The Drive & Control Company

Rexroth
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Rexroth Inline counter terminal

R-IB IL CNT(/CN)-PAC

Application Description
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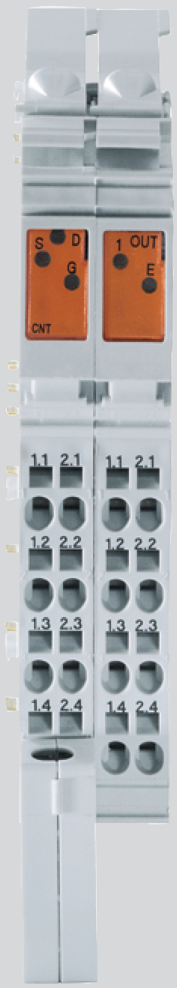

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1 Important directions for use

1.1 Appropriate use

1.1.1 Introduction

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

☞ Bosch Rexroth, as manufacturer, is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth products, make sure that all the pre-requisites for appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the product takes the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

1.1.2 Areas of use and application

The InlineFieldline system of Rexroth is an input/output system in the degree of protection IP 67. It allows the machine-oriented and highly reliable installation in harsh environmental conditions.a modular and flexibly scalable input/output system in the degree of protection IP 20. It can be operated locally at the IndraControl L or peripherally via a field bus coupler.

The Rexroth InlineFieldline system may only be used with the accessories and parts specified in this document. If a component has not been specifically named, then it may not be either mounted or connected. The same applies to cables and lines.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant function descriptions.

Typical applications of the Rexroth InlineFieldline system are:

- Handling and assembly systems,
- Packaging and foodstuff machines,
- Printing and paper processing machines and
- Machine tools.

The Rexroth InlineFieldline system may only be operated under the assembly, installation and ambient conditions as described here (temperature, system of protection, humidity, EMC requirements, etc.) and in the position specified.

In residential areas as well as in business and commercial areas Class A devices may be used with the following note:

This is a Class A device. In a residential area, this device may cause radio interferences. In such a case, the user may be required to introduce suitable countermeasures at his own cost.

1.2 Inappropriate use

Using the Rexroth InlineFieldline system outside of the above-referenced areas of application or under operating conditions other than described in the document and the technical data specified is defined as "inappropriate use".

The Rexroth InlineFieldline system may not be used if

- they are subject to operating conditions that do not meet the above specified ambient conditions. This includes, for example, operation under water, in the case of extreme temperature fluctuations or extremely high maximum temperatures or if
- Bosch Rexroth has not specifically released them for that intended purpose. Please note the specifications outlined in the general Safety Guidelines!

2 Use of the safety instructions

2.1 Structure of the safety instructions

The safety instructions are structured as follows:

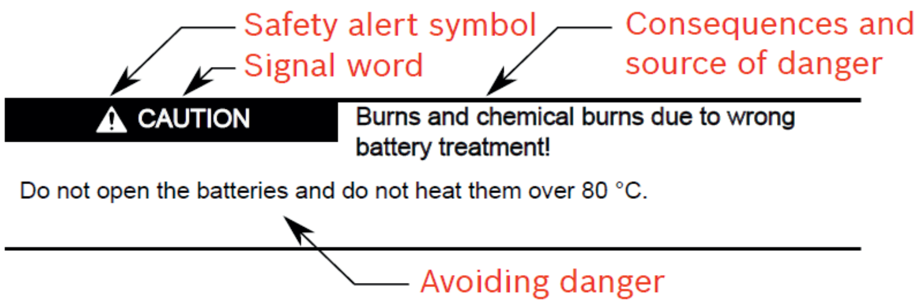


Abb. 2-1 Structure of the safety instructions

2.2 Explaining signal words and safety alert symbol

The safety instructions in this documentation contain specific signal words (danger, warning, caution, notice) and, if necessary, a safety alert symbol (according to ANSI Z535.6-2006).

The signal word is used to draw attention to the safety instruction and also provides information on the severity of the hazard.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words danger, warning and caution is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **can** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury can occur.

NOTICE

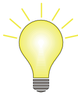
In case of non-compliance with this safety instruction, material damage can occur.

2.3 Symbols used

Hints are represented as follows:

This is an information.

Tips are represented as follows:



This is a tip for the user.

2.4 Signal graphic explanation on the device

Prior to the installation and commissioning of the device, refer to the device documentation.

3 Process data words

The counter terminal is configured, controlled and read via process data.

3.1 Process data channel assignment

The process image of the counter terminal on the bus ring consists of two data words.

NOTICE	**Misinterpretation of values when the data consistency is violated**

Ensure data consistency of two words to prevent the possibility of the values being misinterpreted.

Please observe the notes in Chapter "Tips for working with the counter terminal" on page 50.

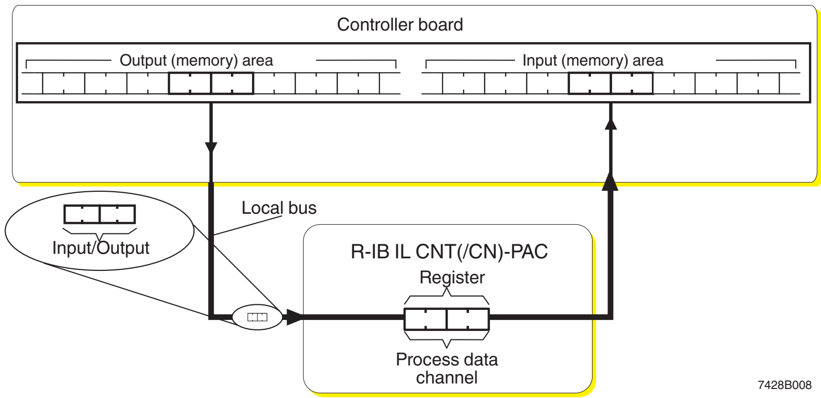


Fig. 3-1 Process image in the I/O (memory) area of your controller board

The data words are located in the process data (memory) area on your controller board. This memory area is a process image of your entire application, i.e., your bus configuration. The addresses are assigned through the physical or logical addressing of the controller board.

The process data (memory) area consists of an output (memory) area and an input (memory) area. The two memory areas do not necessarily have to be different.

Definition

Direction of output data flow:	From the controller board to the terminal
Direction of input data flow:	From the terminal to the controller board

3.2 Output words

The terminal is configured and controlled by means of various commands transmitted via the two output words.

The command code, and, if necessary, the associated parameters, are transmitted from the controller board to the terminal via the output words. If no parameters are required, the assignment of the parameter bits is irrelevant.

Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Assignment	Command code						Parameter									

Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Assignment	Parameter															

Command code: The settings for these bits depend on the command to be transmitted.
Valid command codes are listed in Chapter 4, "Commands for working with the counter terminal". Set the bits according to your application and the explanations in Chapter 4, "Commands for working with the counter terminal".

Parameter: The settings for these bits depend on the command to be transmitted.
Set the bits according to your application and the explanations in Chapter 4, "Commands for working with the counter terminal".

3.3 Input words

The terminal uses two input words.

If any command other than *Read counter* is sent, the command code and any associated parameters are mapped (mirrored) in the input words at the same position as in the output word.

If parameter word 1 is not needed, its assignment is irrelevant. In this case, it does **not** mirror the assignment of output word 1.

In bit 15 of input word 0, an error bit is set for one of the following reasons:

- The terminal has not yet been configured.
- There is an invalid parameter in the operating mode specified.
- The counter is read without an operating mode specified.
- A reserved bit has been set.

Assignment of input words during parameterization (except after *Read counter*)

Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Assignment	Mirroring of the command code						Mirroring of the parameter									

Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Assignment	Mirroring of the parameter															

Input words after sending the *Read counter* command

After sending the *Read counter* command, the command code (00000_{bin}) is mirrored in bit 15 ... bit 10 of input word 0.

The status of the control input (gate) is indicated in bit 9.

The status of the output (OUT) or the result of the evaluation of a relation condition is indicated in bit 8 (value outside the specified range, see Chapter "Relation condition" on page 21).

