SIEMENS

SIMATIC

S7-300
SM 335 - High-speed analog mixed module for SIMATIC S7-300

Manual

02/2009
A5E02409063-01

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 corresponding information is not taken into account.

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

Qualified Personnel

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

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Preface

Purpose of the manual

This manual describes the functions of analog I/O module SM 335; AI4/AO4 x 14/12 Bit. We shall use the short name SM 335 for this module.

The information in this manual helps you to:

- Operate an SM 335 in a SIMATIC S7 - 300 system
- View help on the operation, functions and technical data of SM 335

Basic knowledge required

This manual presumes general knowledge in the field of automation engineering.

Range of validity of this manual

The manual describes the components based on the data valid at the time of its release.

SIEMENS reserves the right to include current product information for new modules.

This manual is valid for the following module:

Module	Order number	As of version
SM 335	6ES7335- 7HG02-0AB0	01

Changes compared to the previous version

Changes / enhancements compared to the previous version described in this manual:

- New order number SM 335, 6ES7335-7HG02-0AB0.

  Module 6ES7335-7HG02-0AB0 is compatible with module 6ES7335-7HG01-0AB0.
- The noise filter which had to be implemented for module version 6ES7335-7HG01-0AB0 is no longer required for reliable operation of module 6ES7335-7HG02-0AB0!

Position in the overall documentation structure

The following documentation forms part of the S7-300 documentation package which is also available on the Internet (http://support.automation.siemens.com/WW/view/en/), including the corresponding contribution ID.

Name of the manual	Description
Manual CPU 31xC and CPU 31x, technical data Contribution ID: 12996906	Control and display elements, communication, memory concept, cycle and reaction times, technical data.
Operating Instructions S7-300, CPU 31xC and CPU 31x: Installation Contribution ID: 13008499	Project design, installation, wiring, addressing, commissioning, maintenance and test functions, diagnostics and troubleshooting.
System Manual PROFINET system description Contribution ID: 19292127	Basic description of PROFINET: Network components, data exchange and communication, PROFINET IO, Component-based Automation, application example of PROFINET IO and Component-based Automation.
Programming Manual Migration from PROFIBUS DP to PROFINET IO Contribution ID: 19289930	Guideline for migration from PROFIBUS DP to PROFINET IO.
Manual • CPU 31xC: Technological functions Contribution ID: 12429336 • CD containing examples	Description of the technological functions: positioning, counting, point-to-point coupling, loop control. The CD contains examples of the technological functions.
Manual S7-300 Automation System: Module Data Contribution ID: 8859629	Descriptions of functions and technical specifications of the signal modules, power supplies, and interface modules.
Instructions List CPU 31xC and CPU 31x Contribution ID: 13206730	List of the CPU's instruction set and corresponding execution times. Listing of executable blocks.
Getting Started Available anthology of Getting Started manuals: • S7-300 Getting Started Contribution ID: 15390497 • PROFINET Getting Started Collection Contribution ID: 19290251	Using concrete examples, the Getting Started documentation provides step-by-step instructions focused on commissioning a fully functional application.

Other manuals on S7-300 and ET 200M

Name of the manual	Description
Reference Manual • CPU Data: CPU 312 IFM - 318-2 DP • Contribution ID: 8860591	Control and display elements, communication, memory concept, cycle and reaction times, technical data
Installation Manual S7-300 Automation System: Installation: CPU 312 IFM – 318-2 DP Contribution ID: 15390415	Project design, installation, wiring, addressing, commissioning, maintenance and test functions, diagnostics and troubleshooting.
Configuring Manual ET 200M signal modules for process automation Contribution ID: 7215812	Description of integration in process automation, parameter configuration using SIMATIC PDM, digital input modules, digital output modules.
Manual Distributed I/O Device ET 200M HART analog modules Contribution ID: 22063748	Description of configuration and commissioning of HART analog modules.
Manual Distributed I/O Device ET 200M Contribution ID: 1142798	Description of configuration, assembly and wiring.
YOU ARE CURRENTLY READING the Manual SM 335 - High-speed analog mixed module for SIMATIC S7-300 Contribution ID: 1398483	Describes how to implement an SM 335 module in a SIMATIC S/-300. Overview of the operating functions, function descriptions and technical data of SM 335.

Guide

The manual contains various features supporting quick access to specific information:

- The manual starts with a table of contents, including an index of the tables contained in the manual.
- Key terms are explained in the glossary.
- Navigate to the most important topics in our documents using the index.

Approvals

The SIMATIC ET 200M product range conforms to the following approvals:

- Underwriters Laboratories, Inc.: UL 508 registered (Industrial Control Equipment)
- Canadian Standards Association: CSA C22.2 Number 142, (Process Control Equipment)
- Factory Mutual Research: Approval Standard Class Number 3611.

For more information about approvals and standards, refer to the "Standards and approvals" section in the SIMATIC S7-300 Module Data Manual (http://support.automation.siemens.com/WW/view/en/8859629).

CE Label

The SIMATIC S7-300 product series satisfies the requirements and safety specifications of the following EC directives:

- EC Directive 73/23/EEC "Low-voltage Directive"
- EC Directive 89/336/EEC "EMC Directive"

C-Tick-Mark

The SIMATIC S7-300 product series meets the requirements of the AS/NZS 2064 standard (Australia and New Zealand).

Standards

The SIMATIC S7-300 product series meets the requirements and criteria to IEC 61131-2.

Recycling and disposal

The S7-300 is low in contaminants and can therefore be recycled. For ecologically compatible recycling and disposal of your old device, contact a certificated disposal service for 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 there, contact your local Siemens representative:

Find your contact partner on the Internet (http://www.automation.siemens.com/partner/).

A guide to the technical documentation for the various SIMATIC products and systems is available on the Internet (http://www.siemens.com/simatic-tech-doku-portal).

The online catalog and ordering systems are available on the Internet (http://www.siemens.com/automation/mall).

Training Centers

Siemens offers appropriate courses to help you get started with the S7-300 and the SIMATIC S7 automation system. Contact your regional training center, or the central training center in D-90327 Nuremberg.
More information is available on the Internet (http://www.siemens.com/sitrain) .

Technical support

You can contact Technical Support for all A&D products by means of the Internet (http://www.siemens.com/automation/support-request) Web form for the Support Request.

For additional information about Siemens Technical Support, refer to Internet (http://www.siemens.com/automation/service&support).

Service & Support on the Internet

In addition to our documentation, we offer our complete knowledge base on the Internet.

On the Internet (http://www.siemens.com/automation/service).

There you will find

- Our Newsletter, which constantly provides you with the latest information about your products.
- The right documents for your product on our Service & Support pages
- Worldwide forum in which users and experts exchange ideas
- Your local contact partner for Industry Automation in our contacts database.
- Information about on-site services, repairs, spare parts, and lots more.

Table of contents

1 Properties and technical data of SM 335

1.1 Properties of SM 335

SM 355 is an I/O module for SIMATIC S7-300 and features the same general technical data as all of the other signal modules of SIMATIC S7-300. SM 335; AI4/AO4 14/12 Bit features the following properties.

Order number

6ES7335-7HG02-0AB0

Analog inputs

- 4 analog inputs, electrically isolated
- Integrated encoder supply 10 V / 25 mA
- Resolution of the measured value:
  - Bipolar: 13 bits + sign
  - Unipolar: 14 bits
- Selectable measured value:
  - 2 voltage inputs
  - 2 inputs, optional as current or voltage inputs

Analog outputs

- 4 analog outputs, electrically isolated
- Any range selection per analog output

Loads can only be connected to the analog outputs by means of 2-wire circuit!

- Resolution of the analog value:
  - Bipolar: 11 bits + sign
  - Unipolar: 12 bits

Operating modes

- 2 default operating mode data:
  - Free cycle
  - Conditional cycle
- 2 special operating modes:
  - Comparator
  - Measuring only

Interrupts / diagnostics

- Parameterizable diagnostics
- Parameterizable diagnostics interrupt
- Parameterizable cycle end interrupt (triggers a hardware interrupt on the CPU)

1.2 Terminal diagram of SM 335

For information about the wiring of the inputs/outputs of SM 335, refer to chapter Wiring the inputs and outputs (Page 25) and to the Operating Instructions SIMATIC S7-300, Installation (http://support.automation.siemens.com/WW/view/en/13008499).

The "X" imprint on the module identifies the version, in this case version 1. The version number is used to distinguish between products with the same order number. The version is incremented after upward compatible function extensions or bug fixes.

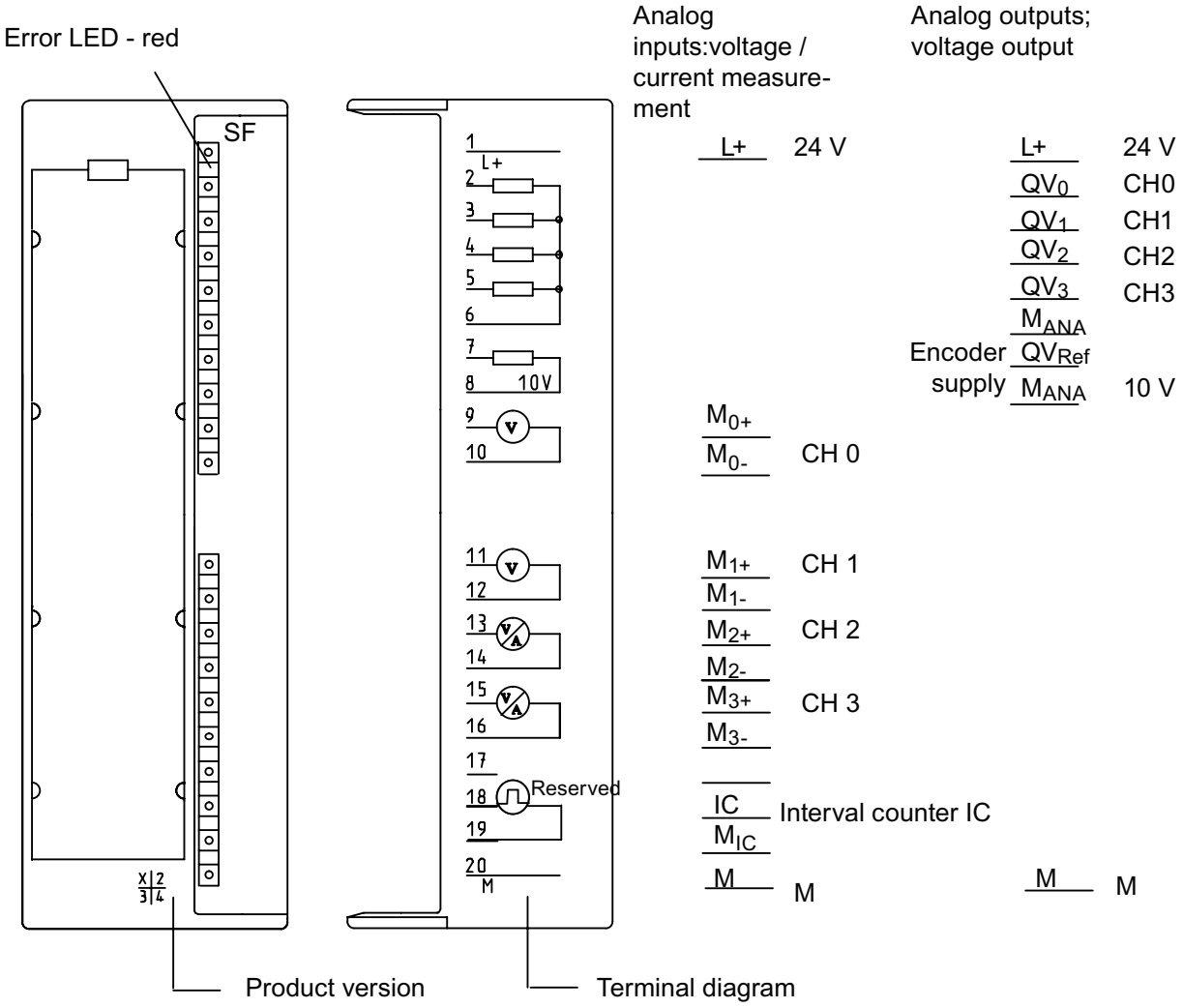

Figure 1-1 Terminal diagram of SM 335

1.3 Block diagram of SM 335

Electrical isolation

SM 335 contains a variety of different analog elements. The analog outputs are electrically isolated to the backplane bus of SIMATIC S7-300. All outputs are connected to the common potential M_{ANA}. The encoder supply output and the analog outputs are connected to common potential M_{ANA}.

The analog outputs are electrically isolated to each other and to the backplane bus of SIMATIC S7-300.

The input for internal counter IZ is electrically isolated to all other analog components and to the backplane bus of SIMATIC S7-300.

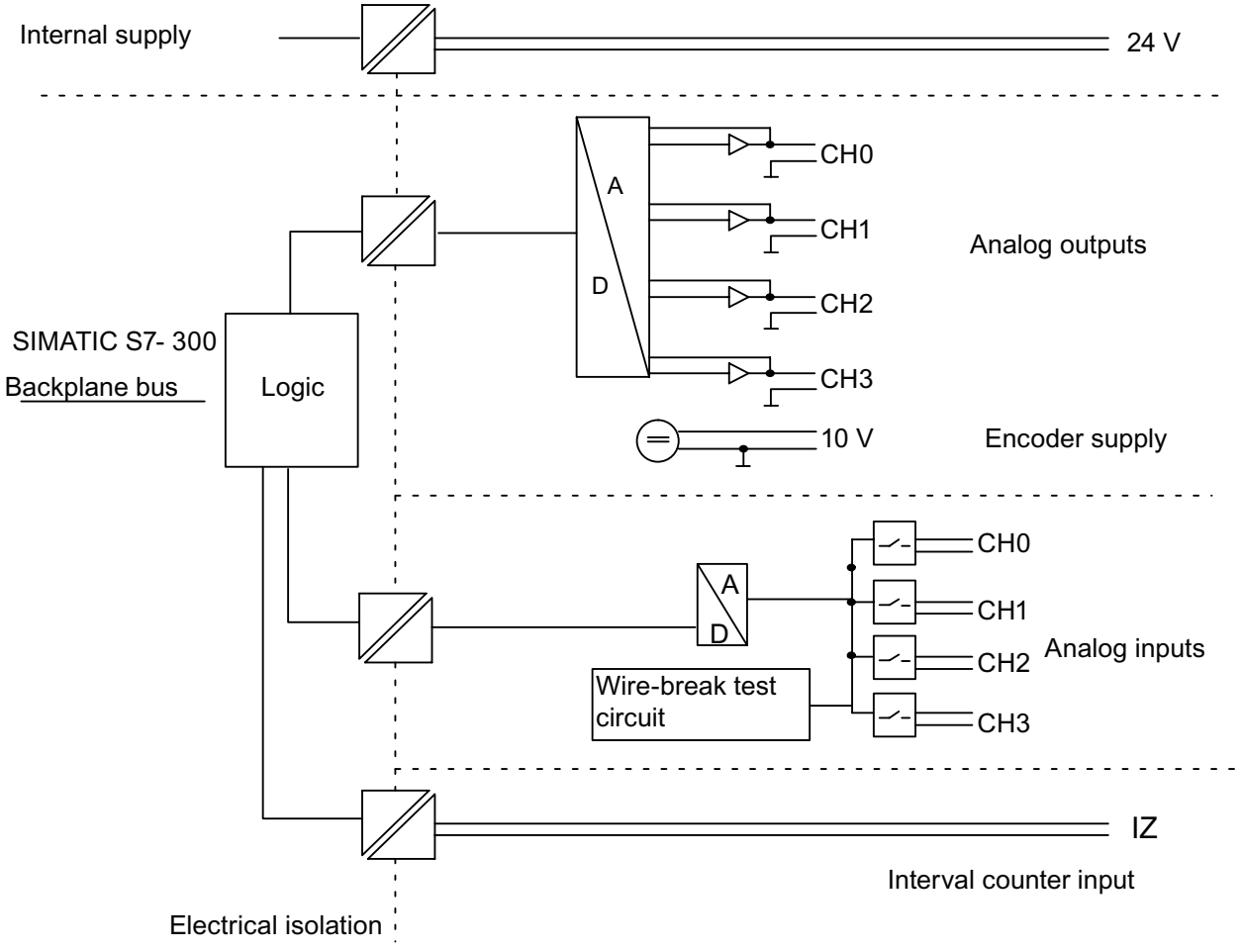

Figure 1-2 Block diagram of SM 335

1.4 Setting up the measuring range using the measuring range module

Measuring range module

A measuring range module is installed on the left-hand side of the analog I/O module. Use this measuring module to define the type of measurement at the analog inputs, i.e. voltage or current measurement.

Settings

The measuring range module features the optional "A", "C" and "D" settings. Setting "D" is the factory default.

The following table shows the assignment of the measuring range settings for the module's analog input circuitry.

Set up the measuring range in HW Config. You can choose between different current or voltage ranges; refer to chapter Configuring and parameterizing (Page 43). HW Config also displays the required setting for the measuring range module.

Table 1- 1 Settings of the measuring range module and default settings of the measuring range of SM 335

Settings of the measuring range module	Wiring the analog inputs	Measuring range (default)
A	Input 0: Voltage	± 10 V
	Input 1: Voltage	± 10 V
	Input 2: Current	± 10 V
	Input 3: Current	4 to 20 mA
B	Not used	-
C	Input 0: Voltage	± 10 V
	Input 1: Voltage	± 10 V
	Input 2: Current	4 to 20 mA
	Input 3: Current	4 to 20 mA
D	Input 0: Voltage	± 10 V
	Input 1: Voltage	± 10 V
	Input 2: Current	± 10 V
	Input 3: Current	± 10 V

1.5 Technical data of SM 335

1.5.1 General technical data of SM 335

Table 1- 2 General technical data

Dimensions and weights	
Dimensions W x H x D (mm)	40 x 125 x 120
Weight	Approx. 300 g

Module-specific data	
Number of inputs	4
Number of outputs	4
Cable length, shielded	200 m
For wire-break check in the range from 0 to 10 V	30 m

Voltages, currents, potentials	
Rated load voltage	24 VDC
• Reverse polarity protection	Yes
Electrical isolation	Yes
Permissible potential difference • Between inputs (V_{CM}) • Between the input (M connector) and central grounding point • Isolation test voltage	 3 V / 1.5 V / (10 V ranges) 75 VDC/60 VAC 500 VDC
Current consumption • From SIMATIC S-7 300 backplane bus • From L+ • Power loss	 75 mA max. 150 mA max. Max. 3,6 W

Status, interrupts, diagnostics	
Interrupts • Limit interrupt • End of cycle interrupt • Diagnostics interrupt	 No Yes, parameterizable Yes, parameterizable
Diagnostics functions • Fault indication on the module for group errors • Reading diagnostics information	Yes, parameterizable Yes, red LED Yes

Other	
UL/CSA/FM	Yes

1.5.2 Technical data of analog inputs

Table 1- 3 Technical data of analog inputs

Noise suppression, error limits for inputs	
Interference voltage suppression for f = n x, (f1 = interference frequency) • Common-mode noise (V_{pp} < 3 V) • Series mode interference (peak value of interference < rated input range)	 > 65 dB 0 dB
Crosstalk between inputs • at 50 Hz • at 60 Hz	 -65 dB -65 dB
Operational limit for voltage measurements (across temperature range, relative to input range)	± 0,15 % (at 14 bits resolution)
Operational limit for current measurements (across temperature range, relative to input range)	0.25 %
Basic error limit (operational error limit at 25° C, relative to input range)	± 0.1% (at 14 bits resolution)
Temperature error (relative to input range)	± 0.13%
Linearity error (relative to input range)	± 0.015 %
Repetition accuracy (in transient state at 25°C, relative to input range)	± 0.05%

Encoder selection data		
Input ranges (rated values) / input impedance • Voltage	± 1 V ± 10 V ± 2.5 V 0 to 2 V 0 to 10 V	10 MΩ 10 MΩ 10 MΩ 10 MΩ 10 MΩ
• Current (2 channels max.)	± 10 mA 0 to 20 mA 4 to 20 mA	100 Ω 100 Ω 100 Ω
Permissible voltage at voltage input (destruction limit)	± 30 V	
Maximum current at current input (destruction limit)	25 mA	
Wiring of the signal transducers		
• For voltage measurement • For current measurement – As 2-wire transducer – As 4-wire transducer • For resistance measurement	Supported Not possible Supported Not possible	

Generation of analog input values	
Measuring principle	Successive approximation
Conversion time in µs (per channel) • Basic conversion time for 4 channels in ms	Max. 200 Max. 1
Resolution • Bipolar • Unipolar	 13 bits + sign 14 bits

Data of the encoder supply output	
Rated voltage	10 V
Max. output current	25 mA
Short-circuit-proof	Yes
Operational limit (across temperature range)	0,2 %
Temperature error	0.002 %/K
Basic error of rated voltage	0.1%

1.5.3 Technical data of analog outputs

Table 1- 4 Technical data of analog outputs

Generation of analog output values	
Resolution (including overrange) • ± 10 V • From 0 to 10 V	 11 bits + sign 12 bits + sign
Output delay in µs	Max. 800
Settling time • For resistive load • For capacitive load • For inductive load	 < 0.1 ms ≤ 3.3 ms < 0.5 ms
Injection of substitution values	Yes

Noise suppression, error limits of outputs	
Crosstalk between the outputs	- 40 dB
Operational error limits (across the temperature range, in relation to output range)	0.5 %
Basic error limit (operational error limit at 25°, relative to output range)	0.2 %
Temperature error	0.02 %/K
Linearity error (in relation to output range)	± 0.05 %
Repetition accuracy (in transient state at 25°, relative to output range)	± 0.05 %
Output ripple (relative to output range)	± 0,05 %

Actuator selection data	
Output ranges (rated values)	± 10 V From 0 to 10V
Load resistance • For voltage outputs • For capacitive load • For inductive load	 Min. 3 kΩ Max. 1 µF Max. 1 mH
Voltage output • Short-circuit protection • Short-circuit current	 Yes 8 mA max.
Connection of actuators • For voltage output – 2-wire connection – 4-wire connection (measuring line)	 Supported Not possible

1.5.4 Technical data of the interval counter

Table 1- 5 Technical data of the interval counter

Specific data of the interval counter	
Number of inputs	1
Cable length, shielded	200 m

Voltages, currents, potentials	
Rated load voltage L+	24 VDC
• Reverse polarity protection	Yes
Electrical isolation	Yes
Permissible potential difference	
• Interval counter input (M_{IZ} terminal) to the four analog inputs	75 VDC/60 VAC
• Between the input (M_{IZ} terminal) and central grounding point	75 VDC/60 VAC

Generation of analog values for the interval counter	
Measuring principle	Detection of the rising edge and count between two edges
Time difference resolution	0.5 µs
Max. frequency	400 Hz
• Parameterizable	No
• Noise suppression at interference frequency f1 in dB	0

Noise suppression, input error limits	
Noise suppression at F = n * (f1 ± 1%), (f1 = interference frequency)	
• Common-mode interference (V_{SS} < 3 V)	> 80 dB
• Series-mode interference	0 dB
(Peak value of the interference < rated value of the input range)	
Operating error limit (across temperature range)	Max. 1 % at 400 Hz
Intrinsic error limit (operational limit at 25°C)	0,005 %
Temperature error (0 to 60°C)	± 0.003 %/K
Linearity error	0

Encoder selection data	
Permitted continuous input voltage (destruction limit)	± 30 V
Permitted current at interval counter input (destruction limit)	5 mA
Valid minimum pulse width at the counter input • Low • High	 1 ms 1 ms
Valid voltage range between terminals IZ and M_{IZ} • For Low pulse • For High pulse	 -30 V through + 5 V (- 4.4 mA to 0.7 mA) +18 V through + 30 V (2.5 mA to 4.4 mA)

1.6 Operating modes of SM 335

Operating modes

SM 335 can operate in the following modes:

- Free cycle (corresponds with the setting in HW Config for SM 335: 0.5 ms cycle time)
- Conditional cycle (corresponds with the setting in HW Config for SM 335: 1 to 16 ms cycle time)

Special operating modes

SM 335 can also be toggled to operate briefly in one of the following modes:

- Special "Comparator" mode
- Special "Measuring Only" mode

A description of those special modes is provided in chapter Special operating modes of SM 335 (Page 77). This chapter also describes how to switch to the special operating modes.

