SIEMENS

SIMATIC

ET 200S
Technological Functions

Operating Instructions

04/2008
A5E00124867-06

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.

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

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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.

Prescribed Usage

Note the following:

WARNING
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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We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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1 Preface

How this Manual Is Structured...

This manual is a supplement to the *ET 200S Distributed I/O System manual.* This manual is part of the documentation package 6ES7 151-1AA10-8AA0.

It contains descriptions of the ET-200S modules that are particularly suited for use in certain processes.

How to Find Your Way Around

At the beginning of each chapter you will find a **Product Overview**, which lists the features and applications of the module described. You will also find the order number of the module and the name and release of the software required.

For the current GSD file, go to:

http://support.automation.siemens.com

In each chapter you will then find a section with the heading **Brief Instructions on Commissioning.** These brief instructions tell you in a series of short steps how to install and configure the module, how to integrate it in your use program, and how to test it in your user program.

Index

The index contains keywords that come up in the manual.

Additional Support

Please talk to your Siemens contact at one of our agencies or local offices if you have any questions about the products described here and do not find the answers in this manual.

You will find information on who to contact at:

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- Information about on-site service, repairs and spare parts. Lots more can be found on our "Services" pages.

1Count24V/100kHz

2

2.1 Product Overview

Order Number

6ES7 138-4DA04-0AB0

Compatibility

The 1Count24V/100kHz with the order number 6ES7 138-4DA04-0AB0 replaces the 1Count24V/100kHz with the order number 6ES7 138-4DA03-0AB0 with full compatibility. In STEP 7 version V5.3 SP2 and later, you can use it in non-isochronous and isochronous modes.

Features

- Connection of a pulse generator to count 24 V signals up to a frequency of 100 kHz.
- Can be operated using terminal modules TM-E15S24-01 and TM-E15S26-A1
- Isochronous mode
- Modified user data interface [1]

  [1] Instead of 8 bytes of input data and 8 bytes of output data, 12 bytes of input data and 6 bytes of output data are used, provided the IM 151 supports this.

  The following IM 151 modules support this function:

  – IM151-1/Standard order no. 6ES7 151-1AA04-0AB0 and higher

  – IM151-1/HF order no. 6ES7 151-1BA01-0AB0 and higher
- Modes of the 1Count24V/100kHz:

  Counting modes:

  – Count continuously

  – Count once

  – Count periodically

Measuring modes:

- Frequency measurement
- Rotational speed measurement
- Period measurement

Position feedback:

- Position detection
- Fast mode

- Gate control, synchronization or latch function via digital input (P or M switch)
- One real digital output for direct control or output of the comparison result
- One virtual digital output
- Firmware update[1]
- Identification data [1]

[1] The following IM 151 modules support this function: IM 151-1 Standard: 6ES7151-1AA04-0AB0 and later and IM 151-1 High Feature: 6ES7151-1BA01-0AB0 and later

Connectable Counting Signals

The 1Count24V/100kHz can count the signals of the following encoders:

- 24 V pulse encoder with direction level
- 24 V pulse encoder without direction level
- 24 V incremental encoder with two tracks that are 90° out of phase (rotary encoder).

Adjustment During Operation

- Counting modes
  - You can change the function and behavior of the digital outputs during operation
- Measuring modes
  - You can change the function of the DO1 digital output during operation
  - You can change the integration time and the update time during operation

Configuration

You can use either of the following to configure the 1Count24V/100kHz:

- STEP 7 V5.3 SP2 or higher
- HSP hardware support package (available online) as of STEP 7 V5.2 SP1

Firmware Update

To add functions and for troubleshooting, it is possible to load firmware updates to the operating system memory of the 1Count24V/100kHz using STEP 7 HW Config.

Note

When you launch the firmware update, the old firmware is deleted. If the firmware update is interrupted or canceled for any reason, the 1Count24V/100kHz will no longer function correctly as a result. Re-launch the firmware update and wait until this has completed successfully.

Identification Data [1]

- Hardware release status
- Firmware release status
- Serial number

[1] See also ET 200S Distributed I/O System Manual, section: Identification Data

2.2 Clocked Mode

Note

The principles of isochrone mode are described in a separate manual.

See Isochrone Mode Function Manual (A5E00223279).

Hardware Requirements

You will require the following for the 1Count24V/100kHz in isochrone mode:

- A CPU that supports isochrone mode
- A master or PROFINET master that supports the equidistant bus cycle
- An IM 151 that supports isochrone mode

Features

Depending on the system parameter assignment, the 1Count24V/100kHz works either in non-isochrone or isochrone mode.

In isochrone mode, data exchange between the bus master and 1Count24V/100kHz is isochronous to the cycle.

In isochrone mode, all 8 bytes/12 bytes of the user data interface are consistent.

If an error occurs during parameter assignment, the 1Count24V/100kHz does not go into isochrone mode.

If isochrone mode fails due to faults or failure/delay of global control (GC), the 1Count24V/100kHz will return to isochrone mode during the next cycle without an error response.

If isochrone mode fails, the user data interface is not updated.

The T_i/T_o overlap is supported by the module in firmware version V1.0.1 and later.

2.3 Example: Start 1Count24V/100kHz

Introduction

These instructions guide you to a functioning application that will enable you to count the switching operations of a contact and become familiar with and check the basic hardware and software functions of the 1Count24/100kHz. The counting mode used in this example is "Count continuously".

Requirements

The following requirements must be satisfied:

- You have commissioned an ET 200S station on an S7 station with a master.
- You must have the following:
  – A TM-E15S24-01 terminal module
  – A 1Count24V/100kHz
  – A momentary contact switch and the necessary wiring material

Installation, Wiring and Fitting

1. Install and wire the TM-E15S24-01 terminal module (see Figure).
2. Connect the 1Count24V/100kHz to the terminal module (you will find detailed instructions on how to do this in the *ET 200S Distributed I/O System* Manual).

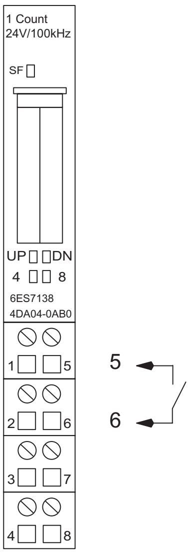


Figure 2-1 Terminal Assignment for the Example

Configuring with STEP 7 using HW Config

You must first adapt the hardware configuration of your existing ET 200S station.

1. Open the relevant project in SIMATIC Manager.
2. Open the HW Config configuration table in your project.
3. Select the 1Count 24V/100kHz Counting Mode from the hardware catalog.

   The number 6ES7 138-4DA04-0AB0 C appears in the infotext. Drag the entry to the slot at which you have installed your 1Count24V/100kHz.
4. Double-click this number to open the "Properties" - 1Count 24V/100kHz (R-S Slot Number) tab.
5. On the Addresses tab, you will find the addresses of the slot to which you have dragged the 1Count24V/100kHz. Make a note of these addresses for subsequent programming.
6. On the Parameters tab you will find the default settings for the 1Count24V/100kHz. Leave the default settings unchanged.
7. Save and compile your configuration, and download the configuration in STOP mode of the CPU by choosing "PLC > Download to Module".

Integration into the User Program

(not for modified user data interface)

1. Create block FC101 and integrate it in your control program (in OB1, for example).

   This block requires the data block DB1 with a length of 16 bytes. The start address of the module in the following example is 256.

STL		Description
Block: FC101		
Network 1: Presettings		
L	0	//Delete control bits
T	DB1.DBD0	
T	DB1.DBD4	
SET		
S	DB1.DBX4.0	//Open SW gate
Network 2: Write to the control interface		
L	DB1.DBD0	//Write 6 bytes to the 1Count24V/100kHz //Configured start address of the outputs
T	PAD 256	
L	DB1.DBW4	
T	PAW 260	
Network 3: Read from the feedback interface		//Read 8 bytes from the 1Count24V/100kHz //Configured start address of inputs
L	PED 256	
T	DB1.DBD8	
L	PED 260	
T	DB1.DBD12	

Testing

Use "Monitor/Modify Variables" to monitor the count value and the gate.

1. Select the "Block" folder in your project. Choose the "Insert > S7 Block > Variable Table" menu command to insert the VAT 1 variable table, and then confirm with "OK".
2. Open the VAT 1 variable table, and enter the following variables in the "Address" column:

   DB1.DBD8 (current count value)

   DB1.DBx13.0 (internal gate status)
3. Choose "PLC > Connect To > Configured CPU" to switch to online.
4. Choose "Variable > Monitor" to switch to monitoring.
5. Switch the CPU to RUN mode.

   The "internal gate status" bit must be set.
6. Use your counting contact to generate pulses.

Result

You can now see that:

- The UP LED on the 1Count24V/100kHz is on. The status of the UP LED changes with each new pulse.
- The count value in the block changes.

2.4 Terminal Assignment Diagram

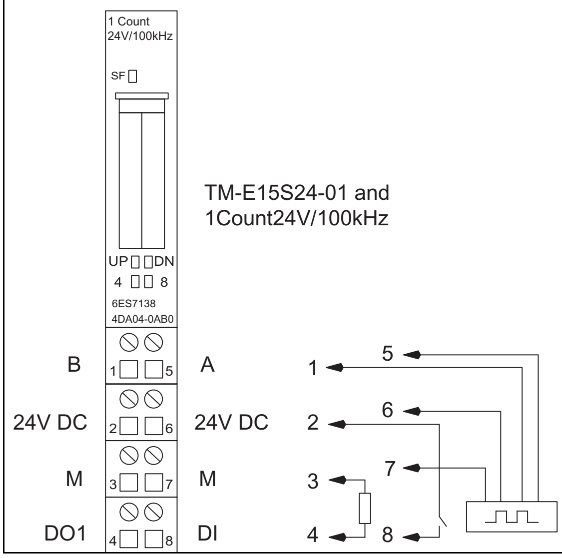
Wiring Rules

The cables (terminals 1 and 5 and terminals 2 and 8) must be shielded. The shield must be supported at both ends. To do this use the shield contact (see the *ET 200S Distributed I/O System* manual).

Terminal Assignment of the 1Count24V/100kHz

In the following tables you will find the terminal assignment for the 1Count24V/100kHz:

Table 2-1 Terminal Assignment of the 1Count24V/100kHz

View	Terminal Assignment	Remarks
		B: Direction input or track B A: Pulse input or track A 24V DC: Sensor supply M: Chassis ground DI: Digital input DO1: Digital output

Pulse Generator Connection

Encoder Type	Connection	Count Direction
Pulse generator without direction indicator	24 V count pulses at terminal 5 (A)	pulses
Pulse generator with direction indicator	24 V count pulses at terminal 5 (A) and 24 V direction at terminal 1 (B)	Up, down
Pulse generator with 2 tracks that are 90° out of phase	Track A terminal 5 (A) and track B terminal 1 (B)	Up, down

2.5 Settings modes of the 1Count24V/100kHz

Introduction

To begin with, decide how you want to use the 1Count24V/100kHz. You can choose between the following modes:

Counting modes	Measuring modes	Position feedback	Fast mode
Count continuously	Frequency measurement	Position detection	Position feedback in short (isochronous) cycles
Count once	Rotational speed measurement		
Count periodically	Period measurement		
Parameters are assigned to the various modes. You will find the parameter lists in the descriptions of the modes. You can integrate the 1Count24V/100kHz in your project in two different ways. Decide whether you want to work with a GSD file or with STEP 7.			

Integrating 1Count24V/100kHz with STEP 7

Integrating 1Count24V/100kHz with STEP 7 (in isochronous and non-isochronous mode)			
Select an entry from the hardware catalog that corresponds to the operating mode you want.			
For counting modes, select the "1Count24V Counting Mode V2.0" entry	For measuring modes, select the "1Count24V Measuring Mode V2.0" entry	For position detection, select the "1Count24V Position Detection V2.0" entry	For Fast Mode, select the "1COUNT24V Fast Mode V2.0" entry
The number 6ES7 138-4DA04-0AB0 C appears in the infotext. Drag the entry to the slot at which you have installed your 1Count24V/100kHz.	The number 6ES7 138-4DA04-0AB0 M appears in the infotext. Drag the entry to the slot at which you have installed your 1Count24V/100kHz.	The number 6ES7 138-4DA04-0AB0 W appears in the infotext. Drag the entry to the slot at which you have installed your 1Count24V/100kHz.	The number 6ES7 138-4DA04-0AB0 F appears in the infotext. Drag the entry to the slot at which you have installed your 1Count24V/100kHz.
Select the parameters.			

Integrating 1Count24V/100kHz with GSD File

Integrating 1Count24V/100kHz with GSD file (only in non-isochronous mode)		
Select an entry in the GSD file that corresponds to the operating mode you want.		
For counting modes, select C 6ES7 138-4DA04-0AB0 1CNT24V	For measuring modes, select M 6ES7 138-4DA04-0AB0 1CNT24V	For position feedback, select W 6ES7 138-4DA04-0AB0 1CNT24V
Select the parameters.		

Note

Fast mode is designed for use in especially short isochronous cycles. You need STEP 7 to configure isochronous operation.

2.6 Count Modes

2.6.1 Overview

Principle

The counting modes are used in counting applications (for counting of items, for example).

For the "Counting modes" parameter, you can select from the following modes:

- Count continuously (for position detection with incremental encoders, for example)
- Count once (for counting items up to a maximum limit, for example)
- Count periodically (in applications with recurring counting operations, for example)

To execute one of these modes, you have to assign parameters to the 1Count24V/100kHz.

Maximum Count Range

The high counting limit is +2147483647 (2^{31} - 1).

The low counting limit is -2147483648 (-2^{31}).

Load Value

You can specify a load value for the 1Count24V/100kHz.

This load value is either applied directly as the new count value (LOAD_VAL) or it is applied as the new count value when the following events occur (LOAD_PREPARE):

In the Count once and Count periodically counting modes:

- The low or high counting limit is reached when a main count direction is not assigned.
- The assigned high counting limit is reached when the main count direction is up.
- Zero is reached when the main count direction is down.

In all counting modes:

- The counting operation is started by a SW gate or HW gate (if the counting operation is continued, the load value is not applied).
- Synchronization
- Latch and retrigger

Gate Control

To control the 1Count24V/100kHz, you have to use the gate functions.

Main Count Direction

With the main count direction, you assign which RESET states (status following parameter assignment) the load value and count value can take on. It is thus possible to create incrementing or decrementing count applications. The assigned main count direction has no effect on the direction evaluation when the count pulses are detected.

RESET States of the Following Values after Parameter Assignment

Table 2-2 RESET States

Value	Main count direction	RESET state
Load value	None Up Down	0 0 Assigned high counting limit
Count value	None Up Down	0 0 Assigned high counting limit
Comparison value 1 and 2	None Up Down	0 0 Assigned high counting limit
Latch value	None Up Down	0 0 Assigned high counting limit

Isochrone Mode

In isochrone mode, the 1Count24V/100kHz accepts control bits and control values from the control interface in each bus cycle and reports back the response in the same cycle.

In each cycle the 1Count24V/100kHz transfers the count and latch value that were valid at time T_i and the status bits valid at time T_i.

A count controlled by hardware input signals can only be transferred in the same cycle if the input signal occurred before time T_i.

(see *Isochrone Mode* Manual)

See also

Parameter Assignment for the Count Modes (Page 62)

2.6.2 Endless Counting

Definition

In this mode, the 1Count24V/100kHz counts continuously starting from the load value:

- If the 1Count24V/100kHz reaches the high counting limit when counting up, and another count pulse then comes, it will jump to the low counting limit and continue counting from there without losing a pulse.
- If the 1Count24V/100kHz reaches the low counting limit when counting down, and another count pulse then comes, it will jump to the high counting limit and continue counting from there without losing a pulse.
- The high counting limit is set to +2147483647 (2^{31} - 1).
- The low counting limit is set to -2147483648 (-2^{31}).

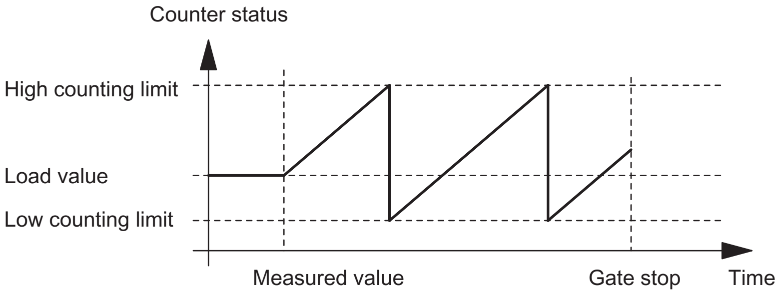


Figure 2-2 Count Continuously with Gate Function

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate
- Latch function
- Synchronization

Function of the Digital Outputs

For the "Function DO1" and "Function DO2" parameters, select one of the following functions for each digital output:

- Output, no switching by comparator
- Switch on at count greater than or equal to the comparison value
- Switch on at count less than or equal to the comparison value
- Pulse on reaching the comparison value
- Switch at comparison values (DO1 only)

Influencing the Behavior of the Digital Outputs via:

- Hysteresis
- Pulse duration

Changing Values during Operation

The following values can be changed during operation:

- Load value (LOAD_PREPARE)
- Count (LOAD_VAL)
- Comparison value 1 (CMP_VAL1)
- Comparison value 2 (CMP_VAL2)
- Function and behavior of the digital outputs (C_DOPARAM)

See also

Latch Function (Page 40)

Synchronization (Page 44)

Behavior Types of the Outputs in Count Modes (Page 46)

Assignment of the Feedback and Control Interface for the Count Modes (Page 54)

2.6.3 Once-Only Counting

Definition

In this mode, the 1Count24V/100kHz counts once only, depending on the assigned main count direction ("Main Count Direction" parameter).

- When there is no main count direction:
  - Counts starting from the load value.
  - Counts up or down.
  - The counting limits are fixed at the maximum count range.
  - If the high or low counting limit is violated, the gate is closed automatically, and the counter jumps to the respective counting limit.
- When the main count direction is up:
  - Counts starting from the load value.
  - Counts up or down.
  - When the high counting limit is reached, the counter jumps to the load value and the gate is closed.
  - The high counting limit can be assigned, and the load value has RESET state = 0 and can be changed.
- When the count direction is down:
  - Counts starting from the load value.
  - Counts up or down.
  - When the low counting limit is reached, the 1Count24V/100kHz jumps to the load value and the gate is closed.
  - The low counting limit is fixed at 0, and the load value can be assigned (parameter: high counting limit) and can be changed.

The internal gate is automatically closed in the event of an overflow/underflow at the counting limits. To restart counting, you have to open the gate again.

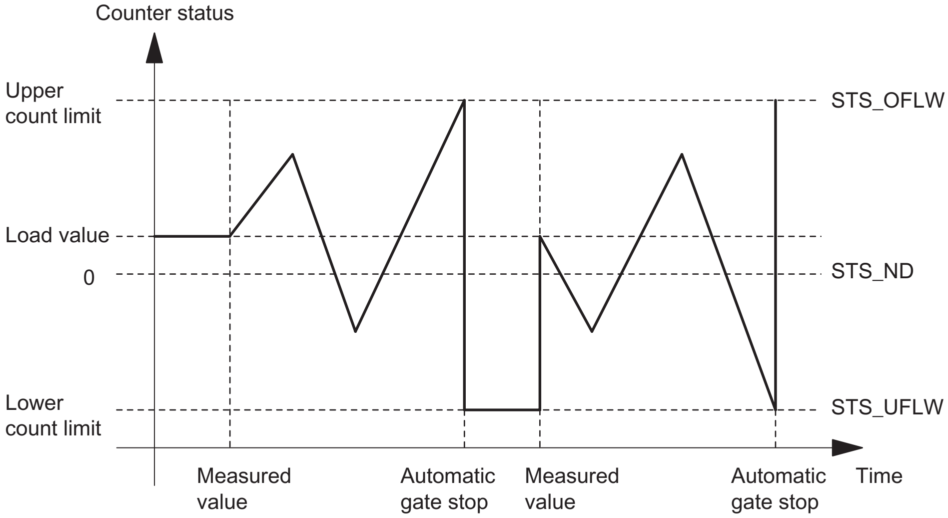


Figure 2-3 Count Once Without Main Count Direction; Canceling Gate Function

With an interrupting gate function, the 1Count24V/100kHz remains at the underflow when the gate is started.

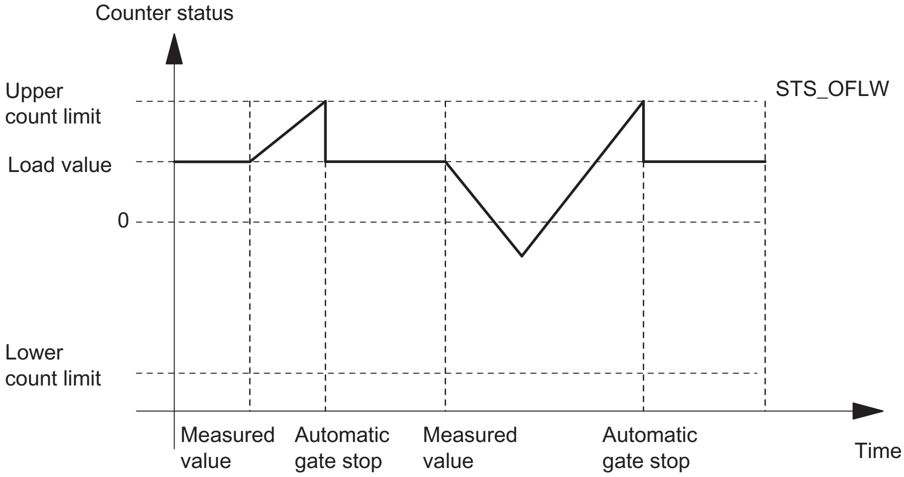


Figure 2-4 Count Once with Up as the Main Count Direction

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate
- Latch function
- Synchronization

Function of the Digital Outputs

For the "Function DO1" and "Function DO2" parameters, select one of the following functions for each digital output:

- Output, no switching by comparator
- Switch on at count greater than or equal to the comparison value
- Switch on at count less than or equal to the comparison value
- Pulse on reaching the comparison value
- Switch at comparison values (DO1 only)

Influencing the Behavior of the Digital Outputs via:

- Hysteresis
- Pulse duration

Values that Can Be Changed during Operation:

- Load value (LOAD_PREPARE)
- Count (LOAD_VAL)
- Comparison value 1 (CMP_VAL1)
- Comparison value 2 (CMP_VAL2)
- Function and behavior of the digital outputs (C_DOPARAM)

See also

Latch Function (Page 40)

Synchronization (Page 44)

Behavior Types of the Outputs in Count Modes (Page 46)

Assignment of the Feedback and Control Interface for the Count Modes (Page 54)

Gate Functions in Count Modes (Page 37)

2.6.4 Periodic Counting

Definition

In this mode, the 1Count24V/100kHz counts periodically, depending on the main count direction set.

- When there is no main count direction:
  - Counts as of the load value.
  - Counts up or down.
  - The count limits are fixed at the maximum count range.
  - In the event of an overflow or underflow at the respective count limit, the 1Count24V/100kHz jumps to the load value and continues counting from there.
- When the main count direction is up:
  - Counts as of the load value.
  - Counts up or down.
  - The upper limit can be assigned parameters, and the load value has a RESET status of 0 and can be changed.
  - When the upper count limit is reached, the 1Count24V/100kHz jumps to the load value and continues counting from there.

- When the count direction is down:
  - Counts as of the load value.
  - Counts up or down.
  - When the lower count limit is reached, the 1Count24V/100kHz jumps to the load value and continues counting from there.
  - The lower limit is fixed at 0, and the load value can be assigned parameters (parameter: upper count limit) and can be changed.

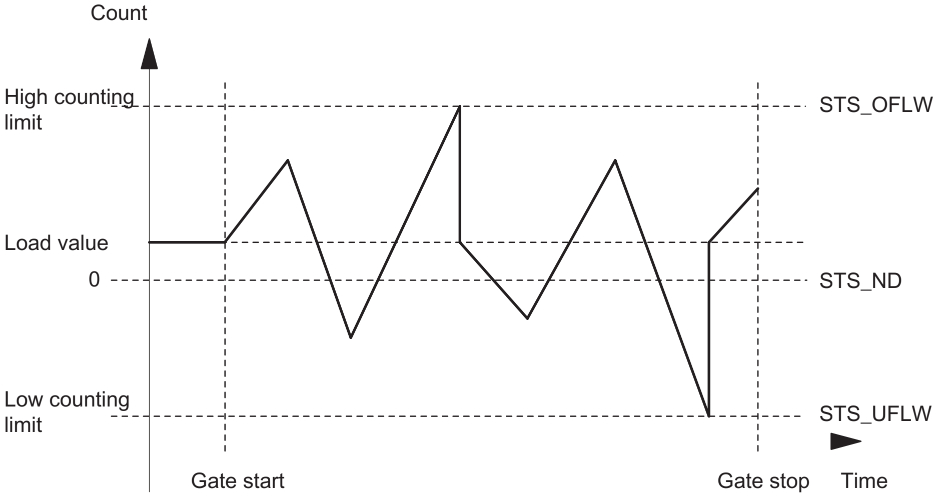


Figure 2-5 Periodic Counting without a Main Count Direction

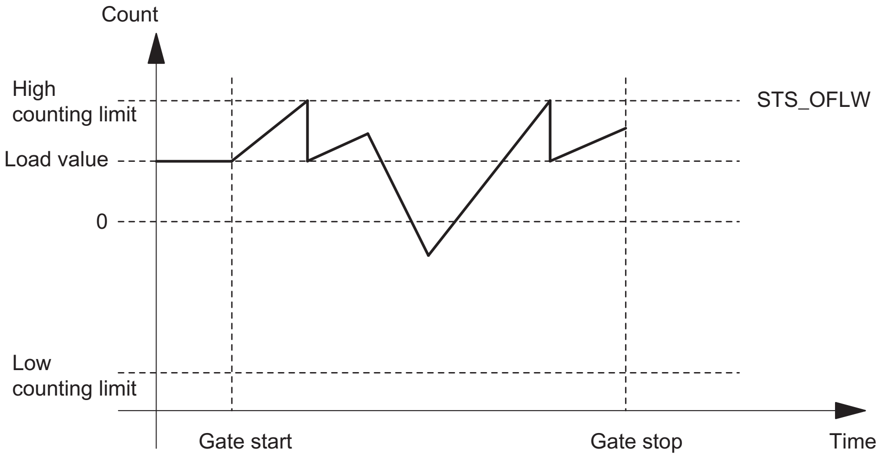


Figure 2-6 Periodic Counting with Up as the Main Count Direction

Function of the Digital Input

Select one of the following functions for the digital input:

- Input
- Hardware gate
- Latch Function
- Synchronization

Function of the Digital Outputs

Select one of the following functions for each digital output:

- Output, no switching through comparator
- Activation at a counter status greater than or equal to the comparison value
- Activation at a counter status less than or equal to the comparison value
- Pulse on reaching the comparison value
- Switching at comparison values (DO1 only)

Influencing the Behavior of the Digital Outputs

The behavior of the digital outputs can be influenced as follows:

- Hysteresis
- Pulse duration

Changing values during operation

The following values can be changed during operation:

- Load value (LOAD_PREPARE)
- Counter status (LOAD_VAL)
- Comparison value 1 (CMP_VAL1)
- Comparison value 2 (CMP_VAL2)
- Function and behavior of the digital outputs (C_DOPARAM)

See also

Latch Function (Page 40)

Synchronization (Page 44)

Behavior Types of the Outputs in Count Modes (Page 46)

Assignment of the Feedback and Control Interface for the Count Modes (Page 54)

Gate Functions in Count Modes (Page 37)

2.6.5 Behavior of the Digital Input

Digital Input of the 1Count24V/100kHz

The DI digital input can be operated with different sensors (P switch and series mode or M switch).

Note

If you have selected the 24V M switch setting for the "Sensor A, B, DI" parameter, you must use M-switching sensors.

The level of the digital input can be inverted by assigning parameters (exception: inverting is not possible in the latch function).

To filter the input signal, you can switch on a filter depending on the minimum pulse duration or the maximum signal frequency (parameter: sensor and input filter).

The STS_DI feedback bit indicates the level of the digital input.

2.6.6 Gate Functions in Count Modes

Software Gate and Hardware Gate

The 1Count24V/100kHz has two gates

- A software gate (SW gate), which is controlled by the SW_GATE control bit.

  The software gate can only be opened by a positive edge of the SW_GATE control bit. It is closed when this bit is reset. Note the transfer times and run times of your control program.

- A hardware gate (HW gate), which is controlled by the digital input on the 1Count24V/100kHz. You assign the hardware gate as the function of the digital input (Function DI "HW Gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

Internal gate

The internal gate is the logical AND operation of the HW gate and SW gate. Counting is only active when the HW gate and the SW gate are open. The STS_GATE feedback bit (internal gate status) indicates this. If a HW gate has not been assigned, the setting of the SW gate is decisive. Counting is activated, interrupted, continued, and canceled by means of the internal gate. In the Count once counting mode, the internal gate is closed automatically when there is an overflow/underflow at the counting limits.

Canceling- and Interrupting-Type Gate Function

When assigning the gate function ("Gate Function" parameter), you can specify whether the internal gate is to cancel or interrupt counting. When counting is canceled, after the gate is closed and restarted, counting starts again from the beginning. When counting is interrupted, after the gate is closed and restarted, counting continues from the previous value.

The diagrams below indicate how the interrupting and canceling gate functions work:

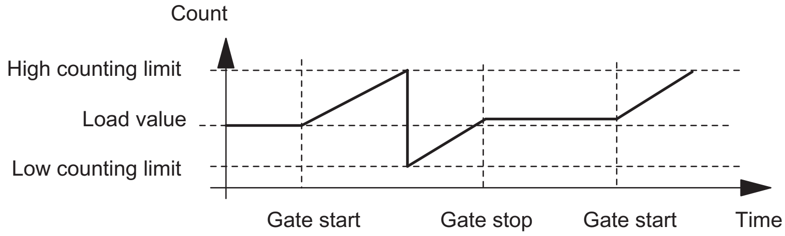


Figure 2-7 Count Continuously, Up, Interrupting Gate Function

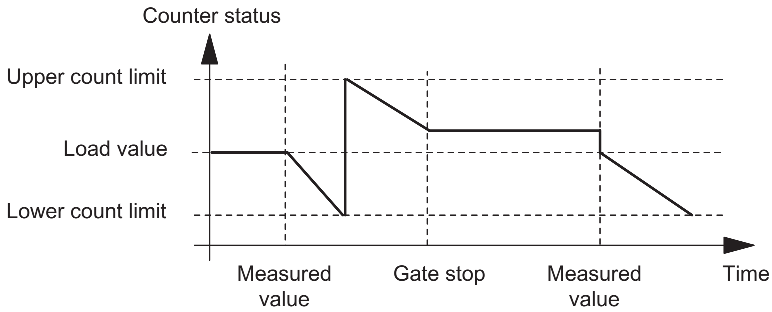


Figure 2-8 Count Continuously, Down, Canceling Gate Function

Gate Control by Means of the SW Gate Only

When the gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count, or
- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts at time T_o in cycle "n+1". In the same cycle "n+1", the 1Count24V/100kHz delivers the current count value from time T_i. (see *Isochrone Mode* Manual)

Gate Control by Means of the SW Gate and HW Gate

If the SW gate opens when the HW gate is already open, counting continues starting from the current count.

When the HW gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count, or
- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts at time T_o in cycle "n+1" if the HW gate is already open at this time. If the HW gate opens between T_o and T_i in cycle "n+1", counting only starts once the HW gate is open. In both cases, the 1Count24V/100kHz delivers the current count value in cycle "n+1" starting from time T_i.

2.6.7 Latch Function

Introduction

There are two latch functions:

- The Latch and Retrigger function
- The Latch function

The Latch and Retrigger Function

Requirement

In order to use this function, you must first select it with the "Latch and Retrigger on Positive Edge" parameter from the possible functions of the digital input.

Description

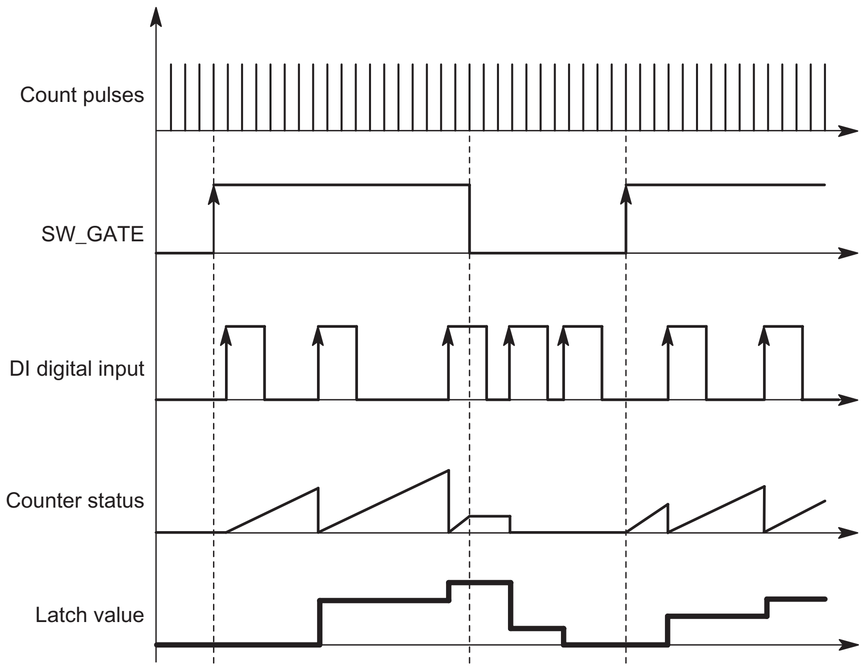


Figure 2-9 Latch and Retrigger with Load Value = 0

This function stores the current internal count of the 1Count24V/100kHz and retriggers counting when there is a positive edge on the digital input. This means that the current internal count at the time of the positive edge is stored (latch value), and the 1Count24V/100kHz is then loaded again with the load value, from which counting resumes.

The counting mode must be enabled with the SW gate before the function can be executed. It is started with the first positive edge on the digital input.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the status of the latch and retrigger signal.

The latch value is preassigned with its RESET state. It is not changed when the SW gate is opened.

Direct loading of the counter does not cause the indicated stored count to be changed.

If you close the SW gate, counting is only interrupted; this means that when you open the SW gate again, counting is continued. The digital input DI remains active even when the SW gate is closed.

Counting is also latched and triggered in isochrone mode with each edge on the digital input. The count that was valid at the time of the last edge before T_i is displayed in the feedback interface.

The Latch Function

Requirement

In order to use this function, the Function DI parameter must be set to "Latch on Positive Edge".

Description

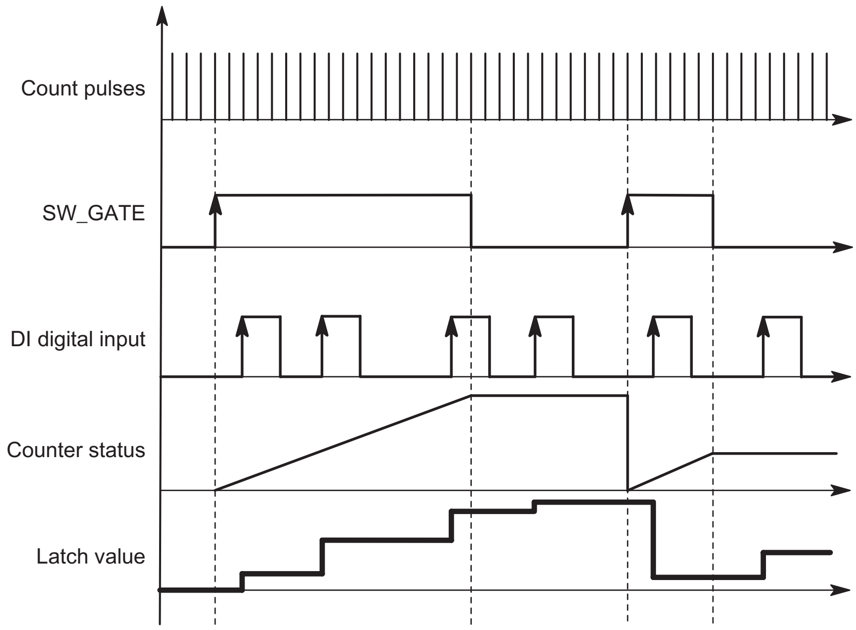


Figure 2-10 Latch with a Load Value of 0

Count and latch value are preassigned with their RESET states.

The counting function is started when the SW gate is opened. The 1Count24V/100kHz begins at the load value.

The latch value is always the exact count at the time of the positive edge on the digital input DI.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the level of the latch signal.

Direct loading of the counter does not cause the indicated stored count to be changed.

In isochrone mode, the count that was latched at the time of the last positive edge before T_i is displayed in the feedback interface.

When you close the SW gate, the effect is either canceling or interrupting, depending on the parameter assignment. The digital input DI remains active even when the SW gate is closed.

Further possible causes of parameter assignment errors with the latch function:

- Incorrect parameter assignment of the digital output function (Function DI)

Modified User Data Interface

If the 1Count24V/100kHz is inserted behind an IM 151 that supports the reading and writing of wider user data interfaces, the current count value can be read from bytes 8-11 of the feedback interface.

See also

Overview (Page 26)

2.6.8 Synchronization

Requirement

In order to use this function, you must first select it with the "Synchronize on Positive Edge" Function DI parameter.

Description

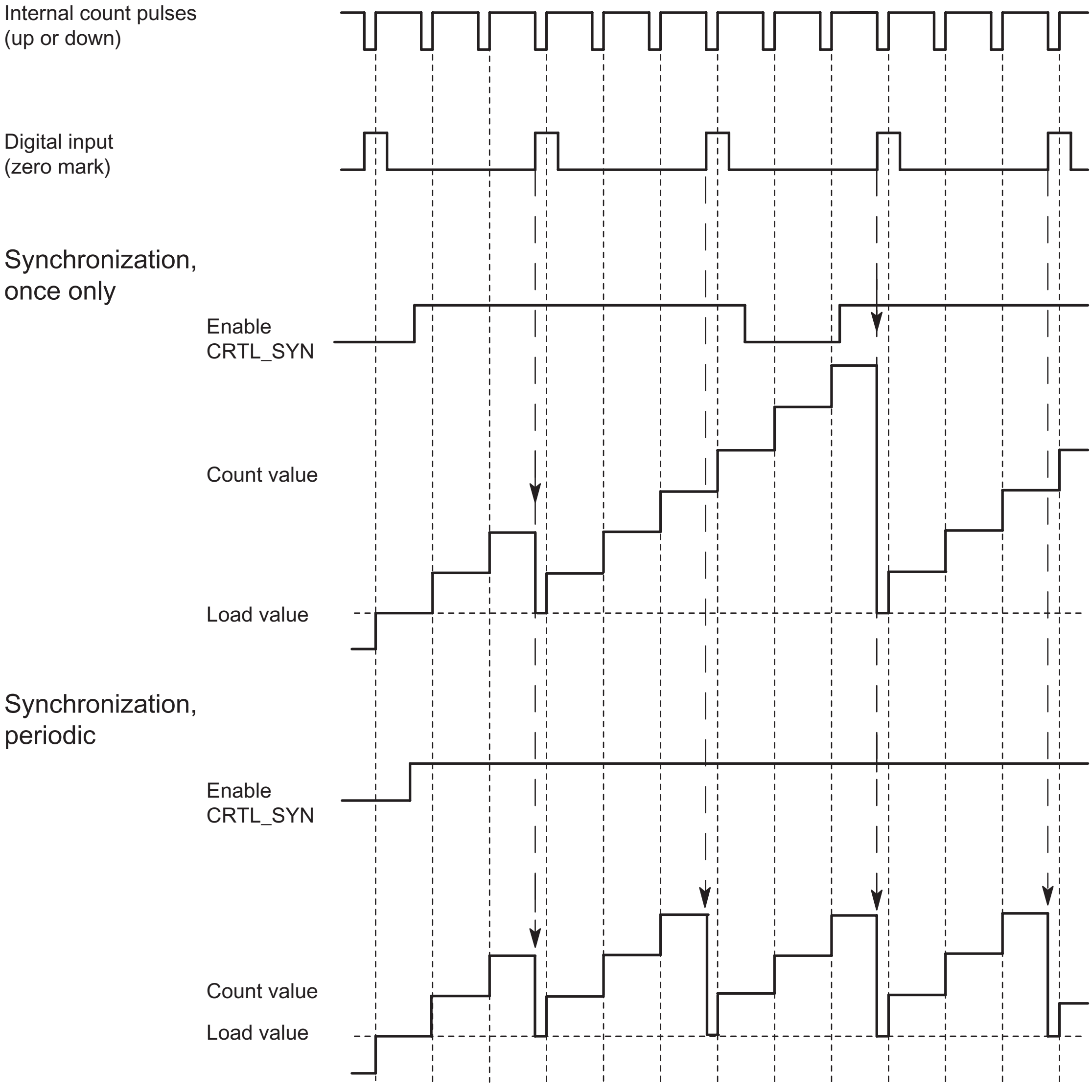


Figure 2-11 Once-Only and Periodic Synchronization

If you have assigned synchronization, the rising edge of a reference signal on the input sets the 1Count24V/100kHz to the load value.

You can select between once-only and periodic synchronization ("Synchronization" parameter).

The following conditions apply:

- The counting mode must have been started with the SW gate.
- The "Enable synchronization CTRL_SYN" control bit must be set.
- In once-only synchronization, the first edge loads the 1Count24V/100kHz with the load value after the enable bit is set.
- In periodic synchronization, the first edge and each subsequent edge load the 1Count24V/100kHz with the load value after the enable bit is set.
- After successful synchronization, the STS_SYN feedback bit is set. It must be reset by the RES_STS control bit.
- The signal of a bounce-free switch or the zero mark of a rotary encoder can serve as the reference signal.
- The STS_DI feedback bit indicates the level of the reference signal.

In isochrone mode, the set feedback bit STS_SYN indicates that the rising edge on the digital input was between time T_i in the current cycle and time T_i in the previous cycle.

2.6.9 Behavior Types of the Outputs in Count Modes

Introduction

The 1Count24V/100kHz lets you store two comparison values, which are assigned to the digital outputs. The outputs can be activated, depending on the count and the comparison values. The various ways of setting the behavior of the outputs are described in this section.

Description

The 1Count24V/100kHz has a real digital output and a virtual digital output that exists only as a status bit in the feedback interface.

Parameters can be assigned for both outputs ("Function DO1" and "Function DO2" parameters).

You can change the function and the behavior of the digital outputs during operation. The new function takes effect immediately.

You can choose from the following functions:

- Output
- Count ≥ comparison value
- Count ≤ comparison value
- Pulse on reaching the comparison value
- Switch at comparison values (DO1 only)

Output

You can switch the outputs on and off with the control bits SET_DO1 and SET_DO2.

The control bits CTRL_DO1 or CTRL_DO2 must be set for this.

You can query the status of the outputs with the status bits STS_DO1 and STS_DO2 in the feedback interface.

The status bits STS_CMP1 and STS_CMP2 indicate that the relevant output is or was switched on. These status bits retain their status until they are acknowledged. If the output is still switched, the corresponding bit is set again immediately. These status bits are also set when the control bit SET_DO1 or SET_DO2 is operated without DO1 or DO2 being enabled.

Isochrone mode: In isochrone mode, the output DO1 is switched at time T_o. The status of the virtual output DO2 is signaled at time T_i.

Count ≤ Comparison Value and Count ≥ Comparison Value

If the comparison conditions are fulfilled, the respective comparator switches on the output. The status of the output is indicated by STS_DO1 and STS_DO2.

The control bits CTRL_DO1 or CTRL_DO2 must be set for this.

The comparison result is indicated by the status bits STS_CMP1 or STS_CMP2. You cannot acknowledge and thus reset these bits until the comparison conditions are no longer fulfilled.

Isochrone mode: In isochrone mode, as well, the DO1 output is switched as soon as the comparison condition is fulfilled and is therefore independent of the bus cycle. The status of the virtual output DO2 is signaled at time T_i.

Comparison Value Reached, Output Pulse

If the count reaches the comparison value, the comparator switches on the respective digital output for the assigned pulse duration.

The control bit CTRL_DO1 or CTRL_DO2 must be set for this.

The status bits STS_DO1 and STS_DO2 always have the status of the corresponding digital output.

The comparison result is indicated by the status bit STS_CMP1 or STS_CMP2 and cannot be reset by acknowledgment until the pulse duration has elapsed.

If a main count direction is assigned, the comparator switches only when the comparison value in the main count direction is reached.

If a main count direction is not assigned, the comparator switches when the comparison value is reached from either direction.

If the digital output is set by control bit SET_DO1 or SET_DO2, it is reset when the pulse duration has elapsed.

Isochrone mode: In isochrone mode, as well, the DO1 output is switched as soon as the comparison condition is fulfilled and is therefore independent of the bus cycle. The status of the virtual output DO2 is signaled at time T_i.

Pulse Duration when the Comparison Value is Reached

The pulse duration begins when the respective digital output is set. The inaccuracy of the pulse duration is less than 2 ms.

The pulse duration can be set to suit the actuators used. The pulse duration specifies how long the output is to be set for. The pulse duration can be preselected between 0 ms and 510 ms in increments of 2 ms.

If the pulse duration = 0, the output is set until the comparison condition is no longer fulfilled. Note that the count pulse times must be greater than the minimum switching times of the digital output.

Isochrone mode: In isochrone mode, as well, the DO1 output is switched as soon as the comparison condition is fulfilled and is therefore independent of the bus cycle. The status of the virtual output DO2 is signaled at time T_i.

Switch at Comparison Values

The comparator switches the output when the following conditions are met:

- The two comparison values must be loaded using the load functions CMP_VAL1 and CMP_VAL2, and
- After the comparison values are loaded, the DO1 output must be enabled with CRTL_DO1.

The following table shows you when the DO1 is switched on or off:

	DO1 is switched on when	DO1 Is switched off when
V2 < V1 (see Figure below)	V2 ≤ count ≤ V1	V2 > count or count > V1
V2 = V1	V2 = count = V1	V2 ≠ count ≠ V1
V2 > V1 (see Figure below)	V1 > count or count > V2	V1 ≤ count ≤ V2

The comparison result is indicated by the status bit STS_CMP1. You can only acknowledge and thus reset this bit when the comparison condition is no longer fulfilled.

There is no hysteresis in the case of this output behavior.

It is not possible to control the DO1 output with the SET_DO1 control bit in the case of this output behavior.

Isochrone mode: In isochrone mode, as well, the DO1 output is switched as soon as the comparison condition is fulfilled and is therefore independent of the bus cycle. The status of the virtual output DO2 is signaled at time T_i.

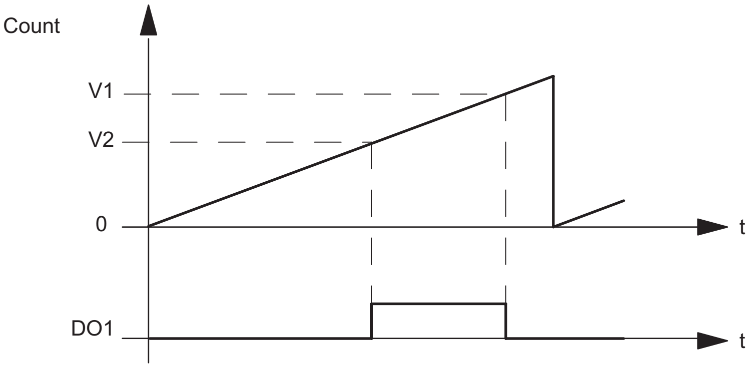


Figure 2-12 V2 < V1 at the Start of Counting

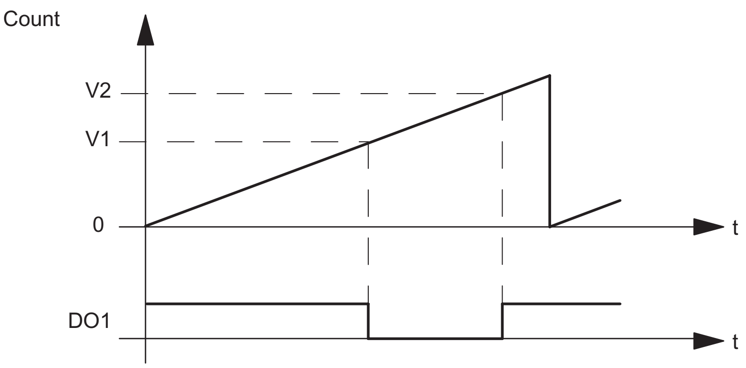


Figure 2-13 V2 > V1 at the Start of Counting

Setting or Modifying the Function and Behavior of the Digital Output DO1

When setting or modifying the behavior of DO1, you must take all assignable interdependencies into account. Failure to do so will generate a parameter assignment error or a loading error.

Boundary conditions:

If you assign "Switch at Comparison Values" for DO1, you must:

- Set hysteresis = 0, and
- Assign "Output" for the DO2 output

Hysteresis

An encoder can remain at a particular position and then fluctuate around this position. This state causes the count to fluctuate around a particular value. If there is a comparison value in this fluctuation range, for example, the associated output is switched on and off in accordance with the rhythm of the fluctuations. To prevent switching occurring in the case of small fluctuations, the 1Count24V/100kHz is equipped with an assignable hysteresis. You can assign a range between 0 and 255 (0 means: hysteresis switched off).

Hysteresis also works with overflow and underflow.

Method of Operation with Count ≤ Comparison Value and Count ≥ Comparison Value

The diagram below provides an example of how hysteresis works. The figure shows the differences in the behavior of an output when hysteresis of 0 (= switched off) is assigned as opposed to hysteresis of 3. In the example, the comparison value is 5.

The following settings are assigned for the counter: "Main count direction" = "Up" and "Switch on at count ≥ comparison value".

When the comparison condition is met, hysteresis becomes active. While the hysteresis is active, the comparison result remains unchanged.

If the count value goes outside the hysteresis range, hysteresis is no longer active. The comparator switches again according to its comparison conditions.

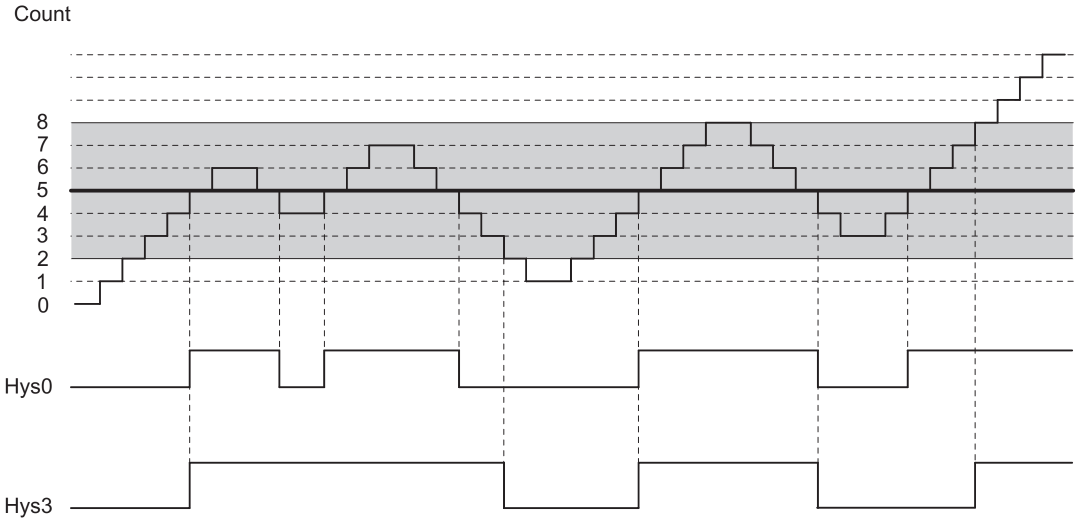


Figure 2-14 Example of How Hysteresis Works

Note

If the count direction changes on the comparison value when hysteresis is active, the output is reset.

Method of Operation when the Comparison Value Is Reached and the Pulse Duration = 0

The diagram below provides an example of how hysteresis works. The figure shows the differences in the behavior of an output when hysteresis of 0 (= switched off) is assigned as opposed to hysteresis of 3. In the example, the comparison value is 5.

The following settings are assigned for the counter: "Pulse on reaching the comparison value", "No main count direction" and "Pulse duration = 0".

When the comparison conditions are met, hysteresis becomes active. While the hysteresis is active, the comparison result remains unchanged. If the count value goes outside the hysteresis range, hysteresis is no longer active. The comparator deletes the result of the comparison.

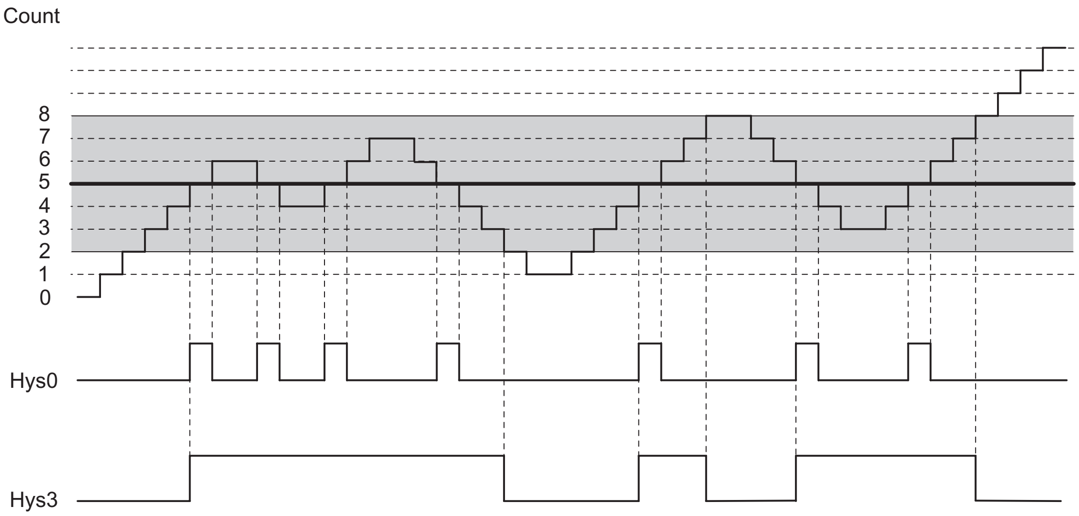


Figure 2-15 Example of How Hysteresis Works

Method of Operation when the Comparison Value Is Reached, Output Pulse Duration

The diagram below provides an example of how hysteresis works. The figure shows the differences in the behavior of an output when hysteresis of 0 (= switched off) is assigned as opposed to hysteresis of 3. In the example, the comparison value is 5.

The following settings are assigned for the counter: "Pulse on reaching the comparison value", "No main count direction" and "pulse duration > 0".

When the comparison conditions have been met, hysteresis becomes active and a pulse of the assigned duration is output.

If the count value goes outside the hysteresis range, hysteresis is no longer active.

When hysteresis becomes active, the 1Count24V/100kHz stores the count direction.

If the hysteresis range is exited in a different direction to the one stored, a pulse is output.

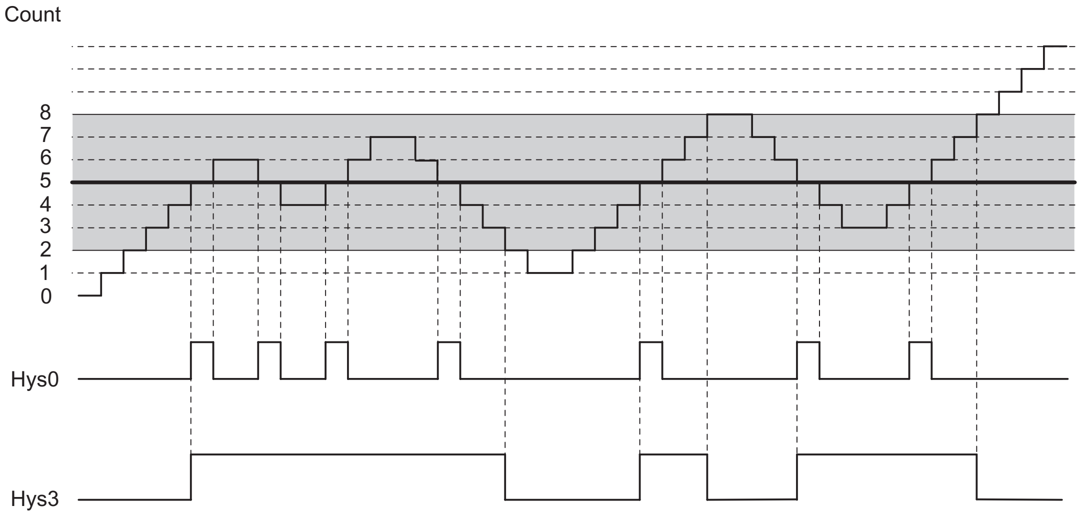


Figure 2-16 Example of How Hysteresis Works

Controlling the Outputs Simultaneously with the Comparators

If you have selected a comparison function for the outputs, you can continue to control the outputs with SET_DO1 or SET_DO2. This allows you to simulate the effect of the comparison functions on your control program:

- The output is set with the positive edge of SET_DO1 or SET_DO2.

  However, if the Pulse on Reaching the Comparison Value function is selected, only one pulse with the specified duration is output. SET_DO1 and SET_DO2 have no effect when pulse duration = 0.

  The SET_DO1 control bit is not permitted with the Switch at Comparison Values output behavior.
- A negative edge of SET_DO1 or SET_DO2 resets the output.

Note that the comparators are still active and can set or reset the output if the comparison result changes.

Note

An output set by SET_DO1 or SET_DO2 is not reset by the comparator.

Loading Comparison Values

You transfer the comparison values to the 1Count24V/100kHz. The counting is not affected by this.

Valid Range for the Two Comparison Values

Main count direction: None	Main count direction: Up	Main count direction: Down
Low counting limit to high counting limit	–2147483648 to high counting limit –1	1 to 2147483647

Modifying the Function and Behavior of Digital Outputs

You can modify the functions and behavior of the outputs during operation using the control interface. The 1Count24V/100kHz deletes the outputs and accepts the values as follows:

- Function of digital outputs DO1 and DO2: If you change this function so that the comparison condition is satisfied, the output is not set until after the next count pulse. However, if hysteresis is active, the 1Count24V/100kHz does not make any changes at the output.
- Hysteresis: An active hysteresis (see How Hysteresis Works) continues to be active following the change. The new hysteresis range is applied the next time the comparison value is reached.
- Pulse duration: The new pulse duration takes effect with the next pulse.

2.6.10 Assignment of the Feedback and Control Interface for the Count Modes

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Note

The following data of the control and feedback interfaces are consistent for the 1Count24V/100kHz:

Bytes 0 to 3

Bytes 4 to 7

Bytes 8 to 11 (modified user data interface)

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Assignment Tables

Table 2-3 Feedback Interface (Inputs)

Address	Assignment		Designation
Bytes 0 to 3	Count value or stored count value in the case of the latch function on the digital input		
Byte 4	Bit 7:	Short circuit of the encoder supply	ERR_24V
	Bit 6:	Short circuit / wire break / overtemperature	ERR_DO1
	Bit 5:	Parameter assignment error	ERR_PARA
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Resetting of status bits active	RES_STS_A
	Bit 1:	Load function error	ERR_LOAD
	Bit 0:	Load function is running	STS_LOAD
Byte 5	Bit 7:	Down direction status	STS_C_DN
	Bit 6:	Up direction status	STS_C_UP
	Bit 5:	Reserve = 0	
	Bit 4:	DO2 status	STS_DO2
	Bit 3:	DO1 status	STS_DO1
	Bit 2:	Reserve = 0	
	Bit 1:	DI status	STS_DI
	Bit 0:	Internal gate status	STS_GATE
Byte 6	Bit 7:	Zero-crossing in the count range when counting without a main count direction	STS_ND
	Bit 6:	Low counting limit	STS_UFLW
	Bit 5:	High counting limit	STS_OFLW
	Bit 4:	Comparator 2 status	STS_CMP2
	Bit 3:	Comparator 1 status	STS_CMP1
	Bit 2:	Reserve = 0	
	Bit 1:	Reserve = 0	
	Bit 0:	Synchronization status	STS_SYN
Byte 7	Reserve = 0		
Bytes 8 to 11	Count value [1]		
[1] Modified user data interface			

Table 2-4 Control Interface (Outputs)

Address		Assignment			
Bytes 0 to 3		Load value direct, preparatory, comparison value 1 or 2			
	Byte 0	Behavior of DO1, DO2 of the 1Count24V/100kHz			
		Bit 2	Bit 1	Bit 0	Function DO1
		0	0	0	Output
		0	0	1	Switch on at count ≥ comparison value
		0	1	0	Switch on at count ≤ comparison value
		0	1	1	Pulse on reaching the comparison value
		1	0	0	Switch at comparison values
		1	0	1	blocked
		1	1	0	blocked
		1	1	1	blocked
			Bit 5	Bit 4	Function DO2
			0	0	Output
			0	1	Switch on at count ≥ comparison value
			1	0	Switch on at count ≤ comparison value
			1	1	Pulse on reaching the comparison value
		Bits 3, 6, and 7: Reserve = 0			
	Bytes 1 to 3	Byte 1:	Hysteresis DO1, DO2 (range 0 to 255)		
		Byte 2:	Pulse duration [2ms] DO1, DO2 (range 0 to 255)		
		Byte 3:	Reserve = 0		
Byte 4	EXTF_ACK	Bit 7:	Error diagnostics acknowledgment		
	CTRL_DO2	Bit 6:	Enable DO2		
	SET_DO2	Bit 5:	Control bit DO2		
	CTRL_DO1	Bit 4:	Enable DO1		
	SET_DO1	Bit 3:	Control bit DO1		
	RES_STS	Bit 2:	Start resetting of status bit		
	CTRL_SYN	Bit 1:	Enable synchronization		
	SW_GATE	Bit 0:	SW gate control bit		
Byte 5		Bit 7:	Reserve = 0		
		Bit 6:	Reserve = 0		
		Bit 5:	Reserve = 0		
	C_DOPARAM	Bit 4:	Change function and behavior of DO1, DO2		
	CMP_VAL2	Bit 3:	Load comparison value 2		
	CMP_VAL1	Bit 2:	Load comparison value 1		
	LOAD_PREPARE	Bit 1:	Load counter preparatory		
	LOAD_VAL	Bit 0:	Load counter direct		
Bytes 6 to 7		Reserve = 0 [1]			
[1] Not used for modified user interface					

Notes on the Control Bits

Table 2-5 Notes on the Control Bits

Control bits	Notes
C_DOPARAM	Change function and behavior of DO1, DO2 (see figure below) The values from bytes 0 to 2 are applied as new function, hysteresis, and pulse duration of DO1, DO2. This may result in the following error: The conditions for the "Switch at comparison values" behavior are not fulfilled.
CMP_VAL1	Load comparison value 1 (see figure below) The value from bytes 0 to 3 is transferred to comparison value 1 with the control bit "Load comparison value CMP_VAL1".
CMP_VAL2	Load comparison value 2 (see figure below) The value from bytes 0 to 3 is transferred to comparison value 2 with the control bit "Load comparison value CMP_VAL2".
CTRL_DO1	Enable DO1 You use this bit to enable the DO1 output.
CTRL_DO2	Enable DO2 You use this bit to enable the DO2 output.
CTRL_SYN	You use this bit to enable synchronization.
EXTF_ACK	Error acknowledgment The error bits must be acknowledged with the EXTF_ACK control bit after the cause is removed. (see figure below)
LOAD_PREPARE	Load counter preparatory (see figure below) The value from bytes 0 to 3 is applied as the load value.
LOAD_VAL	The value from bytes 0 to 3 is loaded directly as the new counter value (see figure below).
RES_STS	Start resetting of status bit The status bits are reset through the acknowledgment process between the RES_STS bit and the RES_STS_A bit. (see figure below)
SET_DO1	Control bit DO1 Switches the DO1 digital output on and off when CTRL_DO1 is set.
SET_DO2	Control bit DO2 Switches the DO2 digital output on and off when CTRL_DO2 is set.
SW_GATE	SW gate control bit The SW gate is opened/closed via the control interface with the SW_GATE bit.

Notes on the Feedback Bits

Table 2-6 Notes on the Feedback Bits

Feedback bits	Notes
ERR_24V	Short circuit of the encoder supply The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_DO1	Short circuit/wire break/overtemperature due to overload at output DO1 The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_LOAD	Load function error (see figure below) The LOAD_VAL, LOAD_PREPARE, CMP_VAL1, CMP_VAL2, and C_DOPARAM bits cannot be set simultaneously during transfer. This results in setting the ERR_LOAD status bit, similar to loading an incorrect value (which is not accepted).
ERR_PARA	Parameter assignment error ERR_PARA
RES_STS_A	Resetting of the status bits active (see figure below)
STS_C_DN	Down direction status
STS_C_UP	Up direction status
STS_CMP1	Comparator 1 status The STS_CMP1 status bit indicates that the output is or was switched on. It must be acknowledged with the RES_STS control bit. If the status bit is acknowledged when the output is still switched on, the bit is set again immediately. This bit is also set if the SET_DO1 control bit is used when DO1 is not enabled.
STS_CMP2	Comparator 2 status The STS_CMP2 status bit indicates that the output is or was switched on. It must be acknowledged with the RES_STS control bit. If the status bit is acknowledged when the output is still switched on, the bit is set again immediately. This bit is also set if the SET_DO2 control bit is used when DO2 is not enabled.
STS_DI	DI status The status of the DI is indicated in all modes with the STS_DI bit in the feedback interface.
STS_DO1	DO1 status The STS_DO1 status bit indicates the status of the DO1 digital output.
STS_DO2	DO2 status The STS_DO2 status bit indicates the status of the virtual DO2 digital output.
STS_GATE	Internal gate status: Counting
STS_LOAD	Load function running (see figure below)
STS_ND	Zero-crossing in the count range when counting without a main counting direction. The bit must be reset by the RES_STS control bit.
STS_OFLW STS_UFLW	High counting limit violated Low counting limit violated Both bits must be reset.
STS_SYN	Synchronization status After successful synchronization, the STS_SYN bit is set. It must be reset by the RES_STS control bit.

