



## Product Information on the Manual

Edition 04.2003

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### S7-300 Module Specifications, Edition 11/2002, (A5E00105505-02)

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#### Introduction

The S7-300 product family has been enhanced and improved. This document contains details of the features and technical specifications of the modules.

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# **1 SM 321 digital input module; DI 16 × DC 24 V; with hardware interrupt and diagnostic interrupt, clocked; (6ES7 321-7BH01-0AB0)**

## **Order number**

6ES7 321-7BH01-0AB0

## **Characteristics**

The SM 321; DI 16 × DC 24 V; with hardware and diagnostic interrupts has the following features:

- 16 inputs, isolated in groups of 16
- 24 VDC rated input voltage
- Input characteristic curve according to IEC 61131, Type 2
- Suitable for switches and two / three / four-wire BEROs (proximity switches)
- 2 short-circuit-proof sensor supplies for 8 channels each
- External redundant power supply possible to supply sensors
- "Sensor supply (Vs)" status display
- Group error display
- Supports clocked operation
- Supports the function "Reparameterization in RUN mode"
- Programmable diagnostics
- Programmable diagnostic interrupt
- Programmable hardware interrupt
- Programmable input delays

# **Terminal connection diagram and block diagram of the SM 321; DI 16 × DC 24 V**

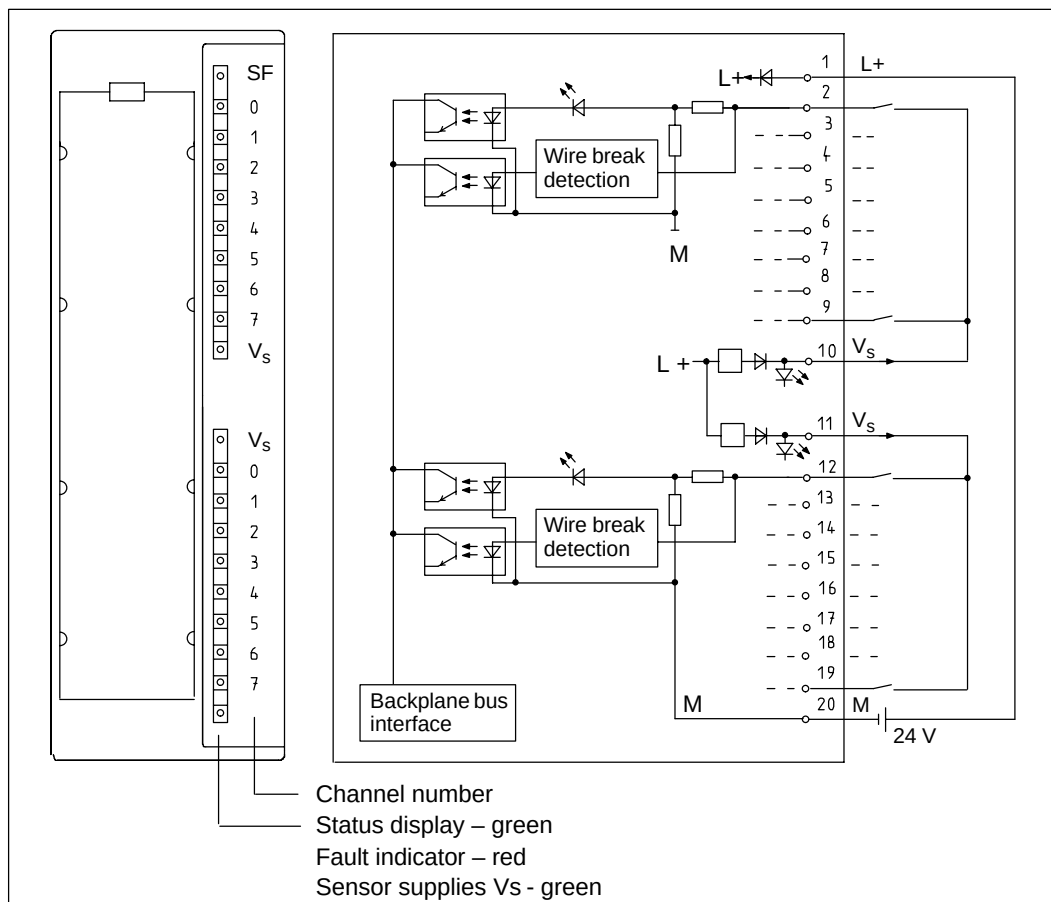


Figure 1 Module view and block diagram of the SM 321; DI 16 × DC 24 V

### Terminal assignment diagram for the redundant supply of sensors

The figure below shows how sensors can additionally be supplied by means of  $V_s$  with a redundant voltage source – for example, via another module.

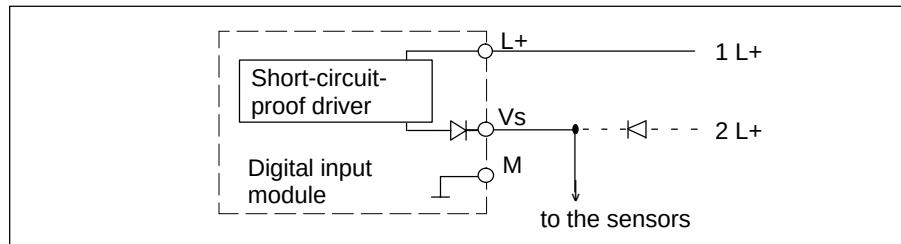


Figure 2 Terminal assignment diagram for the redundant supply of sensors of the SM 321; DI 16 × DC 24 V

### Terminal assignment diagram of the resistor wiring of the sensors

To detect a wire break, it is necessary to wire sensor contacts with a resistor.

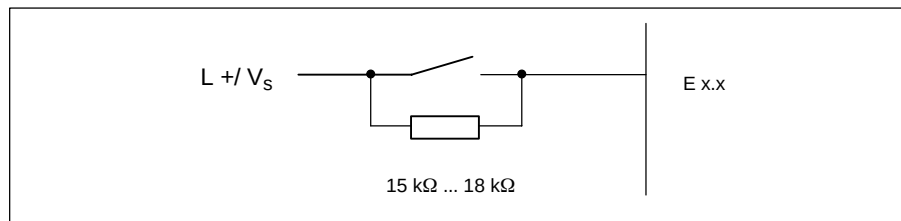


Figure 3 Terminal assignment diagram of the resistor wiring of the sensors of the SM 321; DI 16 × DC 24 V

