Inline modular counter terminal

User manual

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User manual
Inline modular counter terminal

2014-07-21

Designation: UM EN IB IL CNT-PAC

Revision: 03

This user manual is valid for:

Designation	Hardware/firmware version	Order No.
IB IL CNT-PAC	02/1.06 or later	2861852
IB IL CNT-XC-PAC	00/1.07 or later	2702134

Please observe the following notes

User group of this manual

The use of products described in this manual is oriented exclusively to:

– Qualified electricians or persons instructed by them, who are familiar with applicable standards and other regulations regarding electrical engineering and, in particular, the relevant safety concepts.
– Qualified application programmers and software engineers, who are familiar with the safety concepts of automation technology and applicable standards.

Explanation of symbols used and signal words

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

There are three different categories of personal injury that are indicated with a signal word.

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

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

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

This symbol together with the signal word **NOTE** and the accompanying text alert the reader to a situation which may cause damage or malfunction to the device, hardware/software, or surrounding property.

This symbol and the accompanying text provide the reader with additional information or refer to detailed sources of information.

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1 Function description

1.1 Function description

The functions of the IB IL CNT-PAC and IB IL CNT-XC-PAC are identical.
Please refer to the module-specific data sheet for hardware differences.

The terminal is a counter terminal designed for use within an Inline station. It is also known as a counter.

The counter terminal detects and processes fast pulse sequences from sensors. The terminal has a counter input (source), a control input (gate), and a switching output that can be freely parameterized by the terminal itself. In this way, it is possible to achieve fast response times that are independent of both the bus and controller.

The terminal can be operated in four different modes:

- Frequency measurement
- Event counting
- Time measurement
- Pulse generation

Sensors with 24 V DC and 5 V DC supply can be connected to the terminal.

The switching output supplies a maximum current of 500 mA.

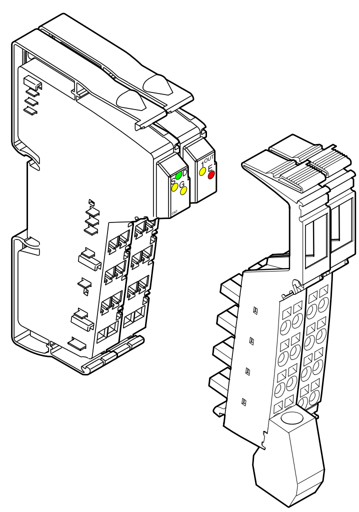

Figure 1-1 The terminal with associated connectors

Terminal features:

- Event counting:
  The counting conditions and the output switching behavior can be selected.
- Frequency measurement:
  Time-driven or state-driven frequency measurements with gate times (time in which measurement is performed) from 10 ms to 10 s are possible.
- Time measurement:
  Relation conditions can be evaluated during time measurement. The result of the evaluation can be output via the process data or the digital output. This allows a controlled response when values exceed or fall below the limit values.
- Pulse generation:
  The pulse generator generates square-wave signals with frequencies of 1 kHz to 10 kHz in 500 Hz increments.
- The event counting and frequency measurement modes yield a 24-bit value, the time measurement a 16-bit measured value.
- A combination of source and gate signal can be selected as counter signal.
- During operation, a start or end value can be changed without the counter having to be stopped.
- An RC filter can be connected to source and gate. This allows the use of mechanical switches.
- It is not necessary to send a counter start command to start the counting process. Counting starts immediately after the command for selecting the operating mode is transmitted.
- The counter terminal uses process data operation.

Fields of application

Event counting

Event counting is used for counting goods.

Event counting example

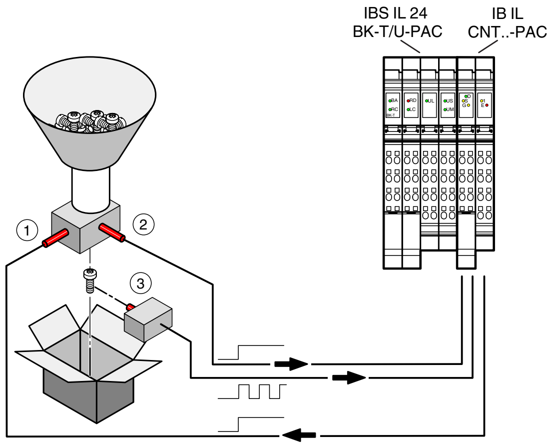

Figure 1-2 Example system for counting goods

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 Figure 1-2, sets consisting of, for example, 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.

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

Pulse generator

The pulse generator can be used to produce and output pulse trains with different frequencies.

1.2 Diagnostics and status indicators

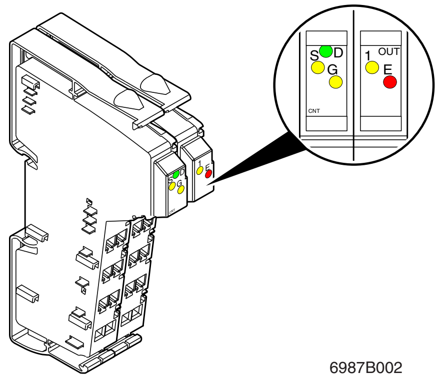

Figure 1-3 Diagnostics and status indicators

Diagnostics and status indicators

The following states can be read from the counter terminal:

Table 1-1 Diagnostics and status indicators

Des.	Color	Meaning
D	Green LED	Diagnostics
	ON:	Local bus active
	Flashing:	
	0.5 Hz (slow)	Communications power present, local bus not active
	2 Hz (medium)	Communications power present, local bus active, I/O error present
	4 Hz (fast)	Communications power present, terminal before the flashing terminal has failed, terminal behind the flashing terminal is not part of the configuration frame
	OFF:	Communications power not present, local bus not active
E	Red LED	Sensor supply short-circuit
	ON:	Connector 1 short-circuited between terminals 1.2 and 1.3 or between terminals 2.2 and 2.3
	OFF:	No error
S	Yellow LED	Counter input status (source)
	ON:	Input set
	OFF:	Input not set
G	Yellow LED	Control input status (gate)
	ON:	Input set
	OFF:	Input not set
1	Yellow LED	Output status
	ON:	Output set
	OFF:	Output not set

1.3 Terminal point assignment

A shielded cable is required for connecting sensors to the 5 V counter input and the 5 V control input. In this case, the shield connector should be used.

If no shielded cables are used, two IB IL SCN-8 standard connectors can be employed.