Access to the Control and Feedback Interface in STEP 7 Programming

Table 2-7 Access to the Control and Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD File [1)] (Hardware catalog\PROFIBUS-DP\Additional FIELD DEVICES\I/O\ET 200S)	Configuring with STEP 7 using HW Config (Hardware catalog\PROFIBUS-DP\ ET 200S)
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command (e.g. L PID)
Control interface	Write with SFC 15 "DPWR_DAT"	Transfer command (e.g. T PQD)
[1] Load and transfer commands are also possible with CPU 3xxC, CPU 3xx with MMC, CPU 4xx (V3.0 and later), and WinLC RTX (PC CPU).		

Resetting of the Status Bits
STS_SYN, STS_CMP1, STS_CMP2, STS_OFLW, STS_UFLW, STS_ND

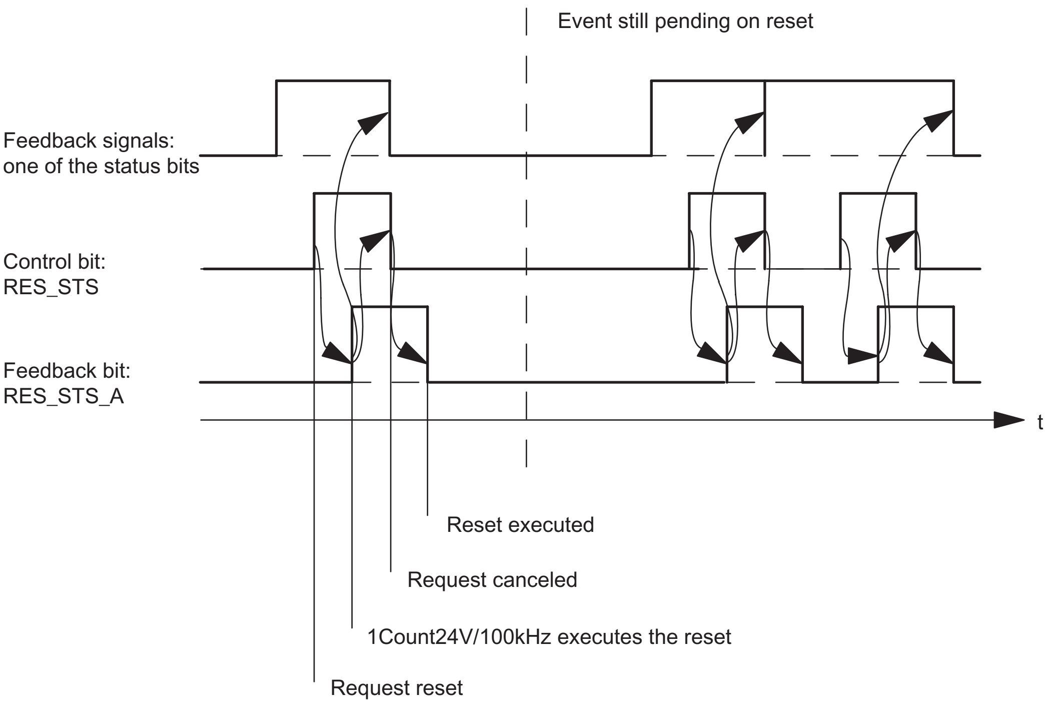


Figure 2-17 Resetting of the Status Bits

Acceptance of Values with the Load Function

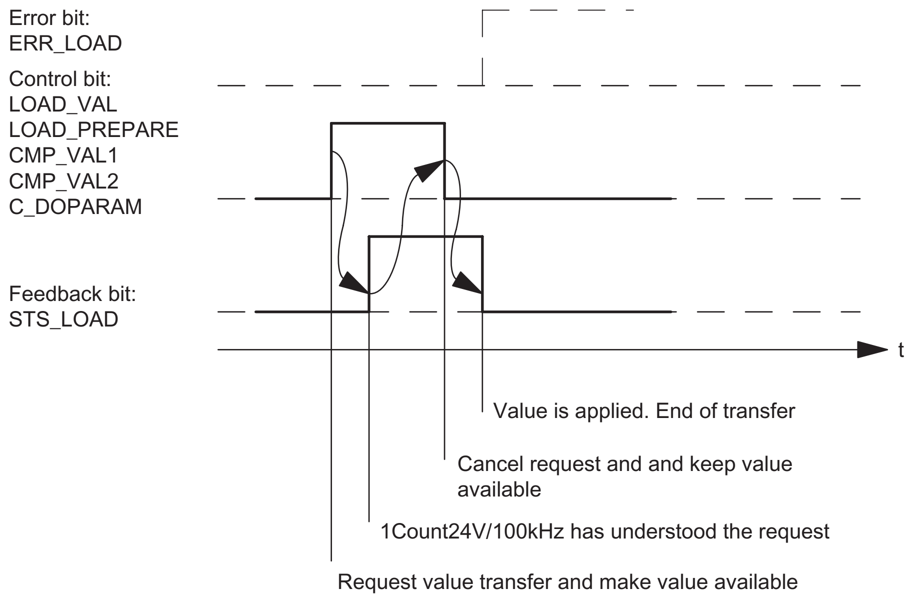


Figure 2-18 Acceptance of Values with the Load Function

Note

Only one of the following control bits can be set at a particular time:

CMP_VAL1 or CMP_VAL2 or LOAD_VAL or LOAD_PREPARE or C_DOPARAM.

Otherwise, the ERR_LOAD error is reported until all the specified control bits are deleted again.

The ERR_LOAD error bit is only deleted when the following is carried out correctly.

Acknowledgment Principle in Isochrone Mode

In isochrone mode, exactly 4 bus cycles are always required to reset the status bits and to accept values during the load function.

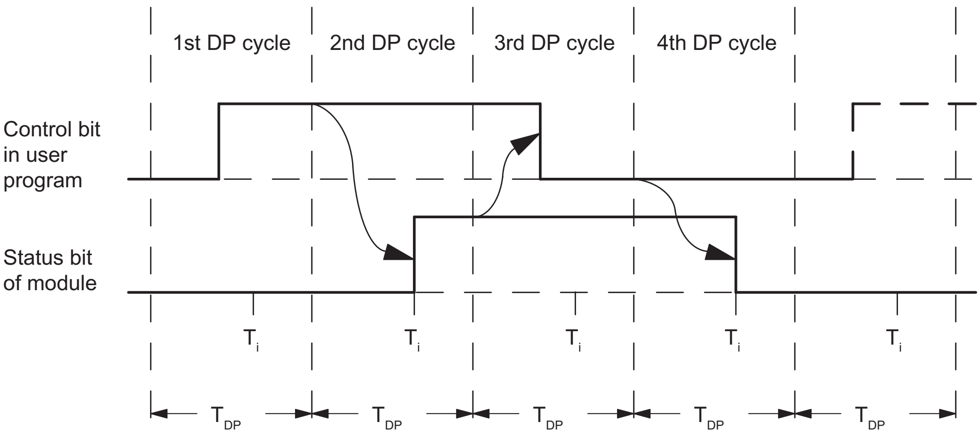


Figure 2-19 Acknowledgment Principle in Isochrone Mode

Error Detection

The program errors must be acknowledged. They have been detected by the 1Count24V/100kHz and are indicated in the feedback interface. A channel-specific diagnosis is carried out if you have enabled group diagnostics in your parameter assignment (see the *ET 200S Distributed I/O System* Manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

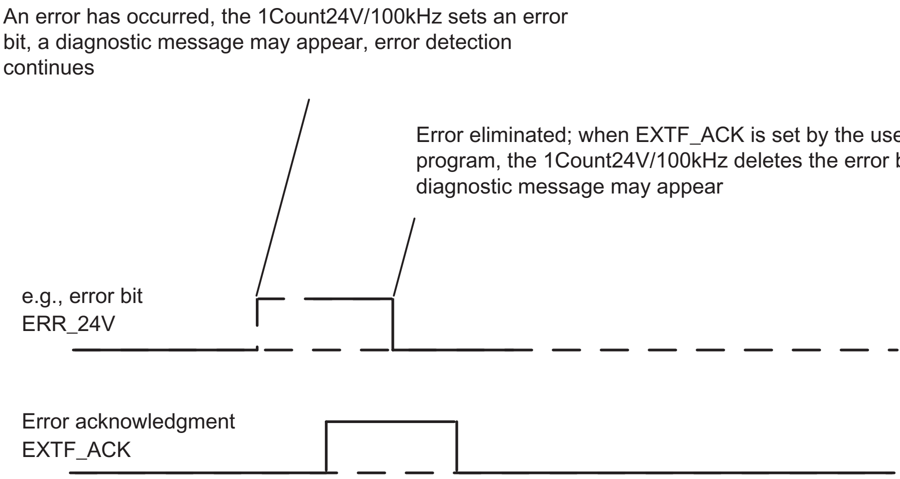


Figure 2-20 Error Acknowledgment

In the case of continuous error acknowledgment (EXTF_ACK=1) or at CPU/Master Stop, the 1Count24V/100kHz signals errors as soon as they are detected and resets them as soon as they have been eliminated.

2.6.11 Parameter Assignment for the Count Modes

Introduction

You can use either of the following to assign parameters for the 1Count24V/100kHz:

- A GSD file (http://www.ad.siemens.de/csi/gsd)
- STEP 7 V5.3 SP2 or later

Parameter List for Counting Modes

Table 2-8 Parameter List for Counting Modes

Parameter	Value range	Default
Enable		
Group diagnostics	Disable/enable	Disable
Behavior in the event of the parent controller failing		
Behavior at CPU/Master-STOP	Turn off DO1/ Continue working mode/ DO1 substitute a value/ DO1 keep last value	Turn off DO1
Encoder parameters		
Signal evaluation A, B	Pulse and direction/ Rotary encoder single/ double/ quadruple	Pulse and direction
Encoder and input filter • At count input (track A) • At direction input (track B) • At digital input DI	 • 2.5 μs/25 μs • 2.5 μs/25 μs • 2.5 μs/25 μs	 • 2.5 μs • 2.5 μs • 2.5 μs
Sensor A, B, DI	24V P switch, normal mode/ 24V M switch	24V P switch, normal mode
Direction input B	Normal/Inverted	Normal
Output parameters		
Function DO1	Output/ Switch on at count ≥ comparison value/ Switch on at count ≤ comparison value/ Pulse on reaching the comparison value/ Switch at comparison values	Output
Function DO2	Output/ Switch on at count ≥ comparison value/ Switch on at count ≤ comparison value/ Pulse on reaching the comparison value	Output
Substitute value DO1	0/1	0
Diagnostics DO1[1]	Off/on	Off
Hysteresis DO1, DO2	0...255	0
Pulse duration [2 ms] DO1, DO2	0...255	0

Parameter	Value range	Default
Mode		
Counting mode	Continuous counting/ One-time counting/ Periodic counting	Count continuously
Gate function	Cancel counting/ Interrupt counting	Cancel counting
Input signal HW gate	Normal/Inverted	Normal
Function DI	Input/ HW gate/ Latch and retrigger on positive rising edge/ Synchronization on positive edge	Input
Synchronization[2]	Once-only/Periodically	Once-only
Main count direction	None/Up/Down	None
High counting limit	2 … 7FFF FFFF	7FFF FFFF
[1] DO1 diagnostics (wire break, short circuit) is possible only with pulse lengths of > 90 ms on digital output DO1. [2] Only relevant if Function DI = Synchronization on positive edge		

Parameter Assignment Error

- Incorrect mode
- Incorrect main count direction
- The "Input signal HW gate" parameter is set to inverted and the "Function DI" parameter is not set to HW gate.
- High counting limit incorrect
- The value for the behavior of DO2 is not set to output although "Switch at comparison values" has been assigned for DO1.
- The value for hysteresis does not equal 0 although "Switch at comparison values" has been assigned for DO1.

What to Do in the Event of Errors

Check the set value ranges.

2.7 Measurement Modes

2.7.1 Overview

Introduction

For the "Measuring Mode" parameter, you can select from the following modes:

- Frequency measurement
- Period measurement
- Rotational speed measurement

For the "Measuring Method" parameter, you can select from the measurement methods:

- With integration time
- Continuous-action

To execute one of these modes, you have to assign parameters to the 1Count24V/100kHz.

Sequence of Measurements with Integration Time

The measurement is carried out during the assigned integration time. When the integration time elapses, the measured value is updated.

The end of a measurement is indicated by the STS_CMP1 status bit. This bit is reset by the RES_STS control bit in the control interface.

If there were not at least two rising edges in the assigned integration time, 0 is returned as the measured value.

A value of -1 is returned up until the end of the first integration time.

You can change the integration time for the next measurement during operation.

Direction Reversal

If the direction of rotation is reversed during an integration time, the measured value for this measurement period is uncertain. If you evaluate the STS_C_UP and STS_C_DN feedback bits (direction evaluation), you can respond to any process irregularities.

2.7.2 Sequence of continuous-action measurement

Measuring Principle

The 1Count24/100kHz counts each positive edge of a pulse and assigns it a time value in µs.

The update time indicates the time interval at which the measured value is updated by the module in the feedback interface.

The following applies for a pulse train with one or more pulse trains per update time:

Dynamic measuring time =	Time of last pulse in the current update time interval
	minus
	Time of last pulse in the previous update time interval

When the update time has elapsed, a new measured value is calculated and output with the dynamic measuring time.

If the current update time does not contain a pulse, the following dynamic measuring time results:

Dynamic measuring time =	Time of current, elapsed update time
	minus
	Time of last pulse

When the update time has elapsed, an estimated measured value is calculated with the dynamic measuring time under the assumption that a pulse occurred at the end of the update time.

If the "1 Pulse per dynamic measuring time" estimated measured value is less than the last measured value during the frequency and speed measurement, this estimated measured value is output as the new measured value. With the period measurement, the dynamic measuring time is output as the estimated period if the dynamic measuring time is greater than the last measured period.

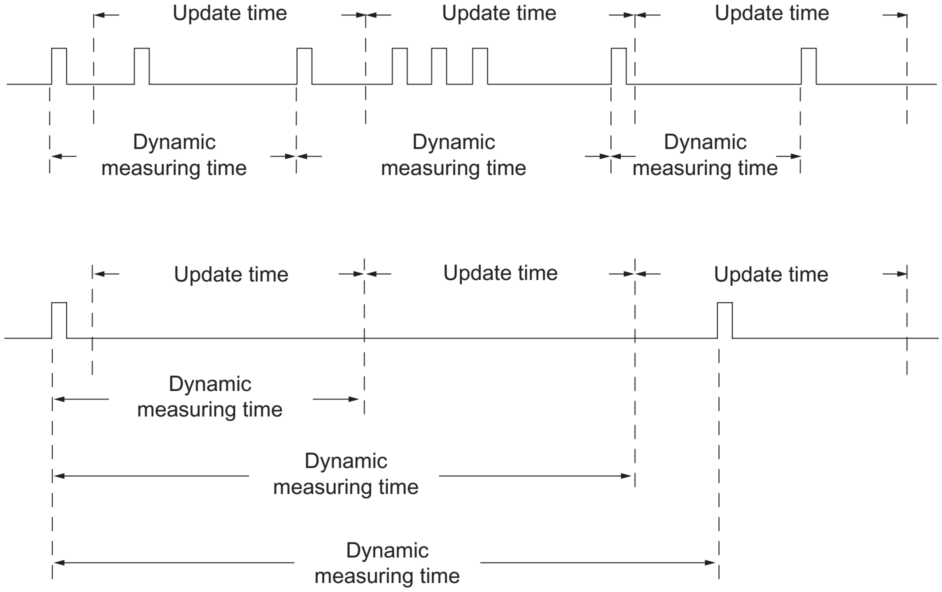


Figure 2-21 Measuring Principle

The 1Count24V/100kHz measures continuously. When assigning parameters, you specify an update time.

During the time until the end of the first elapsed update time, a value of "-1" is returned.

The continuous measurement begins after the gate is opened with the first pulse of the pulse train to be measured. The first measured value can be calculated after the second pulse, at the earliest.

A measured value (frequency, period, or speed) is output in the feedback interface each time the update time elapses. The end of a measurement is indicated with the STS_CMP1 status bits. This bit is reset with the RES_STS and RES_STS_A bits according to the complete acknowledgement principle.

If the direction of rotation is reversed during an update time, the measured value for this measurement period is undefined. By evaluating the STS_C_DN and STS_C_UP feedback bits (direction evaluation), you can respond to any process irregularities.

The following figure illustrates the principle of continuous measurement using frequency measurement as an example.

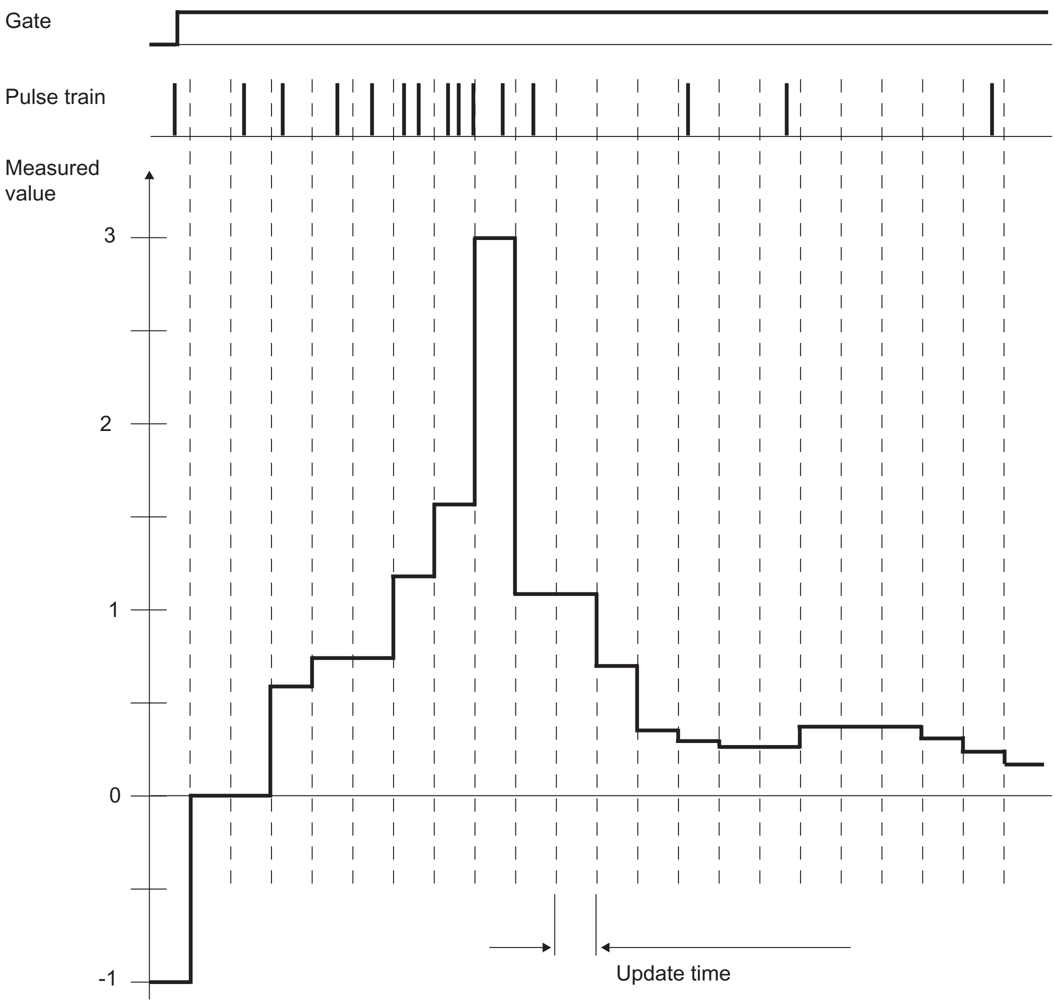


Figure 2-22 Principle of Continuous Measurement (Frequency Measurement Example)

Gate Control

To control the 1Count24V/100kHz, you have to use the gate functions.

Isochrone Mode

In isochrone mode, the 1Count24V/100kHz accepts control bits and control values from the control interface in each bus cycle and reports back the response in the same cycle.

In each cycle, the 1Count24V/100kHz transfers a measured value and the status bits that were valid at time T_i.

The measurement starts and ends at time T_i.

Integration Time and Update Time in Isochrone Mode

If the integration time/update time lasts several T_{DP} cycles, you can recognize the new measured value in the user program at the bit STS_CMP1 status bit (measurement completed) of the feedback interface. This enables monitoring of the measuring operation or a synchronization with the measuring operation. It takes 4 T_{DP} cycles, however, for this message to be acknowledged. The minimum integration time/update time in this case is (4 x T_{DP}).

If the application can tolerate a jitter in the integration time/update time of T_{DP} and a measured value that remains constant for several cycles, you do not need to continually evaluate status bit STS_CMP1. Integration times/update times of (1 x T_{DP}) to (3 x T_{DP}) are then possible.

Because isochronous operation was lost in the last T_{DP} cycle of the integration time, the integration time/update time is increased by one T_{DP} cycle. This does not corrupt the measured value.

Note

The value range limits for the integration time/update time must not be exceeded (see tables for the individual measuring modes).

A violation of the value range limits will result in a parameter assignment error, and the 1Count24V/100kHz will not go into isochrone mode.

Note

When you change the configuration from non-isochrone to isochrone mode and vice versa, you must always adjust the integration time/update time parameter if you want to keep the length of the integration time/update time.

2.7.3 Frequency Measurement

Definition

In frequency measurement mode, the 1Count24V/100kHz counts the pulses that arrive within a set integration time.

Integration time

Preset the integration time with the integration time parameter (see the table).

Table 2-9 Calculating the Integration Time

Specific Conditions		Integration time	Range of n	
			n_{min}	n_{max}
Non-clocked mode	Any T_{DP}	n x 10 ms	1	1000
Clocked Mode	T_{DP} < 10 ms	n x T_{DP}	(10 ms/T_{DP} [ms]) +1 [1]	1000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	10000 ms/T_{DP} [ms] [1]
[1]Any digits after the decimal point that come about after dividing by T_{DP} can be omitted. These limits must not be violated. If these limits are violated the 1Count24V/100kHz generates a parameter assignment error and will not go into clocked mode.				

Frequency Measurement

The value of the calculated frequency is made available in the unit Hz*10^{-3}. The measured frequency value can be read at the feedback interface (byte 0 to 3).

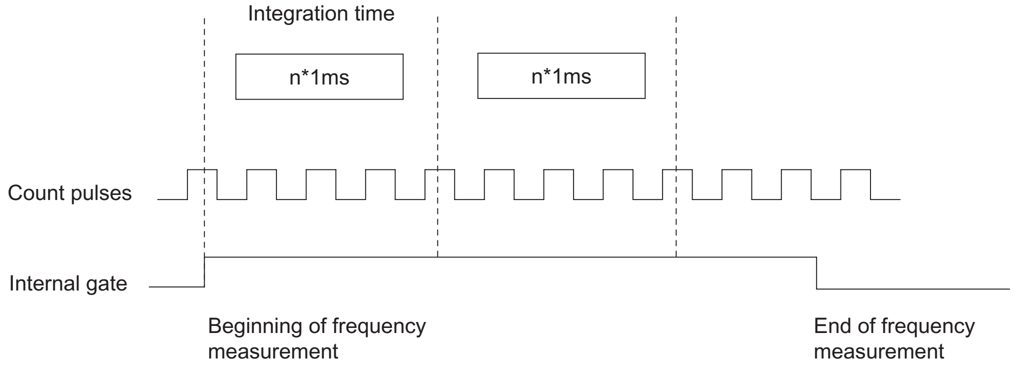


Figure 2-23 Frequency Measurement with Gate Function

(1) Internal Gate
(2) Count pulses
(3) Integration time
(4) End of frequency measurement
(5) Beginning of frequency measurement

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Lower limit f_u	Upper limit f_o
0 to 99,999,999 Hz*10^{-3}	f_u+1 to 100,000,000 Hz*10^{-3}

Possible Measurement Ranges with Error Indication

Integration time	fmin + absolute error	fmax + absolute error
10 s	0.1 Hz ± 0.001 Hz	100000 Hz ± 18 Hz
1 s	1 Hz ± 0.001 Hz	100000 Hz ± 11 Hz
0.1 s	10 Hz ± 0.002 Hz	100000 Hz ± 10 Hz
0.01 s	100 Hz ± 0.013 Hz	100000 Hz ± 13 Hz

Function of the Digital Input

Select one of the following functions for the digital input:

- Input
- Hardware gate

Function of the DO1 Digital Output

Select one of the following functions for the DO1 digital output:

- Output (no switching by means of limit-value monitoring)
- Measured value outside the limits
- Measured value under the lower limit
- Measured value over the upper limit

Changing values during operation

The following values can be changed during operation:

- Lower limit (LOAD_PREPARE)
- Upper limit (LOAD_VAL)
- Function of the DO1 (C_DOPARAM) digital output
- Integration time (C_INTTIME)

2.7.4 Continuous Frequency Measurement

Definition

In frequency measurement mode, the 1Count24V/100kHz counts the pulses that arrive within a dynamic measuring time.

Update Time

The 1Count24V/100kHz updates the measured values cyclically. You preset the update time with the Update Time parameter (see table). You can change the update time during operation.

Table 2-10 Calculation of the Update Time

Boundary conditions		Update time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	1000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	(10 ms/T_{DP} [ms]) +1 [1]	1000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	10000 ms/T_{DP} [ms] [1]

[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count24V/100kHz generates a parameter assignment error and will not go into isochrone mode.

Frequency Measurement

The value of the calculated frequency is made available in the unit Hz*10^{-3}. The measured frequency value can be read in the feedback interface (byte 0 to 3).

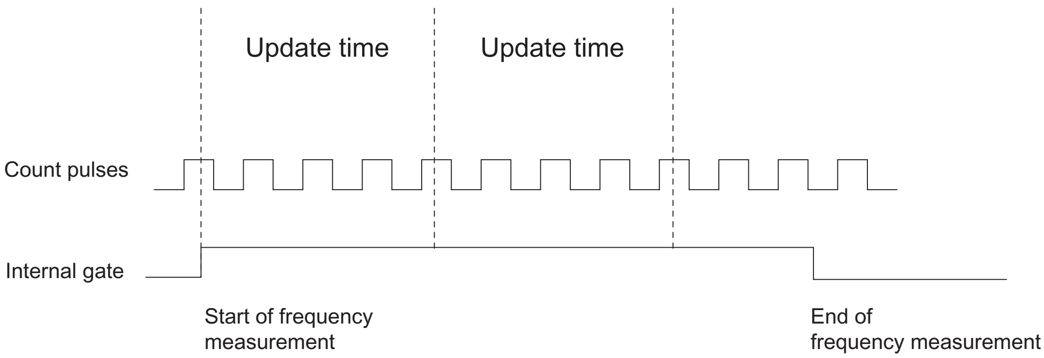


Figure 2-24 Frequency Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Encoder type	Low limit f_u	High limit f_o
24-V encoders	0 to 99,999,999 Hz*10^{-3}	f_u+1 to 100,000,000 Hz*10^{-3}

Possible Measuring Ranges with Error Indication

Frequency f	Absolute error
0.1 Hz	±0.001 Hz
1 Hz	±0.001 Hz
10 Hz	±0.003 Hz
100 Hz	±0.02 Hz
1 000 Hz	±0.18 Hz
10 000 Hz	±1.8 Hz
100 000 Hz	±18 Hz

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate

Function of the Digital Output DO1

For the "Function DO1" parameter, select one of the following functions for the DO1 digital output:

- Output (no switching by the limit-value monitoring)
- Measured value outside the limits
- Measured value under the low limit
- Measured value over the high limit

Changing Values during Operation

The following values can be changed during operation:

- Low limit (LOAD_PREPARE)
- High limit (LOAD_VAL)
- Function of the Digital Output DO1 (C_DOPARAM)
- Integration time/update time (C_INTTIME)

See also

Gate Functions in Measurement Modes (Page 83)

Behavior of the Output in Measurement Modes (Page 84)

Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 86)

2.7.5 Rotational Speed Measurement

Definition

In rotational speed measurement mode, the 1Count24V/100kHz counts the pulses that arrive from a rotary encoder within a set integration time and calculates the speed of the connected motor.

Integration Time

You preset the integration time with the Integration Time parameter (see table).

Table 2-11 Calculation of the Integration Time

Boundary conditions		Integration time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	1000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	(10 ms/T_{DP} [ms]) + 1 [1]	1000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	10000 ms/T_{DP} [ms] [1]

[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count24V/100kHz generates a parameter assignment error and will not go into isochrone mode.

Rotational Speed Measurement

For rotational speed measurement mode, you also have to assign the pulses per encoder or motor revolution.

The rotational speed is returned in the unit 1×10^{-3} /min.

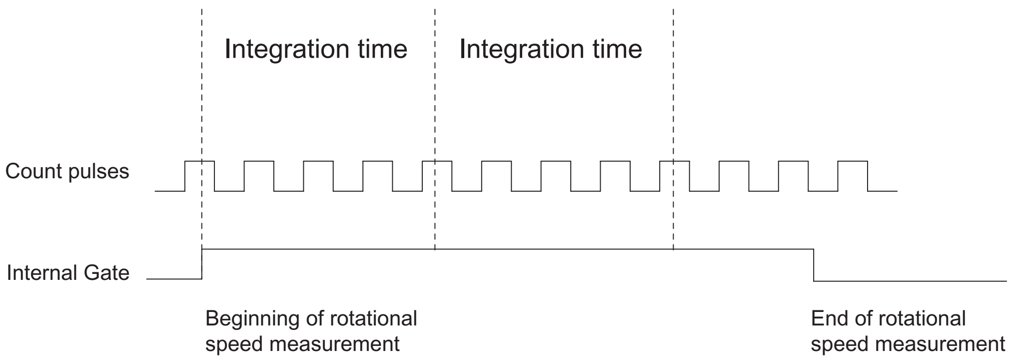


Figure 2-25 Rotational Speed Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Low limit n_u	High limit n_o
0 to 24 999 999 x10^{-3} /min	n_u+1 to 25 000 000 x10^{-3} /min

Possible Measuring Ranges with Error Indication

Table 2-12 Possible Measuring Ranges with Error Indication (Number of Pulses per Encoder Revolution = 60)

Integration time	n_{min} ± absolute error	n_{max} ± absolute error
10 s	1 /min ± 0.03 /min	25000 /min ± 4.5 /min
1 s	1 /min ± 0.03 /min	25000 /min ± 2.8 /min
0.1 s	10 /min ± 0.03 /min	25000 /min ± 2.6 /min
0.01 s	100 /min ± 0.04 /min	25000 /min ± 3.2 /min

2.7.6 Continuous Rotational Speed Measurement

Definition

In rotational speed measurement mode, the 1Count24V/100kHz counts the pulses that are received from a tachometer generator within a dynamic measuring time and calculates the speed from this value with the number of pulses per encoder revolution.

Update Time

The 1Count24V/100kHz updates the measured values cyclically. You preset the update time with the Update Time parameter (see table). You can change the update time during operation.

Table 2-13 Calculation of the Update Time

Boundary conditions		Update time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	1000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	(10 ms/T_{DP} [ms]) + 1 [1]	1000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	10000 ms/T_{DP} [ms] [1]

[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count24V/100kHz generates a parameter assignment error and will not go into isochrone mode.

Rotational Speed Measurement

For the rotational speed measurement mode, you must also assign the pulses per encoder revolution.

The rotational speed is returned in the unit 1×10^{-3} /min.

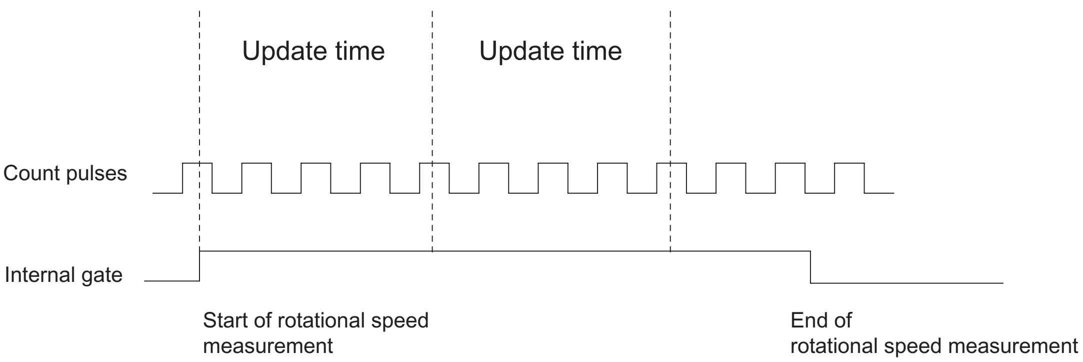


Figure 2-26 Rotational Speed Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Low limit n_u	High limit n_o
0 to 24 999 999 x10^{-3} /min	n_u+1 to 25 000 000 x10^{-3} /min

Possible Measuring Ranges with Error Indication

Table 2-14 Possible Measuring Ranges with Error Indication (Number of Pulses per Encoder Revolution = 60)

Rotational speed n	Absolute error
1 /min	±0.04 /min
10 /min	±0.04 /min
100 /min	±0.05 /min
1 000 /min	±0.21 /min
10 000 /min	±1.82 /min
25 000 /min	±4.50 /min

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate

Function of the Digital Output DO1

For the "Function DO1" parameter, select one of the following functions for the DO1 digital output:

- Output (no switching by the limit-value monitoring)
- Measured value outside the limits
- Measured value under the low limit
- Measured value over the high limit

Values that Can Be Changed During Operation

- Low limit (LOAD_PREPARE)
- High limit (LOAD_VAL)
- Function of the digital output DO1 (C_DOPARAM)
- Integration time/update time (C_INTTIME)

See also

Gate Functions in Measurement Modes (Page 83)
Behavior of the Output in Measurement Modes (Page 84)
Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 86)

2.7.7 Period Measurement

Definition

In period measurement mode, the 1Count24V/100kHz measures the time between two positive edges of the counting signal by counting the pulses of an internal quartz-accurate reference frequency (16 MHz) within a preset integration time.

Integration Time

You preset the integration time with the Integration Time parameter (see table).

Table 2-15 Calculation of the Integration Time

Boundary conditions		Integration time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	12000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	10 ms/T_{DP} [ms] +1 [1]	12000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	120000 ms/T_{DP} [ms] [1]

[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count24V/100kHz generates a parameter assignment error and will not go into isochrone mode.

Period Measurement

The value of the calculated period is given in the unit 1 µs and 1/16 µs. The measured period can be read in the feedback interface (byte 0 to 3).

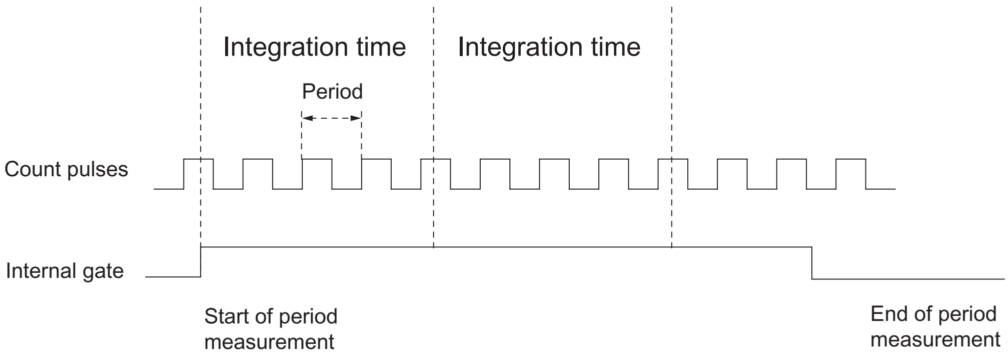


Figure 2-27 Period Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

1 µs resolution

Low limit T_u	High limit T_o
0 to 119 999 999 µs	T_u+1 to 120 000 000 µs

1/16 µs resolution

Low limit T_u	High limit T_o
0 to 1 919 999 999 µs	T_u+1 to 1 920 000 000 µs

Possible Measuring Ranges with Error Indication

1 µs resolution

Integration time	T_{min} ± absolute error	T ± absolute error
100 s	1 µs* (10 ± 0)	1 µs* (100 000 000 ± 10 000)
10 s	1 µs* (10 ± 0)	1 µs* (10 000 000 ± 1 000)
1 s	1 µs* (10 ± 0)	1 µs* (1 000 000 ± 100)
0.1 s	1 µs* (10 ± 0)	1 µs* (100 000 ± 10)
0.01 s	1 µs* (10 ± 0)	1 µs* (10 000 ± 1)

1/16 µs resolution

Integration time	T_{min} ± absolute error	T ± absolute error
100 s	1/16 µs* (160 ± 0)	1/16 µs* (1 600 000 000 ± 160 000)
10 s	1/16 µs* (160 ± 0)	1/16 µs* (160 000 000 ± 16 000)
1 s	1/16 µs* (160 ± 0)	1/16 µs* (16 000 000 ± 1 600)
0.1 s	1/16 µs* (160 ± 0)	1/16 µs* (1 600 000 ± 160)
0.01 s	1/16 µs* (160 ± 0)	1/16 µs* (160 000 ± 16)

2.7.8 Continuous Period Measurement

Definition

In period measurement mode, the 1Count24V/100kHz indicates the dynamic measuring time as a period. If the period is less than the update time, then an average is calculated for the period.

Update Time

The 1Count24V/100kHz updates the measured values cyclically. You preset the update time with the Update Time parameter (see table). You can change the update time during operation.

Table 2-16 Calculation of the Update Time

Boundary conditions		Update time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	12000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	10 ms/T_{DP} [ms] +1 [1]	12000
	$T_{DP} \geq 10$ ms	n x T_{DP}	1	120000 ms/T_{DP} [ms] [1]
[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted. These limits must not be violated. If these limits are violated, the 1Count24V/100kHz generates a parameter assignment error and will not go into isochrone mode.				

Period Measurement

The value of the calculated period is given in the unit 1 µs and 1/16 µs. The measured period can be read in the feedback interface (byte 0 to 3).

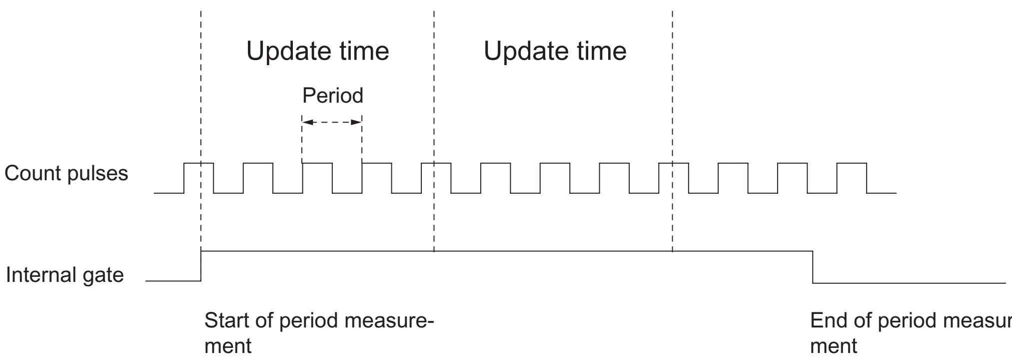


Figure 2-28 Period Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

1 µs resolution

Low limit T_u	High limit T_o
0 to 119 999 999 µs	T_u+1 to 120 000 000 µs

1/16 µs resolution

Low limit T_u	High limit T_o
0 to 1 919 999 999 µs	T_u+1 to 1 920 000 000 µs

Possible Measuring Ranges with Error Indication

1 µs resolution

Period T_{min} ± Absolute error	Period T_{min} ± Absolute error
1 µs* (10 ± 0)	1 µs* (100 000 ± 10)
1 µs* (100 ± 0)	1 µs* (1 000 000 ± 100)
1 µs* (1 000 ± 0)	1 µs* (10 000 000 ± 1 002)
1 µs* (10 000 ± 0)	1 µs* (100 000 000 ± 10 020)

1/16 µs resolution

Period T_{min} ± Absolute error	Period T_{min} ± Absolute error
1/16 µs* (160 ± 1)	1/16 µs* (1 600 000 ± 160)
1/16 µs* (1 600 ± 1)	1/16 µs* (16 000 000 ± 1 600)
1/16 µs* (16 000 ± 3)	1/16 µs* (160 000 000 ± 16 000)
1/16 µs* (160 000 ± 20)	1/16 µs* (1 600 000 000 ± 160 000)

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate

Function of the Digital Output DO1

For the "Function DO1" parameter, select one of the following functions for the digital output:

- Output (no switching by the limit-value monitoring)
- Measured value outside the limits
- Measured value under the low limit
- Measured value over the high limit

Values that Can Be Changed During Operation

- Low limit (LOAD_PREPARE)
- High limit (LOAD_VAL)
- Function of the Digital Output DO1 (C_DOPARAM)
- Integration time/update time (C_INTTIME)

See also

Gate Functions in Measurement Modes (Page 83)
Behavior of the Output in Measurement Modes (Page 84)
Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 86)

2.7.9 Gate Functions in Measurement Modes

Software Gate and Hardware Gate

The 1Count24V/100kHz has two gates

- A software gate (SW gate), which is controlled by the SW_GATE control bit.

  The software gate can only be opened by a positive edge of the SW_GATE control bit. It is closed when this bit is reset. Note the transfer times and run times of your control program.
- A hardware gate (HW gate), which is controlled by the digital input on the 1Count24V/100kHz. You assign the hardware gate as the function of the digital input (Function DI "HW Gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

Internal gate

The internal gate is the logical AND operation of the HW gate and SW gate. Counting is only active when the HW gate and the SW gate are open. The STS_GATE feedback bit (internal gate status) indicates this. If a HW gate has not been assigned, the setting of the SW gate is decisive.

Gate Control

Gate control by means of the SW gate only

The opening/closing of the SW gate starts/stops measurement.

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, measurement starts at time T_i in cycle "n+1".

Gate control by SW gate and HW hate

The opening and closing of the SW gate with the HW gate open starts/stops measurement.

The opening and closing of the HW gate with the SW gate open starts/stops measurement.

The SW gate is opened/closed by means of the control interface with the SW_GATE bit.

The HW gate is opened/closed by means of a 24-V signal on the digital input.

In isochrone mode, when the SW gate is open, measurement starts at time T_i, immediately after the HW gate has opened. The measurement ends at time T_i, which occurs immediately after the HW gate has closed.

When the HW gate is open, the measurement starts at time T_i in the cycle, immediately after the SW has opened, and ends at time T_i in the cycle, which occurs immediately after the SW gate has closed.

2.7.10 Behavior of the Output in Measurement Modes

Introduction

The various ways of setting the behavior of the output are described in this section.

Behavior of the Output in Measuring Modes

You can assign parameters for the digital output of the 1Count24V/100kHz.

You can store a high and a low limit for frequency measurement, rotational speed measurement or period measurement. If the limits are violated, digital output DO1 is activated. These limit values can be assigned and changed with the load function.

You can change the function and the behavior of the digital output during operation. The new function takes effect immediately. In isochrone mode it always takes effect at time T_i.

You can choose from the following functions:

- Output
- Measured value outside the limits (limit-value monitoring)
- Measured value under the low limit (limit-value monitoring)
- Measured value over the high limit (limit-value monitoring)

Output

If you want to switch the output on or off, you must enable it with the CTRL_DO1 control bit.

You can switch the output on and off with the SET_DO1 control bit.

You can query the status of the output with the STS_DO1 status bit in the feedback interface.

In isochrone mode, the output is switched at time T_o.

Limit-Value Monitoring

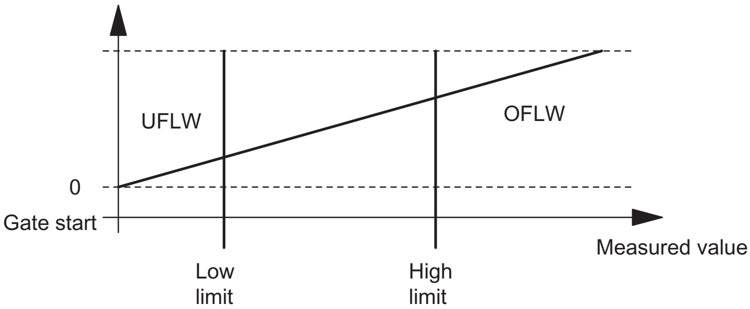


Figure 2-29 Limit-Value Monitoring

After the integration time elapses, the measured value obtained (frequency, rotational speed, or period) is compared with the assigned limit values.

If the current measured value is under the assigned low limit (measured value <low limit), the STS_UFLW = 1 bit is set in the feedback interface.

If the current measured value is over the assigned high limit (measured value > high limit), the STS_OFLW = 1 bit is set in the feedback interface.

You must acknowledge these bits with the RES_STS control bit.

If the measured value is still outside or again outside the limits after acknowledgment, the corresponding status bit is set again.

If you set the low limit at 0, you switch off dynamic monitoring of violation of the low limit value.

Depending on the parameter assignment, the enabled digital output DO1 can be set by the limit-value monitoring:

"Function DO1" parameter	DO1 is Set ...
Measured value outside the limits	Measured value < low limit OR measured value > high limit
Measured value under the low limit	Measured value < low limit
Measured value over the high limit	Measured value > high limit

In isochrone mode the output is switched at the end of measurement at time T_i.

2.7.11 Assignment of the Feedback and Control Interfaces for the Measurement Modes

Note

The following data of the control and feedback interfaces are consistent for the 1Count24V/100kHz:

Bytes 0 to 3

Bytes 4 to 7

Bytes 8 to 11 (modified user data interface)

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Assignment Tables

Table 2-17 Feedback Interface (Inputs)

Address	Assignment		Designation
Bytes 0 to 3	Measured value		
Byte 4	Bit 7:	Short circuit of the encoder supply	ERR_24V
	Bit 6:	Short circuit / wire break / overtemperature	ERR_DO
	Bit 5:	Parameter assignment error	ERR_PARA
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Resetting of status bits active	RES_STS_A
	Bit 1:	Load function error	ERR_LOAD
	Bit 0:	Load function is running	STS_LOAD
Byte 5	Bit 7:	Down direction status	STS_C_DN
	Bit 6:	Up direction status	STS_C_UP
	Bit 5:	Reserve = 0	
	Bit 4:	Reserve = 0	
	Bit 3:	DO1 status	STS_DO1
	Bit 2:	Reserve = 0	
	Bit 1:	DI status	STS_DI
	Bit 0:	Internal gate status	STS_GATE
Byte 6	Bit 7:	Reserve = 0	
	Bit 6:	Low limit of measuring range	STS_UFLW
	Bit 5:	High limit of measuring range	STS_OFLW
	Bit 4:	Reserve = 0	
	Bit 3:	Measurement completed	STS_CMP1
	Bit 2:	Reserve = 0	
	Bit 1:	Reserve = 0	
	Bit 0:	Reserve = 0	

Address	Assignment	Designation
Byte 7	Reserve = 0	
Bytes 8 to 11	Count value [1]	
[1] Modified user data interface		

Table 2-18 Control Interface (Outputs)

Address	Assignment			
Bytes 0 to 3	**Low limit or high limit**			
	Function of DO1			
	Byte 0:	Bit 1	Bit 0	Function DO1
		0	0	Output
		0	1	Measured value outside the limits
		1	0	Measured value under the low limit
		1	1	Measured value over the high limit
	Bytes 1 to 3:		Reserve = 0	
	Integration time			
	Byte 0, 1:	Integration time [n*10ms] (Range 1 to 1000/12000)		
	Byte 2, 3:	Reserve = 0		
Byte 4	Bit 7:	Error diagnostics acknowledgement EXTF_ACK		
	Bit 6:	Reserve = 0		
	Bit 5:	Reserve = 0		
	Bit 4:	Enable DO1 CTRL_DO1		
	Bit 3:	Control bit DO1 SET_DO1		
	Bit 2:	Start resetting of status bit RES_STS		
	Bit 1:	Reserve = 0		
	Bit 0:	SW gate control bit SW_GATE		
Byte 5	Bit 7:	Reserve = 0		
	Bit 6:	Reserve = 0		
	Bit 5:	Reserve = 0		
	Bit 4:	Change function of DO1, C_DOPARAM		
	Bit 3:	Reserve = 0		
	Bit 2:	Change integration time, C_INTTIME		
	Bit 1:	Load high limit LOAD_PREPARE		
	Bit 0:	Load low limit LOAD_VAL		
Bytes 6 to 7	Reserve = 0 [1]			
[1] Not used for modified user interface				

Notes on the Control Bits

Table 2-19 Notes on the Control Bits

Control bits	Notes
C_DOPARAM	Change function of DO1 (see figure below) The value from byte 0 is adopted as the new function of DO1.
C_INTTIME	Change integration time (see figure below) The value from bytes 0 and 1 is adopted as the new integration time for the next measurement.
CTRL_DO1	Enable DO1 You use this bit to enable the DO1 output.
EXTF_ACK	Error acknowledgment The error bits must be acknowledged with the EXTF_ACK control bit after the cause is removed. (see figure below)
LOAD_PREPARE	Load high limit (see figure below) The value from bytes 0 to 3 is adopted as the new high limit.
LOAD_VAL	Load low limit (see figure below) The value from bytes 0 to 3 is adopted as the new low limit.
RES_STS	Start resetting of status bit The status bits are reset through the acknowledgment process between the RES_STS bit and the RES_STS_A bit. (see figure below)
SET_DO1	Control bit DO1 Switches the DO1 digital output on and off when CTRL_DO1 is set.
SW_GATE	SW gate control bit The SW gate is opened/closed via the control interface with the SW_GATE bit.

Notes on the Feedback Bits

Table 2-20 Notes on the Feedback Bits

Feedback bits	Notes
ERR_24V	Short circuit of the encoder supply The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_DO1	Short circuit/wire break/overtemperature at output DO1 The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_LOAD	Load function error (see figure below) The LOAD_VAL, LOAD_PREPARE, C_DOPARAM, and C_INTTIME bits cannot be set simultaneously during transfer. This results in setting the ERR_LOAD status bit, similar to loading an incorrect value (which is not accepted).
ERR_PARA	Parameter assignment error ERR_PARA
RES_STS_A	Resetting of the status bits active (see figure below)
STS_C_DN	Down direction status
STS_C_UP	Up direction status
STS_CMP1	Measurement completed After every elapsed time interval (update time/integration time), the measured value is updated. Measurement with integration time The end of a measurement (after the interval has elapsed) is indicated with the STS_CMP1 status bit. Continuous measurement At the end of the update time, the end of the measurement is signaled with status bit STS_CMP1 if a measured value is output. The bit remains 0 if an estimated measured value is output. This bit is reset by the RES_STS control bit in the control interface.
STS_DI	DI status The status of the DI is indicated in all modes with the STS_DI bit in the feedback interface.
STS_DO1	DO1 status
STS_GATE	Internal gate status: Measuring
STS_LOAD	Load function running (see figure below)
STS_OFLW STS_UFLW	High measuring limit violated Low measuring limit violated Both bits must be reset.

Access to the Control and Feedback Interface in STEP 7 Programming

Table 2-21 Access to the Control and Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD file [1)] **(Hardware catalog\PROFIBUS-DP\Additional FIELD DEVICES\I/O\ET 200S)**	**Configuring with STEP 7 using HW Config (Hardware catalog\PROFIBUS-DP\ ET 200S)**
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command (e.g. L PID)
Control interface	Write with SFC 15 "DPWR_DAT"	Transfer command (e.g. T PQD)
[1] Load and transfer commands are also possible with CPU 3xxC, CPU 3xx with MMC, CPU 4xx (V3.0 and later), and WinLC RTX (PC CPU).		

Resetting of the Status Bits STS_CMP1, STS_OFLW, STS_UFLW

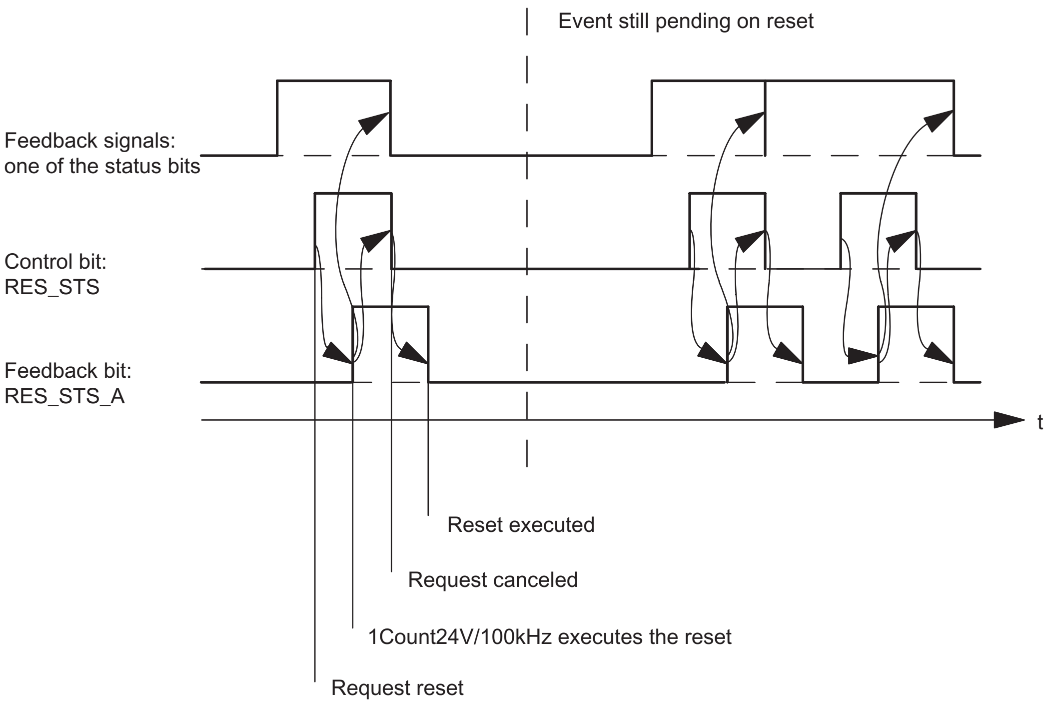


Figure 2-30 Resetting of the Status Bits

Acceptance of Values with the Load Function

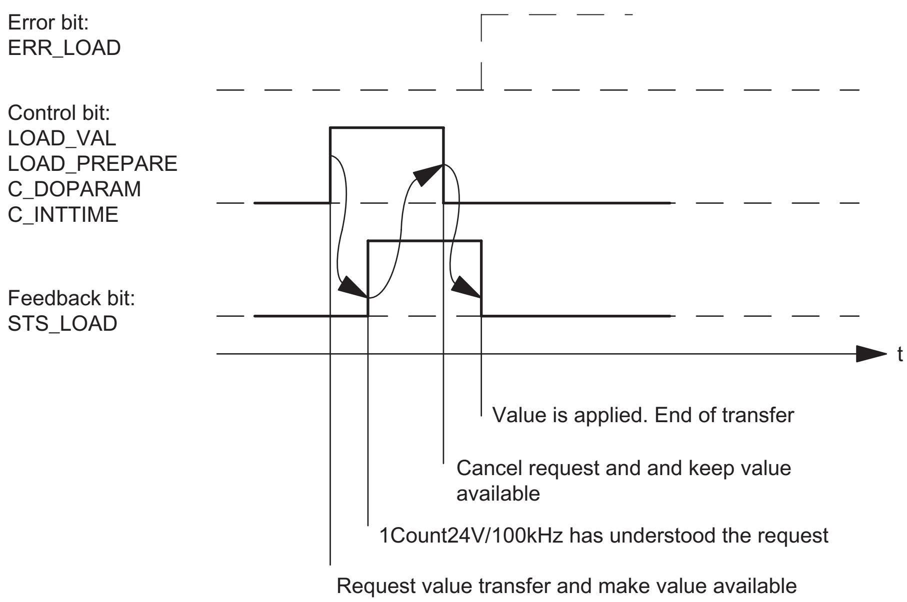


Figure 2-31 Acceptance of Values with the Load Function

Note

Only one of the following control bits can be set at a particular time:

LOAD_VAL or LOAD_PREPARE or C_DOPARAM or C_INTTIME.

Otherwise, the ERR_LOAD error is reported until all the specified control bits are deleted again.

The ERR_LOAD error bit is only deleted when a correct value is transferred as follows.

Acknowledgment Principle in Isochrone Mode

In isochrone mode, exactly 4 bus cycles are always required to reset the status bits and to accept values during the load function.

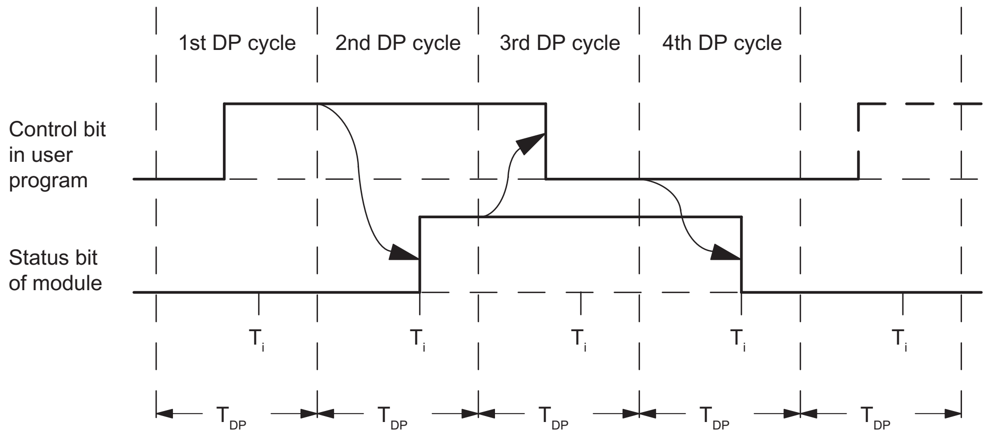


Figure 2-32 Acknowledgment Principle in Isochrone Mode

Error Detection

The diagnostic errors must be acknowledged. They have been detected by the 1Count24V/100kHz and are indicated in the feedback interface. A channel-specific diagnosis is carried out if you have enabled group diagnostics in your parameter assignment (see the *ET 200S Distributed I/O System* Manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

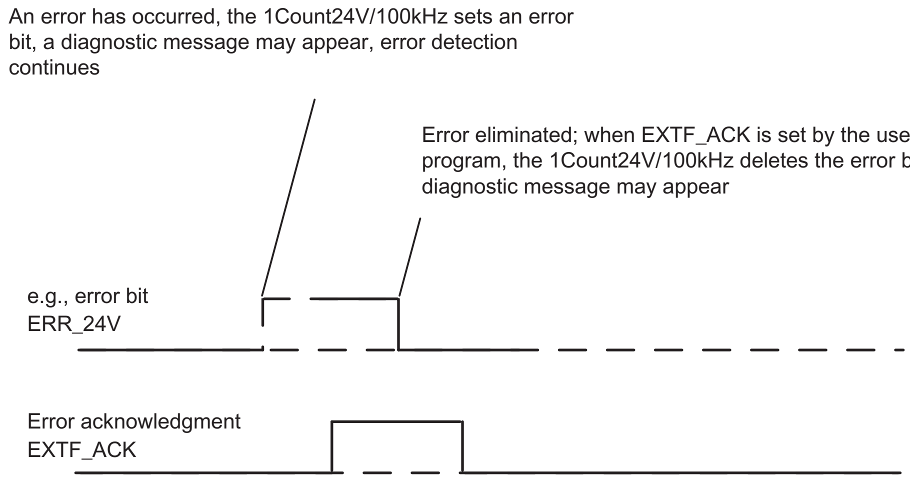


Figure 2-33 Error Acknowledgment

In the case of continuous error acknowledgment (EXTF_ACK=1) or at CPU/Master Stop, the 1Count24V/100kHz signals the errors as soon as they are detected and deletes them as soon as they have been eliminated.

2.7.12 Parameter Assignment for Measurement Modes

Introduction

You can use either of the following to assign parameters for the 1Count24V/100kHz:

- A GSD file (http://www.ad.siemens.de/csi/gsd)
- STEP 7 V5.3 SP2 or later

Parameter List for Measuring Modes

Table 2-22 Parameter List for Measuring Modes

Parameter	Value Range	Default
Enable		
Group diagnostics	Disable/enable	Disable
Behavior in the event of the parent controller failing		
Behavior at CPU/Master-STOP	Turn off DO1/ Continue working mode/ DO1 substitute a value/ DO1 keep last value	Turn off DO1
Encoder parameters		
Signal evaluation A, B	Pulse and direction/ Rotary encoder (single)	Pulse and Direction
Encoder and input filter - At count input (track A) - At direction input (track B) - At digital input DI	 2.5 µs/25 µs 2.5 µs/25 µs 2.5 µs/25 µs	 2.5 µs 2.5 µs 2.5 µs
Sensor A, B, DI	24V P switch, normal mode/ 24V M switch	24V P switch, normal mode
Direction input B	Normal/Inverted	Normal
Output parameters		
Diagnostics DO1[1]	Off/on	Off
Function DO1	Output/ Outside the limits/ Under the low limit/ Over the high limit	Output
Substitute value DO1	0/1	0

Parameter	Value Range	Default
Mode		
Measuring mode	Frequency measurement/ Rotational speed measurement/ Period measurement	Frequency measurement
Measuring method	With integration time/continuous	With integration time
Resolution of period	1 µs 1/16 µs	1 µs
Function DI	Input/HW gate	Input
Input signal HW gate	Normal/Inverted	Normal
Low limit	Frequency measurement: 0...f_{max}-1 Rotational speed measurement: 0...n_{max}-1 Period measurement: 0...T_{max}-1	 0 0 0
High limit	Frequency measurement: low limit+1...f_{max} Rotational speed measurement: low limit+1...n_{max} Period measurement: low limit+1...T_{max}	 f_{max} n_{max} t_{max}
Integration time [n*10ms] (update time)	Frequency measurement: 1 to 1000 Rotational speed measurement: 1 to 1000 Period measurement: 1 to 12000	 10 10 10
Encoder pulses per revolution[2]	1...65535	1
[1] DO1 diagnostics (wire break, short circuit) is possible only with pulse lengths of > 90 ms on digital output DO1.		
[2] Only relevant in rotational speed measurement mode		

Parameter Assignment Error

The following parameter assignment errors may occur:

- Incorrect mode
- Low limit incorrect
- High limit incorrect
- Integration time incorrect
- Encoder pulses incorrect

What to Do in the Event of Errors

Check the set value ranges.

2.8 Fast mode

2.8.1 Overview

Introduction

This mode is suitable for position detection is especially short isochronous cycles.

This mode represents a subset of the functionality of the continuous counting mode.

It is intended for isochronous mode and differs from continuous counting by having a lower TDP Module$_{min}$ and a TWA equal to zero. The module is operated in this mode as a pure input module, i.e., there is no control interface in this operating mode.

This mode is available starting with FW Version V2.0 of the module. The module must be configured as "1Count24V Fast Mode V2.0" in HW Config.

Maximum Count Range

A total of 25 bits are available for the count value.

Load Value

You can specify a load value for the 1Count24V.

This load value is applied directly as the start value.

Gate Control

To control the 1Count24V, you can use the HW gate.

State according to Parameter Assignment

Count value corresponds to the load value set in HW Config.

Isochronous Mode

In each cycle, the 1Count24V transfers the count and the status bits that were valid at time T_i.

See also

Assigning parameters for fast mode (Page 100)

2.8.2 Fast mode

Definition

In this mode, the 1Count24V counts continuously starting from the start value:

When counting up, if the 1Count24V reaches the maximum value that can be represented with 25 bits (all bits of the counter are set) and another count pulse arrives, the count value jumps to "0" and resumes counting from there without losing a pulse.

When counting down, if the 1Count24V reaches the value "0" and another count pulse arrives, the count value jumps to the maximum value that can be represented with 25 bits (all bits of the counter are set) and resumes counting without losing a pulse.

Function of the Digital Input

For the "Function DI" parameter, select between the following functions:

Digital input off.

- Input
- HW gate
- Synchronization on positive edge

See also

Assigning parameters for fast mode (Page 100)

Synchronization (Page 97)

Gate function in the case of fast mode (Page 96)

2.8.3 Gate function in the case of fast mode

Hardware Gate

The 1Count24V has a HW gate, which can be controlled via the digital input on the 1Count24V.

You assign the hardware gate as the function of the digital input (Function DI "HW Gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

If no HW gate is assigned, counting becomes active immediately.

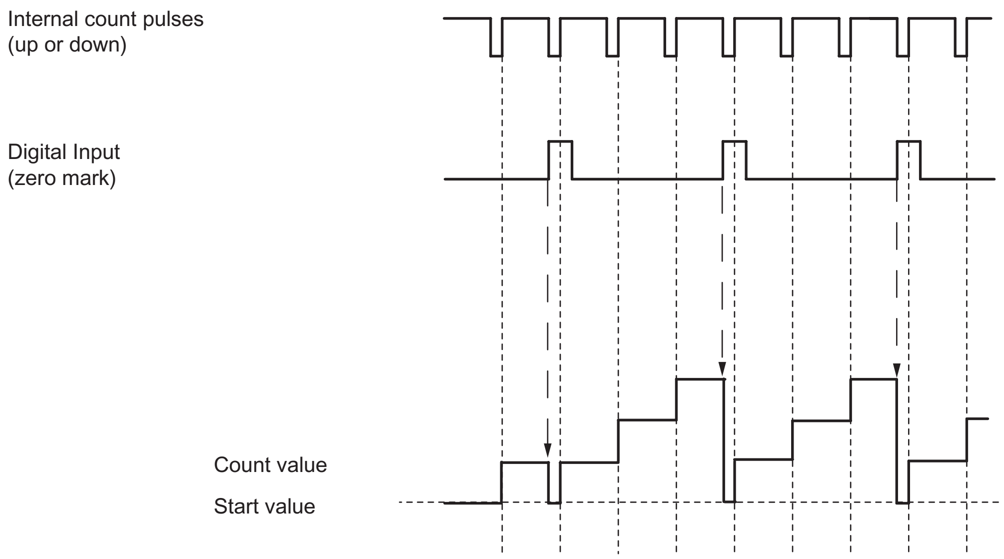
The STS_GATE checkback signal indicates whether counting is active.