## Technical specifications of the SM 321; DI 16 × DC 24 V

| Dimensions and Weight                                                                                                                        |                                                             | Diagnostic functions                                                                                          | Parameters can be assigned               |
|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------|
| Dimensions W × H × D (in millimeters)                                                                                                        | 40 × 125 × 117                                              | <ul style="list-style-type: none"> <li>Group error display</li> </ul>                                         | Red LED (SF)                             |
| Weight                                                                                                                                       | Approx. 200 g                                               | <ul style="list-style-type: none"> <li>Diagnostics information read-out</li> </ul>                            | Possible                                 |
| Data for Specific Module                                                                                                                     |                                                             | Monitoring for                                                                                                |                                          |
| Supports clocked operation                                                                                                                   | Yes                                                         | <ul style="list-style-type: none"> <li>Wire break</li> </ul>                                                  | Yes, for I < 1 mA                        |
| Reparameterization in RUN mode possible                                                                                                      | Yes                                                         | <b>Sensor Power Supply Outputs</b>                                                                            |                                          |
| <ul style="list-style-type: none"> <li>Behavior of non parameterized inputs</li> </ul>                                                       | Supply the last valid process value before parameterization | Number of outputs                                                                                             | 2                                        |
| Number of inputs                                                                                                                             | 16                                                          | Output voltage                                                                                                |                                          |
| Length of cable                                                                                                                              |                                                             | <ul style="list-style-type: none"> <li>With load</li> </ul>                                                   | min. L+ (–2.5 V)                         |
| <ul style="list-style-type: none"> <li>Unshielded</li> <li>Shielded</li> </ul>                                                               | max. 600 m<br>max. 1000 m                                   | Output current                                                                                                |                                          |
|                                                                                                                                              |                                                             | <ul style="list-style-type: none"> <li>Rated value</li> <li>Permitted range</li> </ul>                        | 120 mA<br>0 to 150 mA                    |
| <b>Voltages, Currents, Potentials</b>                                                                                                        |                                                             | Additional (redundant) supply                                                                                 | Permitted                                |
| Power rated voltage of the electronics and sensor L+                                                                                         | 24 VDC                                                      | Short-circuit protection                                                                                      | Yes, electronic                          |
| <ul style="list-style-type: none"> <li>Reverse polarity protection</li> </ul>                                                                | Yes                                                         | <b>Data for Selecting a Sensor</b>                                                                            |                                          |
| Number of inputs that can be triggered simultaneously                                                                                        |                                                             | Input voltage                                                                                                 |                                          |
| <ul style="list-style-type: none"> <li>Horizontal configuration</li> </ul>                                                                   | Up to 60 °C                                                 | <ul style="list-style-type: none"> <li>Rated value</li> <li>For signal "1"</li> <li>For signal "0"</li> </ul> | 24 VDC<br>13 to 30 V<br>From –30 to +5 V |
| <ul style="list-style-type: none"> <li>Vertical configuration</li> </ul>                                                                     | Up to 40 °C                                                 | Input current                                                                                                 |                                          |
| Isolation                                                                                                                                    |                                                             | <ul style="list-style-type: none"> <li>At signal "1"</li> </ul>                                               | typ. 7 mA                                |
| <ul style="list-style-type: none"> <li>Between channels and backplane bus</li> </ul>                                                         | Yes                                                         | Input characteristic curve                                                                                    | According to IEC 61131, type 2           |
| Permitted potential difference                                                                                                               |                                                             | Connection of Two-Wire BEROs                                                                                  | Possible                                 |
| <ul style="list-style-type: none"> <li>Between the different circuits</li> </ul>                                                             | 75 VDC / 60 VAC                                             | <ul style="list-style-type: none"> <li>Permitted bias current</li> </ul>                                      | max. 2 mA                                |
| Insulation tested with                                                                                                                       | 500 VDC                                                     | Resistor wiring of the sensor for wire break monitoring                                                       | 10 to 18 kOhm                            |
| Current consumption                                                                                                                          |                                                             | <b>Time/Frequency</b>                                                                                         |                                          |
| <ul style="list-style-type: none"> <li>From the backplane bus</li> <li>From load voltage L+ (without sensor supply V<sub>S</sub>)</li> </ul> | max. 130 mA<br>max. 90 mA                                   | Internal preparation time for status processing (in non-clocked operation)                                    |                                          |
| Power dissipation of the module                                                                                                              | typ. 4 W                                                    | <ul style="list-style-type: none"> <li>Enabling of hardware and diagnostic interrupt</li> </ul>               | max. 40 μs                               |
| <b>Status, interrupts, diagnostics</b>                                                                                                       |                                                             | Input delay                                                                                                   |                                          |
| Status display                                                                                                                               |                                                             | <ul style="list-style-type: none"> <li>Parameters can be assigned</li> <li>Rated value</li> </ul>             | Yes<br>typ. 0.1/0.5/3/15/20 ms           |
| <ul style="list-style-type: none"> <li>Inputs</li> <li>Sensor power supplies (V<sub>S</sub>)</li> </ul>                                      | Green LED per channel<br>Green LED per output               |                                                                                                               |                                          |
| Interrupts                                                                                                                                   |                                                             |                                                                                                               |                                          |
| <ul style="list-style-type: none"> <li>Hardware interrupt</li> <li>Diagnostic interrupt</li> </ul>                                           | Parameters can be assigned<br>Parameters can be assigned    |                                                                                                               |                                          |

## 1.1 Clock synchronization

### Characteristics

Reproducible response times (i.e. times of the same length) are achieved in SIMATIC by means of an equidistant DP bus cycle and the synchronization of the following free-running individual cycles:

- Free-running cycle of the user program. On account of cyclic program branches the length of the cycle time may vary.
- Free-running, variable DP cycle on the PROFIBUS subnet.
- Free-running cycle on the DP slave backplane bus.
- Free-running cycle at signal conditioning and conversion in the electronic modules of the DP slaves.

With equidistance the DP cycle runs with the same clock pulse and for the same length. The priority classes of a CPU (OB 61 to OB 64) and the clocked I/Os are synchronized with this clock pulse. The I/O data are thus transferred at defined, fixed intervals (clock synchronization).

### Prerequisites

- The DP master and DP slave must support clock synchronization. *STEP 7* as of Version 5.2 is required.

### Mode: clock synchronization

The following conditions apply to clocked mode:

|                                                                                                                                                                                                                                      |                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Filter and processing time $T_{WE}$ between the actual values being read in and made available in the transfer buffer (the specified value for $T_{WE}$ applies regardless of the activation of the hardware interrupt or diagnosis) | 255 to 345 $\mu$ s |
| Includes an input delay of                                                                                                                                                                                                           | 100 $\mu$ s        |
| $T_{DPmin}$                                                                                                                                                                                                                          | 2.5 ms             |
| Diagnostic interrupt                                                                                                                                                                                                                 | max. 4 x $T_{DP}$  |

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#### Note

In clocked mode, the input delay of the inputs is always 100  $\mu$ s, regardless of the input delay parameterized in STEP7.

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## Further information

You will find further information on clock synchronization in the online help system of *STEP 7*, in the manual *ET 200M Distributed I/O System* and in the manual *Clock Synchronization*.

## 1.2 Parameterizing the SM 321; DI 16 × DC 24 V

### Parameter assignment

Section 3.3 of the reference manual describes how digital modules are generally parameterized.

### Parameters of the SM 321; DI 16 × DC 24 V

You will find an overview of the parameters that can be set for the SM 321; DI 16 × DC 24 V, together with the default settings, in the following table.

The default settings apply if you have not performed parameter assignment in *STEP 7*.

Table 1 Parameters of the SM 321; DI 16 × DC 24 V

| Parameter                                                                                                       | Value Range                                                            | Default Settings | Parameter Type | Scope         |
|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|------------------|----------------|---------------|
| Enable <ul style="list-style-type: none"><li>Diagnostic interrupt</li><li>Hardware interrupt</li></ul>          | Yes/no<br>Yes/no                                                       | No<br>No         | Dynamic        | Module        |
| Input delay/voltage type                                                                                        | 0.1 ms (DC)<br>0.5 ms (DC)<br>3 ms (DC)<br>15 ms (DC)<br>20 ms (DC/AC) | (DC)             | Static         | Module        |
| Diagnosis <ul style="list-style-type: none"><li>Sensor supply missing</li><li>Wire break</li></ul>              | Yes/no<br>Yes/no                                                       | No<br>No         | Static         | Channel group |
| Trigger for hardware interrupt <ul style="list-style-type: none"><li>Rising edge</li><li>Falling edge</li></ul> | Yes/no<br>Yes/no                                                       | No<br>No         | Dynamic        | Channel group |

### Assignment of the sensor supplies to channel groups

The module's two sensor supplies supply two channel groups: inputs 0 to 7 and inputs 8 to 15. In these channel groups you also parameterize the diagnosis for the sensor supply.

## Assigning interrupt parameters to channel groups

The table below shows the channels that can be combined to form a channel group if you would like to parameterize interrupt processing.

You will need the channel group number to set the parameters in the user program with an SFC.

Table 2 Assignment of the interrupt parameters to the inputs of the SM 321;  
DI 16 × DC 24 V

| Parameter...                                                             | Can Be Set in Following Channel Groups | Channel Group Number |
|--------------------------------------------------------------------------|----------------------------------------|----------------------|
| Hardware interrupt<br>(for falling, rising or both types of pulse edges) | 0 and 1                                | 0                    |
|                                                                          | 2 and 3                                | 1                    |
|                                                                          | 4 and 5                                | 2                    |
|                                                                          | 6 and 7                                | 3                    |
|                                                                          | 8 and 9                                | 4                    |
|                                                                          | 10 and 11                              | 5                    |
|                                                                          | 12 and 13                              | 6                    |
|                                                                          | 14 and 15                              | 7                    |
| Diagnostic interrupt<br>(if there is no sensor supply)                   | 0 to 7<br>8 to 15                      | -                    |
| Wire break                                                               | 0 and 1                                | 0                    |
|                                                                          | 2 and 3                                | 1                    |
|                                                                          |                                        | :                    |

## Tolerances of the programmable input delays

Table 3 Tolerances of the input delays of the SM 321; DI 16 × DC 24 V

| Programmed Input delay | Tolerance     |
|------------------------|---------------|
| 0.1 ms                 | 60 to 140 µs  |
| 0.5 ms                 | 400 to 900 ms |
| 3 ms (preset)          | 2.6 to 3.3 ms |
| 15 ms                  | 12 to 15 ms   |
| 20 ms                  | 17 to 23 ms   |

## 1.3 Behavior and diagnostics of the SM 321; DI 16 × DC 24 V

### Effect of operating and mode supply voltage on the input values

The input values of the SM 321; DI 16 × DC 24 depend on the operating mode of the CPU and the supply voltage of the module.

