SIEMENS

SIMATIC

S7-400
Counter module FM 450-1

Equipment Manual

Preface

Product Overview 1

This is how the FM 450-1 counts 2

Installation and Removal 3

Wiring 4

Parameter assignment 5

Program 6

Commissioning 7

Modes, settings, parameters and commands 8

Encoder signals and their evaluation 9

Assignment of the DB 10

Errors and diagnostics 11

Technical Data 12

Spare parts 13

References 14

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Preface

Purpose of this manual

This manual describes all steps required to use the FM 450-1 function module efficiently. It supports you in installing and commissioning the module. The procedures for installing and removing, wiring, assigning parameters, and programming are explained.

This manual is intended for the programmers of STEP 7 programs and for those responsible for configuring, commissioning, and servicing automation systems.

Basic knowledge required

This manual requires general knowledge of automation engineering.

You also require knowledge of the use of computers or PC-type equipment (such as programming devices) based on a Windows 95/98/2000 or NT operating system as well as STEP 7 programming skills.

Scope of this manual

The present manual contains the description of the FM 450-1 valid at the time the manual is published. We reserve the right to describe changes to the functions of the FM 450-1 in the form of product information.

Standards

The S7-400 automation system meets the requirements and criteria of IEC 61131-2.

Recycling and disposal

Owing to the fact that its equipment is low in contaminants, the FM 450-1 can be recycled. For environmentally compliant recycling and disposal of your discarded device, please contact a company certified for the disposal of electronic waste.

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- Your local partner for Automation and Drives.
- Information about on-site service, repairs, and spare parts. Much more can be found under "Services".

Table of contents

Preface **3**

1 Product Overview **9**

1.1 Chapter overview 9

1.2 Properties 9

1.3 Fields of applications of the FM 450-1 11

1.4 The FM 450-1 hardware 13

1.5 The FM 450-1 software 15

2 This is how the FM 450-1 counts **17**

2.1 Basics 17

2.2 Gate functions 19

3 Installation and Removal **21**

3.1 Chapter overview 21

3.2 Preparing for Mounting 21

3.3 Installing the FM 450-1 22

3.4 Removal of the FM 450-1 22

4 Wiring **25**

4.1 Chapter overview 25

4.2 Terminal assignment of the front connector 25

4.3 Wiring Front Connectors 31

4.4 Module status after power is switched on 34

5 Parameter assignment **37**

5.1 Chapter overview 37

5.2 Installing and calling parameter assignment screen forms 37

6 Program **39**

6.1 Chapter overview 39

6.2 The FC CNT_CTRL function 39

6.3 The FC DIAG_INF function 43

6.4 Example application 44

6.5 Technical specifications of the blocks 46

7 Commissioning **47**

7.1 Chapter overview 47

7.2 Working steps during mechanical installation 47
7.3 Working steps for parameter assignment 51
8 Modes, settings, parameters and commands 57
8.1 Chapter overview 57
8.2 Overview of modes, settings and commands 57
8.3 Basics on calling modes, settings and commands 59
8.4 Infinite counting 59
8.5 Single counting 61
8.6 Periodic counting 62
8.7 Count range 64
8.8 Setting: Behavior of the digital outputs 65
8.9 Setting: Pulse duration 67
8.10 Command: Open and close gate 68
8.11 Command: Set counter 71
8.12 Initiating a process interrupt 76
9 Encoder signals and their evaluation 79
9.1 Chapter overview 79
9.2 Encoders which can be connected 79
9.3 5-V differential signals 80
9.4 24-V signals 81
9.5 Signal evaluation 83
10 Assignment of the DB 87
10.1 Assignment of the DB 87
11 Errors and diagnostics 91
11.1 Chapter overview 91
11.2 Faults indicated via the diagnostics LEDs 91
11.3 Initiation of diagnostics interrupts 92
11.4 Data error 95
11.5 Operator error 96
12 Technical Data 99
12.1 General technical specifications 99
12.2 Technical Data 99
12.3 Standards and approvals 101
12.3.1 Currently valid markings and approvals 101
12.3.2 CE approval 102
12.3.3 CCC approval 103

12.3.4 UKCA approval 104
12.3.5 Explosion protection 104
12.3.6 cULus approval 105
12.3.7 cULus HAZ. LOC. approval 105
12.3.8 cFMus approval 105
12.3.9 Approval for Australia and New Zealand 106
12.3.10 Approval for the Korea and South Korea 106

13 Spare parts 107

14 References 109

Glossary 111

Index 115

Product Overview

1

1.1 Chapter overview

Section overview

This section provides you with an overview of the FM 450-1 function module.

- It informs you of what the FM 450-1 can do.
- Examples demonstrate some of the possible applications of the FM 450-1.
- You will learn how the FM 450-1 is integrated into the S7-400 automation system, and familiarize yourself with the vital components of FM 450-1.

1.2 Properties

Properties

The FM 450-1 is a fast counter module to be used in the S7-400 automation system. There are two counters on the module which can work in the following counting ranges as required:

- 0 to 4 294 967 295 (0 to 2^{32} - 1)
- - 2 147 483 648 to + 2 147 483 647 (-2^{31} to 2^{31} - 1).

The maximum input frequency of the counter signals is up to 500 kHz depending on the encoder signal.

The FM 450-1 can be used for the following counting tasks:

- Continuous counting
- Single counting
- Periodic counting

You can start and stop the count either via the user program (software gate) or via external signals (hardware gate).

Comparison values

You can store two comparison values per counter on the module; they are assigned to the two corresponding outputs on the module. If the counter status reaches one of the comparison values, then the output assigned to it can be set so that it triggers control operations directly in the process.

Load value

You can determine an initial value (load value) for each counter on the FM 450-1 The counter is set at the initial value if a software or hardware-related signal to the module comes up.

Hardware interrupts

When comparison values are reached, for overflow, underflow and/or for zero crossing of a counter, the FM 450-1 can trigger a Hardware interrupt.

Diagnostic interrupt

When the following events occur, the FM 450-1 can trigger a diagnostic interrupt:

- External auxiliary voltage faulty
- Encoder 5.2 VDC supply faulty
- Module not assigned parameters or errors in parameter assignment
- Watchdog timeout
- RAM defective
- Hardware interrupt lost
- Fault in signal A, B, or N of the 5 V encoder

Pulse duration

You can determine a pulse duration for the digital outputs of the FM 450-1. The pulse duration is used to specify how long the corresponding digital output is to be set. You can specify a value between 0 and 500 ms for the pulse duration. This value applies to both outputs. By prescribing a pulse duration you can adapt the FM 450-1 to existing actors.

Which signals can the FM 450-1 count?

The FM 450-1 can count signals that are generated by the following encoders:

- Incremental 5-V encoders
- Incremental 24-V encoders
- 24-V pulse encoders with direction level
- 24-V initiators without direction level
  e.g., light barrier or BERO

Input filter

For the purpose of suppressing interference, you can assign input filters (RC elements) with a uniform filter time for the 24 V inputs A*, B*, and N* and for the digital inputs. The following two input filters are available:

Table 1-1 Input filter

Characteristics	Input filter 1 (default)	Input filter 2
Typical input delay	1 µs	15 µs
Maximum count frequency	200 kHz	20 kHz
Minimum pulse width of the count signals	2.5 µs	25 µs

1.3 Fields of applications of the FM 450-1

You can use the FM 450-1 as follows:

The main field of application of the FM 450-1 is where it is necessary to count signals with high frequencies and fast reactions must be triggered when a prescribed counter reading is reached.

Examples are:

- Packaging plants,
- sorting plants,
- dosing plants

Example application for an FM450-1

Here a specific number of parts is to be filled into a box. An FM 450-1 counter assumes the job of counting the parts and controlling the two motors for transporting the parts and the box.

If the box is in the right position, belt A is stopped via the light barrier, the counting process is started and the motor for belt B switched on. If the programmed number of parts are in the box, the FM 450-1 stops the motor for belt B and switches on the motor for belt A so that the box can be transported away. The counting process can start again when the next box reaches the light barrier

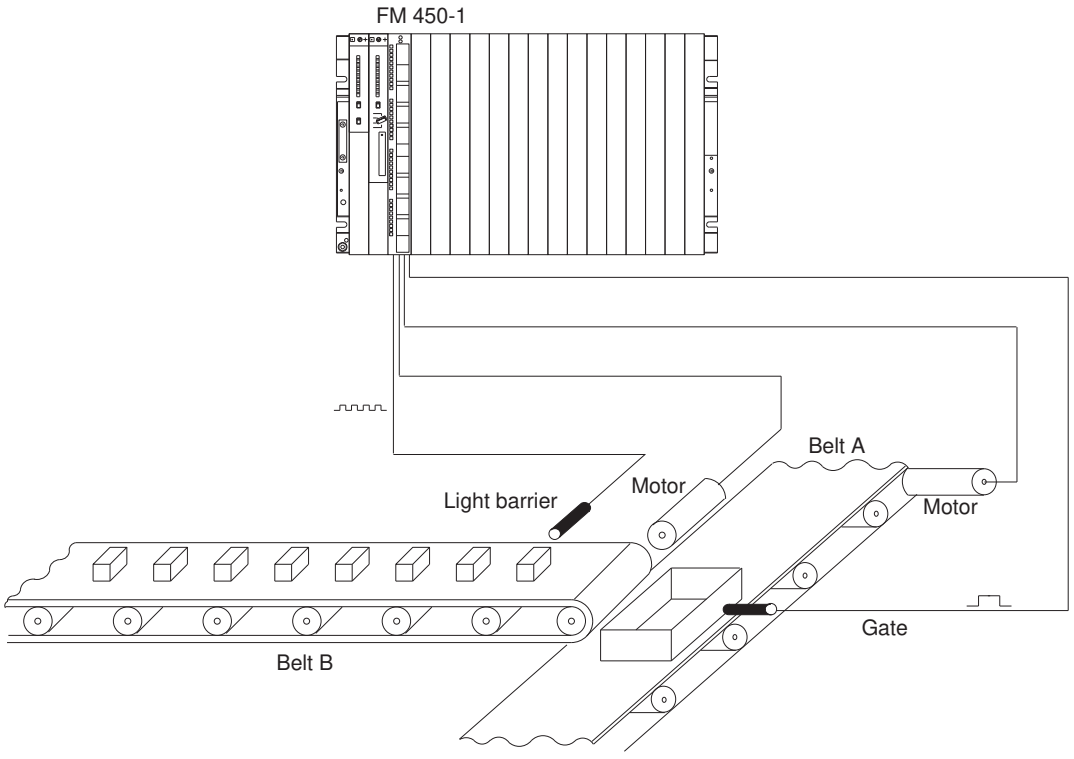


Figure 1-1 Example application for an FM450-400 in the S7-400

1.4 The FM 450-1 hardware

View of module

The illustration shows the FM 450-1 module with front connector plugged in.

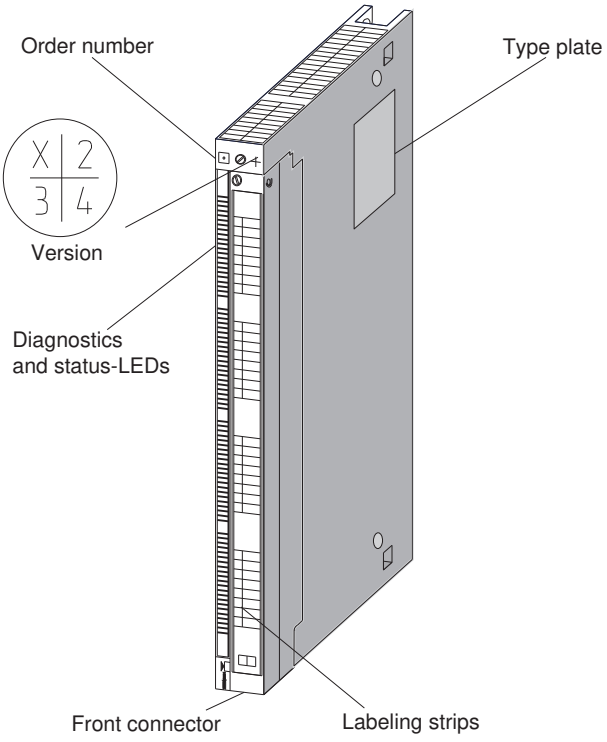


Figure 1-2 Illustration of the FM 450-1

Order number and version

The full order number of the FM 450-1 is shown on the rating plate.

The abbreviated order number and the version of the FM 450-1 are marked on the top end of the front of the module.

Diagnostic and status LEDs

The FM 450-1 has 16 LEDs. The LEDs are for diagnostic purposes and indicate the state of the FM 450-1 and its digital inputs and outputs. The following table lists labeling, color and function of the LED displays.

Table 1-2 Labeling, color and function of the LEDs

Labeling	Color	Function
INTF	Red	Internal error
EXTF	Red	External error

Labeling	Color	Function
CH1 CR CH2 CR	Green	Counter in operation; status of the lowest value bit of counter 1 (CH 1) or counter 2 (CH2)
CH1 DIR CH2 DIR	Green	Count direction; LED illuminated if counter 1 (CH1) or counter 2 (CH2) is counting backwards.
CH1 IN 0 CH2 IN 0	Green	Status of input 1I0 of counter 1 and/or 2I0 of counter 2
CH1 IN 1 CH2 IN 1	Green	Status of input 1I1 of counter 1 and/or 2I1 of counter 2
CH1 IN 2 CH2 IN 2	Green	Status of input 1I2 of counter 1 and/or 2I2 of counter 2
CH1 OUT 0 CH2 OUT 0	Green	Status of output 1Q0 of counter 1 and/or 2Q0 of counter 2
CH1 OUT 1 CH2 OUT 1	Green	Status of output 1Q1 of counter 1 and/or 2Q1 of counter 2

Front connectors

The front connector has the following terminals:

- 5-V or 24-V encoder signals for counters 1 and 2
- Encoder supply
- Digital input signals to start, stop and set counters 1 and 2
- Digital output signals Q0 and Q1 for counters 1 and 2
- Auxiliary voltage 1L+ to generate the encoder supply voltages
- Load voltage 2L+ to supply the digital outputs

The front connector can be ordered separately (see chapter "Spare parts (Page 107)").

Front connector coding

If you hook in the front connector, the front connector coding engages. Thereafter this front connector can only be attached to an FM 450-1 module.

Labeling strips

A plate block with four labeling strips is included with the module. These strips can be labeled individually with the corresponding signal names.

1.5 The FM 450-1 software

Software packages of the FM 450-1

You will require the software package on the supplied CD to integrate the FM 450-1 into the S7-400. It includes:

- Parameterization software with parameterization interfaces
- Software for the CPU (blocks)
- Documentation

parameter assignment screen forms

The FM 450-1 is adapted to the respective task via parameters. These parameters are stored in an SDB and transferred to the module by the CPU.

The parameters can be determined via the parameter assignment screen forms. These parameter assignment screen forms are installed on your programming device and opened in STEP 7.

Software for the S7-400-CPU

The software for the CPU consists of the FC CNT_CTRL function, which is invoked in the CPU user program. This FC enables communication between the CPU and the FM 450-1. In addition, there is also the FC DIAG_INF for the FM 450-1 with which you can transmit diagnostic data into the DB of FC CNT_CTRL.

This figure shows an S7-400 layout with an FM 450-1 and several signal modules.

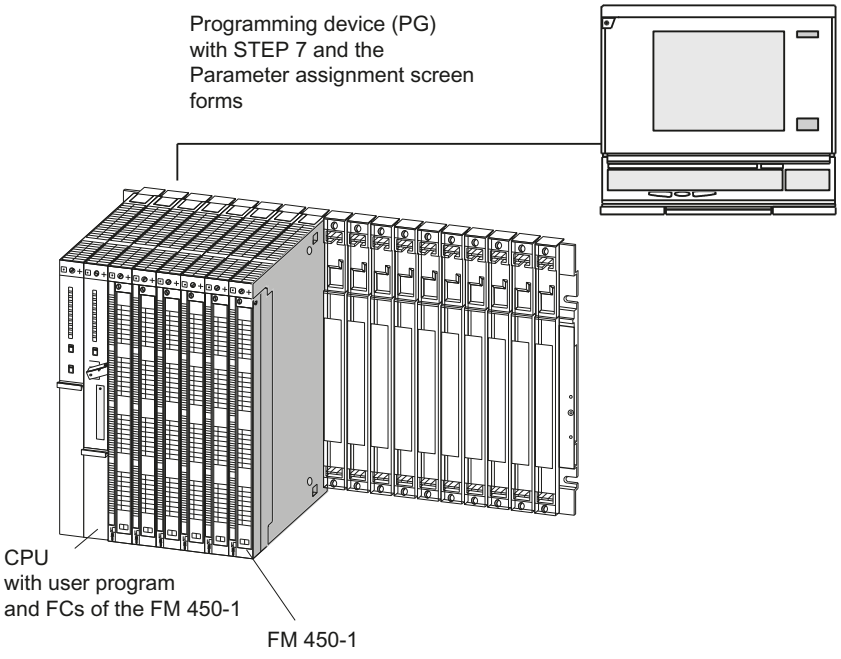


Figure 1-3 Layout of a SIMATIC S7-400 with an FM 450-1

This is how the FM 450-1 counts

2

2.1 Basics

What is counting?

Counting refers to the recording and totaling of events. In the case of the FM 450-1 function module encoder signals are captured and evaluated accordingly.

Count range, count limits

The FM 450-1 can count both forwards and backwards. When you select the count range, you determine the limits between which the FM 450-1 can count.

Count range	Low count limit	High count limit
Count range 1: 0 to +32 bit	0	+4 294 967 295
Count range 2: -31 to +31 bit	-2 147 483 648	+2 147 483 647

Load value

You can lay down an initial value for each of the two FM 450-1 counters from which the counting is to begin. This initial value is the load value. You can specify any value within the count limits for the load value.

Comparison values

You can use two digital outputs on the module for each counter in order to trigger reactions in a process at a certain counter reading, independently of the CPU. You store two comparison values for each counter on the FM 450-1. If the counter reading reaches one of the two comparison values, the digital output assigned belonging to the comparison value is set and/or a Hardware interrupt is generated.

Operating modes

You can count rectangular pulses in three different ways with the FM 450-1:

- Continuous counting, with or without gate function
- Single counting with hardware or software gate
- Periodic counting with hardware or software gate

The differences manifest themselves in the way the FM 450-1 behaves when a counter reaches a count limit.

Continuous counting

If when counting in the up direction a counter has reached the high count limit and a further count pulse comes, then the counter jumps to the low count limit and begins to total the count pulses; thus, it counts continuously.

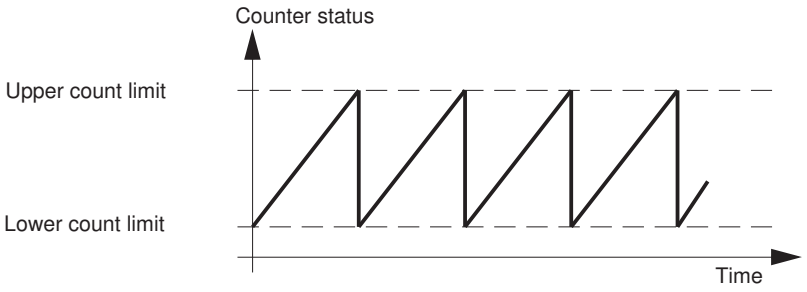


Figure 2-1 Continuous counting in the up direction

If when counting in the down direction a counter has reached the low count limit and a further count pulse comes, then it jumps to the high count limit and then goes on counting down from there.

Single counting

For single counting the counter starts from the load value. If when counting up a counter has reached the high count limit and a further count pulse comes, then the counter jumps to the low count limit and comes to a halt even if further count pulses come.