1.6.1 Free cycle mode

Cycle

The term "cycle" in the context of SM 335 refers to the successive measurement of the value at all analog inputs. The measuring cycle restarts after all inputs were read. This cycle has nothing in common with cyclic program execution on a SIMATIC S7 CPU.

Free cycle

Within the free cycle of SM 335 all analog I/O of SM 335 are processed successively and without interruption. Conversion of the first analog input restarts immediately after all inputs and outputs have been processed.

To activate the free cycle, set up a cycle time of 0.5 ms for SM 335 in HW Config.

The following figure shows the structure of the cycle time for the free cycle.

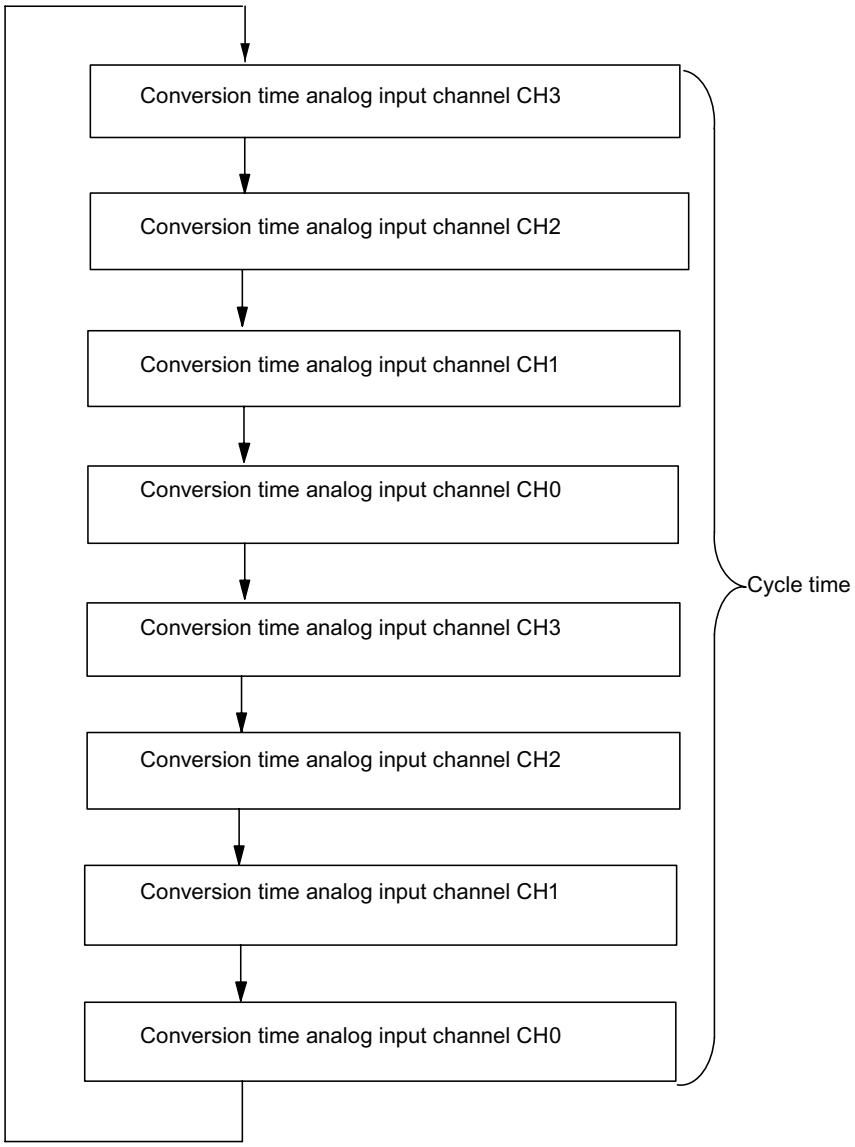

Figure 1-3 Cycle time for the free cycle of SM 335

Runtime of the free cycle is split up into the following time slices:

- Basic load of one cycle: Approx. 200 µs
- Runtime for reading the value of an analog channel: Approx. 200 µs
- Runtime for the output of an analog value: Approx. 50 µs

SM 335 only updates an analog output channel after the corresponding output value has changed.

- Cycle time required to output dynamic values with four active input channels and four active output channels:

  1200 µs (200 µs + 4 x 200 µs + 4 x 50 µs).
- Cycle time derived from infrequently or unchanged output values at four active input channels and four active output channels:

  1000 µs (200 µs + 4 x 200 µs + 4 x 0 µs).
- Cycle time derived from infrequently or unchanged output values at one active input channel and four active output channels:

  400 µs (200 µs + 1 x 200 µs + 4 x 0 µs).

Deselection of the diagnostics functions does not have any effect on the cycle time.

1.6.2 Conditional cycle mode

Conditional cycle

You can setup a fixed cycle time in the conditional cycle mode. After all analog inputs have been converted, SM 335 outputs an optional end of cycle interrupt to the CPU; refer to chapter Hardware interrupt (Page 60). SM 335 now goes into wait state until the analog outputs were updated and starts the next processing cycle on expiration of the specified cycle time.

The end of cycle interrupt can be used to synchronize a user program by calling OB 40. This interrupt also facilitates fast execution of the user program (e.g., for control loop routines).

To activate the conditional cycle, set up a cycle time of 1 to 16 ms for SM 335 in HW Config.

The following figure shows the structure of the cycle time for the conditional cycle.

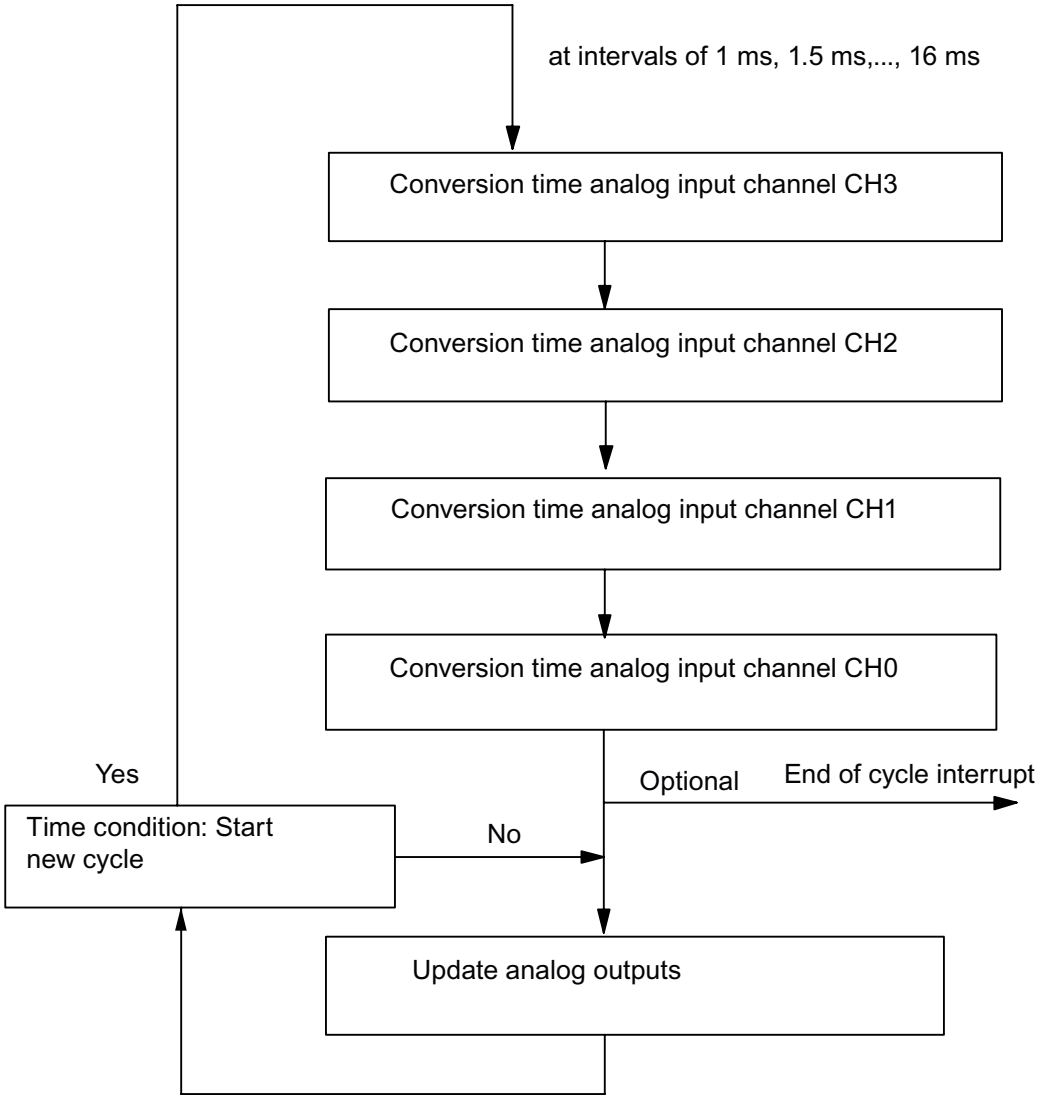

Figure 1-4 Cycle time for the conditional cycle of SM 335

Wiring the inputs and outputs

2

2.1 Basics of the wiring of SM 335

You must install the SM 335 before wiring the analog I/O. Install SM 335 as any other I/O module of SIMATIC S7-300. Refer to the Operating Instructions SIMATIC S7-300, Hardware and Installation (http://support.automation.siemens.com/WW/view/en/13008499). Note the installation guidelines in these operating instructions.

For more information about the wiring of the analog I/O of SM 335, refer to the SIMATIC S7-300 Automation System, Module Data (http://support.automation.siemens.com/WW/view/en/8859629) Manual.

The manual provides a description of the special features which only apply to SM 335.

Rules

As a rule:

- Protect the cables against interference and use shielded and twisted pairs.
- The accuracy of your measurements depends on
  - the load
  - the cable interconnecting SM 335 and the load
  - the reference voltage

Power supply

Connect a 24 VDC power supply to SM 335. Connect this 24 V supply to L+ (PIN 1) and its ground to M (PIN 20).

Grounding

Connect the 24 V supply ground

- directly to the 24 V supply voltage
- or to the S7-CPU (if using the 24 V supply on the CPU).

2.2 Wiring the analog inputs

Wiring analog inputs

Wire the analog outputs for operation as voltage outputs. For more information, refer to the SIMATIC S7-300 Automation System, Modules (http://support.automation.siemens.com/WW/view/en/8859629) Manual

Recommendation

Particularly the measuring input voltages could be susceptible to interference coupling due to the high conversion speed of SM 335. The configuration described in the section below is generally best practice to minimize interference susceptibility.

It is helpful to terminate the analog inputs of SM 335 and the corresponding ground to a terminal block from which you can distribute the ground potential to the analog inputs.

Installation

This basically results in the following configuration:

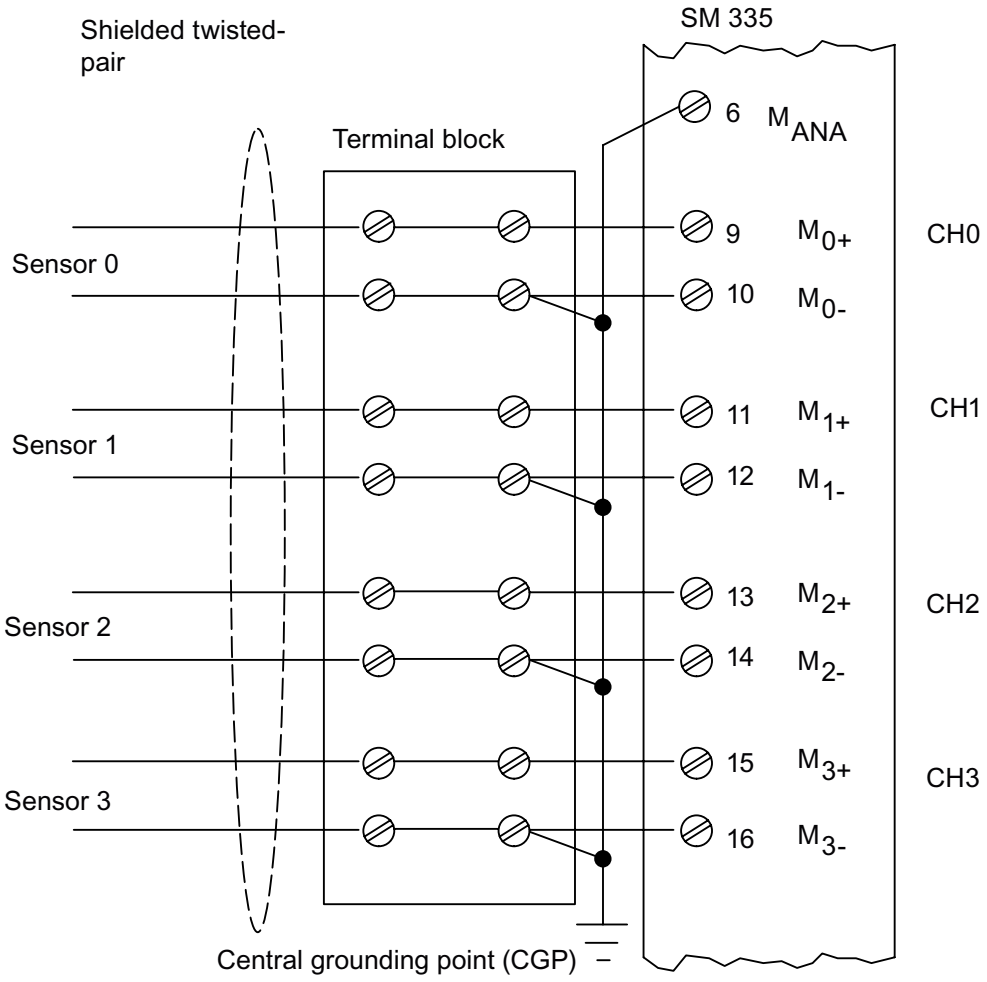

Figure 2-1 Wiring sensors

Non-isolated

By contrast to other applications (e.g. wiring of thermocouples), you should bond the analog ground of the encoders to a potential close to the SM 335. Best practice is to interconnect pins 10, 12, 14 and 16 with analog ground M_{ANA} (PIN 6) and to connect M_{ANA} close to the module within the rack to the central grounding point (CGP) of the module. You should keep this connection as short as possible.

Do not connect the sensors to a potential twice, as this creates ground loops which can lead to interference coupling. If using shielded sensors and the shield is wired to analog ground in this case, you must disconnect the shield from analog ground.

Limited potential difference U_{CM}

There can be only a limited potential difference VCM (common-mode voltage) between the measuring circuits M– of the input channels and the reference potential of the measuring circuit M_{ANA}.

You must take corresponding measures (depending on the encoder's potentials) to prevent the valid value from being exceeded.

For more information, refer to the SIMATIC S7-300 Automation Systems, Module Data (http://support.automation.siemens.com/WW/view/en/8859629) Manual.

If operated SM 335 in non-isolated mode, the common mode voltage between the encoder and M_{ANA} must not exceed the valid maximum value, for SM 335 will otherwise output a corresponding diagnostics interrupt and read the value $7FFF_H$ from the relevant channel.

The potential between M_{ANA} and 24 V supply ground may not exceed a maximum of 60 VAC/75 VDC.

Analog inputs which are not wired

Short the analog inputs of SM 335 which are not wired and connect them to M_{ANA}. Disable all analog inputs which are not wired in HW Config in order to optimize interference resistance at the SM 335 and reduce the cycle time in "free cycle" mode.

You can also use analog inputs which are not wired to monitor the encoder supply or analog outputs. This also increases interference resistance.

2.3 Wiring the analog outputs

Recommendation

It is helpful to terminate the analog outputs of SM 335 and their corresponding ground to a terminal block from which you can distribute the ground potential to the analog outputs.

Installation

This basically results in the following installation:

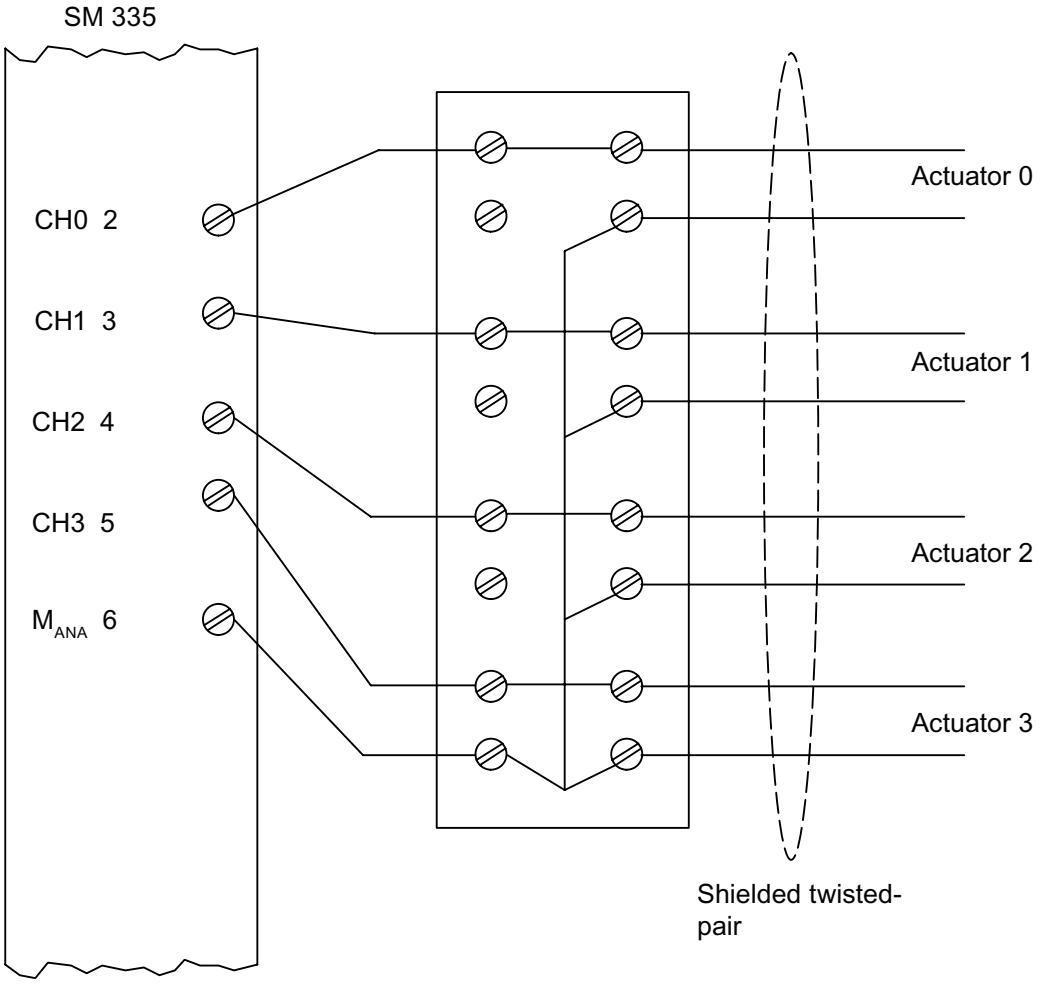

Figure 2-2 Wiring actuators to SM 335

Non-isolated

Shielded actuators whose shield is grounded and connected to the actuator's ground cable form a ground loop. You should, therefore, disconnect the shield from the actuator's ground cable, or use an actuator whose ground cable is not connected to ground.