If the supplied connectors are replaced with other ones, connector marking will differ depending on the connectors used.

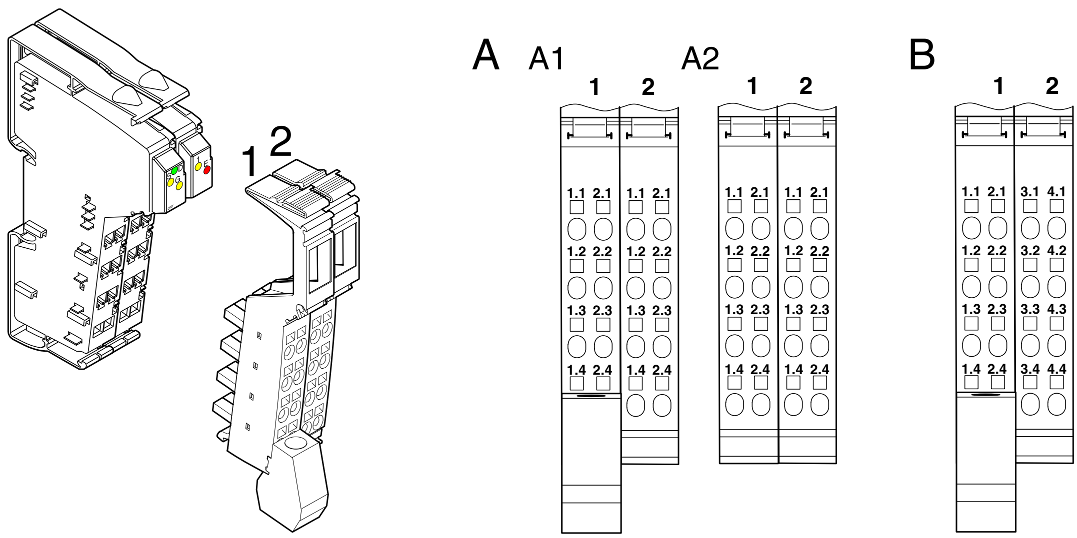

Figure 1-4 Terminal point numbering:
Separately numbered connectors (**A**) and consecutively numbered connectors (**B**)

A Separately numbered connectors (each connector from 1.1 to 2.4)

A1
- Using the IB IL CNT-PAC and IB IL CNT-XC-PAC with the connectors provided
- Using the IB IL AO/CNT-PLSET connector set

A2
- Using the IB IL SCN 8 connectors (standard connectors)

B Consecutively numbered connectors (from 1.1 to 4.4)
- Using the IB IL CNT-PAC/CN

Table 1-2 Terminal point assignment

Connector	Terminal point A	Terminal point B	Signal	Assignment
1	1.1	1.1	S+	24 V counter input (source)
	2.1	2.1	G+	Control input 24 V (gate)
	1.2	1.2	U_{INI}	+24 V sensor voltage
	2.2	2.2	U_{INI}	+24 V sensor voltage
	1.3	1.3	S-	Reference ground for the counter input (source) and the segment voltage
	2.3	2.3	G-	Reference ground for the control input (gate) and the sensor voltage
	1.4	1.4	Shield	Shield connection (high resistance and capacitive to FE)
	2.4	2.4	Shield	Shield connection (high resistance and capacitive to FE)
2	1.1	3.1	S+*	5 V counter input (source)
	2.1	4.1	G+*	Control input 5 V (gate)
	1.2	3.2	OUT	Output The terminal points are jumpered internally.
	2.2	4.2		
	1.3	3.3	GND	Reference ground for the output The terminal points are jumpered internally.
	2.3	4.3		
	1.4	3.4	FE	Functional earth ground (directly to FE)
	2.4	4.4	FE	Functional earth ground (directly to FE)

Use only one counter input (S+ or S+*) and one control input (G+ or G+*) on the terminal.

The short-circuit-protected sensor voltage U_{INI} is generated from the segment voltage U_S. The main voltage U_M is not used at the counter terminal points.

2 Connecting cables

> Please refer to the IL SYS INST UM E user manual for information on how to set up an Inline station and to mount and remove terminals.

2.1 Power supply

The terminal is supplied with power via the potential routers. No additional supply voltage connections are required.

2.2 Connecting sensors and actuators

The sensors and the actuator are connected to the terminals using connectors. The terminal is supplied with a shield connector and a standard connector.

The shield connector must be employed if sensors for 5 V signals are used. If such signals are not used, the cables do not need to be shielded and two standard connectors may also be used.

Connect shielded and unshielded cables as described in the IL SYS INST UM E user manual.

2.2.1 Connection technology for sensors and actuators

24 V sensors

The 24 V sensors can be connected using the following methods:
- 2-wire technology (signal and 24 V)
- 3-wire technology (signal, 24 V and GND)

5 V sensors

The 5 V sensors can be connected using the following method:
- 2-wire technology (signal, GND) with shield and external 5 V supply

Actuator

The actuator can be connected using 2-wire technology (signal and GND).

2.2.2 Connecting a 24 V sensor

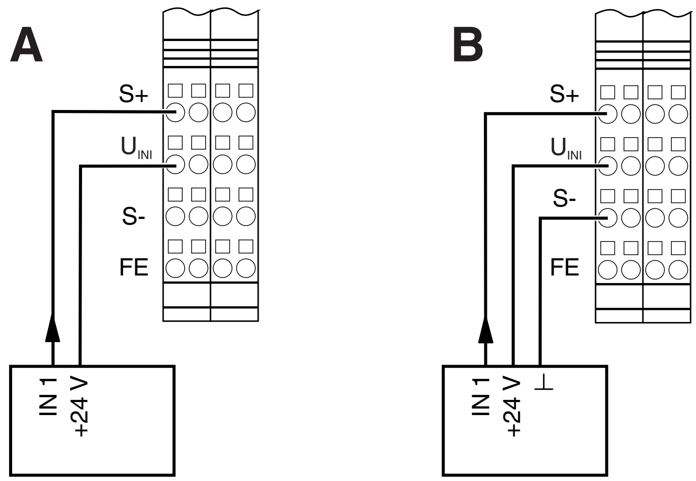

Figure 2-1 Connecting a 24 V sensor (example: counter input)

Signal	Terminal point	Meaning
S+	1/1.1	24 V counter input (source)
U_{INI}	1/1.2	+24 V sensor voltage
S-	1/1.3	Reference ground for the counter input and the segment voltage
FE	1/1.4	Functional earth ground

2-wire technology

Detail A shows the connection of a 2-wire sensor to the 24 V counter input. The sensor signal is routed to the S+ terminal point. The sensor is supplied by the voltage U_S.

