SIEMENS

SIMATIC

S7-300
FM 350-2 Counter module

Manual

05/2011
A5E01365983-03

Legal information

Warning notice system

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

CAUTION

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

NOTICE

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

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

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

⚠ WARNING

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

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

Siemens AG
Industry Sector
Postfach 48 48
90026 NÜRNBERG
GERMANY

A5E01365983-03
℗ 07/2011

Preface

Preface

Purpose of this manual

This manual describes all the steps required for using the FM 350-2 function module. It introduces you quickly and effectively to the functions of FM 350-2.

This manual is intended for persons having the required qualifications to commission, operate, and program the hardware product described.

Basic knowledge required

This manual requires general knowledge of automation engineering.

Users should also be familiar with the operation of computers or auxiliary programming equipment similar to PCs (e.g., programming devices) operating under the operating system platform Windows 2000, XP or Vista. Users should also be familiar with the STEP 7 standard software. For this information, refer to the Programming with STEP 7 manual.

In particular when using a PLC in safety-oriented locations, pay attention to the information on the safety of electronic controls in sections "Wiring (Page 37)" and "Technical specifications (Page 147)".

Scope of this manual

This manual contains the description of the FM 350-2 function module valid at the date of publishing. We reserve the right to describe any changes to the functions of FM 350-2 in a Product Information.

Standards

The S7-300 automation system meets the requirements and criteria of IEC 61131-2.

Recycling and disposal

FM 350-2 is recyclable due to its non-toxic materials. For environmentally compliant recycling and disposal of your electronic waste, please contact a company certified for the disposal of electronic waste.

Additional support

If you have any further questions about the use of products described in this manual and do not find the right answers here, contact your local Siemens representative (http://www.siemens.com/automation/partner):

A guide to the technical documentation for the various products and systems is available on the Internet:

- SIMATIC Guide manuals (http://www.siemens.com/simatic-tech-doku-portal)

The online catalog and online ordering systems are also available on the Internet:

- A&D Mall (http://www.siemens.com/automation/mall)

Training center

To help you get started with automation technology and systems, we offer a variety of courses. Contact your regional Training Center or the central Training Center in D-90327 Nuremberg, Germany.

- Internet: SITRAIN homepage (http://www.sitrain.com)

Technical Support

You can access technical support for all A&D projects via the following:

- Online support request form: (http://www.siemens.com/automation/support-request)

Service & Support on the Internet

In addition to our documentation, we offer a comprehensive online knowledge base on the Internet at:

Industry Automation and Drive Technologies - Homepage (http://www.siemens.com/automation/service&support)

There you will find the following information, for example:

- The newsletter that provides up-to-date information on your products.
- The documents you need via our Search function in Service & Support.
- A forum for global information exchange by users and specialists.
- 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

Product Overview

1

1.1 FM 350-2 functionality

Functionality

The FM 350-2 function module is an 8-channel counter module with dosing functions for use in the S7-300 automation system. Maximum counting range of the FM:

- -31 to +31 Bit:
  -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 20 kHz per count channel depending on the encoder signal.

The FM 350-2 can be used to perform the following tasks:

- Continuous counting up/down
- Single counting up/down
- Periodic counting up/down
- Frequency measurement
- Rotational speed measurement
- Period measurement
- Dosing

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

Count, gate, and direction signals can be connected directly to the module.

Comparison Values

You can store a comparison value for each count channel on the module (four comparison values in "dosing" mode). If the count value reaches this comparison value, the relevant output can be set/reset to initiate direct control actions in the process and/or a hardware interrupt can be triggered.

Count limits

In the operating modes "single counting," "periodic counting," and "dosing" you can set count limits within the maximum count range. The following applies:

- In main count direction up, the count starts at 0 (start value) and you specify an end value between 2 and 2 147 483 647.
- In main count direction down, you specify a start value between 2 and 2 147 483 647, the end value is set at 0.

Hardware Interrupts

Four hardware interrupts are possible per count channel. Two hardware interrupts can be generated by each edge change at the hardware gate. Two additional specific hardware interrupts can be generated depending on the operating mode setting, and five specific hardware interrupts in "dosing" mode.

Count Process

Count processes can be started or stopped via the software gate or via the hardware gate and the software gate.

Diagnostic Interrupt

The FM 350-2 can trigger a diagnostic interrupt if any of the following occur:

- Faulty NAMUR encoder supply
- Module not assigned parameters or errors in parameter assignment
- Watchdog timeout
- Hardware interrupt lost
- Wire break or short-circuit at a NAMUR input

Counting Signals

The FM 350-2 can count signals generated by the encoders listed below. Only bounce-free encoders are permitted.

- 24-V incremental encoders, push-pull or current-sourcing switches
- 24-V pulse encoders with direction level
- 24-V initiators without direction level

  for example, light barrier or BERO (type 2)
- NAMUR encoders in accordance with DIN 19 234

24-V signals or NAMUR-compliant signals can be connected in groups of four to the count input. Encoder signals higher than 8.2 V must not be connected to an input group that is assigned for operation with a NAMUR encoder.

The gate and direction inputs only support 24-V signals.

Input Filter

For the purpose of suppressing interference, an input filter (RC element) with a uniform filter time for all inputs of 50 µs is set for the inputs.

High-speed responses to specific count events are possible per count channel via a digital output (or four digital outputs in "dosing" mode). The outputs can be controlled dependent on the count or via programmable control bits.

Reaction to S7-300 Failure

The response of the FM 350-2 to CPU STOP can be assigned. The current operating mode can continue to run or be interrupted. The digital outputs may retain the most recently set last values, or receive substitution values, or be disabled.

⚠ CAUTION

Property damage can occur.

If you assigned the response of the FM 350-2 so that the digital outputs are set to substitute values on CPU STOP, these values are also set for digital outputs that are not enabled.

Ensure that substitute values at disabled digital outputs cannot cause dangerous states in the plant.

Reaction to Module Supply Failure

The response of the FM 350-2 to a failure of the module supply depends on whether the FM 350-2 is being operated with a standard backplane bus or an active backplane bus.

- Standard backplane bus

  When the module supply of the FM 350-2 fails, the CPU recognizes an I/O access error. The FM 350-2 does **not** automatically restart when power returns.

- Active backplane bus

  When the module supply of the FM 350-2 fails, a "module-removed" interrupt is sent to the CPU. When power returns, a hardware insertion interrupt will be reported to the CPU.

1.2 Application Areas of the FM 350-2

Primary Field of Application

An FM 350-2 is primarily used in applications requiring signal counting, high-speed reaction to a default count value, or frequency measurements, or speed measurements.

Examples:

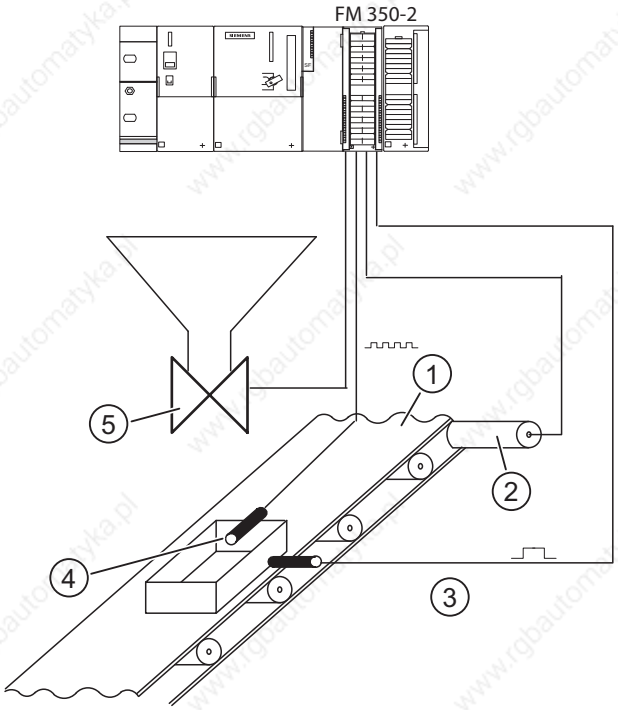
- Packaging plants
- Sorting plants
- Dosing plants
- Rotational speed controls and gas turbine monitoring

Example of an FM 350-2 Application

A box is to be filled with a certain number of parts taken from a collection bin. Channel 0 counts the parts and controls the filling valve. Channel 1 controls the motor of the box conveyor and counts the number of boxes.

When the box is in the correct position, the valve is opened and the box is filled with parts. When the specified number of parts is reached, the valve is closed and the transport of the boxes is started. Any following parts continue to be counted until a new box appears.

A new number of parts can be specified during the transport of the box. The number of parts placed in a box and the number of boxes can be monitored.



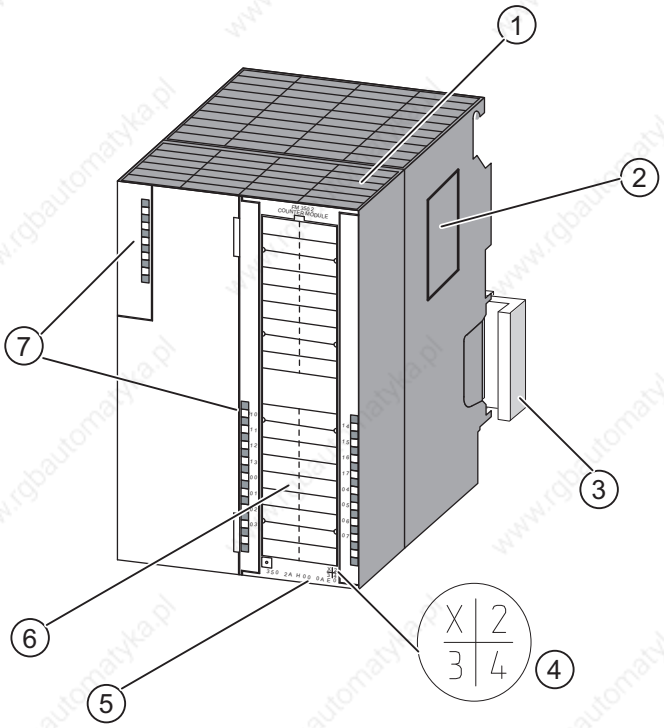
(1) Conveyor
(2) Motor
(3) Gate
(4) Light barriers
(5) Valve

Figure 1-1 Example of an FM 350-2 Application in the S7-300 System

1.3 FM 350-2 Hardware

Module view

The figure shows an FM 350-2 with front connector and bus connector, front panel covers closed.



(1) Front Connector
(2) Rating plate
(3) Bus connector SIMATIC interface
(4) Version
(5) Order number
(6) Labeling strips
(7) Diagnostics LEDs
Status LEDs

Figure 1-2 View of the FM 350-2 module

Front Connector

The FM 350-2 features the following front connector options:

- Count signals
- Direction signals
- Module power supply
- Input signals for hardware gate
- Output signals
- NAMUR 8V2 encoder supply

Please order the front connector separately.

Labeling strips

Included with the module is a labeling strip on which you can write your relevant signal names.

The terminal assignments are printed on the inside of the front panel cover.

Order Number and Release

The order number and the release of the FM 350-2 are shown at the bottom of the front panel.

Bus connectors

The module communicates within an S7-300 segment via bus connectors. The bus connector is supplied with your FM 350-2.

Status and Diagnostics LEDs

FM 350-2 is equipped with one diagnostics LED, eight status LEDs for the digital inputs, and eight status LEDs for the digital outputs. The table below lists the LED displays, including their labeling, color and function.

Labeling	Color	Function
SF	red	Group error
I0	green	Status of hardware gate channel 0
I1	green	Status of hardware gate channel 1
I2	green	Status of hardware gate channel 2
I3	green	Status of hardware gate channel 3
I4	green	Status of hardware gate channel 4
I5	green	Status of hardware gate channel 5
I6	green	Status of hardware gate channel 6
I7	green	Status of hardware gate channel 7
Q0	green	Status of output Q0

Labeling	Color	Function
Q1	green	Status of output Q1
Q2	green	Status of output Q2
Q3	green	Status of output Q3
Q4	green	Status of output Q4
Q5	green	Status of output Q5
Q6	green	Status of output Q6
Q7	green	Status of output Q7

1.4 FM 350-2 software

FM 350-2 Configuration Package

To integrate FM 350-2 in the S7-300 system, you need the configuration package containing:

- Parameter assignment screens and
- Functions for integrating FM 350-2 in the user program

Parameter assignment screen forms

The FM 350-2 is adapted to the respective task via parameters. These parameters are stored in the CPU and transferred from the CPU to the module.

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.

Functions for Integrating the FM 350-2

The functions used to integrate the FM 350-2 in the user program consist of the FC CNT2_CTR, FC CNT2_WR/FB CNT2WRPN, and FC CNT2_RD/FB CNT2RDPN, which are called in the user program on the CPU. These FCs enable communication between the CPU and the FM 350-2. In addition, there is also the FC DIAG_RD for the FM 350-2 with which you can transmit diagnostic data to the DB of FC CNT_CTRL.

This figure shows an S7-300 configuration with an FM 350-2 and several signal modules.

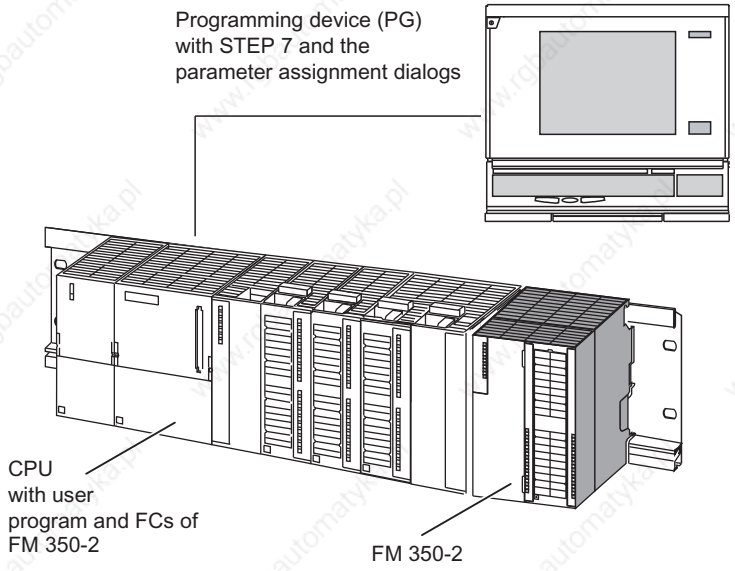


Figure 1-3 Configuration of a SIMATIC S7-300 with FM 350-2

How the FM 350-2 Counts

2

2.1 Definitions

Counting

Counting refers to the recording and totaling of events. FM 350-2 records encoder signals and evaluates these accordingly.

Count range

The FM 350-2 can count up and down. The maximum range within which FM 350-2 can count is 31 bits (continuous counting mode).

Count range	Low Count Limit	High Count Limit
Count range: -31 to +31 bit	- 2 147 483 648	+ 2 147 483 647

Count limits

You can define the high count limit between 2 and 2147483647 for single counting, periodic counting, and dosing modes. The low count limit is set permanently to 0.

Main count direction

You can set the main count direction for the FM 350-2 as "up" or "down." This defines the count limit as start and end value for the single count, periodic count, and dosing modes.

Even if you set the main count direction "down," to count down you must either apply a corresponding direction signal or set "inverted count direction" when you set the FM 350-2 parameters.

Load Value

FM 350-2 supports the definition of default load values for each one of the eight counters. You can directly input this load value to update the counter.

You can also load this value in preparation, i.e. the counter applies this new count value based on the following events:

- Reaching the end value in count direction up
- Reaching 0 in count direction down
- Canceling of the count process by a software gate or a hardware gate (when the count process is interrupted the load value is not used)

Comparison Values

In order to trigger responses in the process independently of the CPU when a specific count is reached, you can use the eight digital outputs on the module. For this purpose you can assign one comparison value for each count channel on the FM 350-2 (four comparison values for a proportioning channel). You can specify each value between the count limits as a comparison value. If the count reaches the comparison value, the corresponding digital output is set/reset and/or a hardware interrupt is generated.

Example

In the example shown in the section "Application Areas of the FM 350-2 (Page 12)", the valve should be closed as soon as the box contains the programmed number of parts. For this, you can specify this number as the comparison value for the FM 350-2 and use the corresponding digital output to close the valve.

2.2 Operating Modes

2.2.1 Overview

Counting modes

FM 350-2 offers three methods of counting rectangular pulses:

- Continuous counting
- Single counting
- Periodic counting

The differences between the modes become apparent based on the reaction of FM 350-2 after a counter has reached a limit.

There are also four other operating modes based on count processes:

- Frequency measurement
- Rotational speed measurement
- Period duration measurement
- Dosing

With the exception of "dosing," all operating modes can be assigned separately to each channel. For example: Channel 1 = frequency measurement; channel 2 = single counting, etc. The operating mode "proportioning" requires four channels (channels 0 to 3 and/or 4 to 7).

2.2.2 Infinite count

Function principle

When the counter reaches the high limit in main count direction up, and a further count pulse is received, the counter jumps to the low count limit, and restarts incrementing the count value, i.e., it thus performs continuous counting.

When the counter reaches the low limit in main count direction down, and a further count pulse is received, the counter jumps to the high count limit, and continues counting down from there.

The counting range in this operating mode is always -31 to +31 bits (-2,147,483,648 to +2,147,483,647). It cannot be changed. The counter starts its count at zero after a restart of the module.

If a comparison value was assigned, when the current counter reading = the comparison value a hardware interrupt can be triggered and/or the output can be switched.

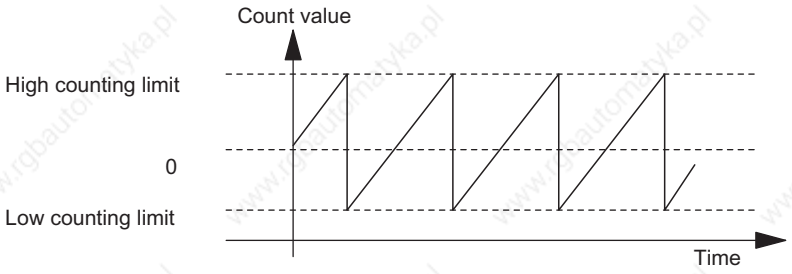


Figure 2-1 Continuous counting in main count direction up

2.2.3 Single counting

Function principle

In single counting, the start value and end value (max. count range: 0 to +2147483647) and the primary count direction for single count mode are set using a programming interface.

When counting up, the counter starts at zero and then increments the count until it reaches the end value. When the counter reaches the "End value -1," and a further count pulse is received, it returns to zero and freezes, irrespective of any further incoming pulses.

When counting down, the counter starts at the set start value and then decrements the count until it reaches zero. When the counter value = 1, and a further count pulse is received, it returns to the start value and freezes, irrespective of any further incoming pulses.

If the counter counts against the selected main count direction and overshoots or undershoots the start value, the module returns the current counter reading with the correct sign. An overflow or underflow does not occur in this case. The behavior of the output remains unchanged.

If a comparison value was assigned, when the current counter reading = the comparison value a hardware interrupt can be triggered and/or the output can be switched.

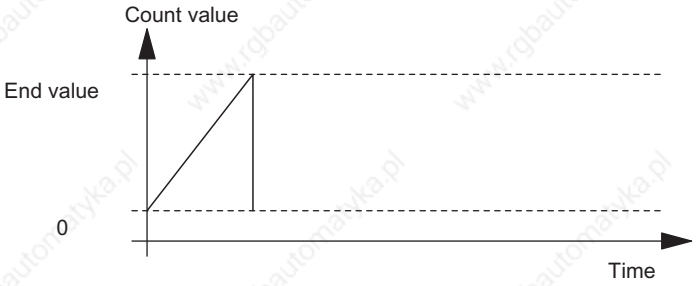


Figure 2-2 Single count in up direction

2.2.4 Periodic counting

Function principle

In periodic counting, the start value and end value (max. count range: 0 to +2.147,483,647) and the primary count direction for periodic count mode are set using a programming interface.

When counting up, the counter starts at the start value 0. When the counter reaches the "end value -1" and a further count pulse is received, the counter jumps back to 0 and continues to add the count pulses.

When counting down, the counter starts at the set start value. When the counter reaches the value 1 and a further count pulse is received, the counter jumps back to the start value and continues to count down from there.

If the counter counts against the selected main count direction and overshoots or undershoots the start value, the module returns the current counter reading with the correct sign. An overflow or underflow does not occur in this case. The output reaction remains unchanged.

If a comparison value was assigned when the current counter reading = the comparison value, a hardware interrupt can be triggered and/or the output can be switched.

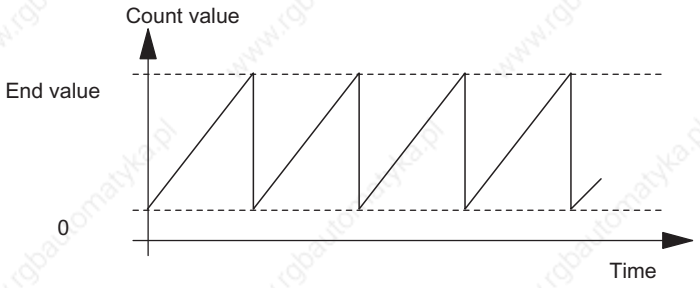


Figure 2-3 Periodic count in up direction

2.2.5 Frequency measurement

Function principle

In frequency measurement the FM 350-2 counts the pulses which are received in a time window set via the parameter assignment dialog box. Integration times between 10 ms and 10 seconds can be set.

At the end of each time window the frequency value is updated. The calculated frequency is displayed in the unit 10^{-3} Hz (range: 0 to $2^{31} \times 10^{-3}$ Hz).

If no valid value was calculated, -1 is returned. If no pulses are counted in a time interval, the module returns 0×10^{-3} Hz (= 0 Hz).

You can start and end frequency measurements using the gate functions.

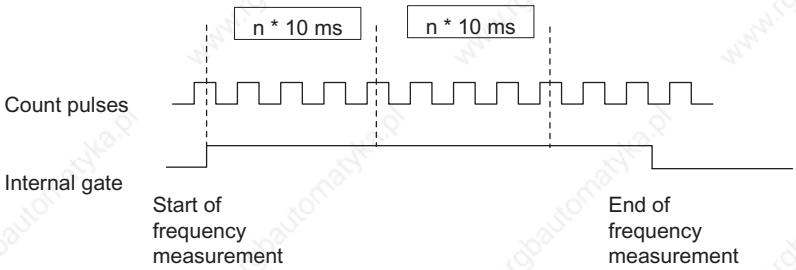


Figure 2-4 Frequency measurement with gate function

You can set two frequency comparison values

(Range of values for the low limit: 0 to 9,999,999 × 10^{-3} Hz;

Range of values for the high limit: 1 to 10,000,000 × 10^{-3} Hz).

You can choose from the following hardware interrupts:

- Start of frequency measurement with a hardware gate (positive edge)
- End of frequency measurement with a hardware gate (negative edge)
- End of measurement value recording (integration time expired)
- Frequency below or above limits

After each time interval has expired, the frequency determined is compared with the set frequency limits (fu / fo). If the current frequency lies below the set low limit or above the set high limit a hardware interrupt is triggered if this has been assigned accordingly.

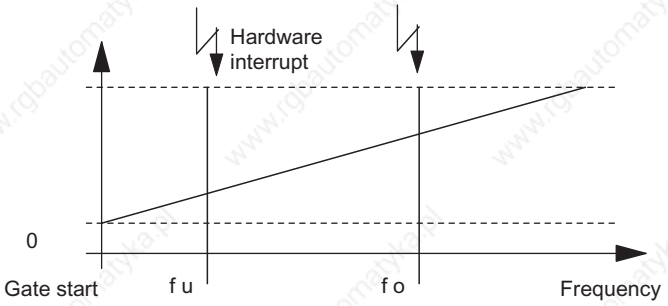


Figure 2-5 Frequency measurement with frequency reference values

2.2.6 Rotational speed measurement

Function principle

The speed measurement mode is similar to the frequency measurement mode.

In addition to the length of the time window, you must specify the number of pulses per motor or encoder revolution for the speed measurement in the parameter assignment screen form.

The value for the speed is updated at the end of each time window. The calculated speed is displayed in the unit 1×10^{-3} rpm.

If no valid value was calculated, -1 is returned. If no pulses are counted in a time interval, the module returns 0×10^{-3} rpm (= 0 rpm).

