SIEMENS

SIMATIC

S7-300

Product information for the S7-300 Automation System Manual, Module Data

Product Information

Introduction

The present product information describes additions and corrections to the S7-300 Automation System Manual, Module Data, issued 03/2011 online (http://support.automation.siemens.com/WW/view/en/8859629).

Digital input module SM 321; DI 16 x DC 24 V; with hardware and diagnostic interrupts, isochronous

Order number: "Standard module"

6ES7321-7BH01-0AB0

Order number: "SIPLUS S7-300 module"

6AG1321-7BH01-2AB0

Properties

TheSM 321; DI 16 x DC 24 V; with hardware and diagnostic interrupts are distinguished by the following features:

- 16 inputs, electrically isolated in groups of 16
- Rated input voltage 24 VDC
- Input characteristics to IEC 61131, Type 2
- suitable for switches and 2- /3-/4-wire proximity switches (BEROs)
- 2 short circuitproof sensor supplies for each group of 8 channels
- external redundant sensor supply is supported
- "Sensor supply (Vs)" status display
- Group error display (SF)
- Supports isochronous mode
- Supports parameter reassignment in RUN
- Programmable diagnostics
- Programmable diagnostic interrupt
- Programmable hardware interrupts
- Programmable input delays

High-feature operation (HF operation)

From product class ES06, the module supports

- channel-granular diagnostics
  and
- channel-granular hardware interrupts.

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Requirements for the HF operation

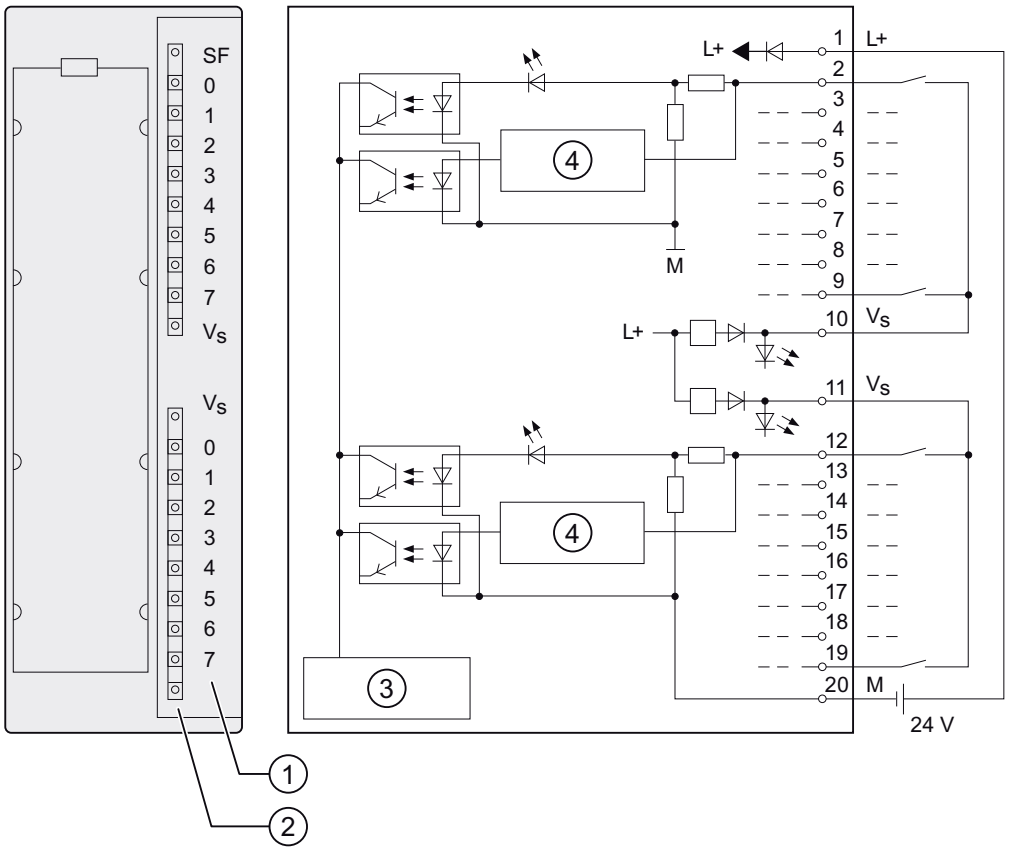
If the following requirements are met, the module will work in HF operation:

- Distributed operation in conjunction with a High-Feature interface module with:
  - PROFIBUS, as of IM153-2BAx2-0XB0
  - PROFINET, as of IM153-4BA00-0XB0
- Configured as of STEP7 V5.5+SP1+Hotfix 1 and/or SIMATIC process control system PCS 7 as of V8.0
  - as "SM 321 DI16xDC24V, Alarm, HF"
    or
- Configured using the corresponding GSD file with:
  - PROFIBUS as "6ES7321-7BH01-0AB0 HF 16DE"
  - PROFINET as "SM 321 DI16xDC24V HF".