When the HW gate is opened, this causes counting to continue starting from the current count.

2.8.4 Synchronization

Introduction

In order to use this function, you must first select it with the "Synchronize on Positive Edge" Function DI parameter.



If you have assigned synchronization, the positive edge of a reference signal on the input sets the 1Count24V to the start value.

The following conditions apply:

- Fast mode must be active (HW gate).
  - When synchronization is activated, the first edge and each additional edge loads the 1Count24V with the start value.
- The signal of a bounce-free switch or the zero mark of a rotary encoder can serve as the reference signal.
- The STS_DI feedback bit indicates the level of the reference signal.

2.8.5 Assignment of feedback interface for fast mode

Note

For the 1Count24V, the following data of the feedback interface are consistent:

- Bytes 0 to 3

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Assignment Tables

Address	Assignment		Name
Bytes 0 to 3	Bit 31	Sign of life	LZ
	Bit 30	Isochronous mode applied	STS_TIC
	Bit 29	Parameter assignment error	ERR_PARA
	Bit 28	Group error • Encoder supply short circuit	EXTF
	Bit 27	DI status	STS_DI
	Bit 26	Status of direction up/down	STS_DIR
	Bit 25	Status of (internal) gate	STS_GATE
	Bits 0 to 24	Count value	

Notes on the Feedback Bits

Feedback bit	Notes
LZ	The sign of life is toggled on each update of the feedback interface, i.e. the last sent value is inverted.
STS_TIC	Isochronous mode (if assigned) was applied.
ERR_PARA	The assigned module parameters are faulty.
EXTF	Group error Possible cause: • Encoder supply short circuit EXTF is reset when the causes of the errors are eliminated.
STS_DI	The bit displays the status of the digital input DI.
STS_DIR	Status of direction; for encoder value change from larger to smaller encoder positions (including zero crossover) → "1 " for encoder value change from larger to smaller encoder positions (including zero crossover) → "0 "
STS_GATE	Status of (internal) gate: Counting

Access to the Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using HW Config
Feedback interface	Load command, e.g. L PID

Error Detection in Fast Mode

The encoder supply short circuit error is detected by the 1Count24V and indicated in the feedback interface (EXTF).

The fault indication in the feedback interface is extinguished as soon as this error is no longer detected by the 1Count24V.

The parameter error bit is acknowledged by means of a correct parameter assignment.

2.8.6 Assigning parameters for fast mode

Introduction

You use the following to assign parameters for the 1Count24V:

- STEP 7 Version 5.4 or higher; if necessary, the HSP (hardware support package) must be downloaded from the Internet

Parameter List for Fast Mode

Parameter	Value Range	Default
Behavior in the event of higher-level controller failure		
Behavior at CPU/Master STOP	Stop operating mode Continue operating mode	Stop operating mode
Basic parameters		
Signal evaluation A, B	Pulse and direction/ Rotary encoder single/double/quadruple	Pulse and direction
Encoder and input filter • At counter input (track A) • At direction input (track B) • At digital input DI	 2.5 μs/25 μs 2.5 μs/25 μs 2.5 μs/25 μs	 2.5 μs 2.5 μs 2.5 μs
Sensor A, B, DI	24V P switch, push-pull/ 24V M switch	24V P switch, push-pull
Direction input B	Normal/inverted	Normal
Mode		
Fast mode	Fast mode	Fast mode
Gate function	Cancel counting/ Interrupt counting	Cancel counting
Input signal HW gate	Normal/inverted	Normal
Function DI	Input / HW gate/ Synchronization on positive edge	Input
Load value	-16777216 ... +16777215	0

Parameter Assignment Error

- The "Input signal HW gate" parameter is set to inverted and the "Function DI" parameter is not set to HW gate.

What to Do in the Event of Errors

Check the set value ranges.

2.9 Position Detection

2.9.1 Overview

Description

This mode encompasses a subset of the functionality of the continuous counting mode. It is intended for isochrone mode and differs from continuous counting by a smaller T_{DP} Module$_{min}$ and a T_{WA} equal to zero. This T_{WA} equal to zero makes it possible to operate the module as an input module only. In this case, however, the possible controls are no longer synchronized with T_o but rather are executed in the T_{DP} cycle before or after T_i.

To execute this mode, you must assign parameters to the 1Count24V/100kHz.

Maximum Count Range

The high counting limit is +2147483647 (2^{31} – 1).

The low counting limit is –2147483648 ($–2^{31}$).

Load value

You can specify a load value for the 1Count24V/100kHz.

This load value is either applied directly as the new count value (LOAD_VAL) or it is applied as the new count value when the following events occur (LOAD_PREPARE):

- The counting operation is started by a SW gate or HW gate (if the counting operation is continued, the load value is not applied).
- Synchronization
- Latch and retrigger

Gate Control

To control the 1Count24V/100kHz, you have to use the gate functions.

RESET States of the Following Values after Parameter Assignment

Table 2-23 RESET States

Value	RESET state
Load value	0
Count value	0
Latch value	0

Isochrone mode

In isochrone mode the 1Count24V/100kHz accepts control bits and control values from the control interface in each bus cycle and reports back the response in this mode in the same cycle or in the next cycle.

In each cycle the 1Count24V/100kHz transfers the count and latch value that were valid at time T_i and the status bits valid at time T_i.

A count controlled by hardware input signals can only be transferred in the same cycle if the input signal occurred before time T_i.

2.9.2 Position Detection

Definition

In this mode, the 1Count24V/100kHz counts continuously starting from the load value:

- If the 1Count24V/100kHz reaches the high counting limit when counting up, and another count pulse then comes, it will jump to the low counting limit and continue counting from there without losing a pulse.
- If the 1Count24V/100kHz reaches the low counting limit when counting down, and another count pulse then comes, it will jump to the high counting limit and continue counting from there without losing a pulse.
- The high counting limit is set at +2147483647 ($2^{31} – 1$).
- The low counting limit is set to –2147483648 ($–2^{31}$).

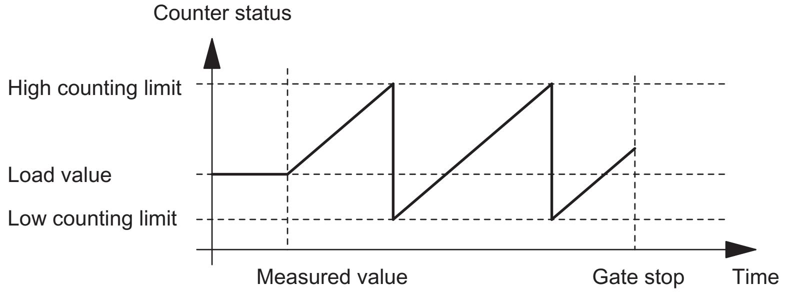


Figure 2-34 Count Continuously with Gate Function

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate
- Latch function
- Synchronization

See also

Assigning Parameters for Position Feedback (Page 118)

Gate Functions for Position Detection (Page 104)

Latch Function (Page 107)

Synchronization (Page 110)

2.9.3 Gate Functions for Position Detection

Software Gate and Hardware Gate

The 1Count24V/100kHz has two gates

- A software gate (SW gate), which is controlled by the SW_GATE control bit.

  The software gate can only be opened by a positive edge of the SW_GATE control bit. It is closed when this bit is reset. Note the transfer times and run times of your control program.

- A hardware gate (HW gate), which is controlled by the digital input on the 1Count24V/100kHz.

  You assign the hardware gate as the function of the digital input (Function DI "HW Gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

Internal Gate

The internal gate is the logical AND operation of the HW gate and SW gate. Counting is only active when the HW gate and the SW gate are open. The STS_GATE feedback bit (internal gate status) indicates this. If a HW gate has not been assigned, the setting of the SW gate is decisive. Counting is activated, interrupted, continued, and canceled by means of the internal gate.

Canceling- and Interrupting-Type Gate Function

When assigning the gate function, you can specify whether the internal gate is to cancel or interrupt counting. When counting is canceled, after the gate is closed and restarted, counting starts again from the beginning. When counting is interrupted, after the gate is closed and restarted, counting continues from the previous value.

The diagrams below indicate how the interrupting and canceling gate functions work:

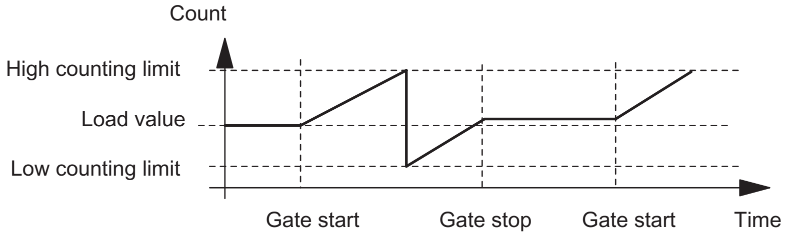


Figure 2-35 Position Detection, Up, Interrupting Gate Function

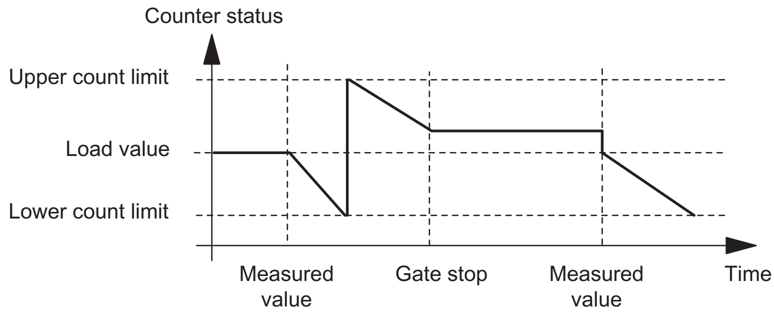


Figure 2-36 Position Detection, Down, Interrupting Gate Function

Gate Control

Gate control by means of the SW gate only

When the gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count

  or

- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts before or after T_i, depending on the position of T_i.

Gate control by means of the SW gate and HW gate

If the SW gate opens when the HW gate is already open, counting continues starting from the current count.

When the HW gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count

  or

- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts in cycle "n+1" before or after T_i, if the HW gate is already open at this time. If the HW gate opens after the SW gate has been opened, then counting does not start until the HW gate opens.

2.9.4 Latch Function

Overview

There are two latch functions:

- The Latch and Retrigger function
- The Latch function

The Latch and Retrigger Function

In order to use this function, you must first select it with the "Latch and Retrigger on Positive Edge" Function DI parameter.

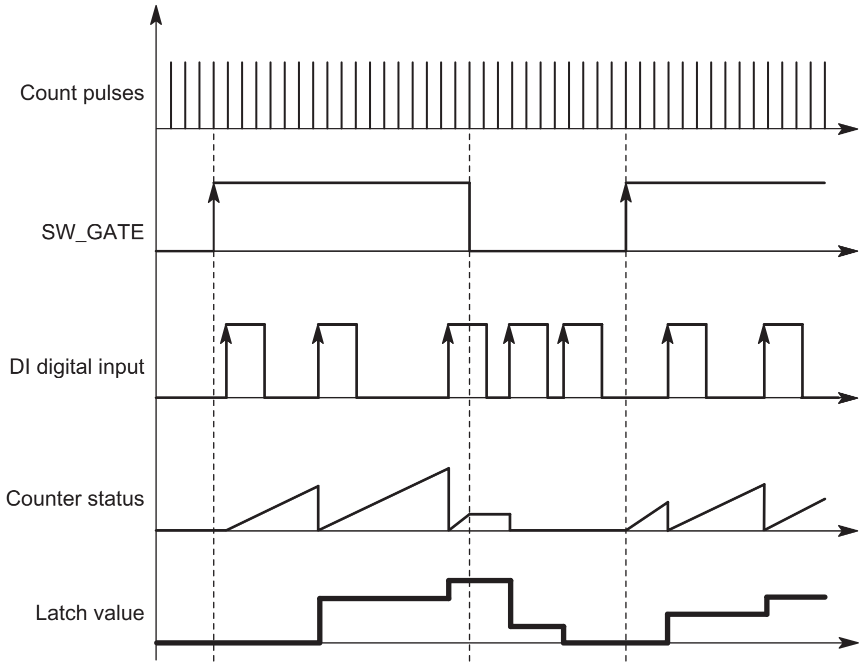


Figure 2-37 Latch and Retrigger with Load Value = 0

This function stores the current internal count of the 1Count24V/100kHz and retriggers counting when there is a positive edge on the digital input. This means that the current internal count at the time of the positive edge is stored (latch value), and the 1Count24V/100kHz is then loaded again with the load value, from which counting resumes.

The counting mode must be enabled with the SW gate before the function can be executed. It is started with the first positive edge on the digital input.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the status of the latch and retrigger signal.

The latch value is preassigned with its RESET state (see corresponding table). It is not changed when the SW gate is opened.

Direct loading of the counter does not cause the indicated stored count to be changed.

If you close the SW gate, it only interrupts counting; this means that when you open the SW gate again, counting is continued. The digital input DI remains active even when the SW gate is closed.

Counting is also latched and triggered in isochrone mode with each edge on the digital input. The count that was valid at the time of the last edge before T_i is displayed in the feedback interface.

The Latch Function

In order to use this function, the Function DI parameter "Latch on Positive Edge" must be selected for the digital input.

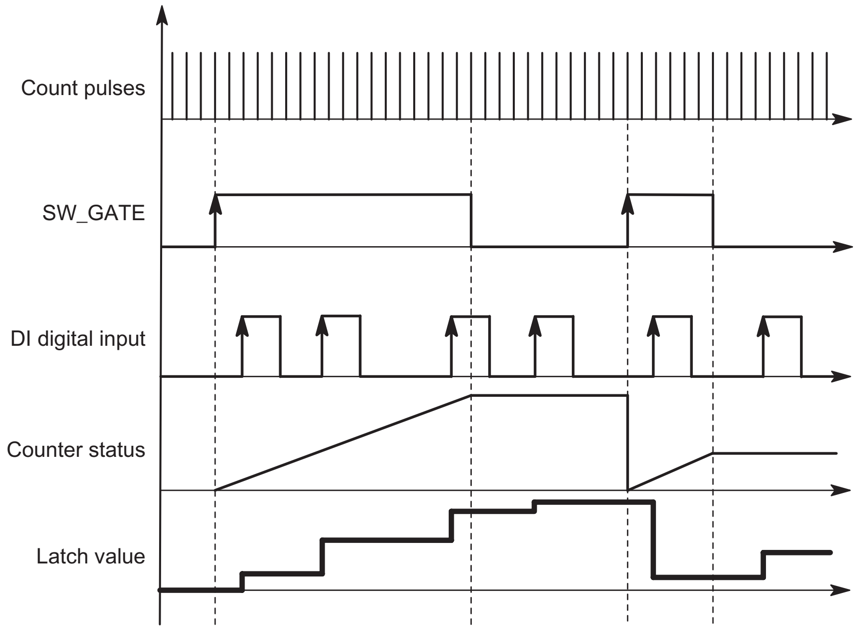


Figure 2-38 Latch with a Load Value of 0

Count and latch value are preset with their RESET states (see corresponding table).

The counting function is started when the SW gate is opened. The 1Count24V/100kHz begins at the load value.

The latch value is always the exact count at the time of the positive edge on the digital input DI.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the level of the latch signal.

Direct loading of the counter does not cause the indicated stored count to be changed.

In isochrone mode, the count that was latched at the time of the last positive edge before T_i is displayed in the feedback interface.

When you close the SW gate, the effect is either canceling or interrupting, depending on the parameter assignment. The digital input DI remains active even when the SW gate is closed.

Further possible causes of parameter assignment errors with the latch function:

- Incorrect parameter assignment of the digital output function (Function DI)

Modified User Data Interface

If the 1Count24V/100kHz is inserted behind an IM 151 that supports the reading and writing of broader user data interfaces, the current count value can be read from bytes 8-11 of the feedback interface.

2.9.5 Synchronization

Synchronization

In order to use this function, you must first select it with the "Synchronize on Positive Edge" Function DI parameter.

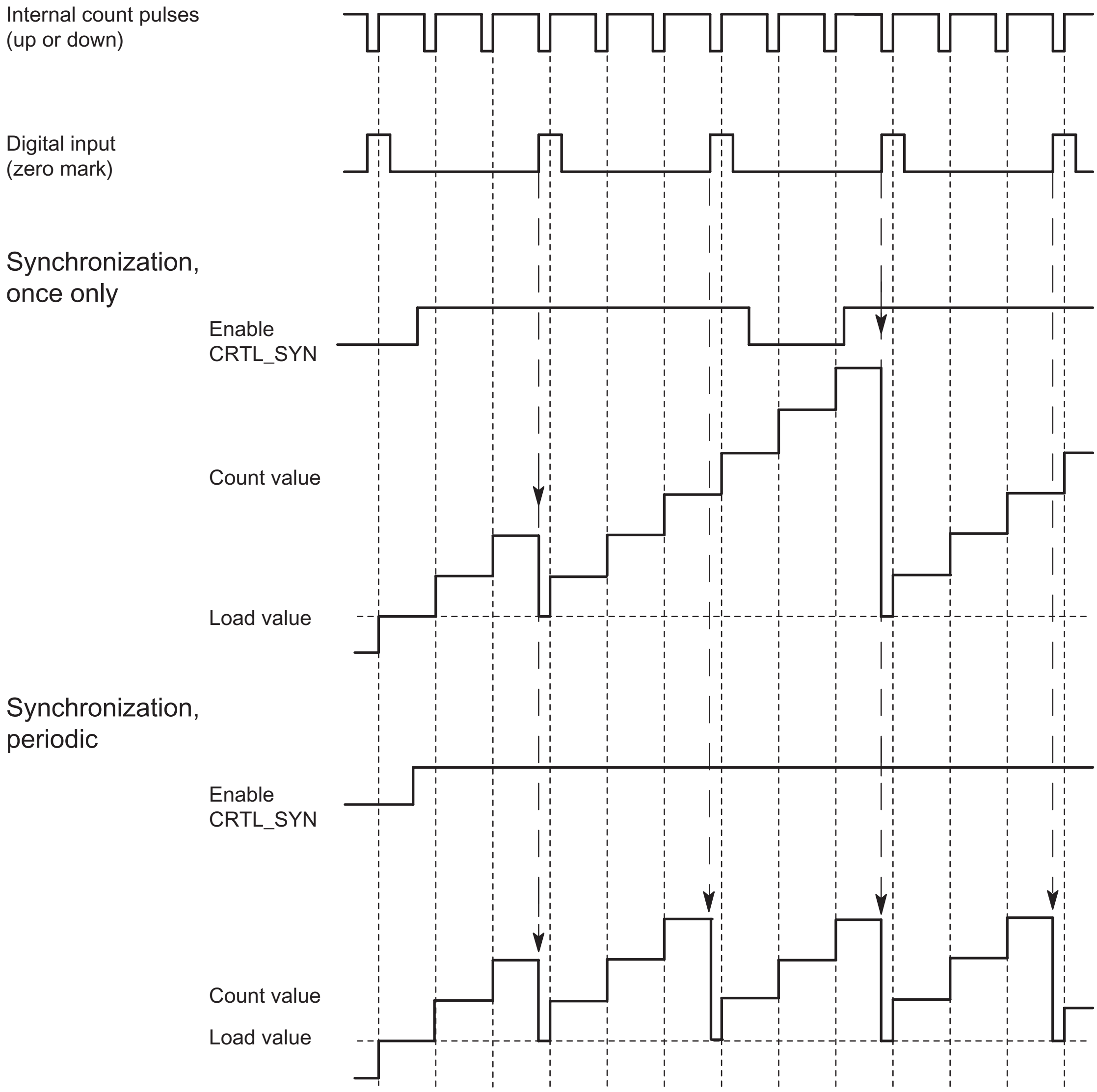


Figure 2-39 Once-Only and Periodic Synchronization

If you have assigned synchronization, the positive edge of a reference signal on the input sets the 1Count24V/100kHz to the load value.

You can select between once-only and periodic synchronization ("Synchronization" parameter).

The following conditions apply:

- The counting mode must have been started with the SW gate.
- The "Enable synchronization CTRL_SYN" control bit must be set.
- In once-only synchronization, the first edge loads the 1Count24V/100kHz with the load value after the enable bit is set.
- In periodic synchronization, the first edge and each subsequent edge load the 1Count24V/100kHz with the load value after the enable bit is set.
- After successful synchronization, the STS_SYN feedback bit is set. It must be reset by the RES_STS control bit.
- The signal of a bounce-free switch or the zero mark of a rotary encoder can serve as the reference signal.
- The STS_DI feedback bit indicates the level of the reference signal.

In isochrone mode, the set feedback bit STS_SYN indicates that the positive edge on the digital input was between time T_i in the current cycle and T_i in the previous cycle.

2.9.6 Assignment of the Feedback and Control Interface for Position Feedback

Note

The following data of the control and feedback interfaces are consistent for the 1Count24V/100kHz:

Bytes 0 to 3

Bytes 4 to 7

Bytes 8 to 11 (modified user data interface)

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Assignment Tables

Table 2-24 Feedback Interface (Inputs)

Address	Assignment		Designation
Bytes 0 to 3	Count value or stored count value in the case of the latch function on the digital input		
Byte 4	Bit 7:	Short circuit of the encoder supply	ERR_24V
	Bit 6:	Reserve = 0	
	Bit 5:	Parameter assignment error	ERR_PARA
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Resetting of status bits active	RES_STS_A
	Bit 1:	Load function error	ERR_LOAD
	Bit 0:	Load function is running	STS_LOAD
Byte 5	Bit 7:	Down direction status	STS_C_DN
	Bit 6:	Up direction status	STS_C_UP
	Bit 5:	Reserve = 0	
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Reserve = 0	
	Bit 1:	DI status	STS_DI
	Bit 0:	Internal gate status	STS_GATE
Byte 6	Bit 7:	Zero crossing	STS_ND
	Bit 6:	Low counting limit	STS_UFLW
	Bit 5:	High counting limit	STS_OFLW
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Reserve = 0	
	Bit 1:	Reserve = 0	
	Bit 0:	Synchronization status	STS_SYN

Address	Assignment	Designation
Byte 7	Reserve = 0	
Bytes 8 to 11	Count value [1]	
[1] Modified user data interface		

Table 2-25 Control Interface (Outputs)

Address		Assignment			
Bytes 0 to 3		Load value direct, preparatory, comparison value 1 or 2			
	Byte 0	Behavior of DO1, DO2 of the 1Count24V/100kHz			
		Bit 2	Bit 1	Bit 0	Function DO1
		0	0	0	Output
		0	0	1	Switch on at count ≥ comparison value
		0	1	0	Switch on at count ≤ comparison value
		0	1	1	Pulse on reaching the comparison value
		1	0	0	Switch at comparison values
		1	0	1	blocked
		1	1	0	blocked
		1	1	1	blocked
			Bit 5	Bit 4	Function DO2
			0	0	Output
			0	1	Switch on at count ≥ comparison value
			1	0	Switch on at count ≤ comparison value
			1	1	Pulse on reaching the comparison value
		Bits 3, 6, and 7: Reserve = 0			
	Bytes 1 to 3	Byte 1:	Hysteresis DO1, DO2 (range 0 to 255)		
		Byte 2:	Pulse duration [2ms] DO1, DO2 (range 0 to 255)		
		Byte 3:	Reserve = 0		
Byte 4	EXTF_ACK	Bit 7:	Error diagnostics acknowledgment		
		Bit 6:	Reserve = 0		
		Bit 5:	Reserve = 0		
		Bit 4:	Reserve = 0		
		Bit 3:	Reserve = 0		
	RES_STS	Bit 2:	Start resetting of status bit		
	CTRL_SYN	Bit 1:	Enable synchronization		
	SW_GATE	Bit 0:	SW gate control bit		
Byte 5		Bit 7:	Reserve = 0		
		Bit 6:	Reserve = 0		
		Bit 5:	Reserve = 0		
		Bit 4:	Reserve = 0		
		Bit 3:	Reserve = 0		
		Bit 2:	Reserve = 0		
	LOAD_PREPARE	Bit 1:	Load counter preparatory		
	LOAD_VAL	Bit 0:	Load counter direct		

Address		Assignment
Bytes 6 to 7		Reserve = 0 [1]
[1] Not used for modified user interface		

Notes on the Control Bits

Table 2-26 Notes on the Control Bits

Control bits	Notes
CTRL_SYN	You use this bit to enable synchronization.
EXTF_ACK	Error acknowledgment The error bits must be acknowledged with the EXTF_ACK control bit after the cause is removed. (see figure below)
LOAD_PREPARE	Load counter preparatory (see figure below) The value from bytes 0 to 3 is applied as the load value.
LOAD_VAL	The value from bytes 0 to 3 is loaded directly as the new count value.
RES_STS	Start resetting of status bit The status bits are reset through the acknowledgment process between the RES_STS bit and the RES_STS_A bit. (see figure below)
SW GATE	The SW gate is opened/closed via the control interface with the SW_GATE bit.

Notes on the Feedback Bits

Table 2-27 Notes on the Feedback Bits

Feedback bits	Notes
ERR_24V	Short circuit of the encoder supply The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_LOAD	Load function error (see figure below) The LOAD_VAL, LOAD_PREPARE, CMP_VAL1, CMP_VAL2, and C_DOPARAM bits cannot be set simultaneously during transfer. This results in setting the ERR_LOAD status bit, similar to loading an incorrect value (which is not accepted).
ERR_PARA	Parameter assignment error ERR_PARA
RES_STS_A	Resetting of the status bits active (see figure below)
STS_C_DN	Down direction status
STS_C_UP	Up direction status
STS_DI	DI status The status of the DI is indicated in all modes with the STS_DI bit in the feedback interface.
STS_GATE	Internal gate status: Counting
STS_LOAD	Load function running (see figure below)
STS_ND	Zero-crossing in the count range when counting without a main counting direction. The bit must be reset by the RES_STS control bit.

Feedback bits	Notes
STS_OFLW STS_UFLW	High counting limit violated Low counting limit violated Both bits must be reset.
STS_SYN	Synchronization status: After successful synchronization, the STS_SYN bit is set. It must be reset by the RES_STS control bit.

Access to the Control and Feedback Interface in STEP 7 Programming

Table 2-28 Access to the Control and Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD file [1)] (Hardware catalog\PROFIBUS-DP\Additional FIELD DEVICES\I/O\ET 200S)	Configuring with STEP 7 using HW Config (Hardware catalog\PROFIBUS-DP\ ET 200S)
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command (e.g. L PID)
Control interface	Write with SFC 15 "DPWR_DAT"	Transfer command (e.g. T PQD)
[1] Load and transfer commands are also possible with CPU 3xxC, CPU 3xx with MMC, CPU 4xx (V3.0 and later), and WinLC RTX (PC CPU).		

Resetting of the Status Bits STS_SYN, STS_OFLW, STS_UFLW, STS_ND

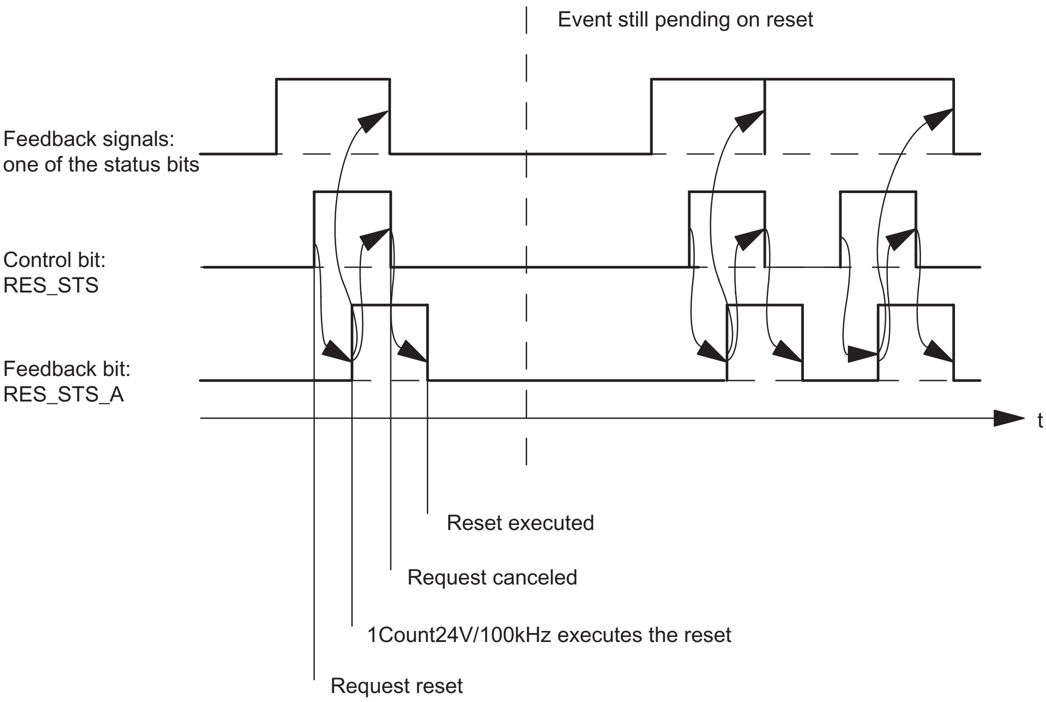


Figure 2-40 Resetting of the Status Bits

Acceptance of Values with the Load Function

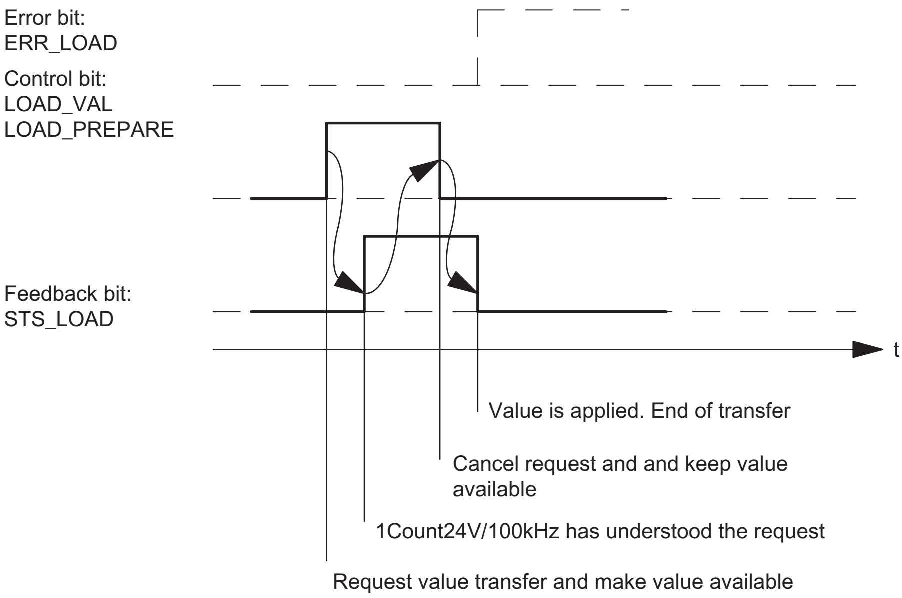


Figure 2-41 Acceptance of Values with the Load Function

Note

Only one of the following control bits can be set at a particular time:

LOAD_VAL or LOAD_PREPARE.

Otherwise, the ERR_LOAD error is reported until all the specified control bits are deleted again.

The ERR_LOAD error bit is only deleted when a correct value is transferred as follows.

Acknowledgment Principle in Isochrone Mode

In isochrone mode, exactly 4 or 6 bus cycles are always required to reset the status bits and to accept values during the load function.

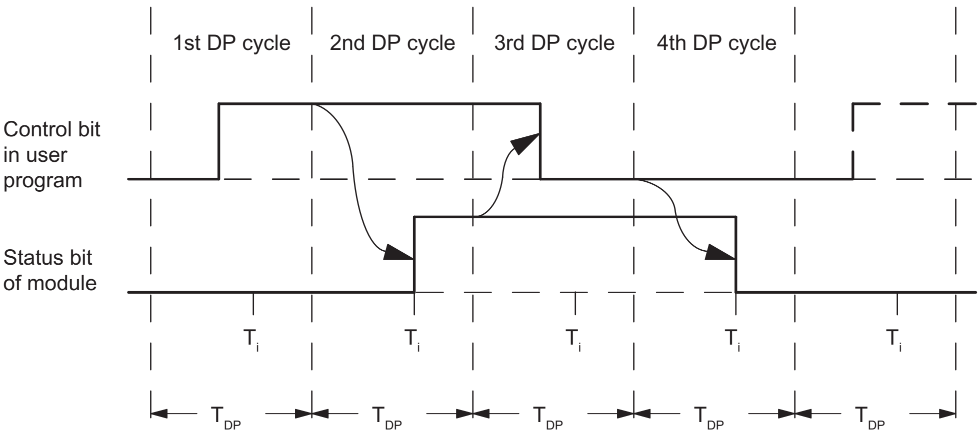


Figure 2-42 Acknowledgment Principle in Isochrone Mode

Error Detection

The program errors must be acknowledged. They have been detected by the 1Count24V/100kHz and are indicated in the feedback interface. A channel-specific diagnosis is carried out if you have enabled group diagnostics in your parameter assignment (see the *ET 200S Distributed I/O System* Manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

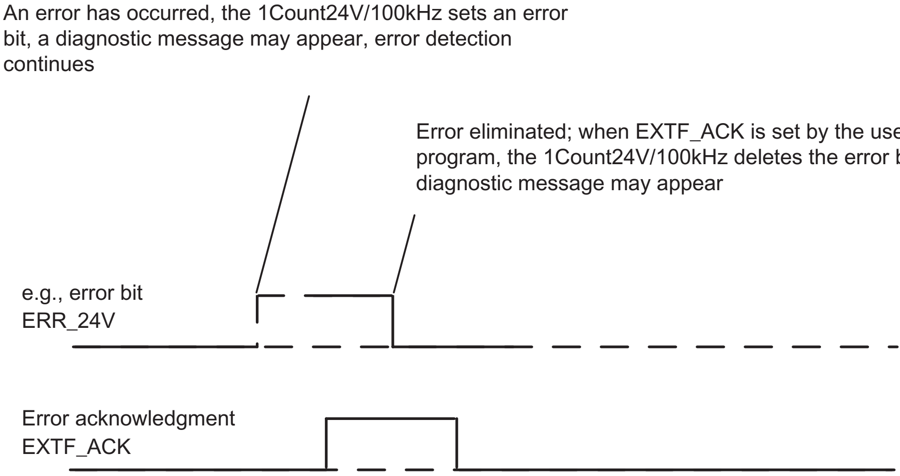


Figure 2-43 Error Acknowledgment

In the case of continuous error acknowledgment (EXTF_ACK=1) or at CPU/Master Stop, the 1Count24V/100kHz signals the errors as soon as they are detected and deletes them as soon as they have been eliminated.

2.9.7 Assigning Parameters for Position Feedback

Introduction

You can use either of the following to assign parameters for the 1Count24V/100kHz:

- A GSD file (http://www.ad.siemens.de/csi/gsd)
- STEP 7 V5.3 SP2 or later

Parameter List for Position Feedback

Table 2-29 Parameter List for Position Feedback

Parameter	Value Range	Default
Enable		
Group diagnostics	Disable/enable	Disable
Behavior in the event of the parent controller failing		
Behavior at CPU/Master-STOP	Turn off Continue working mode	Turn off
Encoder parameters		
Signal evaluation A, B	Pulse and direction/ Rotary encoder single/double/quadruple	Pulse and direction
Encoder and input filter • At count input (track A) • At direction input (track B) • At digital input DI	 2.5 µs/25 µs 2.5 µs/25 µs 2.5 µs/25 µs	 2.5 µs 2.5 µs 2.5 µs
Sensor A, B, DI	24V P switch, normal mode/ 24V M switch	24V P switch, normal mode
Direction input B	Normal/Inverted	Normal
Mode		
Position feedback	Position detection	Position detection
Gate function	Cancel counting/ Interrupt counting	Cancel counting
Input signal HW gate	Normal/Inverted	Normal
Function DI	Input/ HW gate/ Latch and retrigger on positive edge/ Synchronization on positive edge	Input
Synchronization[1]	Once-only/Periodic	Once-only
[1] Only relevant if Function DI = Synchronization on positive edge		

Parameter Assignment Error

- The "Input signal HW gate" parameter is set to inverted and the "Function DI" parameter is not set to HW gate.

What to Do in the Event of Errors

Check the set value ranges.

2.10 Evaluation of count and direction signal

Signal Evaluation A, B

Signal evaluation by means of A, B allows you to count directionally. Different evaluation modes are possible depending on the parameter assignment:

- Pulse and direction
- Rotary encoder

In the case of 24-V pulse generators with a direction indicator, there must be a time span of at least 5 μs/50 μs between the direction signal (B*) and the count signal (A*), depending on the input filter that has been assigned parameters.

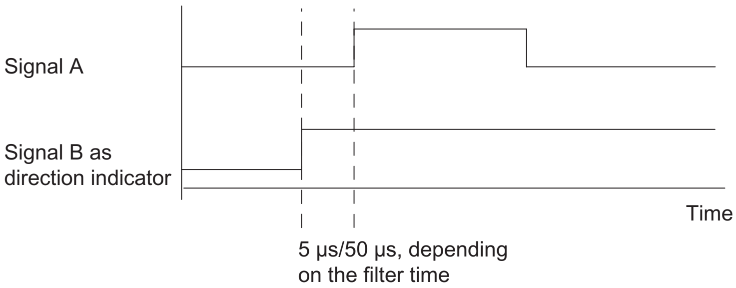


Figure 2-44 Time Span between the Direction Signal and the Count Signal

If you connect a 24-V rotary encoder with two tracks that are 90 degrees out of phase at the count and direction inputs, you can assign parameters to a single evaluation in all the measurement and count modes.

You can also assign parameters to dual or quad evaluation in all count modes.

In all evaluation modes, you can invert direction detection at input B by parameter assignment.

The count and direction inputs can be operated with different sensors (P switch and series mode or M switch).

Note

If you have selected the 24V M switch setting with the 1Count24V/100kHz for the "Sensor A, B, DI" parameter, you must use the M-switching sensors.

Pulse and Direction

The level at direction input B is used as the direction setting.

An unwired input corresponds to the "Up" count direction if you have selected "Pulse/direction" for the "Signal evaluation" parameter.

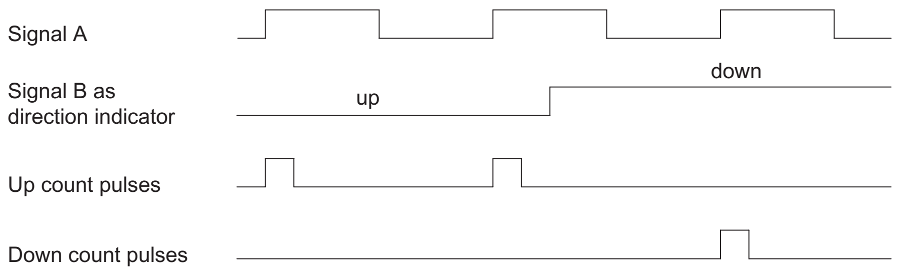


Figure 2-45 Signals of a 24-V Pulse Generator with Direction Indicator

Rotary Encoder

The 1Count24V/100kHz can count the edges of the signals. Normally, only the edge at A is evaluated (single evaluation). To obtain a higher resolution, when assigning parameters ("Signal Evaluation" parameter), you can select whether the signals are to be subjected to single, double, or quadruple evaluation.

Multiple evaluation is only possible with asymmetric incremental encoders with A and B signals that are 90 degrees out of phase.

Single Evaluation

Single evaluation means that only one edge of A is evaluated; up count pulses are recorded at a positive edge at A and low level at B, and down count pulses are recorded at a negative edge at A and low level at B.

The diagram below illustrates the single evaluation of the signals.

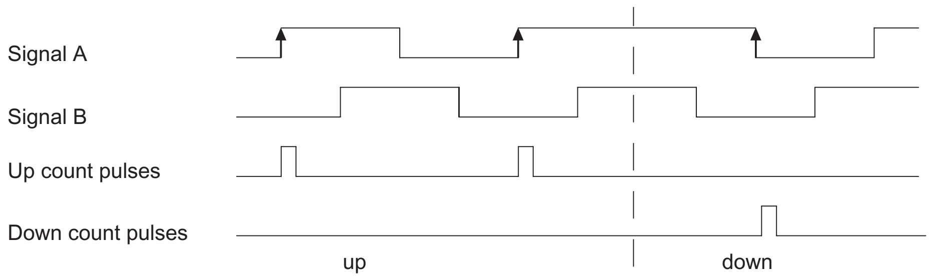


Figure 2-46 Single Evaluation

Double Evaluation

Double evaluation means that the positive and negative edge of the A signal are evaluated. Whether up or down count pulses are generated depends on the level of the B signal.

The diagram below illustrates the double evaluation of the signals.

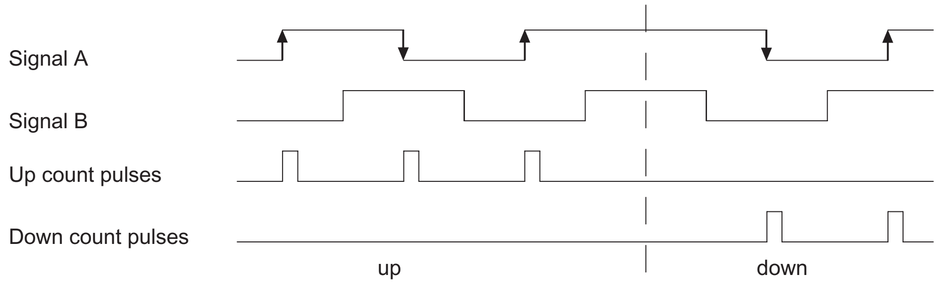


Figure 2-47 Double Evaluation

Quadruple Evaluation

Quadruple evaluation means that the positive and negative edges of the A and B signals are evaluated. Whether up or down count pulses are generated depends on the levels of the A and B signals.

The diagram below illustrates the quadruple evaluation of the signals.

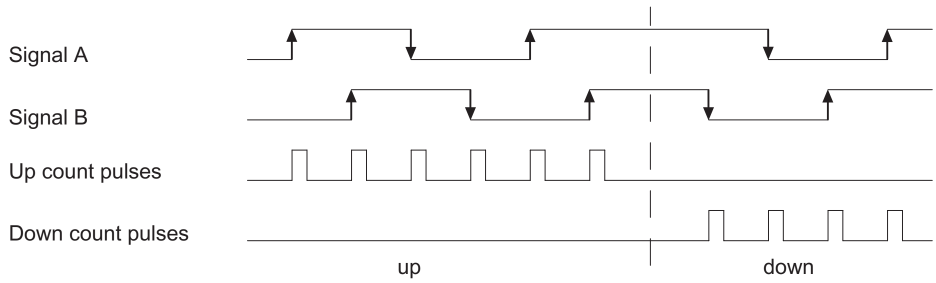


Figure 2-48 Quadruple Evaluation

Note

A counting frequency of 100 kHz refers to the maximum frequency of the A and B signals. With double evaluation, a maximum frequency of 200 kHz is produced for the counting pulses; with quadruple evaluation, the maximum frequency is 400 kHz.

2.11 Behavior at CPU-Master-STOP

Setting the Behavior at CPU/Master-STOP

You can assign the behavior of the 1Count24V/100kHz in the event of the failure of the parent controller.

Parameter	Status of the 1Count24V/100kHz at CPU/Master STOP	What Happens if New Parameters Have Been Assigned?
Turn off DO1	The current mode is canceled, the gate closed, and the digital output blocked; comparison values 1 and 2 and the load value are reset; the high and low limit values, function and behavior of the digital outputs and the integration time are handled in accordance with the parameter assignments.	The changed parameters are accepted and take effect.
Continue working mode[1]	The current mode continues, and the gate and digital output retain their status.	The gate is closed, the current mode is terminated, the digital output is blocked, and the changed parameters are accepted and take effect.
DO 1 substitute a value	The current mode is canceled, the gate closed, and the digital output blocked; comparison values 1 and 2 and the load value are reset; the high and low limit values, function and behavior of the digital outputs and the integration time are handled in accordance with the parameter assignments. When a pulse is output when the comparison value is reached, the substitute value is 1 only for the duration of the pulse.	The changed parameters are accepted and take effect.
DO 1 keep last value	The current mode is canceled, the gate closed, and the digital output blocked; comparison values 1 and 2 and the load value are reset; the high and low limit values, function and behavior of the digital outputs and the integration time are handled in accordance with the parameter assignments.	The changed parameters are accepted and take effect.
[1]If the mode is to continue during a change from CPU-/Master-STOP to RUN (startup), the CPU/Master must not clear the outputs. Possible solution: In the part of the user program that is processed during startup, set the SW gate control bit and transfer the values to the 1Count24V/100kHz.		

Leaving the Assigned State

Under what conditions does the 1Count24V/100kHz leave the assigned state?

The CPU or master must be in RUN mode, and you have to make a change at the control interface.

Automatic New Parameter Assignment

A new parameter assignment of the ET 200S station is made by your CPU/ DP master:

- Upon power on of the CPU/DP master
- Upon power on of the IM 151/IM 151 FO
- After failure of the DP transmission
- After loading a modified parameter assignment or configuration of the ET 200S station to the CPU/DP master
- When the 1Count24V/100kHz is inserted
- Upon power on or inserting of the appropriate power module

2.12 Technical Specifications

Technical Specifications

General technical specifications	
Dimensions and Weight	
Dimensions W x H x D (mm)	15x81x52
Weight	Approx. 40 g
Data for Specific Modules	
Number of Channels Counter range	1 32 bits
Voltages, Currents, Potentials	
Rated load voltage L+ • Range • Reverse polarity protection	24 VDC 20.4 ... 28.8 V Yes
Galvanic isolation • Between backplane bus and counter function • Between counter function and load voltage	 Yes No
Encoder supply • Output voltage • Output current	 L+ (-0.8 V) max. 500 mA, short circuit-proof
Current consumption • From the backplane bus • From load voltage L+ (no load)	 max. 10 mA max. 42 mA
Power dissipation	Typ. 1 W
Data on the counting signals and the digital input	
Galvanic isolation	No, from shield only
Input voltage	
• Rated value	24 VDC
• 0 signal	-30 V to 5 V
• 1 signal	11 V to 30 V
Input current	
• 0 signal	≤2 mA (quiescent current)
• 1 signal	9 mA (typical)
Minimum pulse width (maximum counting frequency) • Filter on • Filter off	 ≥ 25 µs ≥ 2.5 µs
Connection of a two-wire BERO type 2	Possible
Input characteristic	In accordance with IEC 1131, Part 2, Type 2
Shielded cable length • Filter 200 kHz • Filter 20 kHz	 50 m 100 m

General technical specifications	
Data for the Digital Output	
Output voltage • Rated value • 0 signal • 1 signal	 24 VDC ≤ 3V ≥ L+ (-1V)
Output current	
• 0 signal (residual current)	≤ 0.5 mA
• 1 signal	
Permitted range	5 mA to 2.0 A
Rated value	
40°C	2 A
50°C	1 A
60°C	0.5 A
Switching frequency • Resistive load • Inductive load • Lamp load	 100 Hz 2 Hz ≤ 10 Hz
Lamp load Output delay (resistive load) Short-circuit protection for output Response threshold Inductive extinction Digital input control Cable lengths • Unshielded • Shielded	≤ 5 W 100 μs Yes 2.6 A to 4 A Yes; L+ -(50 to 60 V) Yes 600 m 1000 m
Status, Diagnostics	
Digital input DI status display	LED 8 (green)
Digital output DO status display Up count value change Down count value change Fault indicator Diagnostic information	LED 4 (green) UP LED (green) DN LED (green) SF LED (red) Yes
Measuring Ranges in the Measuring Modes	
Maximum measuring range • Frequency measurement • Rotational speed measurement • Period measurement	 0.1 Hz to 100 kHz 1/min to 25000 /min 10 μs to 120 s
Response times	
Update rate of the counting modes	
• Non-isochronous mode	1 ms
• Isochronous mode	T_{DP}

General technical specifications	
Isochronous Times of the Module	
in counting modes	
TCI	380 µs
TCO	320 µs
T_{oi}Min	55 µs
T_{DP}Min	900 µs
in measuring modes	
TCI	465 µs
TCO	280 µs
T_{oi}Min	50 µs
T_{DP}Min	995 µs
in position feedback	
TCI	370 µs
TCO	-
T_{oi}Min	-
T_{DP}Min	815 µs

1Count5V/500kHz

3

3.1 Product Overview

Order Number:

6ES7 138-4DE02-0AB0

Compatibility

The 1Count5V/500kHz with the order number 6ES7 138-4DE02-0AB0 replaces the 1Count5V/500kHz with the order number 6ES7 138-4DE01-0AB0 and is fully compatible. In STEP 7 version V5.3 SP2 and later, you can use it in non-isochronous and isochronous modes.

Features

- A 5 V incremental encoder can be connected in order to count 5 V RS422 signals up to a frequency of 500 kHz.
- The 1Count5V/500kHz is a double-width module and can only be used with a 4-row TM-E30S44-01 terminal module.
- Isochronous mode
- Modified user data interface [1]

  [1] Instead of 8 bytes of input data and 8 bytes of output data, 12 bytes of input data and 6 bytes of output data are used, provided the IM 151 supports this.

  The following IM 151 modules support this function:

  – IM151-1/Standard order no. 6ES7151-1AA04-0AB0 and higher

  – IM151-1/HF order no. 6ES7151-1BA01-0AB0 and higher
- Modes of the 1Count5V/500kHz:

  Counting modes:

  – Count continuously

  – Count once

  – Count periodically

Measuring modes:

– Frequency measurement
– Rotational speed measurement
– Period measurement

Position feedback:

– Position detection
– Fast mode

- Gate control, synchronization or latch function via digital inputs
- 2 digital outputs for direct control or output of the comparison results.
- Firmware update [1]
- Identification data [1]

[1] The following IM 151 modules support this function: IM 151-1 Standard: 6ES7151-1AA04-0AB0 and later and IM 151-1 High Feature: 6ES7151-1BA01-0AB0 and later.

Connectable Counting Signals

The 1Count5V/500kHz can count the signals of the encoders:

- 5 V incremental encoder with two tracks that are 90° out of phase at the count inputs.

Adjustment During Operation

- Counting modes
  – You can change the function and behavior of the digital outputs during operation.
- Measuring modes
  – You can change the function of the DO1 digital output during operation
  – You can change the integration time/update time during operation

Configuration

You can use either of the following to configure 1Count5V/500kHz:

- STEP 7 V5.3 SP2 or higher
- HSP hardware support package (available online) as of STEP 7 V5.2 SP1

Firmware Update

To add functions and for troubleshooting, it is possible to load firmware updates to the operating system memory of the 1Count5V/500kHz using STEP 7 HW Config.

Note

When you launch the firmware update, the old firmware is deleted. If the firmware update is interrupted or canceled for any reason, the 1Count5V/500kHz will no longer function correctly as a result. Re-launch the firmware update and wait until this has completed successfully.

Identification Data [1]

- Hardware release status
- Firmware release status
- Serial number

[1] See also ET 200S Distributed I/O System Manual, section: Identification Data

3.2 Clocked Mode

Note

The principles of isochronous mode are described in a separate manual.

See Isochrone Mode function manual (A5E00223279).

Hardware Requirements

You will require the following for the 1Count5V/500kHz in isochronous mode:

- A CPU that supports isochronous mode
- A master that supports the equidistant bus cycle
- An IM 151 that supports isochronous mode

Features

Depending on the system parameter assignment, the 1Count5V/500kHz works in either non-isochronous or isochronous mode.

In isochronous mode, data exchange between the master and 1Count5V/500kHz is isochronous to the bus cycle (PROFIBUS DP/PROFINET).

In isochronous mode, all 8 bytes/12 bytes of the feedback interface are consistent.

If an error occurs during parameter assignment, the 1Count5V/500kHz does not go into isochronous mode.

If isochronous mode fails due to faults or failure/delay of global control (GC), the 1Count5V/500kHz will return to isochronous mode during the next cycle without an error response.

If isochronous mode fails, the feedback interface is not updated.

The T_i/T_o overlap is supported by the module in firmware version V1.0.1 and later.

See also

Synchronization (Page 156)

3.3 Example: Start 1Count5V/500kHz

Task

These instructions guide you to a functioning application that will enable you to count the pulses of an encoder and become familiar with and check the basic hardware and software functions of your 1Count5V/500kHz. The counting mode used in this example is "Count continuously".

Requirements

The following requirements must be satisfied:

- You have commissioned an ET 200S station on an S7 station with a master.
- You must have the following:
  - A TM-E30S44-01 terminal module
  - A 1Count5V/500kHz
  - A 5 V encoder with a 24 V encoder supply and the material required for wiring

Installation, Wiring and Fitting

1. Install and wire the TM-E30S44-01 terminal module (see Figure).
2. Connect the 1Count5V/500kHz to the terminal module (you will find detailed instructions on how to do this in the *ET 200S Distributed I/O System* Manual).

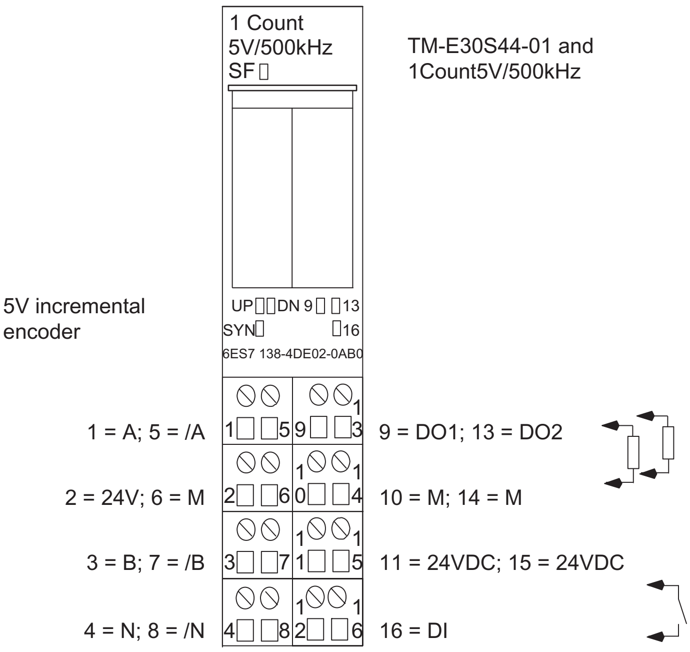


Figure 3-1 Terminal Assignment for the Example

Configuring with STEP 7 using HW Config

You must first adapt the hardware configuration of your existing ET 200S station.

1. Open the relevant project in SIMATIC Manager.
2. Open the HW Config configuration table in your project.
3. Select the 1Count5V/500kHz Counting Mode from the hardware catalog. The number 6ES7 138-4DE02-0AB0 C appears in the infotext.
4. Drag the entry to the slot at which you have installed your 1Count5V/500kHz.
5. Double-click this number to open the 1Count5V/500kHz C (R-S Slot Number) tab.

   On the Addresses tab, you will find the addresses of the slot to which you have dragged the 1Count5V/500kHz. Make a note of these addresses for subsequent programming.

   On the Parameters tab you will find the default settings for the 1Count5V/500kHz. Leave the default settings unchanged.
6. Save and compile your configuration, and download the configuration in STOP mode of the CPU by choosing "PLC > Download to Module".

Integration into the User Program (Not for Modified User Data Interface)

Create block FC101 and integrate it in your control program (in OB1, for example). This block requires the data block DB1 with a length of 16 bytes. The start address of the module in the following example is 256.

STL		Description
Block: FC101		
Network 1: Presettings		
L	0	//Delete control bits
T	DB1.DBD0	
T	DB1.DBD4	
SET		
S	DB1.DBX4.0	//Open SW gate
Network 2: Write to the control interface		
L	DB1.DBD0	//Write 6 bytes to the 1Count5V/500kHz
T	PAD 256	//Configured start address of the outputs
L	DB1.DBW4	
T	PAW 260	
Network 3: Read from the feedback interface		
		//Read 8 bytes from the 1Count5V/500kHz
L	PED 256	//Configured start address of the inputs
T	DB1.DBD8	
L	PED 260	
T	DB1.DBD12	

Testing

Use "Monitor/Modify Variables" to monitor the count value and the gate.

1. Select the "Block" folder in your project. Choose the "Insert > S7 Block > Variable Table" menu command to insert the VAT 1 variable table, and then confirm with OK.
2. Open the VAT 1 variable table, and enter the following variables in the "Address" column:

   DB1.DBD8 (current count value)

   DB1.DBx13.0 (internal gate status)
3. Choose "PLC > Connect To > Configured CPU" to switch to online.
4. Choose "Variable > Monitor" to switch to monitoring.
5. Switch the CPU to RUN mode.

   The "internal gate status" bit must be set.
6. Use your encoder to generate pulses.

Result

You can now see that:

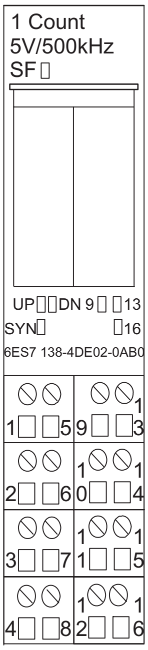
- The UP LED on the 1Count5V/500kHz is on. The status of the UP LED changes with each new pulse.
- The count value in the block changes.

3.4 Terminal Assignment Diagram

Wiring Rules

The cables (terminals 1 and 8 and terminals 15 and 16) must be shielded. The shield must be supported at both ends. To do this use the shield contact (see the *ET 200S Distributed I/O System* manual in the Appendix).

Table 3-1 Terminal Assignment of the 1Count5V/500kHz

View	Terminal Assignment	Remarks
5V incremental encoder 1 = A; 5 = /A 2 = 24V; 6 = M 3 = B; 7 = /B 4 = N; 8 = /N 	TM-E30S44-01 and 1Count5V/500kHz 9 = DO1; 13 = DO2 10 = M; 14 = M 11 = 24VDC; 15 = 24VDC 16 = DI 	A, /A: Track A B, /B: Track B N, /N: Track N 24 VDC: Sensor supply M: Chassis ground DI: Digital input DO1: Digital output DO2: Digital output

3.5 Operating mode of the 1Count5V/500kHz

Introduction

To begin with, decide how you want to use the 1Count5V/500kHz. You can choose from the following operating modes:

Counting modes	Measuring modes	Position feedback	Fast mode
Count continuously	Frequency measurement	Position detection	Position feedback in short (isochronous) cycles
Count once	Rotational speed measurement		
Count periodically	Period measurement		
Parameters are assigned to the various modes. You will find the parameter lists in the descriptions of the modes. You can integrate the 1Count5V/500kHz into your project in two different ways. Decide whether you want to work with a GSD file or with STEP 7.			

Integrating 1Count5V/500kHz with STEP 7

Integrating the 1Count5V/500kHz with STEP 7 (in isochronous and non-isochronous mode)			
Select an entry from the hardware catalog that corresponds to the operating mode you want.			
For counting modes, select the "1Count5V Counting Mode V2.0" entry	For measuring modes, select the "1Count5V Measuring Mode V2.0" entry	For position detection, select the "1Count5V Position Detection V2.0" entry	For fast mode, select the "1COUNT5V Fast Mode V2.0" entry
The number 6ES7138-4DE02-0AB0 C appears in the infotext. Drag the entry to the slot at which you have installed your 1Count5V/500kHz.	The number 6ES7138-4DE02-0AB0 M appears in the infotext. Drag the entry to the slot at which you have installed your 1Count5V/500kHz.	The number 6ES7138-4DE02-0AB0 W appears in the infotext. Drag the entry to the slot at which you have installed your 1Count5V/500kHz.	The number 6ES7138-4DE02-0AB0 F appears in the infotext. Drag the entry to the slot at which you have installed your 1Count5V/500kHz.
Select the parameters.			

Integrating 1Count5V/500kHz with GSD File

Integrating the 1Count5V/500kHz with STEP 7 (in non-isochronous mode only)		
Select an entry in the GSD file that corresponds to the operating mode you want.		
Select the entry C 6ES7138-4DE02-0AB0 1CNT5V for counting modes	Select the entry M 6ES7138-4DE02-0AB0 1CNT5V for measuring modes	Select the entry W 6ES7138-4DE02-0AB0 1CNT5V for position feedback
Select the parameters.		

Note

Fast mode is designed for use in especially short isochronous cycles. You need STEP 7 to configure isochronous operation.

3.6 Count Modes

3.6.1 Overview

Introduction

The counting modes are used in counting applications (for counting of items, for example).

For the "Counting Mode" parameter, you can select from the following modes:

- Count continuously (for position detection with incremental encoders, for example)
- Count once (for counting items up to a maximum limit, for example)
- Count periodically (in applications with recurring counting operations, for example)

To execute one of these modes, you have to assign parameters to the 1Count5V/500kHz.

Maximum Count Range

The high counting limit is +2147483647 (2^{31} - 1).

The low counting limit is -2147483648 (-2^{31}).

Load Value

You can specify a count value through a load value for the 1Count5V/500kHz.

This load value is either applied directly as the new count value (LOAD_VAL) or it is applied as the count value when one of the following events occurs (LOAD_PREPARE):

- In the Count once and Count periodically counting modes
  - The low or high counting limit is reached when a main count direction is not assigned.
  - The assigned high counting limit is reached when the main count direction is up.
  - Zero is reached when the main count direction is down.
- In all counting modes
  - The counting operation is started by a SW gate or HW gate (if the counting operation is continued, the load value is not applied).
  - Synchronization
  - Latch and retrigger

Gate Control

To control the 1Count5V/500kHz, you have to use the gate functions.

Main Count Direction

With the main count direction, you assign which RESET states (status following parameter assignment) the load value and count value can take on. It is thus possible to create incrementing or decrementing count applications. The assigned main count direction has no effect on the direction evaluation when the count pulses are detected.

RESET States of the Following Values after Parameter Assignment

Table 3-2 RESET States

Value	Main count direction	RESET state
Load value	None Up Down	0 0 Assigned high counting limit
Count value	None Up Down	0 0 Assigned high counting limit
Comparison value 1 and 2	None Up Down	0 0 Assigned high counting limit
Latch value	None Up Down	0 0 Assigned high counting limit

Isochrone Mode

In isochrone mode, the 1Count5V/500kHz accepts control bits and control values from the control interface in each bus cycle and reports back the response in the same cycle.

In each cycle, the 1Count5V/500kHz transfers the count or latch value that was valid at time T_i and the status bits valid at time T_i.

A count controlled by hardware input signals can only be transferred in the same cycle if the input signal occurred before time T_i.

(see *Isochrone Mode* Manual)

3.6.2 Endless Counting

Definition

In this mode, the 1Count5V/500kHz counts endlessly as of the load value:

- If the 1Count5V/500kHz reaches the upper count limit when counting up, and another count pulse then comes, it will jump to the lower count limit and continue counting from there without losing the pulse.
- If the 1Count5V/500kHz reaches the lower count limit when counting down, and another count pulse then comes, it will jump to the upper count limit and continue counting from there without losing the pulse.
- The upper count limit is set at +2147483647 (= 2^{31} - 1).
- The lower count limit is set at -2147483648 (= -2^{31}).

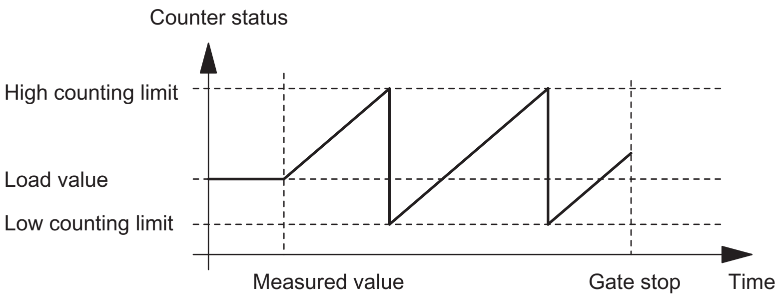


Figure 3-2 Endless Counting with Gate Function

Function of the Digital Input

Select one of the following functions for the digital input:

- Input
- Hardware gate
- Latch Function
- Synchronization

Function of the Digital Outputs

Select one of the following functions for each digital output:

- Output, no switching through comparator
- Activation at a counter status greater than or equal to the comparison value
- Activation at a counter status less than or equal to the comparison value
- Pulse on reaching the comparison value
- Switching at comparison values (DO1 only)

Influencing the Behavior of the Digital Outputs through:

The behavior of the digital outputs can be influenced as follows:

- Hysteresis
- Pulse duration

Changing values during operation

The following values can be changed during operation:

- Load value (LOAD_PREPARE)
- Counter status (LOAD_VAL)
- Comparison value 1 (CMP_VAL1)
- Comparison value 2 (CMP_VAL2)
- Function and behavior of the digital outputs (C_DOPARAM)

See also

Gate Functions in Count Modes (Page 150)

Latch Function (Page 153)

Synchronization (Page 156)

Behavior of the Outputs in Count Modes (Page 160)

Assignment of the Feedback and Control Interface for the Count Modes (Page 168)

3.6.3 Once-Only Counting

Definition

In this mode, the 1Count5V/500kHz counts once only, depending on the main count direction set.

- When there is no main count direction:
  - Counts as of the load value.
  - Counts up or down.
  - The count limits are fixed at the maximum count range.
  - In the event of overflow or underflow at the respective count limit, the gate is closed automatically.
- When the main count direction is up:
  - Counts as of the load value.
  - Counts up or down.
  - When the upper count limit is reached, the counter jumps to the load value and the gate is closed.
  - The upper limit can be assigned parameters, and the load value has a RESET status of 0 and can be changed.
- When the count direction is down:
  - Counts as of the load value.
  - Counts up or down.
  - When the lower count limit is reached, the 1Count5V/500kHz jumps to the load value and the gate is closed.
  - The lower limit is fixed at 0, and the load value can be assigned parameters (parameter: upper count limit) and can be changed.