Using two rotational speed comparison values (value range for the low speed limit value: 0 to 24,999,999 $\times 10^{-3}$ rpm, DWORD; range of values for the high speed limit: 1 to 25,000,000 $\times 10^{-3}$ rpm, DWORD) you can monitor whether the measured speed remains within a defined range. A hardware interrupt can be triggered if this range is exited. The FM 350-2 checks whether the high limit is greater than the low limit and reports a parameter assignment error if this is not the case.

The speed measurement is started and ended using the gate functions.

You can choose from the following hardware interrupts:

- Start of speed measurement by hardware gate (positive edge)
- End of speed measurement by hardware gate (negative edge)
- End of measured value acquisition (integration time expired)
- Violation of speed limits (high or low limits)

2.2.7 Period duration measurement

Principle of operation

With very small frequencies, often the period duration has to be measured instead of the frequency. In the operating mode "period duration measurement" the exact time between two rising edges is measured.

Period duration measurement is started and ended using the gate signals (hardware or software gate).

The period duration can only be recorded in the set main count direction. The permissible measuring range lies between 40 µs and 120 seconds (25,000 Hz to 0.00833 Hz). If a valid value is not available, -1 is returned.

You can set two period duration comparison values on the module via the parameter assignment screen form (value range for the low limit value: 0 to 119,999,999 µs; value range for the high limit value: 40 µs to 120,000,000 µs.

You can choose from the following hardware interrupts:

- Start of period duration measurement with a hardware gate (positive edge)
- End of period duration measurement with a hardware gate (negative edge)
- End of measurement value recording (integration time expired)
- Period duration limits exceeded or not reached

2.2.8 Dosing

Function Principle

The module supports the grouping of four count channels at a single dosing channel in "dosing" mode.

You can specify four comparison values which can be changed individually or in groups of four. The count value is continuously compared with the comparison values; if the current count value = the comparison value, a hardware interrupt can be triggered and/or the corresponding digital output can be switched. You can thus control up to four dosing units with a single dosing counter.

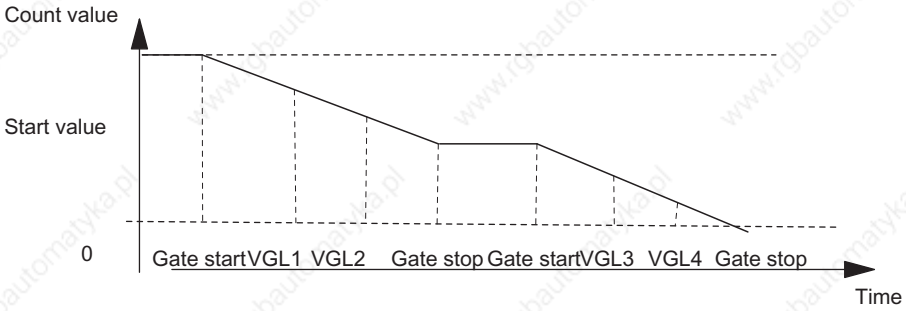


Figure 2-6 Dosing Count in Down Direction

You can choose from the following hardware interrupts:

- Start of dosing by setting a hardware gate (positive edge)
- Cancelation/interruption of dosing by setting a hardware gate (negative edge)
- One hardware interrupt each for the four comparison values

Reaching the count range limits (end value/start value)

2.3 Gate functions

Counting with Gate Functions

Many applications require that the count be started or stopped at a defined time depending on other events. This starting and stopping of the count process is done in the FM 350-2 via a gate function. If the gate is opened, count pulses can reach a counter and the count is started. If the gate is closed, count pulses can no longer reach the counter and the count is stopped.

Software Gate and Hardware Gate

The module features two gate functions:

- A software gate, controlled using control bit "SW_GATE7...0",

  The software gate can only be switched through by an edge change from 0 to 1 of the control bit "SW_GATE7...0". It is closed by resetting this bit.

- A hardware gate controlled via digital inputs I0 to I7 on the module. A hardware gate opens at a 0-1 edge change on the associated digital input and closes at a 1-0 edge change.

Internal Gate

The internal gate is the logic AND operation combining a hardware gate and a software gate. If no hardware gate was assigned, only the setting of the software gate is relevant. The count process is activated, interrupted, resumed, and canceled via the internal gate. The internal gate can also be closed by events dependent on the count value in the operating modes single counting and dosing.

HW gate	SW gate	Internal gate	Count process
open	open	open	active
open	closed	closed	inactive
closed	open	closed	inactive
closed	closed	closed	inactive

When assigning the hardware and software gates you can specify whether the internal gate can cancel or interrupt the count process. When canceled, the count restarts at its start value after the gate was cycled from stop to start. When interrupted, the count is resumed from the last current count value following gate stop and gate start.

Example

The gate is opened and the count pulses are counted by setting the gate signal. If the gate signal is removed, the gate is closed and the count pulses are no longer recorded by the counter. The count value remains constant.

The diagram shows the opening and closing of a gate, and the pulse count.

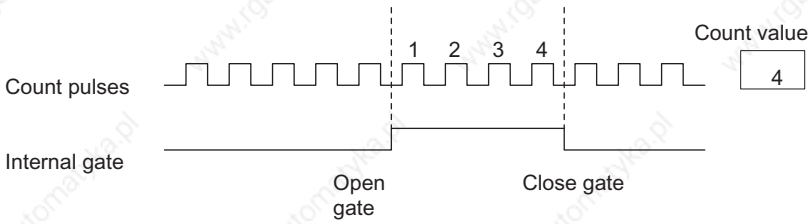


Figure 2-7 Opening and Closing a Gate

Installing and Removing the FM 350-2

3

3.1 Preparing for Installation

Defining the slots

The FM 350-2 function module can be inserted in any slot just as any signal module.

Mechanical Configuration

Refer to the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499) to learn about the options for the mechanical configuration and how to proceed when configuring. The following paragraphs give only a few supplementary tips.

- A maximum of eight signal modules (SM) or function modules (FM) are permitted per rack.
- The maximum number is restricted by the width of the modules or the length of your DIN rail. The FM 350-2 requires an installation width of 80 mm.
- The maximum number is restricted by the total current consumptions of all modules to the right of the CPU from the 5-V rear panel bus supply. FM350-2 has a current consumption of 100 mA.
- The maximum number is restricted by the memory required by the CPU software for communication with the FM 350-2.

Defining the mounting position

A horizontal mounting position should be given preference. In vertical mounting position, make allowances for ambient temperature limits (max. 40 °C.)

Determining the Start Address

The FM 350-2 start address is required for the communication between the CPU and the module. The start address is written to the counter DB. The entry is made either with the help of the Program Editor or in the parameter assignment dialog boxes.

You can determine the start address of the FM 350-2 in accordance with the same rules used to determine the start address of an analog module.

Important Safety Regulations

There are important regulations you must observe for integrating an S7-300 with an FM 350-2 into a plant or a system. These rules and regulations are described in the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499).

See also

DB for FC CNT2_CTR (Page 131)

Programming the FM 350-2 (Page 49)

3.2 FM 350-2, installation and removal

Rules

No special protection measures (ESD guidelines) are required for installing an FM 350-2.

Tools required

You require a 4.5 mm screwdriver for installing and removing the FM 350-2.

Installation Procedure

Below is a description of how to proceed when installing the FM 350-2 on the DIN rail. Additional information on installing modules in the is available in the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499).

1. Set the CPU to STOP.
2. The FM 350-2 is supplied with a bus connector. Plug this into the bus connector of the module to the left of the FM 350-2. The bus connector is located on the rear panel, meaning you may have to loosen the neighboring module.
3. Hook the FM 350-2 onto the rail and swing it down.
4. If further modules are to be installed to the right of the FM 350-2, first connect the bus connector of the next module to the right-hand rear panel bus connector of the FM 350-2.

   If the FM 350-2 is the last module in the rack, do **not** connect an expansion bus.

   Screw-tighten the FM 350-2 (tightening torque = approx. 0.8 to 1.1 Nm.)
5. Label the FM 350-2 with its slot number. Use the number wheel supplied with the CPU for this purpose.

   For more information on the required numbering scheme and how to insert the slot numbers, refer to the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499).
6. Install the shield connecting element.

   Order the shield connecting element under the order number 6ES7390-5AA00-0AA0

Procedure for Removing or Exchanging Modules

The section below explains how to rail-mount the FM 350-2. For more information on removing modules, refer to the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499).

1. Switch off the auxiliary voltage and the load voltage at the front connector.
2. Set the CPU to STOP.

   If you are running the FM 350-2 in an active rear panel bus you can also exchange the module while the CPU is in RUN.
3. Open the front panel. If necessary, remove the labeling strip.
4. Loosen the fixing screw of the front connector, then remove the front connector.
5. Loosen the fixing screw on the module.
6. Swivel the module out of the rail and unhook it.
7. Install the new module if applicable.

Further Information

For more information on installing and removing modules, refer to the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499).

Wiring the FM 350-2

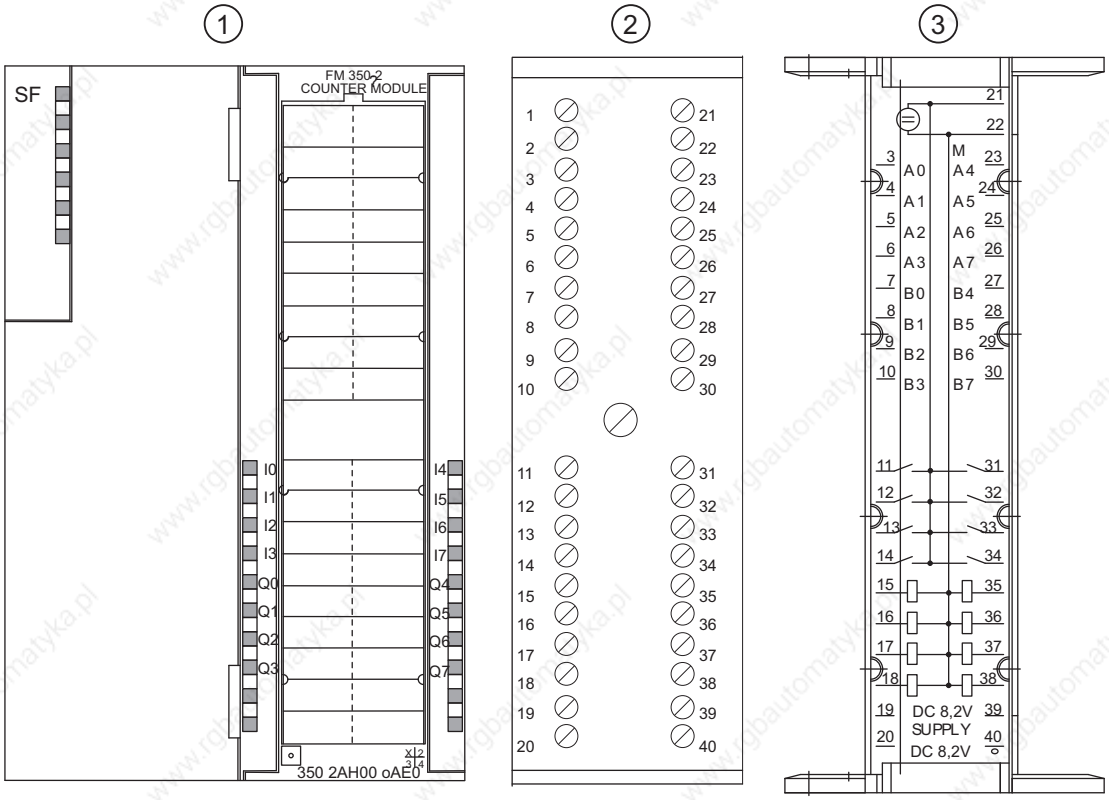
4

4.1 Terminal assignment of the front connector

Front connectors

Wire the count signals, the digital I/O, the encoder supply, and the module power supply using the 40-pin front connector.

The diagram shows the front of the module, the front connector, and the inside of the front panel cover indicating the terminal assignments.



(1) Front of the module

(2) Front connectors

(3) Inside of the front panel cover

Figure 4-1 FM 350-2, front connectors

Front Connector Assignments

The following Table shows the front connector assignments.

Terminal	Name	Input / Output	Function
1	-	-	Not connected
2	-	-	Not connected
3	A0	ON	Channel 0 count input NAMUR / BERO
4	A1	ON	Channel 1 count input NAMUR / BERO
5	A2	ON	Channel 2 count input NAMUR / BERO
6	A3	ON	Channel 3 count input NAMUR / BERO
7	B0	ON	Channel 0 direction input BERO
8	B1	ON	Channel 1 direction input BERO
9	B2	ON	Channel 2 direction input BERO
10	B3	ON	Channel 3 direction input BERO
11	I0	ON	Channel 0 hardware gate input BERO
12	I1	ON	Channel 1 hardware gate input BERO
13	I2	ON	Channel 2 hardware gate input BERO
14	I3	ON	Channel 3 hardware gate input BERO
15	Q0	OFF	Channel 0 digital output 0.5 A
16	Q1	OFF	Channel 1 digital output 0.5 A
17	Q2	OFF	Channel 2 digital output 0.5 A
18	Q3	OFF	Channel 3 digital output 0.5 A
19	P8V2	OFF	NAMUR encoder supply 8.2 V
20	P8V2	OFF	NAMUR encoder supply 8.2 V
21	L+	ON	24-V module power supply
22	M	ON	Ground module supply
23	A4	ON	Channel 4 count input NAMUR / BERO
24	A5	ON	Channel 5 count input NAMUR / BERO
25	A6	ON	Channel 6 count input NAMUR / BERO
26	A7	ON	Channel 7 count input NAMUR / BERO
27	B4	ON	Channel 4 direction input BERO
28	B5	ON	Channel 5 direction input BERO
29	B6	ON	Channel 6 direction input BERO
30	B7	ON	Channel 7 direction input BERO
31	I4	ON	Channel 4 hardware gate input BERO
32	I5	ON	Channel 5 hardware gate input BERO
33	I6	ON	Channel 6 hardware gate input BERO
34	I7	ON	Channel 7 hardware gate input BERO
35	Q4	OFF	Channel 4 digital output 0.5 A
36	Q5	OFF	Channel 5 digital output 0.5 A
37	Q6	OFF	Channel 6 digital output 0.5 A
38	Q7	OFF	Channel 7 digital output 0.5 A

Terminal	Name	Input / Output	Function
39	P8V2	OFF	NAMUR encoder supply 8.2 V
40	P8V2	OFF	NAMUR encoder supply 8.2 V

Note

The circuits for the counter inputs (encoder supply, encoder signals) are isolated from the ground of the CPU.

All inputs are not isolated from each other but are isolated from the S7300 bus.

24 V Voltage Supply

Connect a direct voltage of 24 V to the L+ and M terminals for the voltage supply of the FM 350-2.

8.2 VDC Encoder Supply

From the 24-V voltage supply the module generates a voltage of 8.2 V (max. 200 mA). This voltage is available at the terminals P8V2 (pins 19, 20, 39, and 40) for the voltage supply to the NAMUR encoders and is resistant to short circuits.

The encoder supply is monitored for 8.2 V.

Encoder Signals A0 to A7, B0 to B7

You can connect four different types of encoder:

- NAMUR encoders to DIN 19234 (with diagnostics function):

  The signals are wired to terminals A0 to A7.

- 24-V incremental encoders:

  The signals A0/B0 to A7/B7 are connected via the terminals so labeled.

- 24-V pulse encoder with direction level.

  The count signals are wired to terminals A0 to A7. The directional signals are wired to terminals B0 to B7.

- 24 V pulse encoders.

  The signals are wired to terminals A0 to A7.

Note

You must connect the encoder supply for the 24-V encoders via an external 24 VDC voltage supply.

Digital Inputs I0 to I7 (Hardware Gates)

You can use the digital inputs I0 to I7 for the gate control of the counter.

One digital input is available for each count channel with which you can start and stop the corresponding counter.

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

Digital Outputs Q0 to Q7

The FM 350 has the digital outputs Q0 to Q7 for direct triggering of control actions.

One digital output is available per counter.

The digital outputs are supplied with power by the the 24-V power supply of FM 350-2.

The digital outputs are current-sourcing switches and support a load current of 0.5 A. These outputs are protected against overload and short circuit-proof.

Note

Relays and contactors can be connected direct without external circuitry.

4.2 Wiring front connectors

Cables

There are certain rules for you to observe when selecting cables:

- All input cables must be shielded.
- You must apply the shields of the counter signal cables both at the pulse encoder and in the immediate vicinity of the module, for example, via the shield attachment.
- Use flexible cables with cross-sections of 0.25 to 1.5 mm^2.

Note

If the NAMUR encoder is fed via the module, the cable cross-section must be large enough to carry the required voltage to the encoder despite voltage drops over the cable.

- A wire-end ferrule is not required. If you use wire-end ferrules then use only those without insulation collars in accordance with DIN 46228 Form A, short version.

Tools required

A screwdriver or motor-driven screwdriver with 3.5-mm blade.

Wiring Steps

Proceed as follows when wiring the front connector:

⚠ WARNING

Danger of personal injury.

If you wire the front connector of the FM 350-2 when the power is switched on, you are in danger of injury from electric shock.

Wire the FM 350-2 only when the power is switched off.

1. Open the front panel.
2. Strip the conductors (length 6 mm).
3. Only when using wire-end ferrules:

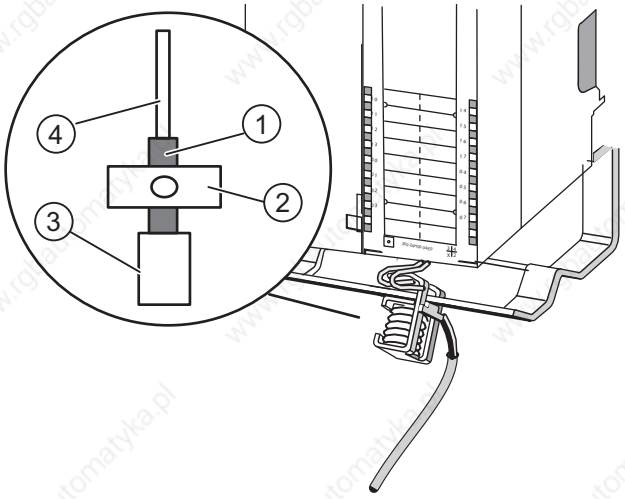
   Press-fit the wire-end ferrules onto the conductors.
4. Feed the enclosed strain relief clamp into the front connector.
5. If the wires exit the module at the bottom, start wiring at the bottom, otherwise at the top. Always screw-tighten the unused terminals (tightening torque 0.6 to 0.8 Nm).
6. Tighten the strain relief clamp for the cable strand.
7. Plug in the front connector and screw it tight.

8. Apply the cable shields to the shield connecting element or to the shield bar.

   Order the shield connecting element under the order number 6ES7390-5AA00-0AA0

9. Label the terminals on the labeling strip.

The diagram shows the FM 350-2 with shielded cables and shield connection element.



(1) Shield
(2) Terminal
(3) + (4) Insulation

Figure 4-2 Wiring shielded cables to FM 350-2

Note

For a detailed description of the wiring of the front connector, refer to the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499).

Example: Connecting a NAMUR encoder

Before you connect and operate a NAMUR encoder on a channel of FM 350-2, program a channel for the operation with NAMUR encoder. The following figure shows the connection of a NAMUR encoder to channel 0.

Figure 4-3 Connecting a NAMUR encoder to channel 0

⚠ CAUTION

Danger of property damage.

If you use another encoder on a channel of the FM 350-2 which was assigned parameters for the connection of a NAMUR encoder, the module may be damaged.

Connect only a NAMUR encoder to a channel of the FM 350-2 which was assigned parameters for the connection of a NAMUR encoder.

Assigning Parameters to the FM 350-2

5

5.1 Installing and opening parameter assignment dialog boxes

Requirements

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

Do not plug in or remove any S7-300 modules while the system exchanges data via MPI.

Installing parameter assignment screen forms

The entire configuration package is on the CD supplied. Install the configuration package as follows:

1. Uninstall any existing configuration packages.
2. Place the CD into the CD drive of your PG / PC.
3. In Windows start the dialog for installing software by double-clicking the "Add and Remove Programs" icon in the "Control Panel".
4. In the dialog, select the CD drive, and in the **Setup** directory, select the **Setup.exe** file and start the installation procedure.
5. Follow the instructions displayed on the installation program step by step.

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

- **SIEMENS\STEP7\S7LIBS\fm_cntli:** FCs, UDTs
- **SIEMENS\STEP7\S7FCOUNT:** Configuration software, Readme, Online Help
- **SIEMENS\STEP7\EXAMPLES:** ZXX34_01_FM350-2
- **SIEMENS\STEP7\S7MANUAL\S7FCOUNT:** Getting Started, Manuals

Note

If you have selected another directory other than SIEMENS\STEP7 when installing STEP 7, this directory will be specified.

Calling parameter assignment screen forms

Proceed as follows to call the FM 350-2 parameter assignment screen forms:

1. Double-click the order number.
2. Acknowledge the dialog which prompts you to save the configuration with "OK".

Reading the README file

The README file may contain important up-to-date information concerning the software supplied. You can read this file using Windows WORDPAD.

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.

5.2 Default Parameter Assignment

Default state

When you switch on the module without assigning any parameters yourself, all eight count channels are assigned as follows:

- Count signal inputs: 24 V;
- Signal evaluation: pulse and direction
- Counter reading: 0
- Digital outputs Q0 to Q7 deactivated
- Hysteresis: 1
- Hardware interrupts: none
- Diagnostics interrupts: none
- Mode: "Infinite count"
- Hardware gate: inactive
- Software gate: closed
- Status messages and counter states: updated

With these settings you can execute simple count tasks without assigning any additional parameters.

Note

Even if you do not use all eight count channels of the FM 350-2, all the unused channels must still be assigned valid parameters. In this case it is advisable to leave the unused channels in their default state.

Programming the FM 350-2

6

6.1 Programming the FM 350-2

Introduction

For linking the FM 350-2 into a user program, you are provided with STEP 7 blocks that make handling functions easier for you.

This section describes these blocks.

Block number	Block name	Meaning	Can/ Must
FC 2	CNT2_CTR	Controls the FM 350-2 in simple counting applications	Must
FC 3 FB 3	CNT2_WR CNT2WRPN	Loads counter values, limit values, and comparison values of the FM 350-2	Can
FC 4 FB 4	CNT2_RD CNT2RDPN	Reads current count and measurement values of the FM 350-2 for four channels each	Can
FC 5	DIAG_RD	Reads diagnostic information in the case of a diagnostic interrupt on the FM 350-2	Can
-	"Counter DB" data block	Contains all relevant data for operating the FM 350-2, is generated from the UDT1 supplied	Must

You must use the blocks marked with "Must;" the blocks marked with "Can" are additional options.

Requirements

If you want to control the FM 350-2 via the user program, the following requirements must be fulfilled:

- All software is installed as described on your PG / PC.

  The blocks are then installed in the library FM_CNTLI, the sample program is installed in the project ZXX34_01_FM350-2.

- The counter data block must be created from UDT1 and initialized (a counter DB, DB2, is already created in the example).

Programming rules

You should note the following rules when programming:

- Only insert the FCs/FBs into the program code that you actually require for your task. Any elements which are not required only place an unnecessary load on program processing and increase the memory required.
- FC2 CNT2_CTR must be called cyclically once for each FM 350-2 used.
- The data in the counter DB only become valid when the CHECKBACK_SIGNALS.PARA bit in the counter DB is set. Then the startup is also coordinated.

Direct accesses

To access count and measurement values in the assigned user area (USER STAT) quickly from every program level, you can also use direct access with L PIW and L PID. For L PIW use the module address plus offset 8 to offset 14 as the address; for L PID use the module address plus offset 8 to offset 12 as the address.

You structure the area from module address + offset 8 in the parameter assignment screen forms for the FM 350-2 using the **Edit > Specify Channels** menu command.

Here you specify which value (count or measurement value) for which channel (0 to 7) should be stored at which module address. Either the low word or the high word of a value or both can be used.

The values are updated every 2 ms.