Bit 7 ... bit 0 of input word 0 and input word 1 contain the results of the performed counting.

A 16-bit value (time measurement operating mode) is represented in input word 1. Bit 7 ... bit 0 of input word 0 are not used for this purpose.

A 24-bit value (frequency measurement and event counting operating modes) is represented in the result bits of input words 0 and 1.

Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Assignment	Not used						G	O	Result (counter status)							

Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 1	Assignment	Result (counter status)															

G: gate Status of the control input

O: OUT Status of the output or result of the mismatch evaluation

Process data words

4 Commands for working with the counter terminal

Various types of commands are available for working with the counter terminal:

- Commands for setting operating modes
- Commands for controlling functions
- Commands for specifying general conditions

If general conditions for the operating modes are required, they must be specified before a command is sent to set the operating mode.

Bit 15 ... bit 10 (bin)	**Command**	**Page**
0000 00	Read counter	Page 35
0001 00	Frequency measurement operating mode	Page 13
0001 01	Event counting operating mode	Page 17
0001 10	Time measurement operating mode	Page 20
0001 11	Pulse generator operating mode	Page 24
0010 00	Control counter: stop counter	Page 33
0010 01	Control counter: start counter	Page 33
0010 10	Control counter: set counter to default	Page 34
0011 00	System settings, e.g., input filter, logic operations	Page 25
0011 11	Read firmware version	Page 30
0100 00	Preset initial value (24 bits, maximum)	Page 31
0101 00	Preset final value (24 bits, maximum)	Page 31
Other	Reserved	

Fig. 4-1 Commands for working with the counter terminal

4.1 Command sequence

When working with the counter terminal, commands must be sent in accordance with a specified sequence.

Step 1: System settings

This step is optional. If you do not need to make any system settings, proceed straight to step 2.

If system settings are required and an initial and/or final value is to be set, these values must be specified in the first step.

Step 2: Operating mode

If the system settings have been made, or none were necessary, set the operating mode now.

The following operating modes can be set:

- Frequency measurement
- Event counting
- Time measurement
- Pulse generator

Step 3: Read counter

To obtain the results of the counter terminal in the input words, the command for reading the counter must now be sent.

This step is optional. If the input data is of no interest, the count does not have to be read. The output, for example, can be directly controlled according to the relation conditions, without any need to access the input data.

4.2 "Frequency measurement operating mode" command

The frequency measurement command consists of the command code and a parameter. The parameter determines the conditions for frequency measurement.

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**0**	**0**	**Parameter**									

The second output word is not used.

Frequency measurement starts immediately after the command is sent.

Parameter			**Measurement**	**Options**
(dec)	**(hex)**	**(bin)**		
1 ... 1000	1 ... 3E8	00 0000 0001 ... 11 1110 1000	Time-controlled	Selection of the time after which a count value is accepted
1020 ... 1023	3FC ... 3FF	11 1111 1100 ... 11 1111 1111	State-controlled	Selection of the gate state with which the counter value is accepted

Fig. 4-2 Parameter for frequency measurement

When the time or state set is reached, the counter is reset to the initial value.

4.2.1 Time-controlled frequency measurement

With time-controlled frequency measurement, the parameter acts as a factor that specifies the gate time (time during which measurement is performed) as a multiple of 10 ms.

When the gate time has elapsed, the counter is reset to the initial value.

The individual quantities are related as follows:

- Gate time = factor x 10 ms
- Resolution = 1 / gate time
- Resolution = 1 / (factor x 10 ms)
- Frequency = count value x 100 / factor

Factor (dec)	Control word (hex) (code and factor)	Resolution in Hz/LSB	Gate time in s
1	1001	100	0.01
2	1002	50	0.02
10	100A	10	0.1
50	1032	2	0.5
100	1064	1	1
500	11F4	0.2	5
1000	13E8	0.1	10

Fig. 4-3 Examples of factor, resolution and gate time

The factor range of 1 ... 1000 enables the counter terminal to be adjusted exactly as required for each application.

The design engineer must select the optimum factor given that resolution and gate time are inversely proportional.

If the measurement has to be as accurate as possible, good resolution (e.g., 0.1 Hz/LSB) must be selected. However, this resolution leads to long gate times.

If rapid response times are important, a short gate time is possible, but will impair resolution.

Simple count value processing may also be necessary for an application. A resolution of 1 Hz/LSB avoids the need for converting the count value into the frequency.

4.2.2 State-controlled frequency measurement

With state-controlled frequency measurement, the parameter specifies the state of the gate input with which counting is performed or the count value accepted.

Parameter (dec)	Control word (hex) (code and parameter)	Counting or acceptance of the count value on
1020	13FC	High level
1021	13FD	Low level
1022	13FE	Rising edge
1023	13FF	Falling edge

Fig. 4-4 Possible values of parameter and state at the gate input

HIGH level With this measurement counting takes place while the gate is HIGH. Counting stops when it changes to LOW. The last count value is accepted into the input data. The next HIGH causes counting to restart from 0.

LOW level With this measurement counting takes place while the gate is LOW. Counting stops when it changes to HIGH. The last count value is accepted into the input data. The next LOW causes the count to restart from 0.

Rising edge With this measurement counting begins immediately after the frequency measurement command is sent. The current count value is accepted into the input data on each rising edge of the gate signal. The counter is reset to 0 and counting continues.

Falling edge With this measurement counting begins immediately after the frequency measurement command is sent. The current count value is accepted into the input data on each falling edge of the gate signal. The counter is reset to 0 and counting continues.

If the condition for counting (e.g., $13FC_{hex}$), is already satisfied at the gate when a command is sent, the first count starts immediately. Depending on the application, this counting cycle may have to be rejected, as only part of the gate signal has been registered.

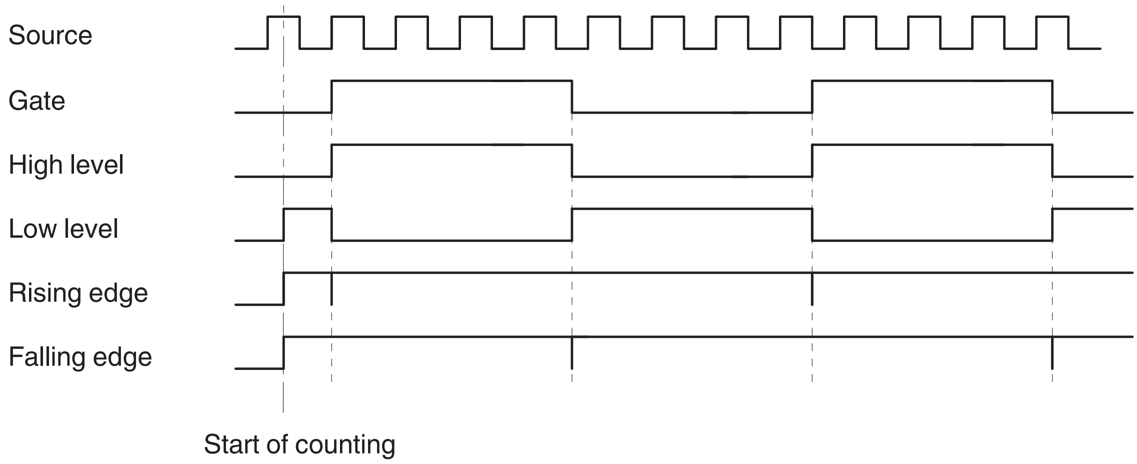


Fig. 4-5 Counting phase depending on gate state

In Fig. 4-5 the “Source” pulse train shows the pulses to be counted. The “Gate” pulse train represents the gate signal.

Counting is activated with the transmission of the frequency measurement command. When counting actually takes place depends on the parameter selected and the gate signal.

4.3 "Event counting operating mode" command

The event counting command consists of the command code and various parameters. The parameters determine the conditions for event counting.

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**R**	**Gate**			**D**	**Output**		

The second output word is not used.

