8.3 SM 326; DI 24 x DC 24V

8.3.1 Properties, Front View, Connection Diagram, and Block Diagram

Order number

6ES7326-1BK02-0AB0

Properties

SM 326; DI 24 x DC 24V has the following properties:

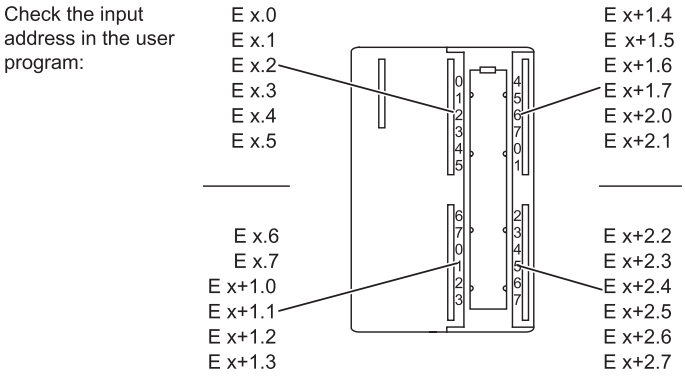
- 24 inputs, electrically isolated groups of 12 inputs
- Rated input voltage 24 V DC
- Suitable for switches and 2-/3-/4-wire proximity switches (BEROs)
- Four short circuit-proof sensor supplies for each of the 6 channels, electrically isolated in groups of 2
- External sensor supply possible
- Group fault display (SF)
- Safety mode display (SAFE)
- Status display for each channel (green LED)
- Configuration in Run (CiR) supported in standard mode (non-safety mode)
- Programmable diagnostics functions
- Assignable diagnostic interrupt
- Supports operation in standard and safety mode
- SIL3/Cat.4/PLe can be achieved without safety protector
- 1oo1 and 1oo2 evaluation can be configured separately for each channel
- Simplified PROFIsafe address assignment
- I&M identification data
- can be used with PROFINET IO
- supports time stamping
- Acknowledgment possible after voltage dip

Note

The fail-safe performance characteristics in the technical data apply to a proof-test interval of 10 years and a mean time to repair of 100 hours.

Address assignment

The following figure shows the assignment of channels to addresses.



x = Module start address

Figure 8-1 Address assignment for SM 326; DI 24 x DC 24V

Configuration in RUN (CiR)

The SM 326; DI 24 x DC 24V (as of order no. 6ES7326-1BK01-0AB0) supports configuration in run (CiR) when operated in standard mode (non-safety mode).

Additional information on CiR

For additional information on CiR, refer to:

- *STEP 7* online help: "System changes in run using CiR"
- in the *Safety Engineering in SIMATIC S7* system description.

Front view

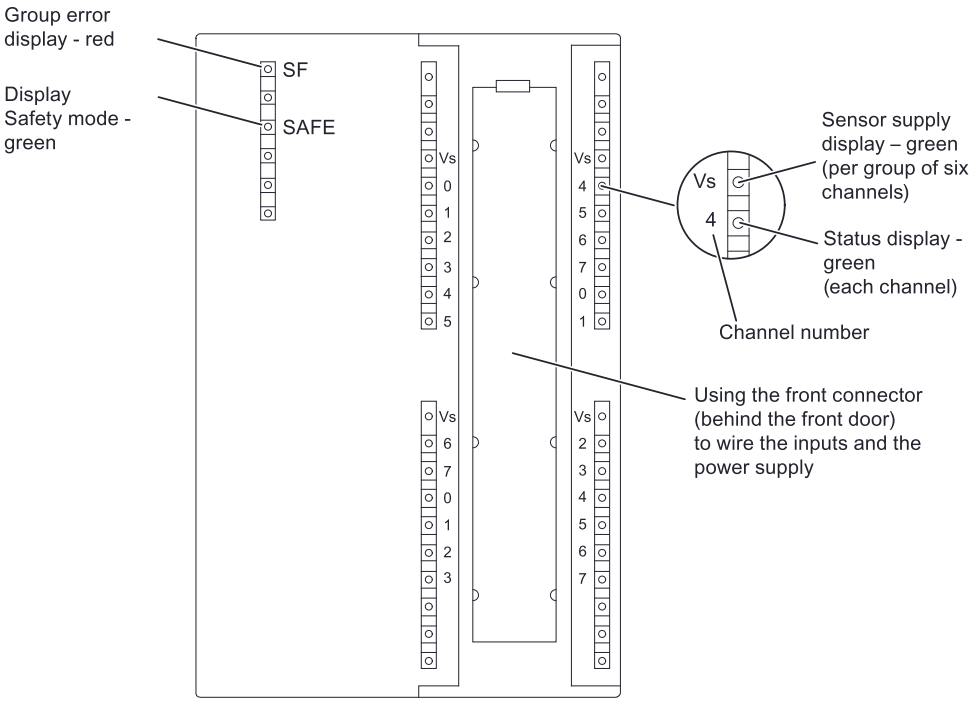


Figure 8-2 Front view of SM 326; DI 24 x DC 24V

Channel numbers

The channel numbers are used to uniquely identify the inputs and to assign channel-specific diagnostic messages. You can configure 1oo1 and 1oo2 evaluation of the sensors separately for each module channel or channel pair (see table below for example).

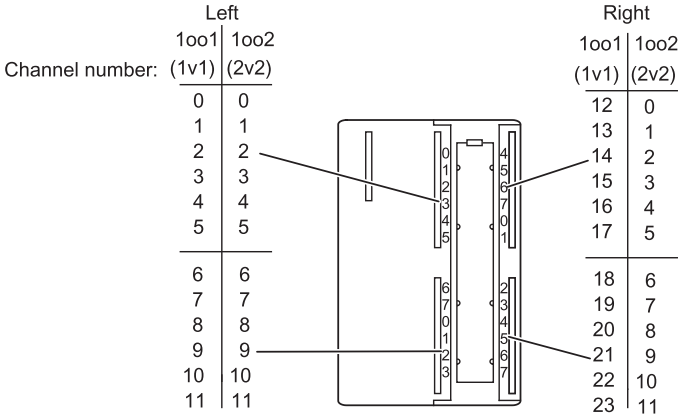
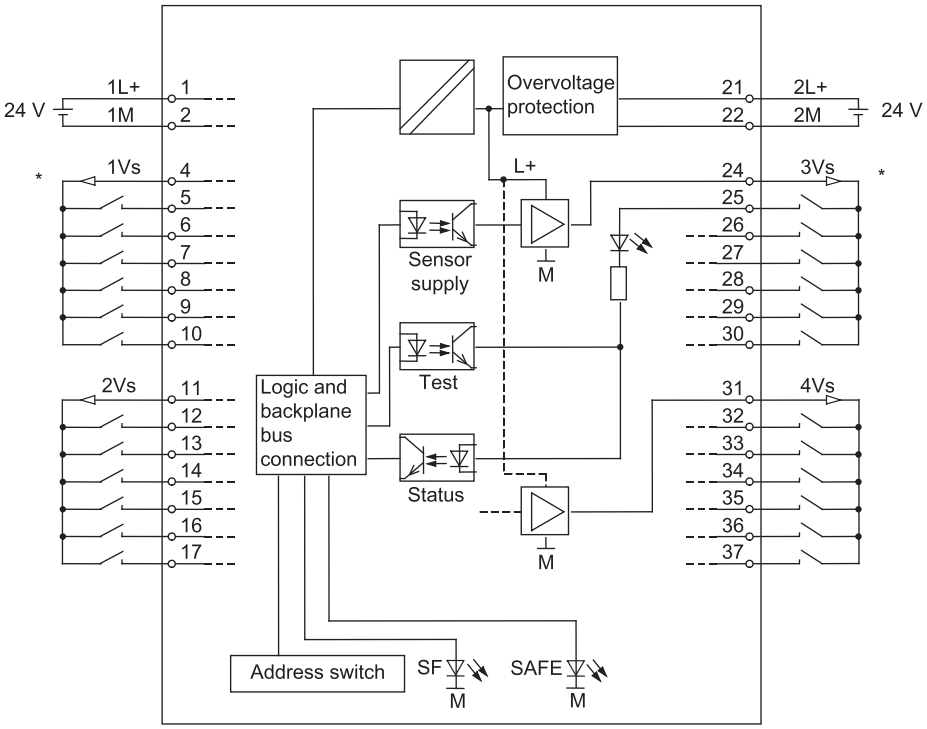


Figure 8-3 Channel numbers for SM 326; DI 24 x DC 24V

Table 8- 1 SM 326; DI 24 x DC 24V: Example of a channel configuration

Left channels	Right channels	Evaluation of the sensors	Description
0	12	1oo2	Channel pair configured for 1oo2 evaluation; channel 0 is available as I x.0 in the I/O input area in the F-CPU
1	13	1oo2	Channel pair configured for 1oo2 evaluation; channel 1 is available as I x.1 in the I/O input area in the F-CPU
2	14	1oo1	Single channels configured for 1oo1 evaluation, channels 2 and 14 are available as I x.2 and I x+1.6 in the I/O input area in the F-CPU
3	15	1oo1	Single channels configured for 1oo1 evaluation, channels 3 and 15 are available as I x.3 and I x+1.7 in the I/O input area in the F-CPU
4	16	1oo2	Channel pair configured for 1oo2 evaluation; channel 4 is available as I x.4 in the I/O input area in the F-CPU

Wiring and block diagram of SM 326; DI 24 x DC 24V and internal sensor supply



* The representation of NO contacts matches the module labeling. Usually, the sensors must be equipped with NC contacts in order to ensure the safe state of process variables.

Figure 8-4 Wiring and block diagram of SM 326; DI 24 x DC 24V and internal sensor supply

External sensor supply

The figure below shows how you can connect the sensors to an external sensor supply (for example, from another module: L+). All 6 channels of a channel group (0 to 5; 6 to 11; 12 to 17 or 18 to 23) must be connected to the same external sensor supply.