Consistency between the values when using direct access is only guaranteed if you access the values as follows in accordance with the structure of this area:

- Low word or high word of the value

  L PIW

  Possible addresses = module address +8, +10, +12, +14
- Both

  L PID

  Possible addresses = module address +8, +12

6.2 Counter DB

Task

All the data you require and some data required for the FCs are in a data block, the counter data block. Each FM 350-2 requires one counter DB. This DB contains entries for addressing FM 350-2, and data of the various FM 350-2 functions.

Creating the Counter DB

Create the counter DB in STEP 7 as a data block with associated user-defined data type. Select UDT1 as the source. UDT1 was copied to the fm_cntli block library of the counter during installation of the FCs. You must not modify UDT1. Copy UDT1 together with the FCs into your project.

To create a counter DB, proceed as follows:

1. In SIMATIC Manager, select **File > Open... > Libraries** to open the fm_cntli library.
2. Copy the data structure UDT1 from the "Blocks" container of the library FM_CNTLI to the "Blocks" container of your project.
3. Use the **Insert > S7 Block > Data Block** menu command to insert a data block, for example, DB 1, in the "Blocks" container.
4. Open the data block and create the counter DB with associated user-defined data type UDT1.

Entering Addresses Automatically

In the parameter assignment dialog boxes you can make the following address entries automatically with the choice of corresponding counter DB.

If you assign the counter DB in question to another FM 350-2 or change the module address of the FM 350-2, you must adjust these address entries.

12	MOD_ADR	WORD	W#16#0	**Module address**: This setting must match the assigned input address of the FM 350-2 (**Configure Hardware > Properties of FM 350-2**).
14	CH_ADR	DWORD	DW#16#0	**Channel address:** Corresponds with the module address in pointer format, i.e. module address *8.

Example

Below you will find an example of a possible method of entering addresses automatically:

1. Open your project in SIMATIC Manager.
2. Open the hardware configuration table in your project.
3. From the hardware catalog select the FM 350-2 with the correct order number and drag it to the required slot.
4. Open the "FM 350-2 Counter" window by double-clicking this FM 350.
5. Change to the "Addresses" tab but retain all the settings on this page.
6. Change to the "Basic Parameters" tab.

   A dialog box is opened in which you can select a data block.

CAUTION
Actual values in the DB are overwritten You can check the block consistency in the SIMATIC Manager. After selecting the block folder of your project, start the consistency check using the menu command "Edit > Check block consistency". The "Check block consistency" dialog box is opened. If you select the menu command "Program > Compile all" in this dialog box, the current values in the DB are overwritten. Therefore, explicitly initialize the module start address of the FM 350-2 in OB 100. This address must be the same as the address configured in HW Config.

6.3 Processing Interrupts

Types of Interrupts

The FM 350-2 can trigger two types of interrupts in the CPU:

- Diagnostic interrupts
- Hardware interrupts

Requirements

For interrupt processing you must have programmed the appropriate interrupt OBs. These are:

- OB82 (I/O_FLT1) for a diagnostic interrupt
- OB40 (HW_INT1) for a hardware interrupt

Note

If you have not programmed the diagnostic interrupt OB or the hardware interrupt OB, the CPU goes into STOP when an interrupt occurs.

Interrupt Information

With both interrupt types the operating system provides you with four bytes of interrupt data which you can evaluate. These four bytes are:

- Complete for a hardware interrupt. No other data are available here.
- Group information for a diagnostic interrupt. In this case, you can read further data from FM 350-2. This is done by calling FC DIAG_RD in OB82. This function reads 16 bytes of diagnostics data from FM 350-2, and writes these to the user DB, starting at address 212.

Diagnostic data

You evaluate the diagnostic data using OB82 or the counter DB. You will find the parameters you can evaluate in the table below.

Error	Evaluate via OB82, Temporary Variables OB82-	Counter DB via FC DIAG_RD		
		Byte	Bit	Entries
Module diagnostics				
Module failed	MDL_DEFECT	212	0	Bit 0 of DIAGNOSTIC_INT_INFO.BYTE0
Internal error	INT_FAULT	212	1	Bit 1 of DIAGNOSTIC_INT_INFO.BYTE0
External error	EXT_FAULT	212	2	Bit 2 of DIAGNOSTIC_INT_INFO.BYTE0
Channel error	PNT_INFO	212	3	Bit 3 of DIAGNOSTIC_INT_INFO.BYTE0
Module not assigned parameters		212	6	Bit 6 of DIAGNOSTIC_INT_INFO.BYTE0
Incorrect parameters in module		212	7	Bit 7 of DIAGNOSTIC_INT_INFO.BYTE0
Internal watchdog	WTCH_DOG_FLT	214	3	Bit 3 of DIAGNOSTIC_INT_INFO.BYTE2
Hardware interrupt lost	HWL_INTR_FLT	215	6	Bit 6 of DIAGNOSTIC_INT_INFO.BYTE3
Channel diagnostics				
Channel error (channel 0)		219	0	Bit 0 of DIAGNOSTIC_INT_INFO.BYTE7
Channel error (channel 1)		219	1	Bit 1 of DIAGNOSTIC_INT_INFO.BYTE7
Channel error (channel 2)		219	2	Bit 2 of DIAGNOSTIC_INT_INFO.BYTE7
Channel error (channel 3)		219	3	Bit 3 of DIAGNOSTIC_INT_INFO.BYTE7
Channel error (channel 4)		219	4	Bit 4 of DIAGNOSTIC_INT_INFO.BYTE7
Channel error (channel 5)		219	5	Bit 5 of DIAGNOSTIC_INT_INFO.BYTE7
Channel error (channel 6)		219	6	Bit 6 of DIAGNOSTIC_INT_INFO.BYTE7
Channel error (channel 7)		219	7	Bit 7 of DIAGNOSTIC_INT_INFO.BYTE7
Single error (channel 0)		220	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE8
Single error (channel 1)		221	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE9
Single error (channel 2)		222	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE10
Single error (channel 3)		223	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE11
Single error (channel 4)		224	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE12

Error	Evaluate via OB82, Temporary Variables OB82-	Counter DB via FC DIAG_RD		
		Byte	Bit	Entries
Single error (channel 5)		225	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE13
Single error (channel 6)		226	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE14
Single error (channel 7)		227	4/6	Bit 4/6 of DIAGNOSTIC_INT_INFO.BYTE15

The entire allocation of data records 0 and 1 is listed in the section "Triggering diagnostics interrupts (Page 142)".

Hardware Interrupt Data

In the case of a hardware interrupt the FM 350-2 provides four bytes of hardware interrupt data which are stored in the status information of OB40 in the temporary variable OB40_POINT_ADDR (bytes 8 to 11). You load the temporary variable with the command L # OB40_POINT_ADDR.

Mode: Single counting, Continuous counting, Periodic counting									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8	-	-	-	-	Comparator responded	Overflow / underflow	Close hardware gate	Open hardware gate
1		Comparator responded	Overflow / underflow	Close hardware gate	Open hardware gate	-	-	-	-
2 to 7	9 to 11	See byte 8							
Mode: Frequency measurement									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8	-	-	-	-	High/low frequency limit exceeded	Frequency measurement ended	Close hardware gate	Open hardware gate
1		High/low frequency limit exceeded	Frequency measurement ended	Close hardware gate	Open hardware gate	-	-	-	-
2 to 7	9 to 11	See byte 8							

Mode: Speed measurement									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8	-	-	-	-	High/low speed limit exceeded	Speed measurement ended	Close hardware gate	Open hardware gate
1		High/low speed limit exceeded	Speed measurement ended	Close hardware gate	Open hardware gate	-	-	-	-
2 to 7	9 to 11	See byte 8							
Mode: Period measurement									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8	-	-	-	-	High/low time limit exceeded	Period measurement completed	Close hardware gate	Open hardware gate
1		High/low time limit exceeded	Period measurement ended	Close hardware gate	Open hardware gate	-	-	-	-
2 to 7	9 to 11	See byte 8							
Mode: Dosing									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8	-	Overflow/ underflow	Comparator 4 triggered	Comparator 3 triggered	Comparator 2 triggered	Comparator 1 triggered	Close hardware gate	Open hardware gate
1	10	See byte 8							

6.4 The CNT2_CTR Function (FC2), Control the Module

Task

With the CNT2_CTR function you control the digital outputs (enable and disable them) and the software gates of the FM 350-2. You also receive checkback signals from the FM 350-2.

Action

The CNT2_CTR function executes the following actions:

1. Initialization of the counter DB
2. Reading the feedback signals. The read values are stored by the FC in the counter DB in the structure CHECKBACK_SIGNALS.
3. Transfers the control signals from the counter DB (CONTROL_SIGNALS structure) to the FM 350-2.

Call

You must call the FC CNT2_CTR cyclically (in OB1 or in the cyclic interrupts - only OB35 in S7-300) for each module. Calling the FC CNT2_CTR in an interrupt program is not permitted.

Before the FC CNT2_CTR call, enter the current control signals in the CONTROL_SIGNALS structure in the counter DB. When the call of FC CNT2_CTR is completed, the updated feedback signals are available in the CHECKBACK_SIGNALS structure of the counter DB for further processing.

The number of the counter DB is specified in the FC call at the parameter DB_NO.

Representation

The FC CNT2_CTR call in the STL and LAD methods of representation is given below.

STL representation

```
CALL    CNT2_CTR    (
        DB_NO       :=      );
```

LAD representation

FC CNT2_CTR Parameters

The following table lists the FC CNT2_CTR parameters:

Name	Declaration Type	Data type	Meaning	The user...	The block...
DB_NO	INPUT	WORD	Number of counter DB	enters	polls

Counter DB

The FC CNT2_CTR works together with the counter DB. You require a counter data block for each FM 350-2. The block contains entries for addressing the FM 350-2 and the data for the individual functions of the FM 350-2. The DB number is specified in the FC call at the parameter DB_NO.

Address	Name	Type	Start value	Comment
21.0 - 7	CTRL_DQ0 - 7	BOOL	FALSE	Enables the digital outputs 0 to 7
22.0 - 7	SET_DQ0 - 7	BOOL	FALSE	Sets the digital outputs 0 to 7
23.0 - 7	SW_GATE0 - 7	BOOL	FALSE	Software gate counters 0 to 7

Address	Name	Type	Start value	Comment
36.1	STS_TFB	BOOL	FALSE	TRUE: PG operation is active, controlling not possible from CPU FALSE: PG operation deactivated
36.4	DATA_ERR	BOOL	FALSE	TRUE: Data error occurred FALSE: no data error
36.7	PARA	BOOL	FALSE	TRUE: FM 350-2 has parameters assigned, all other CHECKBACK_SIGNALS are valid FALSE: FM 350-2 has no parameters assigned
37.0 - 7	STS_CMP0 - 7	BOOL	FALSE	Status of comparators 0 to 7 or status of SET_DQ0 - 7 after digital outputs were set You must evaluate the status after the FC CNT2_CTR call because it is then reset
38.0 - 7	STS_UFLW0 - 7	BOOL	FALSE	Status of underflow counters 0 to 7 in main count direction "down" You must evaluate the status after the FC CNT2_CTR call because it is then reset
39.0 - 7	STS_OFLW0 - 7	BOOL	FALSE	Status of overflow counters 0 to 7 in main count direction "up" You must evaluate the status after the FC CNT2_CTR call because it is then reset

Address	Name	Type	Start value	Comment
40.0 - 7	STS_DIR0 - 7	BOOL	FALSE	Status of count direction counters 0 to 7, applies to the last logged count pulse TRUE: Counter in down count mode FALSE: Counter counts up
41.0 - 7	STS_DI0 - 7	BOOL	FALSE	Status of hardware gates 0 to 7, i.e. the status of the corresponding digital input
42.0 - 7	STS_DQ0 - 7	BOOL	FALSE	Status of digital outputs 0 to 7
43.0 - 7	STS_GATE0 - 7	BOOL	FALSE	Status of internal gate, counters 0 to 7
44	USER_STAT_WORD0	WORD	W#16#0	Depends on parameters set for count/measured value
46	USER_STAT_WORD1	WORD	W#16#0	Depends on parameters set for count/measured value
48	USER_STAT_WORD2	WORD	W#16#0	Depends on parameters set for count/measured value
50	USER_STAT_WORD3	WORD	W#16#0	Depends on parameters set for count/measured value

Initialization of the counter DB

Operating the FM 350-2 is only permitted if the CHECKBACK_SIGNALS.PARA bit is set. When the FM 350-2 starts up, the FC deletes the structures CONTROL_SIGNALS, JOB_WR status, JOB_RD status, RESERVE_0, and RESERVE_1 in the counter DB.

6.5 Load counter values, limit values and comparison values (FC3/FB3)

Task

With the FC CNT2_WR / FB CNT2WRPN, you load the counters and comparators of the FM 350-2 using write jobs. For this you must call the FC CNT2_WR / FB CNT2WRPN once per module as required.

You link the FC CNT2_WR / FB CNT2WRPN into your program only if you have to reload the counters and comparators of the FM 350-2 during operation.

Actions

The FC CNT2_WR / FB CNT2WRPN executes the following actions:

Executes the write job (JOB_WR) from the counter DB. Transmits the relevant data from the counter DB. Displays the status of the write job.

Call

The FC CNT2_WR / FB CNT2WRPN can be called cyclically or, alternatively, in a time-driven program. Calling in the interrupt program is not permissible.

Before processing write jobs you must supply the data area for the write job with the relevant values. The last write job must be completed, i.e. JOB_WR.NO (data byte DBB0) is deleted from the counter DB.

Representation

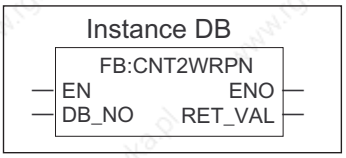
The FC CNT2_WR / FB CNT2WRPN call in the STL and LAD methods of representation is given below.

STL representation

```
CALL  CNT2_WR (
      DB_NO      :=       ,
      RET_VAL    :=       ) ;
```

```
CALL  CNT2WRPN, Instance DB  (
      DB_NO      :=       ,
      RET_VAL    :=       ) ;
```

LAD representation



FC CNT2_WR / FB CNT2WRPN Parameters

The table below lists the parameters of FC CNT2_WR / FB CNT2WRPN.

Name	Declaration type	Data type	Meaning	The user...	The block...
DB_NO	INPUT	WORD	Counter DB number	enters	polls
RET_VAL	OUTPUT	INT	Return code of SFC 58 "WR_REC" or SFB 53 "WRREC"	polls	enters

Write Job

You initiate a new write job by entering it in JOB_WR.NO. Permitted write jobs:

JOB_ WR.NO (DBB0)	Entry in UDT1	Address in counter DB	Meaning counting mode	Meaning frequency mode
0	none	none	No write job / last write job finished	
10	LOAD_VAL0	52	Load counter 0	Load low limit 0
11	LOAD_VAL1	56	Load counter 1	Load low limit 1
12	LOAD_VAL2	60	Load counter 2	Load low limit 2
13	LOAD_VAL3	64	Load counter 3	Load low limit 3
14	LOAD_VAL4	68	Load counter 4	Load low limit 4
15	LOAD_VAL5	72	Load counter 5	Load low limit 5
16	LOAD_VAL6	76	Load counter 6	Load low limit 6
17	LOAD_VAL7	80	Load counter 7	Load low limit 7
20	LOAD_PREPARE_VAL0	84	Load counter 0 in preparation	Load high limit 0
21	LOAD_PREPARE_VAL1	88	Load counter 1 in preparation	Load high limit 1
22	LOAD_PREPARE_VAL2	92	Load counter 2 in preparation	Load high limit 2
23	LOAD_PREPARE_VAL3	96	Load counter 3 in preparation	Load high limit 3
24	LOAD_PREPARE_VAL4	100	Load counter 4 in preparation	Load high limit 4
25	LOAD_PREPARE_VAL5	104	Load counter 5 in preparation	Load high limit 5
26	LOAD_PREPARE_VAL6	108	Load counter 6 in preparation	Load high limit 6
27	LOAD_PREPARE_VAL7	112	Load counter 7 in preparation	Load high limit 7
30	CMP_VAL0	116	Load comparator 0	
31	CMP_VAL1	120	Load comparator 1	
32	CMP_VAL2	124	Load comparator 2	
33	CMP_VAL3	128	Load comparator 3	

JOB_ WR.NO (DBB0)	Entry in UDT1	Address in counter DB	Meaning counting mode	Meaning frequency mode
34	CMP_VAL4	132	Load comparator 4	
35	CMP_VAL5	136	Load comparator 5	
36	CMP_VAL6	140	Load comparator 6	
37	CMP_VAL7	144	Load comparator 7	
40	LOAD_VAL0 to LOAD_VAL3	52 - 67	Load counters 0 to 3	Load low limits 0 to 3
41	LOAD_VAL4 to LOAD_VAL7	68 - 83	Load counters 4 to 7	Load low limits 4 to 7
42	LOAD_VAL0 to LOAD_VAL7	52 - 83	Load counters 0 to 7	Load low limits 0 to 7
50	LOAD_PREPARE_VAL0 to LOAD_PREPARE_VAL3	84 - 99	Load counters 0 to 3 in preparation	Load high limits 0 to 3
51	LOAD_PREPARE_VAL4 to LOAD_PREPARE_VAL7	100 - 111	Load counters 4 to 7 in preparation	Load high limits 4 to 7
52	LOAD_PREPARE_VAL0 to LOAD_PREPARE_VAL7	84 - 111	Load counters 0 to 7 in preparation	Load high limits 0 to 7
60	CMP_VAL0 to CMP_VAL3	116 - 131	Load comparators 0 to 3	
61	CMP_VAL4 to CMP_VAL7	132 - 147	Load comparators 4 to 7	
62	CMP_VAL0 to CMP_VAL7	116 - 147	Load comparators 0 to 7	

Write Job Status

The status of a write job is displayed in the counter DB (data byte DBB1)

Bit in JOB_WR (DBX1.)	Meaning
.BUSY, 0	= 1: Write job busy. The FC CNT2_WR / FB CNT2WRPN sets this bit as soon as it processes a write job (JOB_WR.NO > 0 and JOB_WR.IMPOSS = 0). The FC CNT2_WR / FB CNT2WRPN clears the bit as soon as the write job is finished (JOB_WR.NO = 0).
.DONE, 1	= 1: Write job finished. The FC CNT2_WR / FB CNT2WRPN sets this bit as soon as a write job is finished (even with errors). The FC CNT2_WR / FB CNT2WRPN clears the bit when a new write job starts. You can also clear this bit in the user program.
.IMPOSS, 2	= 1: Write job cannot be processed (the FM 350-2 is not assigned parameters, startup or PG operation are active). You can leave the write job (JOB_WR) or delete it. The FC CNT2_WR / FB CNT2WRPN clears the bit when the above conditions are fulfilled.
.UNKNOWN, 3	= 1: Write job unknown. The write job (JOB_WR) you specified is not in the permitted range (see error message). The FC CNT2_WR / FB CNT2WRPN clears this bit as soon as a valid number is entered in JOB_WR. The unknown number is retained until this happens.

Error Messages

Any errors which occurred are displayed in the binary result bit (BR = 0).

Possible errors are:

- Unknown write job (see JOB_WR.UNKNOWN).
- Data transmission error when transmitting data with SFC58 "WR_REC" / SFB 53 "WRREC". You can read the error data at output parameter RET_VAL

  (see Reference Manual SIMATIC System and Standard Functions for S7-300/400 Volume 1/2 (http://support.automation.siemens.com/WW/view/en/44240604)).
- The transmitted data are checked for data errors and interpreted by the module. If a data error occurs, the bit CHECKBACK_SIGNALS.DATA_ERR = 1 is set in the counter DB. You will find more information on data errors in the parameter assignment dialog boxes under the menu command **Debug > Diagnostics**.

6.6 Read out counter and measurement values (FC4/FB4)

Task

With the FC CNT2_RD / FB CNT2RDPN, you read the count values and measurement values from the FM 350-2 using read jobs. For this you must call the FC CNT2_RD / FB CNT2RDPN cyclically once for each module.

You do not integrate the FC CNT2_RD / FB CNT2RDPN into your program if you are not processing any read jobs.

NOTICE
If data records are read continuously, the test operation with the Start up dialog of the configuration software will be affected negatively. The reading of data records by the configuration package, for example, loading of parameters, is canceled by the CPU if the user program issues a read job. Thus, read jobs should be executed quickly if there is no or hardly any read job request during the test period.

Action

The FC CNT2_RD / FB CNT2RDPN executes the following actions:

1. Executes the read job (JOB_RD) from the counter DB
2. Transmits the relevant data to the counter DB
3. Displays the status of the read job

Call

The FC CNT2_RD / FB CNT2RDPN can be called cyclically or, alternatively, in a time-driven program. Calling in an interrupt program is not permitted.

The last read job must be completed, i.e. JOB_RD.NO (data byte DBB2) is deleted from the counter DB.

Representation

The FC CNT2_RD / FB CNT2RDPN call in the STL and LAD methods of representation is given below.

Table 6- 1 STL representation

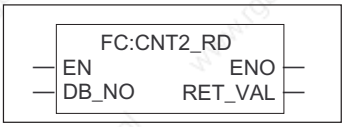
```
CALL                CNT2_RD (
                    DB_NO                :=                ,
                    RET_VAL              :=                );
```

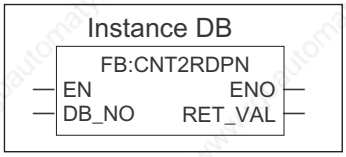
STL representation

```
CALL  CNT2_RD (
      DB_NO      :=      ,
      RET_VAL    :=      ) ;
```

```
CALL  CNT2RDPN, Instance DB (
      DB_NO      :=      ,
      RET_VAL    :=      ) ;
```

LAD representation





FC CNT2_RD / FB CNT2RDPN Parameters

The table below lists the parameters of FC CNT2_RD / FB CNT2RDPN.

Name	Declaration type	Data type	Meaning	The user...	The block...
DB_NO	INPUT	WORD	Number of counter DBs	enters	polls
RET_VAL	OUTPUT	INT	Return code of SFC 59 "RD_REC" / SFB 52 "RDREC"	polls	enters

Read Job

You initiate a new read job by entering it in JOB_RD.NO. Permitted read jobs:

JOB_RD.NO (DBB2)	Entry in UDT1	Address in counter DB	Meaning
0	none	none	No read job / last read job finished
100	ACT_CNTV0 ACT_MSRV0 ACT_CNTV1 ACT_MSRV1 ACT_CNTV2 ACT_MSRV2 ACT_CNTV3 ACT_MSRV3	148 to 179	Actual counter values 0 to 3 and measurement values 0 to 3
101	ACT_CNTV4 ACT_MSRV4 ACT_CNTV5 ACT_MSRV5 ACT_CNTV6 ACT_MSRV6 ACT_CNTV7 ACT_MSRV7	180 to 211	Actual counter values 4 to 7 and measurement values 4 to 7

Read Job Status

The status of a read job is displayed in the counter DB (data byte DBB3)

Bit in JOB_RD (DBX3.)	Meaning
.BUSY, 0	= 1: Read job running. The FC CNT2_RD / CNT2RDPN sets this bit as soon as it processes a read job (JOB_RD.NO > 0 and JOB_RD.IMPOSS = 0). The FC CNT2_RD / FB CNT2RDPN clears the bit as soon as the read job is finished (JOB_RD.NO = 0).
.DONE, 1	= 1: Read job finished. The FC CNT2_RD / FB CNT2RDPN sets this bit as soon as a read job is finished (event with errors). The FC CNT2_RD / FB CNT2RDPN clears the bit when a new read job starts. You can also clear this bit in the user program.
.IMPOSS, 2	= 1: Read job cannot be processed (the FM 350-2 is not assigned parameters, startup or PG operation are active). You can leave the read job (JOB_RD.NO) or delete it. The FC CNT2_RD / FB CNT2RDPN clears the bit when the conditions indicated above are fulfilled.
.UNKNOWN, 3	= 1: Read job unknown. The read job (JOB_RD) you specified is not in the permitted range (see error evaluation). The FC CNT2_RD / FB CNT2RDPN clears this bit as soon as a valid number is entered in JOB_RD.NO. The unknown number is retained until this happens.

Error Messages

Any errors which occurred are displayed in the binary result bit (BR = 0). Possible errors are:

- Unknown read job (see JOB_RD.UNKNOWN).
- Data transmission error when transmitting data with SFC 59 "RD_REC" / SFB 52 "RDREC". You can see the error at the output parameter RET_VAL (see Reference Manual SIMATIC System and Standard Functions for S7-300/400 Volume 1/2 (http://support.automation.siemens.com/WW/view/en/44240604)).