Analog outputs which are not wired

Disable the analog outputs of SM 335 and leave them in open state in order to take them off-voltage. Disable analog outputs in HW Config.

2.4 Wiring the interval counter input

Non-isolated

If wiring the interval counter input for operation in non-isolated mode you must interconnect PIN 19 (M_{IZ}) with PIN 20 (24 V supply ground).

Electrically isolated mode

If wiring the interval counter input for operation in electrically isolated mode you must not interconnect PIN 19 (M_{IZ}) with PIN 20 (24 V supply ground).

Additional information

For more information about the wiring of the interval counter input, refer to chapter Wiring the interval counter input (Page 72).

2.5 Wiring the encoder supply

purpose

The encoder supply is provided for resistive transducers (e.g. linear potentiometers)

Connection

The figure below shows the wiring of the encoder supply

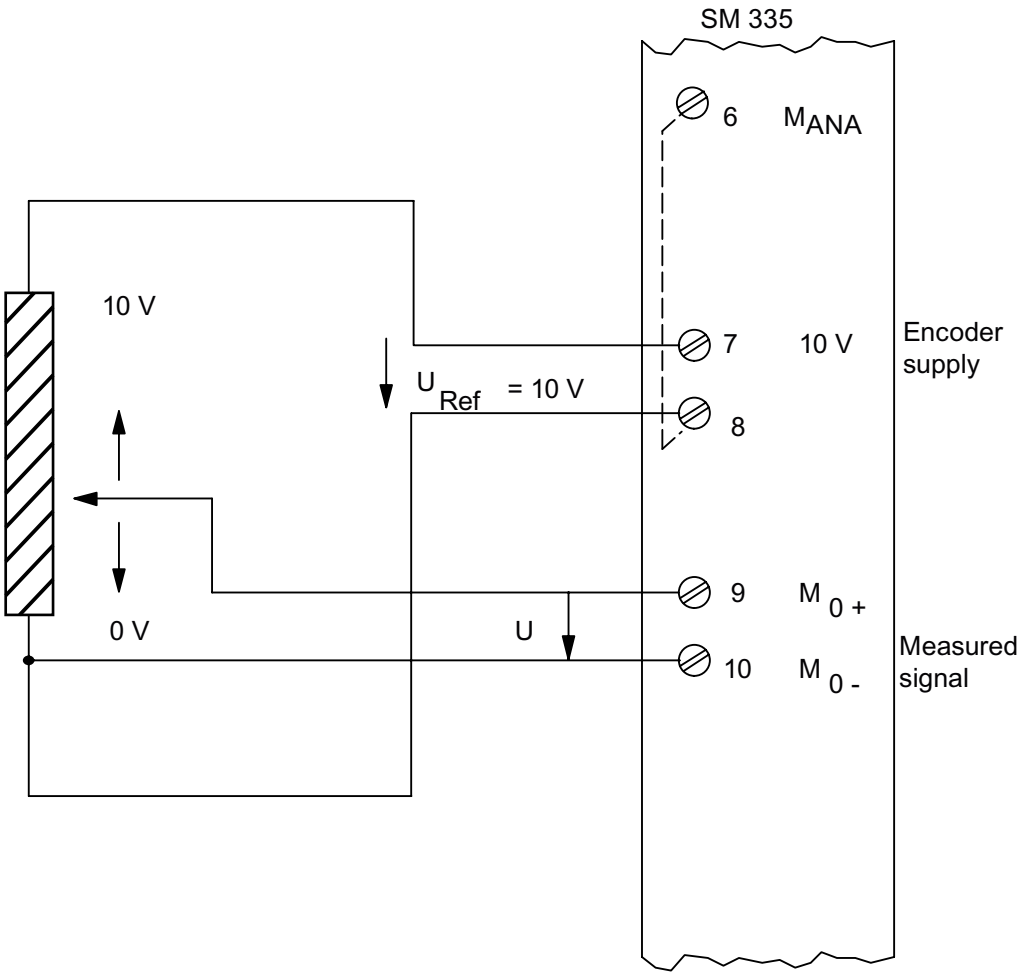

Figure 2-3 Example of the encoder supply via SM 335

Non-isolated installation

Analog ground of SM 335 (PIN 6) is interconnected internally with ground of the 10 V encoder supply (PIN 8).

Do not interconnect PIN 10 once again with PIN 6 or ground if using the 4-wire measurement shown in the previous figure. Such circuitry would develop a ground loop that is subject to interference coupling.

Cables

There is a voltage drop on the line that interconnects SM 335 with the linear potentiometer. Given the high resolution of SM 335, this voltage clearly has the potential to affect analog signal measurements. The voltage drop on a cable can be calculated as follows:

$$U = \frac{r_0 \cdot I \cdot L}{A}$$

U: Voltage drop on the cable
r_0: specific resistance of the conductor
(for Cu: 0.0172 Ω mm²/m)
I: current flow in the cable in amps
L: Length of the cable in m
A: Conductor cross-section in mm²

Based on this fact, it is advisable to route the cables across the shortest distance possible and use conductors with the largest possible cross-section.

2.6 Adjusting the encoder supply

The encoder supply provides a 10 V output voltage. This 10 V supply can develop a slight tolerance. This deviation originates from tolerances of the SM 335 components. You can therefore read back the precise value of the encoder supply for ultra-precision applications.

Voltage value of the encoder supply (ModAddr + 10, 11)

The analog value of the encoder supply (UG) is set to factory default and saved to the module. SM 335 returns the analog value UG in the input values at bytes ModAddr + 10 and ModAddr + 11; refer to the table of input values of SM 335 in chapter Input values (Page 35).

Correction factor

Calculate the correction factor K based on the voltage value of the encoder supply UG and on the required voltage.

$$K = \frac{27648\ (6C00_H)}{U_G}$$

UG has a value between 27620 ($6BE4_H$) and 27676 ($6C1C_H$). The result are correction factors between 0.9989883 and 1.0010127

Measured value

Calculate the corrected analog measured value as follows:

$$U_{Korr} = K \cdot U_{AI}$$

U_{Korr} = corrected analog value
K = correction factor
U_{AI} = analog value measured at the analog input

Data exchange with SM 335

3

Data exchange with SM 335 refers to:

- data transfer from the CPU to SM 335
- reading data from SM 335 by the CPU.

This section provides a summary of all data which can be transferred to SM 335, or returned from SM 335.

Options

You always have several option of reading or writing data:

- Access via I/O addresses (e.g., with L PEW, T PAW)
- Setting parameters
- Writing parameters with the help of SFC 55
- Reading diagnostics data by calling SFC 59
- For additional options, refer to the System and Standard Functions for S7-300/400 (http://support.automation.siemens.com/WW/view/en/1214574) Reference Manual.

Measuring range module

Insert the measuring range module into SM 335 before installing the SM 335 in the rack. The SIMATIC S7-300 Automation System, Module Data (http://support.automation.siemens.com/WW/view/en/8859629) Manual describes how to insert the measuring range module into SM 335. The insert position of the measuring range module sets the measuring mode for the analog inputs (current/voltage measurement).

3.1 Access via I/O addresses

You can use the I/O addresses to access the SM 335

Input values

Input values are values returned by SM 335. The input values contain measured values of SM 335.

You can load the input values by means of I/O addressing command L PEB (or L PEW, or L PED). Within the process image you can also gain read access by means of L EB (or L EW, or L ED); refer to the table of the input value of SM 335 in chapter Input values (Page 35).

Output values

Output values are written to SM 335 in I/O addressing mode using the T PAB (or T PAW, or T PAD) command. Within the process image you can also gain write access by means of T EB (or T EW, or T ED)

You can use the output values to transfer analog values to SM 335. Those analog values are output at the analog outputs of SM 335; refer to the table of the output value of SM 335 in chapter Output values (Page 39) .

3.1.1 Input values

SM 335 converts the signals measured at the inputs to binary values.

Installation

The input values are available at the module start address to module start address + 15 bytes. For information on how to calculate the module start address, refer to the SIMATIC S7-300 Automation System, Module Data (http://support.automation.siemens.com/WW/view/en/8859629) Manual.

The table below shows the assignment of inputs values.

Table 3- 1 Input values of SM 335

Byte	Contents	Value
ModAddr + 0	High byte of the value measured at measuring channel CH 0	$7F_H$ *) or ***)
ModAddr + 1	Low byte of the value measured at measuring channel CH 0	FF_H *) or ***)
ModAddr + 2	High byte of the value measured at measuring channel CH 1	$7F_H$ *) or ***)
ModAddr + 3	Low byte of the value measured at measuring channel CH 1	FF_H *) or ***)
ModAddr + 4	High byte of the value measured at measuring channel CH 2	$7F_H$ *) or ***)
ModAddr + 5	Low byte of the value measured at measuring channel CH 2	FF_H *) or ***)
ModAddr + 6	High byte of the value measured at measuring channel CH 3	$7F_H$ *) or ***)
ModAddr + 7	Low byte of the value measured at measuring channel CH 3	FF_H *) or ***)
ModAddr + 8	In "Comparator" or "Measuring Only" mode: - Number of end of cycle interrupts Otherwise: - Number of failed end of cycle interrupts +1; Default 1	00_H*) or ***)
ModAddr + 9	Comparator mode (at startup) or return code for the "Comparator" and "Measuring Only" modes	00_H*) or 01_H*) or ***)
ModAddr + 10	High byte of the voltage value of the encoder supply (refer to chapter Adjusting the encoder supply (Page 31))	**)
ModAddr + 11	Low byte of the voltage value of the encoder supply (refer to chapter Adjusting the encoder supply (Page 31))	**)
ModAddr + 12	Interval counter (refer to chapter Interval counter input (Page 69))	00_H*) or ***)
ModAddr + 13	Interval duration bits 16 to 24	FF_H *) or ***)
ModAddr + 14	Interval duration bits 8 to 15	FF_H *) or ***)
ModAddr + 15	Interval duration bits 0 to 7	FF_H *) or ***)

*) Initial value

**) set to factory default

***) current value

Analog values (ModAddr + 0...7)

For information about the binary notation of analog values in the CPU and the specific notation associated with a specific analog value, refer to chapters Representation of analog values of analog input channels (Page 40) and Representation of analog values for analog output channels (Page 42).

Number of end of cycle interrupts (ModAddr + 8)

The end of cycle interrupt can be used to synchronize a user program by calling OB 40. This interrupt also facilitates fast execution of the user program (e.g., for control loop routines). However, certain scenarios can prevent SM 335 from outputting the interrupt:

- after generation of a large number of simultaneous hardware interrupts
- in the special "Comparator" mode

SM 335 suppresses end of cycle interrupts as long as the special "Comparator" mode is activated.

SM 335 saves the number of the end of cycle interrupts (1 + the number of failed end of cycle interrupts) to byte ModAddr + 8 after the "Comparator" mode has been terminated.

Example: Content of byte 8 = 5, i.e. only one OB 40 call is generated for the duration of 5 end of cycle interrupts.

The value is also available in the local data of OB 40; refer to chapter Hardware interrupt (Page 60). You should preferably run the evaluation by calling OB 40 in order to ensure consistency of the measured value and of the number of end of cycle interrupts.

Return code (ModAddr + 9)

SM 335 generates a return code at input byte ModAddr + 9 if one of the "Comparator" or "Measuring Only" special modes is activated. The following figure shows the syntax of the return code:

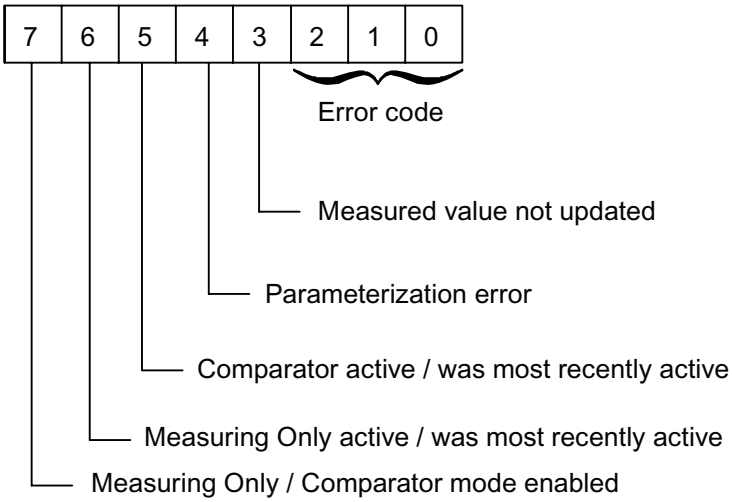

Figure 3-1 Return code of SM 335

The following table shows the meaning of the return code bits. Instead of the return code, the comparator mode is displayed at the startup of SM 335.

Table 3- 2 Meaning of the bits in the return code of SM 335

Bit	Meaning
7	= 1: SM 335 is in "Measuring only" or "Comparator" mode = 0: SM 335 is in "conditional cycle" or "free cycle" mode
6[1)]	= 1: "Measuring Only" mode is activated, or was the last mode activated
5[1)]	= 1: "Comparator" mode is activated, or was the last mode activated
4	= 1: Operating mode cannot be activated. Reason: • The " Comparator" mode cannot be activated if the "Measuring Only" mode is active • The " Measuring Only" mode cannot be activated if the "Comparator" mode is active, or if the "Measuring Only" mode is already activated
3	= 1: the measured value at the analog inputs is not up-to-date (only in "Comparator" - with Comparator 2 mode; Refer to chapter
2, 1, 0	Error code; refer to the table showing the meaning of bits 0, 1 and 2 in the return code of SM 335

1) Only one of the bits 5 and 6 can be set

Table 3- 3 Meaning of bits 0, 1 and 2 in the return code of SM 335

Bit2	Bit1	Bit0	Meaning
0	0	0	No error
0	0	1	Incorrect parameter for the "Comparator" mode (no analog input selected as comparator input)
0	1	0	The analog input to be used for measuring is disabled in the parameter.
0	1	1	An error has occurred at the analog input for the comparator while the "Comparator" mode was active.
1	0	0	Operating mode terminated. Reason: • Comparator: Comparator time expired (refer to chapter SM 335 parameters for the special mode "Comparator" (Page 85)) • Measuring Only (refer to chapter Special "Measuring Only" mode (Page 88)): Measurement completed
1	0	1	The "Comparator" mode was terminated because new parameters were transferred by means of SFC to SM 335.

See also

Principle of the special operating mode "Comparator" (Page 80)

3.1.2 Output values

Principles

You transfer the analog output values you calculated in binary notation in the CPU to SM 335 by entering the "T PAW" command, for example. SM 335 converts the binary output values to analog signals and returns them at the corresponding outputs.

Installation

Transfer the output values to the module start address to module start address + 7 bytes.

You determine the module start address when configuring the SM 335 in HW Config of STEP 7

Table 3- 4 Output values of SM 335

Byte	Contents
ModAddr + 0	High byte of the output value for analog output channel CH
ModAddr + 1	Low byte of the output value for analog output channel CH
ModAddr + 2	High byte of the output value for analog output channel CH
ModAddr + 3	Low byte of the output value for analog output channel CH
ModAddr + 4	High byte of the output value for analog output channel CH
ModAddr + 5	Low byte of the output value for analog output channel CH
ModAddr + 6	High byte of the output value for analog output channel CH
ModAddr + 7	Low byte of the output value for analog output channel CH

Analog values

For information about the binary notation of analog values in the CPU and the specific notation associated with a specific analog value, refer to chapters Representation of analog values of analog input channels (Page 40) and Representation of analog values for analog output channels (Page 42).

3.1.3 Representation of analog values of analog input channels

Representation of analog values

The following tables list the measured value notations for the measuring ranges of the analog input

Table 3- 5 Analog value notation in the bipolar input ranges

Measuring range				Units		Range
± 1 V	± 10 V	± 2.5 V	± 10 mA	decimal	Hexadecimal	
1.185 V : :	11.851 V	2.963 V	11.85 mA	32767 : 32512	$7FFF_H$: $7F00_H$	Overflow
1.1758 V : :	11.758 V : :	2.938 V : :	11.758 mA : :	32508 : 27652	$7EFC_H$: $6C04_H$	Overshoot range
1 V : 0.75 V : 144.68 µV 0 V -144.68 µV : -0.75 : -1 V	10 V : 7.5 V : 1446.8 µV 0 V -1446.8 µV : -7.5 V : -10	2.5 V : 1.875 V : 361,69 0 V -361.69 µV . -1.875 V -2,5	10 mA : 7.5 mA : 1446.8 nA 0 mA -1446.8 nA : -7.5 mA : -10 mA	27648 : 20736 : 4 0 -4 : -20736 : -27648	$6C00_H$: 5100_H : 4_H 0 $FFFC_H$: $AF00_H$: 9400_H	Rated range
: : -1.176 V	: : -11.759 V	: : -2.940 V	: : -11.76 mA	-27652 : -32512	$93FC_H$: 8100_H	Undershoot range
: : -1.185 V	: : -11.851 V	: : -2.963 V	: : -11.85 mA	-32516 : -32768	$80FC_H$: 8000_H	Underflow

Table 3- 6 Analog value notation in the unipolar input ranges

Measuring range				Units		Range
0 to 2 V	0 to 10 V	0 - 20 mA	4 to 20 mA	decimal	hexadecimal	
2.370 V : :	11.852 V : :	23.70 mA : :	22.96 mA : :	32767 : 32512	$7FFF_H$: $7F00_H$	Overflow
2.35 V : :	11.75 V : :	23.5 mA : :	22.8 mA : :	32510 : 27650	$7EFE_H$: $6C02_H$	Overshoot range
2 V : 1.5 V : 144.68 µV 0 V	10 V : 7.5 V : 723.4 µV 0 V	20 mA : 15 mA : 1446.8 nA 0 mA	20 mA : 15 mA : 4 mA + 1157.4 nA 4 mA	27648 : 20736 : 2 0	$6C00_H$: 5100_H : 2_H 0	Rated range
-144.68 µV : -18.446 mV	-723.4 µV : -92.223 mV	1446.8 nA : 18.448 µA	<4 mA Wire-break ($7FFF_H$)	-2 : -225	$FFFE_H$: $FF00_H$	Undershoot range
<-18.446 mV	<-92.223 mV	<-18.448 µA		-32768	8000_H	Underflow

3.1.4 Representation of analog values for analog output channels

Representation of analog values

The following table below lists the representation of analog values for the output channels of SM 335.

12 bits (+ sign) of the output value are converted in the 0 to 10 V range. Bits 0, 1 and 2 are not converted.

11 bits + sign of the output value are converted in the +10 V range. Bits 0, 1, 2 and 3 are not converted.

Table 3- 7 Analog value representation in the 0 V to 10 V and 1 V to 10 V output ranges

Output value		Range	Output voltage	
decimal	hexadecimal		0 to 10 V	± 10 V
32767 : 32512	$7FFF_H$: $7F00_H$	Overflow (off-voltage and off-current)	0 V : 0 V	0 V : 0 V
32504 32496 : 27664 27656	$7EF8_H$ $7EF0_H$: $6C10_H$ $6C08_H$	Overrange	11.756 V 11.753 V : 10.006 V 10.003 V	11.753 V 11.753 V : 10.006 V 10 V
27648 : 20736 : 16 8 0 -8 -16 : -20736 : -27648	$6C00_H$: 5100_H : 10_H 8_H 0_H $FFF8_H$ $FFF0_H$: $AF00_H$: 9400_H	Rated range	10 V : 7.5 V : 5.787 mV 2.8936 mV 0 V 0 V 0 V 0 V : 0 V : 0 V	10 V : 7.5 V : 5.787 mV 0 V 0 V 0 V -5.787 mV : -7.5 V : -10 V
-27656 -27648 : -32496 -32504	$93F8_H$ $93F0_H$: 8110_H 8108_H	Undershoot range	0 V 0 V : 0 V 0 V	-10 V -10.006 V : -11.753 V -11.753 V
-32512 : -32768	8100_H : 8000_H	Underflow (off-voltage and off-current)	0 V : 0 V	0 V : 0 V

3.2 Configuring and parameterizing

Configuring

You configure the SM 335:

- In the S7 system using STEP 7 V5.4 or higher, service pack 3 and the HSP 2043 for the analog I/O module AI/4/14Bit+AO4/12Bit.
- Using the current GSD file for the PROFIBUS interfaces
  - 6ES7153-1AA03-0XB0
  - 6ES7153-2BAx2-0XB0
  - 6ES7153-2BB00-0XB0
- Using the current GSDML file for the PROFINET IO-Device interface modules
  - 6ES7153-4AA00-0XB0
  - 6ES7153-4AA01-0XB0

Parameterization

You can parameterize specific properties of SM 335 (e.g. the cycle time for A/D conversion) in HW Config of STEP 7.