Note

If the SM 321 is not configured as a "HF" module from ES06, then it functions compatible with earlier product classes and does not support channel-granular diagnostics or channel-granular hardware interrupts.

Wiring and block diagrams of SM 321; DI 16 x DC 24 V



① Channel number
② Status displays - green
Error displays - red
Sensor supply V_S -green
③ Backplane bus interface
④ Wire-break detection

Wiring diagram of the redundant sensor supply

The figure below shows how an additional redundant voltage source can be used to power sensors using Vs.

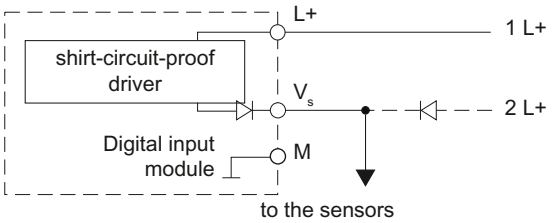
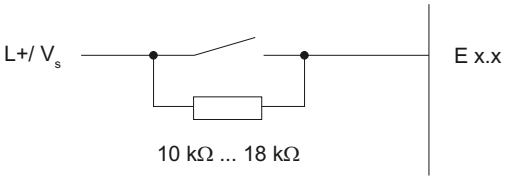


Figure 1 Wiring diagram of the redundant supply of sensors of SM 321; DI 16 x DC 24 V

Wiring diagram of the shunt circuit of the sensors

For wire-break detection, it is necessary to connect a shunt resistor to the transducer contacts.



Technical specifications of SM 321; DI 16 x DC 24 V

Technical specifications	
Dimensions and weight	
Dimensions W x H x D (mm)	40 x 125 x 117
Weight	ca. 200 g
Module-specific data	
Supports isochronous mode	yes
Supports parameter reassignment in RUN	yes
• Response of non-programmed inputs	return the process value which was valid before configuration
Number of inputs	16
Cable length • unshielded • shielded	 max. 600 m max. 1000 m
Voltages, currents, electrical potentials	
Rated supply voltage L+ for the electronic system and sensors	24 VDC
• Reverse polarity protection	yes
Number of simultaneously controlled inputs	
• horizontal mounting position to 60 °C	 16
• vertical mounting position to 40 °C	 16
Electrical isolation • between channels and the backplane bus • between channels – In groups of	 yes 16
Maximum potential difference	
• between different circuits	75 VDC / 60 VAC
Isolation test voltage	500 VDC

Technical specifications	
Current consumption	
• from the backplane bus	max. 130 mA
• from load voltage L + (without sensor supply V_S)	max. 90 mA
Power loss of the module	typ. 4 W
Status, interrupts, diagnostics	
Status display • Inputs	 green LED per channel
• Sensor supplies (Vs)	green LED per output
Interrupts • Hardware interrupt • Diagnostic interrupt	 programmable programmable
Diagnostic functions	programmable
• Group error display	red LED (SF)
• Reading diagnostic information	supported
Monitoring for • wirebreak	 yes, sensing I < 1 mA
Sensor supply outputs	
Number of outputs	2
Output voltage • on load	 min. L+ (- 2.5 V)
Output current • Rated value • Permitted range	 120 mA 0 mA to 150 mA
Additional (redundant) supply	supported
Short-circuit protection	yes, electronic
Sensor selection data	
Input voltage • Rated value • "1" signal • "0" signal	 24 VDC 13 V to 30 V -30 V to + 5 V
Input current • "1" signal	 typ. 7 mA
Input characteristics	to IEC 61131, type 2
Connection of 2-wire BEROs • Permissible quiescent current	supported max. 2 mA
Wiring the signal transducers	using a 20-pin front connector
Shunt circuit of the sensor for wire-break detection	10 kohms to 18 kohms
Time/frequency	
Internal preparation time for diagnostics (in non-isochronous mode) • Enabling of process and diagnostic interrupts	 max. 40 ms
Input delay • programmable • Rated value	 yes typ. 0.1/0.5/3/15/20 ms