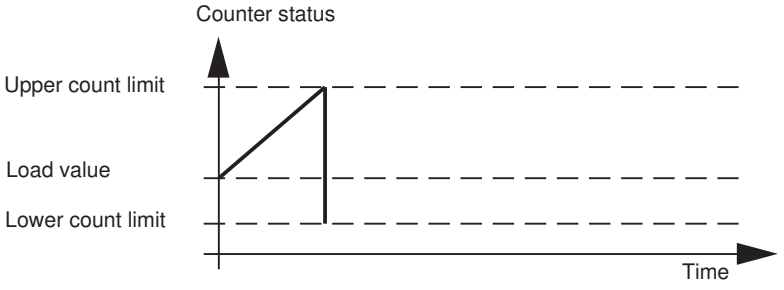


Figure 2-2 Single counting in the up direction

If when counting down a counter has reached the low count limit and a further count pulse comes, then the counter jumps to the high count limit and comes to a halt even if further count pulses come.

Periodic counting

For periodic counting the respective counter starts from the load value. If when counting up the counter reaches the high count limit and further count pulses come, then the counter jumps to the load value and starts totalizing the count pulses.

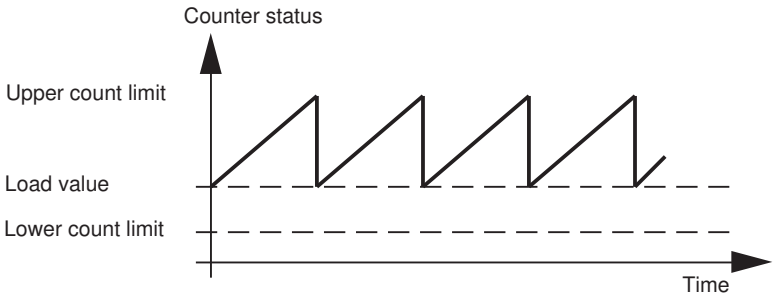


Figure 2-3 Periodic counting in the up direction

If when counting down a counter has reached the low count limit and a further count pulse comes, then the counter jumps to the load value and then continues counting down from there.

2.2 Gate functions

Counting with gate functions

Many applications require that the counting process should be started or stopped at a specifically defined point in time, depending on other events. In the case of the FM 450-1 starting and stopping the counting process like this take place via a gate function. If the gate is opened, count pulses can reach a counter and the counting process is started. If the gate is closed, count pulses can no longer reach the counter and the counting process is stopped.

Software gate and hardware gate

The module possesses two gate functions for each counter:

- A software gate (SW gate) which is controlled via the user program in the CPU.
- A hardware gate (HW gate) that is controlled via the 1I0 and 1I1 (counter 1) and/or 2I0 and 2I1 (counter 2) digital inputs on the module. When assigning parameters for the FM 450-1 you determine if the operation of the hardware gate is to be level controlled or edge controlled.

Example

When the gate signal is set, the gate is opened and the count pulses are counted. If the gate signal is taken away, the gate is closed and the count pulses are no longer picked up by the counter. The counter status remains constant.

The figure shows a gate opening and closing and the pulses being counted:

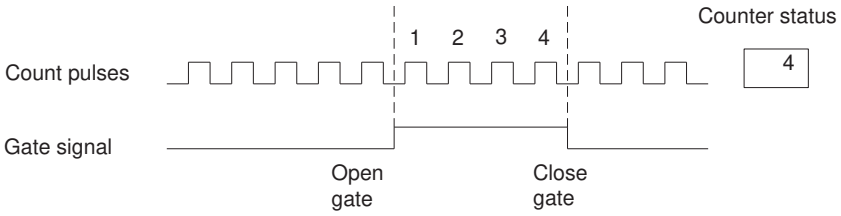


Figure 2-4 Opening and closing a gate

Ending counting process with the gate stop function

You can end the counting process when counting with the SW gate and when counting with the HW gate with the respective gate stop function. For this purpose you set the GATE_STP input parameter of the FC CNT_CTRL.

Installation and Removal

3

3.1 Chapter overview

Overview

In this chapter you will find information on the installation and removal of the FM 450-1

- You will find out what you have to pay attention to during installation. You will obtain information on project planning and on the design of an FM 450-1
- Step by step you will be shown how to install and remove the FM 450-1.

3.2 Preparing for Mounting

Important safety rules

There are important rules to be observed when integrating an S7-400 with an FM 450-1 into a plant or a system.

These rules and regulations are explained in manual /1/.

Defining the slots

The FM 450-1 function module can be installed like a signal module in any central device or extension device.

Designing the mechanical structure

Manual /1/ provides you with information on how the mechanical structure can be designed and how to proceed.

Define start address

The start address of the FM 450-1 is required for the purpose of communication between the CPU and the FM 450-1. The start address is entered into the DB of the FC CNT_CTRL (refer to chapter "Program (Page 39)" and chapter "Assignment of the DB (Page 87)"). The entry is either made with the program editor or out of the user program.

You specify the start address for the module under STEP 7.

3.3 Installing the FM 450-1

Rules

No special protective measures (EGB guidelines) are required for installing the FM 450-1.

Tools required

You require a 4.5 mm screwdriver to install the FM 450-1.

Installation procedure

Proceed as follows to install an FM 450-1

1. Hook the FM 450-1 in at the top and rotate it down.
2. Screw the FM 450-1 tight (torque approx. 0.8 to 1.1 Nm).
3. Label the FM 450-1 with its slot number. For this purpose use the number wheel enclosed with the rack.
   The system according to which you must perform then numbering and the procedure for defining the slot number are described in manual /1/.

Further information

Further information on the installation and removal of modules is to be found in manual /1/.

3.4 Removal of the FM 450-1

Rules

No special protective measures (EGB guidelines) are required for removing the FM 450-1.

Tools required

You require a 4.5 mm screwdriver to remove the FM 450-1.

Procedure for removal

Proceed as follows to remove an FM 450-1

1. Release the front connector and pull it out.
2. Undo the module fixing screw.
3. Rotate the module out of the rack and unhook it.
4. If necessary, install a new module.

Further information

Further information on the installation and removal of modules is to be found in manual /1/.

Wiring

4

4.1 Chapter overview

Chapter overview

In this chapter you will find information on wiring the FM 450-1

- Terminal assignment of the front connector.
- Terminal functions.
- Notes on the selection of cables.
- Procedure when wiring the front connector.
- State of module after it has been wired and the power supply is switched on.

4.2 Terminal assignment of the front connector

Front connectors

You connect the following to the 48-pin front connector:

- count signals,
- digital inputs
- digital outputs
- encoder power supply
- auxiliary voltage and load voltage.

The following illustration shows the front side of the front connector, the strip with the terminal assignment printed on and the labeling strips.

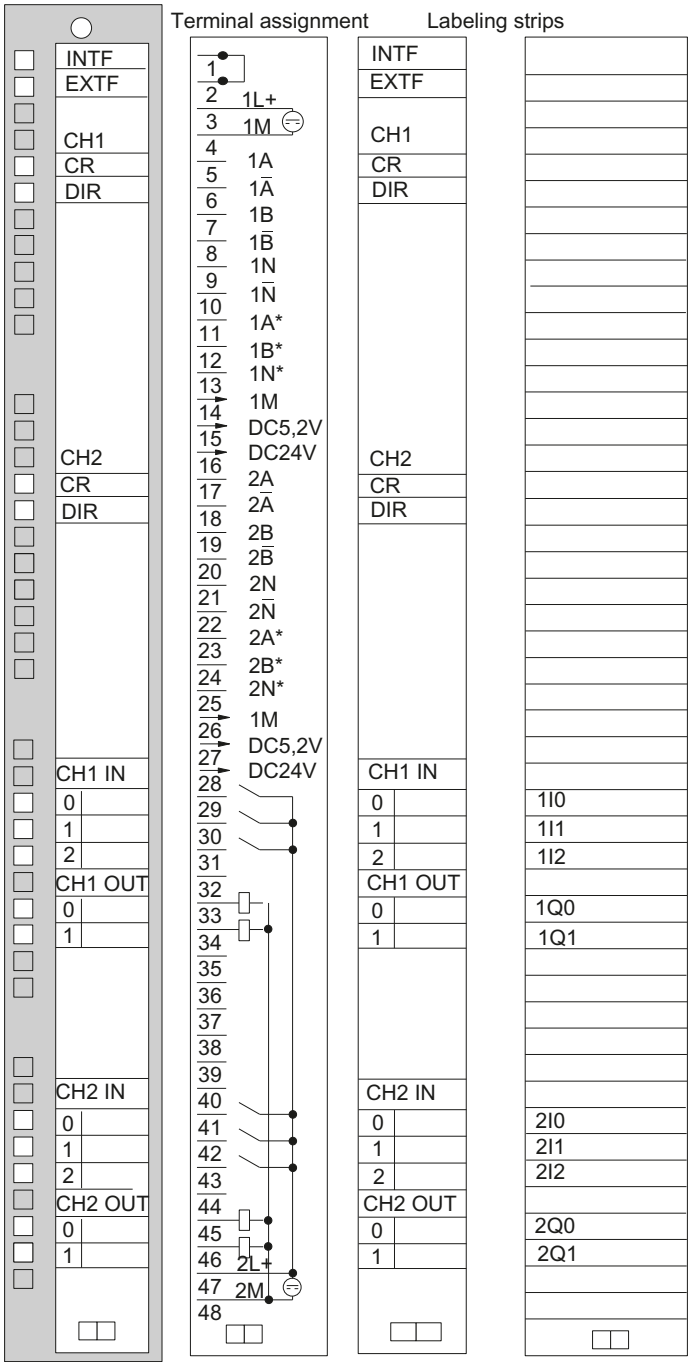


Figure 4-1 Front connector of the FM 450-1

Assignment of front connector

Table 4-1 Assignment of front connector

Terminal	Name	Inputs/ outputs	Function			
			5 V encoder RS 422, symmetrical	**24 V encoder, asymmetric**	**24-V pulse encoder with direction level**	**24 V initiator**
1			-			
2			-			
3	1L+	ON	24 V auxiliary voltage supply for encoders			
4	1M	ON	Auxiliary voltage ground to supply encoders			
Counter 1						
5	1 A	ON	Encoder signal A	-		
6	1 /A	ON	Encoder signal /A	-		
7	1 B	ON	Encoder signal B	-		
8	1 /B	ON	Encoder signal /B	-		
9	1 N	ON	Encoder signal N	-		
10	1 /N	ON	Encoder signal /N	-		
11	1 A*	ON	-	Encoder signal A*		
12	1 B*	ON	-	Encoder signal B*	Directional signal	-
13	1 N*	ON	-	Encoder signal N*	-	
14	1M	OFF	Ground for encoder power supply			
15	5.2 VDC	OFF	5.2 V encoder power supply	-		
16	24 VDC	OFF	-	24 V encoder power supply		
Counter 2						
17	2 A	ON	Encoder signal A	-		
18	2 /A	ON	Encoder signal /A	-		
19	2 B	ON	Encoder signal B	-		
20	2 /B	ON	Encoder signal /B	-		
21	2 N	ON	Encoder signal N	-		
22	2 /N	ON	Encoder signal /N	-		
23	2 A*	ON	-	Encoder signal A*		
24	2 B*	ON	-	Encoder signal B*, directional signal		
25	2 N*	ON	-	Encoder signal N*		
26	1M	OFF	Ground for encoder power supply			
27	5,2 VDC	OFF	5,2 V encoder power supply	-		
28	24 VDC	OFF	-	24 V encoder power supply		
Counter 1						
29	1I0	ON	Digital input 1I0			
30	1I1	ON	Digital input 1I1			
31	1I2	ON	Digital input 1I2 (set counter)			
32			-			

Terminal	Name	Inputs/ outputs	Function			
			5 V encoder RS 422, symmetrical	**24 V encoder, asymmetric**	**24-V pulse encoder with direction level**	**24 V initiator**
33	1Q0	OFF	Digital output 1Q0			
34	1Q1	OFF	Digital output 1Q1			
35			-			
36			-			
37			-			
38			-			
39			-			
40			-			
Counter 2						
41	2I0	ON	Digital input 2I0			
42	2I1	ON	Digital input 2I1			
43	2I2	ON	Digital input 2I2 (set counter)			
44			-			
45	2Q0	OFF	Digital output 2Q0			
46	2Q1	OFF	Digital output 2Q1			
47	2L+	ON	24 V load voltage for the digital inputs and outputs			
48	2M	ON	Load voltage ground for digital inputs and outputs			

Note

The circuits for the counter inputs (encoder power supply, encoder signals) are isolated electrically toward the ground of the CPU. Hence you must connect terminal 4 (1M) to the ground of the CPU with a low impedance!

If you supply the encoders with external voltage, you must also connect the mass of this external voltage supply to the ground of the CPU.

Auxiliary voltage 1L+, 1M

To supply the 5 V and 24 V encoders with voltage, connect a 24 DC V to the 1L + and 1M terminals.

An integrated diode protects the module from reversing the polarity of the auxiliary voltage.

The module monitors whether the auxiliary voltage is connected.

5.2 VDC encoder power supply

The module generates a 5.2 VDC voltage from the 1L+/1M auxiliary voltage at a maximum current of 300mA per count channel; this voltage is available on the respective "DC5.2V" terminal to supply a 5 V encoder with short circuit-proof voltage.

24 VDC encoder power supply

1l+/1M voltage is provided on output "24 VDC" to supply an encoder with short circuit-proof 24-V voltage. The encoder power supply is short-circuit checked.

5 V encoder signals A and /A, B and /B, N and /N

You can connect incremental encoders with 5 V differential signals in compliance with RS422, i.e. incremental encoders with the differential signals A and /A, B and /B, N and /N.

The A and /A, B and /B, N and /N signals are connected via the correspondingly labeled terminals

The signals N and /N are only to be connected if you wish to set the counter to the zero mark of the encoder.

The inputs are not electrically isolated from the S7-400 bus.

24-V encoder signals A*, B* and N*

24 V signals are identified with the letters A*, B* and N*.

You can connect three different types of encoders to each counter:

- Incremental encoders with 24- V signals:
  The signals A*, B* and N* are connected via the correspondingly labeled pins.
- Pulse encoders without directional level:
  The signal is connected to terminal A*
- Pulse encoders with directional level:
  The count signal is connected to the terminal A*. The directional level is connected to terminal B*.

The inputs are not electrically isolated toward the S7-400 bus.

Input filter for 24 V encoder signals

To suppress faults you can assign parameters to the input filters (RC elements) with a uniform filtering time for the 24 V inputs A*, B* and N*. The following two input filters are available for each counter:

Table 4-2 Input filter for 24 V encoder signals

Features	Input filter 1 (default setting)	Input filter 2
Typical input delay	1 µs	15 µs
Maximum count frequency	200 kHz	20 kHz
Minimum pulse width of the count signals	2.5 µs	25 µs

Digital inputs

You can use the digital inputs 1I0 and 1I1 for the gate control of counter°1.
You can use the digital inputs 2I0 and 2I1 for the gate control of counter°2.
The gates can be operated both in the level-controlled and edge-controlled modes (see chapter "Modes, settings, parameters and commands (Page 57)").

The 1I2 digital input is for setting counter 1 to the load value.
The 2I2 digital input is for setting counter 2 to the load value.

The digital inputs are operated with a 24 V nominal voltage.

The digital inputs are electrically isolated from bus and count inputs.

Input filters for digital inputs

To suppress faults you can assign parameters to the input filters (RC elements) with a uniform filtering time for the digital inputs 1I0, 1I1 and 1I2 or 2I0, 2I1 and 2I2. The following two input filters are available:

Table 4-3 Input filters for digital inputs

Characteristics	Input filter 1 (default setting)	Input filter 2
Typical input delay	1 µs	15 µs
Maximum frequency of the input signals	200 kHz	20 kHz
Minimum pulse width of input signals	2.5 µs	25 µs

Digital outputs

For the purpose of directly initiating control processes, the FM 450-1 has the digital outputs 1Q0 and 1Q1 (for counter 1) or 2Q0 and 2Q1 (for counter 2) that are supplied via the load voltage 2L+.

The digital inputs are potentially isolated from the S7-400 bus and count inputs.

The digital outputs are P switches and can carry a load current of 0.5 A. They are protected against overload and short circuit.

Note

The direct connection of relays and cutouts can be executed without external wiring

The time-related behavior of the digital outputs depends on the parameter assignment and is described in greater detail in the chapter "Setting: Behavior of the digital outputs (Page 65)".

2L+ /2M load voltage

To ensure the power supply of the digital outputs 1Q0 and 1Q1 or 2Q1 and 2Q2 you have to connect a load voltage of 24 V to the module terminals 2L+ and 2M.

An integrated diode protects the module from reversing the polarity of the load voltage.

The 2L+ / 2M load voltage is not monitored by the FM 450-1.

4.3 Wiring Front Connectors

Cables

There are a few rules you must observe when selecting the cables:

- The cables for the digital inputs must be shielded.
- The cables for the count signals must be shielded.
- You must apply the shields to the count signal cables both on the pulse encoder and in close proximity to the module, e.g. via the shield application element.
- Cables A and /A, B and /B, N and /N of the incremental 5-V encoder must be twisted in pairs.

The following figure shows details relating to the connection of incremental 5-V encoders.

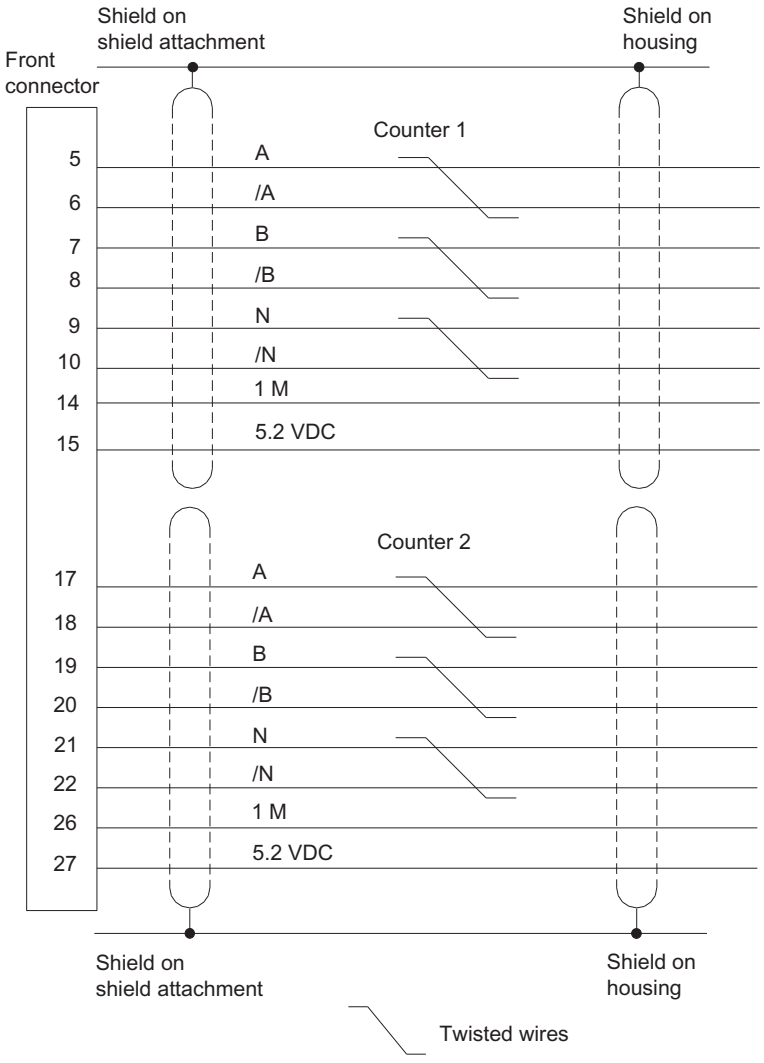


Figure 4-2 Connecting incremental 5 V encoders

Terminal 4 (1M) of the front connector must be connected with the ground of the CPU with a low impedance. If you supply the encoder with external voltage, you must also connect the ground of this external voltage supply to the ground of the CPU.

The following figure shows details relating to the connection of incremental 24 V encoders.

