SIEMENS

SIMOTION

Basic Control

Function Manual

08/2008 Edition

Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

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indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠CAUTION
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

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Note the following:

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This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

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℗ 08/2008

Preface

Contents of the function manual

This document is part of the SIMOTION Programming References documentation package.

This manual will assist you in working with the function blocks of the "Basic Control" software package.

You will learn how the function blocks work.

Function block

The function blocks for "Basic Control" are part of the program library of the "SIMOTION SCOUT" engineering system.

SIMOTION Documentation

An overview of the SIMOTION documentation can be found in a separate list of references.

This documentation is included as electronic documentation with the supplied SIMOTION SCOUT.

The SIMOTION documentation consists of 9 documentation packages containing approximately 80 SIMOTION documents and documents on related systems (e.g. SINAMICS).

The following documentation packages are available for SIMOTION V4.1 SP2:

- SIMOTION Engineering System
- SIMOTION System and Function Descriptions
- SIMOTION Diagnostics
- SIMOTION Programming
- SIMOTION Programming - References
- SIMOTION C
- SIMOTION P350
- SIMOTION D4xx
- SIMOTION Supplementary Documentation

Hotline and Internet addresses

Technical support

If you have any technical questions, please contact our hotline:

	Europe / Africa
Phone	+49 180 5050 222 (subject to charge)
Fax	+49 180 5050 223
Internet	http://www.siemens.com/automation/support-request

	Americas
Phone	+1 423 262 2522
Fax	+1 423 262 2200
E-mail	mailto:techsupport.sea@siemens.com

	Asia / Pacific
Phone	+86 1064 719 990
Fax	+86 1064 747 474
E-mail	mailto:adsupport.asia@siemens.com

Note

Country-specific telephone numbers for technical support are provided under the following Internet address:

http://www.siemens.com/automation/service&support

Calls are subject to charge, e.g. 0.14 €/min. on the German landline network. Tariffs of other phone companies may differ.

Questions about this documentation

If you have any questions (suggestions, corrections) regarding this documentation, please fax or e-mail us at:

Fax	+49 9131- 98 63315
E-mail	mailto:docu.motioncontrol@siemens.com

Siemens Internet address

The latest information about SIMOTION products, product support, and FAQs can be found on the Internet at:

- General information:
  - http://www.siemens.de/simotion (German)
  - http://www.siemens.com/simotion (international)
- Product support:
  - http://support.automation.siemens.com/WW/view/en/10805436

Additional support

We also offer introductory courses to help you familiarize yourself with SIMOTION.

Please contact your regional training center or our main training center at D-90027 Nuremberg, phone +49 (911) 895 3202.

Information about training courses on offer can be found at:

www.sitrain.com

Table of contents

1 Description

1.1 General

The "Basic Control" software consists of the function blocks (FBs) for a continuous PID control (_CTRL_pid) and for a step control (_CTRL_piStep) plus the function block for pulse width modulation (_CTRL_pwm).

The function blocks are software controllers, with each block containing the entire controller functionality. FBs can be called more than once.

The _CTRL_pwm function block is used in connection with the _CTRL_pid function block in order to obtain a controller with pulse output for proportional actuators.

1.2 Product description

Basic Functions

A controller created using function blocks comprises a series of subfunctions that can be parameterized by you. Apart from the control algorithm for a continuous-action or step controller, functions for setpoint and actual value preparation and correction of the manipulated variable are also integrated in the blocks.

Possible applications

A closed-loop control system created using the "Basic Control" function blocks is basically neutral in terms of its application. Its controlling power and thus processing speed depends entirely on the performance of the SIMOTION hardware used.

It is capable of controlling slow systems (temperatures, fill levels, etc.) as well as very fast systems (flows, speeds, etc.).

Controlled system analysis

Note

The static behavior (gain) and the dynamic properties (delay, dead time, integration constant, etc.) of the controlled system are critical factors in the layout and design of the controller and the settings for its static parameters (proportional component) and dynamic parameters (integral and derivative component).

It is therefore essential for you to know the controlled system type and its characteristic data.

Controller selection

Note

The properties of controlled systems are determined by specific process/machine features. It is unlikely that they can be modified in any way. For this reason, you can obtain good control quality only by selecting the most suitable controller type for the controlled system in question and by adapting it correctly to the dynamic response of the system.

Requirement

The following software versions are required for the standard functions described in this documentation:

- SIMOTION SCOUT V4.0 or higher
- SIMOTION Kernel V4.0 or higher
- SIMOTION Technology Packages V4.0 or higher

Function blocks 2

2.1 Overview

This chapter describes the function blocks for "Basic Control". You will find a general description of the data structure containing all input and output parameters of the relevant function block as well as a description of the function block call. Examples will be used to show you how to do the following:

- Integrate the function block
- Instantiate the function block
- Set up variables for the data structure
- Call an instance you have created
- Assign values to input parameters
- Access output parameters of the function block

2.2 Integrating the function blocks in the user project

Creating the FBs instance in the user project

The function blocks are part of the program library of the SIMOTION SCOUT engineering system. For working with the function blocks, an instance has to be created in the user project for each function block used.

Example:

```
VAR_GLOBAL
...
  myFBPID:_CTRL_pid;          // create "_CTRL_pid" instance
  myFBPISTEP:_CTRL_piStep;    // create "_CTRL_piStep" instance
  myFBPWM:_CTRL_pwm;          // create "_CTRL_pwm" instance
...
END_VAR
```

Call (LAD representation)

The LAD representation of the individual function blocks can be found in the respective function block descriptions.

Application example

The application example is included on the "Utilities & Applications" CD-ROM and is available for various SIMOTION hardware platforms.

The "Utilities & Applications" CD-ROM is provided free of charge with SIMOTION SCOUT.

2.3 Continuous control with the _CTRL_pid function block

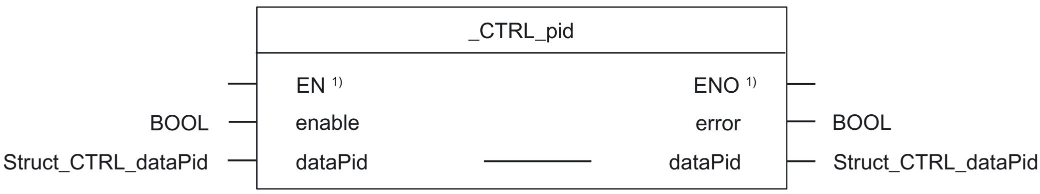
Introduction

The **_CTRL_pid** function block is used to control technical processes with continuous input and output variables on SIMOTION systems. Using parameterization, you can activate or deactivate subfunctions of the PID controller and thus adapt it to the controlled system in question.

Application

You can use the controller individually as a fixed-setpoint PID controller or in multi-loop feedback controls as a cascade, combined, or ratio controller. Its operating principle is based on the PID control algorithm of the sampling controller with analog output signal, possibly supplemented by a pulse shaper stage for generating pulse-width-modulated output signals for two- or three-step controls with proportional actuators.

Call (LAD representation)



[1] LAD-specific parameters

Parameter description

Note

The SIMOTION identifiers have changed as of V4.0. A comparison of the identifiers up to V3.2/as of V4.0 can be found in the Appendix in the table "List of parameters".

Table 2-1 Parameters of the _CTRL_pid function block

Name	P-Type [1]	Data type	Meaning	Actions performed by user	Actions performed by block
enable	IN	BOOL	Block enable	Entered	Checked
dataPid	IN/OUT	Struct_CTRL_dataPid	Data structure	Entered and checked	Checked and entered
error	OUT	BOOL	Request completed with errors	Checked	Entered

[1] Parameter types: IN = input parameters, OUT = output parameters, IN/OUT = in/out parameters

Data structure of the _CTRL_pid function block

The data structure of type **Struct_CTRL_dataPid** contains all input and output parameters of the **_CTRL_pid** function block.

The data structure is used by the **_CTRL_pid** function block. Elements in the data structure are accessed using a variable of data type **Struct_CTRL_dataPid**, which you must define yourself.

The **Struct_CTRL_dataPid** data structure is shown in the table below.

Note

The SIMOTION identifiers have changed as of V4.0. A comparison of the identifiers up to V3.2/as of V4.0 can be found in the Appendix in the table "List of parameters".

Table 2-2 Data structure of Struct_CTRL_dataPid

Parameters	P-Type [1)]	Data type	Value range	Initial value	Description
reset	IN	BOOL	FALSE / TRUE	FALSE	Initialization routine = TRUE • All output parameters are set to FALSE or zero • The integrator is set to initialization value "initialIValue"
manualMode	IN	BOOL	FALSE / TRUE	TRUE	Activate manual mode The control loop is interrupted when the "manualMode" input is enabled. A manually entered value acts as the control output.
actValueType	IN	BOOL	FALSE / TRUE	FALSE	Activate actual I/O value If the actual value must be read in from the I/O, then the "binActValue" input must be interconnected to the I/O and the "actValueType" input must be set.
setPController	IN	BOOL	FALSE / TRUE	TRUE	Activate P-action component It is possible to activate and deactivate PID components individually in the PID algorithm. The P-action component is activated when the "setPController" input is set.
setIController	IN	BOOL	FALSE / TRUE	TRUE	Activate I-action component It is possible to activate and deactivate PID components individually in the PID algorithm. The I-action component is activated when the "setIController" input is set.
holdIValue	IN	BOOL	FALSE / TRUE	FALSE	Freeze I-action component The integrator output can be frozen. To do this, the "holdIValue" input must be set.
setIValue	IN	BOOL	FALSE / TRUE	FALSE	Set I-action component The integrator output can be set to the "initialIValue" input. To do this, the "setIValue" input must be set.