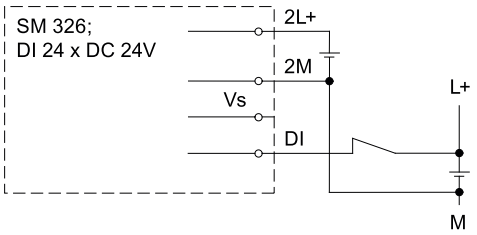


Figure 8-5 External sensor supply for SM 326; DI 24 x DC 24V

Note

Note that the errors outlined cannot be detected when operating with external sensor supply:

- Short-circuit to L+ on the unconnected sensor line (open contact)
- Short-circuit between channels of a channel group
- Short-circuit between channels of different channel groups

For electronic sensors (and therefore with external sensor supply), you can meet these three points by short-circuit proof routing of the sensor lines.

8.3.2 Use cases for the SM 326; DI 24 24V DC

Selecting the application

The figure below helps you to select an application based on availability and fail-safe operation requirements. The next pages provide information on the module wiring for a specific application, and on the parameters to set in *STEP 7* using the *S7 Distributed Safety* or *S7 F Systems* optional package.

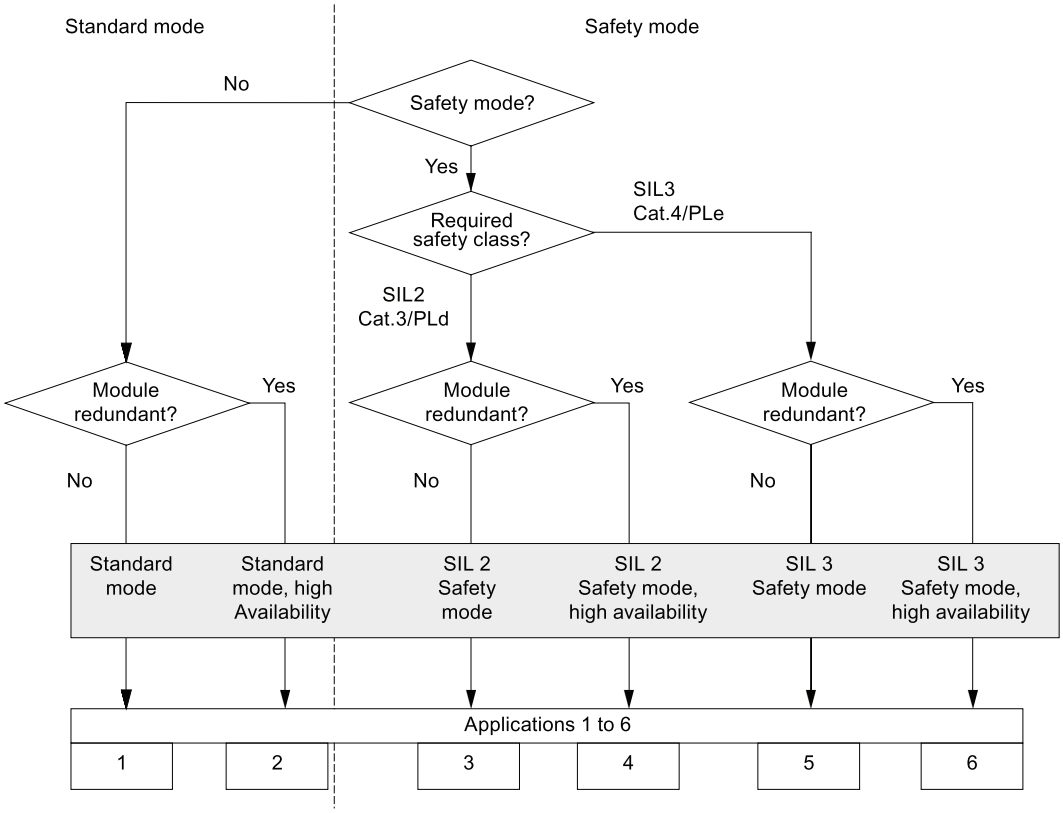


Figure 8-6 SM 326; DI 24 x DC 24V - Selecting an application

WARNING

The maximum Safety Integrity Level is determined by the sensor quality and the length of the proof-test interval to IEC 61508. Always wire sensors whose quality does not meet Safety Integrity Level requirements redundantly to two channels.

Note

You can define 1oo1 and 1oo2 sensor evaluation for a module (for example, see table *SM 326; DI 24 x DC 24V: Example of channel configuration* in the chapter *Properties, front View, wiring diagram and block diagram*).

8.3.3 Application 1 : Standard Mode

Introduction

Below are the wiring scheme and the parameter assignment of SM 326; DI 24 x DC 24V for application 1: Standard mode

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages of SM 326; DI 24 x DC 24V (Page 99)".

Wiring diagram of application 1 with single-channel connection of a one sensor

A sensor is wired to a single channel for each process signal. The sensors can also be connected to an external sensor supply.

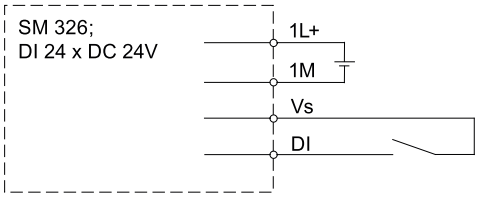


Figure 8-7 Wiring scheme of the SM 326; DI 24 x DC 24V for application 1 – one sensor single-channel connection

Assignable parameters for application 1

Table 8- 2 Parameters for application 1 of SM 326; DI 24 x DC 24V

Parameters	Range of values in standard mode	Type	Effective range
"Parameters" tab			
Mode of operation	Standard mode	static	module
Module parameters:			
Diagnostic interrupt	activated/deactivated	static	module
Module parameters for a power supply group:			
Internal sensor supply of the module	activated/deactivated	static	Power supply group
Short-circuit test	activated/deactivated * (only if "Sensor Supply via Module" is activated)	static	Power supply group
For single channels or channel pairs:			
activated	activated/deactivated	static	channel
* Vs does not clock, if the short-circuit test is deactivated.			

8.3.4 Application 2 : Standard operation with high availability

Introduction

Below are the wiring scheme and the parameter assignment of SM 326; DI 24 x DC 24V for application 2: standard mode with high availability

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages of SM 326; DI 24 x DC 24V (Page 99)".

Wiring scheme of application 2 with single-channel connection of one sensor

One sensor is connected via one channel to two digital modules for each process signal. The sensors must be connected to an external sensor supply.

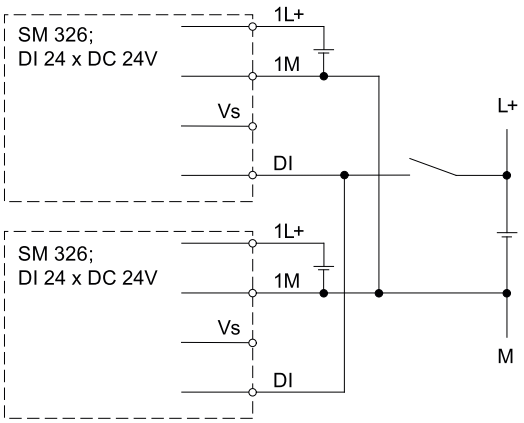


Figure 8-8 Wiring scheme of the SM 326; DI 24 x DC 24V for application 2 – one sensor single-channel connection

Wiring scheme for application 2 with single-channel connection of two redundant sensors

Two redundant sensors are wired to a single channel at the two analog modules for each process signal. The sensors can also be connected to an external sensor supply.

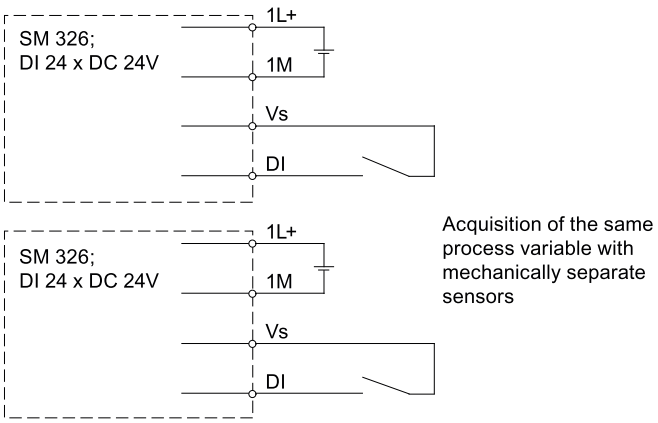


Figure 8-9 Wiring scheme of the SM 326; DI 24 x DC 24V for application 2 – two redundant sensors single-channel connection

Assignable parameters for application 2

Table 8- 3 Parameters for application 2 of SM 326; DI 24 x DC 24V

Parameters	Range of values in standard mode	Type	Effective range
"Parameters" tab			
Mode of operation	Standard mode	static	module
Module parameters:			
Diagnostic interrupt	activated/deactivated	static	module
Module parameters for a power supply group:			
Internal sensor supply of the module	• deactivated (for single-channel connection of a sensor) • activated/deactivated (for redundant sensor)	static	Power supply group
Short-circuit test	activated/deactivated * (only if "Sensor Supply via Module" is activated)	static	Power supply group
For single channels or channel pairs:			
activated	activated/deactivated	static	channel
"Redundancy" tab **			
Redundancy	2 modules	static	module
Redundant module	(selection of an existing additional module of the same type)	static	redundant module pair
Discrepancy time	10 ms to 30000 ms	static	redundant module pair

Parameters	Range of values in standard mode	Type	Effective range
Reaction to discrepancy error	• Link signals by logical "AND" operation • Link signals by logical "OR" operation • Use last valid value	static	redundant module pair
* Vs does not clock, if the short-circuit test is deactivated. ** There are two digital values in the case of redundant configuration in standard mode; you must evaluate them in the standard user program.			