Table 4 Dependencies of the input values of the operating mode of the CPU and the supply voltage L+ of the SM 321; DI 16 × DC 24 V

| CPU Operating State |      | Power Supply L+ to Digital Module | Input Value of Digital Module |
|---------------------|------|-----------------------------------|-------------------------------|
| POWER ON            | RUN  | L+ exists                         | Process value                 |
|                     |      | L+ missing                        | 0 signal                      |
|                     | STOP | L+ exists                         | Process value                 |
|                     |      | L+ missing                        | 0 signal                      |
| POWER OFF           | –    | L+ exists                         | –                             |
|                     |      | L+ missing                        | –                             |

### Diagnostic messages of the SM 321; DI 16 × DC 24 V

The table below provides an overview of the diagnostic messages of the SM 321; DI 16 × DC 24 V.

Table 5 Diagnostic messages of the SM 321; DI 16 × DC 24 V

| Diagnostics Message               | LED | Scope of the Diagnostics | Parameters can be assigned |
|-----------------------------------|-----|--------------------------|----------------------------|
| Sensor supply missing             | SF  | Channel group            | Yes                        |
| Wire-break                        | SF  | Channel group            |                            |
| Module not parameterized          | SF  | Channel group            |                            |
| External auxiliary supply missing | SF  | Module                   | No                         |
| Internal auxiliary power missing  | SF  | Module                   |                            |
| Fuse blown                        | SF  | Module                   |                            |
| Incorrect parameter on module     | SF  | Module                   |                            |
| Watchdog timeout                  | SF  | Module                   |                            |
| EPROM error                       | SF  | Module                   |                            |
| RAM error                         | SF  | Module                   |                            |
| Hardware interrupt lost           | SF  | Module                   |                            |

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**Note**

A prerequisite for detecting the errors indicated by programmable diagnostic messages is that you have assigned parameters to the digital module accordingly in *STEP 7*.

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**Behavior upon failure of the supply voltage**

The failure of the supply voltage of the SM 321; DI 16 × DC 24 is always indicated by the SF LED on the module. Furthermore, this information is made available on the module.

The input value is initially held for 20 to 40 ms before the 0 signal is transferred to the CPU. Supply voltage dips < 20 ms do not change the process value (see Table 4).

Triggering of the diagnostic interrupt depends on the parameter assignment (see Section 1.4).

**Failure of the supply voltage with redundant incoming supply for the sensor supply**

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**Note**

If an external redundant source is applied simultaneously to the sensor supply (Vs), a failure in the internal sensor supply causes a failure of the internal and/or external sensor supply and/or a blown fuse to be indicated instead of a regular sensor supply failure.

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**Short-circuit of sensor supply Vs**

Irrespective of the parameter assignment, the corresponding Vs LED goes out if a short-circuit of the sensor supply Vs occurs.

## Causes of errors and remedial action

Table 6 Diagnostic messages of the SM 321; DI 16 × DC 24 V, causes of errors and remedial action

| Diagnostics Message                   | Possible Error Cause                                                                                                 | Remedy                                                                                                                                                      |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Missing sensor supply                 | Overload of sensor supply                                                                                            | Eliminate overload                                                                                                                                          |
|                                       | Short circuit of sensor supply to M                                                                                  | Eliminate short circuit                                                                                                                                     |
| External auxiliary supply missing     | Power supply L+ to module missing                                                                                    | Feed supply L+                                                                                                                                              |
| Internal auxiliary supply missing     | Power supply L+ to module missing                                                                                    | Feed supply L+                                                                                                                                              |
|                                       | Fuse in module defective                                                                                             | Replace module                                                                                                                                              |
| Fuse blown                            | Fuse in module defective                                                                                             | Replace module                                                                                                                                              |
| Incorrect parameters in module        | One parameter or the combination of parameters is not plausible                                                      | Reassign module parameter                                                                                                                                   |
| Time monitoring triggered (watch dog) | Temporary high electromagnetic interference                                                                          | Eliminate interference                                                                                                                                      |
|                                       | Module defective                                                                                                     | Replace module                                                                                                                                              |
| EPROM error                           | Temporary high electromagnetic interference                                                                          | Eliminate interference and switch on/off power supply of CPU                                                                                                |
|                                       | Module defective                                                                                                     | Replace module                                                                                                                                              |
| RAM error                             | Temporary high electromagnetic interference                                                                          | Eliminate interference and switch on/off power supply of CPU                                                                                                |
|                                       | Module defective                                                                                                     | Replace module                                                                                                                                              |
| Hardware interrupt lost               | The module cannot send an interrupt, since the previous interrupt was not acknowledged; possible configuration error | Change interrupt processing in CPU and reconfigure module parameters, if required<br>The error continues until the module is configured with new parameters |
| Module not parameterized              | Problem at startup                                                                                                   | Reassign module parameter                                                                                                                                   |

## 1.4 Interrupts of the SM 321; DI 16 × DC 24 V

### Introduction

This section describes the interrupt behavior of the SM 321; DI 16 × DC 24 V. The following interrupts exist:

- Diagnostic interrupt
- Hardware interrupt

The OBs and SFCs mentioned below can be found in the online Help for *STEP 7*, where they are described in greater detail.

### Enabling interrupts

The interrupts are not preset – in other words, they are inhibited without appropriate parameter assignment. Assign parameters to the Interrupt Enable in *STEP 7* (refer to Section 1.2).

### Diagnostic interrupt

If you have enabled diagnostic interrupts, then active error events (initial occurrence of the error) and departing error events (message after troubleshooting) are reported by means of an interrupt.

The CPU interrupts the execution of the user program and processes the diagnostic interrupt block (OB 82).

In the user program, you can call SFC 51 or SFC 59 in OB 82 to obtain more detailed diagnostic information from the module.

The diagnostic information is consistent until such time as OB 82 is exited. When OB 82 is exited, the diagnostic interrupt is acknowledged on the module.

### Hardware interrupt

The SM 321; DI 16 × DC 24 V can trigger a hardware interrupt for every channel group at a rising edge, a falling edge, or at both edges of a signal status change.

Perform parameter assignment one channel group at a time. It can be modified at any time (in RUN mode using the user program).

Pending hardware interrupts trigger hardware interrupt processing in the CPU (OB 40). The CPU interrupts the execution of the user program or of the priority classes with low priority.

You can set in the user program of the hardware interrupt OB (OB 40) how the programmable logic controller has to react to an edge change. When the hardware interrupt OB is exited, the hardware interrupt is acknowledged on the module.

The module can buffer one interrupt per channel. If no higher priority run-time levels are waiting to be processed, the buffered interrupts (of all modules) are serviced one after the other by the CPU according to the order in which they occurred.

## Hardware interrupt lost

In an interrupt has been buffered for a channel and another interrupt occurs on that channel before it has been processed by the CPU, a diagnostic interrupt “hardware interrupt lost” is triggered.

More interrupts on this channel are not acquired until processing of the interrupt buffered on this channel has been executed.

## Interrupt-triggering channels

The start information of OB 40 in the OB40\_POINT\_ADDR variable indicates which channel triggered the hardware interrupt. Figure 4 shows the assignment to the bits of the local data double word 8.

| Byte    | Variable        | Data type |              | Description                                   |
|---------|-----------------|-----------|--------------|-----------------------------------------------|
| 6/7     | OB40_MDL_ADDR   | WORD      | B#16#0       | Address of the interrupt-triggering module    |
| As of 8 | OB40_POINT_ADDR | DWORD     | See Figure 4 | Indication of the interrupt-triggering inputs |