Set the unused bits 9 and 8 to 0.

☞ Please note the specified counting direction in bit 3. If bit 3 = 0, the counter counts downwards. Starting event counting with 1400_{hex} produces a down counter.

☞ Counting starts immediately after the command is sent.

R: counting repeat

If counting should be performed only once, it is stopped when the final value is reached. The count value remains at this final value. If counting is constantly repeated, the counter is reset when the final value is reached, and the count repeated from the initial value.

Bit 7	Meaning
0	Single count
1	Repeated count

Fig. 4-6 F parameter: counting repeat

Commands for working with the counter terminal

Gate The “Gate” parameter describes the gate input condition that has to be satisfied for the counting process.

Bits 6/5/4		Meaning
bin	dec	
0 0 0	0	No function
0 0 1	1	Counting at high level
0 1 0	2	Counting at low level
0 1 1	3	Start of counting on rising edge
1 0 0	4	Start of counting on falling edge
1 0 1	5	Reserved
1 1 0	6	Reserved
1 1 1	7	Counting at high level; the count value is reset on a rising edge

Fig. 4-7 Gate parameter

☞ When using the gate signal, observe the response time of 200 µs. When counting is started by the gate signal, counting pulses within these 200 µs are not registered. The stopping of counting is also delayed relative to the gate signal, so that counting pulses within this response time are also registered.

D: counting direction This bit can be used to select up or down counting. If no initial or final value is set, counting goes from 0 to 0 regardless of the counting direction. The final value (terminal count) is reached if an up counter counts from $FFFFFF_{hex}$ to 0, or a down counter from 0 to $FFFFFF_{hex}$.

Bit 3	Meaning
0	Down
1	Up

Fig. 4-8 R parameter: counting direction

Output This parameter defines the switching behavior of the digital output when the final value is reached (terminal count).

Bits 2/1/0		**Designation**	**Meaning**	**Initial setting of output**
bin	**dec**			
0 0 0	0	No function	Output not active	LOW
0 0 1	1	High pulse	Positive pulse generated	LOW
0 1 0	2	Low pulse	Negative pulse generated	HIGH
0 1 1	3	Toggle (L)	Previous state inverted	LOW
1 0 0	4	Toggle (H)	Previous state inverted	HIGH
1 0 1	5	HIGH	Output HIGH	LOW
1 1 0	6	LOW	Output LOW	HIGH
1 1 1	7	Reserved	Reserved	–

Fig. 4-9 Output parameter

The standard length of a HIGH and a LOW pulse is 100 ms. It can, however, be changed using the *System settings* command.

4.4 “Time measurement operating mode” command

The time measurement command consists of the command code and various parameters. The parameters determine the conditions for time measurement.

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**Resolution**		**OUT**	**Type**	**0**	**Relation condition**		

The second output word is not used.

Set the unused bits 9, 8, and 3 to 0.

The count value during time measurement occupies 16 bits. Measurement always starts on a rising edge. Measurement of pulse length ends on a falling edge, measurement of period on the next rising edge. Only when measurement is complete is the count value accepted into the process data. If no counting edge is detected within the timeout, the count value is cleared. An error message is not generated in the event of a timeout.

Resolution The resolution indicates the value per LSB.

Bits 7/6	Meaning	Maximum time	Timeout after
0 0	2 µs	131 ms (up to FW 1.03, device index -101) 126 ms (as of FW 1.06, device index -102)	150 ms (up to FW 1.03, device index -101) 128 ms (as of FW 1.06, device index -102)
0 1	2 ms	131 s (2 min 11 s)	131 s
1 0	10 ms	655 s (10 min 55 s)	655 s
1 1	Reserved	–	–

Fig. 4-10 Resolution parameter

Please note that the indicated resolution is valid for all values, including the presetting of conditions (e.g., initial or final value). If, for example, a resolution of 2 ms per LSB is set, and it is necessary to define an initial value of 50 ms, the value 19_{hex} (25_{dec}) must be entered. At a resolution of 2 ms per LSB, this value corresponds to the 50 ms.

Out: output

Bit 5	Meaning
0	Output not used
1	Output set if relation condition satisfied

Fig. 4-11 OUT parameter: output

Type: measurement type

Bit 4	Meaning
0	Measurement of period (a in Fig. 4-13)
1	Measurement of pulse length (b in Fig. 4-13)

Fig. 4-12 Type parameter: measurement type

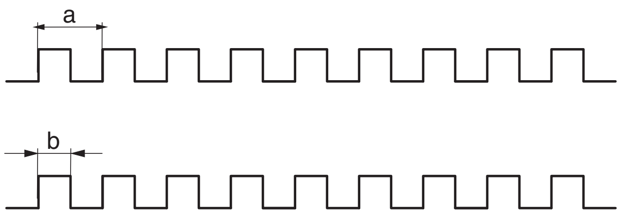


Fig. 4-13 Period and pulse length

Relation condition The relation condition specifies a condition for the output behavior during time measurement. Compliance with the limit values specified in the relation condition is indicated via the output or bit 8 (OUT). The initial and/or the final value from the event counting can be used as limit values. Since the count value only occupies 16 bits, only the lower 16 bits of the initial value and the final value are taken into account.

Output used If the output is being used, bit 8 in input word 0 mirrors the state of the output.

If the relation condition is satisfied, the output is set and a “1” shown in bit 8 of input word 0 for the set output.

If the relation condition is not satisfied, the output is reset and a “0” shown in bit 8 of input word 0.

Output not used If the output is not being used, once the relation condition is satisfied, the bit for the digital output is set (input word 0, bit 8 = 1) in the process data.

If the relation condition is not satisfied, a “0” appears in bit 8 of input word 0.

If the output is not being used, once the relation condition is satisfied, bit 8 in input word 0 changes to “1” and **remains at 1. It has to be reset by the user** by setting bit 8 in output word 0 to “1” (OUT[0] = 0100_{hex}) until bit 8 in input word 0 changes to “0”.

Bits 2/1/0		Meaning
bin	dec	
0 0 0	0	No relation condition
0 0 1	1	Count value greater than or equal to initial value
0 1 0	2	Count value less than initial value
0 1 1	3	Count value within initial and final values
1 0 0	4	Count value outside initial and final values
1 0 1	5	Count value greater than final value with hysteresis
1 1 0	6	Count value less than initial value with hysteresis
1 1 1	7	Reserved

Fig. 4-14 Relation conditions parameter

Whether a limit value is included in the condition or not depends on the condition. Internally, each condition is reduced to a comparison of count value less than initial value and/or count value greater than final value.

In Fig. 4-15 the relation conditions are shown graphically.