Isochronous mode

Properties

Reproducible reaction times (i.e. of the same length) are achieved in a SIMATIC system by means of a constant DP bus cycle, and synchronization of the single cyclic processes outlined below:

- Independent user program cycle. The length of the cycle time may vary due to non-cyclic program branching.
- Independent and variable DP cycle on the PROFIBUS subnet
- Cyclic operation of the backplane bus of the DP slave.
- Cyclic signal conditioning and conversion at the electronic modules of the DP slave.

The constant DP cycle runs in synchronism and at the same length. The CPU run levels (OB61 to OB64) and isochronous IO are synchronized with this cycle. I/O data are therefore transferred at defined and constant intervals (isochronous mode.)

Requirements

- The DP master and slave must support isochronous mode. STEP 7 V5.2 or higher.

Operating mode: Isochronous mode

Conditions of isochronous mode:

Filtering and processing time T_{WE} between reading actual values and writing these to the transfer buffer(the value defined for T_{WE} applies, irrespective of the enable status of diagnostics)	255 µs to 345 µs
includes an input delay time of	100 µs
T_{DPmin}	2.5 ms
Diagnostic interrupt	max. 4 x T_{DP}

Note

In "isochronous" mode, the input delay is automatically set to 100 µs, regardless of the input delay setting in STEP 7

Further information

For further information on the isochronous mode, refer to STEP 7 Online Help, in the operating instructions ET 200M Distributed IO System (http://support.automation.siemens.com/WW/view/en/1142798) and Isochronous Mode (http://support.automation.siemens.com/WW/view/en/15218045) in the manual.

SM 321; DI 16 x DC 24 V - Parameters

The table below shows an overview of configurable parameters and their default settings for SM 321; DI 16 x DC 24 V.

The default settings apply if you have not set any parameters in STEP 7.

Table 1 Parameter of the SM 321; DI 16 x DC 24 V

Parameters	Range of values	Default	Parameter type	Scope	Scope in HF operation
Enable • Diagnostic interrupt • Hardware interrupt	 yes/no yes/no	 no no	dynamic	Module	Module
Input delay/ voltage type	0.1 ms (DC) 0.5 ms (DC) 3 ms (DC) 15 ms (DC) 20 ms (DC/AC)	(DC)	static	Module	Module
Diagnostics • Missing sensor supply	yes/no	no	static	Channel group (8 channels)	Channel group (8 channels)
• Wire break	yes/no	no	static	Channel group (2 channels)	channel-granular
Hardware interrupt trigger • Positive edge	yes/no	no	dynamic	Channel group (2 channels)	channel-granular
• Negative edge	yes/no	no	dynamic	Channel group (2 channels)	channel-granular

Allocating the sensor supplies to channel groups

The module's two sensor supplies power the two channel groups: Inputs 0 to 7 and inputs 8 to 15. You also configure diagnostics for the sensor supply at these channel groups.

Assigning interrupt parameters to channel groups

Diagnostics of missing sensor supply:

The diagnostic interrupt can be set to each 8 channels in channel groups. If there is a fault with the sensor supply, then the diagnostics interrupt will be reported to all channels/channels groups concerned.

Diagnostics interrupts in the event of wire breaks:

In "HF operation" of the SM 321, the diagnostics interrupt can be programmed channel-granularly. If a wire break is registered, it is reported to the corresponding channel.

If the SM 321 is not working in "HF operation", the diagnostics interrupt in channel groups is programmed and reported to each 2 channels. The 16 channels of the SM 321 are compiled into 8 channel groups (0 ... 7). This means, for example, that one diagnostic interrupt is reported for any wire break diagnostic interrupt in channel group 3 (channel 6 and 7), so for any wire breaks in either channel 6 or 7.

Hardware interrupt (triggered by negative, positive or both edges):

In "HF operation" of the SM 321 the edges which trigger hardware interrupts are programmed channel-granularly and the channel-granular edge transitions are reported as hardware interrupts.

If the SM 321 is not working in "HF operation", the edges which trigger hardware interrupts in channel groups are each programmed to 2 channels. That means that the channels compiled in the channel groups always work with the identical programming. However, the corresponding edge transitions are reported channel-granularly per hardware interrupt.