Parameters	P-Type [1]	Data type	Value range	Initial value	Description
initialIValue	IN	REAL	-100.0...100.0 (%) or phys. quantity [3]	0.0	Initialization value for I-action component The integrator output can be set at the "setIValue" input. The initialization value is available at the "initialIValue" input.
setDController	IN	BOOL	FALSE / TRUE	FALSE	Activate D-action component It is possible to activate and deactivate PID components individually in the PID algorithm. The D-action component is activated when the "setDController" input is set.
cycleTime	IN	DINT	≥ 1ms	1000	Block sampling time in ms The time between block calls must be constant. The "cycleTime" input specifies the time between block calls.
setpointValue	IN	REAL	-100.0...100.0 (%) or phys. quantity [2]	0.0	Internal setpoint The "setpointValue" input is used to specify a setpoint.
numericActValue	IN	REAL	-100.0...100.0 (%) or phys. quantity [2]	0.0	Actual value input The "numericActValue" input can be parameterized with a startup value or interconnected to an external actual value in floating-point format.
binActValue	IN	WORD	16#0 to 16#FFFF	16#0000	Actual I/O value The actual value in I/O format is interconnected to the controller at the "binActValue" input.
manualValue	IN	REAL	-100.0...100.0 (%) or phys. quantity [3]	0.0	Manual value The "manualValue" input is used to enter a manual value.
propGain	IN	REAL	[4]	2.0	P-action coefficient The "propGain" input specifies the controller gain.
integTime	IN	DINT	≥ cycleTime	20000	Integration time in ms The "integTime" input determines the dynamic response of the integrator.
derivativeTime	IN	DINT	≥ cycleTime	10000	Derivative time in ms The "derivativeTime" input determines the dynamic response of the differentiator.
delayTime	IN	DINT	≥ cycleTime/2	2000	Delay time of D-action component in ms The algorithm of the D-action component includes a delay that can be parameterized at the "delayTime" input.
deadBand	IN	REAL	≥ 0.0 (%) or phys. quantity [2]	0.0	Dead band width The error signal is routed over a dead band. The "deadBand" input determines the size of the dead band.

Parameters	P-Type [1)]	Data type	Value range	Initial value	Description
upperLimit	IN	REAL	lowerLimit to 100.0 (%) or phys. quantity [3)]	100.0	Upper limit of control output The control output is always limited to an upper and a lower limit. The "upperLimit" input specifies the upper limit.
lowerLimit	IN	REAL	-100.0... upperLimit (%) or phys. quantity [3)]	0.0	Lower limit of control output The control output is always limited to an upper and a lower limit. The "lowerLimit" input specifies the lower limit.
actValueFactor	IN	REAL	[4)]	1.0	Actual value factor The "actValueFactor" input is multiplied by the actual value. This input is used to adjust the range of actual values.
actValueOffset	IN	REAL	[4)]	0.0	Actual value offset The "actValueOffset" input is added to the actual value. This input is used to adjust the range of actual values.
outValueFactor	IN	REAL	[4)]	1.0	Control output factor The "outValueFactor" input is multiplied by the control output. This input is used to adjust the control output range.
outValueOffset	IN	REAL	[4)]	0.0	Control output offset The "outValueOffset" input is added to the control output. This input is used to adjust the control output range.
disturbValue	IN	REAL	-100.0...100.0 (%) or phys. quantity [3)]	0.0	Disturbance value For feedforward control, the disturbance value is interconnected to the "disturbValue" input.
numericOutValue	OUT	REAL	[4)]	0.0	Output value The actual control output in effect is output in floating-point format at the "numericOutValue" output.
binOutValue	OUT	WORD	16#0 to 16#FFFF	16#0000	I/O control output The control output in I/O format is specified at the "binOutValue" output.
upperLimitReached	OUT	BOOL	FALSE / TRUE	FALSE	Upper limit of control output violated The control output is always limited to an upper and a lower limit. The "upperLimitReached" output signals that the control output has exceeded its upper limit.
lowerLimitReached	OUT	BOOL	FALSE / TRUE	FALSE	Lower limit of control output violated The control output is always limited to an upper and a lower limit. The "lowerLimitReached" output signals that the control output has dropped below its lower limit.

Parameters	P-Type [1]	Data type	Value range	Initial value	Description
POutValue	OUT	REAL	[4]	0.0	P-action component The "POutValue" output contains the P-action component of the manipulated variable.
IOutValue	OUT	REAL	[4]	0.0	I component The "IOutValue" output contains the I-action component of the manipulated variable.
DOutValue	OUT	REAL	[4]	0.0	D component The "DOutValue" output contains the D-action component of the manipulated variable.
actValue	OUT	REAL	[4]	0.0	actual value The actual value that is currently in effect is available at the "actValue" output.
deviationValue	OUT	REAL	[4]	0.0	Error signal The actual error signal currently in effect is available at the "deviationValue" output.

[1] Parameter types: IN = input parameter, OUT = output parameter

[2] Parameter in setpoint and actual value branches with identical unit

[3] Parameter in control output branch with identical unit

[4] -3.402823466E+38 to -1.175494351E-38, 0.0, +1.175494351E-38 to +3.402823466E+38

Function description

In addition to the functions in the setpoint and actual value branches, the function block also produces a complete PID controller with continuous manipulated variable output and allows manual correction of the control output (value of the manipulated variable).

Description of subfunctions:

Setpoint branch

The setpoint is entered in floating-point format at the **"setpointValue"** input.

Actual value branch

The actual value can be read either in I/O or floating-point format. The I/O value "binActValue" is internally converted to a floating-point value between -100% to +100% according to the following formula (corresponding to nominal range of an analog module):

$$\text{Actual value (floating-point format)} = \text{Actual value (I/O format)} \cdot \frac{100}{27648}$$

It is possible to normalize the actual value (floating-point format) according to the formula below using the "actValueFactor" and "actValueOffset" parameters:

Normalized actual value (floating-point format) =

Actual value (floating-point format) • actValueFactor + actValueOffset

"1.0" is the default setting for "actValueFactor" and "0.0" the default setting for "actValueOffset".

Error signal generation

The difference between the setpoint and actual value is the error signal. To suppress a slight continuous oscillation resulting from quantization of the manipulated variable (for example, in the case of pulse width modulation with the _CTRL_pwm function block), the error signal is routed over a dead band. The dead band is deactivated with setting "deadBand" = 0.0.

PID algorithm

The PID algorithm operates in the position algorithm. The proportional, integral, and derivative components are connected in parallel and can be activated and deactivated individually, thus making it possible to parameterize P, PI, PD, and PID controllers. In addition, pure I-controllers are possible.

Manual value processing

It is possible to switch between manual and automatic mode. In manual mode, the manipulated variable is corrected to a manually selected value.
The integrator is set internally to "numericOutValue - POutValue - disturbValue" and the differentiator is set to "0.0" and internally aligned. Switchover to automatic mode is therefore smooth.

Control output processing

The control output can be limited to selected values. Signaling bits indicate when a limit is exceeded by the input variable.

The control output (floating-point format) can be normalized according to the formula below using parameters "outValueFactor" and "outValueOffset":

Normalized control output (floating-point format) =

Control output (floating-point format) • outValueFactor + outValueOffset

"1.0" is the default setting for "outValueFactor" and "0.0" the default setting for "outValueOffset".

The control output is also available in I/O format. The floating-point value is internally converted to an I/O value (corresponding to nominal range of an analog module):

Normalized control output (I/O format) =

$$\text{normalized control output (floating-point format)} \cdot \frac{27648}{100}$$

Feedforward control

A disturbance can be applied additively at the "disturbValue" input.

Initialization routine

If you set the "reset" parameter to TRUE, the following occurs:

- All output parameters (parameter type OUT) of the function block are set to FALSE or zero
- The integrator is set to initialization value "initialIValue"

Block diagram

The figure below is a block diagram of the **_CTRL_pid** function block.