Also, position the measuring range modules of the module as required; refer to chapter Setting up the measuring range using the measuring range module (Page 15).

3.2.1 Default settings of SM 335

You can parameterize specific properties of SM 335 (e.g. the cycle time for A/D conversion) in HW Config of STEP 7.

Also, position the measuring range modules of the module as required; refer to chapter Setting up the measuring range using the measuring range module (Page 15).

Default settings of SM 335

The analog I/O module is set to factory defaults. Those defaults are valid unless the parameters were modified in STEP 7-Tool "HW Konfig".

Table 3- 8 Default settings of SM 335

Parameters	Default settings for the analog inputs	Default settings for the analog outputs
Cycle time *)	free cycle (corresponds with the setting 0.5 ms [cycle time of SM335])	
Measuring mode	V or I (4 DMU), according to the position of the measuring range module	V
Measuring range	For V: +/- 10 V For I (4 DMU): 4 to 20 mA	+/- 10 V
Diagnostics interrupt *)	No	No
Hardware interrupt at end of cycle	No	No
Group diagnostics (= short-circuit test at analog output)	No	No
Wire-break check	No	-
Reaction to CPU STOP	-	Outputs have no current or voltage (OCV)
Number of active channels	4	4

*) Valid setting for the entire module

3.2.2 SM 335 parameters which can be set up in HW Config

Parameters of SM 335

Set up the parameters in HW Config of STEP 7.

Table 3- 9 SM 335 parameters in HW Config

Parameters	SM 335	
	Range of values	Default setting
Basic input settings		
• Hardware interrupt for end of cycle	Yes / no	No
• Diagnostics interrupt enable	Yes / no	No
Input diagnostics: Enable contains: • Measuring range undershoot • Measuring range overshoot • Overshoot of the valid common mode voltage	Yes / no	No
Wire-break check	Yes / no	No
Measurement • Type	Disabled Voltage Current (4-wire sensor)	Voltage
• Range	Voltage: ± 1 V; ± 2.5 V; 0 to 10 V; 0 V to + 2 V (channels CH0 to CH3) Default ± 10 V Current: ± 10 mA; 0 mA to + 20 mA +4 mA to + 20 mA (channels CH2 to CH 3)	
• Cycle time for A/D conversion	0,5; *) 1 to 16 ms	0.5 ms *)
Output diagnostics (short-circuit test)	Yes / no	No
Reaction to CPU STOP	"Keep Last Value (KLV)" or "Outputs have no current or voltage (OCV)"	"Outputs have no current or voltage (OCV)"
Output • Mode	Disabled / Voltage	Voltage
• Range	From -10 V to + 10 V From 0 V to + 10 V	

* The 0.5 ms setting in HW Config means: Free cycle

The 1 to 16 ms setting in HW Config means: Conditional cycle

End of cycle interrupt enable

If you enable the end of cycle interrupt, SM 335 generates a hardware interrupt after A/D conversion of the active channels. You can use this interrupt routine to call OB 40 within a fixed time pattern. You can set the cycle time for A/D conversion. SM 335 can generate the end of cycle interrupt, starting at a cycle time of 1 ms for A/D conversion; refer to chapter Hardware interrupt (Page 60).

Diagnostics interrupt enable

If you enable the diagnostics interrupt, SM 335 generates it as soon as it detects an error.

Enabling diagnostics

If you enable input diagnostics, SM 335 scans the analog inputs to detect common mode errors as well as measuring range overshoot and undershoot. If you enable output diagnostics, SM 335 scans the outputs to detect short-circuits.

Wire-break check

The wire-break check can be enabled separately for each analog input. The wire-break check is available for the measuring range:

- 0 to 10 V (starting at a cycle time of 2 ms or longer for A/D conversion)
- 4 to 20 mA (starting at a cycle time of 1.5 ms or longer for A/D conversion)

Reaction to CPU STOP

If the CPU is in STOP or startup state, SM 335 returns a substitute value at the corresponding analog output until a new value is entered. SM 335 uses the following substitute value:

- 0 V (if "Outputs idle" was parameterized in HW Config)

  or

- the most recently output analog value (if "Hold Last Value" was parameterized in HW Config).

3.3 Modifying SM 335 parameters in RUN

HW Config

You can modify certain (dynamic) parameters while the CPU is in RUN state.

You can transfer the SM 335 parameters by calling

- SFC55 "WR_PARM" (central, distributed PROFIBUS)
- SFB53 "WRREC" (central, distributed PROFIBUS/PROFINET)

For additional parameterization options, refer to the System and Standard Functions for S7-300/400 (http://support.automation.siemens.com/WW/view/en/1214574) Reference Manual.

Parameters

The SM 335 parameters have a length of 16 bytes which are split into two data sets (DS0 and DS1).

Save the SM 335 parameters (complete DS1 that is to be transferred to the module) to a data area on the CPU (e.g. bit memory, data block). Transfer the parameters to SM 335 with the help of SFC 55 "WR_PARM" or SFB53 "WRREC".

Data sets

The SM 335 parameters are stored in two data sets (DS0 and DS1).

Data set 0 (DS0)

Data set 0 of SM 335 has a length of 2 bytes and contains the static parameters of SM 335. You cannot modify those parameters.

Data set 1 (DS31)

Data set 1 contains the dynamic parameters of SM 335 which you can modify.

NOTICE
The transfer always has to include the entire data set 1 (bytes 0 to 13).

3.3.1 Static parameters of SM 335

Static parameters can only be modified in HW Config.

Data set 0

Data set 0 (DS 0) of SM 335 contains dynamic parameters.

Byte	Content	Default
0	I/O diagnostics	00_H
1	Reserved	00_H

Diagnostics

Define which analog inputs and outputs you want to trigger a diagnostics interrupt in error case at the parameter for I/O diagnostics in HW Config.

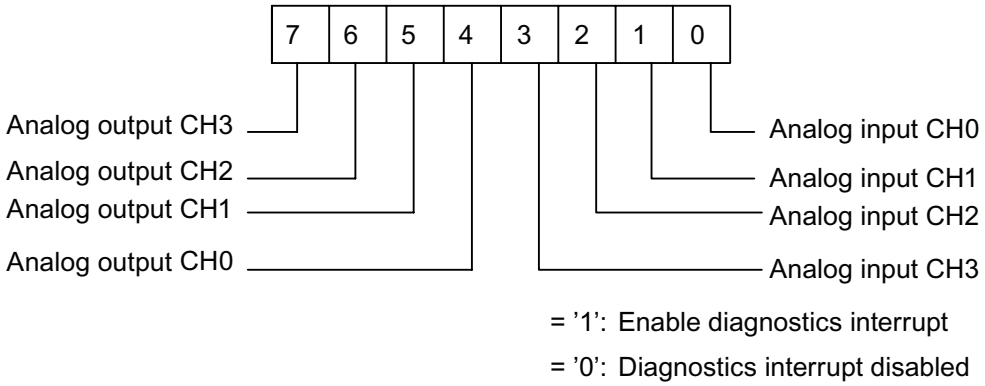

Figure 3-2 Meaning of the bits in the byte for I/O diagnostics

If you enable input diagnostics, SM 335 scans the analog inputs to detect common mode errors as well as measuring range overshoot and undershoot. If you enable output diagnostics, SM 335 scans the outputs to detect short-circuits.

3.3.2 SM 335 parameters for the free and conditional cycle modes

Data set 1 (DS31)

Data set 1 (DS 0) of SM 335 contains dynamic parameters; see the following table.

The parameters can either be set in HW Config, or be modified using SFC 55.

NOTICE
Data set 1 (DS1) always has to be transferred completely.

Table 3- 10 SM 335 parameters in data set 1 (DS1)

Byte	Content	Default
0	Output of interrupts and substitute values	00_H
1	Reserved	00_H
2	Measuring range of analog input channel CH 0	19_H
3	Measuring range of analog input channel CH 1	19_H
4	Measuring range of analog input channel CH 2	Depends on the setting of the measuring range module
5	Measuring range of analog input channel CH 3	
6	Output range of analog output channel CH 0	19_H
7	Output range of analog output channel CH 1	19_H
8	Output range of analog output channel CH 2	19_H
9	Output range of analog output channel CH 3	19_H
10	Measuring cycle time	01_H
11	Dynamic measuring cycle control: Fixed in the free and conditional cycle modes: 00_H	00_H
12	Wire-break check	00_H
13	Monitoring time factor for the interval counter (refer to chapter Parameterizing the interval counter input of SM 335 (Page 74))	00_H

Output of interrupts and substitute values (DS1, byte 0)

At the output of interrupts and substitute values parameter you define:

- whether to generate a hardware interrupt (only for conditional cycle),
- whether to generate a diagnostics interrupt
- whether to output the last valid analog value or 0 as substitute value.

The process and diagnostics interrupt settings affect all module channels.

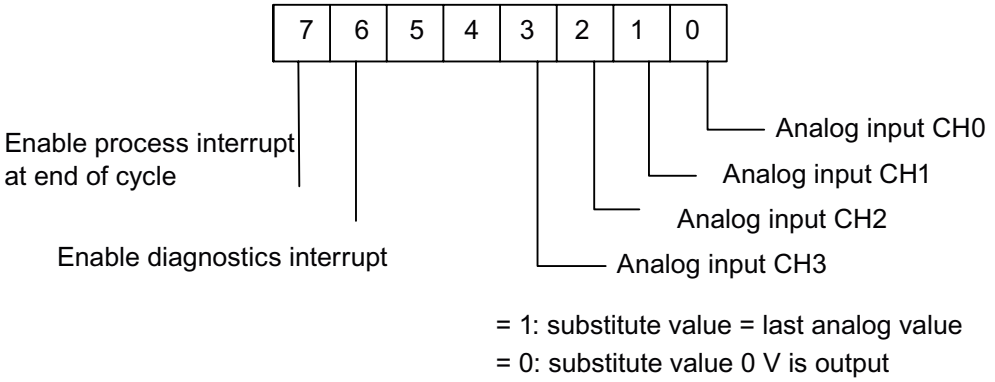

Figure 3-3 Meaning of the bits in the byte for the output of interrupts and substitute values (DS1, byte 0)

Analog input measuring range (DS1, bytes 2 to 5)

The default parameter settings for the measuring range of analog inputs depend on the setting of the measuring range module on SM 335.

Table 3- 11 Parameters for the analog input measuring range

Measuring range module in position	Default parameters (byte address relative to data set 1)	Possible parameters and measuring ranges (bytes 2 to 5)
A	Byte 2 (CH0): 19 $_H$ (voltage) Byte 3 (CH1): 19_H (voltage) Byte 4 (CH2): 19_H (voltage) Byte 5 (CH3): 23_H (current)	For voltage measurement 14_H: - 1 V to + 1 V 14_H: - 1 V to + 1 V 14_H: - 1 V to + 1 V 14_H: - 1 V to + 1 V 14_H: - 1 V to + 1 V for current measurement 21_H: - 10 to + 10 mA 21_H: - 10 to + 10 mA 21_H: - 10 to + 10 mA
B This setting is not allowed for the measuring range module.	Byte 2 (CH0): 00_H Byte 3 (CH1): 00_H Byte 4 (CH2): 00_H Byte 5 (CH3): 00_H	
C	Byte 2 (CH0): 19 $_H$ (voltage) Byte 3 (CH1): 19_H (voltage) Byte 4 (CH2): 23_H (current) Byte 5 (CH3): 23_H (current)	
D	Byte 2 (CH0): 19 $_H$ (voltage) Byte 3 (CH1): 19_H (voltage) Byte 4 (CH2): 19_H (voltage) Byte 5 (CH3): 19_H (voltage)	

Analog output range (DS1, bytes 6 to 5)

Possible measuring ranges:

- 19_H = +/–10 V (default)
- 18_H = 0 –10 V

Channel assignments:

- Byte 6 = analog output channel CH0
- Byte 7 = analog output channel CH1
- Byte 8 = analog output channel CH2
- Byte 9 = analog output channel CH3

Measuring cycle time (DS1, byte 10)

Set up the duration of a measuring cycle at the measuring cycle time parameter. Default value is 01_H.

If you enter the value:

- 01_H, the measuring cycle runs freely, i.e., one measuring cycle has a duration of approx. 0.9 ms (1 to 1.2 ms if the update of analog outputs is included, depending on the number of analog outputs).
- 02_H is equivalent to a measuring cycle of 1 ms
- 03_H is equivalent to a measuring cycle of 1.5 ms, etc.
- 00_H is equivalent to a measuring cycle of 16 ms

Note

Measuring cycle time of 1 ms: The modified values are output before the start of the first measurement (channel CH3). The measurements follow in the next step. The diagnostics functions for detection of short-circuits and overflow/underflow are not executed order to enable the processing of all I/O channels within 1 ms. The comparator function is not executed within the 1 ms cycle. The comparator 1 function cannot be executed due to the lack of sufficient time!

Dynamic measuring cycle control (DS1, byte 11)

The parameter for dynamic measuring cycle control cannot be set up in HW Config. It is used to toggle the module to the special operating modes. In the free and conditional cycle modes, this byte always has the value 00_H.

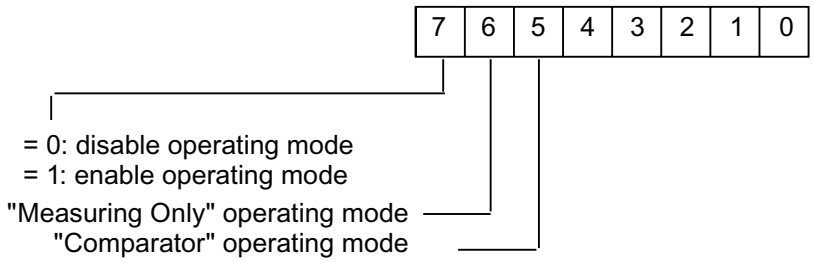

Figure 3-4 Meaning of the bits in the " dynamic measuring cycle control" byte

Wire-break check

You can enable the wire-break check for specific analog inputs at the wire-break check parameter (byte 12 in data set 1).

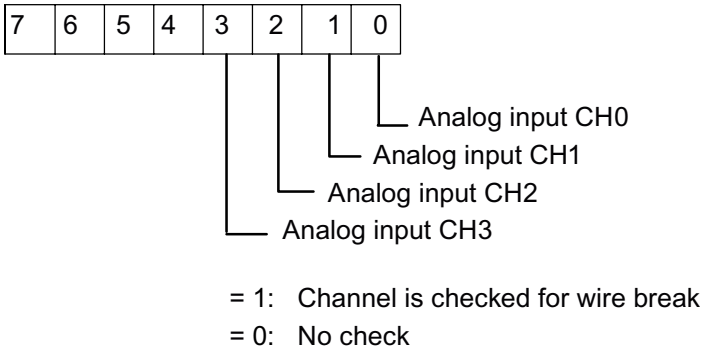

Figure 3-5 Meaning of the bits in the "wire-break check" byte

3.3.3 SM 335 parameters for the special mode "Comparator"

Introduction

If special mode "Comparator" is set, SM 335 compares a default analog value with the analog value measured at one of the analog inputs. In this mode SM 335 behaves similar to a comparator. For more information about the "Comparator" mode, refer to chapter Special operating mode "Comparator" (Page 79).

Switchover

For information about the switchover to the special operating mode "Comparator", refer to chapter Special operating modes of SM 335 (Page 77).

Restriction

The parameters for the special operating mode "Comparator" can only be transferred by way of SFC 55 "WR_PARM" or SFB 53 "WRREC".

NOTICE
The transfer always has to include the entire data set DS1 (bytes 0 to 13).

Data set 1

The parameters which you can toggle dynamically are stored in data set 1 of SM 335.

Table 3- 12 Data set 1 of SM 335 for the special mode "Comparator"

Byte	Content
0	Analog value 1 high byte to be output
1	Analog value 1 low byte to be output
2	Analog value 2 high byte to be output
3	Analog value 2 low byte to be output
4	Analog value 3 high byte to be output
5	Analog value 3 low byte to be output
6	Comparison value "Comparator 1" high byte
7	Comparison value "Comparator 1" low byte
8	Comparison value "Comparator 2" high byte
9	Comparison value "Comparator 2" low byte
10	Comparator time
11	Dynamic measuring cycle control
12	Comparator - check byte
13	Reserved

Analog value to be output

SM 335 outputs the default values at up to 3 analog outputs for comparator 1 or 2; refer to chapter Special operating mode "Comparator" (Page 79).

Comparator time (DS1, byte 1)

SM 335 cannot generate a hardware interrupt for the end of the cycle while comparator 2 mode is enabled. It can therefore happen that SM 335 does not generate an end of cycle interrupt for a longer time.

You can define the maximum comparator activation time by setting the comparator time.

After the active comparator time has expired, SM 335 automatically returns to the "conditional cycle" or "free cycle" mode.

Define the comparator time in milliseconds (1 = 1 ms, 2 = 2 ms, up to 0 = 256 ms).

Dynamic measuring cycle control (DS1, byte 11)

The Dynamic measuring cycle check byte is assigned as follows in the special "Comparator" mode:

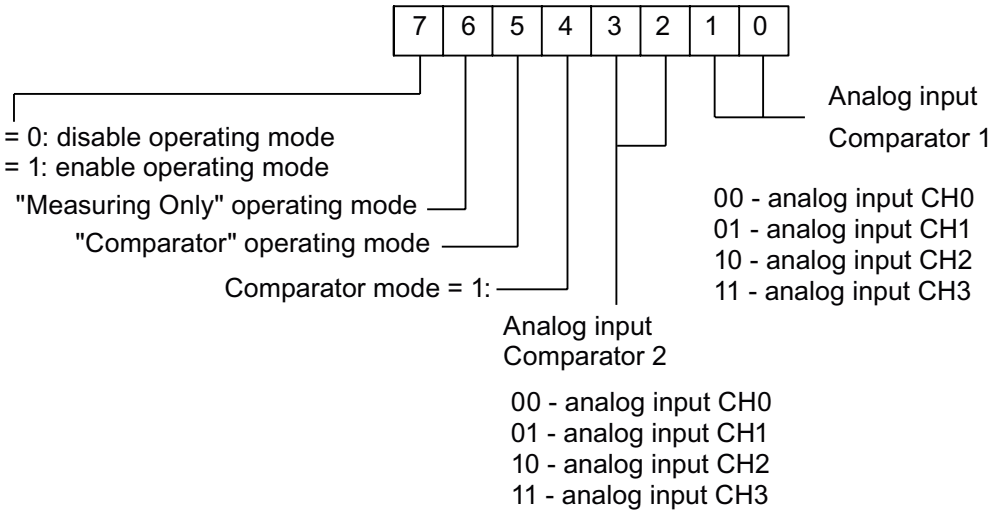

Figure 3-6 Meaning of the bits in the " dynamic measuring cycle control" byte

Note

Bit 4 the in "Dynamic measuring cycle control" (comparator mode) byte must be set to "1".

Comparator check byte (DS1, byte 12)

The comparator can also be monitored in the comparator check byte: The comparator check byte has the following structure:

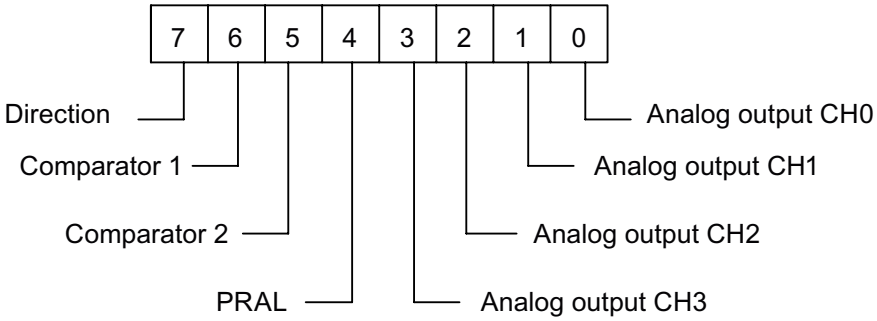

Figure 3-7 Comparator check byte for the special mode "Comparator"

Direction (DS1, Bit 12.7)

If bit 7 of the comparator check byte is set to ’0’, the comparison is carried out in direction of ascending analog values.

If bit 7 is set to ’1’, the comparison is carried out in direction of descending analog values.

Comparator 1 and Comparator 2 (DS1, bit 12.6 + 12.5)

The comparator 1 and 2 bits are used to enable comparator 1 and 2.

Table 3- 13 Checking comparator with check bits and 2

Bit 6	Bit 5	Behavior of the comparator
1	1	Enabling comparators 1 and 2 in succession
0	1	Enabling comparator 2
1	0	Enabling comparator 1
0	0	The special mode "Comparator" is terminated immediately.

PRAL (DS1, bit 12.4)

If you set bit 4 in the comparator check byte to '1', SM 335 generates a hardware interrupt at the switchover point.

Comparator 1 to Comparator 2 switchover point

Comparator 1 is monitored in the free or conditional measuring cycle. After the measured value has reached or exceeded the value of Comparator 1 and a Comparator 2 was defined, only the channel of Comparator 2 is measured cyclically (at intervals of approx.. 40 µs), starting from the switchover point.

The free or put additional measuring cycle is resumed after the measured value has reached or exceeded the value of Comparator 2, or if the parameterized watchdog timeout (max. 8.3 seconds) has been exceeded.