Tolerances of the programmable input delays

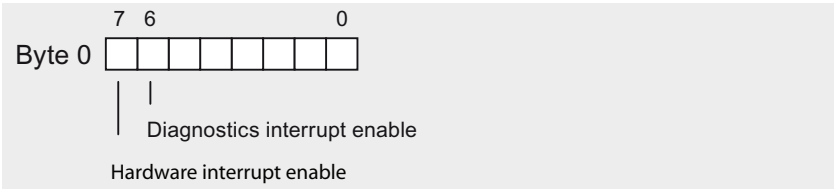
Table 2 Tolerances of the input delay times of theSM 321; DI 16 x DC 24 V

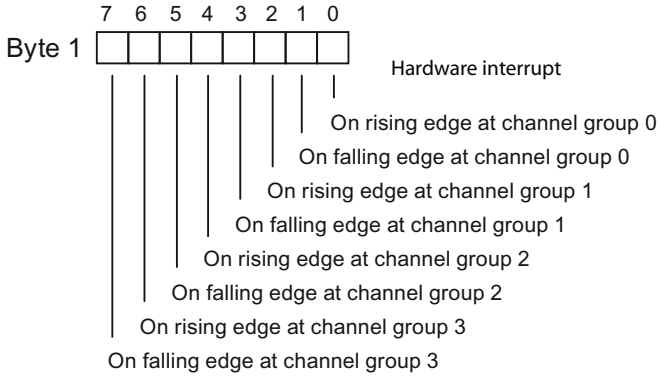
Programmed input delay	Tolerance
0.1 ms	60 µs to 140 µs
0.5 ms	400 ms to 900 ms
3 ms (default)	2.6 ms to 3.3 ms
15 ms	12 ms to 15 ms
20 ms	17 ms to 23 ms

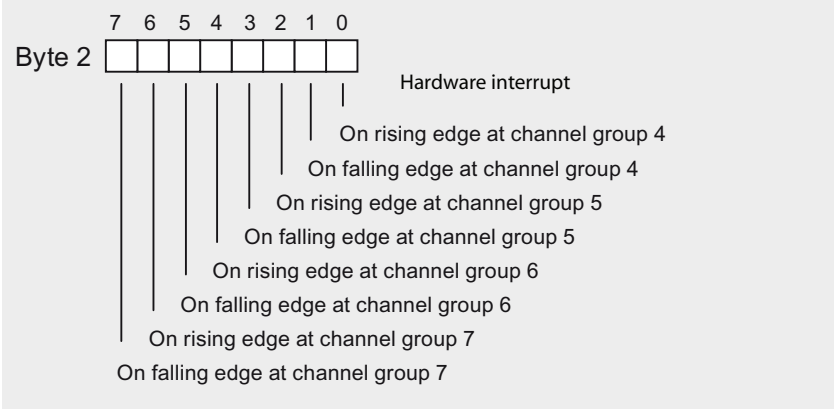
Programming the Data Set 1 parameter of SM 321; DI 16xDC24V not in "HF operation".

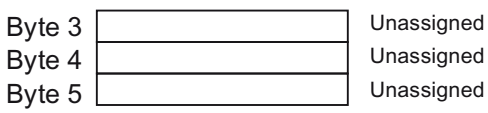
You enable a parameter by setting the corresponding bit to "1".

If the module does not work in "HF operation", programming takes place via the parameter in byte 1 ... 2 with channels groups each with 2 channels.