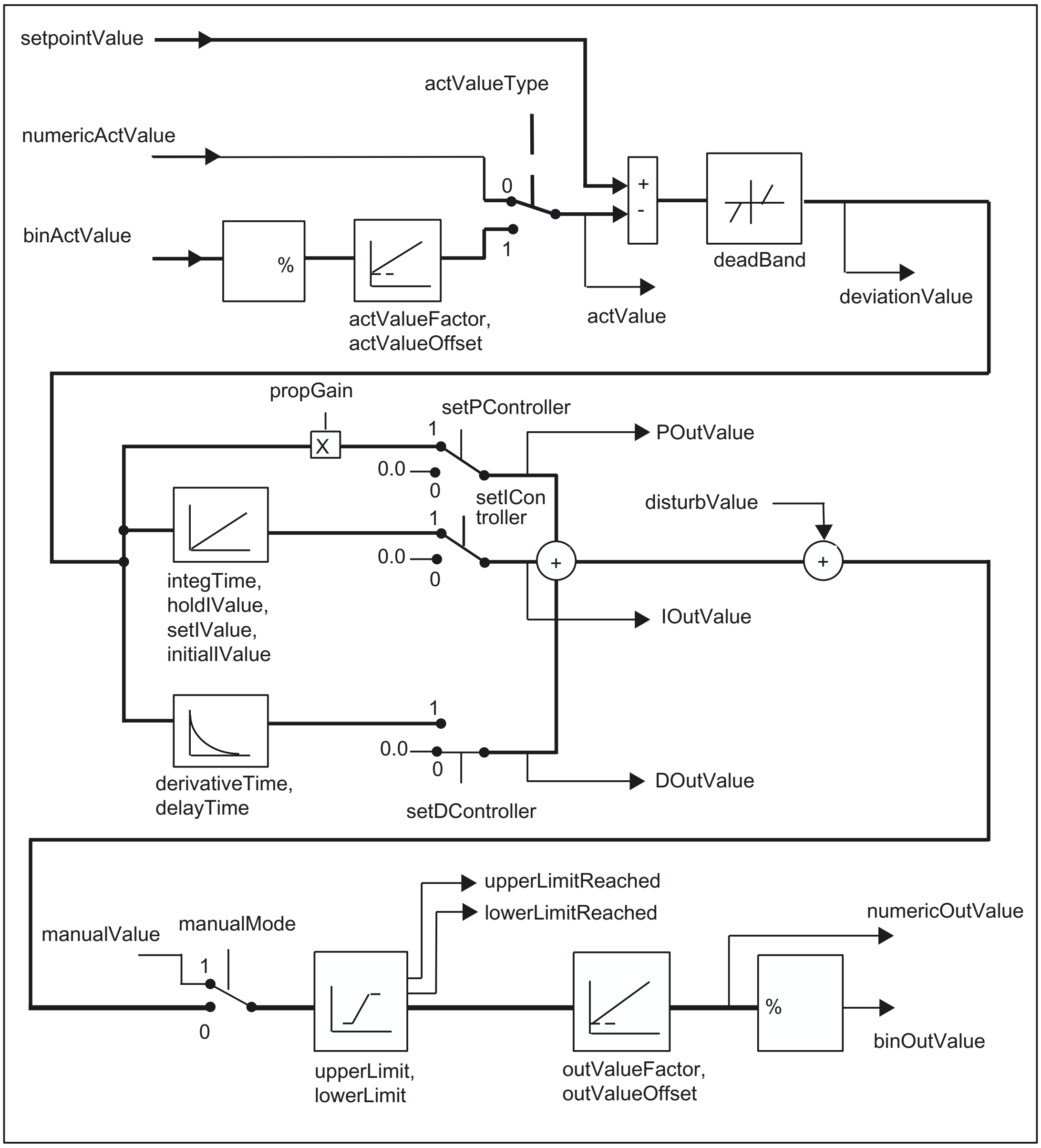


Figure 2-1 Block diagram of the _CTRL_pid function block

Task integration (call)

The **_CTRL_pid** function block must be called cyclically in the BackgroundTask or in the TimerInterruptTask. Calling in the SystemInterruptTask is not permitted. Calling the function block in the **IPOSynchronousTask** is not recommended for runtime reasons.

2.4 Step control using the _CTRL_piStep function block

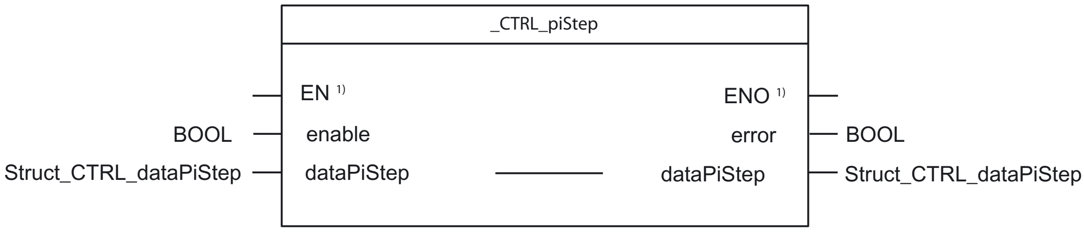
Introduction

The **_CTRL_piStep** function block is used to control technical processes with binary control output signals for integrating actuators on SIMOTION systems. Using parameterization, you can activate or deactivate subfunctions of the PI step controller and thus adapt it to the controlled system in question.

Application

You can use the controller individually as a fixed-setpoint PI controller or in secondary control loops as cascade, combined, or ratio controllers, but not as a master controller. Its operating principle is based on the PI control algorithm of the sampling controller, supplemented by function elements for generating a binary output signal from an analog actuating signal.

Call (LAD representation)



1) LAD-specific parameters

Parameters of the _CTRL_piStep function block

Note

The SIMOTION identifiers have changed as of V4.0. A comparison of the identifiers up to V3.2/as of V4.0 can be found in the Appendix in the table "List of parameters".

Table 2-3 Parameters of the _CTRL_piStep function block

Name	P-Type 1)	Data type	Meaning	Actions performed by user	Actions performed by block
enable	IN	BOOL	Block enable	Entered	Checked
dataPiStep	IN/OUT	Struct_CTRL_dataPiStep	Data structure	Entered and checked	Checked and entered
error	OUT	BOOL	Request completed with errors	Checked	Entered

1) Parameter types: IN = input parameters, OUT = output parameters, IN/OUT = in/out parameters

Data structure of the _CTRL_piStep function block

The data structure of type **Struct_CTRL_dataPiStep** contains all input and output parameters of the **_CTRL_piStep** function block.

The data structure is used by the **_CTRL_piStep** function block.
Elements in the data structure are accessed using a variable of data type **Struct_CTRL_dataPiStep**, which you must define yourself.

The **Struct_CTRL_dataPiStep** data structure is shown in the table below.

Note

The SIMOTION identifiers have changed as of V4.0. A comparison of the identifiers up to V3.2/as of V4.0 can be found in the Appendix in the table "List of parameters".

Table 2-4 Data structure of Struct_CTRL_dataPiStep

Parameters	P-Type 1)	Data type	Value range	Initial value	Description
reset	IN	BOOL	FALSE / TRUE	FALSE	Initialization routine = TRUE All output parameters are set to FALSE or zero
actValueType	IN	BOOL	FALSE / TRUE	FALSE	Activate actual I/O value If the actual value must be read in from the I/O, then the "binActValue" input must be interconnected to the I/O and the "actValueType" input must be set.
cycleTime	IN	DINT	≥1 ms	1000	Sampling time in ms The time between block calls must be constant. The "cycleTime" input specifies the time between block calls.
setpointValue	IN	REAL	-100.0...100.0 (%) or phys. quantity 2)	0.0	Internal setpoint The "setpointValue" input is used to specify a setpoint.
numericActValue	IN	REAL	-100.0...100.0 (%) or phys. quantity 2)	0.0	Actual value input The "numericActValue" input can be parameterized with a startup value or interconnected to an external actual value in floating-point format.
binActValue	IN	WORD	16#0 to 16#FFFF	16#0000	Actual I/O value The actual value in I/O format is interconnected to the controller at the "binActValue" input.
propGain	IN	REAL	4)	2.0	P-action coefficient The "propGain" input specifies the controller gain.
integTime	IN	DINT	≥ cycleTime	20000	Integration time in ms The "integTime" input determines the dynamic response of the integrator.

Parameters	P-Type [1)]	Data type	Value range	Initial value	Description
deadBand	IN	REAL	0.0...100.0 (%) or phys. quantity [2)]	1.0	Dead band width The error signal is routed over a dead band. The "deadBand" input determines the size of the dead band.
upperLimit	IN	BOOL	FALSE / TRUE	FALSE	Upper endstop signal of position feedback The "Control valve at upper endstop" signal is interconnected at the "upperLimit" input. "upperLimit"=TRUE means: The control valve is at the upper endstop.
lowerLimit	IN	BOOL	FALSE / TRUE	FALSE	Lower endstop signal of position feedback The "Control valve at lower endstop" signal is interconnected at the "lowerLimit" input. "lowerLimit"=TRUE means: The control valve is at the lower endstop.
manualMode	IN	BOOL	FALSE / TRUE	FALSE	Activate manual mode for control output signals Control output signal processing is switched to manual mode at the "manualMode" input.
setOutHigh	IN	BOOL	FALSE / TRUE	FALSE	Control output signal High In output signal manual mode, the "outHigh" output signal is manipulated at the "setOutHigh" input.
setOutLow	IN	BOOL	FALSE / TRUE	FALSE	Control output signal Low In output signal manual mode, the "outLow" output signal is manipulated at the "setOutLow" input.
minPulseTime	IN	DINT	≥ cycleTime	3000	Minimum pulse time in ms A minimum pulse length can be parameterized in the "minPulseTime" parameter.
minIdleTime	IN	DINT	≥ cycleTime	3000	Minimum idle time in ms A minimum idle time can be parameterized in the "minIdleTime" parameter.
actuatingTime	IN	DINT	≥ cycleTime	30000	Motor actuating time in ms The runtime between strokes of the control valve is entered in the "actuatingTime" parameter.
actValueFactor	IN	REAL	[4)]	1.0	Actual value factor The "actValueFactor" input is multiplied by the actual value. This input is used to adjust the range of actual values.
actValueOffset	IN	REAL	[4)]	0.0	Actual value offset The "actValueOffset" input is added to the actual value. This input is used to adjust the range of actual values.
disturbValue	IN	REAL	-100.0...100.0 (%) or phys. quantity [3)]	0.0	Disturbance value For feedforward control, the disturbance value is interconnected to the "disturbValue" input.