Analog output (DS1, bits 12.3 to 12.0)

Use bits 0 to 3 of the comparator check byte (DS1, byte 12, see the figure comparator check byte for the special mode "Comparator") to specify at which outputs the analog values defined in DS1 (bytes 0 to 5 in the table of data set 1 of SM 335 for the special mode "Comparator") are to be output.

- Bit i = 1: the specified value is output
- Bit i = 0: the old analog value is retained

You can set up to 3 bits. The analog values are output until a new value is written to the output.

3.3.4 SM 335 parameters for the special mode "Measuring Only"

Introduction

If operating the special mode "Measuring Only" is set, SM 335 only measures the analog inputs within the free cycle without updating the analog outputs. For more information about the "Measuring Only" mode, refer to chapter Special "Measuring Only" mode (Page 88).

Switchover

For information on the switchover to the special mode "Measuring Only", refer to chapter Special operating modes of SM 335 (Page 77).

Data set 1

The dynamic parameters for the special mode "Measuring Only" can only be transferred by way of SFC 55 "WR_PARM" or SFB 53 "WRREC".

NOTICE
The transfer always has to include the entire data set DS1 (bytes 0 to 13).

Note

With the exception of byte 11; the data set 1 parameters you transfer in order to change to the "Measuring Only" mode must be identical with the parameters you transferred for the free or conditional cycle mode.

Table 3- 14 Data set 1 of SM 335 for the special mode "Measuring Only"

Byte	Content
0	Used as in the free and conditional cycle modes (refer to chapter SM 335 parameters for the free and conditional cycle modes (Page 49), table of the SM 335 parameters in data set 1 (DS1)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	Dynamic measuring cycle control
12	Used as in the free and conditional cycle modes (refer to chapter SM 335 parameters for the free and conditional cycle modes (Page 49), table of the SM 335 parameters in data set 1 (DS1)
13	

Dynamic measuring cycle control

Byte 11 of "dynamic measuring cycle control is assigned two functions:

- Enabling the special mode "Measuring Only"
- Enabling / disabling analog inputs

Enabling the operating mode (DS1, byte 11)

To enable the special mode "Measuring Only", you must transfer all parameters for SM 335 and set bit 6 + 7 in byte 11:

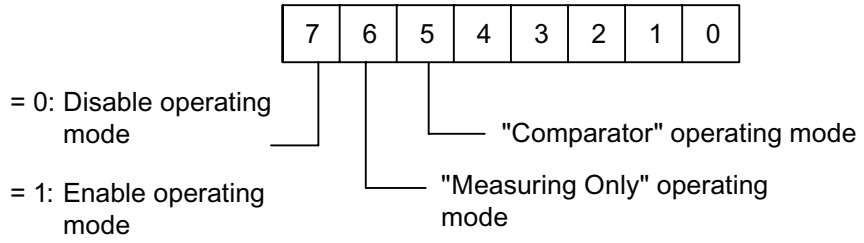

Figure 3-8 Dynamic measuring cycle control for the special mode "Measuring Only"

Disabling analog inputs dynamically

Use bits 0 to 3 to disable the assigned analog input. Bits 0 to 3 are set to ’0’ by default. An analog input is not processed if you set its bit to ’1’. You can achieve a measuring cycle time < 0.5 ms by disabling three analog inputs.

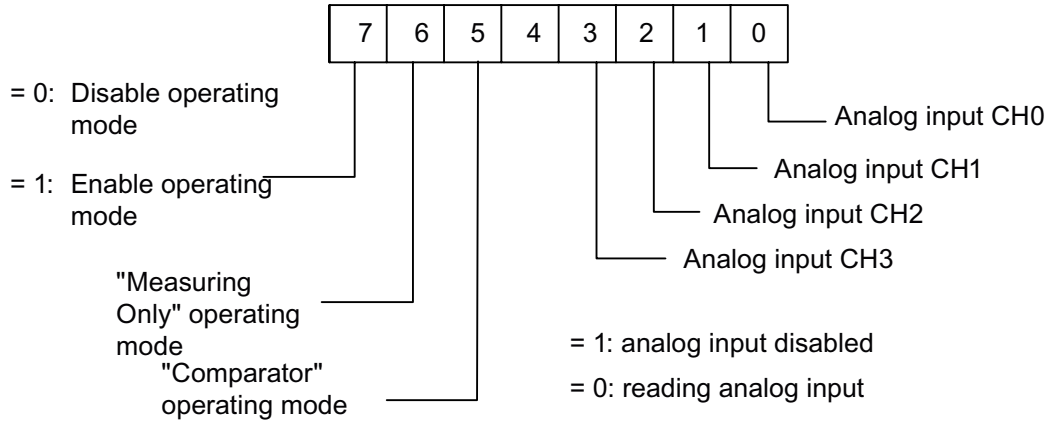

Figure 3-9 Meaning of the bits in the " dynamic measuring cycle control" byte

Bit 4 in the "Dynamic measuring cycle control" (comparator mode) byte must be set to "0".

3.4 Evaluating the diagnostics data of SM 335

Options

You have several options of accessing the diagnostics data of SM 335:

- By means of the local data in OB 82 if the diagnostics interrupt is enabled
- For hardware interrupts by means of the local data in the interrupt OB (e.g. OB 40)
- Reading the diagnostics data by calling SFC 59 (RD_REC).
- For additional options, refer to the System and Standard Functions for S7-300/400 (http://support.automation.siemens.com/WW/view/en/1214574) Reference Manual

Diagnostics interrupt

The CPU executes OB 82 after you enabled diagnostics interrupts for SM 335 and SM 335 has generated a diagnostics interrupt. The local data of OB 82 contains part of the diagnostics data of SM 335; refer to chapter Structure of the diagnostics data for SM 335 (Page 61).

Hardware interrupt

Two events can trigger generation of a hardware interrupt on SM 335:

- Interrupt was triggered by a comparator
- End of cycle interrupt

The event causing the interrupt on SM 335 is stored in the local data of OB 40; refer to chapter Hardware interrupt (Page 60).

Principle

You can view all diagnostics data of SM 335 by calling SFC 59. Chapter Structure of the diagnostics data for SM 335 (Page 61) provides a description of the syntax of diagnostics data.

3.4.1 Hardware interrupt

OB 40

OB 40 is called after SM 335 has generated a hardware interrupt. Information about the event causing the hardware interrupt is stored in the lo9cal data of OB 40.

Local data

The events which triggered a hardware interrupt at SM 335 are stored in byte 8 of the local data.

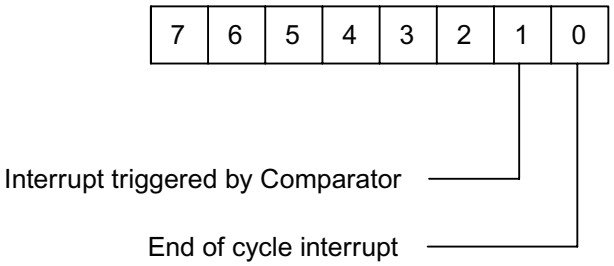

Figure 3-10 Byte 8 of local data after generation of a hardware interrupt on SM 335

Table 3- 15 End of cycle interrupt

Byte	Content
8	Cause of the hardware interrupt = 2#0000 0001
9	Number of measuring cycles[1)]
10	Not used
11	Not used

1) The number of measuring cycles can also be read from the input range ModAddr+8; refer to chapter Input values.

Table 3- 16 Interrupt was triggered by a comparator

Byte	Content
8	Cause of the hardware interrupt = 2#0000 0001
9[1)]	Comparator time [ms] The comparator time is set in byte 10 of the parameterization data set DS 1
10[1)]	Measured value low byte of Comparator 2
11[1)]	Measured value high byte of Comparator 2

1) Bytes 9 to 11 are not used for comparator mode 0

3.4.2 Structure of the diagnostics data for SM 335

Structure

After the diagnostics data set DS 1 was read by calling SFC 59, the diagnostics data of SM 335 are stored in the memory area you specified.

Table 3- 17 Diagnostics data of SM 335

Module diagnostics byte	Content	Default
0	Module diagnostics byte 0; refer to chapter Module diagnostics byte 0 (Page 62)	40_H
1	Module diagnostics byte 1; refer to chapter Module diagnostics byte 1 (Page 63)	Fixed: 35_H
2	Module diagnostics byte 2; refer to chapter Module diagnostics byte 2 (Page 64)	00_H
3	Module diagnostics byte 3; refer to chapter Module diagnostics byte 3 (Page 64)	00_H
4	Channel-specific diagnostics byte; refer to chapter Channel-specific diagnostics bytes (bytes 4 to 15) (Page 65) Channel type: 00_H (general fault), 71_H (input), 73_H (output	00_H
5	Number of diagnostics bits per channel	Fixed: 08_H
6	Number of inputs/outputs	Fixed: 08_H
7	Changes to the I/O diagnostics byte (a set bit corresponds with a change in bytes 8 to 15)	00_H
8	Channel-specific diagnostics byte for analog input CH0	00_H
9	Channel-specific diagnostics byte for analog input CH1	00_H
10	Channel-specific diagnostics byte for analog input CH2	00_H
11	Channel-specific diagnostics byte for analog input CH3	00_H
12	Channel-specific diagnostics byte for analog output CH0	00_H
13	Channel-specific diagnostics byte for analog output CH1	00_H
14	Channel-specific diagnostics byte for analog output CH2	00_H
15	Channel-specific diagnostics byte for analog output CH3	00_H

3.4.3 Module diagnostics byte 0

Structure

Module diagnostics byte 0 of SM 335 contains group error information.

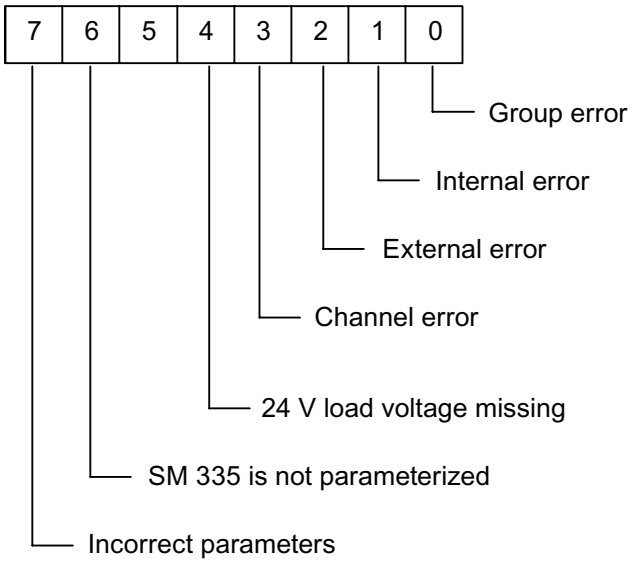

Figure 3-11 Module diagnostics byte 0

Group error

Bit 0 is et in module diagnostics byte 0 if SM 335 indicates an error (exception: SM 335 is not parameterized).

Internal error

Bit 1 is set in module diagnostics byte 0 if SM 335 indicates one of the following errors:

- Watchdog
- EEPROM error
- ADC/DAC error

External error

Bit 2 is set in module diagnostics byte 0 if one of the following errors has occurred:

- Measuring range module not inserted
- Incorrect insertion of the measuring range module (mismatch between the default parameters and the position of the measuring range module)
- External auxiliary voltage failed
- Fault at one of the inputs
  - Common mode error (ground fault)
  - Wire break
  - Measuring range overflow
  - Measuring range underflow
- Fault at one of the outputs (short-circuit to ground)

Channel error

Bit 3 in the module diagnostics byte is set after SM 335 has detected a channel-specific error at one of the channels. For more information, analyze the channel-specific diagnostics bytes (bytes 8 to 15).

24 V load voltage missing

Bit 4 is set in module diagnostics byte 0 after the 24 V load voltage has failed.

SM 335 is not parameterized

Bit 6 is set in module diagnostics byte 0 if SM 335 was not parameterized.

Incorrect parameters

Bit 7 is set in module diagnostics byte 0 if SM 335 was not parameterized correctly, i.e. mismatch between the parameters and the position of the measuring range module on SM 335. This bit is set if any errors in the parameterization are found (e.g. during the transfer of parameters by means of SFC 55 "WR_PARM" or SFB 53 "WRREC".

3.4.4 Module diagnostics byte 1

Structure

Module diagnostics byte 1 always contains the fixed value 35_H

3.4.5 Module diagnostics byte 2

Structure

Module diagnostics bytes 2 and 3 indicate error states.

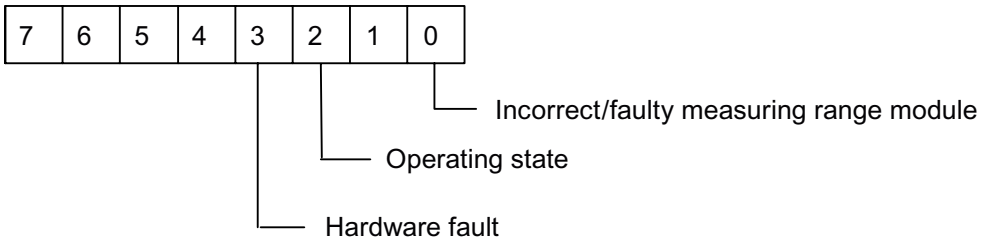

Figure 3-12 Module diagnostics byte 2

Incorrect measuring range module

Bit 0 in module diagnostic byte 2 is set if SM 335 detects a missing or incorrectly inserted measuring range module.

Operating status

Bit 2 is set in module diagnostics byte 2 if SM 335 does not have a valid parameterization.

Hardware fault

Bit 3 is set in module diagnostics byte 2 if SM 335 detects an internal hardware fault. SM 335 outputs 0 V in this case, all inputs return $7FFF_H$, and the counter input is set to FF FF FF_H.

3.4.6 Module diagnostics byte 3

Structure

Module diagnostics bytes 3 and 2 indicate error states.

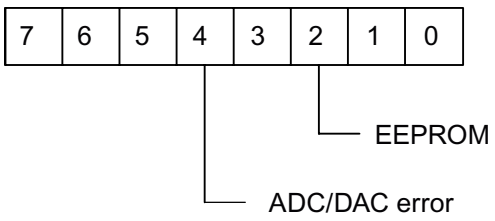

Figure 3-13 Module diagnostics byte 3

EEPROM error

Bit 2 is set in module diagnostics byte 3 if SM 335 detects an internal error in the EEPROM.

ADC/DAC error

Bit 4 is set in module diagnostics byte 3 if SM 335 detects an internal ADC/DAC error.

This error can have three causes:

- 24 V load voltage missing or less than 15 V
- EMC interference
- Internal hardware fault

3.4.7 Channel-specific diagnostics bytes (bytes 4 to 15)

Channel type (byte 4)

In byte 4 of diagnostics data SM 335 indicates the channel type which is in error state (00_H: general fault; 71_H input; 73_H output).

Channel vector (byte 7)

In byte 7 of diagnostics data SM 335 the input or output at which a channel-specific fault is active. The corresponding fault information is available in the bytes 8 to 11 (analog inputs), or in bytes 12 to15 (analog outputs).

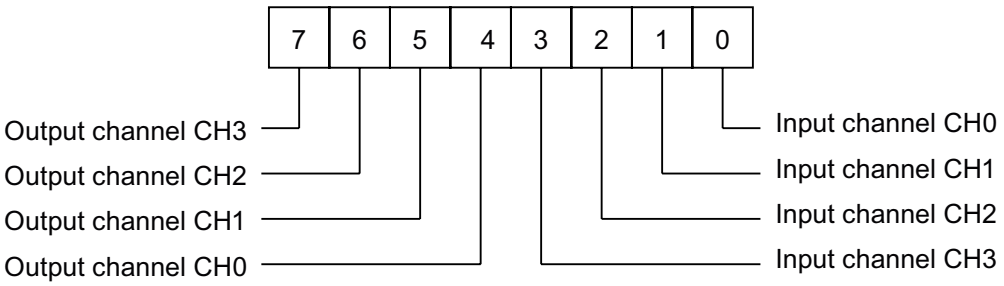

Figure 3-14 Image of changes to channel-specific diagnostic data

Note

Channel-specific faults at the analog output channels CH0 to CH3 or output in the diagnostics view of HW Config as channels CH4 to CH7.

Analog input (bytes 8 to 11)

SM 335 sets the bits in the channel specific diagnostics bytes of the inputs after it has detected a fault at one of the inputs. The channel-specific diagnostics bytes of the inputs are assigned as follows:

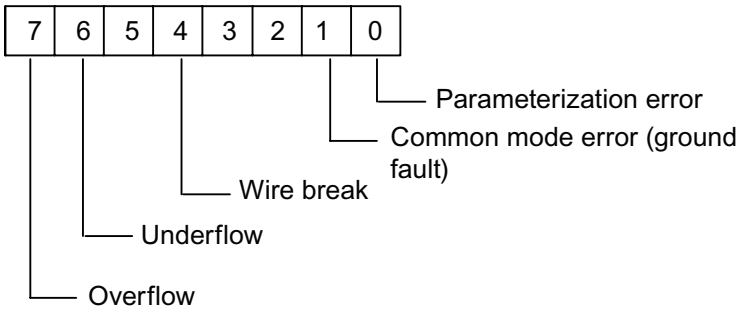

Figure 3-15 Channel-specific diagnostics byte for analog input

Note

Common mode errors are output as ground fault in the diagnostics view of HW Config.

Parameterization error (bytes 8 to 11, bit 0)

This set bit indicates a parameterization error.

Common mode error (bytes 8 to 11, bit 1)

The common mode voltage at the analog input exceeds the limit. If the common mode voltage is too high, SM 335 simultaneously sets bit 2 in module diagnostics byte 1 and the measured value to $7FFF_H$.

SM 335 resets the bit after the common mode voltage has recovered a valid value. (refer to chapter Wiring the analog inputs (Page 26): Wiring the analog inputs)

Wire-break (bytes 8 to 11, bit 4)

Bit 4 In the channel-specific diagnostics byte of the analog input is set after a wire-break has been detected at the analog input.

Underflow, overflow (bytes 8 to 11, bit 6 + 7)

The measured value at the input is checked for overflow (bit 7) and underflow (bit 6). The corresponding bit is set if the analog value is in overflow or underflow state.

Analog output (bytes 12 to 15)

SM 335 sets the bits in the channel-specific diagnostics bytes of the outputs after it has detected a short-circuit or a parameterization error at the corresponding analog output.

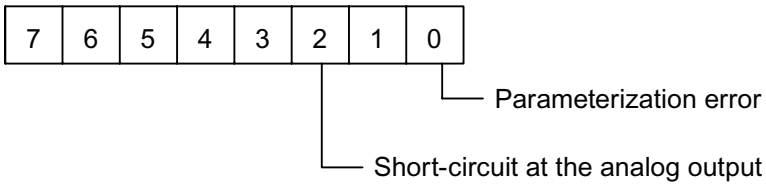

Figure 3-16 Channel-specific diagnostics byte for the analog output

Interval counter input

4

4.1 Principle of an interval counter

Introduction

The interval counter input can be used to log:

- the number of intervals
- the duration of an interval

purpose

You can use the interval counter input to measure the number and duration of intervals (continues count from 0 to 255).

This data can be used, for example, to calculate a velocity if you know the distance covered within the interval.

You can also record the signals of simple rotary encoders and determine the speed based on the interval period.

The number of intervals per time unit or the intervals for distance measurements can also be used to measure velocity.

Principle

An interval counter counts the number of time intervals. The following figure shows a simple encoder. The encoder returns signal "1" if the light falls through one of the slots in the disk. When the disk is in rotation, the encoder outputs the signal shown in the figure.

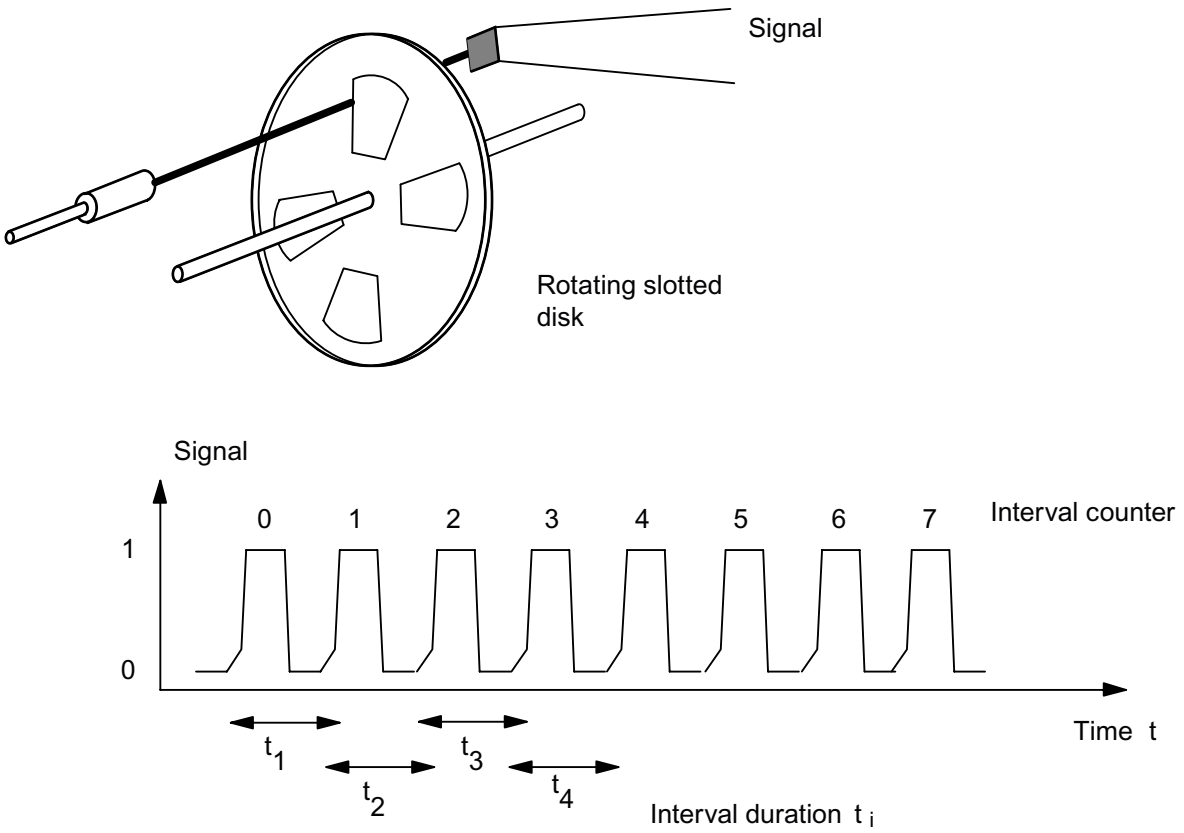

Figure 4-1 Simple encoder, e.g. slotted disk on a shaft

Interval counter

The interval counter counts the number of intervals. The first interval starts at the first signal transition from "0" to "1" (positive edge). It ends at the next positive edge. This edge also marks the start of the next interval.