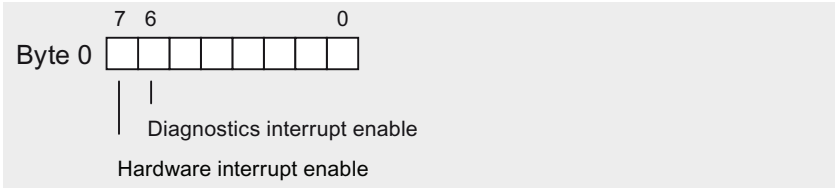


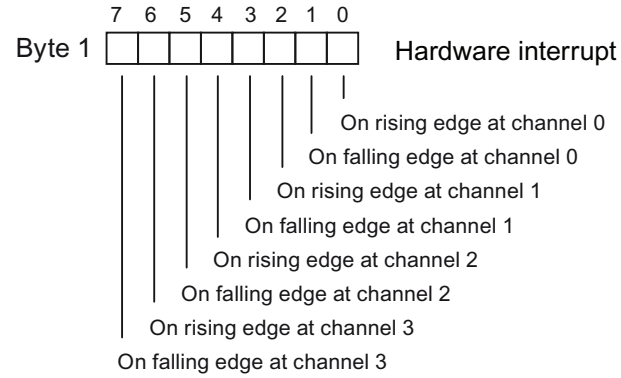


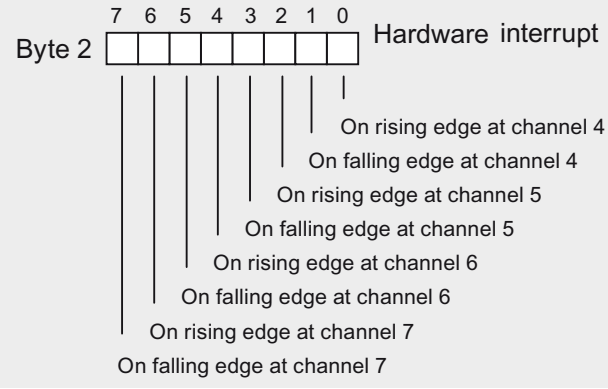
Programming of the Data Set 1 parameter of SM 321; DI 16xDC24V in "HF operation".

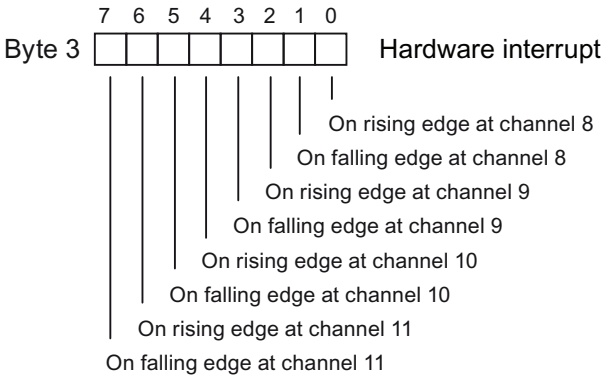
You enable a parameter by setting the corresponding bit to "1".

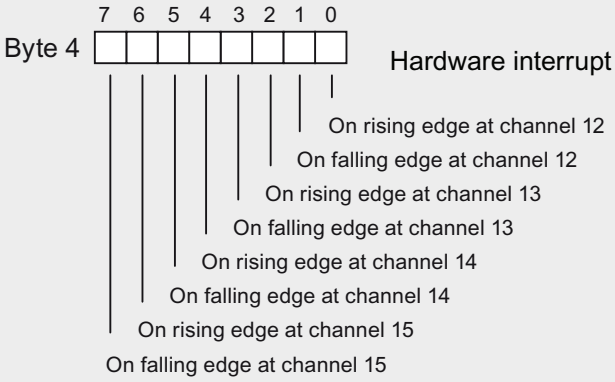
In "HF operation" of the module, the edges which trigger the hardware interrupts are programmed channel-granularly via the parameters in byte 1 ...4.

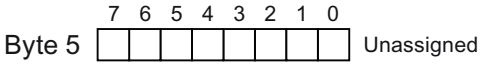







7 6 5 4 3 2 1 0
Byte 3
Hardware interrupt
On rising edge at channel 8
On falling edge at channel 8
On rising edge at channel 9
On falling edge at channel 9
On rising edge at channel 10
On falling edge at channel 10
On rising edge at channel 11
On falling edge at channel 11


7 6 5 4 3 2 1 0
Byte 4
Hardware interrupt
On rising edge at channel 12
On falling edge at channel 12
On rising edge at channel 13
On falling edge at channel 13
On rising edge at channel 14
On falling edge at channel 14
On rising edge at channel 15
On falling edge at channel 15


7 6 5 4 3 2 1 0
Byte 5
Unassigned

SM 321; DI 16 x DC 24 V - Diagnostics

Diagnostic messages of SM 321; DI 16 x DC 24 V

The table below provides an overview of the diagnostic messages.