3-wire technology

Detail B shows the connection of a 3-wire sensor to the 24 V counter input. The sensor signal is routed to the S+ terminal point. The sensor is supplied with power via terminal points U_{INI} and S-.

A 24 V sensor is connected to the control input in exactly the same way as to the counter input. Please ensure counter terminal assignment as described in "Terminal point assignment" on page 11.

2.2.3 Connecting a 5 V sensor

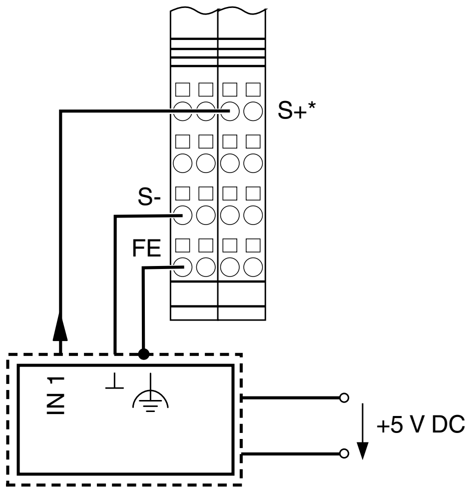

Figure 2-2 Connecting a 5 V sensor

Signal	Terminal point	Meaning
S+*	2/1.1	5 V counter input (source)
S-	1/1.3	Reference ground for the counter input and the segment voltage
FE	1/1.4	Functional earth ground

Figure 2-2 shows the connection of a 2-wire sensor to the 5 V counter input. The sensor signal is routed to the S+* terminal point. The S- terminal point forms the reference ground. The sensor is grounded via the FE terminal point of the shield connector. The 5 V supply for the sensor must be made available externally.

A 5 V sensor is connected to the control input in exactly the same way as to the counter input. Please ensure counter terminal assignment as described in “Terminal point assignment” on page 11.

2.2.4 Connecting an actuator

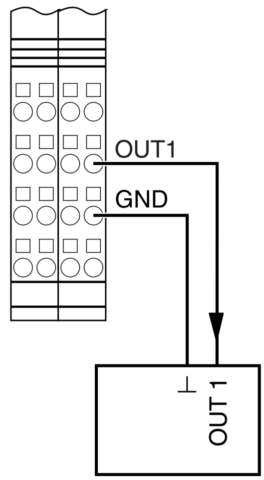

Figure 2-3 Connecting an actuator

Signal	Terminal point	Meaning
OUT 1	2/2.2	Output
GND	2/2.3	Reference ground for the output

Figure 2-3 shows the connection of an actuator. The actuator is supplied by output OUT1. The load is switched directly via the output.

NOTE: Shutdown when overloaded

The maximum current carrying capacity of 500 mA for the output must not be exceeded. Failure to comply with this limitation will cause the output to switch off in the event of overload.

2.3 Connecting shielded cables using the shield connector

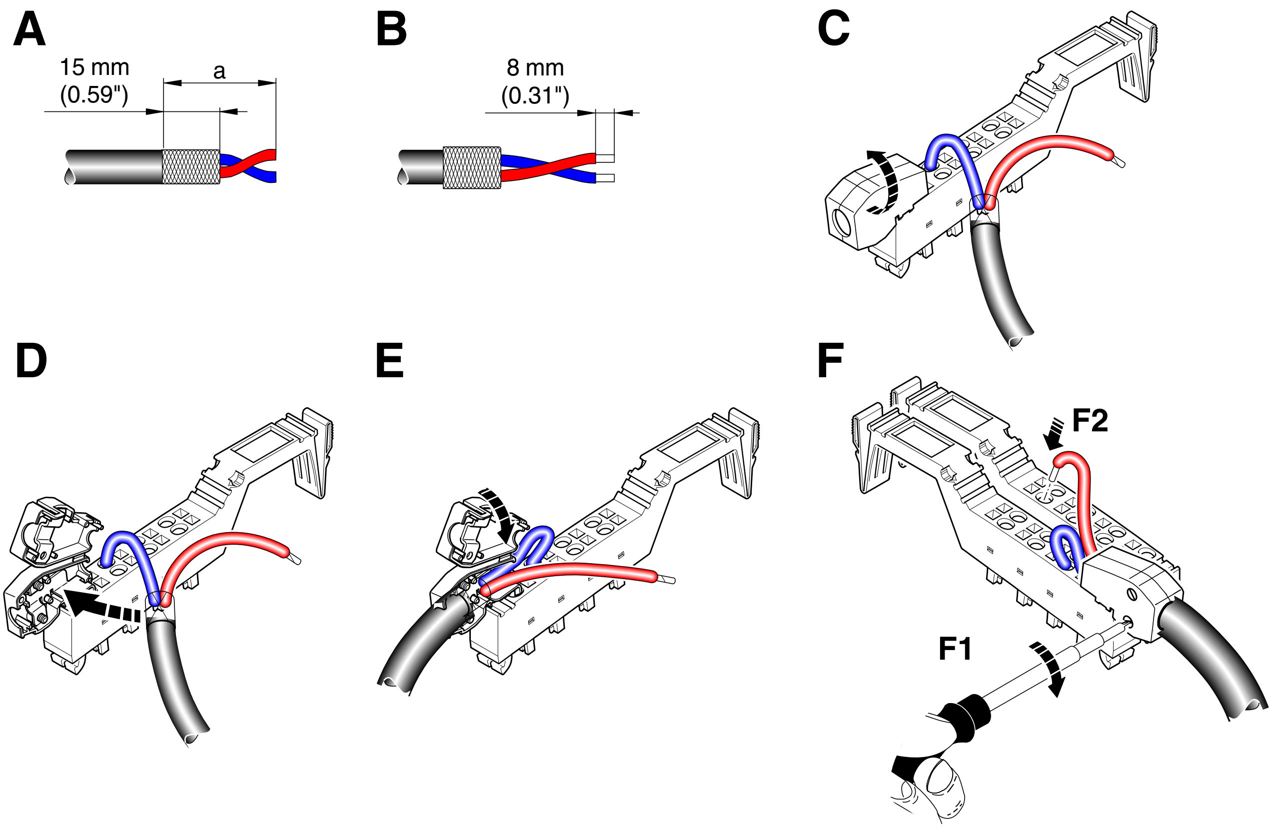

Figure 2-4 Connecting the shield to the shield connector

Only the sensors to the 5 V counter input and the 5 V control input have to be connected via shielded cables. Connection to the 5 V counter input will now be explained. Using the connector pin assignment in Section “Terminal point assignment” on page 11, this input must be wired as follows:

5 V counter input	Connector 2	Terminal point 1.1
GND counter input	Connector 1	Terminal point 1.3
Shield	Connector 1	Shield connection

Connection should be carried out as described in the IL SYS INST UM E user manual. Please note that the cable must be wired on connector 1 and 2. Select a length (a) that also enables proper connection of the cable to connector 2.

