memory bits (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores memory bit.
	%MW	Memory words (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores 16-bit memory word.

Object Type	Object	Object Function	Description
	%MD	Memory double words (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores 32-bit memory word.
	%MF	Memory floating point (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores memory floating point in a mathematical argument which has a decimal in its expression.
	%KW	Constant words (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores 16-bit constant word.
	%KD	Constant double words (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores 32-bit constant word.
	%KF	Constant floating points (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores constant floating point in a mathematical argument which has a decimal in its expression.
System objects	*%S*	System bits, page 322	Stores system bit.
	%SW	System words, page 327	Stores system word.
	%IWS	Input channel status word, page 342	Contains diagnostic information concerning analog input channels.
	%QWS	Output channel status word, page 343	Contains diagnostic information concerning analog output channels.
I/O objects	*%I*	Input bits, page 164	Stores value of the digital input.
	%Q	Output bits, page 165	Stores value of the digital output.
	%IW	Analog input words, page 166	Stores value of the analog input.
	%QW	Analog output words, page 167	Stores value of the analog output.
	%FC	Fast counters, page 169	Serves as either up-counter or down-counter and counts the rising edge of discrete inputs in single word or double word computational mode.
	%HSC	High speed counters, page 172	Counts of discrete input in single word or double word computational mode.
	%PLS	Pulse, page 185	Generates a square wave pulse signal on dedicated output channels.
	%PWM	Pulse width modulation, page 210	Generates a modulated wave signal on dedicated output channels with a variable duty cycle.
	%PTO	Pulse train output, page 223	Generates a pulse train output to control a linear single-axis stepper or servo drive in open loop mode.
	%FREQGEN	Frequency Generator, page 291	Generates a square wave signal on a dedicated output channel with programmable frequency and duty cycle of 50%.
Network objects	*%QWM*	Input registers (Modbus TCP), page 215	The values of Modbus mapping table Input registers sent by the logic controller.
	%IWM	Output registers (Modbus TCP), page 216	The values of Modbus mapping table Output registers received by the logic controller.
	%IN	Digital inputs (IOScanner), page 217	The values of Modbus Serial or TCP IOScanner digital input bits.
	%QN	Digital outputs (IOScanner), page 218	The values of Modbus Serial or TCP IOScanner digital output bits.
	%IWN	Input registers (IOScanner), page 219	The values of Modbus Serial or TCP IOScanner digital input words.
	%QWN	Output registers (IOScanner), page 220	The values of Modbus Serial or TCP IOScanner digital output words.
	%IWNS	IOScanner network diagnostic codes, page 221	The values of Modbus Serial or TCP IOScanner network diagnostic bits.

Object Type	Object	Object Function	Description
Software objects	*%TM*	Timers (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Specifies a time before triggering an action.
	%C	Counters (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Provides up and down counting of actions.
	%MSG	Messages (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores the status message at the communication port.
	%R	LIFO/FIFO registers (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Stores memory up to 16 words of16 bits each in 2 different ways, queue, and stacks.
	%DR	Drums (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Operates on a principle similar to an electromechanical drum controller which changes step according to external events.
	%SBR	Shift bit registers (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Provides a left or right shift of binary data bits (0 or 1).
	%SC	Step counters (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Provides a series of steps to which actions can be assigned.
	SCH	Schedule blocks (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	Controls actions at a predefined month, day, and time.
	%RTC	RTC	Allows reading or writing the value of the Real Time Clock (RTC) on the logic controller.
	PID	PID, page 294	Provides a generic control loop feedback in which output is proportional, integral, and derivative of the input.
	%X	Grafcet steps	Bit objects associated with individual Grafcet (SFC) steps. Object is set to 1 when the corresponding step is active, and set to 0 when the step is deactivated.
PTO objects	Refer to Pulse Train Output, page 223.		
Drive objects	Refer to Drive Objects, page 189.		
Communication objects	%READ_VAR	Read Var (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	The %READ_VAR function block is used to read data from a remote device on Modbus SL or Modbus TCP
	%WRITE_VAR	Write Var (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	The %WRITE_VAR function block is used to write data to an external device using the Modbus SL or Modbus TCP protocol
	%WRITE_READ_VAR	Write Read Var (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	The %WRITE_READ_VAR function block is used to read and write data stored in internal memory words to an external device using the Modbus SL or Modbus TCP protocol.
	%SEND_RECV_MSG	Send Receive Message (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)	The %SEND_RECV_MSG function block is used to send or receive data on a serial line configured for the ASCII protocol.
User-defined function and user-defined function block objects	*%RET0*	Return value	The return value of a user-defined function.
	%PARAM	Parameter	Parameters of a user-defined function or user-defined function block. The parameters are different for each object type.

Object Type	Object	Object Function	Description
	%VAR	Local variable	Local variables of a user-defined function or user-defined function block. The local variables are different for each object type.

Memory objects and software objects are generic objects used in EcoStruxure Machine Expert - Basic, whereas system objects and I/O objects are controller-specific. All controller-specific objects are discussed in the Programming, page 161 section.

For programming details of memory objects, software objects, and communication objects, refer to the EcoStruxure Machine Expert - Basic, Generic Functions Library Guide.

For programming details of PID, Drive, and PTO objects, refer to the Advanced Functions Library Guide.

For more information on user-defined functions and user-defined function blocks, refer to EcoStruxure Machine Expert - Basic Operating Guide (see EcoStruxure Machine Expert - Basic, Operating Guide).

Addressing Objects

Addressing Examples

This table presents addressing examples for various object types:

Object Type	Syntax	Example	Description
Memory objects			
Memory bits	`%M`*i*	`%M25`	Internal memory bit 25.
Memory words	`%MW`*i*	`%MW15`	Internal memory word 15.
Memory double words	`%MD`*i*	`%MD16`	Internal memory double word 16.
Memory floating points	`%MF`*i*	`%MF17`	Internal memory floating point 17.
Constant words	`%KW`*i*	`%KW26`	Constant word 26.
Constant double words	`%KD`*i*	`%KD27`	Internal constant double word 27.
Constant floating points	`%KF`*i*	`%KF28`	Internal constant floating point 28.
System objects			
System bits	`%S`*i*	`%S8`	System bit 8.
System words	`%SW`*i*	`%SW30`	System word 30.
I/O objects			
Digital inputs	`%I`*y.z*	`%I0.5`	Digital input 5 on the controller (embedded I/O).
Digital outputs	`%Q`*y.z*	`%Q3.4`	Digital output 4 on the expansion module at address 3 (expansion module I/O).
Analog inputs	`%IW0.`*y0z*	`%IW0.101`	Analog input 1 on the cartridge 1.
Analog outputs	`%QW0.`*m0n*	`%QW0.202`	Analog output 2 on the cartridge 2.
Fast counters	`%FC`*i*	`%FC2`	Fast counter 2 on the controller.
High speed counters	`%HSC`*i*	`%HSC1`	High speed counter 1 on the controller.
Pulse	`%PLS`*i*	`%PLS0`	Pulse output 0 on the controller.
Pulse width modulation	`%PWM`*i*	`%PWM1`	Pulse width modulation output 1 on the controller.
Pulse train output	`%PTO`*i*	`%PTO1`	Pulse train output 1 on the controller.
Frequency generator	`%FREQGEN`*i*	`%FREQGEN1`	Frequency generator 1 on the controller.

Object Type	Syntax	Example	Description
Network objects			
Input registers (Modbus TCP)	`%QWMi`	`%QWM1`	Input register instance 1.
Output registers (Modbus TCP)	`%IWMi`	`%IWM0`	Output register instance 0.
Digital inputs (IOScanner)	`%INa.b.c`	`%IN300.2.1`	Modbus TCP IOScanner slave device 0 on ETH1, channel 2, digital input 1.
Digital outputs (IOScanner)	`%QNa.b.c`	`%QN101.1.0`	Modbus Serial IOScanner slave device 1 on SL1, channel 1, digital output 0.
Input registers (IOScanner)	`%IWNa.b.c`	`%IWN302.3.0`	Modbus TCP IOScanner slave device 2 on ETH1, channel 3, input register 0.
Output registers (IOScanner)	`%QWNa.b.c`	`%QWN205.0.4`	Modbus Serial IOScanner slave device 5 on SL2, channel 0, output register 4.
IOScanner network diagnostic codes	`%IWNS`*a*	`%IWNS302`	Status of Modbus TCP IOScanner slave device 2 on ETH1.
	`%IWNS`*a.b*	`%IWNS205.3`	Status of channel 3 of Modbus Serial IOScanner slave device 5 on serial line SL2
Software objects			
Timers	`%TMi`	`%TM5`	Timer instance 5.
Counters	`%Ci`	`%C2`	Counter instance 2.
Message	`%MSGi`	`%MSG1`	Program compilation status message 1.
LIFO/FIFO registers	`%Ri`	`%R3`	FIFO/LIFO registers instance 3.
Drums	`%DRi`	`%DR6`	Drum register 6 on the controller.
Shift bit registers	`%SBRi`	`%SBR5`	Shift bit register 5 on the controller.
Step counters	`%SCi`	`%SC5`	Step counter 5 on the controller.
Schedule blocks	`SCH i`	`SCH 3`	Schedule block 3 on the controller.
RTC	`RTCi`	`RTC 1`	Real-time clock (RTC) instance 1.
PID	`PID i`	`PID 7`	PID feedback object 7 on the controller.
Grafcet Steps	`Xi`	`X1`	Grafcet step 1.
PTO objects			
MC_Power_PTO (motion function block)	`%MC_POWER_PTOi`	`%MC_POWER_PTO1`	*MC_POWER_PTO* function block instance 1. For more information on PTO function blocks, refer to *Pulse Train Output (%PTO)*, page 223.
MC_Reset_PTO (administrative function block)	`%MC_RESET_PTOi`	`%MC_RESET_PTO0`	*MC_RESET_PTO* function block instance 0. For more information on PTO function blocks, refer to *Pulse Train Output (%PTO)*, page 223.
Communication objects			
Read Var	`%READ_VARi`	`%READ_VAR2`	*READ_VAR* function block instance 2.
Write Var	`%WRITE_VARi`	`%WRITE_VAR4`	*WRITE_VAR* function block instance 4.
WriteRead Var	`%WRITE_READ_VARi`	`%WRITE_READ_VAR0`	*WRITE_READ_VAR* function block instance 0.
Send Receive Message	`%SEND_RECV_MSGi`	`%SEND_RECV_MSG6`	*SEND_RECV_MSG* function block instance 6.
User-defined function and function block objects			
Return value	`%RETi`	`%RET0`	Return value of a user-defined function.
Parameters	`%PARAMi`	`%PARAM0`	Parameter of a user-defined function.

Object Type	Syntax	Example	Description
Local variables	`%VAR`*`i`*	`%VAR0`	Local variables of a user-defined function.

a: 100 + device number on SL1, 200 + device number on SL2, 300 + device number on ETH1.

b: Channel number of the Modbus Serial IOScanner or Modbus TCP IOScanner device.

c: Object instance identifier in the channel.

i: Object instance identifier that indicates the instance of the object on the controller. For the maximum number of instances of each object, refer to *Maximum Number of Objects*, page 24. If n is the maximum number of an object, the instance range is 0...n-1.

m: Cartridge number on the controller.

n: Channel number on the cartridge.

y: Indicates the I/O type. It is 0 for the controller and 1, 2, and so on, for the expansion modules.

z: Channel number on the controller or expansion module.

Maximum Number of Objects

Description

This table provides information about the maximum number of objects supported by the M100/M200 Logic Controller:

Object Type	Object	Maximum Number Allowed
Memory objects	*%M*	1024
	%MW	• 4000 for TM100C••R and TM100C••RN • 8000 for TM200C•••
	%MD / %MF	• 3999 for TM100C••R and TM100C••RN • 7999 for TM200C•••
	%KW	512
	%KD / %KF	511
System objects	*%S*	160
	%SW	234
	%IWS	1 created automatically for each analog input
	%QWS	1 created automatically for each analog output
I/O objects	*%I*	• 9 for TM100C16R / TM100C16RN / TM200C16• • 14 for TM100C24R / TM100C24RN / TM200C•24• • 20 for TM100C32RN / TM200C•32R / TM200C32T / TM200C32U • 24 for TM100C40R / TM100C40RN / TM200C•40• • 36 for TM200C60R/TM200CE60R
	%Q	• 7 for TM100C16R / TM100C16RN / TM200C16• • 10 for TM100C24R / TM100C24RN / TM200C•24• • 12 for TM100C32RN / TM200C•32R / TM200C32T / TM200C32U • 16 for TM100C40R / TM100C40RN / TM200C•40• • 24 for TM200C60R/TM200CE60R
	%IW	**NOTE:** The M100/M200 Logic Controller has no embedded analog I/Os. Use cartridges or expansion modules to add analog I/Os to your configuration.
	%QW	
	%FC	4
	%HSC	4
	%PLS / %PWM / %PTO / %FREQGEN	• 0 for TM100C••R / TM100C••RN / TM200C••• • 2 for TM200C•••U / TM200C•••T
Network objects	*%QWM*	20

Object Type	Object	Maximum Number Allowed
	%IWM	20
	%IN	128
	%QN	128
	%IWN	128
	%QWN	128
	%IWNS	1 for each configured Modbus Serial IOScanner or Modbus TCP IOScanner device, plus 1 for each channel
	%QWNS	1 for each configured Modbus Serial IOScanner or Modbus TCP IOScanner device, plus 1 for each channel
Software objects	*%TM*	255
	%C	255
	%MSG	1
	%R	4
	%DR	8
	%SBR	8
	%SC	8
	%SCH	16
	%RTC	2
	PID	14
PTO objects	*%MC_MOTIONTASK_PTO*	2
	%MC_POWER_PTO	86
	%MC_MOVEVEL_PTO	86
	%MC_MOVEREL_PTO	86
	%MC_MOVEABS_PTO	86
	%MC_HOME_PTO	86
	%MC_READACTVEL_PTO	40
	%MC_READACTPOS_PTO	40
	%MC_READSTS_PTO	40
	%MC_READMOTIONSTATE_PTO	40
	%MC_READAXISERROR_PTO	40
	%MC_RESET_PTO	40
	%MC_TOUCHPROBE_PTO	40
	%MC_ABORTTRIGGER_PTO	40
	%MC_READPAR_PTO	40
	%MC_WRITEPAR_PTO	40
Drive objects	*%DRV*	16
Communication objects	*%READ_VAR*	32 (if functional level ≥ 10.1) or 16 (if functional level < 10.1)
	%WRITE_VAR	32 (if functional level ≥ 10.1) or 16 (if functional level < 10.1)
	%WRITE_READ_VAR	32 (if functional level ≥ 10.1) or 16 (if functional level < 10.1)
	%SEND_RCV_MSG	16
User-defined function block objects		
`%Q_`	32 (if functional level ≥ 10.0) or 8 (if functional level < 10.0).	
`%I_`	32 (if functional level ≥ 10.0) or 8 (if functional level < 10.0).	

Object Type	Object	Maximum Number Allowed
`%PARAM`	48 (including any existing `%VAR`)	
`%VAR`	48 (including any existing `%PARAM`)	

Task Structure

Tasks and Scan Modes

Overview

EcoStruxure Machine Expert-Basic has the following scan modes:

- **Normal mode**

  Continuous cyclic scanning mode (Freewheeling mode); a new scan starts immediately after the previous scan has completed.
- **Periodic mode**

  Periodic cyclic scanning mode; a new scan starts only after the configured scan time of the previous scan has elapsed. Every scan is therefore the same duration.

EcoStruxure Machine Expert-Basic offers the following task types:

- **Master task**: Main task of the application.

  Master task is triggered by continuous cyclic scanning (in normal scan mode) or by the software timers (in periodic scan mode) by specifying the scan period of 1...150 ms (default 10 ms).
- **Periodic task**: A short duration subroutine processed periodically.

  Periodic tasks are triggered by software timers, so are configured by specifying the scan period of 1...255 ms (default 255 ms) in the periodic scan mode.
- **Event task**: A very short duration subroutine to reduce the response time of the application.

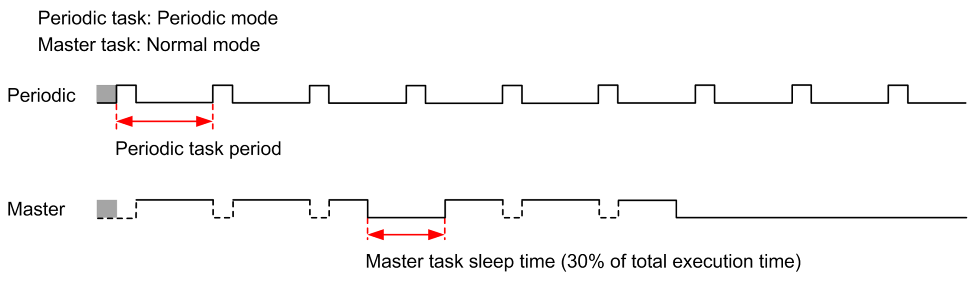
  Event tasks are triggered by the physical inputs or the *HSC* function blocks. These events are associated with embedded digital inputs (%I0.2...%I0.5) (rising, falling or both edges) or with the high speed counters (*%HSC0* and *%HSC1*) (when the count reaches the high speed counter threshold). You can configure 2 events for each HSC function block.

Periodic tasks and events are configured in periodic scan mode. Master task can be configured in either normal scan mode or periodic scan mode.

For more information, refer to the Configuring Program Behavior and Tasks (see EcoStruxure Machine Expert - Basic, Operating Guide).

Master Task in Normal Scan Mode

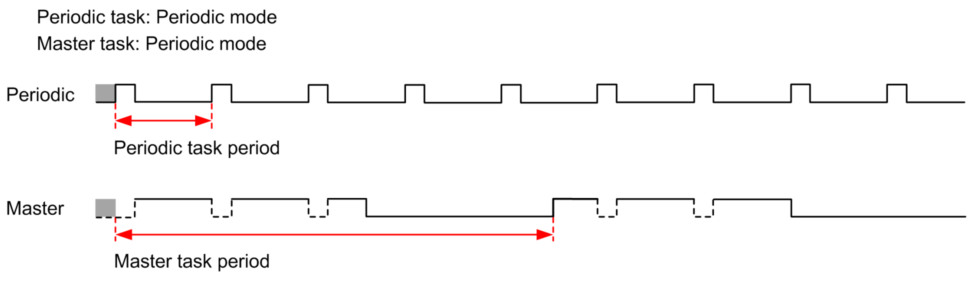
This graphic presents the relationship between master tasks and periodic task execution when the master task is configured in normal scan mode:


Periodic task: Periodic mode
Master task: Normal mode
Periodic
Periodic task period
Master
Master task sleep time (30% of total execution time)

Master Task in Periodic Scan Mode

In periodic mode, the logic controller waits until the configured scan time has elapsed before starting a new scan. Every scan is therefore the same duration.

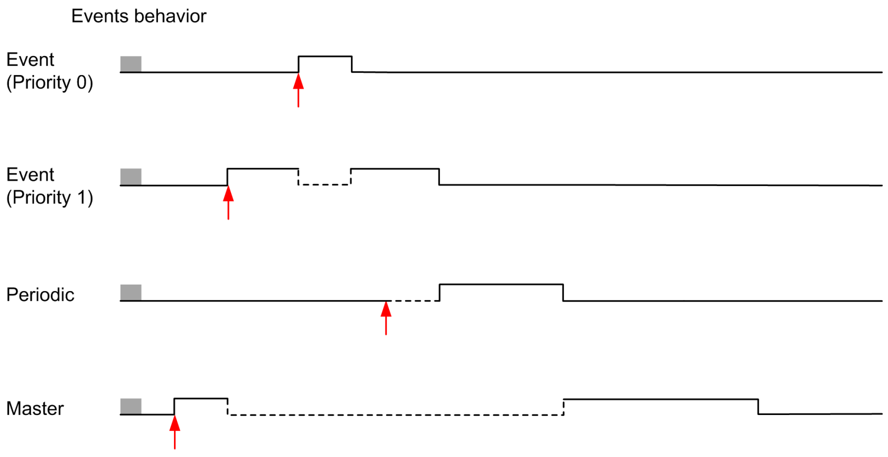
This graphic presents the relationship between master tasks and periodic tasks when the master task is configured in periodic scan mode:



Event Priority Over Master and Periodic Tasks

Event priorities control the relationship between the event tasks, master tasks, and periodic tasks. The event task interrupts the master task and periodic task execution.

This figure presents the relationship between event tasks, master tasks, and periodic tasks in the periodic mode:



The event tasks are triggered by a hardware interruption that sends a task event to the event task.

Watchdog Timer

You can configure a specific application watchdog timer for the master task and periodic task. If the task execution time exceeds the configured watchdog timer period, the logic controller goes to the *HALTED* state.

A system watchdog timer verifies whether the program is using more than 80% of the processing capacity. In this case, the logic controller goes to the *HALTED* state.

Maximum Number of Tasks and Priorities

Tasks Priorities

This table summarizes the task types and their priorities:

Task Type	Scan Mode	Triggering Condition	Configurable Range	Maximum Number of Tasks	Priority
Master	Normal	Normal	Not applicable	1	Lowest
	Periodic	Software timer	1...150 ms		
Periodic	Periodic	Software timer	1...255 ms	1	Higher than master task and lower than event tasks
Event	Periodic	Physical inputs	%I0.2...%I0.5	4	Highest
		%HSC function blocks	Up to two events per %HSC object	4	

Events Priorities

Refer to Event Priorities and Queues (see EcoStruxure Machine Expert - Basic, Operating Guide).

Controller States and Behaviors

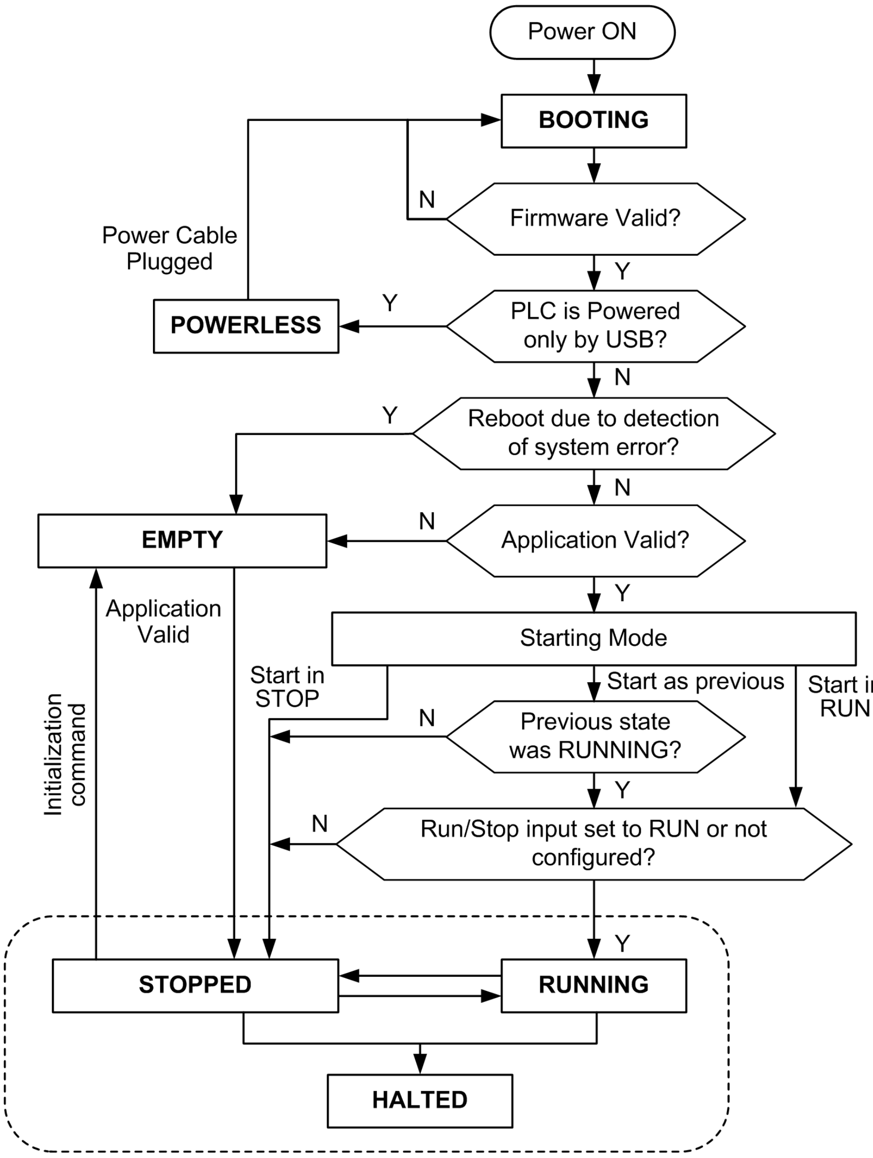
Introduction

This section provides you with information on controller states, state transitions, and behaviors in response to system events. It begins with a detailed controller state diagram and a description of each state. It then defines the relationship of output states to controller states before explaining the commands and events that result in state transitions. It concludes with information about persistent variables and the effect of EcoStruxure Machine Expert-Basic task programming options on the behavior of your system.

Controller States Diagram

Controller States Diagram

This figure describes the controller operating states:



Controller States Description

Introduction

This section provides a detailed description of the controller states.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Never assume that your controller is in a certain controller state before commanding a change of state, configuring your controller options, uploading a program, or modifying the physical configuration of the controller and its connected equipment.
- Before performing any of these operations, consider the effect on all connected equipment.
- Before acting on a controller, always positively confirm the controller state by viewing its LEDs, confirming the condition of the Run/Stop input, checking for the presence of output forcing, and reviewing the controller status information via EcoStruxure Machine Expert-Basic.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

When using the Start In Run feature, the controller will start executing program logic when power is applied to the equipment. It is essential to know in advance how automatic reactivation of the outputs will affect the process or machine being controlled. Configure the Run/Stop input to help control the Start In Run feature. In addition, the Run/Stop input is designed to give local control over remote RUN commands. If the possibility of a remote RUN command after the controller had been stopped locally by EcoStruxure Machine Expert-Basic would have unintended consequences, you must configure and wire the Run/Stop input to help control this situation.

⚠ WARNING

UNINTENDED MACHINE START-UP

- Confirm that the automatic reactivation of the outputs does not produce unintended consequences before using the Start In Run feature.
- Use the Run/Stop input to help control the Start In Run feature and to help prevent the unintentional start-up from a remote location.
- Verify the state of security of your machine or process environment before applying power to the Run/Stop input or before issuing a Run command from a remote location.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Controller States Table

This table provides detailed description of the controller operating states:

Controller state	Description	Communication	Application execution	LED		
				PWR	RUN	ERR
BOOTING	The logic controller does not have a valid firmware. The communication channels are enabled to allow updating of the runtime firmware. It is not possible to log in with EcoStruxure Machine Expert-Basic. Outputs are set to initialization values, page 35.	Restricted	No	On	Off	On
EMPTY	This state indicates that there is not a valid application. It is possible to log in with EcoStruxure Machine Expert-Basic (*download/ animation table*).	Yes	No	On	Off	1 flash

Controller state	Description	Communication	Application execution	LED		
				PWR	RUN	ERR
	Inputs are forced to 0. Outputs are set to initialization values, page 35.					
STOPPED	This state indicates that the logic controller has a valid application which is stopped. Inputs are read. Outputs are set to fallback values, page 37, or forced values, page 37 from EcoStruxure Machine Expert-Basic. Status alarm output is set to 0.	Yes	No	On	Flashing	Off
RUNNING	This state indicates that the logic controller is executing the application. Inputs are read by the application tasks. Outputs are written by the application tasks, or from EcoStruxure Machine Expert-Basic in online mode (animation table, output forcing, page 37). Status alarm output is set to 1.	Yes	Yes	On	On	Off
HALTED	This state indicates that the application is stopped because of an application or system watchdog timeout error has been detected., page 37 Objects retain their values, allowing analysis of the cause of the detected error. The tasks are stopped at the last instruction. The communication capabilities are the same as in *STOPPED* state. Inputs are not read, and keep their last values. Outputs are set to fallback values, page 37. Status alarm output is set to 0.	Yes	No	On	Flashing	On
POWERLESS	This state indicates that the logic controller is powered only by the USB cable. This mode can be used to update the firmware (by USB) or to download/ upload the user application (by USB). To change the state of the logic controller, connect the main power so that the logic controller boots and reloads the installed components. It is possible to log in with EcoStruxure Machine Expert-Basic (*download/ upload/animation table*). Inputs are forced to 0. Outputs are set to initialization values, page 35.	Yes (only USB)	No	On	Flashing	Off

NOTE: The system word %SW6 indicates the logic controller state (*EMPTY*, *STOPPED*, *RUNNING*, *HALTED*, and *POWERLESS*).

Controller State Transitions

Boot Controller

Effect: Command a reboot of the logic controller. For details about power-on sequence, refer to the controller state diagram, page 29.

Methods:

- Power cycle
- Reboot by script
  - The script on a micro SD card can issue a REBOOT as its last command.

Application Download

Effect: Download the application into the logic controller memory.

Methods:

- EcoStruxure Machine Expert-Basic online button:
  - Select the **PC to controller (download)** command.

    Effect: Erase the application in the logic controller and set the logic controller in *EMPTY* state. Download the application in the logic controller memory. If download is successful, a Cold Start is done and the logic controller is set in *STOPPED* state.
- Application file transfer by SD card:
  - Effect: At the next reboot, erase the application in the logic controller and download the application files from the micro SD card to the logic controller memory. If download is successful, a Cold Start is done and the logic controller is set in *STOPPED* state.

Initialize Controller

Effect: Set the controller in *EMPTY* state, and then, after a Cold Start, in *STOPPED* state.

Methods:

- EcoStruxure Machine Expert-Basic online button:
  - Select the **Initialize controller** command.

RUN Controller

Effect: Command a transition to the *RUNNING* state.

Methods:

- Run/Stop (see Modicon M100/M200 Logic Controller, Hardware Guide) switch on front face:
  - It commands a transition to *RUNNING* state on rising edge.
- Run/Stop (see Modicon M100/M200 Logic Controller, Hardware Guide) input:
  - The input must be configured in the application (Configuring Digital Inputs, page 51).
  - It commands a transition to *RUNNING* state on rising edge.
- EcoStruxure Machine Expert-Basic online button:
  - Select the **Run Controller** command.
- Application starting mode (see EcoStruxure Machine Expert - Basic, Operating Guide) setting:
  - **Start in Run** or **Start in Previous State**.

STOP Controller

Effect: Command a transition to the *STOPPED* state.

Methods:

- Run/Stop (see Modicon M100/M200 Logic Controller, Hardware Guide) switch on front face:
  - It forces a transition to *STOPPED* state on low level.
- Run/Stop (see Modicon M100/M200 Logic Controller, Hardware Guide) input:
  - The input must be configured in the application (Configuring Digital Inputs, page 51).
  - It forces a transition to *STOPPED* state on low level.
- EcoStruxure Machine Expert-Basic online button:
  - Select the **Stop Controller** command.
- Application starting mode (see EcoStruxure Machine Expert - Basic, Operating Guide) setting:
  - **Start in Stop** or **Start in Previous State**.
- **Download** command:
  - It needs the controller to be set in *STOPPED* state (after the download the controller is in *STOPPED* state).

Error Detected (Transition to *HALTED* State)

Effect: Command a transition to the *HALTED* state.

Reasons for switching to HALTED state:

- Application Watchdog timeout (configured by the user)
- System Watchdog timeout (system overrun, over 80% of the CPU processing capacity is used)

Cold Start

Cold Start is defined to be a power-up with all data initialized to its default values, and program started from the beginning with program variables cleared. Software and hardware settings are initialized.

Cold Start occurs for the following reasons:

- Boot controller without validated application online modification.
- Download application
- Initialize logic controller

Effects of the Cold Start:

- Initialize the function blocks.
- Clear the user memory.
- Put the system bits `%S` and system words `%SW` to their initial values.
- Reload parameters from post configuration (changes in the post configuration are applied).
- Restore application from flash memory (unsaved online changes are lost).
- Restart the internal components of the controller.

Persistent Variables

Automatic Save on Power Outage

The TM100C••R and TM200C••• controllers automatically save the first 3000 memory words (`%MW0` to `%MW2999`) in the internal flash memory following any interruption of power.

The TM100C••RN controllers automatically save the first 2000 memory words (`%MW0` to `%MW1999`) in the internal flash memory following any interruption of power.

The data is restored to the memory word region during the initialization, even if the controller performs a cold start due to missing or depleted battery.

These *automatically saved* persistent variables are reinitialized in case of a new download, INIT command, or `%S0` activation. Refer to System Bits, page 322.

Save by User Request

You can save memory words in the non-volatile memory or in the SD card. To perform the save operation:

1. Select the destination with `%S90` (refer to System Bits, page 322):
   - Set to 0: non-volatile memory (default)
   - Set to 1: SD card
2. Set the number of memory words to be saved in the system word %SW148 (refer to System Words, page 327).
3. Set the system bit %S93 to 1 (refer to System Bits, page 322).

When the save operation is finished:

- The system bit `%S93` is reset to 0.
- The system bit `%S92` is set to 1, indicating that memory words have been successfully saved in non-volatile memory (`%S90` set to 0).
- The system word `%SW147` indicates the SD card operation result (`%S90` set to 1).

Restore by User Request

You can restore the previously saved memory words. To perform the restore operation:

1. Set the system bit `%S92` to 1.

   The non-volatile memory operation has no effect if `%S92` is 0 (no values were previously saved).
2. Select the source with `%S90` (refer to System Bits, page 322):
   - Set to 0: non-volatile memory (default)
   - Set to 1: SD card
3. To restore from the non-volatile memory, set the number of memory words in the system word %SW148 (refer to System Words, page 327). When restoring from SD card, the complete `Memory Variables.csv` file is processed.
4. Set the system bit %S94 to 1 (refer to System Bits, page 322).

NOTE: When the restore operation is finished:

- The system bit `%S94` is reset to 0 by the system.
- The system word `%SW148` is updated with the number of objects restored (for example if you specify 100 words to restore and only 50 had previously been saved, the value of `%SW148` will be 50).
- The system word `%SW147` indicates the SD card operation result (`%S90` set to 1).

Delete by User Request

You can delete the previously saved memory words on the non-volatile memory.

To perform the delete operation:

1. Set the system bit `%S91` to 1 (refer to System Bits, page 322).
2. When the delete operation is finished, the system bits `%S91` and `%S92` and the system word `%SW148` are reset to 0 by the logic controller.

   NOTE: It is not possible to delete only selected variables; the entire set of saved variables is deleted (meaning `%SW148` has no impact on the erase operation, the erase operation is carried out regardless of the value of `%SW148`).

Output Behavior

Introduction

The controller defines output behavior in response to commands and system events in a way that allows for greater flexibility. An understanding of this behavior is necessary before discussing the commands and events that affect controller states.

The possible output behaviors and the controller states to which they apply are:

- Managed by application program
- Initialization values
- Fallback behavior (see EcoStruxure Machine Expert - Basic, Operating Guide)
  - Maintain values
  - Fallback values
- Output forcing

Managed by Application

Your application manages outputs normally. This applies in the *RUNNING* state.

Hardware Initialization Values

This output state applies in the *BOOTING*, *EMPTY* and *POWERLESS* states.

In the initialization state, the outputs assume the following values:

- For embedded outputs:
  - Fast source transistor output: 0 Vdc
  - Fast sink transistor output: 0 Vdc
  - Relay output: Open

- For expansion module outputs:
  - Regular source transistor output: 0 Vdc
  - Regular sink transistor output: 24 Vdc
  - Relay output: Open

Software Initialization Values

This output state applies when downloading or when resetting the application. It applies at the end of the download or at the end of a cold start.

Input objects (*%I* and *%IW*), network objects (*%QWM*), and Modbus Serial IOScanner input objects (*%IN* and *%IWN*) are set to 0. Output objects (*%Q* and *%QW*), network objects (*%IWM*), and Modbus Serial IOScanner output objects (*%QN* and *%QWN*) are set according to the selected fallback behavior.

Fallback Management

The objective of the fallback behavior is to control the outputs when the controller leaves the *RUNNING* state.

Fallback values are applied on the transition from *RUNNING* to *STOPPED* or *HALTED* states, except for special cases described below.

Fallback Behavior Configuration

Fallback behavior is configured on the **Programming** tab, **Tasks** → **Behavior** window:

- When **Fallback values** is selected, on a fallback occurrence, output values take the values configured in **Fallback value**.
- When **Maintain values** is selected, outputs keep their values on a fallback occurrence, except for outputs configured in pulse generator (PWM, PLS, PTO, FREQGEN) or reflex functions.

Fallback Execution

On a fallback occurrence:

- If **Fallback values** is selected, the output values take the values configured in **Fallback value**.
- If **Maintain values** is selected, the outputs keep their values.

Special cases:

- Alarm output, PTO, and FREQGEN: The fallback is never applied. Their fallback values are forced to 0.
- PLS, PWM) and reflex outputs:
  - If **Fallback values** is selected, the outputs take the values configured in **Fallback value**.
  - If **Maintain values** is selected, the outputs are set to 0.

  NOTE:

  - After a download, the outputs are set to their fallback values.
  - In *EMPTY* state, the outputs are set to 0.
  - As the data image reflects the physical values, fallback values are also applied to the data image. However, using system bit *%S9* to apply fallback values does not modify the values of the data image.

Fallback Values

This output state applies in the *STOPPED* and *HALTED* states.

During fallback, the outputs assume the following values:

- For embedded outputs:
  - Fast transistor output: according to fallback setting
  - Regular transistor output: according to fallback setting
  - Relay output: according to fallback setting
  - Expert I/O functions (HSC, PLS, PWM, PTO and FREQGEN):

    - Source output: 0 Vdc

    - Sink output: 0 Vdc
- For expansion module outputs:
  - Regular transistor output: according to fallback setting
  - Relay output: according to fallback setting

  NOTE: An exception to the application of fallback values is the case of an I/O expansion bus error. For more information, refer to the Embedded Input/ Output Configuration, page 51 chapter.

Output Forcing

The controller allows you to force the state of selected outputs to a defined value for the purposes of system testing, commissioning, and maintenance.

You can force the value of an output while your controller is connected to EcoStruxure Machine Expert-Basic.

To do so, either use the **Force** command in an animation table, or force the value using the F0 or F1 buttons in the Ladder editor.

Output forcing overrides all other commands to an output irrespective of the task logic that is being executed.

The forcing is not released by any online change nor logout of EcoStruxure Machine Expert-Basic.

The forcing is automatically released by Cold Start, page 33 and Application Download, page 32 command.

The forcing does not apply for expert I/O functions (HSC, PLS, PWM, PTO, and FREQGEN).

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- You must have a thorough understanding of how forcing will affect the outputs relative to the tasks being executed.
- Do not attempt to force I/O that is contained in tasks that you are not certain will be executed in a timely manner, unless your intent is for the forcing to take affect at the next execution of the task whenever that may be.
- If you force an output and there is no apparent affect on the physical output, do not exit EcoStruxure Machine Expert-Basic without removing the forcing.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Output Rearming

In the case of a short-circuit or current overload, the common group of outputs automatically enters into thermal protection mode (all outputs in the group are set to 0), and are then periodically rearmed (each second) to test the connection state. However, you must be aware of the effect of this rearming on the machine or process being controlled.

NOTE: The output rearming does not apply to sink outputs.

⚠WARNING

UNINTENDED MACHINE START-UP

Inhibit the automatic rearming of outputs if this feature is an undesirable behavior for your machine or process.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTE: Only the short-circuit between an output set to *TRUE* and 0 is detected. The short-circuit between an output set to *FALSE* and 24 V is not detected.

If necessary, you can use system bits and words to both detect that a short circuit or overload has occurred and on which cluster of outputs it has occurred. System bit *%S10* can be used to detect within your program that an output error has occurred. You can then use the system word *%SW139* to determine programmatically in which cluster of outputs a short circuit or overload has occurred.

The automatic rearming feature can be disabled by setting the system bit *% S49* to 0 (*%S49* is set to 0 by default).

Post Configuration

Introduction

This section describes how to manage and configure the post configuration file of the Modicon M100/M200 Logic Controller.

Post Configuration

Introduction

Post configuration is an option that allows you to modify some parameters of the application without changing the application. Post configuration parameters are defined in a file called **Machine.cfg**, which is stored in the controller.

By default, all communication parameters are set in the configuration of the application. However, under certain conditions, some or all of these parameters can be modified automatically using the post configuration mechanism. One or more communication parameters can be specified in the post configuration file, and those parameters can override the parameters specified by the configuration. For example, one parameter may be stored in the post configuration file to change the EtherNet/IP address of the controller while leaving the other Ethernet parameters, such as the gateway address, unchanged.

Parameters

The post configuration file allows you to modify network parameters.

Ethernet parameters:

- Address configuration mode

- IP address
- Subnet mask
- Gateway address
- Device name

Serial line parameters, for each serial line in the application (embedded port or TMCR2SL1/TMCR2SL1A cartridge):

- Physical medium
- Baud rate
- Parity
- Data bits
- Stop bit
- Modbus address
- Polarization (for RS-485)

Operating Mode

The post configuration file is read and applied:

- after a Cold Start, page 33
- after a reboot, page 32
- after an application download, page 32
- after an Ethernet reconfiguration caused by an Ethernet cable reconnection (exclusively for the Ethernet part of the post configuration file, page 32)

For further details on controller states and transitions, refer to Controller States and Behaviors, page 28.

Post Configuration File Management

Introduction

The post configuration file can be stored, transferred, modified, or deleted with an SD card.

NOTE: A post configuration file example is available in the directory `Firmwares & PostConfiguration\PostConfiguration\add_change\usr\cfg` of the EcoStruxure Machine Expert-Basic installation directory.

Post Configuration File Format

A valid configuration must use the following format:

- The character '#' means beginning of comment, everything after this sign until the end of the line is ignored. Comments are not saved in the post configuration area of the M100/M200 Logic Controller.
- Rule is `channel.parameter=value` (no space around the '=' sign).
- `Channel` and `parameter` are case-sensitive.
- Allowed channel, parameter, and values are in the following table.

Channel	Parameter	Description	Value
ETH	IPMODE	Address configuration mode	0 = Fixed 1 = BOOTP 2 = DHCP
	IP	IP address	Dotted decimal string

Channel	Parameter	Description	Value
	MASK	Subnet mask	Dotted decimal string
	GATEWAY	Gateway address	Dotted decimal string
	NETWORKNAME	Device name on the network	ASCII string (maximum 16 characters)
SL1 SL2	HW	Physical medium	0 = RS-232 (only TMCR2SL1 support) 1 = RS-485
	BAUDS	Data transmission rate	1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200
	PARITY	Parity for error detection	0 = None 1 = Odd 2 = Even
	DATAFORMAT	Data format	7 or 8
	STOPBIT	Stop bit	1 or 2
	MODBUSADDR	Modbus address	1...247
	POLARIZATION	Polarization	0 = No 1 = Yes

NOTE: When using a post configuration file for Ethernet configuration, it is not mandatory to specify all the parameters:

- If the controller is configured (by the user application) in DHCP or BOOTP mode, the network parameters IP (IP address), MASK (subnet mask) and GATEWAY (gateway address) are not configured in the file.
- If a parameter is not configured in the post configuration file, the controller uses the value configured in the user application, page 111.
- If the controller is configured in DHCP or BOOTP mode by the user application and if fixed IP mode (IPMODE=0) is configured in the post configuration file, configure the network parameters (IP (IP address), MASK (subnet mask) and GATEWAY (gateway address)) as they are not configured by the user application. Otherwise, the controller starts with the default Ethernet configuration.

Post Configuration File Transfer

After creating and modifying your post configuration file, it must be transferred to the logic controller. The transfer is performed by using a script to copy the post configuration file to a micro SD card.

Refer to Adding or Changing a Post Configuration, page 148.

Modifying a Post Configuration File

Use a text editor to modify the post configuration file on the PC.

NOTE: Do not change the text file encoding. The default encoding is ANSI.

NOTE: The Ethernet parameters of the post configuration file can be modified with EcoStruxure Machine Expert-Basic. For more information, refer to Connecting to a Logic Controller (see EcoStruxure Machine Expert - Basic, Operating Guide).

Deleting the Post Configuration File

Refer to Removing a Post Configuration File, page 150.

NOTE: The parameters defined in the application will be used instead of the corresponding parameters defined in the post configuration file.

Configuring the M100/M200 Logic Controller

What’s in This Part

Overview

This part provides information about how to configure the M100/M200 Logic Controller references.

How to Configure a Controller

What's in This Chapter

Overview

This chapter describes how to build a configuration in EcoStruxure Machine Expert-Basic and configure the M100/M200 Logic Controller.

Building a Configuration

Introduction

Configure a controller by building a configuration in EcoStruxure Machine Expert-Basic. To build a configuration, first create a new project or open an existing project.

Refer to *EcoStruxure Machine Expert-Basic Operating Guide* for information on how to:

- Create or open an existing project
- Replace the default logic controller
- Add an expansion module to the logic controller
- Add a cartridge to the logic controller
- Save the project.

Some general information about the EcoStruxure Machine Expert-Basic user interface is provided below.

Start Page

The start page window is always displayed when you launch EcoStruxure Machine Expert-Basic. Use this window to register the EcoStruxure Machine Expert-Basic software, manage the connection to the logic controller, and create or select a project to work with.

EcoStruxure Machine Expert-Basic Window

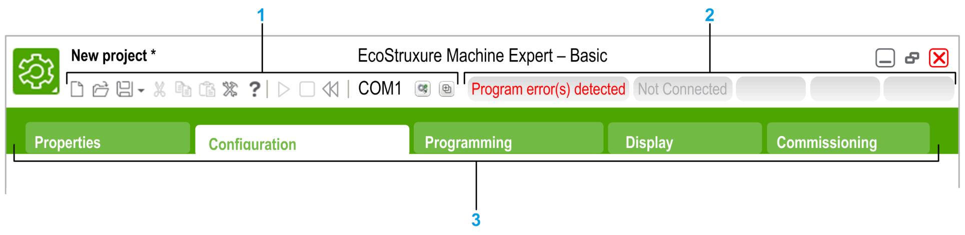
Once you have selected a project to work with, EcoStruxure Machine Expert-Basic displays the main window.

At the top of the main window, a toolbar (see EcoStruxure Machine Expert - Basic, Operating Guide) contains icons that allow you to perform common tasks, including returning to the start page window.

Next to the toolbar, the status bar (see EcoStruxure Machine Expert - Basic, Operating Guide) displays informational messages about the state of the connection to the logic controller.

Below the toolbar and the status bar, the main window is divided into a number of *modules*. Each module controls a different stage of the development cycle, and is accessible by clicking the module tab.

This figure presents the toolbar, status bar, and the module tabs in the main window:



1	Toolbar
2	Status bar
3	Tabs

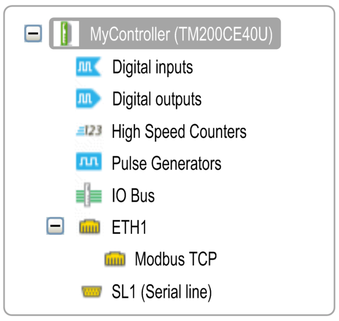
Item	Description
Toolbar	Provides easy access to commonly used functions. For more information, refer to the Toolbar (see EcoStruxure Machine Expert - Basic, Operating Guide).
Status bar	Displays status and information messages on the system status. For more information, refer to the Status bar (see EcoStruxure Machine Expert - Basic, Operating Guide).
Tabs	To develop an application, work your way through the tabs from left to right: • **Properties** Set up the project properties. • **Configuration** Replicate and configure the hardware configuration of the logic controller and associated expansion modules. • **Programming** Develop the program in one of the supported programming languages. • **Commissioning** Manage the connection between EcoStruxure Machine Expert-Basic and the logic controller, upload/download applications, test, and commission the application.

Hardware Tree

The hardware tree is displayed on left-hand side in the **Configuration** window. It presents a structured view of the hardware configuration. When you add a controller, an expansion module, or a cartridge to the project, several nodes are automatically added to the hardware tree.

NOTE: The nodes in the hardware tree are specific to the controller and the hardware configuration. These nodes depend on the I/O functions that the controller, expansion modules, and cartridges provide.

This figure presents the hardware tree of the controller configuration:



Item	Description
Digital inputs	Use to configure the embedded digital inputs of the logic controller.
Digital outputs	Use to configure the embedded digital outputs of the logic controller.
High Speed Counters	Use to configure the embedded high speed counting functions (HSC).
Pulse Generators	Use to configure the embedded pulse generator functions (PLS/PWM/PTO/FREQGEN).
IO Bus	Use to configure the expansion modules and cartridges connected to the logic controller.
ETH1	Use to configure the embedded Ethernet communications.
Modbus TCP	Use to configure the Modbus TCP protocol for Ethernet communications.
SLn **(Serial line)**	Use to configure the embedded serial line or the serial line added using a cartridge. **NOTE:** All M100/M200 references can support only one serial line cartridge.
n Serial line number (1 or 2, controller-specific).	

Editor

The editor area is displayed in center of the **Configuration** window. It displays the graphical representation of hardware configuration of the devices. The hardware configuration in a project can be:

- Only a controller
- A controller with cartridge(s)
- A controller with expansion modules
- A controller with cartridge(s) and expansion modules.

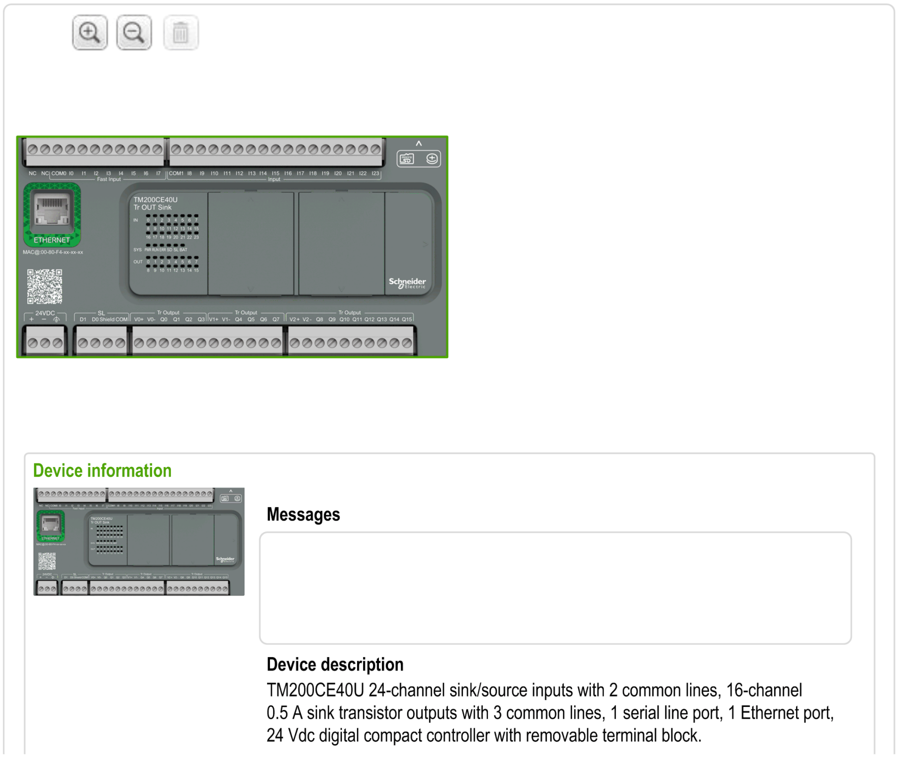
The editor area displays:

- A short description about the device when you click the device image or when you click the device node in the hardware tree.
- Configuration properties of the item selected in the hardware tree.

If you add an expansion module to the configuration, the expansion module appears at the right-hand side of the controller or the previously added expansion module. Cartridges are added on the controller in the cartridge slot.

When configuring a controller, a cartridge, or an expansion module, the configuration properties of the node selected in the hardware tree are displayed below the graphical configuration. These properties allow you to configure the device.

This figure presents the configuration of a controller with an expansion module (the controller is selected):



Device information

Messages

Device description

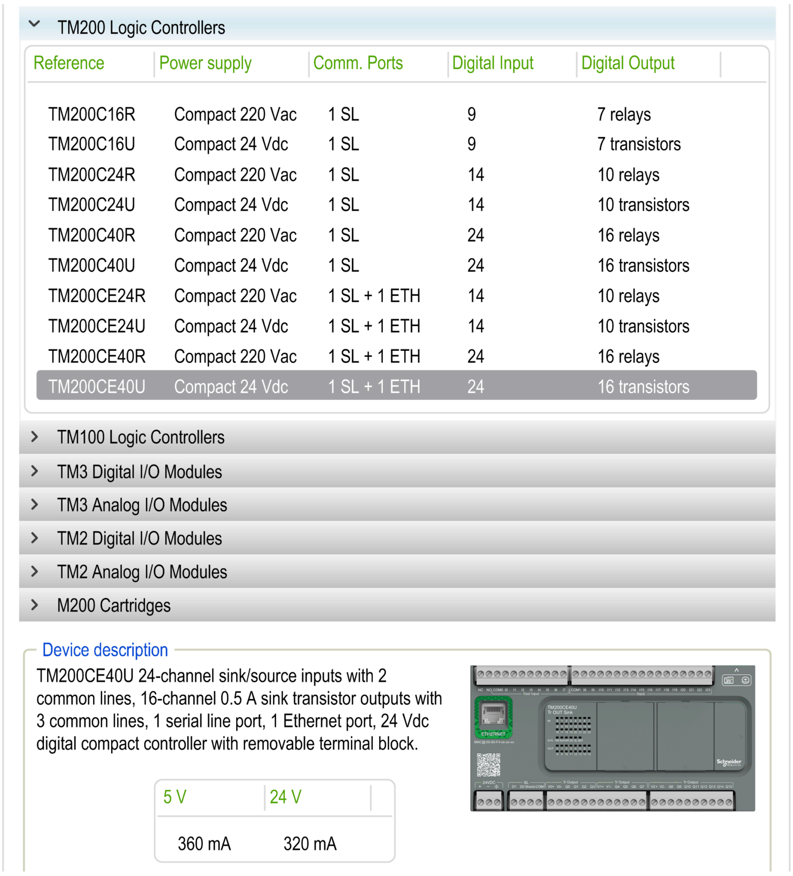
TM200CE40U 24-channel sink/source inputs with 2 common lines, 16-channel 0.5 A sink transistor outputs with 3 common lines, 1 serial line port, 1 Ethernet port, 24 Vdc digital compact controller with removable terminal block.

Catalog

The catalog area is displayed on right-hand side in the **Configuration** window. It displays the complete range of the logic controllers, expansion modules, and cartridges that can be configured using EcoStruxure Machine Expert-Basic. It also provides a short description of the selected device.

You can drag-and-drop the objects from the catalog area to the editor area. You can also replace the existing controller by a different controller with simple drag-and-drop from the catalog.

This figure presents the catalog of the logic controllers and the expansion modules:



TM200 Logic Controllers

Reference	Power supply	Comm. Ports	Digital Input	Digital Output
TM200C16R	Compact 220 Vac	1 SL	9	7 relays
TM200C16U	Compact 24 Vdc	1 SL	9	7 transistors
TM200C24R	Compact 220 Vac	1 SL	14	10 relays
TM200C24U	Compact 24 Vdc	1 SL	14	10 transistors
TM200C40R	Compact 220 Vac	1 SL	24	16 relays
TM200C40U	Compact 24 Vdc	1 SL	24	16 transistors
TM200CE24R	Compact 220 Vac	1 SL + 1 ETH	14	10 relays
TM200CE24U	Compact 24 Vdc	1 SL + 1 ETH	14	10 transistors
TM200CE40R	Compact 220 Vac	1 SL + 1 ETH	24	16 relays
TM200CE40U	Compact 24 Vdc	1 SL + 1 ETH	24	16 transistors

TM100 Logic Controllers

TM3 Digital I/O Modules

TM3 Analog I/O Modules

TM2 Digital I/O Modules

TM2 Analog I/O Modules

M200 Cartridges

Device description

TM200CE40U 24-channel sink/source inputs with 2 common lines, 16-channel 0.5 A sink transistor outputs with 3 common lines, 1 serial line port, 1 Ethernet port, 24 Vdc digital compact controller with removable terminal block.

5 V	24 V
360 mA	320 mA

Optional I/O Expansion Modules

Presentation

I/O expansion modules can be marked as optional in the configuration. The **Optional module** feature provides a more flexible configuration by the acceptance of the definition of modules that are not physically attached to the controller. Therefore, a single application can support multiple physical configurations of I/O expansion modules, allowing a greater degree of scalability without the necessity of maintaining multiple application files for the same application.

Without the **Optional module** feature, when the controller starts up the I/O expansion bus (following a power cycle, application download or initialization command), it compares the configuration defined in the application with the physical I/O modules attached to the I/O bus. Among other diagnostics made, if the controller determines that there are I/O modules defined in the configuration that are not physically present on the I/O bus, an error is detected and the I/O bus does not start.

With the **Optional module** feature, the controller ignores the absent I/O expansion modules that you have marked as optional, which then allows the controller to start the I/O expansion bus.

The controller starts the I/O expansion bus at configuration time (following a power cycle, application download, or initialization command) even if optional expansion modules are not physically connected to the controller.

The following module types can be marked as optional:

- TM3 I/O expansion modules
- TM2 I/O expansion modules

  NOTE: TM3 Transmitter/Receiver modules (the TM3XTRA1 and the TM3XREC1) and TMC4 cartridges cannot be marked as optional.

You must be fully aware of the implications and impacts of marking I/O modules as optional in your application, both when those modules are physically absent and present when running your machine or process. Be sure to include this feature in your risk analysis.

⚠WARNING

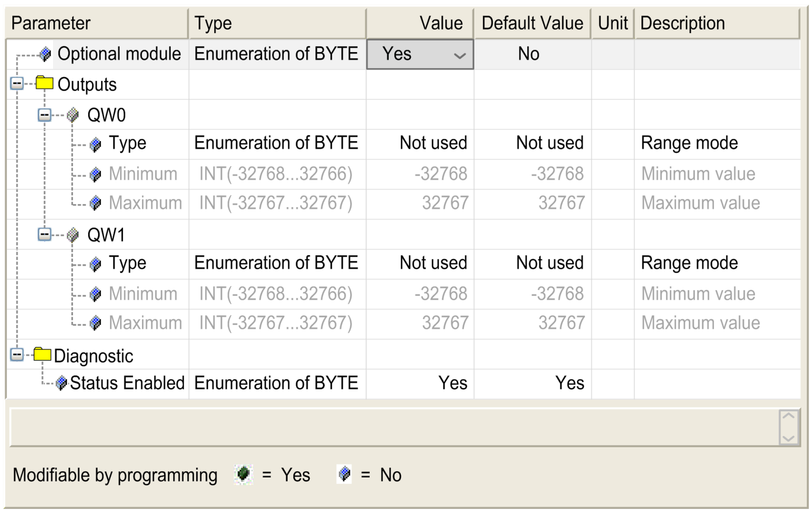
UNINTENDED EQUIPMENT OPERATION

Include in your risk analysis each of the variations of I/O configurations that can be realized marking I/O expansion modules as optional, and in particular the establishment of TM3 Safety modules (TM3S…) as optional I/O modules, and make a determination whether it is acceptable as it relates to your application.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Marking an I/O Expansion Module as Optional

To add an expansion module and mark it as optional in the configuration:

Step	Action
1	Add the expansion module to your controller.
2	In the **Devices tree**, double-click the expansion module.
3	Select the **I/O Configuration** tab.
4	In the **Optional module** line, select **Yes** in the **Value** column: 

Parameter	Type	Value	Default Value	Unit	Description
Optional module	Enumeration of BYTE	Yes	No		
Outputs					
QW0					
Type	Enumeration of BYTE	Not used	Not used		Range mode
Minimum	INT(-32768...32766)	-32768	-32768		Minimum value
Maximum	INT(-32767...32767)	32767	32767		Maximum value
QW1					
Type	Enumeration of BYTE	Not used	Not used		Range mode
Minimum	INT(-32768...32766)	-32768	-32768		Minimum value
Maximum	INT(-32767...32767)	32767	32767		Maximum value
Diagnostic					
Status Enabled	Enumeration of BYTE	Yes	Yes		

Modifiable by programming ● = Yes ● = No

Internal ID Codes

Controllers and bus couplers identify expansion modules by a simple internal ID code. This ID code is not specific to each reference, but identifies the logical structure of the expansion module. Therefore, different references can share the same ID code.

You cannot have two modules with the same internal ID code declared as optional without at least one mandatory module placed between them.

This table shows the internal ID codes of expansion modules:

Modules sharing the same internal ID code	**ID code**
TM2DDI16DT, TM2DDI16DK	0
TM2DRA16RT, TM2DDO16UK, TM2DDO16TK	1
TM2DDI8DT, TM2DAI8DT	4
TM2DRA8RT, TM2DDO8UT, TM2DDO8TT	5
TM2DDO32TK, TM2DDO32UK	3
TM2DMM24DRF, TM2DDI32DK	2
TM2DMM8DRT	6
TM2ALM3LT, TM2AMI2HT, TM2AMI2LT, TM2AMI4LT, TM2AMI8HT, TM2AMM3HT, TM2AMM6HT, TM2AMO1HT, TM2ARI8HT, TM2ARI8LRJ, TM2ARI8LT, TM2AVO2HT	96
TM3DI16K, TM3DI16, TM3DI16G	128
TM3DI8, TM3DI8G, TM3DI8A	132
TM3DQ16R, TM3DQ16RG, TM3DQ16T, TM3DQ16TG, TM3DQ16TK, TM3DQ16U, TM3DQ16UG, TM3DQ16UK	129
TM3DQ32TK, TM3DQ32UK	131
TM3DQ8R, TM3DQ8RG, TM3DQ8T, TM3DQ8TG, TM3DQ8U, TM3DQ8UG	133
TM3DM8R, TM3DM8RG	134
TM3DM16R	141
TM3DM24R, TM3DM24RG	135
TM3DM32R	143
TM3SAK6R, TM3SAK6RG	144
TM3SAF5R, TM3SAF5RG	145
TM3SAC5R, TM3SAC5RG	146
TM3SAFL5R, TM3SAFL5RG	147
TM3AI2H, TM3AI2HG	192
TM3AI4, TM3AI4G	193
TM3AI8, TM3AI8G, TM3AI8C, TM3AI8CG	194
TM3AQ2, TM3AQ2G	195
TM3AQ4, TM3AQ4G, TM3AQ4C, TM3AQ4CG	196
TM3AM6, TM3AM6G, TM3AM6C, TM3AM6CG	197
TM3TM3, TM3TM3G	198
TM3TI4, TM3TI4G	199
TM3TI4D, TM3TI4DG	203
TM3TI8T, TM3TI8TG	200
TM3DI32K	130
TM3XTYS4	136
TM3XFHSC202, TM3XFHSC202G	216
TM3XHSC202, TM3XHSC202G	217

Configuring the M100/M200 Logic Controller

Controller Configuration

Controller configuration depends on the number and type of embedded input/outputs, I/O objects, and communication ports.

Use the **Configuration** tab to configure the properties of your controller and the expansion modules. Select a node in the hardware tree to configure the properties of the controller.

This table shows the available configurations of the M100/M200 Logic Controller:

Reference	Digital inputs	Digital Outputs	High Speed Counters	Pulse Generators	Ethernet	Serial Line
TM100C••R TM100C••RN TM200C••R	X	X	X	–	–	X
TM200C••U	X	X	X	X	–	X
TM200CE••R	X	X	X	–	X	X
TM200CE••U	X	X	X	X	X	X
TM200C••T	X	X	X	X	–	X
TM200CE••T	X	X	X	X	X	X

–	Not available for configuration in EcoStruxure Machine Expert-Basic.
X	Available for configuration in EcoStruxure Machine Expert-Basic. For information on how to configure: • Digital inputs, refer to Configuring Digital Inputs, page 51 • Digital outputs, refer to Configuring Digital Outputs, page 53 • High speed counters, refer to Configuring High Speed Counters, page 61 • Pulse generators, refer to Configuring Pulse Generators, page 55 • Ethernet, refer to Configuring Ethernet, page 111 • Serial line, refer to Configuring Serial Line, page 124.

Updating Firmware Using Executive Loader Wizard

Overview

You can update the firmware of the controller using the Executive Loader Wizard.

Refer to *Controller States and Behavior*, page 28 for information concerning the state of the firmware in your controller.

Updating the Firmware of the Controller

To launch the Exec Loader Wizard, follow these steps:

Step	Action
1	Close all Windows applications, including virtual machines.
2	Click **Start > Programs > Schneider Electric > EcoStruxure Machine Expert-Basic > EcoStruxure Machine Expert-Basic Firmware Update** or run the *ExecLoaderWizard.exe* from the *EcoStruxure Machine Expert-Basic installation folder\Execloader* folder.
3	Follow the steps on the wizard to complete the firmware update.

Embedded Input/Output Configuration

What's in This Chapter

Overview

This chapter describes how to configure the embedded I/O objects of the M100/ M200 Logic Controller.

The number of embedded inputs and outputs depends on the controller reference. For more information, refer to the table of M100/M200 Logic Controller references (see Modicon M100/M200 Logic Controller, Hardware Guide).

Configuring Digital Inputs

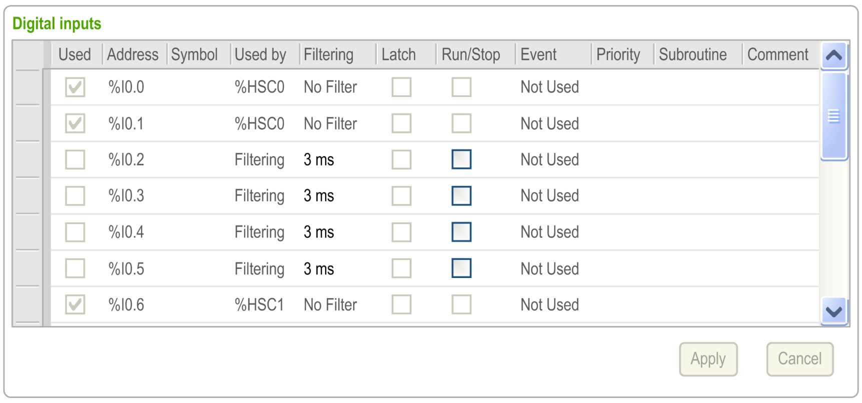
Configuring Digital Inputs

Introduction

By default, all digital inputs are used as regular inputs. Some of the digital inputs are fast and can be used by configuring the high speed counters, page 61 while other inputs can be configured as event sources.

Digital Inputs Configuration

This table describes how to configure the digital inputs:

Step	Action
1	Click the **Digital inputs** node in the hardware tree to display the digital input properties. This figure shows the properties of the digital inputs in the editor area: 

Digital inputs

Used	Address	Symbol	Used by	Filtering	Latch	Run/Stop	Event	Priority	Subroutine	Comment
✓	%I0.0		%HSC0	No Filter	☐	☐	Not Used			
✓	%I0.1		%HSC0	No Filter	☐	☐	Not Used			
☐	%I0.2		Filtering	3 ms	☐	☐	Not Used			
☐	%I0.3		Filtering	3 ms	☐	☐	Not Used			
☐	%I0.4		Filtering	3 ms	☐	☐	Not Used			
☐	%I0.5		Filtering	3 ms	☐	☐	Not Used			
✓	%I0.6		%HSC1	No Filter	☐	☐	Not Used			

Step	Action
2	Edit the properties to configure the digital inputs. For detailed information on the digital input configuration parameters, refer to the table below.

This table describes each parameter of the digital input configuration:

Parameter	Editable	Value	Default value	Description
Used	No	True/False	False	Indicates whether the input channel is being used in a program or not.
Address	No	%I0.x	–	Displays the address of the digital input on the controller, where x represents the channel number. If the controller has 8 digital input channels, x varies from 0...7. If the controller has 16 digital input channels, x varies from 0...15. For example, *%I0.2* is the third digital input channel of the logic controller.
Symbol	Yes	–	–	Allows you to associate a symbol with the digital input object. Double-click in the **Symbol** column, type the name of the symbol, and press Enter.
Used by	No	*Any*	**Filtering**	Displays the name of the component that uses the input channel. For example, if the input channel is used by a subroutine, this field displays **User logic**. The possible values in this field are: • **User logic** • **Filtering** • **Latch** • **Run/Stop** • **Event** • **%HSCx** where x is the high speed counter instance on the controller • **%FC**y where y is the fast counter instance on the controller If an input is being used by more than one operation, all values, separated by commas, are displayed in this field.
Filtering	Yes	**No Filter** **3 ms** **12 ms**	**3 ms**	Allows you to select the noise filter duration for the input channel. Using a filter for the digital inputs reduces the noise on the controller input. If you select filter for an input, you cannot configure that input for: • **Latch** • **Event**
Latch	Yes	True/False	False	Allows you to enable or disable latching for the inputs configured as events (*%I0.2*...*%I0.5*). By default, this option is disabled due to default value of **Filtering**. Set the **Filtering** to **No Filter** to enable the **Latch** option. Latching enables pulses with a duration shorter than the controller scan time to be memorized. When a pulse duration is shorter than a scan time and has a value greater than or equal to 1 ms, the controller latches the pulse, which is then updated in the next scan. If you enable **Latch** for an input, you cannot configure that input for: • **Filtering** • **Run/Stop** • **Event**
Run/Stop	Yes	True/False	False	Allows you to configure 1 digital input as an additional Run/Stop switch. If you configure a digital input as Run/Stop switch, you cannot use the input in any other function block (for example, high speed counter function block, fast counter function block, and so on). If you enable **Run/Stop** for an input, you cannot configure that input for: • **Latch** • **Event**
Event	Yes	**Not Used** **Falling Edge**	**Not Used**	Allows you to select an event that triggers the inputs *%I0.2*...*%I0.5*. By default, this option is disabled due to the default value of **Filtering**. Set **Filtering** to **No Filter** to enable the **Event** option.

Parameter	Editable	Value	Default value	Description
		Rising Edge **Both edges**		When you select an event from the drop-down list (other than **Not Used**): • The **Priority** parameter is enabled to allow you to set the priority of the event. • An event task is created and displayed in the **Configuration** tab.
Priority	Yes	0...7	7	Allows you to set the priority of the triggering event for the inputs *%I0.2...%I0.5*. You can set the priority of each event using the **Priority** parameter that is editable only for the inputs configured as event. Assign each configured event a different priority: if 2 events have same priority, a detected error message appears in the window.
Subroutine	No	–	–	Displays the number of the subroutine associated with an input configured as an event.
Comment	Yes	–	–	Allows you to associate a comment with the digital input object. Double-click in the **Comment** column, type an optional comment, and press Enter.

Additional configuration details are displayed in the **Programming** tab. For more information, refer to Digital Inputs (%I), page 164.

Configuring Digital Outputs

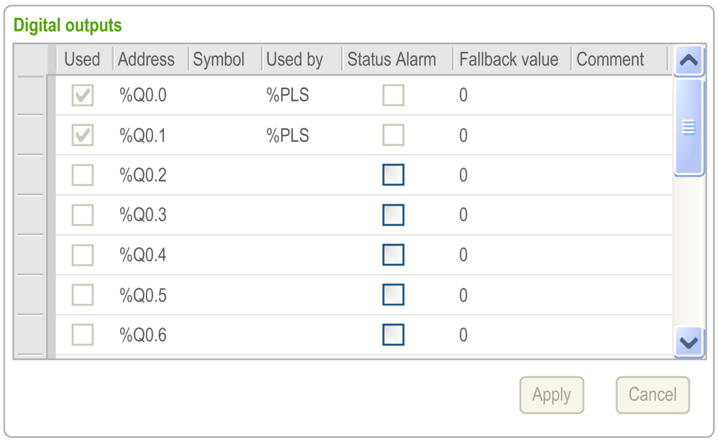
Configuring Digital Outputs

Introduction

By default, all digital outputs are used as regular outputs. For controllers equipped with transistor outputs, two outputs are fast transistor outputs and can be used by configuring the pulse generators, page 55.

Digital Outputs Configuration

This table describes how to configure the digital outputs:

Step	Action
1	Click the **Digital outputs** node in the hardware tree to display the digital output properties. This figure shows the properties of the digital outputs in the editor area: 
2	Edit the properties to configure the digital outputs. For detailed information on the digital output configuration parameters, refer to the table below.

Digital outputs

Used	Address	Symbol	Used by	Status Alarm	Fallback value	Comment
✓	%Q0.0		%PLS	☐	0	
✓	%Q0.1		%PLS	☐	0	
☐	%Q0.2			☐	0	
☐	%Q0.3			☐	0	
☐	%Q0.4			☐	0	
☐	%Q0.5			☐	0	
☐	%Q0.6			☐	0	

This table describes each parameter of the digital output configuration:

Parameter	Editable	Value	Default value	Description
Used	No	True/False	False	Indicates whether the output channel is being used in a program or not.
Address	No	%Q0.x	–	Displays the address of the digital output on the controller, where x represents the channel number. If the controller has 8 digital output channels, x varies from 0...7. If the controller has 16 digital output channels, x varies from 0...15. If the controller has 24 digital output channels, x varies from 0...23. For example, *%Q0.2* is the third digital output channel on the controller.
Symbol	Yes	–	–	Allows you to associate a symbol with the digital output object. Double-click in the **Symbol** column, type the name of the symbol, and press Enter.
Used by	No	*Any*	*Empty*	Displays the name of the component that uses the output channel. For example, if the output channel is used as status alarm, it displays **Alarm**.
Status Alarm	Yes	True/False	False	Allows you to enable or disable the status alarm for the output (*%Q0.0*...*%Q0.7*). You can configure only one output channel for the status alarm. You cannot configure an output as status alarm if the output is used in a program. The value of the status alarm is 1 when the controller is in the *RUNNING* state, and 0 in all other states.

Parameter	Editable	Value	Default value	Description
Fallback value	Yes	1 or 0	0	Specifies the value to apply to this output (fallback to 0 or fallback to 1) when the logic controller enters the *STOPPED* or an exception state. The default value is 0. If **Maintain values** fallback mode is configured, the output retains its current value when the logic controller enters the *STOPPED* or an exception state. This field is disabled for the output configured as **Status Alarm**.
Comment	Yes	–	–	Allows you to associate a comment with the digital output object. Double-click in the **Comment** column, type an optional comment, and press Enter.

Additional configuration details are displayed in the **Programming** tab. For more information, refer to Digital Outputs (%Q), page 165.

Configuring Pulse Generators

Configuring Pulse Generators

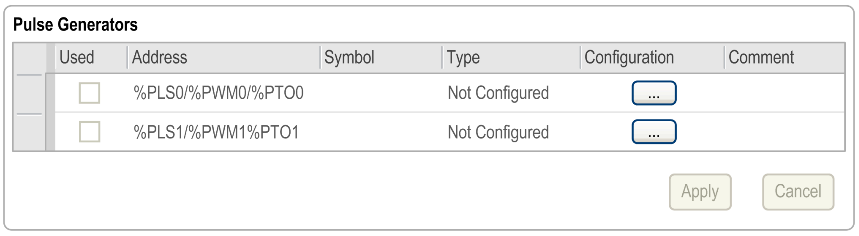
Introduction

The pulse generator function blocks, *Pulse (PLS)*, *Pulse Width Modulation (PWM)*, *Pulse Train Output (PTO)* and *Frequency Generator (FREQGEN)* are used to generate square or modulated wave signals on dedicated output channels *%Q0.0* or *%Q0.1*.

The PWM outputs feature a modulated wave signal with a variable width and duty cycle while the PTO outputs generate a square wave to control a linear single-axis stepper or servo drive in open loop mode. The PLS also creates a square wave for a programmed number of pulses.

Pulse Generators Configuration

This table describes how to configure the pulse generators:

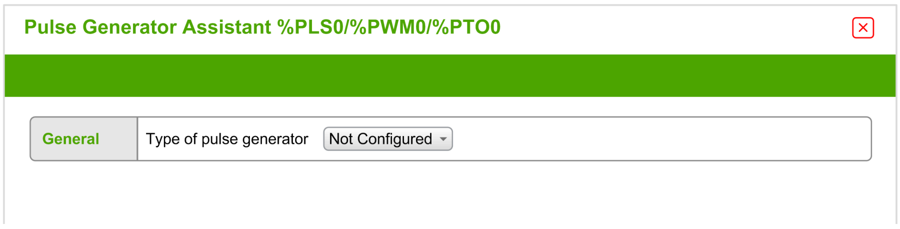
Step	Action
1	Click the **Pulse Generators** node in the hardware tree to display the pulse generator properties. This figure presents the properties of the pulse generators in the editor area:  Pulse Generators Used | Address | Symbol | Type | Configuration | Comment ☐ | %PLS0/%PWM0/%PTO0 | | Not Configured | ... | ☐ | %PLS1/%PWM1%PTO1 | | Not Configured | ... | Apply Cancel
2	Edit the properties to configure the pulse generator output. For detailed information on the pulse generator configuration parameters, refer to the table below.

This table describes each parameter of the pulse generator configuration:

Parameter	Editable	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the pulse generated output is being used in a program or not.
Address	No	%PLSx %PWMx %PTOx %FREQGENx	%PLSx/%PWMx/%PTO/%FREQGENx	Displays the address of the *Pulse* output, *Pulse Width Modulation* output, *Pulse Train Output*, or *Frequency Generator* where x is the output number. If the controller has 2 pulse generators, then the value for x is 0 and 1. For example, `%PLS0` is the address of the first pulse output on the controller. If you select the output type **PLS**, the **Address** field displays only %PLSx and if you select **PWM**, it displays only %PWMx.
Symbol	Yes	–	–	Allows you to specify a symbol to associate with the pulse generator object. Double-click in the **Symbol** column, type the name of the symbol and press **Enter**. **NOTE:** This field is enabled only if the pulse generator is configured.
Type	No	**Not Configured** **PLS** **PWM** **PTO** **FREQGEN**	**Not Configured**	Displays the type of the pulse generator used for the output channel.
Configuration	Yes	**[...]** (Button)	Enabled	Allows you to choose the type of pulse generator. Click this button to open the **Pulse Generator Assistant** window, page 56 for configuration, where x is the pulse generator number on the controller.
Comment	Yes	–	–	Allows you to specify a comment to associate with the pulse generator object. Double-click in the **Comment** column, type the comment and press **Enter**.

Pulse Generator Assistant Window

This graphic presents the **Pulse Generator Assistant** window:


Pulse Generator Assistant %PLS0/%PWM0/%PTO0

General

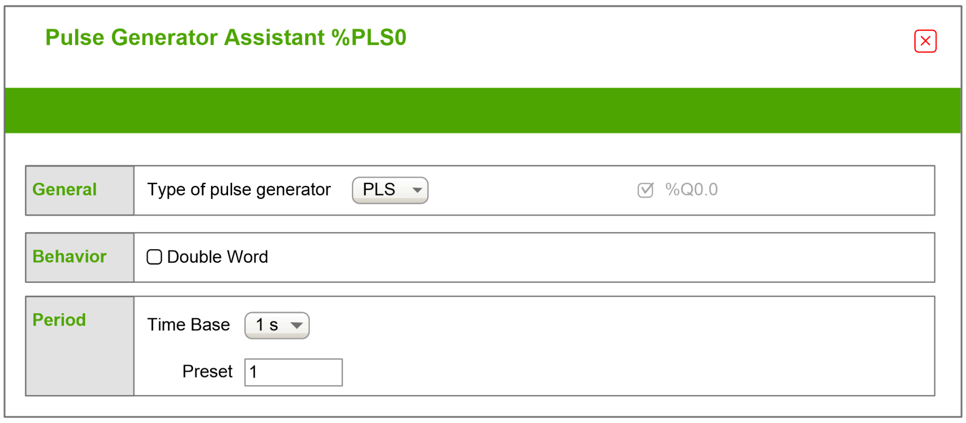
Type of pulse generator: Not Configured

This table describes the parameter of the **Pulse Generator Assistant** window:

Parameter	Editable	Value	Default Value	Description
General				
Type of pulse generator	Yes	**Not Configured** **PLS** **PWM** **PTO** **FREQGEN**	**Not Configured**	Allows you to choose the type of pulse generator and configure the output properties. Select: • **PLS** to configure the output channels in *PLS* mode. Refer to PLS Configuration, page 57. • **PWM** to configure the output channels in *PWM* mode. Refer to PWM Configuration, page 58. • **PTO** to configure the output channels in *PTO* mode. Refer to PTO Configuration, page 59. • **FREQGEN** to configure the output channels in *FREQGEN* mode. Refer to FREQGEN Configuration, page 61.

PLS Configuration

This graphic presents the **Pulse Generator Assistant** window when the **Type of pulse generator** is set to **PLS**:



Pulse Generator Assistant %PLS0

General	Type of pulse generator: PLS ✓ %Q0.0
Behavior	☐ Double Word
Period	Time Base: 1 s Preset: 1

The table describes each parameter available when the channel is configured in **PLS** mode:

Parameter	Editable	Value	Default Value	Description
Behavior				
Double Word	Yes	False	True/False	Allows you to toggle between the data size of Word (16 bits) and Double Word (32 bits). By default, this parameter is disabled, which indicates that the current data size is Word (16 bits). Enabling this field changes the data size to Double Word (32 bits).
Period				
Time Base	Yes	**0.1 ms** **1 ms** **10 ms** **1 s**	**1 s**	Allows you to select the time base for the frequency measurement.
Preset	Yes	Refer to the table below for complete range of preset values for *PLS* type pulse generator.	0	Allows you to specify the preset value for the pulse output.

This table presents the range of values of the **Preset** parameter:

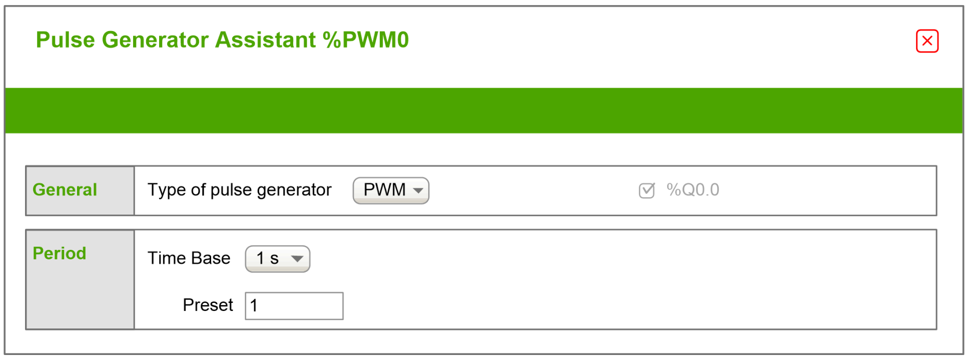
Type	Time Base	Preset Value Range
PLS	0.1 ms	1...20000
	1 ms	1...2000
	10 ms	1...200
	1 s	1 or 2

Additional configuration details are displayed in the **Programming** tab.

For more details on the *Pulse* function block, refer to Pulse (%PLS), page 185.

PWM Configuration

This graphic presents the **Pulse Generator Assistant** window when the **Type of pulse generator** is set to **PWM**:



Pulse Generator Assistant %PWM0

General: Type of pulse generator PWM ☑ %Q0.0

Period: Time Base 1 s, Preset 1

The table describes each parameter available when the channel is configured in **PWM** mode:

Parameter	Editable	Value	Default Value	Description
Period				
Time Base	Yes	**0.1 ms** **1 ms** **10 ms** **1 s**	**1 s**	Allows you to select the time base for the frequency measurement.
Preset	Yes	Refer to the table below for complete range of preset values for *PWM* type pulse generator.	0	Allows you to specify the preset value for the *PWM* output.

This table presents the range of values of the **Preset** parameter:

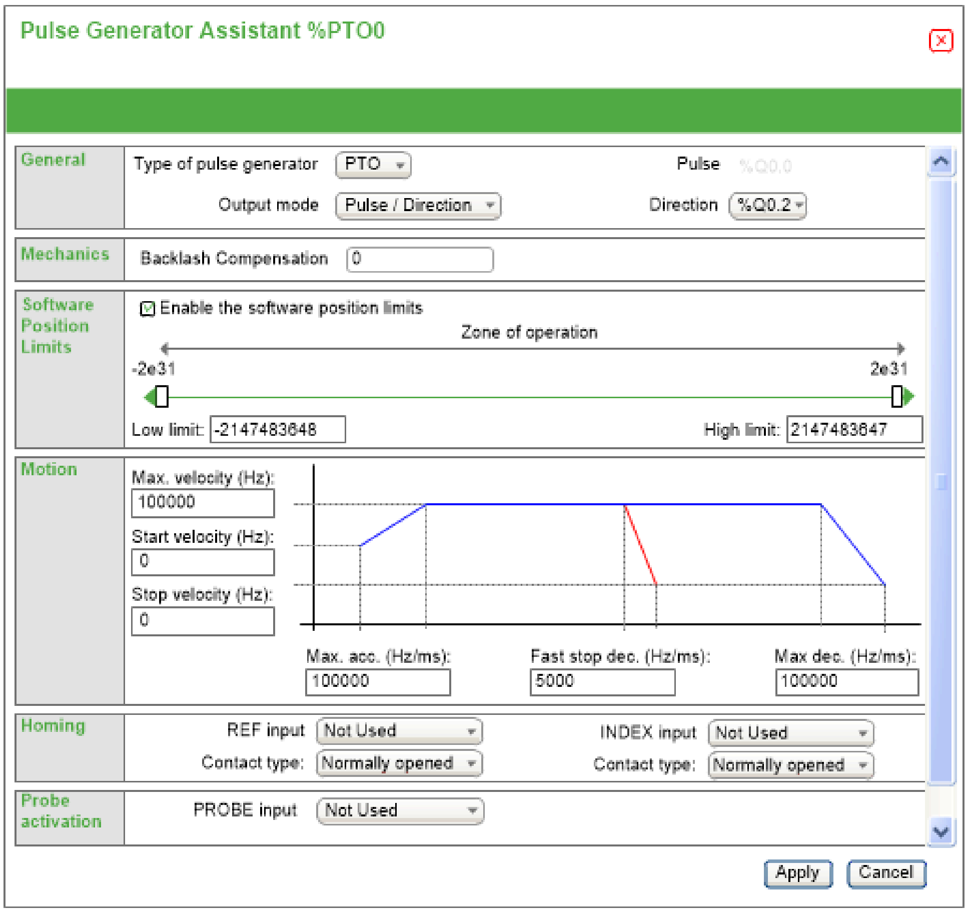
Type	Time Base	Preset Value Range
PWM	0.1 ms	1...10000
	1 ms	1...1000
	10 ms	1...100
	1 s	1

Additional configuration details are displayed in the **Programming** tab.

For more details on the *Pulse Width Modulation* function block, refer to Pulse Width Modulation (%PWM), page 210.

PTO Configuration

This graphic presents the **Pulse Generator Assistant** window when the **Type of pulse generator** is set to **PTO**:


Pulse Generator Assistant %PTO0

General
Type of pulse generator: PTO
Output mode: Pulse / Direction
Pulse: %Q0.0
Direction: %Q0.2

Mechanics
Backlash Compensation: 0

Software Position Limits
☑ Enable the software position limits
Zone of operation
-2e31 2e31
Low limit: -2147483648
High limit: 2147483647

Motion
Max. velocity (Hz): 100000
Start velocity (Hz): 0
Stop velocity (Hz): 0
Max. acc. (Hz/ms): 100000
Fast stop dec. (Hz/ms): 5000
Max dec. (Hz/ms): 100000

Homing
REF input: Not Used
Contact type: Normally opened
INDEX input: Not Used
Contact type: Normally opened

Probe activation
PROBE input: Not Used

The table describes each parameter available when the channel is configured in **PTO** mode:

Parameter	Value	Default	Description
General			
Output Mode, page 231	Clock Wise / Counter Clock Wise Pulse / Direction	Pulse / Direction	Select the pulse output mode. CW = ClockWise / CCW = CounterClockWise **NOTE:** The CW / CCW output mode is only valid for PTO0. This mode disables PTO1.
Pulse	%Q0.0 for PTO0, %Q0.1 for PTO1	%Q0.0 for PTO0, %Q0.1 for PTO1	When **Pulse / Direction** is selected in **Output mode**, select the output that provides the motor operating speed.
Direction	**Not used** %Q0.0...15 (depending on controller reference)	%Q0.2 for PTO0, %Q0.3 for PTO1	When **Pulse / Direction** is selected in **Output mode**, select the output that provides the motor rotation direction. Set to **Not used** (disabled) if directional output is not required for the application. **NOTE:** The application must be configured with a functional level of at least **Level 5.0** to enable the **Not used** option.
Clock Wise	%Q0.0	%Q0.0	When **Clock Wise / Counter Clock Wise** is selected in **Output mode**, select the output that provides the signal for forward motor operating speed and direction.

Parameter	Value	Default	Description
Counter Clock Wise	%Q0.1	%Q0.1	When **Clock Wise / Counter Clock Wise** is selected in **Output mode**, select the output that provides the signal for reverse motor operating speed and direction.
Mechanics			
Backlash Compensation	0...65535	0	Set backlash compensation value. The specified number of backlash compensation pulses are not added to the position counter. See Backlash Compensation, page 228.
Software Position Limits			
Enable the software position limits	Enabled Disabled	Enabled	Select whether to use the software position limits, page 230.
Low Limit	-2,147,483,648... 2,147,483,647	-2,147,483,6-48	Set the software limit position to be detected in the negative direction.
High Limit	-2,147,483,648... 2,147,483,647	2,147,483,6-47	Set the software limit position to be detected in the positive direction.
Motion			
Maximum Velocity	0...100,000	100,000	Set the pulse output maximum velocity (in Hz).
Start Velocity	0...100,000	0	Set the pulse output start velocity, page 225 (in Hz). 0 if not used.
Stop Velocity	0...100,000	0	Set the pulse output stop velocity, page 225 (in Hz). 0 if not used.
Maximum Acceleration	1...100,000	100,000	Set the acceleration maximum value (in Hz).
Fast Stop Deceleration	1...100,000	5,000	Set the deceleration value in case an error is detected (in Hz)
Maximum Deceleration	1...100,000	100,000	Set the deceleration maximum value (in Hz).
Homing			
Enable the REF input	Enabled Disabled	Disabled	Select whether to use the REF input to set the homing position.
Contact type	Normally opened Normally closed	Normally opened	Select whether the switch contact default state is open or closed. **NOTE:** The input type is only available when the “Enable the REF input” is selected.
Enable the INDEX input (% I0.x)	Enabled Disabled	Disabled	Select whether to use the INDEX input as a positive limit signal.
Contact type	Normally opened Normally closed	Normally opened	Select whether the switch contact default state is open or closed. **NOTE:** The input type is only available when the “Enable the INDEX input” is selected.
Probe activation			
Enable the PROBE input	Enabled Disabled	Disabled	Select whether to use the PROBE input. **NOTE:** Refer to Regular Input Characteristics for details on the physical characteristics of the selected input.