Interval duration counter

The interval counter also determines the duration of an interval. A counter is started accordingly at each positive edge and is incremented by the count of 1 until the next positive edge at cyclic intervals of 0.5 µs. We refer to this counter as the interval duration counter.

4.2 Principle of measurement with the interval counter

purpose

The interval counter input is used to record the pulses generated by a simple encoder. The encoder can be attached to the extruder worm of an injection molding machine, for example. You can determine the rotational speed of the worm on the basis of the time interval between two pulses.

Principle

SM 335 measures the time interval between 2 pulses. SM 335 determines the time interval at a resolution of 0.5 µs. The number of intervals measured is also counted.

You can calculate the rotary speed of the extruder worm if you know the number of pulses output by the encoder at each revolution of the extruder worm.

Example

N = 16 pulses are output at each revolution of the extruder worm (N is also referred to as the pulse rate of the encoder). The interval between 2 pulses is equivalent to 50,000 increments of the interval duration counter. The rotational speed of the extruder worm is then calculated as follows:

$$v = \frac{1}{T \cdot N} = \frac{1}{50000 \cdot 0{,}5\ \mu s \cdot 16} = 2{,}5\,\frac{U}{s} = 150\,\frac{U}{min}$$

Lower limit

The interval duration counter returns a 3-byte count value. Those 3 bytes can be used to represent values up to FF FF FF_H (decimal 16777215). The lower limit frequency is derived accordingly for N = 1:

$$v = \frac{1}{T \cdot N} = \frac{1}{16777215 \cdot 0{,}5\ \mu s} = 0{,}1192\ \frac{1}{s} = 7{,}15\,\frac{U}{min}$$

Upper limit

The upper limit frequency is calculated based on the condition of a minimum interval of 2.5 ms between two positive edges. The result is an upper limit frequency of 400 Hz (equivalent to 24000 rpm).

The high and low levels must be active for a minimum duration of 1 ms.

Those limits apply to encoders which return one pulse per revolution. If using encoders which output more than one pulse per revolution, you will have to reconsider the limit frequencies. Some examples are listed in the table below.

Table 4- 1 Limits for different pulse rates N

N	Lower limit	Upper limit
1	7.15 rpm	24000 rpm
4	1.79 rpm	6000 rpm
8	0.89 rpm	3000 rpm
16	0.45 rpm	1500 rpm

4.3 Wiring the interval counter input

Principle

The figure below shows how to wire a switch to the interval counter input. The switch is actuated by a cam disc. The cam disc is mounted on a rotary shaft, for example, on the extruder worm of an injection molding machine.

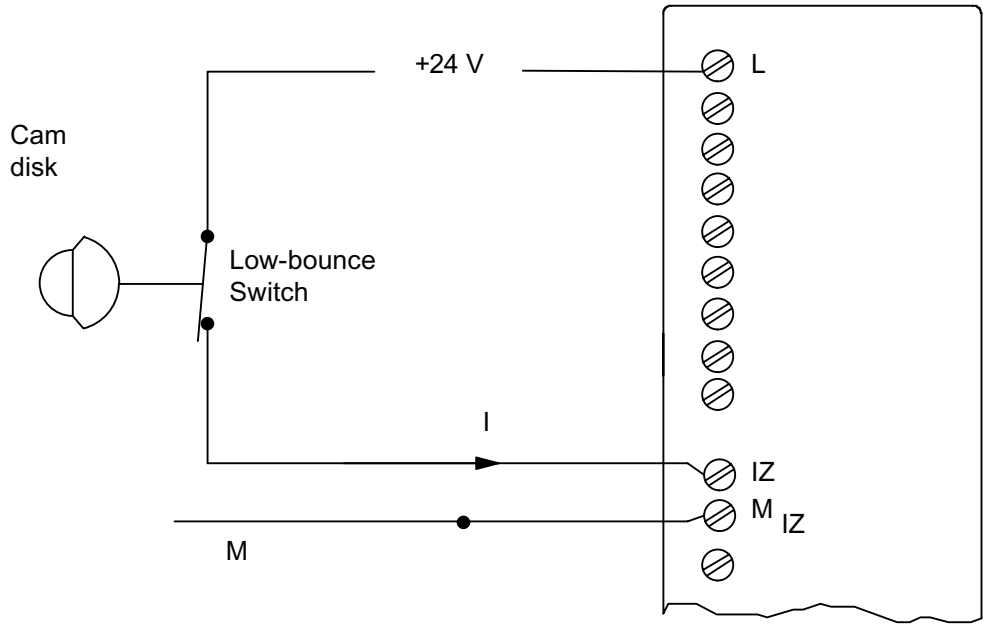

Figure 4-2 Wiring the encoder to the interval counter input

Power supply

You must connect the interval counter input to a 20 V power supply. It is recommended to use the 24 V load voltage supply.

Current

The current flow on a signal line with ’1’ state (connected to + 24 V) must have a minimum value of 2.5 mA and a maximum of 4.4 mA.

You must observe this minimum current to make allowances for a certain voltage drop, for example, if using an electronic proximity switch switch instead of the mechanical, low-bounce switch shown in the drawing above. You'll have to observe the maximum current if compensating for this voltage drop with a voltage higher than 24 V.

Cables

Always used shielded, twisted-pair cables. Interconnect the cable shield with the grounded rack via the shield connection element similar to the other analog cables.

Switch

The switch of the cam disc must be capable of operating at an opening and closing ratio of 1 ms at the highest speed.

Grounding

The interval counter input is electrically isolated from all other terminals to prevent the generation of ground loops.

To provide a reference potential for the interval counter input, it is sufficient to connect the input to the 24 V load voltage which is connected to ground potential; refer to the SIMATIC S7-300, Hardware and Installation (http://support.automation.siemens.com/WW/view/en/13008499) Operating Instructions.

4.4 Parameterizing the interval counter input of SM 335

Parameterization

You can operate into a counter on SM 335 without specific parameterization. The pulse input operates independent on the parameterization of the other analog channels. That is, you do not have to parameterize the pulse input You can add a timeout parameter for the external counter.

Monitoring time

The interval duration is initialized with the value $FFFFFF_H$ on expiration of the monitoring time. This setting allows the early detection of failures (without delay of 8.3 seconds).

The monitoring time is calculated as follows:

$$\text{Monitoring time} \quad \frac{8.388}{256} \cdot \text{Byte 13 of DS 1 [unit/seconds]}$$

Special case: The '0' value is equivalent by default to 8.388 seconds.

Examples:

- Byte 13 (DS1) = 1 → monitoring time = 0,032765625 seconds
- Byte 13 (DS1) = 2 → monitoring time = 0.06553125 seconds

4.5 Values of the interval counter

Address

The pulse input values determined by SM 335 or saved to memory starting at the I/O address ModAddr + 12.

Table 4- 2 Values of the pulse input

MOD address	Content
+12	Interval counter
+13	Interval duration byte 1
+14	Interval duration byte 2
+15	Interval duration byte 3

Interval counter (ModAddr + 12)

The interval counter is a continuous counter with a range from 0 to 255. The counter is initialized internally after the first pulse is detected. The interval counter is incremented by the count of "1" at the second pulse input. The interval counter is incremented by the count of "1" at every further pulse input.

SM 335 saves the currently detected intervals to the data byte at the address "ModAddr + 12". The value is '0' as long as no interval was detected. The interval counter is incremented by the count of "1" at each detected pulse.

Interval counter (ModAddr + 13...15)

Within the duration of an interval, SM 335 counts the time up to the end of the interval in time slices of 0.5 µs. SM 335 saves the value for the interval duration to 3 bytes starting at ModAddr + 13. The value of "Module start address + 13" is greater than the value of "Module start address + 14" byte. "Module start address + 15" byte has the lowest value.

Overflow

SM 335 interprets an interval with a duration greater than 16777215 (FF FF FF_H) times 0.5 µs (8.3886075 s) as overflow and no longer as interval. The value for the interval duration freezes at "FF FF FF_H" and the interval counter is incremented by the count of "1". A new interval starts at the next pulse input. The internal duration is measured once again. The interval counter is incremented again by the count of "1" if a valid interval is measured at the next pulse input.

4.6 Example of a speed calculation using the interval counter

Requirements

Let us assume the SM 335 is inserted in slot 4 and assigned module start address 256. The pulse counter input receives its pulses from an encoder which is attached to the extruder worm. The encoder returns 16 pulses per revolution.

Procedure

Proceed as follows:

1. Read the value from the module.
2. Calculate the rpm of the extruder worm.

Calculating the interval duration

For consistent access to the data of the pulse input the interval counter and interval duration must be read by means of double word access. (Address: module address + byte 12, 13, 14, 15). You then have to clear byte 12 to obtain the interval duration value in Dword format.

Example:

Interval generation = 00 00 A7 $F8_H$, equivalent to decimal 43000

The number of intervals are stored in the byte (ModAddr + 12).

Calculating the speed

N = 16 pulses are output at each revolution of the extruder worm (N is also referred to as the pulse rate of the encoder). The interval between two pulses had a duration of 43000 x 0.5 µs. The rotational speed of the extruder worm is then calculated as follows:

$$v = \frac{1}{T \cdot N} = \frac{1}{43000 \cdot 0{,}5\ \mu s \cdot 16} = 2{,}907\ \frac{U}{s} = 174{,}4\ \frac{U}{min}$$

Special operating modes of SM 335

5

Definition

SM 335 supports two special operating modes:

- "Comparator" and
- "Measuring Only" mode

Comparator

If special mode "Comparator" is set, SM 335 compares an analog value with the analog value measured at one of the analog inputs.

In this mode SM 335 behaves similar to a comparator. This facilitates particularly short reaction times on violation of the parameterized limits.

Measuring only

In the special mode "Measuring Only", SM 335 performs continuous measurements without updating the analog outputs. This facilitates particularly short cycle times for the recording of analog inputs.

5.1 Switchover to the special operating modes

Dynamic measuring cycle control

To switch to one of the special operating modes, you must set the corresponding check bits in data set 1, byte 11 and then transfer the entire data set 1 to the CPU by calling SFC 55 "WR_PARM" or SFB 53 "WRREC"; refer to chapter Modifying SM 335 parameters in RUN (Page 47) .

Note

A special operating mode can only be activated after the previously called special operating mode has been terminated. If this rule is ignored, the diagnostics function reports and internal error.

Comparator (DS1, byte 11)

To enable the special mode "Comparator", you must transfer all parameters for SM 335 and set the bits 4, 5 and 7 in byte 11:

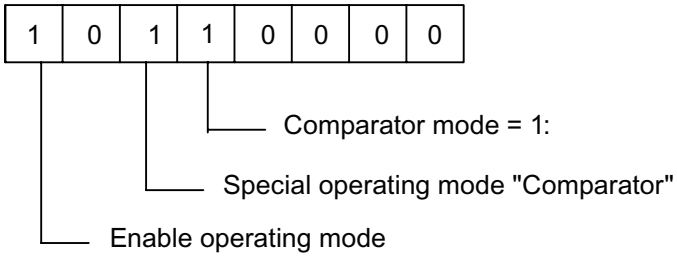

Figure 5-1 Dynamic measuring cycle control for the special mode "Comparator"

Measuring Only (DS1, byte 11)

To enable the special mode "Measuring Only", you must transfer all parameters for SM 335 and set bit 6 and 7 in byte 11:

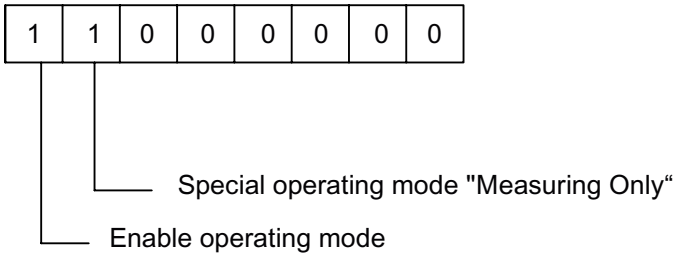

Figure 5-2 Dynamic measuring cycle control for the special mode "Measuring Only"

5.2 Special operating mode "Comparator"

Introduction

In certain scenarios it may be necessary to read an analog value more than once to allow for high-speed response to a specific limit situation. The speed of standard procedure of control systems is unsatisfactory, i.e. the time it takes to read the signal, processing it in the CPU and to output the response is too long. SM 335 provides a special operating mode that resolves this problem, namely the special operating mode "Comparator".

Definition of a comparator

Comparator compares values. That is, it compares the measured analog values with the default analog value (reference value). The comparator triggers a specific reaction if the measured analog value reaches the reference value.

You can define a reference value for each one of the two comparators.

Two comparators

In the special operating mode "Comparator" you can use two comparators which have different properties.

Comparator	Measures	End of cycle interrupts	On reaching the reference value
1	Analog input Comparator 1	are generated continuously	• the SM 335 outputs the default analog values to three analog outputs • generates a hardware interrupt • SM 335 switches to the "conditional cycle" or "free cycle" mode or • changes over to comparator 2
2	Analog input Comparator 2	are suppressed	• the SM 335 outputs the default analog values to three analog outputs • generates a hardware interrupt • writes the number of suppressed end of cycle interrupts • returns to the "conditional cycle" or "free cycle" mode

For more information about the parameterization for the "Comparator" mode, refer to chapter SM 335 parameters for the special mode "Comparator" (Page 53).

5.2.1 Principle of the special operating mode "Comparator"

Three options

The operating mode offers three options of comparing the measured with the default analog value:

- Comparator 1: Measuring at the parameterized inputs similar to standard mode. Simultaneous comparison with a reference value at the comparator input; a process interrupt is generated and the default analog values are output after the reference value has been reached. With Comparator 1 you can access the analog inputs by means of PEW.
- Comparator 2: Measurements only at the comparator input; a process interrupt is generated and the default analog values are output after the reference value has been reached. Access to the value of the input for Comparator 2 is not supported.
- Connecting Comparator 1 and Comparator 2 in series. With this configuration, Comparator 1 does not generate a process interrupt, does not output any analog values, and changes over to Comparator 2.

Comparator 1

The following figure shows how Comparator 1 works:

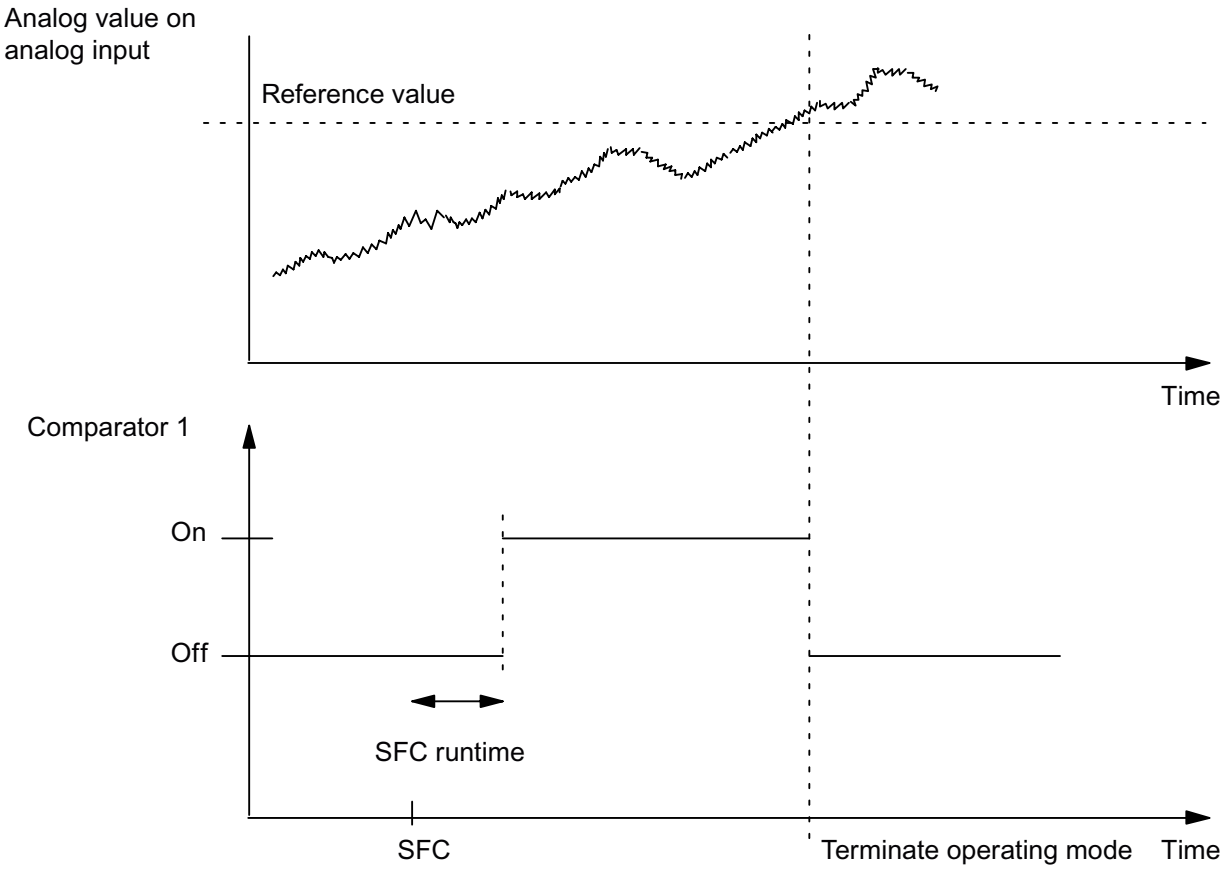

Figure 5-3 Operating principle of Comparator 1

After you called SFC 55, switched SM 335 to the special operating mode "Comparator" and enabled only Comparator 1, SM 335 compares the analog value at the specified input with the reference value.

The module continues to update the analog inputs which can be read by means of PEW.

SM 335 terminates the special operating mode "Comparator" after the specified analog value has been reached.

After having terminated the special operating mode "Comparator", SM 335 outputs the analog values specified in SFC 55. SM 335 outputs these analog values until you write a new analog value to the SM 335. The new analog value must differ at least by one bit from the analog value which was output prior to activation of the special operating mode "Comparator".

Note

Comparator 1 does not operate at the cycle time time of 1 ms.