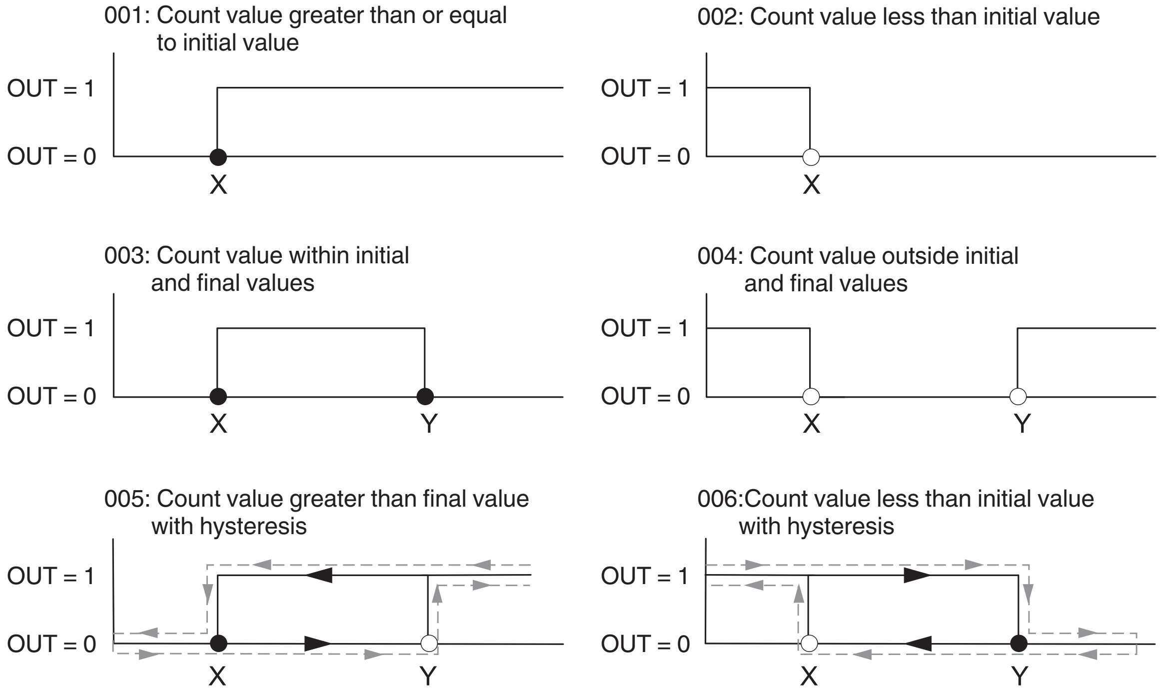


Fig. 4-15 Relation conditions

Key:

X	Initial value
Y	Final value
●	Limit value included
○	Limit value not included

Hystereses: The gray line in those cases with hystereses illustrates the OUT state as a function of the previous state of OUT and the measured value. If, for example, in diagram 006, the measurement is between the initial and final values, OUT can be = 0 or = 1. If OUT was = 0, it remains at 0, if OUT was = 1, it remains at 1.

A hysteresis therefore can be used to stabilize the output behavior of measured values that fluctuate around certain limit values.

Example 1 The effect of a relation condition may be explained by reference to the example of condition “004: Count value outside initial and final values”.

- If the count value is less than the initial value, the relation condition is satisfied and OUT is set to “1”.
- If the count value is greater than or equal to the initial value and less than or equal to the final value, the relation condition is not satisfied and OUT is set to “0”.
- If the count value is greater than the final value, the condition is satisfied and OUT is set to “1”.

Example 2 The output behavior on a condition with hysteresis may be explained by reference to the example of condition “006: Count value less than initial value with hysteresis”.

- If the time measured has not yet been greater than or equal to the final value, the condition is satisfied and OUT = 1.
- If the time measured is greater than or equal to the final value, the condition is no longer satisfied, OUT = 0.
- If the time measured becomes smaller, but is still greater than or equal to the initial value, OUT remains = 0.
- If the time measured is less than the initial value, OUT becomes = 1.
- OUT only returns to = 0 again if the measured value becomes greater than or equal to the final value.

4.5 “Pulse generator operating mode” command

The pulse generator can produce frequencies of 1 kHz ... 10 kHz in 500 Hz increments. This operating mode requires a certain setting for the input circuit, which is made automatically (see Chapter ““System settings” command” on page 25).

The pulse generator command consists of the command code and a factor.

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**Factor**				

The second output word is not used.

The individual quantities are related as follows:

- Pulse frequency = 1000 Hz + (factor x 500 Hz)

Factor dec/hex	$F_{setpoint}$ in Hz	F_{actual} in Hz	Error in %
0 / 00	1000	1000	0
1 / 01	1500	1497	-0.2
2 / 02	2000	2000	0
3 / 03	2500	2500	0
4 / 04	3000	3012	0.4
5 / 05	3500	3521	0.6
6 / 06	4000	4000	0
7 / 07	4500	4505	0.11
8 / 08	5000	5000	0
9 / 09	5500	5495	-0.09

Factor dec/hex	$F_{setpoint}$ in Hz	F_{actual} in Hz	Error in %
10 / 0A	6000	5988	-0.2
11 / 0B	6500	6494	-0.09
12 / 0C	7000	6993	-0.01
13 / 0D	7500	7519	0.25
14 / 0E	8000	8000	0
15 / 0F	8500	8475	-0.29
16 / 10	9000	9009	0.1
17 / 11	9500	9525	0.25
18 / 12	10000	10000	0

Fig. 4-16 Factor, frequency setpoint, actual frequency and error

4.6 "System settings" command

This command makes settings, some of which affect all operating modes.

The system settings command consists of the command code and various parameters.

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**0**	**0**	**IC**		**Source-gate logic operation**				**Reset**	**Pulse length**		

The second output word is not used.

The *System settings* command can be used to make basic settings for all operating modes. However, the definition of the various parameters depends on the operating mode. Not all parameters can be defined in every operating mode.

Parameter	Operating mode(s) in which it may be used
Input circuit (IC)	
• No input circuit (IC parameter = 00_{bin})	All
• Filter for mechanical switches (IC parameter = 01_{bin})	Frequency measurement, event counting, time measurement
• Settings for pulse generator (IC parameter = 10_{bin})	Pulse generator
• Source-gate logic operation (IC parameter = 11_{bin})	Frequency measurement, event counting, time measurement
Source-gate logic operation	Frequency measurement, event counting, time measurement
Bus reset behavior	All
Pulse length	Event counting

Fig. 4-17 Use of the system settings command parameters in the individual operating modes

Apart from the pulse length setting, the system settings are accepted immediately in an activated operating mode.

Commands for working with the counter terminal

IC: input circuit

The input circuit parameter can be used to connect a filter or influence the effect of the states of the two inputs (source-gate logic operation).

If pulse generator operating mode is set, bits 9 and 8 are automatically set to the bit combination 10_{bin} internally. If bits 9 and 8 have been set otherwise, this setting is ignored.

Bits 9 and 8 bin	Status word hex	Function
0 0	300x	Source and gate directly, 100 kHz filter each
0 1	310x	Source and gate filter for mechanical contacts
1 0	320x	Setting for pulse generator
1 1	33xx	Source-gate logic operation, see Fig. 4-19 to Fig. 4-21.

Fig. 4-18 Input circuit parameter

☞ If mechanical switches (e.g., relays) are being used, the source and gate filter should be switched on to eliminate or minimize the contact bounce effects. In the case of semiconductor switches or photoelectric barriers this filter must be switched off.
If different types of switches (mechanical and electronic) are used at the source and gate inputs, the effects of a circuit with and without filters must be checked beforehand.

☞ Please note that the counter terminal always accepts the latest input circuit. For example, it is not possible to set a filter for mechanical contacts first and then perform a source-gate logic operation. In this case only the source-gate logic operation would be accepted, the filter would no longer be connected.

☞ The source-gate logic operation can be used in conjunction with the following operating modes: frequency measurement, event counting, and time measurement.

Source-gate logic operation

With the source-gate logic operation, a signal is formed from the two input signals source (S) and gate (G) that, after processing according to the logic function, is available as a new source signal. In the following, it is referred to as source' (S'). The original source signal is now no longer available. The original gate signal can continue to be used.

This source-gate logic function can be used to implement the most common logic functions (see Fig. 4-19), and also any other possible function (see Fig. 4-21).

Bits 7 ... 4 bin	Status word hex	Function
0 0 0 1	33**1**x	S' = S NOR G
0 0 1 1	33**3**x	S' = $\overline{G}$ (source' = gate inverted)
0 1 0 1	33**5**x	S' = $\overline{S}$ (source' = source inverted)
0 1 1 0	33**6**x	S' = S EXOR G
0 1 1 1	33**7**x	S' = S NAND G
1 0 0 0	33**8**x	S' = S AND G
1 1 0 0	33**C**x	S' = G
1 1 1 0	33**E**x	S' = S OR G

Fig. 4-19 The most common logic functions provided by the source-gate logic operations

Gate	Source	OR 1110_{bin}	EXOR 0110_{bin}	AND 1000_{bin}	NOR 0001_{bin}	NAND 0111_{bin}	S' = $\overline{S}$ 0101_{bin}	S' = G 1100_{bin}	S' = $\overline{G}$ 0011_{bin}
0	0	0	0	0	1	1	1	0	1
0	1	1	1	0	0	1	0	0	1
1	0	1	1	0	0	1	1	1	0
1	1	1	0	1	0	0	0	1	0

Fig. 4-20 Source' depending on the inputs and the source-gate logic operation (most common logic functions)

Gate	Source	0000_{bin}	0010_{bin}	0100_{bin}	1001_{bin}	1010_{bin}	1011_{bin}	1101_{bin}	1111_{bin}
0	0	0	0	0	1	0	1	1	1
0	1	0	1	0	0	1	1	0	1
1	0	0	0	1	0	0	0	1	1
1	1	0	0	0	1	1	1	1	1

Fig. 4-21 Source' depending on the inputs and the source-gate logic operation (other logic functions)

Commands for working with the counter terminal

Define a function as follows:

- Create a table with the states of source and gate in the specified sequence.