8.3.5 Application 3: Safety mode SIL2/Cat.3/PLd

Introduction

Below are the wiring scheme and the parameter assignment of the SM 326; DI 24 x DC 24V digital module for application 3: Safety Mode SIL2/Cat.3/PLd.

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages of SM 326; DI 24 x DC 24V (Page 99)".

Wiring scheme for application 3 with single-channel connection of one single-channel sensor

One sensor is connected via one channel for each process signal (1oo1 evaluation). The sensors can also be connected to an external sensor supply.

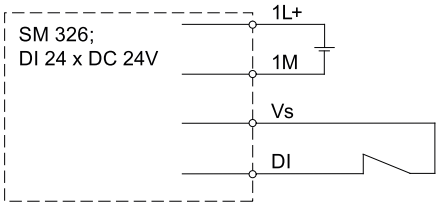


Figure 8-10 Wiring scheme of the SM 326; DI 24 x DC 24V for application 3 – one sensor single-channel connection

WARNING

To achieve SIL2/Cat.3/PLd using this wiring, you must use a suitably qualified sensor.

Assignable parameters for application 3

Table 8- 4 Parameters for application 3 of SM 326; DI 24 x DC 24V

Parameters	Range of values in safety mode	Type	Effective range
"Parameters" tab			
Mode of operation	Safety mode	static	module
F parameter:			
F monitoring time	10 ms to 10000 ms	static	module
Module parameters:			
Diagnostic interrupt	activated/deactivated	static	module
Module parameters for a power supply group:			
Internal sensor supply of the module	activated/deactivated	static	Power supply group
Short-circuit test	activated/deactivated * (only if "Sensor Supply via Module" is activated)	static	Power supply group
For single channels or channel pairs:			
activated	activated/deactivated	static	channel
Evaluation of the sensors	1oo1 evaluation	static	Channel/channel pair
* Vs does not clock, if the short-circuit test is deactivated.			

8.3.6 Application 4: Safety mode SIL2/Cat.3/PLd with high availability (in S7 F/FH Systems only)

Introduction

Below are the wiring scheme and the parameter assignment of the SM 326; DI 24 x DC 24V digital module for application 4: Safety Mode SIL2/Cat.3/PLd with high availability.

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages of SM 326; DI 24 x DC 24V (Page 99)".

Wiring scheme for application 4 with single-channel connection of one sensor

One sensor is connected via one channel to the two digital modules for each process signal (1oo1 evaluation). The sensors must be connected to an external sensor supply.

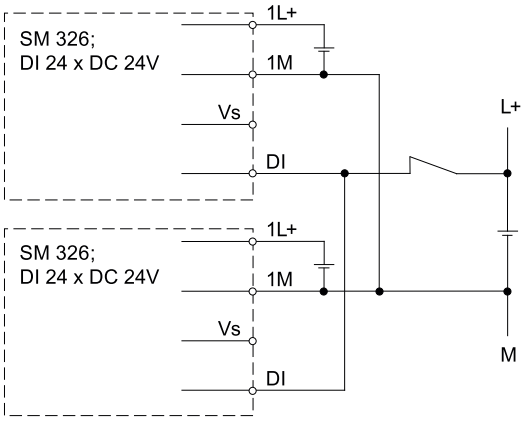


Figure 8-11 Wiring scheme of the SM 326; DI 24 x DC 24V for application 4 – one sensor single-channel connection

WARNING
To achieve SIL2/Cat.3/PLd using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 4 with single-channel connection of two redundant sensors

Two redundant sensors are each connected via one channel to the two analog modules for each process signal (1oo1 evaluation). The sensors can also be connected to an external sensor supply.

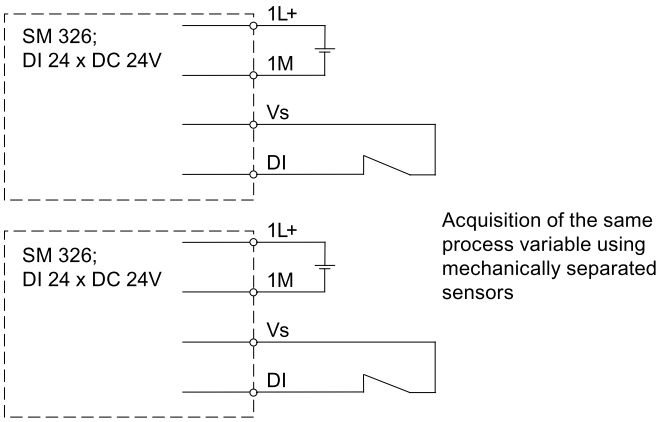


Figure 8-12 Wiring scheme of the SM 326; DI 24 x DC 24V for application 4 – two redundant sensors single-channel connection

WARNING
To achieve SIL2/Cat.3/PLd using this wiring, you must use a suitably qualified sensor.

Assignable parameters for application 4

Table 8- 5 Parameters for application 4 of SM 326; DI 24 x DC 24V

Parameters	Range of values in safety mode	Type	Effective range
"Parameters" tab			
Mode of operation	Safety mode	Static	Module
F parameter:			
F monitoring time	10 ms to 10000 ms	Static	Module
Module parameters:			
Diagnostic interrupt	activated/deactivated	Static	Module
Module parameters for a power supply group:			
Internal sensor supply of the module	Activated/deactivated	Static	Power supply group
Short-circuit test	activated/deactivated * (only if "Sensor Supply via Module" is activated)	static	Power supply group
For single channels or channel pairs:			
activated	activated/deactivated	static	channel
Evaluation of the sensors	1oo1 evaluation	static	channel
"Redundancy" tab			
Redundancy	2 modules	static	module

Parameters	Range of values in safety mode	Type	Effective range
Redundant module	(selection of an existing additional module of the same type)	static	redundant module pair
Discrepancy time	10 ms to 30000 ms	static	redundant module pair
* Vs does not clock, if the short-circuit test is deactivated.			

8.3.7 Application 5: Safety mode SIL3/Cat.4/PLe

Introduction

Below are the wiring scheme and the parameter assignment of the SM 326; DI 24 x DC 24V digital module for application 5: Safety mode SIL3/Cat.4/PLe.

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages of SM 326; DI 24 x DC 24V (Page 99)".

Wiring of sensors when using the internal sensor supply of the module

Note

In general, if you connect *one* sensor to two inputs of the module and you are using the module-internal sensor supply, you must always use the sensor supply of the left half of the module 1Vs (pin 4) or 2Vs (pin 11).

Wiring scheme of application 5 with single-channel connection of one sensor

One sensor is connected via one channel to each of two *opposite inputs* of the digital module for each process signal (1oo2 evaluation). The sensors can also be connected to an external sensor supply.

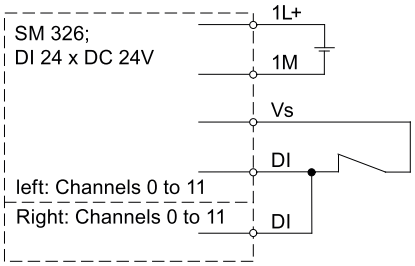


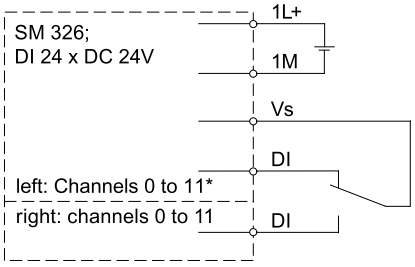
Figure 8-13 Wiring scheme of the SM 326; DI 24 x DC 24V for application 5 – one sensor single-channel connection

WARNING

To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 5 with two-channel nonequivalent connection of one nonequivalent sensor

One nonequivalent sensor is connected via two channels nonequivalently to each of two *opposite inputs* of the digital module for each process signal (1oo2 evaluation). The sensors can also be connected to an external sensor supply. The left channels of the module return the user signals, that is, these signals are available in the I/O area of inputs at the F-CPU if no errors are detected.



*The left channels return the user signals

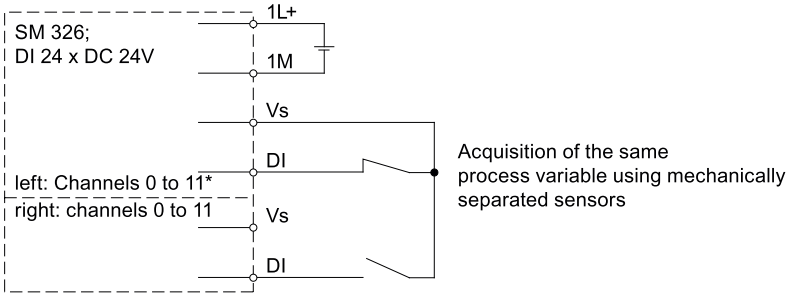
Figure 8-14 Wiring scheme of the SM 326; DI 24 x DC 24V for application 5 – one nonequivalent sensor two-channel nonequivalent connection

WARNING

To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 5 with nonequivalent two-channel connection of two single-channel sensors

Two single-channel sensors are connected via two channels nonequivalently to each of two *opposite inputs* of the digital module for each process signal (1oo2 evaluation structure). The sensors can also be connected to an external sensor supply. The left channels of the module return the user signals, that is, these signals are available in the I/O area of inputs at the F-CPU if no errors are detected.



*The left channels return the user signals

Figure 8-15 Wiring scheme of the SM 326; DI 24 x DC 24V for application 5 – two single-channel sensors two-channel nonequivalent connection

WARNING

To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 5 with two-channel connection of one two-channel sensor

One two-channel sensor is connected via two channels to each of two *opposite inputs* of the digital module for each process signal (1oo2 evaluation). The sensors can also be connected to an external sensor supply.