6.7 The DIAG_RD Function (FC5), Read Diagnostic Interrupt Data

Task

With the function DIAG_RD you can load the diagnostic interrupt data into the counter DB in the case of a diagnostic interrupt.

Action

The FC DIAG_RD executes the following actions:

Reads 16 bytes of diagnostic data from the FM 350-2 Enters these data in the counter DB in the data area DIAGNOSTIC_IN_INFO These data contain the diagnostic status of the whole module (covering all counters).

Call

The function DIAG_RD can only be called in the interrupt OB82.

Representation

The FC DIAG_RD call in the STL and LAD methods of representation is given below.

STL representation

```
CALL    DIAG_RD(    (
        DB_NO       :=      ,
        RET_VAL     :=      ,
```

LAD representation

FC DIAG_RD Parameters

The table below lists the parameters of FC DIAG_RD:

Name	Declaration type	Data type	Meaning	The user...	The block...
DB_NO	INPUT	WORD	Number of counter DBs	enters	polls
RET_VAL	OUTPUT	INT	Return code of SFC 51 "RDSYSST"	polls	enters

See also

Processing Interrupts (Page 53)

6.8 Application and programming example for FM 350-2

6.8.1 Task

Overview

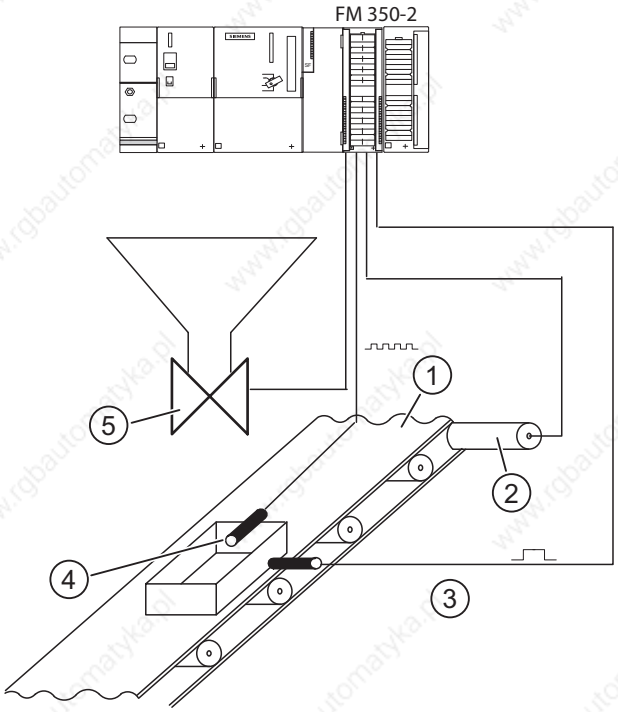
In this example, the FM 350-2 counter module is used to solve two different tasks. The filling unit application uses counter channels 0 and 1. The second application works with count channel 4 to record frequencies with a limit value check.

Filling unit

A box is to be filled with a certain number of parts taken from a collection bin. Channel 0 counts the parts and controls the filling valve. Channel 1 controls the motor of the box conveyor and counts the number of boxes.

When the box is in the correct position, the valve is opened and the box is filled with parts. When the specified number of parts is reached, the valve is closed and the transport of the boxes is started. Any following parts continue to be counted until a new box appears.

A new number of parts can be specified during the transport of the box. The number of parts placed in a box and the number of boxes can be monitored.



(1) Conveyor
(2) Motor
(3) Gate
(4) Light barriers
(5) Valve

Figure 6-1 Example for using an FM 350-2 in the S7-300 (filling unit)

Frequency measurement

At count channel 4 frequencies of up to 10 kHz are measured. The measured frequency is subject to a limit value check for the low limit 1 kHz and the high limit 9 kHz. The status of the limit values and the measured frequency and the continuously counted pulses can be monitored.

Project ZXX34_01_FM350-2

The whole example is located in the STEP 7 project ZXX34_01_FM350-2. The project is part of the configuration package for FM 350-2.

The project comprises the following components:

- The hardware configuration of the SIMATIC S7-300 station with the parameter assignments for the FM 350-2
- The programming example with the blocks (system data, FC2, FC3, FC4, FC5, FC100, DB2, OB1, OB82, UDT1, VAT1, and SFC46)
- The source files for the programming example (CNT2_CYC and UDT1)
- The symbols

Requirements

The following requirements must be fulfilled:

- You must have a SIMATIC S7-300 station, comprising a power supply module, a CPU 314, a digital input/output module DI8/DO8x24V/0.5A, with the necessary accessories such as expansion bus and front connectors. You will find more information in the ZXX34_01_FM350-2 project under "HW Config - Configuring Hardware: SIMATIC S7-300 station (1)
- The PG is connected to the CPU.
- You must have an FM 350-2 module, the corresponding software, and the necessary accessories such as expansion bus, front connectors, encoders or switches, and wiring material.

Installing the software on the programming device

If the configuration package has not been installed, perform the installation (see "Installing and opening parameter assignment dialog boxes (Page 45)").

6.8.2 Wiring the FM 350-2

Procedure

To wire the FM 350-2, proceed as follows:

1. Wire the front connector as follows (you can find additional information in the sections "Terminal assignment of the front connector (Page 37)" and "Wiring front connectors (Page 41)").

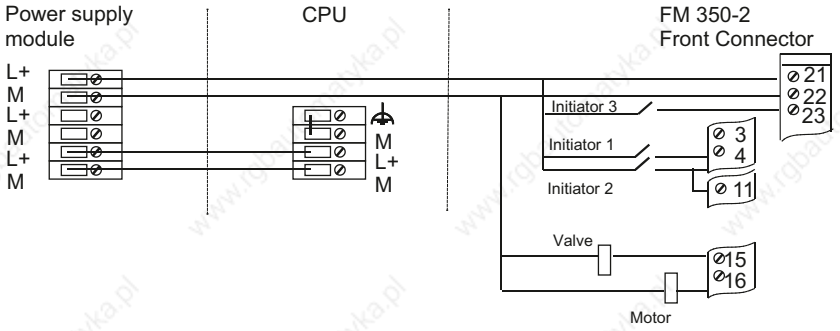


Figure 6-2 Wiring the front connector

Terminal	Name	Meaning
21	L+	24 V power supply
22	M	Ground
23	A4	Frequency input from 24-V initiator 3
3	A0	Count pulses for parts from 24-V initiator 1
4	A1	Count pulses for boxes from 24-V initiator 2
11	I0	Box in position (hardware gate) from terminal 4
15	Q0	Valve control fill box with parts
16	Q1	Motor control for transporting boxes

Debugging

Switch on the voltage on the power supply module. The red LED SF on the FM 350-2 illuminates briefly and extinguishes again after a successful self-test of the FM 350-2.

When you switch on the power supply for the first time, the FM 350-2 has the default parameters assigned (the features of the default parameter assignment are described in section Default Parameter Assignment (Page 47)).

Checking Parameters

Proceed as follows:

1. Open the ZXX34_01_FM350-2 project in the SIMATIC Manager.

2. Open the SIMATIC 300 object.

   The station described above under Requirements is displayed under "HW Config - Configuring Hardware: SIMATIC 300.” The parameter assignments for the applications described above are also stored there under "FM 350-2 Counter.”

   You can view the parameters in the "FM 350-2 Counter" window by double-clicking FM 350-2 Counter entry. The window outputs general information, the addresses, and the basic parameters of the FM 350-2.

3. Click the "Parameters” button.

   The parameter assignment dialog boxes for the FM 350-2 are opened. Here the parameters for encoders, operating modes, interrupt enable, and outputs are stored for each channel.

   Using the menu command **Edit > Specify Channels** you will find the global settings for all channels of the FM 350-2.

4. Enter the parameter assignments for the FM 350-2 in the hardware configuration using the menu command **File > Save** and close the "FM 350-2 Counter" window by clicking the "OK" button.

5. Save the hardware configuration with the menu command **Station > Save**.

6. Exit the Hardware Configuration application with **Station > Exit**.

6.8.3 Using the sample program

Downloading the sample program

Proceed as follows:

1. Open the block container in the project ZXX34_01_FM350-2 via **SIMATIC 300 > CPU 314 > S7 Program > Blocks** by clicking on Blocks.
2. Download the whole example (blocks) to the CPU using the menu command **PLC > Download**.

Executing the sample program

The sample program is executed in OB1. The FC100 called there contains both applications and the corresponding calls for the functions FC CNT2_CTR, FC CNT2_WR and FC CNT2_RD.

1. Switch the CPU to RUN mode.
2. Modify and monitor the example via the digital input/output module and the variable table VAT1.

Input/output assignments

The inputs and outputs are assigned in OB1 memory bits.

Input	Memory bit	Symbol	Meaning
I 0.0	M 0.0	stfill	TRUE: Starts the filling unit
I 0.1	M 0.1	stfrequ	TRUE: Starts recording frequencies
I 0.2	M 0.2	in_load	FALSE ->TRUE: Start to load new quantity
I 0.3	M 0.3	in_act_val	TRUE: Select read actual values
I 0.4	M 0.4	ch_act_val	Selects actual values FALSE: from count channels 0 to 3 TRUE: from count channels 4 to 7
Output	Memory bit	Symbol	Meaning
Q 0.0	M 2.0	state_load	TRUE: Load new quantity executed
Q 0.1	M 2.1	err_wr	TRUE: Error when loading quantity
Q 0.2	M 2.2	err_rd	TRUE: Error reading actual values
Q 0.3	M 2.3	oflw	TRUE: High frequency limit exceeded
Q 0.4	M 2.4	uflw	TRUE: Low frequency limit fallen below

Monitoring using the variable table

Proceed as follows:

1. Open the block VAT1 by double-clicking it.

2. Switch online with the menu command **PLC > Connect To > Configured CPU**.
3. Set monitoring with the menu command **Variable > Monitor**.

6.8.4 Runtime of the example applications

Filling Unit Application Procedure

Below is a description of the sequence of operations of the filling unit application.

1. Start the filling unit application by setting the input I 0.0.

   The output Q 1 of the FM 350-2 is set to bring the box into position.

2. Activate the 24-V initiator 2 (box in position / count pulses for boxes) when the box is in position.

   In VAT1 "fill_unit1".CHECKBACK_SIGNALS.USER_STAT_ WORD1 (number of boxes) 1 is displayed.

   Then the valve is opened via the output Q 0 of the FM 350-2 and the parts are counted. When you activate the 24-V initiator 1, the number of filled parts in "fill_unit1".CHECKBACK_SIGNALS. USER_STAT_ WORD0 (number of parts) is incremented.

   When the count reaches 10 parts the valve is closed and the transport of the box is activated.

   When the next box is in position the procedure is repeated.

You can change the number of parts as follows:

1. Enter the new quantity in VAT1 under "quant" in the modify value.

   The new quantity is specified with the menu command **Variable > Modify**.

2. Set the input I 0.2 to load the new quantity.

   When loading is completed the output Q 0.0 is set.

3. Delete the input I 0.2.

   The output Q 0.0 also goes out.

Frequency Recording Application Procedure

Below is a description of the sequence of operations of the frequency recording application.

1. Start the application for recording frequencies by setting the input I 0.1.

2. Activate the 24-V initiator 3 (frequency input), for example, by connecting a frequency generator. You must ensure that the input level is correct.

   The measured frequency value is displayed in VAT1 in DB2.DBD48.

   An underflow of the lower frequency limit 1 kHz is displayed at the output Q 0.4.

   An overflow of the upper frequency limit 9 kHz is displayed at the output Q 0.3.

   You can also read the actual values (count and measurement values) of the count channels 4 to 7.

3. Set the input I 0.4 and the input I 0.3.

   VAT1 "fill_unit1". ACT_CNTV4 to "fill_unit1".ACT_MSRV7 indicate the actual values as long a this bit is set.

   You can also read the actual values for the count channels 0 to 3 by deleting the input I 0.4. These values are not displayed in VAT1.

Diagnostics

Incorrect wiring can lead to errors which the FM 350-2 indicates by means of the group error LED SF. The FM 350-2 can trigger a diagnostic interrupt in these cases if the basic parameters were set accordingly ("Generate Interrupt: Yes" and "Select Interrupt: Diagnostics or Diagnostics+Hardware"). In the sample program the diagnostic interrupt OB82 is programmed for this purpose. It enters the current diagnostic information for the FM 350-2 in the counter DB.

6.9 PROFINET mode

General

In PROFINET mode, you must use the blocks from the fm_cnti library under "Counter_V2". Their functionality corresponds to that of the blocks under "Counter_V1" and are similarly described in Chapters Programming the FM 350-2 (Page 49) and DB Assignments (Page 131). The CNT2RDPN and CNT2WRPN blocks for PROFINET mode use SFB 52/SFB 53 for data transmission to the FM 350-2.

SFCs for data transmission without PROFINET mode	SFBs for data transmission with PROFINET mode
SFC 58 "WR_REC"	SFB 53 "WRREC"
SFC 59 "RD_REC"	SFB 52 "RDREC"

For the CNT2RDPN and CNT2WRPN blocks, the RET_VALU output parameter is formed from the 2nd and 3rd bytes of the STATUS parameter of the SFB.

Transition to PROFINET mode

The CNT2RDPN and CNT2WRPN blocks are not interface-compatible with the CNT2_RD and CNT2_WR blocks. Proceed as follows when replacing these blocks:

Tool	Function	Comment
LAD/STL/FBD	File > Compile	Upgrade the function calls from the FC 3/FC 4 to FB 3/FB 4 and select an available instance DB. Assign the DB_NO parameter and perform "File > Compile".

The following table shows the blocks with their SFCs/SFBs for data transmission and the corresponding blocks for PROFINET mode.

Blocks from "Counter_V1" for central configuration and PROFIBUS mode	Blocks from "Counter_V2" for PROFINET mode
FC 3 CNT2_WR SFC 58 "WR_REC"	FB 3 CNT2WRPN SFB 53 "WRREC"
FC 4 CNT2_RD SFC 59 "RD_REC"	FB 4 CNT2RDPN SFB 52 "RDREC"

6.10 Technical data of the blocks

Technical specifications

Technical specifications	FC CNT2_CTR	FC CNT2_WR / FB CNT2WRPN	FC CNT2_RD / FB CNT2RDPN	FC DIAG_RD
Block number	FC 2	FC 3 / FB 3	FC 4 / FB 4	FC 5
Version	1.1	1.1 / 2.1	1.1 / 2.0	1.1
Assignment in work memory in bytes	248	832 / 894	402 / 460	198
Assignment in load memory in bytes	314	986 / 1074	490 / 574	272
Assignment in local data area in bytes	6	24 / 36	24 / 32	34
System function called		SFC 58 "WR_REC" / SFB 53 "WRREC"	SFC 59 "RD_REC" / SFB 52 "RDREC"	SFC 51 "RDSYSST"

Starting Up the FM 350-2

7

7.1 Mechanical installation checklist

Checklist

Working step	Options / procedure			(X)
Install FM 350-2	1. Loosen neighboring module and connect expansion bus. 2. Hook module into position and tighten the screws. 3. Attach slot number. 4. Install shield attachment.			
Select cables	Observe the rules and regulations			
Connect the NAMUR encoders	**Terminal**	**Name**	**Function**	
	3	A0	Channel 0 count input NAMUR	
	4	A1	Channel 1 count input NAMUR	
	5	A2	Channel 2 count input NAMUR	
	6	A3	Channel 3 count input NAMUR	
	23	A4	Channel 4 count input NAMUR	
	24	A5	Channel 5 count input NAMUR	
	25	A6	Channel 6 count input NAMUR	
	26	A7	Channel 7 count input NAMUR	
	19	P8V2	NAMUR encoder supply	
	20	P8V2	NAMUR encoder supply	
	39	P8V2	NAMUR encoder supply	
	40	P8V2	NAMUR encoder supply	
Connect 24-V pulse encoder without direction level (initiator/BERO)	**Terminal**	**Name**	**Function**	
	3	A0	Channel 0 count input BERO	
	4	A1	Channel 1 count input BERO	
	5	A2	Channel 2 count input BERO	
	6	A3	Channel 3 count input BERO	
	23	A4	Channel 4 count input BERO	
	24	A5	Channel 5 count input BERO	
	25	A6	Channel 6 count input BERO	
	26	A7	Channel 7 count input BERO	

Working step	Options / procedure			(X)
Connect 24-V pulse encoder with direction level Connect 24-V incremental encoder	**Terminal**	**Name**	**Function**	
	3	A0	Channel 0 count input BERO	
	4	A1	Channel 1 count input BERO	
	5	A2	Channel 2 count input BERO	
	6	A3	Channel 3 count input BERO	
	23	A4	Channel 4 count input BERO	
	24	A5	Channel 5 count input BERO	
	25	A6	Channel 6 count input BERO	
	26	A7	Channel 7 count input BERO	
	7	B0	Channel 0 direction input BERO	
	8	B1	Channel 1 direction input BERO	
	9	B2	Channel 2 direction input BERO	
	10	B3	Channel 3 direction input BERO	
	27	B4	Channel 4 direction input BERO	
	28	B5	Channel 5 direction input BERO	
	29	B6	Channel 6 direction input BERO	
	30	B7	Channel 7 direction input BERO	
Wire digital inputs and outputs	**Terminal**	**Name**	**Function**	
	11	I0	Channel 0 digital input HW gate	
	12	I1	Channel 1 digital input HW gate	
	13	I2	Channel 2 digital input HW gate	
	14	I3	Channel 3 digital input HW gate	
	31	I4	Channel 4 digital input HW gate	
	32	I5	Channel 5 digital input HW gate	
	33	I5	Channel 6 digital input HW gate	
	34	I7	Channel 7 digital input HW gate	
	15	Q0	Channel 0 digital output 0.5 A	
	16	Q1	Channel 1 digital output 0.5 A	
	17	Q2	Channel 2 digital output 0.5 A	
	18	Q3	Channel 3 digital output 0.5 A	
	35	Q4	Channel 4 digital output 0.5 A	
	36	Q5	Channel 5 digital output 0.5 A	
	37	Q6	Channel 6 digital output 0.5 A	
	38	Q7	Channel 7 digital output 0.5 A	
Connect the auxiliary voltage	**Terminal**	**Name**	**Function**	
	21	L+	24-V module power supply	
	22	M	Ground module supply	

7.2 Parameter assignment checklist

Checklist

Working step	Options / procedure	(X)
Basic parameters	Generate Interrupt Select Interrupt Reaction to CPU STOP	
Addresses	Inputs Outputs Interrupt OB	
Channel selection	Channels 0 to 7 as single counters Channel 0 as proportioning counter, channels 4 to 7 as single counter Channels 0 to 3 as single counters, channel 4 as dosing counter Channels 0 and 4 as dosing counters	
	Counter input channels 0 to 3 NAMUR Counter input channels 4 to 7 NAMUR	
Status display User_Type 1	Channel Count value/measurement value Channel Count value/measurement value	
Status display User_Type 2	Channel Count value/measurement value Channel Count value/measurement value	

Working step	Options / procedure		(X)
Encoder channel n	Signal evaluation	Pulse and direction	
		Single rotary transducer	
		Double rotary transducer	
		Quadruple rotary transducer	
	Inverted rotational direction		
	Pulses per encoder revolution		
	Hardware monitoring	Off	
		On	
	Main count direction	Up	
		Down	
	Hysteresis		

Working step	Options / procedure			(X)
Operating Modes Channel n	Infinite count	Use Hardware Gate		
		Cancel count process on closing a gate		
		Interrupt count process on closing a gate		
	Single counting	Start / End value		
		Use Hardware Gate		
		Cancel count process on closing a gate		
		Interrupt count process on closing a gate		
	Periodic counting	Start / End value		
		Use Hardware Gate		
		Cancel count process on closing a gate		
		Interrupt count process on closing a gate		
	Frequency measurement	Time window		
		Use Hardware Gate		
	Rotational speed measurement	Time window		
		Use Hardware Gate		
	Period duration measurement	Time window		
		Use Hardware Gate		
	Dosing	Start / End value		
		Use Hardware Gate		
		Cancel count process on closing a gate		
		Interrupt count process on closing a gate		
Outputs channel n	Output reaction	Disable output		
		Activate if counter reading >= comparison value		
		Switch on for counter reading <= comparison value		
	Substitute values	Substitute value 1	Substitute value 2	
		Substitute value 3	Substitute value 4	

Working step	Options / procedure	(X)
Select interrupts channel n	Interrupt when opening the HW gate	
	Interrupt when closing the HW gate	
	Interrupt on overflow / underflow	
	Interrupt when measurement completed	
	Below Limit	
	Above Limit	
	Reference value 1 reference value 2	
	Reference value 3 reference value 4	

Operating modes, settings, parameters, and jobs

8

8.1 Definitions

Supported modes of operation

FM 350-2 supports seven channel operating modes. The table below provides an overview of those modes.

Name	Description
Infinite count	The FM 350-2 counts continuously from the current counter reading on opening the internal gate.
Single counting	The FM 350-2 counts from the start value to the end value on opening the internal gate.
Periodic counting	The FM 350-2 counts between the start value and the end value on opening the internal gate.
Frequency measurement	The FM 350-2 determines the frequency of the pulse sequence applied at the input.
Rotational speed measurement	The FM 350-2 determines the rotational speed of the device connected at the input.
Period duration measurement	The FM 350-2 determines the pulse duration of the pulse sequence applied at the input.
Dosing	Four channels of the FM 350-2 are used for proportioning.

The default setting is the continuous counting mode.

Possible settings

You can adapt the FM 350-2 to your counting task with three settings. The following table gives an overview of these settings.

Name	Description
Behavior of the digital outputs	You can choose between three possibilities for the behavior of the outputs on reaching the comparison value.
Triggering hardware interrupts	The FM 350-2 can trigger a hardware interrupt in the case of a variety of selectable events.
Encoders	You must specify different settings for the encoder used.

Basic Parameter Assignment

You assign basic parameters for each FM 350-2 when you configure the hardware. The following Table gives the meanings of the relevant parameters.

Name	Option	Description
Generate Interrupt	No	You enable interrupt generation with this selection
	Yes	
Select Interrupt	None	You enable the relevant interrupts with this selection
	Diagnostics	
	Process	
	Process and diagnostics	
Reaction to CPU STOP	Cancel	Immediate switch off of the outputs Cancel the count
	Continue	The module continues
	Substitute values	Current count functions are terminated. The module switches the set substitute values to the outputs channel by channel.
	Last value	Current count functions are terminated. The outputs of the module are frozen at their state immediately before the stop.

See also

Overview (Page 123)

8.2 Basic Information on Calling Operating Modes, Settings, and Jobs

Selecting the Mode of Operation and Settings

You select the operating modes and settings in the parameter assignment dialog boxes of the FM 350-2.

For information on how to install the programming interfaces and program the FM 350-2 parameters, refer to section Installing and opening parameter assignment dialog boxes (Page 45) and to the integrated help system.

Changing the Mode of Operation and Settings

You can change an operating mode or setting in the parameter assignment dialog boxes. The new operating mode or setting becomes valid after the next transition from STOP to RUN of the CPU.

Jobs

Jobs are: Reading count / measurement values, writing load / count / reference / values and limit values.

Control Bits and Status Bits in the DB

In addition to the control bits, there are status bits in the DB that signal the status of the current operating mode.

Transmission of Control and Status Bits

You transfer the control and status bits from and to the module with the FC CNT2_CTR, which you must integrate into your user program:

The control bits and status bits should, if possible, be addressed symbolically in the user program. The symbolic names are used in the description of the FC in this chapter.

You can find precise information on FC CNT2_CTR in section "Programming the FM 350-2 (Page 49)" and the allocation of the DB in section "DB for FC CNT2_CTR (Page 131)".

8.3 Infinite count

Definition

In this mode the FM 350-2 counts continuously from the current count value (start value, default setting = 0):

- If the counter reaches the high limit and a further count pulse is received, it jumps to the low count limit and continues to count from there without any pulse losses.
- If the counter reaches the low limit and a further count pulse is received, it jumps to the high count limit and continues to count from there without any pulse losses.

The valid count range lies between -2147483648 and +2147483647 (-2^{31} and 2^{31} - 1). You cannot change this count range.