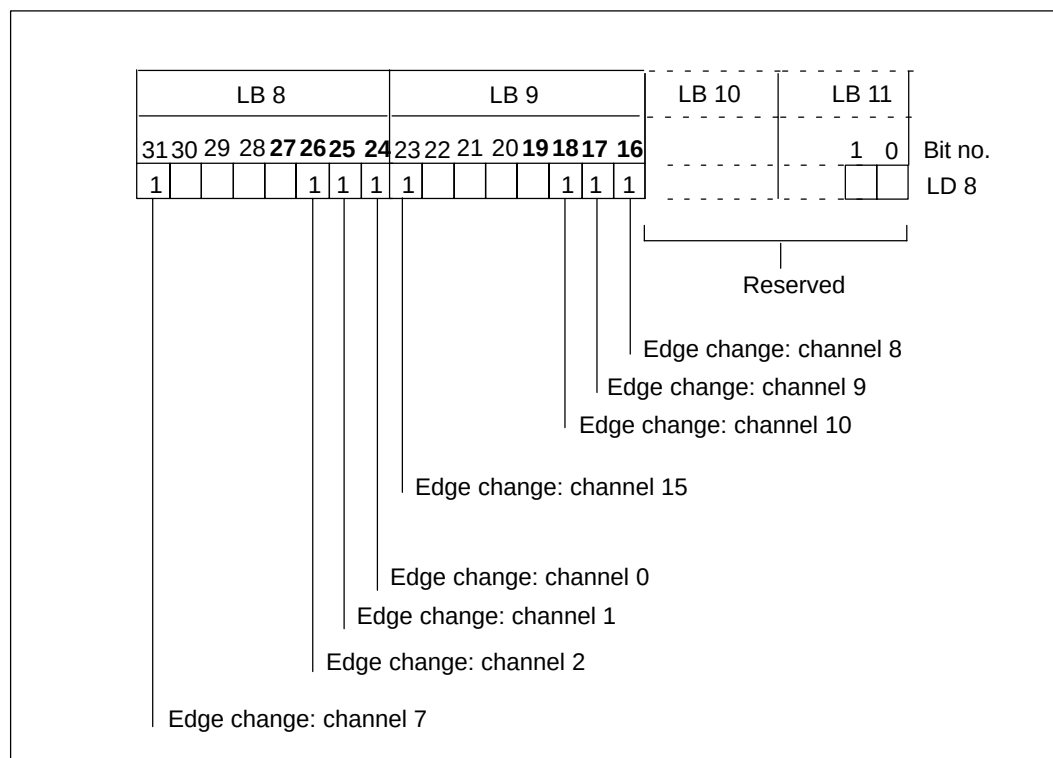


Figure 4 Start information of OB 40: which event triggered the hardware interrupt

## 2      **Analog input module SM 331; AI 8 × 14 Bit High Speed, clocked; (6ES7 331-7HF00-0AB0)**

### **Order number**

6ES7 331-7HF00-0AB0

### **Characteristics**

The SM 331; AI 8 × 14 Bit High Speed has the following features:

- 8 inputs in 4 channel groups
- Measured-value resolution 13 bits + sign
- Measuring method selectable per channel group:
  - Voltage
  - Current
- Arbitrary measuring range selection per channel group
- Programmable hardware interrupt
- Programmable diagnostics
- Programmable diagnostic interrupt
- Supports clocked operation
- Isolated against the backplane bus interface
- Isolated from the load voltage (**not** in the case of the 2-wire transmitter)

**Terminal connection diagram and block diagram of the SM 331;  
AI 8 × 14 Bit High Speed**

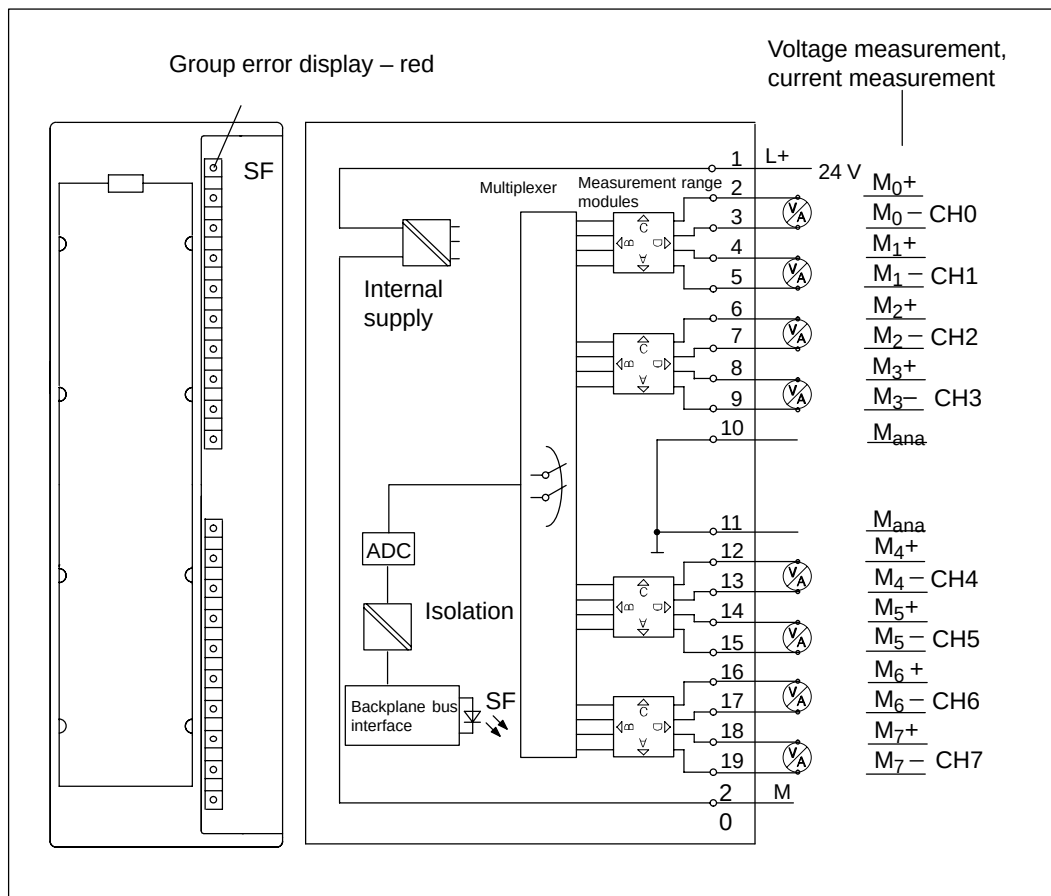


Figure 5 Module view and block diagram of the SM 331; AI 8 × 14 Bit High Speed

## Technical specifications of the SM 331; AI 8 × 14 Bit High Speed

| Dimensions and Weight                                                    |                          |
|--------------------------------------------------------------------------|--------------------------|
| Dimensions W × H × D<br>(in millimeters)                                 | 40 × 125 × 117           |
| Weight                                                                   | Approx. 230 g            |
| Data for Specific Module                                                 |                          |
| Supports clocked operation                                               | Yes                      |
| Number of inputs                                                         | 8                        |
| Length of cable                                                          |                          |
| • Shielded                                                               | max. 200 m               |
| Voltages, Currents, Potentials                                           |                          |
| Rated supply voltage of the electronics L +                              | 24 VDC                   |
| • Reverse polarity protection                                            | Yes                      |
| Power supply of the transmitters                                         |                          |
| • Supply current                                                         | max. 30 mA (per channel) |
| • Short-circuit-proof                                                    | Yes                      |
| Isolation                                                                |                          |
| • Between channels and backplane bus                                     | Yes                      |
| • Between the channels                                                   | No                       |
| • Between channels and power supply of the electronics                   | Yes                      |
| Permitted potential difference                                           |                          |
| • Between inputs and M <sub>ANA</sub> (U <sub>CM</sub> )                 | 11 VDC / 8 VAC           |
| – At signal = 0 V                                                        |                          |
| – Not for 2-wire transmitter                                             |                          |
| • Between the inputs (ECM)                                               | 11 VDC / 8 VAC           |
| • Between M <sub>ANA</sub> and M <sub>internal</sub> (U <sub>ISO</sub> ) | 75 VDC / 60 VAC          |
| Insulation tested with                                                   |                          |
| • Channels against backplane bus and load voltage L +                    | 500 VDC                  |
| Current consumption                                                      |                          |
| • From the backplane bus                                                 | max. 100 mA              |
| • From load voltage L + (without 2-wire transmitter)                     | max. 50 mA               |
| Power dissipation of the module                                          | typ. 1.5 W               |
| Analog value generation                                                  |                          |