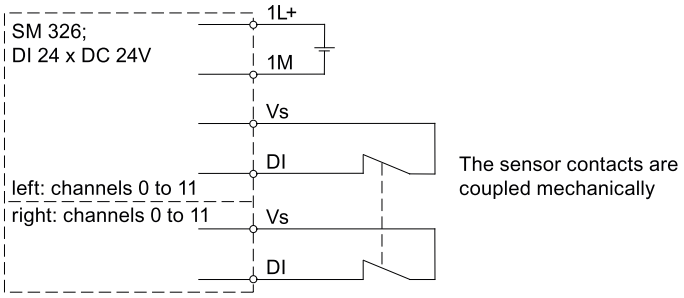


Figure 8-16 Wiring scheme of the SM 326; DI 24 x DC 24V for application 5 – one two-channel sensor two-channel connection

WARNING

To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 5 with two-channel connection of two single-channel sensors

Two single-channel sensors are connected via two channels to each of two *opposite inputs* of the digital module for each process signal (1oo2 evaluation structure). The sensors can also be connected to an external sensor supply.

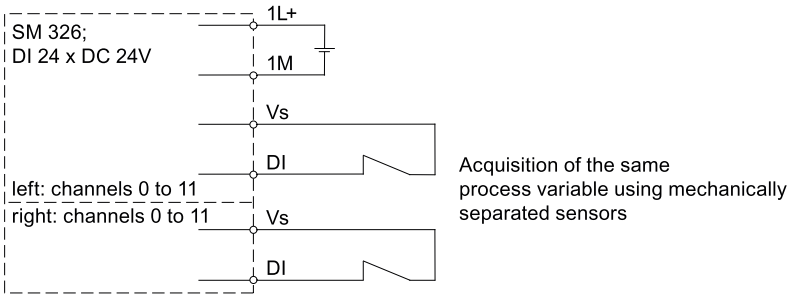


Figure 8-17 Wiring scheme of the SM 326; DI 24 x DC 24V for application 5 – two single-channel sensors two-channel connection

WARNING
To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Assignable parameters for application 5

Table 8- 6 Parameters for application 5 of SM 326; DI 24 x DC 24V

Parameters	Range of values in safety mode	Type	Effective range
"Parameters" tab			
Mode of operation	Safety mode	Static	Module
F parameter:			
F monitoring time	10 ms to 10000 ms	Static	Module
Module parameters:			
Diagnostic interrupt	Activated/deactivated	Static	Module
Module parameters for a power supply group:			
Internal sensor supply of the module	Activated/deactivated	Static	Power supply group
Short-circuit test	activated/deactivated * (only if "Sensor Supply via Module" is activated)	Static	Power supply group
For single channels or channel pairs:			
activated	activated/deactivated	Static	Channel pair
Evaluation of the sensors	1oo2 evaluation	Static	Channel pair
Type of sensor interconnection	• Two-channel, equivalent • Two-channel, nonequivalent • Single-channel	Static	Channel pair
Discrepancy behavior	(only two-channel) • "Provide last valid value" • Provide 0 value	Static	Channel pair
Discrepancy time	10 ms to 30000 ms (only for two-channel)	Static	Channel pair
* Vs does not clock, if the short-circuit test is deactivated.			

8.3.8 Application 6: Safety mode SIL3/Cat.4/PLe with high availability (in S7 F/FH Systems only)

Introduction

Below are the wiring scheme and the parameter assignment of the SM 326; DI 24 x DC 24V digital module for application 6: Safety Mode SIL3/Cat.4/PLe with high availability.

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages of SM 326; DI 24 x DC 24V (Page 99)".

Wiring of sensors when using the internal sensor supply of the module

Note

In general, if you connect *one* sensor to two inputs of the module and you are using the module-internal sensor supply, you must always use the sensor supply of the left half of the module 1Vs (pin 4) or 2Vs (pin 11).

Wiring scheme for application 6 with single-channel connection of two redundant single-channel sensors

Two redundant single-channel sensors are required per process signal. One sensor is connected via one channel to two *opposite inputs* of the digital module for each module (1oo2 evaluation). The sensors can also be connected to an external sensor supply.

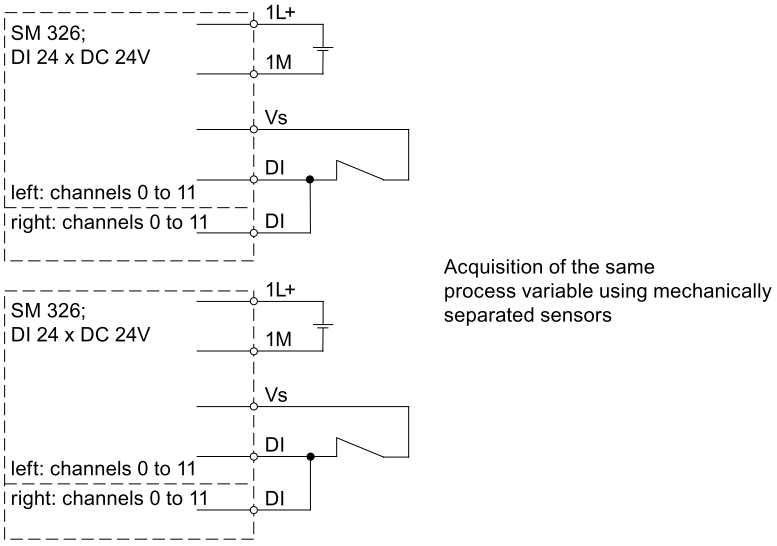


Figure 8-18 Wiring scheme of the SM 326; DI 24 x DC 24V for application 6 – two redundant, single-channel sensors single-channel connection

WARNING

To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 6 with nonequivalent two-channel connection of two redundant nonequivalent sensors

Two redundant nonequivalent sensors are required per process signal. One nonequivalent sensor is connected to each of two *opposite inputs* of the digital module for each module (1oo2 evaluation structure). The sensors can also be connected to an external sensor supply. The left channels of the module return the user signals, that is, these signals are available in the I/O area of inputs at the F-CPU if no errors are detected.

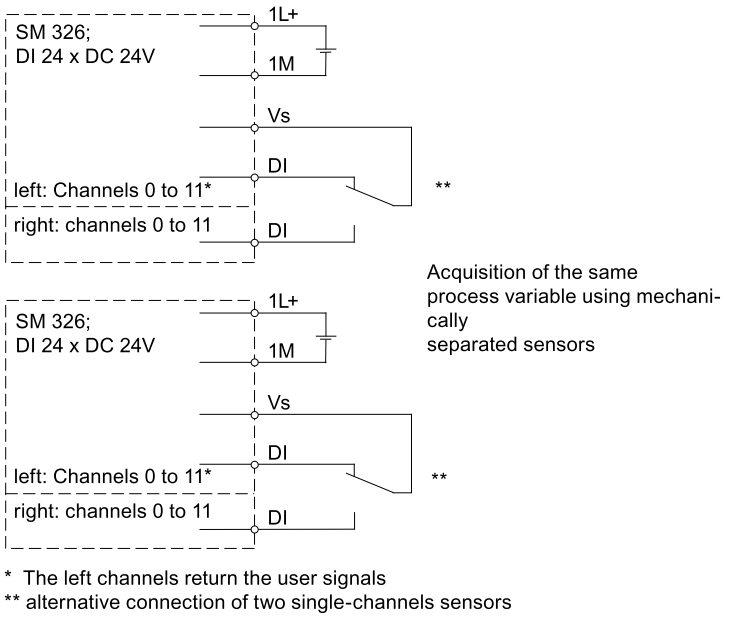


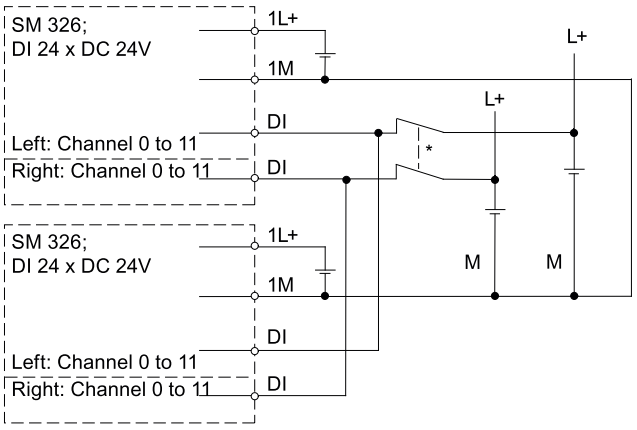
Figure 8-19 Wiring scheme of the SM 326; DI 24 x DC 24V for application 6 – two redundant, nonequivalent sensors two-channel nonequivalent connection

WARNING

To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 6 with two-channel connection of one two-channel sensor

One two-channel sensor is connected via two channels to the two digital modules for each process signal (1oo2 evaluation). The sensors must be connected to an external sensor supply.



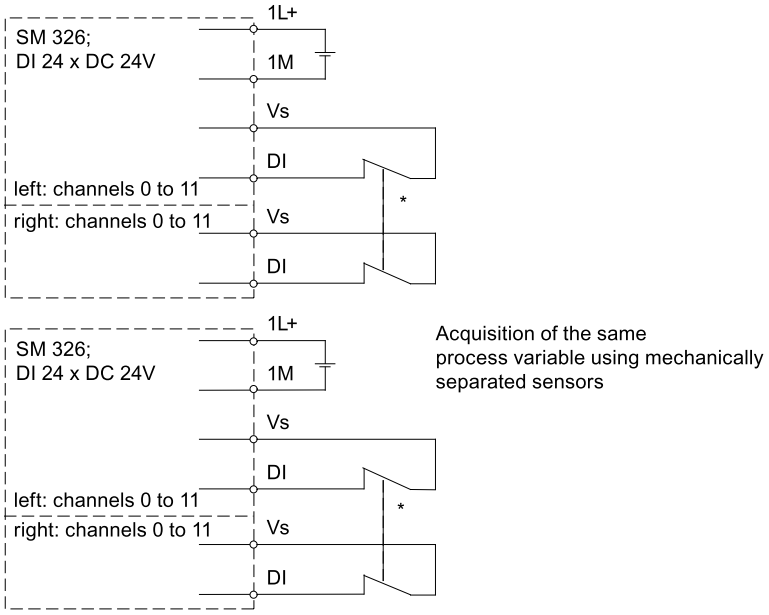
* Sensor contacts are mechanically coupled; alternatively, you can connect two single-channel sensors

Figure 8-20 Wiring scheme of the SM 326; DI 24 x DC 24V for application 6 – one two-channel sensor two-channel connection

WARNING
To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Wiring scheme for application 6 with two-channel connection of two redundant two-channel sensors

Two two-channel, redundant sensors are required per process signal. One sensor is connected via two channels to each of two *opposite inputs* of the digital module for each module (1oo2 evaluation). The sensors can also be connected to an external sensor supply.