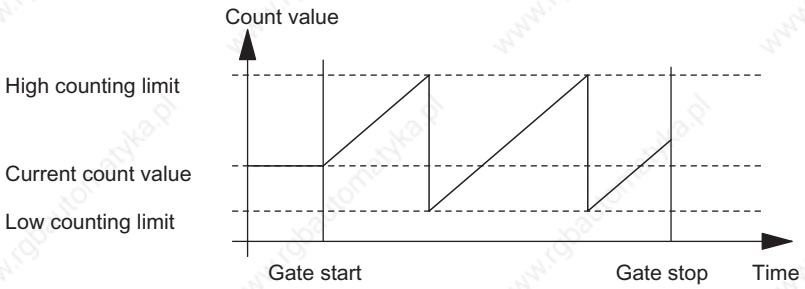


Figure 8-1 Continuous Counting with Gate Function

Selecting the Gate Function

You can select the gate function in this mode. The following possibilities are available to you:

- SW gate
- SW gate and HW gate

  You can add a hardware gate to the software gate. Both gates act together like a logic AND operation, meaning the FM 350-2 counts only when both gates are open.

Opening and closing the software gate

You open and close the software gate for each channel with the control bits SW_GATE0...7 in the data block of the FC CNT2_CTR.

Action	...is initiated by
Open software gate 0...7	Setting SW_GATE0...7, edge transition 0 -> 1
Close software gate 0...7	Resetting SW_GATE0...7

Opening and Closing the Hardware Gate

You open and close a hardware gate by applying the relevant signals to or removing the signals from the corresponding digital input I0...I7.

Action	...is initiated by
Open hardware gate 0...7	Applying signal to input I0 to I7, 0 -> 1
Close hardware gate 0...7	Removing signal from input I0 to I7, 1 -> 0

Canceling and Interrupting Gate Function

The gate function can interrupt or cancel the count process. When canceled, the count starts again from the beginning following gate stop and gate start. When interrupted, the count is resumed from the last current count value following gate stop and gate start.

If you are using a hardware gate in addition to the software gate, the software gate only has an interrupt effect; the hardware gate can interrupt or cancel.

The following figures show how the gate functions interrupt and cancel the count process:

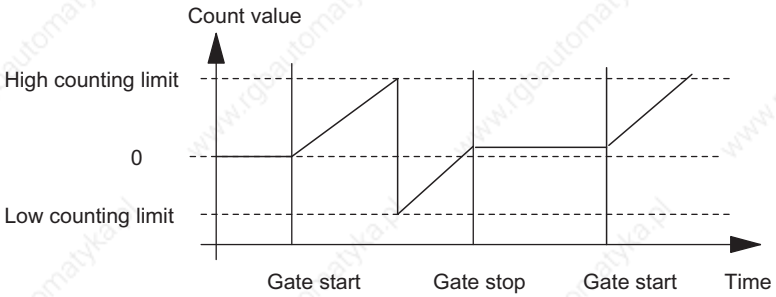


Figure 8-2 Continuous Counting, Interrupting Gate Function

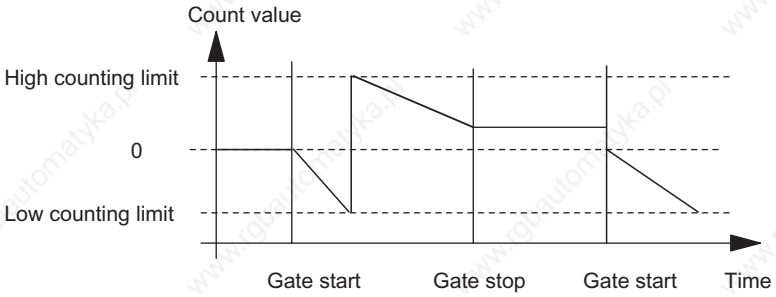


Figure 8-3 Continuous Counting, Canceling Gate Function

Reading Out Count Values

You can read out all count values by calling the jobs 100 (channels 0 to 3) and 101 (channels 4 to 7) of FC CNT2_RD / FB CNT2RDPN. By setting corresponding parameters, you can also assign up to 4 channels to a user-defined area in the I/O input range from where you can read the current count values.

In this operating mode the count value is equivalent to the current count value, and the measurement value is always 0.

Comparison Value

For each count channel of the FM 350-2 you can assign a comparison value within the count range. You can also assign whether and under what conditions a digital output should be set and/or a hardware interrupt triggered in conjunction with this comparison value. You can set the following conditions for this:

- A hardware interrupt is triggered if the current count value matches the comparison value.
- A digital output is set if the current count value is greater than or equal to the comparison value.
- A digital output is set if the current count value is less than or equal to the comparison value.

To be able to set a digital output, you must enable the relevant output by setting bit CTRL_DQ0...7 in the counter DB of FC CNT2_CTR.

You can change the assigned comparison values with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. You can select the extent to which this change applies:

- To each channel (jobs 30 to 37)
- To a group of four channels (job 60 for channels 0 to 3, job 61 for channels 4 to 7)
- To all eight channels (job 62)

Changing the Current Count Value

You can change the current count value with the FC CNT2_WR / FB CNT2WRPN while the CPU is in RUN mode. You can select the extent to which this change applies:

- To each channel (jobs 10 to 17)
- To a group of four channels (job 40 for channels 0 to 3, job 41 for channels 4 to 7)
- To all eight channels (job 42)

See also

Gate functions (Page 30)

8.4 Single counting

Definition

In this mode, the FM 350-2 counts once when the gate is open:

- In main count direction "up" between 0 and the set end value.
- In main count direction "down" between the set start value and 0.

You specify the main count direction and the start and end values in the parameter assignment screen forms.

If you assign the main count direction as "up," the start value is 0 and you specify the end value.

If you assign the main count direction as "down," you specify the start value and the end value is 0.

Selecting the Gate Function

You can select the gate function in this mode. The following possibilities are available to you:

- SW gate
- SW gate and HW gate

  You can add a hardware gate to the software gate. Both gates act together like a logic AND operation, meaning the FM 350-2 counts only when both gates are open.

Opening and Closing the Software Gate

You open and close the software gate for each channel with the control bits SW_GATE0...7 in the data block of FC CNT2_CTR.

Action	...is initiated by
Open software gate 0...7	Set SW_GATE0...7, edge transition 0 -> 1
Close software gate 0...7	Reset SW_GATE0...7

Opening and Closing the Hardware Gate

You open and close a hardware gate by applying the relevant signals to or removing the signals from the corresponding digital input I0...I7.

Action	...is initiated by
Open hardware gate 0...7	Applying signal to input I0...7, 0 -> 1
Close hardware gate 0...7	Removing signal from input I0...7, 1 -> 0

Behavior at the Count Limits

Main count direction up: When the counter reaches "end value -1" and receives a further count pulse, the module sets the counter value to 0, closes the internal gate and terminates the count, regardless of the status of bit SW_GATE0...7. The respective status bit STS_OFLW0...7 is set in the data block of the FC CNT2_CTR. The end value itself is therefore never reached.

Main count direction down: When the counter reaches the value "1" and receives a further count pulse, the module sets counter value to the initial value, closes the internal gate and terminates the count, regardless of the status of bit SW_GATE0...7. The respective status bit STS_UFLW0...7 is set in the data block of the FC CNT2_CTR. The value "0" is therefore never reached.

The status bits STS_OFLW0...7 and STS_UFLW0...7 are acknowledged by the FC CNT2_CTR on every call.

If you want to start the counter again, you must reset the bit SW_GATE0...7 and then set it again. If you assigned a hardware gate as well as a software gate, you must generate an edge change 0 -> 1 at the respective digital input; but not reset and then set the bit SW_GATE0...7.

Canceling and Interrupting Gate Function

The gate function can interrupt or cancel the count process. When canceled, the count restarts at its start value after the gate was cycled from stop to start. When interrupted, the count is resumed from the last current count value following gate stop and gate start.

If you are using a hardware gate in addition to the software gate, the software gate only has an interrupt effect; the hardware gate can interrupt or cancel.

The following figures help to clarify the difference between gate functions that cancel and gate functions that interrupt:

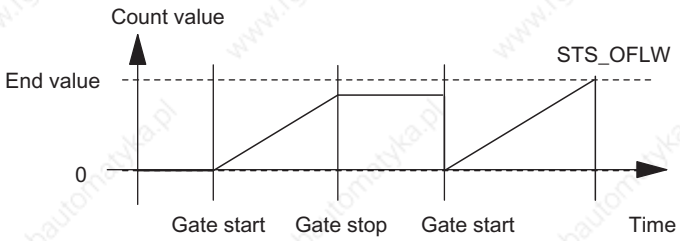


Figure 8-4 Single Counting in Main Count Direction Up, Canceling Gate Function

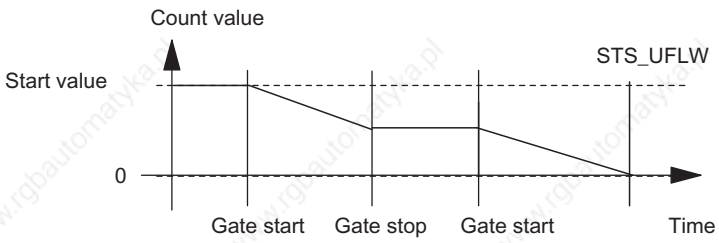


Figure 8-5 Single Counting in Main Count Direction Down, Interrupting Gate Function

Reading Out Count Values

You can read out all count values with jobs 100 (channels 0 to 3) and 101 (channels 4 to 7) of FC CNT2_RD/FB CNT2RDPN. You can also assign up to 4 channels to a user-defined area in the I/O input range from where you can read the current count values.

In this operating mode the count value is equivalent to the current count value, and the measurement value is always 0.

Comparison Value

For each count channel of the FM 350-2 you can assign a comparison value within the assigned count range. You can also assign whether and under what conditions a digital output should be set and/or a hardware interrupt triggered in conjunction with this comparison value. You can set the following conditions for this:

- A hardware interrupt is triggered if the current count value matches the comparison value.
- A digital output is set if the current count value is greater than or equal to the comparison value.
- A digital output is set if the current count value is less than or equal to the comparison value.

If you want a digital output to be set, you must have enabled the respective output in the counter DB of the FC CNT2_CTR with the bit CTRL_DQ0...7.

Note

An enabled digital output is also set when the gate is closed.

You can change the assigned comparison values with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. You can select the extent to which this change applies:

- To each channel (jobs 30 to 37)
- To a group of four channels (job 60 for channels 0 to 3, job 61 for channels 4 to 7)
- To all eight channels (job 62)

Load Value in Preparation

Within the assigned count range you can assign a load value with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. This value is used by the counter as the new start value every time after the following events:

- Reaching the end value in main count direction up
- Reaching 0 in main count direction down
- Canceling of the count process by a software gate or a hardware gate (when the count process is interrupted the load value is not used)

The load value is then the new start value from which the next and all other single counting processes begin. The assigned output and interrupt behavior remains the same.

You can select the extent to which the load value is valid:

- To each channel (jobs 20 to 27)
- To a group of four channels (job 50 for channels 0 to 3, job 51 for channels 4 to 7)
- To all eight channels (job 52)

Load Value Directly

You can change the current count value with the FC CNT2_WR / FB CNT2WRPN while the CPU is in RUN mode. The new count value is used by the counter directly as the current count value.

You can select the extent to which this change applies:

- To each channel (jobs 10 to 17)
- To a group of four channels (job 40 for channels 0 to 3, job 41 for channels 4 to 7)
- To all eight channels (job 42)

Value Range for Load Values

The value range for load values depends on the set main count direction. The range is:

- 0 to end value - 2 in main count direction up
- Start value to 2 in main count direction down

See also

Gate functions (Page 30)

Programming the FM 350-2 (Page 49)

8.5 Periodic count

Definition

In this mode, the FM 350-2 counts:

- In main count direction "up" from the start value 0 to the end value -1, then jumps back to the start value when the next count pulse is received and continues to count up from there.
- In main count direction "down" from the assigned start value to 1, then jumps back to the start value when the next count pulse is received and continues to count down from there.

You specify the main count direction and the start and end values in the parameter assignment screen forms.

If you assign the main count direction as "up", the start value is 0 and you specify the end value.

If you assign the main count direction as "down", you specify the start value and the end value is 0.

Selecting the Gate Function

You can select the gate function in this mode. The following possibilities are available to you:

- SW gate
- SW gate and HW gate

  You can add a hardware gate to the software gate. Both gates act together like an AND logic operation, meaning the FM 350-2 counts only when both gates are open.

Opening and Closing the Software Gate

You open and close the software gate for each channel with the control bits SW_GATE0...7 in the data block of FC CNT2_CTR.

Action	...is initiated by
Open software gate 0...7	Set SW_GATE0...7, edge transition 0 -> 1
Close software gate 0...7	Reset SW_GATE0...7

Opening and Closing the Hardware Gate

You open and close a hardware gate by applying the relevant signals to or removing the signals from the corresponding digital input I0...I7.

Action	...is initiated by
Open hardware gate 0...7	Apply signal to input I0...7, 0 -> 1
Close hardware gate 0...7	Remove signal from input I0...7, 1 -> 0

Behavior at the count limits

Main count direction up: When the counter reaches "end value -1" and receives a further count pulse, the module resets the counter to zero and then resumes the count. The respective status bit STS_OFLW0...7 is set in the data block of the FC CNT2_CTR. The end value itself is therefore never displayed.

Main count direction down: When the counter reaches the value "1" and receives a further count pulse, the module resets the counter to the start value and then resumes the count. The respective status bit STS_UFLW0...7 is set in the data block of the FC CNT2_CTR. The value "0" is therefore never displayed.

The status bits STS_OFLW0...7 and STS_UFLW0...7 are acknowledged by the FC CNT2_CTR on every call.

Canceling and interrupting gate function

The gate function can interrupt or cancel the count process. When canceled, the count restarts at its start value after the gate was cycled from stop to start. When interrupted, the count is resumed from the last current count value following gate stop and gate start.

If you are using a hardware gate in addition to the software gate, the software gate only has an interrupt effect; the hardware gate can interrupt or cancel.

The following figures help to clarify the difference between gate functions that cancel and gate functions that interrupt:

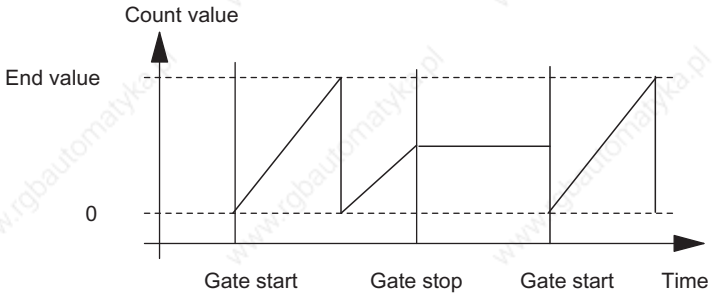


Figure 8-6 Periodic counting in main count direction up, Canceling gate function

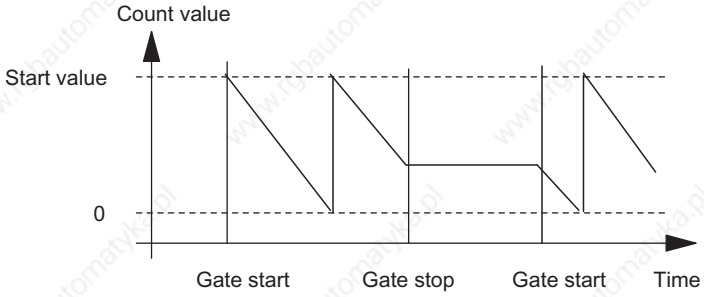


Figure 8-7 Periodic counting in main count direction down, Interrupting gate function

Reading Out Count Values

You can read out all count values with jobs 100 (channels 0 to 3) and 101 (channels 4 to 7) of FC CNT2_RD / FB CNT2RDPN. You can also assign up to 4 channels to a user-defined area in the I/O input range from where you can read the current count values.

In this operating mode the count value is equivalent to the current count value, and the measurement value is always 0.

Comparison value

For each count channel of the FM 350-2 you can assign a comparison value within the assigned count range. You can also specify whether and under what conditions a digital output should be set and/or a hardware interrupt triggered in conjunction with this comparison value. You can set the following conditions for this:

- A hardware interrupt is triggered if the current count value matches the comparison value.
- A digital output is set if the current count value is greater than or equal to the comparison value.
- A digital output is set if the current count value is less than or equal to the comparison value.

If you want a digital output to be set, you must have enabled the respective output in the counter DB of the FC CNT2_CTR with the bit CTRL_DQ0...7.

You can change the assigned comparison values with FC CNT2_WR / FB CNT2WRPN while the CPU is in RUN mode. You can select the extent to which this change applies:

- To each channel (jobs 30 to 37)
- To a group of four channels (job 60 for channels 0 to 3, job 61 for channels 4 to 7)
- To all eight channels (job 62)

Load value in preparation

Within the assigned count range you can assign a load value with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. This value is used by the counter as the new start value every time after the following events:

- Reaching the end value in main count direction up
- Reaching 0 in main count direction down
- Canceling of the count process by a software gate or a hardware gate (when the count process is interrupted the load value is not used)

The load value is then the new start value for the next and all other periodic counts. The assigned output and interrupt behavior remains the same.

You can select the extent to which the load value is valid:

- To each channel (jobs 20 to 27)
- To a group of four channels (job 50 for channels 0 to 3, job 51 for channels 4 to 7)
- To all eight channels (job 52)

Load Value Directly

You can change the current count value with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. The new count value is used by the counter directly as the current count value.

You can select the extent to which this change applies:

- To each channel (jobs 10 to 17)
- To a group of four channels (job 40 for channels 0 to 3, job 41 for channels 4 to 7)
- To all eight channels (job 42)

Value Range for Load Values

The value range for load values depends on the set main count direction. The range is:

- 0 to end value - 2 in main count direction up
- Start value to 2 in main count direction down

See also

Gate functions (Page 30)

Programming the FM 350-2 (Page 49)

8.6 Frequency measurement

Definition

In this mode, the FM 350-2 counts the pulses which are received in a set time window.

Parameter Assignment

You can set the length of the time window and two frequency comparison values (high and low limits) using the parameter assignment dialogs.

The length of the time window is set at an integer parameter n (1 ≤ n ≤ 1000) with a resolution of 10 ms. The system checks the plausibility of the entry to make sure the parameter does not violate limits, and reports a programming error if the result is negative.

Using the two frequency comparison values (range of values of the low limit value: 0 to 9,999,999 × 10^{-3} Hz, DWORD; range of values for the high limit: 1 to 10,000,000 × 10^{-3} Hz, DWORD) you can monitor whether the measured frequency remains within a defined range. A hardware interrupt can be triggered if this range is exited. The module verifies your entries to make sure the high limit > low limit, and reports a parameter assignment error if the result is negative.

The high and low limits can be changed by the user program.

Multiple evaluation is not possible with rotary transducers.

Selecting the Gate Function

In this mode you can select the gate function with which the frequency measurement is started and stopped. The following possibilities are available to you:

- SW gate
- SW gate and HW gate (= internal gate)

  You can add a hardware gate to the software gate. Both gates act together like a logic AND operation, meaning the FM 350-2 only measures frequencies when both gates are open.

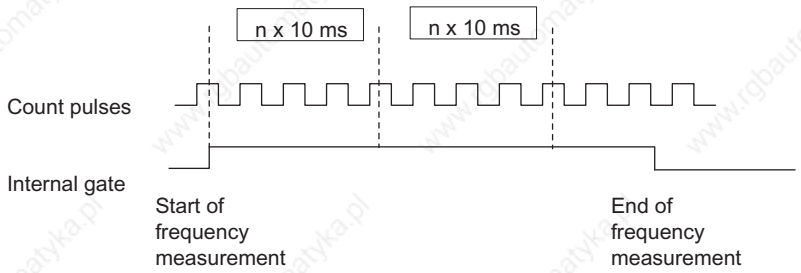


Figure 8-8 Frequency Measurement with Gate Function

Opening and Closing the Software Gate

You open and close the software gate for each channel with the control bits SW_GATE0...7 in the data block of the FC CNT2_CTR to start and stop frequency measurement.

Action	...is initiated by
Open software gate 0...7	Setting SW_GATE0...7, edge transition 0 -> 1
Close software gate 0...7	Resetting SW_GATE0...7

Opening and Closing the Hardware Gate

You open and close the hardware gate by applying the relevant signals to or removing the signals from the corresponding digital input I0...I7. The hardware gate is level-controlled and opened by a positive level (continuous).

Action	...is initiated by
Open hardware gate 0...7	Applying signal to input I0...7
Close hardware gate 0...7	Removing signal from input I0...7

Limit Values

After each time interval has expired, the frequency determined is compared with the assigned limit values (f_u / f_o). The following states are produced:

If the registered frequency is...	... the following bit is set
Greater than the high limit	STS_OFLW0...7
Less than the low limit value	STS_UFLW0...7

The bits STS_OFLW0...7 and STS_UFLW0...7 are reset at each call of the FC CNT2_CTR.

When you assign the parameters, you can specify whether you want a hardware interrupt to be triggered when a limit value is exceeded.

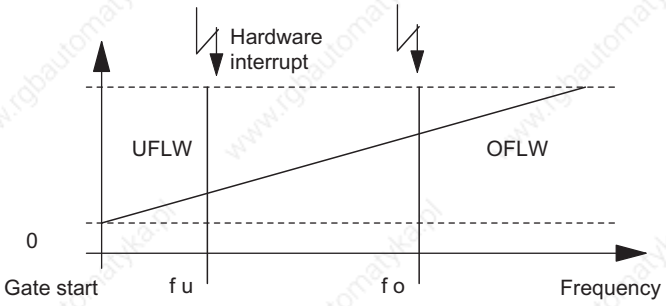


Figure 8-9 Frequency measurement with frequency reference values

Changing Limit Values

You can change the limit values with the FC CNT2_WR / FB CNT2WRPN while the CPU is in RUN mode. You can select the extent to which this change applies:

Changing the **low limit values**:

- To each channel (jobs 10 to 17)
- To a group of four channels (job 40 for channels 0 to 3, job 41 for channels 4 to 7)
- To all 8 channels (job 42)

Changing the **high limit values**:

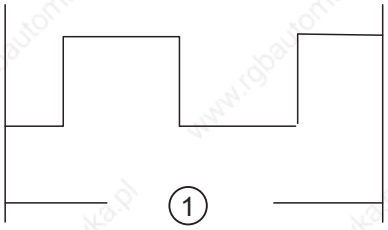
- To each channel (jobs 20 to 27)
- To a group of four channels (job 50 for channels 0 to 3, job 51 for channels 4 to 7)
- To all eight channels (job 52)

Result

The end of a frequency measurement (expiration of the interval) is reported at the status bits STS_CMP7...0. If assigned to the I/O input range, the measured frequency can be read using FC CNT2_CTR or, depending on the channel, it can be read out with jobs 100 and 101 of FC CNT2_RD/FB CNT2RDPN in the unit of 1×10^{-3} Hz.

In this operating mode the count value is equivalent to the current count value, and the measurement value is equivalent to the measured frequency.

The module measures a zero frequency if it does not detect at least two positive edges within the set time window.



(1) Time window

Figure 8-10 Two Positive Edges Within the Time Window

Reversed Direction of Rotation

If the rotation direction is reversed within a time interval, the measurement value for this measurement period is undetermined.

8.7 Rotational speed measurement

Definition

In this mode which is almost identical to the "frequency measurement" mode, the FM 350-2 counts the pulses which are received in a defined time window from a rotational speed encoder and uses this to calculate the rotational speed of the connected motor.

Parameter Assignment

You can set the length of the time window, the number of pulses per encoder revolution, and two rotational speed comparison values (an high and a low limit value) using the parameter assignment dialog boxes.

The length of the time window is set at an integer parameter n ($1 \leq n \leq 1000$) with a resolution of 10 ms. The system checks the plausibility of the entry to make sure the parameter does not violate limits, and reports a programming error if the result is negative.

Using the two rotational speed comparison values (value range for the low speed limit value: 0 to 24,999,999 × 10^{-3} rpm, DWORD; value range for the high speed limit: 1 to 25000000 × 10^{-3} rpm, DWORD) you can monitor whether the measured speed remains within a defined range. A hardware interrupt can be triggered if this range is exited. When entered, a check is made to ensure the high limit is greater than the low limit and a parameter assignment error is reported if this is not the case.