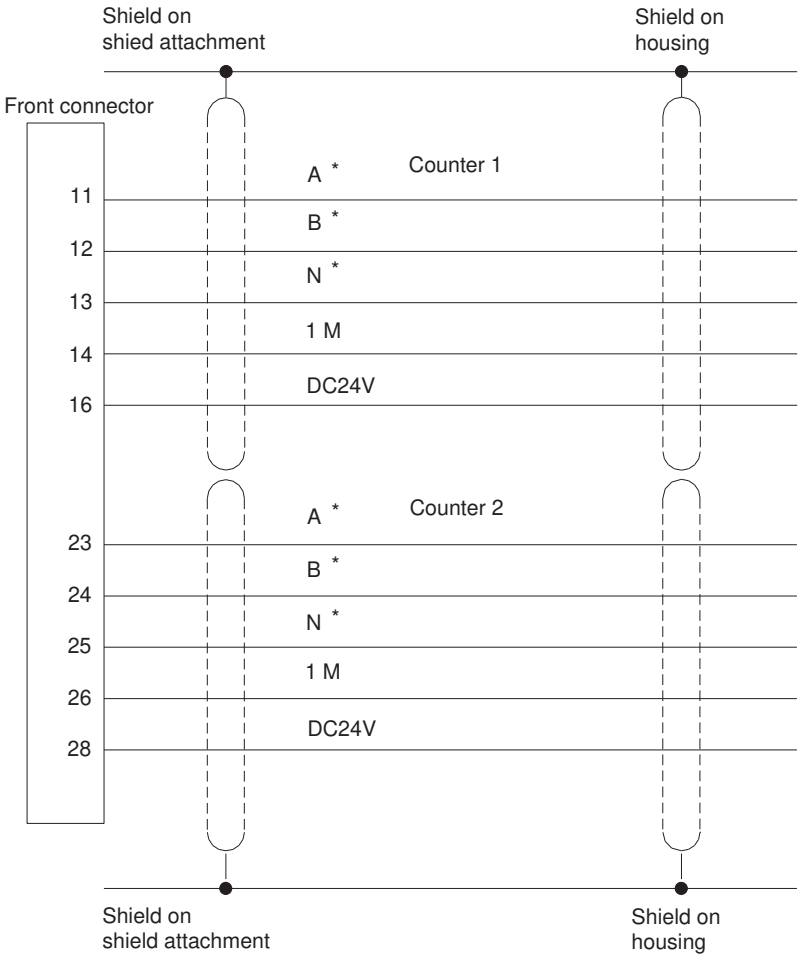


Figure 4-3 Incremental 24 V encoder connection

- Use flexible cables with cross sections of 0.25 to 1.5 mm ^{2}.

Note

If the encoder is supplied via the module, the cable cross section must be selected large enough for sufficient voltage to be applied to the encoder via the cable in spite of a drop in voltage. This applies in particular in the case of incremental 5 V encoders.

- A wire end ferrule is not required. If you use wire end ferrules, they must be of the type without insulating collars in compliance with DIN 46228 Form A, short type!

Wiring steps

Proceed as follows when wiring the front connector:

WARNING
Injury to persons can occur. If you wire the FM 450-1 front connector when the power is switched on, you may injure yourself owing to an electric shock. Always switch off power before you wire the FM 450-1!

1. Pull the cover off the front connector.
2. Insulate the cables (length 6 mm).
3. Do you use wire end ferrules?
   If so: Press-fit the wire end ferrules with the the conductors.
4. Load the enclosed strain relief clamp into the front connector
5. Start wiring from the bottom. If you have a front connector with screw-type contacts also screw unassigned terminals (torque 0.6 to 0.8 Nm).
6. Tighten the strain relief for the cable chain.
7. Close the front connector.
8. Label the terminals on the enclosed labeling strip.

A detailed description of the wiring of a front connector is to be found in manual /1/.

4.4 Module status after power is switched on

Characteristics

After the power supply has been switched on and before any data have been transmitted, the module status is as follows:

- Counter inputs with default setting for 5 V differential signals, track B not inverted; single evaluation (refer to the section "Signal evaluation (Page 83)")
- 0 to +32 bit counting range
- Counter status zero
- Counter setting with digital input 1I2 or 2I2 (and zero mark) disabled
- Input delay for the digital inputs: typically 1 µs
  (max. frequency: 200 kHz, minimum pulse width: 2.5 µs)
- Input delay for 24-V count inputs: typically 1 µs
  (max. frequency: 200 kHz, minimum pulse width: 2.5 µs)
- Outputs 1Q0 and 1Q1 or 2Q0 and 2Q1 switched off
- Pulse duration = 0

- No Hardware interrupts set
- "Continuous counting" mode set
- Gate function switched off (i.e. gate open)
- Status messages are updated

This setting corresponds to the default setting of the module.

RESET status

This module status (default setting) is also called RESET status.

Parameter assignment 5

5.1 Chapter overview

Chapter overview

In this chapter you will learn how to install and start parameter assignment screen forms.

The parameter assignment screen forms have an integrated help function to support you with parameter assignment and commissioning of the FM 450-1.

5.2 Installing and calling parameter assignment screen forms

Marginal conditions

The following conditions apply to the transfer of parameter assignment data to the CPU:

- STEP 7 must be correctly installed on your programming device.
- The programming device must be correctly connected to the CPU.
- The CPU must be in STOP

Note

During data communication via the MPI you must not pull out or plug in any S7-400 modules!

Installing the Parameterization Interfaces

To install the configuration package:

1. Place the supplied CD in the CD drive of your programming device or PC.
2. Start the program "Setup.exe".
3. Follow the operating instructions provided by the installation program.

Important information can be found in the readme file.

Result

The components of the configuration package are installed in the following directories:

- **SIEMENS\STEP7\S7LIBS\FMx501LIB:**FCs, UDTs
- **SIEMENS\STEP7\S7FCOUNT:** Configuration software, Readme, Online Help
- **SIEMENS\STEP7\EXAMPLES:** Examples
- **SIEMENS\STEP7\S7MANUAL\S7FCOUNT:** Getting Started, Manuals

Installing parameter assignment screen forms

Call the SETUP.EXE program on the backup copy of your installation diskette. This installs both the parameter assignment screen forms and the FC CNT_CTRL and the FC DIAG_INF on your programming device. The FCs are added to the standard library in the "FM_CNT_L" catalog. Follow the instructions displayed in the SETUP menu on the display.

Example Program

A comprehensive example program is inserted into the "Examples" sub catalog in the STEP 7 catalog in the FM_ZAEHL project during installation.

Reading the readme file

Important up-to-date information about the provided software can be found in a readme file. You can read this file with the WORDPAD editor in Windows.

Calling parameter assignment screen forms

The parameter assignment screen forms are displayed automatically after successful installation, if you assign the FM 450-1 parameters within the hardware configuration

Calling the integrated help

There is an integrated online help for the parameter assignment screen forms that you can call in any phase of parameter assignment either with the F1 key or with the Help button.

Program

6

6.1 Chapter overview

Chapter overview

In this chapter you can find all the information you require to program the FM 450-1 in the S7-400. Two STEP 7 blocks are provided for integrating the FM 450-1 into a user program and make handling the desired functions as easy as possible for you.

This chapter describes these blocks.

Block number	Block name	Meaning
FC 0	CNT_CTRL	Controlling the FM 450-1 counters
FC 1	DIAG_INF	Read diagnostic data set of the FM 450-1

In addition, an example program demonstrates how to use the blocks. The example program shows how to call the blocks and contains the necessary data block.

6.2 The FC CNT_CTRL function

Functionality

The data required for the FC CNT_CTRL are stored in a DB on the CPU. The FC CNT_CTRL transfers data cyclically from this DB to the FM and fetches data from the FM.

Requirement

- You have created a DB under STEP 7 as a data block with assigned user-specific data type. For this purpose select the UDT 1 as the source. The UDT 1 was copied into the block library for the counter (FM_CNT) when the FCs were installed. You must not modify the UDT 1. Copy the UDT 1 into your project together with the FCs.
- The following valid data must be assigned to the DB required for the FC CNT_CTRL:
  - Module address
    Set the module address (basic address of the FM 450-1) when you configure your hardware.
    The module address must be entered in the MOD_ADR parameter in the DB.
    To enter the module address, the following methods can be used:
    Recommended procedure
    Make the assignment of the module address to the DB in the user program so that the assignment of the module address occurs when user program is called in OB 100 (see example below).
    Alternative procedure
    You can have the module address entered automatically when you select the module in HW Config, open the "Properties" dialog box with the menu command **Edit > Object Properties**, and select the DB using the "Mod Addr" button there. However, in this case, the values entered in the DB (including the module addresses) will be reset to their initial values when a consistency check (menu command **Edit > Check Block Consistency** opens the "Check Block Consistency" dialog box) is performed followed by compilation (menu command **Program > Compile All** in the "Check Block Consistency" dialog box). If a consistency check is performed without compilation, the values are not changed. The menu command **Edit > Compile All** is only required within a consistency check when the project has been edited with STEP 7 V5.0 Service Pack 2 or earlier.
  - Channel address
    The channel address of count channel 1 is the same as the module address in pointer format. The channel address of count channel 2 is the same as the module address + 32 in pointer format.
  - User data length
    The user data length is 32.

Example

The following contains an example of how you can implement the transfer of the module address, the channel address, and the length of the user data to the DB in OB 100. The symbol table contains the following assignments for this example:

FM450_DB_K1	DB 10	DB with the counter data for channel 1
FM450_DB_K2	DB 11	DB with the counter data for channel 2

You program the transfer in STL as follows:

STL

```
Channel 1
L 512                              // Module address = 512
T   FM450_DB_K1.MOD_ADR            // Transfer of module address
L   P# 512.0                       // Module address in pointer format
```

```
STL
T   FM450_DB_K1.CH_ADR              // Transfer of the channel address for channel 1
L 32                                // User data interface length = 32
T   FM450_DB_K1.U_D_LGTH            // Transfer of the user data interface length
Channel 2
L 512                               // Module address = 512
T   FM450_DB_K2.MOD_ADR             // Transfer of module address
L   P# 544.0                        // Module address + 32 in pointer format
T   FM450_DB_K2.CH_ADR              // Transfer of the channel address for channel 2
L 32                                // User data interface length = 32
T   FM450_DB_K2.U_D_LGTH            // Transfer of the user data interface length
```

Call

The FC CNT_CTRL can be called once per counter either cyclically or in a time-controlled program. Calling in the interrupt program is not permissible.

Calling the FC CNT_CTRL in the STL and LAD representations is rendered below.

STL representation

```
CALL    CNT_CTRL, (
        DB_NO       :=,
        SW_GATE     :=,
        GATE_STP    :=,
        OT_ERR_A    :=,
        OT_ERR      :=,
        L_DIRECT    :=,
        L_PREPAR    :=,
        T_CMP_V1    :=,
        T_CMP_V2    :=,
        RES_SYNC    :=,
        RES_ZERO    :=)
```

LAD representation

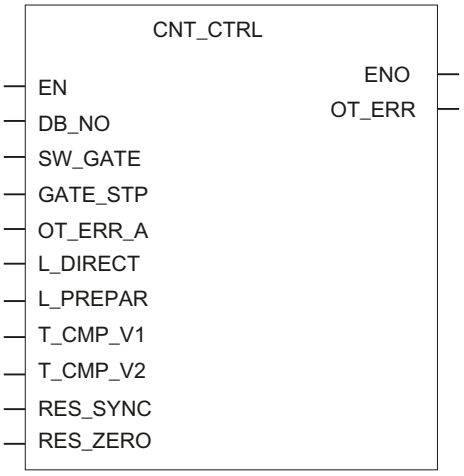


Figure 6-1 Calling the FC CNt_CTRL

Parameters of the FC CNT_CTRL

Name	Declaration type	Data type	Meaning	The user...	The block...
DB_NO	INPUT	BLOCK_DB	Number of the data block with the counter data	enters this	queries this
SW_GATE	INPUT	BOOL	"SW gate (start/stop)" counter control bit	sets and resets this	queries this
GATE_STP	INPUT	BOOL	"Stop gate" counter control bit	sets and resets this	queries this
OT_ERR_A	INPUT	BOOL	Acknowledge operator error	sets and resets this	queries this
OT_ERR	OUTPUT	BOOL	Operator error occurred	queries this	sets and resets this

Name	Declaration type	Data type	Meaning	The user...	The block...
L_DIRECT	IN-OUT	BOOL	Trigger bit for "direct loading" of a counter	sets	queries and resets this
L_PREPAR	IN-OUT	BOOL	Trigger bit for "preparatory loading" of a counter	sets	queries and resets this
T_CMP_V1	IN-OUT	BOOL	Transfer trigger bit for "comparison value 1"	sets	queries and resets this
T_CMP_V2	IN-OUT	BOOL	Transfer trigger bit for "comparison value 2"	sets	queries and resets this
RES_SYNC	IN-OUT	BOOL	Delete "synchronization" status bit	sets	queries and resets this
RES_ZERO	IN-OUT	BOOL	Reset status bits for zero crossing, overflow, underflow and comparator or measurement end	sets	queries and resets this

Processing jobs

You initiate a job for the FM 450-1 by means of the L_DIRECT, L_PREPAR, T_CMP_V1, T_CMP_V2, RES_SYNC, RES_ZERO, OT_ERR_A and GATE_STP FC parameters.

Depending on the job you must enter the load value or a comparison value into the instance DB prior to the calling the FC.

A set in/out parameter (L_DIRECT, L_PREPAR, T_CMP_V1, T_CMP_V2, RES_SYNC and RES_ZERO) is deleted again by the FC CNT_CTRL after the job has been completed. This enables you to recognize that the job has been completely executed by the FM 450-1 and, if necessary, to evaluate this information in the user program.

Startup characteristics

As soon as the FC CNT_CTRL identifies a startup (CPU or FM startup), a pending job is deferred and the startup is acknowledged. Any job you have already initiated is carried out once the startup is finished and is therefore not lost.

Error Messages

If an operator error occurred when the FC is called, it is reported in the OT_ERR parameter. You can read the error information in the DB 1 (variable OT_ERR_B). Thereafter you can acknowledge the operator error with the OT_ERR_A parameter. No new operator error will be reported until you have acknowledged the previous one.

6.3 The FC DIAG_INF function

Functionality

The FC DIAG_INF reads data record DS1 from the FM 450-1 and makes it available to you in the DB of the FC CNT_CTRL. Transfer proceeds as follows:

- If initiation parameter (IN_DIAG=TRUE) the DS1 is read out from the FM°450-1.
- The DS1 is entered into the DB of the FB CNT_CTRL from DW 54 with the aid of the SFC RD_REC.
- The return code of the SFC (RET_VAL) is copied onto the RET_VAL parameter of the FC DIAG_INF.
- As soon as the function has been performed, the initiation parameter IN_DIAG is reset and hence the transfer is reported as completed.

A full description of the SFC RD_REC is to be found in manual°/2/.

Call

The FC DIAG_INF can be called in the cycle and in the interrupt program. However, it is not expedient to call it in the time-controlled program.

Calling the FC DIAG_INF in the STL and LAD representations is rendered below.

STL representation

```
CALL    DIAG_INF  (
        DB_NO     :=,
        RET_VAL   :=,
        IN_DIAG   :=);
```

LAD representation

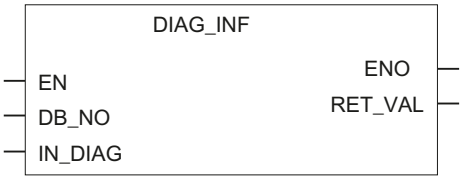


Figure 6-2 Calling the FC DIAG_INF

Parameters of the FC°DIAG_INF

Name	Declaration type	Data type	Meaning	The user...	The block...
DB_NO	INPUT	INT	Number of the data block of the FC CNT_CTRL	enters this	queries this
RET_VAL	OUTPUT	INT	Return code of the SFC 59	queries this	enters this
IN_DIAG	IN-OUT	BOOL	Initiation bit reads diagnostics record DS 1	sets and scans this	resets this

6.4 Example application

Example for the use of the FC CNT_CTRL

The following example is representative for all functions and demonstrates the "Transfer load value to FM 450-1" and "Start counter" functions to show how the FC°CNT_CTRL can be applied.

STL

```
          L       +1000;                                  // Enter load value into
          T       KANAL1.LOAD_VAL;                        // the DB.

          U       INITIATION;
          S       LOAD_DIRECT;                            // DIRECT input parameters
          R       TRIGGER;

          CALL    CNT_CTRL, (                             // Call the FC with the DB
                                                          // Channel 1.
                  SW_GATE             :=START,            // Control software gate
                  GATE_STP            :=GATE_STOP,        // Stop GATE
                  OT_ERR_A            :=ERROR_ACKN,       // Acknowledge operator error
                  OT_ERR              :=OPERATOR_ERR,     // Operator error occurred
                  L_DIRECT            :=LOAD_DIRECT,      // Load new counter value
                  L_PREPAR            :=LOAD_INDIRECT,    // Prepare new counter value
                  T_CMP_V1            := COMP1_LOAD       // Load new comparison value 1
                  T_CMP_V2            :=COMP2_LOAD,       // Load new comparison value 2
                  RES_SYNC            :=RES_SYNCHRO,      // Delete synchronization status bit
                  RES_ZERO            := RES_ZERO);       // Delete "zero crossing" status bit
          AN      OPERATOR_ERROR;                         // If no error has occurred,
          JC      CONT;                                   // CONTinue
                                                          // *** Error evaluation START ***
          L       CHANNEL1.OT_ERR_B;                      // Read additional information
          T       OUTPUT;                                 // and output.
          SET                                             // Generate RLO 1
          S       ERR_ACKN                                // Acknowledge error
          ...                                             // Further error responses
          SPA     END;                                    // *** Error evaluation END ***
CONT:     ...                                             // Continue with normal processing
          AN      LOAD_DIRECT;                            // Load direct function is ready
          S       START;                                  // Open software gate
END:
```

Description of the symbols

The tables lists the symbols used in the example. You specify your own symbol assignments in the S7 symbol table.

Table 6-1 Symbols in the user program

Symbols used	Absolute (example)	Comment
CHANNEL1	DB 1	Data block for FC°CNT_CTRL
CHANNEL1.LOAD_VAL	DB1.DBB14	Counter value specified in DB 1
INITIATE	M 10.0	Initiation bit generated to meet technological requirements
LOAD_DIRECT	M 20.0	Accept counter value directly
START	M 20.1	Start counter
GATE_STOP	M 20.2	Close counter gate
ERR_ACKN	M 20.3	Acknowledge operator error
LOAD_INDIRECT	M 20.4	Load counter value in preparation
COMP1_LOAD	M 20.5	Load comparison value 1
COMP2_LOAD	M 20.6	Load comparison value 2
RES_SYNCHRON	M 20.7	Reset synchronization status bit
RES_ZERO	M 21.0	Reset zero crossing, overflow and underflow status bit
OPERATOR_ERROR	M 21.1	Operator error occurred
CHANNEL 1.OT_ERR_B	DB1.DBX40.0	Operator error information in DB 1

Description of the sequence

Prerequisite:

The value to be transferred must have been entered in the DB°1.

The load value is transferred and started:

When the FC is called, the load value of a channel is transferred to the FM 450-1. Calling the FC °CNT_CTRL selects either the L_DIRECT parameter or the L_PREPAR parameter. The L_DIRECT selection bit specifies that the load value will be loaded directly onto the counter (L_DIRECT=1). The L_PREPAR selection bit specifies that the load value is to be stored in the load register (L_PREPAR=1). The load value in the load register is then loaded onto the counter when the counter is next set. L_PREPAR=1 prepares a new counter value. Load value transfer lasts a minimum of 3 FC calls.

The FC must be called until it has reset the selected initiation bit (L_DIRECT or L_PREPAR). While the job is in progress the I/O parameter remains set. The FC°CNT_CTRL does not output an error message regarding data exchange with the FM.

If the FC CNT_CTRL resets the parameter you had set, the FM 450-1 has accepted the load value. The read-back load value stored in the DB°1 is updated by the FC°CNT_CTRL.