Parameters	P-Type [1]	Data type	Value range	Initial value	Description
outHigh	OUT	BOOL	FALSE / TRUE	FALSE	Control output signal High If the "outHigh" output is set, the control valve must be opened.
outLow	OUT	BOOL	FALSE / TRUE	FALSE	Control output signal Low If the "outLow" output is set, the control valve must be closed.
actValue	OUT	REAL	[4]	0.0	actual value The actual value that is currently in effect is available at the "actValue" output.
deviationValue	OUT	REAL	[4]	0.0	Error signal The actual error signal currently in effect is available at the "deviationValue" output.

[1] Parameter types: IN = input parameter, OUT = output parameter

[2] Parameter in setpoint and actual value branches with identical unit

[3] Parameter in control output branch with identical unit

[4] -3.402823466E+38 to -1.175494351E-38, 0.0, +1.175494351E-38 to +3.402823466E+38

Function description

In addition to the functions in the actual value branch, the function block also produces a complete PI controller with binary output of the control output and allows manual correction of the control output.

Description of subfunctions:

Setpoint branch

The setpoint is entered in floating-point format at the **"setpointValue"** input.

Actual value branch

The actual value can be read either in I/O or floating-point format. The I/O value "binActValue" is converted internally to a floating-point value of -100 to +100 % according to the following formula:

$$\text{Actual value (floating-point format)} = \text{Actual value (I/O format)} \cdot \frac{100}{27648}$$

It is possible to normalize the actual value (floating-point format) according to the formula below using the "actValueFactor" and "actValueOffset" parameters:

Normalized actual value (floating-point format) =
Actual value (floating-point format) • actValueFactor + actValueOffset

"1.0" is the default setting for "actValueFactor" and "0.0" the default setting for "actValueOffset".

Error signal generation

The difference between the setpoint and actual value is the error signal. To suppress a slight continuous oscillation resulting from quantization of the manipulated variable (limited resolution of control output by the control valve), the error signal is routed over a dead band. The dead band is deactivated with setting "deadBand" = 0.0.

PI step algorithm

The PI step controller operates without actuating signal feedback at the output.
A signal is generated to indicate that the upper or lower limit has been reached.
The I-action component of the PI algorithm and the "upper/lower limit reached" signal are calculated in an integrator and compared as a feedback value with the remaining P-action component. The difference is applied to a three-step element and a pulse shaper that generates the pulses for the control valve. The operating frequency of the controller is reduced through adaptation of the response threshold of the three-step element.

Feedforward control

A disturbance can be applied additively at the "disturbValue" input.

Initialization routine

If you set the "reset" parameter to TRUE, all output parameters (parameter type OUT) of the function block are set to FALSE or zero.

Block diagram

The figure below is a block diagram of the **_CTRL_piStep** function block.

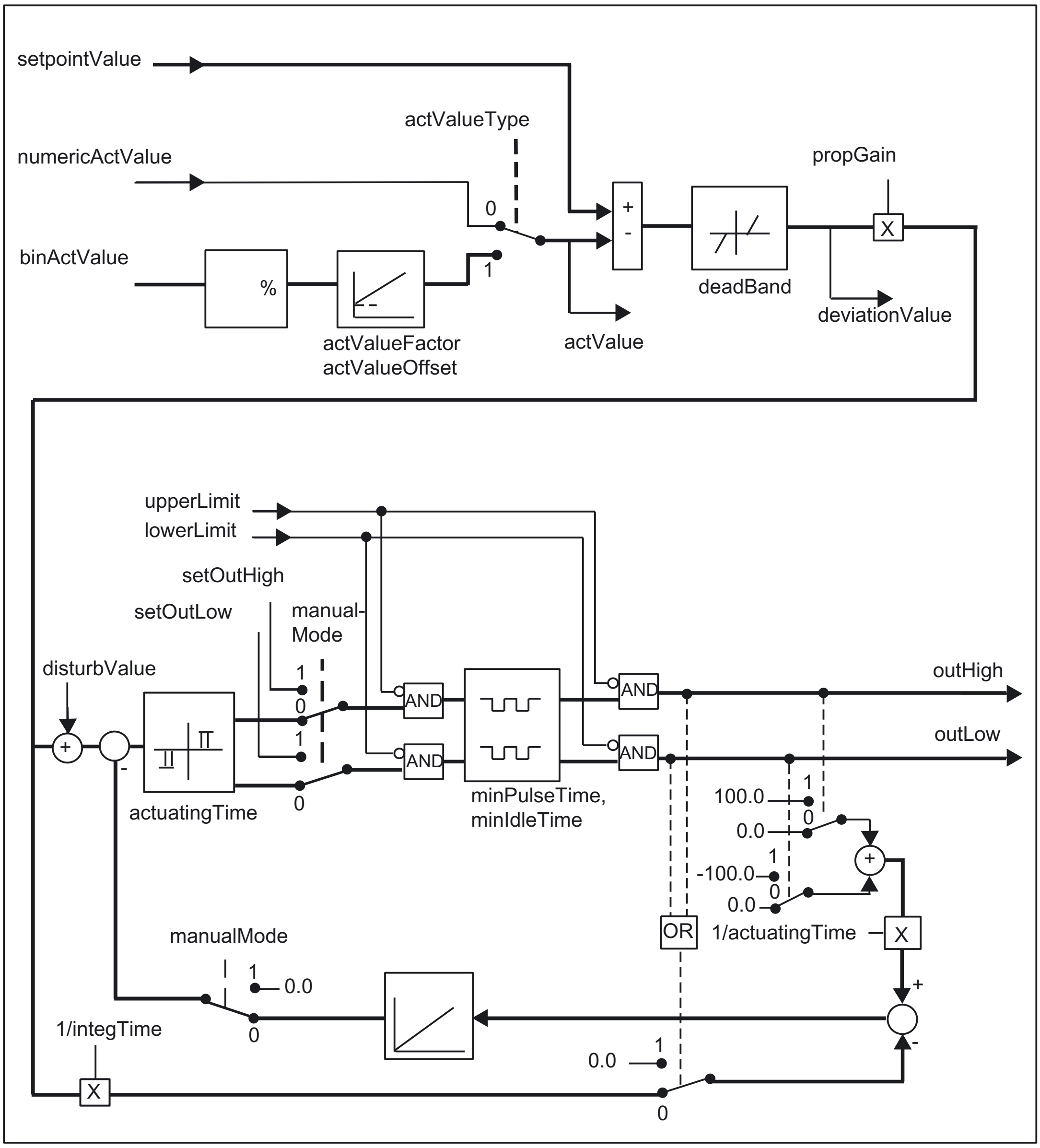


Figure 2-2 Block diagram of the _CTRL_piStep function block

Task integration (call)

The **_CTRL_piStep** function block must be called cyclically in the BackgroundTask or in the TimerInterruptTask. Calling in the SystemInterruptTask is not permitted. Calling the function block in the **IPOSynchronousTask** is not recommended for runtime reasons.

2.5 Pulse width modulation (PWM) with the _CTRL_pwm function block

Introduction

The **_CTRL_pwm** function block is used to create a PID controller with pulse output for proportional actuators.

Application

Two- or three-step PID controllers with pulse width modulation can be implemented with the **_CTRL_pwm** function block. The function block is usually used in conjunction with the **_CTRL_pid** function block.

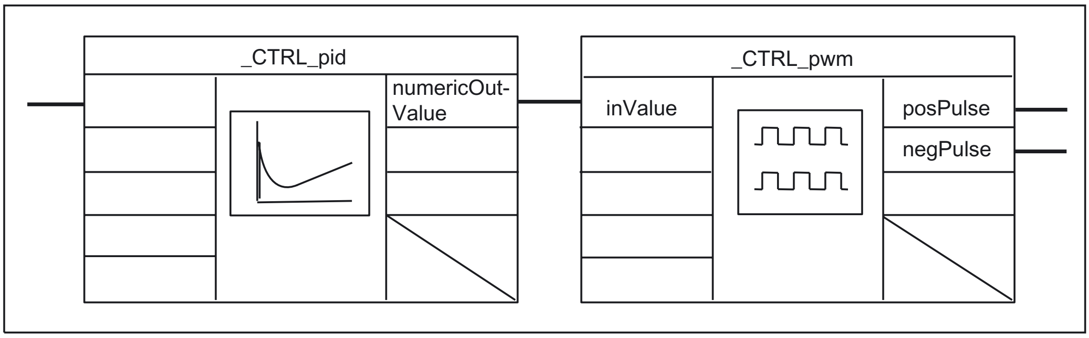
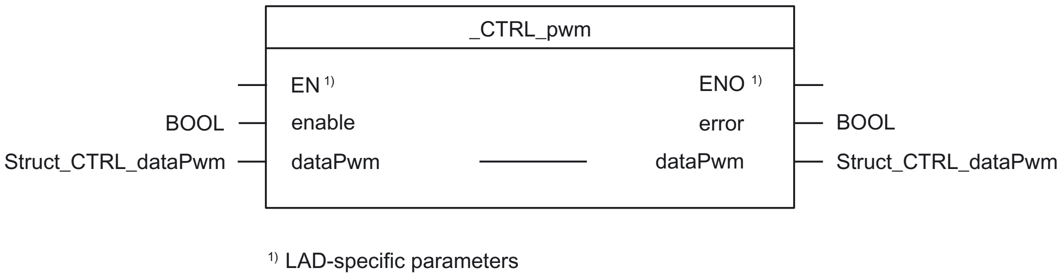


Figure 2-3 _CTRL_pid, _CTRL_pwm function blocks

Call (LAD representation)



Parameter description

Note

The SIMOTION identifiers have changed as of V4.0. A comparison of the identifiers up to V3.2/as of V4.0 can be found in the Appendix in the table "List of parameters".