Additional configuration details are displayed in the **Programming** tab.

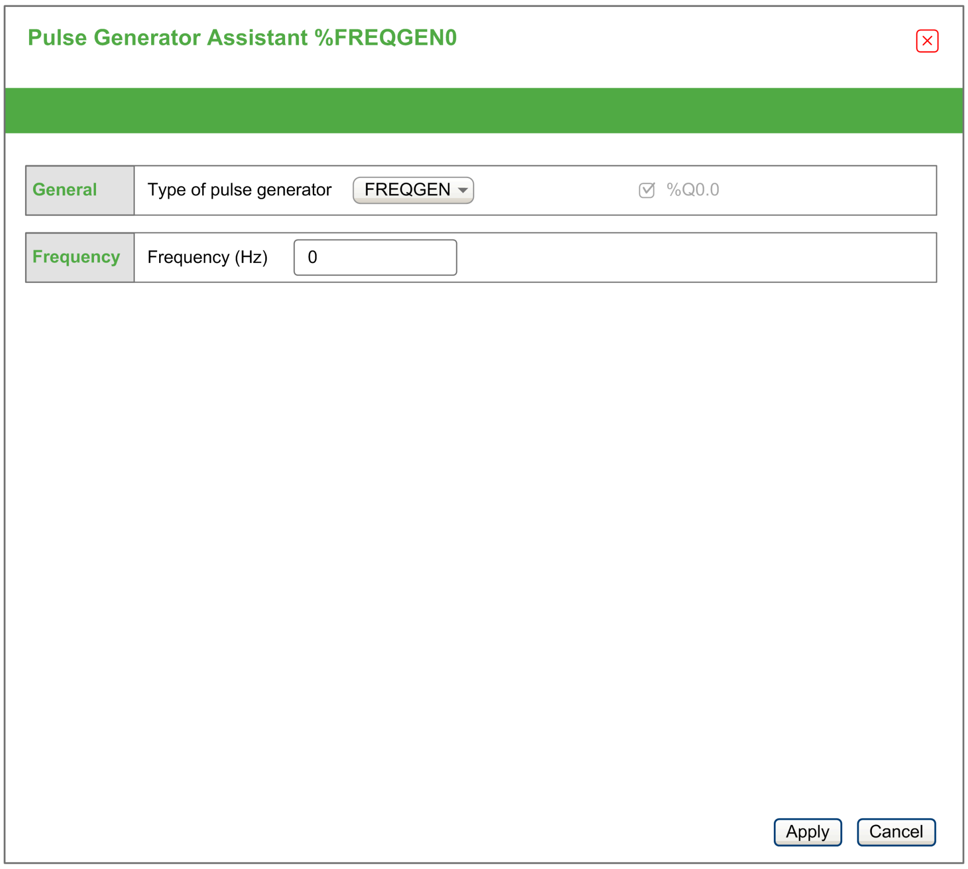
For more details on the *Pulse Train Output* function block, refer to Pulse Train Output (%PTO), page 223.

Configuring Frequency Generator

Configuring Frequency Generator (%FREQGEN)

Pulse Generator Assistant for FREQGEN

This graphic presents the **Pulse Generator Assistant** window when the **Type of pulse generator** is set to **FREQGEN**:


Pulse Generator Assistant %FREQGEN0

General — Type of pulse generator: FREQGEN — ☑ %Q0.0

Frequency — Frequency (Hz): 0

The Frequency Generator (FG) function generates a square wave signal with programmable frequency and duty cycle of 50%. The controller uses an internal clock generator and provides an output signal on a dedicated output channel (%Q0.0). This output signal can directly command a constant motion of the axis. The target frequency is always positive.

For more details on the *FREQGEN* function block, refer to the Frequency Generator (%FREQGEN chapter), page 291.

Configuring High Speed Counters

Configuring High Speed Counters

Introduction

You can configure high speed counters to perform any one of the following functions:

- Single phase
- Dual phase [Pulse / Direction]
- Dual phase [Clock Wise / Counter Clock Wise]
- Dual phase [Quadrature X1]
- Dual phase [Quadrature X2]
- Dual phase [Quadrature X4]
- Frequency meter

Several modes are available with **Single Phase** and **Dual Phase** HSC type counter:

- Single Phase
  - One Shot
  - Modulo Loop
  - Free Large
- Dual Phase
  - Modulo Loop
  - Free Large

In One Shot mode, each pulse applied to the input increments the current value. The counter stops when its current value reaches the maximum value. The overflow flag is then set. For more details, refer to One-shot Counting Mode, page 182.

In Modulo Loop mode, the counter repeatedly counts from 0 to a user-defined modulo value. It then returns to 0 and restarts counting. In reverse, the counter counts down from the modulo value to 0 then presets to the modulo value and restarts counting. For more details, refer to Modulo-Loop Counting Mode, page 183.

In Free Large mode, the counter behaves like a standard up and down counter. This mode can be used with one encoder.

The high speed counter supports counting of digital inputs up to frequencies of 100 kHz in single word or double word computational mode.

Dedicated I/O Assignments

The *High Speed Counter* function blocks use dedicated inputs and auxiliary inputs and outputs. These inputs and outputs are not reserved for the exclusive use of *High Speed Counter* function blocks.

If *%I0.0* is in use by the program as a regular digital input, *%HSC0* is not available.

If *%I0.1* is in use by the program as a regular digital input, *%HSC0*and *%HSC2* are not available.

If *%I0.6* is in use by the program as a regular digital input, *%HSC1* is not available.

If *%I0.7* is in use by the program as a regular digital input, *%HSC1* and *%HSC3* are not available.

This table summarizes the assignments for *%HSC0* and *%HSC1*:

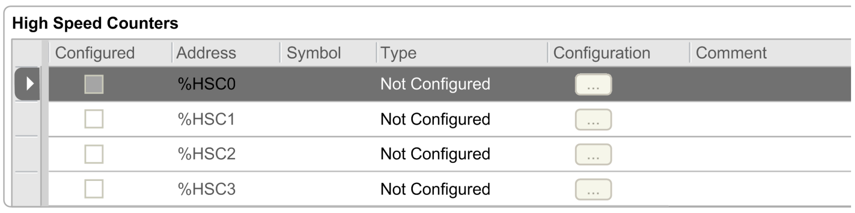
Counter type	Main inputs		Auxiliary inputs		Reflex outputs					
					TM200•••U TM200•••T		TM100C••R TM200•••R		TM100C••RN	
%HSC0	**%I0.0**	**%I0.1**	**%I0.2**	**%I0.3**	**%Q0.4**	**%Q0.5**	**%Q0.0**	**%Q0.1**	**%Q0.0**	**%Q0.1**
%HSC1	**%I0.6**	**%I0.7**	**%I0.5**	**%I0.4**	**%Q0.6**	**%Q0.7**	**%Q0.2**	**%Q0.3**	**Not used**	**Not used**
Single phase	Pulse input	Not used	Preset input*	Catch input*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*
Dual phase [Pulse / Direction]	Pulse input	Direction input	Preset input*	Catch input*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*
Dual phase [Clock Wise / Counter Clock Wise]	CW input Phase A	CCW input Phase B	Preset input*	Catch input*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*
Dual phase [Quadrature X1]	Pulse input Phase A	Pulse input Phase B	Preset input*	Catch input*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*
Dual phase [Quadrature X2]	Pulse input Phase A	Pulse input Phase B	Preset input*	Catch input*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*
Dual phase [Quadrature X4]	Pulse input Phase A	Pulse input Phase B	Preset input*	Catch input*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*	Reflex output R*	Reflex output S*
Frequency meter	Pulse input	Not used	Not used	Not used	Not used	Not used	Not used	Not used	Not used	Not used
* When not used, the input or output functions as a normal digital I/O available to be managed by the application in the main task cycle.										

This table summarizes the assignments for *%HSC2* and *%HSC3*:

Counter type	Main inputs		Auxiliary inputs		Reflex outputs					
					TM200•••U TM200•••T		TM100C••R TM200•••R		TM100C••RN	
%HSC2	**%I0.0**	**%I0.1**	**%I0.2**	**%I0.3**	**%Q0.4**	**%Q0.5**	**%Q0.0**	**%Q0.1**	**%Q0.0**	**%Q0.1**
%HSC3	**%I0.6**	**%I0.7**	**%I0.5**	**%I0.4**	**%Q0.6**	**%Q0.7**	**%Q0.2**	**%Q0.3**	**Not used**	**Not used**
Single phase	Not used	Pulse input	Not used							
* When not used, the input or output functions as a normal digital I/O available to be managed by the application in the main task cycle.										

High Speed Counters Configuration

This table describes how to configure the high speed counters:

Step	Action
1	Click the **High Speed Counters** node in the hardware tree to display the high speed counter properties. **Result:** The properties of the high speed counters are displayed in the editor area:  High Speed Counters Configured | Address | Symbol | Type | Configuration | Comment ☐ | %HSC0 | | Not Configured | ... | ☐ | %HSC1 | | Not Configured | ... | ☐ | %HSC2 | | Not Configured | ... | ☐ | %HSC3 | | Not Configured | ... | For detailed information on the high speed counter configuration, refer to the following table.
2	Click the **[...]** button to configure a high speed counter. **Result:** The high speed counter configuration parameters are displayed in the assistant window. For more details on configuration of single phase and dual phase modes with the assistant, refer to Configuring Single Phase and Dual Phase, page 65. For more details on configuration of frequency meter mode with the assistant, refer to Configuring Frequency Meter, page 69.

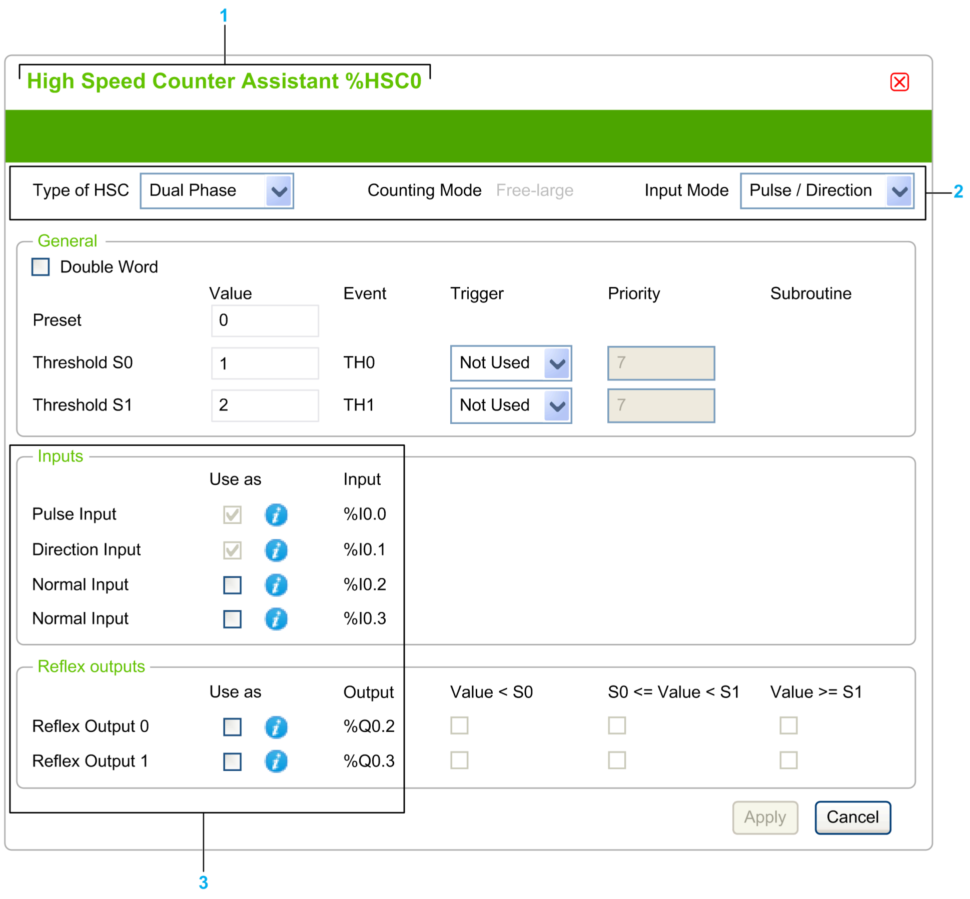
This table describes each parameter of the high speed counters configuration:

Parameter	Editable	Value	Default value	Description
Used	No	True/False	False	Indicates whether the high speed counter is being used in a program or not.
Address	No	%HSCx		Displays the address of the high speed counter, where x is the object number. For example, `%HSC1` is the address of the second high speed counter on the controller.
Symbol	Yes	–	–	Allows you to associate a symbol with the high speed counter object. Double-click in the **Symbol** column, type the name of the symbol, and press Enter.
Type	Yes	**Not Configured** **Single Phase** **Dual Phase** **Frequency Meter**	**Not Configured**	Allows you to select the counter operational mode from the drop-down list.
Configuration	Yes	**[...]** (Button)	Disabled	Allows you to configure the high speed counter parameters using an assistant window. This button is enabled only if the high speed counter function is selected from the list. When the counter type is **Not Configured**, the assistant configuration button is disabled. The **High Speed Counter Assistant (%HSCx)** window appears when you click the configuration button, where x is the counter number on the controller.
Comment	Yes	–	–	Allows you to associate a comment with the high speed counter object. Double-click in the **Comment** column, type an optional comment, and press Enter.

Configuring Single Phase and Dual Phase

Single Phase and Dual Phase with Assistant Window

This figure presents an instance of the assistant window for *%HSC0* configured as **Dual Phase [Pulse / Direction]**:



High Speed Counter Assistant %HSC0

Type of HSC: Dual Phase | Counting Mode: Free-large | Input Mode: Pulse / Direction

General

☐ Double Word

	Value	Event	Trigger	Priority	Subroutine
Preset	0				
Threshold S0	1	TH0	Not Used	7	
Threshold S1	2	TH1	Not Used	7	

Inputs

	Use as	Input
Pulse Input	✓	%I0.0
Direction Input	✓	%I0.1
Normal Input	☐	%I0.2
Normal Input	☐	%I0.3

Reflex outputs

	Use as	Output	Value < S0	S0 <= Value < S1	Value >= S1
Reflex Output 0	☐	%Q0.2	☐	☐	☐
Reflex Output 1	☐	%Q0.3	☐	☐	☐

Item	Description
1	Displays the title of the assistant dialog window. If you are configuring the counter *%HSC0*, the window title appears as **High Speed Counter Assistant (%HSC0)** and for the counter *%HSC1*, the window title appears as **High Speed Counter Assistant (%HSC1)**.
2	Displays the input mode of particular type of high speed counter.
3	Displays the dedicated inputs, auxiliary inputs, and reflex outputs. Properties in this area of the assistant window are different for each counter type and *%HSC* instance. For more details, refer to the Dedicated I/O Assignments, page 62 section.

This table describes each parameter of the assistant screen for high speed counters for both `%HSC0` and `%HSC1`:

Parameter	Editable	Value	Default value	Description
Pre-Configuration				
Type of HSC	Yes	**Not Configured** **Single Phase** **Dual Phase** **Frequency Meter**	**Not Configured**	Indicates the selected counter operational mode and allows you to change it.
Counting Mode when configuring single phase	Yes	**Free Large** **Modulo Loop** **One Shot**	**Free Large**	Indicates the selected counter operational mode and allows you to change it.

Parameter	Editable	Value	Default value	Description
				The options depend on the instance and on the type of HSC in the other instances. Refer to Dedicated I/O Assignments, page 62.
Counting Mode when configuring dual phase	Yes	**Free Large** **Modulo Loop**	**Free Large**	Indicates the selected counter operational mode and allows you to change it. The options depend on the instance and on the type of HSC in the other instances. Refer to Dedicated I/O Assignments, page 62.
Input Mode when configuring dual phase	Yes	**Pulse / Direction** **Clock Wise / Counter Clock Wise** **Quadrature X1** **Quadrature X2** **Quadrature X4**	**Pulse / Direction**	Indicates the selected counter operational mode and allows you to change it. The options depend on the instance and on the type of HSC in the other instances. Refer to Dedicated I/O Assignments, page 62.
General				
Double Word	Yes	True/False	False	Allows you to toggle between input data size of Word (16 bits) and Double Word (32 bits). By default, this parameter is disabled, which indicates that the current data size is Word (16 bits). Enabling this field changes the data size to Double Word (32 bits).
Preset	Yes	0...65535 (Word) 0...4294967295* (Double Word) 0...2147483647 (Double Word) when configuring **Dual Phase [Quadrature X1]**	0 (Word) 0 (Double Word)	Allows you to specify the preset value for the counting functions.
Modulo Value (%HSC.P/.PD)	Yes	0...65535 (Word) 0...4294967295* (Double Word) 0...2147483647 (Double Word) when configuring Dual Phase [Quadrature X1]	0 (Word) 0 (Double Word)	Allows you to specify the modulo value for the counting functions.
Threshold S0	Yes	0...65535 (Word) 0...4294967295* (Double Word) 0...2147483647 (Double Word) when configuring Dual Phase [Quadrature X1]	65535 (Word) 4294967295* (Double Word)	Allows you to specify the value of the HSC flag S0 that contains the value of the threshold TH0.
Threshold S1	Yes	0...65535 (Word) 0...4294967295* (Double Word) 0...2147483647 (Double Word) when configuring Dual	65535 (Word) 4294967295* (Double Word)	Allows you to specify the value for the HSC flag S1 that contains the value of the threshold TH1.

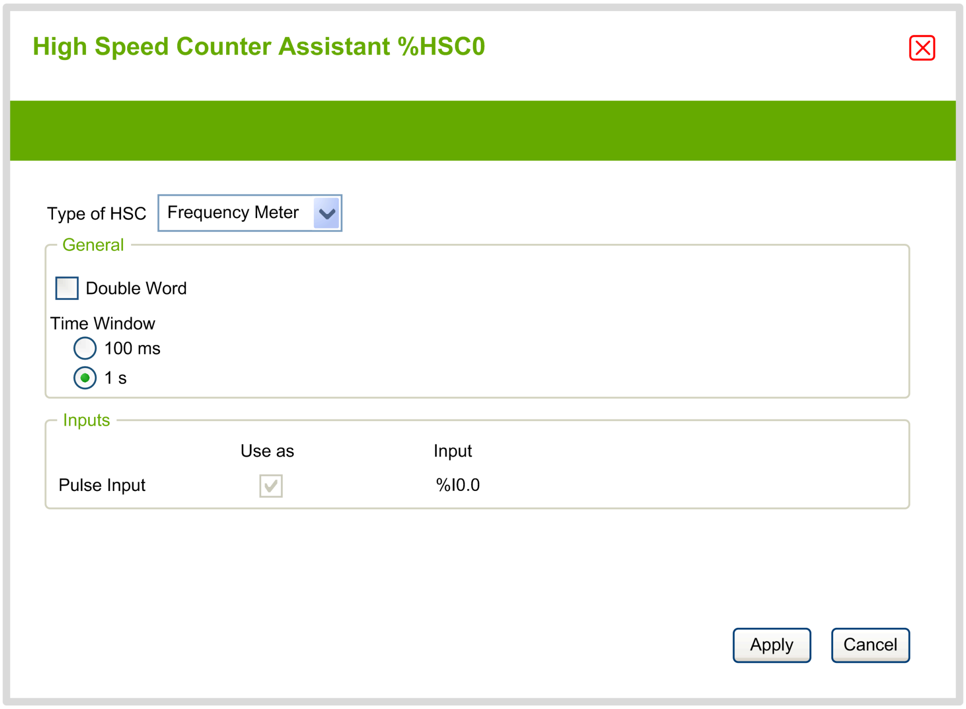
Parameter	Editable	Value	Default value	Description
		Phase [Quadrature X1]		
Trigger	Yes	**Not Used** **Falling Edge** **Rising Edge** **Both edges**	**Not Used**	Allows you to select a triggering function for an event (for both threshold TH0 and TH1) from the drop-down list. If you select a triggering function from the drop-down list (other than **Not Used**), the **Priority** parameter enables for editing to set the priority of the event.
Priority	Yes	0...7	7	Allows you to set the priority of the triggering function of an event (for both threshold TH0 and TH1). This field enables only when you select a **Trigger** function for the event.
Subroutine	No	*Any*	*Empty*	Displays the subroutine associated with an input configured as an event (for both threshold TH0 and TH1).
Inputs Configuration				
When configuring **Single Phase**:				
Pulse Input	No	True/False	True	• For *%HSC0*: *%I0.0* is used as pulse input. • For *%HSC1*:*%I0.6* is used as pulse input.
When configuring **Dual Phase [Pulse / Direction]**:				
Pulse Input	No	True/False	True	• For *%HSC0*: *%I0.0* is used as pulse input. • For *%HSC1*:*%I0.6* is used as pulse input.
Direction Input	No	True/False	True	• For *%HSC0*: *%I0.1* is used as directional input. • For *%HSC1*: *%I0.7* is used as directional input.
When configuring **Dual Phase [Clock Wise / Counter Clock Wise]**:				
Clock Wise Phase A	No	True/False	True	• For *%HSC0*: *%I0.0* is used as pulse input for phase A. • For *%HSC1*: *%I0.6* is used as pulse input for phase A.
Counter Clock Wise Phase B	No	True/False	True	• For *%HSC0*: *%I0.1* is used as pulse input for phase B. • For *%HSC1*: *%I0.7* is used as pulse input for phase B.
When configuring **Dual Phase [Quadrature X1]**, **Dual Phase [Quadrature X2]**, and **Dual Phase [Quadrature X4]**:				
Pulse Input Phase A	No	True/False	True	• For *%HSC0*: *%I0.0* is used as pulse input for phase A. • For *%HSC1*: *%I0.6* is used as pulse input for phase A.
Pulse Input Phase B	No	True/False	True	• For *%HSC0*: *%I0.1* is used as pulse input for phase B. • For *%HSC1*: *%I0.7* is used as pulse input for phase B.
When configuring **Single Phase** and **Dual Phase**:				
Normal Input	Yes	True/False	False	• For *%HSC0*: *%I0.2* is used as normal input. • For *%HSC1*: *%I0.5* is used as normal input. Click the **Use as** check box to use this input as **Preset Input**.
Normal Input	Yes	True/False	False	• For *%HSC0*: *%I0.3* is used as normal input. • For *%HSC1*: *%I0.4* is used as normal input. Click the **Use as** check box to use this input as **Catch Input**.
Reflex Outputs Configuration				

Parameter	Editable	Value	Default value	Description
Reflex Output 0	No	True/False	False	Allows you to enable or disable the reflex output at the address: For TM200•••U/TM200•••T: • *%Q0.4* for *%HSC0* • *%Q0.6* for *%HSC1* For TM100•••R/TM200•••R: • *%Q0.0* for *%HSC0* • *%Q0.2* for *%HSC1*
Reflex Output 1	No	True/False	False	Allows you to enable or disable the reflex output at the address: For TM200•••U/TM200•••T: • *%Q0.5* for *%HSC0* • *%Q0.7* for *%HSC1* For TM100•••R/TM200•••R: • *%Q0.1* for *%HSC0* • *%Q0.3* for *%HSC1*
Value < S0	Yes	True/False	False	Allows you to enable or disable the condition in which the counter is constantly compared to the output value to set the reflex output when the output value is less than the value of HSC flag S0.
S0 <= Value < S1	Yes	True/False	False	Allows you to enable or disable the condition in which the counter is constantly compared to the output value to set the reflex output when the output value is: • Greater than or equal to the value of the HSC flag S0 and • Less than the value of the HSC flag S1. **NOTE:** S1 is not a variable when configuring Modulo-loop mode.
Value >= S1	Yes	True/False	False	Allows you to enable or disable the condition in which the counter is constantly compared to the output value to set the reflex output when the output value is greater than or equal to the value of HSC flag S1. **NOTE:** S1 is not a variable when configuring Modulo-loop mode.
***** for **X1** the value is limited to 2147483647				

Configuring Frequency Meter

Frequency Meter Assistant Window

This figure presents the **High Speed Counter Assistant (%HSC0)** window for the counter type **Frequency Meter**:


High Speed Counter Assistant %HSC0

Type of HSC: Frequency Meter

General

☐ Double Word

Time Window
○ 100 ms
● 1 s

Inputs

	Use as	Input
Pulse Input	✓	%I0.0

This table describes each parameter of the **High Speed Counter Assistant (%HSCx)** window for the counter type **Frequency Meter**:

Parameter	Editable	Value	Default value	Description
Type of HSC	Yes	**Not Configured** **Single Phase** **Dual Phase** **Frequency Meter**	**Not Configured**	Indicates the selected counter operational mode and allows you to change it. The Frequency Meter is configurable on *%HSC0* and/or *%HSC1*. Refer to the Frequency Meter I/O Assignment, page 61.
General				
Double Word	Yes	TRUE/FALSE	FALSE	Allows you to toggle between the input data size from Word (16 bits) to Double Word (32 bits). Enabling this field changes the data size from Word (16 bits) to Double Word (32 bits).
Time Window 100 ms (1)	Yes	TRUE/FALSE	FALSE	Allows you to select the time base of 100 ms to measure the frequency between 100 Hz and 100 kHz.
Time Window 1 s (1)	Yes	TRUE/FALSE	TRUE	Allows you to select the time base of 1 s to measure the frequency between 100 Hz and 100 kHz.
Inputs				
Pulse Input	No	TRUE/FALSE	TRUE	Indicates the input used as pulse input, *%I0.0* for *%HSC0* or *%I0.6* for *%HSC1*.

(1) By default, the time base value is set to 1 s. You can select only 1 time base value for the counter.

Additional configuration details are displayed in the **Programming** tab.

For more details on the *High Speed Counter* function block, refer to High Speed Counter Function Block (%HSC), page 172.

I/O Bus Configuration

What’s in This Chapter

Overview

This chapter describes how to configure the I/O bus (expansion modules) of the M100/M200 Logic Controller.

I/O Configuration General Description

Introduction

In your project, you can add I/O expansion modules to your M100/M200 Logic Controller to increase the number of digital and analog inputs and outputs over those native to the logic controller itself (embedded I/O).

You can add either TM3, TM3R or TM2 I/O expansion modules to the logic controller. Special rules apply in all cases when creating local and remote I/O expansions, and when mixing TM2, TM3 and TM3R I/O expansion modules (refer to Maximum Hardware Configuration).

The I/O expansion bus of the M100/M200 Logic Controller is created when you assemble the I/O expansion modules to the logic controller. I/O expansion modules are considered as external devices in the logic controller architecture and are treated, as such, differently than the embedded I/Os of the logic controller.

I/O Expansion Bus Errors

If the logic controller cannot communicate with one or more I/O expansion modules that is (are) contained in the program configuration and those modules are not configured as optional modules (refer to Optional I/O Expansion Modules), the logic controller considers it as an I/O expansion bus error. The unsuccessful communication may be detected during the startup of the logic controller or during runtime, and there may be any number of causes. Causes of communication exception on the I/O expansion bus include, among other things, disconnection of or physically missing I/O modules, electromagnetic radiation beyond published environmental specifications, or otherwise, inoperative modules.

During runtime, if an I/O expansion bus error is detected, the diagnostic information is contained in `%SW118` and `%SW120` system words, page 327, and the red LED indicator labeled **ERR** flashes.

Active I/O Expansion Bus Error Handling

System bit %S106 is set to 0 by default to specify the use of active I/O error handling. The application can set this bit to 1 to use passive I/O error handling instead.

By default (system bit %S106 set to 0), when the logic controller detects a TM3 module in bus communication error, it sets the bus to a "bus off" condition whereby the TM3 expansion module outputs are set to 0. A TM3 expansion module is considered to be in bus communication error when an I/O exchange with the expansion module has been unsuccessful for at least two consecutive bus task cycles. When a bus communication error occurs, bit n of %SW120 is set to 1, where n is the expansion module number, and %SW118 bit 14 is set to 0.

Normal I/O expansion bus operation can only be restored after eliminating the source of the error and performing one of the following:

- Power cycle
- New application download
- Application request through a rising edge on bit *%S107*
- With EcoStruxure Machine Expert-Basic by selection of the **Initialize Controller** command

Passive I/O Expansion Bus Error Handling

The application can set system bit %S106 to 1 to use passive I/O error handling. This error handling is provided to afford compatibility with previous firmware versions and previous controllers that the M100/M200 Logic Controller replaces.

When passive I/O error handling is in use, the controller attempts to continue data bus exchanges with the modules during bus communication errors. While the expansion bus error persists, the logic controller attempts to re-establish communication on the bus with incommunicative modules, depending on the type of I/O expansion module, TM3 or TM2:

- For TM3 I/O expansion modules, the value of the I/O channels is maintained (**Maintain values**) for approximately 10 seconds while the logic controller attempts to re-establish communication. If the logic controller cannot re-establish communications within that time, all affected TM3 I/O expansion outputs are set to 0.
- For the TM2 I/O expansion modules that may be part of the configuration, the value of the I/O channels is maintained indefinitely. That is to say, the outputs of the TM2 I/O expansion modules are set to **Maintain values** until either power is cycled on the logic controller system, or you issue an **Initialize Controller** command with EcoStruxure Machine Expert-Basic.

In either case, the logic controller continues to solve logic and the embedded I/O continues to be managed by the application (Managed by application, page 35) while it attempts to re-establish communication with the incommunicative I/O expansion modules. If the communication is successful, the I/O expansion modules resume to be managed by the application. If communication with the I/O expansion modules is unsuccessful, you must resolve the reason for the unsuccessful communication, and then cycle power on the logic controller system, or issue an **Initialize Controller** command with EcoStruxure Machine Expert-Basic.

Further, if the incommunicative I/O module(s) disturb the communication with unaffected modules, the unaffected modules will also be considered in error and their corresponding bit in *%SW120* will be set to 1. However, with the ongoing data exchanges that characterize the Passive I/O Expansion Bus Error Handling, the unaffected modules will nonetheless apply the data sent, and will not apply the fallback values as for the incommunicative module.

Therefore, you must monitor within your application the state of the bus and the error state of the module(s) on the bus, and to take the appropriate action necessary given your particular application.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Include in your risk assessment the possibility of unsuccessful communication between the logic controller and any I/O expansion modules.
- If the “Maintain values” option deployed during an I/O expansion bus error is incompatible with your application, use alternate means to control your application for such an event.
- Monitor the state of the I/O expansion bus using the dedicated system words and take appropriate actions as determined by your risk assessment.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

For more information on the actions taken upon start-up of the logic controller when an I/O expansion bus error is detected, refer to Optional I/O Expansion Modules.

Restarting the I/O Expansion Bus

When active I/O error handling is being applied, that is, TM3 outputs set to 0 when a bus communication error is detected, the application can request a restart of the I/O expansion bus while the logic controller is still running (without the need for a Cold Start, Warm Start, power cycle, or application download).

System bit %S107 is available to request restarts of the I/O expansion bus.The default value of this bit is 0. The application can set %S107 to 1 to request a restart of the I/O expansion bus. On detection of a rising edge of this bit, the logic controller reconfigures and restarts the I/O expansion bus if all of the following conditions are met:

- %S106 is set to 0 (that is, I/O expansion bus activity is stopped)
- %SW118 bit 14 is set to 0 (I/O expansion bus is in error)
- At least one bit of %SW120 is set to 1 (at least one expansion module is in bus communication error)

If %S107 is set to 1 and any of the above conditions is not met, the logic controller takes no action.

Match Software and Hardware Configuration

The I/O that may be embedded in your controller is independent of the I/O that you may have added in the form of I/O expansion. It is important that the logical I/O configuration within your program matches the physical I/O configuration of your installation. If you add or remove any physical I/O to or from the I/O expansion bus or, depending on the controller reference, to or from the controller (in the form of cartridges), then you must update your application configuration. This is also true for any field bus devices you may have in your installation. Otherwise, there is the potential that the expansion bus or field bus will no longer function while the embedded I/O that may be present in your controller will continue to operate.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Update the configuration of your program each time you add or delete any type of I/O expansions on your I/O bus, or you add or delete any devices on your field bus.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Configuring Expansion Modules

Introduction

In your project, you can add the following devices to the controller:

- TM3 Digital I/O Modules
- TM3R Digital Mixed I/O Modules
- TM3 Analog I/O Modules
- TM2 Digital I/O Modules
- TM2 Analog I/O Modules

TM3/TM3R Expansion Modules

For more information about module configuration, refer to the following programming and hardware guides of each expansion module type:

Expansion module type	**Hardware Guide**	**Programming Guide**
TM3 Digital I/O Expansion Modules	TM3 Digital I/O Expansion Modules Hardware Guide	TM3 Expansion Modules Programming Guide
TM3R Digital Mixed I/O Expansion Modules	Modicon M100/M200 Logic Controller Hardware Guide	TM3R Expansion Module Configuration, page 99
TM3 Analog I/O Expansion Modules	TM3 Analog Modules Hardware Guide	TM3 Expansion Modules Programming Guide

TM2 Expansion Modules

For more information about module configuration, refer to the programming and hardware guides of each expansion module type:

Expansion module type	**Hardware Guide**	**Programming Guide**
TM2 Digital I/O Modules	TM2 Digital I/O Modules Hardware Guide	TM2 Expansion Modules Programming Guide
TM2 Analog I/O Modules	TM2 Analog I/O Modules Hardware Guide	

Cartridge Configuration

What’s in This Chapter

Overview

This chapter describes how to configure the cartridges of the M100/M200 Logic Controller.

Cartridge Configuration General Information

General Description

Introduction

The TMCR2••• cartridges connect to Modicon M100/M200 Logic Controllers to increase the number of I/Os or serial lines available on the controller.

Cartridges can be:

- Digital cartridges
- Analog cartridges
- Serial line cartridges

Cartridges Features

The following table describes the TMCR2••• cartridge features:

Reference	Description
TMCR2DM4U	TMCR2 cartridge with 2 digital inputs and 2 transistor sink outputs
TMCR2AI2	TMCR2 cartridge with 2 analog voltage or current inputs (0...10 V, 0...20 mA, 4...20 mA), 12 bits
TMCR2AQ2C	TMCR2 cartridge with 2 analog current outputs (4...20 mA), 12 bits
TMCR2AQ2V	TMCR2 cartridge with 2 analog voltage outputs (0...10 V), 12 bits
TMCR2AM3	TMCR2 cartridge with 2 analog voltage inputs and 1 analog voltage output (0...10 V), 16 bits
TMCR2TI2	TMCR2 cartridge with 2 analog temperature inputs (thermocouple, RTD), 14 bits
TMCR2SL1	TMCR2 cartridge with 1 serial line (RS-232 or RS-485)
TMCR2SL1A	TMCR2 cartridge with 1 isolated serial line (RS-485)
TMCR2SL1S(1)	TMCR2 cartridge with 1 isolated serial line (RS-485)
(1) TMCR2SL1S can only be supported on function level 12.1 or higher.	

Logic Controller Compatibility

NOTE: For more information on cartridge compatibility with specific controllers, refer to the Modicon M100/M200 Logic Controller hardware guide (see Modicon M100/M200 Logic Controller, Hardware Guide).

The following table describes the number of TMCR2••• cartridges that can be installed in a Modicon M100/M200 Logic Controller:

Reference	Cartridge Slots	Compatible Cartridges Combination	
		TMCR2DM4U **TMCR2AI2** **TMCR2AQ2V** **TMCR2AQ2C** **TMCR2AM3** **TMCR2TI2**	**TMCR2SL1** **TMCR2SL1A** **TMCR2SL1S**(2)
TM200C•16• TM200C•24•	1	1	0
		0	1(2)
TM200C•32• TM200C•40• TM200C•60•	2 (1)	1	0
		0	1
		1	1
		2	0
		0	2(2)

(1) Only one serial line cartridge (TMCR2SL1 or TMCR2SL1A) may be added to a logic controller.
(2) TMCR2SL1S can only be supported on function level 12.1 or higher.

NOTICE

ELECTROSTATIC DISCHARGE

- Verify that empty cartridge slots have their covers in place before applying power to the controller.
- Do not touch the contacts of the cartridge.
- Only handle the cartridge on the housing.
- Take the necessary protective measures against electrostatic discharges.

Failure to follow these instructions can result in equipment damage.

Serial Cartridge Compatibility

When the Function level is less than 12.0, only **TMCR2SL1A** and **TMCR2SL1** is supported. Only one serial cartridge can be configured in all PLC types.

When the Function level is 12.1 or higher，new serial cartridge **TMCR2SL1S** is supported. These PLC with 2 cartridge slots can configure two serial cartridges with the following limitation.

TCMR2SL1A	TCMR2SL1	TCMR2SL1S （**Function level >=12.1**）
1	0	0
0	1	0
0	0	1
1	0	1
0	0	2

Using Cartridges in a Configuration

Adding a Cartridge

TMCR2••• cartridges can be connected to the M100/M200 Logic Controller with 1 or 2 cartridge slots.

NOTE: It is not possible to configure 2 serial line cartridges on the same logic controller when the function level is less than 12.1. However, it is possible to configure 2 serial line cartridges to the same logic controller when the function level is 12.1 or higher. For more information on cartridge compatibility with the M100/M200 Logic Controller, refer to Logic Controller Compatibility, page 74.

NOTE: The controller must have at least one free cartridge slot.

The following steps explain how to add a cartridge to a logic controller in a EcoStruxure Machine Expert-Basic configuration:

Step	Description
1	Click the **Configuration** tab in the EcoStruxure Machine Expert-Basic window.
2	In the hardware catalog area of the window, select **M200 Cartridges**.
3	Select a cartridge reference. **Result**: A description of the physical characteristics of the selected cartridge appears in the bottom right-hand corner of the EcoStruxure Machine Expert-Basic window.
4	Drag and drop the cartridge onto an empty cartridge slot of the M100/M200 Logic Controller. **Result**: The cartridge is added to the **MyController > IO Bus** area of the device tree. For serial line cartridges, the **SL2 (Serial line)** node appears. For analog cartridges, the **Analog inputs** or **Analog outputs** subnode appears immediately below the cartridge reference. The following information about the selected cartridge is displayed in the lower central area of the EcoStruxure Machine Expert-Basic window: • Information about the current status of the cartridge. • For application cartridges, a list of project templates available for the cartridge.

Replacing an Existing Cartridge

To replace an existing cartridge with a difference reference, drag and drop the new cartridge onto the cartridge to be replaced.

A message appears asking you to confirm the operation. Click **Yes** to continue.

Removing a Cartridge

To remove a cartridge from a controller, either click the cartridge and press the **Delete** key, or right-click on the cartridge and click **Remove** on the contextual menu that appears.

If the cartridge contains at least one address being used in the user logic of the program, a message appears asking you to confirm the operation. Click **Yes** to continue.

Configuring Cartridges

Overview

You can configure cartridges on:

- The **Configuration** tab

- The **Programming** tab

Displaying Configuration Details

The steps below describe how to view the configuration of digital inputs on the **Configuration** tab:

Step	Description
1	Select the **Configuration** tab.
2	For digital cartridges, select **Cartridge x > Digital inputs** or **Cartridge x > Digital outputs** in the device tree on the left of the EcoStruxure Machine Expert-Basic window. For analog cartridges, select **Cartridge x > Analog inputs** or **Cartridge x > Analog outputs** in the device tree on the left of the EcoStruxure Machine Expert-Basic window. For serial line cartridges, select **Cartridge x > SL2 (Serial line)** in the device tree on the left of the EcoStruxure Machine Expert-Basic window. The properties of the selected cartridge are displayed.
3	Refer to TMCR2 Standard Cartridges Configuration, page 78 for configuration details.

Displaying Programming Properties

The **Programming** tab allows you to configure programming-related properties of digital or analog cartridges, such as symbols and comments.

To display cartridge properties in the **Programming** tab:

Step	Description
1	Select the **Programming** tab.
2	For digital cartridges, click **Tools > I/O objects > Digital inputs** or **Tools > I/O objects > Digital outputs** For analog cartridges, click **Tools > I/O objects > Analog inputs** or **Tools > I/O objects > Analog outputs** A list of I/O addresses appears in the lower central area of the EcoStruxure Machine Expert-Basic window (%I for digital inputs, %Q for digital outputs, %IW for analog inputs, %QW for analog outputs).
3	Scroll down to the range of addresses corresponding to the cartridge you are configuring. The following properties are displayed: • **Used**. Whether the address is being used in your program • **Address**. The analog input or analog output address. • **Symbol**. An optional symbol associated with the address. Double-click in the **Symbol** column and type the name of a symbol to associate with this input. If a symbol already exists, right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol in the application. • **Comment**. An optional comment associated with the address. Double-click in the **Comment** column and type a comment to associate with this address.

TMCR2••• Cartridges Configuration

TMCR2DM4U

Introduction

The TMCR2DM4U is a standard M200 cartridge featuring 2 digital sink/source inputs and 2 digital transistor sink outputs.

For further hardware information, refer to TMCR2DM4U (see Modicon M100/ M200 Logic Controller, Hardware Guide).

Configuring the Cartridge Module

For each digital input, you can define:

Parameter	Value	Default value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%I0.x0y`	-	Shows the address of the input channel, where *x* is the cartridge number and *y* is the channel number
Symbol		-	Specify a optional symbol to associate with the corresponding digital input object to be used in the program.
Comment		-	Type an optional comment to associate with the corresponding digital input object.

For each digital output, you can define:

Parameter	Value	Default value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%Q0.x0y`	-	Shows the address of the output channel, where *x* is the cartridge number and *y* is the channel number
Symbol		-	Specify a optional symbol to associate with the corresponding digital output object to be used in the program.
Fallback value	**0**...**1**	0	Specifies the fallback value of the output channel.
Comment		-	Type an optional comment to associate with the corresponding digital output object.

TMCR2AI2

Introduction

The TMCR2AI2 is a standard cartridge featuring 2 analog voltage or current input channels with 12-bit resolution.

The channel input types are:

- 0...10 V
- 0...20 mA
- 4...20 mA

For further hardware information, refer to TMCR2AI2 (see Modicon M100/M200 Logic Controller, Hardware Guide).

If you have physically wired, for example, your analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert-Basic, you may damage the analog circuit.

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Configuring the Module

For each input, you can define:

Parameter		Value	Default value	Description
Used		True/False	False	Indicates whether the address is being used in a program.
Address		`%IW0.x0y`	-	The address of the input channel, where *x* is the cartridge number and *y* is the channel number
Symbol		-	-	Double-click and type an optional symbol to associate with the corresponding analog input object to be used in the program.
Type		**0 - 10 V** **0 - 20 mA** **4 - 20 mA**	**0 - 10 V**	Select the mode of the channel.
Scope		**Normal**	**Normal**	The range of values for a channel.
Min.	**0 - 10 V**	-32768...32767	0	Specifies the lower measurement limit.
	0 - 20 mA		0	
	4 - 20 mA		4000	
Max.	**0 - 10 V**	-32768...32767	10000	Specifies the upper measurement limit.
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Filter		0...100	0	Specifies the filtering value. Multiply by the **Filter Unit** value to obtain the filtering time.
Filter Unit		100 ms	100 ms	Specifies the unit of time for the filtering value.
Units		-	-	-
Comment		-	-	Double-click and type an optional comment to associate with the channel.

TMCR2AQ2C

Introduction

The TMCR2AQ2C is a standard cartridge featuring 2 analog current output channels with 12-bit resolution.

The channel output types are:

- 4...20 mA

For further hardware information, refer to TMCR2AQ2C (see Modicon M100/M200 Logic Controller, Hardware Guide).

If you have physically wired, for example, your analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert-Basic, you may damage the analog circuit.

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Configuring the Cartridge Module

For each output, you can define:

Parameter	Value	Default value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%QW0.x0y`	-	Shows the address of the output channel, where *x* is the cartridge number and *y* is the channel number
Symbol	-	-	Double-click and type an optional symbol to associate with the corresponding analog output object to be used in the program.
Type	**4 - 20 mA**	**4 - 20 mA**	The mode of the channel.
Scope	**Normal**	**Normal**	The range of values for a channel.
Minimum	-32768...32767	4000	Specifies the lower measurement limit.
Maximum	-32768...32767	20000	Specifies the upper measurement limit.
Fallback value	**Min.**...**Max.**	0 (**Min.** if 0 is not in the range)	Specifies the fallback value of the output channel.
Units	-	-	-
Comment	-	-	Double-click and type an optional comment to associate with the channel.

TMCR2AQ2V

Introduction

The TMCR2AQ2V is a standard cartridge featuring 2 analog voltage output channels with 12-bit resolution.

The channel output types are:

- 0...10 V

For further hardware information, refer to TMCR2AQ2V (see Modicon M100/M200 Logic Controller, Hardware Guide).

If you have physically wired, for example, your analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert-Basic, you may damage the analog circuit.

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Configuring the Cartridge Module

For each output, you can define:

Parameter	Value	Default value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%QW0.x0y`	-	Shows the address of the output channel, where *x* is the cartridge number and *y* is the channel number
Symbol	-	-	Double-click and type an optional symbol to associate with the corresponding analog output object to be used in the program.
Type	**0 - 10 V**	**0 - 10 V**	The mode of the channel.
Scope	**Normal**	**Normal**	The range of values for a channel.
Minimum	-32768...32767	0	Specifies the lower measurement limit.
Maximum	-32768...32767	10000	Specifies the upper measurement limit.
Fallback value	**Min.**...**Max.**	0 (**Min.** if 0 is not in the range)	Specifies the fallback value of the output channel.
Units	-	-	-
Comment	-	-	Double-click and type an optional comment to associate with the channel.

TMCR2AM3

Introduction

The TMCR2AM3 is a standard M200 cartridge featuring 2 analog current or voltage input channels and 1 analog current or voltage output channels with 16-bit resolution.

The channel input types are:

- 0...5V
- 0...10 V
- 0...20 mA
- 4...20 mA

The channel output types are:

- 0...5V
- 0...10 V
- 0...20 mA
- 4...20 mA

For further hardware information, refer to TMCR2AM3 (see Modicon M100/M200 Logic Controller, Hardware Guide).

If you have physically wired, for example, your analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert-Basic, you may damage the analog circuit.

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Configuring the Cartridge Module

For each input, you can define:

Parameter	Value	Default value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%IW0.x0y`	-	Shows the address of the input channel, where *x* is the cartridge number and *y* is the channel number
Symbol	-	-	Double-click and type an optional symbol to associate with the corresponding analog input object to be used in the program.
Type	**0 - 5 V** **0 - 10 V** **0 - 20 mA** **4 - 20 mA**	**0 - 5 V**	The mode of the channel.
Scope	**Customized** **Normal**	**Customized**	The range of values for the channel.
Minimum	-32768...32767	4000	Specifies the lower measurement limit.
Maximum	-32768...32767	20000	Specifies the upper measurement limit.
Filter	0...6	0	Specifies the filtering level to apply on this channel: • 0: No filtering • 1, 2: Smooth filtering • 3, 4: Average filtering • 5, 6: High filtering
Filter Unit		-	-
Units		-	-
Comment			Double-click and type an optional comment to associate with the channel.

For the output, you can define:

Parameter	Value	Default value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%QW0.x0y`	-	Shows the address of the output channel, where *x* is the cartridge number and *y* is the channel number
Symbol	-	-	Double-click and type an optional symbol to associate with the corresponding analog output object to be used in the program.

Parameter	Value	Default value	Description
Type	**0 - 5 V** **0 - 10 V** **0 - 20 mA** **4 - 20 mA**	**0 - 5 V**	The mode of the channel.
Scope	**Customized** **Normal**	**Customized**	The range of values for a channel.
Minimum	-32768...32767	4000	Specifies the lower measurement limit.
Maximum	-32768...32767	20000	Specifies the upper measurement limit.
Fallback value	**Min.**...**Max.**	0 (**Min.** if 0 is not in the range)	Specifies the fallback value of the output channel.
Units		-	-
Comment			Double-click and type an optional comment to associate with the channel.

TMCR2TI2

Introduction

The TMCR2TI2 is a standard cartridge featuring 2 analog input channels with 14-bit resolution.

The channel input types are:

- K Thermocouple
- J Thermocouple
- R Thermocouple
- S Thermocouple
- B Thermocouple
- E Thermocouple
- T Thermocouple
- N Thermocouple
- C Thermocouple
- PT100
- PT1000
- NI100
- NI1000

For further hardware information, refer to TMCR2TI2 (see Modicon M100/M200 Logic Controller, Hardware Guide).

If you have physically wired, for example, your analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert-Basic, you may damage the analog circuit.

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Configuring the Module

For each input, you can define:

Parameter	Value	Default value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%IW0.x0y`	-	The address of the input channel, where *x* is the module number and *y* is the channel number
Symbol	-	-	Double-click and type an optional symbol to associate with the corresponding analog input object to be used in the program./P
Type	**K Thermocouple** **J Thermocouple** **R Thermocouple** **S Thermocouple** **B Thermocouple** **E Thermocouple** **T Thermocouple** **N Thermocouple** **C Thermocouple** **PT100** **PT1000** **NI100** **NI1000**	**K Thermocouple**	Choose the mode of the channel.
Scope	**Normal** **Celsius (0.1°C)** **Fahrenheit (0.1°F)** (except Thermocouple B and C) **Fahrenheit (0.2°F)** (for Thermocouple B and C only)	**Normal**	Choose the temperature units for a channel.
Minimum	See the table below		Specifies the lower measurement limit.
Maximum	See the table below		Specifies the upper measurement limit.
Filter	0...100	0	Specifies the filtering value. Multiply by the **Filter Unit** value to obtain the filtering time.
Filter Unit	100 ms	100 ms	Specifies the unit of time for the filtering value.
Units	See the table below		Displays the temperature unit configured.
Comment	-	-	Double-click and type an optional symbol to associate with the corresponding analog input object to be used in the program.

Type	**Customized**		**Celsius**			**Fahrenheit**		
	Min.	**Max.**	**Min.**	**Max.**	**Units**	**Min.**	**Max.**	**Units**
K Thermocouple	-32768	32767	-2000	13000	0.1 °C	-3280	23720	0.1 °F
J Thermocouple	-32768	32767	-2000	10000	0.1 °C	-3280	18320	0.1 °F
R Thermocouple	-32768	32767	0	17600	0.1 °C	320	32000	0.1 °F
S Thermocouple	-32768	32767	0	17600	0.1 °C	320	32000	0.1 °F
B Thermocouple	-32768	32767	0	18200	0.1 °C	160	16540	0.2 °F
E Thermocouple	-32768	32767	-2000	8000	0.1 °C	-3280	14720	0.1 °F

Type	Customized		Celsius			Fahrenheit		
	Min.	**Max.**	**Min.**	**Max.**	**Units**	**Min.**	**Max.**	**Units**
T Thermocouple	-32768	32767	-2000	4000	0.1 °C	-3280	7520	0.1 °F
N Thermocouple	-32768	32767	-2000	13000	0.1 °C	-3280	23720	0.1 °F
C Thermocouple	-32768	32767	0	23150	0.1 °C	160	20995	0.2 °F
PT100	-32768	32767	-2000	8500	0.1 °C	-3280	15620	0.1 °F
PT1000	-32768	32767	-2000	6000	0.1 °C	-3280	11120	0.1 °F
NI100	-32768	32767	-600	1800	0.1 °C	-760	3560	0.1 °F
NI1000	-32768	32767	-600	1800	0.1 °C	-760	3560	0.1 °F

TMCR2SL1

Introduction

The TMCR2SL1 is a standard cartridge module featuring 1 serial line.

For further hardware information, refer to TMCR2SL1 (see Modicon M100/M200 Logic Controller, Hardware Guide).

The serial line can be configured for any one of the following protocols:

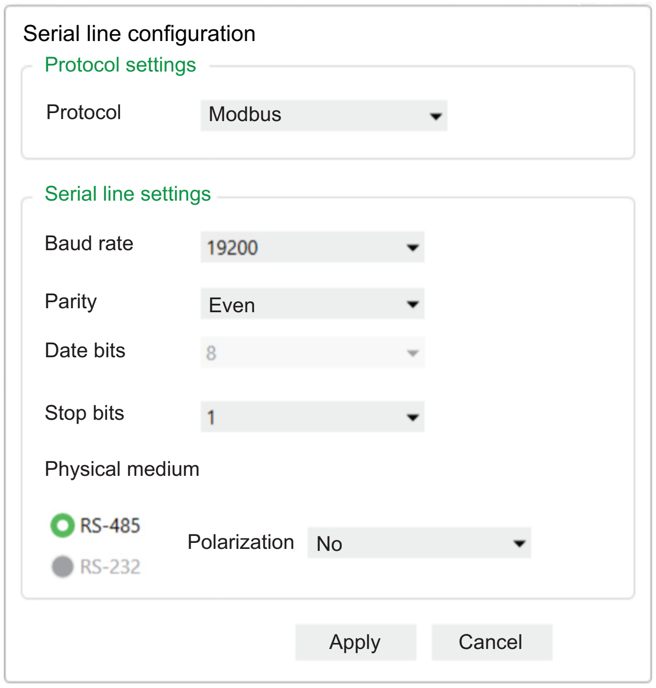
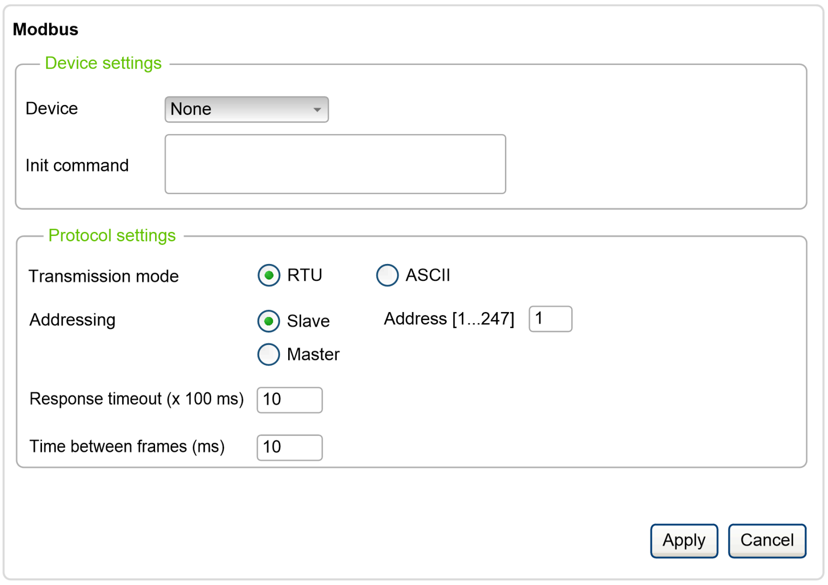
- Modbus RTU
- Modbus ASCII
- ASCII
- Modbus Serial IOScanner

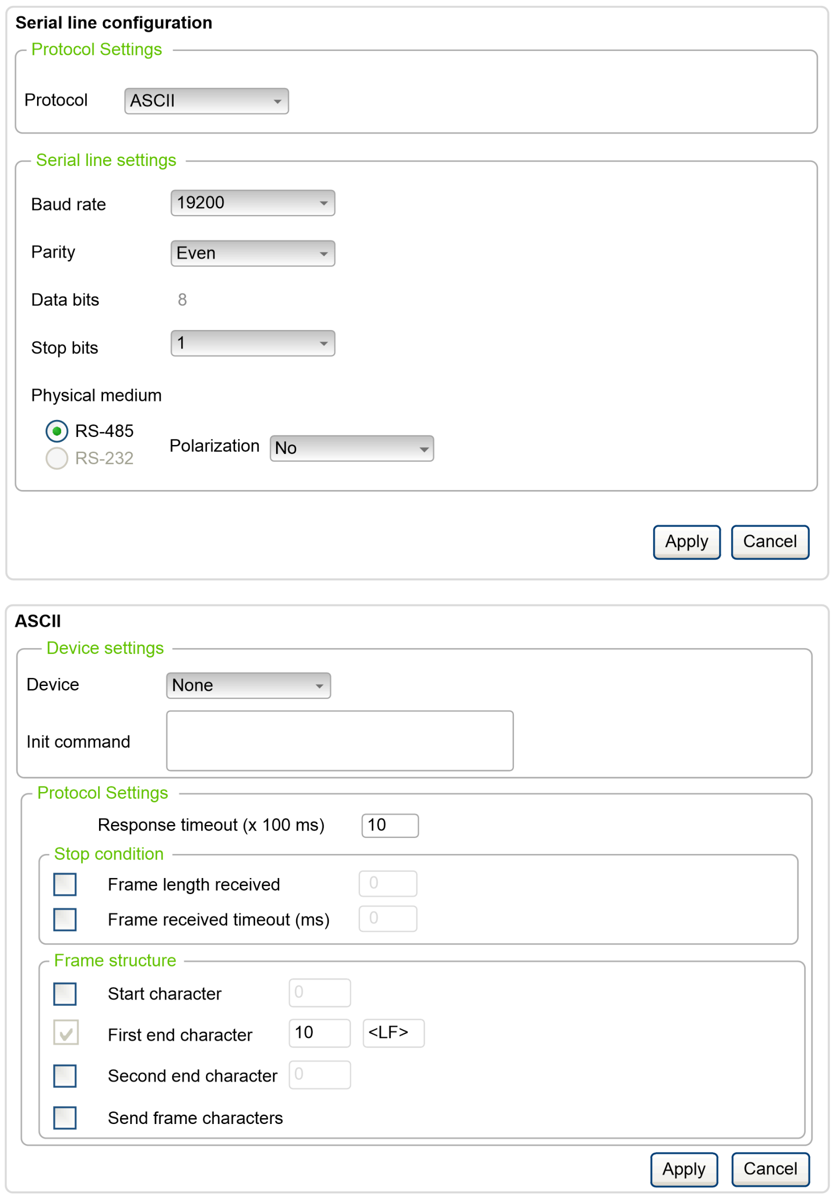
You can configure both physical and protocol settings for the serial line. Serial lines are configured for the Modbus RTU protocol by default.

NOTE: You can only add one serial line cartridge to the controller.

Serial Line Configuration

This table describes how to configure the serial line:

Step	Action
1	Click the **SL1 (Serial line)** node in the hardware tree to display the serial line properties. These figures present the properties of the serial line for **Modbus** protocols:  Serial line configuration Protocol settings Protocol: Modbus Serial line settings Baud rate: 19200 Parity: Even Date bits: 8 Stop bits: 1 Physical medium [✓ RS-485] RS-232 Polarization: No  **Modbus** Device settings Device: None Init command: Protocol settings Transmission mode: [✓ RTU] ASCII Addressing: [✓ Slave] Master Address [1...247]: 1 Response timeout (x 100 ms): 10 Time between frames (ms): 10
	These figures present the properties of the serial line for **ASCII** protocol:

Step	Action
	 **Serial line configuration** Protocol Settings Protocol: ASCII Serial line settings Baud rate: 19200 Parity: Even Data bits: 8 Stop bits: 1 Physical medium [✓ RS-485] RS-232 Polarization: No Apply Cancel **ASCII** Device settings Device: None Init command: Protocol Settings Response timeout (x 100 ms): 10 Stop condition ☐ Frame length received: 0 ☐ Frame received timeout (ms): 0 Frame structure ☐ Start character: 0 ✓ First end character: 10 <LF> ☐ Second end character: 0 ☐ Send frame characters Apply Cancel
2	Edit the properties to configure the serial line. For detailed information on the serial line configuration parameters, refer to the table below.

This table describes each parameter of the serial line:

Parameter	Editable	Value	Default value	Description
Physical settings				
Baud rate	Yes	**1200** **2400** **4800** **9600** **19200** **38400** **57600** **115200**	**19200**	Allows you to select the data transmission rate (bits per second) for the modem from the drop-down list.
Parity	Yes	**None** **Even**	**Even**	Allows you to select the parity of the transmitted data for error detection.

Parameter	Editable	Value	Default value	Description
		Odd		Parity is a method of error detection in transmission. When parity is used with a serial port, an extra data bit is sent with each data character, arranged so that the number of 1 bits in each character, including the parity bit, is always odd or always even. If a byte is received with the wrong number of 1 bits, the byte is corrupt. However, an even number of detected errors can pass the parity check.
Data bits	Yes (only for the **ASCII** protocol	**7** **8**	**7** for Modbus ASCII, **8** for Modbus RTU	Allows you to select the number of data bits from the drop-down list. The number of data bits in each character can be 7 (for true ASCII) or 8 (for any kind of data, as this matches the size of a byte). 8 data bits are almost universally used in all applications.
Stop bits	Yes	**1** **2**	**1**	Allows you to select the number of stop bits from the drop-down list. A stop bit is a bit indicating the end of a byte of data. For electronic devices, 1 stop bit is usually used. For slow devices like electromechanical teleprinters, 2 stop bits are used.
Physical medium	Yes	**RS-485** True/False **RS-232** True/False	**RS-485** True	Allows you to select the physical medium for communication. You can only select either the **RS-485** or **RS-232** medium. Enabling one medium disables the other one. A physical medium in data communications is the transmission path over which a signal propagates. It is an interface for interconnection of devices with the logic controller.
Polarization	Yes	**Yes** **No**	**No**	Polarization resistors are integrated in the cartridge module. Specify whether to switch on or off polarization.
Protocol settings				
Protocol	Yes	**Modbus RTU** **Modbus ASCII** **ASCII** **Modbus Serial IOScanner**	**Modbus RTU**	Allows you to select the protocol transmission mode for communication from the drop-down list. Protocol advanced parameters are displayed based on the selected protocol. Refer to the following figures and tables.
Protocol settings for the **Modbus RTU** and **Modbus ASCII** protocols:				
Addressing	Yes	**Slave** **Master**	**Slave**	Allows you to select the addressing mode. You can only select either of the **Slave** or **Master** addressing. Enabling one addressing mode disables the other one.
Address [1...247]	Yes	1...247	1	Allows you to specify the address ID of the slave. **NOTE:** This field is displayed only for the addressing of the slave. For master, this field does not appear on the screen.
Response time (x 100 ms)	Yes	10...255 ms	10	Allows you to specify the response time of the protocol to the queries.
Time between frames (ms)	Yes	3...255 ms	10	Allows you to specify the time between frames of the protocol.
Protocol settings for the **ASCII** protocol:				
Stop condition				

Parameter	Editable	Value	Default value	Description
Response time (x 100 ms)	Yes	1...255	10	Allows you to specify the response time of the protocol to the queries.
Frame length received	Yes	0...255	0	Allows you to specify the frame length received.
Frame received timeout (ms)	Yes	0...255	10	Allows you to specify the frame received timeout.
Frame structure				
Start character	Yes	0...255	58 (if check box is selected)	Allows you to specify the start character of the frame.
First end character	Yes	0...255	10 (if check box is selected)	Allows you to specify the first end character of the frame.
Second end character	Yes	0...255	10 (if check box is selected)	Allows you to specify the second end character of the frame.
Send frame characters	Yes	True/False	False	Allows you to enable or disable sending first end character of the frame to the ASCII protocol.

TMCR2SL1A

Introduction

The TMCR2SL1A is a standard cartridge module featuring 1 isolated serial line.

For further hardware information, refer to TMCR2SL1A (see Modicon M100/M200 Logic Controller, Hardware Guide).

The serial line can be configured for any one of the following protocols:

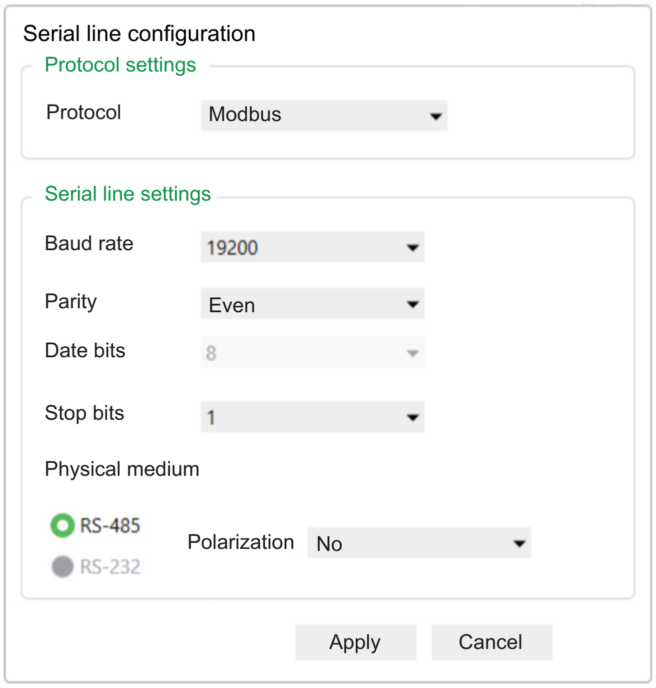
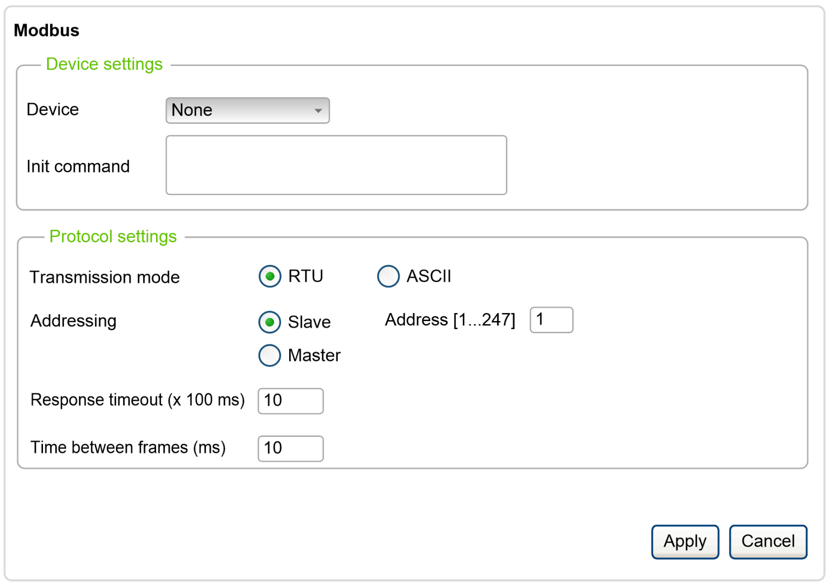
- Modbus RTU
- Modbus ASCII
- ASCII
- Modbus Serial IOScanner

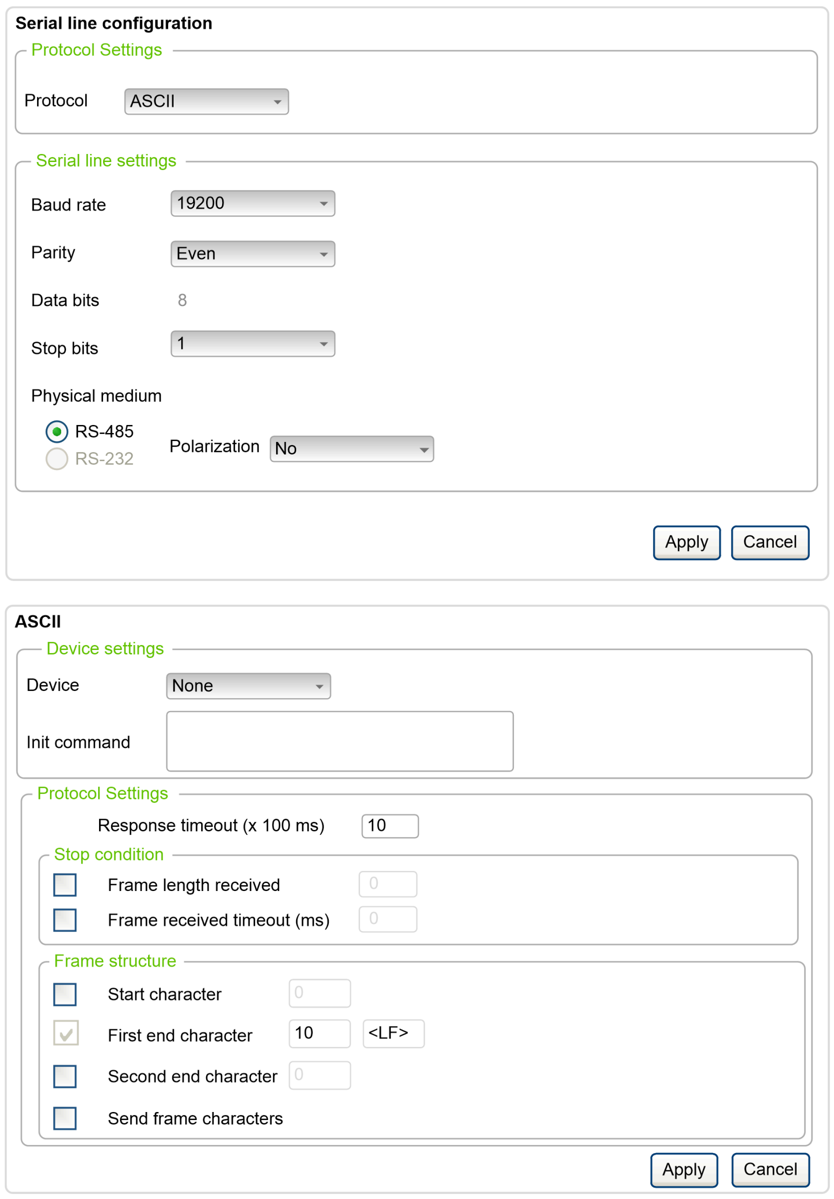
You can configure both physical and protocol settings for the serial line. Serial lines are configured for the Modbus RTU protocol by default.

NOTE: You can only add one serial line cartridge to the controller.

Serial Line Configuration

This table describes how to configure the serial line:

Step	Action
1	Click the **SL1 (Serial line)** node in the hardware tree to display the serial line properties. These figures present the properties of the serial line for **Modbus** protocols:  Serial line configuration Protocol settings Protocol: Modbus Serial line settings Baud rate: 19200 Parity: Even Date bits: 8 Stop bits: 1 Physical medium [✓ RS-485] RS-232 Polarization: No Apply Cancel  **Modbus** Device settings Device: None Init command: Protocol settings Transmission mode: [✓ RTU] ASCII Addressing: [✓ Slave] Master Address [1...247]: 1 Response timeout (x 100 ms): 10 Time between frames (ms): 10 Apply Cancel
	These figures present the properties of the serial line for **ASCII** protocol:

Step	Action
	 **Serial line configuration** Protocol Settings Protocol: ASCII Serial line settings Baud rate: 19200 Parity: Even Data bits: 8 Stop bits: 1 Physical medium ● RS-485 ○ RS-232 Polarization: No Apply Cancel **ASCII** Device settings Device: None Init command: Protocol Settings Response timeout (x 100 ms): 10 Stop condition ☐ Frame length received: 0 ☐ Frame received timeout (ms): 0 Frame structure ☐ Start character: 0 ✓ First end character: 10 <LF> ☐ Second end character: 0 ☐ Send frame characters Apply Cancel
2	Edit the properties to configure the serial line. For detailed information on the serial line configuration parameters, refer to the table below.

This table describes each parameter of the serial line:

Parameter	Editable	Value	Default value	Description
Physical settings				
Baud rate	Yes	**1200** **2400** **4800** **9600** **19200** **38400** **57600** **115200**	**19200**	Allows you to select the data transmission rate (bits per second) for the modem from the drop-down list.
Parity	Yes	**None** **Even** **Odd**	**Even**	Allows you to select the parity of the transmitted data for error detection.

Parameter	Editable	Value	Default value	Description
				Parity is a method of error detection in transmission. When parity is used with a serial port, an extra data bit is sent with each data character, arranged so that the number of 1 bits in each character, including the parity bit, is always odd or always even. If a byte is received with the wrong number of 1 bits, the byte is corrupt. However, an even number of detected errors can pass the parity check.
Data bits	Yes (only for the **ASCII** protocol	**7** **8**	**7** for Modbus ASCII, **8** for Modbus RTU	Allows you to select the number of data bits from the drop-down list. The number of data bits in each character can be 7 (for true ASCII) or 8 (for any kind of data, as this matches the size of a byte). 8 data bits are almost universally used in all applications.
Stop bits	Yes	**1** **2**	**1**	Allows you to select the number of stop bits from the drop-down list. A stop bit is a bit indicating the end of a byte of data. For electronic devices, 1 stop bit is usually used. For slow devices like electromechanical teleprinters, 2 stop bits are used.
Physical medium	Yes	**RS-485** True/False **RS-232** True/False	**RS-485** True	Allows you to select the physical medium for communication. You can only select either the **RS-485** or **RS-232** medium. Enabling one medium disables the other one. A physical medium in data communications is the transmission path over which a signal propagates. It is an interface for interconnection of devices with the logic controller.
Polarization	Yes	**Yes** **No**	**No**	Polarization resistors are integrated in the cartridge module. Specify whether to switch on or off polarization.
Protocol settings				
Protocol	Yes	**Modbus RTU** **Modbus ASCII** **ASCII** **Modbus Serial IOScanner**	**Modbus RTU**	Allows you to select the protocol transmission mode for communication from the drop-down list. Protocol advanced parameters are displayed based on the selected protocol. Refer to the following figures and tables.
Protocol settings for the **Modbus RTU** and **Modbus ASCII** protocols:				
Addressing	Yes	**Slave** **Master**	**Slave**	Allows you to select the addressing mode. You can only select either of the **Slave** or **Master** addressing. Enabling one addressing mode disables the other one.
Address [1...247]	Yes	1...247	1	Allows you to specify the address ID of the slave. **NOTE:** This field is displayed only for the addressing of the slave. For master, this field does not appear on the screen.
Response time (x 100 ms)	Yes	10...255 ms	10	Allows you to specify the response time of the protocol to the queries.
Time between frames (ms)	Yes	3...255 ms	10	Allows you to specify the time between frames of the protocol.
Protocol settings for the **ASCII** protocol:				
Stop condition				

Parameter	Editable	Value	Default value	Description
Response time (x 100 ms)	Yes	1...255	10	Allows you to specify the response time of the protocol to the queries.
Frame length received	Yes	0...255	0	Allows you to specify the frame length received.
Frame received timeout (ms)	Yes	0...255	10	Allows you to specify the frame received timeout.
Frame structure				
Start character	Yes	0...255	58 (if check box is selected)	Allows you to specify the start character of the frame.
First end character	Yes	0...255	10 (if check box is selected)	Allows you to specify the first end character of the frame.
Second end character	Yes	0...255	10 (if check box is selected)	Allows you to specify the second end character of the frame.
Send frame characters	Yes	True/False	False	Allows you to enable or disable sending first end character of the frame to the ASCII protocol.

TMCR2SL1S

Introduction

The TMCR2SL1S is a standard cartridge module featuring 1 isolated serial line.

For further hardware information, refer to TMCR2SL1S (see Modicon M100/M200 Logic Controller, Hardware Guide).

The serial line can be configured for any one of the following protocols:

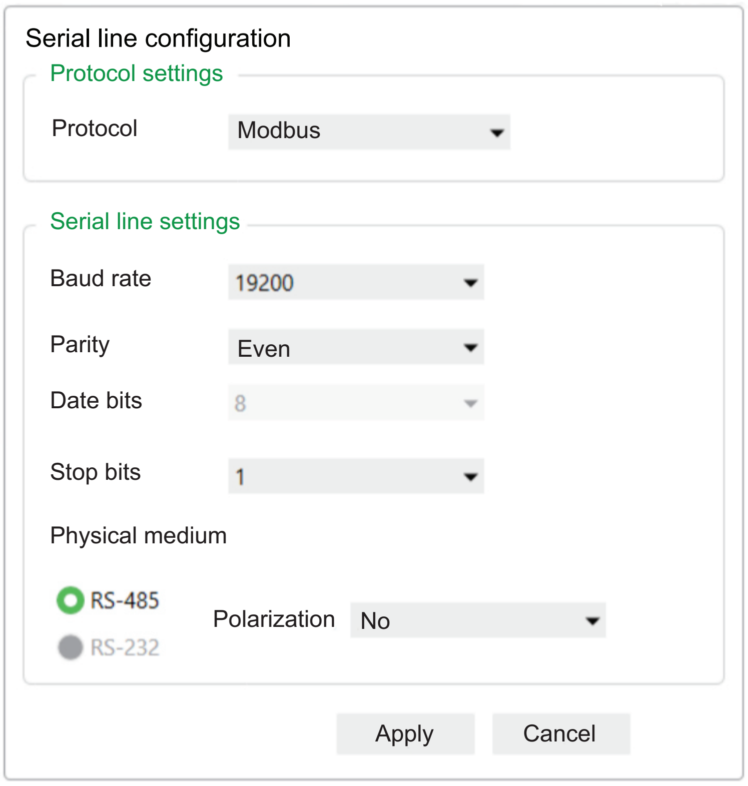
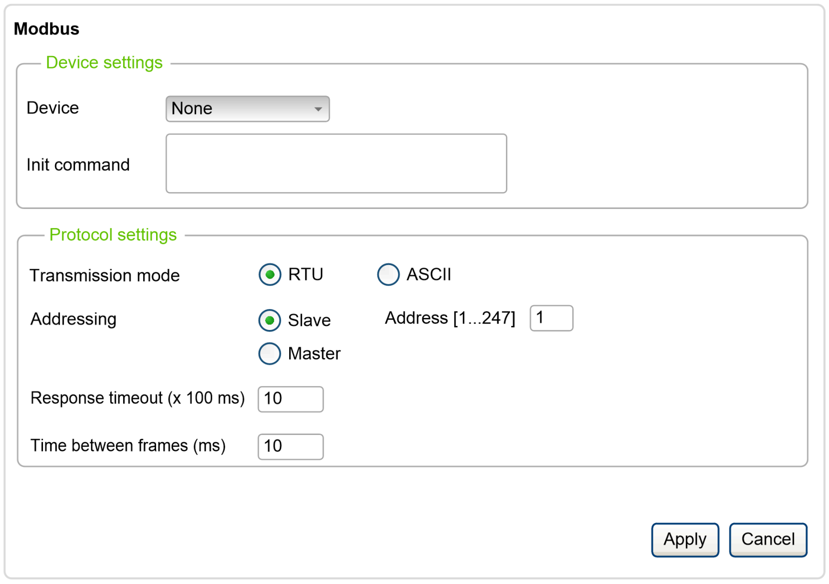
- Modbus RTU
- Modbus ASCII
- ASCII
- Modbus Serial IOScanner

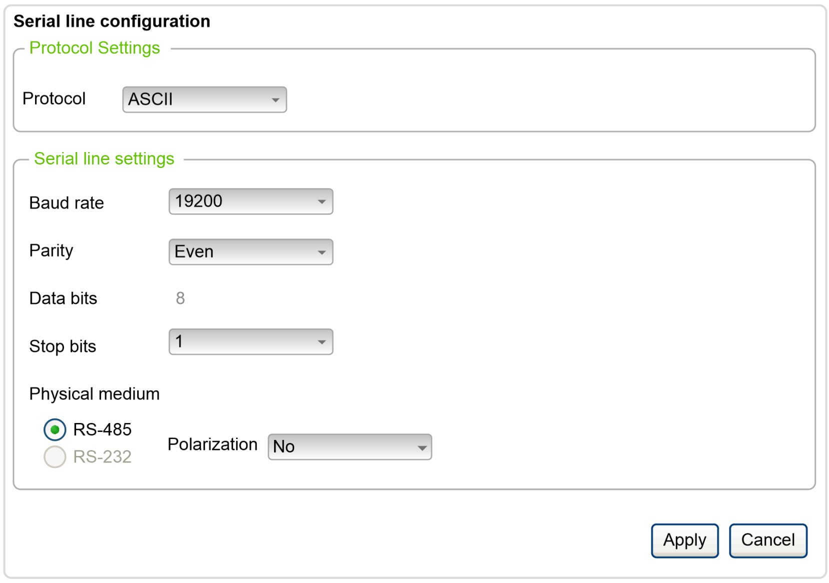
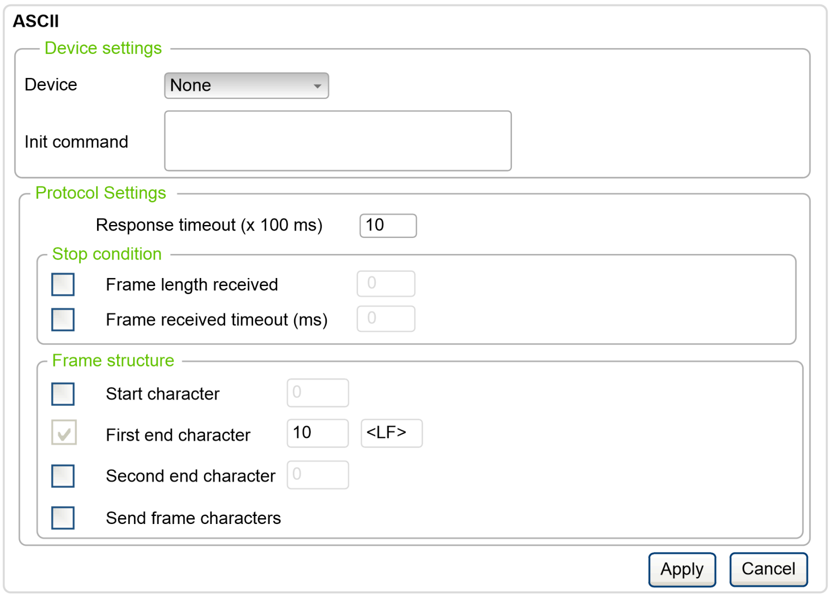
You can configure both physical and protocol settings for the serial line. Serial lines are configured for the Modbus RTU protocol by default.

NOTE: You can only add one serial line cartridge to the controller.

Serial Line Configuration

This table describes how to configure the serial line:

Step	Action
1	Click the **SL1 (Serial line)** node in the hardware tree to display the serial line properties. These figures present the properties of the serial line for **Modbus** protocols:  Serial line configuration Protocol settings Protocol: Modbus Serial line settings Baud rate: 19200 Parity: Even Date bits: 8 Stop bits: 1 Physical medium: [✓ RS-485] RS-232 Polarization: No  **Modbus** Device settings Device: None Init command: Protocol settings Transmission mode: [✓ RTU] ASCII Addressing: [✓ Slave] Master Address [1...247]: 1 Response timeout (x 100 ms): 10 Time between frames (ms): 10
	These figures present the properties of the serial line for **ASCII** protocol:

Step	Action
	 **Serial line configuration** Protocol Settings: Protocol: ASCII. Serial line settings: Baud rate: 19200; Parity: Even; Data bits: 8; Stop bits: 1; Physical medium: ● RS-485 ○ RS-232; Polarization: No. Apply / Cancel  **ASCII** Device settings: Device: None; Init command: (empty). Protocol Settings: Response timeout (x 100 ms): 10. Stop condition: ☐ Frame length received: 0; ☐ Frame received timeout (ms): 0. Frame structure: ☐ Start character: 0; ✓ First end character: 10 <LF>; ☐ Second end character: 0; ☐ Send frame characters. Apply / Cancel
2	Edit the properties to configure the serial line. For detailed information on the serial line configuration parameters, refer to the table below.

This table describes each parameter of the serial line:

Parameter	Editable	Value	Default value	Description
Physical settings				
Baud rate	Yes	**1200** **2400** **4800** **9600** **19200** **38400** **57600** **115200**	**19200**	Allows you to select the data transmission rate (bits per second) for the modem from the drop-down list.
Parity	Yes	**None** **Even** **Odd**	**Even**	Allows you to select the parity of the transmitted data for error detection.

Parameter	Editable	Value	Default value	Description
				Parity is a method of error detection in transmission. When parity is used with a serial port, an extra data bit is sent with each data character, arranged so that the number of 1 bits in each character, including the parity bit, is always odd or always even. If a byte is received with the wrong number of 1 bits, the byte is corrupt. However, an even number of detected errors can pass the parity check.
Data bits	Yes (only for the **ASCII** protocol	**7** **8**	**7** for Modbus ASCII, **8** for Modbus RTU	Allows you to select the number of data bits from the drop-down list. The number of data bits in each character can be 7 (for true ASCII) or 8 (for any kind of data, as this matches the size of a byte). 8 data bits are almost universally used in all applications.
Stop bits	Yes	**1** **2**	**1**	Allows you to select the number of stop bits from the drop-down list. A stop bit is a bit indicating the end of a byte of data. For electronic devices, 1 stop bit is usually used. For slow devices like electromechanical teleprinters, 2 stop bits are used.
Physical medium	Yes	**RS-485** True/False **RS-232** True/False	**RS-485** True	Allows you to select the physical medium for communication. You can only select either the **RS-485** or **RS-232** medium. Enabling one medium disables the other one. A physical medium in data communications is the transmission path over which a signal propagates. It is an interface for interconnection of devices with the logic controller.
Polarization	Yes	**Yes** **No**	**No**	Polarization resistors are integrated in the cartridge module. Specify whether to switch on or off polarization.
Protocol settings				
Protocol	Yes	**Modbus RTU** **Modbus ASCII** **ASCII** **Modbus Serial IOScanner**	**Modbus RTU**	Allows you to select the protocol transmission mode for communication from the drop-down list. Protocol advanced parameters are displayed based on the selected protocol. Refer to the following figures and tables.
Protocol settings for the **Modbus RTU** and **Modbus ASCII** protocols:				
Addressing	Yes	**Slave** **Master**	**Slave**	Allows you to select the addressing mode. You can only select either of the **Slave** or **Master** addressing. Enabling one addressing mode disables the other one.
Address [1...247]	Yes	1...247	1	Allows you to specify the address ID of the slave. **NOTE:** This field is displayed only for the addressing of the slave. For master, this field does not appear on the screen.
Response time (x 100 ms)	Yes	10...255 ms	10	Allows you to specify the response time of the protocol to the queries.
Time between frames (ms)	Yes	3...255 ms	10	Allows you to specify the time between frames of the protocol.
Protocol settings for the **ASCII** protocol:				
Stop condition				

Parameter	Editable	Value	Default value	Description
Response time (x 100 ms)	Yes	1...255	10	Allows you to specify the response time of the protocol to the queries.
Frame length received	Yes	0...255	0	Allows you to specify the frame length received.
Frame received timeout (ms)	Yes	0...255	10	Allows you to specify the frame received timeout.
Frame structure				
Start character	Yes	0...255	58 (if check box is selected)	Allows you to specify the start character of the frame.
First end character	Yes	0...255	10 (if check box is selected)	Allows you to specify the first end character of the frame.
Second end character	Yes	0...255	10 (if check box is selected)	Allows you to specify the second end character of the frame.
Send frame characters	Yes	True/False	False	Allows you to enable or disable sending first end character of the frame to the ASCII protocol.

TMCR2 Analog Cartridge Diagnostics

Introduction

For analog cartridges, the operating status of each I/O channel is given by the objects:

- %IWS0.x0y for input channel `y` of cartridge `x`
- %QWS0.x0y for output channel `y` of cartridge `x`

The real-time values of these objects can be read when in online mode, using either an animation table (see EcoStruxure Machine Expert - Basic, Operating Guide) or the application.

Input Channel Status Description

This table describes the possible values of the %IWS input channel status word:

Byte value	Description
0	Normal
1	Data conversion in progress
2	Initialization
3	Input operation setting error or cartridge with no input
4	Undefined
5	Wiring error detected (input voltage/current high limit exceeded).
6	Wiring error detected (input voltage/current low limit exceeded).
7	Non-volatile memory error
8...255	Undefined

Output Channel Status Description

This table describes the possible values of the %QWS output channel status word:

Byte value	Description
0	Normal
1	Undefined
2	Initialization
3	Output operation setting error or cartridge with no output
4	Undefined
5	Undefined
6	Undefined
7	Non-volatile memory error
8...255	Undefined

TM3R Expansion Module Configuration

What's in This Chapter

Overview

This chapter describes how to configure the TM3R expansion modules of the M100/M200 Logic Controller.

I/O Configuration General Practices

Match Software and Hardware Configuration

The I/O that may be embedded in your controller is independent of the I/O that you may have added in the form of I/O expansion. It is crucial that the logical I/O configuration within your program matches the physical I/O configuration of your installation. If you add or remove any physical I/O to or from the I/O expansion bus, or, depending on the controller reference, to or from the controller (in the form of cartridges), it is imperative that you update your application configuration. This is also true for any field bus devices you may have in your installation. Otherwise, there is the possibility that the I/O expansions will no longer function while the embedded I/O that may be present in your controller will continue to operate.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Update the configuration of your program each time you add or delete any type of I/O expansions on your I/O bus, or you add or delete any devices on your field bus.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Configuring the TM3R Digital I/O Modules

Introduction

The range of TM3R digital I/O expansion modules includes:

- TM3R Digital Mixed Input/Output Modules (see Modicon TM3 (EcoStruxure Machine Expert - Basic), Expansion Modules Configuration, Programming Guide)

Configuring the Modules

Configuration tab: Displaying Configuration Details in the Configuration Tab, page 107 describes how to view the configuration of these modules.

Programming tab: Displaying Configuration Details in the Programming Tab, page 108 describes how to view and update programming-related properties of these modules.

Using I/O Modules in a Configuration

Adding a Module

The following steps explain how to add a TM3R expansion module to the logic controller in a EcoStruxure Machine Expert-Basic project:

Step	Action
1	Click the **Configuration** tab in the EcoStruxure Machine Expert-Basic window.
2	In the catalog area, click one of the following module types to expand the list of expansion modules: • **TM3 Digital I/O Modules**
3	Select the TM3R expansion module to add from the list. **Result**: The description of the physical characteristics of the selected expansion module appears in the bottom of the catalog area.
4	Drag the selected expansion module to the editor area and drop the module on the right-hand side of the controller or the last expansion module in the configuration or the TM3 bus coupler. **Result**: The module is added under the **My Controller > I/O Bus** branch of the hardware tree and the description of the physical characteristics of the selected module appears in the bottom of the editor area.

Inserting a Module Between two Existing Modules

Drag the module between two modules, or between the controller and the first module until a vertical green bar appears and then drop the module.

NOTE: The addresses change when you change the position of modules by inserting a new module. For example, if you move an input module from position 4 to position 2, the addresses change from `I4.x` to `I2.x`, and all corresponding addresses in the program are automatically renamed.

The I/O that may be embedded in your controller is independent of the I/O that you may have added in the form of I/O expansion. It is important that the logical I/O configuration within your program matches the physical I/O configuration of your installation. If you add or remove any physical I/O to or from the I/O expansion bus or, depending on the controller reference, to or from the controller (in the form of cartridges), then you must update your application configuration. This is also true for any field bus devices you may have in your installation. Otherwise, there is the potential that the expansion bus or field bus will no longer function while the embedded I/O that may be present in your controller will continue to operate.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Update the configuration of your program each time you add or delete any type of I/O expansions on your I/O bus, or you add or delete any devices on your field bus.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Replacing an Existing Expansion Module

You can replace an existing module with a new module by dragging the new module and dropping it onto the module to be replaced.

A message appears asking you to confirm the operation. Click **Yes** to continue.