You must generate the "initiation" bit to comply with your technological requirement. This bit may be set at "1" for one cycle only. Please note, that the FC must be called until the I/O parameter of the FC CNT_CTRL is reset.

6.5 Technical specifications of the blocks

Table 6-2

Technical Specifications	FC CNT_CTRL	FC DIAG_INF
Block number	FC 0	FC 1
Version	3.0	3.0
Assignment in work memory	540 bytes	246 bytes
Assignment in load memory	634 bytes	326 bytes
Assignment in local data area	4 bytes	38 bytes
System function called	-	SFC 51 RDSYSST

- Internal update time of the FM°450-1: 0.5°ms.
- SDB 100: approx. 240°bytes

Commissioning 7

7.1 Chapter overview

Chapter overview

In this chapter you will find checklists for commissioning the FM 450-1. These checklists enable you to

- check all working steps up to full operation of the module,
- avoid operating faults by the module.

7.2 Working steps during mechanical installation

Check list

Use the following checklist to check and document the working steps during mechanical installation of the FM 450-1.

Working step	Options/procedure	(X)
Define the slot	All slots that are not already occupied or due to be occupied by a power supply module, a CPU or an IM.	
Install the FM 450-1	1. Hook FM into position and screw tight 2. Attach slot number	
Select cables	Observe rules and specifications in chapter "Wiring (Page 25)".	

Working step	**Options/procedure**				**(X)**
Connect 5 V encoders	**Counter 1:**	**Terminal**	**Name**	**Function**	
	5 V incremental encoders with differential signals A and /A, B and /B, N and /N	14 15 5 6 7 8 9 10	1M 5.2 VDC A /A B /B N /N	Ground for encoder power supply 5.2 V encoder power supply Encoder signal A Encoder signal /A Encoder signal B Encoder signal /B Encoder signal N Encoder signal /N	
	Counter 2:	**Terminal**	**Name**	**Function**	
	5 V incremental encoders with differential signals A and /A, B and /B, N and /N	26 27 17 18 19 20 21 22	1M 5.2 VDC A /A B /B N /N	Ground for encoder power supply 5.2 V encoder power supply Encoder signal A Encoder signal /A Encoder signal B Encoder signal /B Encoder signal N Encoder signal /N	

Working step	Options/procedure				(X)
Connect 24 V encoders	**Counter 1:**	**Terminal**	**Name**	**Function**	
	24V incremental encoders	14 16 11 12 13	1M 24 VDC A* B* N*	Ground for encoder power supply 24 V encoder power supply Encoder signal A* Encoder signal B* Encoder signal N*	
	Counter 2:	**Terminal**	**Name**	**Function**	
	24V incremental encoders	26 28 23 24 25	1M 24 VDC A* B* N*	Ground for encoder power supply 24 V encoder power supply Encoder signal A* Encoder signal B* Encoder signal N*	
	Counter 1:	**Terminal**	**Name**	**Function**	
	24V pulse encoder without direction level initiator/ BERO)	14 16 11	1M 24 VDC A*	Ground for encoder power supply 24 V encoder power supply Encoder signal A*	
	Counter 2:	**Terminal**	**Name**	**Function**	
	24V pulse encoder without direction level initiator/ BERO)	26 28 23	1M 24 VDC A*	Ground for encoder power supply 24 V encoder power supply Encoder signal A*	
	Counter 1:	**Terminal**	**Name**	**Function**	
	24-V pulse encoder with direction level	14 16 11 12	1M 24 VDC A* B*	Ground for encoder power supply 24 V encoder power supply Encoder signal A* Direction level B*	
	Counter 2:	**Terminal**	**Name**	**Function**	
	24-V pulse encoder with direction level	26 28 23 24	1M 24 VDC A* B*	Ground for encoder power supply 24 V encoder power supply Encoder signal A* Direction level B*	

Working step	**Options/procedure**				**(X)**
Wiring digital inputs and outputs	**Counter 1:**	**Terminal**	**Name**	**Function**	
	Digital inputs and outputs	29	1I0	Digital input START	
		30	1I1	Digital input STOP	
		31	1I2	Digital input SET	
		33	1Q0	Digital output Q0	
		34	1Q1	Digital output Q1	
	Counter 2:	**Terminal**	**Name**	**Function**	
	Digital inputs and outputs	41	2I0	Digital input START	
		42	2I1	Digital input STOP	
		43	2I2	Digital input SET	
		45	2Q0	Digital output Q0	
		46	2Q1	Digital output Q1	
Connecting auxiliary voltage and load voltage		**Terminal**	**Name**	**Function**	
	Encoder supply	3	1L+	24V auxiliary voltage	
		4	1M	Auxiliary voltage ground	
	Supply for digital inputs and outputs	47	2L+	24V load voltage	
		48	2M	Load voltage ground	

7.3 Working steps for parameter assignment

Check list

Use the following checklist to check and document the working steps during parameter assignment of the FM°450-1. Assign the parameters of the FM°450-1 counters in the same order as the check list.

Working step	Options/procedure			(X)
Assign the FM 450-1 parameters	**Select encoders for counter 1**			
	5-V encoder with symmetrical signals	Monitoring	A + B + N	
			A + B	
			A	
			None	
	24-V encoder with asymmetrical signals	Interface	Sinking output	
			Sourcing output/push-pull	
		Frequency range/ minimum pulse width	≤200 kHz/≥2.5 µs	
			≤20 kHz/≥25 µs	
	24V encoders with a pulse train and direction signal	Interface	Current-sinking output	
			Current-sourcing output/ push-pull	
		Frequency range/ minimum pulse width	≤200 kHz/≥2.5 µs	
			≤20 kHz/≥25 µs	
	24-V initiator			
	Signal evaluation	Single		
		Double		
		Quadruple		
		Frequency and direction (with 24V encoders)		

Step	Options/procedure			(X)
Assign the FM 450-1 parameters	**Select encoders for counter 2**			
	5-V encoder with symmetrical signals	Monitoring	A + B + N	
			A + B	
			A	
			None	
	24-V encoder with asymmetrical signals	Interface	Current-sinking output	
			Current-sourcing output/ push-pull	
		Frequency range/ minimum pulse width	≤200 kHz/≥2.5 µs	
			≤20 kHz/≥25 µs	
	24-V encoder with a pulse train and direction signal	Interface	Current-sinking output	
			Current-sourcing output/ push-pull	
		Frequency range/ minimum pulse width	≤200 kHz/≥2.5 µs	
			≤20 kHz/≥25 µs	
	24-V initiator			
	Signal evaluation	Single		
		Double		
		Quadruple		
		Frequency and direction (with 24-V encoders)		

Step	Options/procedure		(X)
Assign the FM 450-1 parameters	**Specify mode for counter 1**		
	Continuous counting	Without gate	
		With SW gate	
		With HW gate	
	Single counting	With SW gate	
		With HW gate	
	Periodic counting	With SW gate	
		With HW gate	
	Set count range	0 to +32 bit	
		-31 bit to +31 bit	
	Specify mode for counter 2		
	Continuous counting	Without gate	
		With SW gate	
		With HW gate	
	Single counting	With SW gate	
		With HW gate	
	Periodic counting	With SW gate	
		With HW gate	
	Set count range	0 to +32 bit	
		-31 bit to +31 bit	
	Specify the behavior of the digital inputs for counter 1		
	HW gate	Level-controlled	
		Edge-controlled	
	Minimum pulse width	≥2.5 µs	
		≥25 µs	
	Set counter	Single setting	
		Multiple setting	
	Evaluate zero mark for setting		
	Specify the behavior of the digital inputs for counter 2		
	HW gate	Level-controlled	
		Edge-controlled	
	Minimum pulse width	≥2.5 µs	
		≥25 µs	
	Set counter	Single setting	
		Multiple setting	
	Evaluate zero mark for setting		

Step	Options/procedure			(X)
Assign the FM 450-1 parameters	**Specify the behavior of the digital outputs for counter 1**			
	Output 1Q0	Disable		
		Active from comparison value 1 to overflow		
		Active from comparison value 1 to underflow		
		Active for "pulse duration" when comparison value 1 is reached in up direction		
		Active for "pulse duration" when comparison value 1 is reached in down direction		
		Active for "pulse duration" when comparison value 1 is reached in up or down direction		
	Output 1Q1	Disable		
		Active from comparison value 2 to overflow		
		Active from comparison value 2 to underflow		
		Active for "pulse duration" when comparison value 2 is reached in up direction		
		Active for "pulse duration" when comparison value 2 is reached in down direction		
		Active for "pulse duration" when comparison value 2 is reached in up or down direction		
	Pulse duration	0 to 500 ms		
	Specify the behavior of the digital outputs for counter 2			
	Output 2Q0	Disable		
		Active from comparison value 1 to overflow		
		Active from comparison value 1 to underflow		
		Active for "pulse duration" when comparison value 1 is reached in up direction		
		Active for "pulse duration" when comparison value 1 is reached in down direction		
		Active for "pulse duration" when comparison value 1 is reached in up or down direction		
	Output 2Q1	Disable		
		Active from comparison value 2 to overflow		
		Active from comparison value 2 to underflow		
		Active for "pulse duration" when comparison value 2 is reached in up direction		
		Active for "pulse duration" when comparison value 2 is reached in down direction		
		Active for "pulse duration" when comparison value 2 is reached in up or down direction		
	Pulse duration	0 to 500 ms		

Step	Options/procedure		(X)
Assign the FM 450-1 parameters	**Enable digital outputs**		
	CTRL_DQ0 in DB 1 CTRL_DQ1 in DB 1		
	Specify load value and comparison values for counter 1 and enter in DB		
	Load value		
	Comparison value 1		
	Comparison value 2		
	Specify load value and comparison values for counter 2 and enter in DB		
	Load value		
	Comparison value 1		
	Comparison value 2		
	Enter basic data in DB 1		
	Module address		
	Channel address		
	User data length	32	
	Select interrupts for counter 1		
	Interrupt when door is opened		
	Interrupt when door is closed		
	Interrupt in case of overflow		
	Interrupt in case of underflow		
	Interrupt in case of zero crossing		
	Interrupt when comparison value 1 is reached in the up direction		
	Interrupt when comparison value 1 is reached in the down direction		
	Interrupt when comparison value 2 is reached in the up direction		
	Interrupt when comparison value 2 is reached in the down direction		
	Interrupt when setting counter		
	Select interrupts for counter 2		
	Interrupt when door is opened		
	Interrupt when door is closed		
	Interrupt in case of overflow		
	Interrupt in case of underflow		
	Interrupt in case of zero crossing		
	Interrupt when comparison value 1 is reached in the up direction		
	Interrupt when comparison value 1 is reached in the down direction		
	Interrupt when comparison value 2 is reached in the up direction		
	Interrupt when comparison value 2 is reached in the down direction		
	Interrupt counter is set		
Integrate FCs in user program	Integrate FC CNT_CTRL		
	Integrate FC DIAG_INF		

Modes, settings, parameters and commands

8

8.1 Chapter overview

Chapter overview

This chapter gives you

- an overview of the three modes, the various settings and the commands available and how to call them.
- A description of the three modes
- A description of the settings
- A description of the two commands
- Marginal conditions and notes which you must heed when using these functions.

8.2 Overview of modes, settings and commands

Which modes are available?

For the FM°450-1 there are the three following modes:

Table 8-1 Operating modes of FM°450-1

Name	Description
Continuous counting (with or without gate)	Starting from the current counter status the FM°450-1 counts continuously.
Single counting with SW gate or with HW gate	When the gate opens, the FM 450-1 counts from the load value to the count limit.
Periodic counting with SW gate or with HW gate	When the gate opens, the FM 450-1 counts between the load value and the count limit.

You can configure the two FM 450-1 counters in different modes.

The default setting is the "Continuous counting" mode.

Choice of count range, behavior of the two digital outputs, pulse duration, evaluation of the count signals, and the selection of the signal to set the counter all depend on the mode.

Which settings are available?

You can adapt the FM 450-1 to your count job by means of the following five settings:

Table 8-2 The FM 450-1 settings

Name	Description
Count range	You select the count limit with the count range.
Behavior of digital outputs Q0 and Q1	You can choose between six possibilities for the behavior of the outputs on reaching the comparison value.
Pulse duration	Pulse duration indicates the time for which the output is to be set.
Triggering hardware interrupts	When the various selectable events occur, the FM 450-1 can trigger a hardware interrupt.
Encoders	You must specify different settings for the encoder used. These are described in section "Encoder signals and their evaluation (Page 79)".

Which commands are available?

You can influence the counting process of the FM 450-1 by means of the following commands:

Table 8-3 The FM 450-1 commands

Name	Description
Open and close gate	The counting process starts when a gate opens and ends when it closes.
Set counter	The counter can be set to the load value using various signals.

Basic parameter assignment

When configuring the hardware you define the basic parameter assignment of each FM 450-1. The following table shows the significance of the relevant parameters.

Table 8-4 Parameters for the basic parameter assignments

Name	Option	Description
Interrupt selection	None	You enable the corresponding interrupts via this selection.
	Diagnostics	
	Process	
	Process and diagnostics	
Reaction to a CPU STOP	STOP	Outputs immediately disabled counting process aborted
	Continue operating	The module continues operating.
	Terminate active job	The single count process continues until it terminates itself or, in modes with a HW gate, until it is terminated by closing the HW gate. The periodic counting process is reparameterized into a single counting process and is terminated as such.

8.3 Basics on calling modes, settings and commands

Calling modes, settings and commands

- You select modes and settings in the FM°450-1 parameter assignment screen forms. The parameter assignment data are automatically stored on the programming device and in the rack SDB.
  Notes on installing parameter assignment screen forms and on assigning the FM°450-1 parameters can be found in the chapter "Parameter assignment (Page 37)" and, after the software has been installed, also in the integrated Help function.
- Modes and settings are modified in the parameter assignment screen forms. The new mode or setting is valid from the next time the FM 450-1 starts.
- Commands are either generated via hardware signals, which are connected to the front connector, or by setting the relevant input parameters of the FC CNT_CTRL in the user program to influence the count process. The input parameters are stored as control bits in the DB of the FC CNT_CTRL.

Control and status bits in the DB

In addition to the control bits, there are status bits in the DB which signalize the status of the count process. The control and status bits are each allocated two bytes in the DB (see the chapter "Assignment of the DB (Page 87)".)

Transferring control and status bits

You transfer control and status bits between the CPU and module with the FC°CNT_CTRL, which you must integrate into your user program:

Use symbolic names for the control and status bits in the user program. The symbolic names are used in this chapter in the description of the FC.

The exact description of the FC CNT_CTRL is to be found in the chapter "Program (Page 39)"; the DB assignments are to be found in the chapter "Assignment of the DB (Page 87)".

8.4 Infinite counting

Overview

In this mode an FM 450-1 counter counts infinitely from the current counter status:

- When counting up, if the counter reaches the upper count limit and a further count pulse comes, it jumps to the lower limit and continues counting from there without any pulse loss.
- When counting down, if the counter reaches the lower count limit and a further count pulse comes, it jumps to the upper limit and continues counting from there without any pulse loss.

Select gate function

In this mode you can select the gate function Options:

- Without gate (default)
- SW gate
- HW gate, level-controlled or edge-controlled

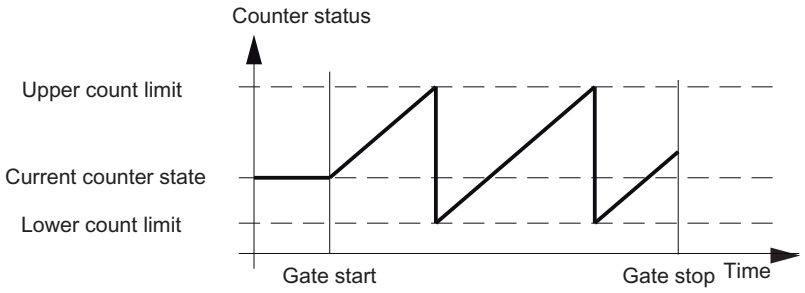


Figure 8-1 Infinite counting with load value and gate function

Open and close SW gate

You open and close the SW gate of the relevant counter with the input parameter SW_GATE of the FC CNT_CTRL (see chapter "The FC CNT_CTRL function (Page 39)").

Action	Initiating event
Open SW gate	Set SW_GATE
Close SW gate	Reset SW_GATE

Opening and closing HW gate

You open and close the HW gate of the relevant counter by applying or removing the corresponding signals to or from the inputs 1I0 and 1I1 (counter 1) and/or 2I0 and 2I1 (counter 2).

Action	Initiating event
Opening HW gate (level controlled)	Applying signal to input 1I0 (2I0)
Closing HW gate (level controlled)	Removing signal from input 1I0 (2I0)
Opening HW gate (edge controlled)	Applying positive edge to input 1I0 (2I0)
Closing HW gate (edge controlled)	Applying positive edge to input 1I1 (2I1)

When the HW gate opens the counter resumes counting from the current counter status.

Terminating counting process with the gate stop function

In addition you can end the count process when counting with the SW gate or HW gate by means of the gate stop function of the relevant counter. For this purpose you set the GATE_STP input parameter of the FC CNT_CTRL.

8.5 Single counting

Overview

In this mode an FM°450-1 counter counts once from the load value up to the count limit.

Select gate function

In this mode you can select the gate function Options:

- SW gate
- HW gate, level-controlled or edge-controlled

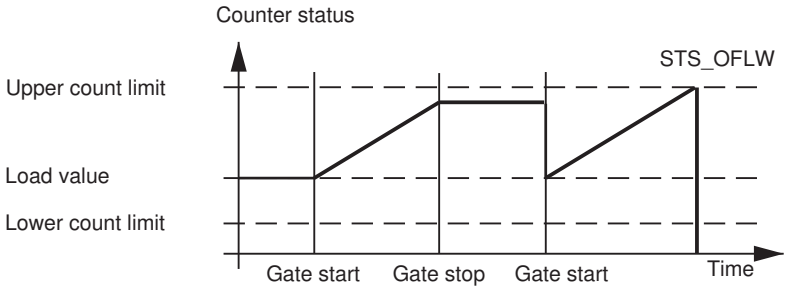


Figure 8-2 Single counting with load value and gate function

Open and close SW gate

You open and close the SW gate and set the counter to the load value with the input parameter SW_GATE of the FC CNT_CTRL.

Action	Initiating event
Open SW gate	Set SW_GATE
Close SW gate	Reset SW_GATE

Opening and closing HW gate

You open and close the hardware gate and set the counter to the load value by applying or removing the relevant signals at the inputs 1I0 and 1I1 (Counter 1) and/or 2I0 and 2I1 (Counter 2).

Action	Initiating event
Opening HW gate (level controlled)	Applying signal to input 1I0 (2I0)
Opening HW gate (edge controlled)	Applying positive edge to input 1I0 (2I0)
Closing HW gate (level controlled)	Removing signal from input 1I0 (2I0)
Closing HW gate (edge controlled)	Applying positive edge to input 1I1 (2I1)

In the case of a level-controlled HW gate, a signal at output 1I0 (2I0) is used to reopen the gate and set the relevant counter to the load value.

If in the case of an edge controlled HW gate a positive edge is again applied to input 1I1 (2I1), the counter resumes counting from the load value irrespective of whether the gate is closed or still open (retriggering) provided input 1I1 (2I1) is not set.

Behavior at count limits

If the counter reaches the upper or lower count limit and another count pulse arrives, the counter is set to the other count limit.

Thereafter the gate is closed and the counting process terminated, even if the SW_GATE parameter is still set or the HW gate is still open. The corresponding status bit is set in the DB of the FC CNT_CTRL.

Count limit reached	Bit in the DB
Upper count limit	STS_OFLW is set
Lower count limit	STS_UFLW is set

If you want to restart the counter, you must reset the SW_GATE parameter and/or reopen the HW gate. The counting process is then continued from the load value.

Terminating counting process with the gate stop function

In addition you can terminate the counting process at any time using the gate stop function. For this purpose you set the GATE_STP input parameter of the FC°CNT_CTRL.