Gate	Source
0	0
0	1
1	0
1	1

- Define the state of source’ depending on source and gate. If, for example, source’ is always to adopt the state “1”, except for when source = “0” and gate = “1” simultaneously, enter the corresponding combination of states for source’ in the table.

Gate	Source	Source’
0	0	1
0	1	1
1	*0*	*0*
1	1	1

- Derive from this table the bit combination for the source-gate logic operation that has to be entered in output word 0.

Gate	Source	Source’	Bit in OUT[0]
0	0	1	4
0	1	1	5
1	0	0	6
1	1	1	7

The bit combination for the required source-gate logic operation is 1011_{bin}.

Reset: bus reset behavior

Bus reset behavior can be used to select whether a bus reset is to have an effect on the terminal or not.

Bit 3	Meaning
0	(Default state) A bus reset resets the output, stops all counting operations, and clears the operating mode set.
1	No response to a bus reset

Fig. 4-22 Bus reset behavior parameter

Pulse length

The pulse length parameter can be used to change the length of a pulse of the digital output in the event counting operating mode. The default value is 100 ms.

The value of the pulse length can be changed at any time, however, the setting is not accepted and hence is not effective until event counting operating mode is set.

If the pulse length is to be changed during event counting, after the value has been changed, the command for setting event counting operating mode must be resent.

Bits 2/1/0	Pulse length
0 0 0	10 ms
0 0 1	50 ms
0 1 0	100 ms
0 1 1	200 ms

Bits 2/1/0	Pulse length
1 0 0	300 ms
1 0 1	400 ms
1 1 0	500 ms
1 1 1	1000 ms

Fig. 4-23 Pulse length parameter

4.7 “Read firmware version” command

This command can be used to read the firmware version of your counter terminal. It can be used at any time. The result is shown immediately in input word 1.

Output word Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**1**	**1**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

x The setting of this bit is irrelevant.

The second output word is not used.

Input word Input word 0 (IN[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**1**	**1**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

x The setting of this bit is irrelevant.

Input word 1 (IN[1]) (example)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**(0)**	**(0)**	**(0)**	**(0)**

(0) The setting of this bit is irrelevant. In this example, the irrelevant bits have been set to 0.

In this example, input word 1 has the value 1000_{hex}. The last digit of the hex value is not taken into account. The firmware version is therefore 1.00.

4.8 "Preset initial value" and "Preset final value" commands

These commands are used in the **event counting** and **time measurement** operating modes.

The *Preset initial value* ($40xx_{hex}$) and *Preset final value* ($50xx_{hex}$) commands are used to preset defined values for counting and time measurement.

Since event counting works with 24-bit values, initial and final values can be preset as 24-bit values.

Time measurement uses 16-bit values, so only the value of output word 1 is used (16-bit) for working in this operating mode, even if a 24-bit value has been preset.

The commands can be sent at any time and are accepted immediately, even during an active counting/time measurement.

NOTICE	**Misinterpretation of values when the data consistency is violated**

Ensure data consistency of two words to prevent the possibility of the values being misinterpreted.

Please observe the notes in Chapter "Tips for working with the counter terminal" on page 50.

Commands for working with the counter terminal

Preset initial value

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**Initial value**							

Output word 1 (OUT[1])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Initial value															

Preset final value

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**Final value**							

Output word 1 (OUT[1])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Final value															

When specifying initial and final values for time measurement, please note any resolution set (see, for example, “Resolution” on page 20). A set resolution per LSB also applies to the initial and final values.

If, for example, a resolution of 2 ms per LSB has been set for time measurement, and an initial value of 50 ms is to be defined, the value 19_{hex} (25_{dec}) must be entered. At a resolution of 2 ms per LSB, this value corresponds to the 50 ms.

If, during a count, a new initial value is set, the counter is set to this value immediately, regardless of its current state.

If, during a count, a new final value is set, this value is accepted immediately for the current count.

If, for example, no initial value has been set for repeat counting, and the final value is equal to 10, counting starts at 0. The counter counts up to 9 and resets the count value to 0 on the next pulse.

4.9 “Stop counter” and “Start counter” commands

These commands are only valid in **event counting** operating mode.

The counter starts counting immediately after the operating mode command is sent. The *Stop counter* command (2000_{hex}) is used to stop a counting operation. The *Start counter* command (2400_{hex}) is used to start a counting operation. The count value is frozen after the operation is stopped. Counting is restarted from the frozen count value after a new *Start counter* command.

Stop counter

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**0**	**0**	**0**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

x The setting of this bit is irrelevant.

The second output word is not used.

Start counter

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**0**	**0**	**1**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

x The setting of this bit is irrelevant.

The second output word is not used.

4.10 “Set counter to default” command

This command can be used for **all** operating modes.

The operating mode command causes the counter to start counting immediately, the *Start counter* command does not have to be sent. This is made possible by the fact that not all counter environment variables are cleared when an operating mode command is sent.

If the counter terminal is to be set to a defined initial state, the *Set counter to default* command (2800_{hex}) must be sent. This command clears all of the counter environment variables:

- The pulse length is set to the default value.
- The input circuit is set to 100 kHz.
- The counter is stopped.
- The operating mode is cleared.
- The bus reset behavior remains unchanged.

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**0**	**1**	**0**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

x The setting of this bit is irrelevant.

The second output word is not used.

☞ If the R-IB IL CNT(/CN)-PAC terminal is being tested to try out various operating modes, it is advisable to send the command 2800_{hex} before parameterizing a new operating mode.

4.11 “Read counter” command

This command can be used for **all** operating modes.

The *Read counter* command allows the result to be read in different operating modes.

The command for reading the counter only contains the command code. There are no parameters in this command.

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**

x The setting of this bit is irrelevant.

The second output word is not used.

Input word Assignment of the input words after the *Read counter* command:

<table>
<tr><td colspan="16">Input word 0</td><td colspan="16">Input word 1</td></tr>
<tr><td colspan="8">High byte</td><td colspan="8">Low byte</td><td colspan="8">High byte</td><td colspan="8">Low byte</td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>G</td><td>O</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td>x</td><td colspan="16">16-bit measured value from time measurement</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>G</td><td>O</td><td colspan="24">24-bit measured value from event counting and frequency measurement</td></tr>
</table>

x The setting of this bit is irrelevant.

G Status of the signal at the control input (gate)

O During time measurement:
Status of the output or
result of the evaluation of the relation condition without using the output

Commands for working with the counter terminal

G: gate Bit 9 of input word 1 shows the status of the signal at the control input (gate).

O: OUT (output) This bit is only used in time measurement operating mode. In all other operating modes, bit 8 = 0.

During time measurement, bit 8 of input word 1 indicates the status of the output or the result of the evaluation of a relation condition.

If the output is being used, its status is indicated.

If the output is not being used, and a relation condition has been selected, the result of its evaluation is indicated.

If time measurement operating mode is being used, see Chapter *""Time measurement operating mode" command" on page 20* for additional information about this bit.

Bits 15 ... 10 The command is mirrored in bits 15 ... 10 of input word 0. Bit 15 is the error bit. If bit 15 = 0, there is no error.