Removing a Module

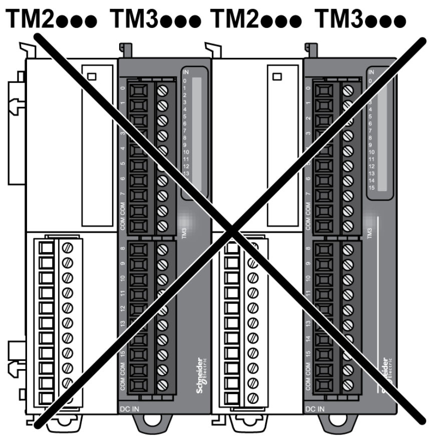
You can remove an expansion module by pressing the **Delete** key or by right-clicking the module and clicking **Remove** on the contextual menu that appears.

If the expansion module contains at least one address being used in a program, a message appears asking you to confirm the operation. Click **Yes** to continue.

Mixing Expansion Module Types

You can mix different I/O module types on the same logic controller (for example, TM3R, TM3, and TM2 modules).

Place any TM2 module(s) at the end of your configuration after any TM3 module (s):



In this case, however, the I/O bus of the logic controller operates at the speed of the slower module type. For example, when both TM2 and TM3 modules are used, the I/O bus of the logic controller operates at the speed of the TM2 modules.

Maximum Hardware Configuration

EcoStruxure Machine Expert-Basic displays a message when:

- The maximum number of modules supported by the logic controller is exceeded.
- The total power consumption of all expansion modules directly connected to the logic controller exceeds the maximum current delivered by the logic controller.

Refer to the hardware guide of your controller for more information on the maximum supported configuration.

Optional I/O Expansion Modules

Presentation

I/O expansion modules can be marked as optional in the configuration. The **Optional module** feature provides a more flexible configuration by the acceptance of the definition of modules that are not physically attached to the logic controller. Therefore, a single application can support multiple physical configurations of I/O expansion modules, allowing a greater degree of scalability without the necessity of maintaining multiple application files for the same application.

Without the **Optional module** feature, when the logic controller starts up the I/O expansion bus (following a power cycle, application download or initialization command), it compares the configuration defined in the application with the physical I/O modules attached to the I/O bus. Among other diagnostics made, if the logic controller determines that there are I/O modules defined in the configuration that are not physically present on the I/O bus, an error is detected and the I/O bus does not start.

With the **Optional module** feature, the logic controller ignores the absent I/O expansion modules that you have marked as optional, which then allows the logic controller to start the I/O expansion bus.

The logic controller starts the I/O expansion bus at configuration time (following a power cycle, application download, or initialization command) even if optional expansion modules are not physically connected to the logic controller.

The following module types can be marked as optional:

- TM3 I/O expansion modules
- TM2 I/O expansion modules

  NOTE: TM3 Transmitter/Receiver modules (TM3XTRA1 and the TM3XREC1) and TMC2 cartridges cannot be marked as optional.

The application must be configured with a functional level of at least **Level 3.2** for modules marked as optional to be recognized as such by the logic controller.

You must be fully aware of the implications and impacts of marking I/O modules as optional in your application, both when those modules are physically absent and present when running your machine or process. Be sure to include this feature in your risk analysis.

⚠ WARNING

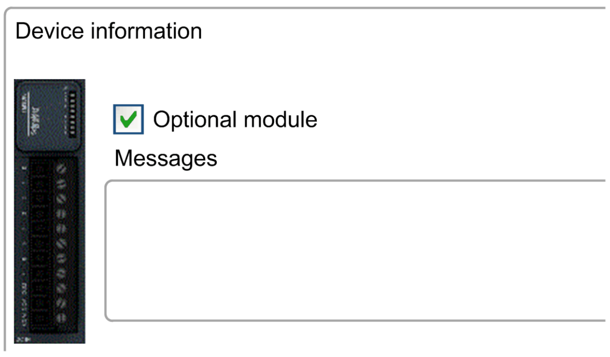
UNINTENDED EQUIPMENT OPERATION

Include in your risk analysis each of the variations of I/O configurations that can be realized marking I/O expansion modules as optional, and in particular the establishment of TM3 Safety modules (TM3S…) as optional I/O modules, and make a determination whether it is acceptable as it relates to your application.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Marking an I/O Expansion Module as Optional in Offline Mode

To add a module and mark it as optional in the configuration:

Step	Action
1	Drag-and-drop the I/O expansion module from the catalog to the editor.
2	In the **Device information** area, select the **Optional module** check box:  Device information ✓ Optional module Messages

To mark an existing I/O expansion module as optional in the configuration:

Step	Action
1	Select the I/O expansion module in the editor.
2	In the **Device information** area, select the **Optional module** check box.

Optional I/O Expansion Modules in Online Mode

EcoStruxure Machine Expert - Basic operates in online mode when a physical connection to a logic controller has been established.

When in EcoStruxure Machine Expert - Basic online mode, the modification of the **Optional module** feature is disabled. You can visualize the downloaded configuration in the application:

- An I/O expansion module represented in yellow is marked as optional and not physically connected to the logic controller at start-up. An information message to that effect is displayed in the **Device information** area.
- An I/O expansion module represented in red is not marked as optional and not detected at start-up. An information message to that effect is displayed in the **Device information** area.

The selection of the **Optional module** feature is used by the logic controller to start the I/O bus. The following system words are updated to indicate the status of the physical I/O bus configuration:

System Word	Comment
`%SW118` Logic controller status word	Bits 13 and 14 are pertinent to the I/O module status relative to the I/O bus. Bit 13, if FALSE, indicates that there are mandatory modules as defined by the I/O expansion bus configuration that are absent or otherwise inoperative when the logic controller attempts to start the I/O expansion bus. In this case, the I/O bus does not start. Bit 14, if FALSE, indicates that one or more modules have ceased communication with the logic controller after the I/O expansion bus is started. This is the case whether an I/O expansion module is defined as mandatory or as an optional module but present at start-up.
`%SW119` I/O expansion module configuration	Each bit, starting with bit 1 (bit 0 is reserved), is dedicated to a configured I/O expansion module and indicates whether the module is optional (TRUE) or mandatory (FALSE) when the controller attempts to start the I/O bus.
`%SW120` I/O expansion module status	Each bit, starting with bit 1 (bit 0 is reserved), is dedicated to a configured I/O expansion module and indicates the status of the module. When the logic controller attempts to start the I/O bus, if the value of `%SW120` is non-zero (indicating that an error is detected for at least one of the modules), the I/O expansion bus does not start unless the corresponding bit in `%SW119` is set to TRUE (indicating the module is marked as an optional module). When the I/O bus is started, if the value of `%SW120` is modified by the system, it indicates that an error is detected on one or more I/O expansion modules (regardless of the **Optional module** feature).

Internal ID Codes

Logic controllers identify expansion modules by a simple internal ID code. This ID code is not specific to each reference, but identifies the structure of the expansion module. Therefore, different references can share the same ID code.

If you declare two modules with the same internal ID code next to each other in the configuration and both are declared as optional, a message appears at the bottom of the **Configuration** window. There must be at least one non-optional module between two optional modules.

This table shows the internal ID codes of expansion modules:

Modules sharing the same internal ID code	ID code
TM2DDI16DT, TM2DDI16DK	0
TM2DRA16RT, TM2DDO16UK, TM2DDO16TK	1
TM2DDI8DT, TM2DAI8DT	4
TM2DRA8RT, TM2DDO8UT, TM2DDO8TT	5
TM2DDO32TK, TM2DDO32UK	3
TM2DMM24DRF, TM2DDI32DK	2
TM2DMM8DRT	6
TM2ALM3LT, TM2AMI2HT, TM2AMI2LT, TM2AMI4LT, TM2AMI8HT, TM2AMM3HT, TM2AMM6HT, TM2AMO1HT, TM2ARI8HT, TM2ARI8LRJ, TM2ARI8LT, TM2AVO2HT	96
TM3DI16K, TM3DI16, TM3DI16G	128
TM3DQ16R, TM3DQ16RG, TM3DQ16T, TM3DQ16TG, TM3DQ16TK, TM3DQ16U, TM3DQ16UG, TM3DQ16UK	129
TM3DQ32TK, TM3DQ32UK	131
TM3DI8, TM3DI8G, TM3DI8A	132
TM3DQ8R, TM3DQ8RG, TM3DQ8T, TM3DQ8TG, TM3DQ8U, TM3DQ8UG	133
TM3DM8R, TM3DM8RG	134
TM3DM24R, TM3DM24RG	135
TM3SAK6R, TM3SAK6RG	144
TM3SAF5R, TM3SAF5RG	145
TM3SAC5R, TM3SAC5RG	146
TM3SAFL5R, TM3SAFL5RG	147
TM3AI2H, TM3AI2HG	192
TM3AI4, TM3AI4G	193
TM3AI8, TM3AI8G, TM3AI8C, TM3AI8CG	194
TM3AQ2, TM3AQ2G	195
TM3AQ4, TM3AQ4G, TM3AQ4C, TM3AQ4CG	196
TM3AM6, TM3AM6G, TM3AM6C, TM3AM6CG	197
TM3TM3, TM3TM3G	198
TM3TI4, TM3TI4G	199
TM3TI4D, TM3TI4DG	203
TM3TI8T, TM3TI8TG	200
TM3DI32K	130
TM3XTYS4	136

Configuring Digital I/Os

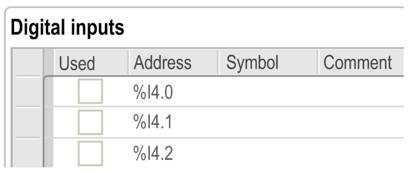
Overview

You can configure digital I/Os of your expansion module using:

- **Configuration** tab:
  - Digital inputs, page 106
  - Digital outputs, page 107
- **Programming** tab, page 108.

Configuring Digital Inputs in the Configuration Tab

Follow these steps to display and configure the digital input properties in the **Configuration** tab:

Step	Description
1	Click the **Configuration** tab in the EcoStruxure Machine Expert-Basic window.
2	In the hardware tree, click **MyController > IO Bus > Module x > Digital inputs**, where x is the expansion module number on the controller. **Result**: The digital input properties of the selected module are displayed in the editor area, for example:  Digital inputs Used | Address | Symbol | Comment ☐ | %I4.0 | | ☐ | %I4.1 | | ☐ | %I4.2 | |
3	Edit the properties to configure the digital inputs: • **Used**: Indicates whether the corresponding address is being used in the program or not. • **Address**: Displays the address of the digital input on the expansion module. For details on addressing I/O objects, refer to I/O Addressing (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide). • **Symbol**: Allows you to specify a symbol to associate with the corresponding digital input object to be used in the program. Double-click in the **Symbol** column, type the symbol name of the corresponding object, and press **Enter**. • **Comment**: Allows you to specify a comment to associate with the corresponding digital input object. Double-click in the **Comment** column, type a comment for the corresponding object, and press **Enter**.
4	Click **Apply** to save the changes.

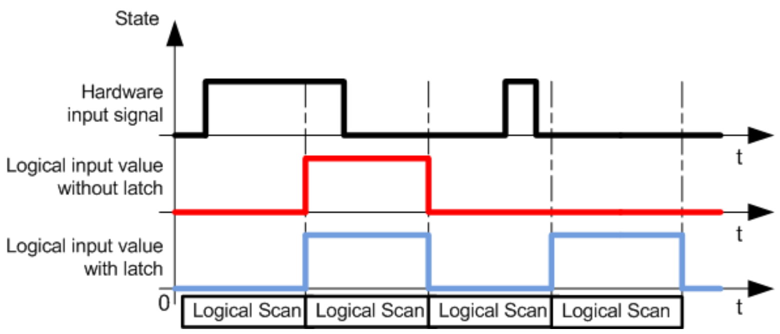
Configuring the Latch and Filter Parameters

The latch parameter allows incoming pulses with amplitude widths shorter than the controller scan time to be captured and recorded. You can select the type of edge (rising, falling, both or none).

The filter parameter reduces the effect of bounce on a controller digital input.

NOTE: The more the filter value is low, the more the effects of electromagnetic interference are maximized.

The following timing diagram illustrates the latching effects:



NOTE: You can configure these parameters on the following modules:

- TM3DI• except TM3DI8A
- TM3DM•
- TM3XHSC202 / TM3XHSC202G

This table describes how to configure the latch and filter parameters.

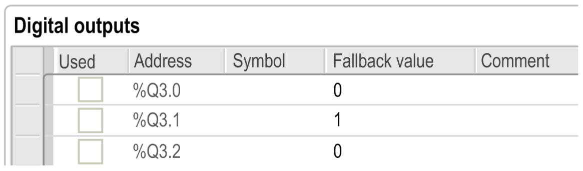
Step	Action
1	Click the module node **>** **I/O Configuration** tab.
2	Select **2** as **Value** for **Functional Mode**.
3	Select an input.
4	Configure the parameters.

This table describes the latch and filter parameters:

Parameter	Type	Value	Default Value	Unit	Description
Fonctional Mode	**Enumeration of BYTE**	**1** **2**	**1**	–	**Fonctional Mode 2** allows you to configure latch and filter parameters.
Inputs					
Latch	**Enumeration of BYTE**	**No** **Both edges** **Rising edge** **Falling edge**	**No**	–	Latching allows incoming pulses with amplitude widths shorter than controller scan time to be captured and recorded. **NOTE: Latch** is not supported when the expansion module is used with a Modicon TM3 Bus Coupler.
Filter	**Enumeration of BYTE**	**0** **0.1** **0.2** **0.3** **0.5** **1** **2** **4** **12**	**4**	ms	Integrator filtering value reduces the effect of bounce on a controller input.

Configuring Digital Outputs in the Configuration Tab

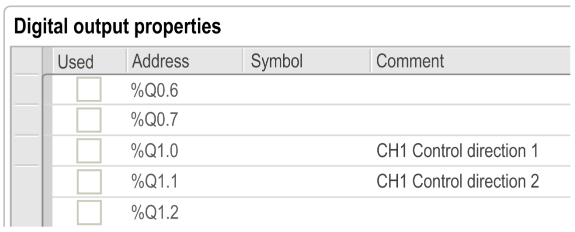
Follow these steps to display and configure the digital output properties in the **Configuration** tab:

Step	Description
1	Click the **Configuration** tab in the EcoStruxure Machine Expert-Basic window.
2	In the hardware tree, click **MyController > IO Bus > Module x > Digital outputs**, where x is the expansion module number on the controller. **Result**: The digital output properties of the selected module are displayed in the editor area, for example:  Digital outputs Used | Address | Symbol | Fallback value | Comment ☐ | %Q3.0 | | 0 | ☐ | %Q3.1 | | 1 | ☐ | %Q3.2 | | 0 |
3	Edit the properties to configure the digital outputs: • **Used**: Indicates whether the corresponding address is being used in the program or not. • **Address**: Displays the address of the digital output on the expansion module. For details on addressing I/O objects, refer to I/O Addressing (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide). • **Symbol**: Allows you to specify a symbol to associate with the corresponding digital output object to be used in the program. Double-click in the **Symbol** column, type the symbol name of the corresponding object, and press **Enter**. • **Fallback value**. Allows you to specify the value to apply to the corresponding output (fallback to 0 or fallback to 1) when the logic controller enters the STOPPED or an exception state. The default value is 0. If **Maintain values** fallback mode is configured, the output retains its current value when the logic controller enters the STOPPED or an exception state. For more details on maintaining output values, refer to Fallback Behavior. • **Comment**: Allows you to specify a comment to associate with the corresponding digital output object. Double-click in the **Comment** column, type a comment for the corresponding object, and press **Enter**.
4	Click **Apply** to save the changes.

Displaying Configuration Details in the Programming Tab

The **Programming** tab displays configuration details of all inputs/outputs and allows you to update programming-related properties such as symbols and comments.

Follow these steps to view and update details of I/O modules in the **Programming** tab:

Step	Description
1	Click the **Programming** tab in the EcoStruxure Machine Expert-Basic window.
2	In the left-hand area of the **Programming** tab, click on the **Tools** tab and from the **I/O objects** branch, select one of the following I/O types to display the properties: • **Digital inputs** • **Digital outputs** • **Analog inputs** • **Analog outputs** **Result**: A list of all embedded and expansion module I/O addresses appears in the lower central area of the EcoStruxure Machine Expert-Basic window, for example:  Digital output properties Used | Address | Symbol | Comment ☐ | %Q0.6 | | ☐ | %Q0.7 | | ☐ | %Q1.0 | | CH1 Control direction 1 ☐ | %Q1.1 | | CH1 Control direction 2 ☐ | %Q1.2 | |

Step	Description
3	Scroll down to the range of addresses corresponding to the expansion module you are configuring. The following properties are displayed: • **Used**: Indicates whether the corresponding address is being used in the program or not. • **Address**: Displays the address of the digital output on the expansion module. For details on addressing I/O objects, refer to I/O Addressing (see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide). • **Symbol**: Allows you to specify a symbol to associate with the corresponding I/O object to be used in the program. Double-click in the **Symbol** column, type the symbol name of the corresponding object, and press **Enter**. If a symbol already exists, right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments. • **Comment**: Allows you to specify a comment to associate with the corresponding I/O object. Double-click in the **Comment** column, type a comment for the corresponding object, and press **Enter**.
4	Click **Apply** to save the changes.

TM3R Analog I/O Modules Diagnostics

Introduction

The operating status of each I/O channel is given by the objects:

- %IWSx.y for input channel `y` of module `x`
- %QWSx.y for output channel `y` of module `x`

Input Channel Status Byte Description

This table describes the %IWS input channel status bytes:

Byte value	Description
0	Normal
1	Undefined
2	Undefined
3	Configuration error detected.
4	External power supply error detected.
5	Wiring error detected (input voltage/current high limit exceeded).
6	Wiring error detected (input voltage/current low limit exceeded).
7	Hardware error detected.
8...255	Undefined

Output Channel Status Byte Description

This table describes the %QWSoutput channel status byte:

Byte value	Description
0	Normal
1	Undefined

Byte value	Description
2	Undefined
3	Configuration error detected
4	External power supply voltage limits exceeded
5	Undefined
6	Undefined
7	Hardware error detected
8...255	Undefined

Embedded Communication Configuration

What’s in This Chapter

Overview

This chapter describes how to configure the communication features of the M100/ M200 Logic Controller.

Ethernet Configuration

Configuring Ethernet Network

Introduction

You can configure the TCP/IP connection to the logic controller by configuring the Ethernet network. The Ethernet establishes a local area network (LAN) between the logic controller and other devices. The Ethernet configuration provides you the ability to configure the IP address of the network device.

NOTE: The controller-PC link uses the TCP/IP protocol. It is required for this protocol to be installed on the PC.

You can obtain the IP address by the following protocols:

- Dynamic Host Configuration Protocol (DHCP)
- Bootstrap Protocol (BOOTP)

You can also specify the IP address by specifying the following addresses:

- IP address
- Subnet mask
- Gateway address

NOTE: Schneider Electric adheres to industry best practices in the development and implementation of control systems. This includes a "Defense-in-Depth" approach to secure an Industrial Control System. This approach places the controllers behind one or more firewalls to restrict access to authorized personnel and protocols only.

⚠WARNING

UNAUTHENTICATED ACCESS AND SUBSEQUENT UNAUTHORIZED MACHINE OPERATION

- Evaluate whether your environment or your machines are connected to your critical infrastructure and, if so, take appropriate steps in terms of prevention, based on Defense-in-Depth, before connecting the automation system to any network.
- Limit the number of devices connected to a network to the minimum necessary.
- Isolate your industrial network from other networks inside your company.
- Protect any network against unintended access by using firewalls, VPN, or other, proven security measures.
- Monitor activities within your systems.
- Prevent subject devices from direct access or direct link by unauthorized parties or unauthenticated actions.
- Prepare a recovery plan including backup of your system and process information.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Ethernet Services

The logic controller supports the following services:

- Modbus TCP Server (see Modicon M258 Logic Controller, Programming Guide)
- Modbus TCP Clinet (see Modicon M258 Logic Controller, Programming Guide)
- Modbus TCP Slave Device

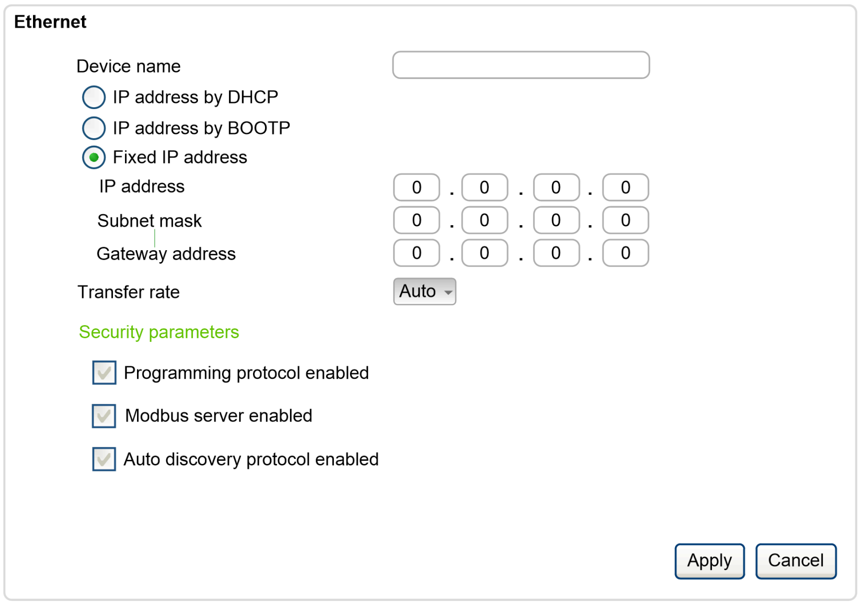
This table presents the maximum number of TCP server connections:

Connection Type	**Maximum Number of Connections**
Server	8
Client	1

Each server based on TCP manages its own set of connections. When a client tries to open a connection that exceeds the poll size, the logic controller closes the oldest connection, other than the connection with EcoStruxure Machine Expert-Basic . The server connections stay open as long as the logic controller stays in its present operational state (RUNNING, STOPPED, or HALTED). The server connections are closed when a transition is made from its present operational state (RUNNING, STOPPED, or HALTED), except in case of power outage (because the controller does not have time to close the connections).

Ethernet Configuration

This table describes how to configure the Ethernet:

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Click the <b>ETH1</b> node in the hardware tree to display the Ethernet properties in the editor area.

Ethernet
Device name
IP address by DHCP
IP address by BOOTP
[✓ Fixed IP address]
IP address 0 . 0 . 0 . 0
Subnet mask 0 . 0 . 0 . 0
Gateway address 0 . 0 . 0 . 0
Transfer rate Auto
Security parameters
✓ Programming protocol enabled
✓ Modbus server enabled
✓ Auto discovery protocol enabled
Apply Cancel</td></tr>
<tr><td>2</td><td>Edit the properties to configure the Ethernet.
For detailed information on the Ethernet configuration parameters, refer to the table below.</td></tr>
</table>

NOTE: The Security Parameters displayed depend on the functional level (see EcoStruxure Machine Expert - Basic, Operating Guide) selected for the application.

This table describes each parameter of the Ethernet configuration:

<table>
<tr><th>Parameter</th><th>Editable</th><th>Value</th><th>Default Value</th><th>Description</th></tr>
<tr><td colspan="5"><b>Ethernet</b></td></tr>
<tr><td><b>Device name</b></td><td>No</td><td><i>Any</i></td><td><b>M200</b> (if the controller used in the configuration is M100/M200 Logic Controller)</td><td>Displays the name of the device that is connected with the Ethernet network.</td></tr>
<tr><td><b>IP address by DHCP</b></td><td>Yes(1)</td><td>True/False</td><td>False</td><td>Allows you to obtain the IP address from the DHCP server on the network.</td></tr>
<tr><td><b>IP address by BOOTP</b></td><td>Yes(1)</td><td>True/False</td><td>False</td><td>Allows you to obtain the IP address from the Boot PROM configuration server on the network.</td></tr>
<tr><td><b>Fixed IP address</b></td><td>Yes(1)</td><td>True/False</td><td>True</td><td>Allows you to specify the IP address manually for host or network interface identification.</td></tr>
<tr><td><b>IP address</b></td><td>Yes(2)</td><td><i>w.x.y.z</i>(3)</td><td>0.0.0.0</td><td>Allows you to specify the IP address of the device in the Ethernet network. See Address Classes, page 115

Assigning 0.0.0.0 (the default) as IP address for the M100/M200 Logic Controller forces the firmware to generate an IP address from the MAC address.

The generated IP address is 10.10.XXX.YYY, where XXX and YYY are the decimal values of the last 2 bytes (EE.FF) of the MAC address (AA.BB.CC.DD.EE.FF)

Example:

MAC address: 00:80:78:19:19:73

EE (19 hex) = <b>25</b> decimal)

FF (73 hex) = <b>155</b> decimal

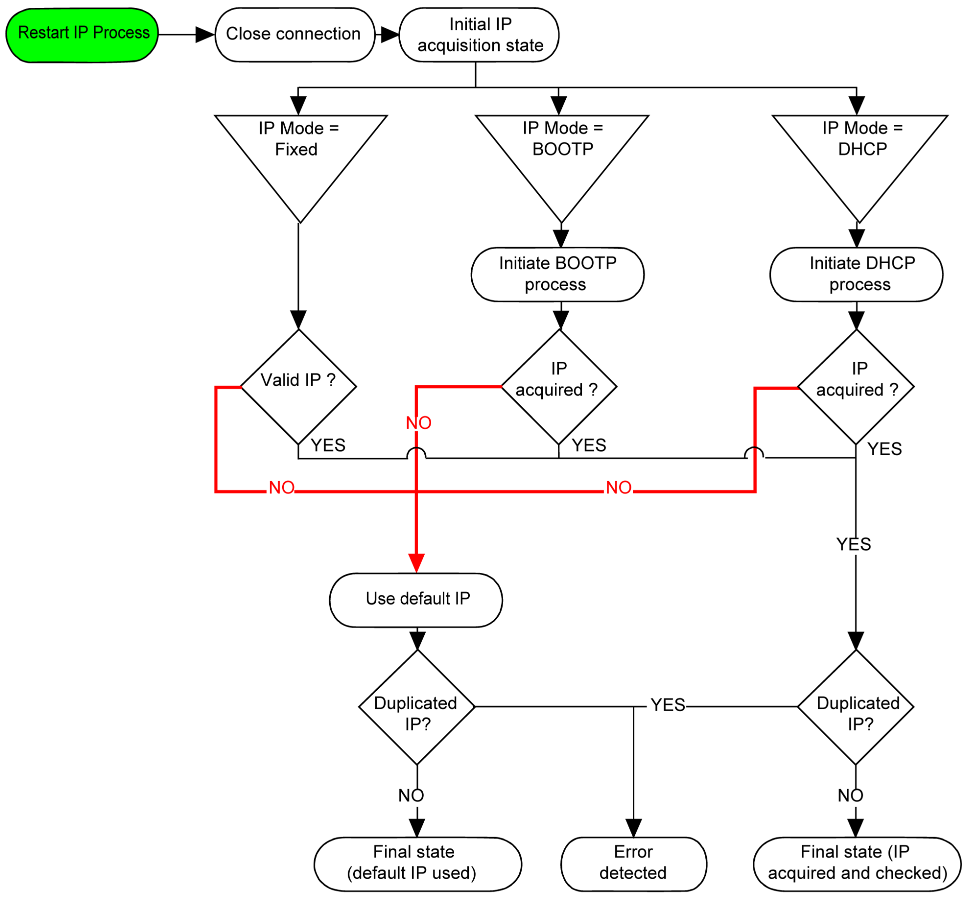
IP address generated: 10.10.<b>25.155</b>.</td></tr>
</table>

Parameter	Editable	Value	Default Value	Description
				The firmware also generates an IP address from the MAC address if the specified IP address is identified as being a duplicate address on the network. Bit 9 of system word %SW118 is set to 1 (see System Words Description, page 328) and system word %SW62 is set to 1 (see System Words Description, page 328) when a duplicated IP address is detected. The MAC address of the logic controller is stored in %SW107-%SW109 (see System Words Description, page 328).
Subnet mask	Yes(2)	*w.x.y.z*(3)	0.0.0.0	Allows you to specify the address of the subnetwork to authorize a group of devices for data exchange. It determines which bits in an IP address correspond to the network address and which bits correspond to the subnet portions of the address. See Subnet Mask, page 116.
Gateway address	Yes(2)	*w.x.y.z*(3)	0.0.0.0	Allows you to specify the IP address of the node (a router) on a TCP/IP network that serves as an access point to another network. See Gateway Address, page 116.
Transfer Rate	No	–	**Auto**	Displays the selected mode for Ethernet speed. Auto stands for "Auto Negotiation".
Security Parameters				
Programming protocol enabled	Yes	True/False	True	Allows you to enable or disable programming protocol for communication with the other devices in the network.
Auto discovery protocol enabled	Yes	True/False	True	Allows you to enable or disable auto discovery protocol to automatically detect the devices in a network.
Modbus server enabled	Yes	True/False	True	Allows you to enable or disable Modbus server for serial device connectivity.
(1) You can select any 1 option for IP addressing. Selecting any 1 option, disables the other options. (2) These options are enabled only if you select the option **Fixed IP Address** for IP addressing. (3) *w*, *x*, *y*, and *z* are the bytes that store the address and each byte can store a value in the range 0...255.				

NOTE: When a protocol listed in **Security Parameters** is disabled, requests from the corresponding server type are ignored. The corresponding configuration screen remains accessible; however, program execution is not affected.

Address Management

This diagram presents the different types of address systems for the M100/M200 Logic Controller:



NOTE: If a device programmed to use the DHCP or BOOTP addressing methods is unable to contact its respective server, the controller uses the default IP address. It will, however, constantly repeat its request.

The IP process restarts in the following cases:

- Controller reboot
- Ethernet cable reconnection
- Application download (if IP parameters change)
- DHCP or BOOTP server detected after a prior addressing attempt was unsuccessful or when the DHCP address lease expires.

Address Classes

The IP address is linked:

- to a device (the host)
- to the network to which the device is connected

An IP address is always coded using 4 bytes.

The distribution of these bytes between the network address and the device address may vary.This distribution is defined by the address classes.

The different IP address classes are defined in this table:

Address Class	Byte1			Byte 2	Byte 3	Byte 4
Class A	0	Network ID		Host ID		
Class B	1	0	Network ID		Host ID	

Address Class	Byte1					Byte 2	Byte 3	Byte 4
Class C	1	1	0	Network ID				Host ID
Class D	1	1	1	0	Multicast Address			
Class E	1	1	1	1	0	Address reserved for subsequent use		

Subnet Mask

The subnet mask is used to address several physical networks with a single network address. The mask is used to separate the subnetwork and the device address in the host ID.

The subnet address is obtained by retaining the bits of the IP address that correspond to the positions of the mask containing 1, and replacing the others with 0.

Conversely, the subnet address of the host device is obtained by retaining the bits of the IP address that correspond to the positions of the mask containing 0, and replacing the others with 1.

Example of a subnet address:

IP address	192 (11000000)	1 (00000001)	17 (00010001)	11 (00001011)
Subnet mask	255 (11111111)	255 (11111111)	240 (11110000)	0 (00000000)
Subnet address	192 (11000000)	1 (00000001)	16 (00010000)	0 (00000000)

NOTE: The device does not communicate on its subnetwork when there is no gateway.

Gateway Address

The gateway allows a message to be routed to a device that is not on the current network.

If there is no gateway, the gateway address is 0.0.0.0.

Configuring Modbus TCP or Modbus TCP IOScanner

Introduction

You can configure the Ethernet port for Modbus TCP or Modbus TCP IOScanner as:

- Modbus mapping, page 117
- Client mode, page 118

Only one instance of IOScanner can be defined: if you configure it on a serial port, you cannot configure it on an Ethernet port and vice versa. Refer to Configuring Modbus Serial IOScanner, page 128.

The maximum number of TCP and Serial IOScanner objects is:

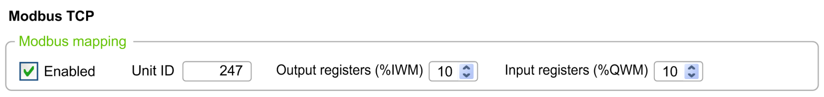
- 128, if the **Functional Level** < **6.0**.
- 512, if the **Functional Level** ≥ **6.0**.

If a communication interruption occurs, the IOScanner stops. For more information on the status, refer to the description of `%SW212` in the System Words Description, page 328.

Use the following system bits to reset or suspend the Modbus TCP IOScanner, refer to `%S112` and `%S115` in the System Bits Description, page 323.

Configuring Modbus TCP: Modbus Mapping

This table describes how to configure Modbus mapping:

Step	Action
1	In the **Configuration** window, click **ETH1**→ **Modbus TCP** to display the Modbus TCP properties. The following illustration shows the properties displayed in the editor area:  Modbus TCP Modbus mapping ☑ Enabled Unit ID 247 Output registers (%IWM) 10 Input registers (%QWM) 10
2	Select **Enabled** to edit the properties to configure **Modbus mapping**. **NOTE:** If the **Enabled** button is grayed out, verify that the **Functional Level** of your application (**Programming > Tasks > Behavior** tab) is at least **Level 3.2**.
3	Click **Apply**.

This table describes each parameter of the **Modbus mapping** configuration:

Parameter	Editable[1]	Value	Default Value	Description
Enabled	Yes	TRUE/FALSE	FALSE	Select to enable **Modbus mapping**. **NOTE:** If you deselect the **Enabled** check box, and you have used network variables in your program, they are no longer valid and your program can no longer be compiled. If you wish to temporarily disable the Modbus TCP/IP services without invalidating the use of its network variables, you can deactivate the **Security Parameters** for the protocol in the Ethernet properties window, page 115.
Unit ID	Yes	1...247	-	Specify the unit ID of the local server. Modbus TCP requests originating from a device with the same unit ID are sent to the Modbus mapping table instead of the regular Modbus server.
Output registers (% IWM)	Yes	1...20	10	The number of output registers available. Output registers are used to store the values of Modbus TCP (%IWM) objects.
Input registers (%QWM)	Yes	1...20	10	The number of input registers available. Input registers are used to store the values of Modbus TCP (%QWM) objects.

[1] Only if the **Modbus server enabled** option is selected in the **Security Parameters** section of the Ethernet properties windows, page 115.

Modbus TCP Slave Device I/O Mapping Table

When the Modbus TCP slave device has been configured, Modbus commands sent to its unit ID (Modbus address) access network objects (*%IWM* and *%QWM*) of the controller, instead of the regular Modbus words accessed when the unit ID is 255. This facilitates read/write operations by a Modbus master I/O scanner application.

If the unit ID selected in the master is not the one configured in the M100/M200 slave (or vice versa), data is read or written to regular Modbus words *%MWx* instead of network objects *%IWMx* and *%QWMx*. No Modbus error is returned.

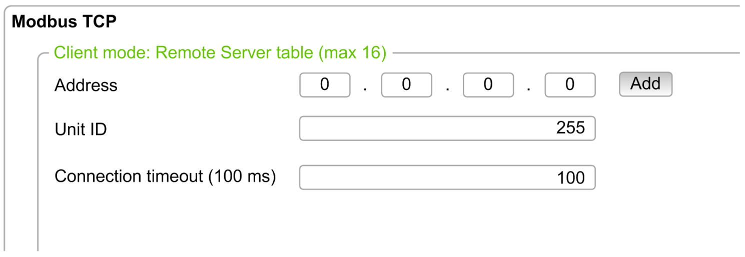
Access to the Modbus TCP slave I/O mapping table (*%IWM*/*%QWM*) is done with the same priority as access to regular Modbus words (*%MW*).

The Modbus TCP slave device responds to a subset of the Modbus function codes, but does so in a way that differs from Modbus standards, with the purpose of exchanging data with the external I/O scanner. The following Modbus function codes are supported by the Modbus TCP slave device:

Function Code Dec (Hex)	Function	Comment
3 (3 hex)	Read output register	Allows the master I/O scanner to read network object `%QWM` of the device
4 (4 hex)	Read input registers	Allows the master I/O scanner to read network object `%IWM` of the device
6 (6 hex)	Write single register	Allows the master I/O scanner to write a single network object `%IWM` of the device
16 (10 hex)	Write multiple registers	Allows the master I/O scanner to write to multiple network objects `%IWM` of the device
23 (17 hex)	Read/write multiple registers	Allows the master I/O scanner to read network object `%QWM` and write network object `%IWM` of the device

Configuring Modbus TCP: Client Mode

This table describes how to configure client mode:

Step	Action
1	In the **Configuration** window, click **ETH1**→ **Modbus TCP** to display the Modbus TCP properties. The following illustration shows the properties displayed in the editor area:  **Modbus TCP** Client mode: Remote Server table (max 16) Address 0 . 0 . 0 . 0 Add Unit ID 255 Connection timeout (100 ms) 100
2	Add a remote device. Refer to Adding Remote Devices, page 118.
3	If you want to configure Modbus TCP IOScanner, select **Enable Modbus TCP IOScanner**. **NOTE:** If the **Enable Modbus TCP IOScanner** button is grayed out, verify that the **Functional Level** of your application (**Programming > Tasks > Behavior** tab) is at least **Level 6.0** and that there is no instance configured in **Serial line > Modbus Serial IOScanner**. You can configure and add remote devices for Modbus TCP even if Modbus TCP IOScanner is enabled.

Adding Remote Devices

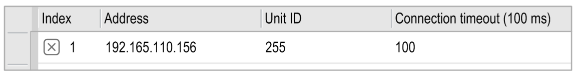
The following table describes the parameters of **Client mode: remote device table (max 16)** to add a device:

Parameter	Editable[(1)]	Value	Default Value	Description
IP address	Yes	*w.x.y.z*[(2)]	–	Allows you to specify the IP address of the device to add.
Generic **Drive** **Predefined**	Yes	Selection	Generic	Allows you to select the type of device to add. **Drive** and **Predefined** are available if Modbus TCP IOScanner is enabled.

[(1)] Only if the **Modbus server enabled** option is selected in the **Security Parameters** section of the Ethernet properties window.

[(2)] *w*, *x*, *y*, and *z* are the bytes that store the address and each byte can store a value in the range.

This table describes how to add a remote device:

Step	Action
1	Enter the IP address in the **IP address** field.
2	Select **Generic**, **Drive**, or **Predefined**. **Drive** and **Predefined** are only enabled if **Enable Modbus TCP IOScanner** is selected.
3	Click the **Add** button. The **Add** button is disabled if: • The maximum of 16 devices is already configured. • The IP address is in an incorrect format. **Result**: A list of remote devices that you have added appears on the screen.  Index / Address / Unit ID / Connection timeout (100 ms) 1 / 192.165.110.156 / 255 / 100
4	Click **Apply**.

This table describes each column of the table listing the remote devices:

Parameter	Editable	Value	Default Value	Description
ID	No	0...15	**0**	Unique device identifier assigned by EcoStruxure Machine Expert-Basic.
Name	Yes	1...32 characters The device name must be unique.	**Device x** (1)	The name of the device.
Address	No	– *%DRVn*(2)	– *%DRVn*	*%DRVn* is used to configure the device in the application using Drive function blocks, page 189.
Type	No	Type of the device	–	To change the device type, you must remove the device from the list (by right-clicking and choosing **Delete**), then add the correct device type.
Index	No	1...16	–	The index number of the devices which are remotely connected.
IP address	Yes	*w.x.y.z*(2)	–	Address used to identify the device within the network. Duplicate slave addresses are allowed.
Response timeout (x 100 ms)	Yes	0...65535	10	The connection timeout duration. The period of time (in units of 100 ms) during which the controller attempts to establish a TCP connection to the remote device. At the end of this period, if a TCP connection is still not established, the controller stops connection attempts until the next connection request with an EXCH instruction.
Reset variable	Yes	%Mn	–	Specify the address of the memory bit to use to reset the device (re-send the initialization requests). When the specified memory bit is set to 1 by the application, the device is reset.
Scanned	No	TRUE/FALSE	TRUE	Allows to see which device is configured for Modbus TCP IOScanner.
Init Request Unit ID	Yes	0...255	255	Specify the unit ID of the local device. Modbus TCP requests originating from a device with the same unit ID are sent to the Modbus mapping table instead of the regular Modbus server.
Init. requests (3)	Yes	...	–	Click to display the Initialization request assistant window, page 120.
Channels Unit ID	Yes	0...255	255	Specify the unit ID of the local device.

Parameter	Editable	Value	Default Value	Description
				Modbus TCP requests originating from a device with the same unit ID are sent to the Modbus mapping table instead of the regular Modbus server.
Channels (3)	Yes	...	–	Click to display the Channel assistant window, page 121.

(1) *w*, *x*, *y*, and *z* are the bytes that store the address and each byte can store a value in the range 0...255.

(2) *x* and *n* are integers respectively incremented each time a device or a drive device is added.

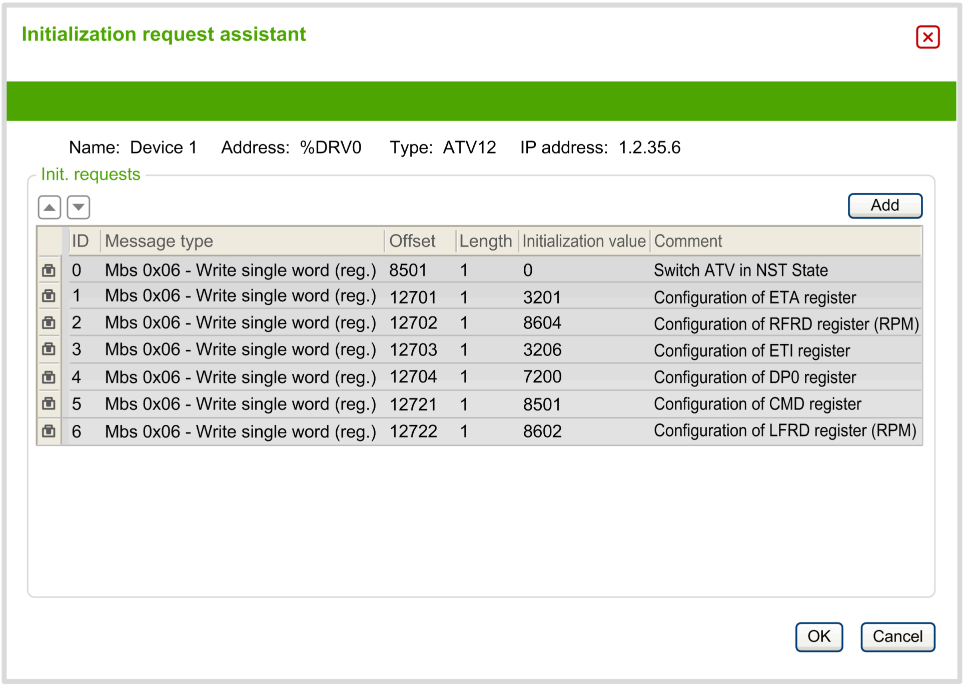
(3) Enabled if **Modbus Serial IOScanner** is not configured in **Serial line** node →**Protocol Settings**.

Configuring Initialization Requests

Initialization requests are device-specific commands sent by the Modbus TCP IOScanner or Modbus Serial IOScanner to initialize a slave device. The Modbus TCP IOScanner or Modbus Serial IOScanner does not start cyclic data exchange with the device until all its initialization requests have been acknowledged by the device. During the initialization phase, network objects are not updated.

Up to 20 initialization requests can be defined for each slave device.

The **Initialization request assistant** window presents the defined initialization requests:



Name: Device 1 Address: %DRV0 Type: ATV12 IP address: 1.2.35.6

ID	Message type	Offset	Length	Initialization value	Comment
0	Mbs 0x06 - Write single word (reg.)	8501	1	0	Switch ATV in NST State
1	Mbs 0x06 - Write single word (reg.)	12701	1	3201	Configuration of ETA register
2	Mbs 0x06 - Write single word (reg.)	12702	1	8604	Configuration of RFRD register (RPM)
3	Mbs 0x06 - Write single word (reg.)	12703	1	3206	Configuration of ETI register
4	Mbs 0x06 - Write single word (reg.)	12704	1	7200	Configuration of DP0 register
5	Mbs 0x06 - Write single word (reg.)	12721	1	8501	Configuration of CMD register
6	Mbs 0x06 - Write single word (reg.)	12722	1	8602	Configuration of LFRD register (RPM)

Preconfigured initialization requests are displayed with a lock symbol and a gray background. Some parameters cannot be modified for predefined initialization requests.

According to the device type that you selected, some initialization requests may be configured.

This table describes the properties of initialization requests:

Parameter	Editable	Value	Default Value	Description
ID	No	0...19	**0**	Unique initialization request identifier.
Message type	Yes, if initialization request is not predefined.	See Supported Modbus Function Codes, page 134	**Mbs 0x05 - Write single bit (coil)**	Select the Modbus function code for the type of exchange to use for this initialization request.

Parameter	Editable	Value	Default Value	Description
				NOTE: If configuring a generic device that does not support the default **Mbs 0x05 - Write single bit (coil)** request type, you must replace the default value with a supported request type.
Offset	Yes, if initialization request is not predefined.	0...65535	0	Offset of the first register to initialize.
Length	Yes, if initialization request is not predefined.	1 for **Mbs 0x05 - Write single bit (coil)** 1 for **Mbs 0x06 - Write single word (register)** 128 for **Mbs 0x0F - Write multiple bits (coils)** 123 for **Mbs 0x10 - Write multiple words (reg.)**	1	Number of objects (memory words or bits) to be initialized. For example, if writing multiple words with **Offset** = 2 and **Length** = 3, *%MW2*, *%MW3*, and *%MW4* are initialized.
Initialization value	Yes, if initialization request is not predefined.	0...65535 if memory words (registers) are being initialized 0...1 if memory bits (coils) are being initialized	0	Value to initialize the targeted registers with.
Comment	Yes, if initialization request is not predefined.	-	Empty	Optionally, type a comment to associate with this request.

Click **Add** to create new initialization requests.

Select an entry then use the up arrow and down arrow buttons to change the order in which the initialization requests are sent to the device.

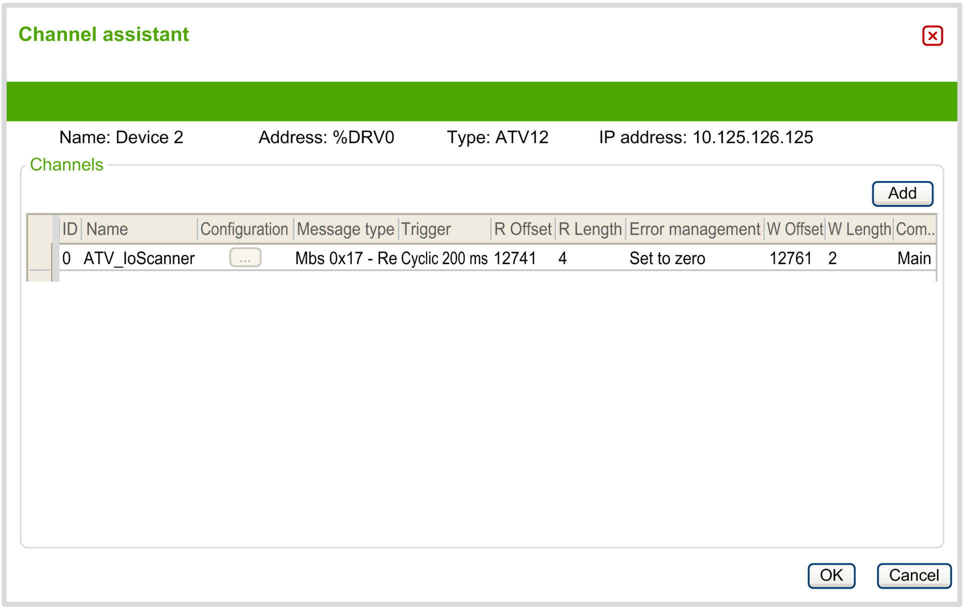
When the initialization requests have been defined, click **OK** to save the configuration and close the **Initialization request assistant**.

Channel Assistant

Up to 10 channels can be defined for each slave device. Each channel represents a single Modbus request.

NOTE: The number of objects defined (items of data read and written) is validated when you click **Apply** on the properties window.

The **Channel assistant** window lists the defined channels:



Name: Device 2 Address: %DRV0 Type: ATV12 IP address: 10.125.126.125

Channels

ID	Name	Configuration	Message type	Trigger	R Offset	R Length	Error management	W Offset	W Length	Com..
0	ATV_IoScanner	...	Mbs 0x17 - Re	Cyclic 200 ms	12741	4	Set to zero	12761	2	Main

Preconfigured channels are displayed with a lock symbol 🔒 and a gray background. Some parameters cannot be modified for predefined channels.

This table describes the properties of channels:

Parameter	Editable	Value	Default Value	Description
ID	No	0...19	**0**	Unique initialization identifier.
Name	Yes	0...32 characters	Device_channel0	Double-click to edit the name of the channel.
Configuration	Yes	...	-	Click to display the Channel Assistant window, page 121.
Message type	No	-	-	The Modbus function code that was selected in the Channel Assistant window, page 121.
Trigger	No	-	-	The trigger type and cycle time that was selected in the Channel Assistant window, page 121.
R Offset	No	-	-	The READ object offset that was selected in the Channel Assistant window, page 121.
R Length	No	-	-	The READ object length that was selected in the Channel Assistant window, page 121.
Error management	No	-	-	The error management policy that was selected in the Channel Assistant window, page 121.
W Offset	No	-	-	The WRITE object offset that was selected in the Channel Assistant window, page 121.
W Length	No	-	-	The WRITE object length that was selected in the Channel Assistant window, page 121.
Comment	Yes	-	Empty	Optionally, type a comment to associate with this channel.

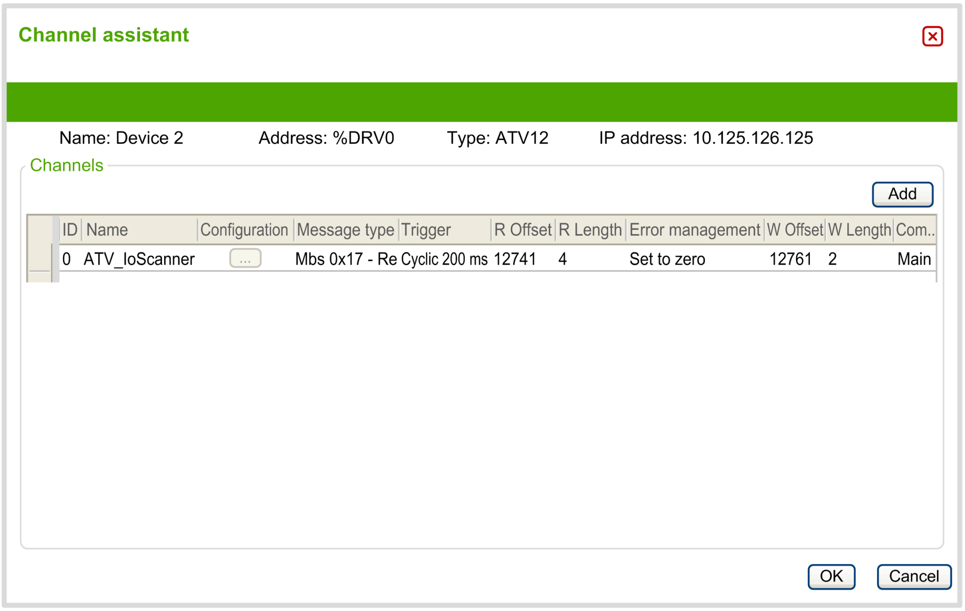
Click **Add** to create a new channel.

When the channels have been defined, click **OK** to save the configuration and close the **Channel assistant**.

Configuring Channels

Use the **Channel assistant** window to configure channels.

The following example shows a channel configured for a Read/Write Multiple Words request (Modbus function code 23). It reads one word from the register with offset 16#0C21 and writes two words to the register with offset 16#0C20. This request is executed when there is a rising edge of the defined **Trigger** (see table below):



Name: Device 2   Address: %DRV0   Type: ATV12   IP address: 10.125.126.125

ID	Name	Configuration	Message type	Trigger	R Offset	R Length	Error management	W Offset	W Length	Com..
0	ATV_IoScanner	...	Mbs 0x17 - Re	Cyclic 200 ms	12741	4	Set to zero	12761	2	Main

This table describes the properties of channels:

Parameter	Editable	Value	Default Value	Description
Name	Yes	0...32 characters	**Device 0_Channel0**	Enter a name for the channel.
Message type	Yes	See Supported Modbus Function Codes, page 134	**Mbs 0x17 - Read/Write mult. words (reg.)**	Select the Modbus function code for the type of exchange to use on this channel.
Trigger	Yes	**Cyclic** **Rising edge**	**Cyclic**	Choose the trigger type for the data exchange: • **Cyclic**: The request is triggered with the frequency defined in the **Cycle Time (x 10 ms)** field • **Rising edge**: The request is triggered upon detection of a rising edge of a memory bit. Specify the address of the **Memory bit** to use.
Cycle time (x 10 ms) (If **Cyclic** is selected)	Yes	1...6000	20	Specify the periodic trigger cycle time, in units of 10 ms.
Memory bit (If **Rising edge** is selected)	Yes	*%Mn*	-	Specify a memory bit address, for example, *%M8*. The data exchange is triggered when a rising edge of this memory bit is detected.
Comment	Yes	-	Empty	Optionally, type a comment to describe the purpose of the channel.
READ objects				
Offset	Yes	0...65535	0	Address of the first memory word (register) or bit (coil) to read.
Length	Yes	See Supported Modbus Function Codes, page 134 for maximum length	-	Number of memory words (registers) or bits (coils) to read.
Error management	Yes	**Set to zero** **Retain last value**	**Set to zero**	Specify how to manage the situation when data can no longer be read from the device: • Select **Set to zero** to set the last data values received to zero. • Select **Retain last value** to keep the last data values received.

Parameter	Editable	Value	Default Value	Description
WRITE objects				
Offset	Yes	0...65535	0	Address of the first memory word (register) or bit (coil) to write.
Length	Yes	See Supported Modbus Function Codes, page 134 for maximum length	-	Number of memory words (registers) or bits (coils) to write.

Click **OK** to complete channel configuration.

Serial Line Configuration

Configuring Serial Line

Introduction

The M100/M200 Logic Controller references are equipped with one serial line (SL1).

The serial line can be configured for one of the following protocols:

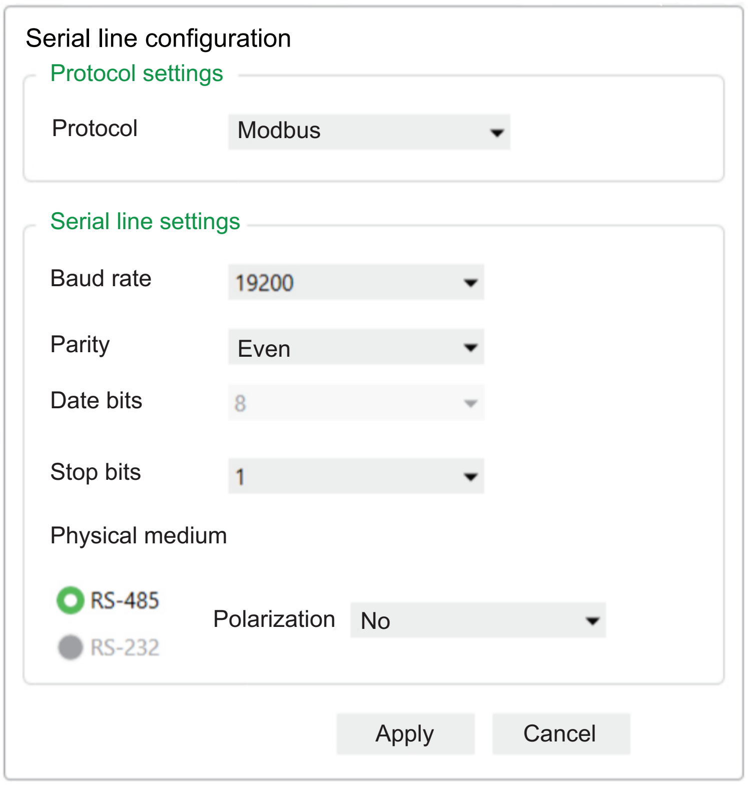
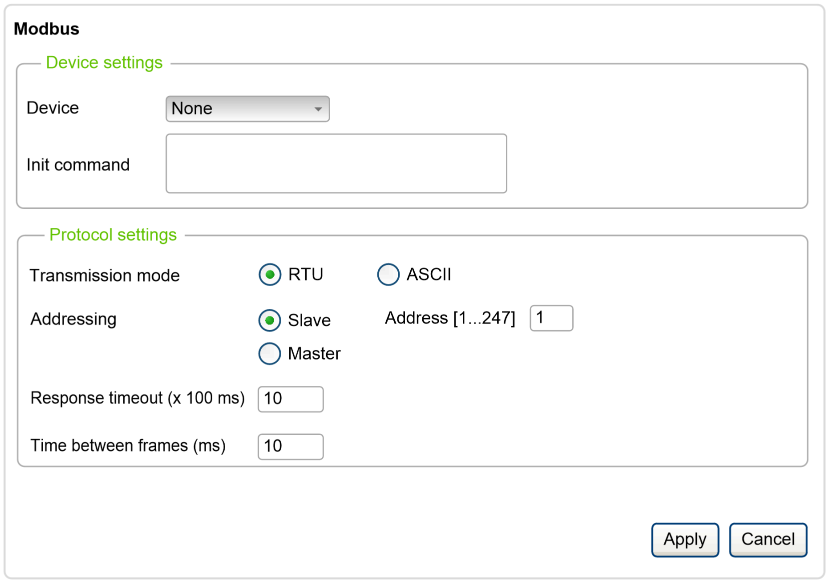
- Modbus (RTU or ASCII), page 124. Serial lines are configured for the Modbus RTU protocol by default.
- ASCII, page 124
- Modbus Serial IOScanner, page 128. Only one instance can be configured: if configured on one serial line, it cannot be used on the other serial line.

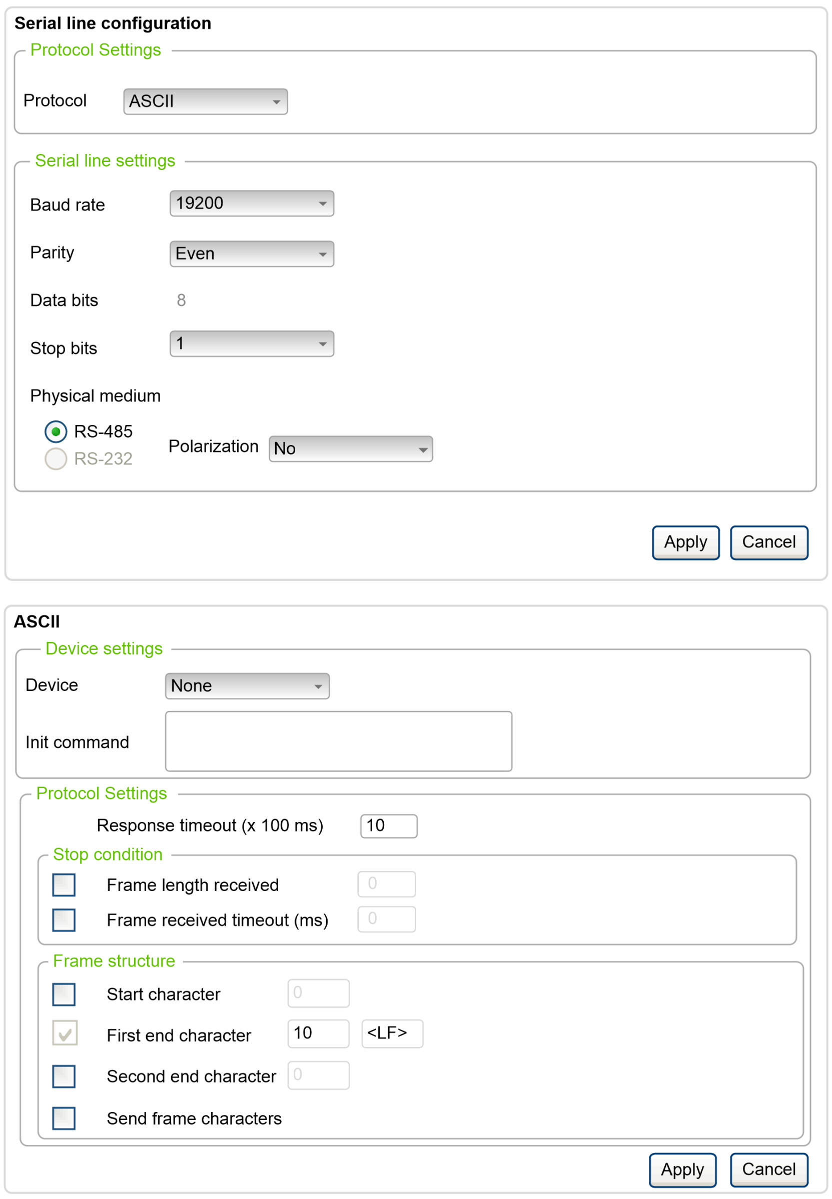
  NOTE: Care must be taken when both the Modbus Serial IOScanner and Message (%MSG) function blocks are used in your application, as this can lead to the cancellation of on-going IOScanner communication.

  The application must be configured with a functional level of at least **Level 5.0** to support the Modbus Serial IOScanner.

Serial Line Configuration

This table describes how to configure the serial line:

Step	Action
1	Click the **SL1 (Serial line)** node in the hardware tree to display the serial line properties. These figures present the properties of the serial line for **Modbus** protocols:  Serial line configuration Protocol settings Protocol: Modbus Serial line settings Baud rate: 19200 Parity: Even Date bits: 8 Stop bits: 1 Physical medium: [✓ RS-485] RS-232 Polarization: No  Modbus Device settings Device: None Init command: Protocol settings Transmission mode: [✓ RTU] ASCII Addressing: [✓ Slave] Master Address [1...247]: 1 Response timeout (x 100 ms): 10 Time between frames (ms): 10
	These figures present the properties of the serial line for **ASCII** protocol:

Step	Action
	 **Serial line configuration** Protocol Settings Protocol: ASCII Serial line settings Baud rate: 19200 Parity: Even Data bits: 8 Stop bits: 1 Physical medium ● RS-485 ○ RS-232 Polarization: No Apply Cancel **ASCII** Device settings Device: None Init command: Protocol Settings Response timeout (x 100 ms): 10 Stop condition ☐ Frame length received: 0 ☐ Frame received timeout (ms): 0 Frame structure ☐ Start character: 0 ✓ First end character: 10 <LF> ☐ Second end character: 0 ☐ Send frame characters Apply Cancel
2	Edit the properties to configure the serial line. For detailed information on the serial line configuration parameters, refer to the table below.

This table describes each parameter of the serial line:

Parameter	Editable	Value	Default value	Description
Physical Settings				
Baud rate	Yes	**1200** **2400** **4800** **9600** **19200** **38400** **57600** **115200**	**19200**	Allows you to select the data transmission rate (bits per second) for the modem from the drop-down list.
Parity	Yes	**None** **Even** **Odd**	**Even**	Allows you to select the parity of the transmitted data for error detection.

Parameter	Editable	Value	Default value	Description
				Parity is a method of error detection in transmission. When parity is used with a serial port, an extra data bit is sent with each data character. It is arranged so that the number of bits set to 1 in each character, including the parity bit, is always odd or always even. If a byte is received with the wrong number of bits set to 1, the byte is corrupted.
Data bits	Yes (only for the **ASCII** protocol)	**7** **8**	**8**	Allows you to select the data bit from the drop-down list. The number of data bits in each character can be 7 (for true ASCII) or 8.
Stop bits	Yes	**1** **2**	**1**	Allows you to select the stop bit from the drop-down list. Stop bit is a bit indicating the end of a byte of data. For electronic devices usually 1 stop bit is used. For slow devices like electromechanical teleprinters, 2 stop bits are used.
Physical medium	Yes	**RS-485** True	**RS-485** True	Allows you to select the physical medium for communication. A physical medium in data communications is the transmission path over which a signal propagates. It is an interface for interconnection of devices with the logic controller.
Polarization	Yes	**Yes** **No**	**No**	Polarization resistors are integrated in the controller and cartridge modules. This parameter allows you to switch on or off polarization.
Protocol settings				
Protocol	Yes	**Modbus RTU** **Modbus ASCII** **ASCII** **Modbus Serial IOScanner**	**Modbus RTU**	Allows you to select the protocol transmission mode for communication from the drop-down list. Protocol advanced parameters are displayed based on the selected protocol. Refer to the following figures and tables.
Protocol settings for the **Modbus RTU** and **Modbus ASCII** protocols:				
Addressing	Yes	**Slave** True/False **Master** True/False	**Slave** True	Allows you to select the addressing mode. You can only select either of the **Slave** or **Master** addressing. Selecting any of the addressing modes clears the present one.
Address [1...247]	Yes	1...247	1	Allows you to specify the address ID of the slave. **NOTE:** This field is displayed only for the addressing of the slave. For master, this field does not appear on the screen.
Response time (x 100 ms)	Yes	0...255 ms	10	Allows you to specify the response time of the protocol to the queries.
Time between frames (ms)	Yes	2...255 ms	10	Allows you to specify the period of time between frames of the protocol. (corresponds to inter-frame delay used in other products). The value specified is automatically adjusted to conform to a Modbus standard 3.5 character time delay.
Protocol settings for the **ASCII** protocol:				

Parameter	Editable	Value	Default value	Description
Response time (x 100 ms)	Yes	0...255 ms	10	Allows you to specify the response time of the protocol to the queries.
Stop condition				
Frame length received	Yes (only if the check box is selected)	1...255	0 (if check box is not selected) 1 (if check box is selected)	Allows you to specify the length of the received frame. **NOTE:** You can configure only one parameter for stop condition that is either **Frame length received** or **Frame received timeout (ms)**.
Frame received timeout (ms)	Yes (only if the check box is selected)	1...255	0 (if check box is not selected) 10 (if check box is selected)	Allows you to specify the timeout duration for the received frame.
Frame structure				
Start character	Yes (only if the check box is selected)	1...255	0 (if check box is not selected) 58 (if check box is selected)	Allows you to specify the start character of the frame. The ASCII character corresponding to the start character value is displayed on right-hand side of the value field.
First end character	Yes	1...255	0 (if check box is not selected) 10 (if check box is selected)	Allows you to specify the first end character of the frame. **NOTE:** To be able to enable or disable the **First end character**, configure at least one stop condition parameter. The ASCII character corresponding to the first end character value is displayed on right-hand side of the value field.
Second end character	Yes (only if the check box is selected)	1...255	0 (if check box is not selected) 10 (if check box is selected)	Allows you to specify the second end character of the frame. **NOTE:** This field is disabled with the disabled **First end character** parameter. The ASCII character corresponding to the second end character value is displayed on right-hand side of the value field.
Send frame characters	Yes	True/False	False	Allows you to enable or disable sending first end character of the frame to the ASCII protocol.

Configuring Modbus Serial IOScanner

Description

Only one instance of IOScanner can be defined: if you configure it on an Ethernet port, you cannot configure it on a serial port. Refer to Configuring Modbus TCP IOScanner, page 128.

The maximum number of TCP and Serial IOScanner objects is:

- 128, if the **Functional Level** < **6.0**.
- 512, if the **Functional Level** ≥ **6.0**.

If a communication interruption occurs, the IOScanner stops. For more information on the status, refer to the description of `%SW210` or `%SW211` in the System Words Description, page 328.

To reset or suspend the Modbus Serial IOScanner, refer to `%S110`, `%S111`, `%S113` and `%S114` in the System Bits Description, page 323.

Protocol Settings

This table describes the parameters when the **Modbus Serial IOScanner** protocol is selected:

Parameter	Editable	Value	Default Value	Description
Transmission mode	Yes	**RTU** **ASCII**	**RTU**	Select the protocol transmission mode for communication from the drop-down list.
Response timeout (x 100 ms)	Yes	0...255	10	Defines the maximum time that the controller waits for a response before terminating the exchange in error. Enter 0 to disable the timeout.
Time between frames (ms)	Yes	1...255	10	The period of time between frames (corresponds to inter-frame delay used in other products). **NOTE:** The value is subject to adjustment to conform to Modbus standard 3.5 character time delay.

Adding a Device on the Modbus Serial IOScanner

Introduction

This section describes how to add devices to be scanned by the Modbus Serial IOScanner.

You can add up to 16 Modbus slave devices.

EcoStruxure Machine Expert-Basic is supplied with a number of predefined device types. Predefined device types have predefined initialization requests and preconfigured channels to facilitate integration of the devices in the network.

A generic slave device is also provided, for which initialization requests and channels must be configured.

Adding a Device on the Modbus Serial IOScanner

To add a device on the Modbus Serial IOScanner:

Step	Action
1	Choose either: • **Drive** and select one of the supported device types from the dropdown list. • **Others** and select the device type from the dropdown list. If you cannot find your device type in either list, select **Generic device** and configure it.
2	Click **Add**.
3	Configure the device as described in Device Settings, page 129.
4	Click **Apply**.

Device Settings

This table describes the parameters when the **Modbus Serial IOScanner** protocol is selected:

Parameter	Editable	Value	Default Value	Description
ID	No	0...15	**0**	Unique device identifier assigned by EcoStruxure Machine Expert-Basic.
Name	Yes	1...32 characters The device name must be unique.	**Device x**[1]	Specify a unique name for the device.
Address	No	– *%DRVn* [1] [2]	– *%DRV0*	*%DRV*n is used to configure the device in the application using Drive function blocks, page 189.
Type	No	Type of the device	–	The device type is not editable. To change the device type, you must remove the device from the list (by right-clicking and choosing **Delete**), then add the correct device type.
Slave address	Yes	1...247	1	Address used to identify the device within the network. Duplicate slave addresses are allowed.
Response timeout (x 100 ms)	Yes	0...255	10	The timeout (in milliseconds) used in data exchanges with the device. This value can be adapted individually to the device and overrides the **Response timeout** set for the master in the **Protocol Settings**.
Reset variable	Yes	%Mn	–	Specify the address of the memory bit to use to reset the device (re-send the initialization requests). When the specified memory bit is set to 1 by the application, the device is reset.
Init. requests	Yes	...	-	Click to display the Initialization request assistant window, page 130.
Channels	Yes	...	-	Click to display the Channel assistant window, page 132.

[1] *x* and *n* are integers incremented each time a device or a drive device is added.

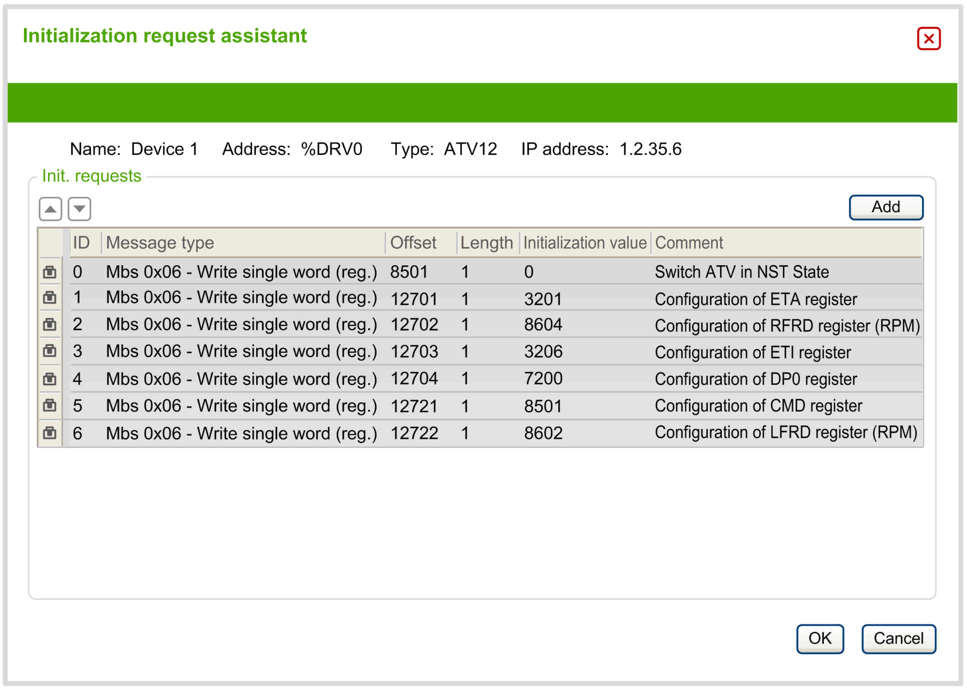
[2] Only if **Drive** is selected as the device type.

Configuring Initialization Requests

Initialization requests are device-specific commands sent by the Modbus TCP IOScanner or Modbus Serial IOScanner to initialize a slave device. The Modbus TCP IOScanner or Modbus Serial IOScanner does not start cyclic data exchange with the device until all its initialization requests have been acknowledged by the device. During the initialization phase, network objects are not updated.

Up to 20 initialization requests can be defined for each slave device.

The **Initialization request assistant** window presents the defined initialization requests:



Name: Device 1 Address: %DRV0 Type: ATV12 IP address: 1.2.35.6

	ID	Message type	Offset	Length	Initialization value	Comment
🔒	0	Mbs 0x06 - Write single word (reg.)	8501	1	0	Switch ATV in NST State
🔒	1	Mbs 0x06 - Write single word (reg.)	12701	1	3201	Configuration of ETA register
🔒	2	Mbs 0x06 - Write single word (reg.)	12702	1	8604	Configuration of RFRD register (RPM)
🔒	3	Mbs 0x06 - Write single word (reg.)	12703	1	3206	Configuration of ETI register
🔒	4	Mbs 0x06 - Write single word (reg.)	12704	1	7200	Configuration of DP0 register
🔒	5	Mbs 0x06 - Write single word (reg.)	12721	1	8501	Configuration of CMD register
🔒	6	Mbs 0x06 - Write single word (reg.)	12722	1	8602	Configuration of LFRD register (RPM)

Preconfigured initialization requests are displayed with a lock symbol 🔒 and a gray background. Some parameters cannot be modified for predefined initialization requests.

According to the device type that you selected, some initialization requests may be configured.

This table describes the properties of initialization requests:

Parameter	Editable	Value	Default Value	Description
ID	No	0...19	**0**	Unique initialization request identifier.
Message type	Yes, if initialization request is not predefined.	See Supported Modbus Function Codes, page 134	**Mbs 0x05 - Write single bit (coil)**	Select the Modbus function code for the type of exchange to use for this initialization request. **NOTE:** If configuring a generic device that does not support the default **Mbs 0x05 - Write single bit (coil)** request type, you must replace the default value with a supported request type.
Offset	Yes, if initialization request is not predefined.	0...65535	0	Offset of the first register to initialize.
Length	Yes, if initialization request is not predefined.	1 for **Mbs 0x05 - Write single bit (coil)** 1 for **Mbs 0x06 - Write single word (register)** 128 for **Mbs 0x0F - Write multiple bits (coils)** 123 for **Mbs 0x10 - Write multiple words (reg.)**	1	Number of objects (memory words or bits) to be initialized. For example, if writing multiple words with **Offset** = 2 and **Length** = 3, *%MW2*, *%MW3*, and *%MW4* are initialized.

Parameter	Editable	Value	Default Value	Description
Initialization value	Yes, if initialization request is not predefined.	0...65535 if memory words (registers) are being initialized 0...1 if memory bits (coils) are being initialized	0	Value to initialize the targeted registers with.
Comment	Yes, if initialization request is not predefined.	-	Empty	Optionally, type a comment to associate with this request.

Click **Add** to create new initialization requests.

Select an entry then use the up arrow and down arrow buttons to change the order in which the initialization requests are sent to the device.

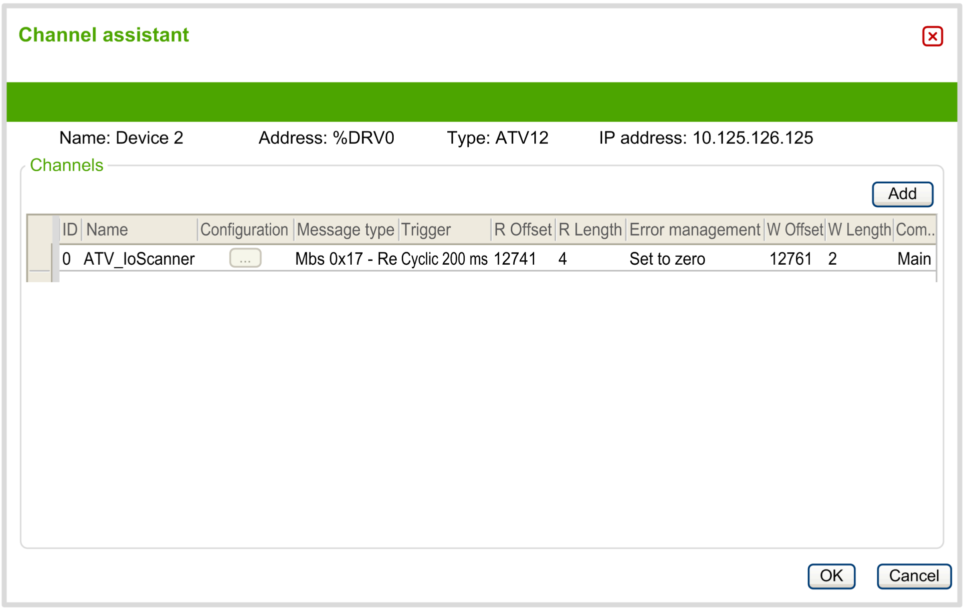
When the initialization requests have been defined, click **OK** to save the configuration and close the **Initialization request assistant**.

Channel Assistant

Up to 10 channels can be defined for each slave device. Each channel represents a single Modbus request.

NOTE: The number of objects defined (items of data read and written) is validated when you click **Apply** on the properties window.

The **Channel assistant** window lists the defined channels:



Name: Device 2 Address: %DRV0 Type: ATV12 IP address: 10.125.126.125

ID	Name	Configuration	Message type	Trigger	R Offset	R Length	Error management	W Offset	W Length	Com..
0	ATV_IoScanner	...	Mbs 0x17 - Re	Cyclic 200 ms	12741	4	Set to zero	12761	2	Main

Preconfigured channels are displayed with a lock symbol and a gray background. Some parameters cannot be modified for predefined channels.

This table describes the properties of channels:

Parameter	Editable	Value	Default Value	Description
ID	No	0...19	**0**	Unique initialization identifier.
Name	Yes	0...32 characters	Device_channel0	Double-click to edit the name of the channel.
Configuration	Yes	...	-	Click to display the Channel Assistant window, page 121.
Message type	No	-	-	The Modbus function code that was selected in the Channel Assistant window, page 121.

Parameter	Editable	Value	Default Value	Description
Trigger	No	-	-	The trigger type and cycle time that was selected in the Channel Assistant window, page 121.
R Offset	No	-	-	The READ object offset that was selected in the Channel Assistant window, page 121.
R Length	No	-	-	The READ object length that was selected in the Channel Assistant window, page 121.
Error management	No	-	-	The error management policy that was selected in the Channel Assistant window, page 121.
W Offset	No	-	-	The WRITE object offset that was selected in the Channel Assistant window, page 121.
W Length	No	-	-	The WRITE object length that was selected in the Channel Assistant window, page 121.
Comment	Yes	-	Empty	Optionally, type a comment to associate with this channel.

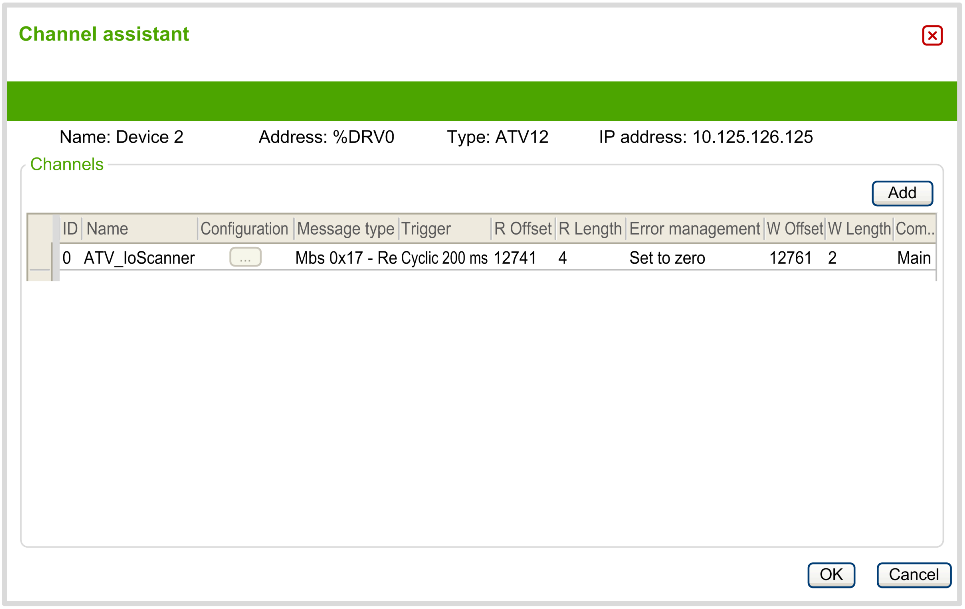
Click **Add** to create a new channel.

When the channels have been defined, click **OK** to save the configuration and close the **Channel assistant**.

Configuring Channels

Use the **Channel assistant** window to configure channels.

The following example shows a channel configured for a Read/Write Multiple Words request (Modbus function code 23). It reads one word from the register with offset 16#0C21 and writes two words to the register with offset 16#0C20. This request is executed when there is a rising edge of the defined **Trigger** (see table below):



Name: Device 2   Address: %DRV0   Type: ATV12   IP address: 10.125.126.125

Channels

ID	Name	Configuration	Message type	Trigger	R Offset	R Length	Error management	W Offset	W Length	Com..
0	ATV_IoScanner	...	Mbs 0x17 - Re	Cyclic 200 ms	12741	4	Set to zero	12761	2	Main

This table describes the properties of channels:

Parameter	Editable	Value	Default Value	Description
Name	Yes	0...32 characters	**Device 0_Channel0**	Enter a name for the channel.
Message type	Yes	See Supported Modbus Function Codes, page 134	**Mbs 0x17 - Read/Write mult. words (reg.)**	Select the Modbus function code for the type of exchange to use on this channel.
Trigger	Yes	**Cyclic**	**Cyclic**	Choose the trigger type for the data exchange:

Parameter	Editable	Value	Default Value	Description
		Rising edge		• **Cyclic**: The request is triggered with the frequency defined in the **Cycle Time (x 10 ms)** field • **Rising edge**: The request is triggered upon detection of a rising edge of a memory bit. Specify the address of the **Memory bit** to use.
Cycle time (x 10 ms) (If **Cyclic** is selected)	Yes	1...6000	20	Specify the periodic trigger cycle time, in units of 10 ms.
Memory bit (If **Rising edge** is selected)	Yes	*%M*n	-	Specify a memory bit address, for example, *%M8*. The data exchange is triggered when a rising edge of this memory bit is detected.
Comment	Yes	-	Empty	Optionally, type a comment to describe the purpose of the channel.
READ objects				
Offset	Yes	0...65535	0	Address of the first memory word (register) or bit (coil) to read.
Length	Yes	See Supported Modbus Function Codes, page 134 for maximum length	-	Number of memory words (registers) or bits (coils) to read.
Error management	Yes	**Set to zero** **Retain last value**	**Set to zero**	Specify how to manage the situation when data can no longer be read from the device: • Select **Set to zero** to set the last data values received to zero. • Select **Retain last value** to keep the last data values received.
WRITE objects				
Offset	Yes	0...65535	0	Address of the first memory word (register) or bit (coil) to write.
Length	Yes	See Supported Modbus Function Codes, page 134 for maximum length	-	Number of memory words (registers) or bits (coils) to write.

Click **OK** to complete channel configuration.

Supported Modbus Function Codes

Supported Modbus Function Codes

Presentation

This section lists the supported Modbus function codes and their effect on controller memory variables for:

- Modbus Serial
- Modbus Serial IOScanner, page 135
- Modbus TCP, page 136
- Modbus TCP IOScanner, page 135

Modbus Serial

The following Modbus requests are supported:

Supported Modbus Function Code	Supported Sub-Function Code	Description
1 (0x01) or 2 (0x02)	–	Read multiple internal bits %M
3 (0x03) or 4 (0x04)	–	Read multiple internal registers %MW
5 (0x05)	–	Write single internal bit %M
6 (0x06)	–	Write single internal register %MW
8 (0x08)	0 (0x00), 10 (0x0A)...18 (0x12)	Diagnostics
15 (0x0F)	–	Write multiple internal bits %M
16 (0x10)	–	Write multiple internal registers %MW
23 (0x17)	–	Read/write multiple internal registers %MW
43 (0x2B)	14 (0x0E)	Read device identification (regular service)

NOTE: The impact of Modbus function codes used by a master M100/M200 Logic Controller depends on the slave device type. In the major types of slave device:

- Internal bit means %M
- Input bit means %I
- Internal register means %MW
- Input register means %IW

Depending on the type of slave and the slave address, an internal bit should be a %M or %Q; an input bit should be a %I or %S, an input register should be a %IW or a %SW and an internal register should be a %MW or a %QW. For more details, refer to the slave device.

Modbus Serial IOScanner and Modbus TCP IOScanner

This table lists the Modbus function codes supported by the Modbus Serial IOScanner and Modbus TCP IOScanner:

Function Code Dec (Hex)	Description	Available For Configuration	Maximum Length (Bits)
1 (1 hex)	Read multiple bits (coils)	**Channel**	128
2 (2 hex)	Read multiple bits (discrete inputs)	**Channel**	128
3 (3 hex)	Read multiple words (holding registers)	**Channel**	125
4 (4 hex)	Read multiple words (input registers)	**Channel**	125
5 (5 hex)	Write single bit (coil)	**Channel** **Initialization Value** (default message type for initialization values)	1
6 (6 hex)	Write single word (register)	**Channel** **Initialization Value**	1
15 (0F hex)	Write multiple bits (coils)	**Channel** **Initialization Value**	128
16 (10 hex)	Write multiple words (registers)	**Channel** **Initialization Value**	123
23 (17 hex)	Read/write multiple words (registers)	**Channel** (default message type for channel configuration)	125 (read) 121 (write)

Modbus Mapping Table for Modbus TCP

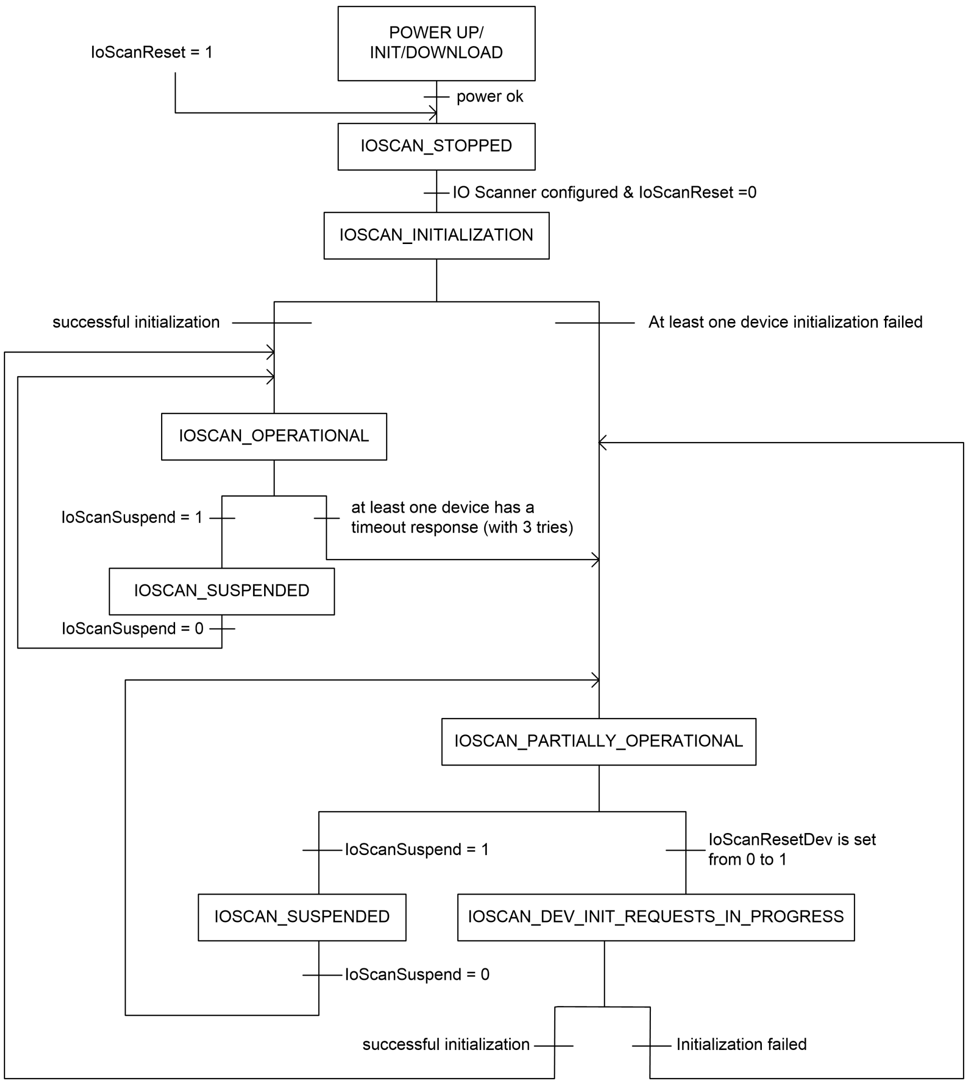
Modbus TCP slave devices support a subset of the Modbus function codes. Function codes originating from a Modbus master with matching unit ID are directed to the Modbus mapping table and access network objects (*%IWM* and *% QWM)* of the controller. Refer to Modbus TCP Slave Device I/O Mapping Table, page 117.

State Machine Diagram for Modbus IOscanner

State Machine Diagram for Modbus IOscanner

Description

The following graphic shows the states of the Modbus IOScanner:


POWER UP/ INIT/DOWNLOAD
IoScanReset = 1
power ok
IOSCAN_STOPPED
IO Scanner configured & IoScanReset =0
IOSCAN_INITIALIZATION
successful initialization
At least one device initialization failed
IOSCAN_OPERATIONAL
IoScanSuspend = 1
at least one device has a timeout response (with 3 tries)
IOSCAN_SUSPENDED
IoScanSuspend = 0
IOSCAN_PARTIALLY_OPERATIONAL
IoScanSuspend = 1
IoScanResetDev is set from 0 to 1
IOSCAN_SUSPENDED
IOSCAN_DEV_INIT_REQUESTS_IN_PROGRESS
IoScanSuspend = 0
successful initialization
Initialization failed

The following table displays the system objects for each IOScanner position:

Object Description	**SL1**	**SL2**	**Ethernet**
State of the IOScanner	`%SW210`	`%SW211`	`%SW212`
IoScanReset	`%S110`	`%S111`	`%S112`
IoScanSuspend	`%S113`	`%S114`	`%S115`
IoScanResetDev	`%Mx` defined in the device configuration		

Micro SD Card

What’s in This Chapter

Introduction

The Modicon M100/M200 Logic Controller allows file transfers with a Micro SD card.