* Mechanically coupled sensors; alternative connection of two single-channels sensors

Figure 8-21 Wiring scheme of the SM 326; DI 24 x DC 24V for application 6 – two two-channel, redundant sensors two-channel connection

WARNING
To achieve SIL3/Cat.4/PLe using this wiring, you must use a suitably qualified sensor.

Assignable parameters for application 6

Table 8- 7 Parameters for application 6 of SM 326; DI 24 x DC 24V

Parameters	Range of values in safety mode	Type	Effective range
"Parameters" tab			
Mode of operation	Safety mode	Static	Module
F parameter:			
F monitoring time	10 ms to 10000 ms	Static	Module
Module parameters:			
Diagnostic interrupt	activated/deactivated	Static	Module
Module parameters for a power supply group:			
Internal sensor supply of the module	activated/deactivated	Static	Power supply group
Short-circuit test	activated/deactivated * (only if "Sensor Supply via Module" is activated)	Static	Power supply group
For single channels or channel pairs:			
activated	activated/deactivated	Static	Channel pair
Evaluation of the sensors	1oo2 evaluation	Static	Channel pair
Type of sensor interconnection	• Two-channel, equivalent • Two-channel, nonequivalent • Single-channel	Static	Channel pair
Discrepancy behavior	(only two-channel) • "Provide last valid value" • Provide 0 value	Static	Channel pair
Discrepancy time	10 ms to 30000 ms (only for two-channel)	Static	Channel pair
"Redundancy" tab			
Redundancy	2 modules	Static	Module
Redundant module	(selection of an existing additional module of the same type)	Static	redundant module pair
Discrepancy time	10 ms to 30000 ms	Static	redundant module pair
* Vs does not clock, if the short-circuit test is deactivated.			

8.3.9 Diagnostic messages of SM 326; DI 24 x DC 24V

Diagnostics using the LED display

The F-SM indicates faults by means of its SF LED (group fault LED). The SF LED is activated when the F-SM generates a diagnostic message.

The SF LED flashes as long as a cleared fault has not been acknowledged. It goes dark when all faults have been eliminated and acknowledged.

The SF LED flashes until you acknowledge passivation following a module fault.

Possible diagnostic messages

The following table provides an overview of the diagnostic messages for SM 326; DI 24 x DC 24V.

Diagnostic messages are assigned either to a channel or to the entire module. Some diagnostic messages occur only in certain applications.

Table 8- 8 Diagnostic messages of SM 326; DI 24 x DC 24V

Diagnostic message	Signaled in the application	Effective range of diagnostics	Assignable
Internal short-circuit or defective sensor supply	**1, 2, 3, 4, 5, 6**	Channel	Yes
Short-circuit to L+ on the unconnected sensor line (open contact)			
Ground-short circuit or defective sensor supply			
Discrepancy error (1oo2 evaluation)	**5, 6**		
No external auxiliary voltage	**1, 2, 3, 4, 5, 6**	Module	No
Module parameters not assigned			
Incorrect module parameters			
Communication error			
Internal supply voltage of the module failed			
Time monitoring activated (watchdog)			
EPROM error RAM error			
Processor failure			
Parameter assignment error (with specification of a consecutive number)			
Internal error in read circuit/test circuit	**1, 2, 3, 4, 5, 6**	Channel	
CRC signature error	**3, 4, 5, 6**	Module	
Timeout of safety message frame monitoring			
Message frame error	**1,2**	Module	

Short-circuit to M and L+

Sequence of the internal short-circuit tests:

- Short-circuit to chassis ground is always tested, independent of the configuration.
- Short-circuit to L+ is only tested if "Sensor supply via module" and "Short-circuit test" are configured in *HW Config*.

Causes of the problem and corrective measures

The table below shows possible causes of the problem and appropriate corrective measures for the individual diagnostic messages of SM 326; DI 24 x DC 24V.

Table 8- 9 Diagnostic messages and associated corrective measures for SM 326; DI 24 x DC 24V

Diagnostic message	Possible causes of the problem	Corrective measures
Internal short-circuit or defective sensor supply	Internal sensor supply error	Replace the module
Short-circuit to L+ on the unconnected sensor line (open contact)	Short circuit to L+ of the unconnected sensor line (open contact)	Eliminate the short-circuit
Ground-short circuit or defective sensor supply	Short-circuit of input to M	Eliminate the short-circuit
	Internal sensor supply error	Replace the module
Short-circuit at open sense line (open contact)	Short-circuit of the unconnected sensor line to M	Eliminate the short-circuit
	Interruption of the line between the module and sensor	Restore the cable connection
Discrepancy error (1oo2 evaluation)	Process signal error Defective sensor	Check the process signal; replace the sensor
	Assigned discrepancy time too short	Check the discrepancy time parameters
No external auxiliary voltage	Module supply voltage L+ missing	Connect supply voltage L+
Module parameters not assigned	No parameters transferred to module	Assign new module parameters
Incorrect module parameters	Faulty parameters transferred to module	Assign new module parameters
Communication error	Error in communication between the CPU and the module, for example, due to defective PROFIBUS connection or electromagnetic interference in excess of limits.	Check the PROFIBUS connection Eliminate the interference
	Timeout of safety message frame monitoring	Check the monitoring time parameters
	CRC signature error, for example, due to electromagnetic interference in excess of limits.	Eliminate the interference
	CPU is in STOP	Read the diagnostics buffer
Internal supply voltage of the module failed	Internal fault at the L+ supply voltage	Replace the module

Diagnostic message	Possible causes of the problem	Corrective measures
Time monitoring activated (watchdog)	Overload due to diagnostics request (SFCs)	Reduce the number of diagnostics requests
	Electromagnetic interference has exceeded limits	Eliminate the interference
	Defective module	Replace the module
EPROM error RAM error	Electromagnetic interference has exceeded limits	Eliminate the interference and cycle the power supply OFF/ON
	Defective module	Replace the module
Processor failure	Electromagnetic interference has exceeded limits	Eliminate the interference
	Defective module	Replace the module
	Switching rate exceeded	Reduce switching rate
Internal error in read circuit/test circuit	Defective module	Replace the module
CRC signature error	CRC signature error during communication between the CPU and the module has occurred, for example, due to electromagnetic interference in excess, faults during sign-of-life monitoring error or standard program accesses F-SM.	Eliminate the interference
Timeout of safety message frame monitoring	Assigned monitoring time exceeded	Check the monitoring time parameters
	Startup of the fail-safe signal module	—
Message frame error	Sign-of-life and/or CRC signature entered in the data message frame	Check the sign-of-life and CRC signature entries in the data message frame for "0" value

8.3.10 Technical data - SM 326; DI 24 x DC 24V

Overview

Technical data		
Dimensions and Weight		
Dimensions W x H x D (mm)	80 x 125 x 120	
Weight	Approx. 442 g	
Module-Specific Specifications		
Configuration in Run (CiR) supported	Yes (only in standard mode)	
• Behavior of non-configured inputs during CiR	Return the process value that was valid prior to parameter assignment	
Supports time stamping	Yes	
• Accuracy	20 ms to 30 ms	
Number of inputs		
• Single-channel	24	
• Dual-channel	12	
Assigned address area		
• In the I/O input area	10 bytes	
• In the I/O output area	4 bytes	
Cable length		
• Unshielded	100 m, maximum	
• Shielded	200 m, maximum	
Front connectors	40-pin	
Maximum achievable Safety Integrity Level in safety mode		
• According to IEC 61508	SIL 3	
• According to EN 954-1	Category 4	
• According to ISO 13849:2006	PLe	
Fail-safe performance characteristics	SIL 2	SIL 3
• low demand mode (average probability of failure on demand)	< 1.00E-04	< 1.00E-05
• high demand / continuous mode (probability of a dangerous failure per hour)	< 1.00E-08	< 1.00E-09
Voltages, Currents, Potentials		
Rated supply voltage of the electronic system and sensors 1L+, 2L+	24 V DC	
• Reverse polarity protection	Yes	
• Power failure ride-through (does not apply to sensor supply outputs)	5 ms	

Technical data	
Number of simultaneously controllable inputs	
• Horizontal installation Up to 40 °C Up to 60 °C	24 24 (with 24 V) 18 (with 28.8 V)
• Vertical installation Up to 40 °C	 24
Electrical isolation	
• Between channels and backplane bus	Yes
• Between channels in groups of	12
Maximum potential difference between different circuits	75 V DC 60 V AC
Insulation test voltage	500V DC / 350V AC for 1 min or 600V DC for 1s
Current consumption	
• From backplane bus	100 mA, maximum
• From load voltage 1L+, 2L+ (no sensors)	450 mA, maximum
Power loss of the module	10 W, typical
Status, Interrupts, Diagnostics	
Status display	Green LED per channel
Interrupts	
• Diagnostic interrupt	Programmable
Diagnostics functions	Programmable
• Group fault display	Red LED (SF)
• Fail-safe mode display	Green LED (SAFE)
• Diagnostic information can be read out	Possible
Sensor Supply Outputs	
Number of outputs	4
Electrical isolation between channels and backplane bus	Yes
• In groups of	2
Output voltage	
• Loaded	Minimum L+ (-1.5 V)
Output current	
• Rated value	400 mA
• Approved range	0 to 400 mA
Additional (redundant) infeed	Permissible
Short-circuit protection	Yes, electronic
Sensor selection data	
Input voltage	
• Rated value	24 V DC
• For "1" signal	11 to 30 V
• For "0" signal	- 30 to 5 V

Technical data	
Input current	
• For "1" signal	Typ. 10 mA
Input characteristic	According to IEC 61131-2 Type 1
Connection of 2-wire BERO	Supported if parameter "with short-circuit test" = "no"
Permissible quiescent current	2 mA, maximum
Time, Frequency	
Internal signal preparation time (without input delay) for	Min./max.
• Standard mode	6 ms / 22 ms
• Safety mode SIL2/Cat.3/PLd	10 ms / 23 ms
• Safety mode SIL3/Cat.4/PLe	10 ms / 22 ms
Input delay	
• For "0" after "1"	2.1 ms to 3.4 ms
• For "1" after "0"	2.1 ms to 3.4 ms
Acknowledgment time	
• In safety mode with 1oo1 evaluation of the sensors	Max. 29 ms
• In safety mode with 1oo2 evaluation of the sensors	Max. 29 ms
Minimum sensor signal duration	see table *Minimum duration of sensor signals for reliable detection by SM 326; DI 24 x DC 24 V* in chapter "Sensor and Actuator Requirements for F-SMs in Safety Mode (Page 47)".