Comparator 2

The following figure shows how Comparator 2 works:

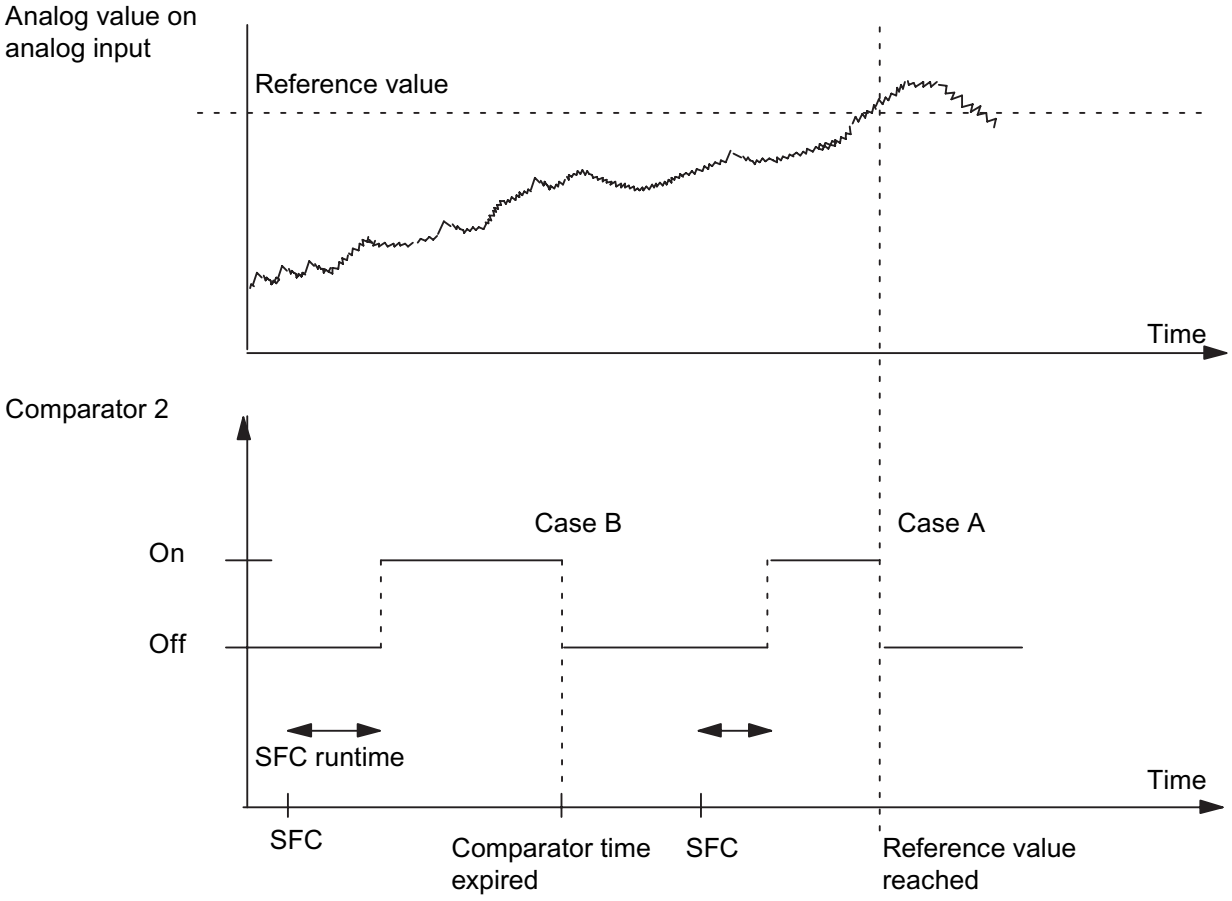

Figure 5-4 Operating principle of Comparator 2

Case A: Reference value reached

As soon as the measured analog value has reached the reference value, SM 335

- generates a process interrupt
- writes the specified analog values to the specified analog outputs
- writes the number of failed end of cycle interrupts to the input value area (byte ModAddr + 8)
- terminates the special mode "Comparator".

After having terminated the special operating mode "Comparator", SM 335 outputs the analog values specified in SFC 55. SM 335 outputs these analog values until you write a new analog value to the SM 335. The new analog value must differ at least by one bit from the analog value which was output prior to activation of the special operating mode "Comparator" (refer to the tip at "Reaction to case A and B).

Case B: Comparator time expired

SM 335 remains in special operating mode "Comparator" until the reference value has been reached, or the comparator time has expired. If the reference value has not been reached on expiration of the comparator time, SM 335 terminates the special operating mode "Comparator" and returns to the free cycle or conditional cycle mode without modifying the analog outputs.

Reaction for case A and B

After you called the SFC which has switched SM 335 to the special mode "Comparator" and only enabled Comparator 2,

- SM 335 only performs measurements at one analog input (at the highest rate possible)
- suppresses and includes the count of the end of cycle interrupts
- compares the measured value with the reference value.

Tip: To output the analog value which was output prior to activation of the special operating mode "Comparator", change the least significant bit in the binary notation of the analog value accordingly This does not have any effect on the output analog value, because the least significant bit is truncated. However, SM 335 interprets the new binary notation as the new analog value.

Note

The analog inputs of SM 335 are not yet updated after the special operating mode "Comparator" with Comparator 2 has been terminated. The analog inputs are not updated until the next measuring cycle of SM 33 has been started.

Remedy: Do not read the values from the analog inputs until the next end of cycle interrupt has been cleared.

Comparator 1 and 2

The following figure shows how SM 335 works with two enabled comparators:

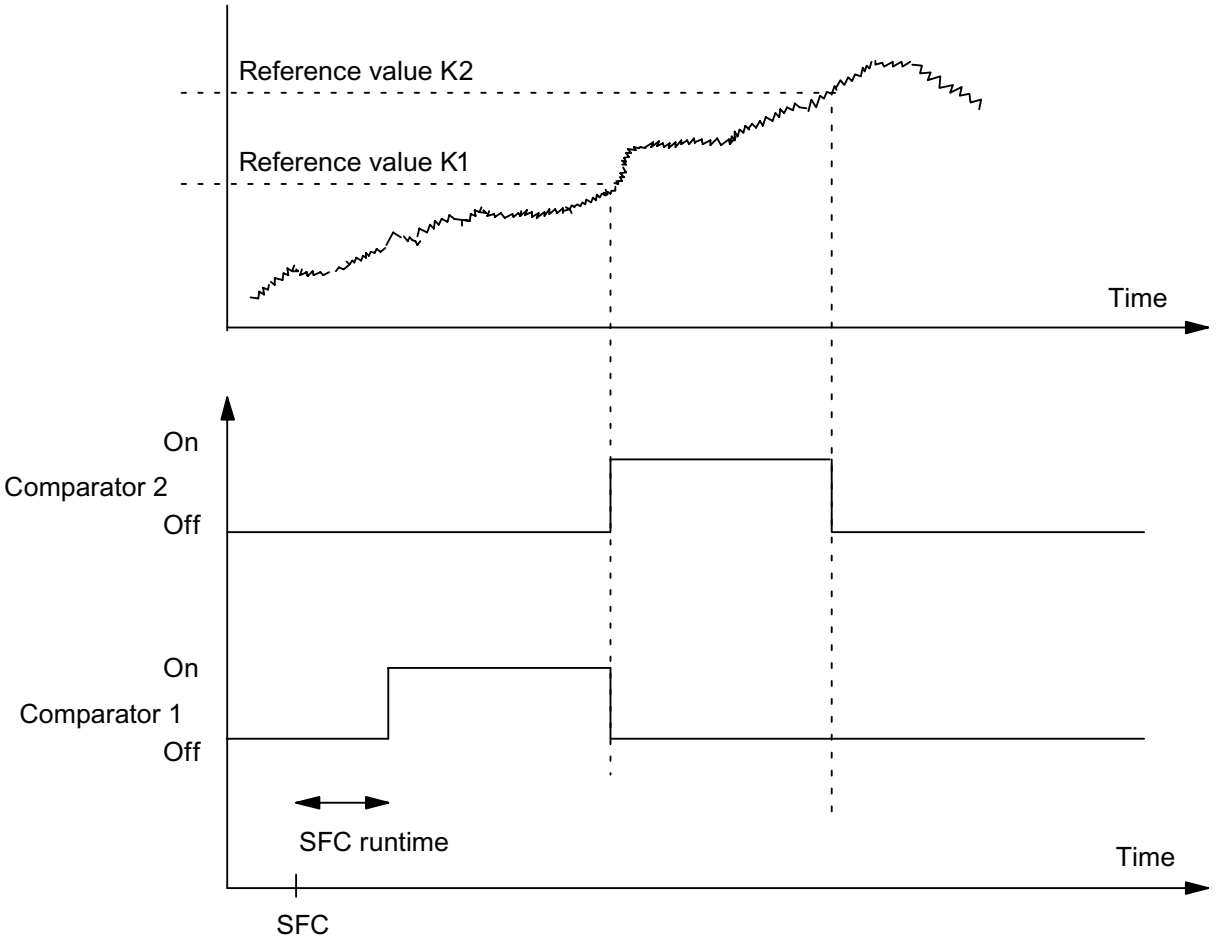

Figure 5-5 Comparators 1 and 2 wired in series

Operation with Comparator 2

The analog inputs at controller side are not updated during the runtime of Comparator 2. The module is operating in standalone mode.

Message by means of return code of SM 335; refer to the table in chapter Input values (Page 35) for information about the bits in the return code of SM 335.

Application

The following figure shows an application for the comparator function.

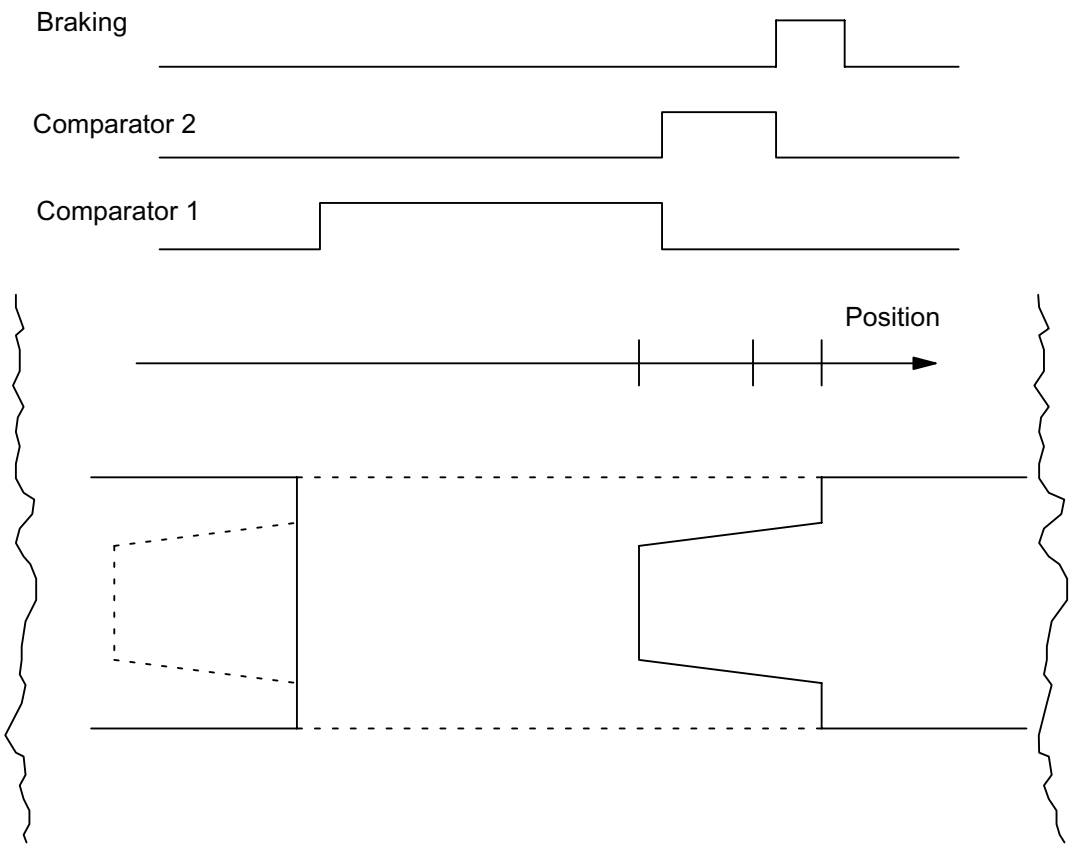

Figure 5-6 Application for the special operating mode "Comparator"

A form/mold is being closed. This closing motion must be carried out at a high speed. The tool position is detected by means of a linear potentiometer, for example SM 335 measures the analog signal of the linear potentiometers.

Simultaneously with the closing of the form/mold, SM 335 is switched to the special operating mode "Comparator", whereby Comparator 1 and 2 are wired in series.

While the form/mode is being closed, Comparator 1 compares the measured analog value with the reference value for Comparator 1. This analog value is reached at a certain position of the form/mold. SM 335 now enables Comparator 2 and only continues measurements at this analog input. The measured analog value reaches the reference value for Comparator 2 just before the form/mold has been closed. A process interrupt is generated. You can initiate the breaking motion in the interrupt OB. To obtain still more speed, enter an analog value which is output at one of the analog outputs of SM 335. Using this analog output you can directly control the drive for the form/mold motion. This method lets you achieve fast closing motions and reproducible, high-speed braking actions.

5.2.2 SM 335 parameters for the special mode "Comparator"

Restriction

The parameters for the special operating mode "Comparator" can only be transferred by means of SFC 55 WR_PARA.

Data set 1

The parameters which you can toggle dynamically are stored in data set 1 of SM 335.

Table 5- 1 Data set 1 of SM 335 for the special mode "Comparator"

Byte	Content
0	Analog value 1 high byte to be output
1	Analog value 1 low byte to be output
2	Analog value 2 high byte to be output
3	Analog value 2 low byte to be output
4	Analog value 3 high byte to be output
5	Analog value 3 low byte to be output
6	Reference value "Comparator 1" high byte
7	Reference value "Comparator 1" low byte
8	Reference value "Comparator 2" high byte
9	Reference value "Comparator 2" low byte
10	Comparator time
11	Dynamic measuring cycle control
12	Comparator - check byte
13	Reserved

Comparator time (DS1, byte 10)

SM 335 cannot generate a process interrupt for the end of the cycle while comparator 2 mode is enabled. It can therefore happen that SM 335 does not generate an end of cycle interrupt for a longer time. You can define the maximum comparator activation time by setting the comparator time. After the active comparator time has expired, SM 335 automatically returns to the "conditional cycle" or "free cycle" mode. Define the comparator time in milliseconds (1 = 1 ms, 2 = 2 ms, up to 0 = 256 ms).

The set comparator time is reported in the local data of OB 40, provided SM 335 has generated a corresponding process interrupt. (refer to table 'Interrupt table triggered by the comparator' in chapter Hardware interrupt (Page 60).

Dynamic measuring cycle control (DS1, byte 11)

The dynamic measuring cycle check byte is assigned as follows in the special operating mode "Comparator 1":

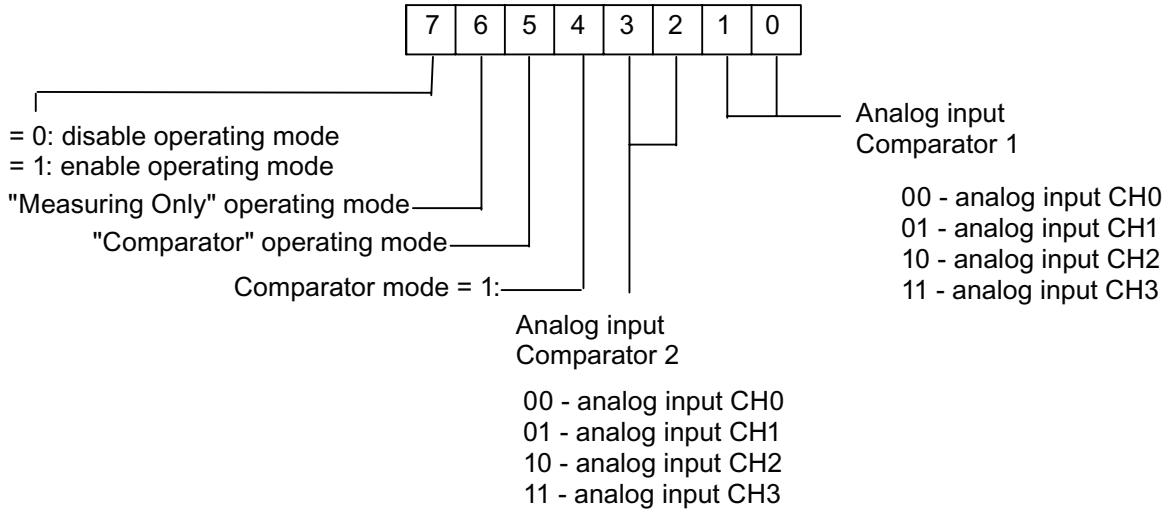

Figure 5-7 Meaning of the bits in the " dynamic measuring cycle control" byte (comparator)

The "dynamic measuring cycle control" byte has several functions.

- Enabling the special operating mode "Measuring Only"
- Enabling the special operating mode "Comparator"
- Comparator assignment

Comparator check byte (DS1, byte 12)

The comparator can also be monitored in the comparator check byte: The comparator check byte has the following structure:

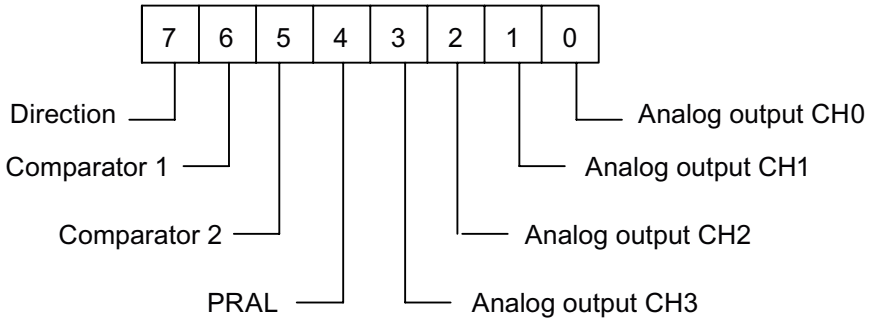

Figure 5-8 Comparator check byte for the special mode "Comparator"

Direction (DS1, Bit 12.7)

If bit 7 of the comparator check byte is set to '0', the comparison is carried out in direction of ascending analog values; refer to the figure above. If bit 7 is set to ’1’, the comparison is carried out in direction of descending analog values.

PRAL (DS1, bit 12.4)

SM 335 generates a process interrupt at the switchover point after you set bit 4 of the comparator check byte to ’1’.

Analog output (DS1, bits 12.3 to 12.0)

Use bits 0 to 3 of the comparator check byte (DS1, byte 12, see the figure above) to specify at which outputs the analog values defined in DS1 (bytes 0 to 5 in the table of data set 1 of SM 335 for the special operating mode "Comparator") are to be output.

- Bit i = ’1’: the specified value is output
- Bit i = 0: the old analog value is retained

You can set up to 3 bits. The analog values are output until a new value is written to the output.

Comparator 1 and Comparator 2 (DS1, bits 12.6 to 12.5)

The comparator 1 and 2 bits are used to enable comparator 1 and 2.

Table 5- 2 Checking comparator with check bits 1 and 2

Bit 6	Bit 5	Behavior of the comparator
1	1	Enabling comparators 1 and 2 in succession
0	1	Enabling comparator 1
1	0	Enabling comparator 2
0	0	The special operating mode "Comparator" is terminated immediately.

Measured value Comparator 2

The measured value of Comparators 2 can be read from the local data of OB 40. (bytes 10 and 11, refer to the 'Interrupt triggered by the comparator' section in chapter Hardware interrupt (Page 60).

5.3 Special "Measuring Only" mode

Disabling outputs

If operating the special mode "Measuring Only" is set, SM 335 only measures the analog inputs within the free cycle without updating the analog outputs. The analog outputs retain their last analog value for a certain time in accordance with the number of active analog inputs.

Number of active analog inputs	Output of the updated analog after
1	Approx. 78 ms
2	Approx. 66 ms
3	Approx. 52 ms
4	Approx. 47 ms

Note

- The watchdog is disabled while SM 335 performs continuous measurements. This state could prevent the detection of internal module faults.
- Interrupts are not generated in this operating mode (no diagnostics / process interrupts)
- A new analog value is output on expiration of the time.

purpose

You can use the special operating mode "Measuring Only" for high-speed successive reading of the values from an analog input in order to obtain current analog values for a short period of time (T_A <0.5 ms). After time has expired, SM 335 returns to the previously parameterized operating mode.

5.3.1 Changing over to the special operating mode "Measuring Only"

Restriction

The parameters for the special operating mode "Measuring Only" can only be transferred to SM 335 by way of SFC 55 WR_PARA. All parameters must be transferred simultaneously.

Data set 1

Transfer the dynamic parameters of SM 335 for the special operating mode "Measuring Only" in data set 1.

Note

The data set 1 parameters you transfer in order to change over to the "Measuring Only" mode must be identical with the parameters you transferred for the "free cycle" or "conditional cycle" mode, with the exception of byte 11.

Table 5- 3 Data set 1 of SM 335 for the special mode "Measuring Only"

Byte	Content
0	Assigned as defined in chapter SM 335 parameters for the free and conditional cycle modes (Page 49)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	Dynamic measuring cycle control
12	Assigned as defined in chapter SM 335 parameters for the free and conditional cycle modes (Page 49)
13	

Dynamic measuring cycle control (DS1, byte 11)

Byte 11 of "dynamic measuring cycle control" is assigned three functions:

- Enabling the special operating mode "Measuring Only"
- Enabling the special operating mode "Comparator"
- Enabling / disabling analog inputs

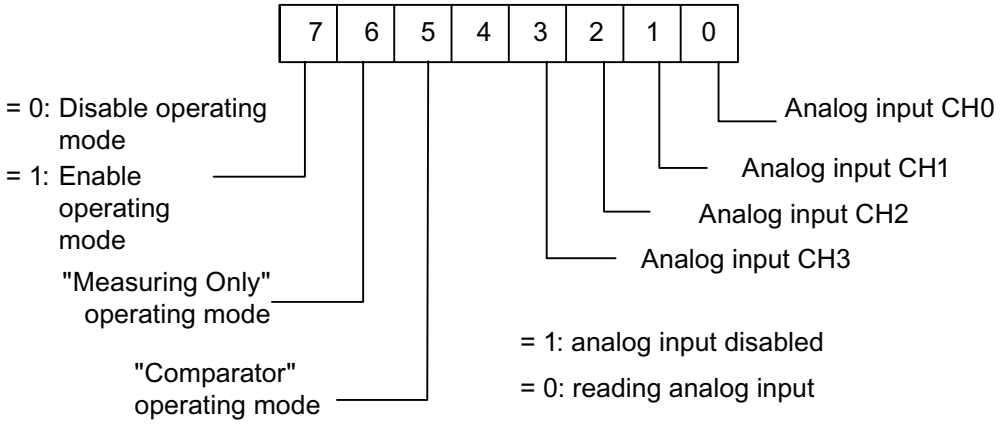

Figure 5-9 Meaning of the bits in the "dynamic measuring cycle control" byte (Measuring Only)

Enabling an operating mode

Set bits 7 and 6 to ’1’ to enable the "Measuring Only" mode. Set bits 4 and 5 to '0'.