This chapter describes how to manage Modicon M100/M200 Logic Controller files with a Micro SD card.

File Management Operations

Introduction

The Modicon M100/M200 Logic Controller allows the following types of file management with an micro SD card:

- Clone management, page 140: back up the application, firmware, and post configuration (if it exists) of the logic controller
- Firmware management, page 142: download firmware directly to the logic controller
- Application management, page 145: back up and restore the logic controller application, or copy it to another logic controller of the same reference
- Post configuration management, page 148: add, change, or delete the post configuration file of the logic controller
- Error log management, page 153: back up or delete the error log file of the logic controller
- Memory management, page 157: back up and restore memory objects of the logic controller

  NOTE:

  - Certain commands require a power cycle of the logic controller. See the description of the commands for more information.
  - The Modicon M100/M200 Logic Controller accepts only micro SD cards formatted in FAT or FAT32. Use an SD card of a well-known brand and the volume should be less or equal to 64 GB.

With the use of the SD card, powerful operations can be automatically conducted affecting the behavior of your logic controller and resident application. Care must be taken when inserting an SD card into the controller; you must be aware of the affect that the contents of the SD card will have on your logic controller.

NOTE: File management with SD card uses script files. These scripts can be automatically created with the Memory management task, page 157.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- You must have operational knowledge of your machine or process before connecting this device to your controller.
- Ensure that guards are in place so that any potential unintended equipment operation will not cause injury to personnel or damage to equipment.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

If you remove power to the device, or there is a power outage or communication interruption during the transfer of the application, your device may become inoperative. If a communication interruption or a power outage occurs, reattempt the transfer. If there is a power outage or communication interruption during a firmware update, or if an invalid firmware is used, your device will become inoperative. In this case, use a valid firmware and reattempt the firmware update.

NOTICE

INOPERABLE EQUIPMENT

- Do not interrupt the transfer of the application program or a firmware change once the transfer has begun.
- Re-initiate the transfer if the transfer is interrupted for any reason.
- Do not attempt to place the device into service until the file transfer has completed successfully.

Failure to follow these instructions can result in equipment damage.

NOTE: Before inserting a micro SD card in the controller, verify that the micro SD card contains a valid script file if the micro SD card is not empty. Otherwise, the controller remains in BOOTING mode as it does not detect any valid script during booting. In this case, remove the micro SD card to make the controller start normally.

SD Card Supported File Types

Introduction

This table lists the file locations and types of file that can be managed by cloning or script commands:

Folder	Description	Default file name
`/`	Script file	`Script.cmd`
`/`	Script log	`Script.log`
`/sys/os`	Logic controller firmware file	`M200M100.mfw`
`/TM3`	TM3 analog expansion modules firmware	`TM3_Ana.mfw`
`/usr/app`	Application file	`*.smbk`
`/usr/cfg`	Post configuration file	`Machine.cfg`
`/usr/mem`	Memory back up file	`Memories.csv`
`/sys/log`	Detected error log file	`PlcLog.csv`

Script File Commands

A script file is a text file stored in the root directory of the micro SD card containing commands to manage exchanges with the controller. Script files must be encoded in ANSI format.

This table describes the supported script commands:

Command	Description	Source	Destination
Download	Download a file from the micro SD card to the controller.	Select the file to download.	Select the controller destination folder.
Upload	Upload files contained in folder of controller memory to the micro SD card.	Select the folder.	Select the micro SD card folder.
Delete	Delete files contained in a controller folder.	Select the folder and enter a specific file name. **Important:** by default, all folder files are selected.	-
Reboot	Restart the controller (this command must be the last command in the script).	-	-

NOTE:

- All commands can only be executed when the controller in the STOP or BOOTING state. No command is executed if a micro SD card is inserted when the controller is in RUN mode.
- When a micro SD card command is in progress, start controller commands are ignored. When the micro SD card command completes, you must start the controller manually.To do so, switch the RUN/STOP button to the RUN position, or execute the RUN command in EcoStruxure Machine Expert-Basic.

Script File Examples

Download commands:
```
Download "/usr/Cfg"
Download "/sys/os/M200M100.mfw"
```

Upload commands:
```
Upload "/usr/app/*"
Upload "/usr/cfg/Machine.cfg"
```

Delete commands:
```
Delete "/usr/app/*"
```

Reboot commands:
```
Reboot
```

NOTE: Post configuration files specified in **Upload** or **Delete** commands must have the extension `.cfg` or `.CFG`.

If no post configuration file is specified, or the specified file name does not exist, the default file name `Machine.cfg` is assumed.

Script Log

A `script.log` file is automatically created in the SD card root directory after script operations. The status of the script operations can be verified reading this file.

Clone Management

Cloning

Function 1: cloning allows you to automatically back up the application, firmware, and post configuration (if it exists) of the Modicon M100/M200 Logic Controller to the micro SD card. There is no need to create any scripts.

Function 2: The micro SD card can then be used to later restore the firmware, application, and post configuration (if it exists) to the logic controller, or copy them to another logic controller with the same reference.

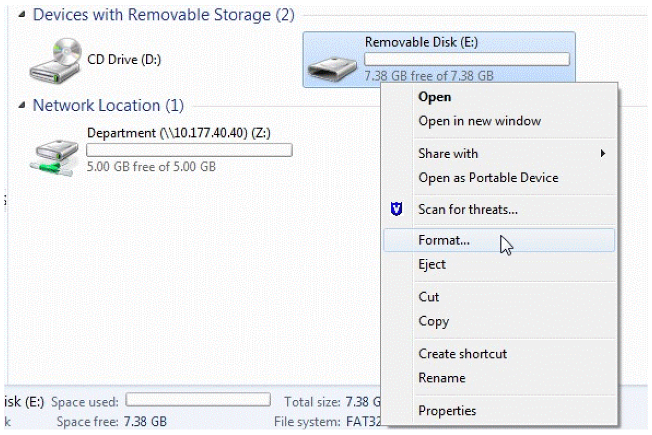
Before cloning a controller, the M100/M200 Logic Controller verifies whether the application is copy-protected or not . For details, refer to Password Protecting an Application (see EcoStruxure Machine Expert - Basic, Operating Guide).

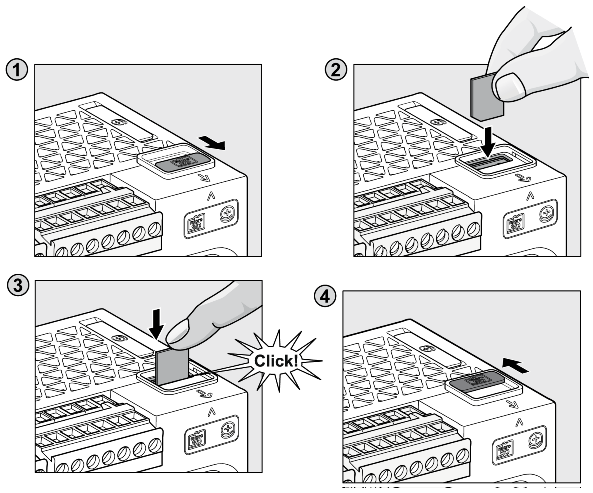
NOTE:

- To realize function 1, the micro SD card must be empty and correctly formatted to perform this procedure.
- The detected error log and data memory are not cloned.
- If the application is password-protected, the clone operation is completed but the user application cannot be restored and the **ERR** LED is permanently on.

Creating a Clone Micro SD Card (function 1)

This procedure describes how to copy the application, firmware, and post configuration (if it exists) from the controller to a micro SD card:

Step	Action
1	Format a micro SD card on the PC (or the micro SD card is empty and correctly formatted to perform this procedure.  Devices with Removable Storage (2) CD Drive (D:) Removable Disk (E:) 7.38 GB free of 7.38 GB Network Location (1) Department (\\10.177.40.40) (Z:) 5.00 GB free of 5.00 GB Open Open in new window Share with Open as Portable Device Scan for threats... Format... Eject Cut Copy Create shortcut Rename Properties isk (E:) Space used: Space free: 7.38 GB Total size: 7.38 G File system: FAT32
2	Remove the power from the controller.

Step	Action
3	Insert the micro SD card in the controller. 
4	Restore power to the controller. **Result:** The clone operation starts automatically and the **SD** LED is illuminated during the operation. If an error is detected, the **SD** LED flashes and the detected error is logged in the *Script.log* file.
5	Wait until the end of the operation (until the **SD** LED is off or flashing). **NOTE:** The clone operation lasts 2 to 3 minutes. The clone operation has a low priority in order to minimize impact on the program and communication performance of the logic controller.
6	Remove the micro SD card from the controller. When the clone micro SD card is created, store it properly in a safe place.

Restoring or Copying from a Clone Micro SD Card (function 2)

This procedure describes how to download the application, firmware, and post configuration (if it exists) stored in the micro SD card to your controller:

Step	Action
1	Remove power from the controller.
2	Insert the clone micro SD card into the controller.
3	Restore power to the controller. **Result:** The clone operation is in progress. **NOTE:** The **SD** LED is turned on during the operation.
4	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in the *Script.log* file.
5	Remove the micro SD card to restart the controller.

NOTE: Downloading a cloned application to the controller first removes the existing application from controller memory, regardless of any user access-rights that may be enabled in the target controller.

Firmware Management

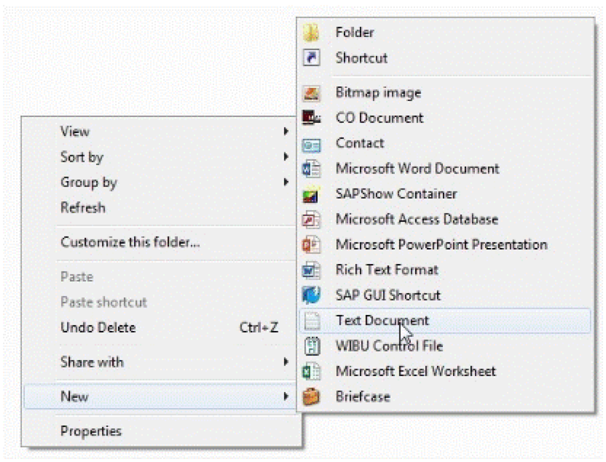
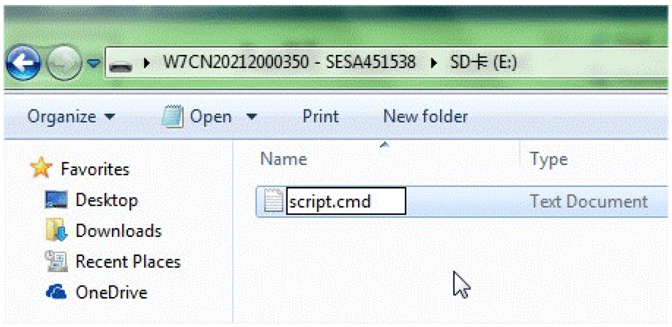
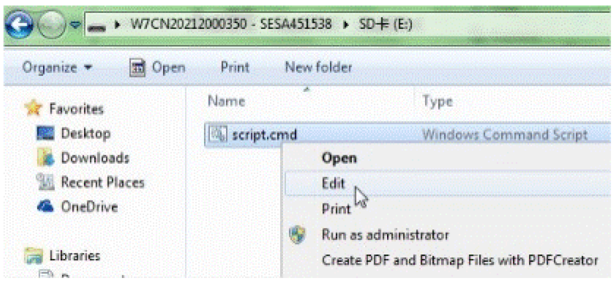
Overview

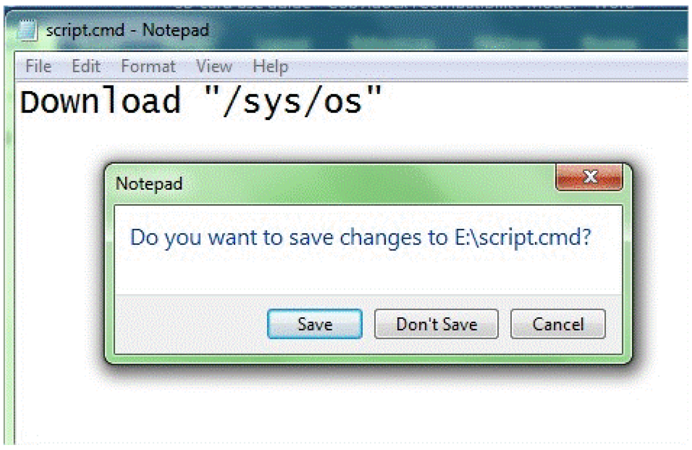
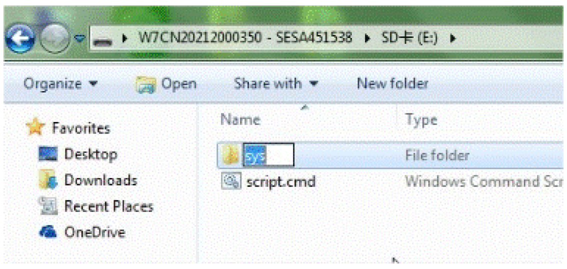
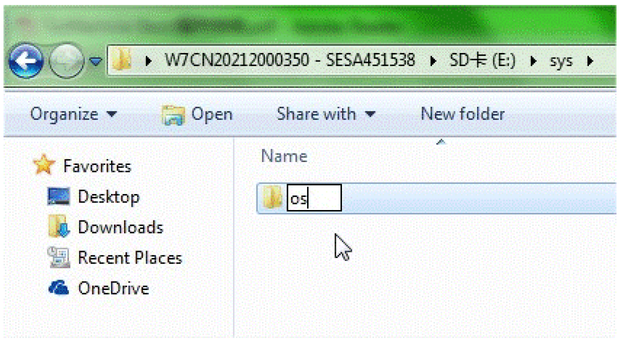
You can use a micro SD card to download firmware updates directly to the logic controller or TM3 analog expansion modules.

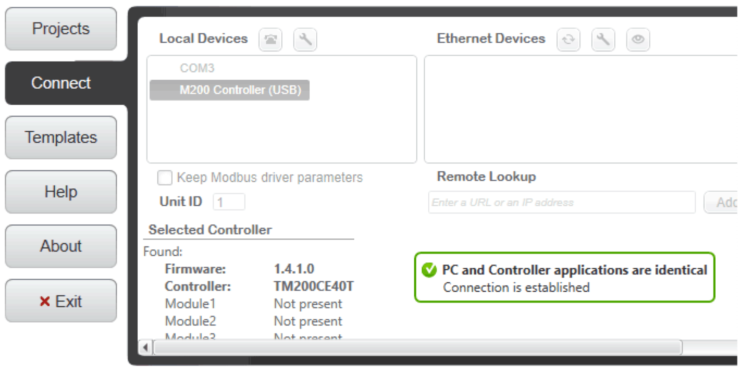
Refer to Controller States and Behavior, page 28 for information on the logic controller operating states and status of the LEDs.

Downloading Firmware to the Controller

This table describes how to download a firmware to the logic controller using an SD card:

Step	Action
1	Insert an empty micro SD card into the PC that is running EcoStruxure Machine Expert-Basic.
2	Create a file called *script.cmd* in the SD card root directory.  View Sort by Group by Refresh Customize this folder... Paste Paste shortcut Undo Delete Ctrl+Z Share with New Properties Folder Shortcut Bitmap image CO Document Contact Microsoft Word Document SAPShow Container Microsoft Access Database Microsoft PowerPoint Presentation Rich Text Format SAP GUI Shortcut Text Document WIBU Control File Microsoft Excel Worksheet Briefcase  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document
3	Edit the*script.cmd* file and insert the following line: `Download "/sys/os"`  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Libraries Name Type script.cmd Windows Command Script Open Edit Print Run as administrator Create PDF and Bitmap Files with PDFCreator

Step	Action
	 script.cmd - Notepad `Download "/sys/os"` Notepad Do you want to save changes to E:\script.cmd?
4	Create the folder *sys* in the SD card root directory and the subfolder *os* under it. Then copy the firmware file in the *os* folder:  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) ▸ Organize ▾ Open Share with ▾ New folder Favorites Desktop Downloads Recent Places OneDrive Name Type sys File folder script.cmd Windows Command Scr  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) ▸ sys ▸ Organize ▾ Open Share with ▾ New folder Favorites Desktop Downloads Recent Places OneDrive Name os **NOTE:** A firmware file example and the script are available in the folder*Firmwares & PostConfiguration\M200M100\* of the EcoStruxure Machine Expert-Basic installation folder. The firmware file name for the M100/M200 Logic Controller is `M200M100.mfw`.
5	Remove the micro SD card from the PC.
6	Remove the power from the controller and insert the micro SD card into the micro SD card slot of the logic controller.
7	Restore power to the controller. **Result:** Copying of the firmware file begins. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress.
8	Wait until the end of the operation (until the **SD** system LED is off or flashing).
9	Remove the SD card.

Step	Action
10	Reconnect the USB programming cable to the logic controller and login to the logic controller with the EcoStruxure Machine Expert-Basic software. The status of the controller firmware update can be verified reading the `script.log` file created automatically in the SD card root directory.
11	Verify the firmware updating status.  Projects Connect Templates Help About × Exit Local Devices Ethernet Devices COM3 M200 Controller (USB) Keep Modbus driver parameters Remote Lookup Enter a URL or an IP address AddUnit ID 1 Selected Controller Found: Firmware: 1.4.1.0 Controller: TM200CE40T Module1 Not present Module2 Not present PC and Controller applications are identical Connection is established

Downloading Firmware to TM3 Analog Expansion Modules

The firmware can be updated in TM3 expansion modules that have a firmware version greater than or equal to 26. If necessary, the version of firmware can be confirmed using EcoStruxure Machine Expert-Basic.

Firmware updates are performed using a script file on an SD card. When the SD card is inserted in the SD card slot of the M100/M200 Logic Controller, the logic controller updates the firmware of the TM3 analog expansion modules on the I/O bus, including those that are:

- Connected remotely, using a TM3 Transmitter/Receiver module
- In configurations comprising a mix of TM3 and TM2 expansion modules.

This table describes how to download a firmware to one or more TM3 expansion modules using an SD card:

Step	Action
1	Apply power to the controller.

2	Ensure that the controller is in the *EMPTY* state by deleting the application in the logic controller. You can do this with EcoStruxure Machine Expert-Basic by using one of the following script commands:
	
	`Delete “usr/*”`
	
	`Delete “usr/app”`
	
	Refer to File Management Operations, page 137 for details.

3	Insert an empty SD card into the PC.
4	Create a file called *script.cmd* in the SD card root directory.

5	Edit the file and insert the following command:
	
	`Download "/TM3/<filename>/*"`
	
	NOTE: `<filename>` is the file name of the firmware you wish to update. The asterisk signifies that all analog modules will be updated.
	
	To download the firmware to one specific TM3 expansion module, replace the asterisk with the position of the expansion module in the configuration. For example, to specify the module at position 4:
	
	`Download "/TM3/<filename>/4"`

6	Create the folder path */TM3/* in the SD card root directory and copy the firmware file to the *TM3* folder.

Step	Action
	NOTE: A firmware file (the firmware file valid at the time of the installation of EcoStruxure Machine Expert-Basic) and an example script are available in the folder *Firmwares & PostConfiguration\TM3\* of the EcoStruxure Machine Expert-Basic installation folder.
7	Remove the SD card from the PC and insert it into the SD card slot of the controller. **Result:** The logic controller begins transferring the firmware file from the SD card to the updatable TM3 analog expansion modules or to the one module specified in step 5. During this operation, the **SD** system LED on the controller is illuminated. **NOTE:** The firmware update takes 10 to 15 seconds for each expansion module being updated. Do not remove power from the controller, or remove the SD card, while the operation is in progress. Otherwise, the firmware update may be unsuccessful and the modules may no longer function correctly. In this case, run the Recovery Procedure to reinitialize the firmware on the modules.
8	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in `Script.log` file.

If you remove power to the device, or there is a power outage or communication interruption during the transfer of the application, your device may become inoperative. If a communication interruption or a power outage occurs, reattempt the transfer. If there is a power outage or communication interruption during a firmware update, or if an invalid firmware is used, your device will become inoperative. In this case, use a valid firmware and reattempt the firmware update.

NOTICE

INOPERABLE EQUIPMENT

- Do not interrupt the transfer of the application program or a firmware change once the transfer has begun.
- Re-initiate the transfer if the transfer is interrupted for any reason.
- Do not attempt to place the device into service until the file transfer has completed successfully.

Failure to follow these instructions can result in equipment damage.

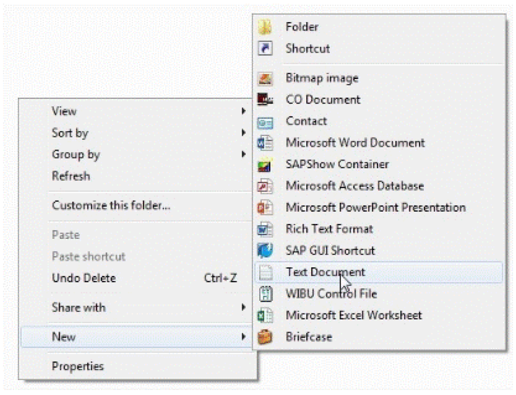
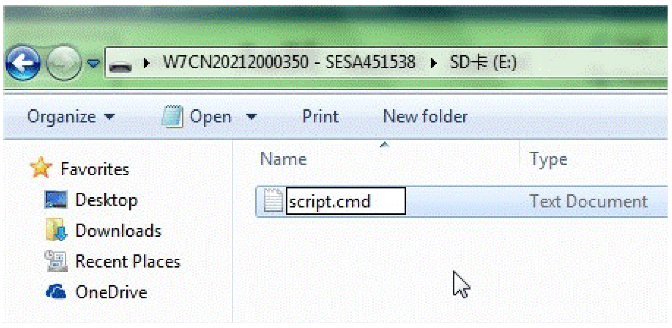
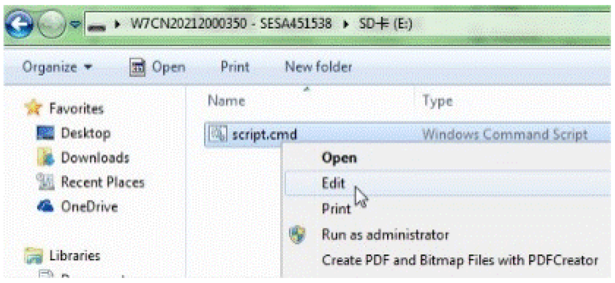
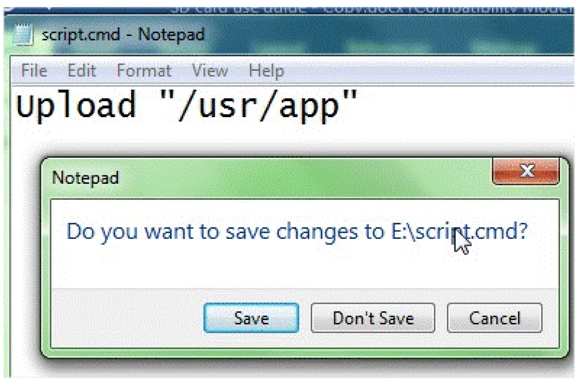
Application Management

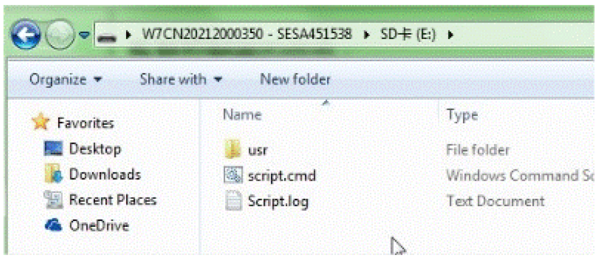
Overview

You can use a micro SD card to back up and restore your controller application, or copy it to another controller with the same reference.

Backing Up an Application

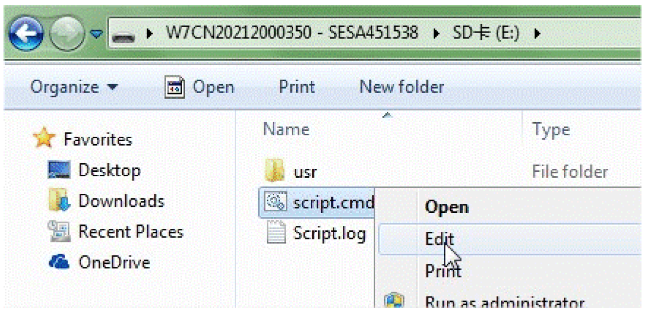
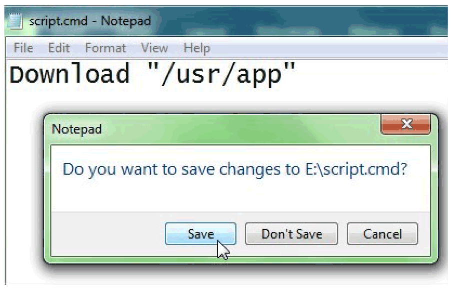
This table describes how to back up the controller application on the micro SD card:

Step	Action
1	Create a *script.cmd* file with a text editor on your PC in the SD card root memory.  View Sort by Group by Refresh Customize this folder... Paste Paste shortcut Undo Delete Ctrl+Z Share with New Properties Folder Shortcut Bitmap image CO Document Contact Microsoft Word Document SAPShow Container Microsoft Access Database Microsoft PowerPoint Presentation Rich Text Format SAP GUI Shortcut Text Document WIBU Control File Microsoft Excel Worksheet Briefcase  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document
2	Edit the *script.cmd* file and insert the following line: `Upload "/usr/app"`  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Libraries Name Type script.cmd Windows Command Script Open Edit Print Run as administrator Create PDF and Bitmap Files with PDFCreator  script.cmd - Notepad File Edit Format View Help Upload "/usr/app" Notepad Do you want to save changes to E:\script.cmd? Save Don't Save Cancel
3	Remove the power from the controller.
4	Insert the prepared micro SD card in the controller.

Step	Action
5	Restore the power to the controller. **Result:** Copying of the application file begins. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress. **NOTE:** The application backup process has a low priority in order to minimize impact on the program and communication performance of the logic controller.
6	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in the *Script.log* file. **Result:** The application file (`*.smbk`) is saved on the micro SD card.  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Share with New folder Favorites Desktop Downloads Recent Places OneDrive Name / Type usr / File folder script.cmd / Windows Command Sc Script.log / Text Document

Restoring an Application or Copying an Application to Another Controller

This table describes how to transfer the controller application from the micro SD card to the controller:

Step	Action
1	Take an SD card previously created and edit the *script.cmd* file in the root folder of the SD card with a text editor.  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type usr File folder script.cmd Script.log Open Edit Print Run as administrator
2	Replace the content of the script by the following line: `Download "/usr/app"`  script.cmd - Notepad File Edit Format View Help Notepad Save Don't Save Cancel `Download "/usr/app"` Do you want to save changes to E:\script.cmd?
3	Remove power from the controller.
4	Insert the prepared micro SD card in the controller.
5	Restore power to the controller.

Step	Action
	Result: Copying of the application file begins. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress.
6	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in the *Script.log* file.
7	Remove the SD card to restart the controller.

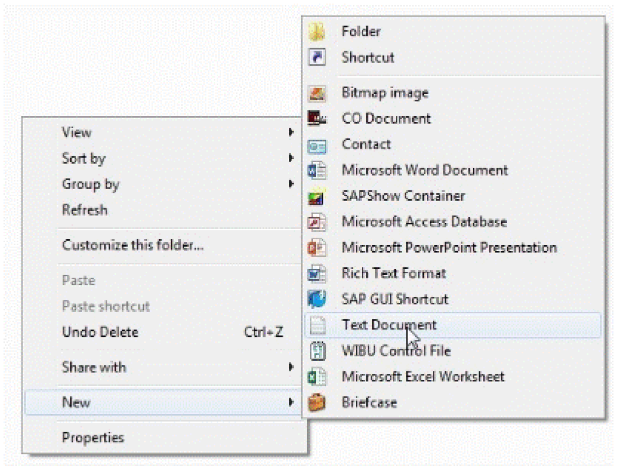
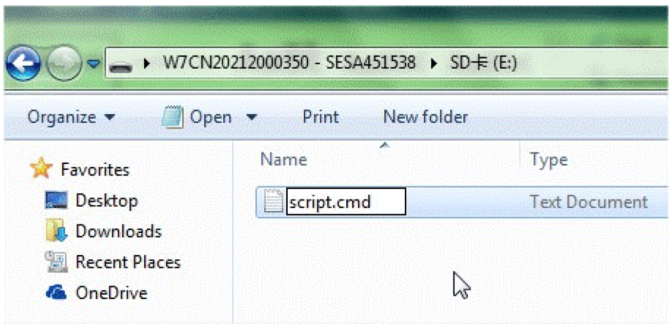
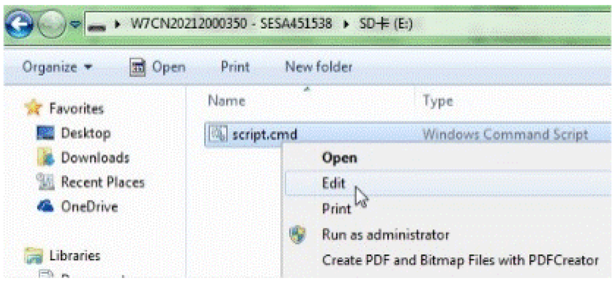
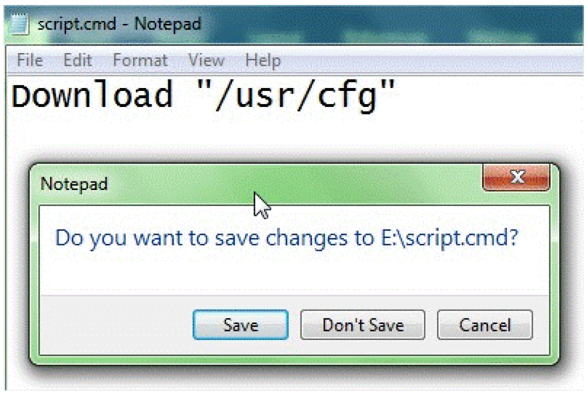
Post Configuration Management

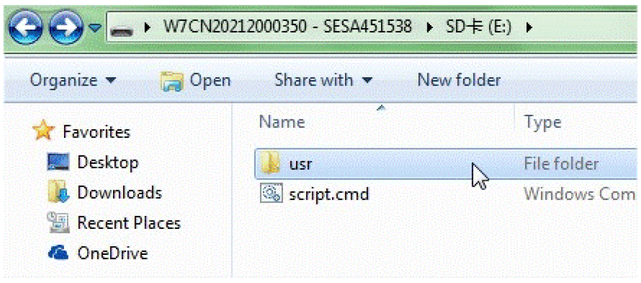
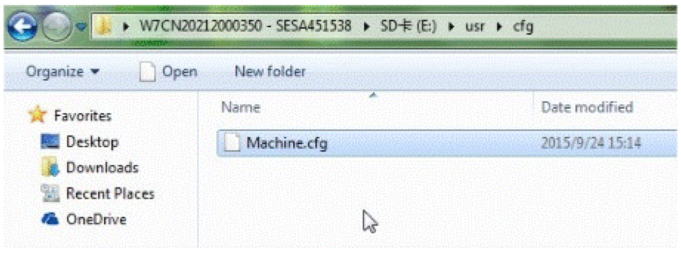
Overview

You can use an SD card to add, change, or delete the post configuration file of your controller.

Adding or Changing a Post Configuration

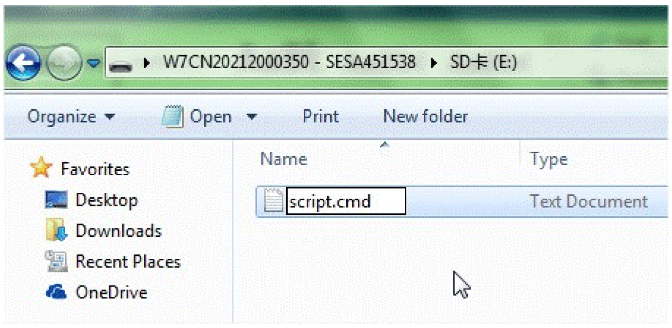
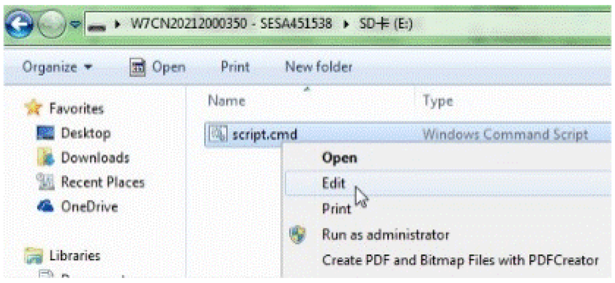
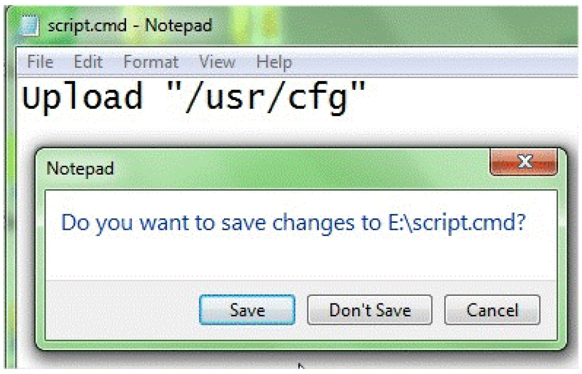
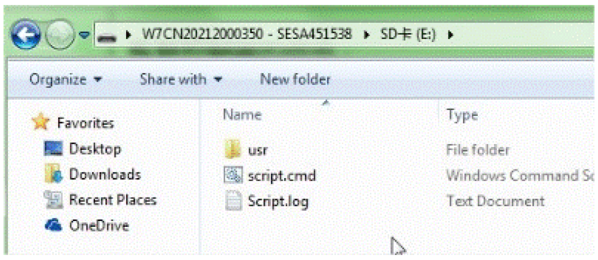
This table describes how to add or change the controller post configuration:

Step	Action
1	Create a file called *script.cmd* in the SD card root directory.  View Sort by Group by Refresh Customize this folder... Paste Paste shortcut Undo Delete Ctrl+Z Share with New Properties Folder Shortcut Bitmap image CO Document Contact Microsoft Word Document SAPShow Container Microsoft Access Database Microsoft PowerPoint Presentation Rich Text Format SAP GUI Shortcut Text Document WIBU Control File Microsoft Excel Worksheet Briefcase  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document
2	Edit the file and insert the following line: *Download "/usr/cfg"* and then save the file.  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Libraries Name Type Open Edit Print Run as administrator Create PDF and Bitmap Files with PDFCreator script.cmd Windows Command Script  script.cmd - Notepad File Edit Format View Help Notepad Save Don't Save Cancel `Download "/usr/cfg"` Do you want to save changes to E:\script.cmd?
3	Create the folder `usr` in the SD card root directory and then create the subfolder `cfg` in it.

Step	Action
	Copy the post configuration file (`Machine.cfg`) to the folder `\usr\cfg`:  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) ▸ Organize Open Share with New folder Favorites Desktop Downloads Recent Places OneDrive Name Type usr File folder script.cmd Windows Com  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) ▸ usr ▸ cfg Organize Open New folder Favorites Desktop Downloads Recent Places OneDrive Name Date modified Machine.cfg 2015/9/24 15:14 **NOTE:** A post configuration file example and the associated script are available in the directory *Firmwares & PostConfiguration\PostConfiguration\add_change\* of the EcoStruxure Machine Expert-Basic installation directory.
4	If necessary, edit the `Machine.cfg` file to configure your post configuration parameters.
5	Remove the power from your controller.
6	Insert the prepared SD card in the controller.
7	Restore the power to your controller. **Result:** Downloading of the post configuration file begins. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress. **NOTE:** Before the download the file format is checked, as well as if all of the channels, parameters, and values configured are valid; in case of detected error the download is aborted.
8	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in the `script.log` file.
9	Do a power cycle or initialization command to apply the new post configuration file.

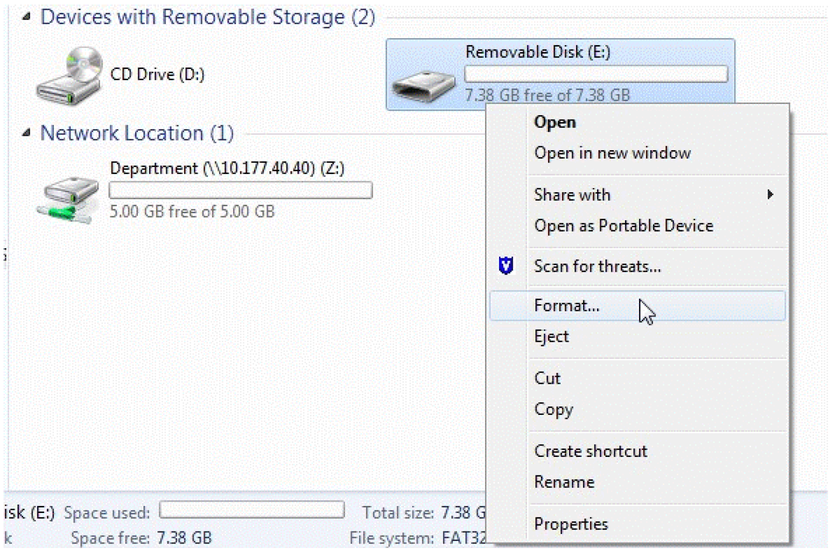
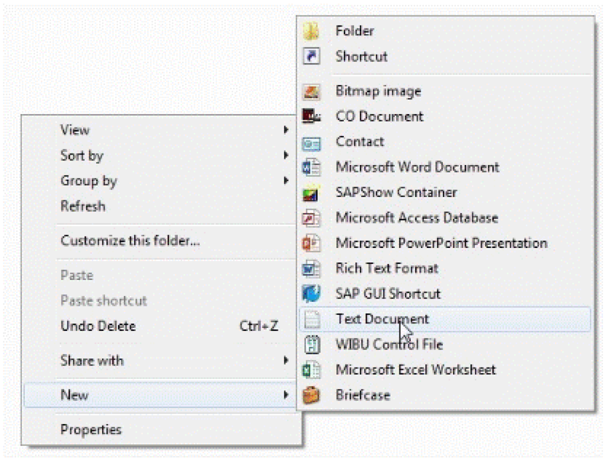
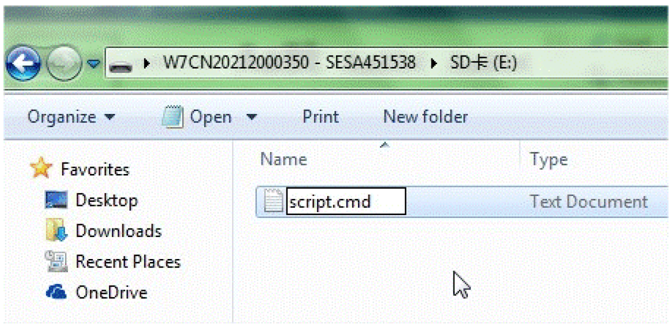
Reading a Post Configuration File

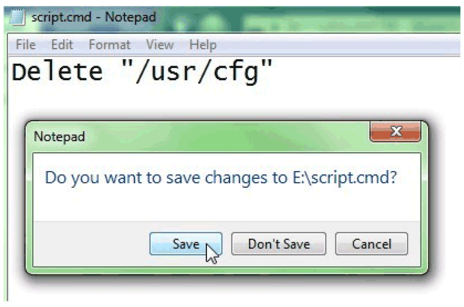
This table describes how to read the post configuration file of the controller:

Step	Action
1	Create a `script.cmd` file with a text editor on your PC in the SD card root directory.  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document
2	Edit the file and insert the following line. Then save the file: `Upload "/usr/cfg"`  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Libraries Name Type script.cmd Windows Command Script Open Edit Print Run as administrator Create PDF and Bitmap Files with PDFCreator  script.cmd - Notepad File Edit Format View Help Notepad Save Don't Save Cancel `Upload "/usr/cfg"` Do you want to save changes to E:\script.cmd?
3	Remove the power from the controller.
4	Insert the prepared SD card in the controller.
5	Restore the power to the controller. **Result:** Copying of the post configuration file begins. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress. **NOTE:** The application backup process has a low priority to minimize impact on the program and communication performance of the logic controller.
6	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in the `script.log` file. **Result:** The post configuration file is saved on the SD card.  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) ▸ Organize Share with New folder Favorites Desktop Downloads Recent Places OneDrive Name Type usr File folder script.cmd Windows Command Sc Script.log Text Document

Removing a Post Configuration File

This table describes how to remove the post configuration file of the controller:

Step	Action
1	Insert an empty SD card into the PC.  Devices with Removable Storage (2) CD Drive (D:) Removable Disk (E:) 7.38 GB free of 7.38 GB Network Location (1) Department (\\10.177.40.40) (Z:) 5.00 GB free of 5.00 GB Open Open in new window Share with Open as Portable Device Scan for threats... Format... Eject Cut Copy Create shortcut Rename Properties isk (E:) Space used: Total size: 7.38 G Space free: 7.38 GB File system: FAT32
2	Create a file called `script.cmd` in the SD card root directory.  View Sort by Group by Refresh Customize this folder... Paste Paste shortcut Undo Delete Ctrl+Z Share with New Properties Folder Shortcut Bitmap image CO Document Contact Microsoft Word Document SAPShow Container Microsoft Access Database Microsoft PowerPoint Presentation Rich Text Format SAP GUI Shortcut Text Document WIBU Control File Microsoft Excel Worksheet Briefcase  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document

Step	Action
3	Edit the file and insert the following line: `Delete "/usr/cfg"`  Delete "/usr/cfg" Do you want to save changes to E:\script.cmd? script.cmd - Notepad File Edit Format View Help Notepad Save Don't Save Cancel
4	Copy the script file available in the directory *Firmwares & PostConfiguration \PostConfiguration\remove\* of the EcoStruxure Machine Expert-Basic installation directory to the root directory of the SD card.
5	Remove the power from the controller.
6	Insert the prepared SD card in the controller.
7	Restore the power to the controller. **Result:** The post configuration file is removed. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress.
8	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in the `script.log` file.
9	Do a power cycle or an initialization command the controller to apply the application parameters.

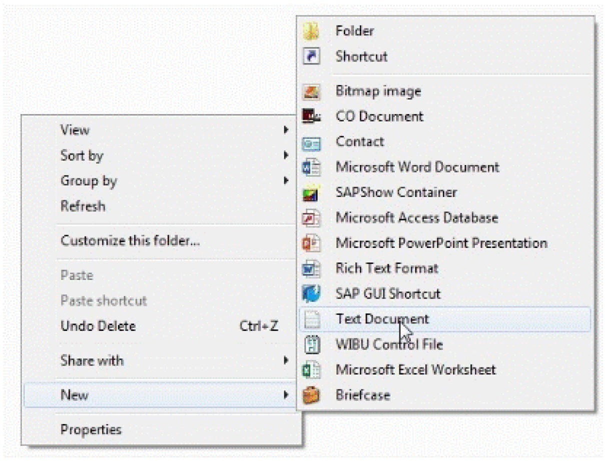
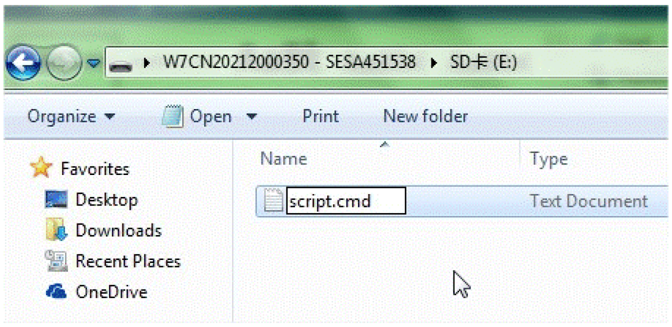
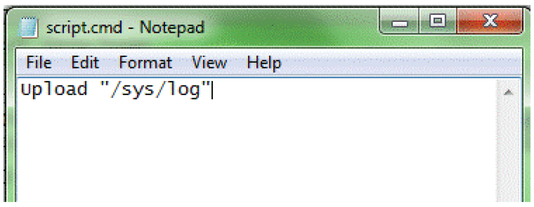
Error Log Management

Overview

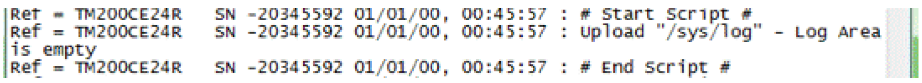
You can use the micro SD card to back up or delete the error log file of the logic controller.

Backing Up the Error Log

This table describes how to back up the logic controller error log file on the micro SD card:

Step	Action
1	Create a *script.cmd* file with a text editor on your PC in the SD card root directory.  View Sort by Group by Refresh Customize this folder... Paste Paste shortcut Undo Delete Ctrl+Z Share with New Properties Folder Shortcut Bitmap image CO Document Contact Microsoft Word Document SAPShow Container Microsoft Access Database Microsoft PowerPoint Presentation Rich Text Format SAP GUI Shortcut Text Document WIBU Control File Microsoft Excel Worksheet Briefcase  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document
2	Edit the file and insert the following line: `Upload "/sys/log"`  `Upload "/sys/log"`
3	Insert the prepared micro SD card in the logic controller.
4	Put the RUN/STOP switch on the logic controller on the STOP position. **Result:** Transfer of the error log file begins. During the operation, the **SD** system LED on the logic controller is illuminated.
5	Wait until the end of the operation (until the **SD** LED is off or flashing. If an error is detected, the LEDs flash and the detected error is logged in the `Script.log` file. **Result:** The error log file (`PlcLog.csv`) is saved on the micro SD card.

NOTE: The SD LED will stay off if there is no error record in the controller.The RUN and ERR LEDs will flash per one second. The information in the `Script.log` file will be as below:

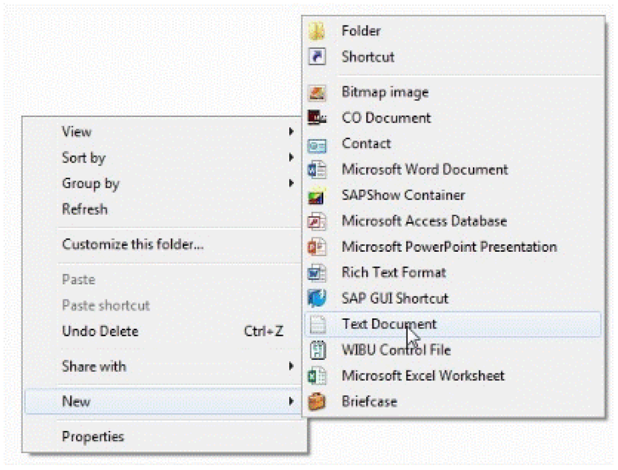
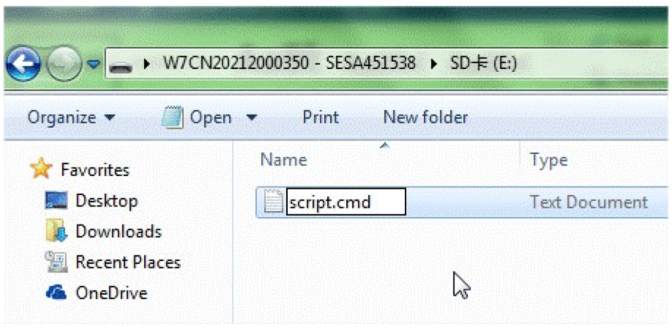
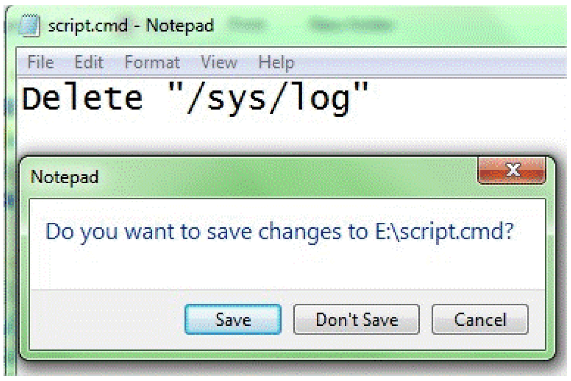


```
Ref = TM200CE24R    SN -20345592 01/01/00, 00:45:57 : # Start Script #
Ref = TM200CE24R    SN -20345592 01/01/00, 00:45:57 : Upload "/sys/log" - Log Area
is empty
Ref = TM200CE24R    SN -20345592 01/01/00, 00:45:57 : # End Script #
```

NOTE: Do not remove the power from the controller during the process. Turn the RUN/STOP switch of the logic controller on the STOP position. Then insert the SD card and the SD LED will turn on. The SD LED will turn off when the process finishes.

Deleting the Error Log

This table describes how to delete the error log file in the logic controller:

Step	Action
1	Create a *script.cmd* file with a text editor on your PC in the SD card root directory.  View Sort by Group by Refresh Customize this folder... Paste Paste shortcut Undo Delete Ctrl+Z Share with New Properties Folder Shortcut Bitmap image CO Document Contact Microsoft Word Document SAPShow Container Microsoft Access Database Microsoft PowerPoint Presentation Rich Text Format SAP GUI Shortcut Text Document WIBU Control File Microsoft Excel Worksheet Briefcase  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document
2	Edit the file and insert the following line: `Delete "/sys/log"`  script.cmd - Notepad File Edit Format View Help Delete "/sys/log" Do you want to save changes to E:\script.cmd? Save Don't Save Cancel
3	Insert the prepared micro SD card in the logic controller.
4	Turn the RUN/STOP switch of the logic controller to the STOP position. **Result:** Deleting of the error log file begins. During the operation, the **SD** system LED on the logic controller is illuminated.
5	Wait until the end of the operation (until the **SD** LED is off or flashing. If an error is detected, the LEDs flash and the detected error is logged in the `Script.log` file. **Result:** The error log file (`PlcLog.csv`) is deleted from the logic controller.

Error Log Format

The logic controller provides an error list containing the last 10 detected errors in the log memory. Each error entry into the error log file is composed of the following parts:

- Date and time
- Level
- Context
- Error code

After an upload through the micro SD card, the code is represented as in the example below:

```
02/06/14, 12:04:01, 0x0111000100
```

This table describes the meaning of the hexadecimal error representation:

Group	Error code (hex)	Error description	Result
General	*08000011xx*	Invalid hardware calibration parameters	Ethernet channel is inoperative `%SW118.bit10` set to 0 **ERR** LED flashes
Operating system	0F01xxxxxx	Operating system error detected	Transition to HALTED state
Memory management	0F030009xx	Internal memory allocation error detected	Transition to HALTED state
SD card	*010C001Bxx*	Error while accessing an SD card; the operation exceeded an internal timeout (3000 ms).	The SD card operation is canceled.
Watchdog timer	0104000Axx	Logic controller resource utilization greater than 80% - first detection	Watchdog timeout signaled: • *%s11* set to 1 *ERR* LED flashes
	0804000Bxx	Logic controller resource utilization greater than 80% - second consecutive detection	Transition to HALTED state
	0804000Cxx	Task watchdog timer in master task	Transition to HALTED state
	0804000Dxx	Task watchdog timer in periodic task	Transition to HALTED state
Battery	*0105000Exx*	Battery is depleted	Depleted battery signaled: `%S75` set to 1 **BAT** LED illuminated
User application	0807000Fxx	Application is not compatible with firmware	Transition to EMPTY state
	08070010xx	Checksum error detected	Transition to EMPTY state
Ethernet	010B0014xx	Duplicate IP address detected	Duplicate IP signaled • *%SW62* set to 1 • *%SW118.bit9* set to 0. *ERR* LED flashes
Embedded I/O	*010D0013xx*	Short-circuit detected on protected output	Over-current signaled: `%SW139` set to 1 (depending on the output block) **ERR** LED flashes

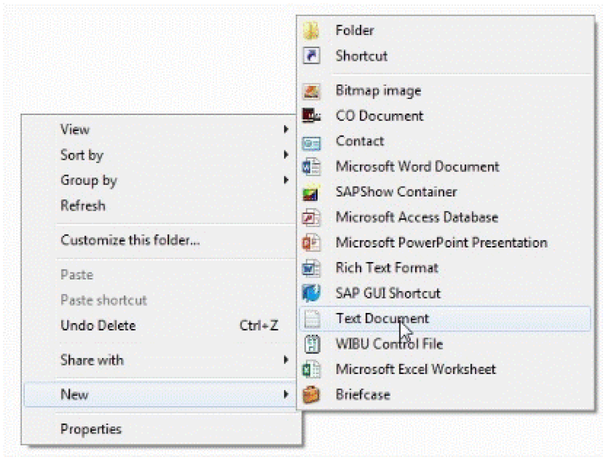
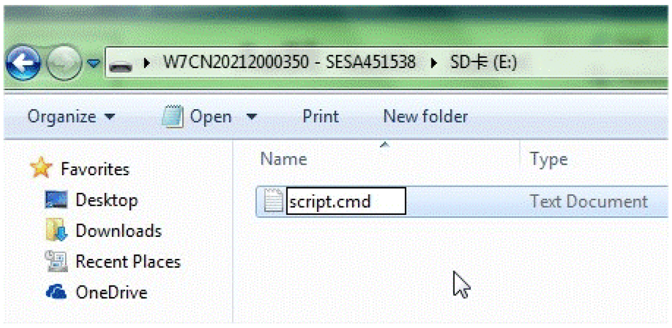
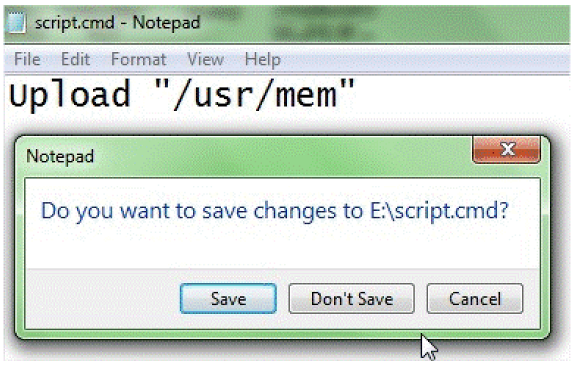
Group	Error code (hex)	Error description	Result
Read non-volatile memory	*01110000xx*	Read error detected - file not found	Unsuccessful read operation
	01110001xx	Read error detected - incorrect logic controller type	
	01110002xx	Read error detected - incorrect header	
	01110003xx	Read error detected - incorrect area descriptor	
	01110004xx	Read error detected - incorrect area descriptor size	
Write non-volatile memory	*01120002xx*	Write error detected - incorrect header	Unsuccessful write operation
	01120004xx	Write error detected - incorrect area descriptor size	
	01120005xx	Write error detected - unsuccessful erase	
	01120006xx	Write error detected - incorrect header size	
Persistent variable	*01130007xx*	Checksum error detected in persistent variables	Persistent variables cannot be restored
	01130008xx	Size error detected in persistent variables	
Ethernet IP	*01140012xx*	Unsuccessful Ethernet IP variable creation	Variable cannot be created, unsuccessful operation

Memory Management: Backing Up and Restoring Controller Memory

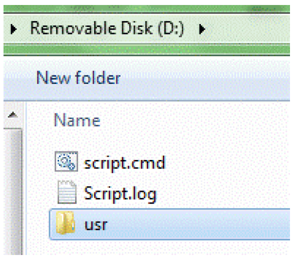
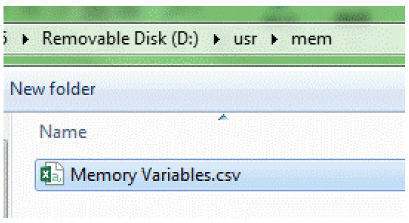
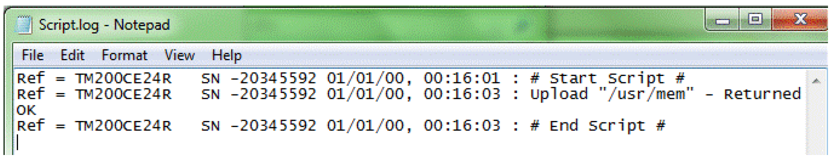
Overview

You can use an SD card to back up and restore controller memory objects, or copy the memory objects to another controller.

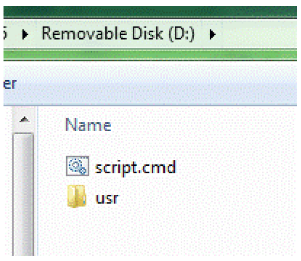
Backing Up Controller Memory

Step	Action
1	Create a *script.cmd* file with a text editor on your PC in the SD card root directory.  View Sort by Group by Refresh Customize this folder... Paste Paste shortcut Undo Delete Ctrl+Z Share with New Properties Folder Shortcut Bitmap image CO Document Contact Microsoft Word Document SAPShow Container Microsoft Access Database Microsoft PowerPoint Presentation Rich Text Format SAP GUI Shortcut Text Document WIBU Control File Microsoft Excel Worksheet Briefcase  W7CN20212000350 - SESA451538 ▸ SD卡 (E:) Organize Open Print New folder Favorites Desktop Downloads Recent Places OneDrive Name Type script.cmd Text Document
2	Edit the file and insert the following line: `Upload "/usr/mem"`  script.cmd - Notepad File Edit Format View Help Upload "/usr/mem" Notepad Do you want to save changes to E:\script.cmd? Save Don't Save Cancel
3	Insert the prepared SD card in the controller.

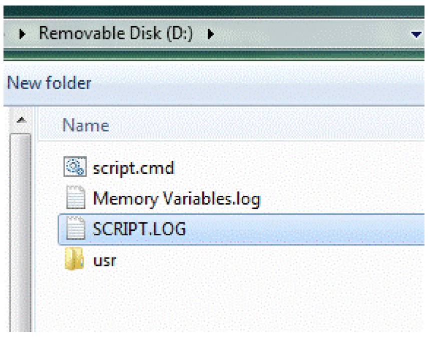
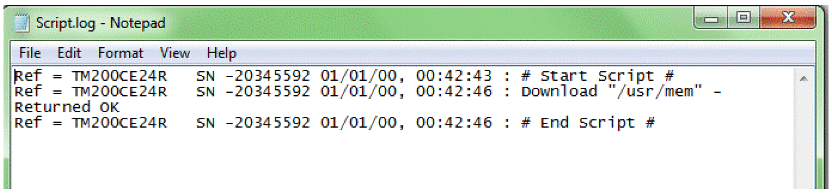
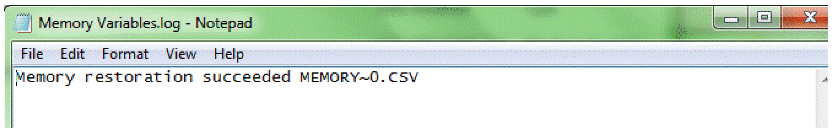
Step	Action
4	Turn the RUN/STOP switch of the logic controller on the STOP position. **Result:** Copying of the memory begins. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress. **NOTE:** The memory backup process has a low priority to minimize impact on the program and communication performance of the logic controller.

5	Wait until the end of the operation (until the **SD** LED is off or flashing).
	
	If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in `Script.log` file.
	
	Result: The memory file (`*.csv`) is saved on the SD card.
	
	 Removable Disk (D:)
	New folder
	Name
	script.cmd
	Script.log
	usr
	
	 Removable Disk (D:) usr mem
	New folder
	Name
	Memory Variables.csv
	
	
	`Ref = TM200CE24R   SN -20345592 01/01/00, 00:16:01 : # Start Script #`
	`Ref = TM200CE24R   SN -20345592 01/01/00, 00:16:03 : Upload "/usr/mem" - Returned OK`
	`Ref = TM200CE24R   SN -20345592 01/01/00, 00:16:03 : # End Script #`

Restoring Controller Memory or Copying to Another Controller

Step	Action
1	Edit the *script.cmd* file in the root folder of the SD card with a text editor. 
2	Edit the file and insert the following line: `Download "/usr/mem"`
3	Insert the prepared SD card in the controller.
4	Turn the RUN/STOP switch of the controller on the STOP position. **Result:** Copying of the memory file begins. During the operation, the **SD** system LED on the logic controller is illuminated. **NOTE:** Avoid removing power from the logic controller while the operation is in progress.

Step	Action

5	Wait until the end of the operation (until the **SD** LED is off or flashing).
	
	If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in `Script.log` file.
	
	 Removable Disk (D:)
	New folder
	Name
	script.cmd
	Memory Variables.log
	SCRIPT.LOG
	usr
	
	
	`Ref = TM200CE24R    SN -20345592 01/01/00, 00:42:43 : # Start Script #`
	`Ref = TM200CE24R    SN -20345592 01/01/00, 00:42:46 : Download "/usr/mem" -`
	`Returned OK`
	`Ref = TM200CE24R    SN -20345592 01/01/00, 00:42:46 : # End Script #`
	
	 Memory Variables.log - Notepad
	File Edit Format View Help
	`Memory restoration succeeded MEMORY~0.CSV`

6	Remove the SD card and restart the controller.

Programming the M100/M200 Logic Controller

What's in This Part

Overview

This part provides information about the system and I/O objects specific to the M100/M200 Logic Controller. These objects are displayed in the **Programming** tab.

For descriptions of all other objects, refer to EcoStruxure Machine Expert-Basic Generic Functions Library Guide.

How to Use the Source Code Examples

What's in This Chapter

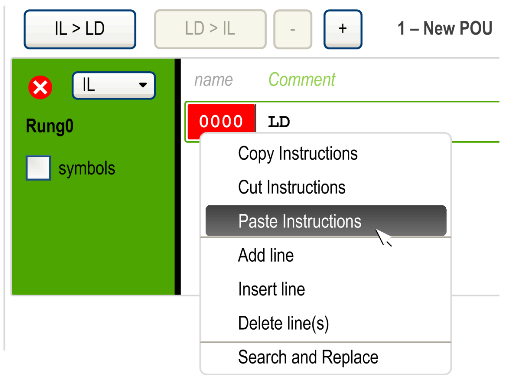
How to Use the Source Code Examples

Overview

Except where explicitly mentioned, the source code examples contained in this book are valid for both the Ladder Diagram and Instruction List programming languages. A complete example may require more than one rung.

Reversibility Procedure

To obtain the equivalent Ladder Diagram source code:

Step	Action
1	Select and copy (**Ctrl+C**) the source code for the first rung of the sample program shown in this manual.
2	In EcoStruxure Machine Expert-Basic, create a new rung by clicking on the toolbar.
3	In this rung, click the **LD > IL** button to display Instruction List source code.
4	Select the line number **0000**, then right-click and choose **Paste Instructions** to paste the source code into the rung:  IL > LD LD > IL - + 1 – New POU IL Rung0 symbols name Comment 0000 LD Copy Instructions Cut Instructions Paste Instructions Add line Insert line Delete line(s) Search and Replace **NOTE:** Remember to delete the **LD** instruction from the last line of the rung if you have pasted the instructions by inserting the line(s) before the default LD operator.
5	Click the **IL > LD** button to display the Ladder Diagram source code.
6	Repeat the previous steps for any additional rungs in the sample program.

Example

Instruction List program:

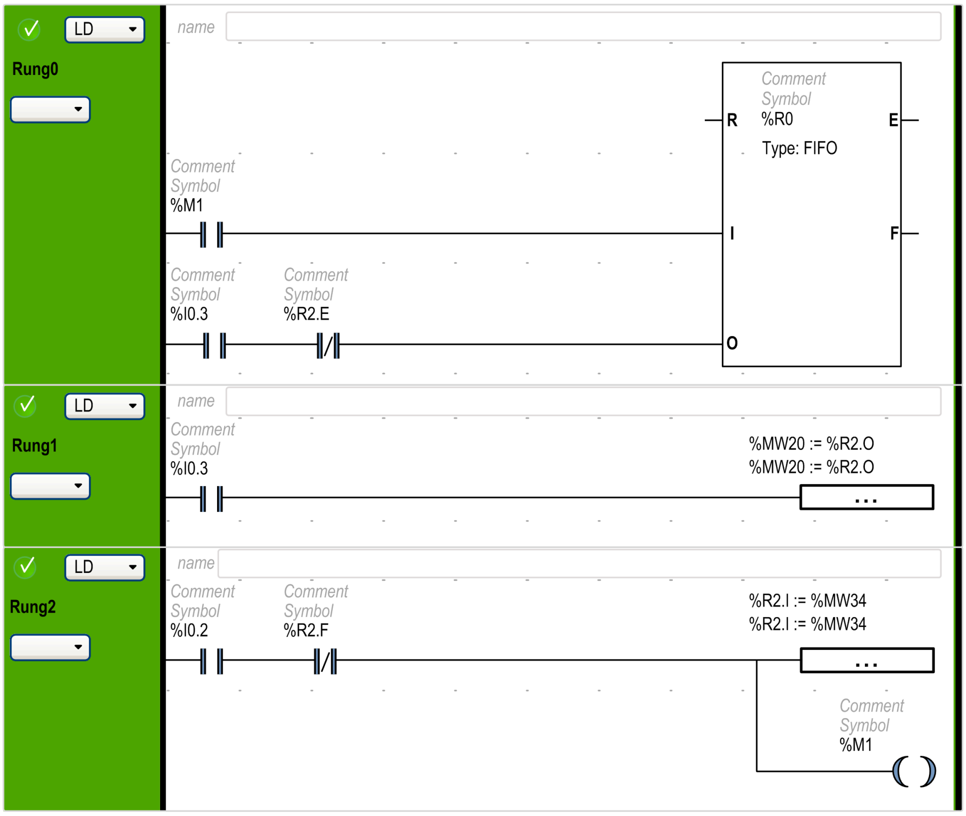
Rung	Source Code

0	`BLK  %R0`
	`LD   %M1`
	`I`
	`LD   %I0.3`
	`ANDN %R2.E`
	`O`
	`END_BLK`

1	`LD   %I0.3`
	`[%MW20:=%R2.O]`

2	`LD   %I0.2`
	`ANDN %R2.F`
	`[%R2.I:=%MW34]`
	`ST   %M1`

Corresponding Ladder Diagram:



I/O Objects

What’s in This Chapter

Digital Inputs (%I)

Introduction

Digital input bit objects are the image of digital inputs on the logic controller.

Displaying Digital Input Properties

Follow these steps to display properties of the digital inputs:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **I/O objects > Digital inputs**. **Result**: Digital input properties appear on the screen.

Digital Inputs Properties

This table describes each property of the digital input:

Parameter	Editable	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the input channel is being referenced in a program.
Address	No	%I0.i	–	Displays the address of the digital input on the controller, where i represents the channel number. If the controller has n digital input channels, the value of i is given as 0...n-1. For example, *%I0.2* is the digital input at the digital input channel number 2 of the logic controller.

Parameter	Editable	Value	Default Value	Description
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this input. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with this address. Double-click in the **Comment** column and type an optional comment to associate with this channel.

Digital Outputs (%Q)

Introduction

Digital output bit objects are the image of digital outputs on the logic controller.

Displaying Digital Output Properties

Follow these steps to display properties of the digital outputs:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **I/O objects > Digital outputs**. **Result**: Digital output properties appear on the screen.

Digital Outputs Properties

This table describes each property of the digital output:

Parameter	Editable	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the output channel is being referenced in a program.
Address	No	%Q0.i	–	Displays the address of the digital output on the controller, where i represents the channel number. If the controller has n digital output channels, the value of i is given as 0...n-1. For example, *%Q0.3* is the digital output at the digital output channel number 3 of the logic controller.

Parameter	Editable	Value	Default Value	Description
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this output. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Comment	Yes	–	–	The comment associated with this address. Double-click in the **Comment** column and type an optional comment to associate with this channel.

Analog Inputs (%IW)

Introduction

Analog input word objects are the digital values of an analog signal connected to the logic controller.

Two 0-10V analog inputs are embedded in the cartridges TMCR2AI2, TMCR2TI2, and TMCR2AM3. The embedded analog inputs use a 10 bits resolution converter so that each increment is approximately 10 mV ($10V/2^{10}$-1). Once the system detects the value 1023, the channel is considered to be saturated.

Refer to the M100/M200 Hardware Guide (see Modicon M100/M200 Logic Controller, Hardware Guide) for more details.

Displaying Analog Input Properties

Follow these steps to display properties of the analog inputs:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **I/O objects > Analog inputs**. **Result**: Analog input properties appear on the screen.

Analog Inputs Properties

This table describes each property of the analog input:

Parameter	Editable	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the input channel is being referenced in a program.
Address	No	%IW0.i	–	Displays the address of the embedded analog input on the controller, where i represents the channel number. If the controller has n analog input channels, the value of i is given as 0... n-1.

Parameter	Editable	Value	Default Value	Description
				For example, `%IW0.1` is the analog input at the analog input channel number 1 of the logic controller.
		%IW0.x0y	–	Displays the address of the analog output channel on the cartridge, where x is the cartridge number and and y is the channel number.
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this input. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Comment	Yes	–	–	The comment associated with this address. Double-click in the **Comment** column and type a comment to associate with this address.

Analog Outputs (%QW)

Introduction

Analog output word objects are the digital values of the analog signals received from the logic controller using cartridges.

Two 0-10 V analog outputs and two 4-20 mA analog outputs are embedded in the cartridges TMCR2AQ2C and TMCR2AQ2V respectively.

One 0-5 V/0-10 V analog voltage output or 4-20 mA analog current output is embedded in the cartridge TMCR2AM3.

Refer to Modicon M100/M200 Logic Controller Hardware Guide (see Modicon M100/M200 Logic Controller, Hardware Guide) for more details.

Displaying Analog Output Properties

Follow these steps to display properties of the analog outputs:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **I/O objects > Analog outputs**. **Result**: Analog output properties appear on the screen.

Analog Outputs Properties

This table describes each property of the analog output:

Parameter	Edita-ble	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the output channel is being referenced in a program.
Address	No	%QW0.x0y	–	Displays the address of the analog output channel on the cartridge, where x is the cartridge number and y is the channel number.
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this output. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Comment	Yes	–	–	The comment associated with this address. Double-click in the **Comment** column and type a comment to associate with this address.

Function Blocks

What's in This Chapter

Fast Counter (%FC)

Using Fast Counter Function Blocks

This section provides descriptions and programming guidelines for using *Fast Counter* function blocks.

Description

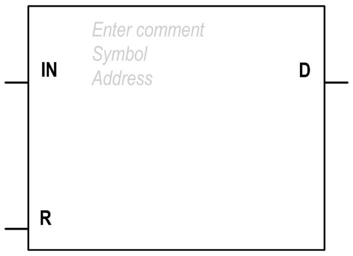
Introduction

The *Fast Counter* function block ***1123*** serves as either an up-counter or a down-counter. It can count the rising edge of digital inputs up to frequencies of 5 kHz in single word or double word computational mode. Because *Fast Counter* function blocks are managed by specific hardware interrupts, maintaining maximum frequency sampling rates may vary depending on your specific application and hardware configuration.

The *Fast Counter* function blocks `%FC0`, `%FC1`, `%FC2`, and `%FC3` use dedicated inputs `%I0.2`, `%I0.3`, `%I0.4` and `%I0.5` respectively. These bits are not reserved for their exclusive use. Their allocation must be considered with the use of other function blocks for these dedicated resources.

Illustration

This illustration is a *Fast Counter* function block in single-word mode:



Inputs

The *Fast Counter* function block has the following inputs:

Label	Description	Value
IN	Enable	At state 1, the value is updated according to the pulses applied to the physical input. At state 0, the value is held at its last value.
R	Reset (optional)	Used to initialize the block. At state 1: • `%FC.P` or `%FC.PD` values are taken into account. • The value is reset to 0 if configured as an up-counter, or set to `%FC.P` or `%FC.PD` if configured as a down-counter. • The Done bit `%FC.D` is set back to its default value.

Outputs

The *Fast Counter* function block has the following output:

Label	Description	Value
D	Done (`%FCi.D`)	This bit is set to 1 when: • `%FCi.V` or `%FCi.VD` reaches the preset value `%FCi.P` or `%FCi.PD` configured as an up-counter. • or when `%FCi.V` or `%FCi.VD` reaches 0 when configured as a down-counter. This read-only bit is reset only by setting `%FCi.R` to 1.

Configuration

Parameters

To configure parameters, follow the *Configuring a Function Block procedure* in the EcoStruxure Machine Expert - Basic, Generic Functions Library Guide and read the description of *Memory Allocation Modes* in the EcoStruxure Machine Expert-Basic Operating Guide.

The *Fast Counter* function block has the following parameters:

Parameter	Description	Value
Used	Address used	If selected, this address is currently in use in a program.
Address	`%FCi` *Fast Counter* address	The instance identifier, where it is from 0 to the number of objects available on this logic controller. Refer to Maximum Number of Objects table, page 24 for the maximum number of *Fast Counters*.
Input	`%IO.i`	The dedicated input associated with this function block instance. `%IO.2...%IO.5`
Symbol	Symbol	The symbol associated with this object. Refer to the EcoStruxure Machine Expert-Basic Operating Guide (Defining and Using Symbols) for details.
Configured	Whether to count up or down	Set to one of: • **Not used** • **Up Counter** • **Down Counter**
Preset	Preset value (`%FCi.P` or `%FCi.PD`)	Initial value may be set: • Using associated object `%FCi.P` from 0 to 65535 in single word mode, • Using associated object `%FCi.PD` from 0 to 4294967295 in double word mode.

Parameter	Description	Value
Double Word	Double word mode	If selected, use double word mode. Otherwise, use single-word mode.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Objects

The *Fast Counter* function block is associated with the following objects:

Object	Description	Value

`%FCi.V`
 	
`%FCi.VD`
	Current value	The current value increments or decrements according the up or down counting function selected. For up-counting, the current counting value is updated and can reach 65535 in single word mode (`%FCi.V`) and 4294967295 in double word mode (`%FCi.VD`). For down-counting, the current value is the preset value `%FC.P` or `%FC.PD` and can count down to 0.

`%FCi.P`
 	
`%FCi.PD`
	Preset value	A new preset value is taken into account only if the R input is active. See description in Parameters table above.

`%FCi.D`	Done	See description in Outputs table above.

Operation

This table describes the main stages of *Fast Counter* function block operations:

Operation	Action	Result
Count up	A rising edge appears at the Count up input.	The current value `%FCi.V` is incremented by 1 unit.
	When the preset value `%FCi.P` or `%FCi.PD` is reached.	The Done output bit `%FCi.D` is set to 1.
Count down	A rising edge appears at the down-counting input.	The current value `%FCi.V` is decremented by 1 unit.
	When the value is 0.	The Done output bit `%FCi.D` is set to 1.

Special Cases

This table contains a list of special operating cases for the *Fast Counter* function block:

Special case	Description
Effect of cold restart (`%S0=1`)	Resets the *Fast Counter* attributes with the values configured or user application. Refer to System Bits (%S), page 322.
Effect of controller stops	The *Fast Counter* stops counting when the controller is set to STOPPED state and resumes counting when it returns to RUNNING state. The counter resumes counting from the last value before entering the STOPPED state.

Programming Example

Introduction

In this example, the application counts a number of items up to 5000 while `%I0.1` is set to 1. The input for `%FC1` is the dedicated input `%I0.3`. When the preset value is reached, `%FC1.D` is set to 1 and retains the same value until `%FC1.R` is commanded by the result of *AND* on `%I0.2` and `%M0`.

Programming

This example is a *Fast Counter* function block:

Rung	**Instruction**

0	`BLK    %FC1`
	`LD     %I0.1`
	`IN`
	`LD     %I0.2`
	`AND    %M0`
	`R`
	`OUT_BLK`
	`LD     D`
	`ST     %Q0.0`
	`END_BLK`

NOTE: Refer to the reversibility procedure, page 161 to obtain the equivalent Ladder Diagram.

High Speed Counter (%HSC)

Using High Speed Counter Function Blocks

This section provides descriptions and programming guidelines for using *High Speed Counter* function blocks.

Description

Introduction

The *High Speed Counter* function block ***11123*** can be configured by EcoStruxure Machine Expert-Basic to perform any one of the following functions:

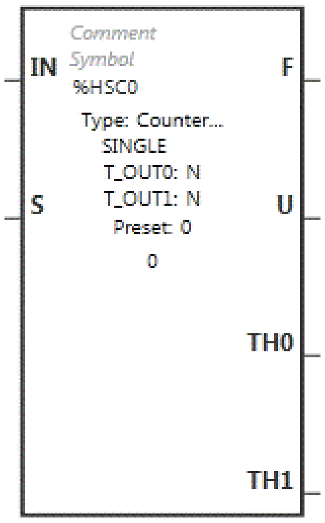
- Single Phase
- Dual Phase [Pulse / Direction]
- Dual Phase [Clock Wise / Counter Clock Wise]
- Dual Phase [Quadrature X1]
- Dual Phase [Quadrature X2]
- Dual Phase [Quadrature X4]
- Frequency Meter

The *High Speed Counter* function block works at a maximum frequency of 100 kHz for all counting modes with a range 65535 in single word and 4294967295 in double word.

The *High Speed Counter* function block uses dedicated inputs and auxiliary inputs and outputs. Refer to the M100/M200 Logic Controller - Hardware Guide for more information on inputs and outputs.

You must initialize the *High Speed Counter* function in the **Configuration** tab using the **High Speed Counter Assistant** before using an instance of the function block. Refer to Configuring High Speed Counters, page 61.

Graphical Representation



Inputs

The *High Speed Counter* function block has the following inputs:

Label	Description	Value
IN	Enable (required) At state 1, the counting function or frequency measurement is enabled. At state 0, the present value is held at its last value.	0 or 1
S	Preset input. At rising edge, initializes the present value with the preset value.: This also initializes the operation of the threshold outputs and takes into account any user modifications to the threshold values set in the properties window or the program.	0 or 1

The *High Speed Counter* function block is associated with the following input objects:

Object	Type	Description	Value

`%HSCi.P`
 	
`%HSCi.PD`
	WORD
	
	DOUBLE WORD
		Preset value
		
		NOTE: It is modulo value when configured to Modulo- Loop mode.
			See Auxiliary Inputs, page 176.

`%HSCi.S0`
 	
`%HSCi.S0D`
	WORD
	
	DOUBLE WORD
		Threshold 0	See Output Threshold in Counting Modes, page 176.

`%HSCi.S1`
 	
`%HSCi.S1D`
	WORD
	
	DOUBLE WORD
		Threshold 1	See Output Threshold in Counting Modes, page 176.

`%HSCi.T`	WORD	Time base	See High Speed Counter in Frequency Meter Mode, page 69.

Object	Type	Description	Value
`%HSCi.R`	BOOL	Enable reflex output 0	At state 1 enables the reflex output 0.
`%HSCi.S`	BOOL	Enable reflex output 1	At state 1 enables the reflex output 1.

Outputs

The *High Speed Counter* function block has the following outputs:

Label	Description	Value
F	Overflow Set to 1 if an arithmetic overflow occurs.	0 or 1
U	Counting direction Set by the system, this bit is used by the `Dual Phase` counting functions to indicate the direction of counting.	0: Down counting 1: Up counting
TH0	Threshold bit 0 Set to 1 when the present value is greater than or equal to the threshold value S0 (`%HSCi.S0`). Test this bit only once in the program because it is updated in real time. The user application is responsible for the validity of the value at its time of use.	0 or 1
TH1	Threshold bit 1 Set to 1 when the present value is greater than or equal to the threshold value S1 (`%HSCi.S1`). Test this bit only once in the program because it is updated in real time.	0 or 1

The *High Speed Counter* function block is associated with the following output objects:

Object	Type	Description	Value

`%HSCi.V`
 	
`%HSCi.VD`
	WORD
	
	DOUBLE WORD
		Present value
		
		NOTE: Present value is always changing. Write operation to `%HSCi.V` or `%HSCi.VD` is prohibited. Attention must be paid if `%HSCi.V` or `%HSCi.VD` is referred directly in programming.
			See High Speed Counter in Counting Modes, page 175.

`%HSCi.C`
 	
`%HSCi.CD`
	WORD
	
	DOUBLE WORD
		Capture value	See Auxiliary Inputs, page 176.

`%HSCi.U`	BOOL	Counting direction	0: Down counting 1: Up counting
`%HSCi.F`	BOOL	Overflow	0: No overflow 1: Counter overflow

Properties

The *High Speed Counter* function block has the following properties:

Property	Value	Description
Used	Activated / deactivated checkbox	Indicates whether the address is in use.
Address	`%HSCi`, where *i* is from 0 to 3, depending on the type(s) of counters configured.	*i* is the instance identifier. Refer to the maximum number of objects, page 24 for the number of available *High Speed Counter* objects.
Symbol	User-defined text	The symbol that uniquely identifies this object. For details, refer to the EcoStruxure Machine Expert-Basic Operating Guide (Defining and Using Symbols).
Preset	• from 0 to 65535 for `%HSCi.P` • from 0 to 4294967295 for `%HSCi.PD`	Preset value to initialize the *HSC* current value (`%HSCi.P`, `%HSCi.PD`). Not valid for the Frequency Meter.
S0	• from 1 to 65535 for `%HSCi.S0` • from 1 to 4294967295 for `%HSCi.S0D`	Threshold 0 value is used as a comparator with the current value. The value of S0 must be less than S1 (`%HSCi.S1`).
S1	• from 2 to 65535 for `%HSCi.S1` • from 2 to 4294967295 for `%HSCi.S1D`	Threshold 1 value is used as a comparator with the current value. The value of S1 must be greater than S0 (`%HSCi.S0`).
Time Base	100 ms or 1 s for `%HSCi.T`	Frequency measurement time base
Comment	User-defined text	A comment to associate with this object.

Special Cases

This table presents a list of special cases when programming the *High Speed Counter* function block:

Special Case	Description
Effect of cold restart (`%S0=1`)	Resets the *High Speed Counter* attributes with the values configured by the program.
Effect of controller stop	The *High Speed Counter* stops its function and the outputs stay in their current state. **NOTE:** When the controller stops, the reflex outputs are set to 0 if Maintain values is selected for the outputs. Otherwise, if Maintain values is not selected, the reflex outputs take the fallback values. For more information on configuring fallback behavior, refer to Fallback Behavior, page 36.

High Speed Counter in Counting Modes

Introduction

The *High Speed Counter* function block works at a maximum frequency of 100 kHz, with a range of 0 to 65535 in single word mode and 0 to 4294967295 in double word mode.

The pulses to be counted are applied in the following way:

Function	Description	Input type	*%HSC0*	*%HSC1*	*%HSC2*	*%HSC3*
Single Phase	The pulses are applied to the physical input associated to **Pulse Input**.	**Pulse Input**	`%I0.0`	`%I0.6`	`%I0.1`	`%I0.7`
Dual Phase [Pulse / Direction]	The pulses are applied to the physical input associated to	**Pulse Input**	`%I0.0`	`%I0.6`	–	–

Function	Description	Input type	%HSC0	%HSC1	%HSC2	%HSC3
	Pulse Input, the current operation (upcount/downcount) is given by the state of the **Direction Input**.	**Direction Input**	`%I0.1`	`%I0.7`	–	–
Dual Phase [Clock Wise / Counter Clock Wise]	The pulses are applied to the physical inputs associated to **Clock Wise Input** and **Counter Clock Wise Input**.	**ClockWise Input**	`%I0.0`	`%I0.6`	–	–
		CounterClockWise Input	`%I0.1`	`%I0.7`	–	–
Dual Phase [Quadrature X1]	The 2 phases of the encoder are applied to physical inputs associated to **Pulse Input Phase A** and **Pulse Input Phase B**.	**Pulse Input Phase A**	`%I0.0`	`%I0.6`	–	–
		Pulse Input Phase B	`%I0.1`	`%I0.7`	–	–
Dual Phase [Quadrature X2]	The 2 phases of the encoder are applied to physical inputs associated to **Pulse Input Phase A** and **Pulse Input Phase B**.	**Pulse Input Phase A**	`%I0.0`	`%I0.6`	–	–
		Pulse Input Phase B	`%I0.1`	`%I0.7`	–	–
Dual Phase [Quadrature X4]	The 2 phases of the encoder are applied to physical inputs associated to **Pulse Input Phase A** and **Pulse Input Phase B**.	**Pulse Input Phase A**	`%I0.0`	`%I0.6`	–	–
		Pulse Input Phase B	`%I0.1`	`%I0.7`	–	–

Output Thresholds

During counting, the current value is compared to two thresholds: `%HSCi.S0` or `%HSCi.S0D` and `%HSCi.S1` or `%HSCi.S1D`.

In single word mode, modifications to these threshold values are taken into account regardless of the value of the **Preset** input.

In double word mode, modifications to the threshold values made in an animation table are not taken into account. Modifications made in the application are, however, taken into account regardless of the value of the **Preset** input.

Threshold value modifications are saved in the logic controller (`%HSCi.S0`, `%HSCi.S1`, `%HSCi.S0D` and `%HSCi.S1D` objects), but not in the **Configuration** window of EcoStruxure Machine Expert-Basic.

According to the result of the comparisons, the bit objects, `%HSCi.TH0` and `%HSCi.TH1`, are:

- set to 1 if the current value is greater than or equal to the corresponding threshold
- reset to 0 if the current value is less than the corresponding threshold.

Physical reflex outputs can be configured to respond differentially within the context of the compare results of the threshold values and the current value of the counters.

NOTE: None, 1 or 2 reflex outputs can be configured.

For more information on the configuration of reflex outputs, refer to Configuring Single Phase and Dual Phase, page 65.

`%HSCi.U` is an output of the function block; it gives the direction of the associated counter variation (1 for UP, 0 for DOWN).

Auxiliary Inputs

Counting operations are made on the rising edge of pulses, and only if the counting function block is enabled.

There are two optional inputs used in counting mode: **Catch Input** and **Preset Input**:

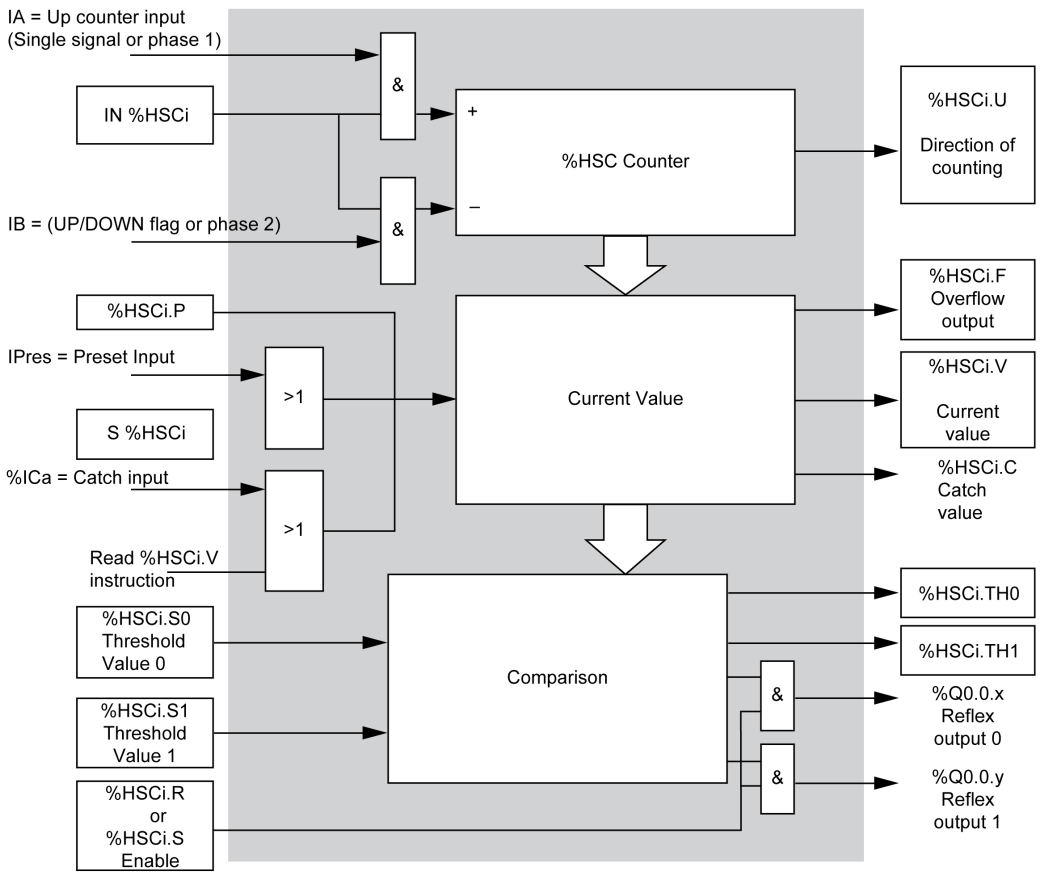
- The **Catch Input** is used to capture the current value (`%HSCi.V` or `%HSCi.VD`) and store it in `%HSCi.C` or `%HSCi.CD`. The catch inputs are specified as `%I0.3` for `%HSC0` and `%I0.4` for `%HSC1` if available.
- The **Preset Input** initializes `%HSCi.V` or `%HSCi.VD` value with the preset value for:
  - Single Phase: one-shot mode
  - Single Phase: Free-Large mode
  - Dual Phase: Free-Large mode

  The **Preset Input** resets the value 0 for:
  - Single Phase: modulo mode
  - Dual Phase: modulo mode

  NOTE:
  - `%HSCi.F` is also set to 0. The **Preset Input** is specified as `%I0.2` for `%HSC0` and/or `%I0.5` for `%HSC1`.
  - **Preset input** is called **Modulo Input** in Modulo mode.