3 Process data mode

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

3.1 Process data channel assignment

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

ACHTUNG: Misinterpretation of values when the data consistency is violated

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

See also Section “Tips for working with the counter terminal” on page 55.

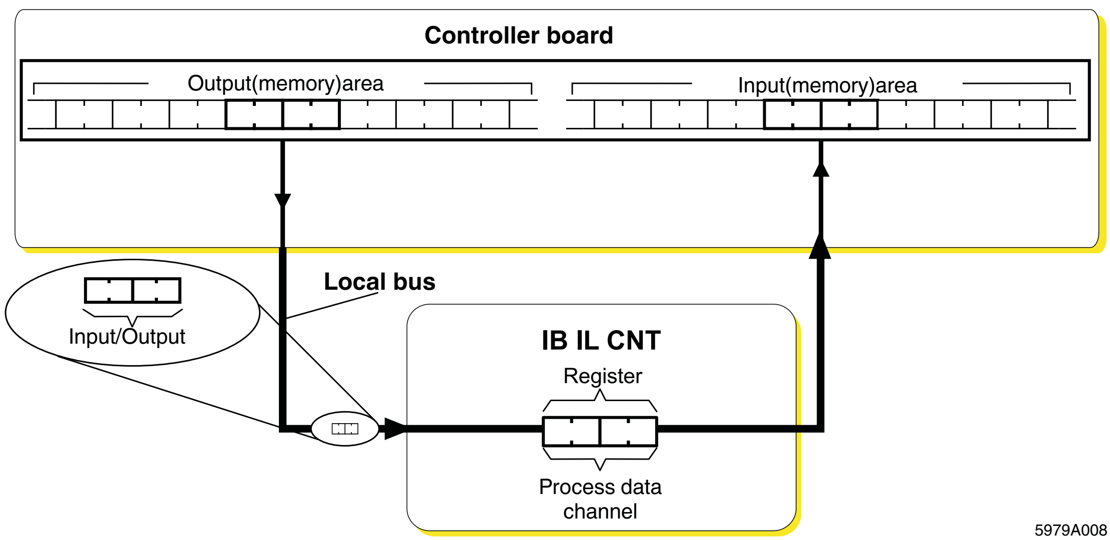

Figure 3-1 Process image in the I/O (memory) area of the controller board

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

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

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 via various commands transmitted through the two output words.

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

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

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

Valid command codes are listed in Section 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 if:

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

Word 0															
MSB															LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Commando code mirroring Bit 15 = Error bit						Parameter mirroring									

Word 1															
MSB															LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Parameter mirroring															

Read counter

After the *Read Counter* command has been sent, the command code (00000_{bin}) is mirrored in bits 15 through 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 specified range, see Section “Relation condition” on page 31).

Bits 7 through 0 of input word 0 and input word 1 contain the results of the counting performed.

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

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

Word 0															
MSB															LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	Gate	OUT	Result (Counter status)							

Word 1															
MSB															LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Result (Counter status)															

4 Commands for working with the counter terminal

Various types of commands are available for working with the counter terminal:
- Commands for setting the operating modes
- Commands for controlling the 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 mode.

Table 4-1 Commands for working with the counter terminal

Bits 15 through 10 (bin)	Command	Page
0000 00	Read Counter	page 42
0001 00	Frequency Measurement Mode	page 24
0001 01	Event Counting Mode	page 28
0001 10	Time Measurement Mode	page 30
0001 11	Pulse Generator Mode	page 34
0010 00	Control Counter: Stop Counter	page 41
0010 01	Control Counter: Start Counter	page 41
0010 10	Control Counter: Set Counter to Default	page 42
0011 00	System Settings, e. g., input filter, logic operations	page 35
0011 11	Read Firmware Version	page 39
0100 00	Preset Initial Value (24 bits, maximum)	page 40
0101 00	Preset Final Value (24 bits, maximum)	page 40
Other	Reserved	

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 no system settings are required, 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 controlled directly through the terminal according to relation conditions, without any need to access the input data.

4.2 Frequency Measurement Mode command

The Frequency Measurement Mode command comprises 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**	**Parameters**									

The second output word is not used.

Frequency measurement starts immediately after the command is sent.

Table 4-2 Parameters for frequency measurement

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

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

Table 4-3 Examples of factor, resolution and gate time

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

The factor range of 1 through 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 is 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.

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

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

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 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 in 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., $13FC_{hex}$ HIGH), 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.

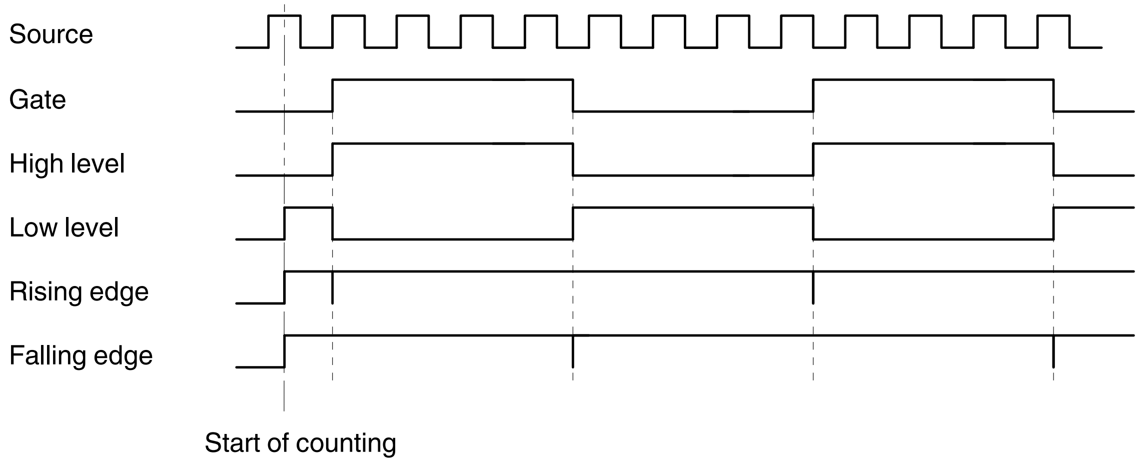

Figure 4-1 Counting phase depending on gate state

In Figure 4-1 the "source" 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. Whether counting actually takes place depends on the parameter selected and the gate signal.