Note

The maximum cable lengths currently specified in this manual ensure against functional impairment, even without more precise examination of the boundary conditions. If the boundary conditions, such as EMC, cable type, cable routing, etc. are examined more closely, longer cables can be used for all F-SMs.

8.7 SM 326; F-DO 10 x DC 24V/2A PP (6ES7326-2BF10-0AB0)

8.7.1 Properties, front view, wiring diagram and block diagram

Order number

6ES7326-2BF10-0AB0

Properties

SM 326; F-DO 10 x DC 24V/2A PP has the following properties:

- 10 outputs, two electrically isolated groups of 5
- Output current 2 A
- Rated load voltage 24 V DC
- Protection against short circuit and overload
- Suitable for solenoid valves, DC relay contactors, and signal lamps
- Assignable redundant operation
- Operation in safety mode
- SIL3/Cat.4/PLe can be achieved without safety protector
- Group fault display (SF)
- Safety mode display (SAFE)
- Status display for each channel (green LED)
- Display of channel-specific errors (red LED)
- Programmable diagnostics functions
- Programmable diagnostic interrupt
- Firmware update via *HW Config*
- I&M identification data
- can be used with PROFINET IO
- "Keep last valid value" parameter
- Simplified redundant circuit
- Channel-selective passivation

Note

The fail-safe performance characteristics in the technical data apply to a proof-test interval of 20 years and a mean time to repair of 100 hours.

"Keep last valid value" parameter setting

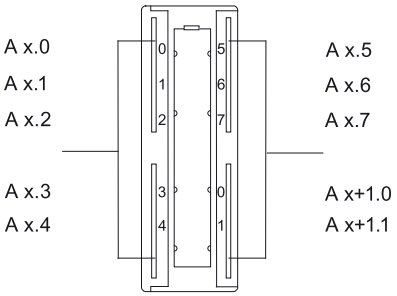
WARNING

If "Keep last valid value" has been assigned, the last valid process value 0 *or* 1 will be retained with events such as abort of PROFIsafe communication or F-CPU stop.

For more information, refer to the section entitled "Fault reactions in safety mode with parameter setting "Keep last valid value" (Page 55)".

Address assignment

Check the output address in the user program:



x = Module start address

Figure 8-50 Address assignment for SM 326; F-DO 10 x DC24V/2A PP

Front view

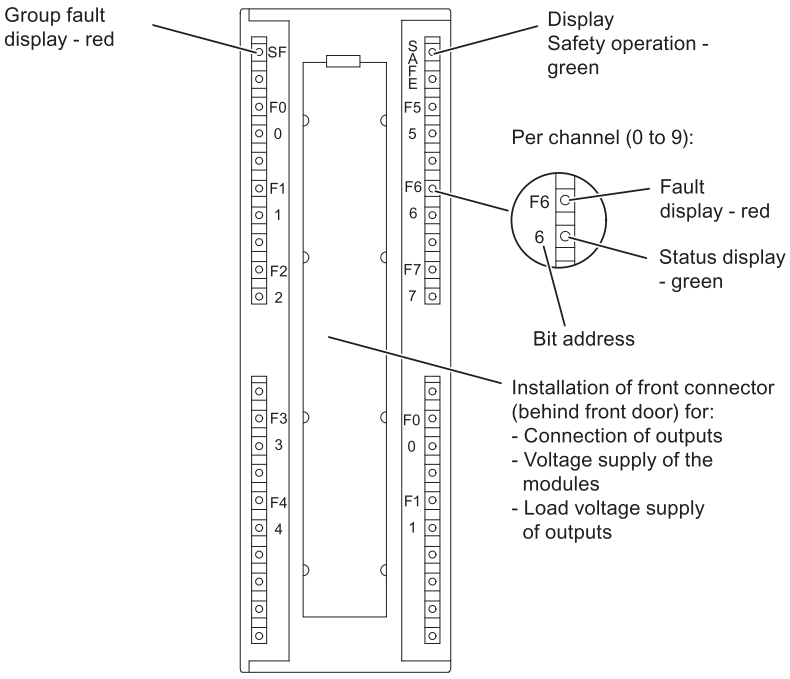


Figure 8-51 Front view of SM 326; F-DO 10 x DC 24V/2A PP

Wiring and block diagram

The following figure shows the wiring and block diagram of SM 326; F-DO 10 x DC 24V/2A PP.

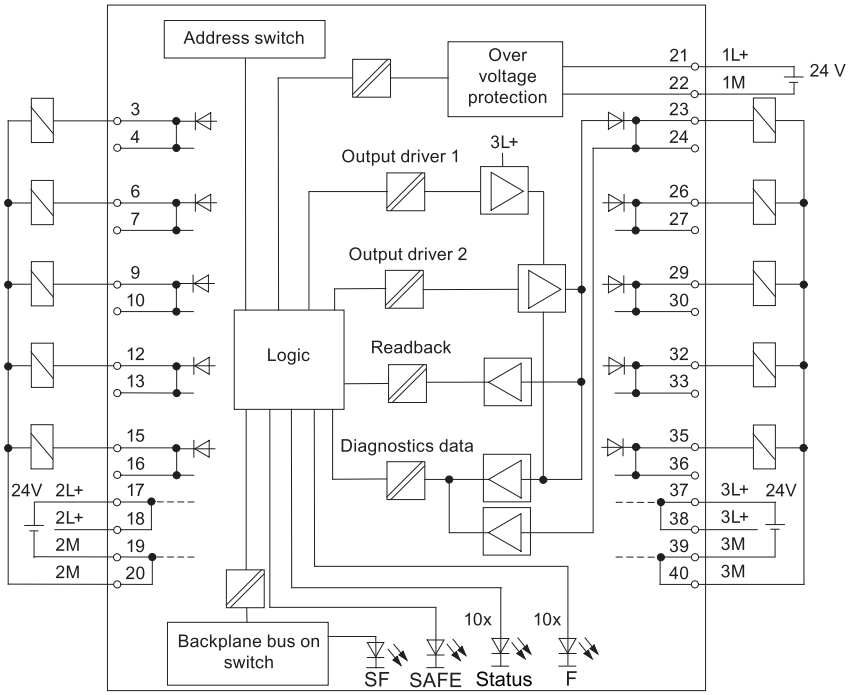


Figure 8-52 Wiring and block diagram of SM 326; F-DO 10 x DC 24V/2A PP

The potential groups 1L+, 2L+ and 3L+ can be supplied by separated power supply units but also by one common power supply unit.

Channel numbers

The channel numbers are used to identify the outputs and to assign channel-specific diagnostic messages.

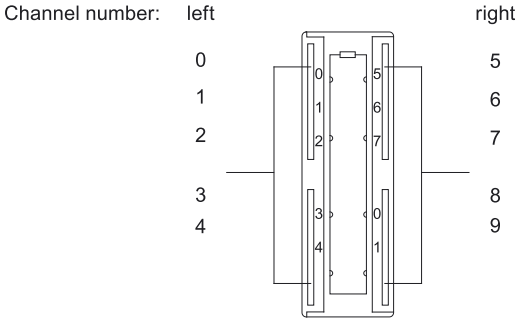


Figure 8-53 Channel numbers for SM 326; F-DO 10 x DC 24V/2A PP

8.7.2 SM 326; F-DO 10 x DC 24V/2A PP applications

Selecting the application

The figure below helps you to select an application based on availability and fail-safe operation requirements. The next pages provide information on the module wiring for a specific application, and on the parameters to set in *STEP 7* using the *S7 Distributed Safety* or *S7 F Systems* optional package.