Only single evaluation can be set for the encoder signals.

Selecting the Gate Function

In this mode you can select the gate function with which the speed measurement is started and stopped. The following possibilities are available to you:

- SW gate
- SW gate and HW gate

  You can add a hardware gate to the software gate. Both gates act together like an AND logic operation, meaning the FM 350-2 only performs the speed measurement when both gates are open.

Opening and Closing the Software Gate

You open and close the software gate for each channel with the control bits SW_GATE0...7 in the data block of the FC CNT2_CTR to start and stop the speed measurement.

Action	...is initiated by
Open software gate 0...7	Setting SW_GATE0...7, edge transition 0 -> 1
Close software gate 0...7	Resetting SW_GATE0...7

Opening and Closing the Hardware Gate

You open and close a hardware gate by applying the relevant signals to or removing the signals from the corresponding digital input I0...I7.

Action	...is initiated by
Open hardware gate 0...7	Apply signal to input I0...7, 0 -> 1
Close hardware gate 0...7	Remove signal from input I0...7, 1 -> 0

Limit Values

After each time interval has expired, the rotational speed determined is compared with the set limit values. The following states are produced:

If the rotational speed is...	... the following bit is set
Greater than the high limit	STS_OFLW0...7
Less than the low limit value	STS_UFLW0...7

The bits STS_OFLW0...7 and STS_UFLW0...7 are reset at each call of the FC CNT2_CTR.

When you assign the parameters, you can specify whether you want a hardware interrupt to be triggered when a limit value is exceeded.

Changing Limit Values

You can change the limit values with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. You can select the extent to which this change applies:

Changing the **low limit values**:

- To each channel (jobs 10 to 17)
- To a group of four channels (job 40 for channels 0 to 3, job 41 for channels 4 to 7)
- To all 8 channels (job 42)

Changing the **high limit values**:

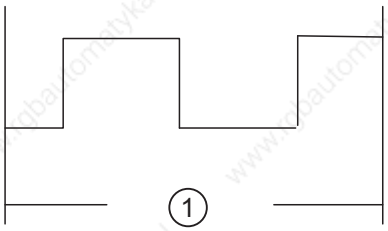
- To each channel (jobs 20 to 27)
- To a group of four channels (job 50 for channels 0 to 3, job 51 for channels 4 to 7)
- To all 8 channels (job 52)

Result

The end of a speed measurement (expiration of the interval) is reported at the status bits STS_CMP7...0. If assigned to the I/O input range, the measured speed value can be read using FC CNT2_CTR, or it can be read out, depending on the channel, with jobs 100 and 101 of FC CNT2_RD/FB CNT2RDPN in the unit of 1×10^{-3} rpm.

In this operating mode the count value is equivalent to the current count value, and the measurement value is equivalent to the measured rotational speed.

The module measures a zero speed if it does not detect at least two positive edges within the set time window.



(1) Time window

Figure 8-11 Two Positive Edges Within the Time Window

Reversed Direction of Rotation

If the rotation direction is reversed within a time interval, the measurement value for this measurement period is undetermined.

8.8 Period duration measurement

Definition

In this mode, the FM 350-2 measures the exact time between two rising edges of the count signal by counting the pulses from an internal quartz-accuracy reference frequency (1 MHz).

Parameter Assignment

You can set two period comparison values (an high and a low limit value) using the parameter assignment dialog boxes.

The length of the time window is set at an integer parameter n (1 ≤ n ≤ 1000) with a resolution of 10 ms. The system checks the plausibility of the entry to make sure the parameter does not violate limits, and reports a parameter assignment error if the result is negative.

Using the two period comparison values (value range for the low limit value: 0 to 119,999,999 µs, DWORD; value range for the high limit value: 40 to 120,000,000 µs, DWORD) you can monitor whether the measured period remains within a specified range. A hardware interrupt can be triggered if this range is exited. The module verifies your entries to make sure the high limit > low limit, and reports a parameter assignment error if the result is negative.

Only single evaluation can be set for the encoder signals.

Selecting the Gate Function

In this mode you can select the gate function with which the period measurement is started and stopped. The following possibilities are available to you:

- SW gate
- SW gate and HW gate (= internal gate)

  You can add a hardware gate to the software gate. Both gates act together like a logic AND operation, meaning the FM 350-2 only measures periods when both gates are open.

Opening and Closing the Software Gate

You open and close the software gate for each channel with the control bits SW_GATE0...7 in the data block of the FC CNT2_CTR to start and stop period measurement.

Action	...is initiated by
Open software gate 0...7	Set SW_GATE0...7, edge transition 0 -> 1
Close software gate 0...7	Reset SW_GATE0...7

Opening and Closing the Hardware Gate

You open and close a hardware gate by applying the relevant signals to or removing the signals from the corresponding digital input I0...I7.

Action	...is initiated by
Open hardware gate 0...7	Apply signal to input I0...7, 0 -> 1
Close hardware gate 0...7	Remove signal from input I0...7, 1 -> 0

Limit Values

After each time interval has expired, the period determined is compared with the set limit values. The following states are produced:

If the period determined is...	... the following bit is set
Greater than the high limit	STS_OFLW0...7
Less than the low limit value	STS_UFLW0...7

The bits STS_OFLW0...7 and STS_UFLW0...7 are reset at each call of the FC CNT2_CTR.

Changing Limit Values

You can change the limit values with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. You can select the extent to which this change applies:

Changing the **low limit values**:

- To each channel (jobs 10 to 17)
- To a group of four channels (job 40 for channels 0 to 3, job 41 for channels 4 to 7)
- To all 8 channels (job 42)

Changing the **high limit values**:

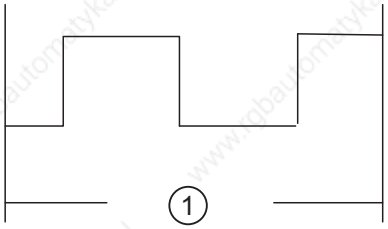
- To each channel (jobs 20 to 27)
- To a group of four channels (job 50 for channels 0 to 3, job 51 for channels 4 to 7)
- To all 8 channels (job 52)

Result

The end of a period measurement (expiration of the interval) is reported at the status bits STS_CMP7...0. If assigned to the I/O input range, the measured value can be read using FC CNT2_CTR, or it can be read out, depending on the channel, with jobs 100 and 101 of the FC CNT2_RD / FB CNT2RDPN in the unit of µs.

In this operating mode the count value is equivalent to the current count value, and the measurement value is equivalent to the measured period.

If the minimum of two rising edges were not present in the set time window, 0 is measured as the period (see figure below).



(1) Time window

Figure 8-12 Two Positive Edges Within the Time Window

Reversed Direction of Rotation

If the rotation direction is reversed within a time interval, the measurement value for this measurement period is undetermined.

8.9 Dosing

Definition

In this mode, four count channels of the FM 350-2 are combined together in one dosing channel. When the gate is open, the FM 350-2 counts once in the main count direction:

- In main count direction "up" between 0 and the set end value.
- In main count direction "down" between the set start value and 0.

You specify the main count direction and the start and end values in the parameter assignment screens.

If you assign the main count direction as "up," the start value is 0 and you specify the end value.

If you assign the main count direction as "down," you specify the start value and the end value is 0.

Parameter Assignment

Using the parameter assignment screen forms you can set the start and end values, the main count direction, and the channels to be used for dosing (channels 0 to 3 as dosing channel 0; channels 4 to 7 as dosing channel 1, selected using the menu command **Edit > Specify Channels**).

Selecting the Gate Function

You can select the gate function in this mode. The following possibilities are available to you:

- SW gate
- SW gate and HW gate

  You can add a hardware gate to the software gate. Both gates act together like an AND logic operation, meaning the FM 350-2 counts only when both gates are open.

Opening and Closing the Software Gate

You open and close the software gate for each channel with the control bits SW_GATE0 (channels 0...3) and SW_GATE 4 (channels 4...7) in the data block of the FC CNT2_CTR to start and stop dosing.

Action	...is initiated by
Open software gate 0, 4	Setting SW_GATE0, 4, edge change 0->1
Close software gate 0, 4	Resetting SW_GATE0, 4

Opening and Closing the Hardware Gate

You open and close a hardware gate by applying the relevant signals to or removing the signals from the corresponding digital input I0, I4.

Action	...is initiated by
Open hardware gate 0, 4	Applying signal to input I0, I4, 0 -> 1
Close hardware gate 0, 4	Removing signal from input I0, I4, 1 -> 0

Behavior at the Count Limits, Software Gate

Main count direction up: When the counter reaches "end value -1" and receives a further count pulse, the module sets count value = 0, closes the internal gate and terminates the count, regardless of the status of bit SW__GATE0, 4. The respective status bit STS_OFLW0, 4 is set in the data block of the FC CNT2_CTR. The end value itself is therefore never reached.

Main count direction down: When the counter reaches the value "1" and receives a further count pulse, the counter sets the count value to the start value, closes the internal gate and terminates the count, regardless of the status of bit SW_GATE0, 4. The respective status bit STS_UFLW0, 4 is set in the data block of the FC CNT2_CTR. The value "0" is therefore never reached.

If you want to start the counter again, you must reset the bit SW_GATE0, 4 and then set it again.

Behavior at the Count Limits, Hardware Gate

Main count direction up: If the counter has reached the value "end value -1" and a further count pulse is received, the counter is set to 0, the internal gate is closed, and the count is terminated even if the SW_GATE0, 4 bit and the input I0, I4 are still set. The end value itself is therefore never reached. The respective status bit STS_OFLW0, 4 is set in the data block of the FC CNT2_CTR.

Main count direction down: If the counter has reached the value "1" and a further count pulse is received, the counter is set to the start value, the internal gate is closed, and the count is terminated even if the SW_GATE0, 4 and the input I0, I4 are still set. The value "0" is therefore never reached. The respective status bit STS_UFLW0, 4 is set in the data block of the FC CNT2_CTR.

If you want to start the counter again, you must reset the input I0, I4, and then set it again. You can only start a new count with the hardware gate.

Canceling and Interrupting Gate Function

The gate function can interrupt or cancel the dosing process. When canceled, the dosing process starts again from the beginning following gate stop and gate start. When interrupted, the dosing process is resumed from the last current count value following gate stop and gate start.

If you are using a hardware gate in addition to the software gate, the software gate only has an interrupt effect; the hardware gate can interrupt or cancel.

The following figures help to clarify the difference between gate functions that cancel and gate functions that interrupt:

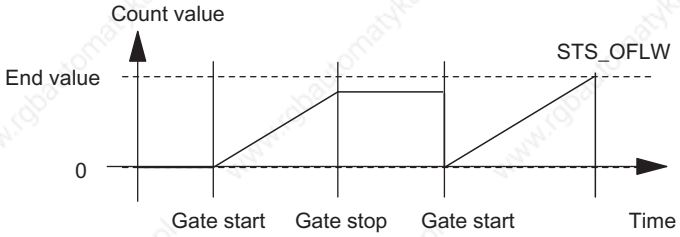


Figure 8-13 Dosing in Main Count Direction Up, Canceling Gate Function

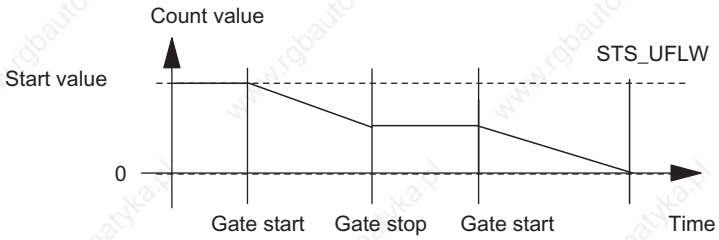


Figure 8-14 Dosing in Main Count Direction Down, Interrupting Gate Function

Reading Out Count Values

If assigned in the I/O input range, the count value can be read out with the FC CNT2_CTR or, depending on the channel, with jobs 100 and 101 of the FC CNT2_RD / FB CNT2RDPN.

In this operating mode the count values 0 and 4 are equivalent to the current count value, and the other count values and the measurement values are 0.

Comparison Value

For each dosing channel of the FM 350-2 you can assign four comparison values within the set count range. You can also assign whether and under what conditions a digital output should be set and/or a hardware interrupt triggered in conjunction with a comparison value. You can set the following conditions for this:

- A hardware interrupt is triggered if the current count value matches the comparison value.
- A digital output is set if the current count value is greater than or equal to a comparison value.
- A digital output is set if the current count value is less than or equal to a comparison value.

If you want a digital output to be set, you must have enabled the respective output in the counter DB of the FC CNT2_CTR with the bit CTRL_DQ0...7.

Note

Outputs can only be set while the CPU is in RUN mode if the gate is open.

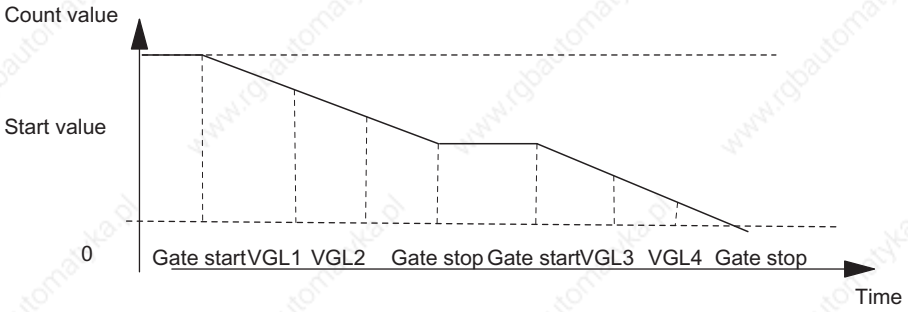


Figure 8-15 Dosing in Main Count Direction Down

You can change the assigned comparison values with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. The changes affect one dosing channel only (jobs 30 to 33 for the individual comparison values of the first channel, jobs 34 to 37 for the individual comparison values of the second channel, job 60 for the first channel as a group, job 61 for the second channel as a group).

Load Value in Preparation

Within the assigned count range you can assign a load value with FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. This value is used by the counter as the new start value every time after the following events:

- Reaching the end value in main count direction up
- Reaching 0 in main count direction down
- Canceling of the count process by a software gate or a hardware gate (when the count process is interrupted the load value is not used)

The load value is then the new start value from which the next and all other dosing processes begin. The assigned output and interrupt behavior remains the same.

You can select the extent to which the load value is valid:

- To the first channel (job 20)
- To the second channel (job 24)

Load Value Directly

You can change the current count value with the FC CNT2_WR/FB CNT2WRPN while the CPU is in RUN mode. The new count value is used by the counter directly as the dosing value.

You can select the extent to which this change applies:

- To the first channel (job 10)
- To the second channel (job 14)

CAUTION
Danger of property damage. Assigned substitute values are always output when the CPU goes to STOP mode even if the gate is closed and also to outputs that are not enabled. Only assign substitute values which will not lead to dangerous states in the plant if they are output.

Value Range for Load Values

The value range for load values depends on the set main count direction. The range is:

- 0 to end value - 2 in main count direction up
- Start value to 2 in main count direction down

8.10 Setting: Behavior of the digital outputs

Introduction

You can store eight comparison values on the FM 350-2 for each counter. These comparison values are assigned to the eight digital outputs (comparison value 0: Q0, comparison value 1: Q1, etc.). The respective output can be set depending on the count value and the comparison value. This section describes the various methods of setting the behavior of the outputs.

Comparison Values

You set the comparison values in the parameter assignment dialog boxes. When the CPU is in RUN mode you can enter the comparison values in the data block of the FC CNT2_WR / FB CNT2WRPN (CMP_VAL0...7) and transfer them to the FM 350-2 by using jobs 30 to 37 or 60 to 62. (See the description of the relevant mode). The count is not affected by this.

The comparison values must lie inside the count range of the respective operating mode; the count range limits are not permitted as comparison values.

If you nevertheless want to set the comparison value to the start value or end value in a counting mode with main count direction, you must anticipate the following behavior:

Assigned behavior of digital inputs	Reaction of assigned digital output
Activate if count value >= comparison value	The output is always switched on independent of the count value
Activate if count value <= comparison value	The output is always switched off independent of the count value

Enabling the Outputs

Before the outputs can be set, you must enable them first by setting the relevant bits in the counter DB. If you reset one of these bits, the associated output is switched off immediately. The bits are transferred between the data block and the module by the FC CNT2_CTR.

Output	...is enabled by
Q0...7	CTRL_DQ0...7

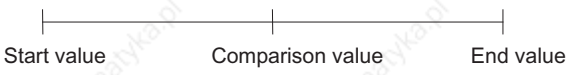
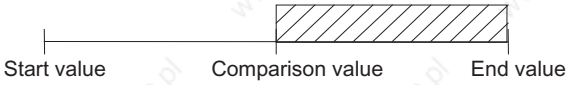
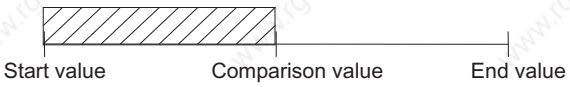
Status of the Outputs

You can see the status of the outputs from the green status LEDs and from the relevant bits in the data block.

Status of the output	Status of the LEDs	Status of the bit
Q0...7 set	Q0...7 lights up	STS_DQ0...7 set
Q0...7 reset	Q0...7 dark	STS_DQ0...7 reset

Behavior of the Outputs

For the outputs, you can program one of three possible responses to reaching the comparison value. The various possibilities are shown in the table below for main count direction up.

Behavior of the outputs	
Comparison not executed	
	The output remains deactivated and is not influenced by the events comparison value, zero crossing, jump from end value to start value, or jump from start value to end value.
Activate if count value >= comparison value	
	The output is activated if the counter is in the range between the comparison value n and the end value. Setting the counter to a value between the comparison value and the end value activates the output.
Activate if count value <= comparison value	
	The output is activated if the counter is in the range between the comparison value and the start value. Setting the counter to a value between the comparison value and the start value activates the output.
= output active Observe the requirements specified below.	

Requirements

If you want to set an output to "activate if count value >= comparison value" or "activate if count value <= comparison value", you must ensure that the time between reaching the comparison value and the start or end value is greater than the minimum switching time of the outputs (switching time: 300 µs); otherwise, the control pulses at the outputs are lost.

Disabling the Outputs

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

- Module watchdog timeout (internal error)
- Removing the enable bits (CTRL_DQ0...7 for Q0...7 in the DB)

Controlling the Outputs

Irrespective of switching the outputs using comparators, you can set and reset the outputs once they are enabled by CTRL_DQ0...7 using the SET_DQ0...7 bit.

The following applies to the relationship between controlling and switching: Controlling has priority over switching using the comparators. This means:

- If switching using the comparator is not planned for the output, the output can be used as a digital output.

You can always control the outputs using SET_DQ0...7 if you select a compare function for the outputs. You can use this setup in the user program to simulate the effect of the comparison function:

- The output is set with the positive edge of SET_DQ0...7.
- A negative edge of SET_DQ0...7 resets the output.

Note that the comparators remain active and the output can be set or reset when the comparison result is changed.

Note

An output set with SET_DQ0..7 cannot be reset via the comparator.

Reaction to CPU STOP

The outputs behave as you set in the basic parameters under "Reaction to CPU STOP". Below you will find additional information on the individual settings and their effects on the reaction of the outputs depending on whether a transition from RUN to STOP or from STOP to RUN occurs in the CPU.

- **RUN to STOP:**

  Substitution values: The set substitute values are always output even if the gate is closed and the respective output is not enabled.

  Continue: The transition from RUN to STOP is ignored. FM 350-2 continues to count. When a comparison value is reached, the assigned action is performed (for example, switching a DO).

- **STOP to RUN:**

  Cancel: The module starts again.

  Substitution values / last value: If the parameters did not change, the substitute values/last values on all channels are removed as soon as the **first** operation at a channel is detected.

  Continue: If the parameters have not changed, the FM 350-2 continues from the current count. If the parameters have changed, the module restarts and the count value is reset.

Default Setting

The default setting for the outputs is disabled.

8.11 Triggering a hardware interrupt

Introduction

With the FM 350-2, you can set which events are to trigger a hardware interrupt. For this purpose, assign the FM 350-2 interrupts in the parameter assignment dialog boxes.

What is a Hardware Interrupt?

If you want to program a response to a specific event independently of the CPU cycle, the FM 350-2 can trigger a hardware interrupt. The CPU interrupts the cyclic program on receiving the interrupts and executes the hardware interrupt OB40.

Which Events Can Trigger a Hardware Interrupt?

The following events during operation of the FM 350-2 can trigger a hardware interrupt:

- Opening the hardware gate
- Closing the hardware gate
- Overflow / underflow
- Reaching a comparison value (either direction)
- Undershooting/exceeding limit values
- Measurement ended

Independent of the set operating mode, you can select a number of events to trigger a hardware interrupt. Observe the conditions applicable to hardware interrupts triggered when the count reaches a reference value.

Enabling the Hardware Interrupt

You enable the interrupts for the module in the parameter assignment dialog boxes when configuring the hardware and you decide whether the module is to trigger a diagnostic interrupt and/or a hardware interrupt.

Hardware Interrupt OB, OB40

If a hardware interrupt occurs, the user program is interrupted, the data are transferred from the module to the start information of OB40, and OB40 is called. The hardware interrupt is acknowledged by exiting OB40.

If OB40 has not been programmed, the CPU goes into STOP. If you then switch back to RUN, the hardware interrupt requirements are deleted.

Hardware Interrupt Reaction Time

The hardware interrupt reaction time or the time between an event occurring to trigger the hardware interrupt and the message from the hardware interrupt to the CPU is between 0.5 and 2.5 ms.

Start Information

The temporary variable OB40_POINT_ADDR is written in the start information of OB40.

The variable OB40_POINT_ADDR consists of four bytes (bytes 8 to 11). The information on the event that initiated the hardware interrupt is entered into these bytes.

The following table shows which bits are set for which interrupt. All bits not listed have no meaning and are zero.

Mode: Continuous counting, single counting, periodic counting									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8					Comparator responded	Overflow / underflow	Close hardware gate	Open hardware gate
1		Comparator responded	Overflow / underflow	Close hardware gate	Open hardware gate				
2 to 7	9 to 11	See byte 8							
Mode: Frequency measurement									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8					High/low frequency limit exceeded	Frequency measurement ended	Close hardware gate	Open hardware gate
1		High/low frequency limit exceeded	Frequency measurement ended	Close hardware gate	Open hardware gate				
2 to 7	9 to 11	See byte 8							
Mode: Speed measurement									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8					High/low speed limit exceeded	Speed measurement ended	Close hardware gate	Open hardware gate
1		High/low speed limit exceeded	Speed measurement ended	Close hardware gate	Open hardware gate				
2 to 7	9 to 11	See byte 8							

Mode: Period measurement									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8					High/ low time limit exceed ed	Period measur ement ended	Close hardwar e gate	Open hardwar e gate
1	1	High/ low time limit exceede d	Period measur ement ended	Close hardwar e gate	Open hardwar e gate				
2 to 7	9 to 11	See byte 8							
Mode: Dosing									
Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	8	-	Overflo w / underflo w	Compar ator 4 triggere d	Compar ator 3 triggere d	Compar ator 2 triggere d	Compar ator 1 triggere d	Close hardwar e gate	Open hardwar e gate
4	10	See byte 8							

Hardware Interrupt Lost

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.

If a time of less than 2 ms lies between two events which should trigger a hardware interrupt, the second hardware interrupt is lost but a diagnostic interrupt cannot be triggered.

Default Setting

No hardware interrupt is assigned in the default setting.

See also

Setting: Behavior of the digital outputs (Page 115)

8.12 Mapping the count and measurement values of all channels in the expanded user data

Mapping of all count and measurement values in the user data image

Under certain conditions, all count and measurement values can be mapped in the user data image (use of extended user data).

The following basic conditions apply to use of extended user data:

- Configure the module "6ES7350-2AH01-0AE0 E" in HW Config.
- The extended user data can only be used locally:
  - downstream from an IM153-2 V5.0 (order number: 6ES7 153-2BA02-0XB0 V5.0) or later
  - downstream from an IM153-4 PN HF V3.0 (order number: 6ES7 153-4BA00-0XB0 V3.0) or later
- A total of 40 bytes of input data are now available.
- The update cycle of the extended user data differs from the update cycle of the first 16 bytes of input data. Depending on the PROFIBUS DP cycle time, the update cycle of the extended user data is approximately 100 to 200 ms.