The internal gate is automatically closed in the event of an overflow/underflow at the count limits. To restart counting, you have to open the gate again.

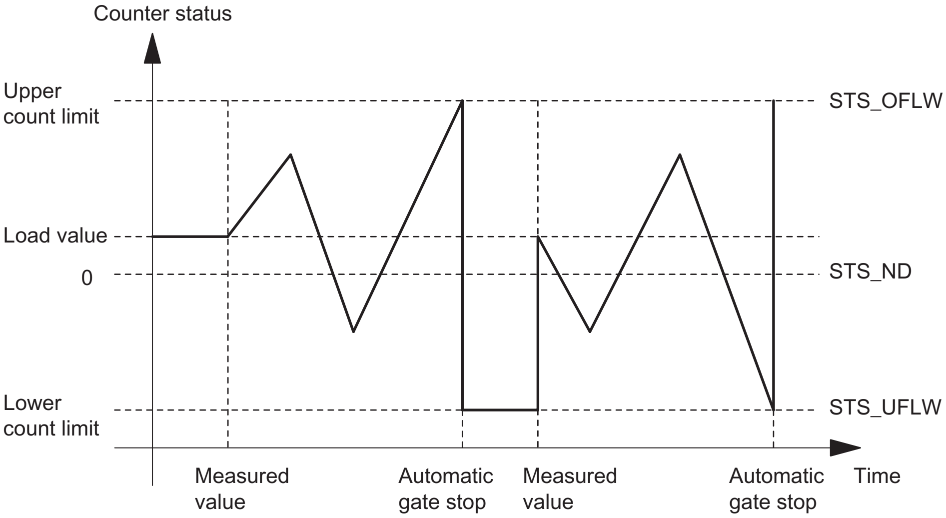


Figure 3-3 Once-Only Counting Without Main Count Direction; Terminating Gate Function

With an interrupting gate function, the count remains at the underflow when the gate is started.

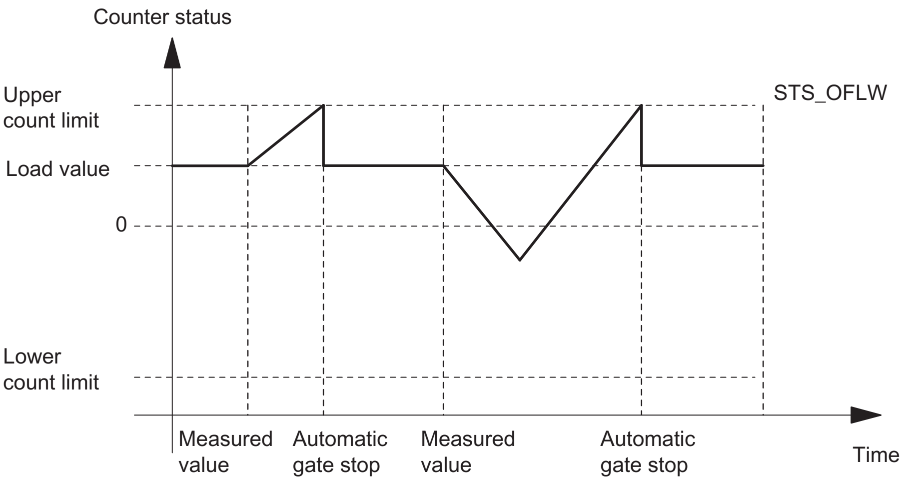


Figure 3-4 Once-Only Counting with Up as the Main Count Direction

Function of the Digital Input

Select one of the following functions for the digital input:

- Input
- Hardware gate
- Latch Function
- Synchronization

Function of the Digital Outputs

Select one of the following functions for each digital output:

- Output, no switching through comparator
- Activation at a counter status greater than or equal to the comparison value
- Activation at a counter status less than or equal to the comparison value
- Pulse on reaching the comparison value
- Switching at comparison values (DO1 only)

Influencing the Behavior of the Digital Outputs through:

The behavior of the digital outputs can be influenced as follows:

- Hysteresis
- Pulse duration

Changing values during operation

The following values can be changed during operation:

- Load value (LOAD_PREPARE)
- Counter status (LOAD_VAL)
- Comparison value 1 (CMP_VAL1)
- Comparison value 2 (CMP_VAL2)
- Function and behavior of the digital outputs (C_DOPARAM)

See also

Gate Functions in Count Modes (Page 150)

Latch Function (Page 153)

Synchronization (Page 156)

Behavior of the Outputs in Count Modes (Page 160)

Assignment of the Feedback and Control Interface for the Count Modes (Page 168)

3.6.4 Periodic Counting

Definition

In this mode, the 1Count5V/500kHz counts periodically, depending on the main count direction set.

- When there is no main count direction:
  - Counts as of the load value.
  - Counts up or down.
  - The count limits are fixed at the maximum count range.
  - In the event of an overflow or underflow at the respective count limit, the 1Count5V/500kHz jumps to the load value and continues counting from there.
- When the main count direction is up:
  - Counts as of the load value.
  - Counts up or down.
  - The upper limit can be assigned parameters, and the load value has a RESET status of 0 and can be changed.
  - When the upper count limit is reached, the 1Count5V/500kHz jumps to the load value and continues counting from there.

- When the count direction is down:
  - Counts as of the load value.
  - Counts up or down.
  - When the lower count limit is reached, the 1Count5V/500kHz jumps to the load value and continues counting from there.
  - The lower limit is fixed at 0, and the load value can be assigned parameters (parameter: upper count limit) and can be changed.

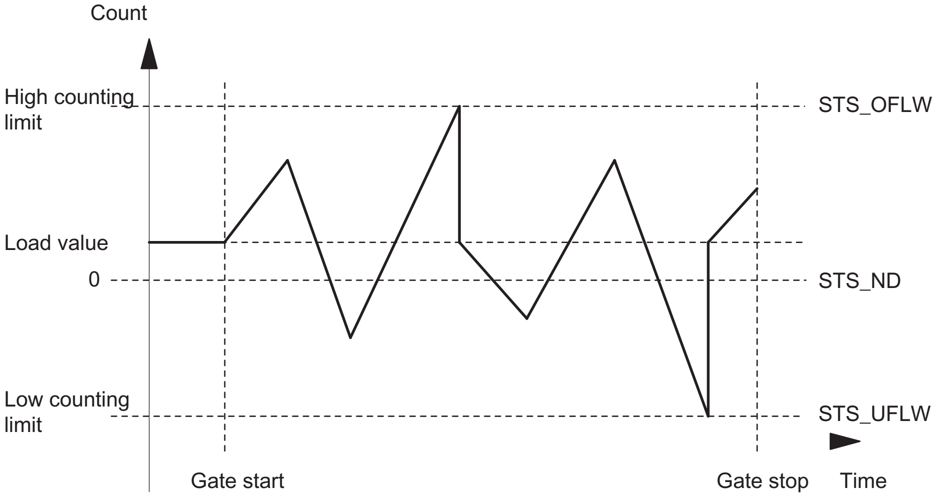


Figure 3-5 Periodic Counting without a Main Count Direction

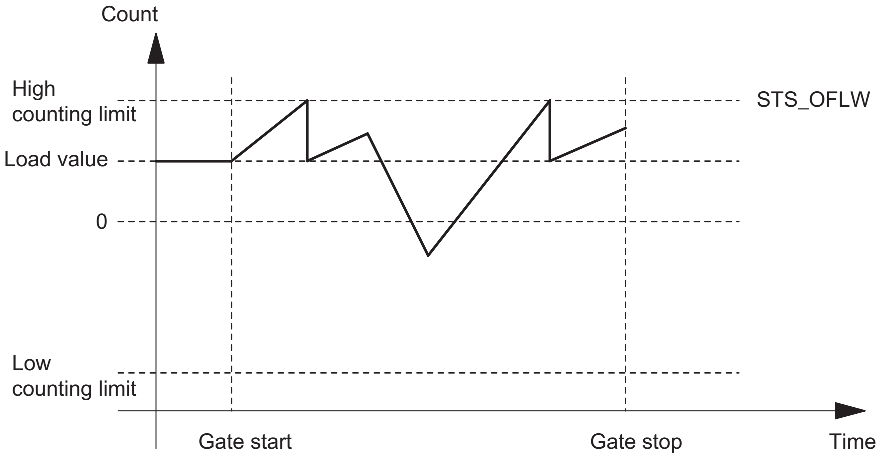


Figure 3-6 Periodic Counting with Up as the Main Count Direction

Function of the Digital Input

Select one of the following functions for the digital input:

- Input
- Hardware gate
- Latch Function
- Synchronization

Function of the Digital Outputs

Select one of the following functions for each digital output:

- Output, no switching through comparator
- Activation at a counter status greater than or equal to the comparison value
- Activation at a counter status less than or equal to the comparison value
- Pulse on reaching the comparison value
- Switching at comparison values (DO1 only)

Influencing the Behavior of the Digital Outputs through:

The behavior of the digital outputs can be influenced as follows:

- Hysteresis
- Pulse duration

Changing values during operation

The following values can be changed during operation:

- Load value (LOAD_PREPARE)
- Counter status (LOAD_VAL)
- Comparison value 1 (CMP_VAL1)
- Comparison value 2 (CMP_VAL2)
- Function and behavior of the digital outputs (C_DOPARAM)

See also

Gate Functions in Count Modes (Page 150)

Latch Function (Page 153)

Synchronization (Page 156)

Behavior of the Outputs in Count Modes (Page 160)

Assignment of the Feedback and Control Interface for the Count Modes (Page 168)

3.6.5 Behavior of the Digital Inputs

Digital Input of the 1Count5V/500kHz

The DI digital input can be operated with 24 V sensors (P switch and series mode).

In the case of the input and HW gate functions, the level of the digital input can be inverted by means of parameter assignment.

The STS_DI feedback bit indicates the level of the digital input.

3.6.6 Gate Functions in Count Modes

Software Gate and Hardware Gate

The 1Count5V/500kHz has two gates

- A software gate (SW gate), which is controlled by the SW_GATE control bit.

  The software gate can only be opened by a positive edge of the SW_GATE control bit. It is closed when this bit is reset. Note the transfer times and run times of your control program.
- A hardware gate (HW gate), which is controlled by means of the digital input on the 1Count5V/500kHz. You assign the hardware gate as the function of the digital input (Function DI "HW Gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

Internal gate

The internal gate is the logical AND operation of the HW gate and SW gate. Counting is only active when the HW gate and the SW gate are open. The STS_GATE feedback bit (internal gate status) indicates this. If a HW gate has not been assigned, the setting of the SW gate is decisive. Counting is activated, interrupted, continued, and canceled by means of the internal gate. In the Count once counting mode, the internal gate is closed automatically when there is an overflow/underflow at the counting limits.

Canceling- and Interrupting-Type Gate Function

When assigning the gate function ("Gate Function" parameter), you can specify whether the internal gate is to cancel or interrupt counting. When counting is canceled, after the gate is closed and restarted, counting starts again from the beginning. When counting is interrupted, after the gate is closed and restarted, counting continues from the previous value.

The diagrams below indicate how the interrupting and canceling gate functions work:

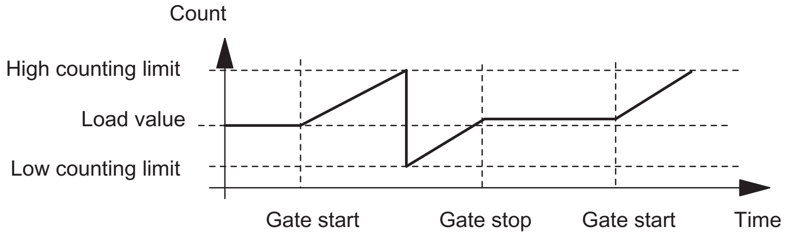


Figure 3-7 Count Continuously, Up, Interrupting Gate Function

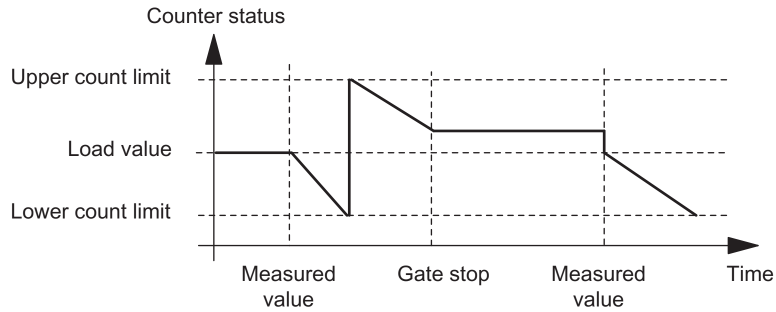


Figure 3-8 Count Continuously, Down, Canceling Gate Function

Gate control by means of the SW gate only

When the gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count, or
- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts at time T_o in cycle "n+1". In the same cycle "n+1", the 1Count24V/100kHz delivers the current count value from time T_i. (see *Isochronous Mode* Manual).

Gate control by means of the SW gate and HW gate

If the SW gate opens when the HW gate is already open, counting continues starting from the current count.

When the HW gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count, or
- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts at time T_o in cycle "n+1" if the HW gate is already open at this time. If the HW gate opens between T_o and T_i in cycle "n+1", counting only starts once the HW gate is open. In both cases, the 1Count24V/100kHz delivers the current count value in cycle "n+1" starting from time T_i.

3.6.7 Latch Function

Introduction

There are two latch functions:

- The Latch and Retrigger function
- The Latch function

The Latch and Retrigger Function

In order to use this function, you must first select it with the "Latch and Retrigger on Positive Edge" Function DI parameter.

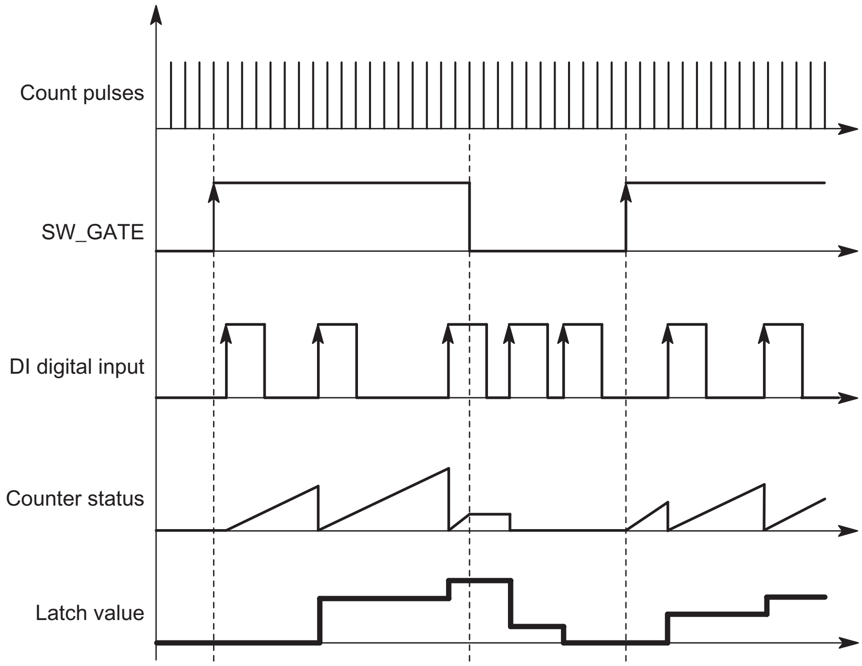


Figure 3-9 Latch and Retrigger with Load Value = 0

This function stores the current internal count of the 1Count5V/500kHz and retriggers counting when there is a positive edge on the digital input.

This means that the current internal counter status at the time of the positive edge is stored (latch value), and the 1Count5V/500kHz is then loaded again with the load value, from which counting resumes.

The counting mode must be enabled with the SW gate before the function can be executed. It is started with the (first) positive edge on the digital input.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the level of the latch and retrigger signal.

The latch value is preassigned with its RESET state (see RESET states table). It is not changed when the SW gate is opened.

Direct loading of the counter does not cause the indicated stored count to be changed.

If you close the SW gate, counting is only interrupted; this means that when you open the SW gate again, counting is continued. The DI digital input remains active even when the SW gate is closed.

Counting is also latched and triggered in isochrone mode with each edge on the digital input. The count that was valid at the time of the last edge before T_i is displayed in the feedback interface.

The Latch Function

In order to use this function, the Function DI parameter must be set to "Latch on Positive Edge".

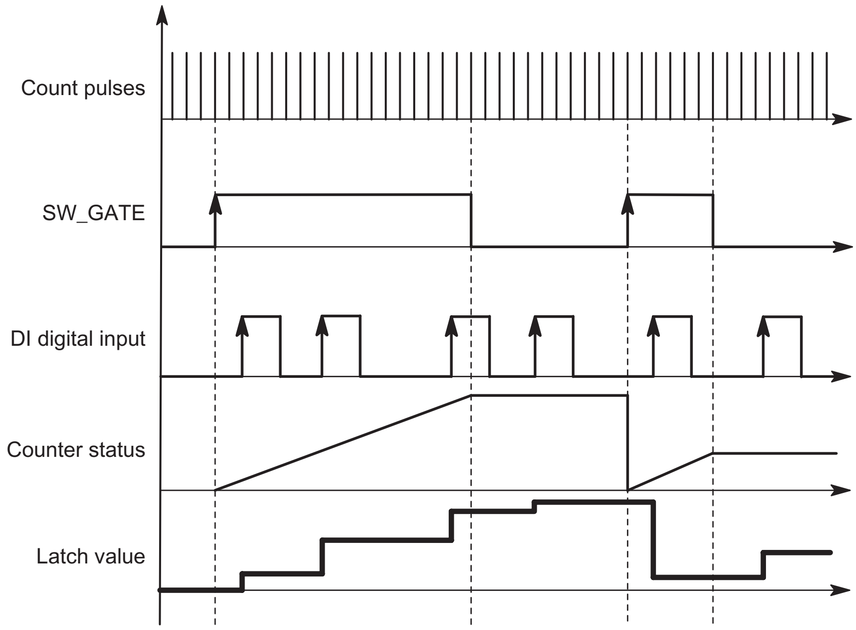


Figure 3-10 Latch with a Load Value of 0

Count and latch value are preset with their RESET states (see RESET states table).

The counting function is started when the SW gate is opened. The 1Count5V/500kHz begins at the load value.

The latch value is always the exact count at the time of the positive edge on the digital input DI.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the level of the latch signal.

Direct loading of the counter does not cause the indicated stored count to be changed.

In isochrone mode, the count that was latched at the time of the last positive edge before T_i is displayed in the feedback interface.

When you close the SW gate, the effect is either canceling or interrupting, depending on the parameter assignment. The digital input DI remains active even when the SW gate is closed.

Further possible causes of parameter assignment errors with the latch function:

- Incorrect parameter assignment of the digital output function (Function DI)

Expanded Feedback Interface

If the 1Count5V/500kHz is inserted behind an IM 151 that supports the reading and writing of broader user data interfaces, the current count value can be read from bytes 8 to 11 of the feedback interface.

3.6.8 Synchronization

Introduction

There are two methods of synchronizing the 1Count5V/500kHz:

- Synchronization with DI
- Synchronization with DI and zero mark

Synchronization with DI

In order to use this function, you must first select it with the "Synchronize on Positive Edge" Function DI parameter.

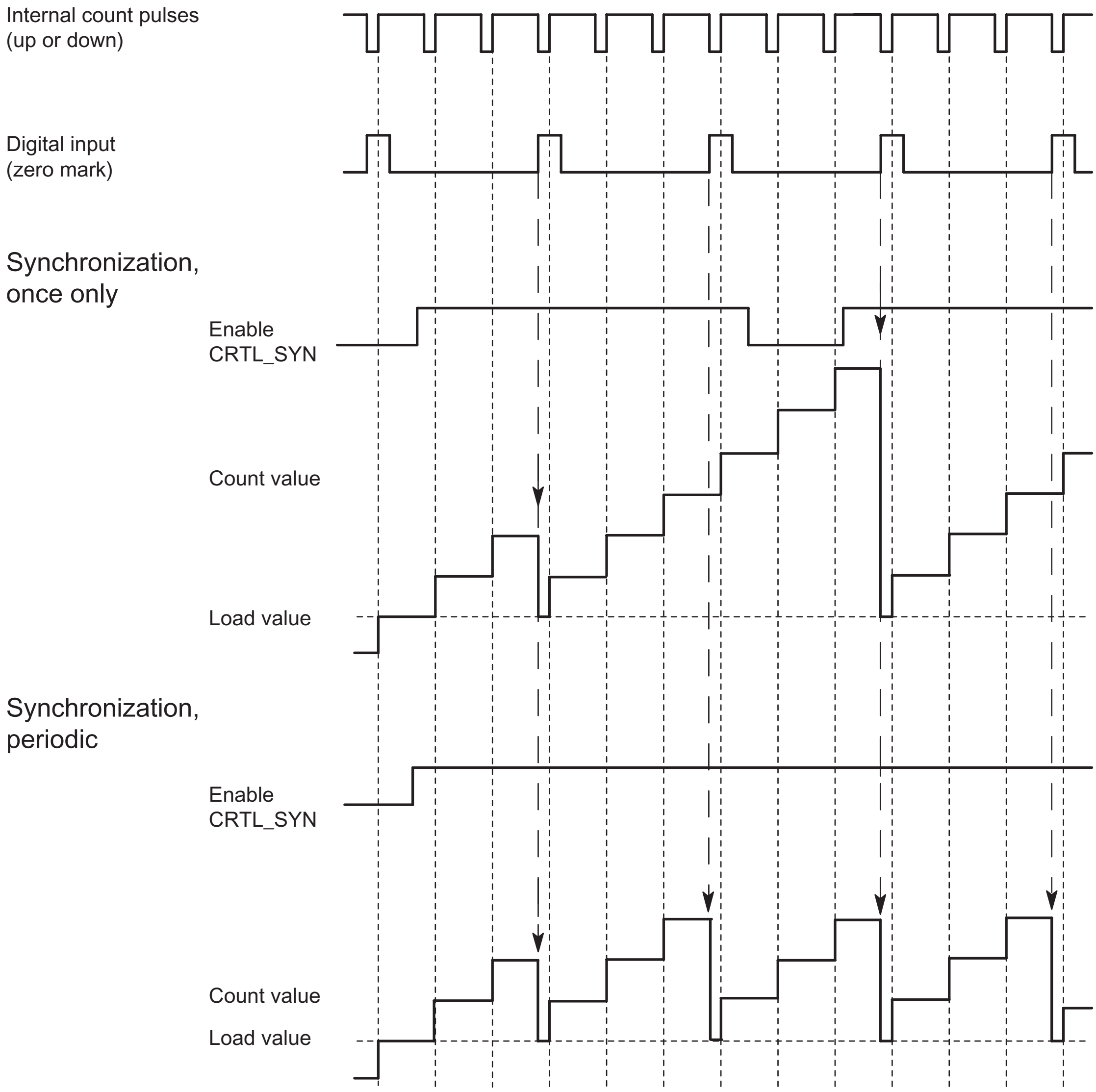


Figure 3-11 Once-Only and Periodic Synchronization

If you have assigned synchronization, the positive edge of a reference signal on the input sets the 1Count5V/500kHz to the load value.

You can select between once-only and periodic synchronization ("Synchronization" parameter).

The following conditions apply:

- The counting mode must have been started with the SW gate.
- The "Enable synchronization CTRL_SYN" control bit must be set.
- In once-only synchronization, the first edge loads the1Count5V/500kHz with the load value after the enable bit is set.
- In periodic synchronization, the first edge and each subsequent edge load the 1Count5V/500kHz with the load value after the enable bit is set.
- After successful synchronization, the STS_SYN feedback bit is set and the SYN LED comes on. The RES_STS control bit resets the feedback bit and switches the LED off.
- The signal of a bounce-free switch can serve as the reference signal.
- The STS_DI feedback bit indicates the level of the reference signal.

In isochrone mode, the set feedback bit STS_SYN indicates that the positive edge on the digital input was between time T_i in the current cycle and T_i in the previous cycle.

Synchronization with DI and Zero Mark

In order to be able to use this function, you must have selected it from the digital input function parameters.

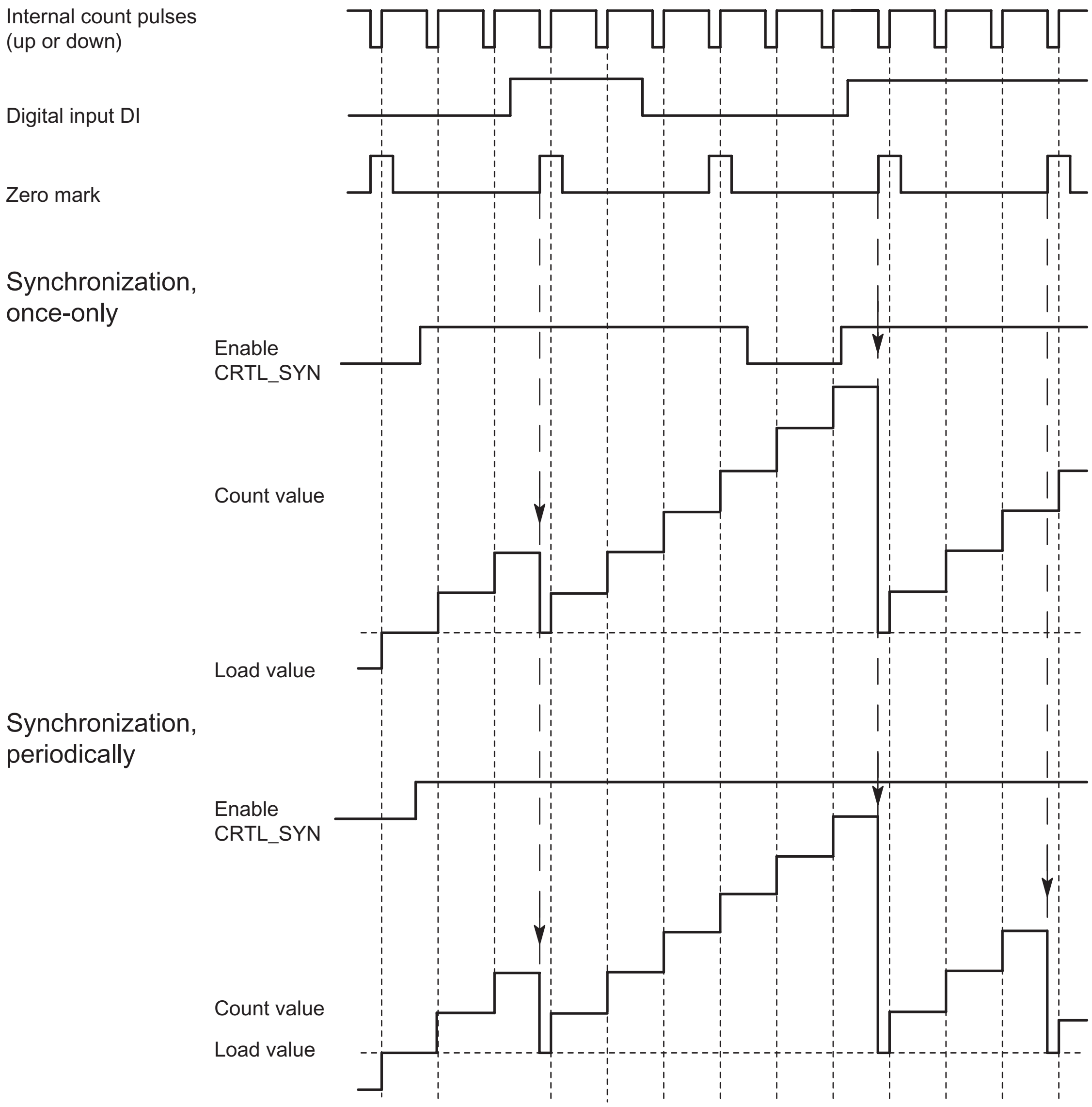


Figure 3-12 Once-Only and Periodic Synchronization

If you have assigned synchronization with DI and zero mark, the DI serves as the HW enable. When the HW enable is active, the 1Count5V/500kHz is loaded with the load value by the zero mark of the encoder.

You can select between once-only and periodic synchronization.

The following conditions apply:

- The counting mode must have been started with the SW gate.
- The "Enable synchronization CTRL_SYN" control bit must be set.
- In once-only synchronization, the first zero mark loads the 1Count5V/500kHz with the load value after the enable bit and the HW enable are set.
- In periodic synchronization, the first and each subsequent zero mark load the 1Count5V/500kHz with the load value after the enable bit and the HW enable are set.
- After successful synchronization, the STS_SYN feedback bit is set and the SYN LED comes on. The RES_STS control bit resets the feedback bit and switches the LED off.
- The signal of a bounce-free switch can serve as the reference signal.
- The STS_DI feedback bit indicates the level of the reference signal.

In isochrone mode, the set feedback bit STS_SYN indicates that the positive edge on the digital input was between time T_i in the current cycle and T_i in the previous cycle.

3.6.9 Behavior of the Outputs in Count Modes

Introduction

The 1Count5V/500kHz lets you store two comparison values, which are assigned to the digital outputs. The outputs can be activated, depending on the count and comparison values. The various ways of setting the behavior of the outputs are described in this section.

Behavior Types of the Digital Outputs

The 1Count5V/500kHz has two digital outputs.

Parameters can be assigned for both outputs ("Function DO1" and "Function DO2" parameters).

You can change the function and the behavior of the digital outputs during operation.

You can choose from the following functions:

- Output
- Count ≥ comparison value
- Count ≤ comparison value
- Pulse on reaching the comparison value
- Switch at comparison values (DO1 only)

Output

You can switch the outputs on and off with the control bits SET_DO1 and SET_DO2.

The control bits CTRL_DO1 or CTRL_DO2 must be set for this.

You can query the status of the outputs with the status bits STS_DO1 and STS_DO2 in the feedback interface.

The status bits STS_CMP1 and STS_CMP2 indicate that the relevant output is or was switched on. These status bits retain their status until they are acknowledged. If the output is still switched, the corresponding bit is set again immediately. These status bits are also set when the control bit SET_DO1 or SET_DO2 is operated without DO1 or DO2 being enabled.

Isochrone mode: In isochrone mode, the outputs DO1 and DO2 are switched at time T_o.

Count ≤ Comparison Value and Count ≥≤ Comparison Value

If the comparison conditions are fulfilled, the respective comparator switches on the output. The status of the output is indicated by STS_DO1 and STS_DO2.

The control bits CTRL_DO1 or CTRL_DO2 must be set for this.

The comparison result is indicated by the status bits STS_CMP1 or STS_CMP2. You cannot acknowledge and thus reset these bits until the comparison conditions are no longer fulfilled.

Isochrone mode: In isochrone mode as well, the DO1 and DO2 outputs are switched as soon as the comparison condition is fulfilled and are therefore independent of the bus cycle.

Comparison Value Reached, Output Pulse

If the count reaches the comparison value, the comparator switches on the respective digital output for the assigned pulse duration.

The control bit CTRL_DO1 or CTRL_DO2 must be set for this.

The status bits STS_DO1 and STS_DO2 always have the status of the corresponding digital output.

The comparison result is indicated by the status bit STS_CMP1 or STS_CMP2 and cannot be reset by acknowledgment until the pulse duration has elapsed.

If a main count direction is assigned, the comparator switches only when the comparison value in the main count direction is reached.

If a main count direction is not assigned, the comparator switches when the comparison value is reached from either direction.

If the digital output is set by control bit SET_DO1 or SET_DO2, it is reset when the pulse duration has elapsed.

Isochrone mode: In isochrone mode as well, the DO1 and DO2 outputs are switched as soon as the comparison condition is fulfilled and are therefore independent of the bus cycle.

Pulse Duration when the Comparison Value is Reached

The pulse duration begins when the respective digital output is set. The inaccuracy of the pulse duration is less than 2 ms.

The pulse duration can be set to suit the actuators used. The pulse duration specifies how long the output is to be set for. The pulse duration can be preselected between 0 ms and 510 ms in increments of 2 ms.

If the pulse duration = 0, the output is set until the comparison condition is no longer fulfilled. Note that the count pulse times must be greater than the minimum switching times of the digital output.

Isochrone mode: In isochrone mode as well, the DO1 and DO2 outputs are switched as soon as the comparison condition is fulfilled and are therefore independent of the bus cycle.

Switch at comparison values

The comparator switches the output when the following conditions are met:

- The two comparison values must be loaded using the load functions CMP_VAL1 and CMP_VAL2, and
- After the comparison values are loaded, the DO1 output must be enabled with CRTL_DO1.

The following table shows you when the DO1 is switched on or off:

	DO1 is switched on when	DO1 Is switched off when
V2 < V1 (see Figure below)	V2 ≤ count ≤ V1	V2 > count or count > V1
V2 = V1	V2 = count = V1	V2 ≠ count ≠ V1
V2 > V1 (see Figure below)	V1 > count or count > V2	V1 ≤ count ≤ V2

The comparison result is indicated by the status bit STS_CMP1. You can only acknowledge and thus reset this bit when the comparison condition is no longer fulfilled.

There is no hysteresis in the case of this output behavior.

It is not possible to control the DO1 output with the SET_DO1 control bit in the case of this output behavior.

Isochrone mode: In isochrone mode, as well, the DO1 output is switched as soon as the comparison condition is fulfilled and is therefore independent of the bus cycle.

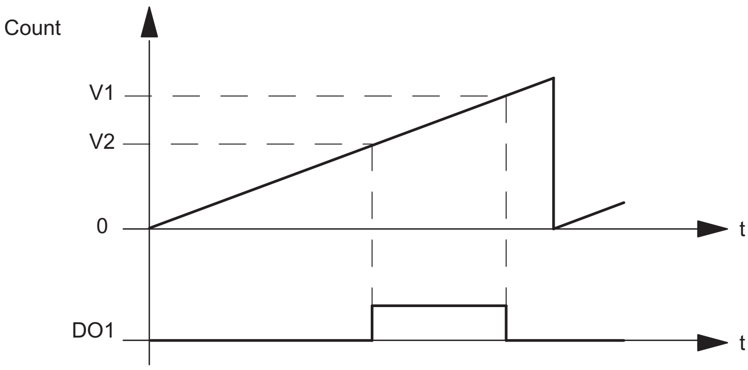


Figure 3-13 V2 < V1 at the Start of Counting

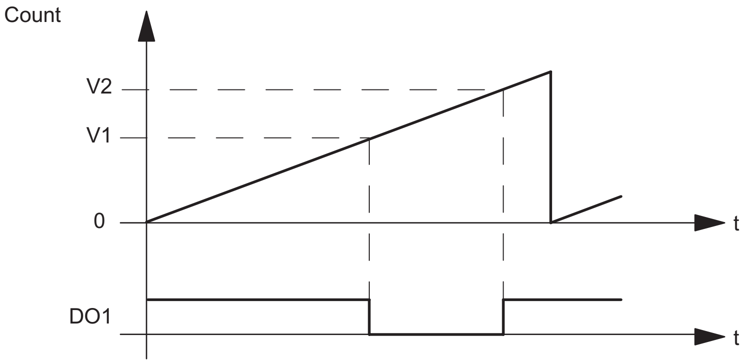


Figure 3-14 V2 > V1 at the Start of Counting

Setting or Modifying the Function and Behavior of the Digital Output DO1

When setting or modifying the behavior of DO1, you must take all assignable interdependencies into account. Failure to do so will generate a parameter assignment error or a loading error.

Boundary conditions:

If you assign "Switch at Comparison Values" for DO1, you must:

- Set hysteresis = 0, and
- Assign "Output" for the DO2 output

Hysteresis

An encoder can remain at a particular position and then fluctuate around this position. This state causes the count to fluctuate around a particular value. If there is a comparison value in this fluctuation range, for example, the associated output is switched on and off in accordance with the rhythm of the fluctuations. To prevent switching occurring in the case of small fluctuations, the 1Count5V/500kHz is equipped with an assignable hysteresis. You can assign a range between 0 and 255 (0 means: hysteresis switched off).

Hysteresis also works with overflow and underflow.

Method of Operation with Count ≤ Comparison Value and Count ≥ Comparison Value

The diagram below provides an example of how hysteresis works. The figure shows the differences in the behavior of an output when hysteresis of 0 (= switched off) is assigned as opposed to hysteresis of 3. In the example, the comparison value is 5.

The following settings are assigned for the counter: "Main count direction" = "Up" and "Switch on at count ≥ comparison value".

When the comparison condition is met, hysteresis becomes active. While the hysteresis is active, the comparison result remains unchanged.

If the count value goes outside the hysteresis range, hysteresis is no longer active. The comparator switches again according to its comparison conditions.

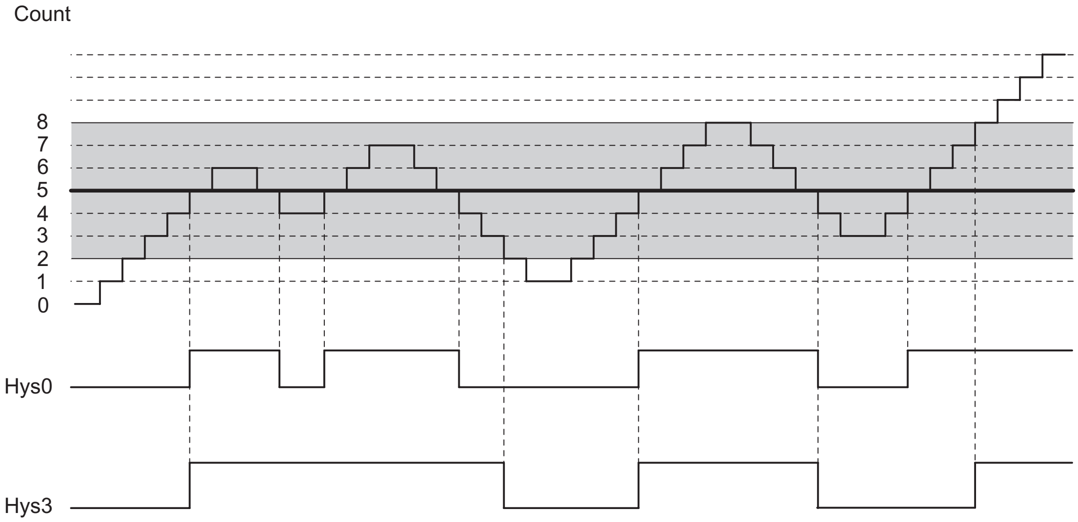


Figure 3-15 Example of How Hysteresis Works

Note

If the count direction changes on the comparison value when hysteresis is active, the output is reset.

Method of Operation when the Comparison Value Is Reached and the Pulse Duration = 0

The diagram below provides an example of how hysteresis works. The figure shows the differences in the behavior of an output when hysteresis of 0 (= switched off) is assigned as opposed to hysteresis of 3. In the example, the comparison value is 5.

The following settings are assigned for the counter: "Pulse on reaching the comparison value", "No main count direction" and "Pulse duration = 0".

When the comparison conditions are met, hysteresis becomes active. While the hysteresis is active, the comparison result remains unchanged. If the count value goes outside the hysteresis range, hysteresis is no longer active. The comparator deletes the result of the comparison.

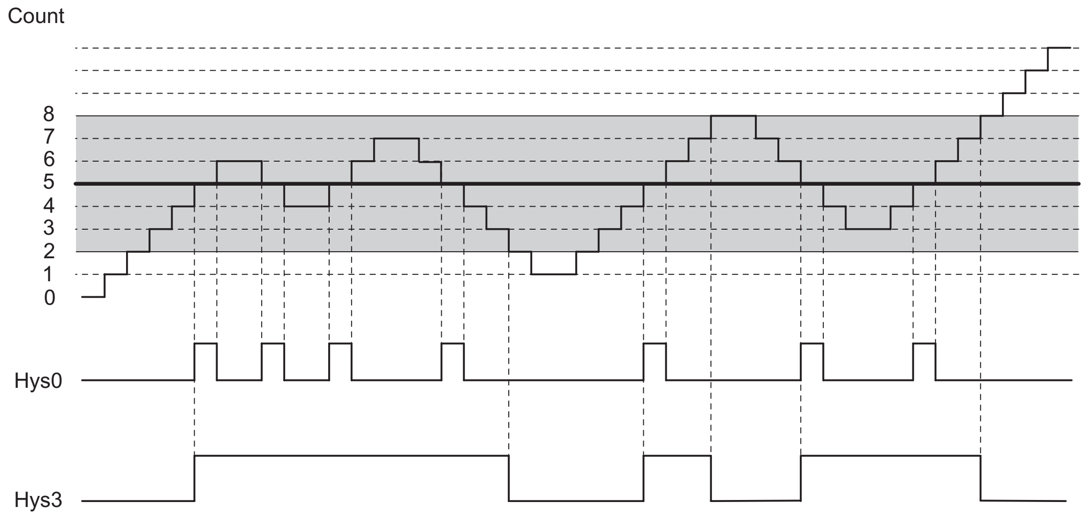


Figure 3-16 Example of How Hysteresis Works

Method of Operation when the Comparison Value Is Reached, Output Pulse Duration

The diagram below provides an example of how hysteresis works. The figure shows the differences in the behavior of an output when hysteresis of 0 (= switched off) is assigned as opposed to hysteresis of 3. In the example, the comparison value is 5.

The following settings are assigned for the counter: "Pulse on reaching the comparison value", "No main count direction" and "pulse duration > 0".

When the comparison conditions have been met, hysteresis becomes active and a pulse of the assigned duration is output.

If the count value goes outside the hysteresis range, hysteresis is no longer active.

When hysteresis becomes active, the 1Count5V/500kHz stores the count direction. If the hysteresis range is exited in a different direction to the one stored, a pulse is output.

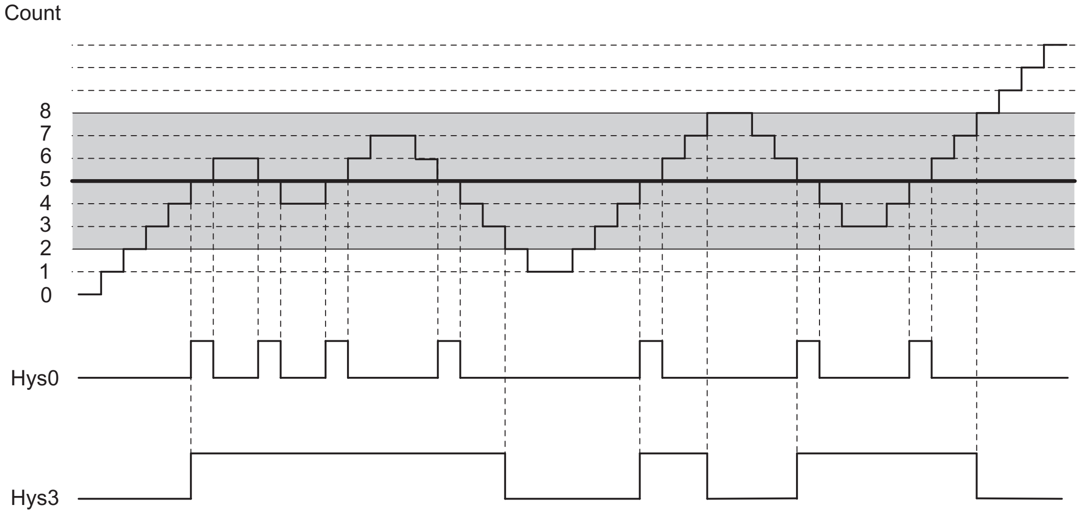


Figure 3-17 Example of How Hysteresis Works

Controlling the Outputs Simultaneously with the Comparators

If you have selected a comparison function for the outputs, you can continue to control the outputs with SET_DO1 or SET_DO2. This allows you to simulate the effect of the comparison functions on your control program:

- The output is set with the positive edge of SET_DO1 or SET_DO2. However, if the "Pulse on Reaching the Comparison Value" function is selected, only one pulse with the specified duration is output. When pulse duration = 0, the output can be set with SET_DO1 or SET_DO2, as long as the count value is located on the comparison value or hysteresis is active. The SET_DO1 control bit is not permitted with the "Switch at Comparison Values" output behavior.
- A negative edge of SET_DO1 or SET_DO2 resets the output.

Note that the comparators are still active and can set or reset the output if the comparison result changes.

Note

An output set with SET_DO1 or SET_DO2 is not reset at the comparison value (by the comparator).

Loading Comparison Values

You transfer the comparison values to the 1Count5V/500kHz. The counting is not affected by this.

Table 3-3 Valid Range for the Two Comparison Values

Main count direction: None	Main count direction: Up	Main count direction: Down
Low counting limit to high counting limit	-2147483648 to high counting limit -1	1 to 2147483647

Modifying the Function and Behavior of Digital Outputs

You can modify the functions and behavior of the outputs during operation using the control interface. The 1Count5V/500kHz deletes the outputs and accepts the values as follows:

- Function of digital outputs DO1 and DO2: If you change this function so that the comparison condition is satisfied, the output is not set until after the next count pulse. However, if hysteresis is active, the 1Count5V/500kHz does not make any changes at the output.
- Hysteresis: An active hysteresis (see How Hysteresis Works) continues to be active following the change. The new hysteresis range is applied the next time the comparison value is reached.
- Pulse duration: The new pulse duration takes effect with the next pulse.

3.6.10 Assignment of the Feedback and Control Interface for the Count Modes

Note

The following data of the control and feedback interfaces are consistent for the 1Count5V/500kHz:

Bytes 0 to 3

Bytes 4 to 7

Bytes 8 to 11 (modified user data interface)

Use the access or addressing mode for data consistency over the entire control and feedback interface on your DP master (only for configuration using the GSD file).

Assignment Tables

The tables show the assignment of the feedback and control interface for the counting modes.

Table 3-4 Feedback Interface (Inputs)

Address	Assignment	Designation
Bytes 0 to 3	Count value or stored count value in the case of the latch function on the digital input	
Byte 4	Bit 7: Short circuit of the encoder supply	ERR_24V
	Bit 6: Short circuit / wire break / overtemperature	ERR_DO1
	Bit 5: Parameter assignment error	ERR_PARA
	Bit 4: Short circuit / wire break / overtemperature	ERR_DO2
	Bit 3: Short circuit / wire break / encoder signal	ERR_ENCODER
	Bit 2: Resetting of status bits active	RES_STS_A
	Bit 1: Load function error	ERR_LOAD
	Bit 0: Load function is running	STS_LOAD
Byte 5	Bit 7: Down direction status	STS_C_DN
	Bit 6: Up direction status	STS_C_UP
	Bit 5: Reserve = 0	
	Bit 4: DO2 status	STS_DO2
	Bit 3: DO1 status	STS_DO1
	Bit 2: Reserve = 0	
	Bit 1: DI status	STS_DI
	Bit 0: Internal gate status	STS_GATE

Address	Assignment	Designation
Byte 6	Bit 7: Zero-crossing in the count range when counting without a main count direction	STS_ND
	Bit 6: Low counting limit	STS_UFLW
	Bit 5: High counting limit	STS_OFLW
	Bit 4: Comparator 2 status	STS_CMP2
	Bit 3: Comparator 1 status	STS_CMP1
	Bit 2: Reserve = 0	
	Bit 1: Reserve = 0	
	Bit 0: Synchronization status	STS_SYN
Byte 7	Reserve = 0	
Bytes 8 to 11	Count value [1]	
[1] Modified user data interface		

Table 3-5 Control Interface (Outputs)

Address		Assignment			
Bytes 0 to 3		Load value direct, preparatory, comparison value 1 or 2			
	Byte 0	Behavior of DO1, DO2 of the 1Count5V/500kHz			
		Bit 2	Bit 1	Bit 0	Function DO1
		0	0	0	Output
		0	0	1	Switch on at count ≥ comparison value
		0	1	0	Switch on at count ≤ comparison value
		0	1	1	Pulse on reaching the comparison value
		1	0	0	Switch at comparison values
		1	0	1	blocked
		1	1	0	blocked
		1	1	1	blocked
			Bit 5	Bit 4	Function DO2
			0	0	Output
			0	1	Switch on at count ≥ comparison value
			1	0	Switch on at count ≤ comparison value
			1	1	Pulse on reaching the comparison value
		Bits 3, 6, and 7: Reserve = 0			
	Bytes 1 to 3	Byte 1: Hysteresis DO1, DO2 (range 0 to 255)			
		Byte 2: Pulse duration [2ms] DO1, DO2 (range 0 to 255)			
		Byte 3: Reserve = 0			
Byte 4	EXTF_ACK	Bit 7: Error diagnostics acknowledgment			
	CTRL_DO2	Bit 6: Enable DO2			
	SET_DO2	Bit 5: Control bit DO2			
	CTRL_DO1	Bit 4: Enable DO1			
	SET_DO1	Bit 3: Control bit DO1			
	RES_STS	Bit 2: Start resetting of status bit			
	CTRL_SYN	Bit 1: Enable synchronization			
	SW_GATE	Bit 0: SW gate control bit			

Address		Assignment
Byte 5		Bit 7: Reserve = 0
		Bit 6: Reserve = 0
		Bit 5: Reserve = 0
	C_DOPARAM	Bit 4: Change function and behavior of DO1, DO2
	CMP_VAL2	Bit 3: Load comparison value 2
	CMP_VAL1	Bit 2: Load comparison value 1
	LOAD_PREPARE	Bit 1: Load counter preparatory
	LOAD_VAL	Bit 0: Load counter direct
Bytes 6 to 7		Reserve = 0 [1]
[1] Not used for modified user interface		

Notes on the Control Bits

Table 3-6 Notes on the Control Bits

Control bits	Notes
C_DOPARAM	Change function and behavior of DO1, DO2 (see figure below) The values from bytes 0 to 2 are applied as new function, hysteresis, and pulse duration of DO1, DO2. This may result in the following error: The conditions for the "Switch at comparison values" behavior are not fulfilled.
CMP_VAL1	Load comparison value 1 (see figure below) The value from bytes 0 to 3 is transferred to comparison value 1 with the control bit "Load comparison value CMP_VAL1".
CMP_VAL2	Load comparison value 2 (see figure below) The value from bytes 0 to 3 is transferred to comparison value 2 with the control bit "Load comparison value CMP_VAL2".
CTRL_DO1	Enable DO1 You use this bit to enable the DO1 output.
CTRL_DO2	Enable DO2 You use this bit to enable the DO2 output.
CTRL_SYN	You use this bit to enable synchronization.
EXTF_ACK	Error acknowledgment The error bits must be acknowledged with the EXTF_ACK control bit after the cause is removed. (see figure below)
LOAD_PREPARE	Load counter preparatory (see figure below) The value from bytes 0 to 3 is applied as the load value.
LOAD_VAL	The value from bytes 0 to 3 is loaded directly as the new counter value (see figure below).
RES_STS	Start resetting of status bit The status bits are reset by means of the acknowledgment process between the RES_STS bit and the RES_STS_A bit. (see figure below)
SET_DO1	Control bit DO1 Switches the DO1 digital output on and off when CTRL_DO1 is set.

Control bits	Notes
SET_DO2	Control bit DO2 Switches the DO2 digital output on and off when CTRL_DO2 is set.
SW_GATE	SW gate control bit The SW gate is opened/closed via the control interface with the SW_GATE bit.

Notes on the Feedback Bits

Table 3-7 Notes on the Feedback Bits

Feedback bits	Notes
ERR_24V	Short circuit of the encoder supply The error bit must be acknowledged with the EXTF_ACK control bit (see figure below). Diagnostic message, if assigned.
ERR_DO1	Short circuit/wire break/overtemperature due to overload at output DO1 The error bit must be acknowledged with the EXTF_ACK control bit (see figure below). Diagnostic message, if assigned.
ERR_DO2	Short circuit/wire break/overtemperature at output DO2 The error bit must be acknowledged with the EXTF_ACK control bit (see figure below). Diagnostic message, if assigned.
ERR_ENCODER	Short circuit / wire break of 5 V encoder signal The error bit must be acknowledged with the EXTF_ACK control bit (see figure below). Diagnostic message, if assigned.
ERR_LOAD	Load function error (see figure below) The LOAD_VAL, LOAD_PREPARE, CMP_VAL1, CMP_VAL2, and C_DOPARAM bits cannot be set simultaneously during transfer. This results in setting the ERR_LOAD status bit, similar to loading an incorrect value (which is not accepted).
ERR_PARA	Parameter assignment error ERR_PARA
RES_STS_A	Resetting of the status bits active (see figure below)
STS_C_DN	Down direction status
STS_C_UP	Up direction status
STS_CMP1	Comparator 1 status The STS_CMP1 status bit indicates that the output is or was switched on. It must be acknowledged with the RES_STS control bit. If the status bit is acknowledged when the output is still switched on, the bit is set again immediately. This bit is also set if the SET_DO1 control bit is used when DO1 is not enabled.
STS_CMP2	Comparator 2 status The STS_CMP2 status bit indicates that the output is or was switched on. It must be acknowledged with the RES_STS control bit. If the status bit is acknowledged when the output is still switched on, the bit is set again immediately. This bit is also set if the SET_DO2 control bit is used when DO2 is not enabled.
STS_DI	DI status The status of the DI is indicated in all modes with the STS_DI bit in the feedback interface.
STS_DO1	DO1 status The STS_DO1 status bit indicates the status of the DO1 digital output.
STS_DO2	DO2 status The STS_DO2 status bit indicates the status of the DO2 digital output.

Feedback bits	Notes
STS_GATE	Internal gate status: Counting
STS_LOAD	Load function running (see figure below)
STS_ND	Zero-crossing in the count range when counting without a main counting direction. The bit must be reset by the RES_STS control bit.
STS_OFLW STS_UFLW	High counting limit violated Low counting limit violated Both bits must be reset.
STS_SYN	Synchronization status After successful synchronization, the STS_SYN bit is set. It must be reset by the RES_STS control bit.

Access to the Control and Feedback Interface in STEP 7 Programming

Table 3-8 Access to the Control and Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD file [1]) (Hardware catalog\PROFIBUS-DP\Additional FIELD DEVICES\I/O\ET 200S)	Configuring with STEP 7 using HW Config (Hardware catalog\PROFIBUS-DP\ ET 200S)
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command (e.g. L PID)
Control interface	Write with SFC 15 "DPWR_DAT"	Transfer command (e.g. T PQD)
[1] Load and transfer commands are also possible with CPU 3xxC, CPU 3xx with MMC, and CPU 4xx (V3.0 and later).		

Resetting of the Status Bits STS_SYN, STS_CMP1, STS_CMP2, STS_OFLW, STS_UFLW, STS_ND

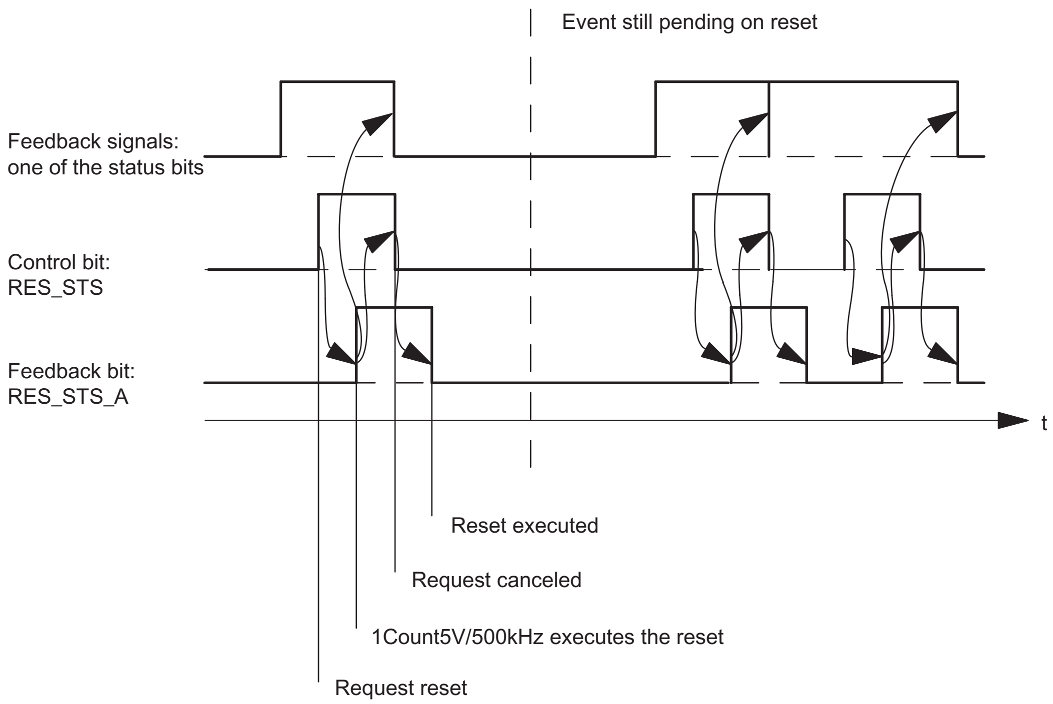


Figure 3-18 Resetting of the Status Bits

Acceptance of Values with the Load Function

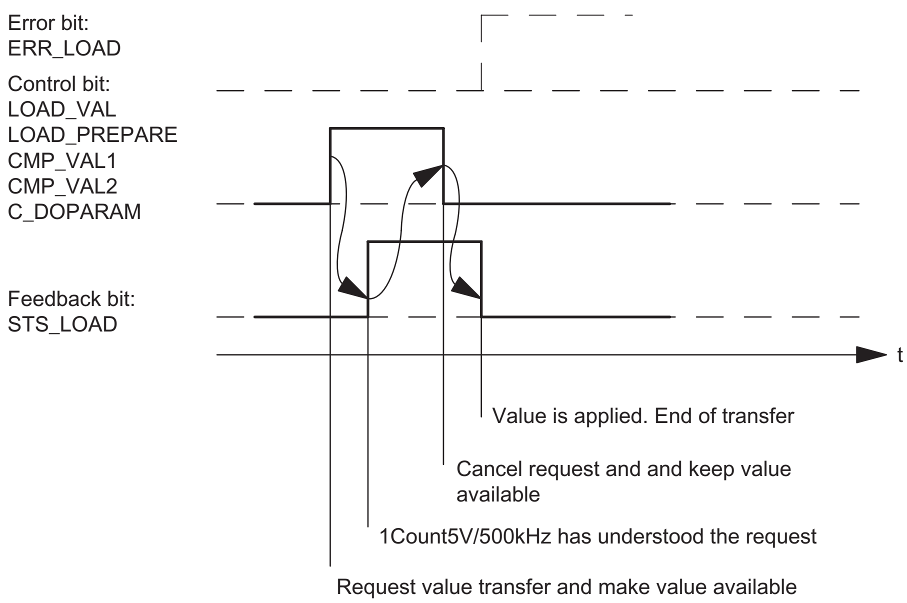


Figure 3-19 Acceptance of Values with the Load Function

Note

Only one of the following control bits can be set at a particular time:

CMP_VAL1 or CMP_VAL2 or LOAD_VAL or LOAD_PREPARE or C_DOPARAM.

Otherwise, the ERR_LOAD error is reported until all the specified control bits are deleted again.

The ERR_LOAD error bit is only deleted when the following is carried out correctly.

Acknowledgment Principle in Isochrone Mode

In isochrone mode, exactly 4 bus cycles are always required to reset the status bits and to accept values during the load function.

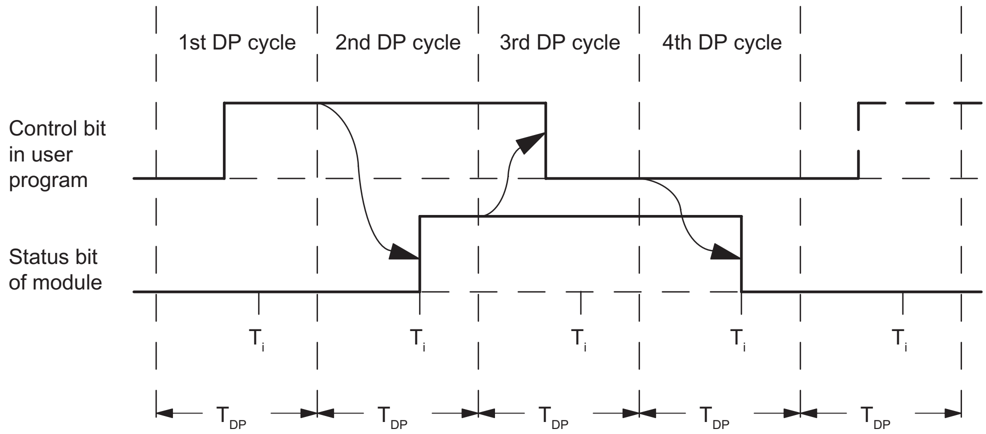


Figure 3-20   Acknowledgment Principle in Isochrone Mode

Error Detection

The program errors must be acknowledged. They have been detected by the 1Count5V/500kHz and are indicated at the feedback interface.

A channel-specific diagnosis is carried out if you have enabled group diagnostics in your parameter assignment (see the *ET 200S Distributed I/O System* Manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

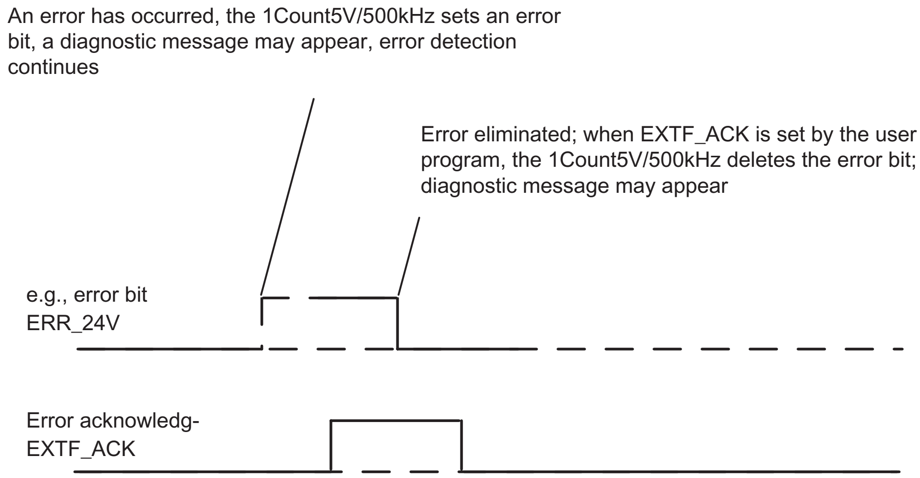


Figure 3-21 Error Acknowledgment

In the case of continuous error acknowledgment (EXTF_ACK=1) or at CPU/Master Stop, the 1Count5V/500kHz signals errors as soon as they are detected and resets them as soon as they have been eliminated.

3.6.11 Parameter Assignment for the Count Modes

Introduction

You can use either of the following to assign parameters for the 1Count5V/500kHz:

- A GSD file (http://www.ad.siemens.de/csi/gsd)
- STEP 7 V5.3 SP2 or later

Parameter List for Counting Modes

Table 3-9 Parameter List for Counting Modes

Parameter	Value Range	Default
Enable		
Group diagnostics	Disable/enable	Disable
Behavior in the event of higher-level controller failure		
Behavior at CPU/Master STOP	Turn off DO/ Continue working mode/ DO substitute a value/ DO keep last value	Turn off DO
Encoder parameters		
Signal evaluation A, B	Rotary encoder single/double/quadruple	Rotary encoder single
Diagnostics A and B	Off/on	Off
Diagnostics N	Off/on	Off
Direction input B	Normal/inverted	Normal
Output parameters		
Function DO1	Output/ Switch on at count ≥ comparison value/ Switch on at count ≤ comparison value/ Pulse on reaching the comparison value/ Switch at comparison values	Output
Function DO2	Output/ Switch on at count ≥ comparison value/ Switch on at count ≤ comparison value/ Pulse on reaching the comparison value	Output
Substitute value DO1	0/1	0
Substitute value DO2	0/1	0
Diagnostics DO1[1]	Off/on	Off
Diagnostics DO2[1]	Off/on	Off
Hysteresis DO1, DO2	0...255	0
Pulse duration [2 ms] DO1, DO2	0...255	0

Parameter	Value Range	Default
Mode		
Counting mode	Continuous counting/ One-time counting/ Periodic counting	Count continuously
Gate function	Cancel counting/ Interrupt counting	Cancel counting
Input signal HW gate	Normal/inverted	Normal
Function DI	Input/ HW gate/ Latch and retrigger at positive edge/ Synchronization at positive edge/ Latch at positive edge/ HW enable for synchronization	Input
Synchronization[2]	Once only/Periodic	Once-only
Main count direction	None/Up/Down	None
High counting limit	2 … 7FFF FFFF	7FFF FFFF
[1] DO1/DO2 diagnostics (wire break) is possible only with pulse lengths of > 90 ms on digital output DO1/DO2. [2]Only relevant if Function DI = Synchronization on positive edge or HW enable for synchronization		

Parameter Assignment Error

- Incorrect mode
- Incorrect main count direction
- The "Input signal HW gate" parameter is set to inverted and the "Function DI" parameter is not set to HW gate.
- High counting limit incorrect
- The value for the behavior of DO2 is not set to output although "Switch at comparison values" has been assigned for DO1.
- The value for hysteresis does not equal 0 although "Switch at comparison values" has been assigned for DO1.
- Function DI incorrect
- "On" is set for diagnostics N although "Off" was set for diagnostics A and B.

What to Do in the Event of Errors

Check the set value ranges.

3.7 Measurement Modes

3.7.1 Overview

Introduction

You can choose between the following modes:

- Frequency Measurement
- Period Measurement
- Rotational Speed Measurement

To execute one of these modes, you have to assign parameters to the 1Count5V/500kHz.

Measurement Process

The measurement is carried out during the parameter assignment integration time. When the integration time elapses, the measured value is updated.

The end of a measurement is indicated by the STS_CMP1 status bit. This bit is reset by the RES_STS control bit at the control interface.

If there were not at least two rising edges in the integration time which has been assigned parameters, 0 is returned as the measured value.