Operation

This illustration is the operation diagram of the counting mode in single word mode (in double word mode, use the double word function variables):



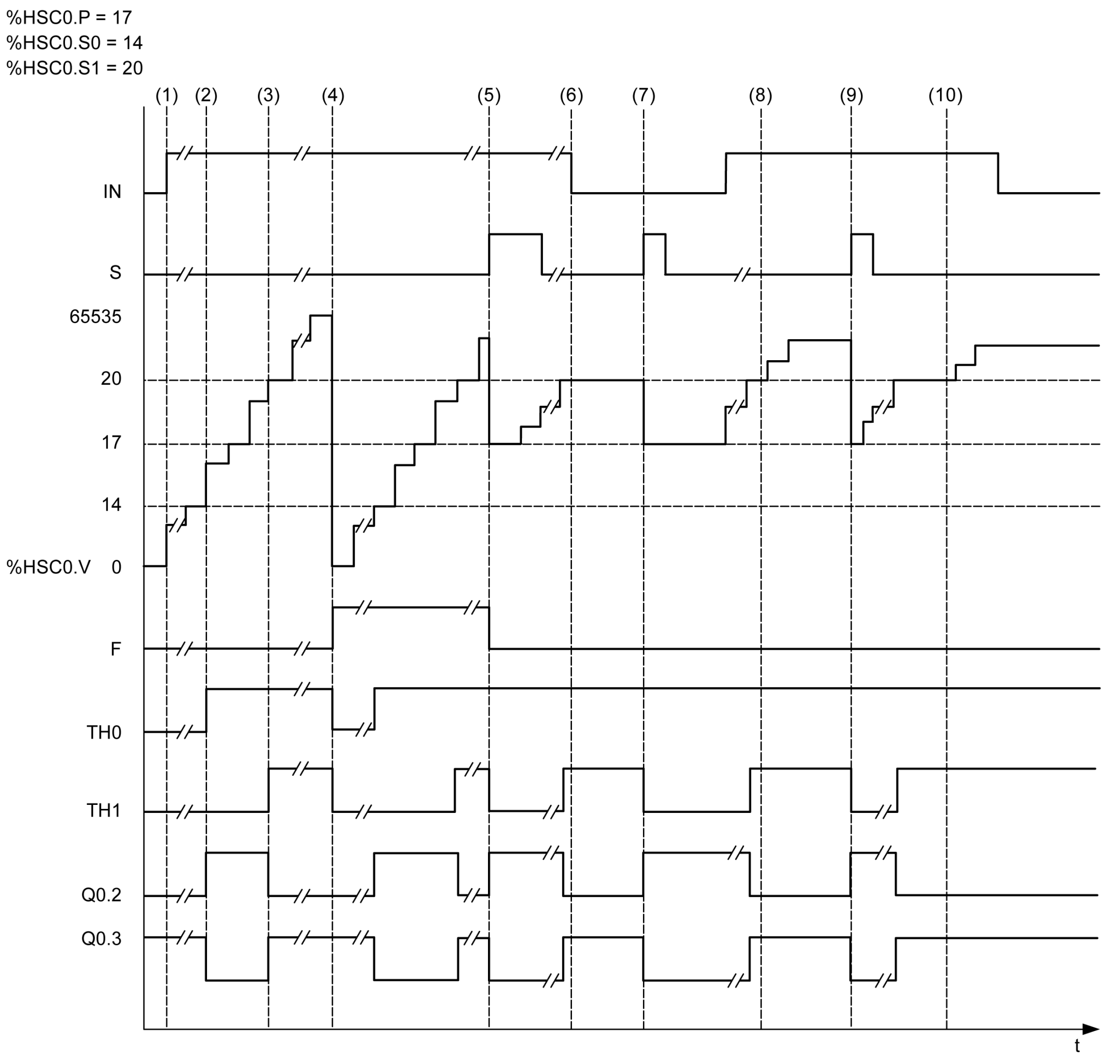
NOTE: Reflex outputs are managed independently from the controller cycle time.

Single Phase Timing Diagram

Reflex output configuration example:

Reflex Output	Value < %HSC0.S0	%HSC0.S0 <= Value < %HSC0.S1	Value >= %HSC0.S1
`%Q0.4`	–	X	–
`%Q0.5`	X	–	X

Timing diagram:



(1) *IN* is set to 1: the counting function is activated (*%HSC0.U = 1* because *%HSC0* is an up-counter)

(2) *%Q0.4* (Reflex Output) and *TH0* are set to 1

(3) *TH1* is set to 1

(4) The maximum value is reached so on the next count *%HSC0.V* is reset to 0 and F is set to 1

(5) *S* is set to 1, the current value, *%HSC0.V*, is set to preset value.

(6) The current function is inhibited while *IN* is set to 0

(7) While the function is inhibited, *S* is set to 1 so the current value is set to preset value 17

(8) Change of threshold value *S1* to 17

(9) *S* is set to 1 so the new value of *S1* will be granted at the next count

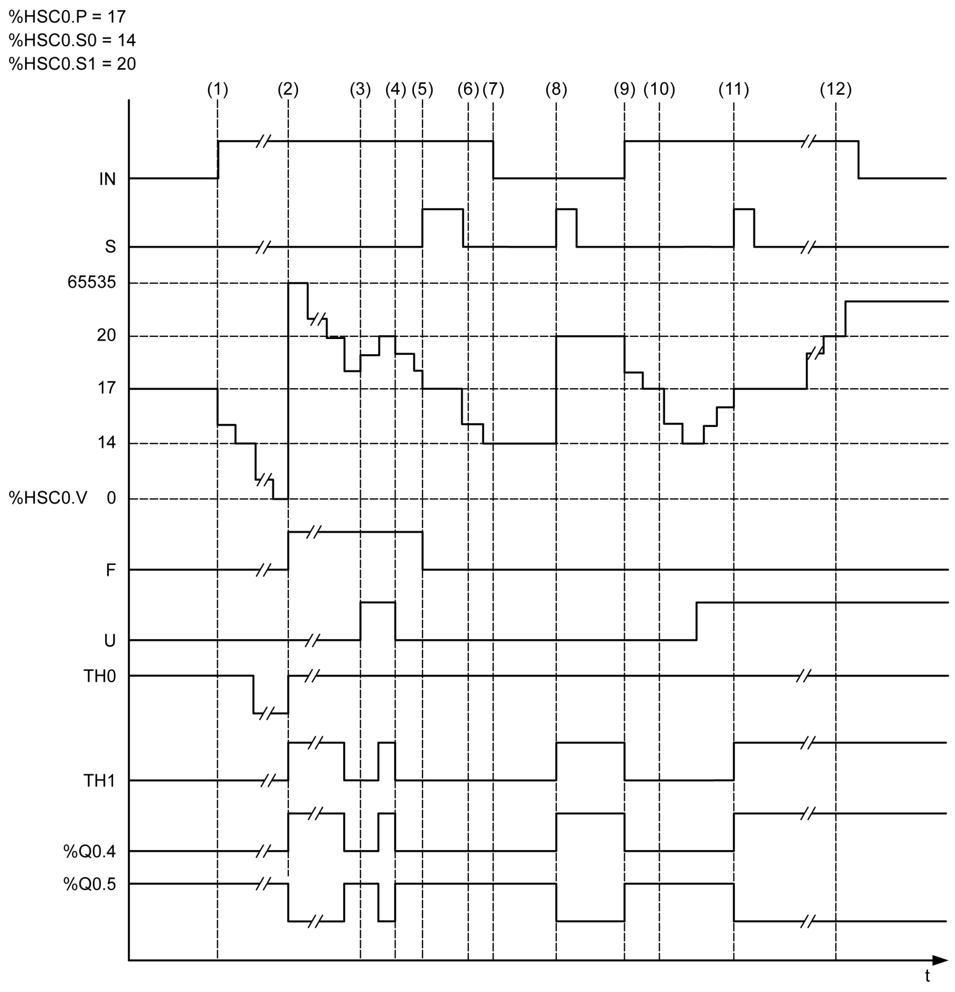
(10) Catch input is set to 1 so `%HSC0.C = 20`

Dual Phase [Pulse / Direction] Timing Diagram

Reflex output configuration example:

Reflex Output	Value < %HSC0.S0	%HSC0.S0 <= Value < %HSC0.S1	Value >= %HSC0.S1
`%Q0.4`	–	–	X
`%Q0.5`	X	X	–

Timing diagram:



(1) Input IN is set to 1 so down-counting mode starts (`%HSC0.U = 0` that is, *IB = 0*)

(2) The current value reaches 0 so *F* output flag is set to 1 and *%HSC0.V* is set to 65535 at the next count

(3) Change at the *IB* input, the counter is now in up counting mode and *%HSC0.U = 1*

(4) *IB* input is set to 0 so the counter is in down counting mode and *%HSC0.U* is set to 0

(5) Input *S* is set to 1 while down counting is in progress, so *%HSC0.V* is initialized to the Preset value `%HSC0.P = 17`

(6) *S* is reset to 0 and the preset value *%HSC0.P* is changed to 20

(7) The input *IN* is set to 0 so the function is inhibited, *%HSC0.V* is held

(8) *S* is set to 1 so the new preset value (`%HSC0.P = 20`) is taken into account and the reflex outputs are updated

(9) *IN* input is set to 1 and the function restarts in down counting mode

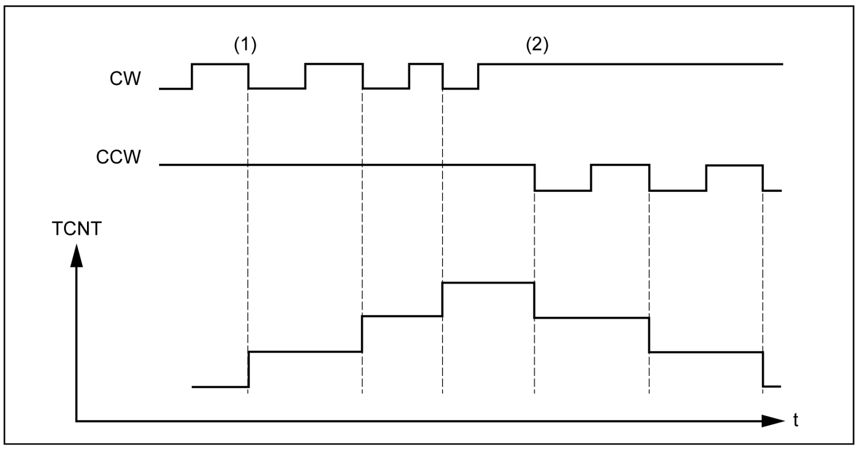
(10) The threshold value *%HSC0.S1* is set to 17

(11) *S* input active makes threshold *S1* new value to be granted at the next count and resets *%HSC0.V* to preset value 17

(12) A catch of the current value *%HSC0.V* is made so `%HSC0.C = 20`

Dual Phase [Clock Wise / Counter Clock Wise] Timing Diagram

Timing diagram:



(1) Up-counting starts

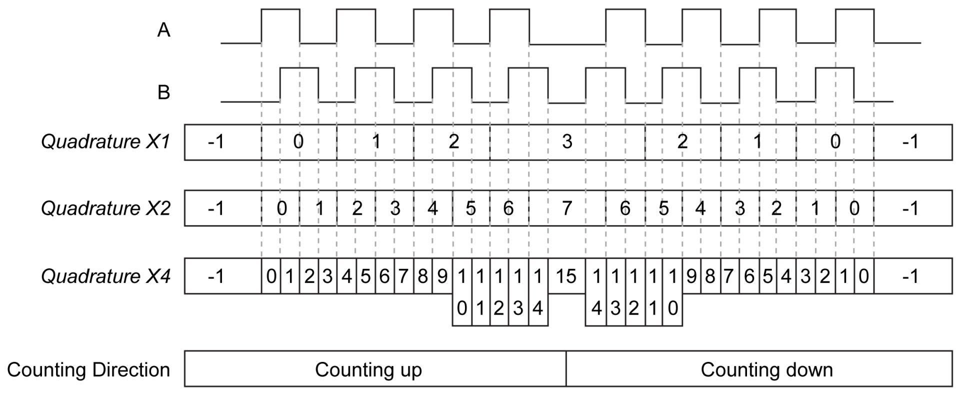
(2) Down-counting starts

Dual Phase [Quadrature X1], Dual Phase [Quadrature X2], Dual Phase [Quadrature X4] Timing Diagram

The encoder signal is counted according to the input mode selected, as shown below:

X1	1 count for each encoder cycle
X2	2 counts for each encoder cycle
X4	4 counts for each encoder cycle

Timing diagram:



Quadrature X1 When channel A leads channel B, the counter increments on the rising edge of channel A. When channel B leads channel A, the counter decrements on the falling edge of channel A.

Quadrature X2 Counter increments or decrements on each edge of channel A, depending on which channel leads the other. Each cycle results in two increments or decrements.

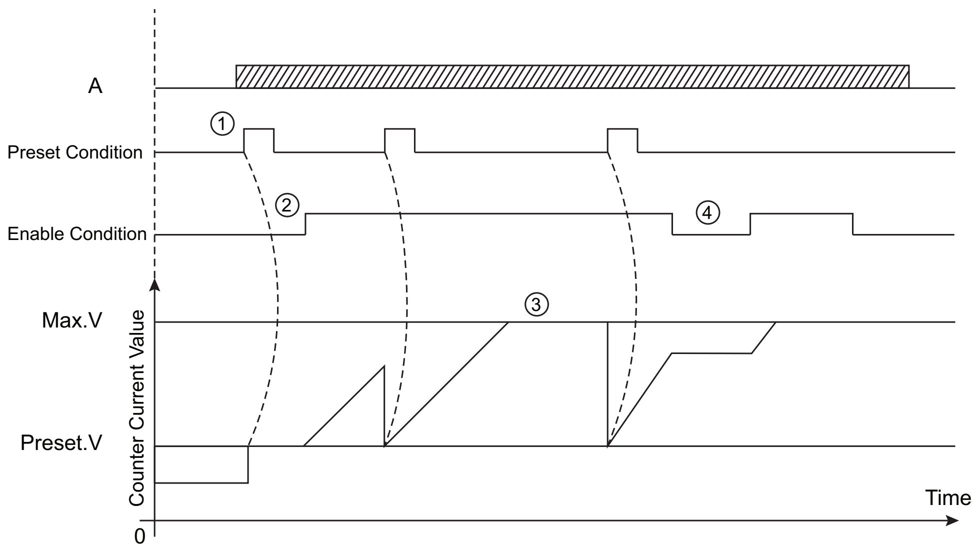
Quadrature X4 The counter increments or decrements on each edge of channels A and B. Whether the counter increments or decrements depends on which channel leads the other. Each cycle results in 4 increments or decrements.

One-shot Counting Mode

Overview

- Only one input is required for pulse.
- On the rising edge of the preset condition, the counter is enabled and the current value is set to the preset value.
- When counter is enabled, each pulse applied to the input increments the current value. The counter stops when its current value reaches the maximum value. The overflow flag is then set.
- The counter value remains at maximum value even if new pulses are applied to the input.
- A new preset is needed to activate the counter again.

One-shot Mode Timing Diagram



A: Pulse input

I$_N$: Enable condition

S: Preset Condition

Max.V: Max value for counter (65535 for single word and 4294967295 for double word)

Preset.V: Preset value

This table explains the stages from the preceding graphic:

Stage	Action
1	On the rising edge of the Preset condition, the preset value is loaded in the counter (regardless of the current value) and the counter is enabled.
2	When Enable condition = 1, the current counter value increments on each pulse on input A until it reaches 65535 for single word (4294967295 for double word).
3	The counter waits until the next rising edge of the Preset condition. **NOTE:** At this point, pulses on input A have no effect on the counter.
4	When Enable condition = 0, the counter ignores the pulses from input A and retains its current value until the Enable condition = 1. The counter resumes counting pulses from input A on the rising edge of the Enable input from the held value.

Modulo-loop Counting Mode

Overview

The **Modulo-loop** mode can be used for repeated actions on a series of moving objects, such as packaging and labeling applications.

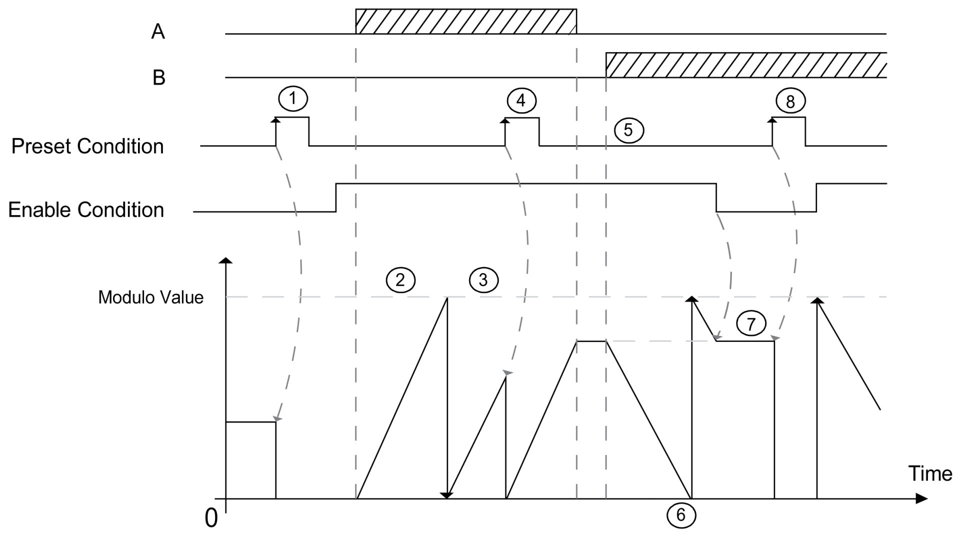
Principle

On a rising edge of the preset condition, the counter is enabled and the current value is reset to 0.

When counter is enabled:

Incrementing direction:	the counter increments until it reaches the modulo value. At the next pulse, the counter is reset to 0, a modulo flag is set to 1, and the counting continues.
Decrementing direction:	the counter decrements until it reaches 0. At the next pulse, the counter is set to the modulo value, a modulo flag is set to 1, and the counting continues.

Modulo-loop Mode Timing Diagram



Stage	Action
1	On the rising edge of preset condition, the current value is reset to 0 and the counter is enabled.
2	When Enable condition = 1, each pulse on A increments the counter value.
3	When the counter reaches the (modulo-1) value, the counter loops to 0 at the next pulse and the counting continues. `Modulo_Flag` is set to 1.
4	On the rising edge of preset condition, the current counter value is reset to 0.
5	When Enable condition = 1, each pulse on B decrements the counter.
6	When the counter reaches 0, the counter loops to (modulo-1) at the next pulse and the counting continues.
7	When Enable condition = 0, the pulses on the inputs are ignored.
8	On the rising edge of preset condition, the current counter value is reset to 0.

High Speed Counter in Frequency Meter Mode

Introduction

The frequency meter mode of an *High Speed Counter* is used to measure the frequency of a periodic signal in Hz on input IA (pulse input phase A).

The frequency range which can be measured is 1 Hz to 100 kHz.

It is possible to choose between 2 time bases, the choice being made by the object `%HSC.T` (Time base):

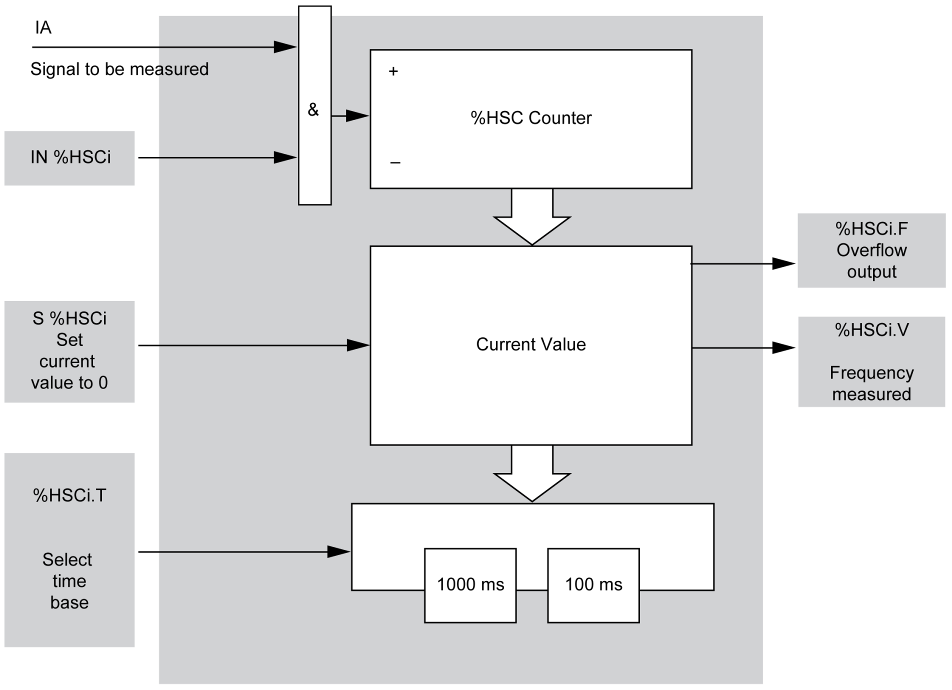
Time base	**Accuracy**	**Update**
100 ms	0.05% for 100 kHz 10% for 100 Hz	10 times per second
1 s	0.005% for 100 kHz 10% for 10 Hz	Once per second

Accuracy Measurement

$$Accuracy(\%) = \frac{1}{f[Hz]} \times \frac{1}{TB[s]} \times 100$$

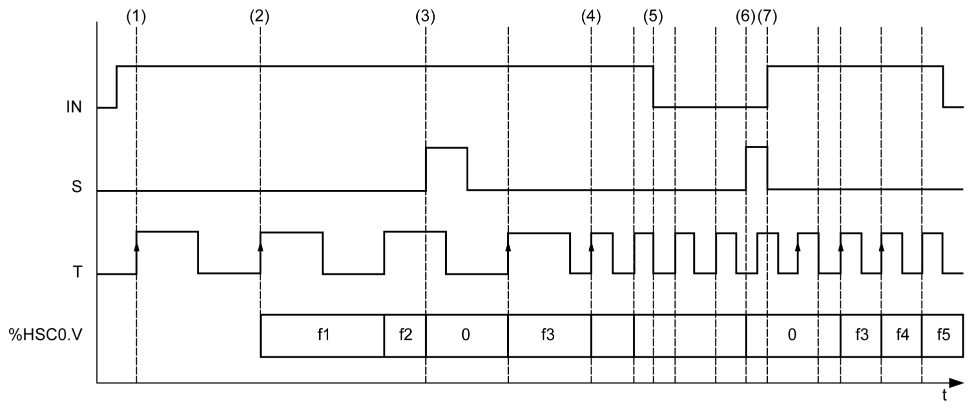
Operation

This illustration is the operation diagram of the frequency meter mode:



Timing Diagram

This timing diagram is an example of using a *High Speed Counter* in frequency meter mode:



(1) The first frequency measurement starts at a rising edge of the *TB* signal

(2) *%HSC0.V* is updated after one period of the *TB*

(3) On input *S* rising edge, the current value *%HSC0.V* is set to 0

(4) *%HSC0.T* is set to 100 ms, so the current measurement is canceled and a new one starts

(5) Input *IN* is set to 0, so the frequency measurement function is inhibited and *% HSC0.V* is held

(6) On input *S* rising edge, the current value *%HSC0.V* is set to 0

(7) *S* is set to 0 and *IN* is set to 1, so the measurement starts at the next rising edge of the *TB* signal

f*x* corresponds to the current frequency value.

Pulse (%PLS)

Using Pulse Function Blocks

This section provides descriptions and programming guidelines for using *Pulse* function blocks.

Description

Introduction

The *Pulse* function block is used to generate square wave signals.

Two *Pulse* function blocks are available on the dedicated output channel `%Q0.0` or `%Q0.1`. Logic controllers with relay outputs for these two channels do not support the *Pulse* function block. Refer to the M100/M200 Logic Controller - Hardware Guide for more information on inputs and outputs.

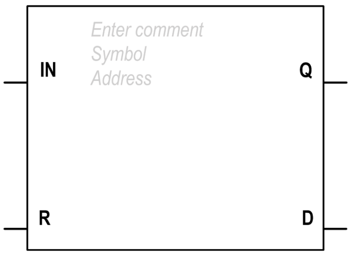
The *Pulse* function block allows only a single signal width, or duty cycle, of 50%.

You can choose to limit either the number of pulses or the period when the pulse train is executed. These factors can be determined at the time of configuration and/or updated by the program.

You must configure the *Pulse* function block in the **Configuration > Pulse Generators** before using an instance of the function block. Refer to Configuring Pulse Generators, page 55.

Illustration

This illustration is a *Pulse* function block:



Inputs

The *Pulse* function block has the following inputs:

Label	Object	Description	Value
IN	`%PLSi.IN`	Enable	At state 1, the pulse is produced at the dedicated output channel. At state 0, the output channel is set to 0.
R	`%PLSi.R`	Reset to 0 (optional)	At state 1, outputs `%PLSi.Q` and `%PLSi.D` are set to 0. The number of pulses generated in period T is set to 0.

Outputs

The *Pulse* function block has the following outputs:

Label	Object	Description	Value
Q	`%PLSi.Q`	Generation in progress	At state 1, indicates that the *Pulse* signal is generated at the dedicated output channel configured.
D	`%PLSi.D`	Generation complete (optional)	At state 1, signal generation is complete. The number of desired pulses has been reached.

Configuration

Parameters

To configure parameters, follow the *Configuring a Function Block procedure* in the EcoStruxure Machine Expert - Basic, Generic Functions Library Guide and read the description of *Memory Allocation Modes* in the EcoStruxure Machine Expert-Basic Operating Guide.

The *Pulse* function block has the following parameters:

Parameter	Description	Value
Used	Address used	If selected, this address is currently in use in a program.
Address	`%PLSi` *Pulse* address	The instance identifier, where i is from 0 to the number of objects available on this logic controller. Refer to Maximum Number of Objects table, page 24 for the maximum number of *Pulse* objects.

Parameter	Description	Value
Symbol	Symbol	The symbol associated with this object. Refer to the EcoStruxure Machine Expert-Basic Operating Guide (Defining and Using Symbols) for details.
Preset	Preselection of the period (`%PLSi.P`)	• Time Base = 1 s, `%PLSi.P`=1 or 2 • Time Base = 10 ms, 1<=`%PLSi.P`<=200 • Time Base = 1 ms, 1<=`%PLSi.P`<=2000 • Time Base = 0.1 ms, 1<=`%PLSi.P`<=20000
Num. Pulse	Number of pulses (`%PLSi.N`, `%PLSi.ND`)	To produce an unlimited number of pulses, set `%PLS.N` or `%PLS.ND` to 0.
Current	Current output (`%PLSi.Q`)	0 or 1.
Done	Done pulse (`%PLSi.D`)	At state 1, signal generation is complete. The number of desired pulses has been reached. It is reset by either setting the IN or the R inputs to 1.
Duty Cycle	`%PLSi.R`	This value gives the percentage of the signal in state 1 in a period. The width Tp is thus equal to: `TP = T x (%PLSi.R:100)`. The user application writes the value for `%PLSi.R`. It is this word which controls the duty cycle of the period. The default value is 0 and values greater than 100 are considered to be equal to 100.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Objects

The *Pulse* function block is associated with the following objects:

Object	Description	Size (bit)	Default Value	Range	
`%PLSi.P`	Preset value	16	Preset (set on **Configuration > Pulse Generators**)	**Preset** `%PLSi.P`	**Time Base**
				1...20000	0.1 ms
				1...2000	1 ms
				1...200	10 ms
				1 or 2	1 s (default)
`%PLSi.N`	Number of pulses	16	0	0...32767	
`%PLSi.ND`		32	0	0...2147483647	

Rules of Use

The output signal period `T` is set with **Preset** and the **Time Base** parameters such as `T = %PLSi.P` x.**Time Base**.

This table shows the range of available periods:

Time Base	Frequency
0.1 ms	0.5 Hz...10000 Hz
1 ms	0.5 Hz...1000 Hz
10 ms	0.5 Hz...100 Hz
1 s	0.5 Hz...1 Hz

The **Time Base** is set on the **Configuration > Pulse Generators** and cannot be modified. Refer to Configuring Pulse Generators, page 55.

If `%PLSi.P` is:

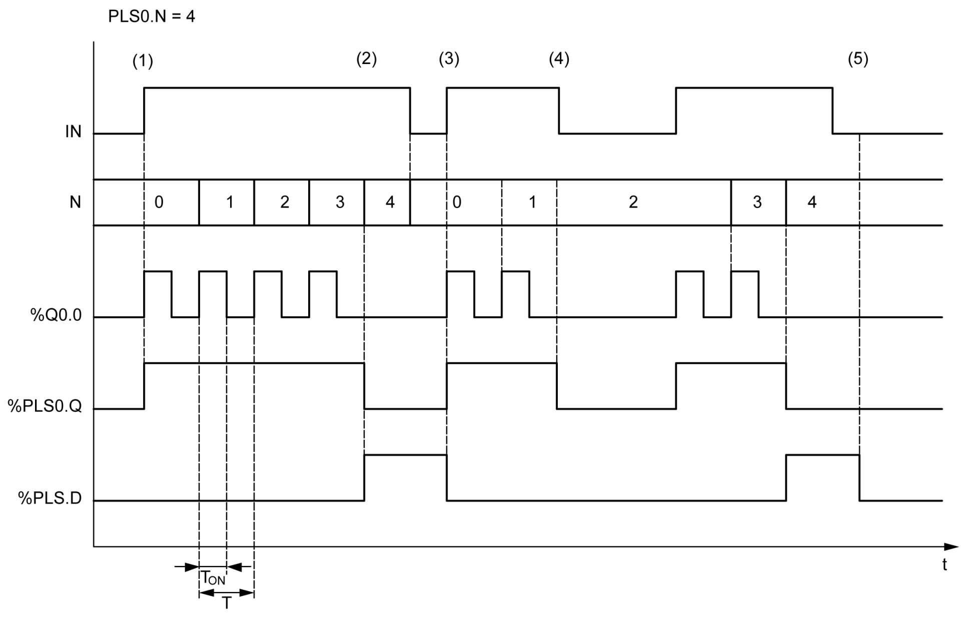
- Changed, the output signal period is changed at the end of the current period.
- Set to 0, the pulse generation function is stopped.
- Out of range, the parameter is forced to 0 and the pulse generation function is stopped.

If `%PLSi.N` (or `%PLSi.ND` in **Double Word** mode) is:

- Changed, the number of pulses to be generated is used at the next execution of the pulse generation function (`%PLSi.D` = 1 or after `%PLSi.R` = 1).
- Set to 0, unlimited number of pulses are generated.
- Out of range, the parameter is forced to 0.

Timing Diagram

This diagram displays the timing for *Pulse* function block:



(1) *IN* input is set to 1, the pulse signal is generated at the dedicated output (`%Q0.0`) so `%PLSi.Q` is set to 1

(2) The number of pulses reaches `%PLS0.N` (=4) so the Done flag output (`%PLS0.D`) is set to 1 and the pulse generation is stopped (`%PLS0.Q = 0`)

(3) *IN* input is set to 1 so `%PLS0.D` is reset to 0

(4) *IN* input is set to 0 so the output channel is set to 0 and `%PLS0.Q` = 0 indicates that the signal generation is not active

(5) `%PLS0.D` is set to 0 by setting *R* input to 1

Special Cases

Special Case	Description
Effect of cold restart (`%S0=1`)	• Pulse generation is stopped. • During the controller initialization, output is reset to 0. • If after the controller initialization: ◦ the controller enters the STOPPED state, the fallback behavior is applied to the output. ◦ the controller enters the RUN state, the configuration parameters are restored.
Effect at controller stop	• Pulse generation is stopped • The **Fallback** behavior is applied to the output.
Effect of online modification	None

Programming Example

Introduction

The *Pulse* function block can be configurated as in this programming example.

Programming

This example is a *Pulse* function block:

Rung	Instruction

0	`BLK    %PLS0`
	`LD     %M1`
	`IN`
	`LD     %M0`
	`R`
	`OUT_BLK`
	`LD     Q`
	`ST     %Q0.5`
	`LD     D`
	`ST     %M10`
	`END_BLK`

NOTE: Refer to the reversibility procedure, page 161 to obtain the equivalent Ladder Diagram.

Drive Function Blocks (%DRV)

Using Drive Function Blocks

This section provides descriptions and programming guidelines for using Drive Function Blocks.

Description

Presentation

Drive function blocks **DRV** allow drive devices such as Altivar Speed Drives to be controlled by a Modicon M100/M200 Logic Controller. For example:

- Control the speed of a motor managed by an ATV drive and update it continuously
- Monitor the status of the ATV drive and motor
- Manage errors detected in the ATV drive.

Communications take place over one of the following methods:

- Configuring one of the serial lines of the logic controller as a Modbus Serial IOScanner, page 128 using the Modbus RTU protocol.
- Configuring the Ethernet port as a Modbus TCP IOScanner, page 116.

In EcoStruxure Machine Expert-Basic, first add targeted ATV drive types to the Modbus Serial IOScanner or Modbus TCP IOScanner. This sets up predefined channels and initialization requests allowing data to be read from and written to specific registers on the ATV drive, including for example:

- **ETA** Status Word
- **ETI** Extended Status Word
- **RFRD** Output Velocity (RPM)
- **DP0** Error Code on Last Error
- **CMD** Control Word

Data transfer is carried out using Modbus request type **FC23 - Read/Write Multiple Registers**. This allows the program, for example, to read from the **ETA**, **ETI**, and **DP0** registers and write to the **CMD** register with a single Modbus request.

The following single-axis Drive function blocks are available in the **Programming** tab of EcoStruxure Machine Expert-Basic:

Function Block	Description
MC_Power_ATV, page 196	Enables or disables the power stage of a device.
MC_Jog_ATV, page 194	Starts the Jog operating mode on a device.
MC_MoveVel_ATV, page 198	Specifies a target velocity for a device.
MC_Stop_ATV, page 200	Stops the current movement on a device.
MC_ReadStatus_ATV, page 202	Returns status information about a device.
MC_ReadMotionState_ATV, page 203	Returns status information on the current movement of a device.
MC_Reset_ATV, page 205	Reset device error regarding the drive state, page 191 and acknowledge MC_Power_ATV, page 196 errors.

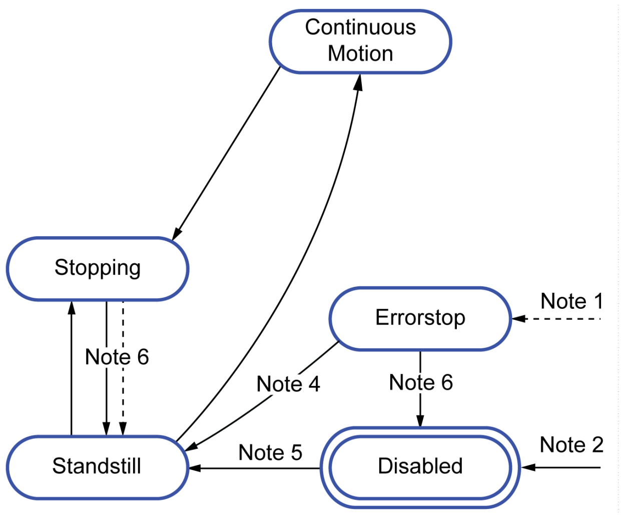
A maximum of 16 instances of each Drive function block can be used in a program at any one time.

When a device is added to the Modbus Serial IOScanner or Modbus TCP IOScanner, EcoStruxure Machine Expert-Basic allocates an axis for the device using a *%DRVn* object, where *n* is the number of the ATV drive. Each time you add a Drive function block to your program, you must associate it with an axis, creating a link between the function block, the axis, and the target device defined in the Modbus Serial IOScanner or Modbus TCP IOScanner.

Drive and Logic Controller States

Drive State Diagram

The drive is always in one of the states defined in the diagram below. When a Drive function block is executed or an error occurs, this may cause a state transition:



Note 1 From any state if an error occurs.

Note 2 From any state (if no *ErrorAxis*) when *%MC_Power_ATV.status* is 0.

Note 3 Transition from *ErrorStop* to *Disabled* state only if *%MC_Reset_ATV.Done* = 1 and *%MC_Power_ATV.status* = 0.

Note 4 Transition from *ErrorStop* to *Standstill* state only if *%MC_Reset_ATV.Done* = 1 and *%MC_Power_ATV.Enable* = 1 and *%MC_Power_ATV.Status* = 1.

Note 5 Transition from *DISABLED* to *Standstill* state only if *%MC_Power_ATV. Enable* = 1 and *%MC_Power_ATV.Status* = 1.

Note 6 Transition from *Stopping* to *Standstill* state only if *%MC_Stop_ATV.Done* = 1 and *%MC_Stop._ATV.Execute* = 0.

This table describes the drive states:

State	Description
Disabled	Initial state. The drive is not in an operational status or in an error status.
Standstill	The drive is in an operational status (ETA = 16#xx37) and *Velocity* = 0 (RFRD = 0).
ErrorStop	The drive is in an error status (ETA = 16#xxx8)
Continuous motion	The drive is in an operational status (ETA = 16#xx37) and *Velocity* ≠ 0 (RFRD ≠ 0).
Stopping	*MC_Stop_ATV* function block is executing.

The function block MC_ReadStatus_ATV, page 202 can be used to read the status of the ATV drive.

Logic Controller State Transitions

The following table describes how the Drive function blocks are affected by changes in the logic controller state:

Logic Controller State	Impact on Drive Function Blocks
RUNNING	Drive function blocks are executed normally according to the user logic.
STOPPED	The configured drive axes are stopped when the controller goes into the *STOPPED* state, unless the **Fallback Behavior** option is set to **Maintain values**. If the **Fallback Behavior** option is set to **Fallback values**, the command 0x00 is sent to the ATV drive, which leads to a Switch on Disabled (NST) status. Otherwise, if **Fallback Behavior** is set to **Maintain values**, no action is taken (the command is not changed).
HALTED	The configured drive axes are stopped when the controller goes into the *HALTED* state, unless the **Fallback Behavior** option is set to **Maintain values**. If the **Fallback Behavior** option is set to **Fallback values**, the command 0x00 is sent to the ATV drive, which leads to a Switch on Disabled (NST) status. Otherwise, if **Fallback Behavior** is set to **Maintain values**, no action is taken (the command is not changed).
POWERLESS, *EMPTY*	Drive function blocks are not executed (the Modbus Serial IOScanner or Modbus TCP IOScanner is stopped). This is also the case when the application in the controller is updated.

NOTE: In the case of the controller state of *HALTED* or *STOPPED*, and you have selected to **Maintain values**, the drive is not given any further commands by the controller. Therefore, the drive must determine the appropriate state to assume. If you chose to **Maintain values** for the drive, you must include this in your hazard and risk analysis for any consequential and possibly hazardous events.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Ensure that a risk assessment is conducted and respected according to EN/ISO 12100 during the design of your machine.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Adding a Drive Function Block

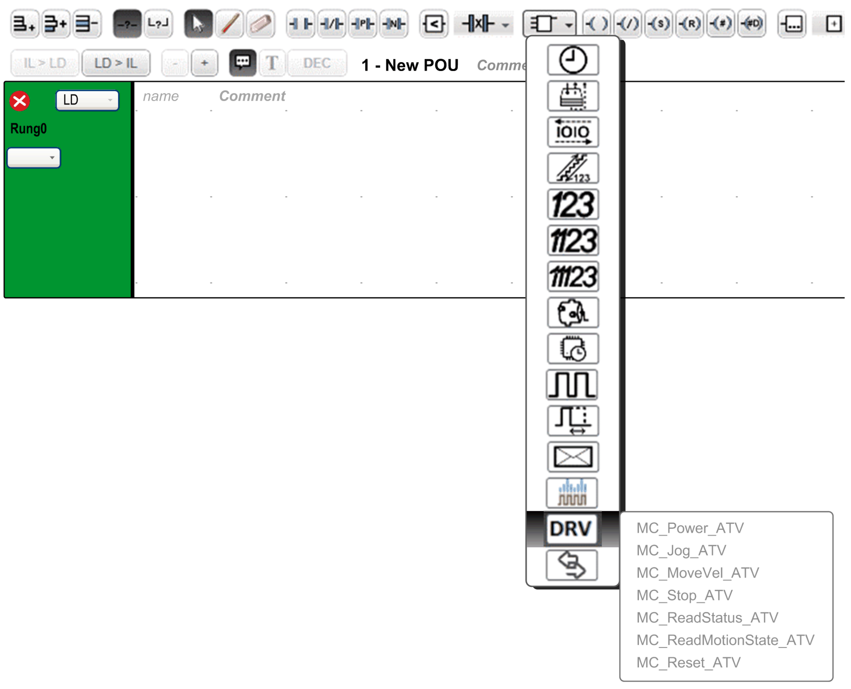
Prerequisites

Prerequisites to add a Drive function block:

- A Modbus Serial IOScanner or Modbus TCP IOScanner must be configured on a serial line or on Ethernet.
- The ATV drives to be controlled must be added and configured, page 128 on the Modbus Serial IOScanner or Modbus TCP IOScanner .

Adding a Drive Function Block

Follow these steps to add an instance of a Drive function block:

Step	Action
1	Select the **Programming** tab.
2	Select **Function Blocks > Drive** as shown in the following graphic:  IL > LD LD > IL DEC 1 - New POU Comment LD Rung0 name Comment DRV MC_Power_ATV MC_Jog_ATV MC_MoveVel_ATV MC_Stop_ATV MC_ReadStatus_ATV MC_ReadMotionState_ATV MC_Reset_ATV
3	Click into the rung to place the selected function block.
4	Associate the inputs/outputs of the function block.

Removing a Function Block

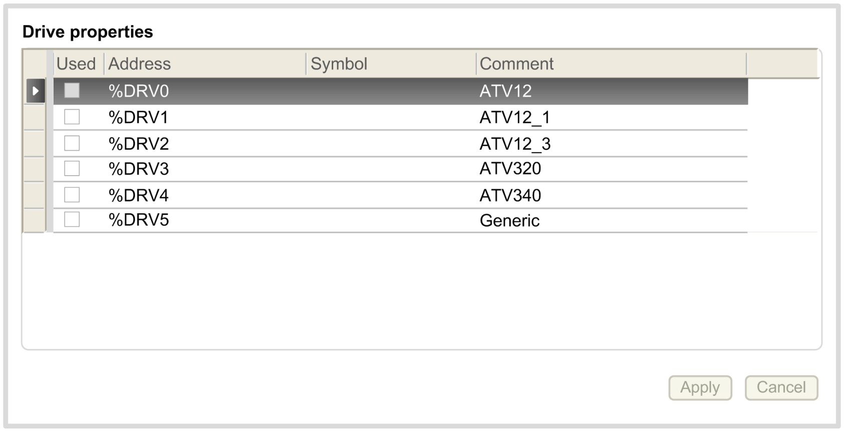
Follow these steps to remove an instance of a Drive function block:

Step	Action
1	In the **Programming** tab, click the instance of the function block.
2	Press **Delete** to remove the selected function block.

Function Block Configuration

Configuring Drive Objects

Each Drive function block is associated with a Drive (%DRV) object. To display a list of configured Drive objects:

Step	Action
1	Select the **Programming > Tools** tab and click **Drive objects > Drive** to display Drive object properties.  Drive properties Used / Address / Symbol / Comment %DRV0 — ATV12 %DRV1 — ATV12_1 %DRV2 — ATV12_3 %DRV3 — ATV320 %DRV4 — ATV340 %DRV5 — Generic Apply / Cancel
2	Update the properties as required and click **Apply**

Drive function blocks have the following properties:

Parameter	Editable	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the Drive object is in use in the program.
Address	No	*%DRVn*	*%DRVn*	The address of the Drive object, where *n* is the object number.
Symbol	Yes	–	–	Allows you to specify a symbol to associate with the Drive object. Double-click the cell to define or edit a symbol.
Comment	Yes	–	–	Allows you to specify a comment to associate with the Drive object. Double-click the cell to define or edit a comment.

MC_Jog_ATV: Start Jog Mode

Description

This function block starts the Jog operating mode. A Jog operation commands a device to move forwards or backwards at a specified velocity.

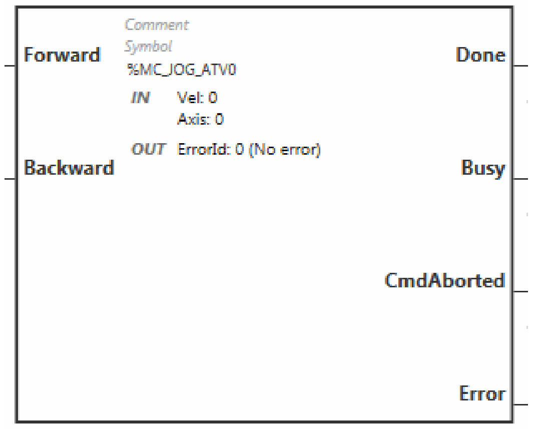
If either of the function blocks MC_MoveVel_ATV, page 198 or MC_Stop_ATV, page 200 is enabled while this function block is executing (*Busy* output set to 1), the MC_Jog_ATV function block commands the movement. The *Busy* output is reset to 0 and the *CmdAborted* output is set to 1.

When a Jog operation is in progress, a change of velocity value (*Vel*) is only applied on detection of a falling/rising edge of the *Forward* or *Backward* inputs.

If either of the Error or CmdAborted outputs is set to 1, the *Forward* and *Backward* inputs must first be reset to 0 and then a new rising edge applied to the *Forward* and/or *Backward* inputs to restart the movement.

Starting a Jog operation while the MC_Stop_ATV, page 200 function block is executing causes a Stop Active Error. Starting a Jog operation when the drive is not in an operational status (ETA ≠ 16#xx37) causes a Not Run Error.

Graphical Representation



Inputs

This table describes the inputs of the function block:

Input	Object	Initial Value	Description
Forward	-	0	Setting either the *Forward* input or the *Backward* input to 1 starts the jog movement. If the *Forward* and *Backward* inputs are both set to 1, the operating mode remains active, the jog movement is stopped, and the *Busy* output remains set to 1. If the *Forward* and *Backward* inputs are both set to 0, the operating mode is terminated and the *Done* output is set to 1 for one cycle.
Backward	-	0	
Vel	*%MC_JOG_ATVi.VEL* where i is 0...15	0	Target velocity for the Jog operating mode, in revolutions per minute (rpm). During jog movement, a change in the velocity value *Vel* is only applied upon detection of a falling/rising edge of the *Forward* or *Backward* input. Range: -32768...32767
Axis	*%MC_JOG_ATVi.AXIS* where i is 0...15	-	Identifier of the axis (*%DRV0...%DRV15*) for which the function block is to be executed. The axis must first be declared in the **Configuration** tab.

Outputs

This table describes the outputs of the function block:

Output	Output Object	Initial Value	Description
Done	*%MC_JOG_ATVi.DONE*	0	Set to 1 for one cycle when both the *Forward* and *Backward* inputs are set to 0. Set to 1 to indicate that the Jog operating mode is terminated.
Busy	*%MC_JOG_ATVi.BUSY*	0	Set to 1 when: • *Jog* is in progress (*Forward* = 1 or *Backward* = 1 • Both the *Forward* and *Backward* inputs are set to 1, indicating that the Jog operating mode remains active and the jog movement is stopped.
CmdAborted	*%MC_JOG_ATVi.CMDABORTED*	0	Set to 1 if function block execution terminates due to another command being executed.

Output	Output Object	Initial Value	Description
Error	*%MC_JOG_ATVi.ERROR*	0	Set to 0 when no error is detected. Set to 1 if an error occurs during execution. Function block execution is finished. The *ErrorId* output object indicates the cause of the error.
ErrorId	*%MC_JOG_ATVi.ERRORID*	0 (No error)	Error code returned by the function block when the *Error* output is set to 1. For details on the errors, refer to Error Codes, page 207. Range: 0...65535

Parameters

Double-click the function block to display the function block parameters.

The *MC_Jog_ATV* function block has the following parameters:

Parameter	Value	Description
Used	Address used	If selected, this address is currently in use in a program.
Address	`%MC_Jog_ATVi`	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the maximum number of Drive objects, refer to the table Maximum Number of Objects, page 24.
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols.
Axis	**%DRV***n*, where n is 0...15 **None**	Select the axis (Drive object instance) for which the function block is to be executed. The Drive object must have been previously configured on the Modbus TCP IOScanner or Modbus Serial IOScanner, page 129.
Vel	Target velocity	Enter the target velocity for the Jog operating mode and press Enter. Default value: 0 Range: -32768...32767
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Update the parameters as required and click **Apply**.

MC_Power_ATV: Enable/Disable Power Stage

Description

This function block enables or disables the drive power stage.

A rising edge of the input *Enable* enables the power stage. When the power stage is enabled, the output *Status* is set to 1.

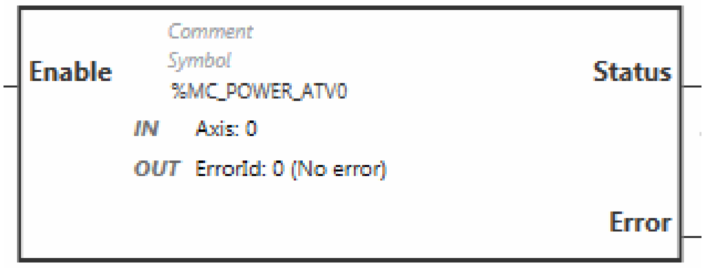
A falling edge of the input *Enable* disables the power stage (*Shutdown* command without *Error*). When the power stage is disabled, the output *Status* is reset to 0.

If the internal status register ETA of the ATV drive has not reached an operational status before the expiration of the timeout value, a *Timeout Error* is generated. The timeout is calculated as the channel cycle time multiplied by 4, or 10 seconds, whichever is greater. A minimum of 10 seconds is required to allow for drive reaction time.

If errors are detected during execution of the function block, the output *Error* is set to 1. This leads to a Shutdown command (CMD = 16#0006) to disable the ATV drive (Ready to switch on status, ETA = 16#xx21).

If an error occurs, only a successful execution of MC_Reset_ATV, page 205 function block can restore the power stage.

Graphical Representation



Inputs

This table describes the inputs of the function block:

Label	Object	Initial value	Description
Enable	-	0	Set to 1 to start execution of the function block and enable the power stage. Set to 0 to stop execution of the function block and disable the power stage.
Axis	*%MC_POWER_ATVi.AXIS* where i is 0...15	-	Identifier of the axis (*%DRV0*...*%DRV15*) for which the function block is to be executed.

Outputs

This table describes the outputs of the function block:

Label	Object	Initial value	Value
Status	*%MC_POWER_ATVi.STATUS* where i is 0...15	0	Default value: 0 • 0: Power stage is disabled. • 1: Power stage is enabled. Set to 1 when the ATV drive reaches an operational status (ETA = 16#xx37)
Error	*%MC_POWER_ATVi.ERROR* where i is 0...15	0	Set to 0 when no error is detected. Set to 1 if an error occurs during execution. Function block execution is finished. The *ErrorId* output object indicates the cause of the error.
ErrorId	*%MC_POWER_ATVi.ERRORID* where i is 0...15	0 (No error)	Error code returned by the function block when the *Error* output is set to 1. For details on the errors, refer to Error Codes, page 207. Range: 0...65535

Parameters

Double-click the function block to display the function block parameters.

The *MC_Power_ATV* function block has the following parameters:

Parameter	Value	Description
Used	Address used	If selected, this address is currently in use in a program.
Address	`%MC_Power_ ATVi`	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the maximum number of Drive objects, refer to the table Maximum Number of Objects, page 24.
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols.
Axis	**%DRV***n*, where n is 0...15 **None**	Select the axis (Drive object instance) for which the function block is to be executed. The Drive object must have been previously configured on the Modbus TCP IOScanner or Modbus Serial IOScanner, page 129.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Update the parameters as required and click **Apply**.

MC_MoveVel_ATV: Move at Specified Velocity

Description

This function block starts the Profile Velocity operating mode with a specified velocity. When the target velocity is reached, the *InVel* output is set to 1.

If the MC_Jog_ATV, page 194 or MC_Stop_ATV, page 200 function blocks are enabled while this function block is executing (*Busy* output set to 1), *MC_MoveVel_ATV* commands the movement. In this case, the *Busy* output is reset to 0 and the *CmdAborted* output is set to 1.

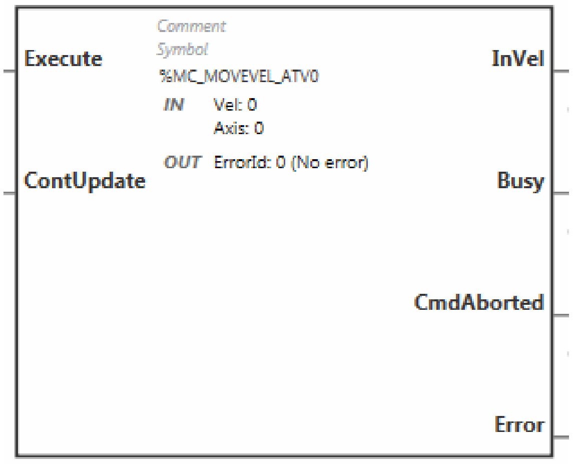
The *ContUpdate* and *Vel* input values are applied on a rising edge of the *Execute* input.

If either of the *Error* or *CmdAborted* outputs of *MC_MoveVel_ATV* is set to 1, a new rising edge of *Execute* is necessary to resume the movement.

Starting this function block while the MC_Stop_ATV, page 200 function block is executing leads to a Stop Active Error.

Starting this function block when the drive is not in an operational status (ETA ≠ 16#xx37), leads to a Not Run Error.

Graphical Representation



Inputs

This table describes the inputs of the function block:

Input	Object	Initial Value	Description
Execute	-	0	Set to 1 to start execution of the function block.
ContUpdate	-	0	Set to 1 before executing the function block to enable continuous updating of the *Vel* parameter value.
Vel	*%MC_MOVEVEL_ ATVi.VEL* where i is 0...15	0	Target velocity for the operating mode, in units of revolutions per minute (rpm). Range: -32 768...32 767. A negative value forces movement in the opposite direction.
Axis	*%MC_MOVEVEL_ ATVi.AXIS* where i is 0...15	-	Identifier of the axis (*%DRV0...%DRV15*) for which the function block is to be executed. The axis must first be declared in the **Configuration** tab.

Outputs

This table describes the outputs of the function block:

Output	Object	Initial Value	Description
InVel	*%MC_MOVEVEL_ATVi.INVEL*	0	0 indicates that the target velocity (*Vel*) has not been reached. Set to 1 when the target velocity (*Vel*) is reached.
Busy	*%MC_MOVEVEL_ATVi.BUSY*	0	Set to 1 when the function block is executed. Remains at 1 even after the target velocity is reached. Reset to 0 when the function block is stopped or aborted.
CmdAborted	*%MC_MOVEVEL_ATVi.CMDABORTED*	0	Set to 1 if function block execution is terminated due to another command being executed.
Error	*%MC_MOVEVEL_ATVi.ERROR*	0	Set to 0 when no error is detected. Set to 1 if an error occurs during execution. Function block execution is finished. The *ErrorId* output object indicates the cause of the error.
ErrorId	*%MC_MOVEVEL_ATVi.ERRORID*	0 (No error)	Error code returned by the function block when the *Error* output is set to 1. For details on the errors, refer to Error Codes, page 207. Range: 0...65535

NOTE: When the speed command of the ATV drive is low (< 10), the *InVel* and *ConstantVel* parameters may be invalid because the speed range of the ATV drive itself may be inaccurate.

Parameters

Double-click the function block to display the function block parameters.

The *MC_MoveIVel_ATV* function block has the following parameters:

Parameter	Value	Description
Used	Address used	If selected, this address is currently in use in a program.
Address	`%MC_MoveIVel_ ATVi`	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the maximum number of Drive objects, refer to the table Maximum Number of Objects, page 24.

Parameter	Value	Description
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols.
Axis	**%DRV***n*, where n is 0...15 **None**	Select the axis (Drive object instance) for which the function block is to be executed. The Drive object must have been previously configured on the Modbus TCP IOScanner or Modbus Serial IOScanner, page 129.
Vel	Target velocity	Enter the target velocity for the operating mode and press Enter. Default value: 0 Range: -32768...32767. A negative value forces movement in the opposite direction.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Update the parameters as required and click **Apply**.

MC_Stop_ATV: Stop Movement

Description

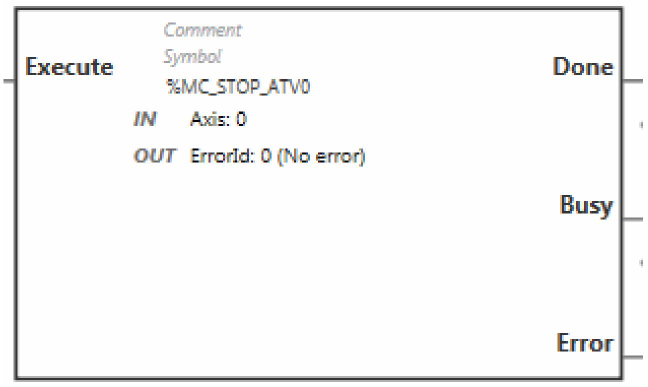
This function block stops the ongoing movement of the specified drive.

Drive-specific stop parameters, for example deceleration, are provided by the configuration of the drive.

Once started by a rising edge on the *Execute* input, any further activity on the *Execute* input is ignored until *Done* is set to TRUE. Executing another Drive function block while *MC_Stop_ATV* is busy does not abort the stop procedure—the function block *MC_Stop_ATV* remains busy and the other function block ends in an error.

The stop procedure can only be interrupted by disabling the power stage or if an error occurs (for example, ATV Not Run error or Modbus TCP IOScanner or Modbus Serial IOScanner error).

Graphical Representation



Inputs

This table describes the inputs of the function block:

Input	Object	Initial Value	Description
Execute	-	0	Set to 1 to start execution of the function block. The execution of other motion function block is not possible when the *Busy* output is set to 1. In this case, the other function block returns an error.
Axis	*%MC_STOP_ATVi.AXIS* where i is 0...15	-	Identifier of the axis (*%DRV0...%DRV15*) for which the function block is to be executed.

Outputs

This table describes the outputs of the function block:

Output	Output Object	Initial Value	Description
Done	*%MC_STOP_ATVi.DONE*	0	Set to 1 to indicate the function block execution is complete.
Busy	*%MC_STOP_ATVi.BUSY*	0	Set to 1 when function block execution begins.
Error	*%MC_STOP_ATVi.ERROR*	0	Set to 0 when no error is detected. Set to 1 if an error occurs during execution. Function block execution is finished. The *ErrorId* output object indicates the cause of the error.
ErrorId	*%MC_STOP_ATVi.ERRORID*	0 (No error	Error code returned by the function block when the *Error* output is set to 1. For details on the errors, refer to Error Codes, page 207. Range: 0...65535

Parameters

Double-click the function block to display the function block parameters.

The *MC_Stop_ATV* function block has the following parameters:

Parameter	Value	Description
Used	Address used	If selected, this address is currently in use in a program.
Address	`%MC_Stop_ATVi`	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the maximum number of Drive objects, refer to the table Maximum Number of Objects, page 24.
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols.
Axis	**%DRV***n*, where n is 0...15 **None**	Select the axis (Drive object instance) for which the function block is to be executed. The Drive object must have been previously configured on the Modbus TCP IOScanner or Modbus Serial IOScanner, page 129.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Update the parameters as required and click **Apply**.

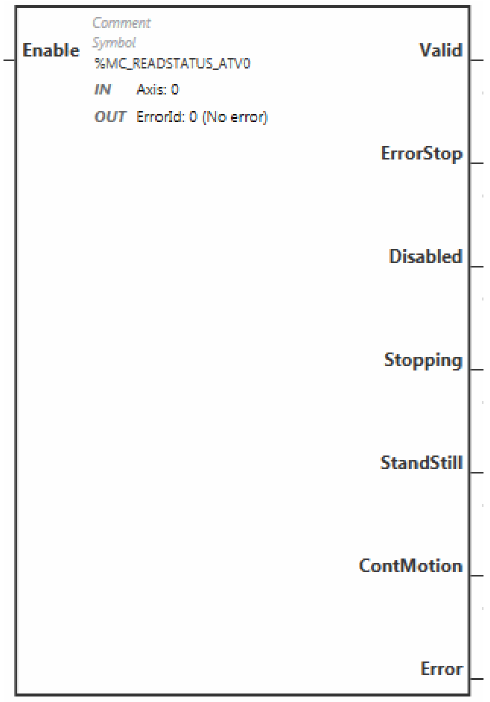
MC_ReadStatus_ATV: Read Device Status

Description

The function block reads the status of the ATV drive.

Refer to Drive State Diagram, page 191 for details on the states.

Graphical Representation



Inputs

This table describes the inputs of the function block:

Label	Object	Initial value	Description
Enable	-	0	Set to 1 to enable the function block.
Axis	*%MC_READSTATUS_ATVi. AXIS* where i is 0...15	-	Identifier of the axis (*%DRV0...%DRV15*) for which the function block is to be executed.

Outputs

This table describes the outputs of the function block:

Label	Object	Initial value	Description
Valid	*%MC_ READSATUS _ATVi. VALID*	0	Set to 1 while the function block is running without errors.
ErrorStop	*%MC_ READSTATUS _ATVi. ERRORSTOP*	0	Set to 1 if the ATV drive is in an error status (ETA = 16#xxx8).
Disabled	*%MC_ READSTATUS _ATVi. DISABLED*	0	Set to 1 if the ATV drive is not in an operational status and not in an error status.
Stopping	*%MC_ READSTATUS _ATVi. STOPPING*	0	Set to 1 if the *MC_Stop_ATV* function block is being executed, or the movement is being stopped.

Label	Object	Initial value	Description
Standstill	*%MC_ READSTATUS _ATVi. STANDSTILL*	0	Set to 1 if the ATV drive is in an operational status and the velocity is 0 (ETA = 16#xx37 and RFRD = 0).
ContMotion	*%MC_ READSTATUS _ATVi. CONTMOTION*	0	Set to 1 if the ATV drive is in an operational status and the velocity is not equal to 0 (ETA = 16#xx37 and RFRD ≠ 0).
Error	*%MC_ READSTATUS _ATVi. ERROR*	0	Set to 0 when no error is detected. Set to 1 if an error occurs during execution. Function block execution is finished. The *ErrorId* output object indicates the cause of the error.
ErrorId	*%MC_READSTATUS_ATVi. ERRORID*	0 (No error)	Error code returned by the function block when the *Error* output is set to 1. For details on the errors, refer to Error Codes, page 207. Range: 0...65535

Parameters

Double-click the function block to display the function block parameters.

The *MC_ReadStatus_ATV* function block has the following parameters:

Parameter	Value	Description
Used	Address used	If selected, this address is currently in use in a program.
Address	`%MC_ ReadStatus_ ATVi`	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the maximum number of Drive objects, refer to the table Maximum Number of Objects, page 24.
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols.
Axis	**%DRV***n*, where n is 0...15 **None**	Select the axis (Drive object instance) for which the function block is to be executed. The Drive object must have been previously configured on the Modbus TCP IOScanner or Modbus Serial IOScanner, page 129.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

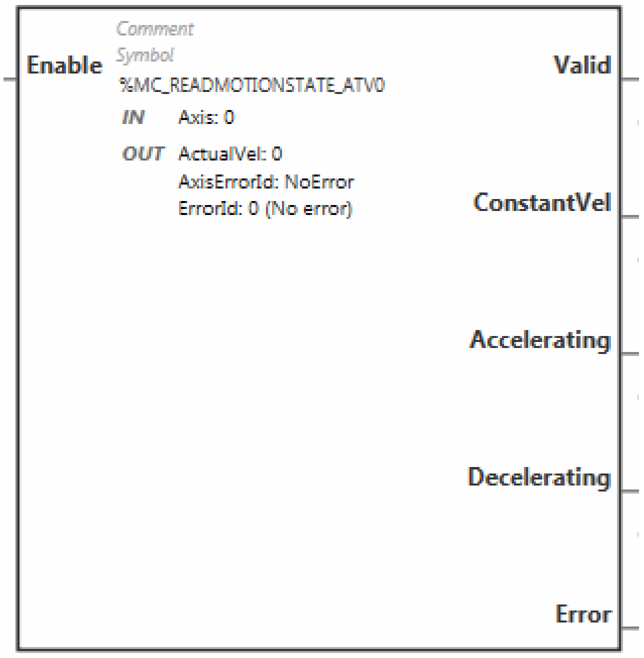
Update the parameters as required and click **Apply**.

MC_ReadMotionState_ATV: Read Motion State

Description

This function block outputs status information on the movement read from the ATV drive.

Graphical Representation



Inputs

This table describes the inputs of the function block:

Input	Object	Initial Value	Description
Enable	-	0	Set to 1 to start execution of the function block.
Axis	*%MC_READMOTIONSTATE_ATVi. AXIS* where i is 0...15	-	Identifier of the axis (*%DRV0...%DRV15*) for which the function block is to be executed.

Outputs

This table describes the outputs of the function block:

Output	Object	Initial Value	Description
Valid	*%MC_ READMOTIONSTATE _ATVi.VALID*	0	Set to 1 while the function block is running without errors.
ConstantVel	*%MC_ READMOTIONSTATE _ATVi.CONSTANTVEL*	0	Set to 1 when a movement at constant velocity is being performed (ETA register).
Accelerating	*%MC_ READMOTIONSTATE _ATVi.ACCELERATING*	0	Set to 1 when the motor is accelerating (ETI register).
Decelerating	*%MC_ READMOTIONSTATE _ATVi.DECELERATING*	0	Set to 1 when the motor is decelerating (ETI register).
Error	*%MC_ READMOTIONSTATE _ATVi.ERROR*	0	Set to 0 when no error is detected. Set to 1 if an error occurs during execution. Function block execution is finished. The *ErrorId* output object indicates the cause of the error.
ActualVel	*%MC_READMOTIONSTATE_ ATVi.ACTUALVEL*	0	Velocity returned by the ATV drive (RFRD register). Range: -32768...32767

Output	Object	Initial Value	Description
AxisErrorId	*%MC_READMOTIONSTATE_ ATVi.AXISERRORID*	0	Axis error identifier returned by the ATV drive (DP0 register). There is an axis error when the drive is in an error status. Set to 0 if the drive is not in an error status (ETA register ≠ 16#xxx8) For details on axis errors, refer to AxisErrorId Error Codes, page 207. Range: -32768...32767
ErrorId	*%MC_READMOTIONSTATE_ ATVi.ERRORID*	No error (nOF)	Error code returned by the function block when the *Error* output is set to 1. For details on the errors, refer to Error Codes, page 207. Range: 0...65535

NOTE: When the speed command of the ATV drive is low (< 10), the *InVel* and *ConstantVel* parameters may be invalid because the speed range of the ATV drive itself may be inaccurate.

Parameters

Double-click the function block to display the function block parameters.

The *MC_ReadMotionState_ATV* function block has the following parameters:

Parameter	Value	Description
Used	Address used	If selected, this address is currently in use in a program.
Address	`%MC_ ReadMotionState_ ATVi`	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the maximum number of Drive objects, refer to the table Maximum Number of Objects, page 24.
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols.
Axis	**%DRV***n*, where n is 0...15 **None**	Select the axis (Drive object instance) for which the function block is to be executed. The Drive object must have been previously configured on the Modbus TCP IOScanner or Modbus Serial IOScanner, page 129.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

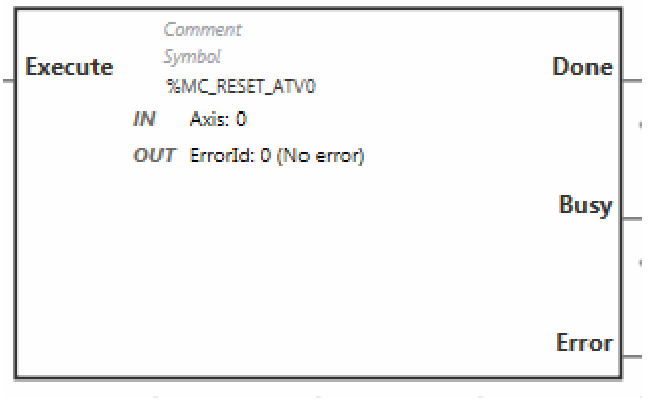
Update the parameters as required and click **Apply**.

MC_Reset_ATV: Acknowledge and Reset Error

Description

This function block is used to acknowledge an error and re-initialize the error condition on the drive. For more information, refer to Drive State Diagram, page 191.

Graphical Representation



Inputs

This table describes the inputs of the function block:

Label	Object	Initial value	Description
Execute	-	0	Set to 1 to start execution of the function block.
Axis	*%MC_RESET_ ATVi.AXIS* where i is 0...15	-	Identifier of the axis (*%DRV0...%DRV15*) for which the function block is to be executed.

Outputs

This table describes the outputs of the function block:

Output	Output Object	Initial Value	Description
Done	*%MC_RESET_ATVi.DONE*	0	Set to 1 when *Reset* has ended without error.
Busy	*%MC_RESET_ATVi.BUSY*	0	Set to 1 when the function block begins execution.
Error	*%MC_RESET_ATVi.ERROR*	0	Set to 1 if the device remains in an error status after timeout expiration. The timeout is calculated as the channel cycle time multiplied by 4, or 200 ms, whichever is greater. A minimum of 200 ms is required to allow for drive reaction time. Refer to Configuring Channels, page 132 for information on the configuring the channel cycle time.
ErrorId	*%MC_RESET_ATVi.ERRORID*	0 (No error)	Error code returned by the function block when the *Error* output is set to 1. For details on the errors, refer to Error Codes, page 207. Range: 0...65535

Parameters

Double-click the function block to display the function block parameters.

The *MC_Reset_ATV* function block has the following parameters:

Parameter	Value	Description
Used	Address used	If selected, this address is currently in use in a program.
Address	`%MC_Reset_ATVi`	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the

Parameter	Value	Description
		maximum number of Drive objects, refer to the table Maximum Number of Objects, page 24.
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols.
Axis	**%DRV***n*, where n is 0...15 **None**	Select the axis (Drive object instance) for which the function block is to be executed. The Drive object must have been previously configured on the Modbus TCP IOScanner or Modbus Serial IOScanner, page 129.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Update the parameters as required and click **Apply**.

Error Codes

ErrorId Error Codes

This table lists the possible function block error codes:

Value	Name	Description
0	No error	No error detected.
1	IOScanner error	Error detected on IOScanner (1).
2	ATV is in an error status	The ATV drive is in an error status (ETA = 16#xxx8).
3	Timeout error	Timeout expired before the *MC_Power_ATV* function block has received the correct status from the drive.
4	Invalid ATV status	The ATV drive has an invalid ETA value.
5	Reset error	The *MC_Reset_ATV* function block is requested while the ATV drive is in an error status.
6	Stop Active error	The *MC_Jog_ATV* or *MV_MoveVelocity_ATV* function block is requested while *MC_Stop* is active.
7	ATV Not Run error	The *MC_Jog_ATV* or *MV_MoveVelocity_ATV* function block is requested while the ATV drive is not operational.
8	Invalid AxisRef error	*AxisRef* input *%DRV* of the function block is invalid (not present in the Modbus TCP IOScanner or Modbus Serial IOScanner configuration, page 128).
9	Internal error	A firmware error occurred.

(1) Only for Modbus TCP IOScanner.

If the `%MC_Power_ATV` function block raises an IOScanner error while the device is being scanned, it may be due to an overload on the Ethernet network. To identify the cause of the error, you can:

- Verify the IOScanner state: %SW212, page 328.
- Verify the drive state: %IWNS (300+x), page 342.
- Verify the channel state: %IWNS (300+x).y, page 342.
- Increase the **Response timeout** of the drive, page 118.

AxisErrorId Error Codes

This table lists the possible function block axis error codes returned by the *MC_ReadMotionStatus* function block:

Value	Name
0	No error (nOF)
2	EEPROM control (EEF1)
3	Incorrect configuration (CFF)
4	Invalid Configuration (CFI)
5	Modbus Comm Interruption (SLF1)
6	Internal Link Error (ILF)
7	Fieldbus Com Interrupt (CnF)
8	External Error (EPF1)
9	Overcurrent (OCF)
10	Precharge Capacitor (CrF)
13	AI2 4-20 mA loss (LFF2)
15	Input Overheating (IHF)
16	Drive Overheating (OHF)
17	Motor Overload (OLF)
18	DC Bus Overvoltage (ObF)
19	Supply Mains Overervoltage (OSF)
20	Single Output Phase Loss (OPF1)
21	Input phase loss (PHF)
22	Supply Mains Undervoltage (USF)
23	Motor Short Circuit (SCF1)
24	Motor Overspeed (SOF)
25	Autotuning Error
26	Internal Error 1 (InF1)
27	Internal Error 2 (InF2)
28	Internal Error 3 (InF3)
29	Internal Error 4 (InF4)
30	EEPROM ROM Power (EEF2)
32	Ground Short Circuit (SCF3)
33	Output Phase Loss (OPF2)
37	Internal Error (InF7)
38	Fieldbus Error (EPF2)
40	Internal Error 8 (InF8)
42	PC Com Interruption (SLF2)
45	HMI Com Interruption (SLF3)
51	Internal Error 9 (InF9)
52	Internal Error 10 (InFA)
53	Internal Error 11 (InFb)
54	IGBT Overheating (tJF)
55	IGBT Short Circuit (SCF4)
56	Motor Short Circuit (SCF5)
60	Internal Error 12 (InFC)
64	Input Contactor (LCF)

Value	Name
68	Internal Error 6 (InF6)
69	Internal Error 14 (InFE)
71	AI3 4-20mA Loss (LFF3)
72	AI4 4-20mA Loss (LFF4)
73	Boards Compatibility (HCF)
77	Conf Transfer Error (CFI2)
79	AI5 4-20mA Loss (LFF5)
99	Channel Switch Error (CSF)
100	Process Underload (ULF)
101	Process Overload (OLC)
105	Angle Error (ASF)
106	AI1 4-20mA Loss (LFF1)
107	Safety Function Error (SAFF)
110	AI2 Th Detected Error (tH2F)
111	AI2 Thermal Sensor Error (t2CF)
112	AI3 Th Detected Error (tH3F)
113	AI3 Thermal Sensor Error (t3CF)
114	Pump Cycle Start Error (PCPF)
119	Pump Low Flow Error (PLFF)
120	AI4 Th Detected Error (tH4F)
121	AI4 Thermal Sensor Error (t4CF)
122	AI5 Th Detected Error (tH5F)
123	AI5 Thermal Sensor Error (t5CF)
126	Dry Run Error (drYF)
127	PID Feedback Error (PFMF)
128	Program Loading Error (PGLF)
129	Program Running Error (PGrF)
130	Lead Pump Error (MPLF)
131	Low Level Error (LCLF)
132	High Level Error (LCHF)
142	Internal Error 16 (InFG)
143	Internal Error 17 (InFH)
144	Internal Error 0 (InF0)
146	Internal Error 13 (InFd)
149	Internal Error 21 (InFL)
151	Internal Error 15 (InFF)
152	Firmware Update Error (FEr)
153	Internal Error 22 (InFM)
154	Internal Error 25 (InFP)
155	Internal Error 20 (InF)
157	Internal Error 27 (InFr)

Pulse Width Modulation (%PWM)

Using Pulse Width Modulation Function Blocks

This section provides descriptions and programming guidelines for using *Pulse Width Modulation* function blocks.

Description

Introduction

The *Pulse Width Modulation* function block generates a variable wave signal on a dedicated output channel, `%Q0.0` or `%Q0.1`, with variable width and, therefore, duty cycle.

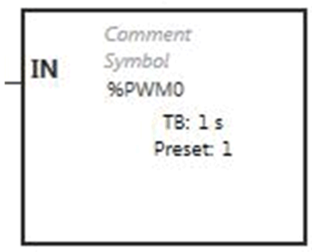
Controllers with relay outputs for these two channels do not support this function.

`%PWM0` uses dedicated output `%Q0.0` and `%PMW1` uses dedicated output `%Q0.1`. The pulse function blocks `%PLS` can also be configured to use these same dedicated outputs. You can configure one or the other of these two functions, but not both, for any given output.

You must configure the *Pulse Width Modulation* function block in the **Configuration > Pulse Generators** before using an instance of the function block. Refer to Configuring Pulse Generators, page 55.

Illustration

This illustration is the *Pulse Width Modulation* function block:



Inputs

The *Pulse Width Modulation* function block has the following input:

Label	Object	Description	Value
IN	`%PWMi.IN`	Enable	At state 1, the *Pulse Width Modulation* signal is generated at the output channel. At state 0, the output channel is set to 0.

Function Block Configuration

Overview

To configure the *Pulse Generator* resource, refer to Configuring Pulse Generators, page 55.

To configure the *Pulse Generator* resource as a PWM, refer to PWM Configuration, page 58.

Parameters

To configure parameters, follow the *Configuring a Function Block procedure* in the EcoStruxure Machine Expert - Basic, Generic Functions Library Guide and read the description of *Memory Allocation Modes* in the EcoStruxure Machine Expert-Basic Operating Guide.

The *Pulse Width Modulation* function block has the following properties:

Property	Value	Description
Used	Activated / deactivated checkbox	Indicates whether the address is in use.
Address	`%PWMi`,where i is 0 or 1	i is the instance identifier.
Symbol	User-defined text	The symbol that uniquely identifies this object. For details, refer to the EcoStruxure Machine Expert-Basic Operating Guide (Defining and Using Symbols) .
Preset	• `%PWMi.P`=1 if **Time Base** = 1 s • 1<=`%PWMi.P`<=100 if **Time Base**= 10 ms • 1<=`%PWMi.P`<=1000 if **Time Base** = 1 ms • 1<=`%PWMi.P`<=10000 if **Time Base** = 0.1 ms	Preselection of the period.
Duty cycle	From 0 to 100. **NOTE:** values greater than 100 are considered to be equal to 100.	The **Duty cycle** is controlled by the object `%PWMi.R` and is the percentage of the signal in state 1 in the period. The width of state 1 (Tp) is thus equal to: `TP = T x (%PWMi.R/100)`. The user application writes the value for `%PWMi.R`.
Comment	User-defined text	A comment to associate with this object.

NOTE: The **Num. Pulse**, **Current**, and **Done** properties that appear in the **Pulse Generators properties** table under the **Programming** tab do not apply to the PWM function.

Objects

The *Pulse Width Modulation* function block is associated with the following objects:

Object	Description	Size (bit)	Default value	Range	
`%PWMi.P`	Preset value	16	Preset (set on **Configuration > Pulse Generators**)	**Preset** `%PWMi.P`	**Time Base**
				1...10000	0.1 ms
				1...1000	1 ms
				1...100	10 ms
				1	1 s (default)
`%PWMi.R`	Duty cycle (Ratio)	16	0	0...100	

If `%PWMi.P` is:

- changed, the output signal period is affected at the end of the ongoing period.
- set to 0, the pulse generation function is stopped.

- out of range, the parameter is forced to 0 and the pulse generation function is stopped.

If `%PWMi.R` is:

- set to 0, the pulse generation function is stopped (output set to 0).
- set to 100, the output signal is set to 1
- changed, the output signal ratio is changed at the end of the current period
- out of range, the parameter is forced to 0.

Time Base

The **Time Base** is set on the **Configuration > Pulse Generators** and can only be modified under the **Configuration** tab. Refer to Configuring Pulse Generators, page 55.

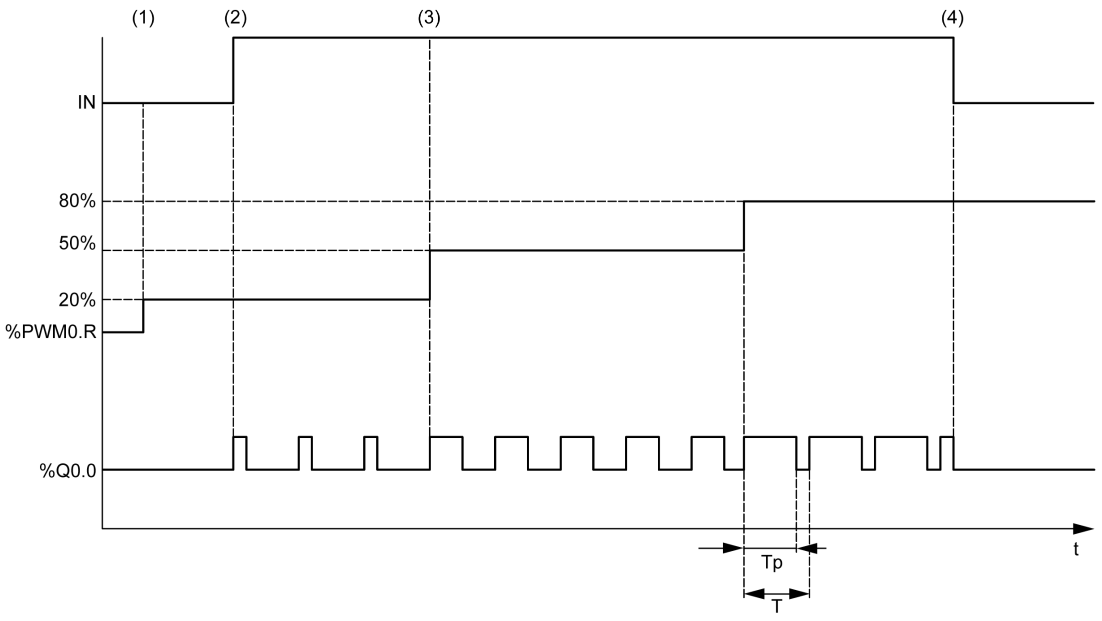
The output signal period `T` is set with the **Preset** and **Time Base** parameters such that `T = %PWMi.P` x **Time Base**.

This table shows the range of available periods:

Time Base	Frequency
0.1 ms	1 Hz...10000 Hz
1 ms	1 Hz...1000 Hz
10 ms	1 Hz...100 Hz
1 s	1 Hz...1 Hz

Timing Diagram

This diagram displays the timing for the *Pulse Width Modulation* function block:



(1) The PWM ratio (*%PWMi.R*) is set to 20%, `IN = 0` so the pulse generation is not active

(2) *IN* is set to 1 so PWM output is activated

(3) The programmable width (*Tp*) changes with *%PWM.R*

(4) *IN* is set to 0 so the *PWM* function is inhibited

Special Cases

Special case	Description
Effect of cold restart (`%S0=TRUE`)	• Pulse generation is stopped. • During the controller initialization, output is reset to 0. • If after the controller initialization: ◦ the controller enters the STOPPED state, the configured fallback strategy is applied to the output. ◦ the controller enters the RUN state, the configuration parameters are restored.
Effect at controller stop	• Pulse generation is stopped. • The fallback behavior is applied to the output.
Effect of online modification	None

Programming Example

Introduction

The *Pulse Width Modulation* function block can be configured as in this programming example.

Programming Example

In this example:

- The signal width is modified by the program according to the state of controller input `%I0.0` and `%I0.1`.
- The time base is set to 10 ms.
- The preset value `%PWM0.P` is set to 50 so the ratio step is equal to 2%.
- The configurable period T is equal to 500 ms.

The result is:

- If `%I0.0` and `%I0.1` are set to 0, the `%PWM0.R` ratio is set at 20%, the duration of the signal at state 1 is then: 20% x 500 ms = 100 ms.
- If `%I0.0` is set to 1 and `%I0.1` is set to 0, the `%PWM0.R` ratio is set at 50% (duration 250 ms).
- If `%I0.0` and `%I0.1` are set to 1, the `%PWM0.R` ratio is set at 80% (duration 400 ms).

Examples of *Pulse Width Modulation* instructions:

Rung	Instruction

0	`LDN    %I0.0`
	`ANDN   %I0.1`
	`[%PWM0.R:=20]`

1	`LD     %I0.0`
	`ANDN   %I0.1`
	`[%PWM0.R:=50]`

2	`LD     %I0.0`
	`AND    %I0.1`
	`[%PWM0.R:=80]`

3	`BLK    %PWM0`
	`LD     %I0.2`
	`IN`
	`END_BLK`

NOTE: Refer to the reversibility procedure, page 161 to obtain the equivalent Ladder Diagram.

Network Objects

What’s in This Chapter

Input Registers Objects (%QWM)

Introduction

Input registers objects are the digital values of Modbus mapping table Input registers received on the logic controller.

Displaying Input Registers Properties

Follow these steps to display properties of Input registers objects:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **Network objects > Input registers**. **Result**: The properties window appears.

Input Registers Properties

This table describes each property of an Input registers object:

Parameter	Editable	Value	Default value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the object is being referenced in a program.
Address	No	%QWMi	–	The address of the Input registers object, where i is the instance identifier. For the maximum number of instances, refer to Maximum Number of Objects, page 24.
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this object. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.

Parameter	Editable	Value	Default value	Description
Fallback value	Yes	-32768...3276-7	0	Specify the value to apply to this object when the logic controller enters the STOPPED or an exception state. **NOTE:** If **Maintain values** fallback mode is configured, the object retains its current value when the logic controller enters the STOPPED or an exception state. The value 0 is displayed and cannot be edited. For more details, refer to Fallback Behavior, page 36.
Comment	Yes	–	–	A comment associated with this object. Double-click in the **Comment** column and type an optional comment to associate with this object.

Output Registers (Modbus TCP) Objects (%IWM)

Introduction

Output registers objects are the digital values of Modbus TCP mapping table output registers received on the logic controller.

Displaying Output Registers Properties

Follow these steps to display properties of Output registers objects:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **Network objects > Output registers (Modbus TCP)**. **Result**: The properties window appears.

Output Registers Properties

This table describes each property of an Output registers object:

Parameter	Editable	Value	Default value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the object is being referenced in a program.
Address	No	%IWMi	–	The address of the Output registers object, where i is the instance identifier. For the maximum number of instances, refer to Maximum Number of Objects, page 24.

Parameter	Editable	Value	Default value	Description
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this object. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with this object. Double-click in the **Comment** column and type an optional comment to associate with this object.

Digital Input (IOScanner) Objects (%IN)

Introduction

Digital input (IOScanner) objects are the digital values received from Modbus Serial IOScanner or Modbus TCP IOScanner devices.

Displaying Digital inputs (IOScanner) Properties

Follow these steps to display properties of Digital inputs (IOScanner) objects:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **Network objects > Digital inputs (IOScanner)**. **Result**: The properties window appears.

Digital inputs (IOScanner) Properties

This table describes each property of an Digital inputs (IOScanner) object:

Parameter	Editable	Value	Default value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the object is being referenced in the program.
Address	No	%IN(i+x).y.z)	–	The address of the object, where: • i: index: ◦ 100 for SL1 ◦ 300 for ETH1(Modbus TCP IOScanner) • x: device ID • y: channel ID • z: object instance identifier For the maximum number of instances, refer to Maximum Number of Objects, page 24.

Parameter	Editable	Value	Default value	Description
Channel	No	Name of the configured channel.	-	The name of the channel being used to receive the data from the device.
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this object. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with this object. Double-click in the **Comment** column and type an optional comment to associate with this object.

Digital Output (IOScanner) Objects (%QN)

Introduction

Digital output (IOScanner) objects are the digital values sent to Modbus Serial IOScanner or Modbus TCP IOScanner devices.

Displaying Digital ouputs (IOScanner) Properties

Follow these steps to display properties of Digital ouputs (IOScanner) objects:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **Network objects > Digital outputs (IOScanner)**. **Result**: The properties window appears.

Digital ouputs (IOScanner) Object Properties

This table describes each property of a Digital ouputs (IOScanner) object:

Parameter	Editable	Value	Default value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the object is being referenced in a program.
Address	No	%QN(i+x).y.z	–	The address of the object, where: • i: index: ◦ 100 for SL1 ◦ 300 for ETH1(Modbus TCP IOScanner) • x: device ID • y: channel ID • z: object instance identifier For the maximum number of instances, refer to Maximum Number of Objects, page 24.

Parameter	Editable	Value	Default value	Description
Channel	Yes	Name of the configured channel.	-	The name of the channel being used to send the data to the device.
Fallback value	Yes	0 or 1	0	Specify the value to apply to this object when the logic controller enters the *STOPPED* or an exception state. **NOTE:** If **Maintain values** fallback mode is configured, the object retains its value when the logic controller enters the *STOPPED* or an exception state. The value 0 is displayed and cannot be edited. For more details, refer to Fallback Behavior, page 36.
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this object. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with this object. Double-click in the **Comment** column and type an optional comment to associate with this object.

Input Register (IOScanner) Objects (%IWN)

Introduction

Input register (IOScanner) objects are the register values received from Modbus Serial IOScanner or Modbus TCP IOScanner devices.

Displaying Input registers (IOScanner) Properties

Follow these steps to display properties of Input registers (IOScanner) objects:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **Network objects > Input registers (IOScanner)**. **Result**: The properties window appears.

Input registers (IOScanner) Properties

This table describes each property of an Input registers (IOScanner) object:

Parameter	Editable	Value	Default value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the object is being referenced in the program.
Address	No	%IWN(i+x).y.z	–	The address of the object, where:

Parame-ter	Editable	Value	Default value	Description
				• i: index: ◦ 100 for SL1 ◦ 300 for ETH1(Modbus TCP IOScanner) • x: device ID • y: channel ID • z: object instance identifier For the maximum number of instances, refer to Maximum Number of Objects, page 24.
Channel	No	Name of the configured channel.	-	The name of the channel being used to receive the data from the device.
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this object. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Com-ment	Yes	–	–	A comment associated with this object. Double-click in the **Comment** column and type an optional comment to associate with this object.

Output Register (IOScanner) Objects (%QWN)

Introduction

Output register (IOScanner) objects are the register values sent to Modbus Serial IOScanner or Modbus TCP IOScanner devices.

Displaying Output registers (IOScanner) Properties

Follow these steps to display properties of Output registers (IOScanner) objects:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **Network objects > Output registers (IOScanner)**. **Result**: The properties window appears.

Output registers (IOScanner) Object Properties

This table describes each property of a Output registers (IOScanner) object:

Parame-ter	Editable	Value	Default value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the object is being referenced in a program.
Address	No	%QWN(i+x).y.z	–	The address of the object, where:

Parame-ter	Editable	Value	Default value	Description
				• i: index: ◦ 100 for SL1 ◦ 300 for ETH1(Modbus TCP IOScanner) • x: device ID • y: channel ID • z: object instance identifier For the maximum number of objects, refer to Maximum Number of Objects, page 24.
Channel	Yes	Name of the configured channel.	-	The name of the channel being used to send the data to the device.
Fallback value	Yes	-32768...327-67	0	Specify the value to apply to this object when the logic controller enters the *STOPPED* or an exception state. **NOTE:** If **Maintain values** fallback mode is configured, the object retains its value when the logic controller enters the *STOPPED* or an exception state. The value 0 is displayed and cannot be edited. For more details, refer to Fallback Behavior, page 36.
Symbol	Yes	–	–	The symbol associated with this address. Double-click in the **Symbol** column and type the name of the symbol to associate with this object. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments.
Com-ment	Yes	–	–	A comment associated with this object. Double-click in the **Comment** column and type an optional comment to associate with this object.

Modbus IOScanner Network Diagnostic Codes (%IWNS)

Device Diagnostic Codes

The following table shows the possible values of the diagnostic codes returned by device x in the corresponding Modbus IOScanner network diagnostic object (*%IWNS(100+x)* for SL1, or *%IWNS(200+x)* for SL2, *%IWNS(300+x)* for ETH1):

Value	Description
0	Device not scanned.
1	Device is being initialized by Modbus IOScanner (Initialization request of device being sent).
2	Device is present and ready to be scanned (initialization requests sent, if any).
3	Device not scanned correctly due to a communication error detected on a channel of the device.
4	Device not initialized correctly due to a communication error detected during initialization request of the device.
5	Device not correctly identified because the vendor name or product code returned by the device does not match the expected values.
6	Communication error occurred during identification and initialization. Possible reasons are: incommunicative or absent device, incorrect communication parameters, or unsupported Modbus function.