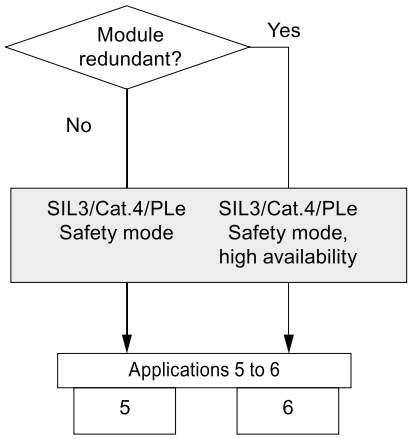


Figure 8-54 Application Selection - SM 326; F-DO 10 x DC 24V/2A PP

Test pulses of the light and dark test

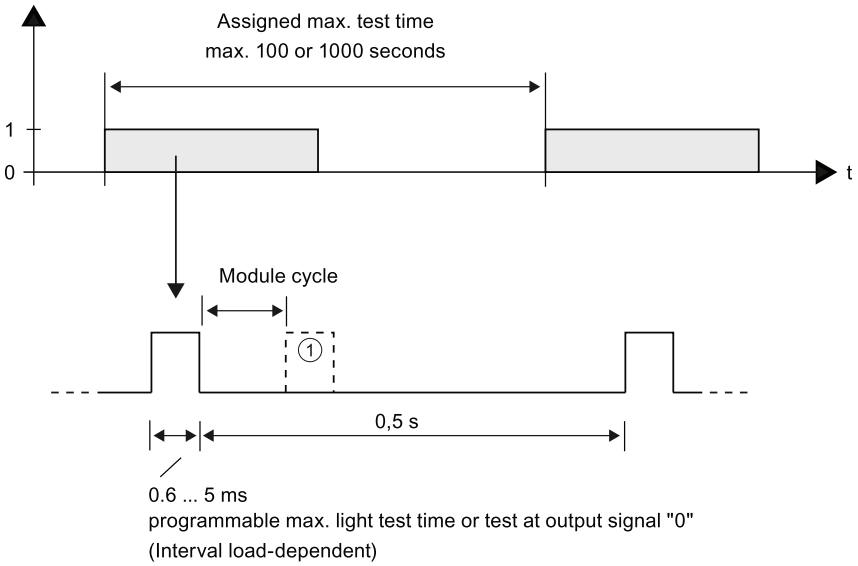


Figure 8-55 Light test, if assigned

The typical break between two test pulses is 0.5 seconds. There can be another test pulse ① in between. The gap between the first test pulse and the additional test pulse is one module cycle.

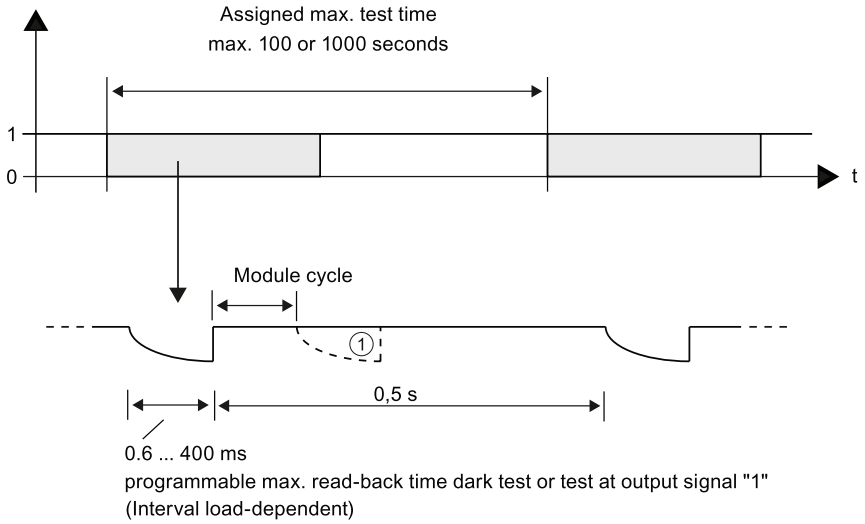


Figure 8-56 Dark test

The typical break between two test pulses is 0.5 seconds. There can be another test pulse ① in between. The gap between the first test pulse and the additional test pulse is one module cycle.

With redundant interconnection, both modules conduct the light and dark test in an asynchronous manner. This can result in an overlap of the test pulses.

Avoiding dark periods when operating in safety mode

Note

If you are using actuators that respond too fast (i.e. < 1 ms) to "dark period" test signals, you can nonetheless use the internal test coordination by wiring two opposite outputs (with assigned redundancy) in parallel using a series diode. Parallel wiring suppresses the dark periods. For more information, refer to the chapter "Application 5.1: Wiring two outputs in parallel for dark period suppression (Page 169)".

8.7.3 Applications 1 to 4

Applications 1 and 2 are omitted because the module supports only safety mode.

Applications 3 and 4 are omitted because the module supports SIL3/Cat.4/PLe.

8.7.4 Application 5: Safety mode SIL3/Cat.4/PLe

Introduction

Below are the wiring scheme and the parameter assignment of SM 326; F-DO 10 x DC 24V/2A PP for

- Application 5: Safety mode SIL3/Cat.4/PLe.

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages SM 326; F-DO 10 x DC 24V/2A PP (Page 173)".

Note

In case of parameter setting with SIL3

The signal at the output has to change daily or even more frequently. If this is not the case with the "0" signal, you will have to activate the light test that meets this condition.

Wiring scheme of application 5

Single-channel connection of one sensor for each process signal. The load voltage supply is wired to terminals 2L+/2M, 3L+/3M of the digital module.

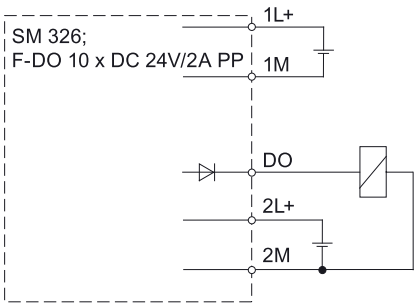


Figure 8-57 Wiring scheme of the SM 326; F-DO 10 x DC 24V/2A PP for application 5

⚠ WARNING

It is no longer possible to shut down an actuator if a cross circuit has developed between 2L+ and DO. To prevent cross circuits between 2L+ and DO, you must route the cables used to connect the actuators in a cross-circuit-proof manner (for example, as separate, sheathed cables or in separate cable ducts).

Connecting two actuators to one digital output

The fail-safe digital output is capable of switching two actuators. The following conditions have to be met:

- Wire L+ and M of the actuators to 2L+ and 2M of the module (same reference potential required).

The actuators can be wired to any one of the 10 digital outputs. The figure below shows an example of an output wiring. This circuit is compliant with SIL 3/Cat. 4/PLe.

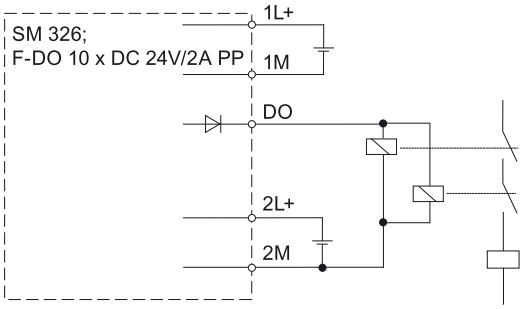


Figure 8-58 Wiring scheme 2 actuators at digital output of SM 326; F-DO 10 x DC 24V/2A PP

WARNING

It is no longer possible to shut down an actuator if a cross circuit has developed between 2L+ and DO. To prevent cross circuits between 2L+ and DO, you must route the cables used to connect the actuators in a cross-circuit-proof manner (for example, as separate, sheathed cables or in separate cable ducts).

Assignable parameters for application 5

Table 8- 23 Parameters for application 5 of SM 326; F-DO 10 x DC 24V/2A PP

Parameters	Range of values	Type	Effective range
"Parameters" tab			
Mode of operation	Safety mode	Static	Module
F_Monitoring_Time (ms)	10 ms to 10000 ms	Static	Module
Diagnostic interrupt	Activated/deactivated	Static	Module
Fail-safe value	*Switch to fail-safe value "0"* Keep last valid value	Static	Module
Maximum test period	100 / 1000 s	Static	Module
Load voltage failure diagnostics	Activated/deactivated	Static	Channel group
Activated	Activated	Static	Channel
Diagnostics: Wire break	Activated/deactivated	Static	Channel
Activated light test	Activated/deactivated	Static	Channel
Max. time for light test (ms)	0.6 ms to 5 ms	Static	Channel
Max. read-back time for dark test (ms)	0.6 ms to 400 ms	Static	Channel
Redundant switched	*Deactivated*	Static	Channel

8.7.5 Application 5.1: Wiring two outputs in parallel for dark period suppression

Applications

Parallel operation of two outputs for dark period suppression is possible for all applications in safety mode (application 5).

Note

In case of parameter setting with SIL3

The signal at the output has to change daily or even more frequently. If this is not the case with the "0" signal, you will have to activate the light test that meets this condition.

⚠ WARNING

Note for "Keep last valid value" parameter setting:

If a module output is 0 due to a channel/module fault and the redundant module output is 1 due to a communication fault/interruption, the process value 1 will be created.

Also note the table "Reaction of the SM 326; F-DO x DC 24V/2A PP to CPU Stop" in the chapter "Reactions to Faults in Safety Mode (Page 52)".

⚠ WARNING

Prevent short circuits to L+ at the SM 326; F-DO 10 x DC 24V/2A PP with protected routing of the signal lines, because the actuator will remain activated otherwise.

In case of a short circuit to L+ it may happen in case of redundant wiring at the output with configured redundancy operation that the associated output will not be switched off.

Wiring scheme

Interconnect two *opposite outputs* with assigned redundancy to form a single output. The parallel circuit in combination with an internal test coordination between the outputs 0 to 4 and 5 to 9 suppresses the "0" test pulse (dark period).

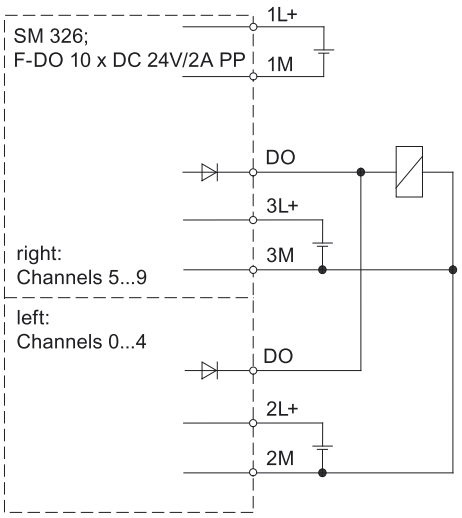


Figure 8-59 Wiring two outputs in parallel for dark period suppression of the SM 326; F-DO 10 x DC 24V/2A PP

Note

Use the same reference potential for 2M and 3M.