The structure of the first 16 bytes in the user data is the same as previous and can be obtained from the previous sections for the respective operating mode. The additional 24 bytes are defined through the operating mode.

Depending on the operating mode, the values (count or measurement value) of channels 2 to 7 are stored in the extended user data. These values are preassigned to "0". The input data are occupied with 0 as long as valid values have not been detected.

Structure of the extended user data depending on the operating mode.

Byte	Counting modes	Measuring modes	Dosing mode (two dosing counters)
0..15	Same as previous – structure can be influenced via parameter assignment	Same as previous – structure can be influenced via parameter assignment	Same as previous – structure can be influenced via parameter assignment
16..19	Count value channel 2	Measurement value channel 2	0
20..23	Count value channel 3	Measurement value channel 3	0
24..27	Count value channel 4	Measurement value channel 4	Dosing counter channel 4
28..31	Count value channel 5	Measurement value channel 5	0
32..35	Count value channel 6	Measurement value channel 6	0
36..39	Count value channel 7	Measurement value channel 7	0

Encoder Signals and Their Evaluation

9

9.1 Overview

Introduction

The count signals that the FM 350-2 can process are rectangular signals generated either by incremental encoders or by signal encoders.

Incremental encoders scan a grating and so generate rectangular electrical pulses. They differ in pulse height and in the number of signals.

Pulse encoders such as light barriers or initiators (BEROs) supply only a rectangular signal with a specific voltage level.

Connecting Different Encoders

You can connect different bounce-free encoders to the FM 350-2 in order to supply the pulses for the count signals. The table below gives an overview of the different encoders and corresponding signals.

Encoders	Signal
24-V incremental encoders	
24-V pulse encoders with direction level	24 V with direction level
24-V initiators	24-V without direction level
NAMUR encoders	8.2-V without direction level

For 24-V pulse encoders with direction level, a minimum time span of 50 µs must lie between direction signal (B) and count signal (A).

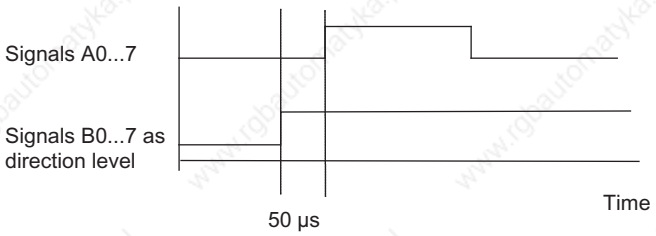


Figure 9-1 Time Span Between Direction Level and Count Signal

Default setting

In the default setting, 24-V count signals with direction evaluation are set.

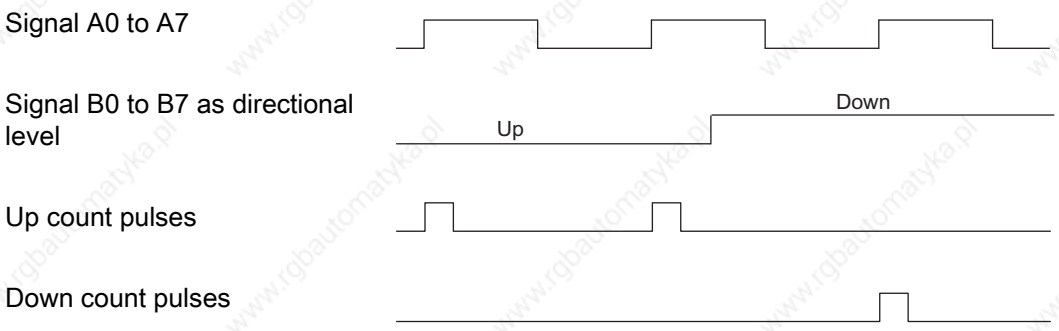
9.2 NAMUR Signals

NAMUR encoder

The encoder supplies one count signal in accordance with DIN 19234 that must be connected to terminal A0...7 of the front connector.

You can wire a directional signal (24 V) to terminal B0...7 of the relevant counter. If your encoder does not return a corresponding signal, you can also generate and interconnect a relevant identifier within the S7 system, or use a suitable process signal.

The diagram shows the time-based signal profile of a NAMUR encoder with directional level



You can assign parameters to the inputs A0...3, A4...7, or all inputs for connecting NAMUR encoders in the parameter assignment dialog boxes.

How are the Signals Monitored?

When programmed accordingly, FM 350-2 monitors wire break and short-circuit at A0 to A7. This indirectly includes monitoring of the 8.2 V encoder supply. This is only possible with NAMUR encoders.

If a wire break or short circuit is detected, the group error LED lights up, you can also assign a diagnostic interrupt to be triggered.

CAUTION

Danger of property damage.

If you use another encoder on a channel of the FM 350-2 which was assigned parameters for the connection of a NAMUR encoder, the module may be damaged.

Connect only a NAMUR encoder to a channel of the FM 350-2 which was assigned parameters for the connection of a NAMUR encoder.

9.3 24-V signals

24-V Incremental Encoder

The 24-V incremental encoder supplies signals A and B. Signals A and B are out of phase by 90°.

Encoders that do not supply inverse signals are known as asymmetric encoders.

You can change the count direction via the "inverted direction" parameter. Assigning the parameter "Main Count Direction: Down" does **not** automatically reverse the count direction.

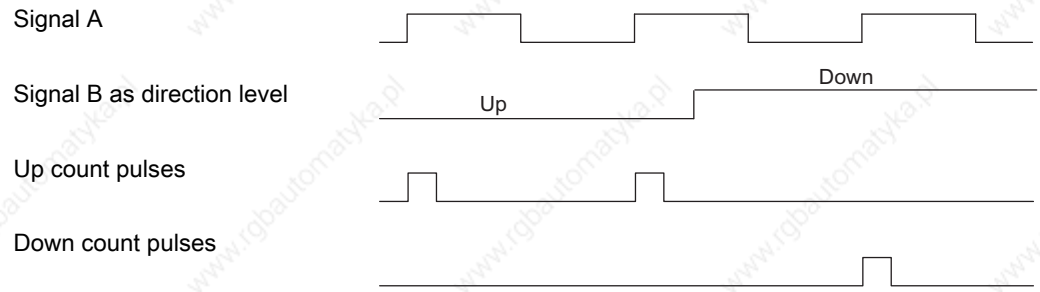
24-V Pulse Encoder Without/With Direction Level

The encoder, for example, an initiator (BERO) or a light barrier, supplies only one count signal that must be connected to terminal A0...7 of the front connector.

Additionally you can wire a directional signal to the terminal B0...7 of the relevant counter. If your encoder does not return a corresponding signal, you can also generate and interconnect a relevant direction within the S7 system, or use a suitable process signal.

The figure shows the sequence of signals of a 24-V pulse encoder with directional signal, and the resultant count pulses.

Signals of a 24-V pulse encoder with direction level



When selecting the encoder, you must select the "Pulse and direction" parameter.

Changing direction by inverting the B signal is possible with these count signals using the parameter setting "inverted direction".

Note

With pulse encoders without direction level, the count value in the case of an oscillating count signal can "run away" as all the signals are added together.

Signal Monitoring

24-V count signals are not monitored for wire break or short circuit.

9.4 Pulse evaluation

Introduction

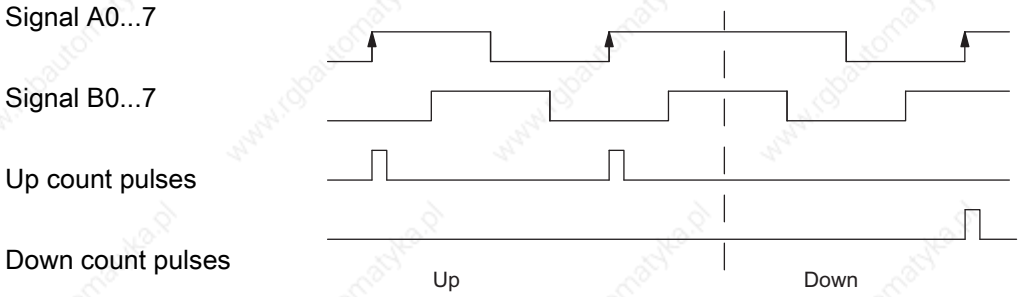
The counters of the FM 350-2 can count the edges of the signals. Normally, only the edge at A is evaluated (single evaluation). To achieve a higher resolution, you can decide when you assign parameters whether the signals are to have single, double, or quadruple evaluation.

Multiple evaluation is only possible in the case of asymmetric 24-V incremental encoders with signals A and B out of phase by 90°.

Single Evaluation

Single evaluation means that only one edge of A is evaluated; up count pulses are captured on a rising edge of A and low level at B, and down count pulses are captured on a rising edge of A and high level at B.

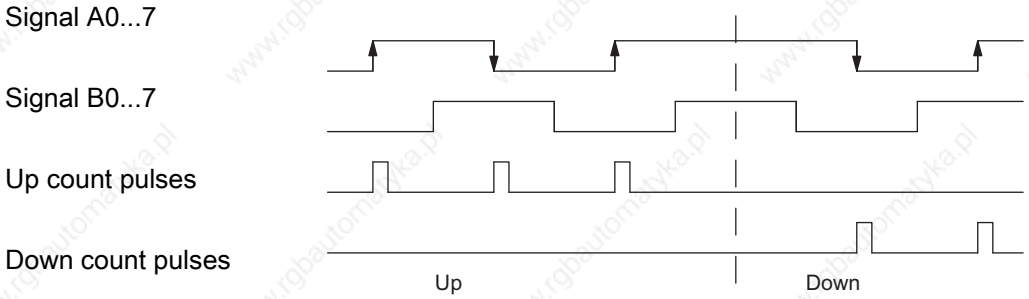
The diagram shows the single evaluation of signals.



Double Evaluation

Double evaluation means that the rising and falling edges of signal A are evaluated; whether up or down count pulses are generated depends on the level of signal B.

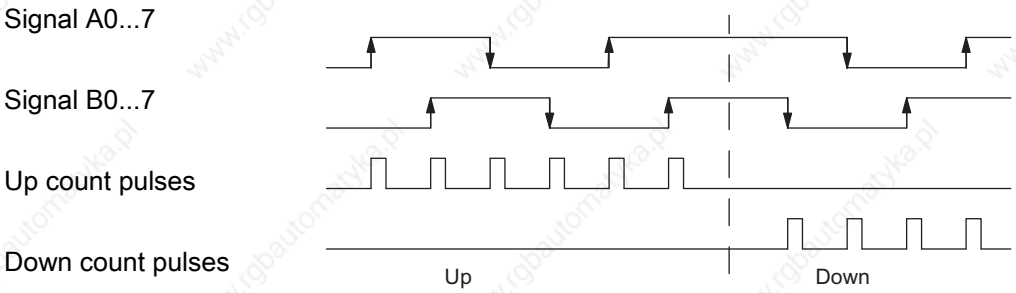
The diagram shows the double evaluation of signals.



Quadruple Evaluation

Quadruple evaluation means that the rising and falling edges of A and B are evaluated; whether up or down count pulses are generated depends on the levels of signals A and B.

The diagram shows the quadruple evaluation of signals.



9.5 Hysteresis

Introduction

An encoder can come to rest at a particular position and then "oscillate" about this position. This causes the count value to fluctuate around a certain value. If there is a comparison value within this fluctuation range, for example, the associated output would be switched on and off in time with these fluctuations. To prevent an output being switched on and off by very small fluctuations, the FM 350-2 has a programmable hysteresis function. You can assign a range between 0 and 255 (0 means: hysteresis deactivated) from which the input treats a fluctuation in the input signal as a real change and an output can be controlled as required.

Function Principle

The following figure shows an example of the effect of hysteresis. The diagram shows the differences in the output behavior when hysteresis values of 0 (= switched off) and 3 are assigned.

The counter is assigned the settings "Main Count Direction Up" and output "On if Count Value >= Comparison Value".

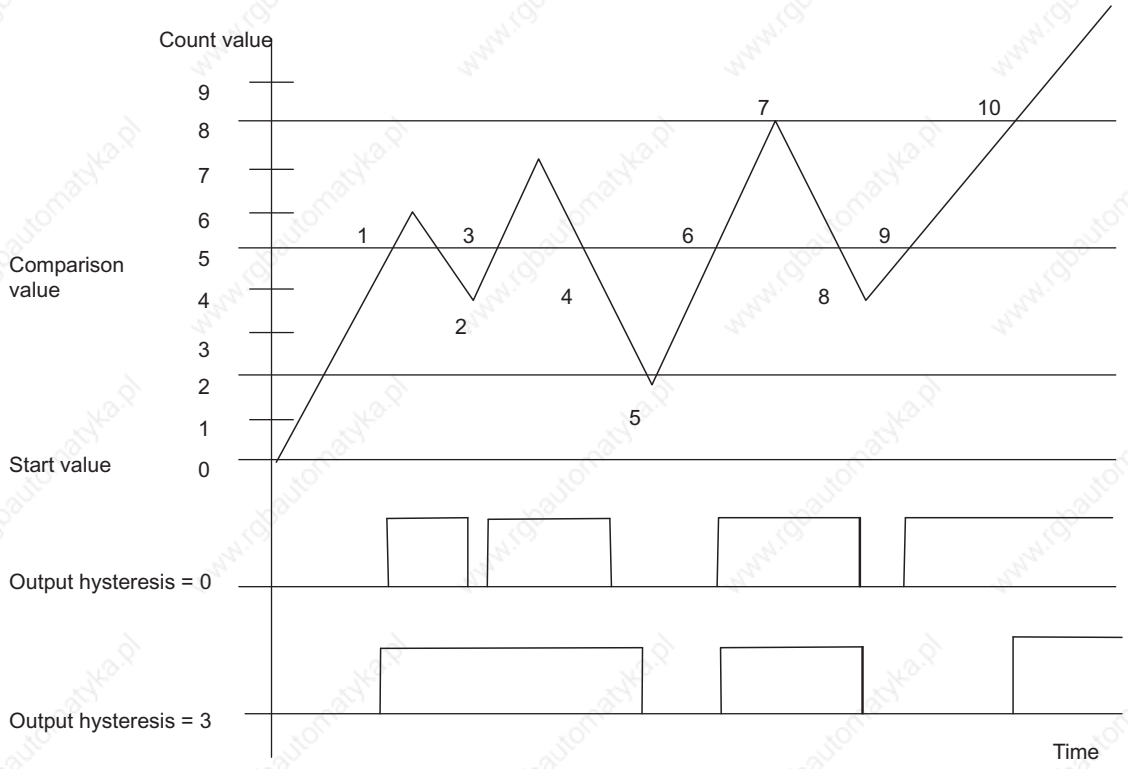


Figure 9-2 Example showing the effect of the hysteresis

Legend

To see the effect of hysteresis, note the behavior of the output depending on the hysteresis set and particularly the count value marked with numbers.

1. The counter reaches the comparison value.

   Hysteresis = 0: The output is set.

   Hysteresis = 3: The output is set.

2. The counter falls below the comparison value (reaches comparison value - 1)

   Hysteresis = 0: The output is reset

   Hysteresis = 3: The output remains set because the counter has not exited the hysteresis range since the output was set.

3. The counter reaches the comparison value.

   Hysteresis = 0: The output is set.

   Hysteresis = 3: The output remains set

4. The counter falls below the comparison value (reaches comparison value - 1)

   Hysteresis = 0: The output is reset

   Hysteresis = 3: The output remains set because the counter has not exited the hysteresis range since the output was set.

5. The counter exits the hysteresis range (Hysteresis = 3)

   Hysteresis = 0: -

   Hysteresis = 3: The output is reset

6. The counter reaches the comparison value.

   Hysteresis = 0: The output is set.

   Hysteresis = 3: The output is set.

7. The counter exits the hysteresis range (Hysteresis = 3)

   Hysteresis = 0: -

   Hysteresis = 3: -

8. The counter falls below the comparison value (reaches comparison value - 1)

   Hysteresis = 0: The output is reset

   Hysteresis = 3: The output is reset because the counter has since exited the hysteresis range.

9. The counter reaches the comparison value.

   Hysteresis = 0: The output is set.

   Hysteresis = 3: The output is not set because the counter has not exited the hysteresis range since the output was reset.

10. The counter exits the hysteresis range (Hysteresis = 3)

    Hysteresis = 0: -

    Hysteresis = 3: The output is set.

DB Assignments

10

10.1 DB for FC CNT2_CTR

Overview

All data belonging to one channel of the module are stored in the data block (DB) of the function CNT2_CTR. The data structure and the length of the DB are defined by UDT1. Before you program the module, the data outlined below must be written to the DB (see the relevant section.)

- Module address (address 12.0)
- Channel address (address 14.0)
- DS offset (address 18.0), permanently at zero

The DB has been generated from UDT1 as a data block with associated user- defined data type. The DB assignments resulting from this are shown below.

Address	Variable	Data type	Initial value	Comment
0.0	NO	BYTE	B#16#0	Number
1.0	BUSY	BOOL	FALSE	TRUE: Write job in progress FALSE: Write job not in progress
1.1	DONE	BOOL	FALSE	TRUE: Write job finished FALSE: Write job not finished
1.2	IMPOSS	BOOL	FALSE	TRUE: Write job not possible FALSE: Write job possible
1.3	UNKNOWN	BOOL	FALSE	TRUE: Write job unknown FALSE: Write job known
2.0	NO	BYTE	B#16#0	Number
3.0	BUSY	BOOL	FALSE	TRUE: Read job in progress FALSE: Read job not in progress
3.1	DONE	BOOL	FALSE	TRUE: Read job finished FALSE: Read job not finished
3.2	IMPOSS	BOOL	FALSE	TRUE: Read job not possible FALSE: Read job possible
3.3	UNKNOWN	BOOL	FALSE	TRUE: Read job unknown FALSE: Read job known
4.0	RESERV_0	ARRAY [1..3] OF WORD	W#16#0	Reserved

Address	Variable	Data type	Initial value	Comment
10.0	RESERV_1	WORD	W#16#0	Reserved
12.0	MOD_ADR	WORD	W#16#0	Module address
14.0	CH_ADR	DWORD	DW#16#0	Channel address
18.0	DS_OFFS	BYTE	B#16#0	Data block offset
19.0	RESERV_2	BYTE	B#16#0	Reserved
20.0	BIT0_0	BOOL	FALSE	Reserved
20.1	BIT0_1	BOOL	FALSE	Reserved
20.2	BIT0_2	BOOL	FALSE	Reserved
20.3	BIT0_3	BOOL	FALSE	Reserved
20.4	BIT0_4	BOOL	FALSE	Reserved
20.5	BIT0_5	BOOL	FALSE	Reserved
20.6	BIT0_6	BOOL	FALSE	Reserved
20.7	BIT0_7	BOOL	FALSE	Reserved
21.0	CTRL_DQ0	BOOL	FALSE	TRUE: Output 0 enabled FALSE: Output 0 not enabled
21.1	CTRL_DQ1	BOOL	FALSE	TRUE: Output 1 enabled FALSE: Output 1 not enabled
21.2	CTRL_DQ2	BOOL	FALSE	TRUE: Output 2 enabled FALSE: Output 2 not enabled
21.3	CTRL_DQ3	BOOL	FALSE	TRUE: Output 3 enabled FALSE: Output 3 not enabled
21.4	CTRL_DQ4	BOOL	FALSE	TRUE: Output 4 enabled FALSE: Output 4 not enabled
21.5	CTRL_DQ5	BOOL	FALSE	TRUE: Output 5 enabled FALSE: Output 5 not enabled
21.6	CTRL_DQ6	BOOL	FALSE	TRUE: Output 6 enabled FALSE: Output 6 not enabled
21.7	CTRL_DQ7	BOOL	FALSE	TRUE: Output 7 enabled FALSE: Output 7 not enabled
22.0	SET_DQ0	BOOL	FALSE	TRUE: Output 0 set FALSE: Output 0 not set
22.1	SET_DQ1	BOOL	FALSE	TRUE: Output 1 set FALSE: Output 1 not set
22.2	SET_DQ2	BOOL	FALSE	TRUE: Output 2 set FALSE: Output 2 not set
22.3	SET_DQ3	BOOL	FALSE	TRUE: Output 3 set FALSE: Output 3 not set
22.4	SET_DQ4	BOOL	FALSE	TRUE: Output 4 set FALSE: Output 4 not set
22.5	SET_DQ5	BOOL	FALSE	TRUE: Output 5 set FALSE: Output 5 not set

Address	Variable	Data type	Initial value	Comment
22.6	SET_DQ6	BOOL	FALSE	TRUE: Output 6 set FALSE: Output 6 not set
22.7	SET_DQ7	BOOL	FALSE	TRUE: Output 7 set FALSE: Output 7 not set
23.0	SW_GATE0	BOOL	FALSE	TRUE: Software gate counter 0 open FALSE: Software gate counter 0 closed
23.1	SW_GATE1	BOOL	FALSE	TRUE: Software gate counter 1 open FALSE: Software gate counter 1 closed
23.2	SW_GATE2	BOOL	FALSE	TRUE: Software gate counter 2 open FALSE: Software gate counter 2 closed
23.3	SW_GATE3	BOOL	FALSE	TRUE: Software gate counter 3 open FALSE: Software gate counter 3 closed
23.4	SW_GATE4	BOOL	FALSE	TRUE: Software gate counter 4 open FALSE: Software gate counter 4 closed
23.5	SW_GATE5	BOOL	FALSE	TRUE: Software gate counter 5 open FALSE: Software gate counter 5 closed
23.6	SW_GATE6	BOOL	FALSE	TRUE: Software gate counter 6 open FALSE: Software gate counter 6 closed
23.7	SW_GATE7	BOOL	FALSE	TRUE: Software gate counter 7 open FALSE: Software gate counter 7 closed
24.0	CTRL_DWORD1	DWORD	DW#16#0	Reserved
28.0	CTRL_DWORD2	DWORD	DW#16#0	Reserved
32.0	CTRL_DWORD3	DWORD	DW#16#0	Reserved
36.0	BIT0_0	BOOL	FALSE	Reserved
36.1	STS_TFB	BOOL	FALSE	TRUE: PG operation active FALSE: PG operation deactivated
36.2	BIT0_2	BOOL	FALSE	Reserved
36.3	BIT0_3	BOOL	FALSE	Reserved
36.4	DATA_ERR	BOOL	FALSE	Data error
36.5	BIT0_5	BOOL	FALSE	Reserved
36.6	BIT0_6	BOOL	FALSE	Reserved
36.7	PARA	BOOL	FALSE	TRUE: Module assigned parameters FALSE: Module not assigned parameters
37.0	STS_CMP0	BOOL	FALSE	TRUE: Comparator 0 triggered FALSE: Comparator 0 not triggered
37.1	STS_CMP1	BOOL	FALSE	TRUE: Comparator 1 triggered FALSE: Comparator 1 not triggered
37.2	STS_CMP2	BOOL	FALSE	TRUE: Comparator 2 triggered FALSE: Comparator 2 not triggered