| Measuring principle                                                                    |            | Instantaneous value conversion |    |          |  |
|----------------------------------------------------------------------------------------|------------|--------------------------------|----|----------|--|
| Integration time/conversion time/ resolution (per channel)                             |            |                                |    |          |  |
| • Parameters can be assigned                                                           | Yes        |                                |    |          |  |
| • Basic conversion time per channel                                                    | 52 μs      |                                |    |          |  |
| • Resolution (incl. overrange)                                                         | 14 bits    |                                |    |          |  |
| • Noise suppression for frequency f1 in Hz                                             | None       | 400                            | 60 | 50       |  |
| • Basic execution time of the module (depending on the number of channels enabled)     | 0.42 ms    |                                |    |          |  |
| Suppression of interference, Limits of Error                                           |            |                                |    |          |  |
| Noise suppression for f = n × (f1 ± 1 %), (f1 = interference frequency) n= 1,2 ...     |            |                                |    |          |  |
| • Common-mode interference (U <sub>CM</sub> < 11 V <sub>SS</sub> )                     | > 80 dB    |                                |    |          |  |
| • Series-mode interference (peak value of interference < rated value of input range)   | > 40 dB    |                                |    |          |  |
| Crosstalk between the inputs                                                           | > 65 dB    |                                |    |          |  |
| Operational limit (in the entire temperature range, with reference to the input range) |            |                                |    |          |  |
| • Voltage input                                                                        | ± 1 V      |                                |    | ± 0.3 %  |  |
|                                                                                        | ± 5 V      |                                |    | ± 0.4 %  |  |
|                                                                                        | ± 10 V     |                                |    | ± 0.3 %  |  |
|                                                                                        | 1 to 5 V   |                                |    | ± 0.4 %  |  |
| • Current input                                                                        | ± 20 mA    |                                |    | ± 0.3 %  |  |
|                                                                                        | 0 to 20 mA |                                |    | ± 0.3 %  |  |
|                                                                                        | 4 to 20 mA |                                |    | ± 0.3 %  |  |
| Basic error limit (operational limit at 25 °C, with reference to the input range)      |            |                                |    |          |  |
| • Voltage input                                                                        | ± 1 V      |                                |    | ± 0.2 %  |  |
|                                                                                        | ± 5 V      |                                |    | ± 0.25 % |  |
|                                                                                        | ± 10 V     |                                |    | ± 0.2 %  |  |
|                                                                                        | 1 to 5 V   |                                |    | ± 0.25 % |  |
| • Current input                                                                        | ± 20 mA    |                                |    | ± 0.2 %  |  |
|                                                                                        | 0 to 20 mA |                                |    | ± 0.2 %  |  |
|                                                                                        | 4 to 20 mA |                                |    | ± 0.2 %  |  |

|                                                                            |                            |
|----------------------------------------------------------------------------|----------------------------|
| Temperature error (with reference to the input range)                      | ± 0.004 %/K                |
| Linearity error (with reference to the input range)                        | ± 0.03 %                   |
| Repeat accuracy (steady state at 25 °C, with reference to the input range) | ± 0.1 %                    |
| Status, Interrupts, Diagnostics                                            |                            |
| Interrupts                                                                 |                            |
| • Hardware interrupt                                                       | Parameters can be assigned |
| • Diagnostic interrupt                                                     | Parameters can be assigned |
| Diagnostic functions                                                       |                            |
| • Group error display                                                      | Red LED (SF)               |
| • Diagnostics information read-out                                         | Possible                   |

| Data for Selecting a Sensor                                 |                                                                              |         |
|-------------------------------------------------------------|------------------------------------------------------------------------------|---------|
| Input range (rated values)/Input resistance                 |                                                                              |         |
| • Voltage                                                   | ± 1 V                                                                        | /10 MΩ  |
|                                                             | ± 5 V                                                                        | /100 kΩ |
|                                                             | ± 10 V                                                                       | /100 kΩ |
|                                                             | 1 to 5 V;                                                                    | /100 kΩ |
| • Current                                                   | ± 20 mA                                                                      | /50 Ω   |
|                                                             | 0 to 20 mA;                                                                  | /50 Ω   |
|                                                             | 4 to 20 mA:                                                                  | /50 Ω   |
| Maximum input voltage for voltage input (destruction limit) | max. 20 V continuous; 75 VDC for no more than 1 s (pulse duty factor 1 : 20) |         |
| Maximum input current for current input (destruction limit) | 40 mA                                                                        |         |
| Connection of the sensor                                    |                                                                              |         |
| • For measuring voltage                                     | Possible                                                                     |         |
| • For measuring current                                     |                                                                              |         |
| As two-wire transmitter                                     | Possible                                                                     |         |
| As four-wire transmitter                                    | Possible                                                                     |         |
| • Load of the 2-wire transmitter (at L+ = DC 24 V)          | max. 820 Ω                                                                   |         |
| Characteristic linearization                                | None                                                                         |         |

## 2.1 Clock synchronization

### Characteristics

Reproducible response times (i.e. times of the same length) are achieved in SIMATIC by means of an equidistant DP bus cycle and the synchronization of the following free-running individual cycles:

- Free-running cycle of the user program. On account of cyclic program branches the length of the cycle time may vary.
- Free-running, variable DP cycle on the PROFIBUS subnet.
- Free-running cycle on the DP slave backplane bus.
- Free-running cycle at signal conditioning and conversion in the electronic modules of the DP slaves.

With equidistance the DP cycle runs with the same clock pulse and for the same length. The priority classes of a CPU (OB 61 to OB 64) and the clocked I/Os are synchronized with this clock pulse. The I/O data are thus transferred at defined, fixed intervals (clock synchronization).

### Prerequisites

- The DP master and DP slave must support clock synchronization. *STEP 7* as of Version 5.2 is required.

### Mode: clock synchronization

The following conditions apply to clocked mode:

|                                                                                                                                                                                                                                      |                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Filter and processing time $T_{WE}$ between the actual values being read in and made available in the transfer buffer (the specified value for $T_{WE}$ applies regardless of the activation of the hardware interrupt or diagnosis) | 516 to 606 $\mu\text{s}$ |
| Includes an input delay of                                                                                                                                                                                                           | 80 $\mu\text{s}$         |
| $T_{DPmin}$                                                                                                                                                                                                                          | 3.5 ms                   |
| Diagnostic interrupt                                                                                                                                                                                                                 | max. $4 \times T_{DP}$   |

#### Note

In clocked mode, the integration time for the module is always set to “none” or “interference frequency”, regardless of the parameter assignment in *STEP 7*. Hardware interrupt functionality is not possible in clocked mode.

### Calculation of the filter and processing time

The same time conditions apply regardless of the number of channels parameterized. The point of time in relation to the clock signal at which a specific channel is read in is calculated on the basis of the following formula:

$$T_{WE\_CH} = (\text{channel number} + 1) \times 52 \mu\text{s} + t_v; t_v = 100 \text{ to } 190 \mu\text{s}$$

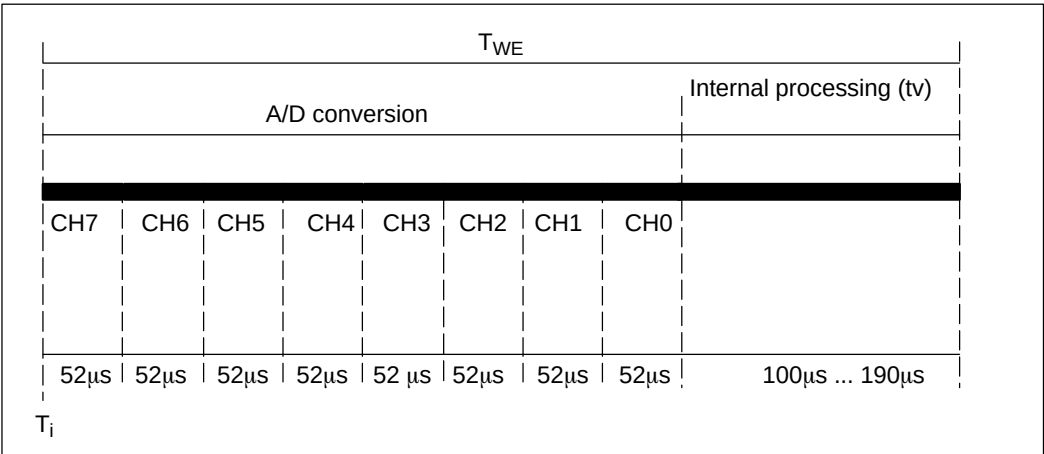


Figure 6      Figure 7      Calculation of the filter and processing time

### **Explanation of functioning in clocked mode**

At T<sub>i</sub> starts AD conversion for channel 7 and saves its result internally. Channels 6 to 0 are then converted sequentially in the same way at intervals of 52 μs. After an additional internal processing time, the results of all the converted channels are made available on the backplane bus to be picked up by the CPU.

### **Further information**

You will find further information on clock synchronization in the online help system of *STEP 7*, in the manual *ET 200M Distributed I/O System* and in the manual *Clock Synchronization*.

## 2.2 Commissioning the SM 331; AI 8 × 14 Bit High Speed

You specify how the SM 331; AI 8 × 14 Bit High Speed is to work by means of measurement range modules on the module and *STEP 7*.

### Measuring range modules

If necessary, the measuring range modules must be replugged to change the measuring method and the measuring range. You then have to switch the 24 V supply off and on again at the front connector. Section 4.4 of the reference manual provides a detailed description of how to do this.

Section 4.20.3 of the reference manual contains a table indicating the settings to be selected for different measurement methods and ranges. The required settings are also printed on the module.

### Default settings for measuring range module

The measuring range modules are preset to "B" (voltage;  $\pm 10$  V) when the module is supplied.