4.3 Event Counting Mode command

The Event Counting Mode command comprises 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**	**F**	**Gate**			**R**	**Output**		

The second output word is not used.

Set the unused bits 9 and 8 to 0.

Please note the default 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.

F: Counting repeat

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

Table 4-5 Parameter F: Counting repeat

Bit 7	Meaning
0	Single count
1	Repeated count

Gate

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

Table 4-6 Gate parameter

Bits 6 / 5 / 4		Meaning
Bin	Dec	
0 0 0	0	Does not serve any 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 by a rising edge

When using the gate signal please 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.

R: 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 $FFFFFF_{hex}$.

Table 4-7 Parameter R: Counting direction

Bit 3	Meaning
0	Down
1	Up

Output

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

Table 4-8 Output parameter

Bits 2 / 1 / 0		Designation	Meaning	Initial setting of output
Bin	Dec			
0 0 0	0	Does not serve any 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	–

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

If you have selected the repeated count (F = 1), you should select one of the output parameters 1_{dec} to 4_{dec}. Only these parameters indicate the end of counting with a status change or a pulse.

4.4 Time Measurement Mode command

The Time Measurement Mode command comprises 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 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 of the LSB.

Table 4-9 Resolution parameter

Bit 7 / 6	Meaning	Maximum time	Timeout after
0 0	2 µs	131 ms (until FW 1.03) 126 ms (FW 1.06 or later)	150 ms (until FW 1.03) 128 ms (FW 1.06 or later)
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	–	–

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, this value corresponds to the 50 ms.

Out: output

Table 4-10 Out parameter: Output

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

Type: Measurement type

Table 4-11 Type parameter: Measurement type

Bit 4	Meaning
0	Measurement of period (a in Figure 4-2)
1	Measurement of pulse length (b in Figure 4-2)

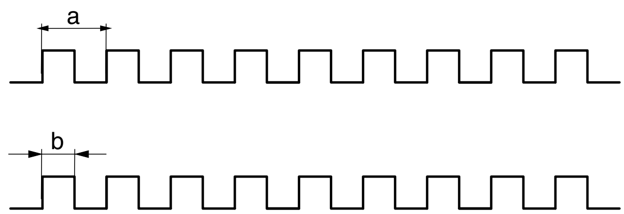

Figure 4-2 Period and pulse length

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 through the output or bit 8 (Out). Only 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" is shown in bit 8 of input word 0 for the set output shown.

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**, as bit 8 is set to "1"(OUT[0] = 0100_{hex}) in output word 0, until bit 8 in input word 0 changes to "0".

Table 4-12 Relation conditions parameter

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

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 Figure 4-3 the relation conditions are shown graphically.

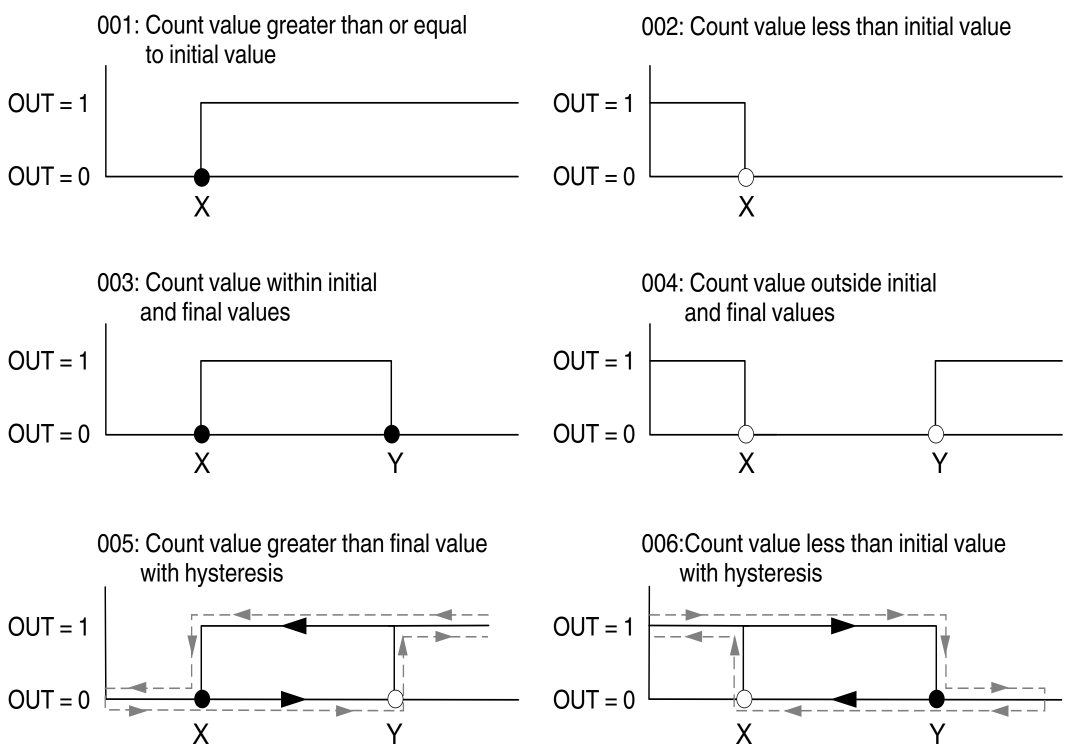

Figure 4-3 Relation conditions

Key:

X	Initial value	●	Limit value included
Y	Final value	○	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 mode

The pulse generator can produce frequencies from 1 kHz through 10 kHz in 500 Hz increments. This operating mode necessitates a certain setting for the input circuit, which is made automatically (see Section “System Settings command” on page 35).