8.6 Periodic counting

Overview

In this mode an FM 450-1 counter counts once from the load value up to the count limit, jumps back to the load value and continues to count.

Select gate function

In this mode you can select the gate function Options:

- SW gate
- HW gate, level-controlled or edge-controlled

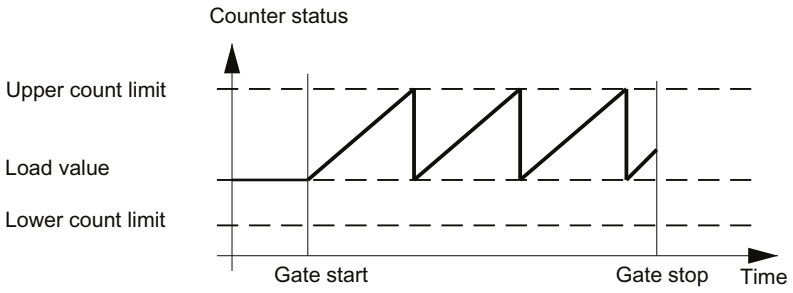


Figure 8-3 Periodic counting with load value and gate function

Open and close SW gate

You open and close the SW gate and set the counter to the load value by setting or resetting the relevant bit in the DB of the FC°CNT_CTRL in the user program (see chapter "Assignment of the DB (Page 87)"). When you open the SW gate, the FM 450-1 starts counting from the load value.

Action	Initiating event
Open SW gate	Set SW_GATE
Close SW gate	Reset SW_GATE

If you want to restart the counter, you must reset the bit. The counter then starts counting from the load value.

Opening and closing HW gate

You open and close the HW gate and set the counter to the load value by applying or removing the relevant signals at the inputs 1I0 and 1I1 (counter 1) and/or 2I0 and 2I1 (counter°2).

Action	Initiating event
Opening HW gate (level controlled)	Applying signal to input 1I0 (2I0)
Closing HW gate (level controlled)	Removing signal from input 1I0 (2I0)
Opening HW gate (edge controlled)	Applying positive edge to input 1I0 (2I0)
Closing HW gate (edge controlled)	Applying positive edge to input 1I1 (2I1)

If in the case of an edge controlled HW gate a positive edge is again applied to input 1I0 (2I0), the relevant counter again starts counting from the load value irrespective of whether the gate is closed or still open (retriggering) provided input 1I1 (2I1) is not set.

Behavior at the Count Limits

If a counter reaches the upper or lower count limit and a further count pulse comes, it begins counting from the load value again. The count process is thereby continued without pulse loss. A corresponding status bit is set in the DB:

Count limit reached	Bit in the DB
Upper count limit	STS_OFLW is set
Lower count limit	STS_UFLW is set

Terminating counting process with the gate stop function

In addition you can terminate the counting process at any time using the gate stop function. For this purpose you set the GATE_STP input parameter of the FC CNT_CTRL.

8.7 Count range

Introduction

There is a 32°bit-wide count register on the module. With the count range you specify if the module counts only in the positive range or if the 32nd°bit is interpreted as a sign bit and hence negative numbers can be represented. This section describes these two count ranges, "0 to +32 bits" and "-31 to +31 bits".

Count ranges

The FM 450-1 counts within different limits in the count ranges 0 to +32 bits and -31 to +31 bits. In each case an overflow or an underflow is identified at the range limits.

In the "-31 to +31 bits" count mode, the counter status is represented in the two's complement.

Count range		Overflow	Underflow
0 to +32 bits [1]	0 to 4 294 967 295 0 to FFFF FFFFH	When the counter status changes from 4 294 967 295 to 0	When the counter status changes from 0°to 4 294 967 295
-31 to +31 bit	-2 147 483 648 to 2 147 483 647 8000 0000H to 7FFF FFFFH	When the counter status changes from +2 147 483 647 to -2 147 483 648	When the counter status changes from -2 147 483 648 to +2 147 483 647

[1] In this count range, you can only specify and evaluate values in hexadecimal.

Overflow, underflow and zero crossing

A bit is set in the DB of FC°CNT_CTRL for both count limits in the case of overflow and underflow (see section "Assignment of the DB (Page 87)").

In the "-31 to +31 bit" count range, a bit is similarly set in the DB on a zero crossing.

In the "0 to +32 bit" count range, an overflow or underflow, depending on the direction of counting, is additionally indicated on a zero crossing.

Event	Bit in the DB
Overflow	STS_OFLW is set
Underflow	STS_UFLW is set
Zero crossing	STS_ZERO is set

Triggering hardware interrupts

You can also signalize the events overflow, underflow and zero crossing by means of hardware interrupts.

8.8 Setting: Behavior of the digital outputs

Introduction

You can store two comparison values (comparison value 1 and 2) for the counters on the module; these are assigned to the respective digital outputs (comparison value°1: 1Q0 and 2Q0, comparison value 2: 1Q1 and 2Q1). The comparison values are compared to the current counter status. When the counter status reaches a comparison value, the relevant output can be set.

Comparison values 1 and 2

You enter the two comparison values in the DB of the FC CNT_CTRL (CMP_V1, CMP_V2) and transfer them to the FM 450-1 by setting the bits T_CMP_V1 or T_CMP_V2 (see the section "Assignment of the DB (Page 87)"). The count is not affected by this.

The comparison values must be within the limits of the respective count range. The comparison value is interpreted according to the selected count range. If you give FFFF FFFF H, for example, as the comparison value, the value is interpreted as 4 294 967 295 within the 0 to +32 bit count range, and as -1 within the -31 to +31 bit count range.

Enabling the outputs

Before you can activate the outputs, you must first enable them by setting the appropriate bits in the DB (see the section Assignment of the DB (Page 87)). If you reset one of these bits, the associated output is disabled immediately even if you have assigned a pulse duration for them.

Output	...is enabled by
Q0	CTRL_DQ0
Q1	CTRL_DQ1

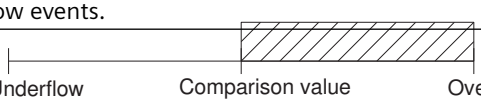
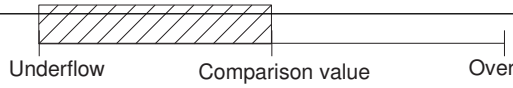
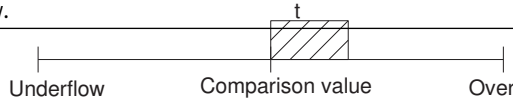
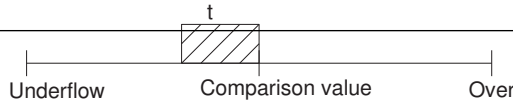
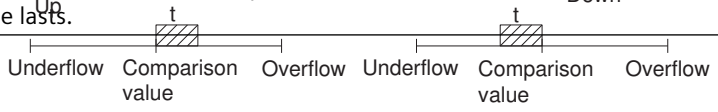
Status of the outputs

You can identify the state of the two outputs from the green status LEDs and the relevant bits in the DB.

Output status	LED status	Bit status
1Q0 (2Q0) is set	CH 1 OUT 0 (CH2 OUT 0) is alight	STS_COMP1 is set
1Q0 (2Q0) is reset	CH 1 OUT 0 (CH2 OUT 0) is dark	STS_COMP1 is reset
1Q1 (2Q1) is set	CH 1 OUT 1 (CH2 OUT 1) is alight	STS_COMP2 is set
1Q1 (2Q1) is reset	CH 1 OUT 1 (CH2 OUT 1) is dark	STS_COMP2 is reset

Behavior of the outputs

For the two outputs you can set one of six possible responses to reaching the comparison value. The various options are shown in the following table.

Digital output parameter assignment	Behavior of the outputs
Disable	 The output remains deactivated and is not affected by the comparison value, zero crossing, overflow, and underflow events.
Active between comparison value and overflow	 The output is enabled when the counter is within the range between comparison value n and overflow. The output is activated by setting the counter to a value between the comparison value and overflow.
Active between comparison value and overflow	 The output is activated when the counter is within the range between comparison value and underflow. The output is activated by setting the counter to a value between the comparison value and underflow.
Active for "pulse duration" when the comparison value is reached in up direction	 The output is activated when the comparison value is reached in the up counting direction for the time the pulse lasts.
Active for "pulse duration" when the comparison value is reached in down direction	 The output is activated when the comparison value is reached in the down count direction for the time the pulse lasts.
Active for "pulse duration" when comparison value is reached in up or down direction	 The output is activated when the comparison value is reached for the time the pulse lasts, irrespective of the counting direction.

A shaded in area in the table signifies: The output is active.

t = pulse duration

Boundary conditions

If you assign the behavior of the digital outputs, you must observe the following boundary conditions.

If ...	then...
... you want to assign parameters for the output to be "active between the comparison value and the overflow or underflow" ...	...you must ensure that the time between the events is longer than the minimum operating time of the outputs (operating time: 300°µs); otherwise the control pulses at the outputs are lost. If the counter status again reaches the comparison value while the output is still active, no new pulse will be initiated. A further pulse can only be initiated when the output is no longer active.
...you want to assign the parameters for the output to be "active for the pulse duration in the up counting direction"...	... you must not enable a hardware interrupt when "the comparison value 1 or 2 in the down direction is reached".
...you want to assign the parameters for the output to be "active for the pulse duration in the down counting direction"...	...you must not enable a hardware interrupt when "the comparison value 1 or 2 in the up direction is reached".

Disabling the outputs

The outputs are disabled by the following events, irrespective of the parameter assignment:

- Module watchdog timeout (internal error)
- Removal of the enable bit (CTRL_DQ0 for Q0 and CTRL_DQ1 for Q1 in the DB, see section "Assignment of the DB (Page 87)")

Default setting

The outputs are disabled in the default setting.

8.9 Setting: Pulse duration

Introduction

As a means of adaptation to the actors used in your process (contactors, control elements etc.) you have the possibility of specifying a pulse duration during which the outputs are set when a comparison value is reached. This section describes what you must take into account if you want to define a pulse duration for the outputs.

The effect of the pulse duration setting

Via the pulse duration you also specify for how long the output should be set at minimum. This setting is only effective if you preselect the behavior of the output accordingly. The pulse duration is without effect if the output is to be set between the comparison value and overflow or underflow.

Pulse duration begins when the output is set. Inaccuracy of the pulse duration is less than 1°ms.

Value range

You can prescribe a value between 0 and 500°ms for the pulse duration. This value applies to both outputs together.

Note

If you specify the pulse duration to be zero you must ensure that the count pulse times are greater than the minimum operation time of the digital outputs (operating time:°300°µs, i°e. the count frequency is less than 3333°Hz); otherwise the control pulses are lost at the outputs.

In this case check if your actor can respond with the operating time 300°µs.

Default value

The default value for the pulse duration is 0.

8.10 Command: Open and close gate

Overview

The FM 450-1 counters have the following gates:

- A hardware gate (HW gate) which you can open and close level controlled or edge controlled.
- A software gate (SW gate) which you can open and close via control bits in the user program.

Selecting a gate

In the "Operating Mode" dialog (see section "Overview of modes, settings and commands (Page 57)"), you specify which gate you want to use for the count process.

The following figures demonstrate the various possibilities for opening and closing the FM °450-1 gates.

Level controlled opening and closing of the HW gate

The following figure shows the level controlled opening and closing of the HW gate of counter °1.

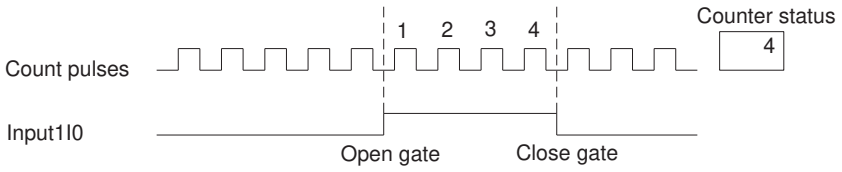


Figure 8-4 Level controlled opening and closing of the HW gate of counter 1

If you set input 1I0 to 1 the count signals can reach counter 1 and are counted. If you reset input 1I0 to 0, the door is closed. The count pulses are no longer counted, counter 1 stops.

If the gate of counter 1 is closed owing to overflow or underflow, you must first reset input 1I0 and apply a positive edge to input 1I0 to reopen the door.

Edge controlled opening and closing of the HW gate

The following figure shows the edge controlled opening and closing of the HW gate of counter 1.

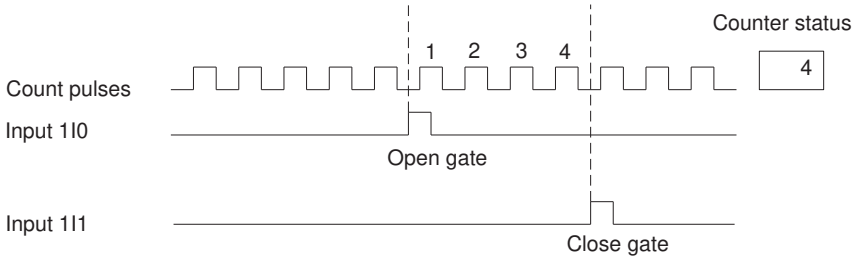


Figure 8-5 Edge controlled opening and closing of the HW gate of counter 1

With the edge controlled door function the HW gate of counter 1 is opened by a positive edge on input 1I0. The door is closed by a positive edge on input 1I1.

If positive edges occur simultaneously on inputs 1I0 and 1I1 an open gate is closed or a closed gate remains closed. If input 1I1 is set a positive edge on input 1I0 cannot open the gate.

The same applies analogously to counter 2 (inputs 2I0 and 2I1).

Status of inputs 1I0 (2I0) and 1I1 (2I1)

The status of the inputs 1I0 (2I0) and 1I1 (2I1) are indicated by the green LEDs CH1 IN 0 (CH 2 IN 0) and CH 1 IN 1 (CH 2 IN 1) and, within the user program, in the STS_STA and STS_STP bit of the DB of the FC°CNT_CTRL.

Gate status

The gate status is indicated in the STS_GATE bit within the user program.

Opening and closing the SW gate

The following figure shows the opening and closing of the SW gate of counter 1.

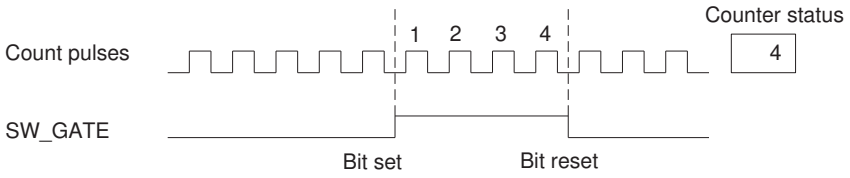


Figure 8-6 Opening and closing the SW gate

The SW gate is opened and closed by setting and resetting the input parameter SW_GATE of the FC CNT_CTRL.

The closed gate can be reopened by setting the input parameter SW_GATE again.

Status of the SW gate

The status of the SW gate is signalized on the STS_SW_G bit of the DB of the FC°CNT_CTRL.

Terminating the count with the gate stop function

In addition, you can terminate the counting process at any time using the gate stop function of the relevant counter, irrespective of the signals applied or the status of the SW gate. For this purpose you set the GATE_STP input parameter of the FC CNT_CTRL.

When you reset the GATE_STP parameter, you can only open the gate for the counter concerned by means of a positive edge, either at input 1I0 or 2I0 (HW gate) or resetting the SW_GATE input parameter (SW gate).

Hardware interrupt

Opening and closing of a HW or SW gate can be used to trigger a hardware interrupt (see section "Initiating a process interrupt (Page 76)".)

Default setting

In the default setting all gates are open; the count pulses are counted.

8.11 Command: Set counter

Overview

If you want to start or continue the counting process of a counter from a specific value (the load value), you must assign parameters for the signal with which the counter is to be set to the load value. You can set the counter as follows:

- With the L_DIRECT input parameter of the FC_CNT_CTRL
- With an external signal either via input 1I2 (2I2) or via the input in conjunction with the zero mark of the encoder.

This section describes the different methods and the time sequence for setting a counter.

Load value

Any number within the count range can be set for the load value.

The load value is interpreted according to the selected count range. If, for example, you specify FFFF FFFF H as the load value, this is interpreted as 4 294 967 295 within the count range 0 to +32 bit and as -1 within the count range -31 to +31 bit.

The load value is entered in the DB of the FC°CNT_CTRL.

Setting the counter via the user program

Regardless of the external events, you can set a counter with the FC°CNT_CTRL by means of the L_DIRECT input parameter. This is also possible while a count is in progress.

The input parameter L_DIRECT is reset by FC CNT_CTRL once the job is successful completed.

If you set the counter via the FC_CNT_CTRL call, setting cannot trigger a hardware interrupt.

Setting the counter with an external signal

The L_PREPAR input parameter prepares a new load value. You can choose between two different external signals with which you set a counter to the load value

- Only input 1I2 (2I2)
- Input 1I2 (2I2) and the zero mark of the encoder

You use the zero mark of the encoder if you want to synchronize the counter to a specific counter status at a specific point in your process. Hence you achieve greater precision in the count process.

The counter is set independent of the mode.

After setting the counter with an external signal, the STS_SYNC bit is set in the DB. The STS_SYNC bit is cleared by the RES_SYNC bit.

Note

The synchronization of a counter with the zero mark only makes sense if the gate is open.

When setting a counter with an external signal, if you have only enabled one count direction, please note the following: When the door closes, only the current count direction is stored (frozen). Hence it is possible for the counter to be synchronized in the opposite direction to the enabled count direction.

Hardware interrupt

Setting a counter with an external signal can be used to trigger a hardware interrupt.

Setting counter with input 1I2 (2I2)

A counter can be loaded with the load value via a rising edge at input 1I2 (2I2).

You can specify the behavior of an FM°450-1 counter with a positive edge at input 1I2 (2I2) with the ENSET_UP and ENSET_DN variables in the DB of the FC_CNT_CTRL and by means of parameter assignment.

Bit	Behavior of the FM 450-1
ENSET_UP set	The counter is only set in the case of up counting
ENSET_DN set	The counter is only set in the case of down counting
ENSET_UP and ENSET_DN set	Counter is set for up and down counting.

Parameter assignment	Behavior of the FM 450-1
Parameter assignment "single setting of counter"	The counter is set only at the first rising edge at input 1I2 (2I2). If the counter is to be set again, you must first set ENSET_UP or ENSET_DN again. The counter is then set again with the next positive edge at input 1I2 (2I2).
Parameter assignment "multiple setting of counter"	As long as ENSET_UP or/and ENSET_DN are set, the counter will be set with each rising edge at input 1I2 (2I2).

Note

It is imperative that you set one of the two variables, ENSET_UP or/and ENSET_DN, so that the relevant counter can be set via input 1I2 (2I2).

Setting counter once with input 1I2 (2I2)

The following figure shows counter 1 being set once with input 1I2. The situation is analogous for counter 2 with input 2I2. In the case represented here, only ENSET_UP is set, i.e., the counter is set during up counting.

The relevant counter is set with the first rising edge at input 1I2, as long as ENSET_UP is set. If you want to set this counter again, first you must reset the relevant ENSET_UP and then set it again. Then the next positive edge at input 1I2 results in the counter being set.

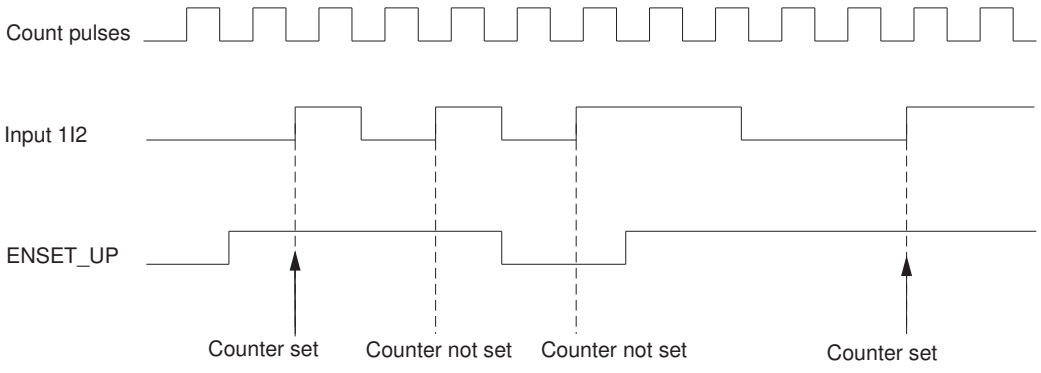


Figure 8-7 Single setting of counter 1 with input 1I2

Multiple setting of the counter with input 1I2 (2I2)

The following figure shows the multiple setting of counter 1with input 1I2. The situation is analogous for counter 2 with input 2I2. In the case represented here, only ENSET_UP is set, i.e., the counter is set during up counting.