To use the following preset measuring methods and measuring ranges, you only have to change the measuring range module to the corresponding setting. Parameter assignment in *STEP 7* is not necessary.

Table 7 Defaults of the SM 331; AI 8 × 14 Bit High Speed via measuring range modules

| Measuring Range Module Setting | Measuring Method                  | Measuring Range |
|--------------------------------|-----------------------------------|-----------------|
| A                              | Voltage                           | $\pm 1$ V*      |
| B                              | Voltage                           | $\pm 10$ V      |
| C                              | Current,<br>Four-wire transmitter | 4 to 20 mA      |
| D                              | Current,<br>Two-wire transmitter  | 4 to 20 mA      |

\* You must short-circuit unused channels and connect them to M<sub>ANA</sub>.

## Parameters

Section 4.7 of the reference manual describes how analog modules are generally parameterized.

An overview of the parameters that you can set and their default settings are shown in the table below.

Table 8 Parameters of the SM 331; AI 8 × 14 Bit High Speed

| Parameter                                                                                                                                 | Value Range                                                                                                                                                                                                                                          | Default Settings     | Parameter Type | Scope                    |
|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------|--------------------------|
| Enable <ul style="list-style-type: none"> <li>Diagnostic interrupt</li> <li>Hardware interrupt up on limit violation</li> </ul>           | Yes/no<br>Yes/no                                                                                                                                                                                                                                     | No<br>No             | Dynamic        | Module                   |
| Trigger for hardware interrupt <ul style="list-style-type: none"> <li>Upper limit value</li> <li>Lower limit value</li> </ul>             | Constraint possible due to measuring range.<br>32511 to –32512<br>–32512 to 32511                                                                                                                                                                    | –                    | Dynamic        | Channel                  |
| Diagnostics <ul style="list-style-type: none"> <li>Group diagnostics</li> </ul>                                                           | Yes/no                                                                                                                                                                                                                                               | No                   | Static         | Channel group            |
| Measurement <ul style="list-style-type: none"> <li>Measuring Method</li> <li>Measuring Range</li> <li>Interference Suppression</li> </ul> | Deactivated<br>U Voltage<br>4DMU Current (4-wire transmitter)<br>2DMU Current (2-wire transmitter)<br>For the settable measuring ranges of the input channels, please refer to section 4.20.3 of the reference manual.<br>None; 400 Hz; 60 Hz; 50 Hz | U<br>± 10 V<br>50 Hz | Dynamic        | Channel or Channel group |

## Channel groups

The channels of the SM 331; AI 8 × 14 Bit High Speed are arranged in four groups of two. You can only ever assign parameters to one channel group.

The SM 331; AI 8 × 14 Bit High Speed has a measuring range module for each channel group.

The table below shows which channels are parameterized as a channel group in each case. You will need the channel group number to set the parameters in the user program with an SFC.

Table 9 Assignment of the channels of the SM 331; AI 8 × 14 Bit High Speed to channel groups

| Channels ... | ... form one Channel Group each |
|--------------|---------------------------------|
| Channel 0    | Channel group 0                 |
| Channel 1    |                                 |
| Channel 2    | Channel group 1                 |
| Channel 3    |                                 |
| Channel 4    | Channel group 2                 |
| Channel 5    |                                 |
| Channel 6    | Channel group 3                 |
| Channel 7    |                                 |

## Special characteristic of channel groups for hardware interrupts

You can set hardware interrupts in *STEP 7* for the channel groups 0 and 1. Note, however, that a hardware interrupt is set only for the first channel in the channel group in each case – in other words, for channel 0 or channel 2.

## Diagnostics

You will find the diagnostic messages that are grouped under the “group diagnosis” parameter in Table 4-47 on page 4-73 of the reference manual.

## 2.3 Measuring methods and measuring ranges of the SM 331; AI 8 × 14 Bit High Speed

### Measuring Methods

You can set the following measuring methods for the input channels:

- Voltage measurement
- Current measurement

You perform the setting by means of the measuring range modules on the module and with the “measuring method” parameter in *STEP 7*.

### Unused Channels

You must short-circuit unused channels and connect them to  $M_{ANA}$ . In this way, you obtain an optimum interference immunity for the analog input module. Set the “measuring method” parameter for unused channels to “disabled”.

### Special characteristics of unused channels for some measuring ranges

Since configured inputs can remain unused because of the channel group generation, you must take note of the following special characteristics of these inputs to enable the diagnostic functions on the used channels.

- **Measuring range 1 to 5 V:** parallel connection of the unused input with the used input of the same channel group.
- **Current measurement, 2-wire transmitter:** two channel wiring options.
  - a) Leave the unused input open and do not enable diagnostics for this channel group. Otherwise, if diagnostics are enabled, the analog module triggers a single diagnostic interrupt and the SF LED of the analog module comes on.
  - b) Connect the unused input with a resistance of 1.5 to 3.3 k $\Omega$ . You may then enable diagnostics for this channel group.
- **Current measurement 4 to 20 mA, 4-wire transmitter:** series connection of the unused input with the input of the same channel group.

## Measuring ranges

You perform the setting of the measuring ranges by means of the measuring range modules on the module and with the “measuring method” parameter in *STEP 7*.

Table 10 Measuring ranges of the SM 331; AI 8 x 14 Bit High Speed

| Method Selected                    | Measuring Range<br>(Type of Sensor) | Measuring Range<br>Module Setting | Description                                                                                                                                 |
|------------------------------------|-------------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| U: voltage                         | ± 1 V                               | A                                 | You will find the digitized analog values in Section 4.3.1 of the reference manual in the part that deals with the voltage measuring range. |
|                                    | ± 5 V                               | B                                 |                                                                                                                                             |
|                                    | 1 to 5 V                            |                                   |                                                                                                                                             |
|                                    | ± 10 V                              |                                   |                                                                                                                                             |
| 4DMU: Current (4-wire transmitter) | 0 to 20 mA<br>4 to 20 mA<br>± 20 mA | C                                 | You will find the digitized analog values in Section 4.3.1 of the reference manual in the part that deals with the current measuring range. |
| 2DMU: Current (2-wire transmitter) | 4 to 20 mA                          | D                                 |                                                                                                                                             |

## Default Settings

The default settings of the module in *STEP 7* are the “voltage” measuring method and the “ $\pm 10\text{ V}$ ” measuring range. You can use this measuring method with this measuring range without parameterizing the SM 331; AI 8 x 14 Bit High Speed using *STEP 7*.

## Special characteristics of the wire-break check for the 4 to 20 mA measuring range

With a parameterized measuring range of 4 to 20 mA and **enabled wire-break check**, the analog input module enters wire-break in the diagnosis when a current falls below 3.6 mA.

If you have enabled diagnostics interrupt during configuration, the module additionally triggers a diagnostic interrupt.

If no diagnostic interrupt has been enabled, the illuminated SF LED is the only indication of the wire-break and you must evaluate the diagnostic bytes in the user program.

With a parameterized measuring range of 4 to 20 mA and **disabled wire-break check** and enabled diagnostic interrupt, the module triggers a diagnostic interrupt when the underflow is reached.

### **3      Analog Output Module SM 332; AO 4 × 16 Bit; clocked; (6ES7 332-7ND01-0AB0)**

#### **Order number**

6ES7 332-7ND01-0AB0

#### **Characteristic**

The Analog Output Module SM 332; AO 4 × 16 Bit has the following characteristic features:

- 4 outputs in 4 channel groups
- Individual output channels can be programmed as
  - voltage outputs
  - current outputs
- Resolution of 16 bits
- Supports clocked operation
- Supports the function “Reparameterization in RUN mode”
- Programmable diagnostics
- Programmable diagnostic interrupt
- Programmable substitute value output
- Galvanic Isolation between:
  - backplane bus interface and analog output channels
  - the different analog output channels
  - analog output and L+, M
  - backplane bus interface and L+, M