A value of -1 is returned by the end of the first integration time.

You can change the integration time for the next measurement during operation.

Reversal of the direction of rotation

If the direction of rotation is reversed during an integration time, the measured value for this measurement period is uncertain. If you evaluate the STS_C_UP and STS_C_DN feedback bits (direction evaluation), you can respond to any process irregularities.

Gate Control

To control the 1Count5V/500kHz, you have to use the gate functions.

Clocked Mode

In clocked mode the 1Count5V/500kHz accepts the control bits and control values from the control interface in each PROFIBUS DP cycle and reports back the response to them in the same cycle.

In each cycle the 1Count5V/500kHz transfers a measured value and the status bits that were valid at the time T_i.

The measurement starts and ends at the time T_i.

Integration Time in Clocked Mode

If the integration time lasts several T_{DP} cycles, you can recognize the new measurement value in the user program on status bit STS_CMP1 (measurement completed) of the feedback interface. This makes it possible to monitor the measurement procedure or for it to be synchronized. It takes 4 T_{DP} cycles, however, for this message to be acknowledged. The minimum integration time in this case is (4 x T_{DP}).

If the application can tolerate a jitter in the integration time of a T_{DP} and a measured value that remains constant for several cycles, you don't have to continually evaluate status bit STS_CMP1. Integration times of (1 x T_{DP}) to (3 x T_{DP}) are then possible.

Because clocking was lost in the last T_{DP} cycle of the integration time, the integration time is increased by one T_{DP} cycle. This does not corrupt the measured value.

NOTICE
The value range limits for the integration time must not be exceeded (see table for every separate measuring mode). If the range limits are violated, this results in a parameter assignment error, and the 1Count5V/500kHz does not go into clocked mode.

Note

When you change the configuration from non-clocked to clocked mode and vice versa, you must always adjust the integration time parameter if you want to keep the length of the integration time.

See also

Parameter Assignment for Measurement Modes (Page 209)

3.7.2 Sequence of continuous-action measurement

Measuring Principle

The 1Count5/500kHz counts each positive edge of a pulse and assigns it a time value in µs.

The update time indicates the time interval at which the measured value is updated by the module in the feedback interface.

The following applies for a pulse train with one or more pulse trains per update time:

Dynamic measuring time =	Time of last pulse in the current update time interval
	minus
	Time of last pulse in the previous update time interval

When the update time has elapsed, a new measured value is calculated and output with the dynamic measuring time.

If the current update time does not contain a pulse, the following dynamic measuring time results:

Dynamic measuring time =	Time of current, elapsed update time
	minus
	Time of last pulse

When the update time has elapsed, an estimated measured value is calculated with the dynamic measuring time under the assumption that a pulse occurred at the end of the update time.

If the "1 Pulse per dynamic measuring time" estimated measured value is less than the last measured value during the frequency and speed measurement, this estimated measured value is output as the new measured value. With the period measurement, the dynamic measuring time is output as the estimated period if the dynamic measuring time is greater than the last measured period.

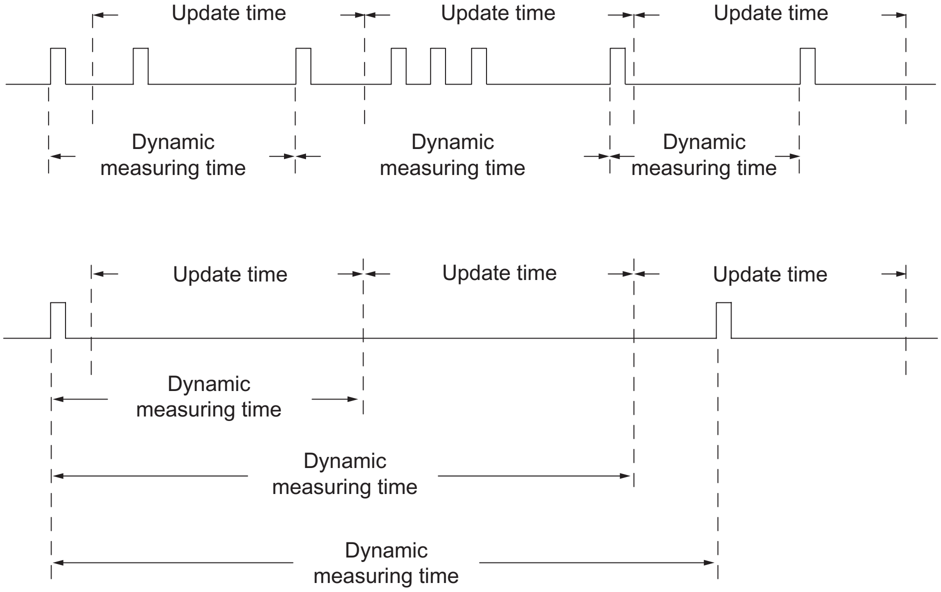


Figure 3-22 Measuring Principle

The 1Count5V/500kHz measures continuously. When assigning parameters, you specify an update time.

During the time until the end of the first elapsed update time, a value of "-1" is returned.

The continuous measurement begins after the gate is opened with the first pulse of the pulse train to be measured. The first measured value can be calculated after the second pulse, at the earliest.

A measured value (frequency, period, or speed) is output in the feedback interface each time the update time elapses. The end of a measurement is indicated with the STS_CMP1 status bits. This bit is reset with the RES_STS and RES_STS_A bits according to the complete acknowledgement principle.

If the direction of rotation is reversed during an update time, the measured value for this measurement period is undefined. By evaluating the STS_C_DN and STS_C_UP feedback bits (direction evaluation), you can respond to any process irregularities.

The following figure illustrates the principle of continuous measurement using frequency measurement as an example.

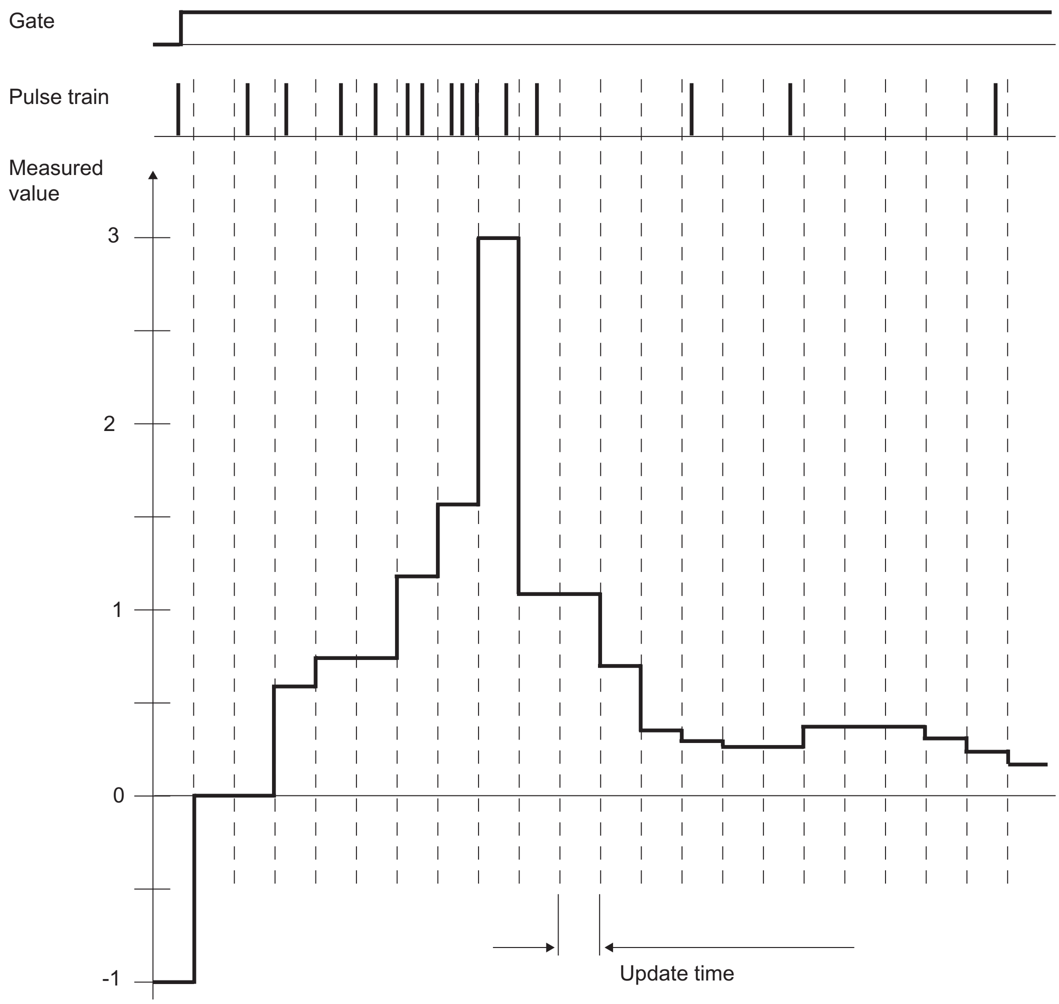


Figure 3-23 Principle of Continuous Measurement (Frequency Measurement Example)

Gate Control

To control the 1Count5V/500kHz, you have to use the gate functions.

Isochrone Mode

In isochrone mode, the 1Count5V/500kHz accepts control bits and control values from the control interface in each bus cycle and reports back the response in the same cycle.

In each cycle, the 1Count5V/500kHz transfers a measured value and the status bits that were valid at the time T_i.

The measurement starts and ends at time T_i.

Integration Time/Update Time in Isochrone Mode

If the integration time/update time lasts several T_{DP} cycles, you can recognize the new measured value in the user program at the bit STS_CMP1 status bit (measurement completed) of the feedback interface. This enables monitoring of the measuring operation or a synchronization with the measuring operation. It takes 4 T_{DP} cycles, however, for this message to be acknowledged. The minimum integration time/update time in this case is (4 x T_{DP}).

If the application can tolerate a jitter in the integration time of a T_{DP} and a measured value that remains constant for several cycles, you don't have to continually evaluate status bit STS_CMP1. Integration times/update times of (1 x T_{DP}) to (3 x T_{DP}) are then possible.

Because isochronous operation was lost in the last T_{DP} cycle of the integration time, the integration time is increased by one T_{DP} cycle. This does not corrupt the measured value.

Note

The value range limits for the integration time/update time must not be exceeded (see tables for the individual measuring modes).

A violation of the value range limits will result in a parameter assignment error, and the 1Count5V/500kHz will not go into isochrone mode.

Note

When you change the configuration from non-isochrone to isochrone mode and vice versa, you must always adjust the integration time/update time parameter if you want to keep the length of the integration time/update time.

3.7.3 Frequency Measurement

Definition

In frequency measurement mode, the 1Count5V/500kHz counts the pulses that arrive within a set integration time.

Integration time

You preset the integration time with the Integration Time parameter (see table).

Table 3-10 Calculation of the Integration Time

<table>
<tr><th colspan="2" rowspan="2">Boundary conditions</th><th rowspan="2">Integration time</th><th colspan="2">Range of n</th></tr>
<tr><th>n_{min}</th><th>n_{max}</th></tr>
<tr><td>Non-isochrone mode</td><td>Any T_{DP}</td><td>n x 10 ms</td><td>1</td><td>1000</td></tr>
<tr><td rowspan="2">Isochrone mode</td><td>T_{DP} < 10 ms</td><td>n x T_{DP}</td><td>(10 ms/T_{DP} [ms]) +1 [1]</td><td>1000</td></tr>
<tr><td>$T_{DP} \geq$ 10 ms</td><td>n x T_{DP}</td><td>1</td><td>1000 ms/T_{DP} [ms] [1]</td></tr>
<tr><td colspan="5">[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count5V/500kHz generates a parameter assignment error and will not go into isochrone mode.</td></tr>
</table>

Frequency Measurement

The value of the calculated frequency is made available in the unit Hz*10^{-3}. The measured frequency value can be read in the feedback interface (byte 0 to 3).

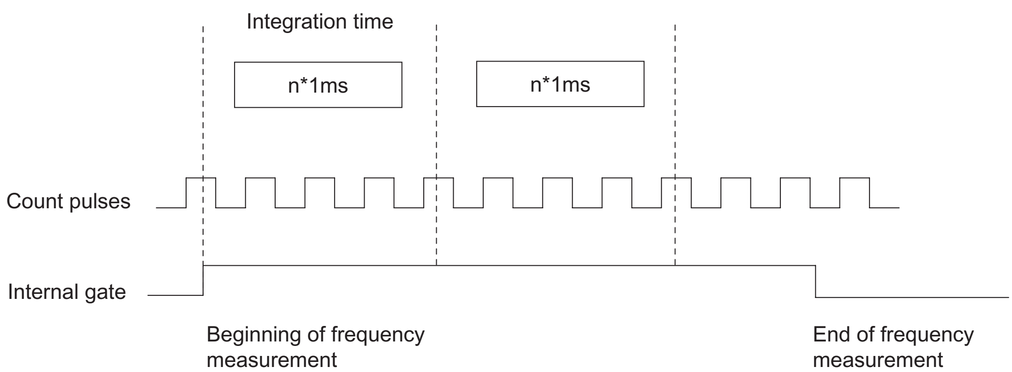


Figure 3-24 Frequency Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Low limit f_u	High limit f_o
0 to 499,999,999 Hz*10^{-3}	f_u+1 to 500,000,000 Hz*10^{-3}

Possible Measuring Ranges with Error Indication

Integration time	f_{min} ± absolute error	f_{max} ± absolute error
10 s	0.1 Hz ± 0.001 Hz	500 000 Hz ± 90 Hz
1 s	1 Hz ± 0.001 Hz	500 000 Hz ± 55 Hz
0.1 s	10 Hz ± 0.002 Hz	500 000 Hz ± 52 Hz
0.01 s	100 Hz ± 0.013 Hz	500 000 Hz ± 63 Hz

See also

Gate Functions in Measurement Modes (Page 199)

Behavior of the Outputs in Measurement Modes (Page 200)

Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 202)

3.7.4 Continuous Frequency Measurement

Definition

In frequency measurement mode, the 1Count5V/500kHz counts the pulses that arrive within a dynamic measuring time.

Update time

The 1Count5V/500kHz updates the measured values cyclically. You preset the update time with the Update Time parameter (see table). You can change the update time during operation.

Table 3-11 Calculation of the Update Time

Boundary conditions		**Update time**	**Range of n**	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	1000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	(10 ms/T_{DP} [ms]) +1 [1]	1000
	T_{DP} ≥ 10 ms	n x T_{DP}	1	1000 ms/T_{DP} [ms] [1]

[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count5V/500kHz generates a parameter assignment error and will not go into isochrone mode.

Frequency Measurement

The value of the calculated frequency is made available in the unit Hz*10^{-3}. The measured frequency value can be read in the feedback interface (byte 0 to 3).

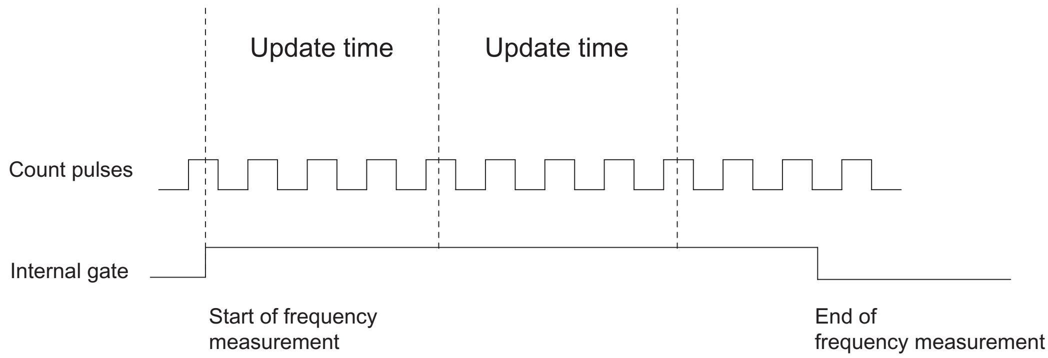


Figure 3-25 Frequency Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Encoder type	Low limit f_u	High limit f_o
5-V encoders	0 to 499,999,999 Hz*10^{-3}	f_u+1 to 500,000,000 Hz*10^{-3}

Possible Measuring Ranges with Error Indication

Frequency f	Absolute error
0.1 Hz	±0.001 Hz
1 Hz	±0.001 Hz
10 Hz	±0.003 Hz
100 Hz	±0.02 Hz
1 000 Hz	±0.18 Hz
10 000 Hz	±1.8 Hz
100 000 Hz	±18 Hz
500 000 Hz	±90 Hz

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate

Function of the Digital Output DO1

For the "Function DO1" parameter, select one of the following functions for the DO1 digital output:

- Output (no switching by the limit-value monitoring)
- Measured value outside the limits
- Measured value under the low limit
- Measured value over the high limit

Function of the Digital Output DO2

- Output

Changing Values during Operation

The following values can be changed during operation:

- Low limit (LOAD_PREPARE)
- High limit (LOAD_VAL)
- Function of the Digital Output DO1 (C_DOPARAM)
- Integration time/update time (C_INTTIME)

See also

Gate Functions in Measurement Modes (Page 199)

Behavior of the Outputs in Measurement Modes (Page 200)

Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 202)

3.7.5 Rotational Speed Measurement

Definition

In rotational speed measurement mode, the 1Count5V/500kHz counts the pulses that arrive from a tachometer generator within a set integration time and calculates the speed of the connected motor.

Integration time

You preset the integration time with the Integration Time parameter.

Table 3-12 Calculation of the Integration Time

Boundary conditions		Integration time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	1000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	(10 ms/T_{DP} [ms]) +1 [1]	1000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	1000 ms/T_{DP} [ms] [1]

[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count5V/500kHz generates a parameter assignment error and will not go into isochrone mode.

Rotational Speed Measurement

For rotational speed measurement mode, you also have to assign the pulses per encoder or motor revolution.

The rotational speed is returned in the unit $1x10^{-3}$ /min.

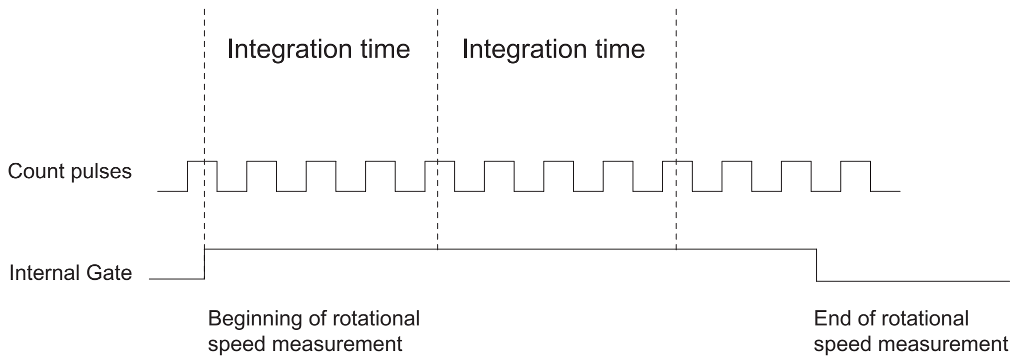


Figure 3-26 Rotational Speed Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Low limit n_u	High limit n_o
0 to 24 999 999 x10^{-3} /min	n_u+1 to 25 000 000 *10^{-3} /min

Possible Measuring Ranges with Error Indication

Table 3-13 Possible Measuring Ranges with Error Indication (Number of Pulses per Encoder Revolution = 60)

Integration time	n_{min} ± absolute error	n_{max} ± absolute error
10 s	1 /min ± 0.03 /min	25 000 /min ± 4.5 /min
1 s	1 /min ± 0.03 /min	25 000 /min ± 2.8 /min
0.1 s	10 /min ± 0.03 /min	25 000 /min ± 2.6 /min
0.01 s	100 /min ± 0.04 /min	25 000 /min ± 3.2 /min

3.7.6 Continuous Rotational Speed Measurement

Definition

In rotational speed measurement mode, the 1Count5V/500kHz counts the pulses that are received from a tachometer generator within a dynamic measuring time, and calculates the speed from this value with the number of pulses per encoder revolution.

Update Time

The 1Count5V/500kHz updates the measured values cyclically. You preset the update time with the Update Time parameter (see table). You can change the update time during operation.

Table 3-14 Calculation of the Integration Time

Boundary conditions		Update time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	1000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	(10 ms/T_{DP} [ms]) +1 [1]	1000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	ms/T_{DP} [ms] [1]
[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted. These limits must not be violated. If these limits are violated, the 1Count5V/500kHz generates a parameter assignment error and will not go into isochrone mode.				

Rotational Speed Measurement

For rotational speed measurement mode, you also have to assign the pulses per encoder or motor revolution.

The rotational speed is returned in the unit 1×10^{-3} /min.

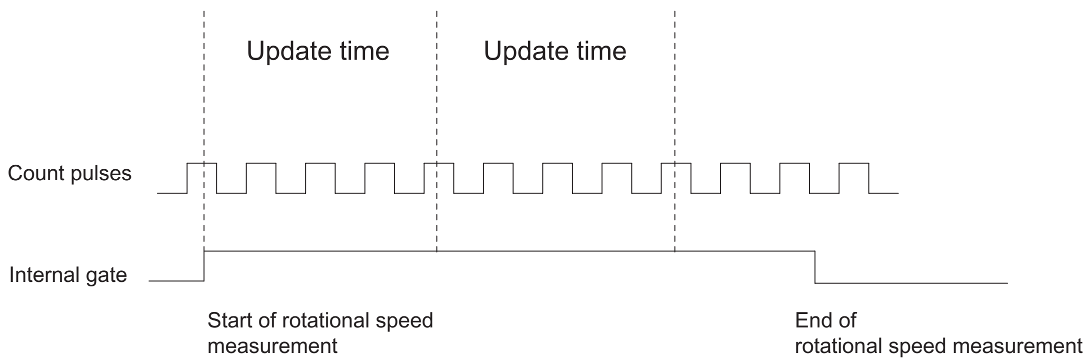


Figure 3-27 Rotational Speed Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

Low limit n_u	High limit n_o
0 to 24 999 999 x10^{-3} /min	n_u+1 to 25 000 000 *10^{-3} /min

Possible Measuring Ranges with Error Indication (Number of Pulses per Encoder Revolution = 60)

Rotational speed n	Absolute error
1 /min	±0.04 /min
10 /min	±0.04 /min
100 /min	±0.05 /min
1 000 /min	±0.21 /min
10 000 /min	±1.82 /min
25 000 /min	±4.5 /min

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate

Function of the Digital Output DO1

For the "Function DO1" parameter, select one of the following functions for the DO1 digital output:

- Output (no switching by the limit-value monitoring)
- Measured value outside the limits
- Measured value under the low limit
- Measured value over the high limit

Function of the Digital Output DO2

- Output

Changing Values during Operation

The following values can be changed during operation:

- Low limit (LOAD_PREPARE)
- High limit (LOAD_VAL)
- Function of the Digital Output DO1 (C_DOPARAM)
- Integration time/update time (C_INTTIME)

See also

Gate Functions in Measurement Modes (Page 199)

Behavior of the Outputs in Measurement Modes (Page 200)

Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 202)

3.7.7 Period Measurement

Definition

In period measurement mode, the 1Count5V/500kHz measures the time between two positive edges of the counting signal by counting the pulses of an internal quartz-accurate reference frequency (16 MHz) within a set integration time.

Integration Time

You preset the integration time with the Integration Time parameter (see the table below).

Boundary conditions		Integration time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	12000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	10 ms/T_{DP} [ms] +1 [1]	12000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	120 000 ms/T_{DP} [ms] [1]

[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted.
These limits must not be violated. If these limits are violated, the 1Count5V/500kHz generates a parameter assignment error and will not go into isochrone mode.

Period Measurement

The value of the calculated period is given in the unit 1 µs and 1/16 µs. The measured period can be read in the feedback interface (byte 0 to 3).

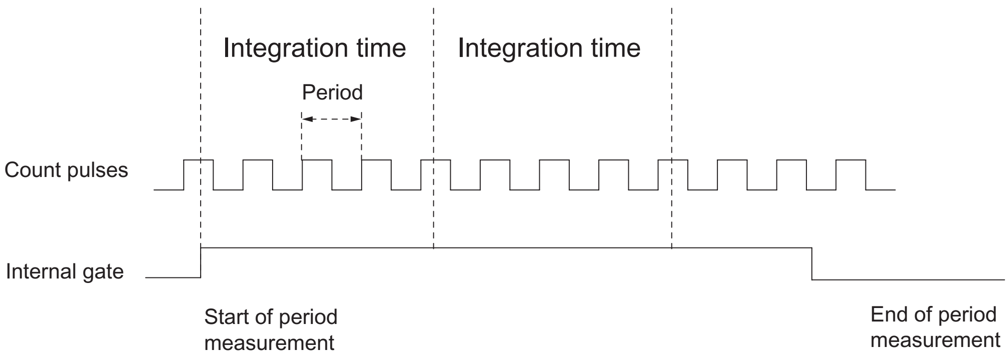


Figure 3-28 Period Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

1 μs resolution

Low limit T_u	High limit T_o
0 to 119 999 999 μs	T_u+1 to 120 000 000 μs

1/16 μs resolution

Low limit T_u	High limit T_o
0 to 1 919 999 999 μs	T_u+1 to 1 920 000 000 μs

Possible Measuring Ranges with Error Indication

1 μs resolution

Integration time	T_{min} ± absolute error	T ± absolute error
100 s	1 μs* (10 ± 0)	1 μs* (100 000 000 ± 10 000)
10 s	1 μs* (10 ± 0)	1 μs* (10 000 000 ± 1 000)
1 s	1 μs* (10 ± 0)	1 μs* (1 000 000 ± 100)
0.1 s	1 μs* (10 ± 0)	1 μs* (100 000 ± 10)
0.01 s	1 μs* (10 ± 0)	1 μs* (10 000 ± 1)

1/16 μs resolution

Integration time	T_{min} ± absolute error	T ± absolute error
100 s	1/16 μs* (160 ± 0)	1/16 μs* (1 600 000 000 ± 160 000)
10 s	1/16 μs* (160 ± 0)	1/16 μs* (160 000 000 ± 16 000)
1 s	1/16 μs* (160 ± 0)	1/16 μs* (16 000 000 ± 1 600)
0.1 s	1/16 μs* (160 ± 0)	1/16 μs* (1 600 000 ± 160)
0.01 s	1/16 μs* (160 ± 0)	1/16 μs* (160 000 ± 16)

See also

Gate Functions in Measurement Modes (Page 199)

Behavior of the Outputs in Measurement Modes (Page 200)

Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 202)

3.7.8 Continuous Period Measurement

Definition

In period measurement mode, the 1Count5V/500kHz indicates the dynamic measuring time as a period. If the period is less than the update time, then an average is calculated for the period.

Update Time

The 1Count5V/500kHz updates the measured values cyclically. You preset the update time with the Update Time parameter (see table). You can change the update time during operation.

Boundary conditions		Update time	Range of n	
			n_{min}	n_{max}
Non-isochrone mode	Any T_{DP}	n x 10 ms	1	12000
Isochrone mode	T_{DP} < 10 ms	n x T_{DP}	10 ms/T_{DP} [ms] +1 [1]	12000
	$T_{DP} \geq$ 10 ms	n x T_{DP}	1	120 000 ms/T_{DP} [ms] [1]
[1] Any digits after the decimal point that come about after dividing by T_{DP} are omitted. These limits must not be violated. If these limits are violated, the 1Count5V/500kHz generates a parameter assignment error and will not go into isochrone mode.				

Period Measurement

The value of the calculated period is given in the unit 1 µs and 1/16 µs. The measured period can be read in the feedback interface (byte 0 to 3).

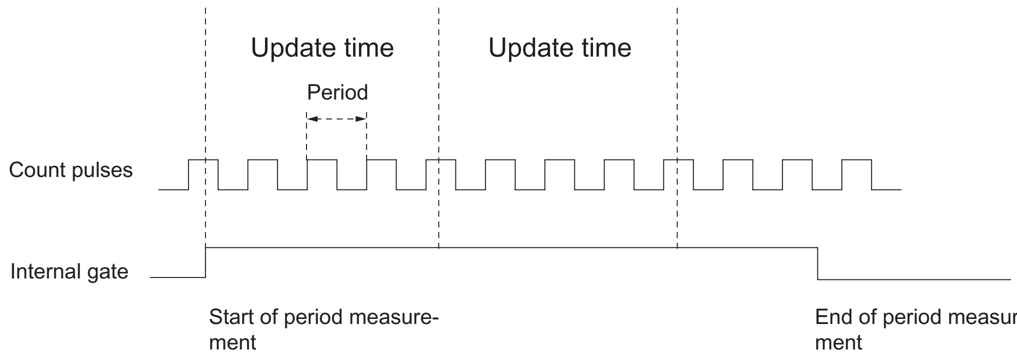


Figure 3-29 Period Measurement with Gate Function

Limit-Value Monitoring

The following value ranges are permitted for limit-value monitoring:

1 μs resolution

Low limit T_u	High limit T_o
0 to 119 999 999 μs	T_u+1 to 120 000 000 μs

1/16 μs resolution

Low limit T_u	High limit T_o
0 to 1 919 999 999 μs	T_u+1 to 1 920 000 000 μs

Possible Measuring Ranges with Error Indication

1 μs resolution

Period T_{min} ± absolute error	Period T_{min} ± absolute error
1 μs* (10 ± 0)	1 μs* (100 000 ± 10)
1 μs* (100 ± 0)	1 μs* (1 000 000 ± 100)
1 μs* (1 000 ± 0)	1 μs* (10 000 000 ± 1 002)
1 μs* (10 000 ± 1)	1 μs* (100 000 000 ± 10 020)

1/16 μs resolution

Period T_{min} ± absolute error	Period T_{min} ± absolute error
1/16 μs* (160 ± 1)	1/16 μs* (1 600 000 ± 160)
1/16 μs* (1 600 ± 1)	1/16 μs* (16 000 000 ± 1 600)
1/16 μs* (16 000 ± 3)	1/16 μs* (160 000 000 ± 16 000)
1/16 μs* (160 000 ± 20)	1/16 μs* (1 600 000 000 ± 160 000)

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate

Function of the Digital Output DO1

For the "Function DO1" parameter, select one of the following functions for the digital output:

- Output (no switching by the limit-value monitoring)
- Measured value outside the limits
- Measured value under the low limit
- Measured value over the high limit

Function of the Digital Output DO2

- Output

Changing Values during Operation

The following values can be changed during operation:

- Low limit (LOAD_PREPARE)
- High limit (LOAD_VAL)
- Function of the digital output DO1 (C_DOPARAM)
- Integration time/update time (C_INTTIME)

See also

Gate Functions in Measurement Modes (Page 199)

Behavior of the Outputs in Measurement Modes (Page 200)

Assignment of the Feedback and Control Interfaces for the Measurement Modes (Page 202)

3.7.9 Gate Functions in Measurement Modes

Software Gate and Hardware Gate

The 1Count5V/500kHz has two gates

- A software gate (SW gate), which is controlled by the SW_GATE control bit.

  The software gate can only be opened by a positive edge of the SW_GATE control bit. It is closed when this bit is reset. Note the transfer times and run times of your control program.
- A hardware gate (HW gate), which is controlled by means of the digital input on the 1Count5V/500kHz. You assign the hardware gate as the function of the digital input (Function DI "HW gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

Internal gate

The internal gate is the logical AND operation of the HW gate and SW gate. Counting is only active when the HW gate and the SW gate are open. The STS_GATE feedback bit (internal gate status) indicates this. If a HW gate has not been assigned, the setting of the SW gate is decisive.

Gate Control

Gate control by means of the SW gate only

The opening/closing of the SW gate starts/stops measurement.

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, measurement starts at time T_i in cycle "n+1".

Gate control by means of the SW gate and HW gate

The opening and closing of the SW gate with the HW gate open starts/stops measurement.

The opening and closing of the HW gate with the SW gate open starts/stops measurement.

The SW gate is opened/closed by means of the control interface with the SW_GATE bit.

The HW gate is opened/closed by means of a 24-V signal on the digital input.

In isochrone mode, when the SW gate is open, measurement starts at time T_i, immediately after the HW gate has opened. The measurement ends at time T_i, which occurs immediately after the HW gate has closed.

When the HW gate is open, the measurement starts at time T_i in the cycle, immediately after the SW has opened, and ends at time T_i in the cycle, which occurs immediately after the SW gate has closed.

3.7.10 Behavior of the Outputs in Measurement Modes

Introduction

The various ways of setting the behavior of the outputs are described in this section.

Behavior of the Outputs in Measurement Modes

You can assign parameters to the digital outputs of the 1Count5V/500kHz.

You can store a high and a low limit for frequency measurement, rotational speed measurement or period measurement. If the limits are violated, digital output DO1 is activated. These limit values can be assigned and changed with the load function.

You can change the function and the behavior of the digital outputs during operation. The new function takes effect immediately. In isochrone mode it always takes effect at time T_i.

You can choose from the following functions:

- Output
- Measured value outside the limits (limit-value monitoring)
- Measured value under the low limit (limit-value monitoring)
- Measured value over the high limit (limit-value monitoring)

Output

If you want to switch the outputs on or off, you must enable them with the CTRL_DO1 and CTRL_DO2 control bits.

You can switch the outputs on and off with the control bits SET_DO1 and SET_DO2.

You can query the status of the outputs with the status bits STS_DO1 and STS_DO2 in the feedback interface.

In isochrone mode, the outputs are switched at time T_o.

Limit-Value Monitoring

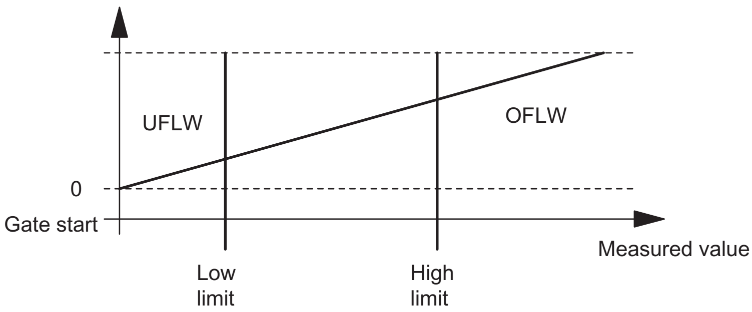


Figure 3-30 Limit-Value Monitoring

After the integration time elapses, the measured value obtained (frequency, rotational speed, or period) is compared with the assigned limit values.

If the current measured value is under the assigned low limit (measured value < low limit), bit STS_UFLW = 1 is set in the feedback interface.

If the current measured value is over the assigned high limit (measured value > high limit), bit STS_OFLW = 1 is set in the feedback interface.

You must acknowledge these bits with the RES_STS control bit.

If the measured value is still outside or again outside the limits after acknowledgment, the corresponding status bit is set again.

If you set the low limit at 0, you switch off dynamic monitoring of violation of the low limit value.

Depending on the parameter assignment, the enabled digital output DO1 can be set by the limit-value monitoring:

"Function DO1" parameter	DO1 is set ...
Measured value outside the limits	Measured value < low limit OR measured value > high limit
Measured value under the low limit	Measured value < low limit
Measured value over the high limit	Measured value > high limit

In isochrone mode, the output is switched at time T_i.

3.7.11 Assignment of the Feedback and Control Interfaces for the Measurement Modes

Note

The following data of the control and feedback interfaces are consistent for the 1Count5V/500kHz:

Bytes 0 to 3

Bytes 4 to 7

Bytes 8 to 11 (modified user data interface)

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Assignment Tables

Table 3-15 Feedback Interface (Inputs)

Address	Assignment	Designation
Bytes 0 to 3	Measured value	
Byte 4	Bit 7: Short circuit of the encoder supply	ERR_24V
	Bit 6: Short circuit / wire break / overtemperature	ERR_DO
	Bit 5: Parameter assignment error	ERR_PARA
	Bit 4: Short circuit / wire break / overtemperature	ERR_DO2
	Bit 3: Short circuit / wire break / encoder signal	ERR_ENCODER
	Bit 2: Resetting of status bits active	RES_STS_A
	Bit 1: Load function error	ERR_LOAD
	Bit 0: Load function is running	STS_LOAD
Byte 5	Bit 7: Down direction status	STS_C_DN
	Bit 6: Up direction status	STS_C_UP
	Bit 5: Reserve = 0	
	Bit 4: DO2 status	STS_DO2
	Bit 3: DO1 status	STS_DO1
	Bit 2: Reserve = 0	
	Bit 1: DI status	STS_DI
	Bit 0: Internal gate status	STS_GATE
Byte 6	Bit 7: Reserve = 0	
	Bit 6: Low limit of measuring range	STS_UFLW
	Bit 5: High limit of measuring range	STS_OFLW
	Bit 4: Reserve = 0	
	Bit 3: Measurement completed	STS_CMP1
	Bit 2: Reserve = 0	
	Bit 1: Reserve = 0	
	Bit 0: Reserve = 0	

Address	Assignment	Designation
Byte 7	Reserve = 0	
Bytes 8 to 11	Count value [1]	
[1] Modified user data interface		

Table 3-16 Control Interface (Outputs)

<table>
<tr><th>Address</th><th colspan="4">Assignment</th></tr>
<tr><td rowspan="9">Bytes 0 to 3</td><td colspan="4">Low limit or high limit</td></tr>
<tr><td colspan="4">Function of DO1</td></tr>
<tr><td>Byte 0:</td><td>Bit 1
0
0
1
1</td><td>Bit 0
0
1
0
1</td><td>Function DO1
Output
Measured value outside the limits
Measured value under the low limit
Measured value over the high limit</td></tr>
<tr><td colspan="2">Bytes 1 to 3:</td><td colspan="2">Reserve = 0</td></tr>
<tr><td colspan="4">Integration time/update time</td></tr>
<tr><td>Byte 0, 1:

Byte 2, 3:</td><td colspan="3">Integration time [n*10ms]
(Range 1 to 1000/12000)
Reserve = 0</td></tr>
<tr><td>Byte 4</td><td>Bit 7:
Bit 6:
Bit 5:
Bit 4:
Bit 3:
Bit 2:
Bit 1:
Bit 0:</td><td colspan="3">Error diagnostics acknowledgement EXTF_ACK
Enable DO2 CTRL_DO2
Control bit DO2 SET_DO2
Enable DO1 CTRL_DO1
Control bit DO1 SET_DO1
Start resetting of status bit RES_STS
Reserve = 0
SW gate control bit SW_GATE</td></tr>
<tr><td>Byte 5</td><td>Bit 7:
Bit 6:
Bit 5:
Bit 4:
Bit 3:
Bit 2:
Bit 1:
Bit 0:</td><td colspan="3">Reserve = 0
Reserve = 0
Reserve = 0
Change function of DO1, C_DOPARAM
Reserve = 0
Change integration time, C_INTTIME
Load high limit LOAD_PREPARE
Load low limit LOAD_VAL</td></tr>
<tr><td>Bytes 6 to 7</td><td colspan="4">Reserve = 0[1]</td></tr>
<tr><td colspan="5">[1] Not used for modified user interface</td></tr>
</table>

Notes on the Control Bits

Table 3-17 Notes on the Control Bits

Control bits	Notes
C_DOPARAM	Change function of DO1 (see figure below) The value from byte 0 is adopted as the new function of DO1.
C_INTTIME	Change integration time (see figure below) The value from bytes 0 and 1 is adopted as the new integration time for the next measurement.
CTRL_DO1	Enable DO1 You use this bit to enable the DO1 output.
CTRL_DO2	Enable DO2 You use this bit to enable the DO2 output.
EXTF_ACK	Error acknowledgment The error bits must be acknowledged with the EXTF_ACK control bit after the cause is removed. (see figure below)
LOAD_PREPARE	Load high limit (see figure below) The value from bytes 0 to 3 is adopted as the new high limit.
LOAD_VAL	Load low limit (see figure below) The value from bytes 0 to 3 is adopted as the new low limit.
RES_STS	Start resetting of status bit The status bits are reset by means of the acknowledgment process between the RES_STS bit and the RES_STS_A bit. (see figure below)
SET_DO1	Control bit DO1 Switches the DO1 digital output on and off when CTRL_DO1 is set.
SET_DO2	Control bit DO2 Switches the DO2 digital output on and off when CTRL_DO2 is set.
SW_GATE	SW gate control bit The SW gate is opened/closed via the control interface with the SW_GATE bit.

Notes on the Feedback Bits

Table 3-18 Notes on the Feedback Bits

Feedback bits	Notes
ERR_24V	Short circuit of the encoder supply The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_DO1	Short circuit/wire break/overtemperature at output DO1 The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_DO2	Short circuit/wire break/overtemperature at output DO2 The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_ENCODER	Short circuit / wire break / encoder signal The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_LOAD	Load function error (see figure below) The LOAD_VAL, LOAD_PREPARE, C_DOPARAM, and C_INTTIME bits cannot be set simultaneously during transfer. This results in setting the ERR_LOAD status bit, similar to loading an incorrect value (which is not accepted).
ERR_PARA	Parameter assignment error ERR_PARA
RES_STS_A	Resetting of the status bits active (see figure below)
STS_C_DN	Down direction status
STS_C_UP	Up direction status
STS_CMP1	Measurement completed After every elapsed time interval (update time/integration time), the measured value is updated Measurement with integration time The end of a measurement (after the interval has elapsed) is indicated with the STS_CMP1 status bit. Continuous measurement At the end of the update time, the end of the measurement is signaled with status bit STS_CMP1 if a measured value is output. The bit remains 0 if an estimated measured value is output. This bit is reset by the RES_STS control bit in the control interface.
STS_DI	DI status The status of the DI is indicated in all modes with the STS_DI bit in the feedback interface.
STS_DO1	DO1 status
STS_DO2	DO2 status
STS_GATE	Internal gate status: Measuring
STS_LOAD	Load function running (see figure below)
STS_OFLW STS_UFLW	High measuring limit violated Low measuring limit violated Both bits must be reset.

Access to the Control and Feedback Interface in STEP 7 Programming

Table 3-19 Access to the Control and Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD file [1]) (Hardware catalog\PROFIBUS-DP\Additional FIELD DEVICES\I/O\ET 200S)	Configuring with STEP 7 using HW Config (Hardware catalog\PROFIBUS-DP\ ET 200S)
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command (e.g. L PID)
Control interface	Write with SFC 15 "DPWR_DAT"	Transfer command (e.g. T PQD)
[1] Load and transfer commands are also possible with CPU 3xxC, CPU 3xx with MMC, and CPU 4xx (V3.0 and later).		

Resetting of the Status Bits STS_CMP1, STS_OFLW, STS_UFLW

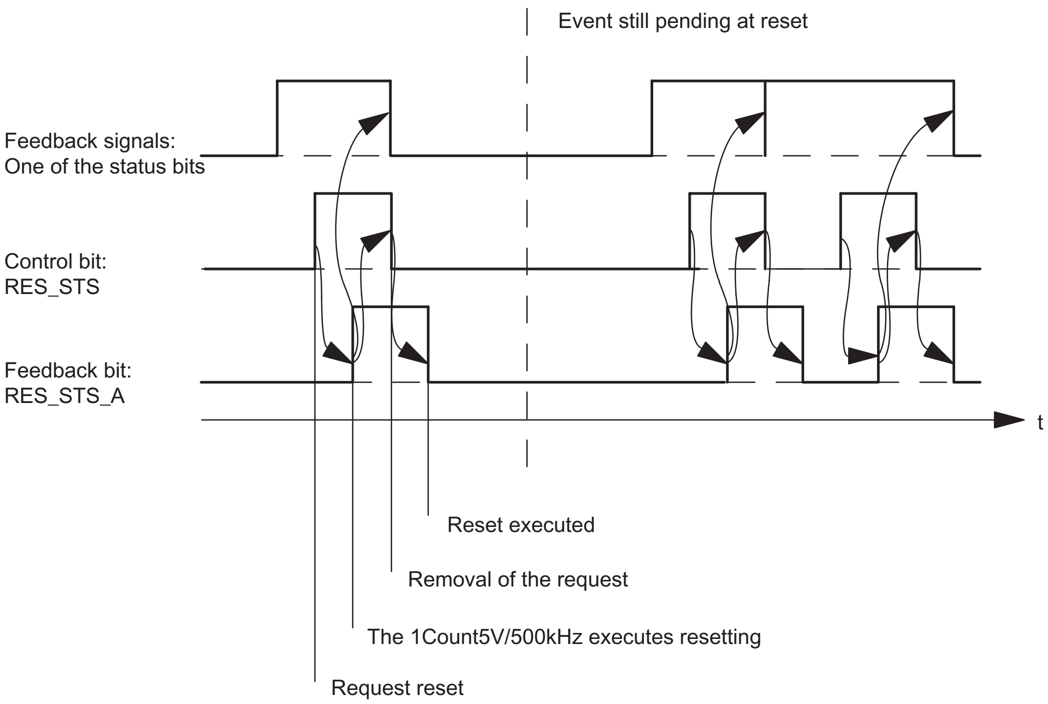


Figure 3-31 Resetting of the Status Bits

Acceptance of Values with the Load Function

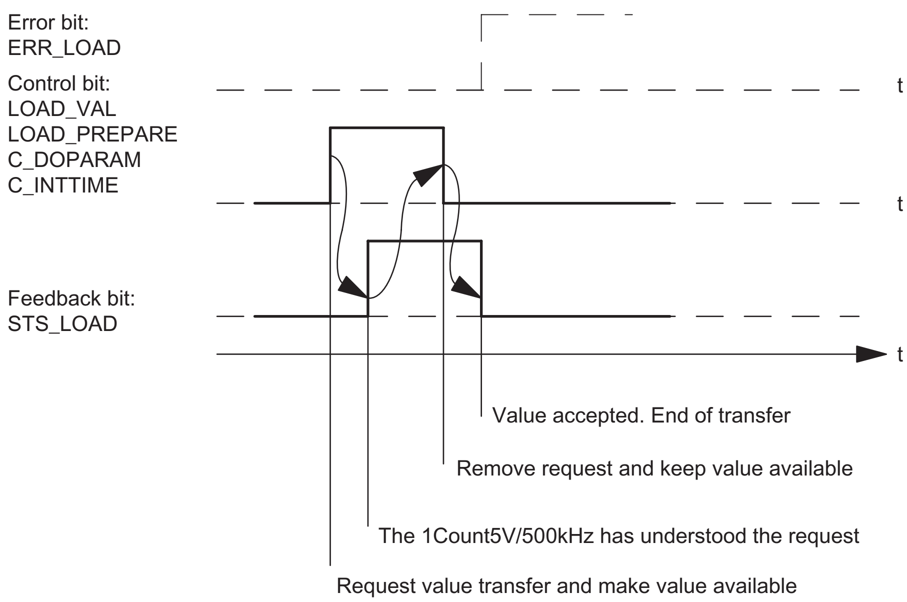


Figure 3-32 Acceptance of Values with the Load Function

Note

Only one of the following control bits can be set at a particular time:

LOAD_VAL or LOAD_PREPARE or C_DOPARAM or C_INTTIME.

Otherwise, the ERR_LOAD error is reported until all the specified control bits are deleted again.

The ERR_LOAD error bit is only deleted when a correct value is transferred as follows.

Acknowledgment Principle in Isochrone Mode

In isochrone mode, exactly 4 bus cycles are always required to reset the status bits and to accept values during the load function.

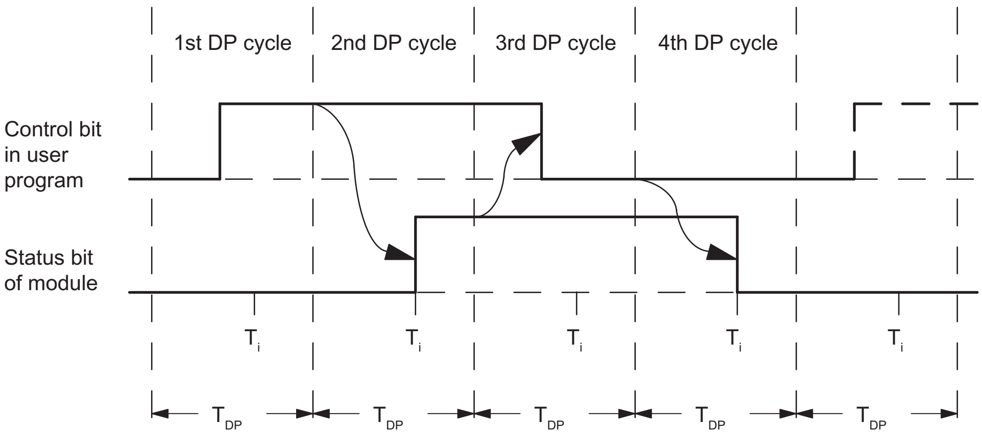


Figure 3-33 Acknowledgment Principle in Isochrone Mode

Error Detection

The diagnostic errors must be acknowledged. They have been detected by the 1Count5V/500kHz and are indicated at the feedback interface. A channel-specific diagnosis is carried out if you have enabled group diagnostics in your parameter assignment (see the *ET 200S Distributed I/O System* Manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

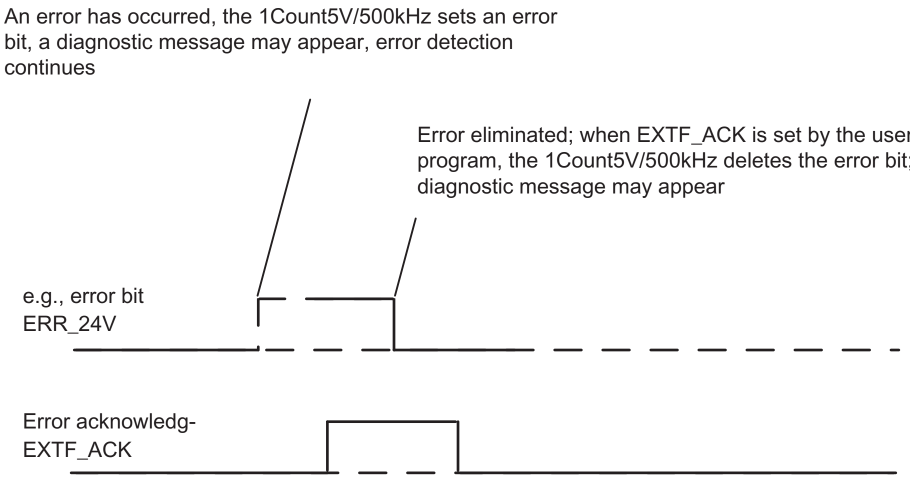


Figure 3-34 Error Acknowledgment

In the case of continuous error acknowledgment (EXTF_ACK=1) or at CPU/Master Stop, the 1Count5V/500kHz signals errors as soon as they are detected and deletes them as soon as they have been eliminated.

3.7.12 Parameter Assignment for Measurement Modes

Introduction

You can use either of the following to assign parameters for the 1Count5V/500kHz:

- A GSD file (http://www.ad.siemens.de/csi/gsd)
- STEP 7 V5.3 SP2 or later

Parameter List for Measuring Modes

Table 3-20 Parameter List for Measuring Modes

Parameter	Value Range	Default
Enable		
Group diagnostics	Disable/enable	Disable
Behavior in the event of the parent controller failing		
Behavior at CPU/Master-STOP	Turn off DO/ Continue working mode/ DO substitute a value/ DO keep last value	Turn off DO
Diagnostics A and B	Off/on	Off
Direction input B	Normal/Inverted	Normal
Output parameters		
Diagnostics DO1[1]	Off/on	Off
Diagnostics DO2[1]	Off/on	Off
Function DO1	Output/ Outside the limits/ Under the low limit/ Over the high limit	Output
Substitute value DO1	0/1	0
Substitute value DO2	0/1	0
Mode		
Measuring mode	Frequency measurement/ Rotational speed measurement/ Period measurement	Frequency measurement
Measuring method	With integration time/continuous	With integration time/
Resolution of period	1 µs 1/16 µs	1 µs
Function DI	Input/HW gate	Input
Input signal HW gate	Normal/Inverted	Normal
Low limit	Frequency measurement: 0 to f_{max}-1 Rotational speed measurement: 0 to n_{max}-1 Period measurement: 0 to T_{max}-1	 0 0 0

Parameter	Value Range	Default
High limit	Frequency measurement: Low limit+1 to f_{max} Rotational speed measurement: Low limit+1 to n_{max} Period measurement: Low limit+1 to T_{max}	 f_{max} n_{max} T_{max}
Integration time [n*10ms]	Frequency measurement: 1...1000 Rotational speed measurement: 1...1000 Period measurement: 1... 12000	 10 10 10
Encoder pulses per revolution[2]	1...65535	1
[1] DO1/DO2 diagnostics (wire break, short circuit) are possible only with pulse lengths of >90 ms on digital output DO1/DO2. [2] Only relevant in rotational speed measurement mode		

Parameter Assignment Error

The following parameter assignment errors may occur:

- Incorrect mode
- Low limit incorrect
- High limit incorrect
- Integration time incorrect
- Encoder pulses incorrect

What to Do in the Event of Errors

Check the set value ranges.

3.8 Fast mode

3.8.1 Overview

Introduction

This mode is suitable for position detection is especially short isochronous cycles.

This mode represents a subset of the functionality of the continuous counting mode.

It is intended for isochronous mode and differs from continuous counting by having a lower TDP $Module_{min}$ and a TWA equal to zero. The module is operated in this mode as a pure input module, i.e., there is no control interface in this operating mode.

This mode is available starting with FW Version V2.0 of the module. The module must be configured as "1Count5V Fast Mode V2.0" in HW Config.

Maximum Count Range

A total of 25 bits are available for the count value.

Load value

You can specify a load value for the 1Count5V.

This load value is applied directly as the start value.

Gate Control

To control the 1Count5V, you can use the HW gate.

State according to Parameter Assignment

Count value corresponds to the load value set in HW Config.

Isochronous Mode

In each cycle, the 1Count5V transfers the count and the status bits that were valid at time T_i.

See also

Assigning parameters for fast mode (Page 217)

3.8.2 Fast mode

Definition

In this mode, the 1Count5V counts continuously starting from the start value:

When counting up, if the 1Count5V reaches the maximum value that can be represented with 25 bits (all bits of the counter are set) and another count pulse arrives, the count value jumps to "0" and resumes counting from there without losing a pulse.

When counting down, if the 1Count5V reaches the value "0" and another count pulse arrives, the count value jumps to the maximum value that can be represented with 25 bits (all bits of the counter are set) and resumes counting without losing a pulse.

Function of the Digital Input

For the "Function DI" parameter, select between the following functions:

Digital input off.

- Input
- HW gate
- Synchronization on positive edge
- HW enable for synchronization

See also

Assigning parameters for fast mode (Page 217)

Synchronization (Page 213)

Gate function in the case of fast mode (Page 212)

3.8.3 Gate function in the case of fast mode

Hardware Gate

The 1Count5V has a HW gate, which can be controlled via the digital input on the 1Count5V.

You assign the hardware gate as the function of the digital input (Function DI "HW Gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

If no HW gate is assigned, counting becomes active immediately.

The STS_GATE checkback signal indicates whether counting is active.

When the HW gate is opened, this causes counting to continue starting from the current count.

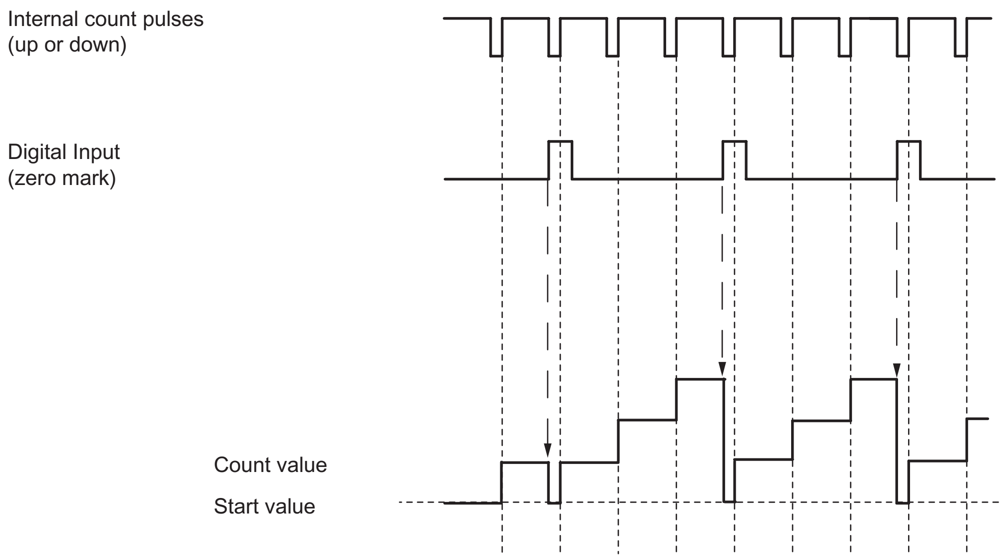
See also

Synchronization (Page 213)

3.8.4 Synchronization

Introduction

In order to use this function, you must first select it with the "Synchronize on Positive Edge" Function DI parameter.



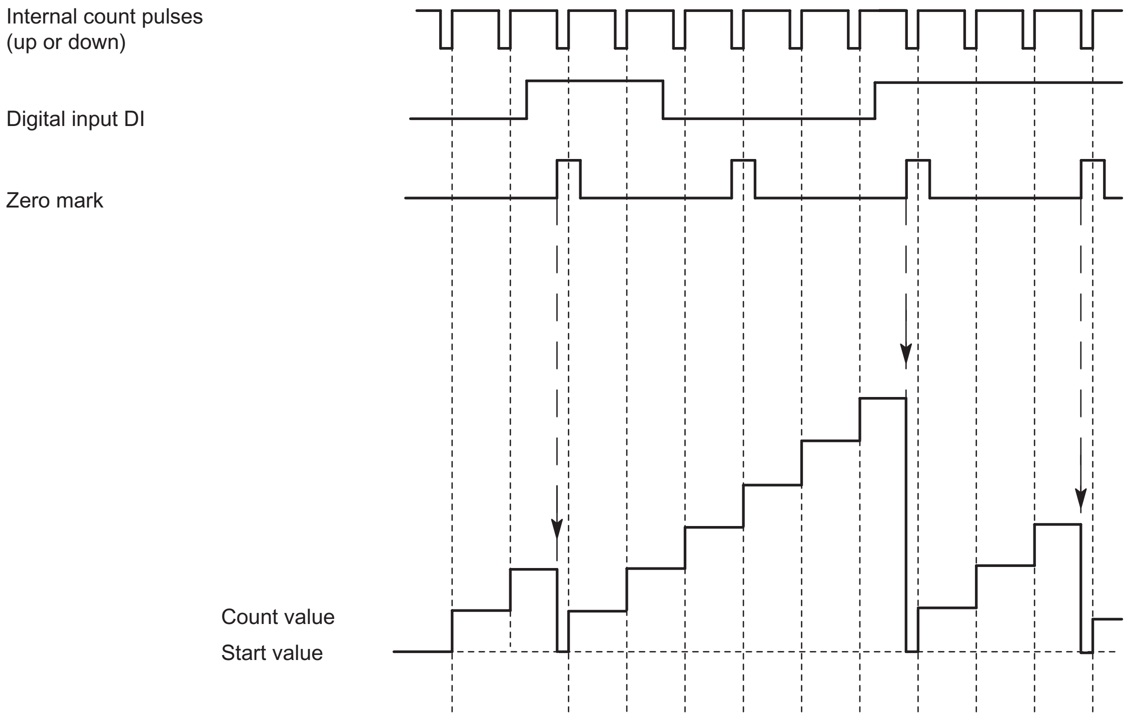
If you have assigned synchronization, the positive edge of a reference signal on the input sets the 1Count5V to the start value.

The following conditions apply:

- Fast mode must be active (HW gate).
  - When synchronization is activated, the first edge and each additional edge loads the 1Count5V with the start value.
- The signal of a bounce-free switch or the zero mark of a rotary encoder can serve as the reference signal.
- The STS_DI feedback bit indicates the level of the reference signal.

Synchronization with DI and Zero Mark

In order to use this function, you must first select it with the "HW enable for synchronization" Function DI parameter.



If you have assigned synchronization with DI and zero mark, the DI serves as the HW enable. When the HW enable is active, the 1Count5V is loaded with the load value by the zero mark of the encoder.

3.8.5 Assignment of feedback interface for fast mode

Note

For the 1Count5V, the following data of the feedback interface are consistent:

- Bytes 0 to 3

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Assignment Tables

Address	Assignment		Name
Bytes 0 to 3	Bit 31	Sign of life	LZ
	Bit 30	Isochronous mode applied	STS_TIC
	Bit 29	Parameter Assignment Error	ERR_PARA
	Bit 28	Group error • Encoder supply short circuit • Short circuit / wire break / encoder signal	EXTF
	Bit 27	DI status	STS_DI
	Bit 26	Status of direction up/down	STS_DIR
	Bit 25	Status of (internal) gate	STS_GATE
	Bits 0 to 24	Count value	

Notes on the Feedback Bits

Feedback bit	Notes
LZ	The sign of life is toggled on each update of the feedback interface, i.e. the last sent value is inverted.
STS_TIC	Isochronous mode (if assigned) was applied.
ERR_PARA	The assigned module parameters are faulty.
EXTF	Group error Possible causes: • Encoder supply short circuit • Short circuit or encoder signal wire break EXTF is reset when the causes of the errors are eliminated.
STS_DI	The bit displays the status of the digital input DI.
STS_DIR	Status of direction; for encoder value change from larger to smaller encoder positions (including zero crossover) → "1 " for encoder value change from larger to smaller encoder positions (including zero crossover) → "0 "
STS_GATE	Status of (internal) gate: Counting

Access to the Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using HW Config
Feedback interface	Load command, e.g. L PID

Error Detection in Fast Mode

The encoder supply short circuit and short circuit/encoder signal wire break errors are detected by the 1Count5V and indicated in the feedback interface (EXTF).

The fault indication in the feedback interface is extinguished as soon as this error is no longer detected by the 1Count5V.

The parameter error bit is acknowledged by means of a correct parameter assignment.

3.8.6 Assigning parameters for fast mode

Introduction

You use the following to assign parameters for the 1Count5V:

- STEP 7 Version 5.4 or higher; if necessary, the HSP (hardware support package) must be downloaded from the Internet

Parameter List for Fast Mode

Parameter	Value Range	Default
Behavior in the event of higher-level controller failure		
Behavior at CPU/Master STOP	Stop operating mode Continue operating mode	Stop operating mode
Basic parameters		
Diagnostics A and B	Off/on	Off
Diagnostics N	Off/on	Off
Signal evaluation A, B	Rotary encoder single/double/quadruple	Rotary encoder single
Direction input B	Normal/inverted	Normal
Mode		
Fast mode	Fast mode	Fast mode
Gate function	Cancel counting/ Interrupt counting	Cancel counting
Input signal HW gate	Normal/inverted	Normal
Function DI	Input / HW gate/ Synchronization on positive edge/ HW enable for synchronization	Input
Load value	-16777216 ... +16777215	0

Parameter Assignment Error

- The "Input signal HW gate" parameter is set to inverted and the "Function DI" parameter is not set to HW gate.

What to Do in the Event of Errors

Check the set value ranges.

3.9 Position feedback

3.9.1 Overview

Description

This mode encompasses a subset of the functionality of the continuous counting mode. It is intended for isochrone mode and differs from continuous counting by a smaller T_{DP} $Module_{min}$ and a T_{WA} equal to zero. This T_{WA} equal to zero makes it possible to operate the module as an input module only. In this case, however, the possible controls are no longer synchronized with T_o but rather are executed in the T_{DP} cycle before or after T_i.

To execute this mode, you must assign parameters to the 1Count5V/500kHz.

Maximum Count Range

The high counting limit is +2147483647 (2^{31} – 1).

The low counting limit is –2147483648 (–2^{31}).

Load value

You can specify a load value for the 1Count5V/500kHz.

This load value is either applied directly as the new count value (LOAD_VAL) or it is applied as the new count value when the following events occur (LOAD_PREPARE):

- The counting operation is started by a SW gate or HW gate (if the counting operation is continued, the load value is not applied).
- Synchronization
- Latch and retrigger

Gate Control

To control the 1Count5V/500kHz, you have to use the gate functions.

RESET States of the Following Values after Parameter Assignment

Table 3-21 RESET States

Value	RESET state
Load value	0
Count value	0
Latch value	0

Isochrone mode

In isochrone mode, the 1Count5V/500kHz accepts control bits and control values from the control interface in each bus cycle and reports back the response in this mode in the same cycle or in the next cycle.

In each cycle, the 1Count5V/500kHz transfers the count or latch value that was valid at time T_i and the status bits valid at time T_i.

A count controlled by hardware input signals can only be transferred in the same cycle if the input signal occurred before time T_i.

See also

Assigning Parameters for Position Feedback (Page 235)

3.9.2 Position detection

Definition

In this mode, the 1Count5V/500kHz counts continuously starting from the load value:

- If the 1Count5V/500kHz reaches the high counting limit when counting up, and another count pulse then comes, it will jump to the low counting limit and continue counting from there without losing a pulse.
- If the 1Count5V/500kHz reaches the low counting limit when counting down, and another count pulse then comes, it will jump to the high counting limit and continue counting from there without losing a pulse.
- The high counting limit is set at +2147483647 (2^{31} – 1).
- The low counting limit is set to –2147483648 ($–2^{31}$).

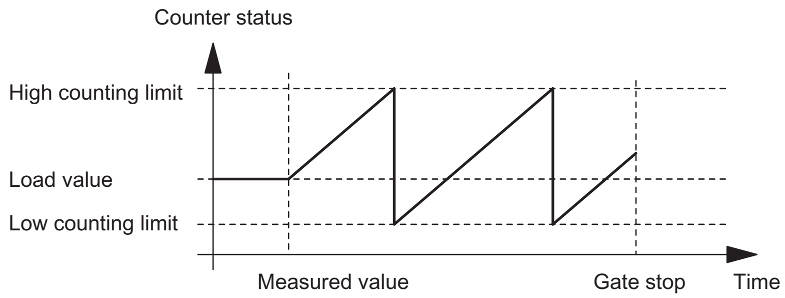


Figure 3-35 Count Continuously with Gate Function

Function of the Digital Input

For the "Function DI" parameter, select one of the following functions for the digital input:

- Input
- HW gate
- Latch Function
- Synchronization
- HW enable for synchronization

See also

Gate Functions for Position Detection (Page 221)

Latch Function (Page 224)

Synchronization (Page 227)

3.9.3 Gate Functions for Position Detection

Software Gate and Hardware Gate

The 1Count5V/500kHz has two gates

- A software gate (SW gate), which is controlled by the SW_GATE control bit.