Disabling analog inputs dynamically

Use bits 0 to 3 to disable the assigned analog input. Bits 0 to 3 are set to ’0’ by default. An analog input is not processed if you set its bit to ’1’. You can achieve a measuring cycle time < 0.5 ms by disabling three analog inputs.

Troubleshooting

6

6.1 Principle of diagnostics

SM 335 is capable of detecting faults at the I/O. You can react to such faults. Use the features of SIMATIC S7-300 accordingly.

The SF LED is lit on SM 335 and on the CPU if SM 335 is in error state. (Requirements: diagnostics was enabled.)

Parameterizing diagnostics

If you enabled the diagnostics interrupt of SM 335, an entry is made in the diagnostics buffer of the CPU if an error state is detected. This includes generation of a diagnostics interrupt and a call of the diagnostics OB (OB 82) in the CPU. For information on parameterizing SM 335 in HW Config, refer to chapter SM 335 parameters which can be set up in HW Config (Page 45).

You can also enable certain diagnostics parameters during the transfer of parameters by calling SFC WR_PARA. The description of SM 335 parameters is available in chapter SM 335 parameters for the free and conditional cycle modes (Page 49).

Diagnostics buffer

The diagnostics buffer is a backed up memory area on the CPU to which diagnostic events are saved in the order of their occurrence. In STEP 7 (PLC → Module status), the user can read data from the diagnostics buffer to determine the precise cause of error.

Diagnostics OB 82

SM 335 generates a diagnostics interrupt if this function is enabled. Diagnostics OB (OB 82) is called in the CPU after a diagnostics interrupt was generated. You can program a fault reaction in OB 82.

The procedure for reading diagnostic data in OB 82 is described in chapter Evaluating diagnostics data in OB 82 (Page 94).

Syntax of the diagnostics data

You can use SFC 59 to read the diagnostics data off SM 335. For information about the syntax of diagnostics data, refer to chapter Structure of the diagnostics data for SM 335 (Page 61).

Advantage of the diagnostics interrupt

OB 82 is called automatically if you enabled the diagnostics interrupt. OB 82 returns the module start address in the local data.

Disadvantage of the diagnostics interrupt

OB 82 interrupts the user program. The time required to execute OB 82 could prolong the reaction time for time sensitive program elements. This problem can be resolved by retrieving only the module start address in OB 82 and evaluating the diagnostics data in OB 1.

6.2 Setting up diagnostics in HW Config

Setting

Parameterize the required diagnostic messages using the STEP 7 tool "HW Config" (refer to the Programming with STEP 7 (http://support.automation.siemens.com/WW/view/en/18652056)) Manual.

Enabling diagnostics

SM 335 can determine various diagnostics events for the I/O and report them to the CPU.

The diagnostics function must be enabled to execute it on the CPU and to enter the diagnostic data in the diagnostics buffer. The enable only applies to the relevant channel group you set.

SM 335 generates a diagnostics message for the following events:

Table 6- 1 Diagnostics messages of SM 335

Diagnostics messages for inputs	Message is output
Parameterization error	Always
External 24 V auxiliary supply missing	Always
Common mode error	Always
Wire break	Only if parameterized
Measuring range undershoot	Only if parameterized
Measuring range overshoot	Only if parameterized

Diagnostics message for outputs	
Short-circuit at output	Always

Wire break

Used the wire-break check to detect a wire break either at the encoder or at its connecting cable. The wire-break check is possible in the measuring ranges 4 to 20 mA and 0 to 10 V. SM 335 reports a wire-break in the 4 to 20 mA range in the current to be measured is less than 1.185 mA. This action triggers a diagnostic message and the ID $7FFF_H$.

Measuring range 0 to 10 V

The wire-break check in the 0 to 10 V input measuring range is based on a different mechanism. The wire-break check is executed after the A/D conversion has been completed at the active analog inputs. Short current pulses with an amplitude of approx. 30 µA power output at the relevant input. SM 335 can detect a wire-break based on the voltage difference generated by this process.

This kind of wire-check can only function if the capacitance of the connecting cable and of the connected encoder is not greater than 10 nF. Cable lengths up to 30 m are generally non-critical. The source resistance must must be greater than 2.5 kohm to prevent the possible generation of a wire-break message.

This is ensured, for example, by connecting a linear potentiometer of max. 10 kohm. (In center position of the wiper both 5 kohm sections form a parallel resistance circuit of 2.5 kohm.)

Diagnostics interrupt enable

The module triggers a diagnostics interrupt if the "Diagnostics interrupt" check box is selected and a diagnostics event occurs. It is also possible to enable or disable the diagnostics functions for specific channels (refer to 'Diagnostics messages of SM 335' table). The CPU calls OB 82 after SM 335 has triggered a diagnostics interrupt.

Note

It it is possible to parameterize diagnostics monitoring functions in HW Config

(e.g. wire break), which, however, disable diagnostics interrupts. A change to diagnostics data always leads to a change of data set 1 which can always be read, independent of the parameterization.

6.3 Evaluating diagnostics data in OB 82

Procedure

You are provided with certain simple mechanisms to access the diagnostics data. The basic procedure is as follows:

1. SM 335 detects a fault and outputs a diagnostic interrupt to the CPU.

2. The CPU reads the diagnostics data from the SM 335

3. Calls diagnostics interrupt OB 82.

Information about the fault is stored in the local data of OB 82. The local data also returns the address of the module that triggered the diagnostics event.

4. You call SFC 59 based on the information from local data of OB 82.

5. With SFC 59 "RD_REC" (read record), you read out the data set DS1 to obtain the channel-specific diagnostics information (refer to chapter Structure of the diagnostics data for SM 335 (Page 61))

You can react to the fault in your program with the help of the diagnostics data.

6.4 Error tree of SM 335

Reading help

You can read the error tree for SM 335 as follows: You can detect an error event by evaluating bit 0 in module diagnostics byte 1.

1. Check whether bit 0 is set in module diagnostics byte 1.
2. If bit 0 is set in module diagnostics byte 1, check the bits indicated by the arrows from module diagnostics byte 1 bit 0.
3. If a bit is set, follow the arrows again from this bit and check which one of the bits is set, and so forth.
4. The table below provides an error description for the corresponding bit.

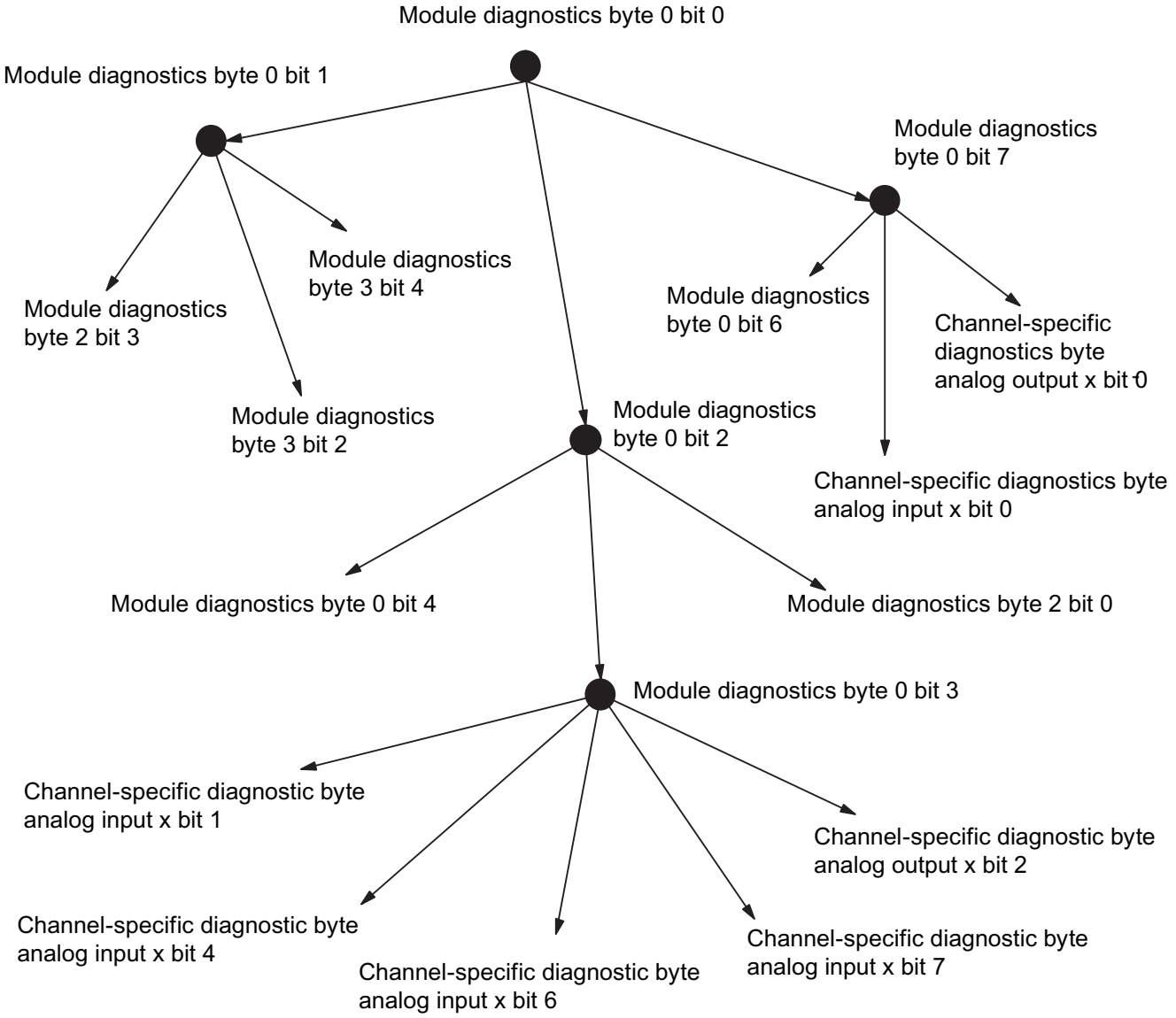

Figure 6-1 Error tree of SM 335

6.5 Troubleshooting

Overview

If you want to evaluate the diagnostic data in a program, the following table helps you to associate the bits set in the diagnostic data with corresponding error descriptions and troubleshooting measures.

Table 6- 2 Faults and troubleshooting on SM 335

Bits set	Error description	Troubleshooting
Module diagnostics byte 0 bit 1 AND module diagnostics byte 2 bit 3	Internal hardware fault The module outputs 0 V; Inputs are set to $7FFF_H$, count value = $FFFFFF_H$	Module failure. Note down the error description and contact your SIEMENS partner.
Module diagnostics byte 0 bit 1 AND module diagnostics byte 3 bit 2		
Module diagnostics byte 0 bit 1 AND module diagnostics byte 3 bit 4	ADC/DAC error The corresponding channel is set to $7FFF_H$ or 0 Volt. Possible cause of error: • 24 V load voltage missing, or less than 10 V • Measuring signal superimposed by RF interference • ADC module failure	1. Check the load voltage 2. Check the input signal for RF elements. You might have an EMC problem 3. Submit the module for inspection or repair.
Module diagnostics byte 0 bit 2 AND module diagnostics byte 0 bit 4	24 V load voltage missing, or less than 10 V; input values are set to $7FFF_H$	Check the load voltage
Module diagnostics byte 0 bit 2 AND module diagnostics byte 0 bit 3 AND channel specific diagnostics byte Analog input x bit 1	Common mode error at input x	Check the input x connection
Module diagnostics byte 0 bit 2 AND module diagnostics byte 0 bit 3 AND channel specific diagnostics byte Analog input x bit 4	Wire break at input x	
Module diagnostics byte 0 bit 2 AND module diagnostics byte 0 bit 3 AND channel specific diagnostics byte Analog input x bit 6	Overflow at input x	The error disappears if the input voltage is within the rated or overshoot range
Module diagnostics byte 0 bit 2 AND module diagnostics byte 0 bit 3 AND channel specific diagnostics byte Analog input x bit 7	Underflow at input x	
Module diagnostics byte 0 bit 2 AND module diagnostics byte 0 bit 3 AND channel specific diagnostics byte Analog output x bit 2	Short-circuit to ground at output x	Check the output x connection
Module diagnostics byte 0 bit 1 AND module diagnostics byte 2 bit 0	Measuring range module in incorrect position or missing.	Verify the correct position of the measuring range module and check whether this position agrees with the parameter settings.

Bits set	Error description	Troubleshooting
Module diagnostics byte 0 bit 7 AND module diagnostics byte 0 bit 6 (Module diagnostics byte 0 bit 0 = '0')	Module is not parameterized. SM 335 operates with default parameters (no process interrupt or diagnostics interrupt).	Parameterize SM 335.
Module diagnostics byte 0 Bit 2 AND channel-specific diagnostics byte analog output x bit 0 Channel-specific diagnostics byte Analog input x bit 0	Incorrect parameters at channel x SM335 reports the channel which has incorrect channel-specific parameters.	Revise the parameterization of SM 335.

List of abbreviations

A

A.1 List of abbreviations

Abbreviations	Explanations
AC	Alternating current
ADC	Analog-to-Digital Converter
AI	Analog input
AO	Analog output
ASS	Outputs off power
CPU	Central Processing Unit of the PLC
DAC	Digital-to-Analog Converter
DB	Data block
DC	Direct current
EMC	Electromagnetic Compatibility
EPROM	Erasable Programmable Read-Only Memory
L+	Power supply 24 VDC
KLV	Keep last valid value
M	Ground
M+ / -	Measuring line (positive / negative)
M_{ANA}	Reference potential of the analog measuring circuit
OB	Organization block
SF	Error LED, *Group error*
SFB	System function block
SFC	System function
SM	Signal module
CMV	Common Mode Voltage

Glossary

2-/3-/4-wire connection

Methods of connecting resistance thermometers / resistances to the front connector of the module, or loads to the voltage output of an analog input module.

2-wire transducer (passive sensor) / 4-wire transducer (active sensor)

Type of transducer (2-wire transducers: power supply via terminals of the analog input module; 4-wire transducers: power supply via separate terminals of the transducer.)

Address

Represents the identifier of a specific address or address range. Examples: input I 12.1; flag word MW 25; data block DB 3.

Backplane bus

Serial data bus for module intercommunication, and power distribution to the modules. Bus connectors interconnect the modules.

Basic conversion time

Time required for the actual coding of a channel (integration time, plus all times required by the internal control, i.e. the channel is fully processed when this time has expired.

Basic error limit

Represents the operational limit at 25 °C, relative the module's rated range.

Basic execution time

Cycle time of an analog IO module when all of its channels are enabled. Equivalent to "number of channels x basic conversion time."

Bus

A transfer medium that interconnects several nodes. Data may be transferred in serial or parallel mode, using electrical or fiber-optic conductors.

Bus segment

Self-contained part of a bus system. Bus segments are coupled by means of → Repeater.

Common mode voltage (CMV)

The voltage common to all terminals of a group, measured between this group and any reference point (usually ground potential.)

Configuring

Refers to the selection and assembly of automation system components, or to software installation and adaptation to a specific process (by programming the modules, for example.)

CPU

Central Processing Unit of the → Automation System. A CPU stores and executes the user program. It contains the operating system, memory, processing unit and communications interfaces.

Cycle time

Denotes the time a → CPU requires for a single execution of the → user program.

Default setting

A useful setting which is used whenever the user does not enter a different value.

Diagnostics

Generic term for → System diagnostics, hardware error diagnostics, and user-specific diagnostics.

Diagnostics buffer

The diagnostics buffer represents a backup memory in the CPU, used to store diagnostics events in their order of occurrence.

In STEP 7 (PLC → Module status), the user can read data from the diagnostics buffer to determine the precise cause of error.

Diagnostics data

All diagnostics events are logged at the CPU and entered in → Diagnostics buffer. If an error OB exists, the buffer is started.

Diagnostics interrupt

Module diagnostics function report errors to the → CPU by means of diagnostics interrupts. The CPU operating system calls OB 82 when a diagnostics interrupt is generated.

Direct access

Denotes access of the CPU to a module via the → backplane bus, while bypassing the → Process image.

Electrically isolated

The reference potential of the control and load voltage circuits at electrically isolated IO modules are isolated galvanically, for example, using optocouplers, relay contacts or transformers. IO circuits can be connected to a common reference potential.

Equipotential bonding

Electrical connection (equipotential conductor) of electrical equipment and external conductive objects to the same or near to same potential, in order to prevent the development of disturbance and dangerous potentials between those objects.

Ground

The conductive earth whose electrical potential can be set equal to zero at any point.

Ground potential may be different from zero in the area of grounding electrodes. The term "reference ground" is frequently used to describe this situation.

Grounding

Grounding means, to connect an electrically conductive component via an equipotential grounding system to a grounding electrode (one or several conductive components with low impedance contact to earth.)

Hardware interrupt

Function initiated by interrupt-triggering modules, based on specific events in the process (high or low limit violated, module has completed cyclic conversion of channels.)

The hardware interrupt is reported to the CPU, The CPU executes the assigned → Organization block according to interrupt priority.

Input delay

STEP 7 parameter for digital input modules. The input delay function is used to suppress coupled disturbance. This includes pulse-shaped disturbance within the range from 0 ms to the set input delay

The input delay tolerance is defined in the technical data of the module. The length of suppressed pulse-shaped disturbance is determined by the length of the input delay.

The permissible input delay is determined by the line length between the encoder and the module. Unshielded encoder supply lines of a grater length (more than 100 m) require a long delay setting.

Integration time

STEP 7 parameter for analog input modules. The integration time is equivalent to the inverse value of the → noise suppression frequency in ms.

Logic block

A SIMATIC S7 logic block contains elements of the *STEP 7* user program. In contrast, a data block only contains data. Available logic blocks: Organization Blocks (OBs), Function Blocks (FBs), Functions (FCs), System Function Blocks (SFBs), System Functions (SFCs).

Measuring range module

Modules installed on analog input modules for the adaptation to different measuring ranges.

Mode of operation

Definition of this term:

1. selection of a CPU operating state using the mode selector switch or a PG
2. the type of program execution at the CPU
3. an analog input module parameter in *STEP 7*

Noise suppression

STEP 7 parameter for analog input modules. The frequency of AC mains may corrupt measured values, in particular in the low voltage ranges, and when thermocouples are being used. At this parameter, the user defines the mains frequency prevailing on his system.

Non-isolated

The reference potential of the control and load voltage circuits of non-isolated IO modules are electrically interconnected.

OB

→ Organization Block

Operating state

Operating states known to SIMATIC S7 automation systems: STOP, → STARTUP, RUN and STOP.

Organization block

OBs form the interface between the CPU operating system and the user program. The sequential order of user program execution is defined in the organization blocks.

Parameters

1. Tag of a → Code block
2. Tag used to set one or several properties of a module. Each module is supplied with default parameters which users may edit in *STEP 7*.

Process image

The CPU saves the signal states of analog IO modules to a process image.

We distinguish between the process image of inputs (PII) and outputs (PIO). The input modules read the process image of inputs (PII) before the operating system executes the user program. The operating system transfers the process image of outputs (PIO) to the output modules at the end of program execution.

Product version

Differentiates products of the same order number. The product version is incremented in the case of upwards compatible enhancements of functionality, production-specific changes (use of new components/parts), and fixes.

Reaction to open thermocouple

STEP 7 parameter for analog input modules operating with thermocouples. This parameter defines whether the module outputs an "Overflow" (7FFFH) or "Underflow" (8000H) value when it detects an open thermocouple.

Reference potential

Potential from which the voltages of participating circuits are derived and measured.

Resolution

Number of bits representing the value of analog modules in binary format. The resolution is module-specific. It is also determined by the → integration time of analog input modules. The precision of the measured value resolution increases with the length of the integration time. The maximum resolution is 16 bits + sign.

SFC

→ System Function

Signal module

Signal modules (SMs) form the interface between the process and the automation system. These are available as digital and analog input/output and IO modules.

STARTUP

STARTUP mode initiates the transition from STOP to RUN mode. STARTUP can be triggered by setting the → mode selector, by power on, or by an operator action on the programming device. S7-300 performs a → restart.

Substitution value

Values output by faulty signal output modules to the process, or used to substitute a process value of a faulty signal input module in the user program.

Users can program the substitute values in STEP 7 (hold last value, substitution value 0 or 1.) Those values must be set at the outputs when the CPU goes into STOP.

System diagnostics

Denotes the detection, evaluation and reporting of error events within the automation system. Examples of such errors are: program errors, or module failure. System errors may be indicated by LED displays, or in *STEP 7*.

Temperature error

Denotes the drift of measured/output values, caused by fluctuation of the ambient temperature at an analog module. It is defined in % per Kelvin, relative to the rated range of the analog module.

Temperature error of internal compensation

Only applies to the measurement of thermocouples. Defines the error to add to the actual temperature error, when "internal comparison" mode is selected. The error is defined either as a percentile value relative to the physical rated range of the analog module, or as an absolute value in °C.

Ungrounded

no galvanic connection to ground potential

User program

Contains statements, tags and data for processing signals which can control a plant or process. It is assigned to a programmable module (CPU, FM, for example) and can be organized in smaller units (blocks).

Wirebreak

Parameter in *STEP 7*. A wirebreak check is used to monitor line continuity between the encoder and input, or between the actuator and output. The module detects a wirebreak based on a current flow at the appropriately programmed input/output.

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