Table 2-5 Parameters of the _CTRL_pwm function block

Name	P-Type [1)]	Data type	Meaning	Actions performed by user	Actions performed by block
enable	IN	BOOL	Block enable	Entered	Checked
dataPwm	IN/OUT	Struct_CTRL_dataPwm	Data structure	Entered and checked	Checked and entered
error	OUT	BOOL	Request completed with errors	Checked	Entered

[1)] Parameter types: IN = input parameters, OUT = output parameters, IN/OUT = in/out parameters

Data structure of the _CTRL_pwm function block

The data structure of type **Struct_CTRL_dataPwm** contains all input and output parameters of the **_CTRL_pwm** function block.

The data structure is used by the **_CTRL_pwm** function block.
Elements in the data structure are accessed using a variable of data type **Struct_CTRL_dataPwm**, which you must define yourself.

The **Struct_CTRL_dataPwm** data structure is shown in the table below.

Note

The SIMOTION identifiers have changed as of V4.0. A comparison of the identifiers up to V3.2/as of V4.0 can be found in the Appendix in the table "List of parameters".

Table 2-6 Data structure of Struct_CTRL_dataPwm

Parameters	P-Type [1)]	Data type	Value range	Initial value	Description
reset	IN	BOOL	FALSE / TRUE	FALSE	Initialization routine = TRUE All output parameters are set to FALSE or zero
inValue	IN	REAL	-100.0...100.0 (%)	0.0	Input variable An analog control output variable is applied at the "inValue" input parameter.
periodTime	IN	DINT	≥ 20 * cycleTime	1000	Period in ms The constant period of pulse width modulation is set in the "periodTime" parameter. It equals the controller sampling time. The ratio of the pulse shaper to controller sampling times determines the accuracy of the pulse width modulation.
minPulseIdleTime	IN	DINT	≥ cycleTime	0	Minimum pulse or minimum idle time in ms A minimum pulse or idle length can be parameterized in the "minPulseIdleTime" parameter.

Parameters	P-Type [1)]	Data type	Value range	Initial value	Description
ratioFactor	IN	REAL	0.1 ...10.0	1.0	Ratio factor Using the "ratioFactor" input parameter, you can alter the ratio of negative to positive pulse times. In a thermal process, this would, for example, allow different time constants for heating and cooling to be compensated (for example, in a process with electrical heating and water cooling).
set3StepControl	IN	BOOL	FALSE / TRUE	TRUE	Activate three-step control The operating mode is activated at the "set3StepControl" input parameter. Both output signals work with the three-step control option.
set2StepControl	IN	BOOL	FALSE / TRUE	FALSE	Activate two-step control for bipolar control output range At the "set2StepControl" input parameter, it is possible to choose between two operating modes: "Two-step control for bipolar control output range" and "Two-step control for unipolar control output range". In this case, "set3StepControl" must be FALSE.
setManualMode	IN	BOOL	FALSE / TRUE	FALSE	Activate manual mode Setting the "setManualMode" input parameter allows you to set output signals manually.
setPosPulse	IN	BOOL	FALSE / TRUE	FALSE	Positive pulse ON (manual mode) In manual three-step control mode, the "posPulse" output parameter can be manipulated at the "setPosPulse" input parameter. In two-step control manual mode, "negPulse" is always set in inverted form to "posPulse".
setNegPulse	IN	BOOL	FALSE / TRUE	FALSE	Negative pulse ON (manual mode) In manual three-step control mode, the "negPulse" output parameter can be manipulated at the "setNegPulse" input parameter. In two-step control manual mode, "negPulse" is always set in inverted form to "posPulse".
cycleTime	IN	DINT	≥ 1ms	10	Sampling time in ms The time between block calls must be constant. The "cycleTime" input specifies the time between block calls.
posPulse	OUT	BOOL	FALSE / TRUE	FALSE	Output signal positive pulse The "posPulse" output parameter is set if a pulse is to be output. This is the positive pulse in three-step control mode. In two-step control mode, "negPulse" is always set in inverted form to "posPulse".

Parameters	P-Type [1)]	Data type	Value range	Initial value	Description
negPulse	OUT	BOOL	FALSE / TRUE	FALSE	Output signal negative pulse The "negPulse" output parameter is set if a pulse is to be output. This is the negative pulse in three-step control mode. In two-step control mode, "negPulse" is always set in inverted form to "posPulse".

[1)] Parameter types: IN = input parameter, OUT = output parameter

Note

The value of input parameters is not limited in the block; no parameterization check is performed.

Function description

The _CTRL_pwm function block transforms the "inValue" input variable (= "numericOutValue" of PID controller) into a pulse train with a constant period by modulating the pulse width. This period corresponds to the cycle time in which the input variable is updated and must be parameterized in the "periodTime" parameter.

The duration of a pulse per period is proportional to the input variable. However, the cycle parameterized in "periodTime" is not identical to the processing cycle of the _CTRL_pwm function block. Instead, a "periodTime" cycle comprises several processing cycles of the _CTRL_pwm function block so that the number of _CTRL_pwm calls per "periodTime" cycle is a measure of the precision of the pulse width.

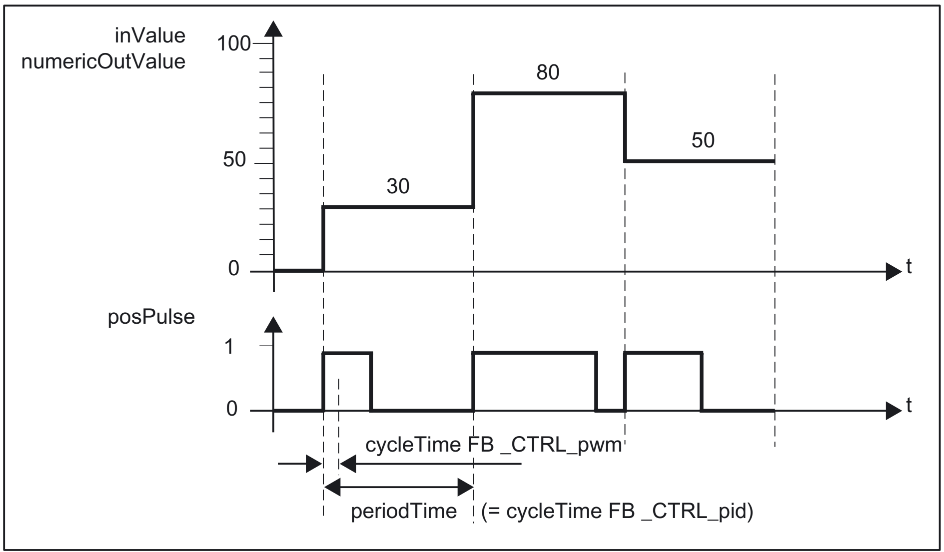


Figure 2-4 Pulse width modulation

An input variable of 30% and 10 calls of _CTRL_pwm function block per "periodTime" therefore mean:

- "TRUE" at the "posPulse" output for the first three calls of the _CTRL_pwm function block (30% of 10 calls)
- "FALSE" at the "positivePulse" output for seven additional calls of the _CTRL_pwm function block (70% of 10 calls)

Block diagram

The figure below is a block diagram of the **_CTRL_pwm** function block.

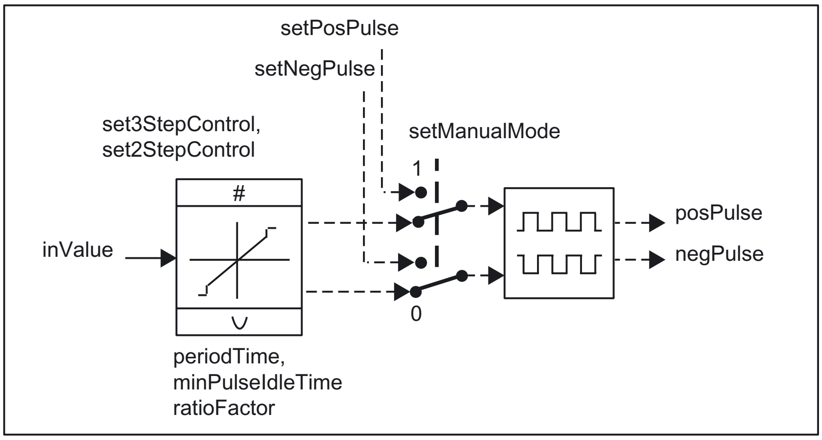


Figure 2-5 Block diagram of the _CTRL_pwm function block

Control output accuracy

With a "sampling ratio" of 1:10 (_CTRL_pid calls to _CTRL_pwm calls), the control output accuracy in this example is limited to 10%, that is, specified "inValue" input values can only be mapped onto a pulse length at the "posPulse" output in a 10% grid. The precision increases in proportion to the number of _CTRL_pwm calls per _CTRL_pid call. For example, if the **_CTRL_pwm** function block is called 100 times more frequently than the **_CTRL_pid** function block, a resolution of 1% of the control output range is achieved.

Note

You must program any reduction in the call frequency yourself.

Operating modes

Depending on how the pulse shaper is parameterized, it is possible to configure a two or three-step control with bipolar or unipolar control range.