The pulse generator command comprises 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)

Table 4-13 Factor, frequency setpoint, actual frequency and error

Factor dec/hex	$F_{setp.}$ in Hz	$F_{act.}$ 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	$F_{setp.}$ in Hz	$F_{act.}$ 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

4.6 System Settings command

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

It comprises 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**		**Logic operation on source-gate**				**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 mode. Not all parameters can be defined in every mode.

Table 4-14 Use of the *System Settings* command parameters in the individual modes

Parameters	Mode(s) in which it may be used
Input configuration IC	
– No input configuration (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
– Logic source-gate operation (IC parameter = 11_{bin})	Frequency measurement, event counting, time measurement
Logic operation on source-gate	Frequency measurement, event counting, time measurement
Bus reset behavior	All
Pulse length	Event counting

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

IC: Input configuration

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

If pulse generator 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.

Table 4-15 Input configuration parameter

Bits 9 and 8 bin	Output word hex	Function
0 0	300x	Source and gate direct, 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 Table 4-16 through Table 4-18.

> If mechanical switches (e.g., relays) are being used, source and gate filters should be switched on to eliminate or minimize the effects of the contacts bouncing. In the case of solid-state switches or light barriers these filters must be switched off.
> If different types of switches (mechanical and electronic) are used at the source and gate inputs, the effects of a configuration with and without filters must be checked beforehand.

> Please note that the counter terminal always accepts the latest input configuration. 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 frequency measurement, event counting and time measurement modes.

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. It is designated 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 Table 4-16), and also any other possible function (see Table 4-18).

Table 4-16 The most common logic functions provided by the source-gate operations

Bits 7 through 4 bin	Output 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

Table 4-17 Source' depending on the inputs and the source-gate operation (most common logic functions)

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

Table 4-18 Source' depending on the inputs and the source-gate operation (other 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

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, the possible combinations of states for source' are given 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 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 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.

Table 4-19 Bus reset behavior parameters

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

Pulse length

The pulse length parameter can be used to change the length of a pulse of the digital output in the event counting 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 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 mode must be resent.

Table 4-20 Pulse length parameter

Bits 2/1/0	Length of pulse	Bits 2/1/0	Length of pulse
0 0 0	10 ms	1 0 0	300 ms
0 0 1	50 ms	1 0 1	400 ms
0 1 0	100 ms	1 1 0	500 ms
0 1 1	200 ms	1 1 1	1000 ms

4.7 Read Firmware Version command

This command can be used to read the firmware version of the counter terminal. This command 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** 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 in this format.

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

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

ACHTUNG: Misinterpretation of values

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

See Section “Tips for working with the counter terminal” on page 55.

Default 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															

Default 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 entering initial and final values for time measurement, please note any resolution set (see, for example, “Resolution” on page 30). A set resolution per LSB also applies to the initial and final values.

If, for example, a resolution of 2 ms 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, 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** mode.

The counter starts counting immediately the 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 re-started 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 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 a mode command is sent.

If the counter terminal is to be set to a defined initial state, the *Set Counter to Default* (2800_{hex}) command 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 IB IL CNT terminal is being tested to try out various operating modes, it is advisable to send the command 2800_{hex} before parameterizing a new 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 the 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 gate input (gate)
O	During time measurement: Status of the output or result of the evaluation of the relation condition without using the output

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 mode. In all other 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 mode is being used, please see Section “Time Measurement Mode command” on page 30 for additional information about this bit.

Bits 15 to 10

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

Bits 7 to 0

Bits 7 through 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

Table 4-21 Limit values and limitations

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 (until FW 1.03) 250 µs ≤ t ≤ 126 ms (FW 1.06 or later)
	Resolution 2 µs, with relation condition	1 µs ≤ t ≤ 131 ms (until FW 1.03) 1 ms ≤ t ≤ 126 ms (FW 1.06 or later)
	Resolution 2 ms	2 ms ≤ t ≤ 131 s
	Resolution 10 ms	10 ms ≤ t ≤ 655 s
Pulse generator		1 kHz ≤ f ≤ 10 kHz

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 designed primarily for the use of electronic switching elements, i.e., solid-state 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 show that the bouncing of mechanical contacts can present problems even with this filter.

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 separate sections.

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" is not related to the parameter "X" to be entered.

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

Frequency measurement mode

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 mode

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**	**F**	**Gate**			**R**	**Output**		
1				**4**				**X**				**X**			

F Counting repeat

R Counting direction

Time measurement mode

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 mode

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**		**Logic operation on source-gate**				**Reset**	**Pulse length**		
3				**0 (X)**				**X**				**X**			

IC Input configuration

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**			

Default 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**			

Default 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**			

5 Examples and tips

Always follow the notes on data consistency on page 55 when programming.

5.1 Example of event counting

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

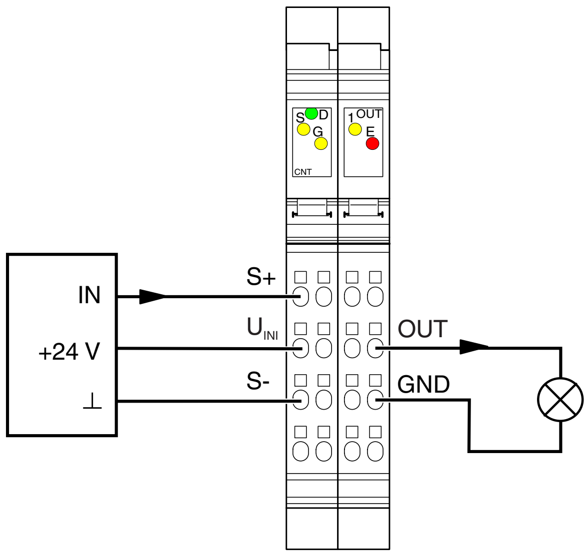

Figure 5-1 Example of wiring for event counting

An optical data link, for example, is 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	Does not serve any 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}

Table 5-1 Example of event counting

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 55.			
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 55.			
Operating mode event counting, 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$_{hex}$ and 132$_{hex}$, the count value only occupies the second input word (IN[1]). If the input word 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]).			

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.

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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]			

5.2 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 hysteresis range is to be 40 ms through 80 ms.

Wiring

The wiring is as shown in Figure 5-1 on page 47.

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!)	$40_{dec} = 28_{hex}$

Table 5-2 Programming the example of time measurement with relation condition

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]			

Table 5-2 Programming the example of time measurement with relation condition [...]