  The software gate can only be opened by a positive edge of the SW_GATE control bit. It is closed when this bit is reset. Note the transfer times and run times of your control program.

- A hardware gate (HW gate), which is controlled by means of the digital input on the 1Count5V/500kHz.

  You assign the hardware gate as the function of the digital input (Function DI "HW Gate"). It is opened on a positive edge at the digital input and closed on a negative edge.

Internal Gate

The internal gate is the logical AND operation of the HW gate and SW gate. Counting is only active when the HW gate and the SW gate are open. The STS_GATE feedback bit (internal gate status) indicates this. If a HW gate has not been assigned, the setting of the SW gate is decisive. Counting is activated, interrupted, continued, and canceled by means of the internal gate.

Canceling- and Interrupting-Type Gate Function

When assigning the gate function, you can specify whether the internal gate is to cancel or interrupt counting. When counting is canceled, after the gate is closed and restarted, counting starts again from the beginning. When counting is interrupted, after the gate is closed and restarted, counting continues from the previous value.

The diagrams below indicate how the interrupting and canceling gate functions work:

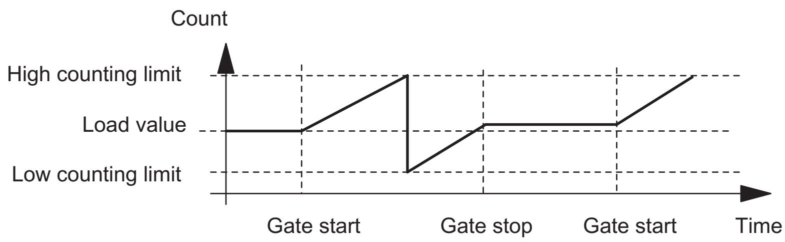


Figure 3-36 Position Detection, Up, Interrupting Gate Function

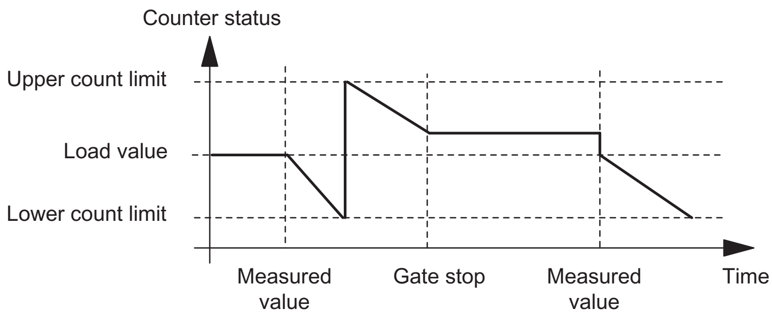


Figure 3-37 Position Detection, Down, Interrupting Gate Function

Gate Control

Gate control by means of the SW gate only

When the gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count, or
- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts before or after T_i, depending on the position of T_i.

Gate control by means of the SW gate and HW gate

If the SW gate opens when the HW gate is already open, counting continues starting from the current count.

When the HW gate is opened, one of the following occurs, depending on the parameter assignment:

- Counting continues from the current count

or

- Counting starts from the load value

If the SW gate is opened in isochrone mode in bus cycle "n" by setting the SW_GATE control bit, counting starts in cycle "n+1" before or after T_i, if the HW gate is already open at this time. If the HW gate opens after the SW gate has been opened, then counting does not start until the HW gate opens.

3.9.4 Latch Function

Overview

There are two latch functions:

- The Latch and Retrigger function
- The Latch function

The Latch and Retrigger Function

In order to use this function, you must first select it with the "Latch and Retrigger on Positive Edge" Function DI parameter.

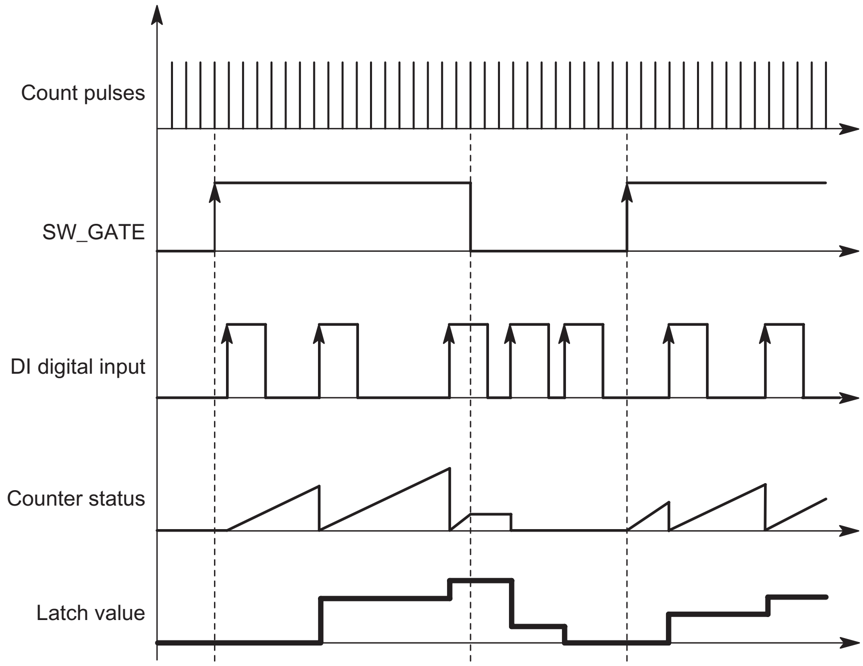


Figure 3-38 Latch and Retrigger with Load Value = 0

This function stores the current internal count of the 1Count5V/500kHz and retriggers counting when there is a positive edge on the digital input. This means that the current internal counter status at the time of the positive edge is stored (latch value), and the 1Count5V/500kHz is then loaded again with the load value, from which counting resumes.

The counting mode must be enabled with the SW gate before the function can be executed. It is started with the first positive edge on the digital input.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the status of the latch and retrigger signal.

The latch value is preassigned with its RESET state (see corresponding table). It is not changed when the SW gate is opened.

Direct loading of the counter does not cause the indicated stored count to be changed.

If you close the SW gate, it only interrupts counting; this means that when you open the SW gate again, counting is continued. The digital input DI remains active even when the SW gate is closed.

Counting is also latched and triggered in isochrone mode with each edge on the digital input. The count that was valid at the time of the last edge before T_i is displayed in the feedback interface.

The Latch function

In order to use this function, the Function DI parameter "Latch on Positive Edge" must be selected for the digital input.

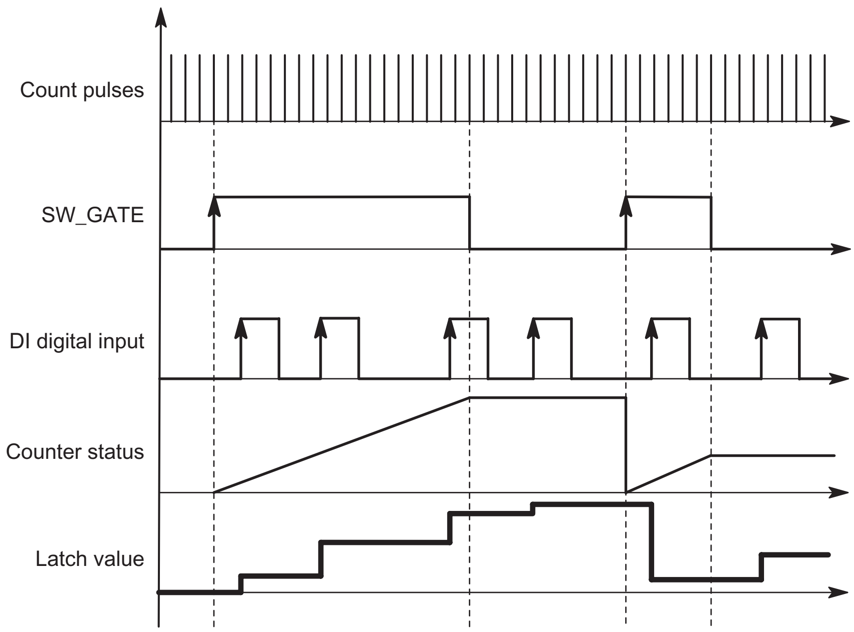


Figure 3-39 Latch with a Load Value of 0

Count and latch value are preset with their RESET states (see corresponding table).

The counting function is started when the SW gate is opened. The 1Count5V/500kHz begins at the load value.

The latch value is always the exact count at the time of the positive edge on the digital input DI.

The stored count rather than the current count is indicated in the feedback interface. The STS_DI bit indicates the level of the latch signal.

Direct loading of the counter does not cause the indicated stored count to be changed.

In isochrone mode, the count that was latched at the time of the last positive edge before T_i is displayed in the feedback interface.

When you close the SW gate, the effect is either canceling or interrupting, depending on the parameter assignment. The digital input DI remains active even when the SW gate is closed.

Further possible causes of parameter assignment errors with the latch function:

- Incorrect parameter assignment of the digital output function (Function DI)

Expanded Feedback Interface

If the 1Count5V/500kHz is inserted behind an IM 151 that supports the reading and writing of broader user data interfaces, the current count value can be read from bytes 8-11 of the feedback interface.

3.9.5 Synchronization

Synchronization

In order to use this function, you must first select it with the "Synchronize on Positive Edge" Function DI parameter.

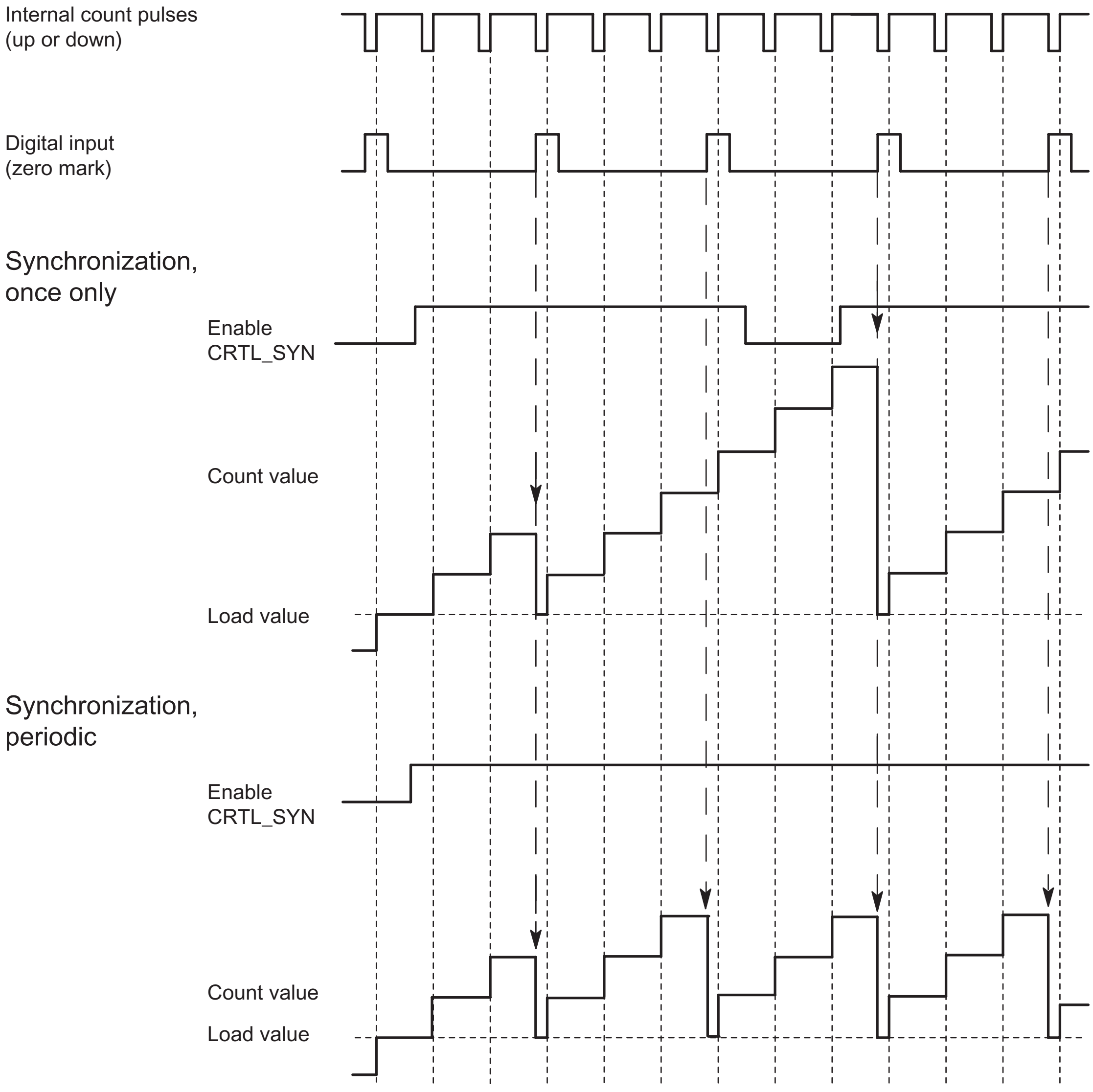


Figure 3-40 Once-Only and Periodic Synchronization

If you have assigned synchronization, the positive edge of a reference signal on the input sets the 1Count5V/500kHz to the load value.

You can select between once-only and periodic synchronization ("Synchronization" parameter).

The following conditions apply:

- The counting mode must have been started with the SW gate.
- The "Enable synchronization CTRL_SYN" control bit must be set.
- In once-only synchronization, the first edge loads the1Count5V/500kHz with the load value after the enable bit is set.
- In periodic synchronization, the first edge and each subsequent edge load the 1Count5V/500kHz with the load value after the enable bit is set.
- After successful synchronization, the STS_SYN feedback bit is set. It must be reset by the RES_STS control bit.
- The signal of a bounce-free switch or the zero mark of a rotary encoder can serve as the reference signal.
- The STS_DI feedback bit indicates the level of the reference signal.

In isochrone mode, the set feedback bit STS_SYN indicates that the positive edge on the digital input was between time T_i in the current cycle and T_i in the previous cycle.

See also

Synchronization (Page 156)

3.9.6 Assignment of the Feedback and Control Interface for Position Feedback

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Note

The following data of the control and feedback interfaces are consistent for the 1Count5V/500kHz:

Bytes 0 to 3

Bytes 4 to 7

Bytes 8 to 11 (modified user data interface)

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Assignment Tables

Table 3-22 Feedback Interface (Inputs)

Address	Assignment		Designation
Bytes 0 to 3	Count value or stored count value in the case of the latch function on the digital input		
Byte 4	Bit 7:	Short circuit of the encoder supply	ERR_24V
	Bit 6:	Reserve = 0	
	Bit 5:	Parameter assignment error	ERR_PARA
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Resetting of status bits active	RES_STS_A
	Bit 1:	Load function error	ERR_LOAD
	Bit 0:	Load function is running	STS_LOAD
Byte 5	Bit 7:	Down direction status	STS_C_DN
	Bit 6:	Up direction status	STS_C_UP
	Bit 5:	Reserve = 0	
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Reserve = 0	
	Bit 1:	DI status	STS_DI
	Bit 0:	Internal gate status	STS_GATE
Byte 6	Bit 7:	Zero crossing	STS_ND
	Bit 6:	Low counting limit	STS_UFLW
	Bit 5:	High counting limit	STS_OFLW
	Bit 4:	Reserve = 0	
	Bit 3:	Reserve = 0	
	Bit 2:	Reserve = 0	
	Bit 1:	Reserve = 0	
	Bit 0:	Synchronization status	STS_SYN

Address	Assignment	Designation
Byte 7	Reserve = 0	
Bytes 8 to 11	Count value [1]	
[1] Modified user data interface		

Table 3-23 Control Interface (Outputs)

Address	Designation	Assignment	
Bytes 0 to 3		Load value direct, preparatory, comparison value 1 or 2	
Byte 4	EXTF_ACK	Bit 7:	Error diagnostics acknowledgment
		Bit 6:	Reserve = 0
		Bit 5:	Reserve = 0
		Bit 4:	Reserve = 0
		Bit 3:	Reserve = 0
	RES_STS	Bit 2:	Start resetting of status bit
	CTRL_SYN	Bit 1:	Enable synchronization
	SW_GATE	Bit 0:	SW gate control bit
Byte 5		Bit 7:	Reserve = 0
		Bit 6:	Reserve = 0
		Bit 5:	Reserve = 0
		Bit 4:	Reserve = 0
		Bit 3:	Reserve = 0
		Bit 2:	Reserve = 0
	LOAD_PREPARE	Bit 1:	Load counter preparatory
	LOAD_VAL	Bit 0:	Load counter direct
Bytes 6 to 7		Reserve = 0 [1]	
[1] Not used for modified user interface			

Notes on the Control Bits

Table 3-24 Notes on the Control Bits

Control bits	Notes
CTRL_SYN	You use this bit to enable synchronization.
EXTF_ACK	Error acknowledgment The error bits must be acknowledged with the EXTF_ACK control bit after the cause is removed. (see figure below)
LOAD_PREPARE	Load counter preparatory (see figure below) The value from bytes 0 to 3 is applied as the load value.
LOAD_VAL	The value from bytes 0 to 3 is loaded directly as the new count value.
RES_STS	Start resetting of status bit The status bits are reset by means of the acknowledgment process between the RES_STS bit and the RES_STS_A bit. (see figure below)
SW_GATE	SW gate control bit The SW gate is opened/closed by means of the control interface with the SW_GATE bit.

Notes on the Feedback Bits

Table 3-25 Notes on the Feedback Bits

Feedback bits	Notes
ERR_24V	Short circuit of the encoder supply The error bit must be acknowledged by the EXTF_ACK control bit (see figure below) Diagnostic message if assigned.
ERR_LOAD	Load function error (see figure below) The LOAD_VAL, LOAD_PREPARE, CMP_VAL1, CMP_VAL2, and C_DOPARAM bits cannot be set simultaneously during transfer. This results in setting the ERR_LOAD status bit, similar to loading an incorrect value (which is not accepted).
ERR_PARA	Parameter assignment error ERR_PARA
RES_STS_A	Resetting of the status bits active (see figure below)
STS_C_DN	Down direction status
STS_C_UP	Up direction status
STS_DI	DI status The status of the DI is indicated in all modes with the STS_DI bit in the feedback interface.
STS_GATE	Internal gate status: Counting
STS_LOAD	Load function running (see figure below)
STS_ND	Zero-crossing in the count range when counting without a main counting direction. The bit must be reset by the RES_STS control bit.
STS_OFLW STS_UFLW	High counting limit violated Low counting limit violated Both bits must be reset.
STS_SYN	Synchronization status After successful synchronization, the STS_SYN bit is set. It must be reset by the RES_STS control bit.

Access to the Control and Feedback Interface in STEP 7 Programming

Table 3-26 Access to the Control and Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD file [1)] (Hardware catalog\PROFIBUS-DP\Additional FIELD DEVICES\I/O\ET 200S)	Configuring with STEP 7 using HW Config (Hardware catalog\PROFIBUS-DP\ ET 200S)
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command (e.g. L PID)
Control interface	Write with SFC 15 "DPWR_DAT"	Transfer command (e.g. T PQD)
[1] Load and transfer commands are also possible with CPU 3xxC, CPU 3xx with MMC, CPU 4xx (V3.0 and later), and WinLC RTX (PC CPU).		

Resetting of the Status Bits STS_SYN, STS_OFLW, STS_UFLW, STS_ND

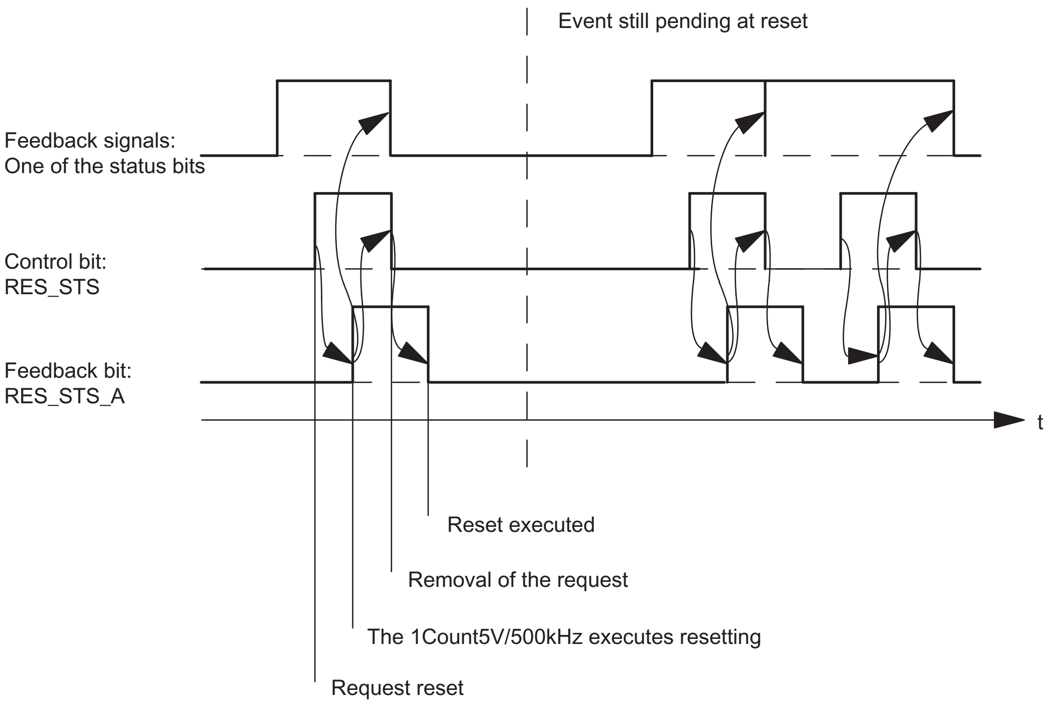


Figure 3-41 Resetting of the Status Bits

Acceptance of Values with the Load Function

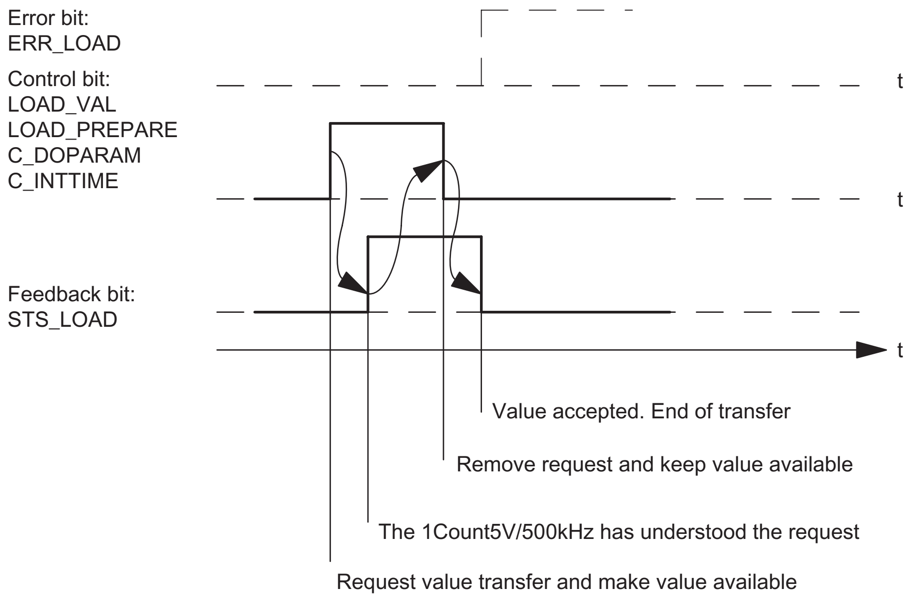


Figure 3-42 Accepting Values with the Load Function (LOAD_VAL; LOAD_PREPARE; C_DOPARAM; C_INTTIME)

Note

Only one of the following control bits can be set at a particular time:

LOAD_VAL or LOAD_PREPARE.

Otherwise, the ERR_LOAD error is reported until all the specified control bits are deleted again.

The ERR_LOAD error bit is only deleted when the following is carried out correctly.

Acknowledgment Principle in Isochrone Mode

In isochrone mode, 4 or 6 bus cycles are required to reset the status bits and to accept values during the load function in this mode.

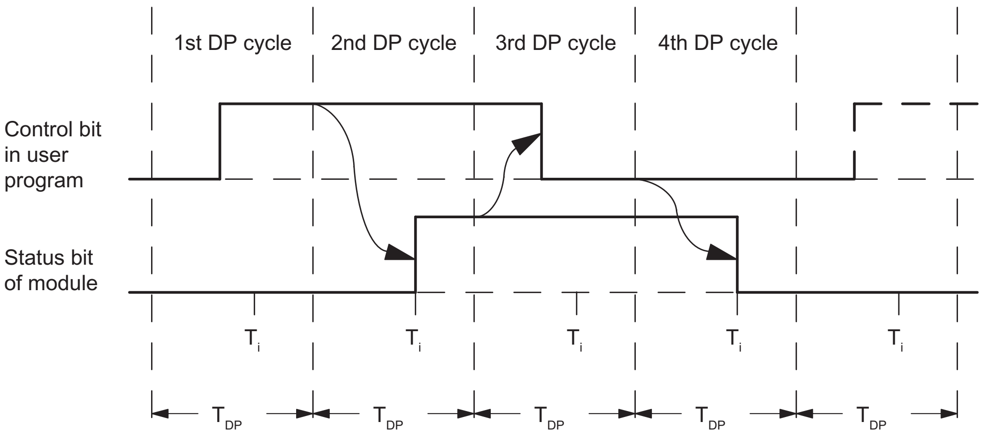


Figure 3-43 Acknowledgment Principle in Isochrone Mode

Error Detection

The program errors must be acknowledged. They have been detected by the 1Count5V/500kHz and are indicated at the feedback interface. A channel-specific diagnosis is carried out if you have enabled group diagnostics in your parameter assignment (see the *ET 200S Distributed I/O System* Manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

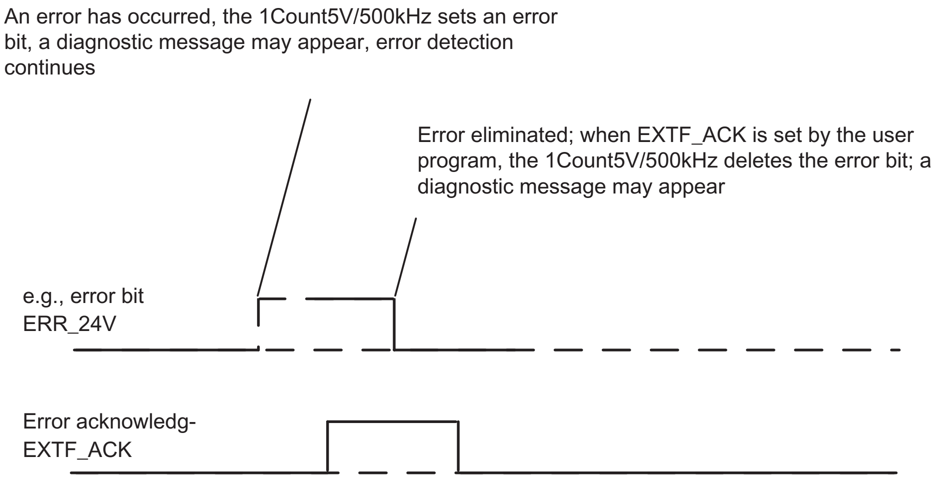


Figure 3-44 Error Acknowledgment

In the case of continuous error acknowledgment (EXTF_ACK=1) or at CPU/Master Stop, the 1Count5V/500kHz signals errors as soon as they are detected and deletes them as soon as they have been eliminated.

3.9.7 Assigning Parameters for Position Feedback

Introduction

You can use either of the following to assign parameters for the 1Count5V/500kHz:

- A GSD file (http://www.ad.siemens.de/csi/gsd)
- STEP 7 V5.3 SP2 or later

Parameter list for Position Feedback

Table 3-27 Parameter list for Position Feedback

Parameter	Value Range	Default
Enable		
Group diagnostics	Disable/enable	Disable
Behavior in the event of higher-level controller failure		
Behavior at CPU/Master STOP	Turn off Continue working mode	Turn off
Encoder parameters		
Diagnostics A and B	Off/on	Off
Diagnostics N	Off/on	Off
Signal evaluation A, B	Rotary encoder single/double/quadruple	Rotary encoder single
Direction input B	Normal/inverted	Normal
Mode		
Position feedback	Position detection	Position detection
Gate function	Cancel counting/ Interrupt counting	Cancel counting
Input signal HW gate	Normal/inverted	Normal
Function DI	Input/ HW gate/ Latch and retrigger on positive edge/ Synchronization on positive edge/ HW enable for synchronization	Input
Synchronization[1]	Once only/Periodic	Once-only
[1] Only relevant if Function DI = Synchronization on positive edge		

Parameter Assignment Error

- The "Input signal HW gate" parameter is set to inverted and the "Function DI" parameter is not set to HW gate.

What to Do in the Event of Errors

Check the set value ranges.

3.10 Evaluation of count and direction signal

Signal Evaluation A, B

Signal evaluation by means of A, B allows you to count directionally. Different evaluation modes are possible depending on the parameter assignment:

Rotary Encoder

The 1Count5V/500kHz can count the edges of the signals. Normally, only the edges at A are evaluated (single evaluation). To obtain a higher resolution, when assigning parameters ("Signal Evaluation" parameter), you can select whether the signals are to be subjected to single, double, or quadruple evaluation.

Multiple evaluation is only possible with asymmetric incremental encoders with A and B signals that are 90 degrees out of phase.

Single Evaluation

Single evaluation means that only one edge of A is evaluated; up count pulses are recorded at a positive edge at A and low level at B, and down count pulses are recorded at a negative edge at A and low level at B.

The diagram below illustrates the single evaluation of the signals.

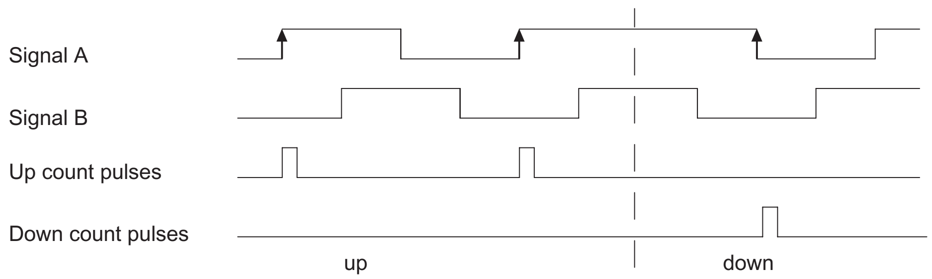


Figure 3-45 Single Evaluation

Double Evaluation

Double evaluation means that the positive and negative edge of the A signal are evaluated. Whether up or down count pulses are generated depends on the level of the B signal.

The diagram below illustrates the double evaluation of the signals.

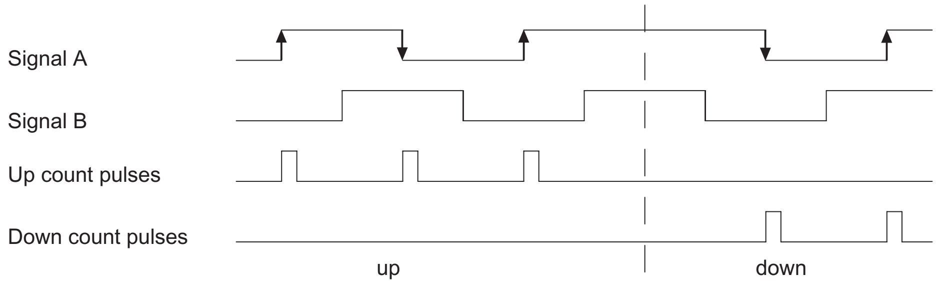


Figure 3-46 Double Evaluation

Quadruple Evaluation

Quadruple evaluation means that the positive and negative edges of the A and B signals are evaluated. Whether up or down count pulses are generated depends on the levels of the A and B signals.

The diagram below illustrates the quadruple evaluation of the signals.

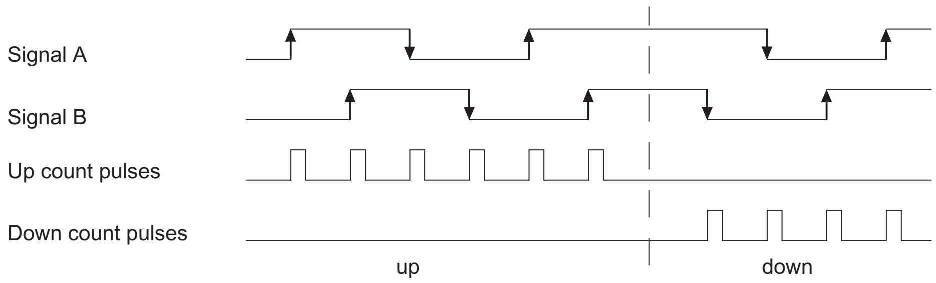


Figure 3-47 Quadruple Evaluation

Note

A counting frequency of 500 KHz refers to the maximum frequency of the A and B signals. With double evaluation, a maximum frequency of 1 MHz is produced for the counting pulses; with quadruple evaluation, the maximum frequency is 2 MHz.

3.11 Behavior at CPU-Master-STOP

Setting the Behavior at CPU/Master-STOP

You can program what the 1Count5V/500kHz is to do in the event of the failure of the parent controller.

Parameters	Status of the 1Count5V/500kHz at CPU/Master STOP	What Happens if New Parameters Have Been Assigned?
Turn off DO	The current mode is terminated, the gate closed, and the digital output blocked; comparison values 1 and 2 and the load value are reset; the high and low limit values, function and behavior of the digital outputs and the integration time are handled in accordance with the parameter assignments.	The changed parameters are accepted and take effect.
Continue working mode[1]	The current mode continues, and the gate and digital output retain their status.	The gate is closed, the current mode is terminated, the digital output is blocked, and the changed parameters are accepted and take effect.
DO substitute a value	The current mode is canceled, the gate closed, and the digital output blocked; comparison values 1 and 2 and the load value are reset; the high and low limit values, function and behavior of the digital outputs and the integration time are handled in accordance with the parameter assignments. When a pulse is output when the comparison value is reached, the substitute value is 1 only for the duration of the pulse.	The changed parameters are accepted and take effect.
DO keep last value	The current mode is canceled, the gate closed, and the digital output blocked; comparison values 1 and 2 and the load value are reset; the high and low limit values, function and behavior of the digital outputs and the integration time are handled in accordance with the parameter assignments.	The changed parameters are accepted and take effect.
[1]If the mode is to continue during a change from CPU-/Master-STOP to RUN (startup), the CPU/Master must not clear the outputs. Possible solution: In the part of the user program that is processed during startup, set the SW gate control bit and transfer the values to the 1Count5V/500kHz.		

Leaving the Assigned State

Under what conditions does the 1Count5V/500kHz leave the assigned state?

The CPU or master must be in RUN mode, and you have to make a change at the control interface.

Automatic New Parameter Assignment

A new parameter assignment of the ET 200S station is made by your CPU/ DP master:

- Upon power on of the CPU/DP master
- Upon power on of the IM 151/IM 151 FO
- After failure of the DP transmission
- After loading a modified parameter assignment or configuration of the ET 200S station to the CPU/DP master
- When the 1Count5V/500kHz is inserted
- Upon power on or inserting of the appropriate power module

3.12 Technical Specifications

Technical Specifications

General Technical Specifications of the 1Count5V/500kHz	
Dimensions and Weight	
Dimensions W x H x D (mm)	30×81×52
Weight	Approx. 65 g
Data for Specific Modules	
Number of Channels Counter range	1 32 bits
Voltages, Currents, Potentials	
Rated load voltage L+	24 VDC
• Range	20-4 ... 28.8 V
• Reverse polarity protection	Yes
Galvanic isolation	
• Between backplane bus and counter function	Yes
• Between counter function and load voltage	No
Encoder supply	
• Output voltage	L+ (-0.8 V)
• Output current	Max. 500 mA, short-circuit proof
Current consumption	
• From the backplane bus	10 mA, maximum
• From load voltage L+ (no load)	45 mA, typical
Power dissipation	Typ. 2 W
Data for the Digital Input	
Galvanic isolation	No, only from shield and backplane bus
Input voltage	
• Rated value	24 VDC
• 0 signal	-30 V to 5 V
• 1 signal	11 V to 30 V
Input current	
• 0 signal	≤2 mA (quiescent current)
• 1 signal	9 mA (typical)
Minimum pulse width	2.5 μs
Connection of a two-wire BERO type 2	Possible
Input characteristic	In accordance with IEC 1131, Part 2, Type 2
Shielded cable length	50 m, maximum

General Technical Specifications of the 1Count5V/500kHz	
Encoder Signals	
• Level	In accordance with RS 422
• Terminating resistance	330 Ω
• Differential input voltage	1 V, minimum
• Maximum counting frequency	500 kHz
• Galvanic isolation from ET200S bus	Yes
• Shielded cable length	50 m, maximum
Data for the Digital Outputs	
Output voltage	
• Rated value	24 VDC
• 0 signal	≤ 3V
• 1 signal	≥ L+ (-1V)
Output current	
• 0 signal (residual current)	≤ 0.5 mA
• 1 signal	
Permitted range	5 mA to 2.4 A
Rated value	2A
Switching frequency	
• Resistive load	100 Hz
• Inductive load	2 Hz
• Lamp load	≤ 10 Hz
Lamp load	≤ 10 W
Output delay (resistive load)	100 µs
Short-circuit protection for output	Yes
Response threshold Inductive extinction Digital input control	2.6 A to 4 A Yes; L+ -(50 to 60 V) Yes
Cable lengths	
• Unshielded	600 m
• Shielded	1000 m
Status, Diagnostics	
Digital input DI status display	LED 16 (green)
Digital output DO1 status display Digital output DO2 status display Up count value change Down count value change Synchronization Fault indicator Diagnostic information	LED 9 (green) LED 13 (green) UP LED (green) DN LED (green) SYN LED (green) SF LED (red) Yes

General Technical Specifications of the 1Count5V/500kHz	
Measuring Ranges in the Measuring Modes	
Maximum measuring range	
• Frequency measurement	0.1 Hz to 500 kHz
• Rotational speed measurement	1/min ... 25000 /min
• Period measurement	10 µs ... 120 s
Response Times	
Update rate of the counting modes	
• Non-isochronous mode	1 ms
• Isochronous mode	T_{DP}
Isochronous Times of the Module	
• in counting modes	
TCI TCO T_{oi}Min T_{DP}Min	380 µs 320 µs 55 µs 900 µs
• in measuring modes	
TCI TCO T_{oi}Min T_{DP}Min	465 µs 280 µs 50 µs 995 µs
• in position feedback	
TCI TCO T_{oi}Min T_{DP}Min	370 µs - - 815 µs

1SSI 4

4.1 Product Overview

Order Number

6ES7 138-4DB03-0AB0

Compatibility

The 1SSI with order number 6ES7 138-DB03-0AB0 replaces the 1SSI with the following order numbers:

- 6ES7 138-4DB02-0AB0
- 6ES7 138-4DB01-0AB0
- 6ES7 138-4DB00-0AB0

and is fully compatible.

Features

- The 1SSI is an interface between an absolute encoder (SSI) and the parent controller. You edit the cyclically recorded encoder value in your controller program.
- Can be operated using terminal modules TM-E15S24-01 and TM-E15S26-A1
- Isochronous mode
- Normalization of the encoder value (that is, discounting of adjusted, irrelevant bits in the encoder value).
- Reversal of the direction of rotation to adjust the direction of movement of the absolute encoder to the axis.
- Latch function for freezing the current encoder value (only possible in standard mode).
- Comparison function between the current encoder value and loadable comparison values (only possible in standard mode).
- Type of encoder value recording can be selected:
  - Free-wheeling
  - Synchronous to the update rate
  - Isochronously

- Fast mode can be selected; with rapid encoder value detection and compressed functionality (cannot be used with the IM 151 with the order number 6ES7 151-1AA00-0AB0).
- Maximum encoder sampling rate (e.g., for ultrasonic encoders) is taken into account in isochronous mode
- Sign of life in isochronous mode
- Parity check of encoder value can be performed
- Gray/dual converter

Supported Encoder Types

The following encoder types are supported:

- Absolute encoder (SSI) with 13 bits

  To

- Absolute encoder (SSI) with 25 bits

Note

Notice!

(Bit width restrictions exist for the predecessor modules of the 6ES7138-4DB03-0AB0 and when using the HSP2022 V1.0.)

Firmware Update [1]

To add functions and for troubleshooting, it is possible to load firmware updates to the operating system memory of the 1SSI using STEP 7 HW Config.

Note

Notice!

When you start the firmware update, the old firmware is deleted. If the firmware update is interrupted or canceled for any reason, the 1SSI will no longer function correctly as a result. Re-launch the firmware update and wait until this has completed successfully. See also ET 200S Distributed I/O System Manual, section: Identification Data.

Identification Data [1]

- Hardware release status
- Firmware release status
- Serial number

See also ET 200S Distributed I/O System Manual, section: Identification Data.

[1] This function is only possible if the header module in use supports the necessary system services.

Configuration

You can use either of the following to configure the 1SSI:

- A GSD file (http://www.ad.siemens.de/csi/gsd)
- STEP 7 V5.4 SP2 and later, or with the HSP hardware support package (available online) STEP 7 V5.3 SP2 and later.

4.2 Clocked Mode

Note

The principles of isochronous mode are described in a separate manual.

See Isochrone Mode function manual (A5E00223279).

Hardware Requirements

You will require the following for the 1SS in isochronous mode:

- A CPU that supports isochronous mode
- A master or Profinet master that supports the equidistant bus cycle
- An IM 151 that supports isochronous mode

Features

Depending on the system parameter assignment, the 1SSI works in either non-isochronous or isochronous mode.

In isochronous mode, the data exchange between the master and 1SSI is isochronous to the bus cycle.

In isochronous mode, all bytes of the feedback interface are consistent.

If isochronous mode fails, the feedback interface is not updated. In the user program, this can be detected with the sign of life in the feedback interface.

4.3 Example: Starting 1SSI

Introduction

These instructions provide an example to guide you to a functioning application that will enable you to become familiar with and check the basic hardware and software functions of the 1SSI. For this example, you will operate the 1SSI in standard mode, rather than isochrone mode.

Requirements

The following requirements must be satisfied:

- You have commissioned an ET 200S station on an S7 station with a master.
- You must have the following:
  - A TM-E15S24-01 terminal module
  - An 1SSI
  - An SSI encoder and the necessary wiring material

Installation, Wiring and Fitting

1. Install and wire the TM-E15S24-01 terminal module (see Figure).
2. Connect the 1SSI to the terminal module (you will find detailed instructions in the *ET 200S Distributed I/O System* Manual).

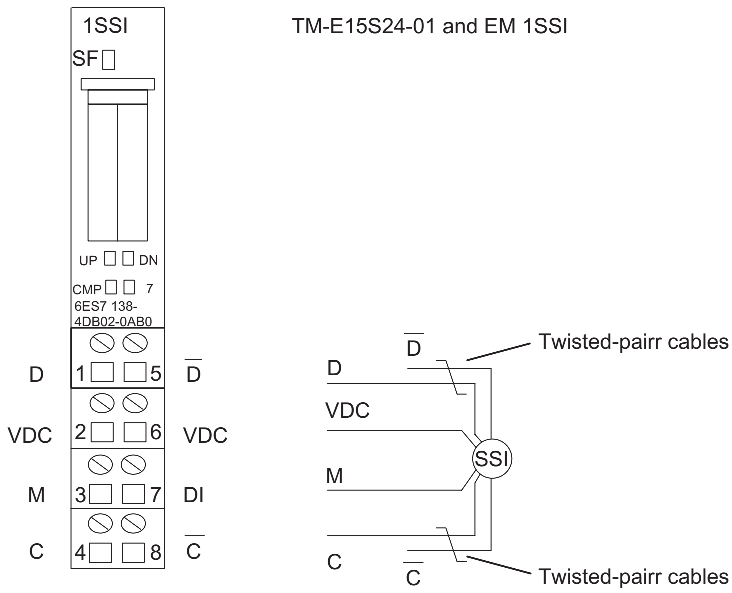


Figure 4-1 Terminal Assignment for the Example

Configuring with STEP 7 using HW Config

You must first adapt the hardware configuration of your existing ET 200S station.

1. Open the relevant project in SIMATIC Manager.
2. Open the HW Config configuration table in your project.
3. From the hardware catalog, select the 1SSI entry with the number 6ES7138-4DB03-0AB0 in the infotext. Drag the entry to the slot at which you have installed your 1SSI.
4. Double-click this number to open the *DP Slave Properties* dialog box.

   On the *Addresses* tab, you will find the addresses of the slot to which you have dragged the 1SSI. Make a note of these addresses for subsequent programming.

   On the *Parameters* tab, you will find the default settings for the 1SSI. Select the encoder type in accordance with the connected SSI encoder and enter all the required data. You will find the encoder data on the type label and in the technical specifications of the encoder.
5. Save and compile your configuration, and download the configuration in STOP mode of the CPU by choosing "PLC > Download to Module".

Creating a Block and Integrating It into the Controller Program

Create block FC101 and integrate it in your control program (in OB1, for example). This block requires the data block DB1 with a length of 16 bytes. The start address of the module in the following example is 256.

STL		Description
Block: FC101		
Network 1: Presettings		
L	0	//Delete control bits
T	DB1.DBD0	
T	DB1.DBD4	
Network 2: Write to the control interface		
L	DB1.DBD0	//Write 8 bytes to the 1SSI
T	PAD 256	//Configured start address of the outputs
L	DB1.DBD4	
T	PAD 260	
Network 3: Read from the feedback interface		
		//Read 8 bytes from the 1SSI
L	PED 256	//Configured start address of the inputs
T	DB1.DBD8	
L	PED 260	
T	DB1.DBD12	

Testing

Use Monitor/Modify Variables to monitor the encoder value and the direction indicator.

1. Select the "Block" folder in your project. Choose the "Insert > S7 Block > Variable Table" menu command to insert the VAT 1 variable table, and then confirm with OK.
2. Open the VAT 1 variable table, and enter the following variables in the "Address" column:

   DB1.DBD8 (encoder value)

   DB1.DBX12.0 (UP status)

   DB1.DBX12.1 (DN status)
3. Choose "PLC > Connect To > Configured CPU" to switch to online.
4. Choose "Variable > Monitor" to switch to monitoring.
5. Switch the CPU to RUN mode.
6. Change the position of the SSI encoder.

Result

You can now see that:

- The UP LED or the DN LED on the 1SSI is on, depending on the direction in which you change the position of the SSI encoder.
- The encoder value in the block changes.

4.4 Terminal Assignment Diagram

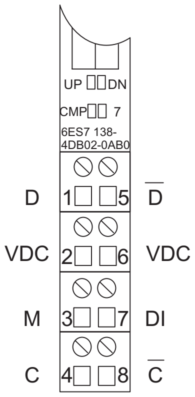
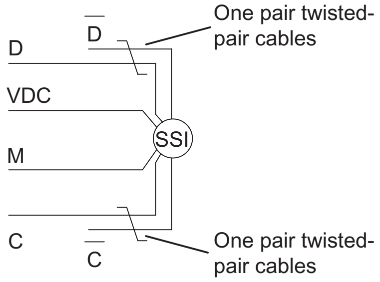
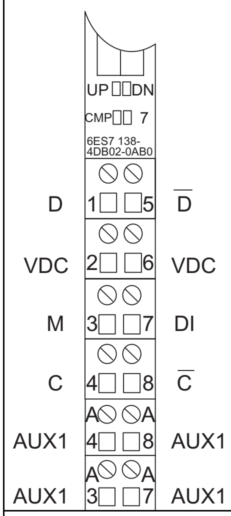
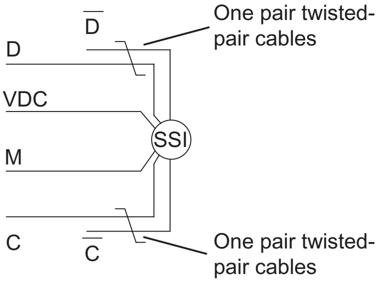
Wiring Rules

The cables (terminals 1 and 5 and terminals 4 and 8) must be shielded, twisted-pair cables. The shield must be supported at both ends. To do this use the shield connection (see the ET 200S Distributed I/O System Manual).

Terminal Assignment

You will find the terminal assignment for the 1SSI in the table below.

Table 4-1 Terminal Assignment of the 1SSI

View	Terminal Assignment	Remarks
	TM-E15S24-01 and EM 1SSI 	Terminals 1 to 8: 1/5: Data from the SSI encoder [1] 2/6: Power supply for absolute encoder and switch [2] 3: Chassis ground 7: Digital input latch function 4/8: SSI clock (clock wire) [1]
	TM-E15S26-A1 and EM 1SSI 	
[1] It is essential that you maintain the correct polarity when wiring the encoder. If you do not, an absolute encoder error is reported. Signals according to RS422 [2]Short circuit-proof, maximum 0.5 A.		

4.5 Configuring standard mode and fast mode

Introduction

In order to take full advantage of the functionality of the 1SSI for the application in question, choose between fast mode and standard mode, depending on your automation task.

Areas of Application	Mode
• Closed-loop control applications such as position controls with path position as actual value • Fast encoder value detection	Fast
• Monitoring or detecting of position points • Length measurement, edge detection, synchronization with workpieces	Standard

Configuring Standard Mode and Fast Mode

Standard Mode	Fast Mode
Parameters are assigned to the various modes. You will find the parameter lists in the descriptions of the modes. You can integrate the 1SSI in your project in two different ways. Decide whether you want to work with the GSD file or with STEP 7 using HW Config.	

Configuring 1SSI with STEP 7 using HW Config (in isochrone and non-isochrone mode)	
Select an entry from the hardware catalog that corresponds to the functionality you want.	
For standard mode, select the 1SSI entry with the number 6ES7 138-4DB03-0AB0 in the infotext.	For fast mode, select the 1SSI fast mode entry with the number 6ES7 138-4DB03-0AB0 Fast in the infotext.
Drag the entry to the slot at which you have installed your 1SSI.	
Select the parameters.	

Configuring 1SSI with the GSD file (only in non-isochrone mode)	
Select an entry in the GSD file that corresponds to the functionality you want.	
Select 6ES7 138-4DB03-0AB0 1SSI for standard mode.	Select 6ES7 138-4DB03-0AB0 1SSI Fast for fast mode.
Select the parameters.	

4.6 Functions of the 1SSI

4.6.1 Overview of 1SSI functions

Operating Principle

The 1SSI records the signals of the connected position encoder cyclically and forwards them, depending on the parameter assignment, to the feedback interface by means of the following functions:

- Encoder value detection
- Gray/binary converter
- Normalization
- Direction reversal
- Comparator (only in standard mode)
- Latch function (only in standard mode)
- Error detection
- Sign of life

The 1SSI uses the "ready for operation" feedback bit to indicate that the functions are executable and the displayed encoder value is valid.

4.6.2 Encoder Value Detection

Description

The absolute encoder transfers its encoder values in message frames to the 1SSI. The transmission of message frames is initiated by the 1SSI. The following alternatives are available for encoder value detection:

- Free-wheeling encoder value detection
- Synchronous encoder value detection
- Isochronous encoder value detection

You can set free-wheeling or synchronous encoder value detection in HW Config with the "Detection" parameter. This parameter only works in non-isochrone mode.

The detection of the encoder value will be isochronous when the 1SSI is in isochronous mode. In this case, the "Detection" parameter is not evaluated.

The following table shows these connections:

Table 4-2 Encoder Value Detection

Mode	"Detection" Parameter	Encoder value detection
Non-isochrone mode	Free-wheeling	Free-wheeling encoder value detection
	Synchronous	Synchronous encoder value detection
Isochrone mode	- (irrelevant)	Isochronous encoder value detection

Free-Wheeling Encoder Value Detection

With free-wheeling encoder value detection, you obtain maximum accuracy with the latch function.

The 1SSI initiates the transmission of a message frame each time the assigned monoflop time elapses.

The 1SSI processes the detected encoder value asynchronously to these free-wheeling message frames in the cycle of the update rate.

This results in encoder values of various ages with the free-wheeling detection of encoder values. The difference between maximum and minimum age is the jitter.

Synchronous Encoder Value Detection

With synchronous encoder value detection, you obtain maximum accuracy with encoder value detection.

The 1SSI initiates the transmission of a message frame in the cycle of its update rate.

The 1SSI processes the transmitted encoder value synchronously to its update rate.

Isochronous Encoder Value Detection

Isochronous encoder value detection is carried out automatically when the equidistant bus cycle is activated in the DP master system and the DP slave is synchronized to the bus cycle.

The 1SSI initiates the transmission of a message frame in every bus cycle at time T_i, as long as the configured maximum encoder sampling rate does not result in a reduction.

The 1SSI processes the transmitted encoder value isochronously to the bus cycle.

4.6.3 Gray/Binary Converter

Description

When Gray is set, the encoder value supplied by the absolute encoder in gray code is converted to binary code. When Binary is set, the supplied encoder value is not converted.

NOTICE
If you selected the Gray setting, the 1SSI always converts the total encoder value (13 to 25 bits). Preceding special bits thus influence the encoder value and trailing bits can under some circumstances be corrupted.

4.6.4 Transmitted Encoder Value and Standardization

Description

The transmitted encoder value contains the encoder position of the absolute value encoder. Depending on the encoder that is used, other bits that are located before and after the encoder position are transmitted in addition to the encoder position.

So that the 1SSI can determine the encoder position, specify the following:

- Encoder type
- Number of trailing bits
- Total steps of the absolute encoder

With normalization, you specify the representation of the encoder value in the feedback interface.

- With "Normalization On", you specify that trailing, irrelevant bits in the encoder value are to be discounted (see the following example).
- With "Normalization Off", you specify that trailing bits are retained and are available for evaluation.

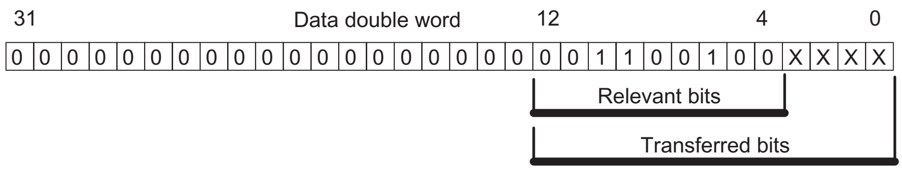
Normalization Example

Presettings:

You use a single-turn encoder with 2^9 (corresponds to 9 bits) = 512 steps/revolution (resolution/360°) with the following parameter assignment:

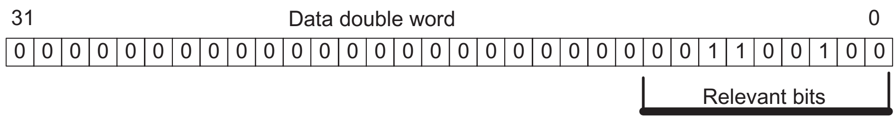
- Encoder type: SSI-13 bit
- Number of trailing bits: 4 places
- Total steps of the absolute encoder: 512

Without normalization: Cyclically recorded encoder position 100



Of the 13 bits transferred, bits 4 to 12 are required for evaluation.

After normalization: encoder position 100



Bits 0 to 3 (indicated above by "x") are discounted

4.6.5 Detection of Direction and Reversal of the Direction of Rotation

Direction Detection

The 1SSI needs the following information to detect the direction of movement of the encoder correctly:

- Encoder type
- Total steps of the absolute encoder
- Number of trailing bits

The information is used as explained in the normalization example.

The direction of movement that is determined is displayed in the feedback interface and at the LEDs.

UP LED: encoder position change from lower to higher value

DN LED: encoder position change from higher to lower value

Direction Reversal

The direction reversal adjusts the direction of movement of the encoder to that of the axis.

Two settings are possible:

- Off

  The direction of the transmitted encoder position is maintained.
- On

  The direction of the transmitted encoder position is reversed. This means that although the encoder sends ascending values, descending values are displayed.

  This reversal applies to the total steps of the absolute encoder, as indicated in the parameter assignment.

Example of Direction Reversal

Presettings:

You use a single-turn encoder with 2^{10} (corresponds to 10 bits) = 1024 steps/revolution (resolution/360°) with the following parameter assignment:

- Encoder type: SSI-13 bit
- Number of trailing bits: 3 places
- Direction reversal: On
- Total steps of the absolute encoder: 1024

Encoder value before direction reversal: cyclically recorded encoder position 1023

Encoder value after direction reversal: displayed encoder position 0

4.6.6 Comparator (Only in Standard Mode)

Description

The encoder position that is detected can be compared with up to two loadable values (without hysteresis). Both comparison results are stored in the feedback interface. The appropriate comparator becomes active only after the comparison value is loaded.

You set the two comparators in the Comparator 1 and Comparator 2 parameters:

Setting	Effect on the Result of Comparison (CMPx)
Not active	The encoder value is not compared. The feedback bit CMPx = 0.
In the up direction	The encoder value is compared in the up direction (UP). • If the encoder value $\geq$ the comparison value, the feedback bit CMPx = 1. • If the encoder value $<$ the comparison value, the feedback bit CMPx = 0. • If the direction is down, the feedback bit CMPx remains unchanged. • If no change is detected in the encoder value, the feedback bit CMPx remains unchanged.
In the down direction	The encoder value is compared in the down direction (DN). • If the encoder value $\leq$ the comparison value, the feedback bit CMPx = 1. • If the encoder value $>$ the comparison value, the feedback bit CMPx = 0. • If the direction is up, the feedback bit CMPx remains unchanged. • If no change is detected in the encoder value, the feedback bit CMPx remains unchanged.
In both directions	The encoder value is compared in both directions. If the direction is up, the following conditions apply: • If the encoder value $\geq$ the comparison value, the feedback bit CMPx = 1. • If the encoder value $<$ the comparison value, the feedback bit CMPx = 0. If the direction is down, the following conditions apply: • If the encoder value $\leq$ the comparison value, the feedback bit CMPx = 1. • If the encoder value $>$ the comparison value, the feedback bit CMPx = 0. • If no change is detected in the encoder value, the feedback bit CMPx remains unchanged.

As soon as you load a comparison value, the comparison result is deleted and is then entered in accordance with the directional setting.

Note

Only one control bit can be set at a particular time:

CMP_VAL1 or CMP_VAL2.

Otherwise, the ERR_LOAD error is reported until both control bits are deleted.

Loading the Comparison Value

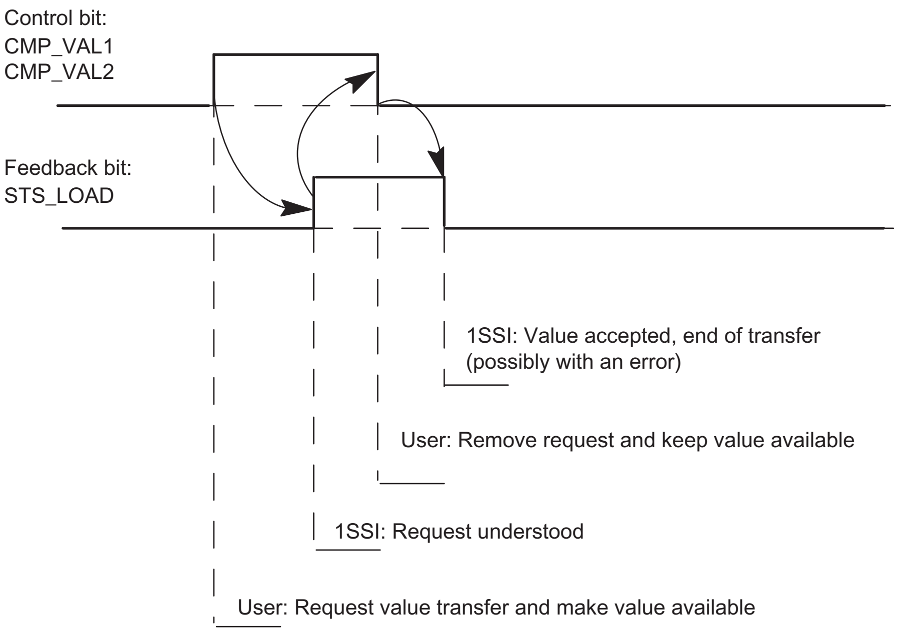


Figure 4-2 Value Transfer

Comparator in Isochronous Mode

In isochronous mode, the comparison values are loaded at time T_o and are effective as of time T_i in the same bus cycle.

4.6.7 Latch Function (Only in Standard Mode)

Description

You use the latch function to freeze the current encoder value of the 1SSI at an edge at the digital input (DI).

The encoder value can thus be evaluated on an event-dependent basis.

A frozen encoder value is identified by the set bit 31 and is preserved until the termination of the latch function.

The frozen encoder value is entered at the feedback interface at the position of the cyclically recorded value and assigned the identifier "Bit 31 set."

Note

Direction determination, comparison, and error monitoring also take place when the encoder value is frozen.

Prerequisites for Using the Latch Function

- You must have specified which edge (rising and/or falling) at the digital input freezes the encoder value.
- You specify that the latch function that is coupled to the digital input is switched on.

Terminating the Latch Function

The latch function must be acknowledged. When the controller program acknowledges the acceptance of the encoder value, bit 31 is deleted and the encoder value is updated again. Freezing is then possible again.

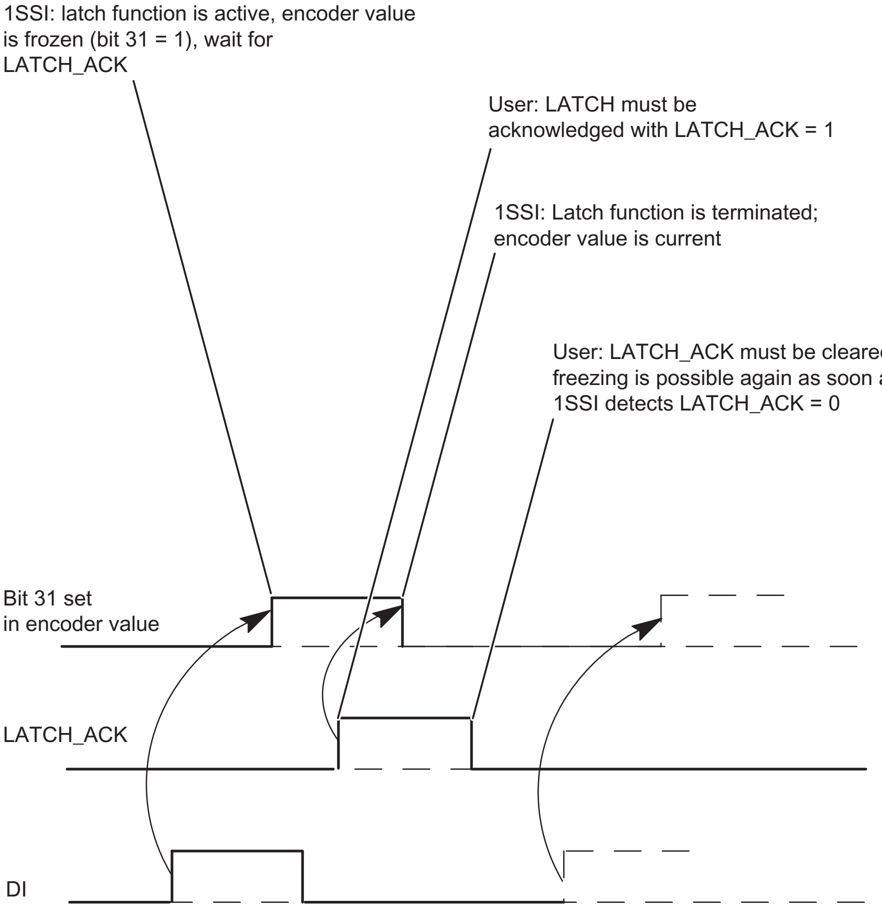


Figure 4-3 Latch Function

4.6.8 Error Detection in Standard Mode

Description

The absolute value encoder and sensor supply short circuit errors must be acknowledged. They have been detected by the 1SSI and are indicated at the feedback interface. A channel-specific diagnosis is carried out after you have enabled group diagnosis at parameter assignment (see the ET 200S Distributed I/O System manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

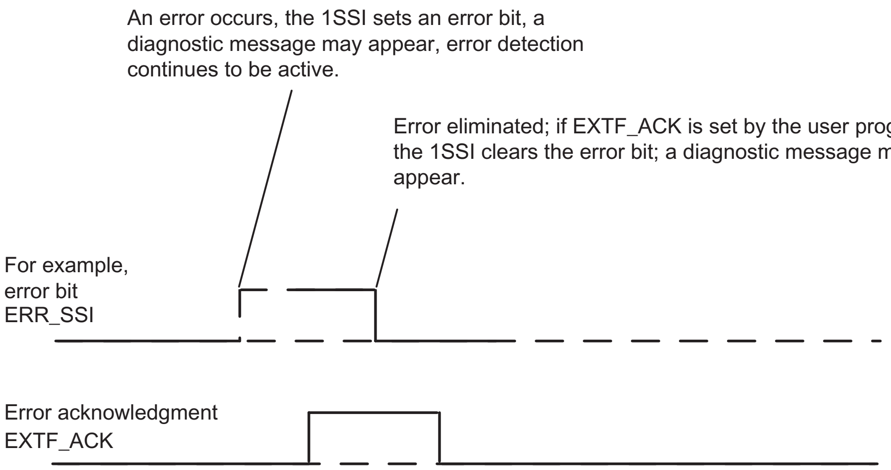


Figure 4-4 Error Acknowledgment

In the case of constant error acknowledgement (EXTF_ACK = 1) or in CPU/master STOP mode, the 1SSI reports the errors as soon as they are detected and clears the errors as soon as they are eliminated.