Table 2-7 Setting the combinations for possible operating modes

Operating mode	Parameters		
	setManualMode	**set3StepControl**	**set2StepControl**
Three-step control	FALSE	TRUE	arbitrary
Two-step control with bipolar control range (-100% to 100%)	FALSE	FALSE	TRUE
Two-step control with unipolar control range (0% to 100%)	FALSE	FALSE	FALSE
Manual mode	TRUE	arbitrary	arbitrary

Three-step control

Three control signal states can be generated in "three-step control" mode. To accomplish this, the status values of binary output signals "posPulse" and "negPulse" are assigned to the respective operating states of the actuator.

Table 2-8 Example of a temperature control

Output signals	Final controlling element		
	Heat	Off	Cool
posPulse	TRUE	FALSE	FALSE
negPulse	FALSE	FALSE	TRUE

The pulse duration is calculated from the input variable using a characteristic curve. The shape of this curve is defined by the minimum pulse and minimum idle times and the ratio factor, see Figure "Symmetrical characteristic curve of the three-step controller (ratio factor = 1)".

The normal value for the ratio factor is 1.

The breakpoints in the characteristic curves are caused by the minimum pulse and minimum idle times.

Minimum pulse or minimum idle time

A properly parameterized minimum pulse or minimum idle time "minPulseIdleTime" can prevent short switch-on or switch-off times that reduce the service life of switchgear and control equipment.

Note

Low absolute values of the "inValue" input variable that would produce a pulse time shorter than "minPulseIdleTime" are suppressed. High input values that would produce a pulse time longer than ("periodTime - minPulseIdleTime") are set to 100% or -100%.

The duration of the positive or negative pulses is calculated by multiplying the input variable (in %) and the period:

$$\text{Pulse duration} = \frac{\text{inValue}}{100} \cdot \text{periodTime}$$

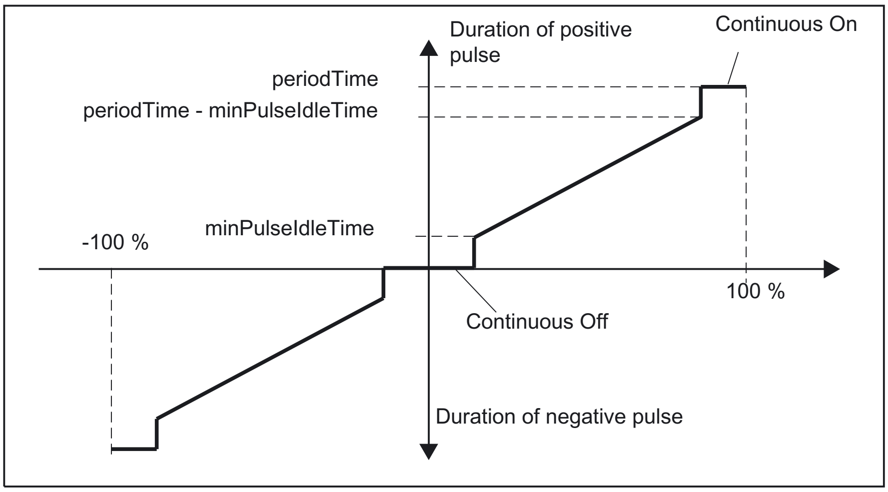


Figure 2-6 Symmetrical characteristic curve of the three-step controller (ratio = 1)

asymmetrical three-step control

Using the "ratioFactor" ratio factor, you can alter the ratio of the positive to negative pulse durations. In a thermal process, for example, this would allow different system time constants for heating and cooling.

The ratio factor also influences the minimum pulse or minimum break time. A ratio factor < 1 means that the threshold value for negative pulses is multiplied by the ratio factor.

Ratio factor < 1

The pulse duration calculated by multiplying the input variable and the period at the negative pulse output is reduced by the ratio factor,see Figure "Asymmetrical characteristic curve of the three-step controller (ratio factor = 0.5)".

$$\text{Positive pulse duration} = \frac{\text{inValue}}{100} \cdot \text{periodTime}$$

$$\text{Negative pulse duration} = \frac{\text{inValue}}{100} \cdot \text{periodTime} \cdot \text{ratioFactor}$$

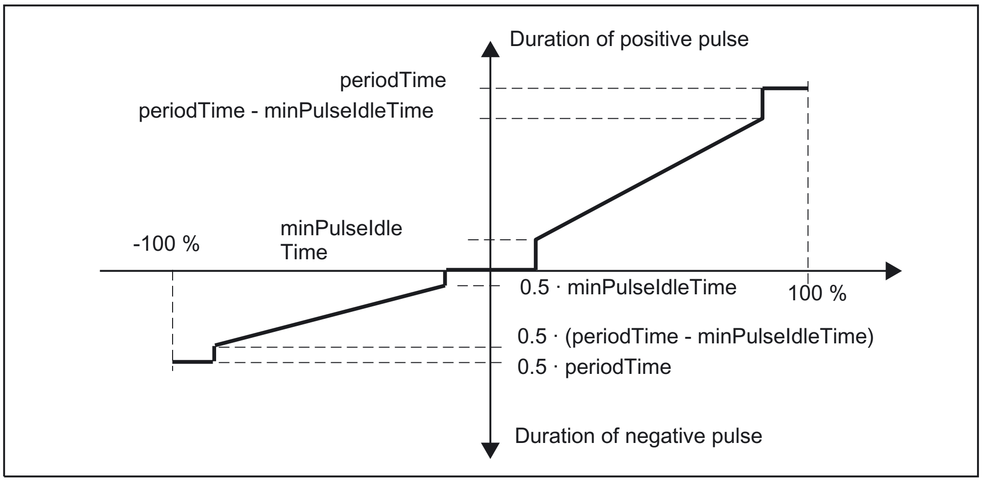


Figure 2-7 Asymmetrical characteristic curve of the three-step controller (ratio = 0.5)

Ratio factor > 1

The pulse duration calculated by multiplying the input variable and the period at the positive pulse output is reduced by the ratio factor.

$$\text{Negative pulse duration} = \frac{\text{inValue}}{100} \cdot \text{periodTime}$$

$$\text{Positive pulse duration} = \frac{\text{inValue}}{100} \cdot \frac{\text{periodTime}}{\text{ratioFactor}}$$

Two-step control

With two-step control, only the "posPulse" pulse output of the _CTRL_pwm function block is connected to the relevant On/Off actuator. Depending on the manipulated value range used, the two-step controller has a bipolar or a unipolar manipulated value range, see diagrams below.

Two-step control with bipolar output range (-100% to 100%)

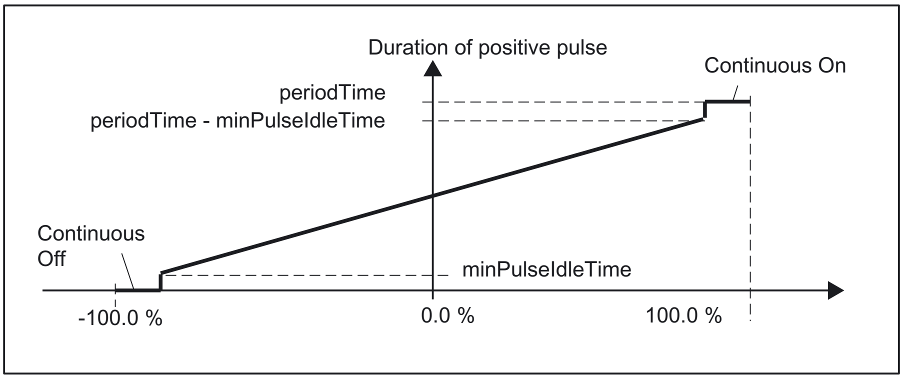


Figure 2-8 Characteristic curve with bipolar control output range (-100% to 100%)

Two-step control with unipolar control output range (0% to 100%)

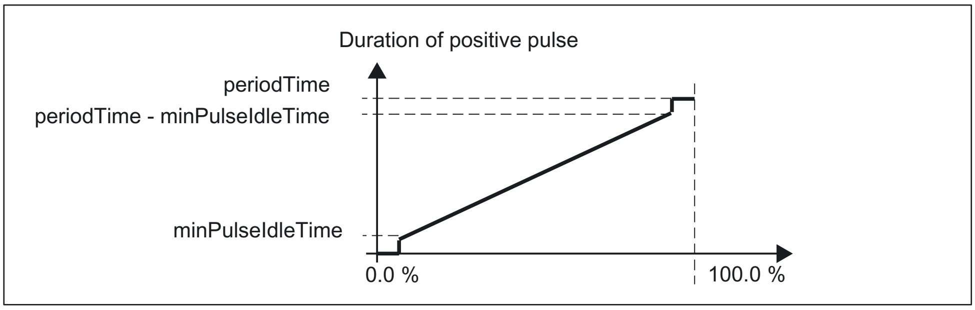


Figure 2-9 Characteristic curve with unipolar control output range (0% to 100%)

The inverted output signal is available at "negPulse" if the two-step controller interconnection in the control loop requires a logically inverted binary signal for the actuating pulses.

Table 2-9 Assignment of the output signals posPulse and negPulse

Pulse	Final controlling element	
	ON	OFF
posPulse	TRUE	FALSE
negPulse	FALSE	TRUE

Manual mode with two-step or three-step control

In manual mode ("setManualMode" = TRUE), it is possible to set the binary outputs of the two- or three-step controller independently of "inValue" using the "setPosPulse" and "setNegPulse" signals.