Channel Diagnostic Codes

The following table shows the possible values of the diagnostic codes returned by device x and channel y in the corresponding Modbus IOScanner network diagnostic object (*%IWNS(100+x).y* for SL1, *%IWNS(200+x).y* for SL2, *%IWNS (300+x).y* for ETH1):

Value	**Description**
0	Channel is active
-1	Channel is inactive
Other	Value of the Communication error code (CommError) see EcoStruxure Machine Expert - Basic, Generic Functions Library Guide)

Pulse Train Output (%PTO)

What's in This Chapter

Using Pulse Train Output Function Blocks

This chapter provides descriptions and programming guidelines for using *Pulse Train Output* function blocks.

Description

Overview

This section describes the *Pulse Train Output* function.

Pulse Train Output (PTO)

Introduction

The M200 PTO function provides two pulse train output channels for a specified number of pulses and a specified velocity (frequency). The PTO function is used to control the positioning or speed of one or two independent linear single-axis stepper or servo drives in open loop mode. The PTO function does not have any position feedback information from the process. Therefore, position information must be integrated in the drive.

The PLS (pulse)PTO, PWM (pulse width modulation), PTO (pulse train output) and FREQGEN (frequency generator) functions use the same dedicated outputs. Only one of these four functions can be used on the same channel. Using different functions on channel 0 and channel 1 is allowed.

A PTO channel can use optional interface signals for homing (Ref), event (Probe), limits (LimP, LimN), or drive interface (DriveReady, DriveEnable).

Automatic origin offset is also managed to improve positioning accuracy. Diagnostics are available for status monitoring, allowing a comprehensive and quick troubleshooting.

Supported Functions

The PTO channels support the following functions:

- two output modes (two channels for Pulse and Direction or one channel for CW/CCW)
- single axis moves (velocity and position)
- relative and absolute positioning, with automatic direction management
- trapezoidal and S-curve acceleration and deceleration

- homing (four modes with offset compensation)
- dynamic acceleration, deceleration, velocity, and position modification
- switch from speed to position mode
- move queuing (buffer of one move)
- position capture and move trigger on event (using probe input)
- backlash compensation
- limits (hardware and software)
- diagnostics

  NOTE: Motion Function Blocks , page 254and Administrative Function Blocks, page 277 help you program these functions.

PTO Characteristics

There are up to six physical inputs for a PTO channel:

- Two are assigned to the PTO function through configuration and are taken into account upon a rising edge on the input:
  - Ref input (*%I0.8* for *%PTO0* and *%I0.10* for *%PTO1*)
  - Index input (*%I0.9* for *%PTO0* and *%I0.11* for *%PTO1*)
  - Probe input (*%I0.12* for *%PTO0* and *%I0.13* for *%PTO1*)
- Three are assigned to the *MC_Power_PTO* function block. They have no fixed assignment (they are not configured in the configuration screen), and are read with all other inputs:
  - *DriveReady* input
  - Limit positive input
  - Limit negative input

  NOTE: These inputs are managed like any other regular input, but are used by the PTO function when assigned to *MC_Power_PTO* function block.

  NOTE: The positive and negative limit inputs are required to help prevent over-travel.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Ensure that controller hardware limit switches are integrated in the design and logic of your application.
- Mount the controller hardware limit switches in a position that allows for an adequate braking distance.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

There are up to three physical outputs for a PTO channel:

- Two outputs are mandatory to manage the output mode of the PTO function. They have a fixed assignment and must be enabled by configuration:
  - CW / CCW
  - Pulse
- The other output, *DriveEnable*, is associated with the *MC_Power_PTO* function block. It has no fixed assignment and is written at the end of the MAST cycle as regular outputs.

The PTO function has the following characteristics:

Characteristic	**Value**
Number of channels	2
Number of axis	1 per channel

Characteristic	Value
Position range	-2,147,483,648...2,147,483,647 (32 bits)
Minimum velocity	0 Hz
Maximum velocity	100 kHz (for a 40/60 duty cycle and max. 200 mA)
Minimum step	1 Hz
Accuracy on velocity	1 %
Acceleration / deceleration (min)	1 Hz/ms
Acceleration / deceleration (max)	100 kHz/ms
Origin offset	-2,147,483,648...2,147,483,647 (32 bits)
Software limits range	-2,147,483,648...2,147,483,647 (32 bits)

Acceleration / Deceleration Ramp

Start Velocity

The **Start Velocity** is the minimum frequency at which a stepper motor can produce movement, with a load applied, without the loss of steps.

Start Velocity parameter is used when starting a motion from velocity 0.

Start Velocity must be in the range 0...`MaxVelocityAppl (see Modicon M241 Logic Controller, PTOPWM, Library Guide).`

Value 0 means that the **Start Velocity** parameter is not used. In this case, the motion starts at a velocity = acceleration rate x 1 ms.

Stop Velocity

The **Stop Velocity** is the maximum frequency at which a stepper motor stops producing movement, with a load applied, without loss of steps.

Stop Velocity is only used when moving from a higher velocity than **Stop Velocity**, down to velocity 0.

Stop Velocity must be in the range 0...`MaxVelocityAppl (see Modicon M241 Logic Controller, PTOPWM, Library Guide).`

Value 0 means that the **Stop Velocity** parameter is not used. In this case, the motion stops at a velocity = deceleration rate x 1 ms.

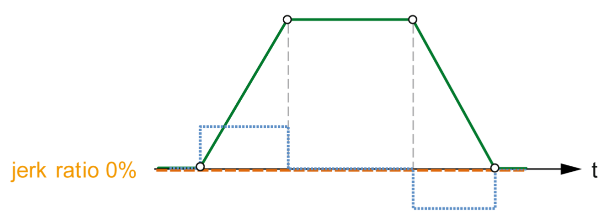
Acceleration / Deceleration

Acceleration is the rate of velocity change, starting from **Start Velocity** to target velocity. Deceleration is the rate of velocity change, starting from target velocity to **Stop Velocity**. These velocity changes are implicitly managed by the PTO function in accordance with `Acceleration`, `Deceleration` and `JerkRatio` parameters following a **trapezoidal** or an **S-curve** profile.

Acceleration / Deceleration Ramp with a Trapezoidal Profile

When the jerk ratio parameter is set to 0, the acceleration / deceleration ramp has a trapezoidal profile.

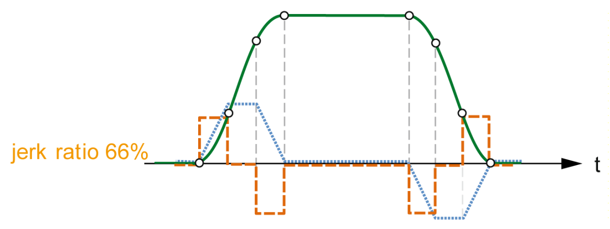
Expressed in Hz/ms, the `acceleration` and `deceleration` parameters represent the rate of velocity change.

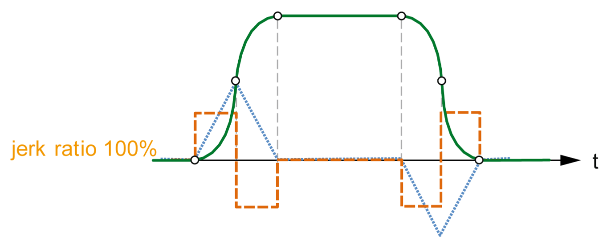
`JerkRatio` 0%: Constant acceleration / deceleration.	
	— velocity ┈ acceleration - - - jerk ∘ Inflexion point

Acceleration / Deceleration Ramp with an S-curve Profile

When the jerk ratio parameter is greater than 0, the acceleration / deceleration ramp has an S-curve profile.

The S-curve ramp is used in applications controlling high inertia, or in those that manipulate fragile objects or liquids. The S-curve ramp enables a smoother and progressive acceleration / deceleration, as demonstrated in the following graphics:

`JerkRatio` 66%: 2/3 of the acceleration and deceleration time is spent in increasing and decreasing the acceleration and deceleration value.	
	— velocity ┈ acceleration - - - jerk ∘ Inflexion point

`JerkRatio` 100%: The entire time is spent in increasing and decreasing the acceleration and deceleration value.	
	— velocity ┈ acceleration - - - jerk ∘ Inflexion point

NOTE: The `JerkRatio` parameter value is common for acceleration and deceleration so that concave time and convex time are equal.

Affect of the S-Curve Ramp on Acceleration / Deceleration

The duration for the acceleration / deceleration is maintained, whatever the `JerkRatio` parameter may be. To maintain this duration, the acceleration or deceleration is other than that configured in the function block (`Acceleration` or `Deceleration` parameters).

When the `JerkRatio` is applied, the acceleration / deceleration is affected.

When the `JerkRatio` is applied at 100%, the acceleration / deceleration is two times that of the configured `Acceleration`/`Deceleration` parameters.

NOTE: If the `JerkRatio` parameter value is invalid, the value is re-calculated to respect the *MaxAccelerationAppl* and *MaxDecelerationAppl* parameters.

`JerkRatio` is invalid when:

- its value is greater than 100. In this case, a `JerkRatio` of 100 is applied.
- its value is less than 0. In this case, a `JerkRatio` of 0 is applied.

Probe Event

Description

The Probe input is enabled by configuration, and activated using the *MC_TouchProbe_PTO* function block.

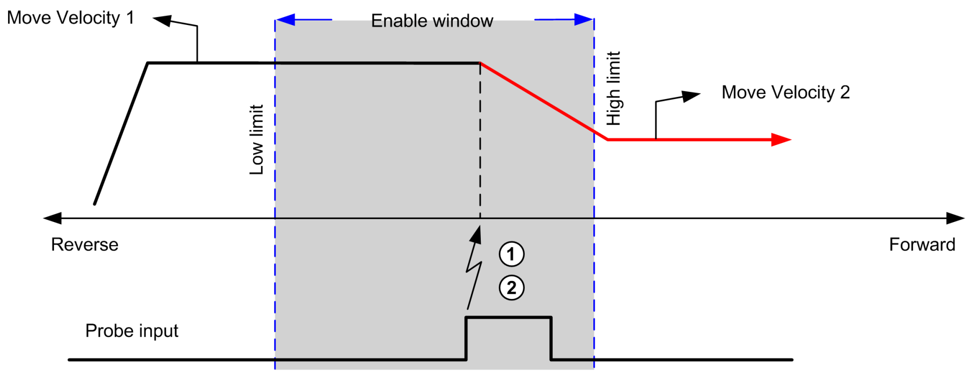
The Probe input is used as an event to:

- capture the position,
- start a move independently of the task.

Motion Trigger

The `BufferMode` input of a motion function block must be set to `seTrigger`.

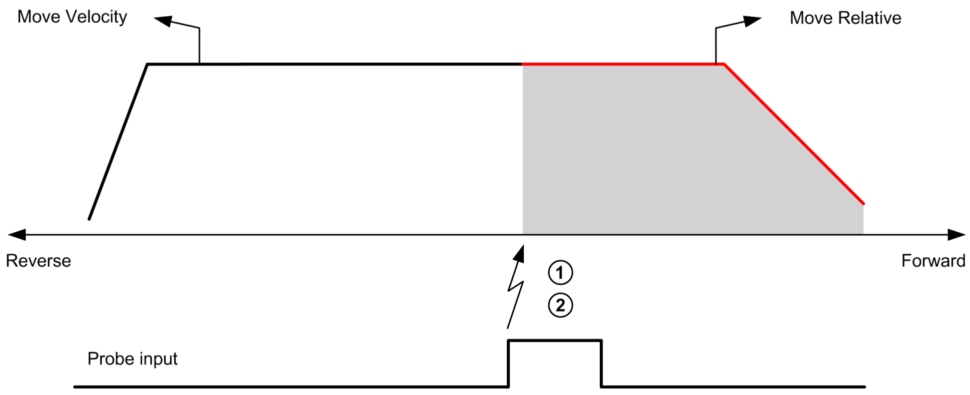
This example illustrates a change target velocity with enable window:



1 Capture the position counter value

2 Trigger *Move Velocity* function block

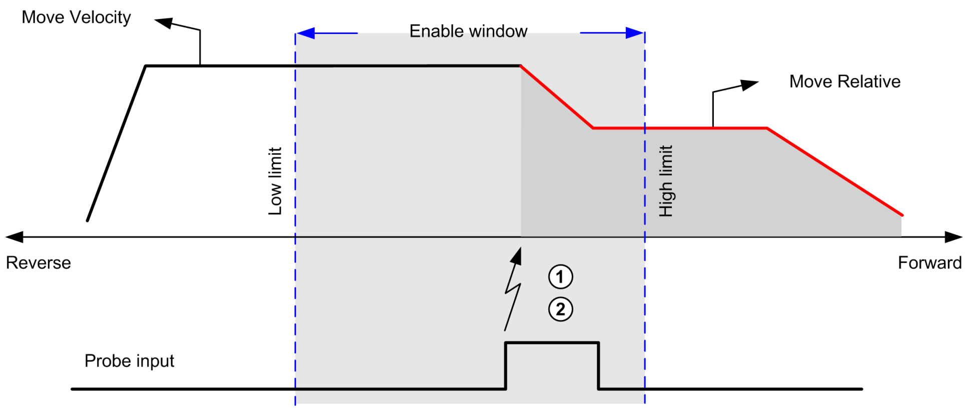
This example illustrates a move of pre-programmed distance, with simple profile and no enable window:



1 Capture the position counter value

2 Trigger *Move Relative* function block

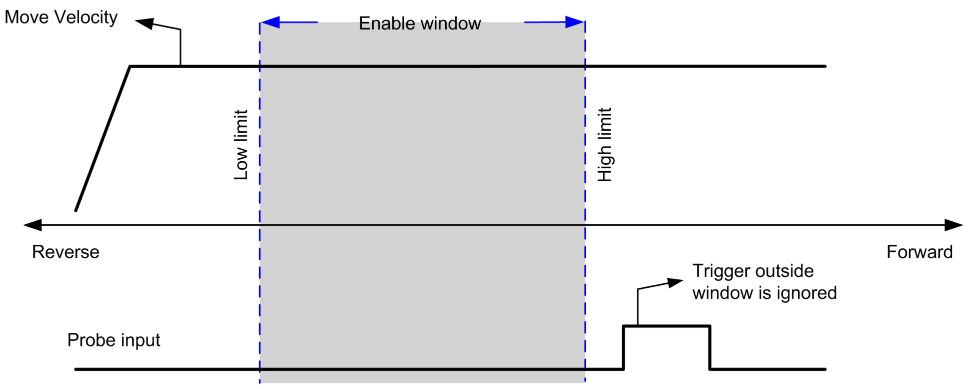
This example illustrates a move of pre-programmed distance, with complex profile and enable window:



1 Capture the position counter value

2 Trigger *Move Relative* function block

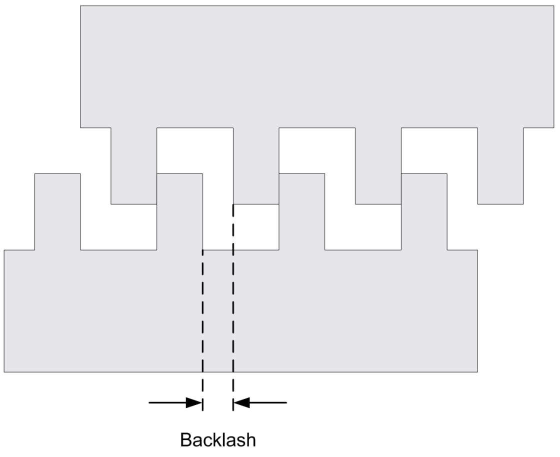
This example illustrates a trigger event out of enable window:



Backlash Compensation

Description

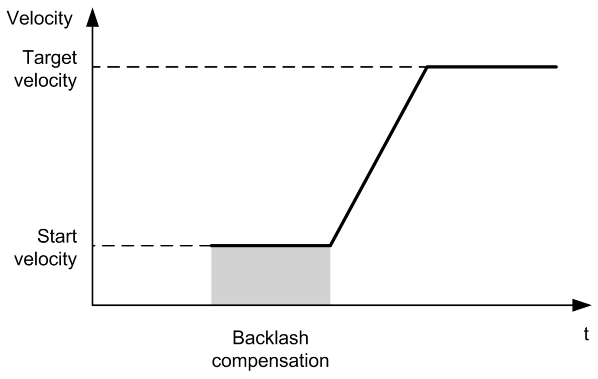
The **Backlash Compensation** parameter is defined as the amount of motion needed to compensate for the mechanical clearance in gears (backlash) when a movement is reversed:



NOTE: The function does not take into account external sources of movement, such as inertia movement or other forms of induced movement.

Backlash compensation is set in number of pulses (0...65535, default value is 0). When set, at each direction reversal, the specified number of pulses is first emitted at start velocity, and then the programmed movement is executed. The backlash compensation pulses are not added to the position counter.

This figure illustrates the backlash compensation:



NOTE:

- Before the initial movement is started, the function cannot determine the amount of backlash to compensate for. Therefore, the backlash compensation is only active after a first move is performed and the compensation is applied at the first direction reversal.
- If an aborting command is received or an error detected before the backlash completion, the absolute position remains unchanged.
- After an abort command, the backlash resumes from current backlash position when a new move is started.

For more details, refer to the Configuring Pulse Train Output, page 231.

Positioning Limits

Introduction

Positive and negative limits can be set to control the movement boundaries in both directions. Both hardware and software limits are managed by the controller.

Hardware and software limit switches are used to manage boundaries in the controller application only. They are not intended to replace any functional safety limit switches wired to the drive. The controller application limit switches must necessarily be activated before the functional safety limit switches wired to the drive. In any case, the type of functional safety architecture, which is beyond the scope of the present document, that you deploy depends on your safety analysis, including, but not limited to:

- risk assessment according to EN/ISO 12100
- FMEA according to EN 60812

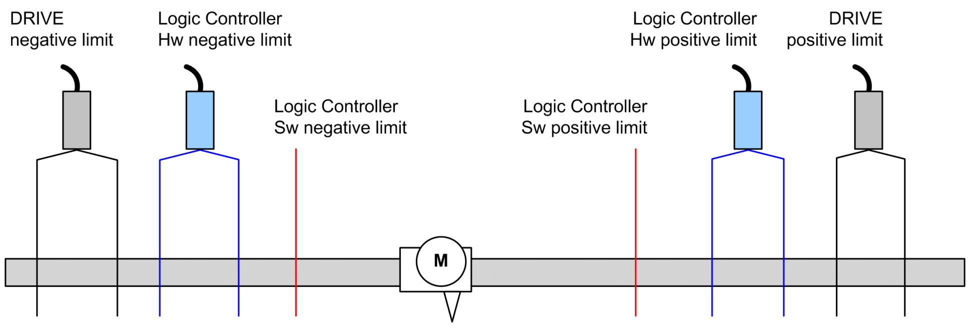
⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Ensure that a risk assessment is conducted and respected according to EN/ISO 12100 during the design of your machine.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

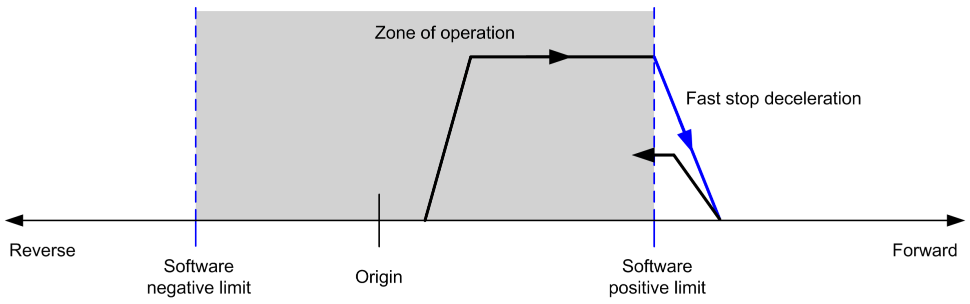
The figure illustrates hardware and software limit switches:



Once either the controller hardware or software limits are crossed, an error is detected and a Fast stop deceleration is performed:

- the function block under execution detects the error state.

To clear the axis error state, and return to a **Standstill** state, execution of *MC_Reset_PTO* is required as any motion command will be rejected (refer to PTO parameters, page 248 *EnableDirPos* or *EnableDirNeg)*while the axis remains outside the limits (function block terminates with `ErrorId`= `InvalidDirectionValue`). It is only possible to execute a motion command in the opposite direction under these circumstances.



Software Limits

Software limits can be set to control the movement boundaries in both directions.

Limit values are enabled and set in the configuration screen, such that:

- Positive limit > Negative limit
- Values in the range -2,147,483,648 to 2,147,483,647

  NOTE: When enabled, the software limits are valid after an initial homing is successfully performed (that is, the axis is homed, *MC_Home_PTO*).

Hardware Limits

NOTE: The restrictions over movement are valid while the limit inputs are FALSE and regardless of the sense of direction. When they return to TRUE, movement restrictions are removed and the hardware limits are functionnally rearmed. Therefore, use falling edge contacts leading to RESET output instructions prior to the function block. Then use those bits to control these function block inputs. When operations are complete, SET the bits to restore normal operation.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Ensure that controller hardware limit switches are integrated in the design and logic of your application.
- Mount the controller hardware limit switches in a position that allows for an adequate braking distance.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTE: Adequate braking distance is dependent on the maximum velocity, maximum load (mass) of the equipment being moved, and the value of the Fast stop deceleration parameter.

Configuration

Overview

This section describes how to configure a PTO channel and the associated parameters.

PTO Configuration

Overview

To configure the *Pulse Generator* resource, refer to Configuring Pulse Generators, page 55.

To configure the *Pulse Generator* resource as a PTO, refer to PTO Configuration, page 59.

Pulse Output Modes

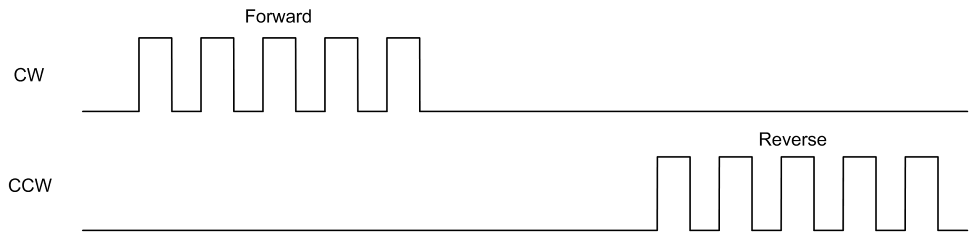
Overview

There are two possible output modes:

- ClockWise / CounterClockwise
- Pulse / Direction

ClockWise (CW) / CounterClockwise (CCW) Mode

This mode generates a signal that defines the motor operating speed and direction. This signal is implemented on the first PTO channel (*PTO0* only).

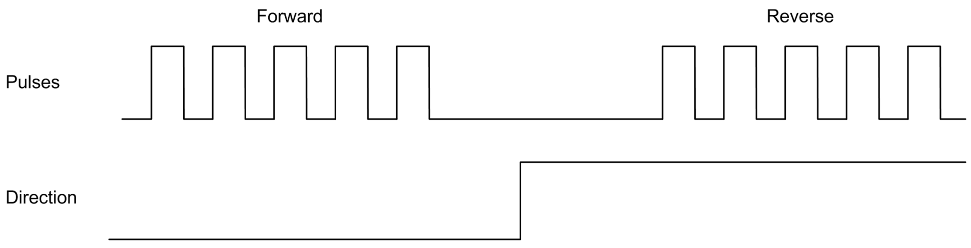


NOTE: *PTO1* is not available when choosing this mode.

Pulse / Direction Mode

This mode generates two signals on the PTO channels:

- The pulse output provides the motor operating speed (*Pulses*).
- The direction output provides the motor rotation direction (*Direction*).



Special Cases

Special Case	Description
Effect of a cold restart (`%S0=TRUE`)	• The axis is set to *Disabled* state. • The PTO function blocks are initialized.
Effect at controller stop	The axis is set to *ErrorStop* state.
Effect of online modification	None

Motion Task Table

Overview

The Motion Task Table is a programming possibility for motion function blocks, dedicated to repetitive motion sequences. A sequence of movements is defined for an axis at configuration time (a sequence can be compared as a recipe that mixes various movements).

The Motion Task Table can be dedicated to several axes and offers a graphical overview of the configured motion sequence.

Use the *MC_MotionTask_PTO* function block to execute a Motion Task Table. When the table is called by the *MC_MotionTask_PTO* function block, it needs to be associated to a specific axis. The Motion Task Table is applied to the axis used by the *MC_MotionTask_PTO* function block. Several *MC_MotionTask_PTO* function blocks can execute the same %MT Motion Task Table instances simultaneously.

Features

The maximum number of Motion Task Table (%MT) instances is 4.

A Motion Task Table contains a sequence of single-axis movements:

- A sequence is a succession of steps.
- Each step defines the parameters of a movement.
- Each step uses a dedicated motion function block instance.

Movements that can be used in the Motion Task Table:

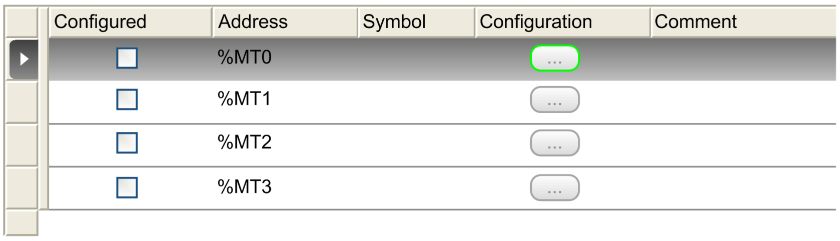
- Move absolute
- Move relative
- Halt
- Set position

- Move velocity

Configuring a Motion Task Table

The **Motion Task Table Assistant** allows you to configure each movement in an ordered sequence and visualize an estimated global movement profile.

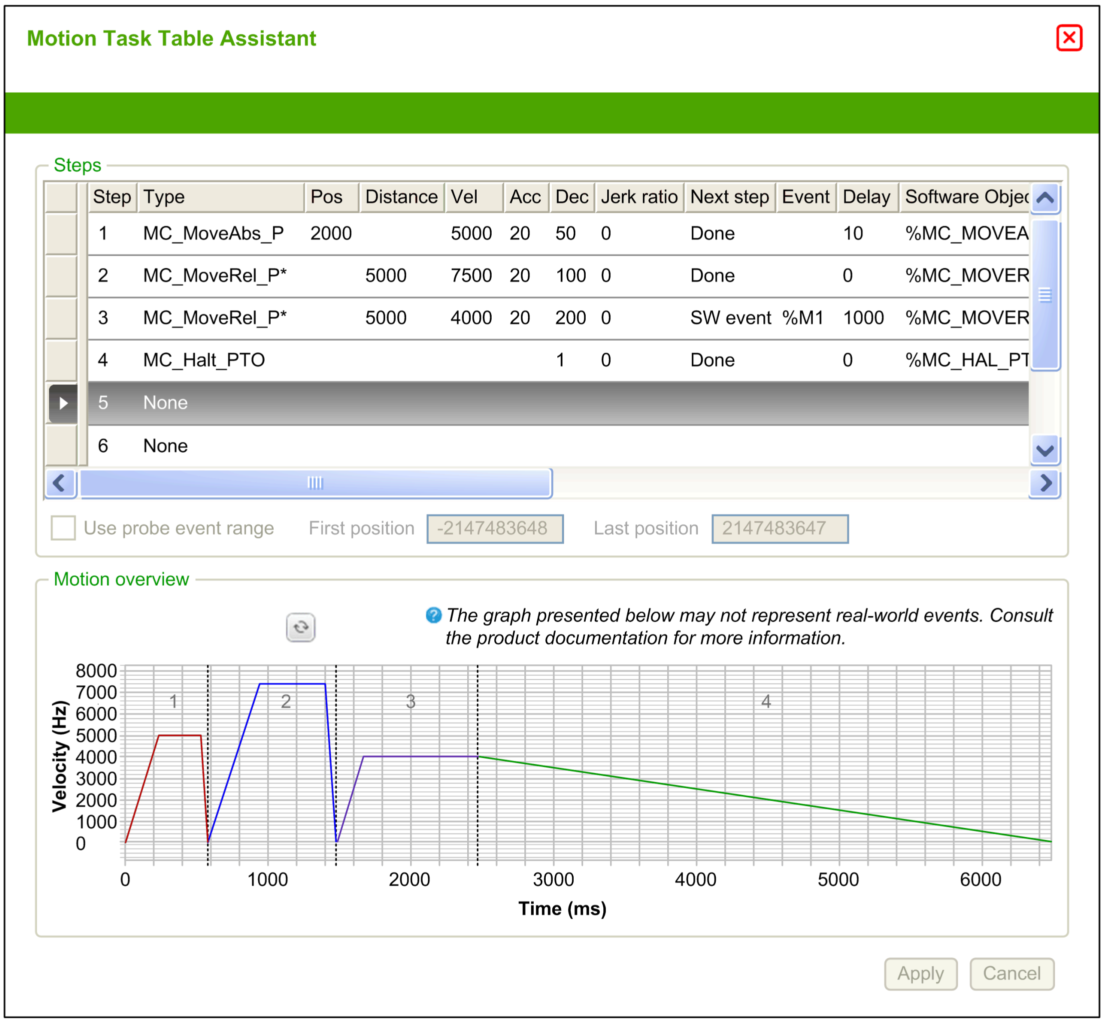
To display the **Motion Task Table Assistant**, proceed as follows:

Step	Action
1	Select the **Programming > Tools** module tab and click **PTO objects > Motion Task Tables** in the hardware tree to display the Motion Task Table properties. **tooltipMotionTaskTables properties**  Configured / Address / Symbol / Configuration / Comment ☐ %MT0 ... ☐ %MT1 ... ☐ %MT2 ... ☐ %MT3 ...
2	Click **[...]** to configure the Motion Task Table.

Motion Task Table properties window description:

Parameter	Editable	Value	Default Value	Description
Configured	No	True/False	False	Indicates whether the Motion Task Table contains configured steps.
Address	No	*%MTx*	*%MTx*	Displays the address of the Motion Task Table where *x* is the table number.
Symbol	Yes	–	–	Allows you to specify a symbol to associate with the Motion Task Table. Double-click the cell to edit the field.
Configuration	Yes	**[...]** (Button)	Enabled	Allows you to configure the sequence of movements using the **Motion Task Table Assistant**.
Comment	Yes	–	–	Allows you to specify a comment to associate with the Motion Task Table. Double-click the cell to edit the field.

Motion Task Table Assistant:



Motion Task Table Assistant

Steps

Step	Type	Pos	Distance	Vel	Acc	Dec	Jerk ratio	Next step	Event	Delay	Software Objec
1	MC_MoveAbs_P	2000		5000	20	50	0	Done		10	%MC_MOVEA
2	MC_MoveRel_P*		5000	7500	20	100	0	Done		0	%MC_MOVER
3	MC_MoveRel_P*		5000	4000	20	200	0	SW event	%M1	1000	%MC_MOVER
4	MC_Halt_PTO					1	0	Done		0	%MC_HAL_PT
5	None										
6	None										

☐ Use probe event range First position -2147483648 Last position 2147483647

Motion overview

The graph presented below may not represent real-world events. Consult the product documentation for more information.

Motion Task Table Assistant main areas:

Steps:	lists the sequence of single axis movements and input parameters for each movement.
Motion overview:	click the refresh button, or **F5**, to generate a graphical view of the movement implemented by the steps sequence. The curve provides a general overview of the movement. The curve is based on the following assumptions: • Initial position is 0. • Position limits are not enabled. • Axis default motion configuration parameters are used. • An event (probe input, POU) occurs after the step completion and a 100 ms delay. • A *%MWx* delay is graphically represented by a 100 ms delay.

Steps window description:

Parameter	**Value**	**Default Value**	**Description**
Step	*1...16*	–	Single axis movement number in the sequence.
Type	*None* *Move absolute* *Move relative* *Halt* *Set position* *Move velocity*	*None*	Motion command. The motion command uses one motion function block instance indicated in the **Software Objects** parameter.

Parameter	Value	Default Value	Description
Pos	See each software object function block parameter value.	*empty*	The move parameters are the parameters of the software object assigned to the step. Parameter description: • **Pos**: Position • **Distance**: Distance • **Vel**: Velocity • **Acc**: Acceleration • **Dec**: Deceleration • **Jerk ratio**: Jerk ratio **NOTE: Vel** parameter for the move velocity motion command is a combination of velocity and direction. In the table, the velocity range for the *MC_MoveVel_PTO* motion command is: - Max Velocity...+ Max Velocity. A negative velocity indicates a negative direction, a positive velocity indicates a positive direction.
Distance			
Vel			
Acc			
Dec			
Jerk ratio			
Next step	*Done* / *In velocity*, *Blending previous*, *Probe input event*, *SW event*, *Delay*	*empty*	The condition that needs to be fulfilled to proceed to the next step in the table sequence. Condition description: • *Done* / *In velocity*: ◦ *Done*: Proceed to the next step when the present step is completed. This parameter is available for the different motion commands except move velocity. ◦ *In velocity*: Proceed to the next step when the requested velocity is reached. This parameter is only available for the move velocity motion command. • *Blending previous*: The velocity of next step is blended with the velocity at the end-position of this step. • *Probe input event*: Proceed to the next step when a defined event is detected on the Probe input. The edge is defined in the **Event** parameter. An input field opens in the bottom of the **Steps** window, **Use probe event range**, described in next table. **NOTE:** One occurrence of **Probe input event** can be used per Motion Task Table. • *SW event*: Proceed to the next step when the memory bit address (*%Mx*) set in the **Event** parameter is set to 1. • *Delay*: Proceed to the next step when the delay (starting at the beginning of the step) elapses. The delay is defined in the **Delay** parameter. **NOTE:** When the *Probe input event*, or *SW event*, or *Delay* event occurs, the next step is started even if the present step is not completed.
Event	– *0/1* *%Mx*	*empty*	**Event** value complements the conditions described in **Next step** parameter. **Next step** choice and corresponding **Event** choice: • *Probe input event*: ◦ 0: Falling edge ◦ 1: Rising edge **NOTE:** The probe input event is independent of the application task cycle and the motion task cycle. • *SW event*: Memory bit *%Mx*. **NOTE:** *%Mx* is evaluated every 4 ms.
Delay	*0...65535* *%MWx*	*empty*	**Delay** value represents the amount of time before proceeding to the next step. Depending on the . **Next step** parameter value, the **Delay** is evaluated from the beginning or the end of the step: • *Done* / *In velocity*: The delay starts when the present step is *Done* or *In Velocity*. • *Blending previous*: Not available.

Parameter	Value	Default Value	Description
			• *Probe input event* and *SW event*: The delay starts at the beginning of the step. ◦ An elapsed delay generates a timeout if the event did not occur, and next step is proceeded. ◦ If the event occurs before the end of the delay, the next step is proceeded and the delay timeout is aborted. **NOTE:** If **Delay** remains to its default value (0), the motion command waits for the probe input or software event to occur, without timeout. • *Delay*: The delay starts at the beginning of the step. The next step is proceeded when the delay is elapsed. **NOTE:** An immediate value cannot be modified in an application POU, whereas, a *%MWx* value must be set by an application POU. The Motion Task Table **Delay** parameter is not modified if *MC_ReadPar_PTO* or *MC_WritePar_PTO* are set using *ParNumber* = 1000 (delay).
Software Objects	*%MC_MOVEABS_PTOx* *%MC_MOVEREL_PTOx* *%MC_HALT_PTOx* *%MC_SETPOS_PTOx* *%MC_MOVEVEL_PTOx*	*empty*	Shows the software object allocated to the step. It is allocated by the system and is a read-only parameter. Those software objects are function block instances.
Symbol	–	*empty*	Allows to specify a symbol to associate with the step software object. Double-click the cell to edit the field.

Use probe event range parameter in the **Steps** window:

Parameter		Value	Default Value	Description
Use probe event range		True/False	False	When TRUE, a trigger event is only recognized within the position range defined between **First position** and **Last position**. The parameter can be modified if **Next step** is set to *Probe input event* in the Motion Task Table.
	First position	*-2147483648...2147483647* *%MDx*	*- 2147483648*	**NOTE: First position** must be less than **Last position**.
	Last position	*-2147483648...2147483647* *%MDx*	*2147483647*	
Illustration of the position range influence on triggering is provided in the section on Probe Event (see Modicon M241 Logic Controller, PTOPWM, Library Guide). **NOTE:** The position where the trigger event was detected is not recorded.				

Managing Step Parameters and Event

The parameters and event defined in a step are only valid at the start of the step execution, therefore:

- A step parameter value modified by the application is only valid if it is modified before the step is active. The parameter can be modified using system allocated software object parameter in a POU.
- A memory object value (*%MW* or *%MWx*) is only valid if updated before the step is active.
- An event is only evaluated once the step is active. In the case of a *Probe input event*, an event occurring before the step is active cannot be detected.

Managing Function Block Instances Used in a Motion Task Table

System allocated software object instances:

- cannot be used in an application POU to control an axis motion.
- Output parameters are not updated by the system during the execution of the Motion Task Table. In other words, the output bits and output parameters are not valid.
- Input parameters:
  - cannot be modified in the software object instance editor, or in the **Programming** tab.
  - can be used to dynamically modify the Motion Task Table in an application POU. To dynamically modify a system allocated software object instance input parameter, use the parameter address or its associated symbol.

    NOTE: The executing step can be modified but the modifications will not be taken into account until the next execution of the step.

  Example of movement described in a Motion Task Table:

  - Step: 2
  - Movement type: Move relative
  - Software object: %MC_MOVEREL_PTO1
  - Symbol: Move_Relative_Label2

  In previous example, the velocity input parameter can be modified by program using one of the following syntaxes:

  - %MC_MOVEREL_PTO1.Vel
  - Move_Relative_Label2.Vel

Management of the function block instances used in a Motion Task Table:

- When a Motion Task Table is configured, the reserved function block instances are set as **Used**.
- If all the instances of a specific function block are reserved, the associated move type cannot be used anymore.

Programming

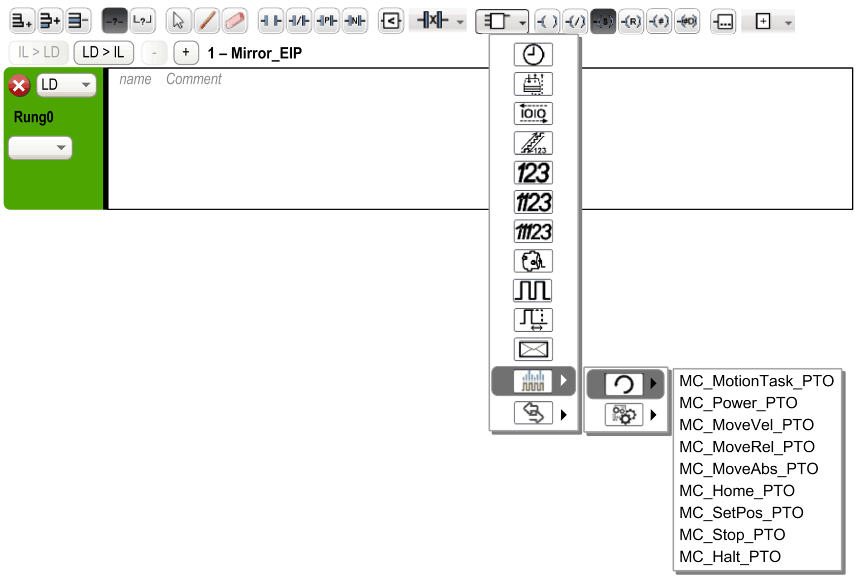
Overview

This section lists the function blocks used to program the *PTO* function and describes how to add or remove those function blocks.

Adding / Removing a Function Block

Adding a Function Block

Follow these steps to add an instance of a PTO function block:

Step	Action
1	Select the **Programming** tab.
2	Select **Function Blocks > PTO > Administrative** or **Function Blocks > PTO > Motion** as shown in the following graphic:  IL > LD LD > IL - + 1 – Mirror_EIP LD Rung0 name Comment MC_MotionTask_PTO MC_Power_PTO MC_MoveVel_PTO MC_MoveRel_PTO MC_MoveAbs_PTO MC_Home_PTO MC_SetPos_PTO MC_Stop_PTO MC_Halt_PTO
3	Click into the rung to place the selected function block.
4	Associate the input/output variables, page 223 of the function block.

NOTE: Set the parameters in the **Configuration** tab.

For more details, refer to PTO Configuration, page 59.

Removing a Function Block

Follow these steps to remove an instance of a PTO function block:

Step	Action
1	In the **Programming** tab, click the instance of the function block.
2	Press **Delete** to remove the selected function block.

PTO Function Blocks

Function Blocks

The PTO function is programmed in EcoStruxure Machine Expert-Basic using the following function blocks:

Category	Function Block	Description
Motion (single axis)	*MC_MotionTask_PTO*, page 255	Calls a Motion Task Table.
	MC_Power_PTO, page 258	Enables power to the axis, switching the axis state from *Disabled* to *Standstill*. While the *%MC_Power_PTO.Status* bit is *FALSE*, no motion function block can be executed for that axis.
	MC_MoveVel_PTO, page 261	Causes the specified axis to move at the specified speed, and transfer the axis to the state *Continuous*. This continuous movement is maintained until a software limit is reached, an aborting move is triggered, or a transition to *ErrorStop* state is detected.

Category	Function Block	Description
	MC_MoveRel_PTO, page 264	Moves the specified axis an incremental distance at the specified speed, and transfer the axis to the state *Discrete*. The target position is referenced from the current position at execution time, incremented by a distance.
	MC_MoveAbs_PTO, page 267	Causes the specified axis to move towards a given position at the specified speed, and transfer the axis to the state *Discrete*. The function block terminates with *Error* set to TRUE, if the axis is not Homed (no absolute reference position is defined). In this case, *ErrorId* is set to *InvalidAbsolute*.
	MC_Home_PTO, page 270	Commands the axis to perform the sequence defining the absolute reference position, and transfers the axis to the state Homing, page 241. The details of this sequence depend on *Homing* configuration parameters setting.
	MC_SetPos_PTO, page 272	Modifies the coordinates of the axis without any physical movement.
	MC_Stop_PTO, page 273	Commands a controlled motion stop and transfers the axis to the state *Stopping*. It aborts any ongoing move execution.
	MC_Halt_PTO, page 275	Commands a controlled motion stop until the velocity is zero, and transfers the axis to the state *Discrete*. With the *Done* output set to TRUE, the state is transferred to *Standstill*.
Administrative	*MC_ReadActVel_PTO*, page 277	Returns the value of the velocity of the axis.
	MC_ReadActPos_PTO, page 278	Returns the value of the position of the axis.
	MC_ReadSts_PTO, page 279	Returns the state diagram, page 252 status of the axis.
	MC_ReadMotionState_PTO, page 281	Returns the motion status of the axis.
	MC_ReadAxisError_PTO, page 282	Returns an axis control error, if any.
	MC_Reset_PTO, page 283	Resets all axis-related errors, conditions permitting, to allow a transition from the states *ErrorStop* to *Standstill*. It does not affect the output of the function blocks instances.
	MC_TouchProbe_PTO, page 284	Activates a trigger event on the probe input. This trigger event allows to record the axis position, and/or to start a buffered move.
	MC_AbortTrigger_PTO, page 286	Aborts function blocks which are connected to trigger events (for example, *MC_TouchProbe_PTO*).
	MC_ReadPar_PTO, page 287	Gets parameters from the PTO.
	MC_WritePar_PTO, page 289	Writes parameters to the PTO.

NOTE: The motion function blocks act on the position of the axis according to the motion state diagram, page 252. The administrative function blocks do not influence the motion state.

NOTE: The *MC_Power_PTO* function block is mandatory before a move command can be issued.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not use the same function block instance in different program tasks.
- Do not change the function block reference (AXIS) while the function block is executing.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

PTO Characteristics

There are up to six physical inputs for a PTO channel:

- Two are assigned to the PTO function through configuration and are taken into account upon a rising edge on the input:
  - Ref input (*%I0.8* for *%PTO0* and *%I0.10* for *%PTO1*)
  - Index input (*%I0.9* for *%PTO0* and *%I0.11* for *%PTO1*)
  - Probe input (*%I0.12* for *%PTO0* and *%I0.13* for *%PTO1*)
- Three are assigned to the *MC_Power_PTO* function block. They have no fixed assignment (they are not configured in the configuration screen), and are read with all other inputs:
  - *DriveReady* input
  - Limit positive input
  - Limit negative input

  NOTE: These inputs are managed like any other regular input, but are used by the PTO function when assigned to *MC_Power_PTO* function block.

  NOTE: The positive and negative limit inputs are required to help prevent over-travel.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Ensure that controller hardware limit switches are integrated in the design and logic of your application.
- Mount the controller hardware limit switches in a position that allows for an adequate braking distance.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

There are up to three physical outputs for a PTO channel:

- Two outputs are mandatory to manage the output mode of the PTO function. They have a fixed assignment and must be enabled by configuration:
  - CW / CCW (respectively *%Q0.0* and *%Q0.1* for *%PTO0* only)
  - Pulse (*%Q0.0* for *%PTO0* and *%Q0.1* for *%PTO1*)
- The other output, *DriveEnable*, is associated with the *MC_Power_PTO* function block. It has no fixed assignment and is written with all other outputs.

The PTO function has the following characteristics:

Characteristic	Value
Number of channels	2
Number of axis	1 per channel
Position range	-2,147,483,648...2,147,483,647 (32 bits)
Minimum velocity	0 Hz
Maximum velocity	100 kHz (for a 40/60 duty cycle and max. 200 mA)

Characteristic	Value
Minimum step	1 Hz
Accuracy on velocity	1 %
Acceleration / deceleration (min)	1 Hz/ms
Acceleration / deceleration (max)	100 kHz/ms
Origin offset	-2,147,483,648...2,147,483,647 (32 bits)
Software limits range	-2,147,483,648...2,147,483,647 (32 bits)

Home Modes

Overview

This section describes the PTO home modes.

Homing Modes

Description

Homing is the method used to establish the reference point or origin for absolute movement.

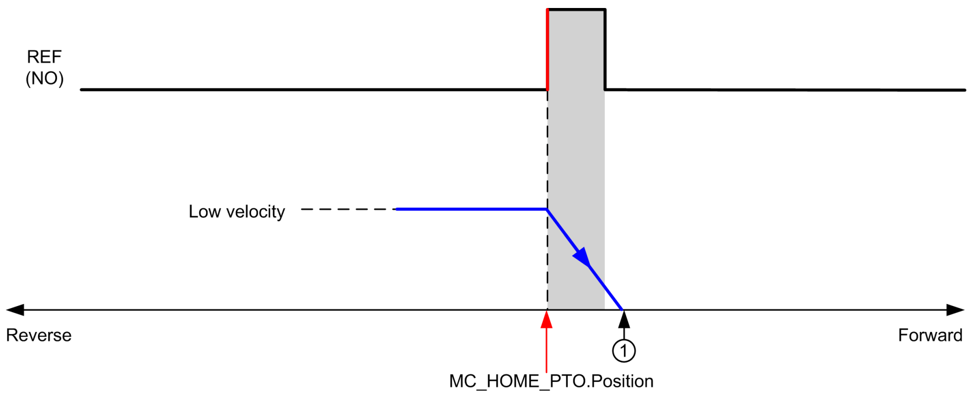
A homing movement can be made using different methods. The M200 PTO channels provide several standard homing movement types:

- position setting, page 242,
- long reference, page 243,
- short reference no reversal, page 244,
- short reference reversal, page 245,
- short reference with INDEX, page 246.

Home Position

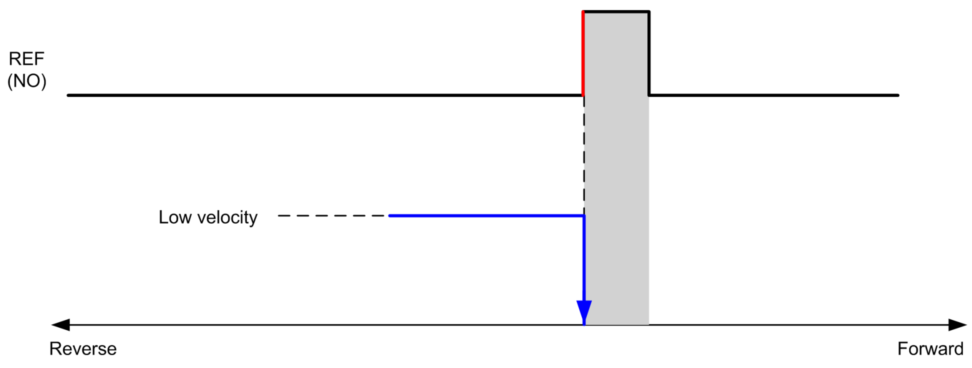
Homing is done with an external switch and the homing position is defined on the switch edge. Then the motion is decelerated until stop.

The actual position of the axis at the end of the motion sequence may therefore differ from the position parameter set on the function block:



REF (NO) Reference point (Normally Open)

To simplify the representation of a stop in the homing mode diagrams, the following presentation is made to represent the actual position of the axis:



REF (NO) Reference point (Normally Open)

Limits

Hardware limits are necessary for the correct functioning of the *MC_Home_PTO* function block (Positioning Limits, page 229 and *MC_Power_PTO*). Depending on the movement type you request with the homing mode, the hardware limits help assure that the end of travel is respected by the function block.

When a homing action is initiated in a direction away from the reference switch, the hardware limits serve to either:

- indicate a reversal of direction is required to move the axis toward the reference switch or,
- indicate that an error has been detected as the reference switch was not found before reaching the end of travel.

For homing movement types that allow for reversal of direction, when the movement reaches the hardware limit the axis stops using the configured deceleration, and resumes motion in a reversed direction.

In homing movement types that do not allow for the reversal of direction, when the movement reaches the hardware limit, the homing procedure is aborted and the axis stops with the Fast stop deceleration.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Ensure that controller hardware limit switches are integrated in the design and logic of your application.
- Mount the controller hardware limit switches in a position that allows for an adequate braking distance.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTE: Adequate braking distance is dependent on the maximum velocity, maximum load (mass) of the equipment being moved, and the value of the Fast stop deceleration parameter.

Position Setting

Description

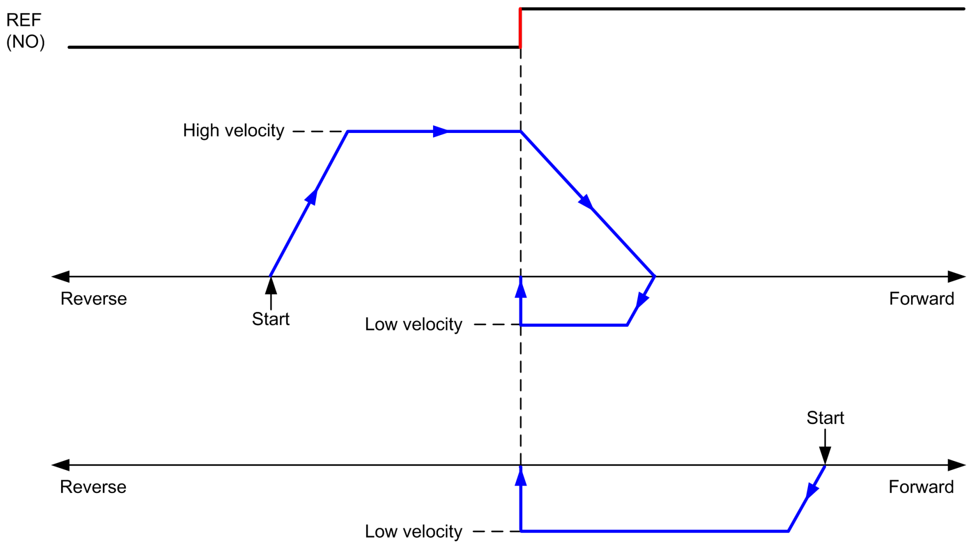
In the case of position setting, the current position is set to the specified position value. No move is performed.

Long Reference

Long Reference: Positive Direction

Homes to the reference switch falling edge in reverse direction.

The initial direction of motion is dependent on the state of the reference switch:

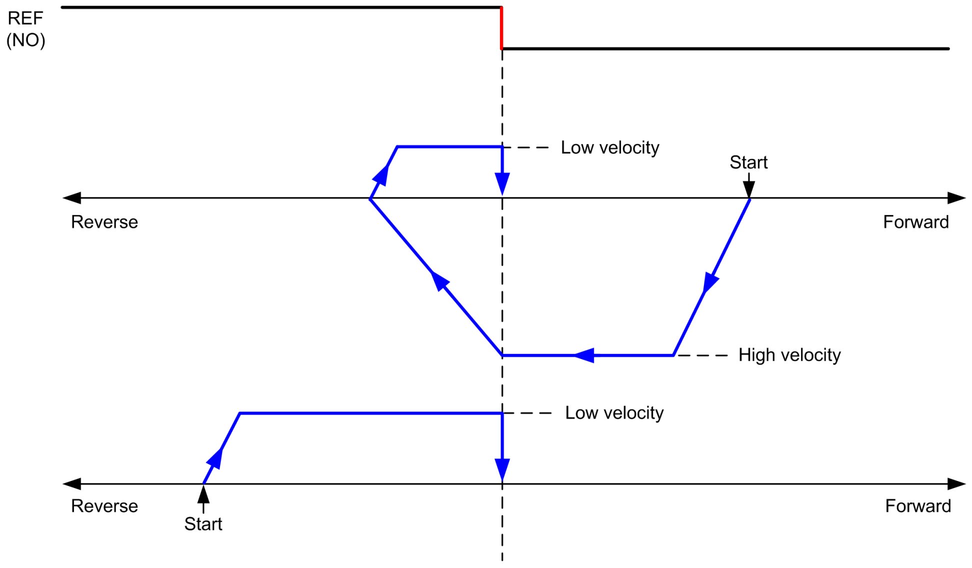


REF (NO) Reference point (Normally Open)

Long Reference: Negative Direction

Homes to the reference switch falling edge in forward direction.

The initial direction of motion is dependent on the state of the reference switch:

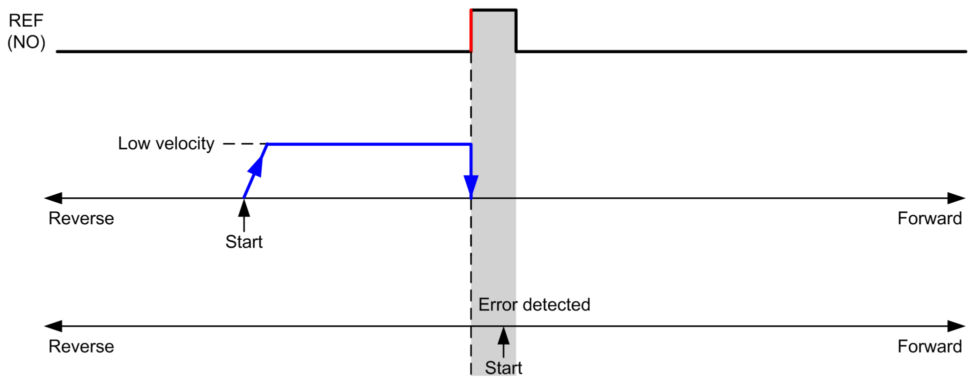


REF (NO) Reference point (Normally Open)

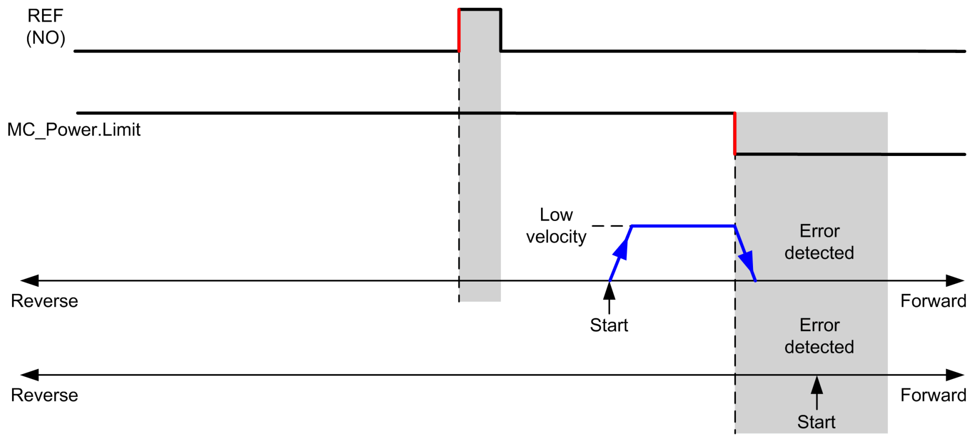
Short Reference No Reversal

Short Reference No Reversal: Positive Direction

Homes at low speed to the reference switch rising edge in forward direction, with no reversal:



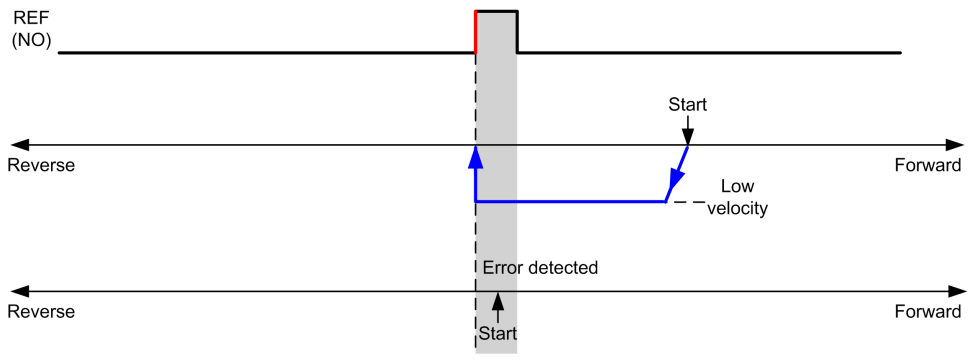
REF (NO) Reference point (Normally Open)



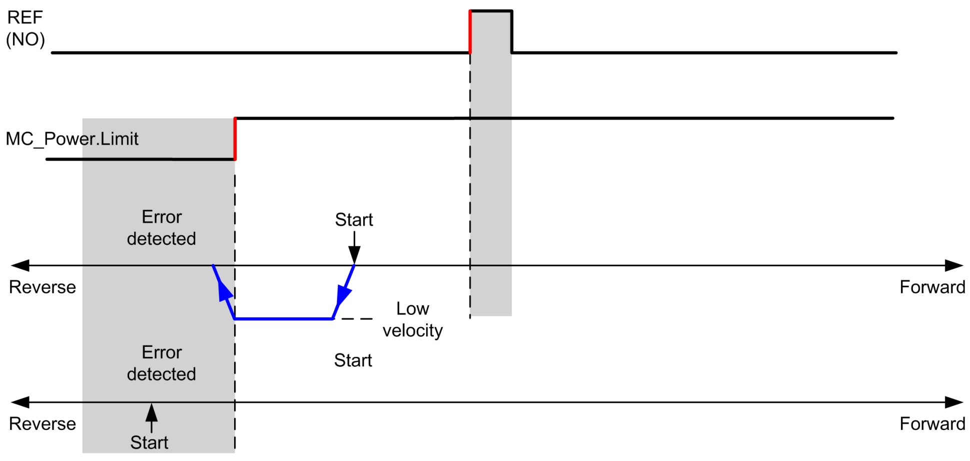
REF (NO) Reference point (Normally Open)

Short Reference No Reversal: Negative Direction

Homes at low speed to the reference switch falling edge in reverse direction, with no reversal:



REF (NO) Reference point (Normally Open)



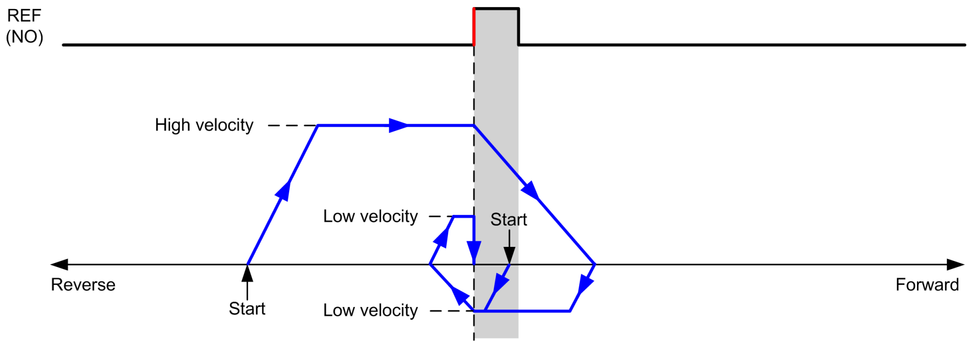
REF (NO) Reference point (Normally Open)

Short Reference Reversal

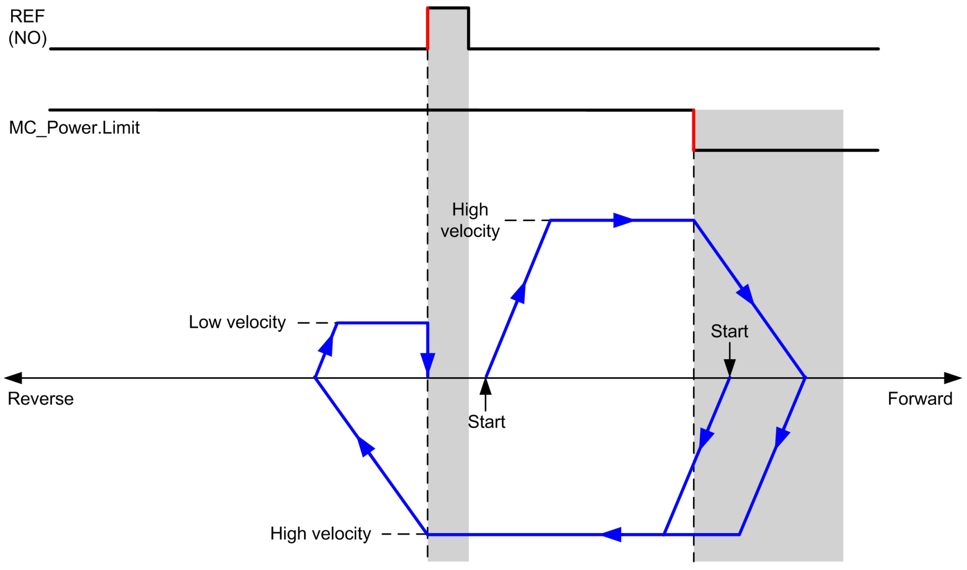
Short Reference Reversal: Positive Direction

Homes to the reference switch rising edge in forward direction.

The initial direction of motion is dependent on the state of the reference switch:



REF (NO) Reference point (Normally Open)

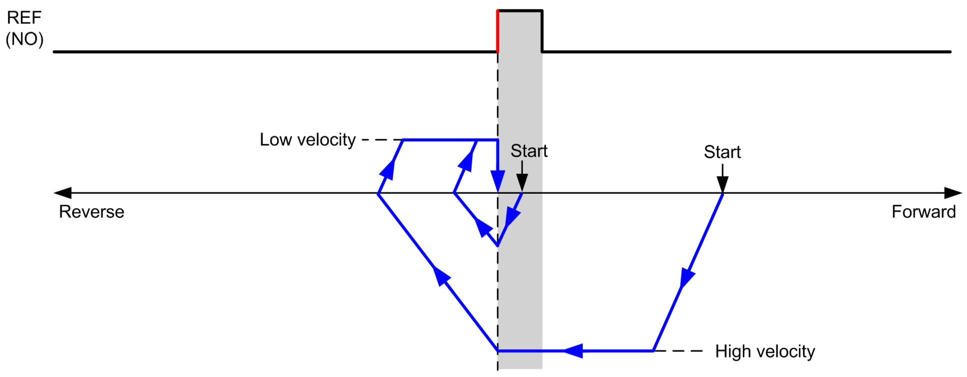


REF (NO) Reference point (Normally Open)

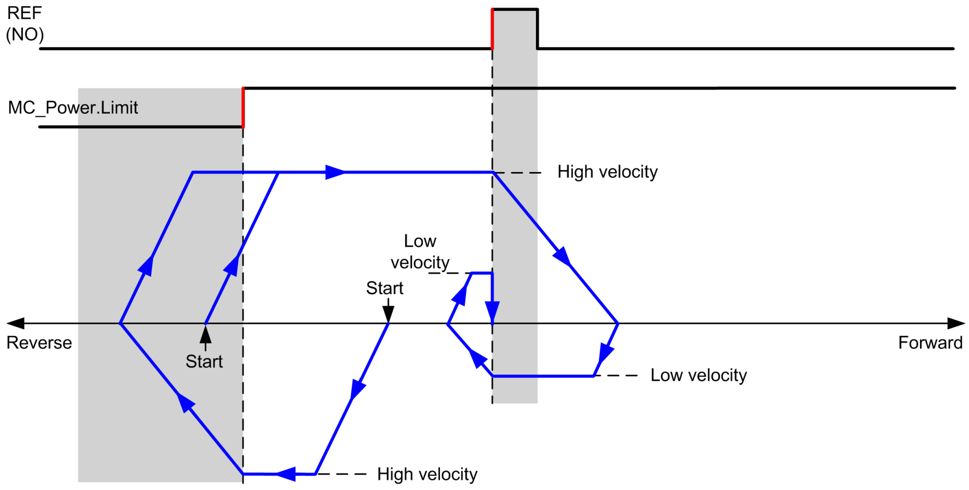
Short Reference Reversal: Negative Direction

Homes to the reference switch rising edge in forward direction.

The initial direction of motion is dependent on the state of the reference switch:



REF (NO) Reference point (Normally Open)



REF (NO) Reference point (Normally Open)

Short Reference with INDEX

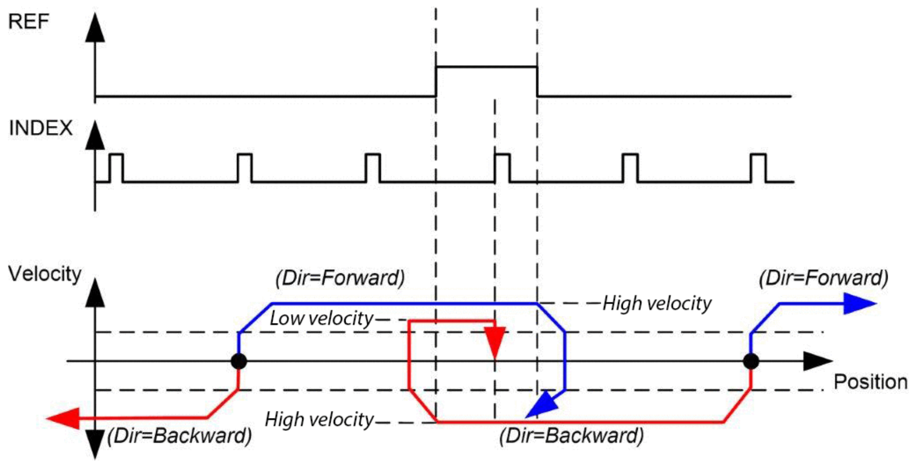
Description

The `PTOHome` and `PTOEnhancedHome` function blocks are used to set the axis to a reference position.

The **Short Reference with INDEX** homing method uses the two homing-specific inputs:

- The **REF** input, used as the positive limit signal: On the rising edge of the signal (negative side), the axis must change direction.
- The **INDEX** input, used as the zero marker signal (Z)

The following diagram illustrates the **Short Reference with INDEX** homing method:



Error Detection

When the **REF** input is enabled, an error is reported in the `LIMIT_FLT` status object when the limit is crossed.

Home Offset

Description

If the origin cannot be defined by switches with enough accuracy, it is possible to make the axis move to a specific position away from the origin switch. Home offset allows making a difference between mechanical origin and electrical origin.

Home offset is set in number of pulses (-2,147,483,648...2,147,483,647, default value 0). When set by configuration, the *MC_Home_PTO* command is executed first, and then the specified number of pulses is output at the home low velocity in the specified direction.

NOTE: The *MC_Home_PTO* command busy flag is only released after origin offset has been completed.

Data Parameters

Overview

This section describes the data parameters of the *PTO* function.

Function Block Object Codes

Direction

This table lists the values for the direction function block object codes:

Name	Value	Description
`mcPositiveDirection`	1	CW, forward, positive (according to **Output Mode** configuration setting).
`mcNegativeDirection`	-1	CCW, backward, reverse, negative (according to **Output Mode** configuration setting).

Buffer Modes

This table lists the values for the buffer modes function block object codes:

Name	Value	Description
`mcAborting`	0	Start FB immediately (default mode). Any ongoing motion is aborted. The move queue is cleared.
`mcBuffered`	1	Start FB after current motion has finished (`Done` or `InVel` bit is set to TRUE). There is no blending.
`mcBlendingPrevious`	3	The velocity is blended with the velocity of the first FB (blending with the velocity of `FB1` at end-position of `FB1`).
`seTrigger`	10	Start FB immediately when an event on the Probe input is detected. Any ongoing motion is aborted. The move queue is cleared.
`seBufferedDelay`	11	Start FB after current motion has finished (`Done` or `InVel` output is set to TRUE) and the time delay has elapsed. There is no blending. The `Delay` parameter is set using *MC_WritePar_PTO*, page 289, with `ParameterNumber` 1000.

Homing Modes

This table lists the values for the homing modes function block object codes:

Name	Value	Description
`PositionSetting`	0	Position.
`LongReference`	1	Long reference.
`ShortReference_Reversal`	20	Short reference.
`ShortReference_NoReversal`	21	Short reference no reversal.
`ShortReference_with_INDEX`	22	Short reference with INDEX.

PTO Parameter

This table lists the values for the PTO parameters function block object codes:

Name	Parameter Number	R/W	Description
`CommandedPosition`	1	R	Commanded position.
`SWLimitPos` (**High Limit**)	2	R/W	Positive software position limit.
`SWLimitNeg` (**Low Limit**)	3	R/W	Negative software position limit.
`EnableLimitPos` (**Enable the Software Position Limits**)	4	R/W	Enable positive software limit switch (0...1).

Name	Parameter Number	R/W	Description
`EnableLimitNeg` (**Enable the Software Position Limits**)	5	R/W	Enable negative software limit switch (0...1).
`MaxVelocityAppl` (**Max. Velocity**)	9	R/W	Maximal allowed velocity of the axis in the application (0...100,000).
`ActualVelocity`	10	R	Velocity of the axis.
`CommandedVelocity`	11	R	Commanded velocity.
`MaxAccelerationAppl` (**Max. acc.**)	13	R/W	Maximal allowed acceleration of the axis in the application (0...100,000).
`MaxDecelerationAppl` (**Max. dec.**)	15	R/W	Maximal allowed deceleration of the axis in the application (0...100,000).
Reserved	16 to 999	-	Reserved for the PLCopen standard.
`Delay`	1000	R/W	Time in ms (0...65,535) Default value: 0
`EnableDirPos`	1004	R/W	Enable positive direction. When value = 0, the positive direction is not allowed on the axis. A move function block that would generate a move in a positive direction ends with `InvalidDirectionValue` error detected (3006). If there is an ongoing movement in the negative direction, and if it is interrupted by a new move command in the positive direction, the error will be detected only at the end of the deceleration of the ongoing negative movement. Defaut value: 1 **NOTE:** A value change is only taken into account at the next move command or the next occurence of velocity = 0.
`EnableDirNeg`	1005	R/W	Enable negative direction. When value = 0, the negative direction is not allowed on the axis. A move function block that would generate a move in a negative direction ends with `InvalidDirectionValue` error detected (3006). If there is an ongoing movement in the positive direction, and if it is interrupted by a new move command in the negative direction, the error will be detected only at the end of the deceleration of the ongoing positive movement. Defaut value: 1 **NOTE:** A value change is only taken into account at the next move command or the next occurence of velocity = 0.

PTO Axis Error Codes

This table lists the values for the PTO axis error codes:

Name	Value	Description
`NoError`	0	No error detected.
Axis Control Alerts		
`InternalError`	1000	Motion controller internal error detected.

Name	Value	Description
`DisabledAxis`	1001	The move could not be started or has been aborted because the axis is not ready.
`HwPositionLimitP`	1002	Hardware positive position limit *limP* exceeded.
`HwPositionLimitN`	1003	Hardware negative position limit *limN* exceeded.
`SwPositionLimitP`	1004	Software positive position limit exceeded.
`SwPositionLimitN`	1005	Software negative position limit exceeded.
`ApplicationStopped`	1006	Application execution has been stoppped (controller in *STOPPED* or *HALT* state).
`OutputProtection`	1007	Short-circuit output protection is active on the PTO channels. Refer to the description of *%S10* and *%SW139* in system bits, page 322 and system words, page 327.
Axis Control Advisories		
`WarningVelocityValue`	1100	Commanded Velocity parameter is out of range, therefore velocity is limited to the configured maximum velocity.
`WarningAccelerationValue`	1101	Commanded Acceleration parameter is out of range, therefore acceleration is limited to the configured maximum acceleration.
`WarningDecelerationValue`	1102	Commanded Deceleration parameter is out of range, therefore deceleration is limited to the configured maximum deceleration.
`WarningJerkRatioValue`	1103	Commanded jerk ratio parameter is limited by the configured maximum acceleration or deceleration. In this case, the jerk ratio is recalculated to respect these maximums.

An **Axis Control Alert** switches the axis in **ErrorStop** state (*MC_Reset_PTO* is mandatory to get out of **ErrorStop** state). The resulting axis status is reflected by *MC_ReadSts_PTO* and *MC_ReadAxisError_PTO*.

PTO Motion Command Error Codes

This table lists the values for the PTO motion command error codes:

Name	Value	Description
`NoError`	0	No error detected.
Motion State Advisory Alerts		
`ErrorStopActive`	2000	The move could not be started or has been aborted because motion is prohibited by an **ErrorStop** condition.
`StoppingActive`	2001	The move could not be started because motion is prohibited by *MC_Stop_PTO* having control of the axis (either the axis is stopping, or `MC_Stop_PTO.Execute` input is held TRUE).
`InvalidTransition`	2002	Transition not allowed, refer to the Motion State Diagram, page 252.
`InvalidSetPosition`	2003	*MC_SetPos_PTO* cannot be executed while the axis is moving.
`HomingError`	2004	Homing sequence cannot start on reference cam in this mode.
`InvalidProbeConf`	2005	The Probe input must be configured.
`InvalidHomingConf`	2006	The Ref input must be configured for this homing mode.
`InvalidAbsolute`	2007	An absolute move cannot be executed while the axis is not successfully homed to an origin position. A homing sequence must be executed first (*MC_Home_PTO*).

Name	Value	Description
`MotionQueueFull`	2008	The move could not be buffered because the motion queue is full.
`InvalidTransitionMotion-Task`	2009	The motion task and the other motion function blocks linked to the same axis cannot be executed concurrently.
Range Advisory Alerts		
`InvalidAxis`	3000	The function block is not applicable for the specified axis.
`InvalidPositionValue`	3001	Position parameter is out of limits, or distance parameter gives an out of limits position.
`InvalidVelocityValue`	3002	Velocity parameter is out of range.
`InvalidAccelerationValue`	3003	Acceleration parameter is out of range.
`InvalidDecelerationValue`	3004	Deceleration parameter is out of range.
`InvalidBufferModeValue`	3005	Buffer mode does not correspond to a valid value.
`InvalidDirectionValue`	3006	Direction does not correspond to a valid value, or direction is invalid due to software position limit exceeded.
`InvalidHomeMode`	3007	Homing mode is not applicable.
`InvalidParameter`	3008	The parameter number does not exist for the specified axis.
`InvalidParameterValue`	3009	Parameter value is out of range.
`ReadOnlyParameter`	3010	Parameter is read-only.
`InvalidStepMotionTask`	3011	Motion task step type is not defined.

A **Motion State Alert** or a **Range Alert** does not affect the axis state, nor any move currently executing, nor the move queue. In this case, the error is only local to the applicable function block: the `Error` output is set to TRUE, and the `ErrorId` object output is set to the appropriate PTO motion command error code.

Operation Modes

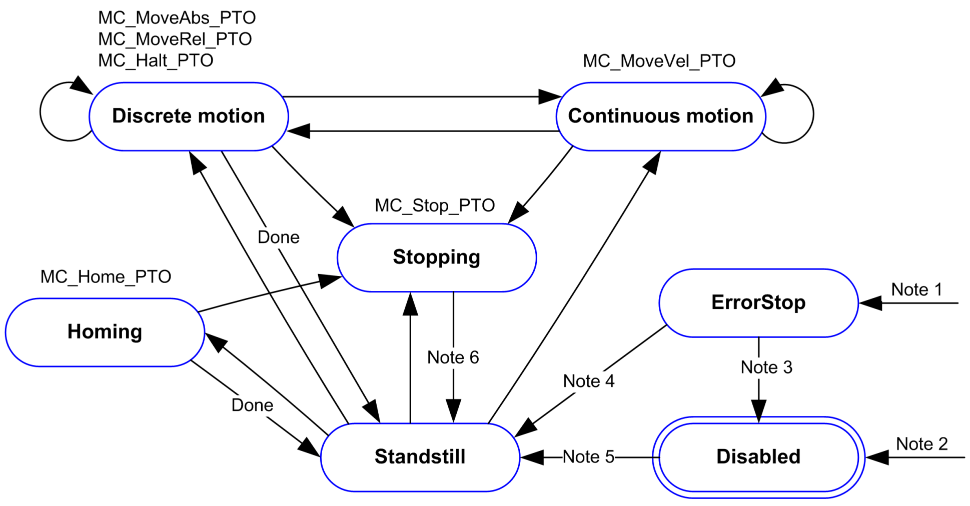
Overview

This section describes the operation modes.

Motion State Diagram

State Diagram

The axis is always in one of the defined states in this diagram:



Note 1 From any state, when an error is detected.

Note 2 From any state except *ErrorStop*, when `%MC_Power_PTO.Status` = FALSE.

Note 3 `%MC_Reset_PTO.Done` = TRUE and `%MC_Power_PTO.Status` = FALSE.

Note 4 `%MC_Reset_PTO.Done` = TRUE and `%MC_Power_PTO.Status` = TRUE.

Note 5 `%MC_Power_PTO.Status` = TRUE.

Note 6 `%MC_Stop_PTO.Done` = TRUE and `%MC_Stop_PTO.Execute` = FALSE.

The table describes the axis states:

State	Description
`Disabled`	Initial state of the axis, no motion command is allowed. The axis is not homed.
`Standstill`	Power is on, no error is detected, and no motion commands are active on the axis. Motion command is allowed.
`ErrorStop`	Highest priority, applicable when an error is detected on the axis or in the controller. Any ongoing move is aborted by a **Fast Stop Deceleration**. `Error` output is set to TRUE on applicable function blocks, and an `ErrorId` sets the error code. As long as an error is pending, the state remains *ErrorStop*. No further motion command is accepted until a reset has been done using *MC_Reset_PTO*.
`Homing`	Applicable when *MC_Home_PTO* controls the axis.
`Discrete`	Applicable when *MC_MoveRel_PTO*, *MC_MoveAbs_PTO*, or *MC_Halt_PTO* controls the axis.
`Continuous`	Applicable when *MC_MoveVel_PTO* controls the axis.
`Stopping`	Applicable when *MC_Stop_PTO* controls the axis.

NOTE: Function blocks which are not listed in the state diagram do not affect a change of state of the axis.

The entire motion command including acceleration and deceleration ramps cannot exceed 4,294,967,295 pulses. At the maximum frequency of 100 kHz, the acceleration and deceleration ramps are limited to 80 seconds.

Motion Transition Table

The PTO channel can respond to a new command while executing (and before completing) the current command according to the following table:

Command		**Next**					
		Home	**MoveVel**	**MoveRel**	**MoveAbs**	**Halt**	**Stop**
Current	**Standstill**	Allowed	Allowed (1)	Allowed (1)	Allowed (1)	Allowed	Allowed
	Home	Rejected	Rejected	Rejected	Rejected	Rejected	Allowed
	MoveVel	Rejected	Allowed	Allowed	Allowed	Allowed	Allowed
	MoveRel	Rejected	Allowed	Allowed	Allowed	Allowed	Allowed
	MoveAbs	Rejected	Allowed	Allowed	Allowed	Allowed	Allowed
	Halt	Rejected	Allowed	Allowed	Allowed	Allowed	Allowed
	Stop	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected

(1) When the axis is at standstill, for the buffer modes `mcAborting/mcBuffered/mcBlendingPrevious`, the move starts immediately.

Allowed the new command begins execution even if the previous command has not completed execution.

Rejected the new command is ignored and results in the declaration of an error.

NOTE: When an error is detected in the motion transition, the axis goes into **ErrorStop** state. The `ErrorId` is set to `InvalidTransition`.

Buffer Mode

Description

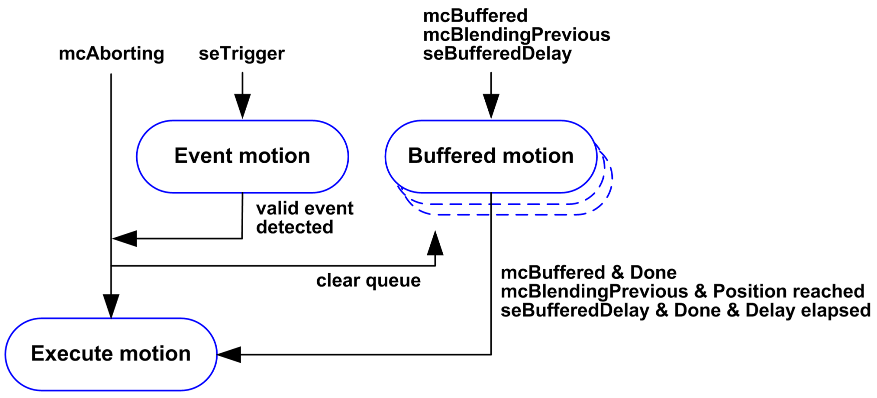
Some of the motion function blocks have an input object called `BufferMode`. With this input object, the function block can either start immediately, start on probe event, or be buffered.

The available options are defined in the buffer modes function block object codes, page 247:

- An aborting motion (`mcAborting`) starts immediately, aborting any ongoing move, and clearing the motion queue.
- An event motion (`seTrigger`) is an aborting move, starting on probe event, page 227.
- A buffered motion (`mcBuffered`, `mcBlendingPrevious`, `seBufferedDelay`) is queued, that is, appended to any moves currently executing or waiting to execute, and starts when the previous motion is done.

Motion Queue Diagram

The figure illustrates the motion queue diagram:



The buffer can contain only one motion function block.

The execution condition of the motion function block present in the buffer is:

- `mcBuffered`: when the current continuous motion is `InVel`, or when the current discrete motion stops.
- `seBufferedDelay`: when the specified delay has elapsed, from the current continuous motion is `InVel`, or from the current discrete motion stops.
- `mcBlendingPrevious`: when the position and velocity targets of current function block are reached.

The motion queue is cleared (all buffered motions are deleted):

- When an aborting move is triggered (`mcAborting` or `seTrigger`): `CmdAborted` output is set to TRUE on buffered function blocks.
- When a *MC_Stop_PTO* function is executed: `Error` output is set to TRUE on cleared buffered function blocks, with `ErrorId=StoppingActive, page 250`.
- When a transition to **ErrorStop** state is detected: `Error` output is set to TRUE on buffered function blocks, with `ErrorId=ErrorStopActive, page 250`.

NOTE:

- Only a valid motion can be queued. If the function block execution terminates with the `Error` output set to TRUE, the move is not queued, any move currently executing is not affected, and the queue is not cleared.
- When the queue is already full, the `Error` output is set to TRUE on the applicable function block, and `ErrorId` output returns the error `MotionQueueFull, page 250`.

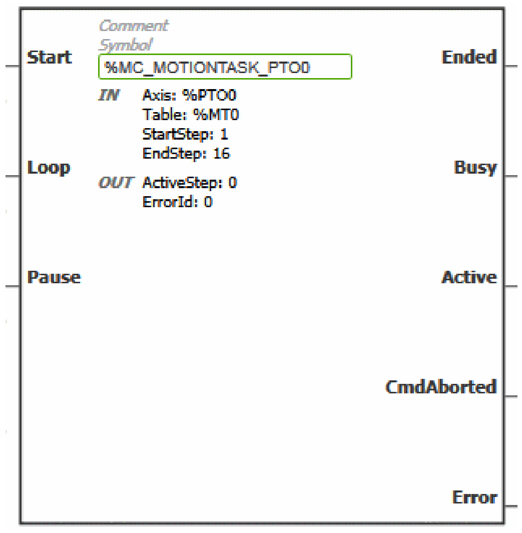
Motion Function Blocks

Overview

This section describes the **Motion** function blocks.

MC_MotionTask_PTO Function Block

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis and motion task table. Double-click the function block to display the function block properties, choose the axis and table, then click `Apply`.

Inputs

This table describes the inputs of the function block:

Input	Initial Value	Description
`Start`	FALSE	On rising edge, starts the function block execution. The `Loop` and `Pause` inputs can be changed during the function block execution and they affect the ongoing execution. The `Axis`, `Table`, `StartStep`, and `EndStep` input objects values define the motion sequence when the rising edge occurs. A subsequent change in these input objects does not affect the ongoing execution. The outputs are set when the function block execution terminates. When FALSE: • When the execution is ongoing (move is *Busy* and *Active*), outputs are refreshed. • When the execution is terminated, the outputs are reset one cycle later.
`Loop`	FALSE	When TRUE, once the function block execution terminates with no detected error, the motion task sequence starts again on *StartStep*. The `Ended` output is set for one cycle. The input is tested when the function block execution terminates with no detected error (*Ended* output is true).
`Pause`	FALSE	When TRUE: • *Active* = 1 and *Busy* = 1 • Forces the axis to the **Halt** state. To reach the **Halt** state, the axis is decelerating in **Discrete motion** state, then the axis goes to the **Standstill** state when velocity = 0. • The **Halt** state is kept as long as the *Pause* input is TRUE. • Keeps the `Active` output set even if velocity is equal to 0. When reset to FALSE after being set to TRUE, the motion task execution resumes in the following conditions: • The motion task resumes with the value of the ongoing velocity. • The active step parameters are used. • The absolute target position is not changed. If the motion task is a move relative type, there is no distance added. • In the step, the **Next step** condition is reset (for example: the delay is restarted from 0, *Probe input event* is enabled and waiting for the configured edge).

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	%PTOx	–	PTO axis instance for which the function block is to be executed. The parameter is set in the function block instance reached in the **Programming > Tools** module tab. Select the **Axis** parameter in **PTO objects > Motion > MC_MotionTask_PTO > MC_MotionTask_PTO_properties** dialog box.
`Table`	%MT	–	Table instance for which the function block is to be executed. The parameter is set in the function block instance reached in the **Programming > Tools** module tab. Select the **Table** parameter in **PTO objects > Motion > MC_MotionTask_PTO > MC_MotionTask_PTO_properties** dialog box.

Input Object	Type	Initial Value	Description
StartStep	Byte	1	Step number that defines the first step executed in the Motion Task Table. The sequence is executed from StartStep to EndStep. Restriction: StartStep ≤ EndStep.
EndStep	Byte	16	Step number that defines the last step executed in the Motion Task Table. The sequence is executed from StartStep to EndStep. Restriction: StartStep ≤ EndStep. **NOTE:** If EndStep is greater than the maximum number of steps defined in the Motion Task Table, the last step of the table is used.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
Ended	0	When TRUE, function block execution is finished with no error detected. Ended output behavior: • If the last step of the motion sequence is a **discrete** movement, the output behaves like a Done output, the other outputs (Busy, Active, CmdAborted, Error) are reset to 0. • If the last step of the motion sequence is a **continuous** movement (move velocity), the output behaves like an InVel output. Other outputs behavior: ◦ Busy and Active are TRUE (1). ◦ CmdAborted and Error are FALSE (0). If a loop is requested (Loop input), the Ended output is TRUE for one task cycle.
Busy	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated.
Active	-	When TRUE, the function block instance has control of the axis. Only one function block at a time can set Active TRUE for the same axis.
CmdAborted	-	When TRUE, function block execution is terminated due to another motion command (MC_Stop_PTO) or an axis error detected.
Error	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output objects of the function block:

Output Object	Type	Initial Value	Description
ActiveStep	Byte	0	Number of the step that is being executed in the Motion Task Table.
ErrorId	Word	*NoError*	Motion command error codes, valid when Error output is TRUE. Refer to PTO motion command error code table, page 250.

Operating Modes

MC_MotionTask_PTO start: The function block can only be started from **Standstill** state.

MC_MotionTask_PTO stop: The function block can be stopped by one of the following actions:

- Setting `Pause` input to TRUE.
- Executing a *MC_Stop_PTO*

The execution of the steps in the motion task follows the same rules and restrictions as each single-axis function block. Generally, in case of detected errors the function block behaves as follows:

- If a motion state or range error is detected during the function block execution:
  - A motion stop command is applied to the motion task using the current step deceleration parameter value. If the step deceleration parameter is not valid, a fast stop deceleration is applied.
  - During the controlled motion stop, the function block outputs `Active` and `Busy` remain TRUE, with the output object `ActiveStep` = 0.
  - Once the motion is stopped, the function block execution is finished with `Error` = 1, and the `ErrorId` output object set to the value corresponding to the detected error type.
- If an axis control error is detected, the axis switches to the **Stopping** state. The function block execution is finished with `Error` = 1, and the `ErrorId` output object set to the value corresponding to the detected error type.

MC_Power_PTO Function Block

Behavior

The axis is disabled, when:

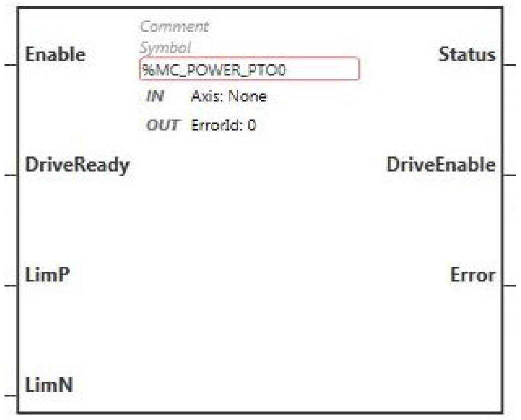
- *%MC_Power_PTO.Enable* = FALSE, or
- *%MC_Power_PTO.DriveReady* = FALSE, or
- an Hardware limit error is detected (*HwPositionLimitP* / *HwPositionLimitN*)

When the axis is disabled, then:

- the Axis switches from *Standstill* to *Disabled* state, or

  from any ongoing move, to *ErrorStop*, and then *Disabled* state (when the error is reset).
- *%MC_ReadSts_PTO.IsHomed* is reset to 0 (a new homing procedure is required).