4.6.9 Error Detection in Fast Mode

Description

The absolute value encoder and sensor supply short circuit errors have been detected by the 1SSI and are indicated at the feedback interface. A channel-specific diagnosis is carried out after you have enabled group diagnosis at parameter assignment (see the ET 200S Distributed I/O System manual).

The parameter assignment error bit is acknowledged by means of correct parameter assignment.

As soon as the absolute value encoder and sensor supply short circuit errors are no longer detected by the 1SSI, the error display at the feedback interface is cleared, and in certain cases the channel-specific diagnosis reports an error-free condition.

4.7 Behavior at CPU-Master-STOP

Description

The 1SSI detects the CPU/ bus master STOP. The reaction to this is to stop the active operation.

Exiting the CPU/Bus Master STOP Status

Without reassigning the parameters of the ET 200 station	• The feedback interface of the 1SSI remains current.
With reassignment of the parameters of the ET 200 station	• You must reload the comparison values. • The latch function has to be triggered with a new edge on the digital input DI.

Reassigning Parameters of the ET 200S Station

A new parameter assignment of the ET 200S station by your CPU/ bus master takes place:

- Upon power on of the CPU/bus master
- Upon power on of the IM 151
- After failure of the bus transmission
- After loading a modified parameter assignment or configuration of the ET 200S station into the CPU/bus master.

4.8 Setting parameters for the 1SSI

Overview

You set the parameters for the 1SSI by means of the GSD file for the ET 200S or using the STEP 7 parameter assignment software. It is not possible to reassign the parameters by means of the user program.

Depending on the mode that you selected, either of the following parameter sets from your parameter assignment appear in the parameter assignment software:

- All parameters (standard mode), or
- A portion of the parameters (fast mode)

You can enter the following parameters (the default appears in bold):

Parameters	Value Range	Note
Group diagnostics	**Disable**/enable	Enabling parameter
Detection	**Free-wheeling**/synchronous	This parameter is irrelevant in isochronous mode and is not evaluated.
Encoder type[1]	No encoder/ **SSI 13-bit /** ... / SSI 25-bit	No encoder: The encoder input is switched off.
Gray/binary converter [1]	**Gray**/binary	Code supplied by the encoder
Transmission rate [1 3]	**125 kHz** / 250 kHz / 500 kHz / 1 MHz / 1.5 MHz / 2 MHz	Note that the transmission rate affects the accuracy and up-to-dateness of the encoder values.
Monoflop time [1 2 3]	16 μs / 32 μs / 48 μs / **64 μs**	The specification of the monoflop time is relevant for free-wheeling encoder value detection. See the vendor's technical specifications.
Parity	**None**, odd, even	An assigned parity bit is included in the "Encoder Type" parameter. If a 25-bit encoder is assigned parity, then 26 bits are read from the encoder. The bit following the LSB (least significant bit) is evaluated as a parity bit. A parity error is reported by means of the following feedback interfaces: • EXTF in fast mode • ERR_SSI in standard mode
Normalization	**Off**/on	–
Number of trailing bits [1]	**0** to 15	The number of trailing bits must be specified.
Direction reversal	**Off**/on	–

Parameters	Value Range	Note
Total steps of the absolute encoder [1]	• Encoder type 13 bits: 16 to 8192 • Encoder type 14 bits: 16 to 16384 • Encoder type 15 bits: 16 to 32768 • Encoder type 16 bits: 16 to 65536 • Encoder type 17 bits: 16 to 131072 • Encoder type 18 bits: 16 to 262144 • Encoder type 19 bits: 16 to 524288 • Encoder type 20 bits: 16 to 1048576 • Encoder type 21 bits: 16 to 2097152 • Encoder type 22 bits: 16 to 4194304 • Encoder type 23 bits: 16 to 8388608 • Encoder type 24 bits: 16 to 16777216 • Encoder type 25 bits: 16 to 33554432	If you find "Total steps - highword" and "Total steps - lowword" in your parameter assignment software instead of "Total steps", the following definition applies: *Total steps = total steps lowword + total steps highword x* 2^{16}
Latch: Encoder value	**Not active** / With rising edge DI / With falling edge DI / With both edges DI	This parameter is available in the parameter assignment software in standard mode only. Not active: The encoder value cannot be frozen.
Comparator 1	**Not active** / In the up direction / In the down direction / In both directions	This parameter is available in the parameter assignment software in standard mode only. Not active: The comparator is switched off.
Comparator 2	**Not active** / In the up direction / In the down direction / In both directions	This parameter is available in the parameter assignment software in standard mode only. Not active: The comparator is switched off.
Sign of life	**Off**, On	This parameter is only active in isochronous mode. When sign of life is on, the sign-of-life bit is toggled, i.e., the last sent value is inverted, each time an encoder value is read in in isochronous mode. If a reduction is assigned in the "Encoder Sampling Rate" parameter, the value is toggled only if an encoder value was actually read in. You can find the sign-of-life bit in the feedback interface in: • Byte 4/bit 7 (standard mode) • Byte 0/bit 7 (fast mode)

Parameters	Value Range	Note
Encoder sampling rate	**No limitation**, 0.1 kHz to 6.3 kHz (in 0.1-kHz steps)	Any encoder sampling rate to be taken into account is set here. This parameter is only active in isochronous mode. It enables the use of slower encoders (such as ultrasound encoders) even in a fast processing cycle. An **integer reduction** n is calculated using the set frequency. In this case, the encoder is read in again only every nth clock cycle. Example: Processing cycle 500 µs Encoder sampling rate: 1.2 KHz (approximately every 833 µs) --> reduction n = 2, i.e., the encoder is read in again only every 2nd processing cycle, i.e., every ms.
[1] See the technical specifications of the absolute encoder. [2] The monoflop time is the time between 2 SSI frames. The assigned monoflop time must be greater than the monoflop time of the absolute encoder (refer to the technical specifications of the manufacturer). [3] The following limitation applies to the monoflop time of the absolute encoder: (1/transmission rate) < monoflop time of absolute encoder < 64 µs		

4.9 Control and Feedback Interfaces in Standard Mode

Note

For the 1SSI, the following data of the control and feedback interface are consistent:

Byte 0 to 3

Byte 4 to 7

Use the access or addressing mode for data consistency over the entire control and feedback interface on your master (only for configuration using the GSD file).

Description

The two tables show the assignment of the control interface (outputs) and the feedback interface (inputs):

Table 4-3 Assignment of the Feedback Interface (Inputs)

Address	Assignment
Bytes 0 to 3	Encoder value double word (bit 31 set, encoder value frozen)
Byte 4	Bit 7: or sign of life LZ Bit 6: Ready for operation RDY Bit 5: Parameter assignment error ERR_PARA Bit 4: Absolute encoder error ERR_SSI Bit 3: Encoder supply short circuit ERR_24V Bit 2: Status DI STS_DI Bit 1: Status DN STS_DN Bit 0: Status UP STS_UP
Byte 5	Bit 7: Reserved = 0 Bit 6: Reserved = 0 Bit 5: Reserved = 0 Bit 4: Reserved = 0 Bit 3: Comparison value 2 reached, CMP2 Bit 2: Comparison value 1 reached, CMP Bit 1: Load function error, ERR_LOAD Bit 0: Load function running, STS_LOAD
Bytes 6 to 7	Reserved = 0

Table 4-4 Assignment of the Control Interface (Outputs)

Address	Assignment
Bytes 0 to 3	Comparison value 1 or 2 (double word)
Byte 4	Bit 7: Error acknowledgment EXTF_ACK Bit 6: Acknowledgment of latch function LATCH_ACK Bit 5: Reserved = 0 Bit 4: Reserved = 0 Bit 3: Reserved = 0 Bit 2: Reserved = 0 Bit 1: Load comparison value 2, CMP_VAL2 Bit 0: Load comparison value 1, CMP_VAL1
Byte 5	Reserved = 0
Bytes 6 to 7	Reserved = 0

Notes on the Control and Feedback Bits

Bits	Notes
CMP	Comparison result of comparator 1
CMP2	Comparison result of comparator 2
CMP_VAL1	Load comparison value 1
CMP_VAL2	Load comparison value 2
ERR_24V	The encoder supply is short-circuited. ERR_24V is reset when the short circuit is eliminated and acknowledged with the EXTF_ACK control bit.
ERR_LOAD	Error while loading the comparison values because both control bits CMP_VAL1 and CMP_VAL2 are set.
ERR_PARA	Incorrect parameter assignment for the ET 200S station. Cause: Total steps of the absolute encoder are not in the range of values for the type of encoder. The parameter bit is cleared when a correct parameter assignment is transmitted.
ERR_SSI	The 1SSI detects an absolute encoder error if the message frames at the SSI interface are faulty. Causes: No encoder connected; wire break in the encoder cable; over voltage of encoder supply; type of encoder, transmission rate, parity error, monoflop time do not correspond to the connected encoder; programmable encoders do not correspond to the settings on the 1SSI; encoder is defective or faults exist. ERR_SSI is reset when the cause of the error is eliminated and acknowledged with the EXTF_ACK control bit.
EXTF_ACK	Error acknowledgement for the absolute encoder ERR_SSI and encoder supply short circuit ERR_24V errors
LATCH_ACK	Acknowledgement for latch function
LZ	This parameter is only active in isochronous mode. When sign of life is on, the sign-of-life bit is toggled, i.e., the last sent value is inverted, each time an encoder value is read in isochronous mode. If a reduction is assigned in the "Encoder Sampling Rate" parameter, the value is toggled only if an encoder value was actually read in.
STS_DI	The bit displays the status of the digital input DI.

Bits	Notes
STS_DN	Status direction down; for encoder value change from larger to smaller encoder positions (including zero crossover)
STS_LOAD	Feedback bit for CMP_VAL1 and CMP_VAL2. The 1SSI uses this bit to indicate that a comparison value is loaded.
STS_UP	Status direction down; for encoder value change from larger to smaller encoder positions (including zero crossover)
RDY	The parameter assignment of the 1SSI is correct, and the module is executing its functions. The displayed feedback is valid. For the absolute value encoder error, ERR_SSI is also set.

Access to the Control and Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD file [1]) (Hardware catalog\PROFIBUS-DP\ Additional FIELD DEVICES\ET 200S)	Configuring with STEP 7 using HW Config (Hardware catalog\PROFIBUS-DP\ ET 200S)
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command, e.g. L PID
Control interface	Write with SFC 15 "DPWR_DAT"	Transfer command, e.g. T PQD
[1] Load and transfer commands are also possible with CPU 3xxC, CPU 318-2 (as of V3.0), CPU 4xx (as of V3.0) and WinLC RTX (PC CPU).		

4.10 Feedback Interface in Fast Mode

Description

Refer to the table below for the assignment of the feedback interface (inputs):

Table 4-5 Assignment of the Feedback Interface (Inputs)

Address	Assignment
Bytes 0 to 3	Bit 31: Reserved = 0 or sign of life LZ Bit 30: Ready for operation (feedback is valid) RDY Bit 29: Parameter assignment error ERR_PARA; Bit 28: Group error absolute encoder or encoder supply short circuit EXTF Bit 27: Status DI STS_DI Bit 26: Status DN STS_DN Bit 25: Status UP STS_UP Bytes 0 to 24: Encoder value

Notes on the Feedback Bits

Bits	Notes
ERR_PARA	Incorrect parameter assignment for the ET 200S station. Cause: Total steps of the absolute encoder are not in the range of values for the type of encoder. The parameter bit is cleared when a correct parameter assignment is transmitted.
EXTF	Group error absolute encoder or encoder supply short circuit Causes: The encoder supply is short-circuited **or** No encoder connected; wire break in the encoder cable; type of encoder, transmission rate, monoflop time do not correspond to the connected encoder; programmable encoders do not correspond to the settings on the 1SSI; encoder is defective or faults or parity errors exist. EXTF is reset when the causes of the errors are eliminated.
LZ	This parameter is only active in isochrone mode. When sign of life is on, the sign-of-life bit is toggled, i.e., the last sent value is inverted, each time an encoder value is read in isochrone mode. If a reduction is assigned in the "Encoder Sampling Rate" parameter, the value is toggled only if an encoder value was actually read in.
STS_DI	The bit displays the status of the digital input DI.
STS_DN	Status direction down; for encoder value change from larger to smaller encoder positions (including zero crossover)
STS_UP	Status direction down; for encoder value change from larger to smaller encoder positions (including zero crossover)
RDY	The parameter assignment of the 1SSI is correct, and the module is executing its functions. The displayed feedback is valid. For the absolute value encoder error, ERR_SSI is also set.

Access to the Feedback Interface in STEP 7 Programming

	Configuring with STEP 7 using the GSD File	Configuring with STEP 7 using HW Config
Feedback interface	Read with SFC 14 "DPRD_DAT"	Load command (e.g. L PID)

4.11 Technical Specifications

Overview

General technical specifications	
Dimensions and Weight	
Dimensions W x H x D (mm)	15 x 81 x 52
Weight	Approx. 40 g
Voltages, Currents, Potentials	
Rated load voltage L+ • Range • Reverse polarity protection	24 VDC 20.4 ... 28.8 V Yes
Galvanic isolation • Between backplane bus and SSI function • Between SSI function and load voltage L+	 Yes No
Encoder supply • Output voltage • Output current	 L+ (-0.8 V) max. 500 mA, short circuit-proof
Current consumption • From the backplane bus • From load voltage L+ (no load)	 max. 10 mA max. 40 mA
Power dissipation of the module	1.0 W
SSI Module Encoder Input	
Position feedback	Absolute
Differential signals for SSI data and SSI clock	According to RS422
Data transmission rate and wire length with absolute encoders (twisted pair and shielded) *)	• 125 kHz max. 320 m • 250 kHz max. 160 m • 500 kHz max. 60 m • 1 MHz max. 20 m • 1.5 MHz max. 10 m • 2 MHz max. 8 m
Digital Input	
Input voltage	0 signal: -30 ... 5 V 1 signal: 11 ... 30 V
Input current	0 signal: ≤2 mA (quiescent current) 1 signal: 9 mA (typical)
Input delay	0 > 1: max. 300 μs 1 > 0: max. 300 μs
Connection of a two-wire BERO type 2	Possible
Shielded cable length	50 m

General technical specifications						
Status, Interrupts, Diagnostics						
Interrupts						
Status display for digital input DI	LED 7 (green)					
Status display of first comparator CMP	CMP LED (green)					
Encoder value change Up	UP LED (green)					
Encoder value change Down	DN LED (green)					
Group error	SF LED (red)					
Encoder Value Inaccuracy in Non-Isochronous Mode						
Free-wheeling encoder value detection						
• Maximum age – Standard mode – Fast mode	(2 x message frame runtime) + Monoflop time + 1 ms (2 x message frame runtime) + Monoflop time + 700 µs					
• Jitter – Standard mode – Fast mode	Message frame runtime + Monoflop time Message frame runtime + Monoflop time					
Synchronous encoder value detection						
• Age – Standard mode – Fast mode	Message frame runtime + 1 ms Message frame runtime + 700 µs					
Isochronous encoder value detection						
• Age in standard mode and fast mode	Encoder value at time T_i of the current bus cycle					
Latch Value Inaccuracy in Non-Isochronous Mode						
Free-wheeling encoder value detection						
• Jitter in standard mode and fast mode	Frame runtime + Monoflop time					
Synchronous encoder value detection						
• Jitter – Standard mode – Fast mode	1 ms 700 µs					
Isochronous encoder value detection						
• Jitter in standard mode and fast mode	Frame runtime + Monoflop time					
Frame runtime of the encoders (for selected encoder widths without parity bit)						
	13 bits	14 bits	16 bits	21 bits	24 bits	25 bits
• 125 kHz	112 µs	120 µs	136 µs	176 µs	200 µs	208 µs
• 250 kHz	56 µs	60 µs	68 µs	88 µs	100 µs	104 µs
• 500 kHz	28 µs	30 µs	34 µs	44 µs	50 µs	52 µs
• 1 MHz	14 µs	15 µs	17 µs	22 µs	25 µs	26 µs
• 1.5 MHz	9 µs	10 µs	11 µs	15 µs	17 µs	17 µs
• 2 MHz	7 µs	8 µs	9 µs	11 µs	13 µs	13 µs
Monoflop time [1]	16 µs / 32 µs / 48 µs / 64 µs					

General technical specifications		
Response Times in Non-Isochronous Mode		
Update rate of the 1SSI		
• In standard mode • In fast mode	1 ms 700 µs	
Isochronous Times for the Module		
• In standard mode	TCI	125 µs + Frame runtime (in µs)
	TCO	125 µs
	T_{oi}Min	0 µs
	T_{DP}Min	400 µs + Frame runtime if frame runtime > 100 µs
		500 µs if frame runtime ≤ 100 µs
• In fast mode	TCI	70 µs + Frame runtime (in µs)
	TCO	0 µs
	T_{oi}Min	0 µs
	T_{DP}Min	210 µs + Frame runtime if frame runtime > 40 µs
		250 µs if frame runtime ≤ 40 µs

[1] The following restriction applies to the monoflop time of the absolute encoder:
(1/transmission rate) < monoflop time of the absolute encoder < 64 µs)

[*)] As long as the encoder in use does not require a shorter line length.

2PULSE 5

5.1 Product Overview

Order Number

6ES7 138-4DD00-0AB0

Features

- 2-channel

  The two channels of the 2PULSE can be used independently of one another; they permit pulse output in four different modes.
  Minimum pulse duration: 200 μs,
  Accuracy: ± (pulse duration x 100 ppm) ±100 μs
- Apart from the set mode, the 2PULSE also has two other functions.
- Digital output DO 0 for channel 0 and digital output DO 1 for channel 1 to output the pulses.
- Digital input DI 0 for channel 0 and digital input DI 1 for channel 1 for enabling.

Operating Modes

- Pulse output mode

  Output of a pulse on the digital output of the 2PULSE with a specifiable pulse duration.
- Pulse-width modulation (PWM) mode

  Output of a pulse train on the digital output of the 2PULSE; the output value corresponds to the ratio of the pulse duration to the period.
- Pulse train mode

  Output of n pulses on the digital output of the 2PULSE with a specifiable period and pulse duration.
- On/Off-delay mode

  The signal pending at the digital input DI is output with an on/off-delay at the digital output DO by the 2PULSE.

Functions

- Direct control of the digital output by means of the control program
- Programmable behavior for CPU/master STOP
- Error detection/diagnostics (short circuit of the digital output and encoder supply)

Configuration

You can use either of the following to configure the 2PULSE:

- A GSD file (http://www.ad.siemens.de/csi/gsd)

or

- STEP 7 V5.0 SP3 and later.

Restrictions with the 2PULSE electronic module (6ES7 138-4DD00-0AB0)

Note

Restrictions for the 2PULSE module with IM151-7 CPU, IM151-1 HIGH FEATURE or IM 151-1 BASIC:

With the IM 151-7 CPU, you must use STEP 7 V5.1, Service Pack 1, Hotfix 1 or higher for configuration.

You **cannot** enable the group diagnostics parameter in the configuration if you use the 2PULSE module.

5.2 Example: Starting 2PULSE

Task

These instructions guide you to a functioning application that will enable you to become familiar with and check the basic hardware and software functions of your 2PULSE. The "Pulse Output" mode will be used as an example here. Channel 0 of the 2PULSE is used in this example.

Requirements

The following requirements must be satisfied:

- You have commissioned an ET 200S station on an S7 station with a master.
- You must have the following:
  - A TM-E15S24-01 terminal module and
  - a 2PULSE.

Installation and Fitting

1. Install and wire the TM-E15S24-01 terminal module (see figure below).
2. Connect the 2PULSE to the terminal module (you will find detailed instructions in the *ET 200S Distributed I/O System* Manual). It is not necessary to wire the 2PULSE for this example.

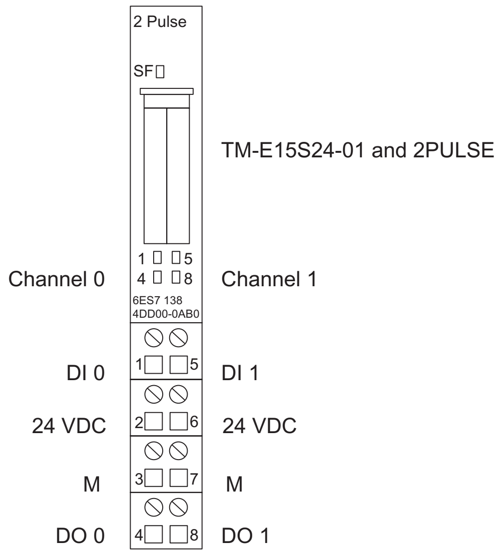


Figure 5-1 Terminal Assignment of the 2PULSE for the Example

Configuring with STEP 7 using HW Config

You must first adapt the hardware configuration of your existing ET 200S station.

1. Open the relevant project in SIMATIC Manager.
2. Open the HW Config configuration table in your project.
3. Select the 2PULSE from the hardware catalog. The number 6ES7 138-4DD00-0AB0 appears in the infotext. Drag the entry to the slot at which you have installed your 2PULSE.
4. Double-click this number to open the *DP Slave Properties* dialog box.

   On the *Addresses tab* you will find the addresses of the slot to which you have dragged the 2PULSE. Make a note of these addresses for subsequent programming.

   On the *Parameters* tab, you will find the default settings for the 2PULSE. Leave the default settings unchanged.
5. Save and compile your configuration, and download the configuration in STOP mode of the CPU by choosing "PLC > Download to Module".

Integration into the Control Program

Create block FC101 and integrate it in your control program (in OB1, for example). This block works in this example with the MB10, MB20 and M30.0 memory bits.

In block FC101, the start address of the inputs and outputs of the 2PULSE is 256. If necessary, take the address from the hardware configuration.

This block sets a pulse duration of 5000 ms and starts pulse output as soon as you have issued the enable using your control program (SW_ENABLE=1).

STL		Description
Block: FC101		
L	PEB256	//Read feedback messages from channel 0 of the 2PULSE
T	MB20	
L	5000	//Write pulse duration of 5000 ms to channel 0 of the 2PULSE
T	PAW256	
L	0	//Generate SW_ENABLE control signal
T	MB10	
U	M30.0	//Query start of pulse output
=	M10.0	//Set SW_ENABLE=1
L	MB10	
T	PAB258	//Write control signals to channel 0 of the 2PULSE

Testing

Start a pulse output with SW_ENABLE=1 and monitor the STS_ENABLE and STS_DO feedback bits using "Monitor/Modify Variables".

1. Select the "Block" folder in your project. Choose the "Insert > S7 Block > Variable Table" menu command to insert the VAT 1 variable table, and then confirm with *OK*.
2. Open the VAT 1 variable table, and enter the following variables in the "Address" column:

   M20.0 (STS_ENABLE)

   M20.1 (STS_DO)

   M30.0 (SW_ENABLE)
3. Choose "PLC > Connect To > Configured CPU" to switch to online.
4. Choose "Variable > Monitor" to switch to monitoring.
5. Switch the CPU to RUN mode.

Result

The following table shows you which activity triggers which result.

Activity	Result
When you switch the CPU to RUN, the following results are obtained:	• All the LEDs are turned off • STS_ENABLE = 0 • STS_DO = 0
Start the pulse output by setting memory bit 30.0 (Variable → Modify →)	
Directly after the start...	• STS_ENABLE = 1 • STS_DO = 1 • LED 4 for DO 0 lights up
After the 5 s pulse duration has expired	• STS_ENABLE = 0 • STS_DO = 0 • LED 4 for DO 0 is turned off

To start further pulse output, you must delete SW_ENABLE (memory bit M30.0 = 0) and reset it (memory bit M30.0 = 1).

You can change the pulse duration in the control program.

5.3 Modes and Functions

5.3.1 Overview

Principle

The 2PULSE has two channels. You can select a separate mode for each channel. You assign parameters to the mode using HWCONFIG or COM PROFIBUS. The mode that has been assigned parameters can then no longer be changed with your control program.

You can select from four different modes for each channel:

- Pulse output
- Pulse-width modulation
- Pulse train
- On/off-delay

In addition to the set mode, the 2PULSE also has the following functions:

- Direct control of the DO digital output by means of your control program; controllable separately for each channel.
- Error detection/diagnostics; the 2PULSE recognizes the errors for each channel separately.
- Behavior at CPU/master STOP; the 2PULSE recognizes the CPU/master STOP for both two channels and responds in accordance with your parameter assignment.

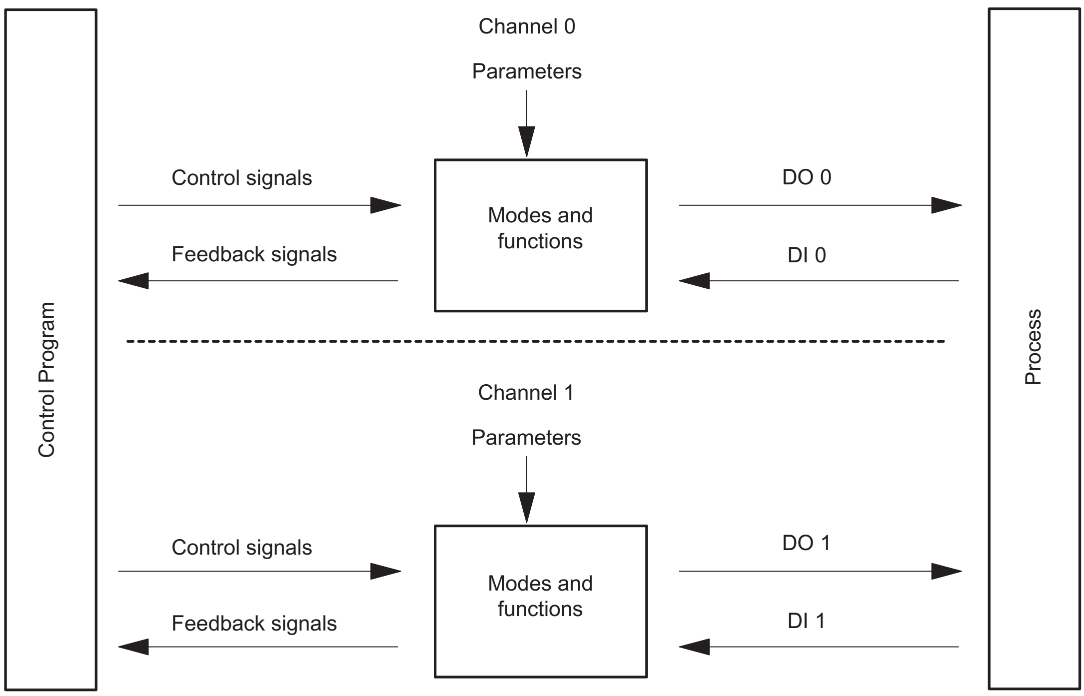


Figure 5-2 How the 2PULSE works

Interfaces to the Control Program and Process

To execute the modes and functions, the 2PULSE has as an interface to the process of a digital input and a digital output for each channel (DI 0, DO 0 for channel 0 and DI 1, DO1 for channel 1).

You can modify and monitor the modes and functions with your control program using control signals and feedback signals.

Parameters are assigned to the various modes. See the technical specifications for programming a complete list of parameters for all modes.

You will find the following in the sections on modes and functions:

- The relevant parameters
- The control and feedback signals

The description of the modes and functions applies to both channels and the channels are therefore not referred to separately in the description.

5.3.2 Pulse Output Mode

Definition

For the pulse duration you set, the 2PULSE outputs a pulse at the DO digital output (output sequence) on expiration of the set on-delay.

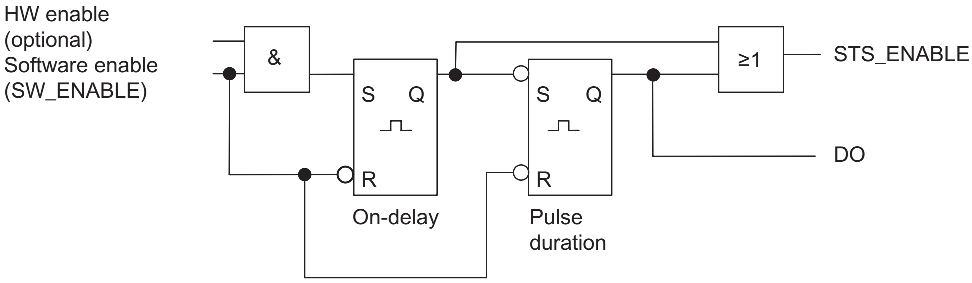


Figure 5-3 Basic Circuit Diagram for Pulse Output Mode

Starting output sequence

You must always issue the enable for the output sequence by means of the software enable (SW_ENABLE 0→1; MANUAL_DO=0) in your control program.

The ACK_SW_ENABLE feedback bit indicates the software enable pending at the 2PULSE.

You can also set the DI digital input of the 2PULSE as hardware enable (HW enable) with the DI function parameter.

If you want to work with the software enable and hardware enable at the same time, when the software enable has been issued, the output sequence starts at the first positive edge of the hardware enable. Further positive edges of the hardware enable during the current output sequence are ignored by the 2PULSE. When the software enable has been issued, a positive edge of the hardware enable is enough to start the next output sequence.

When the enable is issued (positive edge), the on-delay is started and the STS_ENABLE set. On expiration of the on-delay, the pulse is output with the set pulse duration. The output sequence finishes with the end of the pulse; STS_ENABLE is deleted.

If you make an impermissible change to the pulse duration during operation, the ERR_PULS signal indicates a pulse output error. You will then have to restart the output sequence.

The next time the output sequence starts, the 2PULSE deletes the ERR_PULS feedback bit.

Pulse diagram

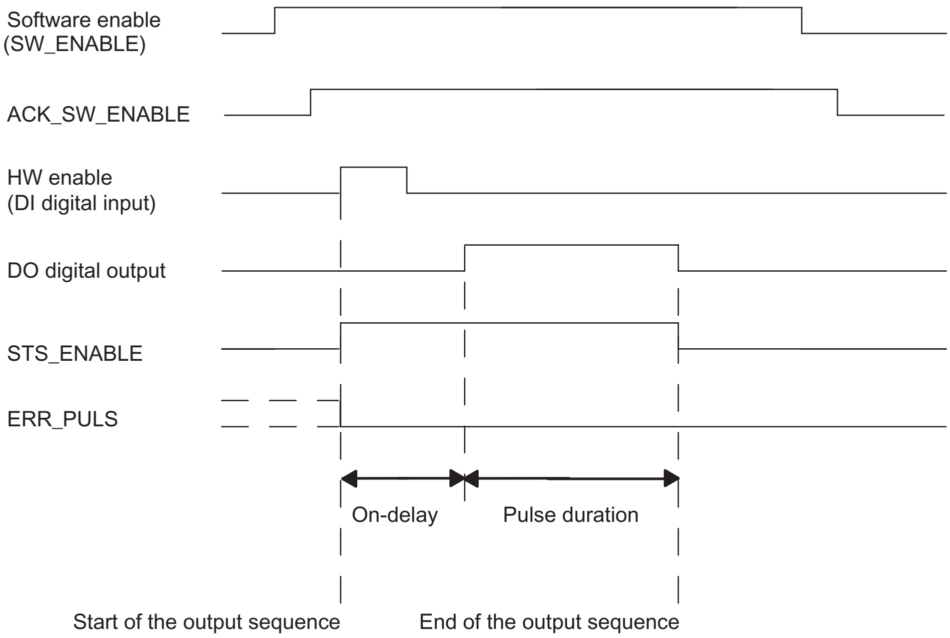


Figure 5-4 Output Sequence for Pulse Output

Interrupting output sequence

Deleting the software enable (SW_ENABLE = 0) during the on-delay or the pulse duration terminates the output sequence, and STS_ENABLE and the DO digital output are deleted.

You will then have to restart the output sequence.

Truth Table

SoftwareEnable SW_ENABLE	HW enable(DI digital input)	DO Digital Output	STS_ENABLE	Output Sequence
1	0→1	0, if on-delay >0 1, if on-delay =0	0→1	Start
0→1	Not used	0, if on-delay >0 1, if on-delay =0	0→1	Start
0	Any status	0	0	Terminate
1	0	Previous status remains		-
1	1	Previous status remains		-
1	Not used	Previous status remains		-
0→1	0	0	0	-
0→1: Positive edge				

Setting Times Using a Time Base

By means of the time base that can be assigned parameters, you can select the resolution and range of the pulse duration and the on-delay.

Time base = 0.1 ms:	You can set times from 0.2 ms to 6.5535 s with a resolution of 0.1 ms.
Time base = 1 ms:	You can set times from 1 ms to 65.535 s with a resolution of 1 ms.

Setting and Changing the Pulse Duration

Set the pulse duration directly in your control program as a numerical value between 0 and 65535.

Pulse duration = time base x set numerical value

If you change the pulse duration when an output sequence is running, the time already output will be subtracted from the new pulse duration and the pulse will continue to be output.

Reducing the Pulse Duration

If you have reduced the pulse duration to a time that is shorter than the time already output, the output sequence is terminated, STS_ENABLE and the DO digital output are deleted, and the ERR_PULS status bit is set. At the next output sequence, the ERR_PULS status bit is deleted.

Setting and Changing the On-Delay

Set the on-delay as a value between 0 and 65535 in the parameters.

on-delay that has been assigned parameters = time base x set numerical value

Using the factor for the on-delay, you can adjust the time that has been assigned parameters in your control program. Set the factor between 0 and 255, with a weighting of 0.1:

On-delay = factor x 0.1 x on-delay that has been assigned parameters

If you change the on-delay factor during the output sequence, the new on-delay is activated at the next output sequence.

Pulse Output Mode Parameters

Parameters	Meaning	Value Range	Default
Mode	Set the pulse output mode.	• Pulse output • Pulse-width modulation • Pulse train • On/off-delay	Pulse output
Time base	Using the time base, select the resolution and range of the pulse duration and the on-delay.	• 0.1 ms • 1 ms	0.1 ms
Function DI	You can use the DI digital input as an input or as a hardware enable.	• Input • HW enable	Input
On-delay	The time from the start of the output sequence to the output of the pulse. You can change the on-delay using your control program.	With time base 0.1 ms: 0 to 65535 With time base 1 ms: 0 to 65535	0

Control and Feedback Signals of Pulse Output Mode

Control and Feedback Signals	Meaning	Value Range	Channel 0 Address	Channel 1 Address
Control Signals				
Software enable (SW_ENABLE)	Starting and termination of the output sequence.	0 = SW_ENABLE deleted 1 = SW_ENABLE set 0→1 = start of output sequence; may be dependent on the hardware enable	Byte 2: Bit 0	Byte 6: Bit 0
Pulse duration	The time that is set for the DO digital output on expiration of the on-delay.	With time base 0.1 ms: 2 to 65535 With time base 1 ms: 1 to 65535 If you violate the lower limit of the range, the 2PULSE will not output a pulse.	Word 0	Word 4
On-delay factor	The on-delay that has been assigned parameters can be changed before the start of the output sequence: On-delay = factor x 0.1 x on-delay that has been assigned parameters	0 to 255 If the on-delay <0.2 ms or if factor = 0, the effective on-delay is = 0. If there is an on-delay > 65.535 s, the on-delay is limited to 65.535 s.	Byte 3	Byte 7

Control and Feedback Signals	Meaning	Value Range	Channel 0 Address	Channel 1 Address
Feedback Signals				
STS_ENABLE	Indicates an output sequence is running.	0 = pulse output blocked 1 = pulse output running	Byte 0: Bit 0	Byte 4: Bit 0
STS_DO	Indicates the signal level at the DO digital output. Note the update rate.	0 = signal at the DO digital output 1 = signal at the DO digital output	Byte 0: Bit 1	Byte 4: Bit 1
STS_DI	Indicates the signal level at the DI digital input.	0 = signal 0 at the DI digital input 1 = signal 1 at the DI digital input	Byte 0: Bit 2	Byte 4: Bit 2
ACK_SW_ENABLE	Indicates the status of SW_ENABLE.	0 = SW_ENABLE deleted 1 = SW_ENABLE set	Byte 0: Bit 3	Byte 4: Bit 3
ERR_PULS	Indicates a pulse output error.	0 = no pulse output error 1 = pulse output error	Byte 0: Bit 4	Byte 4: Bit 4

Input and Output Signals of Pulse Output Mode

Input and Output Signals	Meaning	Value Range	Channel 0 Terminal	Channel 1 Terminal
Input Signal				
HW enable	You can select the HW enable with the DI function parameter. The signal of the DI digital input is then interpreted by the 2PULSE at the start of the output sequence.	0 = HW enable deleted 1 = HW enable issued 0→1= start of the output sequence; dependent on the software enable (SW_ENABLE)	1	5
Output Signal				
Pulse at the DO digital output	A pulse is output at the DO digital output for the set pulse duration.	0 = no pulse 1 = pulse	4	8

5.3.3 Pulse-Width Modulation Mode (PWM)

Definition

You specify an output value to the 2PULSE. The 2PULSE generates continuous pulses on this basis. The output value determines the pulse/interpulse ratio within a period (pulse-width modulation). The period can be adjusted.

The pulse train is output on expiration of the assigned on-delay on the DO digital output of the 2PULSE (output sequence).

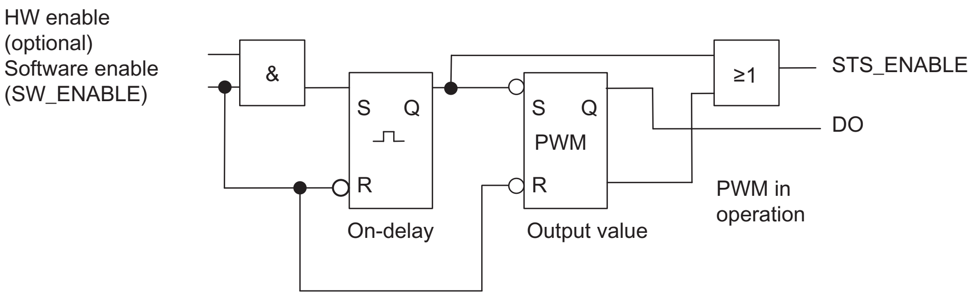


Figure 5-5 Block Diagram for Pulse-Width Modulation Mode

Starting the Output Sequence

You must always issue the enable for the output sequence via a software enable (SW_ENABLE 0→1; MANUAL_DO = 0) in your control program. The ACK_SW_ENABLE feedback bit indicates the software enable pending at the 2PULSE.

You can also set the digital input DI of the 2PULSE as HW enable with the Function DI parameter.

If you want to work with the software enable and hardware enable at the same time, when the software enable has been issued, the output sequence starts with the first positive edge of the hardware enable. Further positive edges of the hardware enable during the current output sequence are ignored by the 2PULSE.

When the enable is issued (positive edge), the on-delay is started and the STS_ENABLE set. The pulse train is output on expiration of the on-delay. The output sequence runs continuously as long as SW_ENABLE is set.

Pulse Diagram

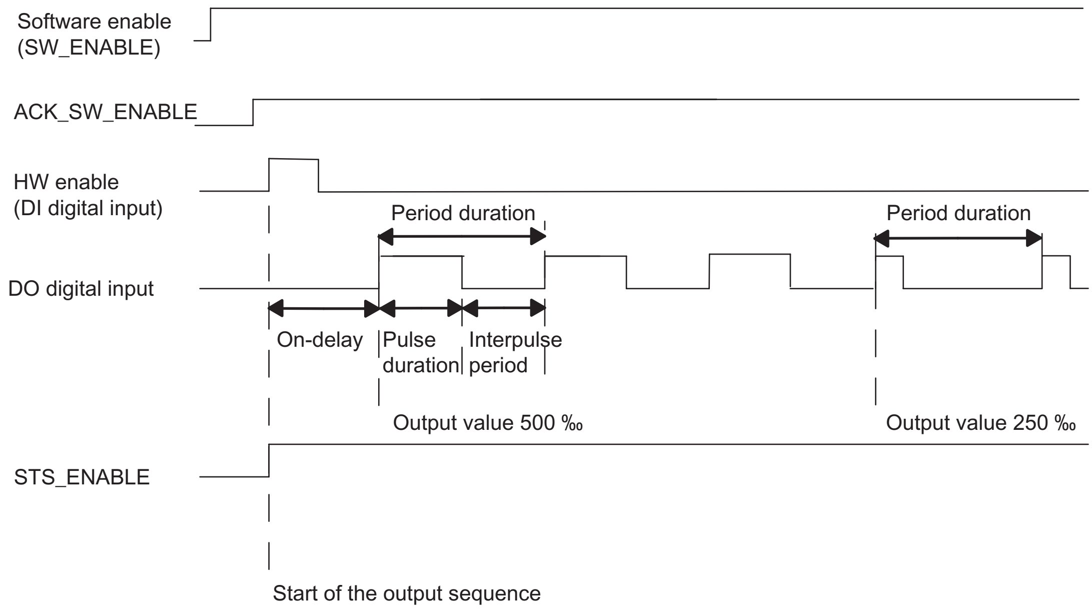


Figure 5-6 Pulse-Width Modulation Output Sequence

Canceling the Output Sequence

Deleting the software enable (SW_ENABLE=0) during the on-delay or the pulse output cancels the output sequence, and STS_ENABLE and the DO digital output are canceled.

You will then have to restart the output sequence.

Truth Table

Software enable SW_ENABLE	Hardware enable (digital input DI)	Digital output DO	STS_ENABLE	Output sequence
1	0→1	0, if on-delay >0 1, if on-delay =0	0→1	Start
0→1	Not used	0, if on-delay >0 1, if on-delay =0	0→1	Start
0	Any status	0	0	Cancel
1	0	Previous status remains		-
1	1	Previous status remains		-
1	Not used	Previous status remains		-
0→1	0	0	0	-
0→1: Positive edge				

Modulation of the Pulse Duration

The 2PULSE calculates the pulse duration on the basis of the output value you set (between 0 and 1000‰):

Pulse duration = (output value/1000 [‰]) x period.

Minimum Pulse Duration and Minimum Interpulse Period

The minimum pulse duration and minimum interpulse period are superimposed on the proportional output characteristic.

You assign the minimum pulse duration and minimum interpulse period using the Minimum/Pulse duration parameter; they always have the same value.

A pulse duration calculated by the 2PULSE that is shorter than the minimum pulse duration is suppressed.

A pulse duration calculated by the 2PULSE that is longer than the period minus the minimum interpulse period is set at 1000‰.

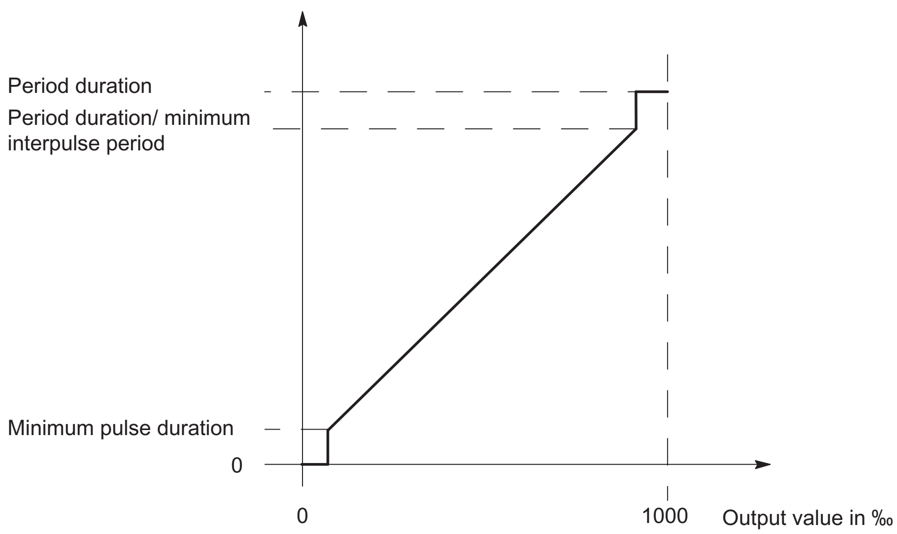


Figure 5-7 Modulation of the Pulse Duration

You specify the period in accordance with the required accuracy of the process variables generated by the actuator.

Setting Times Using a Time Base

You use the assignable time base to select the resolution and range of the period, the minimum pulse duration and the on-delay.

Time base = 0.1 ms:	You can set times from 0.2 ms to 6.5535 s with a resolution of 0.1 ms.
Time base = 1 ms:	You can set times from 1 ms to 65.535 s with a resolution of 1 ms.

Setting and Changing the Output Value

You use the Output Format PWM parameter to select the value range of the output value.

If your output value is between 0 and 1000, select the per mill output format.

If your output value is a SIMATIC S7 analog value (between 0 and 27648), select the S7 analog output output format.

You set the output value directly using your control program.

If you change the output value, the 2PULSE calculates the new pulse duration and interpulse period immediately:

- If you make changes during the interpulse period and if the new output value is smaller than the previous one, the period is extended once only, since the new interpulse period is longer.
- If you make changes during the interpulse period and if the new output value is greater than the previous one, the period is shortened once only, since the new interpulse period is shorter.
- If you make changes during the pulse duration and if the new output value is lower than the previous one, the period can be extended once only, since the interpulse period is longer.
- If you make changes during the pulse duration and if the new output value is greater than the previous one, the period remains constant.

Setting and Changing the Period

Set the period as a value between 2 and 65535 in the parameters:

Assigned period = time base x set numerical value

Using the factor for the period, you can adjust the assigned time in your control program. Set the factor between 0 and 255, with a weighting of 0.1:

Period = factor x 0.1 x assigned period duration

If you change the factor, the 2PULSE immediately calculates the new period and with it the new pulse duration and interpulse period:

- If you make changes during the interpulse period and if the new factor is lower than the previous one, a period that is shorter than the previous one but longer than the new one is set once only.
- If you make changes during the interpulse period and if the new factor is greater than the previous one, a period that is longer than the previous one but shorter than the new one is set once only.
- If you make changes during the pulse duration and if the new factor is lower than the previous one, a period that is shorter than the previous one but longer than the new one can be set once only.
- If you make changes during the pulse duration and if the new factor is greater than the previous one, a period that is longer than the previous one but shorter than the new one can be set once only.

Setting the Minimum Pulse Duration and Minimum Interpulse Period

You specify the minimum pulse duration and the minimum interpulse period as a numerical value between 0 and 65535 using the Minimum/Pulse Duration parameter:

Assigned minimum pulse duration/minimum interpulse period = time base x set numerical value

Setting the On-Delay

You specify the on-delay as a value between 0 and 65535 in the parameters.

Assigned on-delay = time base x set numerical value

Parameters of Pulse-Width Modulation Mode

Parameter	Meaning	Value Range	Default
Mode	Set pulse-width modulation mode.	• Pulse output • Pulse-width modulation • Pulse train • On/off-delay	Pulse output
PWM output format	Select either the per mill or SIMATIC S7 analog value output formats depending on the output value resolution required.	• Per mill • SIMATIC S7 analog value	Per mill
Time base	Use the time base to select the resolution and the value range of the period, the minimum/pulse duration, and the on-delay.	• 0.1 ms • 1 ms	0.1 ms
Function DI	You can use the digital input DI as an input or as a HW enable.	• Input • HW enable	Input
On-delay	The time from the start of the output sequence to the output of the pulse train.	With time base 0.1 ms: 0 to 65535 With time base 1 ms: 0 to 65535	0
Minimum/pulse duration	Minimum pulse duration and minimum interpulse period: Enter the response time of the actuator connected to your DO digital output.	With time base 0.1 ms: 2 to 65535 With time base 1 ms: 1 to 65535 If you fall below the value range, the 2PULSE sets the minimum/pulse duration to 0.2 ms or 1 ms.	10000 → 1 s
Period	The period should always be a multiple of the response time of the actuator connected to the digital output DO. You can change the period with your control program.	With time base 0.1 ms: 2 to 65535 With time base 1 ms: 1 to 65535	20000 → 2 s

Control and Feedback Signals of Pulse-Width Modulation Mode

Control and Feedback Signals	Meaning	Value Range	Channel 0 address	Channel 1 address
Control signals				
Software enable (SW_ENABLE)	Starting and canceling of the output sequence.	0 = SW_ENABLE canceled 1 = SW_ENABLE set 0→1 = start of output sequence; may be dependent on the hardware enable	Byte 2: Bit 0	Byte 6: Bit 0
Output value	The value that is output in pulse-width modulated format on the digital output DO.	Depending on the PWM output format: • Per mill 0 to 1000 • S7 analog output 0 to 27648 If you enter an output value > 1000 or 27648, the 2PULSE limits this to 1000 or 27648.	Word 0	Word 4
Period duration factor	You can change the assigned period: Period = factor x 0.1 x assigned period	Factor: 0 to 255 Period duration: 2 x minimum/pulse duration to 65.635 s. If a period duration of < 2 x minimum/pulse duration occurs or < 400 µs or if factor = 0, the effective period = 2 x minimum/pulse duration. In this case, the signal 0 is issued if the output value on the digital output DO < 500‰ or 13824, and signal = 1 is output if the output value > 500‰ or 13824. If there is a period > 65.535 s, it is limited to 65.535 s.	Byte 3	Byte 7
Feedback signals				
STS_ENABLE	Indicates an output sequence is running.	0 = pulse output blocked 1 = pulse output running	Byte 0: Bit 0	Byte 4: Bit 0
STS_DO	Indicates the signal level on the digital output DO. Note the update rate.	0 = signal 0 on digital output DO 1 = signal 1 on digital output DO	Byte 0: Bit 1	Byte 4: Bit 1
STS_DI	Indicates the signal level on digital input DI.	0 = signal 0 on digital input DI 1 = signal 1 on digital input DI	Byte 0: Bit 2	Byte 4: Bit 2
ACK_SW_ENABLE	Indicates the status of SW_ENABLE.	0 = SW_ENABLE canceled 1 = SW_ENABLE set	Byte 0: Bit 3	Byte 4: Bit 3

Input and Output Signals of Pulse-Width Modulation Mode

Input and Output Signals	Meaning	Value Range	Channel 0 terminal	Channel 1 terminal
Input signal				
HW enable	You can select the HW enable with the Function DI parameter. The signal of the digital input DI is then interpreted by the 2PULSE at the start of the output sequence.	0 = HW enable canceled 1 = HW enable issued 0→1= Start of the output sequence; dependent on the software enable	1	5
Output signal				
Pulse train on the digital output DO	The pulse train is output on the digital output DO.	0 = no pulse 1 = pulse	4	8

5.3.4 Pulse Train Mode

Definition

The 2PULSE outputs the number of pulses you specified as a pulse train at the DO digital output on expiration of the set on-delay (output sequence). The period duration and pulse duration of the pulses can be adjusted.

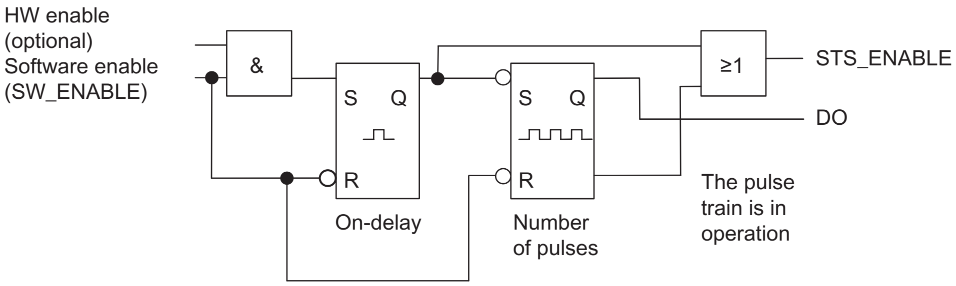


Figure 5-8 Basic Circuit Diagram for Pulse Train Mode

Starting output sequence

You must always issue the enable for the output sequence by means of the software enable (SW_ENABLE 0→1; MANUAL_DO=0) in your control program. The ACK_SW_ENABLE feedback bit indicates the software enable pending at the 2PULSE.

You can also set the DI digital input of the 2PULSE as HW enable with the DI function parameter.

If you want to work with the software enable and hardware enable at the same time, when the software enable has been issued, the output sequence starts at the first positive edge of the hardware enable. Further positive edges of the hardware enable during the current output sequence are ignored by the 2PULSE. When the software enable has been issued, a positive edge of the hardware enable is enough to start the next output sequence.

When the enable is issued (positive edge), the on-delay is started and the STS_ENABLE set. On expiration of the on-delay, the pulse train is output with the set number of pulses. The output sequence finishes as soon as the last pulse has been output; STS_ENABLE is deleted.

If you make an impermissible change to the number of pulses during operation, the ERR_PULS signal indicates a pulse output error.

At the next output sequence, the 2PULSE deletes the ERR_PULS feedback bit.

Pulse Diagram

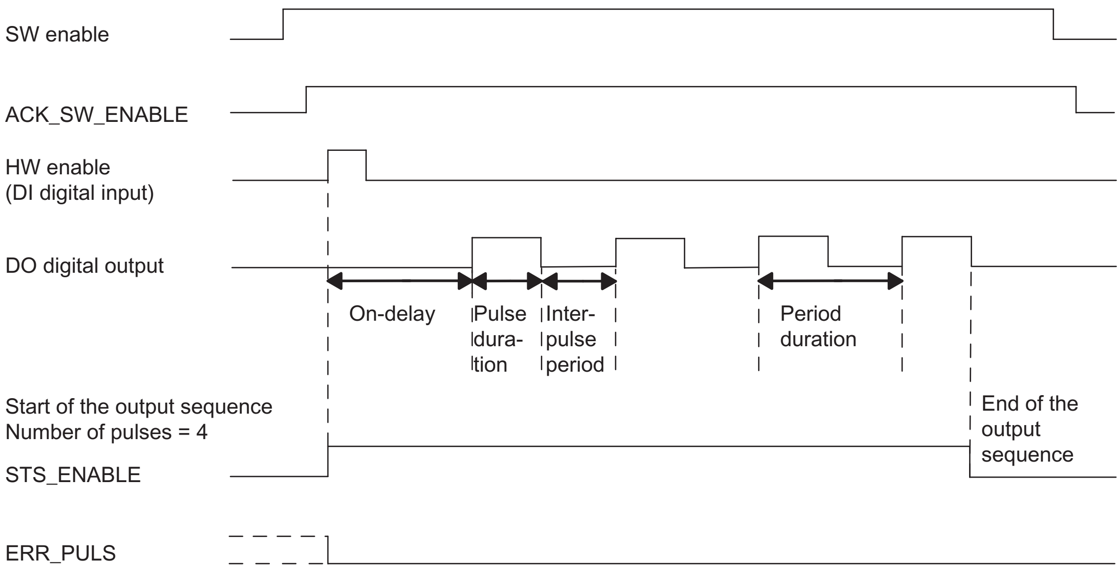


Figure 5-9 Output Sequence of the Pulse Train

Interrupting output sequence

Deleting the software enable during the on-delay or the pulse train terminates the output sequence, and STS_ENABLE and the DO digital output are deleted.

You will then have to restart the output sequence.

Truth Table

SoftwareEnable SW_ENABLE	DI digital input	DO Digital Output	STS_ENABLE	Output Sequence
1	0→1	0, if on-delay >0 1, if on-delay =0	0→1	Start
0→1	Not used	0, if on-delay >0 1, if on-delay =0	0→1	Start
0	Any status	0	0	Terminate
1	0	Previous status remains		-
1	1	Previous status remains		-
1	Not used	Previous status remains		-
0→1	0	0	0	-
0→1: Positive edge				

Setting Times Using a Time Base

Select, by means of the time base that can be assigned parameters, the resolution and range of the period duration, the pulse duration, and the on-delay.

Time base = 0.1 ms:	You can set times from 0.2 ms to 6.5535 s with a resolution of 0.1 ms.
Time base = 1 ms:	You can set times from 1 ms to 65.535 s with a resolution of 1 ms.

Setting and Changing the Number of Pulses

Set the number of pulses directly as a numerical value between 0 and 65535 with your control program.

If you change the number of pulses on expiration of the on-delay, the new value takes effect immediately:

- If you have increased the number of pulses, the new, higher number of pulses is output.
- If you have reduced the number of pulses, and if the lower number of pulses has already been output, the output sequence is terminated, STS_ENABLE and the DO digital output are deleted, and ERR_PULS is set. At the next output sequence, ERR_PULS is deleted.

Setting and Changing the Period Duration

Set the period duration as a value between 2 and 65535 in the parameters:

Period duration that has been assigned parameters = time base x set numerical value

Using the factor for the period duration, you can adjust the time that has been assigned parameters in your control program. Set the factor between 0 and 255, with a weighting of 0.1:

Period duration = factor x 0.1 x period duration that has been assigned parameters

If you change the factor during the output sequence, the new period duration will take effect at the start of the next output sequence.

Setting the Pulse Duration

Set the pulse duration as a numerical value between 1 and 65535 with the minimum/pulse duration parameter:

Pulse duration that has been assigned parameters = time base x set numerical value

Setting the On-Delay

Set the on-delay as a value between 0 and 65535 in the parameters.

On-delay that has been assigned parameters = time base x set numerical value

Parameters of the Pulse Train Mode

Parameters	Meaning	Value Range	Default
Mode	Set the pulse train mode.	• Pulse output • Pulse-width modulation • Pulse train • On/off-delay	Pulse output
Time base	Using the time base, select the resolution and range of the period duration, pulse duration, and on-delay.	• 0.1 ms • 1 ms	0.1 ms
Function DI	You can use the DI digital input as an input or as a HW enable.	• Input • HW enable	Input
On-delay	The time from the start of the output sequence to the output of the pulse train.	With time base 0.1 ms: 0 to 65535 With time base 1 ms: 0 to 65535	0
Minimum/pulse duration	Pulse duration: Enter the response time of the actuator connected on your DO digital output.	With time base 0.1 ms: 2 to 65535 With time base 1 ms: 1 to 65535 If you violate the lower limit of the range, the 2PULSE sets the pulse duration to 0.2 ms or 1 ms.	10000 → 1 s
Period duration	The period duration should always be a multiple of the response time of the actuator connected to the DO digital output. Define the period duration according to the required repetition rate of the pulses. You can change the period duration with your control program.	With time base 0.1 ms: 2 to 65535 With time base 1 ms: 1 to 65535	20000 → 2 s

Control and Feedback Signals of Pulse Train Mode

Control and Feedback Signals	Meaning	Value Range	Channel 0 Address	Channel 1 Address
Control Signals				
Software enable (SW_ENABLE)	Starting and termination of the output sequence.	0 = SW_ENABLE deleted 1 = SW_ENABLE set 0→1 = Start of the output sequence; may be dependent on the HW enable	Byte 2: Bit 0	Byte 6: Bit 0
Number of pulses	Number of pulses that are output at the DO digital output on expiration of the on-delay.	0 to 65535 If the number of pulses is 0, the 2PULSE does not output any pulses. The output sequence is terminated with ERR_PULS = 1.	Word 0	Word 4
Period duration factor	The on-delay that can be assigned parameters can be changed before the start of the output sequence: Period duration = factor x 0.1 x period duration that has been assigned parameters	Factor: 0 to 255 Period duration: > Pulse duration up to 65.535 s If there is a period duration > 65.535 s, it is set to 65.535 s. If a period duration ≤ pulse duration, it is set to a pulse duration of + 0.2 ms.	Byte 3	Byte 7
Feedback Signals				
STS_ENABLE	Indicates an output sequence is running.	0 = pulse output blocked 1 = pulse output running	Byte 0: Bit 0	Byte 4: Bit 0
STS_DO	Indicates the signal level at the DO digital output. Note the update rate.	0 = signal at the DO digital output 1 = signal at the DO digital output	Byte 0: Bit 1	Byte 4: Bit 1
STS_ DI	Indicates the signal level at the DI digital input.	0 = signal 0 at the DI digital input 1 = signal 1 at the DI digital input	Byte 0: Bit 2	Byte 4: Bit 2
ACK_SW_ENABLE	Indicates the status of SW_ENABLE.	0 = SW_ENABLE deleted 1 = SW_ENABLE set	Byte 0: Bit 3	Byte 4: Bit 3
ERR_PULS	Indicates a pulse output error.	0 = no pulse output error 1 = pulse output error	Byte 0: Bit 4	Byte 4: Bit 4

Input and Output Signals of Pulse Train Mode

Input and Output Signals	Meaning	Value Range	Channel 0 Terminal	Channel 1 Terminal
Input Signal				
HW enable	You can select the HW enable with the DI function parameter. The signal of the DI digital input is then interpreted by the 2PULSE at startup.	0 = HW enable deleted 1 = HW enable issued 0→1= Start of the output sequence; dependent on the software enable (SW_Enable)	1	5
Output Signal				
Pulse train at the DO digital output	The preset number of pulses is output at the DO digital output.	0 = no pulse 1 = pulse	4	8

5.3.5 On/Off-Delay Mode

Definition

The signal pending at the digital input DI is output with an on/off-delay at the digital output DO by the 2PULSE.

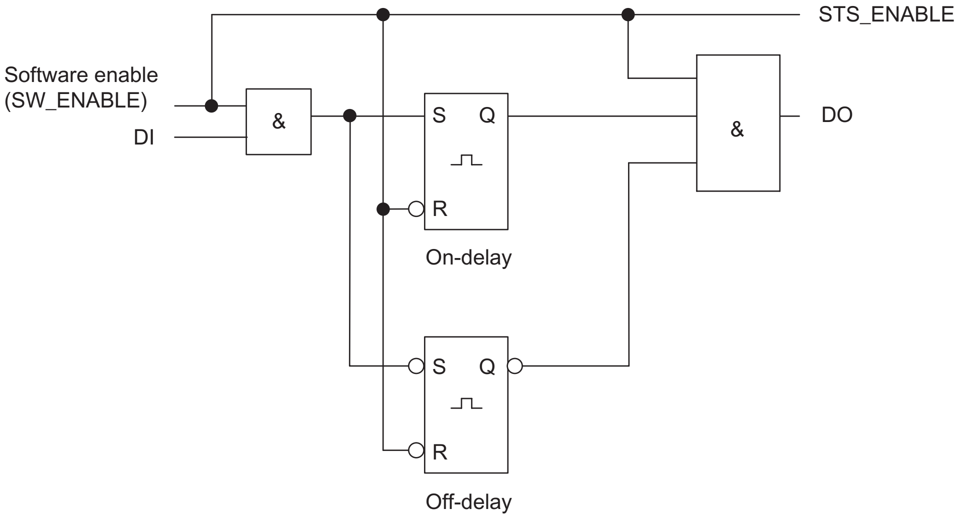


Figure 5-10 Basic Circuit Diagram for On/Off-Delay Mode

Output Sequence Enable

You must always issue the enable for the output sequence via a software enable (SW_ENABLE 0→1; MANUAL_DO = 0) in your control program; this sets STS_ENABLE. The ACK_SW_ENABLE feedback bit indicates the software enable pending at the 2PULSE.

The positive edge on the DI digital input (0→1) starts the on-delay, and on expiration of the on-delay the DO digital output is set.

The negative edge on the DI digital input (1→0) starts the off-delay, and on expiration of the off-delay the DO digital output is deleted.

If the 2PULSE recognizes a pulse duration or interpulse period that is too short, this is displayed by the ERR_PULS pulse output error.

At the next edge at the DI digital input, the 2PULSE deletes the ERR_PULS feedback bit.

Pulse Diagram

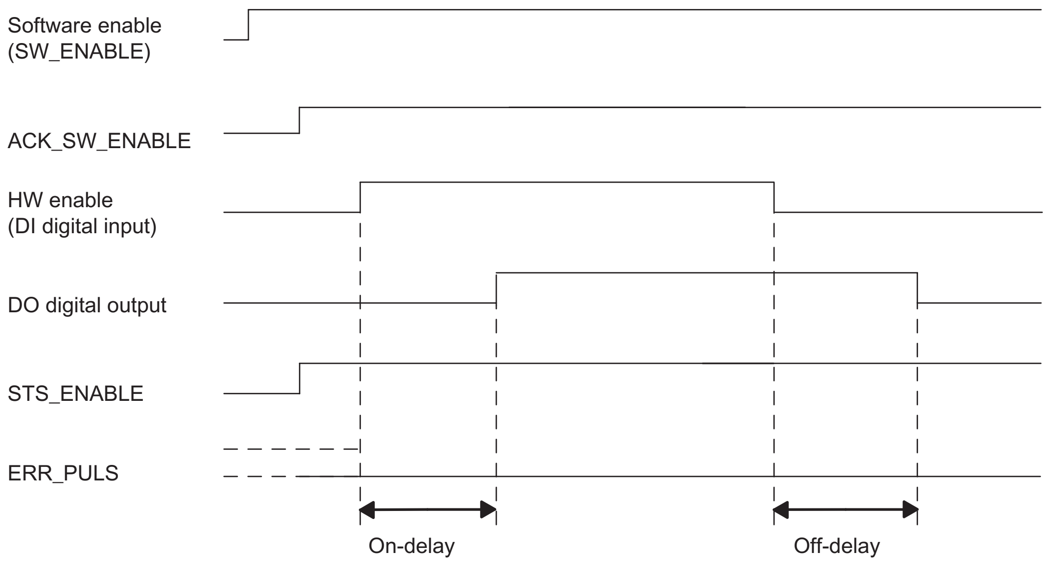


Figure 5-11 On/Off-Delay Output Sequence

Canceling the Output Sequence

Canceling the software enable (SW_ENABLE 0 = 1) during the output sequence causes the output sequence to be canceled, along with STS_ENABLE and the digital output.

Truth Table

Software enable SW_ENABLE	Digital input DI	Digital output DO	STS_ENABLE	Output sequence
1	0→1	0, if on-delay >0 1, if on-delay =0	1	Start
1	1→0	1, if off-delay >0 0, if off-delay =0	1	Start
0	Any status	0	0	Cancel
1	0	Previous status remains	1	-
1	1	Previous status remains	1	-
0→1	0	0	1	-
0→1: Positive edge 1→ 0: Negative edge				

Minimum Pulse Duration/Minimum Interpulse Period of the Digital Output DO

The minimum pulse duration/minimum interpulse period of the digital output DO is 0.2 ms.