Action	OUT[0] hex	OUT[1] hex	OUT[0] bin	OUT[1] bin
Time measurement 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			

Explanation of output pulse diagram

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

The pulse length starts at 0 ms and is slowly increased (segment A in Figure 5-2). 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".

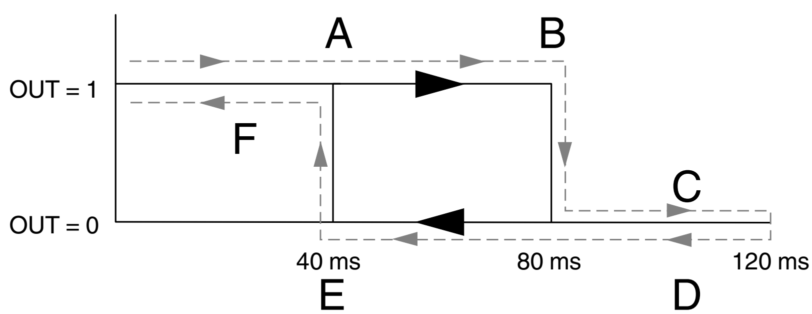

Figure 5-2 Example of a hysteresis

5.3 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" simultaneously. If a limit value is exceeded, it will be detected by the bus.

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

Wiring

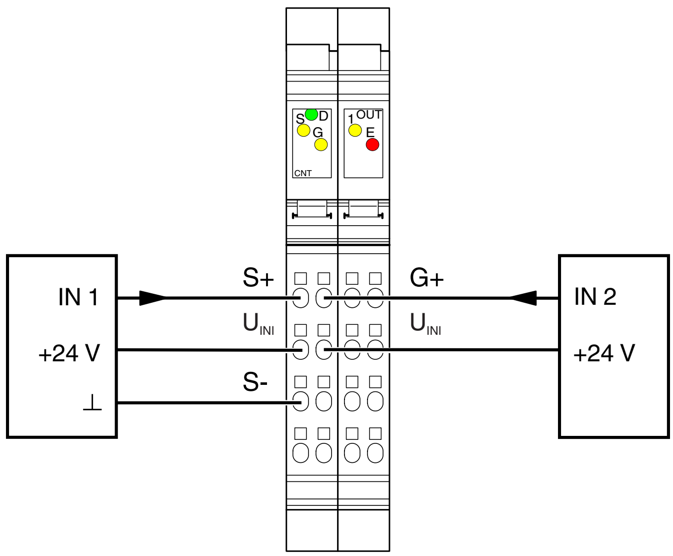

Figure 5-3 Example of wiring for time measurement with source and gate

An light barrier, for example, 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 activated. 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 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").

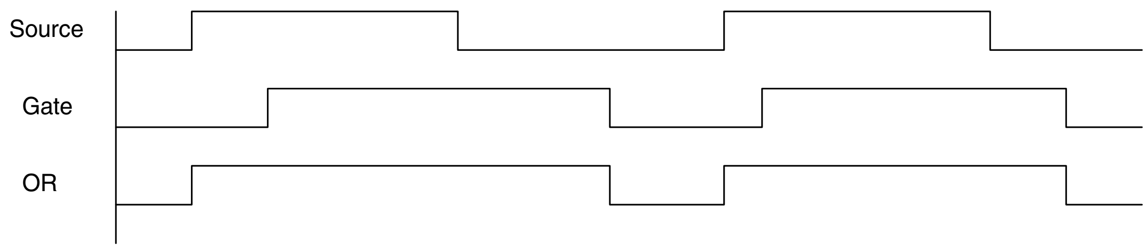

Figure 5-4 Logical ORing of source and gate

Input configu-ration	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		Logic operation on source-gate				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 2 words. If this is not possible in the application, word 1 and then word 0 must be transmitted (see page 55).

Selecting the operating mode

The command for selecting the time measurement 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

Table 5-3 Example of time measurement using system control

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, logic operation on source-gate 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 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			

5.4 Tips for working with the counter terminal

Sequence of the Inline terminals

For the order of the terminals in an Inline station, please refer to the information given in the IL SYS INST UM E user manual.

Ensure data consistency

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 required default value together with the command. This can be checked from the input words. Input word 1 (IN[0]) must contain the command code, input word 2 (IN[1]) the **required** default value.

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

If this is the case send output word 1 first with the default 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 **required** preset. Bit 15 of input word IN[0] must no longer indicate an error now. This shows that the terminal counter has adopted the value required.

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 has to have been transmitted.

If it has become evident that data consistency is no longer ensured, e.g., during transmission of the initial value, the command sequence may appear as shown in Table 5-4.

Table 5-4 Example of presetting an initial value

Action	OUT[0] hex	OUT[1] hex	OUT[0] bin	OUT[1] bin
The initial value has been entered. It is not possible to be sure whether data consistency is ensured.				
Preset Initial Value	4000	1111	**0100 00**00 0000 0000	0001 0001 0001 0001
Wait for acknowledgment	IN[0] = OUT[0]; **IN[1] not equal to OUT[1], e.g. 9999**$_{hex}$			
This acknowledgment shows that data consistency is not ensured. The initial value must be retransmitted taking account of data consistency.				
Step 1: Transmit OUT[1]				
Enter Initial Value	**0000**	1111	**0000 00**00 0000 0000	0001 0001 0001 0001
	OUT[0] may be equal any value other than 4000_{hex}.			
	It is not necessary to wait for the 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.			
	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.			
Step 2: Transmit OUT[0]				
Re-enter Initial Value	4000	1111	**0100 00**00 0000 0000	0001 0001 0001 0001
Wait for acknowledgment	IN[0] = OUT[0]; IN[1] = OUT[1]			
	Check whether the input value corresponds to the value required.			

5.5 Function blocks on the Internet

Function blocks for working with the counter terminal are available on the Internet at phoenixcontact.net/products.

Documentation for working with the function blocks is also available on the Internet.

There are function blocks for various controller boards.

The blocks can be adapted to individual applications for parameterizing the counter terminal.