Table 3 Diagnostic messages of SM 321; DI 16 x DC 24 V

Diagnostic message	Scope of diagnostics	programmable
Sensor supply missing	Channel group (8 channels)	yes
Wire break in "HF operation"	Channel	
Wire break not in "HF operation"	Channel group (2 channels)	
Channel not programmed ("HF operation")	Channel	
Channel module not programmed (non "HF operation")	Channel group	
External auxiliary voltage missing	Module	no
Internal auxiliary voltage missing	Module	
Fuse blown	Module	
No/incorrect programming in module	Module	
Watchdog timeout	Module	
EPROM fault	Module	
RAM fault	Module	
Hardware interrupt lost	Module	

Note

In order to detect the errors indicated by programmable diagnostic messages you must have programmed the digital module accordingly in STEP 7.

If the SM 321 is not working in "HF operation", one of the wire break diagnostic messages reported by the SM 321 always concerns one channel group. It is only possible to determine that one of the two channels has suffered a wire break; it is not possible to identify which one.

The structure of the diagnosis data is described in the S7-300 module data (http://support.automation.siemens.com/WW/view/en/8859629) device manual in chapter "Configuration and Content of the Diagnostics Data from Byte 0"

In "HF operation" the SM 321 supplies the module with a total of 25 Byte diagnostic information (Diagnostic data set 0 with a length of 4 Byte and the Diagnostic data set 1 with a length of 25 Byte).

If the SM 321 work in "HF operation", 16 Byte diagnostic information is formed (Diagnostic data set 0 with a length of 4 Byte and the Diagnostic data set 1 with a length of 16 Byte).

Causes of error and troubleshooting

Table 4 Diagnostics Messages of the SM 321; DI 16 x DC 24 V, causes of error and troubleshooting

Diagnostic message	Possible cause of error	To correct or avoid error
Sensor supply missing	Overload at sensor supply	Eliminate overload
	Short-circuit to M at sensor supply	Eliminate the short-circuit
External auxiliary voltage missing	Power supply L+ to module missing	Feed supply L+
Internal auxiliary voltage missing	Power supply L+ to module missing	Feed supply L+
	Fuse blown in module	Replace the module
Fuse blown	Fuse blown in module	Replace the module
Incorrect module parameters	Implausible parameter or combination thereof	Program the module
Watchdog timeout	Infrequent high electromagnetic interference	Eliminate the interference
	Module defective	Replace the module
EPROM fault	Infrequent high electromagnetic interference	Eliminate interference and cycle the power supply of CPU off/on.
	Module defective	Replace the module
RAM fault	Infrequent high electromagnetic interference	Eliminate interference and cycle the power supply of CPU off/on.
	Module defective	Replace the module
Hardware interrupt lost	The module can not output an interrupt, because the previous interrupt was not acknowledged; possibly a configuration error	Change interrupt processing in the CPU, and reprogram the module as required The error persists until the module is assigned new parameters
Module not programmed	Startup error	Program the module

SM 321; DI 16 x DC 24 V - Behavior

Influence of the operating state and supply voltage on input values

The SM 321; DI 16 x DC 24 input values are determined by the CPU's operating state and the module's power supply.

Table 5 Dependency of input values on the CPU's operating state, and on the L+ power

CPU operating state		Power supply L+ at digital module	input value of the digital module
POWER ON	RUN	L+ present	Process value
		L+ missing	0 signal
	STOP	L+ present	Process value
		L+ missing	0 signal
POWER OFF	-	L+ present	-
		L+ missing	-

Reaction to power failure

Failure of the SM 321; DI 16 x DC 24 power supply is always indicated by the module's SF LED. This information is also available on the module.

The input value is initially held for the duration of 20 ms to 40 ms before the zero signal is transferred to the CPU. Supply voltage dips <20 ms do not influence the process value (see the table above.)

Triggering of diagnostic interrupts is determined by the parameter settings (see chapter Interrupts of SM 321; DI 16 x DC 24 V (Page 13)).

Power supply failure with redundant external sensor supply

Note

When an external redundant power source is connected in parallel to the sensor supply (Vs) and the L+ power supply fails, the module does not report failure of the sensor supply, but rather the failure of the internal and/or external auxiliary voltage, and/or a blown fuse.

Short-circuit at the sensor supply Vs

The relevant Vs LED goes dark if a short-circuit is detected at the sensor supply Vs, irrespective of parameter settings.

SM 321; DI 16 x DC 24 V - Interrupts

Introduction

This section describes the SM 321; DI 16 x DC 24 V in terms of its interrupt behavior. Always distinguish between the following interrupts:

- Diagnostic interrupt
- Hardware interrupt

For detailed information on the OBs and SFCs mentioned below, refer to the STEP 7 Online Help.