Make sure you take this into consideration when you set the on/off-delay and the pulse duration/interpulse period of the digital input DI; otherwise, the response at the digital output DO is not defined.

The Pulse Duration of the Digital Input DI Is Too Short

The 2PULSE detects a pulse that is too short on the negative edge on the digital input DI if:

Pulse duration + off-delay ≤ on-delay.

Response of the 2PULSE to a pulse duration that is too short:

- ERR_PULS is set.
- The current on-delay is deleted.
- The off-delay is not started.
- The signal level at the digital output DO remains at 0.

ERR_PULS is deleted at the next positive edge on the digital input DI.

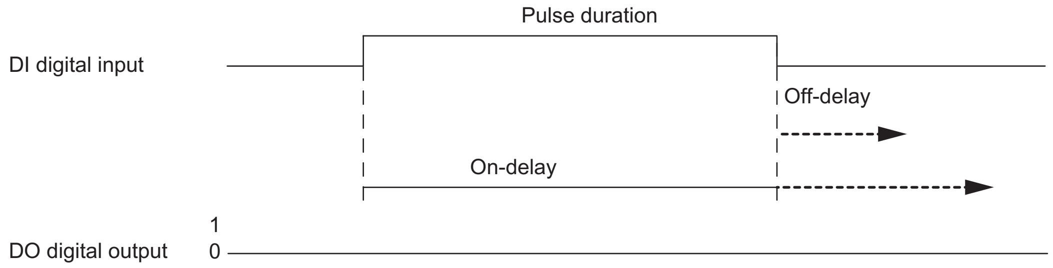


Figure 5-12 The Pulse Duration Is Too Short

The Interpulse Period of the Digital Input DI Is Too Short

The 2PULSE detects an interpulse period that is too short on the positive edge on the digital input DI if:

Interpulse period + on-delay ≤ off-delay.

Response of the 2PULSE to an interpulse period that is too short:

- ERR_PULS is set.
- The current off-delay is deleted.
- The on-delay is not started.
- The signal level at the digital output DO remains at 1.

ERR_PULS is deleted with the next negative edge on the digital input DI.

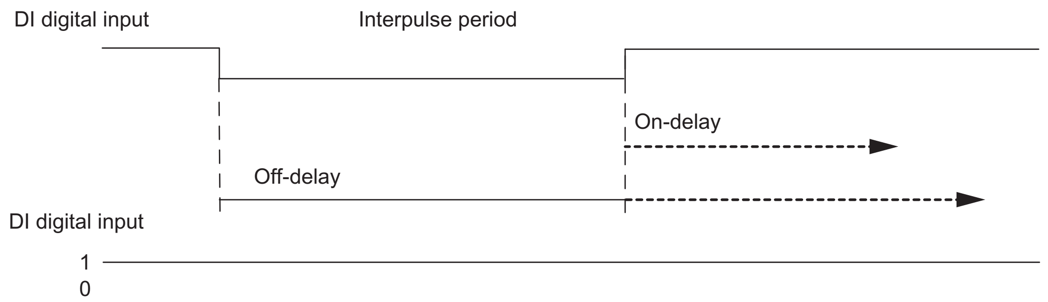


Figure 5-13 The Interpulse Period Is Too Short

Retriggering the Current On-Delay

The 2PULSE starts a new on-delay on the positive edge on the digital input DI if:

On-delay > pulse duration + interpulse period

This deletes the current off-delay.

The digital output DO is only set if signal level 1 is present on the digital input DI longer than the on-delay. This enables you to filter rapid pulse trains.

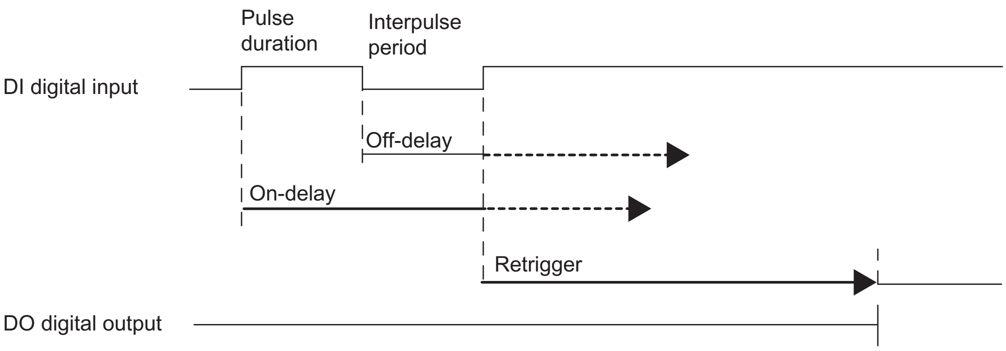


Figure 5-14 Retriggering the Current On-Delay

Retriggering the Current Off-Delay

The 2PULSE starts a new off-delay on the negative edge on the digital input DI if:

Off-delay > pulse duration + interpulse period.

This deletes the current on-delay.

The digital output DO is only deleted if signal level 0 is present on the digital input DI longer than the off-delay.

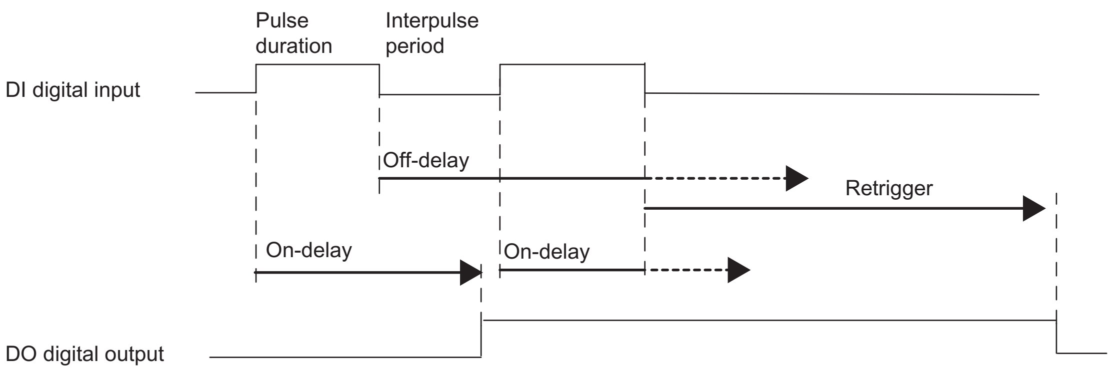


Figure 5-15 Retriggering the Current Off-Delay

Setting Times Using a Time Base

Use the assigned time base to select the resolution and the value range of the on-delay and the off-delay.

Time base = 0.1 ms:	You can set times from 0.2 ms to 6.5535 s with a resolution of 0.1 ms.
Time base = 1 ms:	You can set times from 1 ms to 65.535 s with a resolution of 1 ms.

Setting and Changing the On-Delay

You specify the on-delay as a value between 0 and 65535 in the parameters.

Assigned on-delay = time base x set numerical value

Using the factor for the on-delay, you can adjust the assigned time in your control program. Set the factor between 0 and 255, with a weighting of 0.1:

On-delay = factor x 0.1 x assigned on-delay

If you change the on-delay factor, the new on-delay is activated with the next positive edge on the digital input DI.

Setting and Changing the Off-Delay

Set the off-delay directly as a numerical value between 0 and 65535 in your control program.

Off-delay = time base x set numerical value

If you change the off-delay factor, the new off-delay is activated with the next negative edge on the digital input DI.

Parameters for the On/Off-Delay Mode

Parameter	Meaning	Value Range	Default
Mode	Set the on/off-delay mode.	• Pulse output • Pulse-width modulation • Pulse train • On/off-delay	Pulse output
Time base	Use the time base to select the resolution and the value range of the on-delay and off-delay.	• 0.1 ms • 1 ms	0.1 ms
On-delay	The time between a positive edge of digital input DI and its output on the digital output DO. You can change the on-delay with your control program.	With time base 0.1 ms: 0 to 65535 With time base 1 ms: 0 to 65535	0

Control and Feedback Signals of On/Off-Delay Mode

Control and Feedback Signals	Meaning	Value Range	Channel 0 address	Channel 1 address
Control signals				
Software enable (SW_ENABLE)	You must always issue the software enable in your control program. If you cancel the software enable, the current output sequence will be canceled.	0 = SW_ENABLE canceled 1 = SW_ENABLE set	Byte 2: Bit 0	Byte 6: Bit 0
Off-delay	The time between a negative edge of the digital input DI and its output on the digital output DO.	With time base 0.1 ms: 2 to 65535 With time base 1 ms: 1 bis 65535 If you violate the lower limit of the range, the off-delay will not function.	Word 0	Word 4
On-delay factor	You can change the assigned on-delay: On-delay = factor x 0.1 x assigned on-delay	Factor: 0 to 255 On-delay: 0.2 ms to 65.535 s If the on-delay is < 0.2 ms or if the factor = 0, the effective on-delay = 0. If the on-delay is > 65.535 s, the on-delay is limited to 65.535 s.	Byte 3	Byte 7
Feedback signals				
STS_ENABLE	Indicates the status of the software enable (SW_ENABLE).	0 = software enable blocked 1 = software enable issued	Byte 0: Bit 0	Byte 4: Bit 0
STS_DO	Indicates the signal level on the digital output DO. Note the update rate.	0 = signal 0 on digital output DO 1 = signal 1 on digital output DO	Byte 0: Bit 1	Byte 4: Bit 1
STS_DI	Indicates the signal level on digital input DI.	0 = signal 0 on digital input DI 1 = signal 1 on digital input DI	Byte 0: Bit 2	Byte 4: Bit 2
ACK_SW_ENABLE	Indicates the status of SW_ENABLE.	0 = SW_ENABLE canceled 1 = SW_ENABLE set	Byte 0: Bit 3	Byte 4: Bit 3
ERR_PULS	Indicates a pulse output error if the pulse duration or interpulse period is too short.	0 = no pulse output error 1 = pulse output error	Byte 0: Bit 4	Byte 4: Bit 4

Input and Output Signals for On/Off-Delay Mode

Input and Output Signals	Meaning	Value Range	Channel 0 terminal	Channel 1 terminal
Input signal				
Digital input DI	The signal of the digital input DI is output with an on/off-delay on digital output DO by the 2PULSE.	0 = no pulse 1 = pulse	1	5
Output signal				
Pulse on the digital output DO	The signal of the digital input DI is output with an on/off-delay on digital output DO by the 2PULSE.	0 = no signal 1 = signal	4	8

5.3.6 Function: Direct Control of the DO Digital Output

Definition

You can directly control the digital output DO of the 2PULSE to test the actuator you have connected. To do this, you have to select the function from your control program with the MANUAL_DO control bit set and with the SW_ENABLE control bit deleted.

After you have selected the function, the feedback bits STS_ENABLE and ERR_PULS are deleted by the 2PULSE, and an active output sequence is canceled.

You specify the reset the status of the digital output DO with the SET_DO control bit.

When you delete the MANUAL_DO control bit, you deselect the function for the direct control of the digital output DO. This deletes the digital output DO. You will then have to restart the output sequence.

Control and Feedback Signals/Output Signal

Signals	Meaning	Value Range	Channel 0 address	Channel 1 address
Control signals				
SW_ENABLE	To select the function, the control bit must be deleted.	0 = SW_ENABLE canceled 1 = SW_ENABLE set	Byte 2: Bit 0	Byte 6: Bit 0
MANUAL_DO	You can select and deselect the function with the control bit.	0 = direct control of the DO not selected. 1 = direct control of the DO selected.	Byte 2: Bit 1	Byte 6: Bit 1
SET_DO	You use the control bit to set the status of the digital output DO.	0 = signal 0 on digital output DO 1 = signal 1 on digital output DO	Byte 2: Bit 2	Byte 6: Bit 2
Feedback signals				
STS_ENABLE	Deleted after the function has been selected.	0 = pulse output blocked 1 = pulse output running	Byte 0: Bit 0	Byte 4: Bit 0
STS_DO	Indicates the signal level on the digital output DO. Note the update rate.	0 = signal 0 on digital output DO 1 = signal 1 on digital output DO	Byte 0: Bit 1	Byte 4: Bit 1
STS_ DI	Indicates the signal level on digital input DI.	0 = signal 0 on digital input DI 1 = signal 1 on digital input DI	Byte 0: Bit 2	Byte 4: Bit 2

Output signal	Meaning	Value Range	Channel 0 terminal	Channel 1 terminal
Digital output DO	The status preset with the SET_DO control bit is output on the digital output DO.	0 = no signal 1 = signal	4	8

5.3.7 Function: Error Detection/Diagnostics

Parameter Assignment Error ERR_PARA

If the 2PULSE cannot identify the parameters as its own, it generates a parameter assignment error. The two channels are then not assigned parameters.

The 2PULSE slot you configure must match the setup.

Make sure that you only set the 2PULSE parameters that have been described.

Pulse Output Error ERR_PULS

The 2PULSE detects a channel-specific pulse output error in the pulse output, on/off-delay, and pulse train modes.

You will find information about causes and responses in the respective operating mode descriptions and the technical specifications for programming.

The pulse output error detected is displayed for the relevant channel with the ERR_PULS feedback bit.

Encoder Supply Short Circuit ERR_24V

The 2PULSE detects a short circuit in the encoder supply that it makes available at terminals 2 and 6.

The short circuit error detected is displayed for the two channels with the ERR_24V feedback bit.

Short Circuit of the Digital Output ERR_DO

The 2PULSE detects a short circuit on the digital output of the channel. To do this, you must enable Diagnostics DO in the parameters.

The short circuit detected is displayed for the relevant channel with the ERR_DO feedback bit.

Diagnostic Message

In the event of parameter assignment errors or a short circuit in the encoder supply or in the digital output, 2PULSE generates a diagnostic message for the connected CPU/master. To do this, you must enable the Group diagnostics parameter.

Parameters

Parameter	Meaning	Value Range	Default
Group diagnostics	When group diagnostics has been enabled, the 2PULSE generates a diagnostic message for the CPU/master.	Disable/enable	Disable
Diagnostics DO	The 2PULSE detects a short circuit of the digital output DO when Diagnostics DO= on.	Off/on	Off

Feedback Signals

Feedback Signals	Meaning	Value Range	Channel 0 address	Channel 1 address
ERR_PARA	Indicates a parameter assignment error.	0 = no parameter assignment error 1 = parameter assignment error	Byte 0: Bit 5	Byte 4: Bit 5
ERR_PULS	Indicates a pulse output error.	0 = no pulse output error 1 = pulse output error	Byte 0: Bit 4	Byte 4: Bit 4
ERR_24V	Indicates a short circuit of the encoder supply.	0 = no encoder supply short circuit 1 = encoder supply short circuit	Byte 0: Bit 7	Byte 4: Bit 7
ERR_DO	Indicates a short circuit of the digital output DO. To do this, you must enable Diagnostics DO.	0 = no digital output short circuit 1 = digital output short circuit	Byte 0: Bit 6	Byte 4: Bit 6

5.3.8 Behavior at CPU-Master-STOP

Definition

You can assign parameters to what the 2PULSE is to do in the event of the failure of the parent controller for the two channels together.

Behavior at CPU-Master-STOP	Channel-Specific Response and the Status of the 2PULSE
Turn off DO	Delete the DO digital output Delete STS_ENABLE and Terminate the current output sequence
Continue working mode	The DO digital output remains unchanged STS_ENABLE remains unchanged The current output sequence is continued
DO substitute a value	Output of the channel-specific, substitute value that has been assigned parameters of the DO digital output Delete STS_ENABLE and Terminate the current output sequence
DO keep last value	The DO digital output remains unchanged Delete STS_ENABLE and Terminate the current output sequence

Startup

To start a new output sequence after CPU/master STOP and after ACK_SW_ENABLE has been set, first delete SW_ENABLE, and repeat this deletion until ACK_SW_ENABLE has also been deleted.

If the mode is to continue during a change from CPU-/Master-STOP to RUN (startup), the CPU/Master cannot clear the outputs. Possible solution: In the part of the user program that is processed during startup, set the software enable control bit (SW_ENABLE=1), and write the values to the 2PULSE.

Modified Parameter Assignment

The status assumed by the 2PULSE at CPU/master STOP remains even in the case of parameter assignment or configuration of the ET 200S station. This occurs, for example, at power-up of the CPU/master or the IM 151 or at the resumption of DP transfer.

In "Continue working mode", however, and after a modified parameter assignment or configuration of the ET 200S station has been downloaded to the CPU/master, the 2PULSE terminates the process. As a result, the 2PULSE does the following:

- Deletes the DO digital output.
- Deletes STS_ENABLE.
- Terminates the current output sequence.

5.4 Application Examples

5.4.1 Overview

Introduction

The following application examples give you an overview of possible uses for the 2PULSE in different processes.

You use the 2PULSE in various modes according to your process-related requirements.

The table below presents the possible modes for selected technological processes:

Applications/Technological Processes	Mode
Filling of liquids	Pulse output
Heating a liquid	Pulse-width modulation
Packing piece goods	Pulse train
Applying a protective layer	On/off-delay

Due to the highly complex nature of these technological processes, each application example only represents part of a process.

This part illustrates the principle method of operation of the 2PULSE for the selected task. Assumed prerequisites allow you to evaluate how you can use the 2PULSE optimally in your process.

Additional Applications

Other possible uses are described in this section.

5.4.2 Example: Filling Liquids

Task

Filling is started as soon as a container is under the valve. The valve is opened for a preset pulse duration by means of the 24 V control signal. The amount of liquid is proportional to the specified pulse duration.

The 2PULSE generates the 24 V control signal at its digital output for the pulse duration you have specified. After it has been filled, the container is moved along.

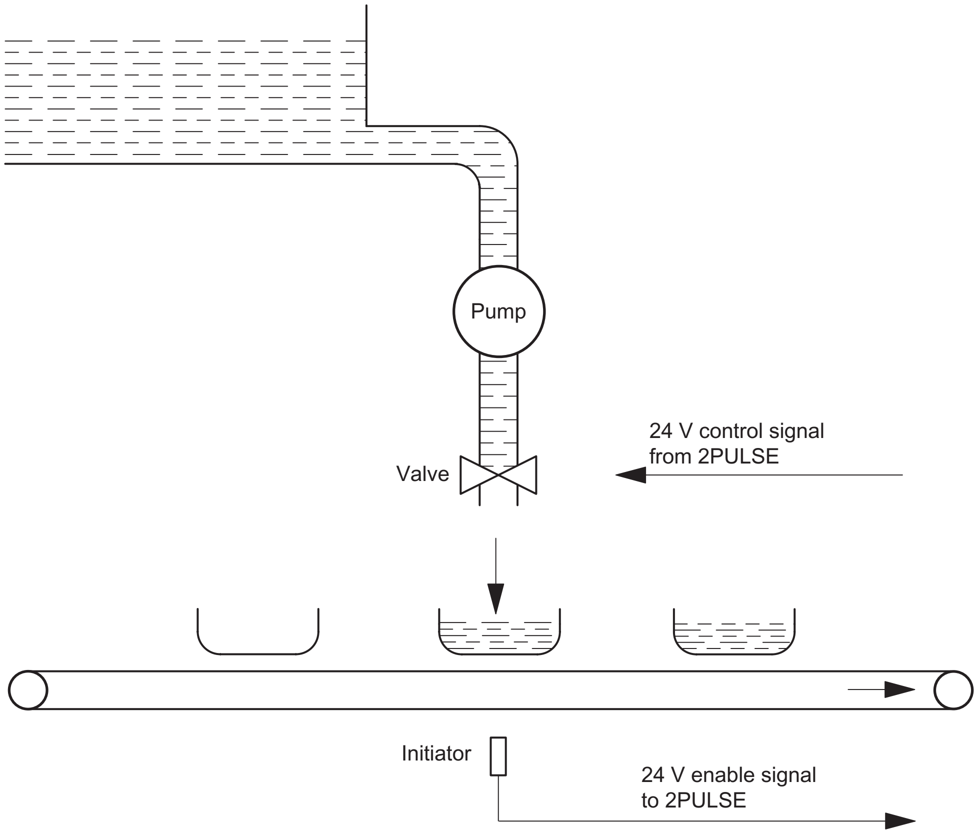


Figure 5-16 Filling Liquids

(1)	Valve
(2)	Pump
(3)	24 V control signal from the 2PULSE
(4)	24 V enable signal to the 2PULSE
(5)	Initiator

Requirements

- The volume of liquid to be filled is proportional to the time the valve is open.
- The cross-section of the feeder pipe cannot be changed.
- The valve only has the two positions OPEN and CLOSED.
- The minimum pulse duration must be longer than the on/off times specified by the manufacturer.

Pulse Output Mode

Use channel 0 of the 2PULSE in pulse output mode for the filling process. In this mode, the 2PULSE generates a pulse at the DO digital output (24 V control signal) for the specifiable pulse duration to control the valve.

Procedure

1. **Starting filling process:** To start the process, use the software enable (SW_ENABLE) on your control program. The 2PULSE uses the 24 V enable signal (DI digital input) to check whether the container is correctly positioned. Then open the valve using the control program (SW_ENABLE 0→1) and start the filling process.
2. **Monitoring filling process:** The error detection/diagnostic function allows you to check in the program that the process is running correctly.
3. **Terminating filling process:** You can find out when the process has finished in the program by evaluating STS_ENABLE.

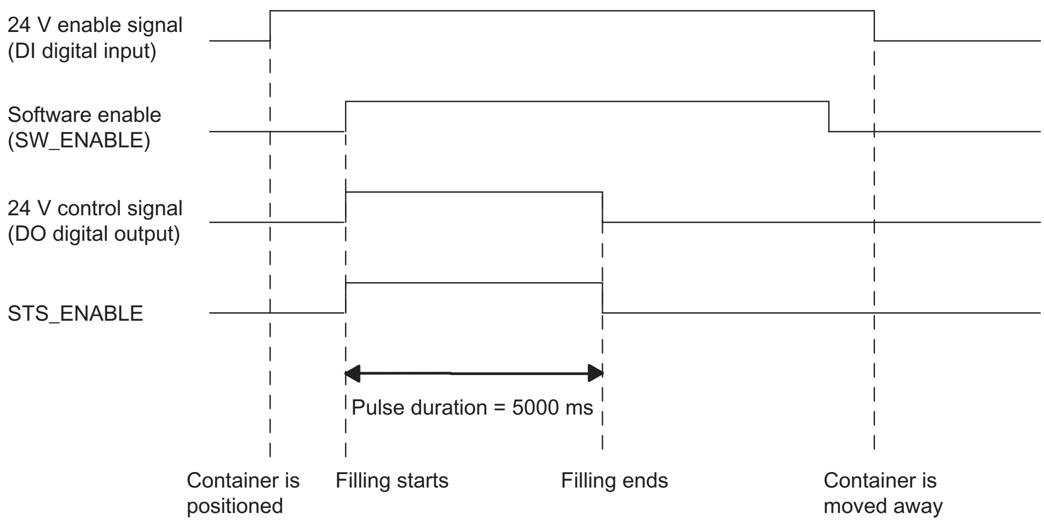


Figure 5-17 Flow Diagram for the Filling Process

Parameters

The following parameters are required for channel 0 of the 2PULSE to fill liquids in pulse output mode.

Table 5-1 Parameter List for the Filling Process

Parameters	Set Value	Meaning
Group diagnosis	Enable	The following errors trigger a diagnostic message: • Short circuit - DO digital output • Short circuit of the sensor supply • Parameter Assignment Error
Diagnostics DO 0	On	The 2PULSE detects the short circuit error at the DO 0 digital output.
Behavior at CPU-Master-STOP	Turn off DO1	
Mode	Pulse output	
Time base	1 ms	All the preset times are specified at a resolution of 1 ms.
DI function 0	Input	The digital input is used to establish whether the container is correctly positioned.
On-delay	0	The valve is opened immediately with SW_ENABLE = 1

The additional parameters of channel 0 of the 2PULSE have no effect on the pulse output mode.

The parameters for channel 1 are not relevant in this application example.

STL program

Below you will find a section from a STEP 7 STL program.

The configured start address of the inputs and outputs of the 2PULSE is 256.

You use this part of the program to start the filling process. To do this, memory marker M30.0 must be set.

The pulse duration in this example is 5000 ms.

STL		Description
Block:		
L	PEB256	Read the feedback messages from channel 0 of the 2PULSE
T	MB20	
L	5000	Write a pulse duration of 5000 ms to channel 0 of the 2PULSE
T	PAW256	
L	0	Generate SW_ENABLE
T	MB10	
U	M20.2	Container is positioned
U	M30.0	Start of the filling process
=	M10.0	Set SW_ENABLE=1
L	MB10	Write control signals to channel 0 of the 2PULSE
T	PAB258	

Wiring/Terminal Assignment Diagram

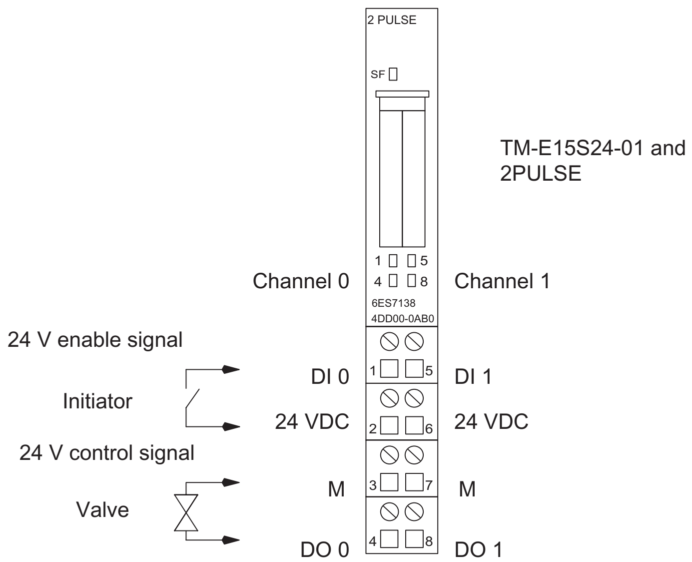


Figure 5-18 Terminal Assignment of the 2PULSE for Filling Liquids

5.4.3 Example: Heating a Liquid

Description

A liquid is heated with an electrical heating element. The energy needed to do this is supplied to the heating element by a switching element (a contactor, for example).

The 2PULSE generates a 24 V control signal on its digital output for the switching element. The temperature of the heating element is determined by the on/off length of the 24 V control signal.

The longer the 24 V control signal is switched on, the longer the heating process and therefore the greater the rise in temperature of the fluid.

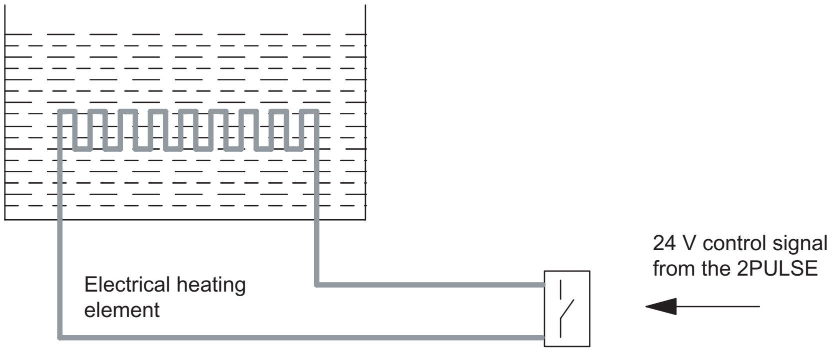


Figure 5-19 Heating a Liquid

Requirements

- The heating element only has two switching states: ON or OFF.
- The actual heating current corresponds to the ratio of the on/off duration of the 24 V control signal.
- The minimum pulse or minimum interpulse period must be greater than the response times of the switching element and heating element.

Pulse-Width Modulation (PWM) Mode

Use channel 0 of the 2PULSE in pulse-width modulation mode to control the heating element. In this mode, the 2PULSE generates a pulse train on the digital output DO (24 V control signal) with a specifiable ratio of pulse duration/period to control the switching element.

Sequence

1. **Starting heating process:** To start the heating process, use the software enable (SW_ENABLE) in your control program.
2. **Monitoring heating process:** The error detection/diagnostic function allows you to check via the program that the heating element is being controlled correctly.

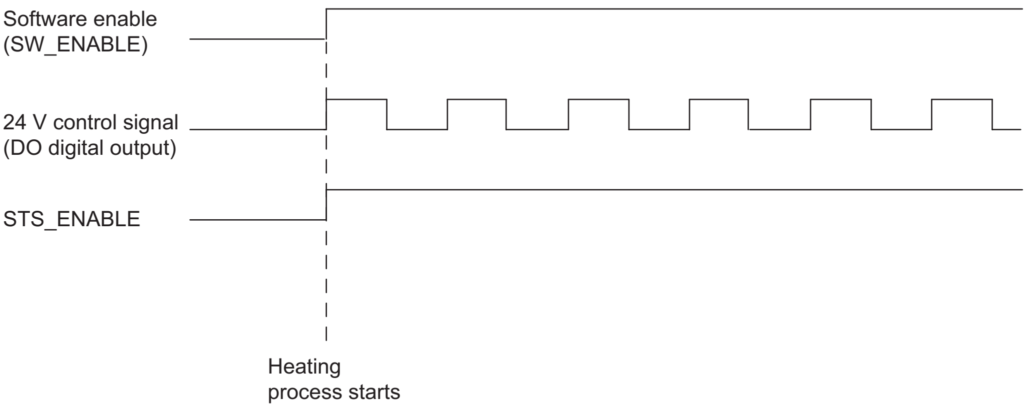


Figure 5-20 Flow Diagram for Heating a Liquid

Parameters

The following parameters are required for channel 0 of the 2PULSE to heat a liquid in pulse-width modulation mode.

Table 5-2 Parameter List for Heating a Liquid

Parameter	Set Value	Meaning
Group diagnostics	Not enabled	The following errors trigger a diagnostic message: • Short circuit of digital output • Short circuit of the encoder supply • Parameter assignment error
Diagnostics DO 0	On	The 2PULSE detects the short circuit error on the digital output DO 0.
Behavior at CPU/Master-STOP	Turn off DO 0	
Mode	Pulse-width modulation	
PWM output format	Per mill	The output value is specified in [‰] (0 to 1000)
Time base	1 ms	All the preset times are specified at a resolution of 1 ms.
Function DI 0	Input	The digital input is not required for this application
On-delay	0	The 24 V control signal is immediately output with SW_ENABLE=1
Minimum/pulse duration	500	Minimum pulse duration: This is 500 ms in the selected time base; this also applies to the minimum interpulse period
Period	30000	This is 30 s in the selected time base

The additional parameters of channel 0 of the 2PULSE have no effect on pulse-width modulation mode.

The parameters for channel 1 are not relevant in this application example.

Programming/Flow Diagram

Below you will find a section from a STEP 7 STL program.

The configured start address of the inputs and outputs of the 2PULSE is 256.

This program section starts the heating process. To do this, memory bit M30.0 must be set. You provide the output value in memory word MW32.

STL		Description
Block:		
L	PEB256	Read the feedback messages from channel 0 of the 2PULSE
T	MB20	
L	MW32	Write output value to channel 0 of the 2PULSE
T	PAW256	
L	10	Write period factor 10 x 0.1 to channel 0 of the 2PULSE
T	PAB259	
L	0	Generate control signal SW_ENABLE
T	MB10	
U	M30.0	Start of heating process
=	M10.0	Set SW_ENABLE=1
L	MB10	Write control signals to channel 0 of the 2PULSE
T	PAB258	

Wiring/Terminal Assignment Diagram

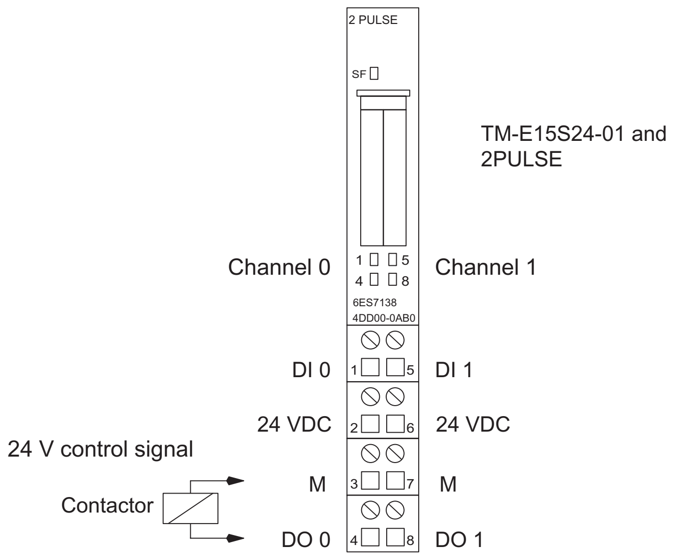


Figure 5-21 Terminal Assignment of the 2PULSE for the Heating of a Liquid

Additional Applications

Limit-value monitoring of the temperature: To monitor the limits of the temperature of the medium, use a temperature sensor evaluated by an analog module. You can monitor the temperature with your control program.

Temperature control: To control the temperature of the medium, use a temperature sensor evaluated by an analog module. You can use one of the software controllers of SIMATIC S7 to do this. Pass on the manipulated variable calculated by the software closed-loop controller directly to the 2PULSE using your control program. If you require separate actuators for heating and cooling, use the second channel of the 2PULSE. If you detect a negative manipulated variable in your control program, pass on the value to the second channel of the 2PULSE.

Heating up a liquid with a heat exchanger: Basic actuators that only have two end settings (OPEN/CLOSED) create an almost continuous manipulated variable through the control of the 24 V control signal. This will enable you to control, for example, the flow through a heat exchanger using a solenoid valve.

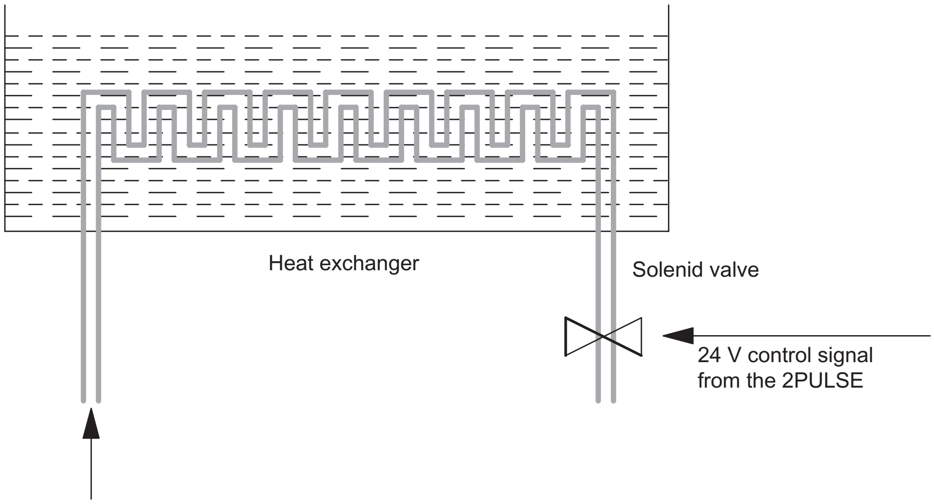


Figure 5-22 Using a Solenoid Valve to Control the Flow

5.4.4 Example: Packing Piece Goods

Description

Packing is started as soon as a folding box from conveyor 1 is in the correct position. The 24 V control signal controls the pusher and, when the compartmentalized conveyor is in operation, pushes the piece goods into the folding box. Each pulse corresponds to a complete movement of the pusher. The next movement of the pusher begins at the next pulse from the pulse train.

The number of items that have to be packed corresponds to the number of output pulses.

The 2PULSE generates the 24 V control signal on its digital output DO with the number of pulses you have specified. After the piece goods have been packed, the folding box is moved on.

Counting begins from the start again when a new folding box passes the initiator.

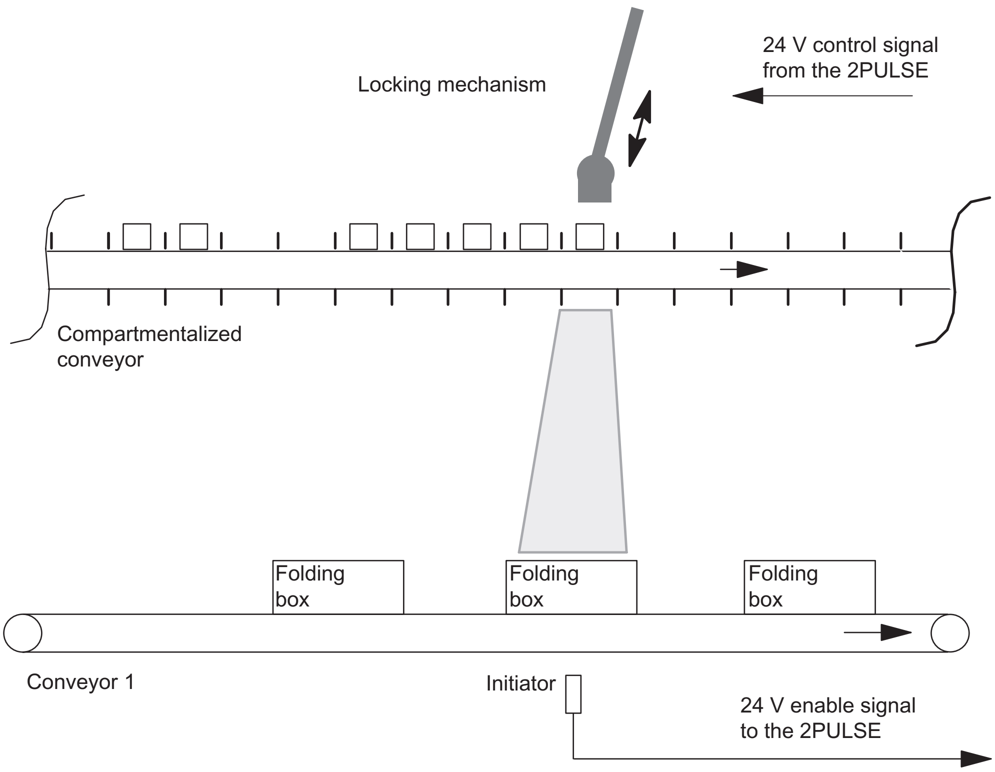


Figure 5-23 Packing Piece Goods

Requirements

- Identical piece goods
- Repetition rate depends on the conveyor behavior
- Constant speed of the compartmentalized conveyor during pulse output
- The pulse duration and interpulse period must be longer than the response time of the pusher.

Pulse Train Mode

Use channel 0 of the 2PULSE in pulse train mode to pack piece goods. In this mode, the 2PULSE generates a specifiable number of pulses on the digital output DO to control the pusher. The pulse duration and period of the output signal can be adjusted.

Sequence

1. **Starting the packing process:** To enable the start, use the software enable (SW_ENABLE 0→1) in your control program. The 2PULSE uses the 24 V enable signal (HW enable, digital input DI) to tell whether the folding box is correctly positioned and then starts the pusher.
2. **Monitoring the packing process:** The error detection/diagnostic function allows you to check via the program that the packing process is running correctly.
3. **End of the packing process:** By evaluating STS_ENABLE, you can find out when the preset number of goods has been packed.

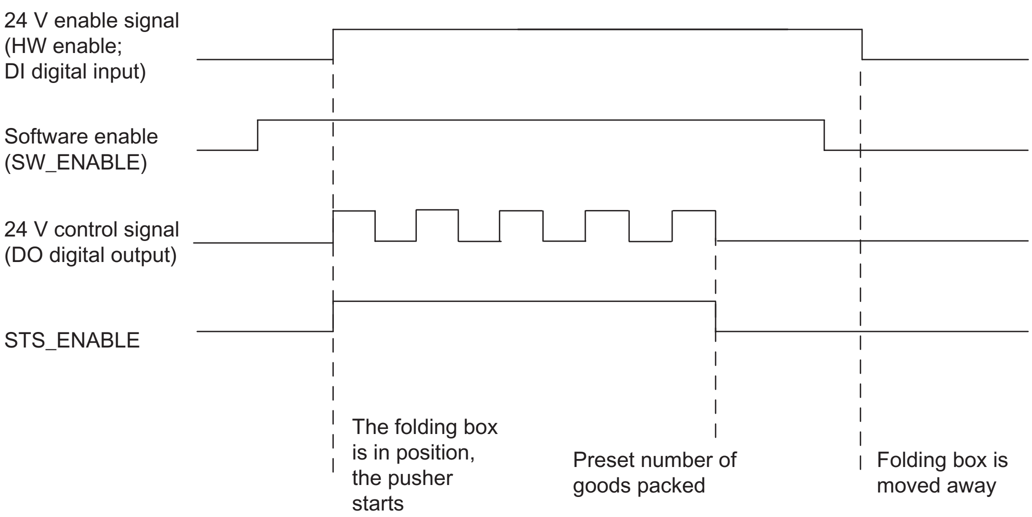


Figure 5-24 Flow Diagram for the Packing of Piece Goods

Parameters

The following parameters are required for channel 0 of the 2PULSE to pack piece goods in pulse train mode.

Table 5-3 Parameter List for the Packing of Piece Goods

Parameter	Set Value	Meaning
Group diagnostics	Enable	The following errors trigger a diagnostic message: • Short circuit of digital output • Short circuit of the encoder supply • Parameter assignment error
Diagnostics DO 0	On	The 2PULSE detects the short circuit error on the digital output DO 0.
Behavior at CPU/Master-STOP	Turn off DO 0	
Mode	Pulse train	
Time base	1 ms	All the preset times are specified at a resolution of 1 ms.
Function DI 0	HW enable	
On-delay	0	The pusher is controlled immediately with the software enable.
Minimum pulse duration	500	This is 500 ms in the selected time base
Period	1000	This is 1 s in the selected time base. This results in an interpulse period of 500 ms.

The additional parameters of channel 0 of the 2PULSE have no effect on pulse train mode.

The parameters for channel 1 are not relevant in this application example.

Programming/Flow Diagram

Below you will find a section from a STEP 7 STL program.

The configured start address of the inputs and outputs of the 2PULSE is 256.

You can use this program section to start the packing process (5 pieces). To do this, memory bit M30.0 must be set.

The HW enable then starts the pulse train.

STL		Description
Block		
L	PEB256	Read the feedback messages from channel 0 of the 2PULSE
T	MB20	
L	5	Write the number of pieces (5) to channel 0 of the 2PULSE
T	PAW256	
L	10	Write period factor 10 x 0.1 to channel 0 of the 2PULSE
T	PAB259	
L	0	Generate control signal SW_ENABLE
T	MB10	Enable the packing process
U	M30.0	
=	M10.0	Set SW_ENABLE=1
L	MB10	Write control signals to channel 0 of the 2PULSE
T	PAB258	

Wiring/Terminal Assignment Diagram

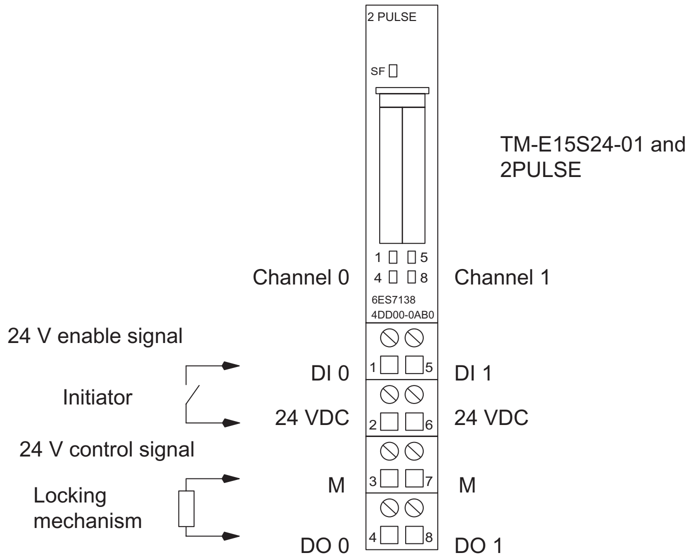


Figure 5-25 Terminal Assignment of the 2PULSE for the Packing of Piece Goods

5.4.5 Example: Applying a Protective Layer

Task

Metal parts are to be covered with a wax layer. The conveyor belt moves at a constant speed. As soon as a metal part passes the initiator, the valve is opened. The distance the item and the wax have to cover is proportional to the time.

The 2PULSE receives a 24 V enable signal from the initiator. The 2PULSE then generates a 24 V control signal at its digital output that opens the valve. The valve remains open while the Initiator sends the 24 V enable signal to the 2PULSE.

To ensure that the wax hits the metal at the optimum time, a corresponding on/off-delay is required.

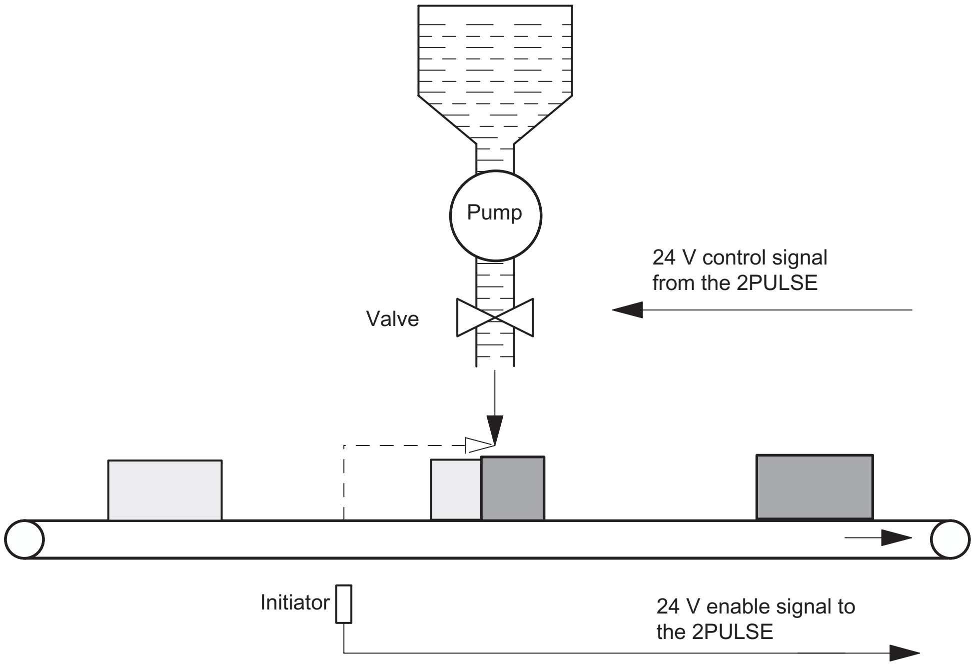


Figure 5-26 Applying a Protective Layer

(1)	Valve
(2)	Pump
(3)	24 V control signal from the 2PULSE
(4)	24 V enable signal to the 2PULSE
(5)	Initiator

Requirements

- The item is moved at a constant and quantifiable speed. (The distance is proportional to the time.)
- The valve only has the two positions OPEN and CLOSED.
- The minimum pulse duration must be longer than the on/off times specified by the manufacturer.

On/Off-Delay Mode

Use channel 0 of the 2PULSE in on/off-delay mode to control the valve. In this mode, the 2PULSE generates a 24 V control signal at its DO digital output to control the valve. This 24 V control signal is switched on and off with the 24 V enable signal.

Procedure

1. **Starting process**: To start the process, use the software enable (SW_ENABLE) on your control program. The 2PULSE uses the 24 V enable signal (DI digital input) to check whether a metal object is positioned at the initiator. The valve is opened on expiration of the on-delay. If the metal object goes past the initiator, the valve is closed after the off-delay has expired.
2. **Monitoring process:** The error detection/diagnostic function allows you to check by means of a program that the valve is being controlled correctly.
3. **Terminating process:** You can tell on the program by evaluating the STS_DO (status of the 24 V control signal) when the process has ended.

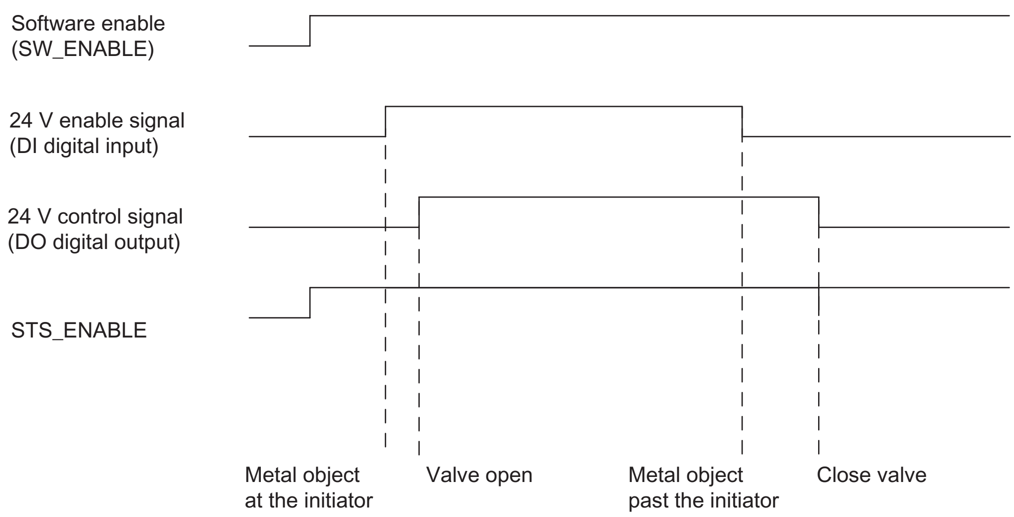


Figure 5-27 Flow Diagram for Applying a Protective Layer

Parameters

The following parameters are required for channel 0 of the 2PULSE to apply a protective layer in on/off-delay mode.

Table 5-4 Parameter List for Applying a Protective Layer

Parameters	Set Value	Meaning
Group diagnosis	Enable	The following errors trigger a diagnostic message: • Short circuit - digital output and • Short circuit of the sensor supply • Parameter Assignment Error
Diagnostics DO 0	On	The 2PULSE detects the short circuit error at the DO 0 digital output.
Behavior at CPU-Master-STOP	Turn off DO	
Mode	On/off-delay	
Time base	1 ms	All the preset times are specified at a resolution of 1 ms.
On-delay	500	The valve is switched on after an on-delay of 500 ms.

The additional parameters of channel 0 of the 2PULSE have no effect on on/off-delay mode.

The parameters for channel 1 are not relevant in this application example.

STL program

Below you will find a section from a STEP7 STL program.

The configured start address of the inputs and outputs of the 2PULSE is 256.

You use this part of the program to start the process. To do this, memory marker M30.0 must be set. Set up the off-delay in memory word MW32.

STL		Description
Block:		
L	PEB256	Read the feedback messages from channel 0 of the 2PULSE
T	MB20	
L	MW32	Write off-delay to channel 0 of the 2PULSE
T	PAW256	
L	10	Write on-delay factor 10 x 0.1 to channel 0 of the 2PULSE
T	PAB259	
L	0	Generate SW_ENABLE control signal
T	MB10	
U	M30.0	Heating process starts
=	M10.0	Set SW_ENABLE=1
L	MB10	Write control signals to channel 0 of the 2PULSE
T	PAB258	

Wiring/Terminal Assignment Diagram

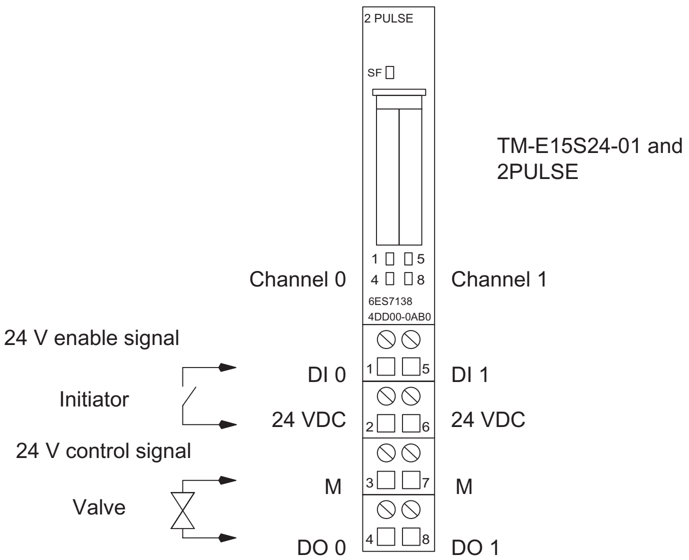


Figure 5-28 Terminal Assignment of the 2PULSE for Applying a Protective Layer

5.5 Technical Specifications of the 2PULSE, Terminal Assignment

Overview

Dimensions and Weight	
Dimensions W x H x D (mm)	15x81x52
Weight	Approx. 40 g
Data for Specific Modules	
Number of Channels	2
Voltage, Currents, Potentials	
Rated load voltage L+ (from the power module) • Reverse polarity protection	24 VDC Yes [1)]
Galvanic isolation • Between the channels • Between the channels and backplane bus	 No Yes
Permissible potential difference • Between different circuits	 75 VDC, 60 VAC
Insulation tested with	500 VDC
Sensor supply • Output voltage • Output current	 L+ -0.8V max. 500 mA, short-circuit proof
Current input • From the backplane bus • From load voltage L+ (no load)	 max. 10 mA max. 40 mA
Power dissipation of the 2PULSE	Typ. 1.8 W
Data for the Digital Inputs	
Input voltage • Rated value • With signal "1" • With signal "0"	 24 VDC 11 V to 30 V -30 V to 5 V
Input current • With signal "1"	 9 mA (typically)
Minimum pulse duration/interpulse period	25 µs
Maximum response time	100 µs
Input characteristic	To IEC 1131, Part 2, Type 2
Connection of 2-wire BEROs • Permitted residual current	Possible ≤ 2 mA
Shielded cable length	Max. 100 m

Dimensions and Weight	
Data for the Digital Outputs	
Output voltage • With signal "1"	 Minimum L+ - 1 V

Output current
• With signal "1"
  – Rated value
  – Permitted Range
• With signal "0" (leakage current)
	
	2 A [2)]
	7 mA...2 A
	max. 0.5 mA

Minimum pulse duration	200 µs
Accuracy	± (pulse duration x 100 ppm) ±100 µs [3)]
Output delay (with resistive load) • At "0" to "1" • At "1" to "0"	 max. 100 µs max. 200 µs
Lamp load	Maximum 10 W
Control of a digital input	Yes
Switching frequency • With resistive load • With inductive load • With lamp load	 2.5 kHz ≤2 Hz ≤10 Hz
Limitation (internal) of the inductive circuit interruption voltage	L+ -(50 V ... 65 V)
Short-circuit protection for output • Response threshold	Yes Typically 10 A
Cable lengths • Unshielded • Shielded	 600 m 1000 m
Status, Interrupts, Diagnostics	
Status indicators	Green LED for DI 0, DI 1, DO 0, DO 1
Diagnostic functions • Group error • Diagnostic information readable	 Red LED "SF" Yes
Update rate for feedback messages	1.2 ms
[1] Polarity reversal can lead to the digital outputs being switched through. [2] See the figures below [3] With a load of ≤ 50 Ω	

The figures below show you the output current in relation to the ambient temperature and the frequency.

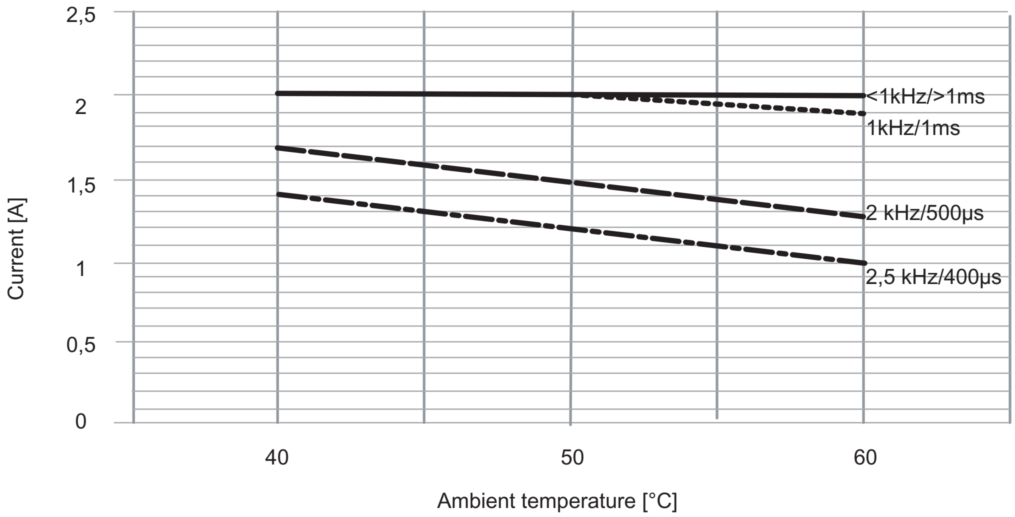


Figure 5-29 Resistive Load - Both Channels PWM 50/50

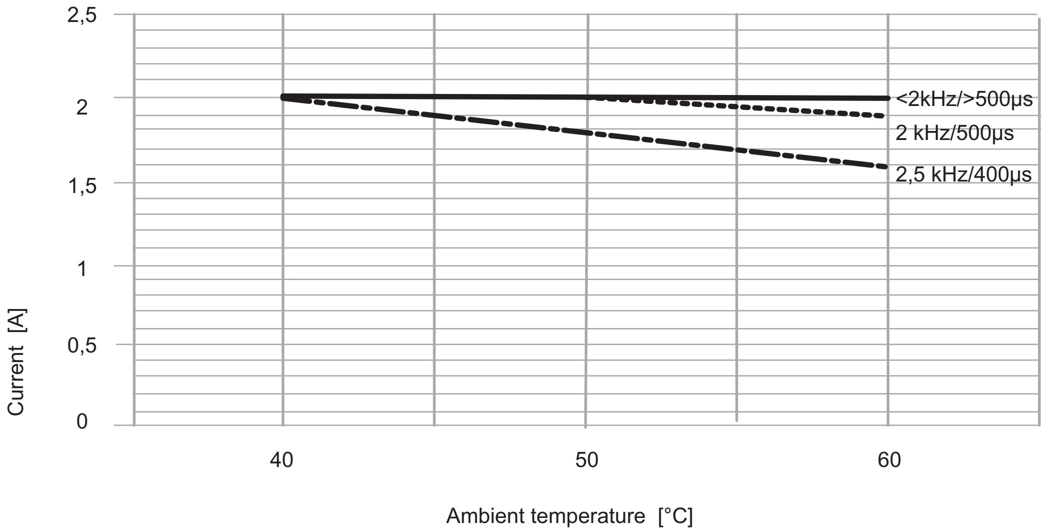
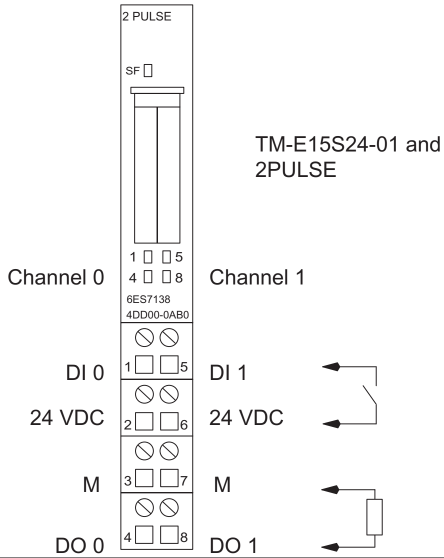


Figure 5-30 Resistive Load - Only Channel 1 PWM 50/50

Terminal Assignment

The following table shows the terminal assignment for the 2PULSE.

View	Terminal Assignment	Meaning
		Channel 0: Terminal 1 to 4 Channel 1: Terminal 5 to 8 24 VDC: Sensor supply M: Chassis ground DI: Input Signal DO: Output Signal (Maximum 2 A per channel)

Wiring Rules

The cables (terminals 1 and 2 and terminals 5 and 6) must be shielded. The shield must be supported at both ends. To do this use the shield contact (see the *ET 200S Distributed I/O System* manual in the Appendix).

5.6 Technical Specifications for Programming, Reference Lists

Assignment of the Control interface

Address		Assignment
Channel 0	Channel 1	
Word 0	Word 4	Depending on the mode • Pulse output: Pulse duration • Pulse-width modulation: Output value • Pulse train: Number of pulses • On/off-delay: Off-delay
Byte 2	Byte 6	Bit 7: Reserve = 0 Bit 6: Reserve = 0 Bit 5: Reserve = 0 Bit 4: Reserve = 0 Bit 3: Reserve = 0 Bit 2: SET_DO Bit 1: MANUAL_DO Bit 0: SW_ENABLE
Byte 3	Byte 7	Depending on the mode • Pulse output: On-delay factor • Pulse-width modulation: Period duration factor • Pulse train: Period duration factor • On/off-delay: On-delay factor

Assignment of the Feedback interface

Address		Assignment
Channel 0	Channel 1	
Byte 0	Byte 4	Bit 7: ERR_24V Bit 6: ERR_DO Bit 5: ERR_PARA Bit 4: ERR_PULS Bit 3: ACK_SW_ENABLE Bit 2: STS_ DI Bit 1: STS_DO Bit 0: STS_ENABLE

Notes on the Control Signals

Control Signal	Notes
Pulse output mode: • Pulse duration • On-delay factor	 The time that is set for the DO digital output on expiration of the on-delay. You can change the on-delay that has been assigned parameters before the start of the output sequence: On-delay = factor x 0.1 x on-delay that has been assigned parameters
Pulse-width modulation mode: • Output value • Period duration factor	 Value that is output with pulse-width modulation at the DO digital output on expiration of the on-delay. You can change the period duration that has been assigned parameters: Period duration = factor x 0.1 x period duration that has been assigned parameters
Pulse train mode: • Number of pulses • Period duration factor	 Number of pulses that are output at the DO digital output on expiration of the on-delay. You can change the period duration that has been assigned parameters before the start of the output sequence: Period duration = factor x 0.1 x period duration that has been assigned parameters
On/off-delay mode: • Off-delay • On-delay factor	 The time between a negative edge at the DI digital input and its output at the DO digital output. You can change the on-delay that has been assigned parameters before the start of the output sequence: On-delay = factor x 0.1 x on-delay that has been assigned parameters
Direct control of the digital output • MANUAL_DO • SET_DO	 You use the control bit to select and deselect the function for directly controlling the digital output. You use the control bit to set the status of the DO digital output.
Software enable (SW_ENABLE)	You must always issue the software enable in your control program. If you don't use a HW enable, the output sequence will be started by the positive edge of the software enable. If you delete the software enable, the current output sequence will be terminated.

Notes on the Feedback Bits

Feedback Bits	Notes
ACK_SW_ENABLE	Indicates the status of the software enable pending at the 2PULSE.
ERR_24V	Indicates a short circuit of the sensor supply.
ERR_DO	Indicates a short circuit at the digital output. To do this, you must switch on DO diagnostics.
ERR_PARA	Indicates a parameter assignment error.
ERR_PULS	Pulse output mode: Indicates a pulse output error. If the pulse duration is reduced after expiration of the on-delay so the time is less than the time already output, this is detected by the 2PULSE. The 2PULSE deletes the feedback bit ERR_PULS next time the output sequence starts. Pulse train mode: Indicates a pulse output error. If the number of pulses is reduced after expiration of the on-delay and the smaller number of pulses is already output, this is detected by the 2PULSE. The 2PULSE deletes the feedback bit ERR_PULS next time the output sequence starts. On/off-delay mode: Indicates a pulse output error if the pulse duration or interpulse period is too short. The 2PULSE deletes the ERR_PULS feedback bit at the next positive edge of the software enable or at the next edge at the DI digital input.
STS_ DI	Indicates the signal level at the DI digital input.
STS_DO	Indicates the signal level at the DO digital output.
STS_ENABLE	Pulse output mode: Is set at the start of the output sequence until the pulse duration expires. If you delete the software enable (SW_ENABLE) or the 2PULSE detects a pulse output error (ERR_PULS), STS_ENABLE is deleted. Pulse-width modulation (PWM): Set at start of output sequence. If you delete the software enable (SW_ENABLE), STS_ENABLE is deleted. Pulse train mode: Is set at the start of the output sequence until the output of the last pulse. If you delete the software enable (SW_ENABLE) or the 2PULSE detects a pulse output error (ERR_PULS), STS_ENABLE is deleted. On/off-delay mode: Indicates the status of the software enable (SW_ENABLE) detected by the 2PULSE.

Access to the Control and Feedback Interface in STEP 7 Programming

	Configuration with STEP 7 Using the DDB File	Configuration with STEP 7 Using HWCONFIG
Feedback interface	Load instruction (L PEW, for example)	Load instruction (L PEW, for example)
Control interface	Transfer instruction (T PQW, for example)	Transfer instruction (T PQW, for example)

Parameter List

Parameters	Value Range	Default
Group diagnosis	Disable/enable	Disable
Behavior at CPU-master STOP	Turn off DO/Continue working mode/DO substitute a value/DO keep last value	Turn off DO
Channel 0		
Diagnostics DO	Off/on	Off
Substitute value DO	0/1	0
Mode	Pulse output/Pulse-width modulation (PWM)/Pulse train/On/off-delay	Pulse output
PWM output format	Per mill/S7 analog output module	Per mill
Time base	0.1 ms/1 ms	0.1 ms
Function DI	Input/HW enable	Input
On-delay	0 - 65535	0
Minimum/pulse duration	0 - 65535	0
Period duration	1 - 65535	20000
Channel 1		
Diagnostics DO	Off/on	Off
Substitute value DO	0/1	0
Mode	Pulse output/Pulse-width modulation (PWM)/Pulse train/On/off-delay	Pulse output
PWM output format	Per mill/S7 analog output module	Per mill
Time base	0.1 ms/1 ms	0.1 ms
Function DI	Input/HW enable	Input
On-delay	0 - 65535	0
Minimum/pulse duration	0 - 65535	0
Period duration	1 - 65535	20000

Index

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