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the inputs of the function block:

Input	Initial Value	Description
`Enable`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.
`Drive-Ready`	FALSE	Signal from the drive indicating its readiness. Is set to TRUE when the drive is ready to start executing motion. If the drive signal is connected to the controller, use the appropriate controller input. If the drive does not provide this signal, you can force the value TRUE for this input with any TRUE boolean value.
`LimP`	TRUE	Hardware limit switch information, in positive direction. Is set to FALSE when the hardware limit switch is reached. If the hardware limit switch signal is connected to the controller, use the appropriate controller input. If this signal is not available, you can force the value TRUE for this input with any TRUE boolean value.
`LimN`	TRUE	Hardware limit switch information, in negative direction. Is set to FALSE when the hardware limit switch is reached. If the hardware limit switch signal is connected to the controller, use the appropriate controller input. If this signal is not available, you can force the value TRUE for this input with any TRUE boolean value.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

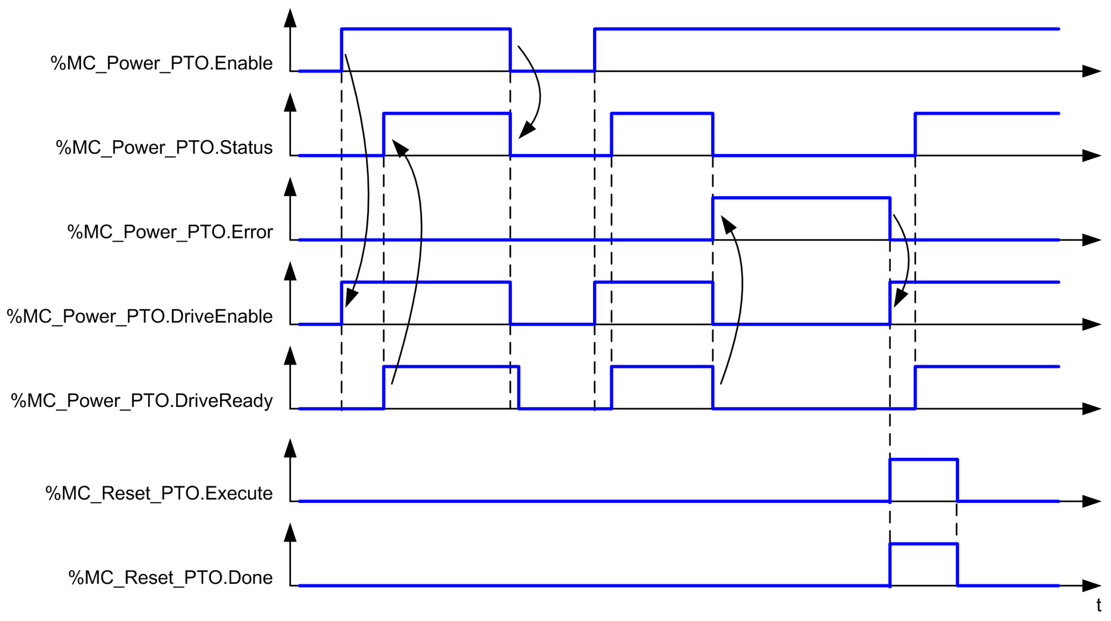
Output	Initial Value	Description
`Status`	FALSE	When TRUE, the drive is reported as ready to accept motion commands.
`DriveEna-ble`	FALSE	When TRUE, indicates to the drive that it can accept motion commands and that it should, therefore, enable power. If the drive input is connected to the controller, use the appropriate controller output. If the drive does not have an input for this signal, you can leave this function block output unused.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

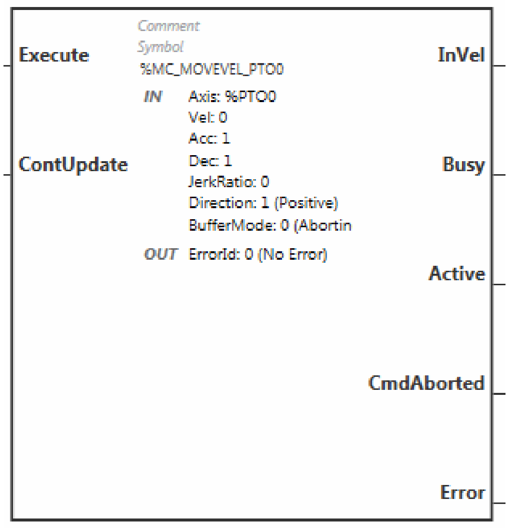
Timing Diagram Example

The diagram illustrates the operation of the *MC_Power_PTO* function block:



MC_MoveVel_PTO Function Block

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the inputs of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution unless the `ContUpdate` input is TRUE. The outputs are set when the function block terminates. If a second rising edge is detected during the execution of the function block, the current execution is aborted and the function block is executed again.
`ContUp-date`	FALSE	When TRUE, makes the function block use any modified values of the input objects (`Vel`, `Acc`, `Dec`, and `Direction`), and apply it to the ongoing command. This input must be TRUE prior to the rising edge on the `Execute` input to be taken into account. **NOTE:** A modification to the value of the *Axis* parameter is not taken into account. You must set *Execute* to 0 and then to 1 to change the *Axis*.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`Vel`	DINT	0	Target velocity. Range Hz: 0...`MaxVelocityAppl, page 248`
`Acc`	DINT	0	Acceleration in Hz/ms

Input Object	Type	Initial Value	Description
			Range (Hz/ms): 1...MaxAccelerationAppl, page 248
Dec	DINT	0	Deceleration in Hz/ms Range (Hz/ms): 1...MaxDecelerationAppl, page 248
JerkRatio	INT	0	Percentage of acceleration / deceleration adjustment used to create the S-curve profile, page 226. Range: 0…100
Direction	INT	mcPo-siti-veDir-ection	Direction of the movement for PTO type CW/CCW forward (CW) = 1 (mcPositiveDirection) reverse (CCW) = -1 (mcNegativeDirection)
Buffer-Mode	INT	mcA-bort-ing	Transition mode from ongoing move. Refer to Buffer Modes table, page 248.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
InVel	FALSE	When TRUE, the target velocity has been reached.
Busy	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as Busy is TRUE.
Active	-	When TRUE, the function block instance has control of the axis. Only one function block at a time can set Active TRUE for the same axis.
CmdAborted	-	When TRUE, function block execution is terminated due to another motion command.
Error	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

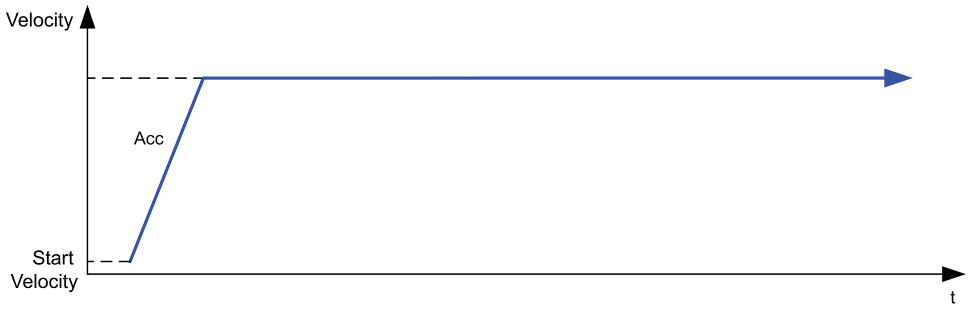
Output Object	Type	Initial Value	Description
ErrorId	Word	*NoError*	Motion command error codes, valid when Error output is TRUE. Refer to PTO motion command error code table, page 250.

NOTE:

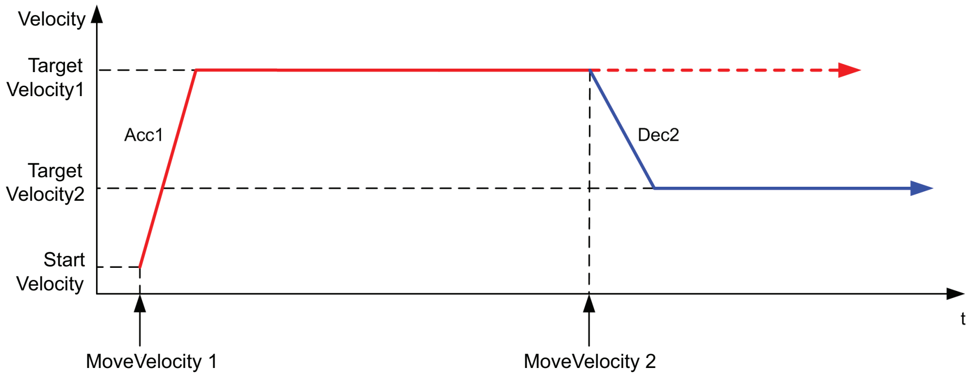
- To stop the motion, the function block has to be interrupted by another function block issuing a new command.
- If a motion is ongoing, and the direction is reversed, first the motion is halted with the deceleration of the *MC_MoveVel_PTO* function block, and then the motion resumes backward.
- The acceleration/deceleration duration of the segment block must not exceed 80 seconds.

Timing Diagram Example

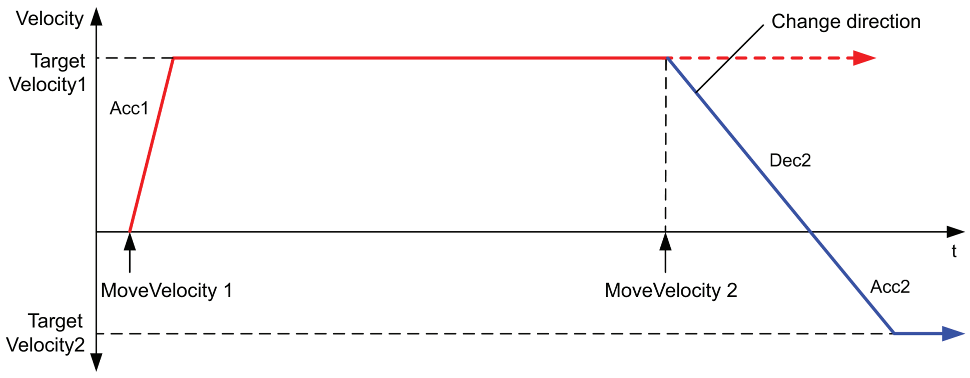
The diagram illustrates a simple profile from **Standstill** state:



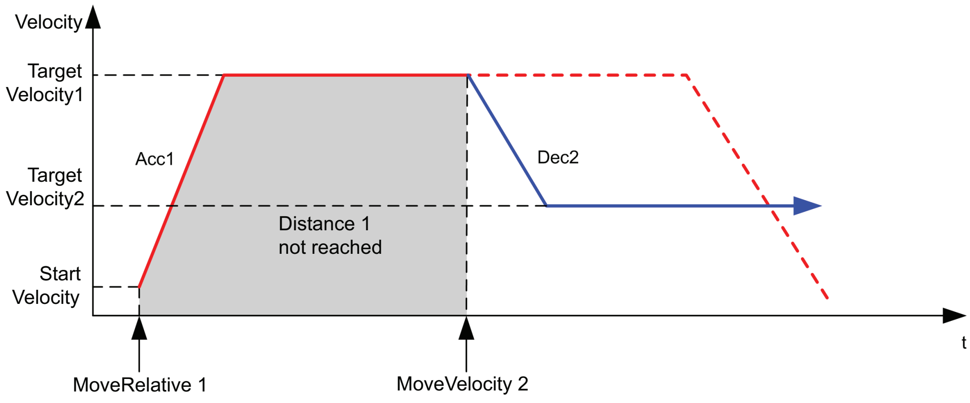
The diagram illustrates a complex profile from **Continuous** state:



The diagram illustrates a complex profile from **Continuous** state with change of direction:

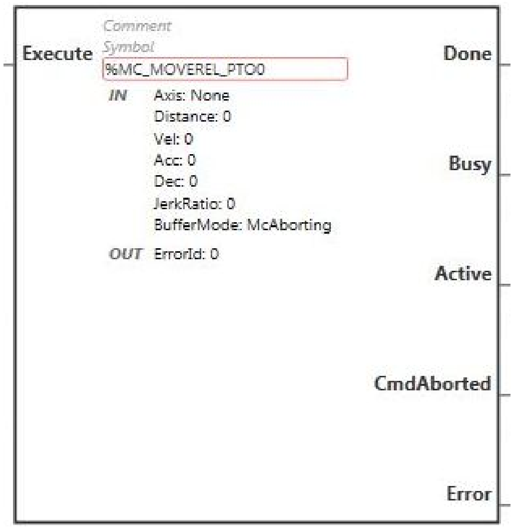


The diagram illustrates a complex profile from **Discrete** state:



MC_MoveRel_PTO Function Block

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`Distance`	DINT	0	Relative distance for the motion, in pulses. The sign specifies the direction.
`Vel`	DINT	0	Target velocity. Range Hz: 0...`MaxVelocityAppl`, page 248
`Acc`	DINT	0	Acceleration in Hz/ms Range (Hz/ms): 1...`MaxAccelerationAppl`, page 248
`Dec`	DINT	0	Deceleration in Hz/ms Range (Hz/ms): 1...`MaxDecelerationAppl`, page 248

Input Object	Type	Initial Value	Description
`JerkRatio`	INT	0	Percentage of acceleration / deceleration adjustment used to create the S-curve profile, page 226. Range: 0…100
`Buffer-Mode`	INT	`mcA-bort-ing`	Transition mode from ongoing move. Refer to Buffer Modes table, page 248.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected. When one movement on an axis is interrupted with another movement on the same axis before the commanded action has been completed, `CmdAborted` is set to TRUE and `Done` is set to FALSE.
`Busy`	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as `Busy` is TRUE.
`Active`	-	When TRUE, the function block instance has control of the axis. Only one function block at a time can set `Active` TRUE for the same axis.
`CmdAborted`	-	When TRUE, function block execution is terminated due to another motion command.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

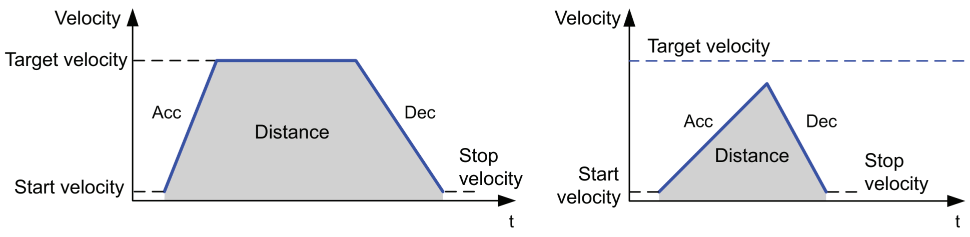
Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

NOTE:

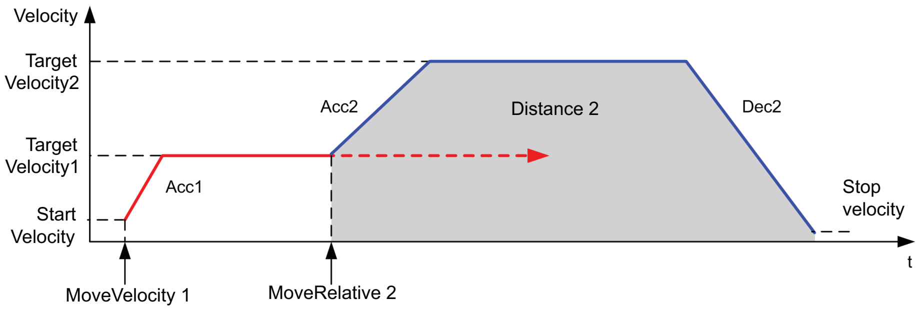
- The function block completes with velocity zero if no further blocks are pending.
- If the distance is too short for the target velocity to be reached, the movement profile is triangular, rather than trapezoidal.
- If a motion is ongoing, and the commanded distance is exceeded due to the current motion parameters, the direction reversal is automatically managed: the motion is first halted with the deceleration of the *MC_MoveRel_PTO* function block, and then the motion resumes backward.
- The acceleration/deceleration duration of the segment block must not exceed 80 seconds.

Timing Diagram Example

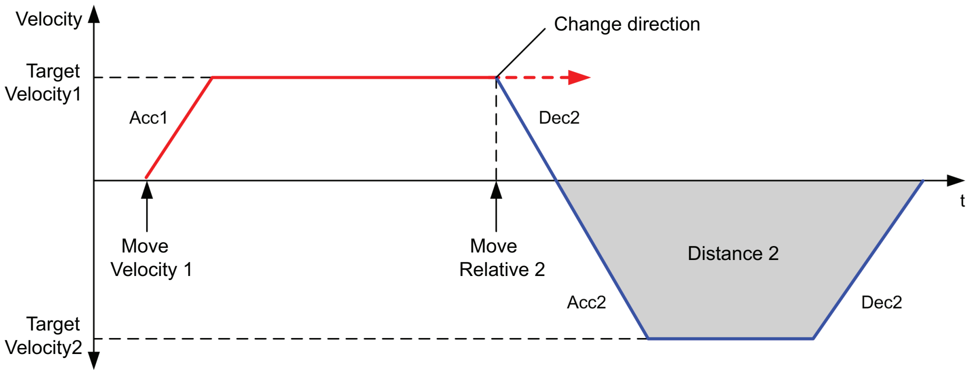
The diagram illustrates a simple profile from **Standstill** state:



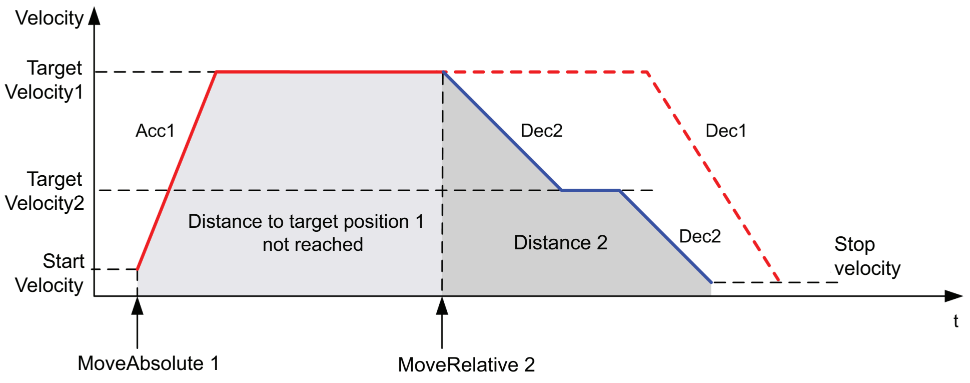
The diagram illustrates a complex profile from **Continuous** state:



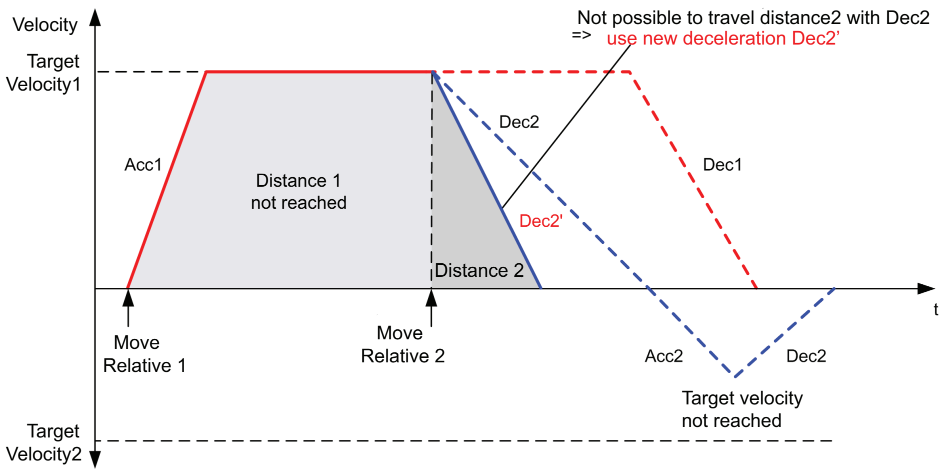
The diagram illustrates a complex profile from **Continuous** state with change of direction:



The diagram illustrates a complex profile from **Discrete** state:

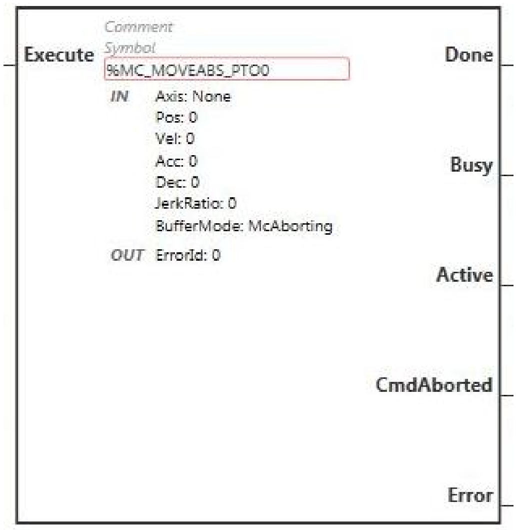


The diagram illustrates a complex profile from **Discrete** state with change of direction:



MC_MoveAbs_PTO Function Block

Graphical Representation



```
%MC_MOVEABS_PTO0
IN   Axis: None
     Pos: 0
     Vel: 0
     Acc: 0
     Dec: 0
     JerkRatio: 0
     BufferMode: McAborting
OUT  ErrorId: 0
```

NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
Axis	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
Pos	DINT	0	Position of the axis.
Vel	DINT	0	Target velocity. Range Hz: 0...MaxVelocityAppl, page 248
Acc	DINT	0	Acceleration in Hz/ms Range (Hz/ms): 1...MaxAccelerationAppl, page 248
Dec	DINT	0	Deceleration in Hz/ms Range (Hz/ms): 1...MaxDecelerationAppl, page 248
JerkRatio	INT	0	Percentage of acceleration / deceleration adjustment used to create the S-curve profile, page 226. Range: 0…100
Buffer-Mode	INT	mcA-bort-ing	Transition mode from ongoing move. Refer to Buffer Modes table, page 248.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
Done	FALSE	When TRUE, function block execution is finished with no error detected. When one movement on an axis is interrupted with another movement on the same axis before the commanded action has been completed, CmdAborted is set to TRUE and Done is set to FALSE.
Busy	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as Busy is TRUE.
Active	-	When TRUE, the function block instance has control of the axis. Only one function block at a time can set Active TRUE for the same axis.
CmdAborted	-	When TRUE, function block execution is terminated due to another motion command.
Error	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

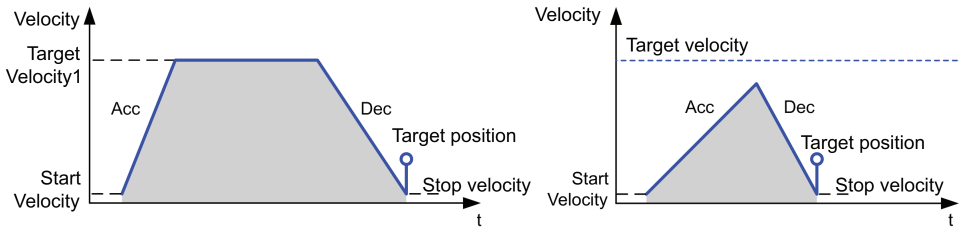
Output Object	Type	Initial Value	Description
ErrorId	Word	*NoError*	Motion command error codes, valid when Error output is TRUE. Refer to PTO motion command error code table, page 250.

NOTE:

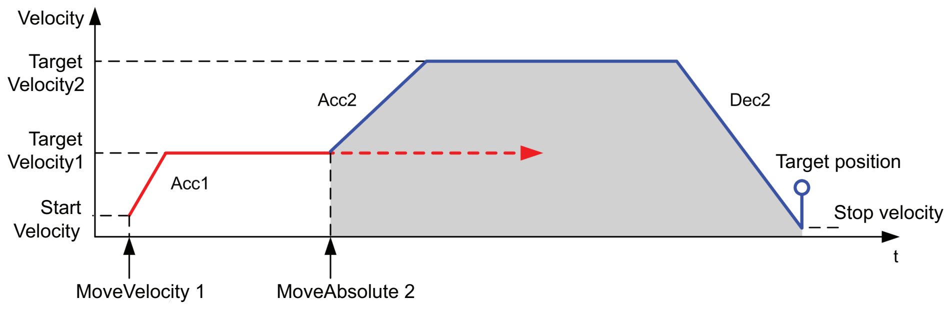
- The function block completes with velocity zero if no further blocks are pending.
- The motion direction is automatically set, according to the current and target positions.
- If the distance is too short for the target velocity to be reached, the movement profile is triangular, rather than trapezoidal.
- If the position cannot be reached with the current direction, the direction reversal is automatically managed. If a motion is ongoing, it is first halted with the deceleration of the *MC_MoveAbsolute_PTO* function block, and then the motion resumes backward.
- The acceleration/deceleration duration of the segment block must not exceed 80 seconds.

Timing Diagram Example

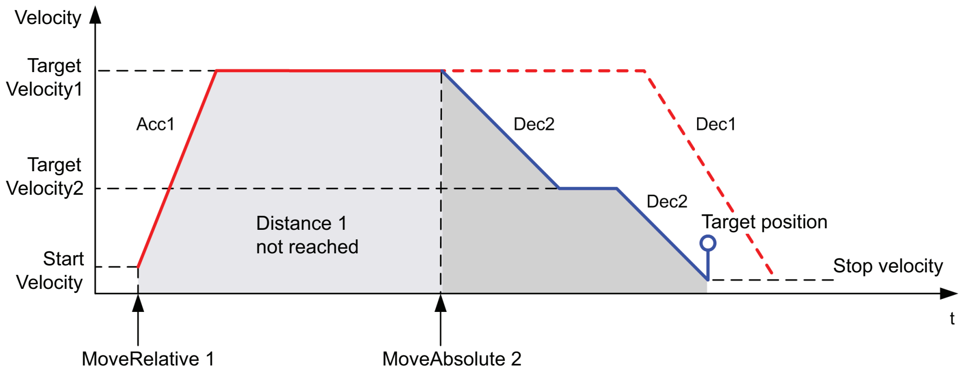
The diagram illustrates a simple profile from **Standstill** state:



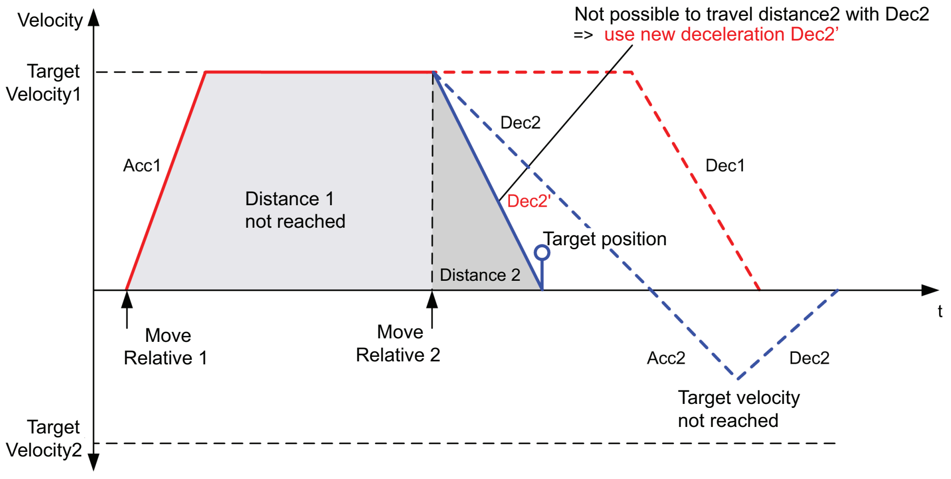
The diagram illustrates a complex profile from **Continuous** state:



The diagram illustrates a complex profile from **Discrete** state:

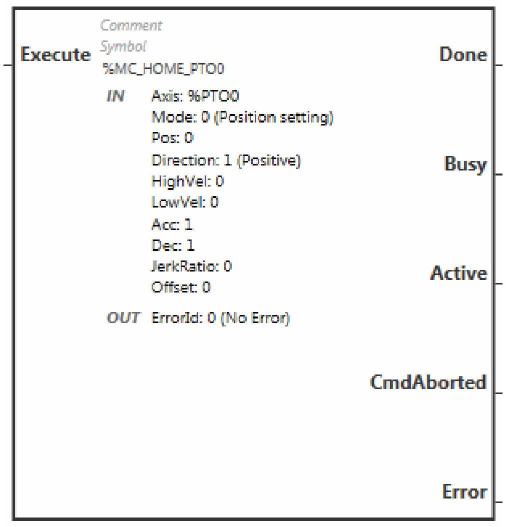


The diagram illustrates a complex profile from **Discrete** state with change of direction:



MC_Home_PTO Function Block

Graphical Representation



Comment
Symbol
%MC_HOME_PTO0
IN Axis: %PTO0
Mode: 0 (Position setting)
Pos: 0
Direction: 1 (Positive)
HighVel: 0
LowVel: 0
Acc: 1
Dec: 1
JerkRatio: 0
Offset: 0
OUT ErrorId: 0 (No Error)

NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
Axis	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
Mode	BYTE	0	Predefined homing sequence type.
Pos	DINT	0	Position of the axis.
HighVel	DINT	0	Target homing velocity for searching the limit or reference switch. Range Hz: 1...MaxVelocityAppl, page 248
LowVel	DINT	0	Target homing velocity for searching the reference switch signal. The movement stops when the limit or reference switch is detected. Range Hz: 1...HighVelocity
Acc	DINT	0	Acceleration in Hz/ms Range (Hz/ms): 1...MaxAccelerationAppl, page 248
Dec	DINT	0	Deceleration in Hz/ms Range (Hz/ms): 1...MaxDecelerationAppl, page 248
JerkRatio	INT	0	Percentage of acceleration / deceleration adjustment used to create the S-curve profile, page 226. Range: 0…100
Direction	INT	mcPo-siti-veDir-ection	Direction of the movement for PTO type CW/CCW forward (CW) = 1 (mcPositiveDirection) reverse (CCW) = -1 (mcNegativeDirection)
Offset	DINT	0	Distance from origin point. When the origin point is reached, the motion resumes until the distance is covered. Direction depends on the sign (Home offset). Range: -2,147,483,648...2,147,483,647

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
Done	FALSE	When TRUE, function block execution is finished with no error detected. When one movement on an axis is interrupted with another movement on the same axis before the commanded action has been completed, CmdAborted is set to TRUE and Done is set to FALSE.
Busy	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as Busy is TRUE.
Active	-	When TRUE, the function block instance has control of the axis. Only one function block at a time can set Active TRUE for the same axis.
CmdAborted	-	When TRUE, function block execution is terminated due to another motion command.
Error	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

NOTE: The acceleration/deceleration duration of the segment block must not exceed 80 seconds.

Timing Diagram Example

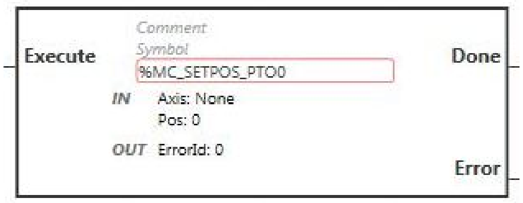
Home modes, page 241

MC_SetPos_PTO Function Block

Behavior

This function block modifies the coordinates of the actual position of the axis without any physical movement. It can only be used when the axis is in a *Standstill* state.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`Pos`	DINT	0	Position of the axis.

Outputs

This table describes the outputs of the function block:

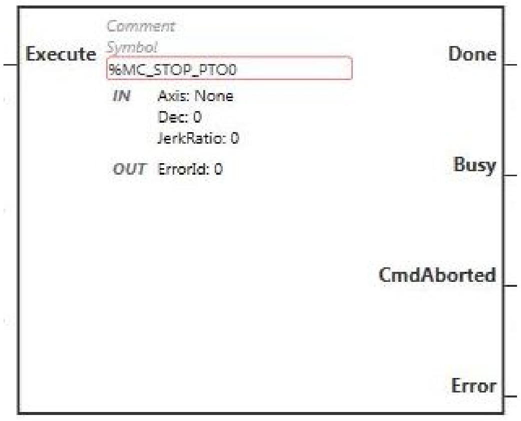
Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_Stop_PTO Function Block

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`Dec`	DINT	0	Deceleration in Hz/ms Range (Hz/ms): 1...`MaxDecelerationAppl`, page 248
`JerkRatio`	INT	0	Percentage of acceleration / deceleration adjustment used to create the S-curve profile, page 226. Range: 0…100

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected. When one movement on an axis is interrupted with another movement on the same axis before the commanded action has been completed, `CmdAborted` is set to TRUE and `Done` is set to FALSE.
`Busy`	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as `Busy` is TRUE.
`CmdAborted`	-	When TRUE, function block execution is terminated due to another motion command.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

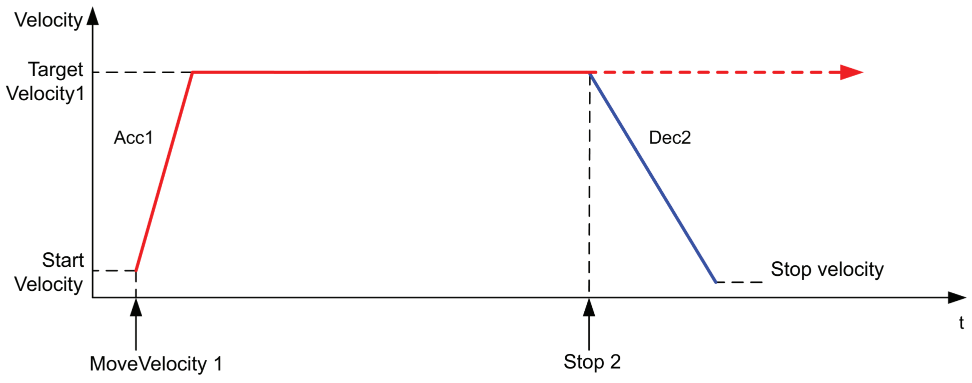
Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

NOTE:

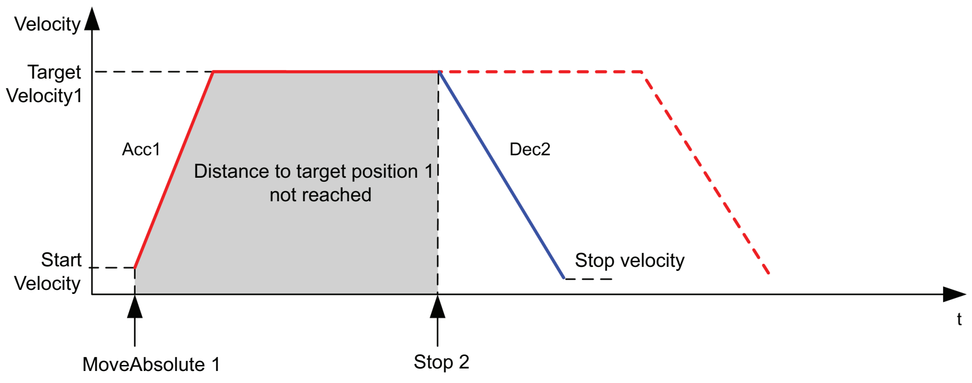
- Calling this function block in state **Standstill** changes the state to **Stopping**, and back to **Standstill** when `Execute` is FALSE.
- The state **Stopping** is kept as long as the input `Execute` is TRUE.
- The `Done` output is set when the stop ramp is finished.
- If `Deceleration` = 0, the fast stop deceleration is used.
- The function block completes with velocity zero.
- The deceleration duration of the segment block must not exceed 80 seconds.

Timing Diagram Example

The diagram illustrates a simple profile from **Continuous** state:

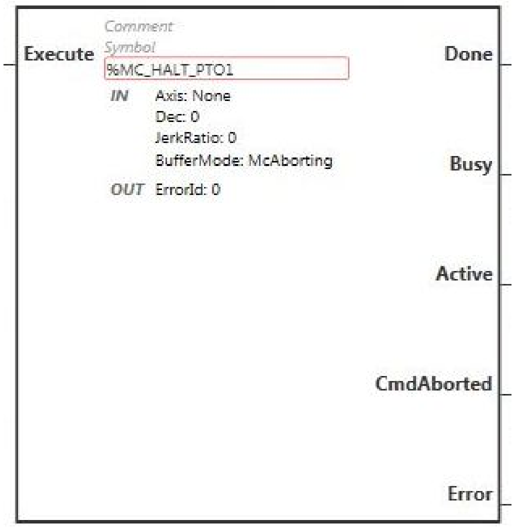


The diagram illustrates a simple profile from **Discrete** state:



MC_Halt_PTO Function Block

Graphical Representation



Execute
Comment
Symbol
%MC_HALT_PTO1
IN Axis: None
Dec: 0
JerkRatio: 0
BufferMode: McAborting
OUT ErrorId: 0
Done
Busy
Active
CmdAborted
Error

NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`Dec`	DINT	0	Deceleration in Hz/ms Range (Hz/ms): 1...`MaxDecelerationAppl, page 248`
`JerkRatio`	INT	0	Percentage of acceleration / deceleration adjustment used to create the S-curve profile, page 226. Range: 0…100
`Buffer-Mode`	INT	`mcA-bort-ing`	Transition mode from ongoing move. Refer to Buffer Modes table, page 248.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected. When one movement on an axis is interrupted with another movement on the same axis before the commanded action has been completed, `CmdAborted` is set to TRUE and `Done` is set to FALSE.
`Busy`	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as `Busy` is TRUE.
`Active`	-	When TRUE, the function block instance has control of the axis. Only one function block at a time can set `Active` TRUE for the same axis.
`CmdAborted`	-	When TRUE, function block execution is terminated due to another motion command.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

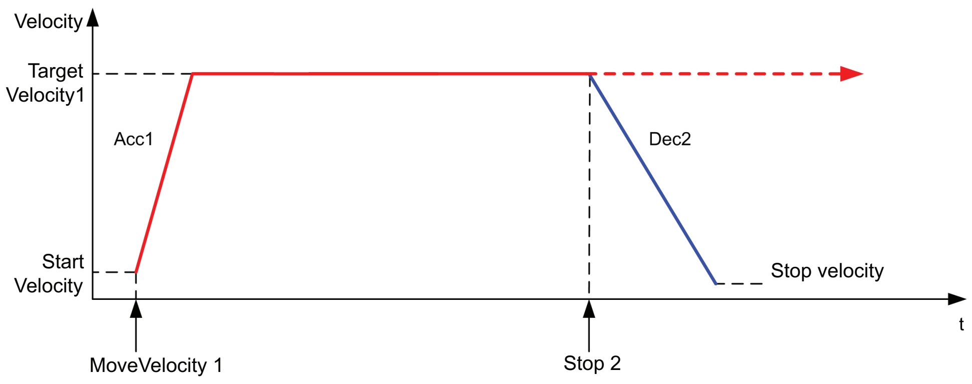
This table describes the output object of the function block:

Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

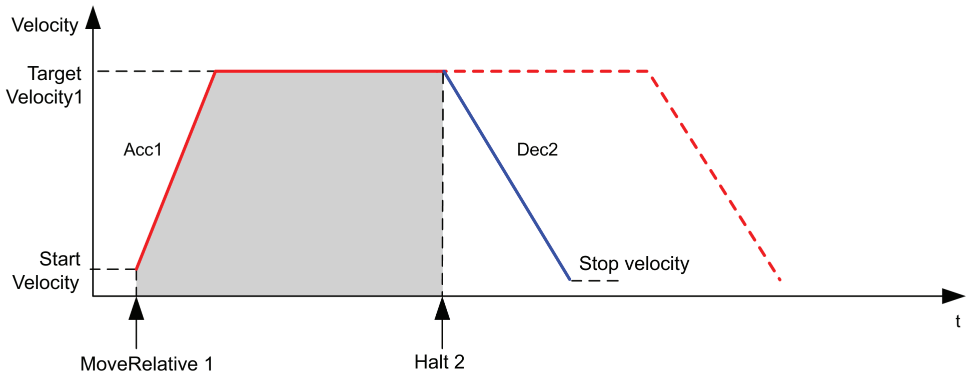
NOTE: The function block completes with velocity zero.

Timing Diagram Example

The diagram illustrates a simple profile from **Continuous** state:



The diagram illustrates a simple profile from **Discrete** state:



Administrative Function Blocks

Overview

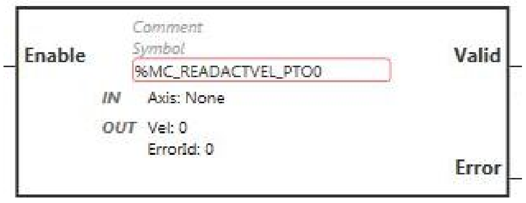
This section describes the **Administrative** function blocks.

MC_ReadActVel_PTO Function Block

Function Description

This function block returns the value of the actual velocity of the axis.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Enable`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Valid`	-	If TRUE, the function block object data is valid.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output objects of the function block:

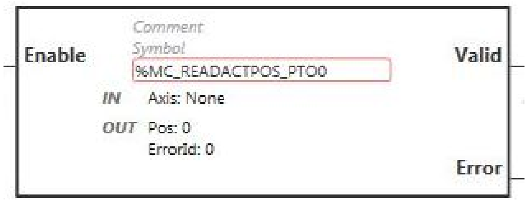
Output Object	Type	Initial Value	Description
`Vel`	DINT	-	Velocity of the axis.
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_ReadActPos_PTO Function Block

Function Description

This function block returns the value of the actual position of the axis.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Enable`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Valid`	-	If TRUE, the function block object data is valid.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output objects of the function block:

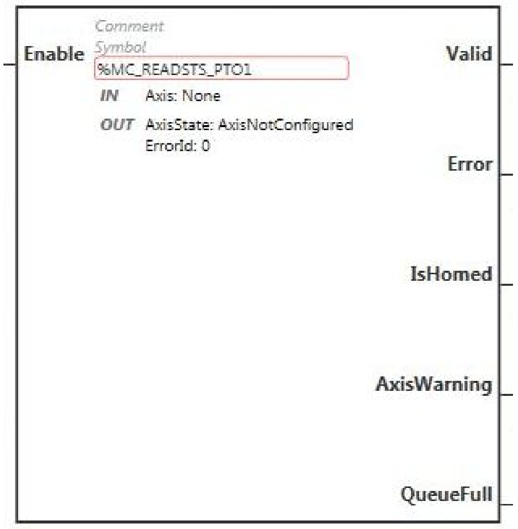
Output Object	Type	Initial Value	Description
`Pos`	DINT	-	Position of the axis.
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_ReadSts_PTO Function Block

Function Description

This function block returns the state diagram, page 252 status of the axis.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Enable`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Valid`	-	If TRUE, the function block object data is valid.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.
`IsHomed`	FALSE	When TRUE, it indicates that the axis has been homed such that the absolute reference point is valid, and absolute motion commands are allowed.
`AxisWarn-ing`	FALSE	When TRUE, an alert or an advisory has been provoked by a motion command. Use *MC_ReadAxisError_PTO* function block to obtain detailed information., page 282
`QueueFull`	FALSE	When TRUE, the motion queue is full and no additional buffered motion commands are allowed.

This table describes the output objects of the function block:

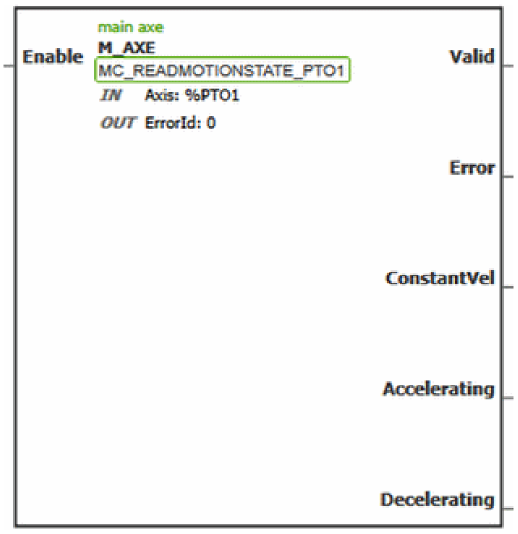
Output Object	Type	Initial Value	Description
`AxisState`	-	-	Code for the state of the axis: 0 = axis not configured 1 = ErrorStop 2 = Disabled 4 = Stopping 8 = Homing 16 = Standstill 32 = Discrete motion 64 = Continuous motion For more information, refer to the States description table, page 252.
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_ReadMotionState_PTO Function Block

Function Description

This function block returns the actual motion status of the axis.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Enable`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Valid`	-	If TRUE, the function block object data is valid.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.
`Constant-Vel`	-	When TRUE, the velocity of the axis is constant.
`Accelerat-ing`	-	When TRUE, the velocity of the axis is increasing.
`Decelerat-ing`	-	When TRUE, the velocity of the axis is decreasing.

This table describes the output object of the function block:

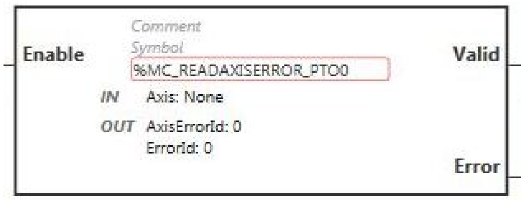
Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_ReadAxisError_PTO Function Block

Function Description

This function block retrieves the axis control error. If no axis control error is pending, the function block returns `AxisErrorId` = 0.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Enable`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Valid`	-	If TRUE, the function block object data is valid.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output objects of the function block:

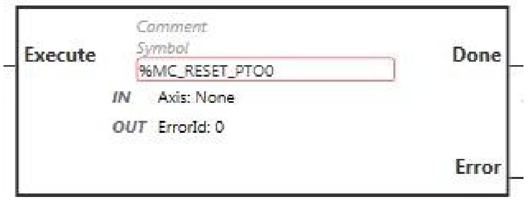
Output Object	Type	Initial Value	Description
`AxisError-Id`	-	-	Axis error codes, valid when `AxisWarning` output is TRUE. Refer to PTO axis error code table, page 249.
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_Reset_PTO Function Block

Behavior

This function block resets all axis-related errors, conditions permitting, to allow a transition from the states **ErrorStop** to **Standstill**. It does not affect the output of the function blocks instances.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

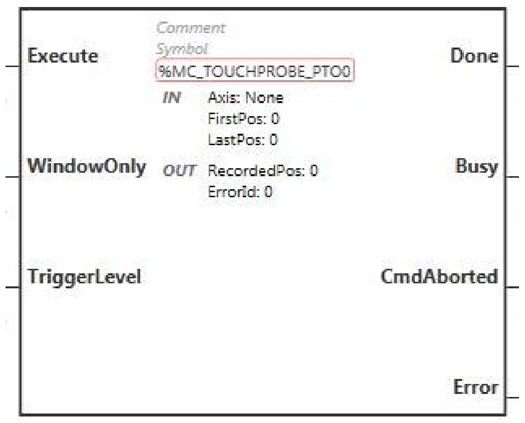
Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_TouchProbe_PTO Function Block

Function Description

This function block is used to activate a trigger event on the probe input. This trigger event allows to record the axis position, and/or to start a buffered move.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the inputs of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates. If a second rising edge is detected during the execution of the function block, the current execution is aborted and the function block is executed again. If the `Execute` input is subsequently set to 0, the axis position is recorded and the `Done` output set to 1 for one MAST cycle. The axis position is then reset and the `Done` output is set to 0.
`WindowOnly`	FALSE	When TRUE, a trigger event is only recognized within the position range (window) defined by `FirstPosition` and `LastPosition`.
`TriggerLevel`	FALSE	When TRUE, position captured or event triggered at rising edge. When FALSE, position captured or event triggered at falling edge.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`FirstPos`	DINT	0	Start of the absolute position from where trigger events are accepted (value included in enable window).
`LastPos`	DINT	0	End of the absolute position from which trigger events are accepted (value included in enable window).

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected. When one movement on an axis is interrupted with another movement on the same axis before the commanded action has been completed, `CmdAborted` is set to TRUE and `Done` is set to FALSE.
`Busy`	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as `Busy` is TRUE.
`CmdAborted`	-	When TRUE, function block execution is terminated due to another motion command.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output objects of the function block:

Output Object	Type	Initial Value	Description
`Recorded-Pos`	-	-	Position where trigger event was detected.
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

NOTE:

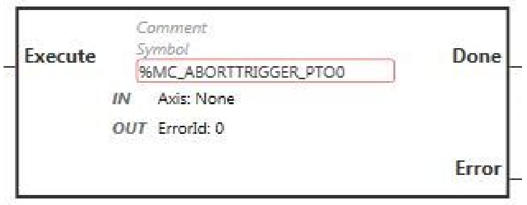
- Only one instance of this function block is allowed on the same axis.
- Only the first event after the rising edge at the *MC_TouchProbe_PTO* function block `Busy` output is valid. Once the `Done` output is set to TRUE, subsequent events are ignored. The function block needs to be reactivated to respond to other events.

MC_AbortTrigger_PTO Function Block

Function Description

This function block is used to abort function blocks which are connected to trigger events (for example, *MC_TouchProbe_PTO*).

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

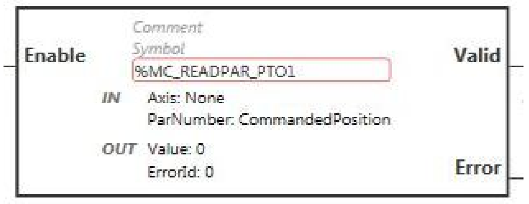
Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_ReadPar_PTO Function Block

Function Description

This function block is used to get parameters from the PTO.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Enable`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`ParNumber`	DINT	0	Code for the parameter you wish to read or write. For more information, refer to PTO Parameter table.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Valid`	-	If TRUE, the function block object data is valid.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output objects of the function block:

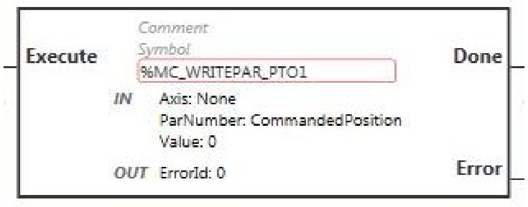
Output Object	Type	Initial Value	Description
`Value`	DINT	0	Value of the requested parameter.
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

MC_WritePar_PTO Function Block

Function Description

This function block is used to write parameters to the PTO.

Graphical Representation



NOTE: When you first enter the function block, you must configure it to use the intended axis. Double-click on the function block to display the function block properties, choose the axis and click `Apply`.

Inputs

This table describes the input of the function block:

Input	Initial Value	Description
`Execute`	FALSE	On rising edge, starts the function block execution. The values of the other function block inputs control the execution of the function block on the rising edge of `Execute`. A subsequent change in these input parameters does not affect the ongoing execution. The outputs are set when the function block terminates.

This table describes the input objects of the function block:

Input Object	Type	Initial Value	Description
`Axis`	PTOx	-	Instance for which the function block is to be executed. The name is declared in the controller configuration.
`ParNumber`	DINT	0	Code for the parameter you wish to read or write. For more information, refer to PTO Parameter table.
`Value`	DINT	0	Value to be written to the parameter chosen with the `ParNumber` input object.

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`Done`	FALSE	When TRUE, function block execution is finished with no error detected.
`Error`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

Output Object	**Type**	**Initial Value**	**Description**
`ErrorId`	Word	*NoError*	Motion command error codes, valid when `Error` output is TRUE. Refer to PTO motion command error code table, page 250.

Frequency Generator (%FREQGEN)

What's in This Chapter

Description

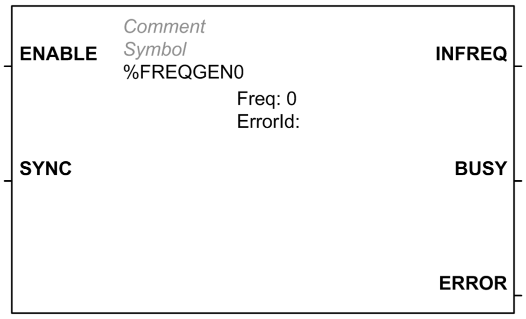
Introduction

The frequency generator *FREQGEN* function block ⎍⎍ commands a square wave signal output at a specified frequency.

The frequency is configurable from 0 Hz to 100 kHz with a 1 Hz step.

Illustration

This illustration is a *FREQGEN* function block:



Inputs

This table describes the inputs of the function block:

Input	Initial Value	Description
`ENABLE`	FALSE	When TRUE, the function block is executed. The values of the other function block inputs can be modified continuously, and the function block outputs are updated continuously. When FALSE, terminates the function block execution and resets its outputs.
`SYNC`	FALSE	When a rising edge is detected, the target frequency is emitted without waiting for the end of the ongoing period output.

This table describes the input object of the function block:

Input Object	Type	Initial Value	Description
`Freq`	DWORD	-	Frequency of the *Frequency Generator* output signal in Hz. Specify the frequency in the Pulse Generators properties (see Modicon M221 Logic Controller, Advanced Functions Library Guide) table (Range: minimum 0 (0 Hz)...maximum 100000 (100 kHz)

Outputs

This table describes the outputs of the function block:

Output	Initial Value	Description
`INFREQ`	-	If TRUE, the frequency generator signal is being output at the frequency specified in the `Freq` input object.
`BUSY`	-	When TRUE, function block execution is in progress. When FALSE, execution of the function block has been terminated. The function block must be kept in an active task of the application program for at least as long as `BUSY` is TRUE.
`ERROR`	FALSE	If TRUE, indicates that an error was detected. Function block execution is finished.

This table describes the output object of the function block:

Output Object	Type	Initial Value	Description
`ErrorId`	Word	*NoError*	Error codes, valid when `ERROR` output is TRUE. Refer to the ErrorId Error Codes table below.

ErrorId Error Codes

This table lists the values for the function block error codes

Name	Value	Description
NoError	`0`	No errors detected.
OutputProtection	`1007`	One or more PTO objects have digital output protection active. Refer to system objects %S10 and %SW139 (see Modicon M221, Logic Controller, Programming Guide) for more details.
InvalidFrequencyValue	`3002`	The frequency `Freq` input object is outside the allowed range.

Configuration

Overview

To configure the *Pulse Generator* resource, refer to Configuring Pulse Generators, page 55.

To configure the *Pulse Generator* resource as a *FREQGEN*, refer to Configuring Frequency Generator , page 61

Properties

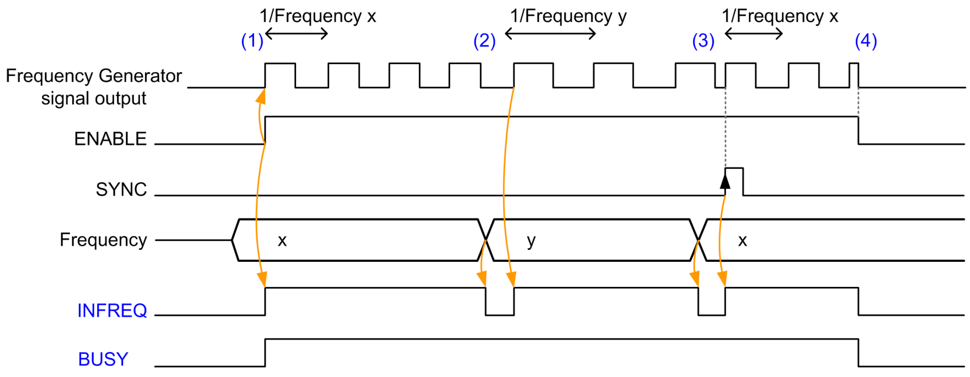
The *FREQGEN* function block has the following properties:

Property	Description	Value
Used	Address used	If selected, this address is in use in a program.
Address	`%FREQGENi` Frequency generator address	The instance identifier, where i is from 0 to the number of objects available on this logic controller. For the maximum number of *FREQGEN* objects, refer to the table Maximum Number of Objects, page 24.

Property	Description	Value
Symbol	Symbol	The symbol associated with this object. For details, refer to Defining and Using Symbols (see EcoStruxure Machine Expert - Basic, Operating Guide).
Freq	Frequency	The frequency of the frequency generator output signal in Hz. Minimum value: 0 (0 Hz). Maximum value:100000 (100 kHz) The default value is 0.
Comment	Comment	An optional comment can be associated with this object. Double-click in the **Comment** column and type a comment.

Timing Diagram

This diagram displays the timing for the *FREQGEN* function block:



(1) The *ENABLE* input is set to 1. The frequency generator signal is generated at the dedicated output. The *INFREQ* output is set to 1. The *BUSY* output is set to 1.

(2) The frequency value is changed. The *INFREQ* output is set to 0 until the new frequency is being generated at the dedicated output. The *BUSY* output remains set to 1.

(3) The *SYNC* input is set to 1. The current frequency generator cycle stops and a new cycle starts. The *INFREQ* output is set to 1. The *BUSY* output remains set to 1.

(4) The *ENABLE* input is set to 0. Frequency generation stops. The *INFREQ* output is set to 0. The *BUSY* output is set to 0.

When the application is stopped, frequency generation stops without waiting for the end of the pulse generation cycle. The *Error* output remains at *FALSE*.

If an error is detected, it is automatically acknowledged when leaving the error condition.

PID Function

What's in This Chapter

PID Operating Modes

PID Operating Modes

Introduction

The EcoStruxure Machine Expert-Basic *PID* controller offers 4 distinct operating modes, configurable in the **General** tab, page 307 of the **PID Assistant** in EcoStruxure Machine Expert-Basic.

The *PID* operating modes are:

- PID mode
- AT + PID mode
- AT mode
- Word address

PID Mode

The simple *PID* controller mode is active by default when the *PID* controller starts up. The gain values Kp, Ti, and Td to be specified in the **PID** tab, page 310 must be known in advance to successfully control the process. You can choose the corrector type of the controller (PID or PI) in the **PID** tab of the **PID Assistant** screen, page 306. If the PI corrector type is selected, the derivative time **Td** field is disabled.

Using *PID* mode, the Auto-Tuning function is disabled and the **AT** tab, page 311 of the **Assistant Configuration** screen is therefore unavailable.

AT + PID Mode

In this mode, the Auto-Tuning function is active when the *PID* controller starts up. The Auto-Tuning function then calculates the gain values Kp, Ti, and Td, page 310 and the type of PID action, page 312. At the end of the Auto-Tuning sequence, the controller switches to *PID* mode for the adjusted setpoint, using the parameters calculated by Auto-Tuning.

If the Auto-Tuning algorithm detects an error, page 317:

- No *PID* parameter is calculated.
- The Auto-Tuning output is set to the output that was applied to the process before starting Auto-Tuning.
- An error message appears in the **List of PID States** drop-down list.
- The *PID* control is cancelled.

While in *AT* + *PID* mode, the transition from Auto-Tuning to *PID* mode is automatic and seamless.

AT Mode

In this mode, the Auto-Tuning function is active when the *PID* controller starts up and automatically calculates both the gain values Kp, Ti, and Td, page 310 and the type of PID action, page 312. After convergence of the Auto-Tuning process and successful completion with the determination of the Kp, Ti, and Td parameters and the type of PID action, page 312 (or after detection of an error in the Auto-Tuning algorithm), the Auto-Tuning numerical output is set to 0 and the **Auto-Tuning Complete** message appears in the List of PID States, page 316 drop-down. The *PID* controller then stops and waits. The calculated Kp, Ti, and Td *PID* coefficients are available in their respective memory words (%MWx).

Word Address

This *PID* mode is selected by assigning the desired value to the word address associated with this selection:

- %MWxx = 0: The controller is disabled.
- %MWxx = 1: The controller operates in simple *PID* mode.
- %MWxx = 2: The controller operates in *AT*+ *PID* mode.
- %MWxx = 3: The controller operates in *AT* mode only.
- %MWxx = 4: The controller operates in simple *PID* mode, with PI corrector type.

This mode *word address* enables you to manage the *PID* controller operating mode with the application, thus making it possible to adapt to your requirements.

PID Auto-Tuning Configuration

PID Auto-Tuning Configuration

Introduction

This section guides you through all the steps necessary to configure the EcoStruxure Machine Expert-Basic *PID* controller using Auto-tuning (AT).

This section contains the following steps:

Step	Topic
1	Configuring analog channel, page 295
2	Pre-requisites for PID configuration, page 296
3	Configuring the PID, page 296
4	Control set-up, page 297

Step 1: Configuring the Analog Channel

A *PID* controller uses an analog feedback signal (known as the process value) to calculate the algorithm used to control the process. The logic controller has an embedded analog input that can be used to acquire this process value.

If an analog output is being used to drive the system to be controlled, make sure that this analog output is correctly configured. Refer to the analog output expansion module of your logic controller.

Step 2: Pre-requisites for PID Configuration

Before configuring the *PID* controller, ensure that the following phases have been performed:

Phase	Description
1	PID is enabled in the program, page 314.
2	**Scan Mode** is set to periodic, page 315.

Step 3: Configuring the PID

Use a solid state output in conjunction with the PID function. Using a relay output may result in quickly exceeding its life cycle limits resulting in an inoperative relay with contacts either frozen open or soldered closed.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION OR INOPERABLE EQUIPMENT

- Do not use relay outputs in conjunction with the PID function.
- Only use solid state outputs if a digital output is required to drive the system to be controlled.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

To implement a *PID* controller with Auto-Tuning, perform the following steps:

Step	Action
1	In the **General** tab, page 307 of the **PID Assistant** screen (in offline mode), select **AT +PID** (or **AT**) or select **Word Address** setting the associated word to 2 or 3, from the Operating Modes, page 294.
2	Activate the **PID States** checkbox and enter the address of the memory word in the field.
3	In the **Input** tab, page 309, enter the address of the analog input used as a measurement.
4	If **Conversion** or **Alarms** are required, refer to **Input** tab, page 309 of **PID Assistant** screen.
5	In the **PID** tab, page 310, enter the value of the setpoint. In general, this value is a memory address or an analog input.
6	**Corrector type** in the **PID** tab must be set to **PID** or **PI**.
7	Set the **Parameters** in the **PID** tab: **Kp (x0,01)**, **Ti (x0,1s)**, and **Td (x0,1s)**. When **AT +PID** or **AT** are the Operating modes, page 294, the parameters should be **memory words addresses (%MWxx)** so the Auto-Tuning algorithm fills in the computed value of the parameters.
8	Enter the *PID* **Sampling period** (Ts, page 304) in the **PID** tab. The **Sampling period** is a key parameter and must be carefully determined.
9	In the **AT** tab, the **AT Mode** must be set to **Authorize** by default. Enter the **Min.** and **Max.** values if the **Measurement Range** is activated (**Authorize** checkbox). Select the **Dynamic AT corrector** from the list that contains **Fast**, **Medium**, **Slow**, or **Word address** corrector type. For further details, refer to the **AT** tab in PID Assistant, page 311.
10	In the **AT** tab, enter the **AT Trigger** memory bit to store the value of the step change during Auto-Tuning. For further details, refer to the **AT** tab in PID Assistant, page 311.
11	In the **Output** tab, page 312, set the **Action** to **Bit Address** from the list. Enter the memory bit address in the **Bit** field. **Limits** can be configured if necessary from Output tab, page 312. In **Analog output** field, set the address of the word: an analog output or a memory word. Set the **Output PWM**, page 312 to **Authorize**. In the manual mode, enter the value in the **Period (0.1 s)** field or the memory word address of the output in the **Output** field. For more details about manual mode operation, refer to Output tab, page 312.
12	Click **OK** to confirm the *PID* controller configuration.

Step 4: Control Setup

Use a solid state output in conjunction with the PID function. Using a relay output may result in quickly exceeding its life cycle limits resulting in an inoperative relay with contacts either frozen open or soldered closed.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION OR INOPERABLE EQUIPMENT

- Do not use relay outputs in conjunction with the PID function.
- Only use solid state outputs if a digital output is required to drive the system to be controlled.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

To start operation in *AT+PID* operating mode, page 294 perform the following steps:

Step	Action
1	Connect the PC to the controller and transfer the application.
2	Switch the controller to RUN mode.

NOTE: Before switching the controller to RUN mode, verify that the operating conditions of the machine allow the RUN mode for the rest of the application.

Step	Action
1	Create an animation table containing the objects defined during configuration. Refer to the *EcoStruxure Machine Expert-Basic Operating Guide* for further details about animation table creation.
2	Verify the consistency of the process value and application's values. This test is important as successful operation of the *PID* controller depends on the accuracy of the measurement. If you have any doubt about the accuracy of the measurement, set the logic controller to the STOP state and verify the wiring of analog channels. If the actuator is not controlled: • For analog output verify the output voltage or current from analog channel. • For PWM output, verify that the: ◦ LED of the dedicated output is lit ◦ wiring of the supplies and 0V circuit ◦ actuator power supply is being applied
3	In the animation table, verify that: • Output mode is set to automatic. • All parameters your application requires are set to the appropriate values.
4	Set the logic controller scan period so that the **Sampling period** (Ts) value of the *PID* controller is an exact multiple of the scan period. For further details on how to determine the Sampling period, refer to Tuning PID, page 300.
5	When the Auto-Tuning sequence is complete, the parameters **Kp**, **Ti**, and **Td** are written in to the RAM memory of the logic controller. The values are saved for as long as the application is valid (power-down less than 30 days) and no cold-start is performed.

The Auto-Tuning process is repeated each time a rising edge is detected on the **AT trigger** memory bit.

PID Standard Configuration

PID Word Address Configuration

Introduction

This section guides you through all the steps required to configure the EcoStruxure Machine Expert-Basic *PID* controller using word address operating mode, page 294. This mode provides greater flexibility of use than the other *PID* modes.

This section contains the following steps:

Step	Topic
1	Prerequisites for PID configuration, page 298
2	Configuring the PID, page 298
3	Control set-up, page 299

Step 1: Prerequisites for PID Configuration

Before configuring the *PID*, ensure that the following phases have been performed:

Phase	Description
1	An analog input is configured as well as an analog output if required.
2	PID is enabled in the program, page 314.
3	Scan mode is set to periodic, page 315.

Step 2: Configuring the PID

Use a solid state output in conjunction with the PID function. Using a relay output may result in quickly exceeding its life cycle limits resulting in an inoperative relay with contacts either frozen open or soldered closed.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION OR INOPERABLE EQUIPMENT

- Do not use relay outputs in conjunction with the PID function.
- Only use solid state outputs if a digital output is required to drive the system to be controlled.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following steps explain how to implement a *PID* controller in **word address** mode. For more details on how to configure the *PID*, refer to the PID Assistant, page 306.

For the dynamic modification of the *PID* parameters (in offline and in online mode), enter the memory addresses in the associated fields, thus avoiding the need to switch to offline mode to make on-the-fly changes to values.

Step	Action
1	In the **General** tab of the **PID Assistant** screen (in offline mode), in the **Operating Modes** ; drop-down list select **Word address**. Check the box associated to PID States and enter the address of the memory word in the field.
2	In the **Input** tab, page 309, enter the address of the analog input used as a measurement. If **Conversion** or **Alarms** are required, refer to **Input** tab, page 309 of PID Assistant, page 306.
3	In the **PID** tab, enter the value of the **Setpoint**. In general, this value is a memory address or an analog input. The **Parameters** (Kp, Ti, and Td) should be **memory words addresses (%MWxx)**. Enter the PID **Sampling period** (Ts, page 304) in the PID tab, page 310. This parameter can also be a memory word (the value can then be set using the animation table). In **Word Address** operating mode, the **Corrector type** is set to **Auto** and greyed out (it cannot be modified manually).
4	In the **AT** tab, the *AT* mode should be checked to **Authorize**. Enter the **Dynamic corrector** and the **AT Trigger**. For further details, refer to **AT** tab, page 311 in **PID Assistant** screen.
5	In the **Output** tab, **Action** should be set to **Bit Address**. Enter a **memory bit address**. **Limits** can be configured if necessary from the Output tab, page 312. In **Analog output** field set the address of the word: an analog output or a memory word. If required, set the **Output PWM**, refer to **Output** tab, page 312 in PID Assistant, page 306.
6	Click **OK** to confirm the *PID* controller configuration.

Step 3: Verifying the Setup

Step	Action
1	Connect the PC to the logic controller and transfer the application.
2	Switch the logic controller to RUN mode.

NOTE: Before switching the logic controller to RUN mode, verify that the operating conditions of the machine allow RUN mode for the rest of the application. The procedure remains the same as the one used in *AT* and *AT +PID* operating modes. The word address configuration allows you to modify the PID operating modes by software. In the case of the PID mode, the procedure is significantly simplified, assuming the parameters (Kp, Ti, Td, and Ts) are known and there is no need to perform Auto-Tuning.

This table gives the generic procedure to set up the *PID* controller

Step	Action
1	Create an animation table containing the objects defined during configuration. Refer to the *EcoStruxure Machine Expert-Basic Operating Guide* for details.
2	Verify the consistency of the process value and other values defined in the animation table. If you have any doubt about the accuracy of the measurement, set the logic controller to STOP and verify the wiring of analog channels. If you see that the actuator is not being controlled: • For analog output, verify the output voltage or current from analog channel. • For PWM output, verify that the: ◦ LED of dedicated output is lit ◦ wiring of the supplies and 0 V circuit is correct ◦ actuator power supply is being applied
3	Set the logic controller scan period so that the **Sampling period** (Ts) of the *PID* controller is an exact multiple of the scan period. For further details on Sampling period, please refer to Determining Sampling Period, page 304.

Step	Action
4	If you plan to use the Auto-Tuning, page 300 function, you may need to run Manual Mode, page 303 to know the **Dynamic corrector** and the **AT Trigger** defined in the **AT** tab, page 311 of the **PID Assistant**.
5	Power up the loop controller using the animation table: • Set the operating mode, page 294. • Enable the PID controller, page 314. • Set the values defined during configuration, page 298 to appropriate values depending on the selected operating mode.

PID Tuning with Auto-Tuning (AT)

Introduction

The Auto-Tuning mode allows automatic tuning of the Kp, Ti, Td, and action parameters to achieve refined convergence of the *PID* function.The Auto-Tuning function provided by EcoStruxure Machine Expert-Basic is particularly suited for automatic tuning of thermal processes.

This section contains the following topics:

- Auto-Tuning requirements
- Description of Auto-Tuning process
- Storage of Calculated Coefficients
- Adjusting *PID* parameters
- Launching the Auto-Tuning
- Limitations on using the Auto-Tuning and the *PID* control

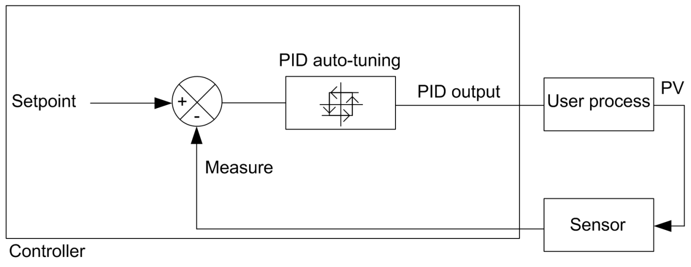
Auto-Tuning Requirements

When using the Auto-Tuning function, make sure that the control process and the logic controller meet the following requirements:

- Process requirements:
  - The process must be a stable open-loop system.
  - The process must be mostly linear over the entire operating range.
  - The process response to a change in level of the analog output follows a transient asymptotic pattern.
  - The process is in a steady state with a null input at the start of the Auto-Tuning sequence.
  - The process must be free of disturbances throughout the entire process. Otherwise, either calculated parameters will be incorrect or the Auto-Tuning process will not operate correctly.
- Configuration requirements:
  - Configure the logic controller to periodic scan mode to ensure a correct run of the Auto-Tuning function.
  - Only use the Auto-Tuning function when no other *PID* controllers are running.
  - Configure the Kp, Ti, and Td coefficients as memory word addresses (% MWxx).
  - Set the Action type in the **Output** tab to a memory bit address (%Mxx).

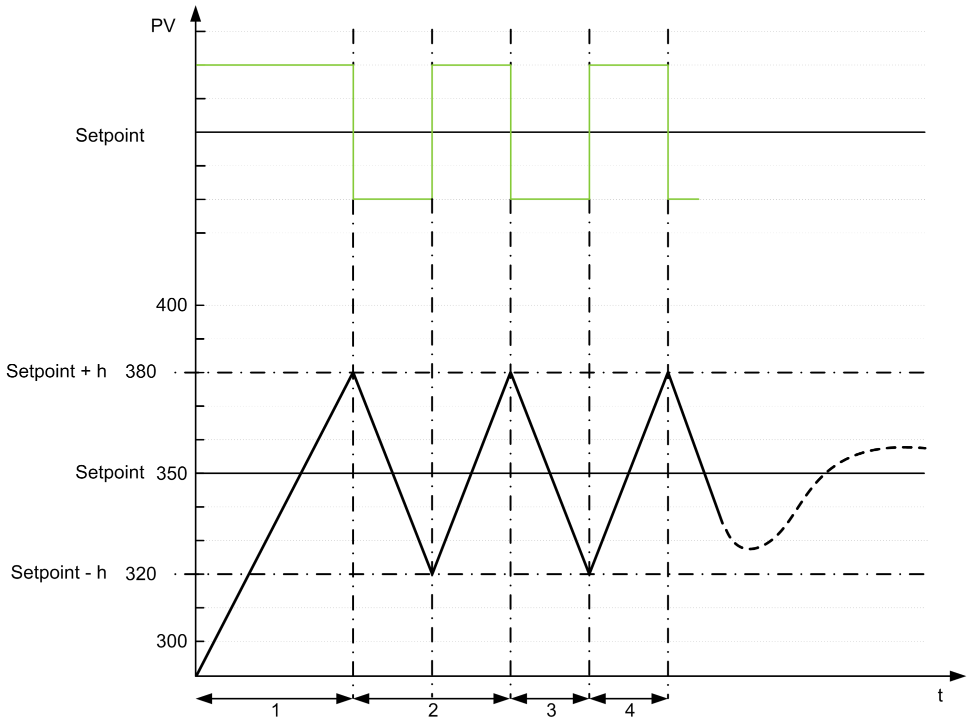
Description of Auto-Tuning Process

The following illustration describes the auto-tuning in the controller and in the application:



Description of Auto-Tuning Calibration Process

The Auto-Tuning calibration process is divided into four consecutive phases. All phases of the process must be fulfilled in order to bring the Auto-Tuning to a successful conclusion. The following process response curves and table describe the four phases of the EcoStruxure Machine Expert-Basic *PID* Auto-Tuning function:



PV Process value

🟩 PID output

h = 1% (**Max** value - **Min** value) of **Measurement Range** field in the **AT** tab

---- PID active

1...4 Auto-Tuning phases (see table below)

The following table describes the Auto-Tuning phases:

Auto-Tuning Phase	Description
1	The PID output is forced to the **Max** value of **Limits** field in **Output** tab until the process value reaches Setpoint + h.
2	There are two steps in Auto-Tuning phase 2:

Auto-Tuning Phase	Description
	1. The PID output is forced to the **Min** value of the **Limits** field in the **Output** tab until the process value reaches Setpoint - h. 2. The PID output is forced to the **Max** value of the **Limits** field in the **Output** tab until the process value reaches Setpoint + h.
3	The PID output is forced to the **Min** value of the **Limits** field in the **Output** tab until the process value reaches Setpoint - h.
4	There are two steps in Auto-Tuning phase 4: 1. The PID output is forced to the **Max** value of the **Limits** field in the **Output** tab until the process value reaches Setpoint + h. 2. The PID output is forced to the **Min** value of the **Limits** field in the **Output** tab, the PID parameters are calculated and the PID becomes active.
(1) The output last applied to the process before start of the Auto-Tuning is used as both the starting point and the relaxation point for the Auto-Tuning process.	

NOTE: The Kp, Ti and Td parameters cannot be calculated if the manual output control is activated during the Auto-Tuning calibration process. Launch the Auto-Tuning calibration process again once the output manual control is finished.

Storage of Calculated Coefficients

After the Auto-Tuning sequence is complete, the memory words assigned to the Kp, Ti, and Td coefficients and the action type are set using the calculated values. These values are written in to the RAM memory and saved in the logic controller as long as the application is valid and no cold start is performed (%S0).

If the system is not influenced by outside disturbances, the calculated values may be written in to the settings of the *PID* controller (refer to the **PID** tab of the PID Assistant, page 310). In this way, the *PID* controller operating mode can be set to *PID* mode.

Adjusting PID Parameters

The Auto-Tuning method may provide a very dynamic command, leading to unwanted overshoots during step change of setpoints. To refine the process regulation provided by the *PID* parameters (Kp, Ti, Td) obtained from Auto-Tuning, you also have the ability to adjust these parameter values manually, directly from the **PID** tab of the **PID Assistant** screen or through the corresponding memory words (%MW). For more details on manual parameters adjustments, refer to the appendices, page 317.

Launching the Auto-Tuning

In the **AT** tab, the **AT Trigger** enables the repetition of Auto-Tuning sequence. The auto-tuning process is launched at each rising edge of the signal linked to **AT Trigger**.

To configure the auto-tuning, refer to AT Tab.

Limitations on Using Auto-Tuning

Thermal processes can often be assimilated to the first order with pure delay model. There are two key parameters that describe this type of model:

- the time constant, τ
- the delay time, θ

Auto-Tuning is best suited for processes in which the time constant (τ) and delay time (θ) meet the following criteria:

- 10 s < (τ + θ) < 2700 s (i.e.: 45 min)
- 2 < τ / θ < 20

Manual Mode

Introduction

The manual mode is accessible through the **PID Assistant** screen (**Output** tab, page 312). This mode allows you to bypass orders from the *PID*. There are 2 main objectives using Manual mode:

- Initialize the set-up
- Determine the sampling period.

Description

The manual mode lets you specify the **Output** value, page 312. This operation can be particularly well suited for testing the system response.

Setting the **bit address** from the **Output** tab, page 312 to 1 activates the manual mode. If Allow is set, then the manual mode is the only accessible mode.

Application

When the manual mode is active the output is assigned a fixed value that you set. This output value is from 0 to 10,000 (0 to 100% for PWM output).

You can also use manual mode to make trials to determine the minimum/ maximum output limitation.

Manual mode is also required to use the process response curve method, page 304 that helps to find the correct sampling time (Ts).

Start the Manual Mode

Before starting manual mode, you should make sure that the logic controller RUN/ STOP switch is in the RUN position.

To start manual mode using an animation table:

Step	Description
1	Enable manual mode by setting the dedicated memory bit to 1. For more details refer to the **Output** tab, page 312.
2	If using PWM, set the PWM period to the desired value.
3	Set the memory word associated with the Operating mode in the **General** tab, page 307 of the **PID Assistant** to 1 (*PID* mode). For more details on operating modes using word address refer to the operating mode description, page 294.
4	Set the memory word associated with the manual output in the **Output** tab, page 312 to the desired value. This manual setpoint value can be selected several times on condition that the system is left in its initial state.
5	Enable the loop controller, page 298.

Stop the Manual Mode

To stop manual mode using an animation table:

Step	Description
1	Disable the loop controller, page 298.
2	Inhibit the manual mode by setting the dedicated memory bit to 0. For more details refer to the **Output** tab, page 312.
3	Set the memory word associated with the Operating mode in the **General** tab, page 307 for the *PID* controller to 0. For more details on operating modes using word address, refer to the operating mode description, page 294.
4	Set the memory word associated to the manual output in the **Output** tab, page 312 to 0.

Determining the Sampling Period (Ts)

Introduction

The Sampling Period (Ts) is the key parameter for *PID* regulation. The Sampling Period (Ts) should be carefully set in the **PID** tab, page 310 of the **PID Assistant** screen. This parameter is highly correlated with the time constant (τ) of the process to control.

This section describes the use of online mode and two methods to determine the sampling period (Ts) are described in this section:

- Process response curve method,
- Trial-and-error method.

Process Response Curve Method

This method is an open loop process that aims to determine the time constant of the process to be controlled. First, it is necessary to ensure that the process can be described by a first order with time delay model. The principle is quite simple: apply a step change at the input of the process while recording the process output curve. Then use a graphical method to determine the time delay of the process.

To determine the sampling period (Ts) using the process response curve method:

Step	Action
1	It is assumed that you have already configured the various settings in the **General**, **Input**, **PID**, **AT** and **Output** tabs of the *PID*.
2	Select the **Output** tab, page 312 from the **PID Assistant** screen.
3	Select **Allow** or **Address bit** from the **Manual Mode** drop-down list to authorize manual output.
4	Set the Output field to a high level (in the [5,000...10,000] range).
5	Download your application to the logic controller. For further details on how to download an application refer to *EcoStruxure Machine Expert-Basic Operating Guide*.
6	Run the *PID* and check the response curve rise.
7	When the response curve has reached a steady state, stop the *PID* measurement.
8	Use the following graphical method to determine the time constant (τ) of the control process: 1. Calculate the process value output at 63% rise ($S_{[63\%]}$) by using the following formula: $S_{[63\%]} = S_{[initial]} + (S_{[final]}-S_{[initial]})x63\%$ 2. Calculate graphically the time abscissa ($t_{[63\%]}$) that corresponds to S(63%). 3. Calculate graphically the initial time ($t_{[initial]}$) that corresponds the start of the process response rise.

Step	Action
	4. Compute the time constant (τ) of the control process by using the following relationship: $τ = t_{[63\%]} - t_{[initial]}$
9	Calculate the sampling period (Ts)[1] based on the value of (τ) that you determined in the previous step, using the following rule: Ts = τ/75
10	Set the Scan period of the Periodic scan mode so that the Sampling Period (Ts) is an exact multiple of the scan period:Scan Period = Ts / n , where n is a positive integer[2]

(1) The base unit for the sampling period is 10ms. Therefore, you should round up/down the value of Ts to the nearest 10ms.

(2) You must choose "n" so that the resulting Scan Period is a positive integer in the range [2...150] ms.

Trial-and-Error Method

The trial-and-error method involves providing successive guesses of the sampling period to the Auto-Tuning function until the algorithm converges successfully towards satisfactory values of Kp, Ti, and Td.

NOTE: Unlike the process response curve method, the trial-and-error method is not based on any approximation law of the process response. However, it has the advantage of converging towards a value of the sampling period that is in the same order of magnitude as the actual value.

To perform a trial-and-error estimation of the Auto-Tuning:

Step	Action
1	Select the **AT** tab from the *PID* configuration window.
2	Set the **Output limitation** of Auto-Tuning to **10,000.**
3	Download your application to the logic controller. For further details on how to download an application, refer to *EcoStruxure Machine Expert-Basic Operating Guide*.
4	Select the **PID** tab from the **PID Assistant** screen.
5	Provide the first or nth guess in the **Sampling Period**[1] field.
6	Launch Auto-Tuning, page 295.
7	Wait until the Auto-Tuning process ends.
8	Two cases can occur: • **Auto-Tuning completes successfully:** Continue to Step 10. • **Auto-Tuning unsuccessful:** Refer to Auto-Tuning detected error codes, page 317. This means that the current guess for the sampling period (Ts) is not correct. Try a new Ts guess and repeat steps 3 through 8, as many times as required until the Auto-Tuning process eventually converges.
9	Follow these guidelines to provide a new Ts guess: • Auto-Tuning ends with the detected error code 800C hex. This means the sampling period Ts is too large. Decrease the value of Ts to provide a new guess. • Auto-Tuning ends with the detected error code 800A hex. This means the sampling period Ts is too small. Increase the value of Ts to provide a new guess.
10	Adjust the *PID* control parameters[2] (Kp, Ti, and Td) in the PID tab , page 310 of the **PID Assistant** screen, as needed.

(1) If you do not have any first indication of the possible range for the sampling period, set this value to the minimum possible: 1 (1 unit of 10 ms).

(2) If the PID regulation provided by this set of control parameters does not provide results that are totally satisfactory, you may still refine the trial-and-error evaluation of the sampling period until you obtain the correct set of Kp, Ti, and Td control parameters.

Online Mode

In online mode, when the logic controller is in the periodic task, the value displayed in the Ts field (in the **PID Assistant** screen, page 306) can be different from the parameter entered (%MW). The Ts value is a multiple of the periodic task, whereas the %MW value is the value read by the logic controller.

PID Assistant

Access the PID Assistant

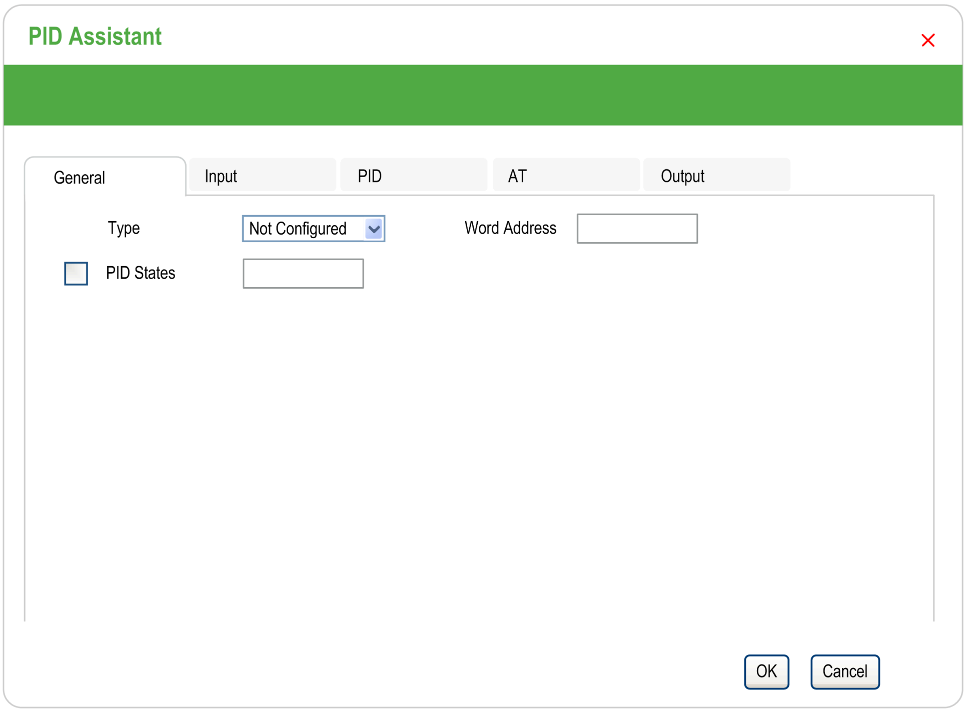
Introduction

Use the **PID Assistant** window of EcoStruxure Machine Expert-Basic to enable you to configure the *PID* controller.

Configuration Assistant

In the *PID* properties table, click the **Configuration [...]** button. The **PID Assistant** screen will appear.

This graphic displays the **PID Assistant** screen:



Type: Not Configured
Word Address
PID States

The **PID Assistant** screen displays several tabs, depending whether, you are in offline or online mode:

Tab	Access mode	Link
General	Offline	General tab, page 307
Input	Offline	Input tab, page 309
PID	Offline	PID tab, page 310
AT	Offline	AT tab, page 311
Output	Offline	Output tab, page 312

Once an operating mode is selected, tabs containing empty fields that require values are shown as display ⊗ and the border of the field is filled in red.

General Tab

Introduction

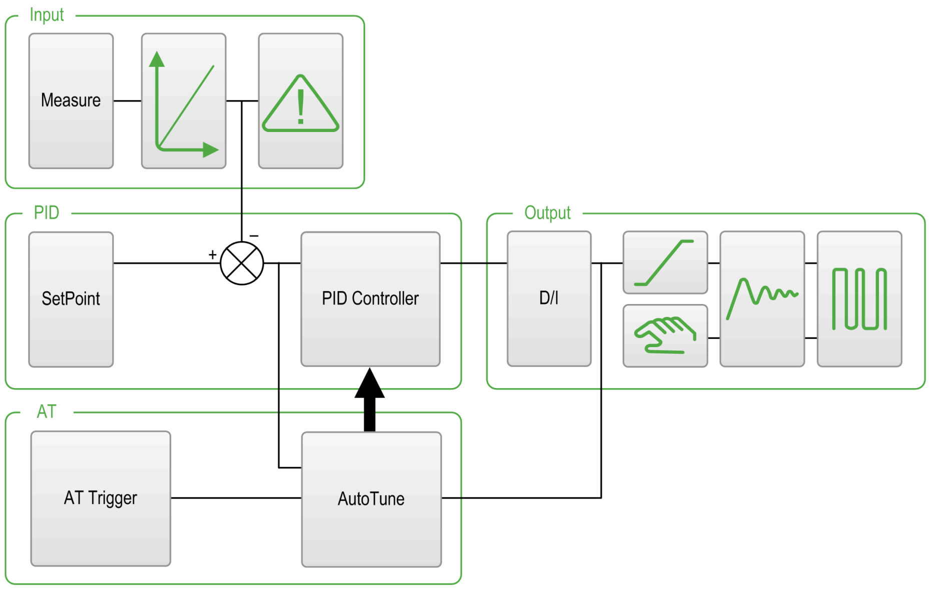
This section describes the **General** tab of the *PID*. **General** tab is displayed by default when you access the *PID* Assistant in offline mode.

Description

The table below describes the settings on the **General** tab.

Parameter	Description
Operating Mode	Represents the *PID* mode to use: • Not configured • PID • AT + PID • AT • Word address For further details about operating modes, refer to PID Operating Mode, page 294.
Word address	You can provide a memory word in this text box (%MWxx) that is used to programmatically set the operating mode. The memory word can take 4 possible values depending on the operating mode you want to set: • %MWx = 0 (PID disabled) • %MWx = 1 (to set PID only) • %MWx = 2 (to set AT + PID) • %MWx = 3 (to set AT only) • %MWx = 4 (to set PI only)
PID States	If you check the box to enable this option, you can provide a memory word in the associated field (%MWxx) that is used by the *PID* controller to store the current *PID* state while running the *PID* controller and/or the Auto-Tuning function. For more details, refer to PID States and Detected Error Codes, page 316.

Graphical Assistant



The graphical assistant helps you to visualize how the *PID* function is built. This is a dynamic graphic that is updated according to the configuration.

The icons shown below describe when it is accessible or what happens if you click on it:

Display	**Description**
SetPoint	Click this button to display the SetPoint field of the **PID** tab, page 310.
PID Controller	Click this button to display the **PID** tab, page 310.
D/I	Click this button to display the **Output** tab, page 312.
Measure	Click this button to display the **Input** tab, page 309.
AT Trigger	Click this button to display the **AT** tab, page 311.
AutoTune	Click this button to display the **AT** tab, page 311.
↗	This button appears when the **Authorize** option is checked in the **Conversion** zone of the **Input** tab, page 309.
⚠	This button appears when the **Authorize** option is checked in the **Alarms** zone of the **Input** tab, page 309.

Display	Description
╱	This button appears if **Limits** is not equal to inhibit in the limits zone of the **Output** tab, page 312.
✋	This button appears if manual mode is not equal to Inhibit in the manual mode zone of the **Output** tab, page 312.
∿	Click this button to display the **Output** tab, page 312.
⎍	This button appears when the **Authorize** option is checked in the Output PWM zone of the **Output** tab, page 312.

Input Tab

Introduction

This section describes the **Input** tab of *PID*. The **input** tab is used to enter the *PID* input parameters.

This tab is only accessible in offline mode and when an operating mode is selected from the **General** tab.

> **NOTE:** To retain input values following a cold restart, use memory words (*%MW*) and not analog inputs (*%IW*).

Description

The table below describes the settings that you may define.