## Terminal connection diagram and block diagram of the SM 332; AO 4 × 16 Bit

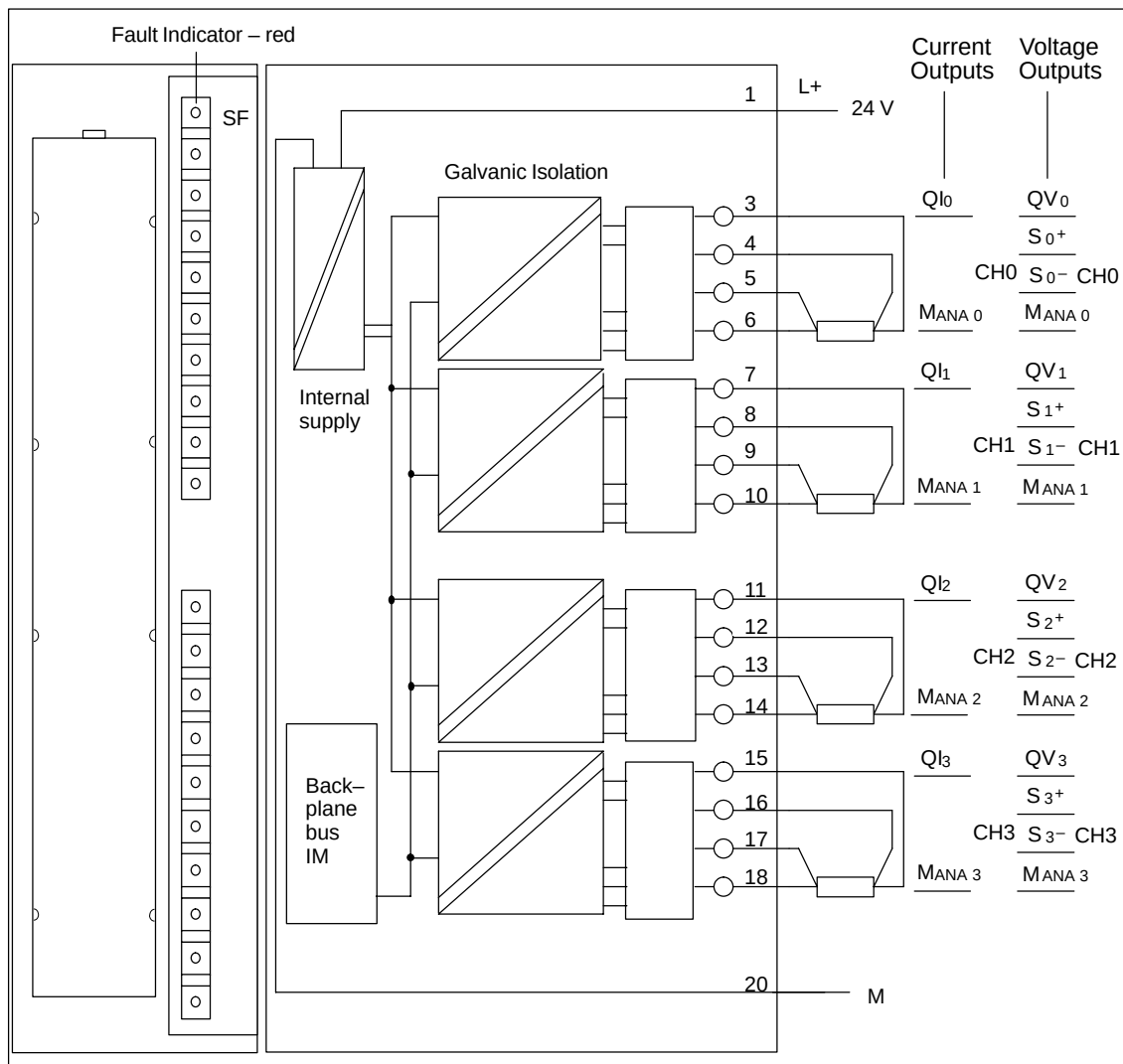


Figure 8 Module view and block diagram of the SM 332; AO 4 x 16 Bit

### Note

Switching the rated load voltage (L+) on and off, can cause wrong intermediate values at the output for approximately 10 ms.

## Technical specifications of the SM 332; AO 4 × 16 bits

| Dimensions and Weight                                                                                                |                                                            | Analog Value Generation                                                                                                                                                                             |  |
|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Dimensions W × H × D<br>(in millimeters)                                                                             | 40 × 125 × 117                                             | Resolution<br>(including overrange)                                                                                                                                                                 |  |
| Weight                                                                                                               | Approx. 220 g                                              | <ul style="list-style-type: none"> <li>±10 V 16 bits</li> <li>0 to 10 V 15 bits</li> <li>1 to 5 V 14 bits</li> <li>±20 m 15 bits</li> <li>0 to 20 mA 14 bits</li> <li>4 to 20 mA 14 bits</li> </ul> |  |
| Data for Specific Module                                                                                             |                                                            | Conversion time (per channel)                                                                                                                                                                       |  |
| Supports clocked operation                                                                                           | Yes                                                        | <ul style="list-style-type: none"> <li>In standard mode 0.8 ms</li> <li>In clocked mode 1.6 ms</li> </ul>                                                                                           |  |
| Reparameterization in RUN mode possible                                                                              | Yes                                                        | Basic response time of module<br>(all channels enabled)                                                                                                                                             |  |
| <ul style="list-style-type: none"> <li>Behavior of non parameterized outputs</li> </ul>                              | Output the last valid output value before parameterization | <ul style="list-style-type: none"> <li>In standard mode 3.2 ms</li> <li>In clocked mode 2.4 ms</li> </ul>                                                                                           |  |
| Number of outputs                                                                                                    | 4                                                          | Settling time                                                                                                                                                                                       |  |
| Length of cable                                                                                                      |                                                            | <ul style="list-style-type: none"> <li>For resistive load 0.2 ms</li> <li>For capacitive load 3.3 ms</li> <li>For inductive load 0.5 ms (1 mH)<br/>3.3 ms (10 mH)</li> </ul>                        |  |
| <ul style="list-style-type: none"> <li>Shielded</li> </ul>                                                           | max. 200 m                                                 |                                                                                                                                                                                                     |  |
| Voltages, Currents, and Potentials                                                                                   |                                                            |                                                                                                                                                                                                     |  |
| Rated load voltage L+                                                                                                | 24 VDC                                                     |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>Reverse polarity protection</li> </ul>                                        | Yes                                                        |                                                                                                                                                                                                     |  |
| Isolation                                                                                                            |                                                            |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>Between channels and backplane bus</li> </ul>                                 | Yes                                                        |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>Between channels and power supply of the electronics</li> </ul>               | Yes                                                        |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>Between the channels</li> </ul>                                               | Yes                                                        |                                                                                                                                                                                                     |  |
| Permitted potential difference                                                                                       |                                                            |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>Between the outputs (ECM)</li> </ul>                                          | 200 VDC /<br>120 VAC                                       |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>Between M<sub>ANA</sub> and M<sub>internal</sub> (U<sub>ISO</sub>)</li> </ul> | 200 VDC /<br>120 VAC                                       |                                                                                                                                                                                                     |  |
| Insulation tested with                                                                                               | 500 VDC                                                    |                                                                                                                                                                                                     |  |
| Current consumption                                                                                                  |                                                            |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>From the backplane bus</li> </ul>                                             | max. 100 mA                                                |                                                                                                                                                                                                     |  |
| <ul style="list-style-type: none"> <li>From the load voltage L+ (no load)</li> </ul>                                 | max. 240 mA                                                |                                                                                                                                                                                                     |  |
| Power dissipation of the module                                                                                      | typ. 3 W                                                   |                                                                                                                                                                                                     |  |