Enabling interrupts

There is no default interrupt setting, i.e. interrupts are disabled if parameters are not set accordingly. You can enable interrupts in STEP 7 (see the chapter Parameters of SM 321; DI 16 x DC 24 V (Page 6)).

Diagnostic interrupt

When diagnostic interrupts are enabled, incoming error events (initial occurrence) and outgoing error events (error is cleared) are reported by means of an interrupt.

The CPU interrupts user program execution in order to process diagnostic interrupt OB82.

You can call SFC51 or 59 in OB82 in the user program to view detailed diagnostics data output by the module.

Diagnostics data remain consistent until the program exits OB82. The module acknowledges the diagnostic interrupt when the program exits OB82.

Hardware interrupt

SM 321; DI 16 x DC 24 V can trigger a hardware interrupt for each channel at the positive, negative, or both edges of a signal transition.

Perform the programming of the SM 321 channel-granularly in "HF operation", otherwise per channel group (see Section Programming SM 321; DI 16 x DC 24 V (Page 6)).

Active hardware interrupts trigger hardware interrupt processing in the CPU (OB40) and interrupt execution of the user program or of object classes with lower priority in the CPU.

You can define the response of the AS to signal edge transitions in the user program of hardware interrupt OB40. The module acknowledges the hardware interrupt when the program exits the hardware interrupt OB.

The module can save one interrupt per channel to the stack. If no higher priority classes are pending processing, the CPU processes the buffered interrupts (of all modules) in the order of their occurrence.

Hardware interrupt lost

A "Hardware interrupt lost" diagnostic interrupt is generated if a successive interrupt is triggered at the channel previously saved to the stack and which has not yet been processed by the CPU.

The CPU does not register any further interrupts at this channel unless it has completed processing of the queued interrupts of the same channel.

Interrupt-triggering channels

The relevant hardware interrupt-triggering channel is logged in the OB40_POINT_ADDR variable of the start information of OB40. The figure shows the bit assignments of DWORD 8 in the local data.

Byte	Variable	Data type		Description
6/7	OB40_MDL_ADDR	WORD	B#16#0	Address of the interrupt-triggering module
starting at 8	OB40_POINT_ADDR	DWORD	see the figure below	Indication of the interrupt-triggering inputs

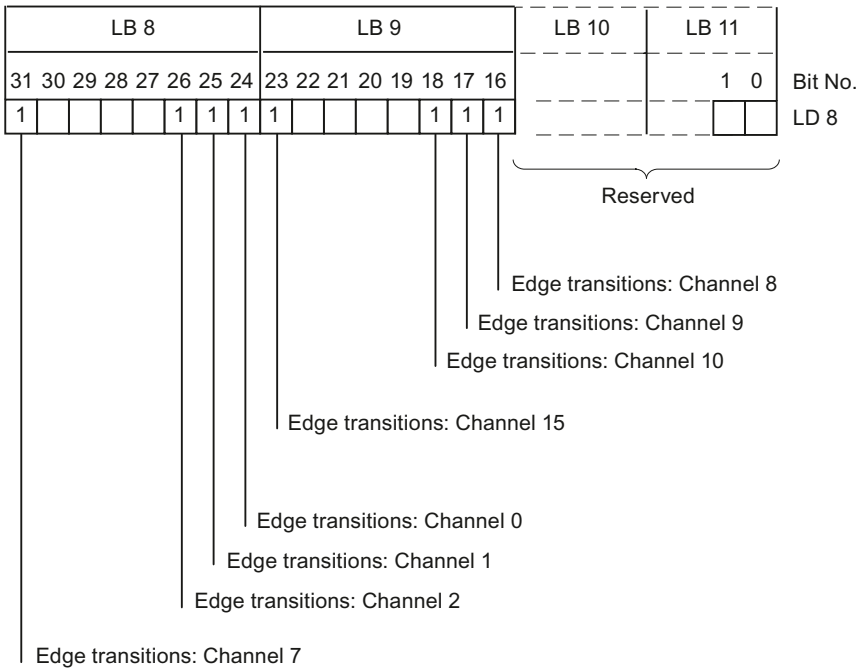


Figure 2 Start Information of OB40: which event has triggered the hardware interrupt

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A5E03696579-01, 10/2011