Parameter	Description	
Measure	Specify the variable that contains the process value to be controlled. The default scale is from 0 to 10000. You can enter either a memory word (`%MWxx`) or an analog input.	
Conversion	**Authorize**	Activate this box to convert the process value [**0...10000**] into a linear range [**Min...Max**]. This conversion also applies to the setpoint value.
	Min value **Max value**	Specify the minimum and maximum values of the conversion scale. The process value is then automatically rescaled within the **[Min value...Max value]** interval. **Min value** or **Max value** can be memory words (`%MWxx`), constant words (`%KWxx`), or a value from -32768 to +32767. **NOTE:** The **Min value** must be less than the **Max value**.
Filter	**Authorize**	Activate this box to apply a filter to the measured input.
	(100 ms)	Specify the filter value from 0 to 10000 or a memory word address (`%MWxx`). The filter time base unit is 100 ms.
Alarms	**Authorize**	Activate this box to activate alarms in input variables. The alarm values should be determined relative to the process value obtained after the conversion phase. The alarm values must be from **Min value** to **Max value** when conversion is active. Otherwise, the alarm values will be from 0 to 10000.

Parameter	**Description**	
	Low **Output**	Specify the low alarm value in the **Low** field. This value can be a memory word (`%MWxx`), a constant (`%KWxx`), or a direct value. **Output** must contain the address of the bit, which will be set to 1 when the lower limit is reached. **Output** can be either a memory bit (`%Mxx`) or an output.
	High **Output**	Specify the high alarm value in the **High** field. This value can be a memory word (`%MWxx`), a constant (`%KWxx)`, or a direct value. **Output** must contain the address of the bit, which will be set to 1 when the upper limit is reached. **Output** can be either a memory bit (`%Mxx`), or an output.

PID Tab

Introduction

Use **PID** tab to enter the internal *PID* parameters.

This tab is only accessible in offline mode and if an operating mode has been selected from the **General** tab.

Description

This table describes the settings that you may define:

Parameter	**Description**	
Setpoint	Specify the *PID* setpoint value. This value can be a memory word (%MWxx), a constant word (%KWxx), or a direct value. This value must therefore be between 0 and 10000 when conversion is inhibited. Otherwise it must be between the **Min value** and the **Max value** for the conversion.	
Corrector type	If the **PID** or **AT + PID** operating mode has been previously chosen in the *PID* properties table, you can select the desired corrector type (**PID** or **PI**) from the drop-down list. If other operating modes (**AT** or **Word Address**) have been chosen, the **Corrector type** is set to **Auto** and greyed out (it cannot be modified manually). If **PI** is selected from the drop-down list, the Td parameter is forced to 0 and this field is disabled.	
Parameters (1)	**Kp (x0,01s)**	Specify the *PID* proportional gain, multiplied by 100. This value can be a memory word (%MWxx), a constant word (%KWxx), or a direct value. The valid range for the Kp parameter is: 0 < Kp < 10000. **NOTE:** If Kp is mistakenly set to 0 (Kp ≤ 0 is invalid), the default value Kp=100 is automatically assigned by the *PID* function.
	Ti (x0,1s)	Specify the integral time for a timebase of 0.1 seconds. This value can be a memory word (%MWxx), a constant word (%KWxx), or a direct value. It must be from 0 to 36000. **NOTE:** To disable the integral action of the *PID*, set this coefficient to 0.
	Td (x0,1s)	Specify the derivative time for a timebase of 0.1 seconds. This value can be a memory word (%MWxx), a constant word (%KWxx), or a direct value. It must be from 0 to 10000.

Parameter	Description	
		NOTE: To disable the derivative action of the *PID*, set this coefficient to 0.
Sampling period	Specify the *PID* sampling period here for a timebase of 10^{-2} seconds (10 ms). This value can be a memory word (%MWxx), a constant word (%KWxx), or a direct value. It must be from 1 (0.01 s) to 10000 (100 s).	
(1) When Auto-Tuning is enabled, you no longer need to set the Kp, Ti, and Td parameters as they are automatically and programmatically set by the Auto-Tuning algorithm. In this case, you must enter in these fields an **internal word address** only (%MWxx). Do not enter a constant or a direct value when Auto-Tuning is enabled.		

AT Tab

Introduction

The **AT** tab is related to the Auto-Tuning function. For more details, refer to PID tuning with Auto-Tuning, page 300.

This tab is only accessible in offline mode and if an operating mode has been selected from the **General** tab.

Description

PID Auto-Tuning is an open-loop process that acts directly on the control process without regulation or any limitation other than provided by the Process Value (PV) limit and the output setpoint. Therefore, both values must be carefully selected within the allowable range as specified by the process to prevent potential process overload.

When the PID is implemented with Auto-Tuning, the **Dynamic AT Corrector** parameter affects the proportional gain (Kp) value. The computation of the proportional gain in Auto-Tuning process depends on the selected dynamic corrector speed. You can select one of the following options:

- **Fast**
- **Medium**
- **Slow**
- **Word address**

See the descriptions of the options in the table below.

⚠WARNING

UNSTABLE PID OPERATION

- The Process Value (PV) limit and the output setpoint values must be set with complete understanding of their effect on the machine or process.
- Do not exceed the allowable range for Process Value and Output Setpoint values.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Do not use a relay output with the PID function.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

This table describes the settings that you may define:

Field	Description	
AT Mode	**Authorize**	Activate this box to enable Auto-Tuning operation. There are 2 ways to use this checkbox, depending on whether you set the operating mode manually or via a word address in the **General** tab of the *PID* function: • If you set the **Operating mode** to **PID + AT** or **AT** from the **General** tab, page 307, then the **Authorize** option is activated and not editable. • If you set the operating mode via a word address `%MWx` (`%MWx` = 2: **PID + AT**; `%MWx` = 3: **AT**), then you have to activate the **Authorize** option manually to allow configuring of the Auto-Tuning parameters.
Measurement Range	**Authorize**	Activate this box to enable the range measurement. **NOTE:** If the range measurement is deactivated the **Min.** value is set to 0 and the **Max.** value is set to 10000.
	Min. **Max**	Set the**Min.** and **Max** values based on the measurement range of 1% above or below the setpoint. The values can be immediate values from 1 to 10000 or a memory word `%MWx`. **NOTE:** The **Min.** value must be less than the **Max.** value. **Example**: If the process value must be around 35°C ± 3°C: • The setpoint is 350. • ± 3°C is h, page 301 and should be 30. • Therefore 1% x (**Max** - **Min**) = 30 • Therefore **Max** = 3100 and **Min** = 100
Dynamic AT corrector	**Fast** **Medium** **Slow** **Word address**	This parameter affects the proportional gain (Kp) value computed by the AT process. • **Fast** provides a fast response time with more overshoot than medium. • **Medium** provides medium response time with medium overshoot. • **Slow** provides a slower response time with less overshoot than medium. • **Word address** provides a response time configured with a specific word object `%MW`.
AT Trigger	**AT Trigger**	This parameter allows you to launch the AT process each time a rising edge is detected on the dedicated bit (memory bit or digital input bit).

Calculated Kp, Ti, Td Coefficients

Once the Auto-Tuning process is complete, the calculated Kp, Ti, and Td *PID* coefficients are stored in their respective memory words (`%MWx`).

Output Tab

Introduction

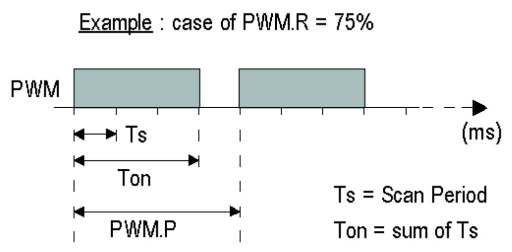
This tab is used to enter the *PID* output parameters.

This tab is only accessible in offline mode and if an operating mode has been selected from the **General** tab.

NOTE: To retain output values following a cold restart, use memory words (*%MW*) and not analog outputs (*%QW*).

Description

This table describes the settings that you may define:

Field	Description
Action	Specify the type of *PID* action on the process here. Three options are available: **Reverse**, **Direct**, and **Bit Address**. If an increase in the output causes an increase in the process value measurement, define inverted action (Reverse); on the other hand, if this causes a process value reduction, make the *PID* direct (Direct). If you select **Bit Address**(1), you can modify the action type by modifying the associated bit, which is either a memory bit (%Mxx) or an input address (%Ix.y). The memory bit is set to 1 if the action is **Direct** and the memory bit is set to 0 if the action is **Reverse**.
Limits	Specify whether to place limits on the *PID* output. 3 options are available: **Enable**, **Disable**, and **Bit Address**. Select **Enable** to set the **Bit** to 1 or select **Disable** to set the **Bit** to 0. Select **Bit Address** for limit management of the bit by modifying the associated bit, which is either a memory bit (%Mxx) or an input address (%Ix.y). Set the high and low limits for the *PID* output. **Min.** or **Max** can be memory word (%MWxx), constant word (%KWxx), or a value from 1 to 10000. **NOTE:** The **Min.** must be less than the **Max** value.
Manual mode	Specify whether to change the *PID* to manual mode. 3 options are available: **Enable**, **Disable**, and **Bit Address**. If you select **Bit Address**, you can switch to manual mode (bit to 1) or automatic mode (bit to 0) using the program, by modifying the associated bit which is either a memory bit (%Mxx) or an input. The **Output** of manual mode must contain the value that you wish to assign to the analog output when the *PID* is in manual mode, page 303. This **Output** can be either a word (%MWxx) or a direct value in the [0...10,000] format.
Analog output	Specify the *PID* output to use when in auto-tuning mode. This **Analog output**(2) can be a memory word address or an analog output address.
Output PWM	Check this box to use the PWM function of *PID*. Specify the modulation period in the **Period (0.1 s)** text box. This period must be from 1 to 500 and can be a memory word (%MWxx) or a constant word (%KWxx). PWM precision depends on both the PWM period and the scan period. The precision is improved when the PWM ratio (%PWM.R) has the greatest number of values. For instance, with scan period = 20ms and PWM period = 200ms, PWM.R can take values 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%. With scan period = 50 ms and PWM period = 200 ms, PWM.R can take values 0%, 25%, 50%, 75% and 100% of the period PWM.P.  Example : case of PWM.R = 75% PWM Ts (ms) Ton Ts = Scan Period PWM.P Ton = sum of Ts Specify the PWM output bit as the value in **Output**. This can be either a memory bit (%Mxx) or an output address. For further details about PWM function, refer to the *Functions Library Guide* of your logic controller.
(1) When Auto-Tuning is enabled, the Auto-Tuning algorithm automatically determines the correct type of action direct or reverse for the control process. You must then enter in the associated **Bit Address** textbox a memory bit (%Mxx) only. (2) Enter a memory address (%MWxx) or an analog output address (%QWx.y).	

PID Programming

Using PID Function

This section provides descriptions and programming guidelines for using **PID** function.

Description

Introduction

A proportional–integral–derivative (*PID*) is a generic control loop feedback mechanism (controller) widely used in industrial control systems. The *PID* controller uses an algorithm that involves 3 separate constant parameters: the proportional, the integral, and derivative values, denoted by P, I, and D respectively.

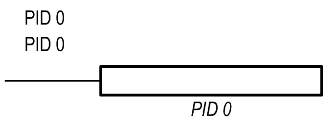
Key Features

The key features of the EcoStruxure Machine Expert-Basic PID function are as follows:

- Analog input
- Linear conversion of the configurable measurement
- High or low configurable input alarm
- Analog or PWM output
- Cutoff for the configurable output
- Configurable direct or inverse action
- Auto-tuning function

Illustration

This is the *PID* function in the Ladder editor of EcoStruxure Machine Expert-Basic:



NOTE: There must be a space between PID and the PID number (for example, PID<space>0).

Parameters

Unlike the *Timer* or the *Counter* function blocks, there is no *PID* function block in EcoStruxure Machine Expert-Basic. The instruction `[PID x]` only enables the *PID* control loop function, where x is the PID number.

To configure the *PID* function, goto the **Programming** window, click **Tools > PID**, and then edit the PID properties (refer to the table below for the configuration parameters).

The *PID* function has the following parameters:

Parameter	Description	Value
Used	Checked if the I/O is used somewhere in the project	True/False False (Default)
PID	Name of the current *PID* object	A program can contain only a limited number of *PID* functions. Refer to the maximum number of objects table for the maximum number of *PID* objects available with your logic controller.
Symbol	Symbol of the current *PID* object	The symbol associated with this *PID* object. For more information, refer to Defining Symbols (see EcoStruxure Machine Expert - Basic, Operating Guide).
[...]	A button to launch the assistant	Click to display the **PID Assistant** screen. For further details, refer to PID Assistant, page 306.
Comment	Comment	A comment can be associated with this object.

Programming and Configuring

Introduction

This section describes how to program and configure the EcoStruxure Machine Expert-Basic *PID* controller.

Enabling the PID Controller

The following example enables the `PID 0` controller loop if the bit %M0 is set to 1:

Rung	Instruction

0	`LD %M0`
	`[PID 0]`

NOTE: Refer to the reversibility procedure, page 161 to obtain the equivalent Ladder Diagram.

PID Analog Measurement

The *PID* function completes a *PID* correction using an analog measurement and setpoint and produces either an analog command in the same format or a PWM on a digital output.

To use *PID* at full scale (the highest resolution), configure the analog input dedicated to the *PID* controller measurement in [0...10,000] format. However, if you use the default configuration [0...4095], the *PID* controller will still function correctly.

Configuring the Scan Period

When using EcoStruxure Machine Expert-Basic *PID* controllers, you must configure the scan mode of the logic controller to **Periodic** scan mode (**Program** tab, **Tasks > Master Task**). In periodic scan mode, each scan of the logic controller starts at a regular time interval so the sampling rate is constant throughout the measurement period. For further details on configuring the scan mode, refer to the *EcoStruxure Machine Expert-Basic Operating Guide*.

In periodic scan mode, the system bit %S19 is set to 1 by the system if the logic controller scan time is greater than the period defined by the user program.

PID States and Detected Error Codes

Introduction

The EcoStruxure Machine Expert-Basic *PID* controller has the ability to write the current state of both the *PID* controller and the Auto-Tuning process to a user-defined memory word. For further information on how to enable and configure the *PID* States memory word, refer to the **General** tab, page 307 of the PID Assistant, page 306.

The *PID* state memory word can record the following types of *PID* information:

- Current state of the *PID* controller
- Current state of the Auto-Tuning process
- *PID* detected error codes
- Auto-Tuning detected error codes

NOTE: The *PID* States memory word is read-only.

PID State Memory Word

PID State	Description
0000 hex	*PID* control is not active
2000 hex	*PID* control is in progress
4000 hex	*PID* setpoint has been reached

Auto-Tuning State Memory Word

Auto-Tuning State	Description
0100 hex	Auto-Tuning phase 1, page 301 in progress
0200 hex	Auto-Tuning phase 2, page 301 in progress
0400 hex	Auto-Tuning phase 3, page 301 in progress
0800 hex	Auto-Tuning phase 4, page 301 in progress
1000 hex	Auto-Tuning phase complete

PID Detected Error Codes

This table describes the potential detected errors that may be encountered during *PID* control:

Detected Error Code	Description
8001 hex	Operating mode value out of range
8002 hex	Linear conversion min and max equal
8003 hex	Upper limit for discrete output lower than lower limit
8004 hex	Setpoint limit out of linear conversion range
8005 hex	Setpoint limit less than 0 or greater than 10000
8006 hex	Setpoint out of linear conversion range
8007 hex	Setpoint less than 0 or greater than 10000
8008 hex	Control action different from action determined at Auto-Tuning start

Auto-Tuning Detected Error Codes

This table records the Auto-Tuning detected error messages and describes possible causes as well as troubleshooting actions:

Detected Error Code	Description
8009 hex	The Process Value (PV) limit has been reached. As Auto-Tuning is an open-loop process, the Process Value (PV) limit works as maximum allowed value.
800A hex	Either the sampling period is too small or the output setpoint is too low. Increase either the sampling period or the Auto-Tuning output setpoint value.
800B hex	Kp is zero.
800C hex	The time constant is negative so the sampling period may be too large. For more details, refer to Limitations on Using the Auto-Tuning, page 302.
800D hex	Delay is negative.
800E hex	Detected error when calculating Kp. The Auto-Tuning algorithm is unstable (no convergence). This may be due to: • Disturbances on the process during Auto-Tuning has caused a distortion of the process static gain evaluation. • The process value transient response is not large enough for Auto-Tuning to determine the static gain. • A combination of the above. Check the *PID* and Auto-Tuning parameters and make adjustments to improve convergence. Check also if there is no disturbance that could affect the process value. Try modifying: • the output setpoint • the sampling period Make sure that there is no process disturbance while Auto-Tuning is in progress.
800F hex	Time constant exceeds delay ratio, $\tau/\theta > 20$. *PID* regulation may no longer be stable. For more details, refer to Limitations on Using the Auto-Tuning, page 302.
8010 hex	Time constant exceeds delay ratio, $\tau/\theta < 2$. *PID* regulation may no longer be stable. For more details, refer to Limitations on Using the Auto-Tuning, page 302.
8011 hex	The limit for static gain Kp has been exceeded, Kp>10000. Measurement sensitivity of some application variables may be too low. The range must be rescaled within the [0...10000] interval.
8012 hex	The computed value of integral time constant Ti has been exceeded, Ti > 20000.
8013 hex	The computed value of derivative time constant Td has been exceeded, Td > 10000.
8014 hex	Invalid input variables value (out of the range defined by low output and high output alarms, page 309).
8015 hex	Filter processing error: • Cycle time out of range. • Filter time < 10 x cycle time.

PID Parameters

Role and Influence of PID Parameters

Introduction

This section describes the role and influence of PID parameters.

PID Controller Model

The EcoStruxure Machine Expert-Basic PID Controller implements a mixed (serial-parallel) PID correction. The integral and derivative actions act both independently and in parallel. The proportional action acts on the combined output of the integral and derivative actions.

Computational Algorithms

Two different computational algorithms are used depending on the value of the integral time constant (Ti):

- If Ti ≠ 0, an incremental algorithm is used,
- If Ti = 0, a positional algorithm is used, along with a +5000 offset that is applied to the PID output.

Influence of Actions

Proportional action is used to influence the process response speed. An increase of the proportional action implies:

- a faster response
- a lower static error
- decrease in stability

Integral action is used to cancel out the static error. An increase of integration action (that is, a decrease of the integral time Ti) induces:

- A faster response
- A decrease in stability

Derivative action is anticipatory. In practice, it adds a term which takes account of the speed of variation in the deviation (which makes it possible to anticipate changes by accelerating process response times when the deviation increases and by slowing them down when the deviation decreases). An increase of derivative action (that is, an increase of the derivative time) implies:

- A slower response
- A reduced overshoot

  NOTE: Given the derivative time, Td is the time used to anticipate the variation of the deviation. Values of Td that are too low or too high can lead to unwanted oscillations.

For each action, a suitable compromize must be found between speed and stability.

Limits of the PID Control Loop

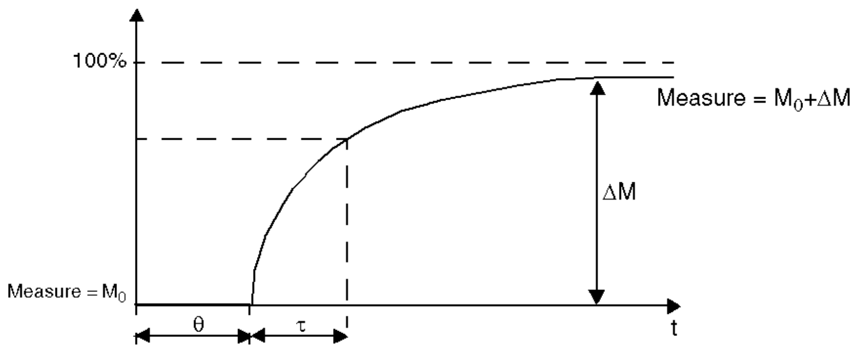
The process is assimilated to a pure delay first order with a transfer function:

$$H(p) = K \times \frac{e^{-\theta p}}{1 + \tau p}$$

where:

τ: model time constant

θ: model delay



The process control performance depends on the ratio $\frac{\tau}{\theta}$

The suitable PID process control is attained in the following domain: 2< $\frac{\tau}{\theta}$ <20

PID process control is best suited for the regulation of processes that satisfy the following condition:

- For $\frac{\tau}{\theta}$ <2, in other words for fast control loops (low θ) or for processes with a large delay (high t) the PID process control is no longer suitable. In such cases more complex algorithms should be used.
- For $\frac{\tau}{\theta}$ >20, a process control using a threshold plus hysterisis is sufficient.

PID Parameter Adjustment Method

Introduction

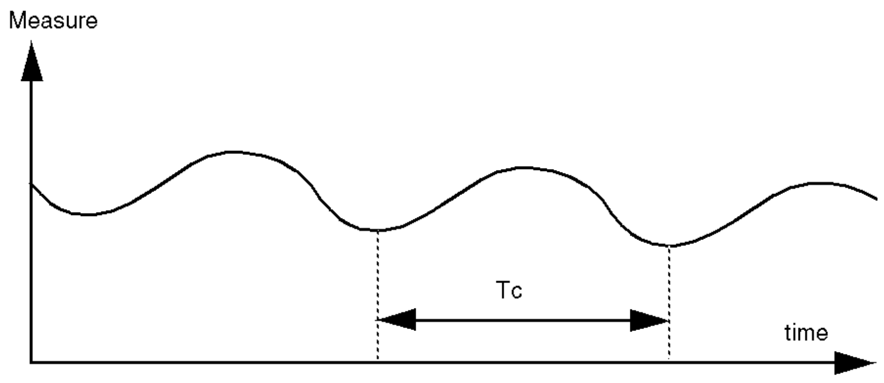
Numerous methods to adjust the PID parameters exist. The preferred method is the Ziegler and Nichols, which has 2 variants:

- closed loop adjustment
- open loop adjustment

Before implementing one of these methods, you must set the PID action, page 312.

Closed Loop Adjustment

This principle uses a proportional command (Ti = 0, Td = 0) to start the process by increasing a proportional coefficient until it starts to oscillate again after having applied a level to the PID corrector setpoint. All that is required is to raise the critical proportional gain (Kpc) which has caused the non-damped oscillation and the oscillation period (Tc) to reduce the values giving an optimal regulation.

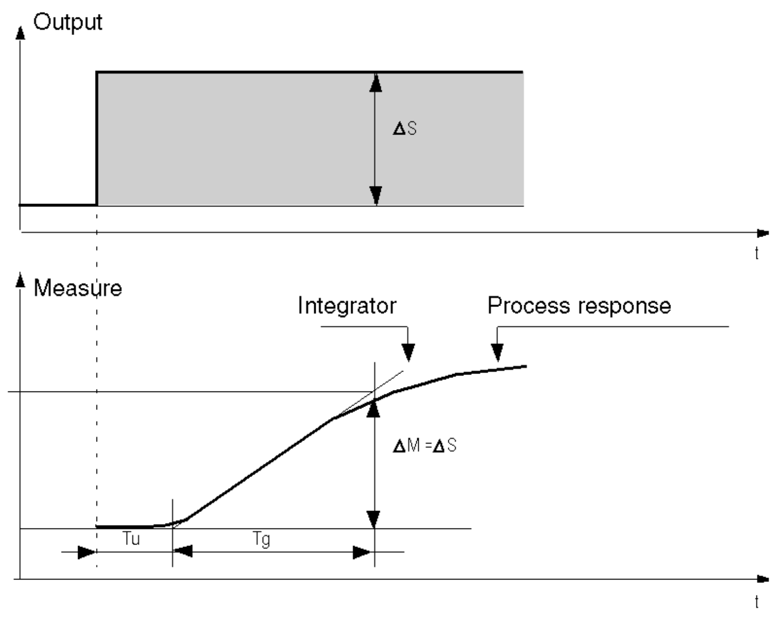


Depending on the corrector type used (PID or PI), the adjustment of the coefficients is executed with the following values:

Corrector	Kp: Proportional Gain	Ti: Integration Time	Td: Derivative
PID	Kpc/1.7	Tc/2	Tc/8
PI	Kpc/2.22	0.83 x Tc	–

Open Loop Adjustment

As the regulator is in manual mode, page 303, you apply a level to the output and make the procedure response start the same as an integrator with pure delay time.



The intersection point on the right hand side, which is representative of the integrator with the time axes, determines the time Tu. Next, the Tg time is defined as the time necessary for the controlled variable (measurement) to have the same variation size (% of the scale) as the regulator output.

Depending on the corrector type used (PID or PI), the adjustment of the coefficients is executed with the following values:

Corrector	Kp: Proportional Gain	Ti: Integration Time	Td: Derivative
PID	-1.2 Tg/Tu	2 x Tu	0.5 x Tu
PI	-0.9 Tg/Tu	3.3 x Tu	–

NOTE: For further details about parameter units, refer to **PID** tab, page 310.

This adjustment method also provides a very dynamic command, which can express itself through unwanted overshoots during the change of pulses of the setpoints. In this case, lower the proportional gain until you get the required behavior. The method does not require any assumptions about the nature and the order of the procedure. You can apply it just as well to the stable procedures as to real integrating procedures. In the case of slow procedures (for example, the glass industry), the user only requires the beginning of the response to regulate the coefficients Kp, Ti, and Td.

System Objects

What’s in This Chapter

System Bits (%S)

Introduction

This section provides information about the function of system bits.

Displaying System Bits Properties

Follow these steps to display properties of the system bits:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **System objects > System Bits**. **Result**: System bit properties appear on the screen.

System Bits Properties

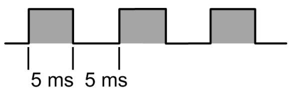
This table describes each property of the system bit:

Parameter	Editable	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the system bit is being referenced in a program.
Address	No	%Si	–	Displays the system bit address, where i is the bit number that represents the sequential position of the system bit in the memory. If the controller has maximum n system bits, the value of i is given as 0...n-1. For example, *%S4* is system bit 4.
Symbol	Yes	–	–	The symbol associated with the system bit. Double-click in the **Symbol** column and type the name of the symbol to associate with the system bit. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of the symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with the system bit. Double-click in the **Comment** column and type an optional comment to associate with the system bit.

System Bits Description

This table presents the description of the system bits and how they are controlled:

System Bit	Function	Description	Init State	Control
`%S0`	Cold start	Normally set to 0, it is set to 1 by: • A power return with loss of data (battery malfunction), • The program or an animation table. This bit is set to 1 during the first complete scan. It is reset to 0 by the system before the next scan.	0	S or U→S, SIM

`%S4`
`%S5`
`%S6`
`%S7`
	Time base: 10 ms
	Time base: 100 ms
	Time base: 1 s
	Time base: 1 min
		The rate of status changes is measured by an internal clock. They are not synchronized with the controller scan.
		Example: `%S4`
		
		5 ms 5 ms
			–	S, SIM (except `%S4`)

`%S9`	Fallback outputs	When `%S9` is set to 1: • For outputs configured as Status Alarms, PTO, or FREQGEN, the outputs are set to 0. • Fallback values are applied to the physical digital and analog outputs (embedded outputs, TM2/TM3 expansion module outputs and TMC2 cartridge outputs). The data image is unaffected by `%S9`. The data image reflects the logic applied by the application. Only the physical outputs are affected. • The fallback values are applied regardless of the fallback behavior mode configured for specific outputs. When `%S9` is set to 0, the data image values are re-applied to the physical outputs. **NOTE:** When the controller is in the *STOPPED* state and **Maintain values** fallback behavior is configured, a rising edge on *%S9* applies fallback values to the physical outputs and to data image values.	0	U
`%S10`	I/O communication status	Normally set to 1 (TRUE on control panel). This bit can be set to 0 (FALSE on control panel) by the system when an I/O communication interruption is detected.	1	S
`%S11`	Watchdog overflow	Normally set to 0. This bit can be set to 1 by the system when the program execution time (scan time) exceeds the maximum scan time (application watchdog) or overload of processor (%SW75 exceeds 80%). Watchdog overflow causes the controller state to change to HALT.	0	S
`%S12`	Logic Controller in RUNNING state	This bit indicates that the controller is in RUNNING state. The system sets the bit to: • 1 when the controller state is RUNNING, • 0 for STOPPED, BOOTING or any other state.	0	S, SIM
`%S13`	First cycle in RUNNING state	Normally set to 0, this bit is set to 1 by the system during the first scan after the controller state has been changed to RUNNING.	1	S, SIM
`%S15`	Input forced	Normally set to 0. Set to 1 by the system if at least one input is being forced.	0	S, SIM
`%S16`	Output forced	Normally set to 0. Set to 1 by the system if at least one output is being forced.	0	S, SIM
`%S17`	Last ejected bit	Normally set to 0. It is set by the system according to the value of the last ejected bit. It indicates the value of the last ejected bit.	0	S→U, SIM
`%S18`	Arithmetic overflow or error	Normally set to 0. It is set to 1 in the case of an overflow when a 16-bit operation is performed, that is: • A result greater than + 32767 or less than - 32768, in single length, • A result greater than + 2147483647 or less than - 2147483648, in double length, • A result greater than + 3.402824E+38 or less than - 3.402824E +38, in floating point,	0	S→U, SIM

System Bit	Function	Description	Init State	Control
		• Division by 0, • The square root of a negative number, • BTI or ITB conversion not significant: BCD value out of limits. It must be tested by the program after each operation where there is a risk of an overflow; then reset to 0 by the program if an overflow occurs.		
`%S19`	Scan period overrun (perGrafcetiodic scan)	Normally at 0, this bit is set to 1 by the system in the event of a scan period overrun (scan time greater than the period defined by the program at configuration or programmed in `%SW0`). This bit is reset to 0 by the program.	0	S→U
`%S20`	Index overflow	Normally at 0, it is set to 1 when the address of the indexed object becomes less than 0 or more than the maximum size of an object. It must be tested by the program after each operation where there is a risk of overflow; then reset to 0 if an overflow occurs.	0	S→U, SIM
`%S21`	Grafcet initialization	Normally set to 0, it is set to 1 by: • A cold restart, `%S0` = 1, • The program, in the preprocessing program part only, using a Set Instruction (`S %S21`) or a set coil –(S)– `%S21`, • The terminal. At state 1, it causes Grafcet initialization. Active steps are deactivated and initial steps are activated. It is reset to 0 by the system after Grafcet initialization.	0	U→S, SIM
`%S22`	Grafcet reset	Normally set to 0, it can only be set to 1 by the program in pre-processing. At state 1, it causes the active steps of the entire Grafcet to be deactivated. It is reset to 0 by the system at the start of the execution of the sequential processing.	0	U→S, SIM
`%S23`	Preset and freeze Grafcet (List)	Normally set to 0, it can only be set to 1 by the program in the pre-processing program module. Set to 1, it validates the pre-positioning of Grafcet (List). Maintaining this bit at 1 freezes the Grafcet (List) execution. It is reset to 0 by the system at the start of the execution of the sequential processing to ensure that the Grafcet chart moves on from the frozen situation.	0	U→S, SIM
`%S28`	String overflow	Set to 1, it indicates that there is an overflow in a memory object when managing strings.	0	S→U, SIM
`%S33`	Read or Write selection for Ethernet server configuration read/change	Normally set to 0. • Set to 0, the `%SW33` to `%SW38` contains the Ethernet parameters in use (IP declared or IP assigned by BOOTP or automatic IP self assigned). These parameters are those configured in the application or those of the post configuration in SD card (in this case, `%SW98` or `%SW99` or `%SW100` is different from 0). • Set to 1 (if there is no post configuration in use), then the new configuration is given by `%SW33` to `%SW38`. This bit can be set to its initial state 0 by the program and the system (on cold restart). Then, the Ethernet is reset to apply the application configuration whatever the current configuration is. This bit cannot be set to 1 if a post configuration is in use.	0	U→S
`%S34`	Ethernet autonegotiation	Not support this function.	0	U
`%S35`	Ethernet half/full duplex mode	Not support this function.	–	U or S
`%S36`	Ethernet speed	Not support this function.	–	U or S
`%S38`	Permission for events to be placed in the events queue	Normally at 1. • Set to 0, events cannot be placed in the events queue. • Set to 1, events are placed in the events queue as soon as they are detected. This bit can be set to its initial state 1 by the program and the system (on cold restart).	1	U→S
`%S39`	Saturation of the events queue	Normally at 0. • Set to 0, all events are reported.	0	U→S

System Bit	Function	Description	Init State	Control
		• Set to 1, at least one event is lost. This bit can be set to 0 by the program and the system (on cold restart).		
`%S49`	Output rearming, page 35	Normally set to 0, this bit can be set to 1 or 0 by the program. • Set to 0, the automatic re-arming of outputs following a short circuit is disabled. • Set to 1, the automatic re-arming of outputs following a short circuit is enabled. **NOTE:** The bit is reset to 0 after a cold start, otherwise the bit value is retained The system bit `%S10` can be used to detect within your program that an output error has occurred. You can then use the system word `%SW139` to determine programmatically in which cluster outputs a short circuit or overload has occurred. **NOTE:** `%S10` and `%SW139` are reset to their initial value when `%S49` is set to 1.	0	U→S
`%S50`	Updating the date and time using words `%SW49` to `%SW53`	Normally set to 0, this bit can be set to 1 or 0 by the program. • Set to 0, the date and time can be read. • Set to 1, the date and time can be updated but not read. While %S50 is set to 1, the controller date and time are no longer updated by the system and cannot be read by the user program. The internal RTC controller is updated on a falling edge of `%S50`. Process details: • If %S50=0, the controller regularly updates the system words %SW49-53 from its internal clock. Reading %SW49-53 then provides the controller internal date & time. • Setting %S50 to 1 stops this update and allows to write to %SW49-53 without being overwritten by the above process. • When the controller detects a falling edge of %S50 (from 1 to 0), it applies the values of %SW49-53 to its internal clock and restarts the update of %SW49-53. This %S50 process is also the mechanism used by EcoStruxure Machine Expert-Basic to update the controller time from the RTC management view. So if EcoStruxure Machine Expert-Basic detects that %S50 is already set to 1, a message informs that EcoStruxure Machine Expert-Basic cannot read the exact value of the controller internal clock. However, this situation does not prevent updates to the controller date & time from the RTC management view but, if used, %S50 will be reset by EcoStruxure Machine Expert-Basic.	0	U→S
`%S51`	Time-of-day clock status	Normally set to 0, this bit can be set to 1 or 0 by the program. • Set to 0, the date and time are consistent. • Set to 1, the date and time must be initialized by the program. When this bit is set to 1, the time of day clock data is not valid. The date and time may never have been configured, the battery may be low, or the controller correction constant may be invalid (never configured, difference between the corrected clock value and the saved value, or value out of range). State 1 transitioning to state 0 forces a Write of the correction constant to the RTC.	0	U→S, SIM
`%S52`	RTC write error detected	This bit, managed by the system, is set to 1 to indicate that an RTC write (requested by %S50) has not been performed because of invalid values in %SW49 to %SW53, page 323. This bit is set to 0 if the requested RTC change has been correctly applied.	0	S, SIM
`%S59`	Update the date and time set in word `%SW59`	Normally set to 0, this bit can be set to 1 or 0 by the program: • Set to 0, the system word `%SW59` is not managed. • On a rising edge of this bit, the date and time are incremented or decremented according to the control bits set in `%SW59`.	0	U
`%S66`	Battery LED	If the battery is missing or in error, the battery LED is ON. Set this bit to 1 to deactivate the battery LED. This system bit is set to 0 at the start.	0	U→S
`%S75`	Battery status	This system bit is set by the system and can be read by the user. It indicates the battery status:	0	S

System Bit	Function	Description	Init State	Control
		• Set to 0, the external battery is operating normally. • Set to 1, external battery power is low, or no external battery is detected.		
`%S90`	Backup/Restore/Erase destination	This system bit selects the destination of the memory words backup/ restore/erase operation: • Set to 0: non-volatile memory (default). • Set to 1: SD card.	0	U
`%S91`	Erase backed up variables	Set this bit to 1 to erase the backed up variables stored in non-volatile memory or the SD card, depending on `%S90`.	–	U→S
`%S92`	`%MW` variables backed up in non-volatile memory	This system bit is set to 1 by the system if memory word (`%MW`) variables are available in non-volatile memory.	–	S
`%S93`	Back up `%MW`	Set this bit to 1 to back up the `%MW` variables in the non-volatile memory or SD card, depending on `%S90`.	–	U→S
`%S94`	Restore `%MW`	Set this bit to 1 to restore the data backed up in non-volatile memory or SD card, depending on `%S90`	–	U→S
`%S96`	Backup program OK	This bit can be read at any time (either by the program or while adjusting), in particular after a cold start. • Set to 0, the backup program is invalid. • Set to 1, the backup program is valid.	0	S, SIM
`%S101`	Changing a port address (Modbus protocol)	Used to change a serial line port address using system words `%SW101` (SL1), `%SW102` (SL2) and `%SW111` (SL3). To do this, `%S101` must be set to 1. • Set to 0, the address cannot be changed. The value of `%SW101`, `%SW102` and `%SW111` matches the current port address, • Set to 1, the address can be changed by changing the values of `%SW101` (SL1), `%SW102` (SL2) and `%SW111` (SL3). **NOTE:** `%S101` cannot be set to 1 if a post configuration file is defined on SL1 or SL2.	0	U
`%S102`	Using the ASCII protocol	Enables the use of the ASCII protocol on SL1 (`%S103`) , SL2 (`%S104`) or SL3 (`%S102`). The ASCII protocol is configured by using system words `%SW103` and `%SW105` for SL1, system words `%SW104` and `%SW106` for SL2, and system words `%SW112` and `%SW113`for SL3.		

`%S103`
 	
`%S104`
		• Set to 0, the protocol used is the one configured in EcoStruxure Machine Expert-Basic, or specified in the post configuration, page 38.
		• Set to 1, the ASCII protocol is used on SL1 (`%S103`) or SL2 (`%S104` or SL3 (`%S102`)). In this case, the system words `%SW103`, `%SW105`, and `%SW121` must be previously configured for SL1, and `%SW104`, `%SW106`, and `%SW122` for SL2, and `%SW112`, `%SW113`, and `%SW123` for SL3. Each change of those %SW will be taken into account after a rising edge to `%S103` or `%S104` or `%S102`.
		NOTE: A rising or falling edge of `%S103` or `%S104` or `%S102`cancels an exchange in progress (EXCH instruction)
		NOTE: Setting `%S103` or `%S104` or `%S102` to 0 reconfigures the serial line with the EcoStruxure Machine Expert-Basic parameters.
		NOTE: `%S103` and `%S104` and `%S102` are ignored if a Modbus Serial Line IOScanner is configured on the corresponding serial line.
			0	U

`%S106`	I/O bus behavior	The default value is 0, meaning that a bus communication error on an expansion module stops the I/O expansion bus exchanges. Set this bit to 1 to specify that the controller continues to make I/O expansion bus exchanges. **NOTE:** When a bus communication error occurs, bit n of %SW120 is set to 1, where n is the expansion module number, and %SW118 bit 14 is set to 0. For more information on bus error handling, refer to I/O Configuration General Description.	0	U/S
`%S107`	I/O bus restart	The default value is 0. Reset to 0 by the system. Set this bit to 1 to force a restart of the I/O expansion bus. On detection of a rising edge of this bit, the logic controller reconfigures and restarts the I/O expansion bus if:	0	U/S

System Bit	Function	Description	Init State	Control
		• %S106 is set to 0 (that is, I/O exchanges are stopped) • %SW118 bit 14 is set to 0 (I/O bus is in error) • At least one bit of %SW120 is set to 1 (identifying the module that is in bus communication error) For more information on bus error handling, refer to I/O Configuration General Description.		
`%S109`	IOScanner reset SL3	Set to 1 to reset the Modbus Serial IOScanner on Serial Line 3.	0	U/S
`%S110`	IOScanner reset SL1	Set to 1 to reset the Modbus Serial IOScanner on Serial Line 1.	0	U/S
`%S111`	IOScanner reset SL2	Set to 1 to reset the Modbus Serial IOScanner on Serial Line 2.	0	U/S
`%S112`	IOScanner reset ETH1	Set to 1 to reset the Modbus TCP IOScanner on Ethernet.	0	U/S
`%S113`	IOScanner suspend SL1	Set to 1 to suspend the Modbus Serial IOScanner on Serial Line 1.	0	U/S
`%S114`	IOScanner suspend SL2	Set to 1 to suspend the Modbus Serial IOScanner on Serial Line 2.	0	U/S
`%S115`	IOScanner suspend ETH1	Set to 1 to suspend the Modbus TCP IOScanner on Ethernet.	0	U/S
`%S116`	IOScanner suspend SL3	Set to 1 to suspend the Modbus Serial IOScanner on Serial Line 3.	0	U/S
`%S119`	Local I/O error detected	Normally set to 1. This bit can be set to 0 when an I/O communication interruption is detected on the logic controller. `%SW118` determines the nature of the communication interruption. Resets to 1 when the communication interruption disappears.	1	S

`%S124`
`%S125`
`%S126`
	Using the Modbus RTU protocol	Enables the use of the Modbus RTU protocol on SL1 (`%S124`) or SL2 (`%S125`) or SL3 (`%S126`). The Modbus RTU protocol is configured by using system words `%SW224` and `%SW227` for SL1, and system words `%SW225` and `%SW228` for SL2, and system words `%SW226` and `%SW229` for SL3.
		• Set to 0, the protocol used is the one configured in EcoStruxure Machine Expert-Basic, or specified in the post configuration, page 38.
		• Set to 1, the Modbus RTU protocol is used on SL1 (`%S124`) or SL2 (`%S125`) or SL3 (`%S126`). In this case, the system words `%SW224` and `%SW227` must be previously configured for SL1, `%SW225` and `%SW228` for SL2, `%SW226` and `%SW229` for SL3. Each change of those %SW will be taken into account after a rising edge to `%S124` or `%S125` or `%S126` .
		NOTE: A rising or falling edge of `%S124` or `%S125` or `%S126` cancels an exchange in progress (EXCH instruction)
		NOTE: Setting `%S124` or `%S125` or `%S126` to 0 reconfigures the serial line with the EcoStruxure Machine Expert-Basic parameters.
		NOTE: `%S124` and `%S125` or `%S126` are ignored if a Modbus Serial Line IOScanner is configured on the corresponding serial line.
		NOTE: `%S124` and `%S125` or `%S126` are ignored if in the post configuration exists.
			0	U

S: Controlled by the system U: Controlled by the user U→S: Set to 1 by the user, reset to 0 by the system S→U: Set to 1 by the system, reset to 0 by the user SIM: Applied in the Simulator				

System Words (%SW)

Introduction

This section provides information about the function of system words.

Displaying System Word Properties

Follow these steps to display properties of the system words:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **System objects > System Words**. **Result**: System word properties appear on the screen.

System Words Properties

This table describes each property of the system word:

Parameter	Editable	Value	Default Value	Description
Used	No	True/False	False	Indicates whether the system word is being referenced in a program.
Address	No	%SWi	–	Displays the system word address, where i is the word number that represents the sequential position of the system word in the memory. If the controller has maximum n system words, the value of i is given as 0...n-1. For example, *%SW50* is system word 50.
Symbol	Yes	–	–	The symbol associated with the system word. Double-click in the **Symbol** column and type the name of the symbol to associate with the system word. If a symbol already exists, you can right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of the symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with the system word. Double-click in the **Comment** column and type an optional comment to associate with the system word.

System Words Description

This table presents the description of the system words and how they are controlled:

System Words	Function	Description	Control
`%SW0`	Controller scan period (master task set to periodic scan mode)	Modifies the controller scan period (1...150 ms) defined in the Master task properties or an animation table.	U, SIM
`%SW1`	Periodic task period	Modifies the cycle time [1...255 ms] of the periodic task, without losing the **Period** value specified in the periodic task properties window. Allows you to recover the **Period** value saved in the periodic task properties window: • In case of a cold start, or • If the value you write in `%SW1` is outside [1...255] range.	U, SIM

System Words	Function	Description	Control
		The %SW1 value can be modified in the program at each end of a cycle, in the program or in an animation table without having to stop the program. Cycle times can be correctly observed while the program is running.	
%SW6	Controller state %MW60012	Controller state: 0 = EMPTY 2 = STOPPED 3 = RUNNING 4 = HALTED 5 = POWERLESS	S, SIM
%SW7	Controller state	• Bit [0]: Backup/restore in progress: ◦ Set to 1 if backup/restore of the program is in progress, ◦ Set to 0 if backup/restore of the program is complete or disabled. • Bit [1]: Configuration of the controller is OK: ◦ Set to 1 if configuration ok. • Bit [2]: SD card status bits: ◦ Set to 1 if SD card is present. • Bit [3]: SD card status bits: ◦ Set to 1 if SD card is being accessed. • Bit [4]: Application memory status: ◦ Set to 1 if application in RAM memory is different from that in flash memory. • Bit [5]: SD card status bits: ◦ Set to 1 if SD card is in error. • Bit [6]: Not used (status 0) • Bit [7]: Controller reserved: ◦ Set to 1 when the controller is in connected mode with EcoStruxure Machine Expert-Basic. • Bit [8]: Application in Write mode: ◦ Set to 1 if application is protected. In this case, the clone operation does not replicate the application (see Clone Management, page 140) • Bit [9]: Not used (status 0) • Bit [10]: Second serial port installed as cartridge (compact only): ◦ 0 = No serial cartridge ◦ 1 = Serial cartridge installed • Bit [11]: Second serial port type: ◦ Set to 1 = EIA RS-485 • Bit [12]: Validity of the application in internal memory: ◦ Set to 1 if the application is valid. • Bit [14]: Validity of the application in RAM memory: ◦ Set to 1 if the application is valid. • Bit [15]: Ready for execution: ◦ 0 = No serial cartridge ◦ 1 = Serial cartridge installed	S, SIM
%SW8	Controller state **NOTE:** SL3 is only supported on the function level 12.1.	Bit [0] – Bit [9]: not used • Bit [10]: Second serial port installed as cartridge (compact only): ◦ 0 = No serial cartridge • Bit [11]: Second serial port type: ◦ Set to 1 = EIA RS-485 Bit [12] – Bit [15]: not used	S, SIM
%SW11	Software watchdog value	Contains the maximum value of the watchdog. The value (10...500 ms) is defined by the configuration.	U, SIM
%SW13	BOOT version Vxx.yy	For example, if %SW13 = 000E hex: • 8 MSB = 00 in hexadecimal, then xx=0 in decimal • 8 LSB = 0E in hexadecimal, then yy=14 in decimal As a result, boot loader version is 0.14, displayed as 14 decimal.	U, SIM

System Words	Function	Description	Control
`%SW14`	Commercial version, Vxx.yy	For example, if `%SW14 = 0232`: • 8 MSB = 02 in hexadecimal, then xx=2 in decimal • 8 LSB = 32 in hexadecimal, then yy=50 in decimal As a result, commercial version is 2.50, displayed as 250 decimal.	S, SIM
`%SW15` - `%SW16`	Firmware version, aa.bb.cc.dd	For example, if `%SW15 = 0003 hex`: • 8 MSB = 00 in hexadecimal, then aa = 00 in decimal • 8 LSB = 03 in hexadecimal, then bb = 03 in decimal For example, if `%SW16 = 0B16 hex`: • 8 MSB = 0B in hexadecimal, then cc = 11 in decimal • 8 LSB = 16 in hexadecimal, then dd = 22 in decimal As a result, firmware version is 0.3.11.22 displayed as 00031122 decimal.	S, SIM
`%SW17`	Default status for floating operation	When an error is detected in a floating arithmetic operation, bit `%S18` is set to 1 and the default status of `%SW17` is updated according to the following coding: • Bit[0]: Invalid operation, result is not a number (NaN) • Bit[1]: Reserved • Bit[2]: Division by 0, result is invalid (-Infinity or +Infinity) • Bit[3]: Result greater in absolute value than +3.402824e+38, result is invalid (-Infinity or +Infinity)	S and U, SIM
`%SW18`–`%SW19`	100 ms absolute timer counter	This counter works using 2 words: • `%SW18` represents the least significant word, • `%SW19` represents the most significant word. `%SW18` increases from 0 to 32767 each 100 ms. When 32767 is reached, `%SW19` is incremented and `%SW18` is reset to 0. These double words are also reset during the initialization phase and on a reset of %S0.	S and U, SIM
`%SW30`	Last scan time (master task)	Indicates the execution time of the last controller scan cycle (in ms). **NOTE:** This time corresponds to the time elapsed between the start (acquisition of inputs) and the end (update of outputs) of a master task scan cycle. If the scan time is 2.250 ms, the `%SW30` is 2 and the `%SW70` is 250.	S
`%SW31`	Max. scan time (master task)	Indicates the execution time of the longest controller scan cycle since the last cold start (in ms). **NOTE:** • This time corresponds to the time elapsed between the start (acquisition of inputs) and the end (update of outputs) of a scan cycle. If the maximum scan time is 2.25 ms, the `%SW31` is 2 and the `%SW71` is 250. • To ensure proper detection of a pulse signal when the latching input option is selected, the pulse width (T_{ON}) and the period (P) must meet the following 2 requirements: ◦ $T_{ON} \geq 1$ ms ◦ The input signal period (P) must follow the Nyquist-Shannon sampling rule stating that the input signal period (P) must be at least twice the maximum program scan time (`%SW31`): P ≥ 2 x `%SW31`. **NOTE:** If this condition is not fulfilled, some pulses may be missed.	S
`%SW32`	Min. scan time (master task)	Indicates the execution time of shortest controller scan cycle since the last cold start (in ms). **NOTE:** This time corresponds to the time elapsed between the start (acquisition of inputs) and the end (update of outputs) of a scan cycle. If the minimum scan time is 2.250 ms, the `%SW32` will be 2 and the `%SW72` will be 250.	S

`%SW33`
`%SW34`
`%SW35`
`%SW36`
`%SW37`
`%SW38`
	IP address for Ethernet server configuration read/ write	The IP settings can be modified. The read or write selection is done using the system bit `%S33`.
		
		The system words `%SW34`...`%SW38` contain the Ethernet parameters:
		• IP address: `%SW33` and `%SW34`
		For IP address AA.BB.CC.DD: `%SW33` = CC.DD and `%SW34` = AA.BB
		• Subnetwork mask: `%SW35` and `%SW36`
		For subnetwork mask AA.BB.CC.DD: `%SW35` = CC.DD and `%SW36` = AA.BB
		• Gateway address: `%SW37` and `%SW38`
		For gateway address AA.BB.CC.DD: `%SW37` = CC.DD and `%SW38` = AA.BB
			U

System Words	Function	Description	Control
`%SW39`	Periodic average time	Indicates the average execution time in µs of the periodic task (last 5 times)	–
`%SW40`	Event 0 average time	Indicates the average execution time in µs of the event task associated with the input `%I0.2` (last 5 times)	–
`%SW41`	Event 1 average time	Indicates the average execution time in µs of the event task associated with the input `%I0.3` (last 5 times)	–
`%SW42`	Event 2 average time	Indicates the average execution time in µs of the event task associated with the input `%I0.4` (last 5 times)	–
`%SW43`	Event 3 average time	Indicates the average execution time in µs of the event task associated with the input `%I0.5` (last 5 times)	–
`%SW44`	Event 4 average time	Indicates the average execution time in µs of the event task associated with the Threshold 0 of `HSC0` or `HSC2` (last 5 times)	–
`%SW45`	Event 5 average time	Indicates the average execution time in µs of the event task associated with the Threshold 1 of `HSC0` or `HSC2` (last 5 times)	–
`%SW46`	Event 6 average time	Indicates the average execution time in µs of the event task associated with the Threshold 0 of `HSC1` or `HSC3` (last 5 times)	–
`%SW47`	Event 7 average time	Indicates the average execution time in µs of the event task associated with the Threshold 1 of `HSC1` or `HSC3` (last 5 times)	–
`%SW48`	Number of events	Indicates how many events have been executed since the last cold start. (Counts all events except cyclic events.) **NOTE:** Set to 0 (after application loading and cold start), increments on each event execution.	S, SIM

`%SW49`
`%SW50`
`%SW51`
`%SW52`
`%SW53`
	Real-Time Clock (RTC)	RTC functions: words containing current date and time values (in BCD):
		`%SW49` xN Day of the week (N=1 for Monday)
		`%SW50` 00SS Seconds
		`%SW51` HHMM: hour and minute
		`%SW52` MMDD: month and day
		`%SW53` CCYY: century and year
		Set the system bit `%S50` to 1 to enable updating the RTC value using system words `%SW49` to `%SW53`. On a falling edge of `%S50` the internal RTC controller is updated using the values written in these words. For more details, see system bit %S50, page 323.
			S and U, SIM

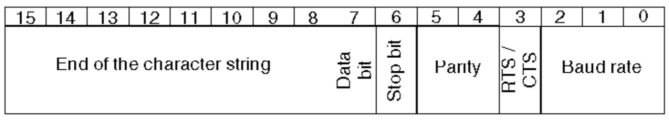
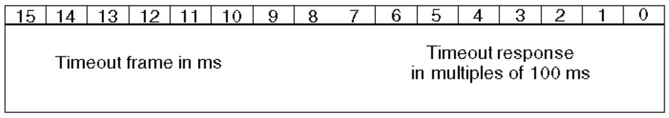
`%SW54`
`%SW55`
`%SW56`
`%SW57`
	Date and time of the last stop	System words containing the date and time of the last power outage or controller stop (in BCD):
		`%SW54` SS Seconds
		`%SW55` HHMM: hour and minute
		`%SW56` MMDD: month and day
		`%SW57` CCYY: century and year
			S, SIM

`%SW58`	Code of last stop	Displays code giving cause of last stop: 0 Unknown reason or initial value (after an application download) 1 Run/Stop input edge 2 Stop at detected software error (controller went in HALTED state) 3 Stop command (EcoStruxure Machine Expert-Basic online button) 4 Power outage 5 Stop at detected hardware error 6 Init in cold start 7 Start in stop 8 Low battery 9 Controller is not OK to run	S, SIM

System Words	Function	Description			Control
		The reasons for the last stop are prioritized in the following order (that is, when the controller is in the *STOPPED* state after a power cycle): 1, 7, 4, 8, 2			
`%SW59`	Adjust current date and time	Contains 2 sets of 8 bits used to increment or decrement the current date and time. Set the appropriate bit of `%SW59` first, then set `%S59` from 0 to 1. The operation is performed when the bit is set on the rising edge of `%S59`.			U
		Increment	**Decrement**	**Parameter**	
		Bit 0	Bit 8	Day of week	Not used
		Bit 1	Bit 9	Seconds	
		Bit 2	Bit 10	Minutes	
		Bit 3	Bit 11	Hours	
		Bit 4	Bit 12	Days	
		Bit 5	Bit 13	Month	
		Bit 6	Bit 14	Years	
		Bit 7	Bit 15	Centuries	Not used
`%SW60`	RTC correction	RTC correction value. Only available for the M200 Logic Controller. Default value is 0. Bit [7]: correction direction, 0 positive, 1 negative Bits [0] to [6]: correction value, range from 0 to 30 If the correction value is not 0, the RTC will automatically be corrected to the value once on each Sunday at 00:00:30. **NOTE:** The RTC correction value can be modified by the user application or animation table with the PLC online. The value will be saved in the flash memory when the power goes off and restored after power on.			U
`%SW62`	Ethernet error detection	Indicates the error code: 0 - No error detected 1 - Duplicate IP: the M200 Logic Controller is configured with its default IP address (generated from the MAC address) 2 - DHCP in progress 3 - BOOTP in progress 4 - Invalid parameters : port is disabled 5 - Fixed IP address: initialization in progress 6 - Ethernet link is down			S
`%SW63`	EXCH1 block error code	EXCH1 error code: 0 - operation was successful 1 - number of bytes to be transmitted exceeds the limit (> 255) 2 - insufficient transmission table 3 - insufficient word table 4 - receive table overflowed 5 - time-out elapsed 6 - transmission 7 - incorrect command within table 8 - selected port not configured/available 9 - reception error: This error code reflects an incorrect or corrupted reception frame. It can be caused due to an incorrect configuration in the physical parameters (for example, parity, data bits, baudrate, and so on) or an unreliable physical connection causing signal degradation. 10 - cannot use `%KW` if receiving			S

System Words	Function	Description	Control
		11 - transmission offset larger than transmission table 12 - reception offset larger than reception table 13 - controller stopped EXCH processing	
`%SW64`	EXCH2 block error code	EXCH2 error code: See `%SW63`.	S
`%SW65`	EXCH3 block error code	1-4, 6-13: See `%SW63`. (Note that error code 5 is invalid and replaced by the Ethernet-specific error codes 109 and 122 described below.) The following are Ethernet-specific error codes: 101 - incorrect IP address 102 - no TCP connection 103 - no socket available (all connection channels are busy) 104 - network is down 105 - network cannot be reached 106 - network dropped connection on reset 107 - connection aborted by peer device 108 - connection reset by peer device 109 - connection time-out elapsed 110 - rejection on connection attempt 111 - host is down 120 - incorrect index (remote device is not indexed in configuration table) 121 - system error (MAC, chip) 122 - receiving process timed-out after data was sent 123 - Ethernet initialization in progress	S
`%SW66`	EXCH4 block error code	EXCH4 error code: See `%SW63` and `%SW64` .	S
`%SW67`	Function and type of controller	Contains the logic controller code ID. For more information, refer to the M100/M200 Logic Controller Code ID table, page 341.	S, SIM
`%SW70`	Scan time microseconds resolution	Indicates the execution time of the last controller scan cycle (in µs). **NOTE:** This time corresponds to the time elapsed between the start (acquisition of inputs) and the end (update of outputs) of a master task scan cycle. If the scan time is 2.250 ms, the `%SW30` will be 2 and the `%SW70` will be 250.	–
`%SW71`	Max. scan time microseconds resolution	Indicates the execution time of the longest controller scan cycle since the last cold start (in ms). **NOTE:** This time corresponds to the time elapsed between the start (acquisition of inputs) and the end (update of outputs) of a scan cycle. If the scan time is 2.250 ms, the `%SW31` will be 2 and the `%SW71` will be 250.	–
`%SW72`	Min. scan time microseconds resolution	Indicates execution time of the shortest controller scan cycle since the last cold start (in ms). **NOTE:** This time corresponds to the time elapsed between the start (acquisition of inputs) and the end (update of outputs) of a scan cycle. If the scan time is 2.250 ms, the `%SW32` will be 2 and the `%SW72` will be 250.	–
`%SW75`	Load of processor	Indicates the percentage of processing load. Processing load is defined as the percentage of the total available processing time that is used to process your program tasks (this value is an average and is calculated every second). In case of processing load higher than 80% for two consecutive periods of time, the controller goes to HALTED state.	S
`%SW76` to `%SW79`	Down counters 1-4	These 4 words serve as 1 ms timers. They are decremented individually by the system every ms if they have a positive value. This gives 4 down counters down counting in ms which is equal to an operating range of 1 ms to 32767 ms. Setting bit 15 to 1 can stop decrementation.	S and U, SIM
`%SW89`	Cartridge slot 1 version	Indicates the firmware version of the cartridge in slot 1.	S

System Words	Function	Description	Control
%SW90	Cartridge slot 2 version	Indicates the firmware version of the cartridge in slot 2.	S
%SW91	TM3 slot 1 version	Indicates the firmware version of the TM3 expansion module in slot 1.	S
%SW92	TM3 slot 2 version	Indicates the firmware version of the TM3 expansion module in slot 2.	S
%SW93	TM3 slot 3 version	Indicates the firmware version of the TM3 expansion module in slot 3.	S
%SW94 %SW95	Application signature %MW60028-%MW60034	If the application changes, in terms of configuration or programming data, the signature (sum of all checksums) also changes. If %SW94 = 91F3 in hexadecimal, the application signature is 91F3 in hexadecimal.	S, SIM
%SW96	Diagnostics for save/restore function of program and %MW	• Bit [1]: This bit is set by the firmware to indicate when the save is complete: ◦ Set to 1 if the backup is complete. ◦ Set to 0 if a new backup request is requested. • Bit [2]: Back up error detected, refer to bits 8, 9, 10, 12 and 14 for further information: ◦ Set to 1 if an error is detected. ◦ Set to 0 if a new backup request is requested. • Bit [6]: Set to 1 if the controller contains a valid application in RAM memory. • Bit [10]: Difference between internal RAM and Flash memory (1 = yes). ◦ Set to 1 if there is a difference. • Bit [12]: Indicates if a restore error has occurred: ◦ Set to 1 if an error is detected. • Bit [14]: Indicates if a Flash memory write error has occurred: ◦ Set to 1 if an error is detected.	S, SIM
%SW97	TM3 slot 4 version	Indicates the firmware version of the TM3 expansion module in slot 4.	S
%SW98	Post configuration status (Serial Line 1)	The bits are set to 1 when the post configuration was applied for the parameter: • Bit[0]: Hardware option (RS-485 or RS-232) • Bit[1]: Baudrate • Bit[2]: Parity • Bit[3]: Data size • Bit[4]: Number of stop bits • Bit[5]: Modbus address • Bit[6]: Polarization (if available in the port)	S
%SW99	Post configuration status (Serial Line 2)	The bits are set to 1 when the post configuration was applied for the parameter: • Bit[0]: Hardware option (RS-485) • Bit[1]: Baudrate • Bit[2]: Parity • Bit[3]: Data size • Bit[4]: Number of stop bits • Bit[5]: Modbus address • Bit[6]: Polarization (if available in the port)	S
%SW100	Post configuration status (Ethernet)	The bits are set to 1 when the post configuration was applied for the parameter: • Bit[0]: IP mode (fixed, DHCP, or BOOTP) • Bit[1]: IP address • Bit[2]: Network submask • Bit[3]: Default gateway • Bit[4]: Device name **NOTE:** The post configuration has priority over the configuration provided by your application. The configuration of your application is not taken into account if the M100/M200 logic controller has a post configuration.	S
%SW101 %SW102 %SW111	Value of the Modbus address port	When bit %S101 is set to 1, you can change the Modbus address of SL1 or SL2 or SL3. The address of SL1 is %SW101. The address of SL2 is %SW102. The address of SL3 is %SW111.	S

System Words	Function	Description	Control
%SW103 %SW104 %SW112	Configuration for use of the ASCII protocol	When bit %S103 (SL1) or %S104 (SL2) is set to 1, the ASCII protocol is used. System word %SW103 (SL1) or %SW104 (SL2) or %SW112 for SL3 must be set according to the elements below:  15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 End of the character string Data bit Stop bit Parity RTS / CTS Baud rate • Baud rate: ◦ 000: 1200 baud, ◦ 001: 2400 baud, ◦ 010: 4800 baud, ◦ 011: 9600 baud, ◦ 100: 19200 baud, ◦ 101: 38400 baud. ◦ 110: 57600 baud. ◦ 111: 115200 baud. • RTS/CTS: ◦ 0: disabled, ◦ 1: enabled. • Parity: ◦ 00: none, ◦ 10: odd, ◦ 11: even. • Stop bit: ◦ 0: 1 stop bit, ◦ 1: 2 stop bits. • Data bits: ◦ 0: 7 data bits, ◦ 1: 8 data bits.	S, U
%SW105 %SW106 %SW113	Configuration for use of the ASCII protocol	When bit %S103 (SL1) or %S104 (SL2) or %S102 (SL3) is set to 1, the ASCII protocol is used. System word %SW105 (SL1) or %SW106 (SL2) or %SW113 (SL3) must be set according to the elements below:  15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Timeout frame in ms Timeout response in multiples of 100 ms	S, U
%SW110	Post configuration status (Serial Line 3)	Refer to %SW98.	S
%SW107 %SW108 %SW109	MAC address	Indicates the controller MAC address (only references with Ethernet channel). For MAC address AA:BB:CC:DD:EE:FF: • %SW107 = AA:BB • %SW108 = CC:DD • %SW107 = EE:FF	S
%SW114	Enable schedule blocks	Enables or disables operation of schedule blocks by the program: • Bit [0]: Enable/disable schedule block number 0 ◦ Set to 0: disabled ◦ Set to 1: enabled • ... • Bit [15]: Enable/disable schedule block number 15 ◦ Set to 0: disabled ◦ Set to 1: enabled Initially all schedule blocks are enabled. The default value is FFFF hex.	S and U, SIM

System Words	Function	Description	Control
%SW115 %SW116 %SW117	Controller serial numbers part 1, 2, and 3 respectively (in BCD)	Allows to obtain the serial number of the controller. Example with the serial number 8A160400008: • %SW115 : 16#0008 • %SW116 : 16#6040 • %SW117 : 16#0001	S
%SW118	Logic controller status word	Indicates conditions on logic controller. For a controller operating normally, the value of this word is FFFF hex. • Bit [9]: ◦ Set to 0: External error detected or communication interruption, for example duplicate IP address. ◦ Set to 1: No error detected. • Bit [10]: ◦ Set to 0: Invalid internal configuration; contact Schneider Electric customer service. ◦ Set to 1: No error detected. • Bit [13]: ◦ Set to 0: Configuration error detected (mandatory modules, as defined by the I/O expansion bus configuration, are absent or otherwise inoperative when the logic controller attempts to start the I/O expansion bus). In this case, the I/O bus does not start. ◦ Set to 1: No error detected. • Bit [14]: ◦ Set to 0: One or more modules have ceased communication with the logic controller after the I/O expansion bus is started. This is the case whether an I/O expansion module is defined as mandatory or optional but present at start-up. ◦ Set to 1: No error detected. • Bit [15]: ◦ Set to 0: Cartridge error detected (configuration or runtime operation). ◦ Set to 1: No error detected. For more information on bus error handling, refer to I/O Configuration General Description. **NOTE:** The other bits of this word are set to 1 and are reserved.	S, SIM
%SW119	Optional module feature configuration	One bit for each expansion module in the configuration: • Bit [0]: Reserved for the logic controller • Bit n: Module n ◦ Set to 1: Module is marked as optional in the configuration. ◦ Set to 0: Module is not marked as optional in the configuration.	S, SIM
%SW120	Expansion I/O module status	1 bit for each expansion module in the configuration. Bit 0 = Reserved for the logic controller When the logic controller attempts to start the I/O bus, bit n: • 0 = no error detected • 1 = error detected or module not present. The I/O expansion bus does not start unless the corresponding bit in %SW119 is set to TRUE (indicating the module is marked as optional). When the I/O bus is started, bit n: • 0 = no error detected • 1 = error detected on the I/O expansion module (regardless, if it is a module marked as optional).	S, SIM
%SW121 %SW122 %SW123	Configuration for use of ASCII protocol	When bit %S103 (SL1) or %S104 (SL2) or %S102 (SL3) is set to 1, the ASCII protocol is used. You can change the ASCII frame size of SL1, SL2 or SL3. The ASCII frame size of SL1 is %SW121, and that of SL2 is %SW122, and that of SL3 is %SW123.	U
%SW128	Cartridge 1 status	Indicates the status code for the cartridge: • LSB: presents the status of the I/O channel 1 • MSB: presents the status of the I/O channel 2 General status: • 0x80: Cartridge is not present and it is not configured in EcoStruxure Machine Expert-Basic.	S, SIM
%SW129	Cartridge 2 status		

System Words	Function	Description	Control
		• 0x81: Module is present but not configured. • 0x82: Internal communication error with the cartridge. • 0x83: Internal communication error with the cartridge. • 0x84: Detected cartridge different from the configuration. • 0x85: Configured cartridge is not detected. Input channel operation status: • 0x00: Normal. • 0x01: Conversion in progress. • 0x02: Initialization. • 0x03: Input operation setting error detected or module without input. • 0x04: Reserved. • 0x05: Wiring error detected (High limit range out). • 0x06: Wiring error detected (Low limit range out). • 0x07: Flash memory error detected. • Others: Reserved. Output channel operation status: • 0x00: Normal. • 0x01: Reserved. • 0x02: Initialization. • 0x03: Output operation setting error detected or module without output. • 0x04: Reserved. • 0x05: Reserved. • 0x06: Reserved. • 0x07: Flash memory error detected. • Others: Reserved.	
`%SW130`	Event execution time	Indicates the last execution time in µs of the event input *%I0.2*.	S
`%SW131`	Event execution time	Indicates the last execution time in µsof the event input *%I0.3*.	S
`%SW132`	Event execution time	Indicates the last execution time in µs of the event input *%I0.4*.	S
`%SW133`	Event execution time	Indicates the last execution time in µs of the event input *%I0.5*.	S
`%SW134`	Event execution time	Indicates the last execution time in µs of the event task associated with the Threshold 0 of *HSC0* or *HSC2*	S
`%SW135`	Event execution time	Indicates the last execution time in µs of the event task associated with the Threshold 1 of *HSC0* or *HSC2*	S
`%SW136`	Event execution time	Indicates the last execution time in µs of the event task associated with the Threshold 0 of *HSC1* or *HSC3*	S
`%SW137`	Event execution time	Indicates the last execution time in µs of the event task associated with the Threshold 1 of *HSC1* or *HSC3*	S
`%SW138`	Periodic task execution time	Indicates the last execution time in µs of the periodic task.	S

`%SW139`	Embedded digital output protection	Indicates the protection error status of output blocks:
		Bit0 = 1 - Q0 - Q3 protect error - Block0
		Bit1 = 1 - Q4 - Q7 protect error - Block1
		Bit2 = 1 - Q8 - Q11 protect error - Block2
		Bit3 = 1 - Q12 - Q15 protect error - Block3
		NOTE: %SW139 is not used for sink outputs.
			S

`%SW140`	Controller last error code 1	Most recent error code written to `PlcLog.csv`: AABBCCCCDD: `%SW142` = AABB hex `%SW141` = CCCC hex `%SW140` = 00DD hex Where:	S
`%SW141`	Controller last error code 2		
`%SW142`	Controller last error code 3		

System Words	Function	Description	Control
		• AA = error level • BB = error context • CCCC = error code • DD = error priority (internal use only)	
`%SW143`	Number of entries in `PlcLog.csv`	Number of error codes contained in `PlcLog.csv`.	S
`%SW147`	SD card operation result	If `%SW90` set to 1, indicates that the SD card operation result after saving memory words. The error codes are: • 0: No error. • 1: Operation in progress. • 10: Eject the SD card. • 11: No SD card detected. • 12: SD card write protected • 13: The SD card is full. • 21: Number of memory words invalid. • 22: No memory words to be saved. • 30: A line in the `CSV` file is invalid. • 31: A line in the `CSV` file is too long. • 32: Format of the `CSV` file invalid. • 40: Error when creating the `CSV` file. • 50: Internal system error. • 51: Error when opening the `CSV` file.	S
`%SW148`	Number of persistent variables	• If `%S90` is set to 0: ◦ For TM100C•••: from `%MW3000` up to `%MW3999` ◦ For TM200C•••: from `%MW3000` up to `%MW4999` • If `%S90` is set to 1: you can save all memory words from `%MW0`. For more information, refer to Persistent Variables Saved by User Request, page 34.	U
`%SW149`	Event execution time	Indicates the last execution time in ms of the event task associated with the input %I0.2.	S
`%SW150`	Event execution time	Indicates the last execution time in ms of the event task associated with the input %I0.3.	S
`%SW151`	Event execution time	Indicates the last execution time in ms of the event task associated with the input %I0.4.	S
`%SW152`	Event execution time	Indicates the last execution time in ms of the event task associated with the input %I0.5.	S
`%SW153`	Event execution time	Indicates the last execution time in ms of the event task associated with the Threshold 0 of `HSC0` or `HSC2`.	S
`%SW154`	Event execution time	Indicates the last execution time in ms of the event task associated with the Threshold 1 of `HSC0` or `HSC2`.	S
`%SW155`	Event execution time	Indicates the last execution time in ms of the event task associated with the Threshold 0 of `HSC1` or `HSC3`.	S
`%SW156`	Event execution time	Indicates the last execution time in ms of the event task associated with the Threshold 1 of `HSC1` or `HSC3`.	S
`%SW157`	Periodic execution time	Indicates the last execution time in ms of the periodic task.	S
`%SW158`	Periodic average time	Indicates the average execution time (last 5 times) of the periodic task in ms.	S
`%SW159`	Event 0 average time	Indicates the average execution time in ms of the event task associated with the input `%I0.2` (last 5 times).	S
`%SW160`	Event 1 average time	Indicates the average execution time in ms of the event task associated with the input `%I0.3` (last 5 times).	S
`%SW161`	Event 2 average time	Indicates the average execution time in ms of the event task associated with the input `%I0.4` (last 5 times).	S
`%SW162`	Event 3 average time	Indicates the average execution time in ms of the event task associated with the input `%I0.5` (last 5 times).	S

System Words	Function	Description	Control
%SW163	Event 4 average time	Indicates the average execution time in ms of the event task associated with the Threshold 0 of HSC0 (last 5 times).	S
%SW164	Event 5 average time	Indicates the average execution time in ms of the event task associated with the Threshold 1 of HSC0 (last 5 times).	S
%SW165	Event 6 average time	Indicates the average execution time in ms of the event task associated with the Threshold 0 of HSC1 (last 5 times).	S
%SW166	Event 7 average time	Indicates the average execution time in ms of the event task associated with the Threshold 1 of HSC1 (last 5 times).	S
%SW168	Modbus TCP - Connections in use	Indicates the number of Ethernet Modbus TCP server connections in use **NOTE:** If you disconnect the cable, the connection is not closed immediately. Each time the cable is re-connected to the network, it requests a new connection and the number of connections in use indicated by %SW168 increases.	S
%SW170	Frames transmitted - Serial line 1	Indicates the number of frames transmitted by the serial line 1	S
%SW171	Frames transmitted - Serial line 2	Indicates the number of frames transmitted by the serial line 2	S
%SW172	Frames transmitted - USB	Indicates the number of frames transmitted by the USB channel	S
%SW173	Frames transmitted - Modbus TCP	Indicates the number of frames transmitted by Modbus TCP on Ethernet	S
%SW174	Frames received successfully - Serial line 1	Indicates the number of frames correctly received by the serial line 1	S
%SW175	Frames received successfully - Serial line 2	Indicates the number of frames correctly received by the serial line 2	S
%SW176	Frames received successfully - USB	Indicates the number of frames correctly received by the USB channel	S
%SW177	Frames received successfully - Modbus TCP	Indicates the number of frames correctly received by Modbus TCP on Ethernet	S
%SW178	Frames received with an error - Serial line 1	Indicates the number of frames received with an error detected by the serial line 1	S
%SW179	Frames received with an error - Serial line 2	Indicates the number of frames received with an error detected by the serial line 2	S
%SW180	Frames received with an error - USB	Indicates the number of frames received with an error by the USB channel	S
%SW181	Frames received with an error - Modbus TCP	Indicates the number of frames received with an error by Modbus TCP on Ethernet	S
%SW188	Frames transmitted - Modbus Mapping table	Total number of frames transmitted via the Modbus mapping table.	S
%SW189	Frames received - Modbus Mapping table	Total number of frames received without error via the Modbus mapping table.	S
%SW190, %SW191	Class 1 outgoing packets sent	Total number of outgoing packets sent for implicit (Class 1) connections.	S
%SW192, %SW193	Class 1 incoming packets received	Total number of incoming packets received for implicit (Class 1) connections.	S
%SW194, %SW195	Unconnected incoming packets received	Total number of incoming unconnected packets, including packets that would be returned if an error was detected.	S
%SW196, %SW197	Unconnected incoming packets invalid	Total number of incoming unconnected packets that had an invalid format, or targeted an unsupported service, class, instance, attribute, or member.	S
%SW198, %SW199	Incoming packets received for explicit (Class 3) connections	Total number of incoming packets for explicit (Class 3) connections, including packets that would be returned if an error was detected.	S

System Words	Function	Description	Control
`%SW200`, `%SW201`	Incoming Class 3 packets invalid	Total number of explicit (Class 3) packets that had an invalid format, or targeted an unsupported service, class, instance, attribute, or member.	S
`%SW202`	Instance input	Instance input configured in EcoStruxure Machine Expert-Basic. Default value: 0	S
`%SW203`	Input size	Input size configured in EcoStruxure Machine Expert-Basic. Default value: 0	S
`%SW204`	Instance output	Instance output configured in EcoStruxure Machine Expert-Basic. Default value: 0	S
`%SW205`	Output size	Output size configured in EcoStruxure Machine Expert-Basic. Default value: 0	S
`%SW206`	Timeout	Total number of connection timeouts that have occurred in connections. Default value: 0	S, U

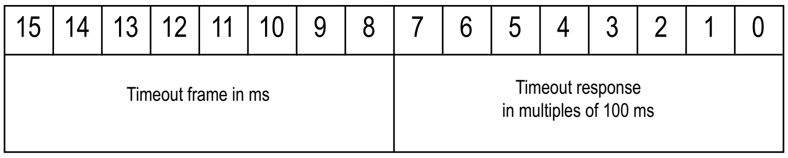
`%SW210`
`%SW211`
`%SW213`
	Status of the IOScanner SL1/SL2/ SL3	Contains the status of the Modbus Serial IOScanner on Serial Line. `%SW210` is for SL1, `%SW211` is for SL2, and `%SW213` is for SL3.
		• 0: IOScanner is stopped
		• 1: Initialization request to device being sent by IOScanner
		• 2: IOScanner is operational
		• 3: IOScanner is partially operational (some devices are not being scanned)
		• 4: IOScanner is suspended
			S

`%SW212`	Status of the Modbus TCP IOScanner	Contains the status of the Modbus TCP IOScanner on Ethernet: • 0: IOScanner is stopped • 1: Initialization request being sent by IOScanner to device • 2: IOScanner is operational • 3: IOScanner is partially operational (some devices are not being scanned) • 4: IOScanner is suspended **NOTE:** The application must be configured with a functional level of at least **Level 6.0** for this system word to be supported.	S
`%SW215`	Frames transmitted – Serial Line 3	Indicates the number of frames transmitted by the Serial Line 3.	S
`%SW216`	Frames received successfully – Serial Line 3	Indicates the number of frames correctly received by the Serial Line 3.	S
`%SW217`	Frames received with an error – Serial Line 3	Indicates the number of frames received with an error detected by the Serial Line 3.	S

`%SW221`
`%SW222`
`%SW223`
	Actual value of configuration (1) for use of the Modbus RTU protocol	The system Word `%SW221` (SL1), `%SW222` (SL2) and `%SW223` (SL3) indicate or monitor the actual value of configuration (1) when using the Modbus RTU protocol (such as the baud rate). Refer to `%SW224`, `%SW225` and `%SW226` for the data format definition.	S

`%SW224`
`%SW225`
`%SW226`
	Configuration (1) for use of the Modbus RTU protocol	When bit `%S124` (SL1) or `%S125` (SL2) or `%S126` (SL3) is set to 1, the Modbus RTU protocol is used.
		System word `%SW224` (SL1) or `%SW225` (SL2) or `%SW226` (SL3) must be set according to the elements as follows:
		Baud Rate:
		• 000: 1200 baud
		• 001: 2400 baud
		• 010: 4800 baud
		• 011: 9600 baud
		• 100: 19200 baud
		• 101: 38400 baud
		• 110: 57600 baud
		• 111: 115200 baud
		Polarization
		• 0: disabled
		• 1: enabled
		Parity
			U

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved								Data Bit	Stop Bit	Parity		Polarization	Baud Rate		

System Words	Function	Description	Control
		• 00: none • 10: odd • 11: even Stop bit • 0: 1 stop bit • 1: 2 stop bits Data bit • 1: 8 data bits	
%SW227 %SW228 %SW229	Configuration (2) for use of the Modbus RTU protocol	When bit %S124 (SL1) or %S125 (SL2) or %S126 (SL3) is set to 1, the Modbus RTU protocol is used. System word %SW227 (SL1) or %SW228 (SL2) or %SW229 (SL3) must be set according to the elements as follows:  15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 Timeout frame in ms Timeout response in multiples of 100 ms **NOTE:** The value range of **Time between frames** (set by the system word) is "2-255", which is the same as the value within the software configuration range. If the value is not in this range, the communication may be affected.	S, U
S: Controlled by the system U: Controlled by the user SIM: Applied in the simulator			

M100/M200 Logic Controller Code ID

This table presents the code IDs of the M100/M200 Logic Controller references:

Reference	Code ID
TM100C16R	0x07C1
TM100C24R	0x07C2
TM100C40R	0x07C4
TM100C16RN	0x07C6
TM100C24RN	0x07C7
TM100C32RN	0x07C8
TM100C40RN	0x07C9
TM200C16R	0x07A1
TM200C16T	0x07A3
TM200C16U	0x07A2
TM200C24R	0x07A7
TM200CE24R	0x07A8
TM200C24T	0x07AB
TM200CE24T	0x07AC
TM200C24U	0x07A9
TM200CE24U	0x07AA
TM200C32R	0x07B9
TM200C32U	0x07AB
TM200C32T	0x07AD
TM200CE32R	0x07BA
TM200C40R	0x07AD

Reference	Code ID
TM200CE40R	0x07AE
TM200C40T	0x07B1
TM200CE40T	0x07B2
TM200C40U	0x07AF
TM200CE40U	0x07B0
TM200C60R	0x07B3
TM200CE60R	0x07B4

Input Channel Status (%IWS)

Introduction

The following provides information about the properties of input channel status words. A dedicated input channel status word exists for each analog input channel added using an I/O expansion module or TMCR2 cartridge.

Displaying Input Channel Status Word Properties

Follow these steps to display the properties of the input channel status words:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **System objects > Input Status Words**. **Result**: Input channel status word properties is displayed.

Input Channel Status Word Properties

This table describes each property of the input channel status word:

Parameter	Edita-ble	Value	Default Value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the input channel status word is being referenced in a program.
Address	No	%IWSx.y or %IWS0.x0y	–	The address of the input channel status word. For I/O expansion modules: • x is the module number • y is the channel number For analog cartridges: • x is the cartridge number • y is the channel number For example, *%IWS0.101* is the address of the second channel of the cartridge in the first slot of the logic controller.

Parameter	Edita-ble	Value	Default Value	Description
Symbol	Yes	–	–	The symbol associated with the input channel status word. Double-click in the **Symbol** column and type the name of the symbol to associate with the input channel status word. If a symbol already exists, right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of the symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with the input channel status word. Double-click in the **Comment** column and type an optional comment to associate with the input channel status word.

For More Information

To view the possible values of the input channel status word:

For information on:	refer to...
TM3 expansion modules	TM3 Analog I/O Modules Diagnostics (see Modicon TM3 (EcoStruxure Machine Expert - Basic), Expansion Modules Configuration, Programming Guide)
TM3R expansion modules	TM3R Analog I/O Modules Diagnostics, page 109
TM2 expansion modules	TM2 Analog I/O Modules Diagnostics
TMCR2 cartridges	TMCR2 Analog Cartridge Diagnostics, page 97

Output Channel Status (%QWS)

Introduction

The following provides information about the properties of output status words. A dedicated output channel status word exists for each analog output channel added using an I/O expansion module or TMCR2 cartridge.

Displaying Output Channel Status Words Properties

Follow these steps to display the properties of the output channel status words:

Step	Action
1	Select the **Tools** tab in the left-hand area of the **Programming** window.
2	Click **System objects > Output Status Words**. **Result**: Output channel status word properties are displayed in the properties window.

Output Channel Status Word Properties

This table describes each property of the output channel status word:

Parameter	Edita-ble	Value	Default Value	Description
Used	No	TRUE/FALSE	FALSE	Indicates whether the output channel status word is being referenced in a program.
Address	No	%QWSx.yor %QWS0.x0y	–	The address of the output channel status word. For I/O expansion modules: • x is the module number • y is the channel number For cartridges: • x is the cartridge number • y is the channel number For example, *%QWS3.0* is the address of the first output channel in the third I/O expansion module connected to the logic controller.
Symbol	Yes	–	–	The symbol associated with the output channel status word. Double-click in the **Symbol** column and type the name of the symbol to associate with the output channel status word. If a symbol already exists, right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of the symbol throughout the program and/or program comments.
Comment	Yes	–	–	A comment associated with the output channel status word. Double-click in the **Comment** column and type an optional comment to associate with the output channel status word.

For More Information

To view the possible values of the output channel status word:

For information on:	refer to...
TM3 expansion modules	TM3 Analog I/O Modules Diagnostics (see Modicon TM3 (EcoStruxure Machine Expert-Basic), Expansion Modules Configuration, Programming Guide)
TM3R expansion modules	TM3R Analog I/O Modules Diagnostics, page 109
TM2 expansion modules	TM2 Analog I/O Modules Diagnostics (see Modicon TM2 (EcoStruxure Machine Expert-Basic), Expansion Modules Configuration, Programming Guide)
TMCR2 cartridges	TMCR2 Analog Cartridge Diagnostics, page 97

Glossary

A

absolute movement:

A movement to a position defined from a reference point.

acceleration / deceleration:

Acceleration is the rate of velocity change, starting from **Start Velocity** to target velocity. Deceleration is the rate of velocity change, starting from target velocity to **Stop Velocity**. These velocity changes are implicitly managed by the PTO function in accordance with acceleration, deceleration, and jerk ratio parameters following a trapezoidal or an S-curve profile.

analog input:

Converts received voltage or current levels into numerical values. You can store and process these values within the logic controller.

analog output:

Converts numerical values within the logic controller and sends out proportional voltage or current levels.

application:

A program including configuration data, symbols, and documentation.

ASCII:

(*American standard code for Information Interchange*) A protocol for representing alphanumeric characters (letters, numbers, certain graphics, and control characters).

B

BOOTP:

(*bootstrap protocol*) A UDP network protocol that can be used by a network client to automatically obtain an IP address (and possibly other data) from a server. The client identifies itself to the server using the client MAC address. The server, which maintains a pre-configured table of client device MAC addresses and associated IP addresses, sends the client its pre-configured IP address. BOOTP was originally used as a method that enabled diskless hosts to be remotely booted over a network. The BOOTP process assigns an infinite lease of an IP address. The BOOTP service utilizes UDP ports 67 and 68.

C

configuration:

The arrangement and interconnection of hardware components within a system and the hardware and software parameters that determine the operating characteristics of the system.

control network:

A network containing logic controllers, SCADA systems, PCs, HMI, switches, ...

Two kinds of topologies are supported:

- flat: all modules and devices in this network belong to same subnet.
- 2 levels: the network is split into an operation network and an inter-controller network.

These two networks can be physically independent, but are generally linked by a routing device.

controller:

Automates industrial processes (also known as programmable logic controller or programmable controller).

D

DHCP:

(*dynamic host configuration protocol*) An advanced extension of BOOTP. DHCP is more advanced, but both DHCP and BOOTP are common. (DHCP can handle BOOTP client requests.)

digital I/O:

(*digital input/output*) An individual circuit connection at the electronic module that corresponds directly to a data table bit. The data table bit holds the value of the signal at the I/O circuit. It gives the control logic digital access to I/O values.

DWORD:

(*double word*) Encoded in 32-bit format.

E

EtherNet/IP:

(*Ethernet industrial protocol*) An open communications protocol for manufacturing automation solutions in industrial systems. EtherNet/IP is in a family of networks that implement the common industrial protocol at its upper layers. The supporting organization (ODVA) specifies EtherNet/IP to accomplish global adaptability and media independence.

expansion bus:

An electronic communication bus between expansion I/O modules and a controller.

F

FreqGen:

(*frequency generator*) A function that generates a square wave signal with programmable frequency.

G

GRAFCET:

The functioning of a sequential operation in a structured and graphic form.

This is an analytical method that divides any sequential control system into a series of steps, with which actions, transitions, and conditions are associated.

H

homing:

The method used to establish the reference point for absolute movement.

HSC:

(*high-speed counter*) A function that counts pulses on the controller or on expansion module inputs.

I

I/O:

(*input/output*)

IEC 61131-3:

Part 3 of a 3-part IEC standard for industrial automation equipment. IEC 61131-3 is concerned with controller programming languages and defines 2 graphical and 2 textual programming language standards. The graphical programming languages are ladder diagram and function block diagram. The textual programming languages include structured text and instruction list.

IL:

(*instruction list*) A program written in the language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (refer to IEC 61131-3).

instruction list language:

A program written in the instruction list language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (see IEC 61131-3).

J

jerk ratio:

The proportion of change of the acceleration and deceleration as a function of time.

L

ladder diagram language:

A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (see IEC 61131-3).

LAN:

(*local area network*) A short-distance communications network that is implemented in a home, office, or institutional environment.

LD:

(*ladder diagram*) A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (refer to IEC 61131-3).

LSB:

(*least significant bit/byte*) The part of a number, address, or field that is written as the right-most single value in conventional hexadecimal or binary notation.

M

MAST:

A processor task that is run through its programming software. The MAST task has 2 sections:

- **IN:** Inputs are copied to the IN section before execution of the MAST task.
- **OUT:** Outputs are copied to the OUT section after execution of the MAST task.

NOTE:

Modbus:

The protocol that allows communications between many devices connected to the same network.

MSB:

(*most significant bit/byte* The part of a number, address, or field that is written as the left-most single value in conventional hexadecimal or binary notation.

P

periodic execution:

The task is executed either cyclically or periodically. In periodic mode, you determine a specific time (period) in which the task is executed. If it is executed under this time, a waiting time is generated before the next cycle. If it is executed over this time, a control system indicates the overrun. If the overrun is too high, the controller is stopped.

PID:

(*proportional, integral, derivative*) A generic control loop feedback mechanism (controller) widely used in industrial control systems.

post configuration:

(*post configuration*) An option that allows to modify some parameters of the application without changing the application. Post configuration parameters are defined in a file that is stored in the controller. They are overloading the configuration parameters of the application.

POU:

(*program organization unit*) A variable declaration in source code and a corresponding instruction set. POUs facilitate the modular re-use of software programs, functions, and function blocks. Once declared, POUs are available to one another.

program:

The component of an application that consists of compiled source code capable of being installed in the memory of a logic controller.

protocol:

A convention or standard definition that controls or enables the connection, communication, and data transfer between 2 computing system and devices.

PTO:

(*pulse train outputs*) A fast output that oscillates between off and on in a fixed 50-50 duty cycle, producing a square wave form. PTO is especially well suited for applications such as stepper motors, frequency converters, and servo motor control, among others.

PWM:

(*pulse width modulation*) A fast output that oscillates between off and on in an adjustable duty cycle, producing a rectangular wave form (though you can adjust it to produce a square wave).

R

RS-232:

A standard type of serial communication bus, based on 3 wires (also known as EIA RS-232C or V.24).

RS-485:

A standard type of serial communication bus, based on 2 wires (also known as EIA RS-485).

RTC:

(*real-time clock*) A battery-backed time-of-day and calender clock that operates continuously, even when the controller is not powered for the life of the battery.

S

S-curve ramp:

An acceleration / deceleration ramp with a `JerkRatio` parameter greater than 0%.

SFC:

(*sequential function chart*) A language that is composed of steps with associated actions, transitions with associated logic condition, and directed links between steps and transitions. (The SFC standard is defined in IEC 848. It is IEC 61131-3 compliant.)

start velocity:

The minimum frequency at which a stepper motor can produce movement, with a load applied, without the loss of steps.

stop velocity:

The maximum frequency at which a stepper motor stops producing movement, with a load applied, without the loss of steps.

T

trapezoidal ramp:

An acceleration / deceleration ramp with a `JerkRatio` parameter set to 0%.

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