The relevant counter is set with the first rising edge at input 1I2, as long as ENSET_UP is set. When you reset ENSET_UP you cannot set the counter with input 1I2. Only after you have set ENSET_UP again will the next positive edge at input 1I2 result in the setting of the counter.

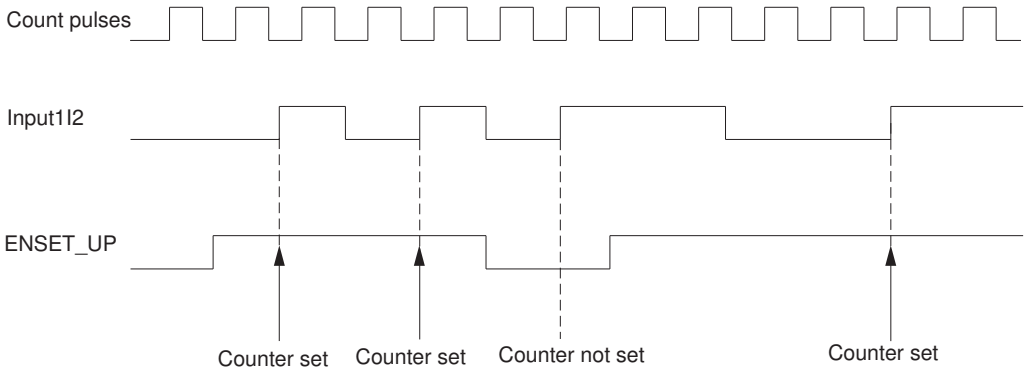


Figure 8-8 Multiple setting of counter 1 with input 1I2

Setting the counter with the zero mark

If you assign the parameters for setting a counter with the zero mark of the encoder, the relevant counter is set with the rising edge of the zero mark.

Setting is only performed if input 1I2 (2I2) of the relevant counter is set at the time of the rising edge of the zero mark.

With the ENSET_UP and ENSET_DN variable is the DB of the FC CNT_CTRL and by assigning parameters, you specify the behavior of the respective FM 450-1 counter in the case of a rising edge of the zero mark.

Bit	Behavior of the FM 450-1 counter
ENSET_UP set	The counter is only set in the case of up counting.
ENSET_DN set	The counter is only set in the case of down counting.
ENSET_UP and ENSET_DN set	Counter is set for up and down counting.

Parameter assignment	Behavior of the FM 450-1 counter
Parameter assignment "single setting of counter"	The counter is set only at the first rising edge of the zero mark. If the counter is to be set again, you must first set ENSET_UP or ENSET_DN again (edge evaluation). The counter is then set again with the next rising edge of the zero mark.
Parameter assignment "multiple setting of counter"	As long as ENSET_UP and/or ENSET_DN are set, the counter will be set with each rising edge of the zero mark.

Note

It is imperative that you set one of the two variables, ENSET_UP or/and ENSET_DN and input 1I2 (2I2) so that the relevant counter can be set with the zero mark.

Single setting with the zero mark

The following figure shows counter 1 being set once with the zero mark. In the case represented here, only ENSET_UP is set, i.e., the counter is set during up counting.

The relevant counter is set with the first rising edge of the zero mark as long as ENSET_UP and input 1I2 are set.

If you want to set counter°1 again, you must reset ENSET_UP and then set it again. If input 1I2 is not set, setting is performed with the first zero mark after setting 1/2. If input 1I2 is set, setting takes place with the next zero mark.

The situation is analogous for counter 2 with input 2I2.

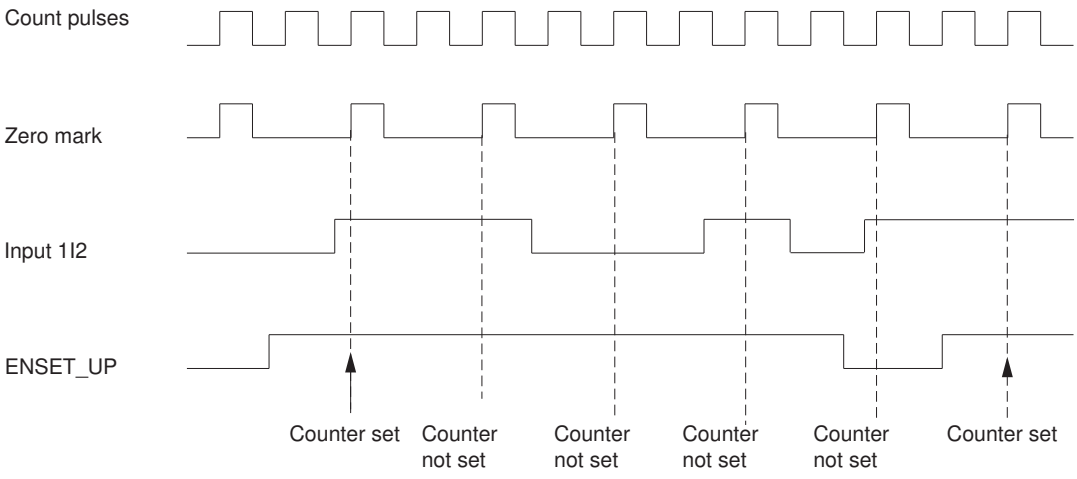


Figure 8-9 Single setting of counter 1 with the zero mark

Multiple setting with the zero mark

The following figure shows multiple setting of counter 1 with the zero mark. In the case represented here, only ENSET_UP is set, i.e., the counter is set during up counting.

The relevant counter is set with each first rising edge of the zero mark as long as ENSET_UP and input 1I2 are set.

The situation is analogous for counter 2 with input 2I2.

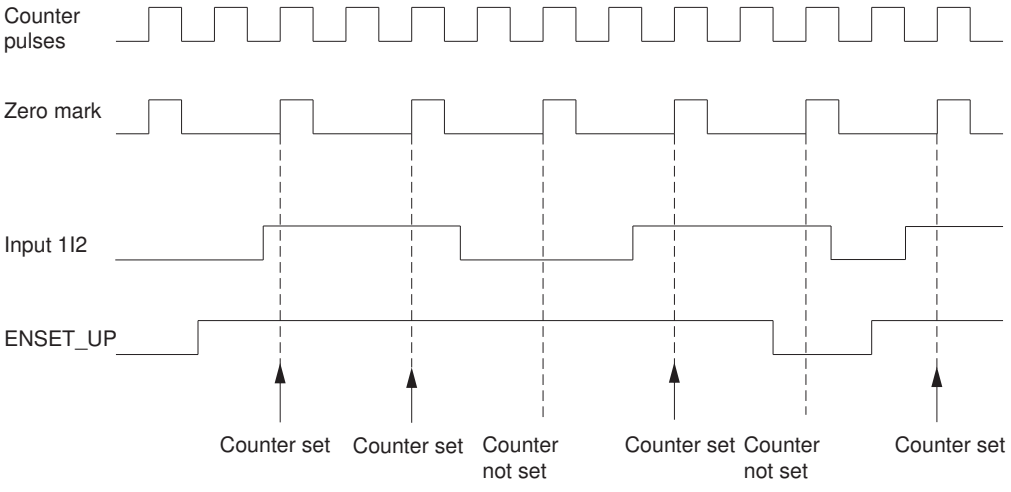


Figure 8-10 Multiple setting of counter 1 with the zero mark

8.12 Initiating a process interrupt

Introduction

For the individual counters of the FM 450-1 you can set which events are to trigger a hardware interrupt during operation. For this purpose you parameterize the counter interrupts in the parameter assignment screen marks.

What is a hardware interrupt?

If a response is to be made to an event regardless of the cycle of the CPU, each counter of the FM 450-1 can trigger a hardware interrupt. The CPU then interrupts the cyclical program and handles the hardware interrupt OB.

Which events can trigger a hardware interrupt?

In the FM 450-1 count mode, the following events can trigger a hardware interrupt (independently of each other for each of the two counters):

- Opening of the gate (in modes with HW or SW gate)
- Closing of the gate (in modes with HW or SW gate)
- Overflow
- Underflow
- Zero crossing
- Reaching comparison value 1 in the up direction
- Reaching comparison value 1 in the down direction
- Reaching comparison value 2 in the up direction
- Reaching comparison value 2 in the down direction
- Setting the counter with an external signal

You can select a random number of events for triggering hardware interrupts, as long as the boundary conditions are observed.

Enabling the hardware interrupt

When configuring the hardware, in the parameter assignment screen masks you enable the interrupts for the module and choose whether the module is to initiate a diagnostic and/ or a hardware interrupt.

Hardware interrupt OB, OB 4x

If a hardware interrupt occurs, the user program is interrupted, the data are transferred from the module to the start information of the OB 4x and the OB 4x is called. The hardware interrupt is acknowledged by quitting the OB 4x.

If no OB 4x is programmed the CPU goes into STOP. If you then switch back to RUN, the hardware interrupt requirements are deleted.

Start information

The temporary variable OB4x_POINT_ADDR is described in the start information of the OB4x.

The OB4x_POINT_ADDR variable (bytes 8 - 11) consists of four bytes. The information on the event that initiated the hardware interrupt is entered into these four bytes. The following table shows which bits are set for which interrupt. All bits not listed have no meaning and are zero.

Byte	Bit	Significance: Interrupt in the case of...
Counter 1		
0	0	Opening the gate
	1	Closing the gate
	2	Overflow
	3	Underflow
	4	Reaching comparison value 1 in the up direction
	5	Reaching comparison value 1 in the down direction
	6	Reaching comparison value 2 in the up direction
	7	Reaching comparison value 2 in the down direction
1	0	Zero crossing
	5	Setting of the counter
Counter 2		
2	0	Opening the gate
	1	Closing the gate
	2	Overflow
	3	Underflow
	4	Reaching comparison value 1 in the up direction
	5	Reaching comparison value 1 in the down direction
	6	Reaching comparison value 2 in the up direction
	7	Reaching comparison value 2 in the down direction
3	0	Zero crossing
	5	Setting of the counter

Lost hardware interrupt

If an event occurs that is to trigger a hardware interrupt and the same previous event has not yet been acknowledged, no further hardware interrupt is triggered; the hardware interrupt is lost.

This can result in the diagnostic interrupt "hardware interrupt lost" depending on the parameters assigned.

Default setting

No hardware interrupt is assigned in the default setting.

Encoder signals and their evaluation

9

9.1 Chapter overview

Chapter overview

This chapter describes:

- which encoders you can connect to the counter module
- the time profile of the encoder signals
- the multiple evaluation of encoder signals by the counter module
- how the module monitors the various encoder signals
- which signals can be assigned input filter parameters.

9.2 Encoders which can be connected

Introduction

The counter module can process rectangular count signals which were generated by incremental encoders or pulse generators.

Incremental encoders scan a barcode to generate rectangular electrical pulses. They differ in terms of pulse amplitude and number of signals.

Pulse generators such as light barriers or proximity switches (BEROs) return only a rectangular signal at a specific amplitude.

Connecting different encoders

The counter module supports different encoders which return pulses for the count signals. The table shows these encoders and the corresponding signals.

Table 9-1 Encoders which can be connected

Encoders	Signal
5-V incremental encoder	Differential signals A and /A, B and /B, N and /N
24-V incremental encoder	A*, B* and N*
24-V pulse encoder	24-V with directional signal
24-V proximity switch	24 V without directional signal

9.3 5-V differential signals

Count signals of 5-V incremental encoders

RS422 signals returned by the 5-V incremental encoder to the module:

- A and /A
- B and /B
- N and /N

The signals /A, /B and /N are the inverted signals of A, B and N. Signals A and B are phase-shifted by 90°.

The tracks A and B of 5-V incremental encoders are used for counting. Track N is used to initialize the counter with the load value, if programmed accordingly.

Encoders featuring these six signals are symmetrical encoders.

The diagram shows the time profile of the encoder signals:

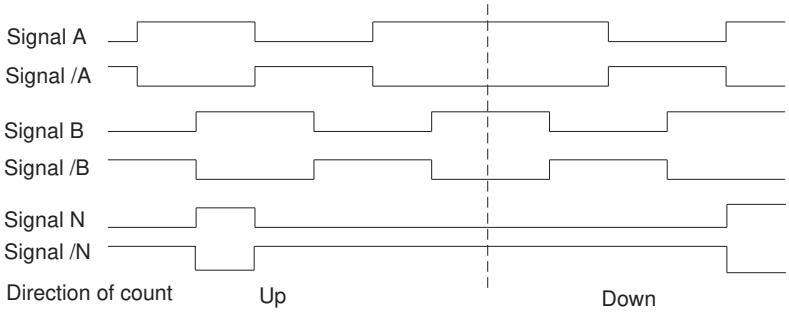


Figure 9-1 Signals of the 5-V incremental encoder

The module detects the count direction by evaluating the ratio of signals A and B. The diagrams in the chapter "Signal evaluation (Page 83)" show which edges of signals A and B are counted in down or up direction.

Changing the count direction

You can change the count direction using the "Count direction normal" and "Count direction inverted" parameters without having to modify the wiring.

Monitoring encoder signals

The module monitors the cable connection, and detects wire-break or short-circuit.

You can define which of the three signal pairs to include in monitoring in your program. There is no need to wire any unused signal pairs, if you have disabled the corresponding diagnostics functions in the program (monitoring.)

An error state at all three signals indicates a defective encoder, or a short-circuit at the "5.2 V DC" encoder supply, or a missing encoder.

When programming is completed, and the module detects an error, the error information will be written to the diagnostics data records DS0 and DS1. This situation my lead to a diagnostics interrupt if programmed accordingly.

Coding plug (only for FM 350-1)

To operate this encoder, insert the coding plug in position A.

9.4 24-V signals

Count signals returned by 24-V encoders

24-V incremental encoders

The 24-V incremental encoder returns the 24-V signals A*, B* and N* to the module. The A* and B* signals are phase-shifted by 90°.

24-V signals are marked with an asterisk "*" character.

The tracks A* and B* of a 24-V incremental encoder are used for counting. Track N* is used to initialize the counter with the load value, if programmed accordingly.

Encoders which do not return inverted signals asymmetrical encoders.

The diagram shows the time profile of the encoder signals:

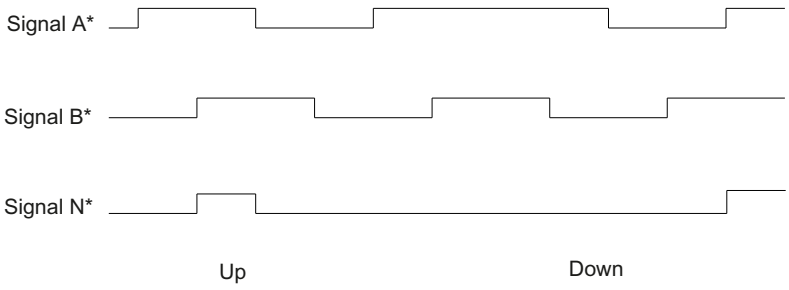


Figure 9-2 Signals of the 24-V incremental encoder

The module detects the count direction by evaluating the ratio of signals A* and B*. The diagrams in the chapter "Signal evaluation (Page 83)" show which edges of the A* and B* signals are incremented or decremented.

You can program the inputs of 24-V encoder signals for the connection of source outputs, or push-pull outputs, or sink outputs. For further information, refer to the encoder manual.

You can change the count direction using the "Count direction normal" and "Count direction inverted" parameters without having to modify the wiring.

24-V pulse encoders without/with direction signal

Encoders such as proximity switches (BERO) or light barriers return only a count signal which you wire to terminal A* of the front connector.

in additional, you can wire a signal for direction detection to terminal B* of the relevant counter. If your encoder does not return a corresponding signal, you can wire a corresponding ID signal you generate within the user program, or use a corresponding process signal.

The diagram shows the time profile of the encoder signals, and the resultant count pulses

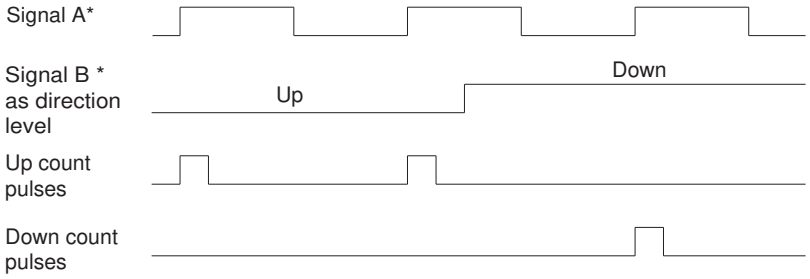


Figure 9-3 Signals of a 24-V pulse generator with direction signal

Programming the encoder inputs

The count direction is defined by programming the encoder inputs. The diagram shows a change of the count direction based on parameter settings.

Table 9-2 Count direction determined by input parameters

Programming	Terminal B*	Count direction
current sourcing, push-pull	not wired	Up
	24 V connected	Down
current sinking	not wired	Down
	Short-circuited to ground	Up

Set the "24 V pulse and direction" parameter for the selected encoder.

You can not reverse the direction of these count signal by inverting the B* signal.

Note

This type of evaluation may cause the count value to "drift off" at the edges if count signal oscillates, as all signals are added.

Input filters for the 24-V count inputs

For the purpose of suppressing interference, you can parameterize input filters with a uniform filter time for the 24 V inputs A*, B* and N* and for the digital inputs. Input filters available:

Table 9-3 Input filters

Features	Input filter 1 (default)	Input filter 2
Typical input delay	1 µs	15 µs
Maximum count frequency	200 kHz	20 kHz
Minimum pulse width of count signals	2.5 µs	25 µs

Monitoring encoder signals

The 24-V count signals are not monitored to detect wire-breaks or short-circuits.

Coding plug (only for FM 350-1)

To operate this encoder, insert the coding plug in position D.

9.5 Signal evaluation

Overview

The counter module supports the count of signal edges. It usually evaluates the edge at A (A*) (single evaluation). Options in the program of increasing the resolution:

- Single evaluation
- Double evaluation
- Quadruple evaluation

Multiple evaluation is only supported for 5-V incremental encoders which return the A and B signal with a phase shift of 90°, for 24-V incremental 24 V encoders with a phase shift of 90° of the A* and B* signals.

Single evaluation

In this mode, the module evaluates only one edge of signal A. Up count pulses are recorded at the positive edge at track A, and if track B is low. Down count pulses are recorded at the positive edge at track A, and if track B is low.

The diagram shows a single evaluation of signals:

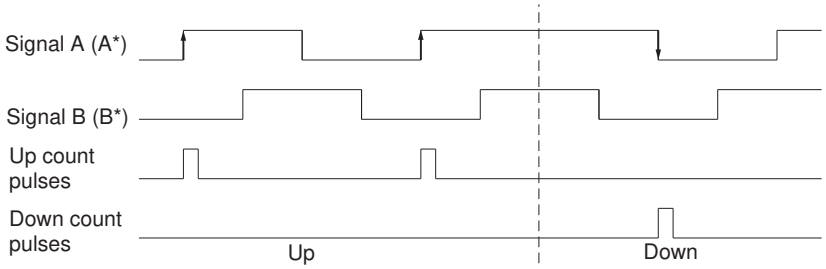


Figure 9-4 Single evaluation

Double evaluation

Double evaluation refers to the evaluation of the positive and negative edges of signal A. The logic level at signal B determines the count direction, i.e. the up or down count pulse.