Address	Variable	Data type	Initial value	Comment
37.3	STS_CMP3	BOOL	FALSE	TRUE: Comparator 3 triggered FALSE: Comparator 3 not triggered
37.4	STS_CMP4	BOOL	FALSE	TRUE: Comparator 4 triggered FALSE: Comparator 4 not triggered
37.5	STS_CMP5	BOOL	FALSE	TRUE: Comparator 5 triggered FALSE: Comparator 5 not triggered
37.6	STS_CMP6	BOOL	FALSE	TRUE: Comparator 6 triggered FALSE: Comparator 6 not triggered
37.7	STS_CMP7	BOOL	FALSE	TRUE: Comparator 7 triggered FALSE: Comparator 7 not triggered
38.0	STS_UFLW0	BOOL	FALSE	TRUE: Underflow counter 0 FALSE: No underflow counter 0
38.1	STS_UFLW1	BOOL	FALSE	TRUE: Underflow counter 1 FALSE: No underflow counter 1
38.2	STS_UFLW2	BOOL	FALSE	TRUE: Underflow counter 2 FALSE: No underflow counter 2
38.3	STS_UFLW3	BOOL	FALSE	TRUE: Underflow counter 3 FALSE: No underflow counter 3
38.4	STS_UFLW4	BOOL	FALSE	TRUE: Underflow counter 4 FALSE: No underflow counter 4
38.5	STS_UFLW5	BOOL	FALSE	TRUE: Underflow counter 5 FALSE: No underflow counter 5
38.6	STS_UFLW6	BOOL	FALSE	TRUE: Underflow counter 6 FALSE: No underflow counter 6
38.7	STS_UFLW7	BOOL	FALSE	TRUE: Underflow counter 7 FALSE: No underflow counter 7
39.0	STS_OFLW0	BOOL	FALSE	TRUE: Overflow counter 0 FALSE: No overflow counter 0
39.1	STS_OFLW1	BOOL	FALSE	TRUE: Overflow counter 1 FALSE: No overflow counter 1
39.2	STS_OFLW2	BOOL	FALSE	TRUE: Overflow counter 2 FALSE: No overflow counter 2
39.3	STS_OFLW3	BOOL	FALSE	TRUE: Overflow counter 3 FALSE: No overflow counter 3
39.4	STS_OFLW4	BOOL	FALSE	TRUE: Overflow counter 4 FALSE: No overflow counter 4
39.5	STS_OFLW5	BOOL	FALSE	TRUE: Overflow counter 5 FALSE: No overflow counter 5
39.6	STS_OFLW6	BOOL	FALSE	TRUE: Overflow counter 6 FALSE: No overflow counter 6
39.7	STS_OFLW7	BOOL	FALSE	TRUE: Overflow counter 7 FALSE: No overflow counter 7

Address	Variable	Data type	Initial value	Comment
40.0	STS_DIR0	BOOL	FALSE	TRUE: Down count direction counter 0 FALSE: Up count direction counter 0
40.1	STS_DIR1	BOOL	FALSE	TRUE: Down count direction counter 1 FALSE: Up count direction counter 1
40.2	STS_DIR2	BOOL	FALSE	TRUE: Down count direction counter 2 FALSE: Up count direction counter 2
40.3	STS_DIR3	BOOL	FALSE	TRUE: Down count direction counter 3 FALSE: Up count direction counter 3
40.4	STS_DIR4	BOOL	FALSE	TRUE: Down count direction counter 4 FALSE: Up count direction counter 4
40.5	STS_DIR5	BOOL	FALSE	TRUE: Down count direction counter 5 FALSE: Up count direction counter 5
40.6	STS_DIR6	BOOL	FALSE	TRUE: Down count direction counter 6 FALSE: Up count direction counter 6
40.7	STS_DIR7	BOOL	FALSE	TRUE: Down count direction counter 7 FALSE: Up count direction counter 7
41.0	STS_DI0	BOOL	FALSE	TRUE: Digital input 0 set FALSE: Digital input 0 not set
41.1	STS_DI1	BOOL	FALSE	TRUE: Digital input 1 set FALSE: Digital input 1 not set
41.2	STS_DI2	BOOL	FALSE	TRUE: Digital input 2 set FALSE: Digital input 2 not set
41.3	STS_DI3	BOOL	FALSE	TRUE: Digital input 3 set FALSE: Digital input 3 not set
41.4	STS_DI4	BOOL	FALSE	TRUE: Digital input 4 set FALSE: Digital input 4 not set
41.5	STS_DI5	BOOL	FALSE	TRUE: Digital input 5 set FALSE: Digital input 5 not set
41.6	STS_DI6	BOOL	FALSE	TRUE: Digital input 6 set FALSE: Digital input 6 not set
41.7	STS_DI7	BOOL	FALSE	TRUE: Digital input 7 set FALSE: Digital input 7 not set
42.0	STS_DQ0	BOOL	FALSE	TRUE: Digital output 0 set FALSE: Digital output 0 not set
42.1	STS_DQ1	BOOL	FALSE	TRUE: Digital output 1 set FALSE: Digital output 1 not set
42.2	STS_DQ2	BOOL	FALSE	TRUE: Digital output 2 set FALSE: Digital output 2 not set
42.3	STS_DQ3	BOOL	FALSE	TRUE: Digital output 3 set FALSE: Digital output 3 not set
42.4	STS_DQ4	BOOL	FALSE	TRUE: Digital output 4 set FALSE: Digital output 4 not set

Address	Variable	Data type	Initial value	Comment
42.5	STS_DQ5	BOOL	FALSE	TRUE: Digital output 5 set FALSE: Digital output 5 not set
42.6	STS_DQ6	BOOL	FALSE	TRUE: Digital output 6 set FALSE: Digital output 6 not set
42.7	STS_DQ7	BOOL	FALSE	TRUE: Digital output 7 set FALSE: Digital output 7 not set
43.0	STS_GATE0	BOOL	FALSE	TRUE: Internal gate counter 0 open FALSE: Internal gate counter 0 closed
43.1	STS_GATE1	BOOL	FALSE	TRUE: Internal gate counter 1 open FALSE: Internal gate counter 1 closed
43.2	STS_GATE2	BOOL	FALSE	TRUE: Internal gate counter 2 open FALSE: Internal gate counter 2 closed
43.3	STS_GATE3	BOOL	FALSE	TRUE: Internal gate counter 3 open FALSE: Internal gate counter 3 closed
43.4	STS_GATE4	BOOL	FALSE	TRUE: Internal gate counter 4 open FALSE: Internal gate counter 4 closed
43.5	STS_GATE5	BOOL	FALSE	TRUE: Internal gate counter 5 open FALSE: Internal gate counter 5 closed
43.6	STS_GATE6	BOOL	FALSE	TRUE: Internal gate counter 6 open FALSE: Internal gate counter 6 closed
43.7	STS_GATE7	BOOL	FALSE	TRUE: Internal gate counter 7 open FALSE: Internal gate counter 7 closed
44	USER_STAT_WORD0	WORD	W#16#0	Depends on parameter assignment of count/measurement values
46	USER_STAT_WORD1	WORD	W#16#0	Depends on parameter assignment of count/measured values
48	USER_STAT_WORD2	WORD	W#16#0	Depends on parameter assignment of count/measured values
50	USER_STAT_WORD3	WORD	W#16#0	Depends on parameter assignment of count/measured values
52	LOAD-VAL0	DINT	L#0	Load counter 0 directly
56	LOAD-VAL1	DINT	L#0	Load counter 1 directly
60	LOAD-VAL2	DINT	L#0	Load counter 2 directly
64	LOAD-VAL3	DINT	L#0	Load counter 3 directly
68	LOAD-VAL4	DINT	L#0	Load counter 4 directly
72	LOAD-VAL5	DINT	L#0	Load counter 5 directly
76	LOAD-VAL6	DINT	L#0	Load counter 6 directly
80	LOAD-VAL7	DINT	L#0	Load counter 7 directly
84	LOAD-PREPARE-VAL0	DINT	L#0	Load counter 0 in preparation
88	LOAD-PREPARE-VAL1	DINT	L#0	Load counter 1 in preparation

Address	Variable	Data type	Initial value	Comment
92	LOAD-PREPARE-VAL2	DINT	L#0	Load counter 2 in preparation
96	LOAD-PREPARE-VAL3	DINT	L#0	Load counter 3 in preparation
100	LOAD-PREPARE-VAL4	DINT	L#0	Load counter 4 in preparation
104	LOAD-PREPARE-VAL5	DINT	L#0	Load counter 5 in preparation
108	LOAD-PREPARE-VAL6	DINT	L#0	Load counter 6 in preparation
112	LOAD-PREPARE-VAL7	DINT	L#0	Load counter 7 in preparation
116	CMP-VAL0	DINT	L#0	Load comparator 0
120	CMP-VAL1	DINT	L#0	Load comparator 1
124	CMP-VAL2	DINT	L#0	Load comparator 2
128	CMP-VAL3	DINT	L#0	Load comparator 3
132	CMP-VAL4	DINT	L#0	Load comparator 4
136	CMP-VAL5	DINT	L#0	Load comparator 5
140	CMP-VAL6	DINT	L#0	Load comparator 6
144	CMP-VAL7	DINT	L#0	Load comparator 7
148	ACT_CNTV0	DINT	L#0	Actual counter value 0
152	ACT_MSRV0	DINT	L#0	Measurement result 0
156	ACT_CNTV1	DINT	L#0	Actual counter value 1
160	ACT_MSRV1	DINT	L#0	Measurement result 1
164	ACT_CNTV2	DINT	L#0	Actual counter value 2
168	ACT_MSRV2	DINT	L#0	Measurement result 2
172	ACT_CNTV3	DINT	L#0	Actual counter value 3
176	ACT_MSRV3	DINT	L#0	Measurement result 3
180	ACT_CNTV4	DINT	L#0	Actual counter value 4
184	ACT_MSRV4	DINT	L#0	Measurement result 4
188	ACT_CNTV5	DINT	L#0	Actual counter value 5
192	ACT_MSRV5	DINT	L#0	Measurement result 5
196	ACT_CNTV6	DINT	L#0	Actual counter value 6
200	ACT_MSRV6	DINT	L#0	Measurement result 6
204	ACT_CNTV7	DINT	L#0	Actual counter value 7
208	ACT_MSRV7	DINT	L#0	Measurement result 7
212.0	BYTE0	BYTE	B#16#0	Reserved
213.0	BYTE1	BYTE	B#16#0	Reserved
214.0	BYTE2	BYTE	B#16#0	Reserved

Address	Variable	Data type	Initial value	Comment
215.0	BYTE3	BYTE	B#16#0	Reserved
216.0	BYTE4	BYTE	B#16#0	Channel type
217.0	BYTE5	BYTE	B#16#0	Length of channel info
218.0	BYTE6	BYTE	B#16#0	Number of channels
219.0	BYTE7	BYTE	B#16#0	Channel error vector
220.0	BYTE8	BYTE	B#16#0	Error counter 0
221.0	BYTE9	BYTE	B#16#0	Error counter 1
222.0	BYTE10	BYTE	B#16#0	Error counter 2
223.0	BYTE11	BYTE	B#16#0	Error counter 3
224.0	BYTE12	BYTE	B#16#0	Error counter 4
225.0	BYTE13	BYTE	B#16#0	Error counter 5
226.0	BYTE14	BYTE	B#16#0	Error counter 6
227.0	BYTE15	BYTE	B#16#0	Error counter 7

See also

The CNT2_CTR Function (FC2), Control the Module (Page 57)

Errors and diagnostics

11

11.1 Errors and diagnostics

Overview

Defects on the module, operator errors, incorrect wiring, or contradictory parameter assignments can cause faults that the module indicates to the user.

The different types of faults are indicated and displayed at different positions and must be acknowledged in different ways.

You will find the following described in this chapter:

- errors which may occur
- where those errors are indicated
- how you acknowledge errors

Errors are divided into the following error classes:

Error class	Cause
Data error	Incorrect jobs from the PLC or programming device
Messages	Module status is reported
Module parameter error	Incorrect basic parameters in module
Channel parameter error	Incorrect channel parameter assignment
Diagnostic error	Diagnostic event occurred

11.2 Types of Errors

Overview of Error Types

The FM 350-2 distinguishes between the following types of errors:

Type of Fault	Description
Internal error	Error state or defect at the module which can not be assigned to a channel (counter.) Example: Watchdog timeout.
External error	I/O error, or external error which can not be assigned to a channel (counter.)
External channel error	I/O error, or external error which can not be assigned specifically to a channel (counter.) Example: Error at the signal line from NAMUR encoder.
Data error	Errors which occur when a channel (counter) is controlled via system data records and limit values or counter states are not maintained or observed. Example: Comparison value lies outside the count range.

Reactions

The FM 350-2 reacts as follows to the faults/errors:

Type of Error	Reaction	LED	Message	Acknowledgment
Internal error	all off	SF	Diagnostic interrupt	---
External error	all off	SF	Diagnostic interrupt	---
External channel error	all off	SF	Diagnostic interrupt	---
Data error	Job rejected		Entry in diagnostic buffer	New job with modified data

Triggering a Diagnostic Interrupt

Internal faults, external faults, and external channel faults can trigger a diagnostic interrupt provided you have enabled the diagnostic interrupt in the relevant parameter assignment dialog box. You can see which fault has caused the LED to light up from the diagnostics data sets DS0 and DS1. For information on the contents of diagnostics data records DS0 and DS1, refer to the relevant chapter.

11.3 Error indication at the group error LED

Where the error is indicated

If the red group error LED lights up, a fault has occurred either on the module (internal fault) or at the cable connections (external fault), or the parameter assignment is faulty.

Which Errors are Indicated?

The following faults are indicated by the group error LED lighting up:

Type of Error	Cause of error	Remedy
Internal error	Watchdog tripped Hardware interrupt lost	Module replacement acknowledged by hardware interrupt processing
External errors	No module parameters Parameter assignment error	Assign parameters and download them
External channel errors	Encoder supply short-circuited or overloaded	Correct the connection
	Fault in NAMUR encoder signals (wire break, short circuit, cable missing)	Correct the connection

11.4 Triggering diagnostics interrupts

Definition of the Diagnostic Interrupt

If a user program is to respond to an internal or external fault, you can assign a diagnostic interrupt that stops the cyclic program of the CPU and calls the diagnostic interrupt OB (OB82).

Events Capable of Triggering a Diagnostic Interrupt

The list shows you which events can trigger a diagnostic interrupt:

- Channel fault in set channel
- No module parameters
- Incorrect parameters in module
- Watchdog timeout
- Hardware interrupt lost
- Signal line monitoring NAMUR encoder reports error
- Encoder supply 8.2 V NAMUR encoder faulty

Enabling the Diagnostic Interrupt

You disable or enable the interrupts for the module in the parameter assignment dialog boxes and you decide there whether the module is to trigger 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 diagnostic data records DS0 and DS1 on the module.
- The group error LED lights up.
- The counting process continues unchanged, provided that an OB 82 is programmed. If no OB 82 is programmed, the CPU goes to STOP.
- The diagnostic interrupt OB (OB 82) is called.
- Diagnostic data record DS0 is entered in the start information of the diagnostic interrupt OB.
- When the fault is remedied, the group error LED goes out.

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. Diagnostic data record DS0 comprises 4 bytes; DS1 comprises 16 bytes with the first 4 bytes being 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 module's diagnostic data record DS1 (and, thus also the content of the DS0) with the FC DIAG_RD. This is only useful if DS0 signals an error in one channel.

Assignment of Diagnostic Data Record DS0 and the Start Information

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

Byte	Bit	Meaning	Remark	Event No.
0	0	Module error	Set for every diagnostic event	8:x:00
	1	Internal error	Set for all internal faults	8:x:01
	2	External error	Set for all external faults	8:x:02
	3	Error in one channel	See DS1, byte 4 for further breakdown	8:x:03
	6	No parameter assignment	Execute parameter assignment	8:x:06
	7	Faulty parameter assignment	For further explanation, see section Data error (Page 146)	8:x:07
1	0 ... 3	Type class	Always assigned 8	
	4	Channel information	Always assigned 1	
2	3	Watchdog timeout	Module defective or strong interference	8:x:33
3	6	Hardware interrupt lost	Check configuration. Hardware interrupt event has been detected and cannot be signaled since the same event has not yet been acknowledged by the user program/CPU.	8:x:46

Diagnostic Data Record DS1

Diagnostic data record DS1 consists of 16 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 from the FC DIAG_RD in the data block of the FC CNT2_CTR starting at DW212.

Byte	Bit	Meaning	Remark	Event No.
4	0 ... 6	Channel type	Always assigned 76H	
	7	Other channel types	Always assigned 0	
5	0 ... 7	Diagnostic information length	Always assigned 8	
6	0 ... 7	Number of channels	Always assigned 8	
7	0	Channel fault vector	Channel bit	
8 Channel 0	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96
9 Channel 1	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96
10 Channel 2	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96
11 Channel 3	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96
12 Channel 4	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96
13 Channel 5	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96
14 Channel 6	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96
15 Channel 7	4	Failure of 8.2 V encoder supply	NAMUR encoder	8:x:94
	6	Signal line NAMUR encoder	Short-circuit / wire break	8:x:96

Diagnostic Text in the Diagnostic Buffer of the CPU

If you want to enter the diagnostic message in the diagnostic buffer of the CPU, you must call the SFC52 ' Write a user-defined diagnostic event to 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 with 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.

11.5 Data error

Occurrence

If jobs are given to the module by the programming device or by means of FC CNT2_WR / FB CNT2WRPN, these are checked. If errors occur during this check, the module signals these data errors.

Incorrect jobs are not accepted by the module.

Display

The data errors are displayed in the parameter assignment screen forms in the **Debug > Diagnostics** menu command.

If an error is located when jobs are checked, the bit CHECKBACK_SIGNALS, DATA_ERR=1 is set in the counter DB.

Acknowledgment

Correct the jobs in accordance with the specifications. Download the corrected jobs again to the FM 350-2.

Diagnostic buffer of the FM 350-2

Entries in the diagnostic buffer of the FM 350-2 are displayed in the parameter assignment screen forms using in the **Debug > Diagnostics** menu command.

Technical data

A

A.1 General technical specifications

The following technical specifications are described in the Operating Instructions SIMATIC S7-300 CPU 31xC and CPU 31x: Installation (http://support.automation.siemens.com/WW/view/en/13008499):

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

Observing the Design Guidelines

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

A.2 Technical data of FM 350-2

Technical specifications

Dimensions and weight	
Dimensions W x H x D [mm]	80 x 125 x 120
Weight	Approx. 460 g
Voltages, currents, potentials	
Auxiliary voltage L+/M	24 VDC
• Range	20,4 ... 28.8 V
• Reverse polarity protection	No
• Electrical isolation	Yes, to rear panel bus and shield
NAMUR encoder supply	
• Output voltage	8.2 V ± 2%
• Output current	Max. 200 mA, short circuit-proof
Current consumption	
• from S7-300 bus	Approx. 100 mA
• from L+ (no-load)	Approx. 150 mA
Power loss of the module	Approx. 10 W
Status, interrupts, diagnostics	
Status display	Yes, 16 green LEDs for status of I0..7, Q0..7
Interrupts	
• Hardware interrupt	Yes, assignable
• Diagnostic interrupt	Yes, assignable
Diagnostic functions	Yes
• Fault indication on the module for group errors	Yes, red LED
• Diagnostic information can be read out	Yes

Data on Counter Signals and Digital Inputs and Outputs	
NAMUR encoder inputs A0...7	
• Level	Acc. to DIN 19 234
• Cable length shielded	100 m
• Input current	0 signal: ≤ 1.2 mA 1 signal: ≥ 2.1 mA
• Input delay	Max. 50 µs
• Max. input frequency	20 kHz
• Electrical isolation	Yes, to rear panel bus and shield
24-V encoder inputs A0...7 Pulse encoders Incremental encoder	Count signal
• Input voltage	Track A 0 signal: -3 to 5 V 1 signal: 11 V to 30.2 V
• Input current	0 signal: ≤ 2 mA (quiescent current) 1 signal: 9 mA (typically)
• Input delay	Max. 50 µs
• Max. input frequency	20 kHz (when t_pulse/ t_pause : 50/50)
• Electrical isolation	Yes, to rear panel bus and shield
• Connection of 2-wire BERO type 2	Possible
• Cable length shielded	100 m
• Demand factor in Horizontal mounting position Vertical mounting position	Up to 40 ºC = 100% Up to 60 ºC = 50% Up to 40 ºC = 50%
24-V encoder inputs B0...7	
Pulse encoder	Direction signal
Incremental encoder	Track B
Max. input frequency All other values as encoder inputs A0...7	10 kHz *)

Digital inputs I0...7	
• Input voltage	0 signal: -3 V to +5 V 1 signal: 11 V to 30.2 V
• Input current	0 signal: ≤ 2 mA (quiescent current) 1 signal: 9 mA (typically)
• Input delay	0>1 max. 50 µs 0>2 1>0 max. 50 µs
• Connection of 2-wire BERO type 2	Possible
• Electrical isolation	Yes, to rear panel bus and shield
• Cable length shielded	100 m
• Demand factor in Horizontal mounting position Vertical mounting position	Up to 40 ºC = 100% Up to 60 ºC = 50% Up to 40 ºC = 50%
Digital outputs	
• Output current	0 signal: 0.5 mA 1 signal: 0.5 A (permitted range 5 mA to 0.6 A)
• Demand factor	100%
• Status display	Yes, green LED
• Output delay	0>1 typ. 300 µs at I_A 0.5 A 0>2 1>0 typ. 300 µs at I_A 0.5 A
• "1" signal level	L+ -0.8 V
• Controls a standard digital input	Yes
• Controls a fast digital input	Yes, see note below
• Short circuit-proof	Yes
• Limiting of inductive cut-off voltage	L+ -40 V (typical)
• Switching frequency	Resistive load max. 500 Hz Inductive load max. 0.5 Hz
• Residual current of all digital outputs with horizontal installation	Up to 40 ºC = 4 A Up to 60 ºC = 2 A
• Residual current of all digital outputs with vertical installation	Up to 40 ºC = 2 A
• Cable length unshielded	100 m
• Cable length shielded	600 m
• Electrical isolation	Yes, to rear panel bus and shield
* This restricts the maximum frequency for operation with incremental encoders to 10 kHz.	

Note

When you connect the 24-V supply voltage via a mechanical contact, the outputs of the FM 350-2 carry a "1" signal for approximately 50 µs owing to the switching. You must remember this if you use the FM 350-2 in combination with fast digital inputs.

For listings of further relevant data, such as environmental conditions, see the *manual*.

Spare parts

B

B.1 Spare parts

Overview

The following Table lists all spare parts of the S7-300 that you can order for the FM 350-2 either additionally or later.

S7–300 parts	Order number
Bus connector	6ES7390-0AA00-0AA0
Labeling sheet	6ES7392-2XX00-0AA0
Slot number plate	6ES7912-0AA00-0AA0
Front connector (40-pin) Screw-type terminals	6ES7392-1AM00-0AA0
Front connector (40-pin) spring-loaded terminals	6ES7392-1BM01-0AA0
Shield attachment (with 2 screw-type bolts)	6ES7390-5AA00-0AA0
Shield connection terminals for	
• 2 cables with 2 to 6 mm shield diameter each	6ES7390-5AB00-0AA0
• 1 cable with 3 to 8 mm shield diameter	6ES7390-5BA00-0AA0
• 1 cable with 4 to 13 mm shield diameter	6ES7390-5CA00-0AA0

Glossary

Asymmetric Signals

Asymmetric signals are two pulse trains A and B out of phase by 90 degrees without inverse traces (/A, /B).

Configuration

Assignment of modules to racks, slots, and addresses. To configure hardware, the user fills out a configuration table in STEP 7.

Double Evaluation

Double evaluation means that the rising edges of pulse trains A and B are evaluated in an incremental encoder.

Encoders

Encoders are used for exact measurement of paths, positions, velocities, rotational speeds, masses, etc.

Function (FC)

A function (FC) is a code block without static data. A function allows parameter passing in the user program. This makes them suitable for programming commonly recurring complex functions.

Function Module (FM)

A function module (FM) is a module that relieves the CPU of the S7 automation systems of process signal processing tasks that are critical in time or memory-intensive. FMs normally use the internal communications bus for fast exchange of data with the CPU. Examples of FM applications: counting, positioning, controlling.

Incremental Encoder

Incremental encoders acquire paths, positions, velocities, rotational speeds, masses, etc., by counting small increments.

Increments per Encoder Revolution

Increments per encoder revolution define the number of increments output by an encoder per revolution.

Initiator

An initiator is a simple BERO switch without direction information. It supplies only a counting signal. Only the rising edge of Signal A is counted. The count direction must be specified by the user.

OD

In STOP and HOLD modes, the "output disable" signal (OD) switches all modules in an S7 automation system to a safe state. A safe state can be, e.g.: Outputs are deenergized or connected to a substitute value.

Quadruple Evaluation

Quadruple evaluation means that all edges of pulse trains A and B are evaluated in an incremental encoder.

SFC

A system function (SFC) is a function integrated in the operating system of the CPU that can be called when necessary in the STEP 7 user program.

Single Evaluation

Single evaluation means that only the rising edge of pulse train A is evaluated in an incremental encoder.

UDT

User-defined data types are created using the data type declaration. UDTs have their own names, which means that they can be reused. For example, a user-defined data type can be used to generate several data blocks with the same structure (e.g., controllers).

Index

G

H

I

M

N

P

R

S

T

U

W