Bits 7 ... 0 Bits 7 ... 0 are irrelevant in a 16-bit count value. In a 24-bit count value, they represent the most significant byte of the result.

With a 24-bit value the count value must be masked out of the two input words.

Count value = (IN[0] & $00FF_{hex}$) x 65536 + IN[1].

4.12 Limit values and limitations on the commands

Operating mode	Options affected	Operating range
Frequency measurement	All	f ≤ 100 kHz
Event counting	All	f ≤ 100 kHz
Time measurement	Resolution 2 µs, without relation condition	250 µs ≤ t ≤ 131 ms (up to FW 1.03) 250 µs ≤ t ≤ 126 ms (as of FW 1.06)
	Resolution 2 µs, with relation condition	1 ms ≤ t ≤ 131 ms (up to FW 1.03) 1 ms ≤ t ≤ 126 ms (as of FW 1.06)
	Resolution 2 ms	2 ms ≤ t ≤ 131 s
	Resolution 10 ms	10 ms ≤ t ≤ 655 s
Pulse generator		1 kHz ≤ f ≤ 10 kHz

Fig. 4-24 Limit values and limitations

The minimum time measurement periods with a resolution of 2 µs, with and without relation condition, are defined through the processing time by the firmware.

The input signals at source and gate must be digital.

The counter terminal is primarily designed for the use of electronic switching elements, i.e., semiconductor switches.

Mechanical contacts can only be used to a limited extent. A filter is provided in the input circuit for this purpose. However, practical tests have shown that the bouncing of mechanical contacts can present problems even with this filter.

Commands for working with the counter terminal

4.13 Overview of all commands

This section provides an overview of all commands. This allows a quick evaluation of which parameters can or must be preset for which command. More detailed information can be found in the individual chapters.

Irrelevant bits, which are identified with an “x” in the explanation of the individual commands, are set to “0” in this overview.

In hexadecimal notation, the value “X” depends on the parameter “X” to be specified.

Only the output words used for the corresponding command are shown.

Frequency measurement

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**0**	**0**	**Parameter (time-controlled/state-controlled)**									
1				**X**				**X**				**X**			

Event counting

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**R**	**Gate**			**D**	**Output**		
1				**4**				**X**				**X**			

R Counting repeat

D Counting direction

Time measurement

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**Reso-lution**		**Out**	**Type**	**0**	**Relation condition**		
1				**8**				**X**				**X**			

Pulse generator

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**Factor (pulse)**				
1				**C**				**X**				**X**			

System settings

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**0**	**0**	**IC**		**Source-gate logic operation**				**Rese t**	**Pulse length**		
3				**0 (X)**				**X**				**X**			

IC Input circuit

Read firmware version

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
3				**C**				**0**				**0**			

Preset initial value

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**Initial value**							
4				**0**				**X**				**X**			

Output word 1 (OUT[1])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Initial value															
X				**X**				**X**				**X**			

Preset final value

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**Final value**							
5				**0**				**X**				**X**			

Output word 1 (OUT[1])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Final value															
X				**X**				**X**				**X**			

Stop counter

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2				**0**				**0**				**0**			

Start counter

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2				**4**				**0**				**0**			

Set counter to default

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
2				**8**				**0**				**0**			

Read counter

Output word 0 (OUT[0])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
0				**0**				**0**				**0**			

Commands for working with the counter terminal

5 Examples and tips

Always follow the notes on data consistency on page 50 when programming.

5.1 Application areas

Event counting Event counting is used for counting goods.

Frequency measurement Frequency measurement is suitable for measuring speeds.

Time measurement Time measurement can be used for an extremely wide range of applications.

- One conceivable example is calculating the size of a part using time measurement. On a conveyor belt, differences in size could be ascertained through differences in time.
- Time measurement can be used to measure speed, if it is necessary to respond to a value falling outside a specified range. For example, the output can be set at a specified maximum speed.

Please note that in time measurement operating mode lower speeds can be measured than in frequency measurement operating mode, since the former utilizes 16-bit and the latter 24-bit measured values.

Pulse generator The pulse generator can be used to generate and output pulse sequences with different frequencies.

5.2 Examples of event counting

5.2.1 Example 1: Counting of goods

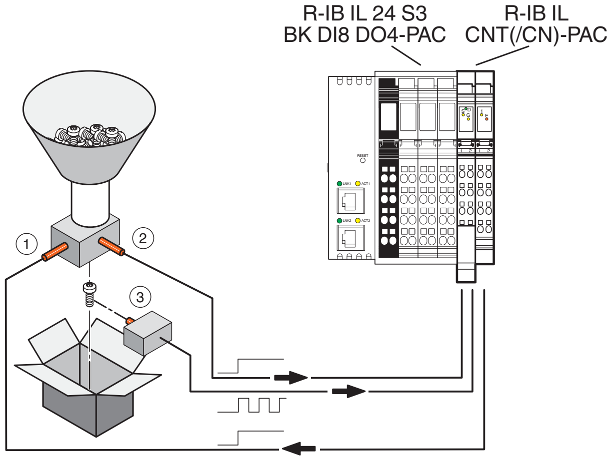


Fig. 5-1 Example system for counting goods

Key:

No.	Sensor/actuator	Associated input/output
1	Valve (flap control)	Switching output
2	Sensor (control signal)	Control input
3	Sensor (counting pulse)	Counter input

In the example shown in Fig. 5-1, sets consisting of 100 screws are to be packed in a cardboard box. The control input (2) enables the count at the counter input (3) when there are screws present in the hopper. Each screw that falls out of the funnel into the box initiates a pulse at the counter input. When there are 100 screws in the box, the switching output (1) is set and the valve triggers the flap to close the hopper. A new box can now be filled.

5.2.2 Example 2: Up-counter

Task

An up-counter is to be configured. Counting is to start at the initial value 123_{hex}. The light is on when counting starts. The output is to be inverted each time the value 132_{hex} is reached.

Wiring

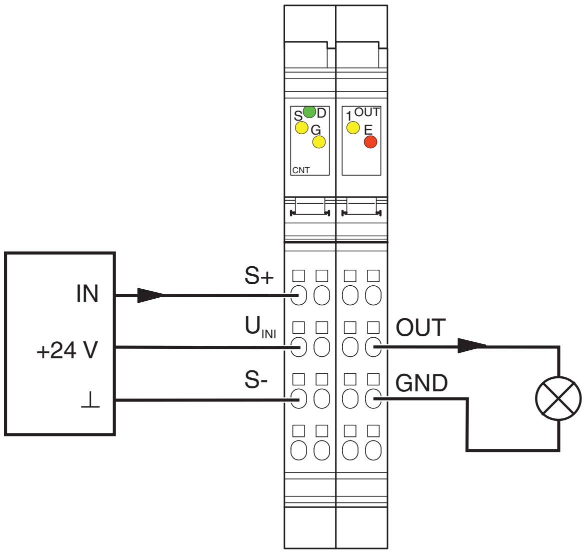


Fig. 5-2 Example of wiring for event counting

A photoelectric barrier, for example, is to be connected to the source input (S+, +24 V, S-). This barrier provides the counting pulses. The output is used to control a light.

Programming

Output word 1 for event counting

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	0	F	Gate			R	Output		
0	0	0	1	0	1	0	0	1	0	0	0	1	1	0	0
1				4				8				C			

F	Repeated count	1_{bin}
Gate	No function	000_{bin}
R	Up counting	1_{bin}
Output	Previous state of the output is inverted when the final value is reached; initial state: set (high)	100_{bin}

Action	OUT[0] hex	OUT[1] hex	OUT[0] bin	OUT[1] bin
Set counter to default	2800	xxxx	**0010 10**00 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
The output word OUT[1] is irrelevant in this case.				
Preset initial value 123_{hex}	4000	0123	**0100 00**00 0000 0000	0000 0001 0010 0011
Wait for acknowledgment	Wait until IN[0] = OUT[0] and IN[1] = OUT[1]			
Check whether the input value corresponds to the value required. Always follow the notes on data consistency on page 50.				
Preset final value 132_{hex}	5000	0132	**0101 00**00 0000 0000	0000 0001 0011 0010
Wait for acknowledgment	Wait until IN[0] = OUT[0] and IN[1] = OUT[1]			
Check whether the input value corresponds to the value required. Always follow the notes on data consistency on page 50.				
Event counting operating mode, upwards, output active, output = toggle	148C	xxxx	**0001 01**00 1000 1100	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Read counter	0000	xxxx	**0000 00**00 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Read count value	Count value = IN[1]			
	As the counting range in this specific case only extends to values between 123_{hex} ... 132_{hex}, the count value only occupies the second input word (IN[1]). If the input value occupies more than 16 bits, the value must be masked out of the two input words: (Count value = (IN[0] & $00FF_{hex}$) x 65536) + IN[1]).			