The diagram shows the double evaluation of signals:

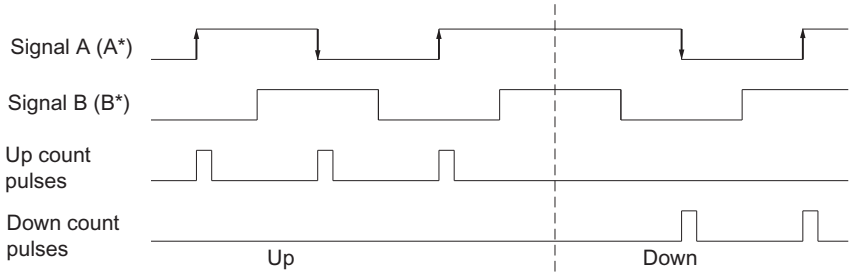


Figure 9-5 Double evaluation

Quadruple evaluation

Quadruple evaluation refers to the evaluation of the positive and negative edges of signals A and B. The logic level at the signals A and B determines the count direction, i.e. the up or down count pulse.

The diagram shows quadruple evaluation of signals:

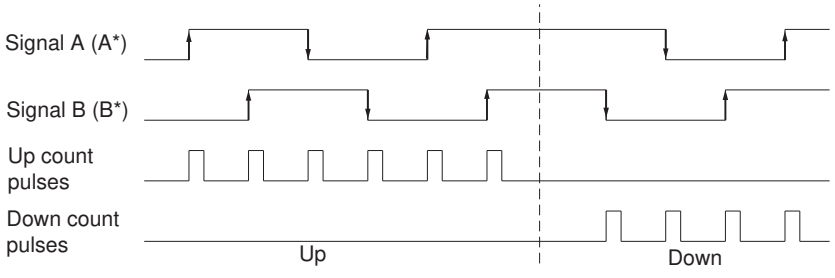


Figure 9-6 Quadruple evaluation

Default

Single evaluation is set by default.

Assignment of the DB

10

10.1 Assignment of the DB

DB for the FC°CNT_CTRL

All data associated with a channel of the module are located in the DB of FC CNT_CTRL. The data structure and the length of the DB is determined by the variable declaration in FC CNT_CTRL. Prior to configuring the module, the DB must have the following valid data assigned to it (see section "Program (Page 39)"):

- Module address (address 6.0)
- Channel starting address (address 8.0)
- User data length (address 12.0)

The DB was generated from the UDT 1 as a data block with associated, user-specific data type (see section "Program (Page 39)"). The DB assignments resulting from this are shown below.

Table 10-1 Assignment of the DB

Address	Variable	Data type	Initial value	Comment
0.0	AR1_BUFFER	DWORD	DW#16#0	AR1 buffer
4.0	FP	BYTE	B#16#0	Flag byte
5.0	RESERVED	BYTE	B#16#0	Reserved
6.0	MOD_ADR	WORD	W#16#0	Module address
8.0	CH_ADR	DWORD	DW#16#0	Channel address
12.0	U_D_LGTH	BYTE	B#16#0	User data length
13.0	A_BYTE_0	BYTE	B#16#0	Reserved
14.0	LOAD_VAL[1]	DINT	L#0	New load value (write user)
18.0	CMP_V1[1]	DINT	L#0	New comparison value 1 (write user)
22.0	CMP_V2[1]	DINT	L#0	New comparison value 2 (write user)
26.0	A_BIT0_0	BOOL	FALSE	Reserved
26.1	TFB	BOOL	FALSE	Test enabled
26.2	A_BIT0_2	BOOL	FALSE	Reserved
26.3	A_BIT0_3	BOOL	FALSE	Reserved
26.4	A_BIT0_4	BOOL	FALSE	Reserved
26.5	A_BIT0_5	BOOL	FALSE	Reserved
26.6	A_BIT0_6	BOOL	FALSE	Reserved
26.7	A_BIT0_7	BOOL	FALSE	Reserved
27.0	ENSET_UP[1]	BOOL	FALSE	Enable setting in up direction (write user)
27.1	ENSET_DN[1]	BOOL	FALSE	Enable setting in down direction (write user)
27.2	A_BIT1_2	BOOL	FALSE	Reserved
27.3	A_BIT1_3	BOOL	FALSE	Reserved

Address	Variable	Data type	Initial value	Comment
27.4	A_BIT1_4	BOOL	FALSE	Reserved
27.5	A_BIT1_5	BOOL	FALSE	Reserved
27.6	A_BIT1_6	BOOL	FALSE	Reserved
27.7	A_BIT1_7	BOOL	FALSE	Reserved
28.0	CTRL_DO0[1]	BOOL	FALSE	Enable digital output DO0 (write user)
28.1	CTRL_DO1[1]	BOOL	FALSE	Enable digital output DO1 (write user)
28.2	A_BIT2_2	BOOL	FALSE	Reserved
28.3	A_BIT2_3	BOOL	FALSE	Reserved
28.4	A_BIT2_4	BOOL	FALSE	Reserved
28.5	A_BIT2_5	BOOL	FALSE	Reserved
28.6	A_BIT2_6	BOOL	FALSE	Reserved
28.7	A_BIT2_7	BOOL	FALSE	Reserved
29.0	A_BIT3_0	BOOL	FALSE	Reserved
29.1	A_BIT3_1	BOOL	FALSE	Reserved
29.2	A_BIT3_2	BOOL	FALSE	Reserved
29.3	A_BIT3_3	BOOL	FALSE	Reserved
29.4	A_BIT3_4	BOOL	FALSE	Reserved
29.5	A_BIT3_5	BOOL	FALSE	Reserved
29.6	A_BIT3_6	BOOL	FALSE	Reserved
29.7	A_BIT3_7	BOOL	FALSE	Reserved
30.0	LATCH_LOAD[1]	DINT	L#0	Current load or latch value (read user)
34.0	ACT_CNTV[1]	DINT	L#0	Current count value (read user)
38.0	DA_ERR_W[1]	WORD	W#16#0	Data error word (read user)
40.0	OT_ERR_B[1]	BYTE	B#16#0	Operator error byte (read user)
41.0	E_BIT0_0	BOOL	FALSE	Reserved
41.1	STS_TFB	BOOL	FALSE	Status test free
41.2	DIAG	BOOL	FALSE	Reserved
41.3	E_BIT0_3	BOOL	FALSE	Reserved
41.4	DATA_ERR[1]	BOOL	FALSE	Data error bit (read user)
41.5	E_BIT0_5	BOOL	FALSE	Reserved
41.6	E_BIT0_6	BOOL	FALSE	Reserved
41.7	PARA[1]	BOOL	FALSE	Module parameters assigned (read user)
42.0	E_BYTE_0	BYTE	B#16#0	Reserved
43.0	STS_RUN	BOOL	FALSE	Status, counter working
43.1	STS_DIR[1]	BOOL	FALSE	Status count direction (read user)
43.2	STS_ZERO[1]	BOOL	FALSE	Status zero crossing (read user)
43.3	STS_OFLW[1]	BOOL	FALSE	Status overflow (read user)
43.4	STS_UFLW[1]	BOOL	FALSE	Status underflow (read user)
43.5	STS_SYNC[1]	BOOL	FALSE	Status counter synchronized (read user)
43.6	STS_GATE[1]	BOOL	FALSE	Status internal gate (read user)
43.7	STS_SW_G[1]	BOOL	FALSE	Status SW gate (read user)
44.0	STS_SET[1]	BOOL	FALSE	Status digital input SET (read user)
44.1	STS_LATCH[1]	BOOL	FALSE	Reserved

Address	Variable	Data type	Initial value	Comment
44.2	STS_STA[1]	BOOL	FALSE	Status digital input START (read user)
44.3	STS_STP[1]	BOOL	FALSE	Status digital input STOP(read user)
44.4	STS_CMP1[1]	BOOL	FALSE	Status output comparison value 1 (read user)
44.5	STS_CMP2[1]	BOOL	FALSE	Status output comparison value 2 (read user)
44.6	STS_COMP1[1]	BOOL	FALSE	Reserved
44.7	STS_COMP2[1]	BOOL	FALSE	Reserved
45.0	E_BIT3_0	BOOL	FALSE	Reserved
45.1	E_BIT3_1	BOOL	FALSE	Reserved
45.2	E_BIT3_2	BOOL	FALSE	Reserved
45.3	E_BIT3_3	BOOL	FALSE	Reserved
45.4	E_BIT3_4	BOOL	FALSE	Reserved
45.5	E_BIT3_5	BOOL	FALSE	Reserved
45.6	E_BIT3_6	BOOL	FALSE	Reserved
45.7	E_BIT3_7	BOOL	FALSE	Reserved
46.0	ACT_CMP1[1]	DINT	L#0	Current comparison value 1 (read user)
50.0	ACT_CMP2[1]	DINT	L#0	Current comparison value 2 (read user)
The following diagnostics data are entered by the FC_DIAG_INF				
54.0	MDL_DEFECT	BOOL	FALSE	Module faults
54.1	INT_FAULT	BOOL	FALSE	Internal error
54.2	EXT_FAULT	BOOL	FALSE	External error
54.3	PNT_INFO	BOOL	FALSE	Channel error
54.4	EXT_VOLTAGE	BOOL	FALSE	Auxiliary voltage fault
54.5	FLD_CNNCTR	BOOL	FALSE	Front connectors
54.6	NO_CONFIG	BOOL	FALSE	Missing parameters
54.7	CONFIG_ERR	BOOL	FALSE	Faulty parameters
55.0	MDL_TYPE	BYTE	B#16#0	Module type
56.0	SUB_MDL_ERR	BOOL	FALSE	Incorrect/missing interface module
56.1	COMM_FAULT	BOOL	FALSE	Communication error
56.2	MDL_STOP	BOOL	FALSE	RUN/STOP operating status indicator
56.3	WTCH_DOG_FAULT	BOOL	FALSE	Watchdog (FM)
56.4	INT_PS_FLT	BOOL	FALSE	Internal power supply fault
56.5	PRIM_BATT_FLT	BOOL	FALSE	Battery monitoring
56.6	BCKUP_BATT_FLT	BOOL	FALSE	Backup fault
56.7	RESERVED_2	BOOL	FALSE	Reserved
57.0	RACK_FLT	BOOL	FALSE	Module rack fault
57.1	PROC_FLT	BOOL	FALSE	CPU fault
57.2	EPROM_FLT	BOOL	FALSE	EPROM fault
57.3	RAM_FLT	BOOL	FALSE	RAM fault
57.4	ADU_FLT	BOOL	FALSE	ADC/DAC fault
57.5	FUSE_FLT	BOOL	FALSE	Fuse
57.6	HW_INTR_FLT	BOOL	FALSE	Hardware interrupt lost
57.7	RESERVED_3	BOOL	FALSE	Reserved
58.0	CH_TYPE	BYTE	B#16#0	Channel type

Address	Variable	Data type	Initial value	Comment
59.0	LGTH_DIA	BYTE	B#16#0	Diagnostics data length per channel
60.0	CH_NO	BYTE	B#16#0	Channel number
61.0	GRP_ERR1	BOOL	FALSE	Group error channel 1
61.1	GRP_ERR2	BOOL	FALSE	Group error channel 2
61.2	D_BIT7_2	BOOL	FALSE	DS1 byte 7 bit 2
61.3	D_BIT7_3	BOOL	FALSE	DS1 byte 7 bit 3
61.4	D_BIT7_4	BOOL	FALSE	DS1 byte 7 bit 4
61.5	D_BIT7_5	BOOL	FALSE	DS1 byte 7 bit 5
61.6	D_BIT7_6	BOOL	FALSE	DS1 byte 7 bit 6
61.7	D_BIT7_7	BOOL	FALSE	DS1 byte 7 bit 7
62.0	CH1_SIGA	BOOL	FALSE	Channel 1, error signal A
62.1	CH1_SIGB	BOOL	FALSE	Channel 1, error signal B
62.2	CH1_SIGZ	BOOL	FALSE	Channel 1, error zero signal
62.3	CH1_BETW	BOOL	FALSE	Channel 1, error between channels
62.4	CH1_5V2	BOOL	FALSE	Channel 1, 5.2 V encoder supply fault
62.5	D_BIT8_5	BOOL	FALSE	DS1 byte 8 bit 5
62.6	D_BIT8_6	BOOL	FALSE	DS1 byte 8 bit 6
62.7	D_BIT8_7	BOOL	FALSE	DS1 byte 8 bit 7
63.0	D_BYTE9	BYTE	B#16#0	DS1 byte 9
64.0	CH2_SIGA	BOOL	FALSE	Channel 2, error signal A
64.1	CH2_SIGB	BOOL	FALSE	Channel 2, error signal B
64.2	CH2_SIGZ	BOOL	FALSE	Channel 2, error zero signal
64.3	CH2_BETW	BOOL	FALSE	Channel 2, error between channels
64.4	CH2_5V2	BOOL	FALSE	Channel 2, 5.2V encoder supply fault
64.5	D_BIT10_5	BOOL	FALSE	DS1 byte 10 bit 5
64.6	D_BIT10_6	BOOL	FALSE	DS1 byte 10 bit 6
64.7	D_BIT10_7	BOOL	FALSE	DS1 byte 10 bit 7
65.0	D_BYTE11	BYTE	B#16#0	DS1 byte 11
66.0	D_BYTE12	BYTE	B#16#0	DS1 byte 12
67.0	D_BYTE13	BYTE	B#16#0	DS1 byte 13
68.0	D_BYTE14	BYTE	B#16#0	DS1 byte 14
69.0	D_BYTE15	BYTE	B#16#0	DS1 byte 15
[1] Variables in the DB that you have to/can enter or read out during work with the FM				

Errors and diagnostics 11

11.1 Chapter overview

Chapter overview

Errors can occur owing to operator errrs or incorrect wiring which the module must communicate to the user.

The errors and faults are divided into the following classes on the module:

- Faults displayed by the diagnostics LEDs that indicate internal and external module faults.
- Faults that can trigger a diagnostics interrupt.
- Operator errors caused by incorrect operation.

The different classes of errors are indicated and displayed in different positions and must be acknowledged in different ways.

This chapter describes

- which errors and faults can occur,
- where these errors and faults are displayed and
- how you acknowledge them.

11.2 Faults indicated via the diagnostics LEDs

Where are the faults displayed?

Faults are indicated by the two red diagnostics LEDs:

- The INTF diagnostics LED displays internal faults of the module.
- The EXTF diagnostics LEDdisplays external faults to the cable connections.

Which fauts are displayed?

The following faults are indicated by the two red diagnostics LEDs lighting up:

Fault type/LED	Cause of fault	Correction
Internal fault INTF diagnostics LED	Fault in EPROM TEST	Module replacement
	Fault in RAM TEST	Module replacement
	Watchdog has responded	Module replacement
	Process interrupt lost	Is acknowledged by processing the process interrupt.

Fault type/LED	Cause of fault	Correction
External fault EXTF Diagnostics LED	Auxilliary voltage 1L+/1M is not connected or 24 VDC encoder supply is short circuited	Correct connection
	5.2 VDC encoder supply short circuited or overloaded	Correct connection
	5 V encoder signals faulty (wire breakage, short circuit, cable missing)	Correct connection

Initiation of a diagnostics interrupt

All faults, except for the fault in the EPROM test can initiate a diagnostics interrupt if you have enabled the diagnostics interrupt in the relevant parameter assignment screen form. You will find out which fault has caused the LED to light up from the diagnostic data records DS0 and DS1. The assignment of the diagnostics data records DS0 and DS1 is described in the next section.

11.3 Initiation of diagnostics interrupts

What is a diagnostics interrupt?

If the user program is to respond to an internal or external fault, you can set the parameters for a diagnostic interrupt that will break off the cyclical program of the CPU device and calls the diagnostics interrupt OB (OB 82).

Which events can initiate a diagnostic interrupt?

The following events can initiate a diagnostic interrupt:

- The external auxiliary 1L+/1M voltage is faulty.
- 5.2 VDC encoder supply short circuited or overloaded.
- The module parameters are incorrectly assigned.
- Watchdog timeout
- RAM defective
- Hardware interrupt lost
- Signal A faulty (wire breakage, short circuit, cable missing)
- Signal B faulty (wire breakage, short circuit, cable missing)
- Signal N faulty (wire breakage, short circuit, cable missing)

Enabling the diagnostic interrupt

You disable or enable the interrupts for the module and you choose whether the module is to initiate a diagnostic interrupt and/or a hardware interrupt.

Responses to a diagnostic interrupt

If an event occurs that can trigger a diagnostic interrupt, the following happens:

- The diagnostic information is stored in the diagnostic data records DS0 and DS1 on the module.
- An error LED lights up.
- The diagnostic interrupt OB is called (OB82).
- Diagnostic data record DS0 is entered in the start information of the diagnostic interrupt OB.
- The count process continues unchanged.

If no OB82 has been programmed, the CPU goes into STOP.

Diagnostic Data Records DS0 and DS1

The information as to which event triggered a diagnostic interrupt is stored in diagnostic data records DS0 and DS1. Diagnostics data record DS0 consists of 4 bytes; DS1 consists of 12 bytes, the first 4 bytes of which are identical to DS0.

Reading the data record from the module

Diagnostic data record DS0 is automatically transferred to the start information when the diagnostic OB is called. These four bytes are stored there in the local data element (bytes 8-11) of OB 82.

You can read out the diagnostic data record DS 1 and hence also the contents of DS0 from the module using FC DIAG_INF. This is only useful if DS0 signals an error in one channel.

Assignment of the Diagnostic Data Record DS0 and the Start Information

The table below shows the assignment of the diagnostic data record DS0 in the start information. All bits not listed have no meaning and are zero.

Table 11-1 Assignment of diagnostic data record DS0

Byte	Bit	Meaning	Remark	Event no.
0	0	Module error	Is set at each diagnostic event.	8:x:00
	1	Internal error	Is set for all internal faults: • Fault in RAM TEST • Watchdog timeout • Lost hardware interrupt	8:x:01
	2	External error	Is set for all external faults: • Auxiliary voltage 1L+/1M is not connected or 5.2 VDC encoder supply is short circuited • 5.2 VDC encoder supply short circuited or overloaded. • 5V signals faulty • Faulty parameter assignment	8:x:02
	3	Error in one channel	1 is always assigned for internal and external faults.	8:x:03
	4	External auxiliary voltage faulty		8:x:04
	7	Faulty parameter assignment		8:x:07
1	0 ... 3	Type class	Always assigned with 8.	
	4	Channel information	Always assigned with 1.	
2	3	Watchdog timeout		8:x:33
3	3	RAM defective		8:x:43
	6	Hardware interrupt lost		8:x:46

Diagnostic data record DS1

Diagnostic data record DS 1 consists of 12 bytes. The first 4 bytes are identical to diagnostic data record DS0. The following table shows the assignment of the remaining bytes. All bits not listed have no meaning and are zero. This data record is entered into DB 1 from DW54 with the FC DIAG_INF.

Table 11-2 Assignment of the bits of bytes 4 to 12 of the diagnostic data record DS1

Byte	Bit	Meaning	Remark	Event no.
4	0 ... 6	Channel type	76H is always assigned.	
	7	Other channel types	0 is always assigned.	
5	0 ... 7	Diagnostic information length	Always allocated to CH.	
6	0 ... 7	Number of channels	2 is always assigned.	
7	0	Channel fault vector	Bit 0 = 1: Fault on channel 1 Bit 1 = 1: Fault on channel 2	

Byte	Bit	Meaning	Remark	Event no.
8	0	Signal A - faulty channel 1		8:x:B0
	1	Signal B - faulty channel 1		8:x:B1
	2	Signal N faulty channel 1		8:x:B2
	4	5.2V encoder supply faulty channel 1		8:x:B4
9		Reserved		
10	0	Signal A - faulty channel 2		8:x:B0
	1	Signal B - faulty channel 2		8:x:B1
	2	Signal N faulty channel 2		8:x:B2
	4	5.2V encoder supply faulty channel 2		8:x:B4
11		Reserved		

How does the diagnostic text appear in the diagnostic buffer?