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B Revision history of technical modifications

Revision	Date	Validity	Modification	
A	09/1999	Until HW 01	First publication	
B	10/2001	HW 02 or later	Modification of the internal wiring	
			Page 1-9	The short-circuit-protected sensor voltage U_{INI} is generated from the **main voltage U_M**. The main voltage U_M is **not directly used** at the counter terminal points. Changed to: The short-circuit-protected sensor voltage U_{INI} is generated from the **segment voltage U_S**. The main voltage U_M **is not used** at the counter terminal points.
			Page 1-10	Basic circuit diagram modified
			Page 1-10	U_{INI}: +24 V sensor voltage, generated from the **main voltage** Changed to: U_{INI}: +24 V sensor supply, generated from the **segment voltage**
			Page 6-92	Deleted: A connection is established to the main circuit U_{Mi}
			Page 6-92	Nominal current consumption at U_S **500 mA**, maximum Changed to: Nominal current consumption at U_S **1 A**, maximum
			Page 6-92	Deleted: Nominal current consumption at U_M 500 mA, maximum
			Page 6-97	Short-circuit protection for the sensor supply voltage (**main circuit**) Changed to: Short-circuit protection for the sensor supply voltage (**segment circuit**)
			Page 6-100	Ordering data for accessories and documentation modified

<table>
<tr><th>Revision</th><th>Date</th><th>Validity</th><th colspan="2">Modification</th></tr>
<tr><td rowspan="6">02</td><td rowspan="6">03/2008</td><td rowspan="6">FW 1.06 or later</td><td colspan="2">User manual extended for all counter terminal variants
Firmware modifications led to modified time response for a time measurement with a resolution of 2 µs</td></tr>
<tr><td>Global</td><td>– Adaptation of the description of all counter variants
– Adaptation of the description on the use of the terminal in various bus systems</td></tr>
<tr><td>Page 1-9</td><td>Added: If you have selected the repeated count (F = 1), you should select one of the output parameters 1_{dec} to 4_{dec}. Only these parameters indicate the end of counting with a status change or a pulse.</td></tr>
<tr><td>Page 4-8</td><td>Table 4-9 Table completed with data for firmware 1.06 or later</td></tr>
<tr><td>Page 4-22</td><td>Table 4-21 Operating range completed with data for firmware 1.06 or later</td></tr>
<tr><td>Section 6</td><td>Technical data revised
– Ambient conditions
– Data for 2 Mbps added
– Values for FW 1.06 or later added (under “Limit values and limitations on the operating modes”)</td></tr>
<tr><td></td><td></td><td></td><td>Page 5-12</td><td>Sequence of the Inline terminals: text replaced with reference to IL SYS INST UM E user manual.</td></tr>
<tr><td>03</td><td>07/2014</td><td></td><td colspan="2">IB IL CNT-XC-PAC terminal added, terminals deleted that are no longer available
Contents deleted that are available in the IL SYS INST UM E user manual or the data sheet for the terminals (except for diagnostics and status indicators and terminal point assignment).</td></tr>
</table>

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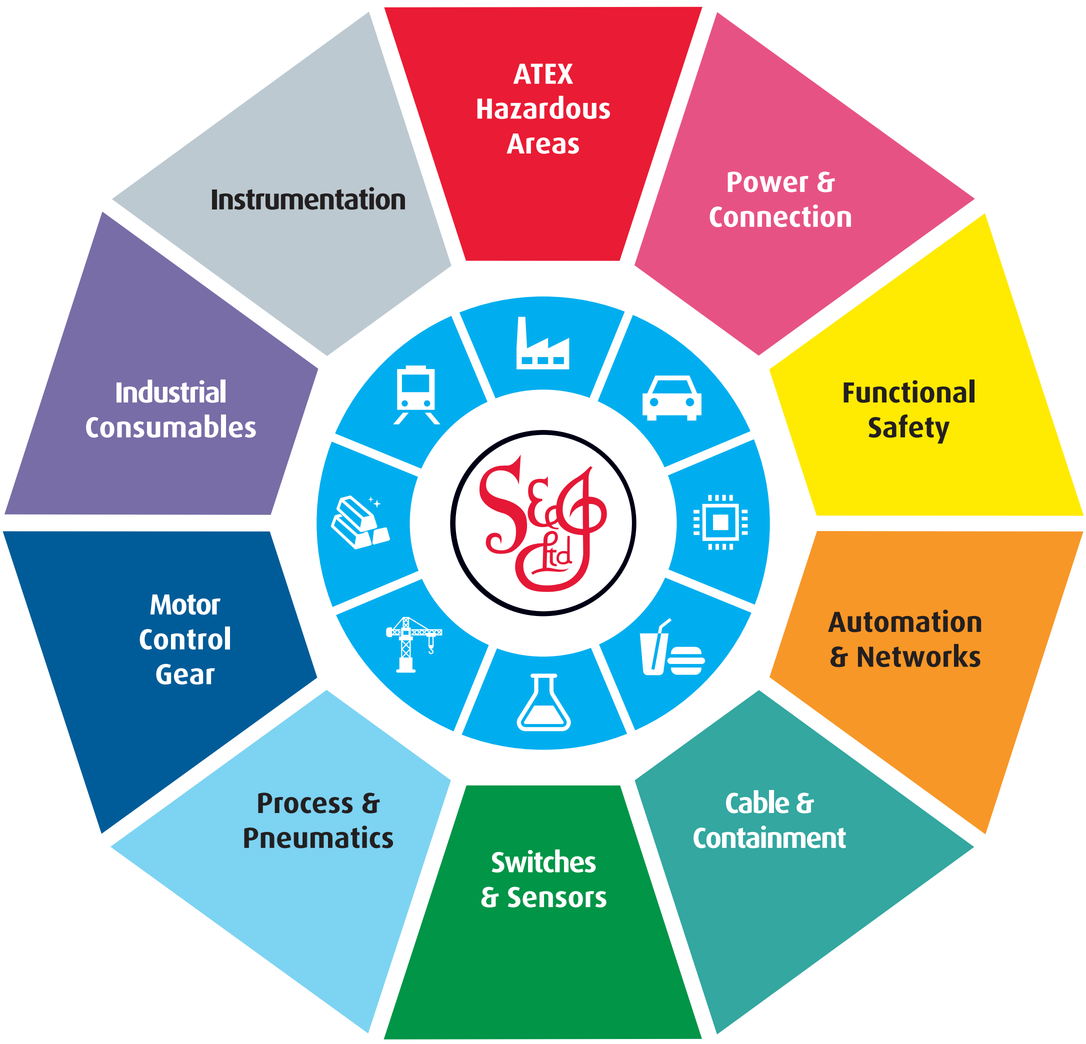

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