Table 2-10 Parameter assignments

	setPosPulse	setNegPulse	posPulse	negPulse
Three-step control	FALSE TRUE FALSE TRUE	FALSE FALSE TRUE TRUE	FALSE TRUE FALSE FALSE	FALSE FALSE TRUE FALSE
Two-step control	FALSE TRUE	arbitrary arbitrary	FALSE TRUE	TRUE FALSE

Initialization routine

If you set the "reset" parameter to TRUE, all output parameters (parameter type OUT) of the function block are set to FALSE or zero.

Task integration (call)

The _CTRL_pwm function block must be called cyclically in the BackgroundTask or in the TimerInterruptTask. Calling in the SystemInterruptTask is not permitted. Calling the function block in the IPOSynchronousTask is not recommended for runtime reasons.

2.6 Calling function blocks

In order to be able to work with the function blocks in your user program, proceed as follows (The numbers shown in the following program segment correspond to the steps below.):

1. Create the function block instance (see the following program segment, e.g. create instance for the _CTRL_pid function block).
2. Set up variables for the data structure.
3. Call instance of the function block.
4. Transfer input parameters.
5. The output parameters of the function block are accessed with <instance name of FB>.<name of output parameter>.

Call example

```
UNIT E_bc_PID;

INTERFACE
VAR_GLOBAL
  myEnablePID   : BOOL;
  myFbPID       : _CTRL_pid;           // create "_CTRL_pid" instance                 (1)
  myDataSetPID  : Struct_CTRL_dataPid; // create variable for data structure          (2)
  myOutValue1   : REAL;                // variable created by user for accessing
                                       // an output variable of the function block
END_VAR

PROGRAM ExamplePID;                // program in TimerInterruptTask
END_INTERFACE

IMPLEMENTATION

PROGRAM ExamplePID                // program in TimerInterruptTask

    myDataSetPID.reset           := FALSE;    // initialization procedure
    myDataSetPID.setpointValue   := 150;      // setpoint value
    myDataSetPID.integTime       := 2000;     // integration time

        // examples for transferring parameters specified by the user to the
        // corresponding parameters of the variable created by the user in the
        // "Struct_CTRL_dataPid" data structure.
        // when the created function block instance is called, the variable created
        // by the user in the "Struct_CTRL_dataPid" data structure is transferred
        // with all of its parameters.

    myFbPID( ENABLE := myEnablePID                                                    (3)
            , dataPid := myDataSetPID                                                 (4)
            );
        // the created "_CTRL_pid" instance is called.
        // the "myDataSetPID" variable created by the user is assigned to the
        // "dataPid" variable that is used in the "_CTRL_pid" function block.

    myOutValue1:=myDataSetPID.numericOutValue;                                        (5)

        // an output variable in the "_CTRL_pid" function block
        // is assigned to an "myOutValue1" variable created by the user.

END_PROGRAM

END_IMPLEMENTATION
```

Note

The ExamplePID program must be assigned in the execution system.

Application example

3

3.1 Application example

Introduction

A closed-loop temperature control is to be implemented for a film sealing machine.

A two-ply film is unwound from roll 1, sealed and rewound onto roll 2.

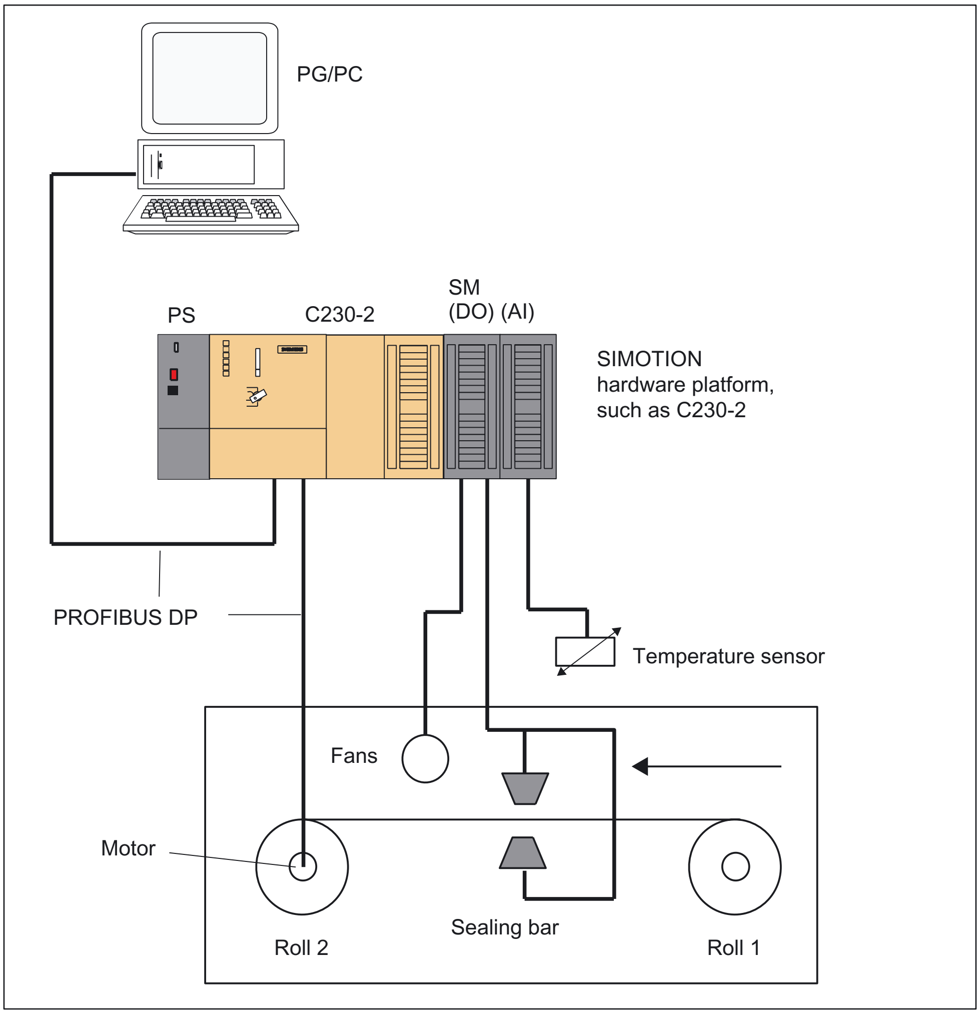


Figure 3-1 Example application for a film sealing machine

Closed-loop temperature control can be implemented by interconnecting the _CTRL_pid function block (continuous controller) and the _CTRL_pwm function block (pulse width modulation).

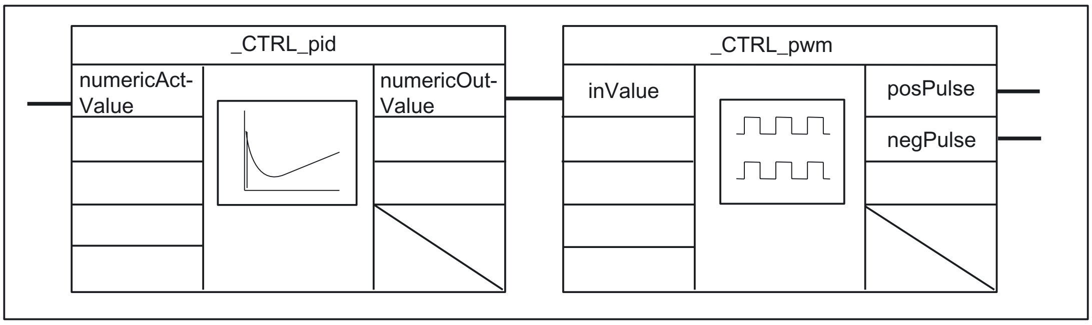


Figure 3-2 Interconnection of function blocks

Three states are to be implemented:

- Heat (sealing bar)
- OFF
- Cool (fan)

The controller output variable will be converted to a pulse train with constant period by modulating the pulse width. The temperature (actual value) is measured using a PT 100 (resistance thermometer), which can be connected to an analog module, for example.

If an analog module is used, it must be parameterized for measurement using PT 100 and the addresses must be set.

Content of application example

Based on the given task, three-step control is selected for the "pulse width modulation" block as this allows three states (heat, off, cool) of the output control signal to be generated.

The "continuous controller" generates the control output, which converts the "pulse width modulation" to a pulse pattern and supplies the "posPulse" and "negPulse" outputs.

The task is accomplished in the "E_bc_PID" unit. This unit contains the "ExamplePID" program, which calls the two blocks. The block calls are implemented using a call counter in such a way that the "continuous controller" is called every 2 seconds and the "pulse width modulation" every 20 milliseconds. As a result, there is a 1:100 resolution of "continuous controller" to "pulse width modulation" block calls.

Using variables, you can initialize the blocks and switch to closed-loop control.
Setting the "myInit" variable (program: E_bc_PID - symbol browser) to "TRUE" causes the initialization routine to be run through once. The variable is reset at the end of the program.

The control is activated when you set the "myCtrlOn" variable to "TRUE" and deactivated when you set it to "FALSE".

The "myInTemperature" variable is used symbolically as an input address. It is an INTEGER data type. It may be necessary to convert the actual temperature value to data type INTEGER (for example, from WORD to INT). The "myInTemperature" variable is assigned to the "myInValue" variable. The "myInValue" variable is assigned to the "myDataSetPID.numericActValue" parameter when the instance created of the _CTRL_pid function block is called. The preassignment of the other input parameters of the instances created of the _CTRL_pid function block or the _CTRL_pwm function block, see Table "Preassigned parameters of the _CTRL_pid function block" and Table "Preassigned parameters of the _CTRL_pwm function block".