If you want to enter the diagnostic message in the diagnostic buffer, you must call the SFC 52 (Enter user-specific message in the diagnostic buffer" in the user program. The event number of the diagnostic message in each case is specified in the input parameter EVENTN. The interrupt is entered in the diagnostic buffer with x=1 as incoming and x=0 as outgoing. The diagnostic buffer contains the relevant diagnostic text in the "Meaning" column as well as the time of the entry.

Default setting

The diagnostic interrupt is disabled in the default setting.

11.4 Data error

When do data errors occur?

If new parameters are transferred to the module, the FM 450-1 checks these parameters. If errors occur during this check, the module reports these data errors.

Wrong parameters are not accepted by the module.

Where are data errors indicated?

The FC CNT_CTRL enters the data errors in DB1 with the error numbers. You can access this data word via the variable name "DA_ERR_W" in the user program The following table shows the numbers of the data errors and the significance of these errors.

Table 11-3 Data error numbers and their significance

No.	Meaning
0	No fault
201	Value too great for receiver selection
202	Value too great for the diagnostics of the pair of signals

No.	Meaning
203	Value too great for the evaluation of the signals
204	Value too great for the input filter of the 24V count signals
205	Value too great for the input filters of the digital inputs
206	Reversing the direction not permitted
207	Value too great for the behavior of digital output 1Q0 (2Q0)
208	Value too great for the behavior of digital output 1Q1 (2Q1)
209	Pulse duration wrong or too long
211	Wrong mode selected
212	No gate or both gates specified
215	When assigning the process interrupt "Reaching the comparison value in the up and/or down count direction" parameters a different count direction was specified than the parameter assignment for the behavior of the outputs "Output active for on pulse duration in up and/or down direction". The directions must match.
216	Gate control interrupts are only possible for modes with gate control
217	No interrupt on reaching the comparison values is permitted for behavior of the digital outputs "active between comparison value and overflow" or "active between comparison value and underflow".

How are data errors acknowledged?

Correct the values for the parameters to comply with the specifications. Transfer the corrected set of parameters to the FM 450-1 again. This again checks the parameters and deletes the data error in DB 1.

11.5 Operator error

When do operator errors occur?

Operator errors occur if you operate the module incorrectly by specifying the wrong control signals.

Where are operator errors indicated?

FC CNT_CTRL enters the operator error numbers in DB1. You can access this data word via the variable name "OT_ERR_B" in your program.

Which operator errors exist?

The table below shows the possible numbers of operator errors and their meaning.

Table 11-4 Operator error numbers and their meaning

Error code	Meaning
0	No fault
1	Mode cannot be started using the SW gate.
2	Mode cannot be aborted.
4	Permitted only if OD is active

How are operator errors acknowledged?

Acknowledge the error with parameter OT_ERR_A in DB 1.

Technical Data

12

12.1 General technical specifications

These general technical specifications are described in the manual /3/:

- Standards and certifications
- Electromagnetic compatibility
- Shipping and storage conditions
- Mechanical and climatic environment conditions
- Specifications for insulation tests, safety class, and degree of protection

Design Guidelines

SIMATIC products meet the requirements if you observe the design guidelines described in the manuals when installing and operating the equipment.

12.2 Technical Data

Technical data

Dimensions and Weight	
Dimensions WxHxD (mm)	25x290x210
Weight	Approx. 650 g

Voltages, currents, potentials	
Auxiliary voltage 1L+/1M	24 VDC
• Range, static	20.4 ... 28.8 V
• Range, dynamic	18.5 ... 30.2 V
• Reverse polarity protection	Yes
2L+/2M load voltage	24 VDC
• Range, static	20.4 ... 28.8 V
• Range, dynamic	18.5 ... 30.2 V
• Reverse polarity protection	Yes
• Electrical isolation	Yes, toward all other voltages
5 V encoder power supply	
• Output voltage	5.2 V ± 2%
• Output current	Maximum 300 mA per count channel, short-circuit proof
24 V encoder power supply	

Voltages, currents, potentials	
• Output voltage	1L+ - 3 V
• Output current	Maximum 300 mA per count channel, short-circuit proof
• Non-periodic overvoltage	Value: 35 V Duration: 500 ms Recovery time: 50 s
Current consumption	
• From the backplane bus 5 V DC, max.	Approx. 300 mA
• From load voltage 1L+ (no load), max.	Approx. 50 mA
• From load voltage 2L+ (no load), max.	Approx. 60 µA
Power loss of the module	Approx. 6 W

Status, interrupts, diagnostics	
Status display	Yes, 14 green LEDs for status of CR, DIR, inputs and outputs
Interrupts	
• Hardware interrupt	Yes, configurable
• Diagnostic interrupt	Yes, configurable
Diagnostics functions	Yes
• Fault indication for internal and external faults	Yes, 2 red LEDs
• Reading diagnostics information	Yes

Data to the count signals and the digital inputs and outputs (applies to both counters)	
Counter inputs 5 V (A , /A; B, /B; N, /N)	
• Level	In compliance with RS 422
• Terminating resistor	approx. 220 Ohms
• Differential input voltage	Min. 0.5 V
• Maximum count frequency	500 kHz
• Electrical isolation toward S7-400 bus	No
Counter inputs 24 V (A*, B*, N*)	
• Low Level	- 30 ... + 5 V
• High level	+ 11 ... + 30 V
• Input current	Typically 9 mA
• Minimum pulse width (maximum count frequency)	≥ 2.5 µs (200 kHz) ≥ 25 µs (20 kHz) (configurable)
Digital inputs	
• Low Level	- 28.8 ... + 5 V
• High level	+ 11 ... + 28.8 V
• Input current	Typically 9 mA
• Minimum pulse width (maximum input frequency)	≥ 2.5 µs (200 kHz) ≥ 25 µs (20 kHz) (configurable)

Data to the count signals and the digital inputs and outputs (applies to both counters)	
Digital outputs	
• Supply voltage	2L+ / 2M
• Electrical isolation	Yes, toward all others except the digital inputs
• Output voltage – High signal "1" – Low signal "0"	 Min. 2L+ - 1.5 V Max. 3 V
• Switching current – Nominal value – Range	 0.5 A (Res./P.D. 5W Tungsten 24VDC) 5 mA to 0.6 A
• Switching time	Max. 300 µs
• Cutoff voltage (inductive)	Limited to 2L+ -39V
• Short-circuit proof	Yes

Note

Other relevant data, e.g. environmental conditions, are listed in Manual /1/.

12.3 Standards and approvals

12.3.1 Currently valid markings and approvals

Introduction

This section contains:

- The standards and test values to which the FM 450-1 Counter Module complies and which it fulfills.
- The test criteria according to which the FM 450-1 was tested.

Technical specifications of the FM 450-1 Counter Module

You can find the technical specifications of the FM 450-1 Counter Module in the equipment documentation. If there are deviations between the statements in this document and the equipment documentation, the statements in the equipment documentation take priority.

Validity of the information on the components

NOTICE
Markings and approvals In the documentation, you can find the markings and approvals which are generally possible or planned in the system. However, only the marking or approval printed on the components of the automation system is valid.

Reference

You can find the certificates for the markings and approvals on the Internet under Service&Support (https://support.industry.siemens.com/cs/ww/de/).

Safety instructions

⚠ WARNING
Personal injury and damage to property may occur Note the following information for use in hazardous areas: • Personal injury and material damage can occur if you establish or disconnect an electrical circuit while the automation system is in operation. • Always be sure to de-energize the system before removing the plug connections.

Note

The FM 450-1 Counter Module is intended for use in industrial areas. If used in residential areas, it may interfere with radio/TV reception.

12.3.2 CE approval

Introduction

CE

The FM 450-1 Counter Module fulfills the requirements and protective aims of the following EC directives and conforms with the harmonized European standards (EN) that have been

published for programmable logic controllers in the Official Journals of the European Community:

- Low-Voltage Directive
- EMC Directive
- Explosion Protection Directive

The EC Declaration of Conformity can be downloaded from the Internet (https://support.industry.siemens.com/cs/document/16693331).

Low-Voltage Directive

2014/35/EU "Electrical Equipment Designed for Use within Certain Voltage Limits" (Low-Voltage Directive)

The FM 450-1 Counter Modules are tested according to the requirements of EN 61131-2, which fall under the Low-Voltage Directive.

EMC Directive

2014/30/EU "Electromagnetic Compatibility" (EMC Directive)

Use in industry

SIMATIC products are designed for industrial applications.

Area of application	Interference requirements	Immunity requirements
Industry	EN 61000-6-4 + A1	EN 61000-6-2

Adhere to the installation guidelines

SIMATIC products meet the requirements if you comply with the installation guidelines described in the manuals during installation and operation.

12.3.3 CCC approval

Certificate:

2020322309002744

Ex nA IIC T4 Gc

According to the following standards:

- GB 3836.1-2010 (Explosive atmospheres - Part 1: Equipment - General requirements)
- GB 3836.8-2014 (Explosive atmospheres-Part 8: Equipment protection by type of protection "n")

12.3.4 UKCA approval

DEKRA 21UKEX0018 X

Importer UK:

Siemens plc

Manchester M20 2UR

12.3.5 Explosion protection

ATEX approval DEKRA 21ATEX0010 X

Type examination certificate number	DEKRA 21ATEX0010 X	
Standards	EN IEC 60079-0	
	EN 60079-7	
Marking	Ex	II 3 G Ex ec IIC T4 Gc
The certificate is valid for the "DEKRA 21ATEX0010 X (https://support.industry.siemens.com/cs/document/109475140)" products listed in the certificate.		

Special conditions

- The device may only be used in areas with a pollution degree of no more than 2 according to EN 60664-1.
- The modules must be installed in a suitable enclosure which provides a degree of protection of at least IP54 in accordance with EN 60079-7, taking into account the ambient conditions of use.
- Measures must be taken to prevent exceeding the rated voltage by more than 119 V of transient disturbance voltages.

IECEx approval IECEx DEK 21.0008X

Certificate number	IECEx DEK 21.0008X
Standards	IEC 60079-0
	IEC 60079-7
Marking	Ex ec IIC T4 Gc
The certificate is valid for the "IECEx DEK 21.0008X (https://support.industry.siemens.com/cs/document/109795939)". products listed in the certificate.	

Special conditions

- The device may only be used in areas with a pollution degree of no more than 2 according to IEC 60664-1.
- The modules must be installed in a suitable enclosure which provides at least IP54 degree of protection in accordance with IEC 60079-7 and taking into account the ambient conditions of use.
- Measures must be taken to prevent exceeding the rated voltage by more than 119 V of transient disturbance voltages.

12.3.6 cULus approval



Underwriters Laboratories Inc. in accordance with:

- UL 508 (Industrial Control Equipment)
- CSA C 22.2 No. 142 (Process Control Equipment)

12.3.7 cULus HAZ. LOC. approval



Underwriters Laboratories Inc. in accordance with:

- UL 61010-2-201 (Industrial Control Equipment)
- CSA / CAN 61010-2-201 (Process Control Equipment)
- ANSI/ISA 12.12.01
- CSA C22.2 No. 213 (Hazardous Location)

Approved for use in:

Class I, Division 2, Group A, B, C, D Tx;

Class I, Zone 2, Group IIC Tx

12.3.8 cFMus approval



Factory Mutual Research (FM) in accordance with:

- Approval Standards FM Class 3600:2018, FM Class 3611:2018, FM Class 3810:2018,
- ANSI/UL 121201.2017,
- ANSI/UL 61010-1:2018

APPROVED for use in:

- Class I, Division 2, Group A, B, C and D
- Class I, Zone 2, Group IIC, hazardous (classified) locations
- Ordinary (unclassified) locations with an ambient temperature rating of 0 °C to + 70 °C, indoor environments

12.3.9 Approval for Australia and New Zealand



The SIMATIC S7-400 product series meets the requirements of the standard EN 61000-6-4:2007 + A1:2001.

12.3.10 Approval for the Korea and South Korea



The SIMATIC S7-400 product series complies with Korean safety standards:

Registration of Broadcasting and Communication Equipment KCC-REM-S49-S7400

Note that this device corresponds to limit class A in terms of the emission of radio frequency interference. This device can be used in all areas, except residential areas.

이 기기는 업무용(A급) 전자파 적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며 가정 외의 지역에서 사용하는 것을 목적으로 합니다.

Spare parts

13

Spare parts

The table lists all the spare parts for the FM 450-1 you can order for this module either additionally or at a later date.

Table 13-1 Accessories and spare parts

Parts for the FM 450-1	Order number
Labeling sheet for the front connector, petrol blue	6ES7492-2AX00-0AA0
Labeling sheet for the front connector, light beige	6ES7492-2BX00-0AA0
Labeling sheet for the front connector, yellow	6ES7492-2CX00-0AA0
Labeling sheet for the front connector, red	6ES7492-2DX00-0AA0
Front connector (48-pin) with screw terminals	6ES7492-1AL00-0AA0
Front connector (48-pin) with spring-loaded terminals	6ES7492-1BL00-0AA0
Front connector (48-pin) with crimp snap-on terminals	6ES7492-1CL00-0AA0

References

14

Supplementary references

The table below lists all manuals to which reference is made in the present manual.

No.	Title	Order number
/1/	SIMATIC; S7-400 Automation System; Installation (http://support.automation.siemens.com/WW/view/en/1117849)	Part of package 6ES7498-8AA04-8AA0
/2/	SIMATIC; System software for the S7-300/400 system and standard functions (http://support.automation.siemens.com/WW/view/en/44240604)	Part of package 6ES7810-4CA07-8AW1
/3/	SIMATIC; S7-400 Automation System S7-400 Module Data (http://support.automation.siemens.com/WW/view/en/1117740)	

Glossary

Asymmetrical signals

Refers to two pulse sequences, phase-shifted by 90°, and with zero mark signal where applicable.

Configuration

Assignment of modules to racks, slots and addresses. Users configuring the hardware fill out a configuration table in STEP 7.

Double evaluation

In this mode, the module evaluates all positive edges of the pulses at track A and B of an incremental encoder.

Encoders

Encoders are used to for the precise recording of rectangular signals reflecting distances, positions, velocity, speed, dimensions, etc.

Encoders with asymmetrical output signals

These encoders return two differential pulse sequences with 90° phase-shift, including a zero mark signal where applicable.

Encoders with symmetrical output signals

These encoders return two differential pulse sequences with 90° phase-shift, including inverted signals to form a zero mark as required.

Function (FC)

According to IEC 1131-3 notations, this is a code block which does not contain static data. A function supports the transfer of parameters in a user program. Functions are thus particularly suitable for programming complex, recurrent functions

Function module (FM)

A module which relieves the CPU of the S7 automation system of process signal processing tasks which are critical in time or memory-intensive. As a rule, FMs use the internal communication bus for high-speed data exchange with the CPU. Examples of FM applications: Counting, positioning, controlling

Incremental encoder

Incremental encoders are used to record distance, position, velocity, speed or weight units by counting small increments.

Increments per encoder revolution

Defines the number of increments the encoder outputs per revolution.

OD

The "output disable" (OD) signal is used in STOP and HOLD state to force all modules of an S7 automation system to safe state. A safe state could be: all outputs are shut off, or supplied with a substitution value.

Power control

The power control unit controls the motor; its simplest form is a contactor relay circuit.

Proximity switch

A simple BERO switch, without directional information. The device returns only a single count signal. The counter records only the positive edges at signal A. The count direction is user-specific.

Pulse duration

The pulse duration setting defines the minimum on time of an output.

Push-pull

Push-pull output of an encoder; supplies an active low signal to 0 V (ground) and an active high signal to +24 V.

Quadruple evaluation

In this mode, the module evaluates all pulse edges at the tracks A and B of an incremental encoder.

SFC

An SFC (system function) is an integrated function of the CPU operating system. The SFC can be called in the STEP 7 user program as required.

Single evaluation

Refers to a the evaluation of positive edges of the pulses at track A of an incremental encoder.

Sinking output

Encoder output which returns an active low signal to 0 V (ground)

Sourcing output

Sourcing output of the encoder which returns an active high signal +24 V.

STOP

STOP as an international term, for example, as an operating command.

STOPP

STOPP (German spelling) as a term used in the manual to define an action which is not a command.

Zero mark

The zero mark is positioned on the third track of an incremental encoder. It returns a zero mark signal after each rotation.

Zero mark signal

The incremental encoder returns one zero mark signal per revolution.

Index

0

0 to +32 bit counting range, 64

2

24 V encoder signals, 29
  Input filter, 29
24 VDC encoder power supply, 29
24-V encoder signals, 81
  Input filter, 11
  Input filters, 83

5

5-V encoder signals, 80, 83

A

Auxiliary voltage 1L+, 1M, 28

B

Basic parameter assignment, 58
Behavior of the digital outputs
  Boundary conditions, 67

C

Check list
  mechanical installation, 47
  Parameter assignment, 51
Command
  Open and close gate, 68
  Set counter, 71
commands
  specifying, 59
Commands, 58
Comparison value, 9, 17, 65
Continuous counting, 18
Control bits, 59
count limits, 17
Count range, 17, 64
Count range -31 to +31 bit, 64

D

Data error, 95
Diagnostic data record DS0
  Assignment, 93
Diagnostic data record DS1
  Assignment, 94
Diagnostic interrupt, 92
  Enabling, 92
  OB 82, 93
Diagnostics interrupt, 92
Digital input I0
  Status, 69
Digital input I1
  Status, 69
Digital input modules, 99
Digital inputs, 30
  Input filters, 30
digital outputs
  Behavior, 66
  Disable, 67
  Enabling, 65
  Status, 65
Digital outputs, 30
Double evaluation, 84

E

ENSET_DN, 72
ENSET_UP, 72
External faults, 91

F

FC CNT_CTRL, 39
  Example, 44
  Parameters, 41
FC DIAG_INF, 43
FCs
  Technical Specifications, 46
FM 450-1
  in the S7-400 layout, 15
  Overview of commands, 58
  Overview of operating modes, 57
  Settings overview, 58
Front connectors, 14
  Terminal assignment, 25

G

Gate stop function, 62, 64, 70

H

Hardware gate, 19
Hardware interrupt, 10, 76
    Enabling, 76
    Initiating, 76
    OB 40, 76
HW gate
    Edge controlled opening and closing of, 69
    Level controlled opening and closing of, 68
    Status, 69
Hysteresis, 10

I

Infinite count mode, 59
Input delay, 30
Input filters, 30
Internal faults, 91

L

Labeling strips, 14
LEDs
    Meaning, 13
Load value, 10, 17, 71

M

Main field of application, 11
modes
    Selecting, 59
Multiple counting, 19

O

OB 40, 76
OB 4x
    Start information, 77
OB82, 93
Open and close SW gate, 60, 61, 63
Opening and closing hardware gate, 63
Operating modes, 57
Operator error, 96
Order number, 13

P

parameter assignment screen forms
    Integrated help function, 38
Parameter assignment screen forms
    Calling, 38
    Installing, 37, 38
Periodic counting mode, 62
Pulse duration
    Default value, 68
    Value range, 68

Q

Q0 see digital outputs, 30
Q1 see digital outputs, 30
Quadruple evaluation, 84

R

README file, 38
RESET status, 35

S

Select gate function, 60, 61, 62
SET, 71
SET see digital inputs, 30
Setting
    Behavior of the digital outputs, 65
    Count range, 64
    Pulse duration, 67
Setting the counter
    Via the user program, 71
    With an external signal, 71
    With digital input I2, 72
    With the zero mark, 74
settings
    Selecting, 59
Settings, 58
Single count mode, 61
Single counting, 18
Single evaluation, 83
Start addresses, 21
START see digital inputs, 30
Startup characteristics, 42
Status bits, 59
STOP see digital inputs, 30

Supply
of encoders, 28
SW gate
Opening and closing the, 70
Status, 70
Symmetrical encoders, 80

V

VDC 5.2 encoder power supply, 28
Version, 13
View of module, 13

Z

Zero crossing, 64