Fig. 5-3 Example of event counting

xxxx	Any value, as it is not used.
0 / 1	Bold text identifies the command code.
0 / 1	The values that are not in bold represent the parameters for the command code.

If a 24-bit value is preset as initial or final value, the commands take the following format:

Preset initial value 123456_{hex}	4012	3456	**0100 00**00 0001 0010	0011 0100 0101 0110
Wait for acknowledgment	Wait until IN[0] = OUT[0] and IN[1] = OUT[1]			
Preset final value $789ABC_{hex}$	5078	9ABC	**0101 00**00 0111 1000	1001 1010 1011 1100
Wait for acknowledgment	Wait until IN[0] = OUT[0] and IN[1] = OUT[1]			

5.3 Example of time measurement with relation conditions

Task The length of pulses is to be measured. The output is to follow a hysteresis loop with the relation condition “count value < initial value with hysteresis”. The limit values of the hysteresis should be 40 ms and 80 ms.

Wiring The wiring is as shown in Fig. 5-2 on page 43.

Programming Output word 1 (OUT[0]) for time measurement

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	Resolution		OUT	Type	0	Relation condition		
0	0	0	1	1	0	0	0	0	1	1	1	0	1	1	0
1				8				7				6			

Resolution	2 ms	01_{bin}
OUT	Output set if relation condition satisfied	1_{bin}
Type	Measurement of pulse length	1_{bin}
Relation condition	Count value < initial value (hysteresis)	110_{bin}

When specifying initial and final values, please note the resolution specified for time measurement!

Initial value:	40 ms (please note resolution)	$20_{dec} = 14_{hex}$
Final value:	80 ms (please note resolution)	$40_{dec} = 28_{hex}$

Examples and tips

Action	OUT[0] hex	OUT[1] hex	OUT[0] bin	OUT[1] bin
Set counter to default command	2800	xxxx	**0010 10**00 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Preset initial value command, initial value = 14_{hex}	4000	0014	**0100 00**00 0000 0000	0000 0000 0001 0100
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Preset final value command, final value = 28_{hex}	5000	0028	**0101 00**00 0000 0000	0000 0000 0010 1000
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Time measurement operating mode with parameters specified above	1876	xxxx	**0001 10**00 0111 0110	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
The following steps are not needed if only the output behavior is of importance.				
Read counter	0000	xxxx	**0000 00**00 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until (IN[0] & $FC00_{hex}$) = (OUT[0] & $FC00_{hex}$)			
16-bit count value	Count value = IN[1]			
Time in ms	Time = count value x resolution; resolution = 2 ms			

Fig. 5-4 Programming the example of time measurement with relation condition

Explanation of output pulse diagram

After the command for the operating mode has been sent, the counter terminal directly begins to count (time measurement) the signals at the input.

The pulse length starts at 0 ms and is slowly increased (segment A in Fig. 5-5). As long as the pulse length is less than the final value (80 ms), the output remains at “1”. When the pulse length equals the final value (point B), the output is set to “0”. The pulse length continues to increase (segment C) until it reaches 120 ms. It then decreases again (segment D). If the pulse length is equal to the initial value (40 ms) (point E), the output is set to “1”. If the pulse length shortens further, the output remains at “1”.

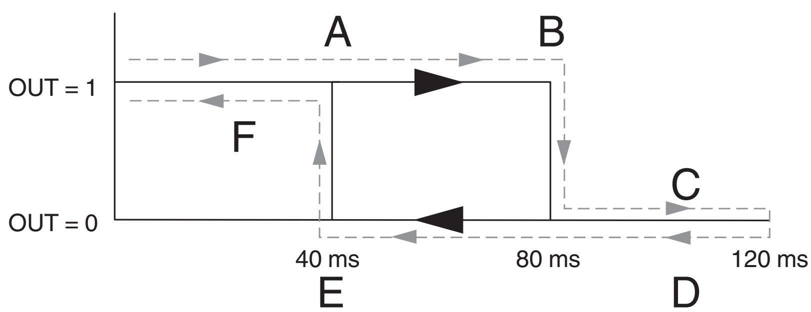


Fig. 5-5 Example of a hysteresis

5.4 Example of time measurement with system settings

Task Limit switches are connected to source and to gate to measure the time during which the signals of the two limit switches are both at “1”. If a limit value is exceeded, it will be detected by the bus.

The time is measured in time measurement operating mode with the pulse length measurement parameter.

Wiring

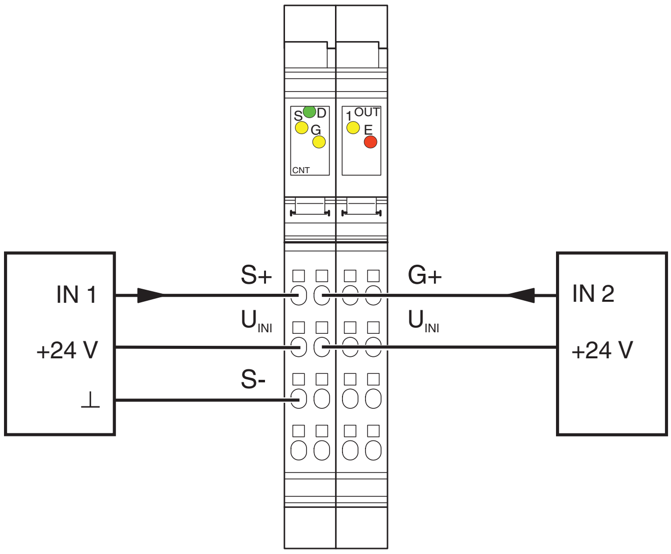


Fig. 5-6 Example of wiring for time measurement with source and gate

A photoelectric barrier is connected to the source input (S+, +24 V, S-). Another sensor is connected to the gate input (G+, +24 V). The output is not controlled. The result of checking the relation condition is indicated in input word 1 (bit 9).

Programming The system settings and marginal conditions commands must be sent before the operating mode selection command.

System settings The logic operation is performed on the two limit switch signals with the system settings command. Logical ORing of the signals is selected (source’ equal to “1” if source or gate signal at “1”).

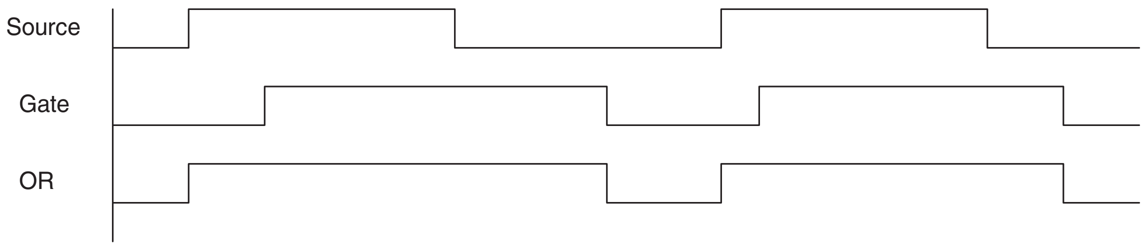


Fig. 5-7 Logical ORing of source and gate

Input circuit	Source-gate logic operation	11_{bin}
Source-gate logic operation	OR	1110_{bin}
Reset	No response to a bus reset	0_{bin}
Pulse length	(Pulse length 10 ms) irrelevant, as no output is to be set	000_{bin}

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	1	0	0	IC		Source-gate logic operation				Reset	Pulse length		
0	0	1	1	0	0	1	1	1	1	1	0	0	0	0	0
3				3				E				0			

The system settings command is $33E0_{hex}$.