| Suppression of interference, Limits of Error                                                                                                                                                                                                                                                                                                    |  | Data for Selecting an Actuator                                                                                                                                                                                                            |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Crosstalk between outputs                                                                                                                                                                                                                                                                                                                       |  | Output ranges (rated values)                                                                                                                                                                                                              |  |
| > 100 dB                                                                                                                                                                                                                                                                                                                                        |  | <ul style="list-style-type: none"> <li>Voltage <math>\pm 10</math> V<br/>0 to 10 V<br/>1 to 5 V</li> <li>Current <math>\pm 20</math> mA<br/>0 to 20 mA<br/>4 to 20 mA</li> </ul>                                                          |  |
| Operational limit (in the entire temperature range, with reference to the output range)                                                                                                                                                                                                                                                         |  | Load resistance (in the nominal range of the output)                                                                                                                                                                                      |  |
| <ul style="list-style-type: none"> <li>Voltage outputs <math>\pm 0.12\%</math></li> <li>Current outputs <math>\pm 0.18\%</math></li> </ul>                                                                                                                                                                                                      |  | <ul style="list-style-type: none"> <li>For voltage outputs min. 1 k<math>\Omega</math><br/>– Capacitive load max. 1 <math>\mu</math>F</li> <li>For current outputs max. 500 <math>\Omega</math><br/>– Inductive load max. 1 mH</li> </ul> |  |
| Basic error (operational limit at 25° C, referred to output range)                                                                                                                                                                                                                                                                              |  | Voltage outputs                                                                                                                                                                                                                           |  |
| <ul style="list-style-type: none"> <li>Voltage outputs <math>\pm 10</math> V <math>\pm 0.02\%</math><br/>0 to 10 V <math>\pm 0.02\%</math><br/>1 to 5 V <math>\pm 0.04\%</math></li> <li>Current outputs <math>\pm 20</math> m <math>\pm 0.02\%</math><br/>0 to 20 mA <math>\pm 0.02\%</math><br/>4 to 20 mA <math>\pm 0.04\%</math></li> </ul> |  | <ul style="list-style-type: none"> <li>Short-circuit protection Yes</li> <li>Short-circuit current max. 40 mA</li> </ul>                                                                                                                  |  |
| Temperature error (with reference to the output range)                                                                                                                                                                                                                                                                                          |  | Current outputs                                                                                                                                                                                                                           |  |
| <ul style="list-style-type: none"> <li>Voltage outputs <math>\pm 0.0025\%</math> / K</li> <li>Current outputs <math>\pm 0.004\%</math> / K</li> </ul>                                                                                                                                                                                           |  | <ul style="list-style-type: none"> <li>No-load voltage max. 18 V</li> </ul>                                                                                                                                                               |  |
| Linearity error (with reference to the output range)                                                                                                                                                                                                                                                                                            |  | Destruction limit against voltages/currents applied from outside                                                                                                                                                                          |  |
| $\pm 0.004\%$                                                                                                                                                                                                                                                                                                                                   |  | <ul style="list-style-type: none"> <li>Voltage at outputs to M<sub>ANA</sub> max. 15 V continuous<br/>75 VDC for max. 0.1 s (pulse duty factor 1 : 20)</li> <li>Current max. 50 mA DC</li> </ul>                                          |  |
| Repeat accuracy (in the steady state at 25° C, referred to the output range)                                                                                                                                                                                                                                                                    |  | Connection of actuators                                                                                                                                                                                                                   |  |
| $\pm 0.002\%$                                                                                                                                                                                                                                                                                                                                   |  | <ul style="list-style-type: none"> <li>For voltage output<br/>– Four-conductor connection (measuring circuit) Possible</li> <li>For current output<br/>– Two-conductor connection Possible</li> </ul>                                     |  |
| Output ripple; band width 0 to 50 kHz (with reference to the output range)                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                           |  |
| $\pm 0.05\%$                                                                                                                                                                                                                                                                                                                                    |  |                                                                                                                                                                                                                                           |  |
| Status, Interrupts, Diagnostics                                                                                                                                                                                                                                                                                                                 |  |                                                                                                                                                                                                                                           |  |
| Interrupts                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                           |  |
| <ul style="list-style-type: none"> <li>Diagnostic Interrupt Programmable</li> </ul>                                                                                                                                                                                                                                                             |  |                                                                                                                                                                                                                                           |  |
| Diagnostic functions                                                                                                                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                           |  |
| <ul style="list-style-type: none"> <li>Group error display Red LED (SF)</li> <li>Diagnostic information readable Possible</li> </ul>                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                           |  |
| Substitute value can be applied                                                                                                                                                                                                                                                                                                                 |  | Yes, programmable                                                                                                                                                                                                                         |  |

## 3.1 Clock synchronization

### Characteristics

Reproducible response times (i.e. times of the same length) are achieved in SIMATIC by means of an equidistant DP bus cycle and the synchronization of the following free-running individual cycles:

- Free-running cycle of the user program. On account of cyclic program branches the length of the cycle time may vary.
- Free-running, variable DP cycle on the PROFIBUS subnet.
- Free-running cycle on the DP slave backplane bus.
- Free-running cycle at signal conditioning and conversion in the electronic modules of the DP slaves.

With equidistance the DP cycle runs with the same clock pulse and for the same length. The priority classes of a CPU (OB 61 to OB 64) and the clocked I/Os are synchronized with this clock pulse. The I/O data are thus transferred at defined, fixed intervals (clock synchronization).

### Prerequisites

- The DP master and DP slave must support clock synchronization. *STEP 7* as of Version 5.2 is required.

### Mode: Clock synchronization

The following conditions are applicable for synchronous operation:

|                                                                                                                              |                        |
|------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Processing and activation time $T_{WA}$ between read in of output value in the transfer buffer and loading in the output DAC | 1.6 ms                 |
| $T_{DPmin}$                                                                                                                  | 2.4 ms                 |
| Diagnostic interrupt                                                                                                         | $4 \times T_{DP, max}$ |

**Processing and Output Update Time**

The same time conditions are always applicable, irrespective of the number of channels programmed.

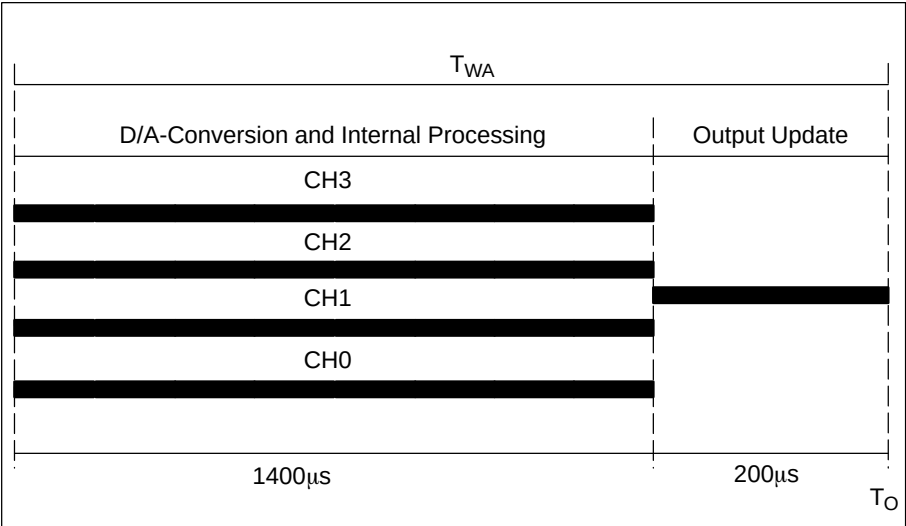


Figure 9 Calculation of the Processing Time and Output Update Time

**Description of the Method of Functioning in Synchronous Operation**

At time  $T_O - T_{WA}$ , the module reads in the output data and saves the data internally. Following internal processing time for each channel, the results are written to each D/A converter.

**Additional Information**

You will find additional information about synchronous operation in the STEP 7 online Help, the *ET 200M Distributed I/O System manual* and in the *Manual Clock Synchronization*.

## 3.2 Commissioning the SM 332; AO 4 × 16 bits

### Parameter

You will find a description of the general procedure for assigning parameters to analog modules in Section 4.7 of the reference manual.

You will find an overview of the programmable parameters and their default values in Table 4-42, on page 4-47 of the reference manual.

### Assigning parameters to channels

You can configure each output channel of the SM 332; AO 4 × 16 bits individually. You can thus assign separate parameters for each output channel.

When you set the parameters with SFCs in the user program, the parameters are assigned to channel groups. Every output channel of the SM 332; AO 4 × 16 bits is assigned to a channel group in this instance – in other words, for example output channel 0 = channel group 0.

---

#### Note

If you modify output ranges when the analog output module SM 332; AO 4 × 16 bits is in operation, incorrect intermediate values may arise across the output.

---

### Diagnostics

You will find the diagnostic messages that are grouped under the "group diagnosis" parameter in Table 4-47, on page 4-79 of the reference manual.

### 3.3 Output Ranges of the Analog Output Module SM 332; AO 4 × 16 bits

#### Connecting the analog outputs

You can connect the outputs as voltage or current outputs, or disable them. You perform connection of the outputs with the "output type" parameter in *STEP 7*.

#### Unused channels

So that unused output channels of the SM 332; AO 4 × 16 bits remain de-energized, you must set the "output type" parameter to "disabled" and leave the terminal open.

#### Output ranges

You program the output ranges for voltage and current outputs in *STEP 7*.

Table 11 Output Ranges of the Analog Output Module SM 332; AO 4 × 16 bits

| Selected Type of Output | Output Range                        | Description                                                                                                                 |
|-------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Voltage                 | 1 to 5 V<br>0 to 10 V<br>± 10 V     | You will find the digital analog values in Section 4.3.2 (of the reference manual) in the voltage and current output ranges |
| Current                 | 0 to 20 mA<br>4 to 20 mA<br>± 20 mA |                                                                                                                             |

#### Default settings

The default settings of the module are "Voltage" for the output type and "± 10 V" for the output range. You can use this combination of output type and output range without parameterizing the SM 332; AO 4 × 16 bits in *STEP 7*.

#### Substitute values

You can configure the SM 332; AO 4 × 16 bits for the CPU operating mode STOP as follows: Outputs De-energized, Hold Last Value or Inject Substitute Values. If you inject substitute values, they must be within the output range.