Heater and fan operation is controlled by relays. Each of these is connected to a hardware output. In the example, the "myOutHeating" variable is used symbolically as the output address for heating and the "myOutCooling" variable for the fan.
The myDataSetPWM.posPulse and myDataSetPWM.negPulse parameters of the instance created of the _CTRL_pwm function block are assigned to the "myOutValueHeating" and "myOutValueCooling" variables, respectively. The "myOutHeating" and "myOutCooling" variables are assigned to the "myOutValueHeating" and "myOutValueCooling" variables, respectively.

The "myDataSetPID.numericOutValue" output parameter of the instance created of the _CTRL_pid function block must first be normalized to between 0 and 100% and then adapted to the three-step control of the _CTRL_pwm function block ("normalizedOutValuePID" variable).
The "normalizedOutValuePID" variable is assigned to the "myDataSetPWM.inValue" parameter when the instance created of the _CTRL_pwm function block is called.

Because the cycle time of the blocks is required for internal block calculations, the "ExamplePID" program must run in a time-triggered task. The cycle time of this task must match the cycle time of the _CTRL_pwm function block.

Note

The real addresses are dependent on the hardware configuration of the relevant machine.

Hardware platform

The application example is available for various SIMOTION hardware platforms.

Note

If the application example is not available for your hardware platform, you must adapt the hardware configuration.

Adapting the application example

The configuration in the example and its available hardware must be adapted.

The following options are available:

1. You can adapt the configuration in the example to the available hardware (insert digital/analog module, assign parameters, and set addresses).
2. You can simulate actual value acquisition and control of output variables (heating and cooling). Operator control and monitoring using the symbol browser.

Calling the application example

The application example can be found on the "SIMOTION Utilities & Applications" CD-ROM. The "Utilities & Applications" CD-ROM is provided free of charge with SIMOTION SCOUT.

1. Unarchive and open the project containing the application example.
2. If you add modules (DO/AI) to the example, you must assign I/O variables to the I/O addresses in the hardware configuration (see table below).

   The **myInTemperature**, **myOutValueHeating**, and **myOutValueCooling** variables must then be commented out or deleted in the program under "VAR_GLOBAL". Otherwise, these variables will be used instead of the I/O variables.
3. Save and compile the example project. Then, you can download the example to the SIMOTION device and switch to **RUN** mode.
4. If the actual value acquisition is simulated, the actual temperature value must be assigned to the **myInTemperature** variable in the symbol browser.
5. Set the **myCtrlOn** variable to TRUE. This activates the control.

	Name	I/O address	Data type
1	myInTemperature	PIW 256	INT
2	myOutValueHeating	PQ4.0	BOOL
3	myOutValueCooling	PQ4.1	BOOL

3.2 Variables used and preassignments

Variables used in the application example

Table 3-1 Variables used in the application example

Icon	Data type	Name
myInit	BOOL	Initialize function blocks
myCtrlOn	BOOL	Activate control
myInTemperature	INT	Variable as symbolic input address
myInValue	INT	Variable for actual temperature value
myOutValueHeating	BOOL	Variable as symbolic output address
myOutValueCooling	BOOL	Variable as symbolic output address
myOutHeating	BOOL	Switch on heating
myOutCooling	BOOL	Switch on cooling

Preassignment of the other input parameters of the _CTRL_pid und _CTRL_pwm function blocks

Table 3-2 Preassigned parameters of the _CTRL_pid function block

Icon	Preassignment	Name
myDataSetPID.reset	FALSE	Initialization routine
myDataSetPID.manualMode	FALSE	Manual mode
myDataSetPID.actValueType	FALSE	Activate actual I/O value
myDataSetPID.setPController	TRUE	Activate P-action component
myDataSetPID.setIController	TRUE	Activate I-action component
myDataSetPID.holdIValue	FALSE	Freeze I-action component
myDataSetPID.setIValue	FALSE	Set I-action component
myDataSetPID.setDController	FALSE	Activate D-action component
myDataSetPID.cycleTime	2000	Block sampling time
myDataSetPID.setpointValue	150	Setpoint
myDataSetPID.binActValue	16#0	Actual I/O value
myDataSetPID.manualValue	0.0	Manual value
myDataSetPID.propGain	6.0	P-action coefficient
myDataSetPID.integTime	2000	Integration time
myDataSetPID.derivativeTime	1000	Differentiation time
myDataSetPID.delayTime	2000	D-action component delay time
myDataSetPID.deadBand	0	Dead band
myDataSetPID.upperLimit	100	Upper limit of control output
myDataSetPID.lowerLimit	-100	Lower limit of control output
myDataSetPID.actValueFactor	1	Actual value factor
myDataSetPID.actValueOffset	0	Actual value offset
myDataSetPID.outValueFactor	1	Control output factor

Icon	Preassignment	Name
myDataSetPID.outValueOffset	0	Control output offset
myDataSetPID.initialIValue	0.0	Initialization value for I-action component
myDataSetPID.disturbValue	0.0	Disturbance value

Table 3-3 Preassigned parameters of the _CTRL_pwm function block

Icon	Preassignment	Name
myDataSetPWM.reset	FALSE	Initialization routine
myDataSetPWM.periodTime	2000	Period
myDataSetPWM.minPulseIdleTime	0	Minimum pulse or minimum idle time
myDataSetPWM.ratioFactor	1.0	Ratio factor
myDataSetPWM.set3StepControl	TRUE	Three-step control
myDataSetPWM.set2StepControl	FALSE	Two-step control
myDataSetPWM.setManualMode	FALSE	Activate manual mode
myDataSetPWM.setPosPulse	FALSE	Positive pulse ON (manual mode)
myDataSetPWM.setNegPulse	FALSE	Negative pulse ON (manual mode)
myDataSetPWM.cycleTime	20	Block sampling time

Appendix A

A.1 List of parameters

A comparison of the SIMOTION identifiers up to V3.2/as of V4.0 is shown in the table below.

Table A-1 List of parameters

Name in the SIMOTION system as of V4.0 (program library in SCOUT)	Name in the SIMOTION system up to V3.2 (SIMOTION function library)
Function block parameters	
_CTRL_pid	_FB_basicControl_PID
enable	-
dataPid	dataPID
error	-
_CTRL_piStep	_FB_basicControl_PIStep
enable	-
dataPiStep	dataPIStep
error	-
_CTRL_pwm	_FB_basicControl_PWM
enable	-
dataPwm	dataPWM
error	-
Data structure elements	
Struct_CTRL_dataPid	Struct_basicControl_dataPID
reset	reset
manualMode	manualMode
actValueType	actualValueType
setPController	setPController
setIController	setIController
holdIValue	freezeIValue
setIValue	setIValue
initialIValue	initialIValue
setDController	setDController
cycleTime	cycleTime
setpointValue	setpointValue
numericActValue	numericalActualValue

Name in the SIMOTION system as of V4.0 (program library in SCOUT)	Name in the SIMOTION system up to V3.2 (SIMOTION function library)
binActValue	binaryActualValue
manualValue	manualValue
propGain	proportionalGain
integTime	integrationTime
derivativeTime	derivativeTime
delayTime	delayTime
deadBand	deadBand
upperLimit	upperLimit
lowerLimit	lowerLimit
actValueFactor	actualValueFactor
actValueOffset	actualValueOffset
outValueFactor	outputValueFactor
outValueOffset	outputValueOffset
disturbValue	disturbanceValue
numericOutValue	numericalOutputValue
binOutValue	binaryOutputValue
upperLimitReached	upperLimitReached
lowerLimitReached	lowerLimitReached
POutValue	POutputValue
IOutValue	IOutputValue
DOutValue	DOutputValue
actValue	actualValue
deviationValue	deviationValue
Struct_CTRL_dataPiStep	Struct_basicControl_dataPIStep
reset	reset
actValueType	actualValueType
cycleTime	cycleTime
setpointValue	setpointValue
numericActValue	numericalActualValue
binActValue	binaryActualValue
propGain	proportionalGain
integTime	integrationTime
deadBand	deadBand
upperLimit	upperLimit
lowerLimit	lowerLimit
manualMode	manualMode
setOutHigh	setOutputHigh
setOutLow	setOutputLow
minPulseTime	minPulseTime
minIdleTime	minIdleTime
actuatingTime	actuatingTime

Name in the SIMOTION system as of V4.0 (program library in SCOUT)	Name in the SIMOTION system up to V3.2 (SIMOTION function library)
actValueFactor	actualValueFactor
actValueOffset	actualValueOffset
disturbanceValue	disturbanceValue
outHigh	outputHigh
outLow	outputLow
actValue	actualValue
deviationValue	deviationValue
Struct_CTRL_dataPwm	Struct_basicControl_dataPWM
reset	reset
inValue	inputValue
periodTime	periodTime
minPulseIdleTime	minPulseIdleTime
ratioFactor	ratioFactor
set3StepControl	setThreeStepControl
set2StepControl	setTwoStepControl
setManualMode	setManualMode
setPosPulse	setPositivePulse
setNegPulse	setNegativePulse
cycleTime	cycleTime
posPulse	positivePulse
negPulse	negativePulse

A.2 List of abbreviations

Table A-2 Abbreviations

Abbreviation	Meaning
FB	Function block
IN	Input parameter
IN/OUT	In/out parameter
LAD	Ladder logic
OUT	Output parameter
SCOUT	**S**IMOTION **C**ontrolling with **O**ptimized **U**sability **T**oolbox

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