Presetting the initial value

The OUT bit in the input word is used to indicate that a limit value has been exceeded. The limit value must be preset as the initial value.

The limit is to be 30 s. An initial value of 30000 ms is therefore preset. The resolution is to be 2 ms. The value to be entered in the parameter word for the *Preset initial value* command is $15000_{dec} = 3A98_{hex}$.

Preset the initial value using

Word 0 = 4000_{hex}

Word 1 = $3A98_{hex}$

Ensure data consistency of two words. If this is not possible in your application, word 1 and then word 0 must be transmitted (see page 50).

Selecting the operating mode

The command for selecting the time measurement operating mode can now be transmitted.

Resolution	2 ms	01_{bin}
OUT	Output not used	0_{bin}
Type	Measurement of pulse length	1_{bin}
Relation condition	Count value ≥ initial value	0001_{bin}

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	1	1	0	0	0	Resolution		OUT	Type	0	Relation condition		
0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1
1				8				5				1			

The time measurement command is thus 1851_{hex}.

Command sequence

Action	OUT[0] hex	OUT[1] hex	OUT[0] bin	OUT[1] bin
Set counter to default command	2800	xxxx	**0010 10**00 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
System settings command, source-gate logic operation active	33E0	xxxx	**0011 00**11 1110 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Preset initial value command, initial value = 3A98$_{hex}$	4000	3A98	**0100 00**00 0000 0000	0011 1010 1001 1000
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Time measurement operating mode, pulse length measurement	1851	xxxx	**0001 10**00 0101 0001	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until IN[0] = OUT[0]			
Read counter	0000	xxxx	**0000 00**00 0000 0000	xxxx xxxx xxxx xxxx
Wait for acknowledgment	Wait until (IN[0] & FC00$_{hex}$) = (OUT[0] & FC00$_{hex}$)			
16-bit count value	Count value = IN[1]			
Time in ms	Time = count value x resolution; resolution = 2 ms			

Fig. 5-8 Example of time measurement using system control

5.5 Tips for working with the counter terminal

NOTICE **Misinterpretation of values when the data consistency is violated**

Ensure data consistency of two words to prevent the possibility of the values being misinterpreted.

If the second output word (OUT[1]) is related to the first (OUT[0]), for example, when presetting an initial value, it is necessary to ensure that the counter terminal receives the desired preset value together with the command. This can be checked via the input words. Input word 1 (IN[0]) must contain the command code, input word 2 (IN[1]) the **desired** preset value.

If data consistency is not ensured, the second word will contain **any** value still present in the input word from an **earlier** transmission. If this happens, the data has not been accepted properly.

If this is the case, send output word 1 first with the preset value, and any command code other than that required. 000000_{bin} is one possibility for this command code. It is the code for *Read counter*. This code has no effect on the parameterization of the terminal. If the terminal has not been configured before a value is preset, or no operating mode has yet been preset, bit 15 of the input word IN[0] will indicate an error after the transmission of this code. This error message can be ignored. It has no effect on the preset value.

Then transmit output word 0 with the command required for presetting the value, without changing output word 1. The output words are mirrored in the two input words. Input words 0 and 1 must now contain the command code and the **desired** preset value. Bit 15 of input word IN[0] must no longer indicate an error now. This shows that the counter terminal has adopted the desired value.

Please note that a new value will not be accepted if the same code for presetting the value is transmitted several times in succession. To change a preset value, at least one other command code must have been transmitted in the meantime.

If it has become evident that data consistency is no longer ensured, for example, during transmission of the initial value, the command sequence may appear as shown in Fig. 5-9.

<table>
<tr><th>Action</th><th>OUT[0]
hex</th><th>OUT[1]
hex</th><th>OUT[0]
bin</th><th>OUT[1]
bin</th></tr>
<tr><td colspan="5">The initial value is preset. It is not possible to be sure whether data consistency is ensured.</td></tr>
<tr><td>Preset initial value</td><td>4000</td><td>1111</td><td>0100 0000 0000 0000</td><td>0001 0001 0001 0001</td></tr>
<tr><td>Wait for acknowledgment</td><td colspan="4">IN[0] = OUT[0];
IN[1] not equal to OUT[1], e.g., 9999$_{hex}$</td></tr>
<tr><td colspan="5">This acknowledgment shows that data consistency is not ensured. The initial value must be retransmitted taking account of data consistency.</td></tr>
<tr><td colspan="5">Step 1: Transmit OUT[1]</td></tr>
<tr><td>Enter initial value</td><td>0000</td><td>1111</td><td>0000 0000 0000 0000</td><td>0001 0001 0001 0001</td></tr>
<tr><td colspan="5">OUT[0] may be equal any value other than 4000_{hex}.</td></tr>
<tr><td colspan="5">It is not necessary to wait for acknowledgment.
Whether OUT[1] is mirrored in IN[1] depends on the code transmitted. With the 000000_{hex} code there is no mirroring of the output word.</td></tr>
<tr><td></td><td colspan="4">Bit 15 of the input word IN[0] can indicate an error, as OUT[0] corresponds to the code for Read counter. The error message can be ignored in this case.</td></tr>
<tr><td colspan="5">Step 2: Transmit OUT[0]</td></tr>
<tr><td>Re-enter initial value</td><td>4000</td><td>1111</td><td>0100 0000 0000 0000</td><td>0001 0001 0001 0001</td></tr>
<tr><td>Wait for acknowledgment</td><td colspan="4">IN[0] = OUT[0]; IN[1] = OUT[1]</td></tr>
<tr><td colspan="5">Check whether the input value corresponds to the value required.</td></tr>
</table>

Fig. 5-9 Example of presetting an initial value

Examples and tips

Sequence of the Inline terminals

The sequence of the terminals within an Inline station should depend on the current consumption of the I/O from the potential jumpers U_M and U_S.

As the voltage at every feed-in terminal is fed in again into the potential jumpers U_M and U_S, the section (main circuit) between bus coupler and feed-in terminal or between feed-in terminal and feed-in terminal must always be considered when calculating the current. If feed-in terminals are not used, the entire station is a main circuit.

Within a main circuit, place the terminals with the highest current consumption first. This has the advantage that the high supply current does not flow through the entire main circuit.

This results in the following sequence:

1. Digital output terminals with 8-slot housing
2. Digital output terminals with 2-slot housing
3. Digital input terminals with 8-slot housing
4. Digital input terminals with 2-slot housing
5. Function modules in any order,
   including the **R-IB IL CNT(/CN)-PAC counter terminal**
6. Analog terminals in any order

☞ The current consumption of the terminals is specified in the “Automation Terminals of the Rexroth Inline Product Range” application description and in every module-specific data sheet.

---

6 Disposal

6.1 General information

Dispose the products according to the respective valid national standard.

6.2 Return

For disposal, our products can be returned free of charge. However, the products must be free of remains like oil and grease or other impurities.

Furthermore, the products returned for disposal must not contain any undue foreign substances or components.

Send the products free of charge to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Bürgermeister-Dr.-Nebel-Straße 2
D-97816 Lohr am Main, Germany

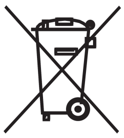
6.3 Packaging

The packaging material consists of cardboard, plastics, wood or styrofoam. Packaging material can be recycled anywhere.

For ecological reasons, please do not return empty packages.

6.4 Batteries and accumulators

Batteries and accumulators can be labelled with this symbol.



The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the health of the individual when they are stored incorrectly or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be disposed of according to the country-specific collection system.

Disposal

7 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries.
You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	**+49 9352 40 5060**
Fax:	**+49 9352 18 4941**
E-mail:	service.svc@boschrexroth.de
Internet:	http://www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

Service and support

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