Note

If you are using actuators that respond too fast (< 1 ms) to "dark period" test signals, you can nonetheless use the internal test coordination by wiring two opposite outputs in parallel (with assigned redundancy). Parallel wiring suppresses the dark periods.

Parameters	Range of values	Type	Effective range
"Parameters" tab			
Mode of operation	Safety mode	static	module
F_Monitoring_Time (ms)	10 ms to 10000 ms	Static	Module
Diagnostic interrupt	Activated/deactivated	Static	Module
Fail-safe value	*Switch to fail-safe value* Keep last valid value	Static	Module
Maximum test period	100 / 1000 s	Static	Module
Load voltage failure diagnostics	Activated/deactivated	Static	Channel group
Activated	Activated/deactivated	Static	channel

Parameters	Range of values	Type	Effective range
Diagnostics: Wire break	Activated/deactivated	Static	Channel
Activated light test	Activated/deactivated	Static	Channel
Max. time for light test (ms)	0.6 ms to 5 ms	Static	Channel
Max. read-back time for dark test (ms)	0.6 ms to 400 ms	Static	Channel
Redundant switched	*Activated*	Static	Channel

Always set the interconnected outputs in parallel instead of setting only one output. Process signals of a redundant I/O system require four outputs with assigned redundancy.

8.7.6 Application 6: Safety mode SIL3/Cat.4/PLe with high availability (in S7 F/FH Systems only)

Introduction

Below are the wiring scheme and the parameter assignment of SM 326; F-DO 10 x DC 24V/2A PP for

- Application 6: Safety mode SIL3/Cat.4/PLe with high availability

Diagnostic messages, possible causes of the problem and their corrective measures are found in tables in the chapter "Diagnostic messages SM 326; F-DO 10 x DC 24V/2A PP (Page 173)".

Note

In case of parameter setting with SIL3

The signal at the output has to change daily or even more frequently. If this is not the case with the "0" signal, you will have to activate the light test that meets this condition.

WARNING

Note for "Keep last valid value" parameter setting:

If a module output is 0 due to a channel/module fault and the redundant module output is 1 due to a communication fault/interruption, the process value 1 will be created.

Also note the table "Reaction of the SM 326; F-DO x DC 24V/2A PP to CPU Stop" in the chapter "Reactions to Faults in Safety Mode (Page 52)".

WARNING

Prevent short circuits to L+ at the SM 326; F-DO 10 x DC 24V/2A PP with protected routing of the signal lines, because the actuator will remain activated otherwise.

In case of a short circuit to L+ it may happen in case of redundant wiring at the output with configured redundancy operation that the associated output will not be switched off.

Wiring scheme of application 6

Each process signal requires one actuator which is controlled redundantly by the two digital modules. The load voltage supply is wired to terminals 2L+/2M, 3L+/3M of the digital module.

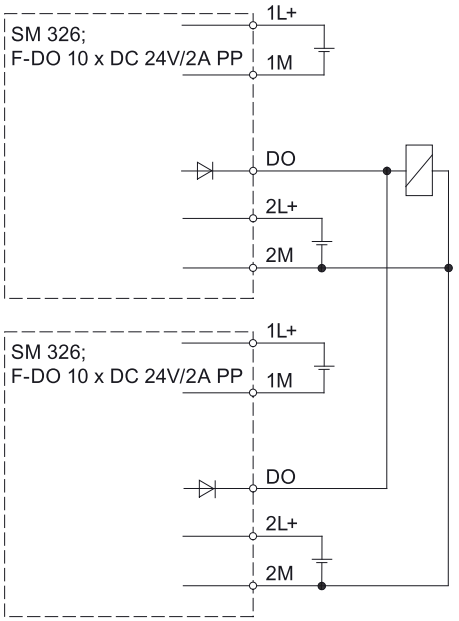


Figure 8-60 Wiring scheme of the SM 326; F-DO 10 x DC 24V/2A PP for application 6

Note

Use the same reference potential for both modules.

Assignable parameters for application 6

Table 8- 24 Parameters for application 6 of SM 326; F-DO 10 x 24V/2A PP

Parameters	Range of values	Type	Effective range
"Parameters" tab			
Mode of operation	Safety mode	Static	Module
F_Monitoring_Time (ms)	10 ms to 10000 ms	Static	Module
Diagnostic interrupt	Activated/deactivated	Static	Module
Fail-safe value	*Switch to fail-safe value* Keep last valid value	Static	Module
Maximum test period	100 / 1000 s	Static	Module
Load voltage failure diagnostics	Activated/deactivated	Static	Channel group
Activated	Activated/deactivated	Static	Channel
Diagnostics: Wire break	Activated/deactivated	Static	Channel
Activated light test	Activated/deactivated	Static	Channel
Max. time for light test (ms)	0.6 ms to 5 ms	Static	Channel
Max. read-back time for dark test (ms)	0.6 ms to 400 ms	Static	Channel
Redundant switched	*Activated*	Static	Channel

8.7.7 Diagnostic messages SM 326; F-DO 10 x DC 24V/2A PP

Diagnostics using the LED display

The F-SM indicates faults by means of its SF LED (group fault LED). The SF LED is activated when the F-SM generates a diagnostic message.

The SF LED flashes as long as a cleared fault has not been acknowledged. It goes dark when all faults have been eliminated and acknowledged.

The SF LED flashes until you acknowledge passivation following a module fault.

Possible diagnostic messages

The following table provides an overview of the diagnostic messages for SM 326; F-DO 10 x DC 24V/2A PP.

Diagnostic messages are assigned either to a channel or to the entire module. Some diagnostic messages occur only in certain applications.

Table 8- 25 Diagnostic messages of SM 326; F-DO 10 x DC 24V/2A PP

Diagnostic message	Signaled in the application	Effective range of diagnostics	Assignable
Wire break	5, 6	Channel	Yes
Short-circuit of output to M, or defective output driver			No
Short circuit of output to L+, or defective output driver	5	Module	
Module parameters not assigned	5, 6	Module	
Incorrect module parameters			
Communication error			
Internal supply voltage of the module failed			
Time monitoring activated (watchdog)			
EPROM fault; RAM fault			
Internal error in read circuit/test circuit, or defective sensor supply			
Processor failure			
Parameter assignment error (with specification of a consecutive number)			
No external auxiliary voltage			
External load voltage missing			
Defective main switch			
Defective output driver			
Overtemperature at output driver			
Defective load voltage or load voltage not connected		Channel group	
CRC signature error	5, 6	Module	
Timeout of safety message frame monitoring			
Switching frequency too high		Channel	

Causes of the problem and corrective measures

The table below shows possible causes of the problem and appropriate corrective measures for the individual diagnostic messages of SM 326, F-DO 10 x DC 24V/2A PP.

Table 8- 26 Diagnostic messages and associated corrective measures for SM 326; F-DO 10 x DC 24V/2A PP

Diagnostic message	Error detection	Possible causes of the problem	Corrective measures
Wire break	Only if the output = 1 or during light period test	Wire break between the module and actuator	Restore the cable connection
		Channel not connected (open)	Disable the "Group Diagnostics" for the channel in the parameter settings.
		Short-circuit to L+ at the output	Eliminate the short-circuit
		Short-circuit between channels which carry different signals	Eliminate the short-circuit
Short-circuit of output to M, or defective output driver	Only if the output = 1 or during light period test	Output overload	Remove the overload within 100 hours after the fault has occurred.
		Short-circuit to M at the output	Remove the short circuit within 100 hours after the fault has occurred.
		Undervoltage at load voltage supply	Check the load voltage supply
		Defective output driver	Replace the module
Short circuit of output to L+, or defective output driver	For non-redundant operation	Short-circuit to L+ at the output	Remove the short circuit within 100 hours after the fault has occurred. Module reset required (cycle power supply off/on)
		Short-circuit between channels which carry different signals	Remove the short circuit within 100 hours after the fault has occurred. Module reset required (cycle power supply off/on)
	general	Defective output driver	Replace the module
Module parameters not assigned	General	No parameters transferred to module	Assign new module parameters
Incorrect module parameters	general	Faulty parameters transferred to module	Assign new module parameters
Internal supply voltage of the module failed	general	Internal fault at supply voltage 1L+	Replace the module

Diagnostic message	Error detection	Possible causes of the problem	Corrective measures
Time monitoring activated (watchdog)	general	Overload due to diagnostics request (SFCs)	Reduce the number of diagnostics requests
		Electromagnetic interference has exceeded limits	Eliminate the interference
		Defective module	Replace the module
Communication error	general	Error in communication between the CPU and the module, for example, due to defective PROFIBUS connection or electromagnetic interference in excess of limits.	Check the PROFIBUS connection Eliminate the interference
		Timeout of data frame monitoring	Check the monitoring time parameters
		CRC signature error, for example, due to electromagnetic interference in excess of limits.	Eliminate the interference
		CPU is in STOP	Read the diagnostics buffer
EPROM error RAM error	general	Electromagnetic interference has exceeded limits	Eliminate the interference and cycle power supply OFF/ON
		Defective module	Replace the module
Internal error in read / test sequence	General	Defective module	Replace the module
Processor failure	general	Electromagnetic interference has exceeded limits	Eliminate the faults, and then remove and insert the module
		Defective module	Replace the module
		Switching rate exceeded	Reduce switching rate
Parameter assignment error (with specification of a consecutive number)	general	Error in dynamic parameter reassignment	Check the parameter assignment in the user program. Contact SIMATIC Customer Support if necessary
No external auxiliary voltage	general	Supply voltage 1L+ of module missing	Connect 1L+
External load voltage missing	general	Supply voltage 1L+ of module missing	Feed in voltage supply
Defective main switch	general	Defective module	Replace the module
Defective output driver	general	Defective module	Replace the module
Overtemperature at output driver	general	Output overload	Eliminate the cause of overload
		Internal fault at output driver	Replace the module

Diagnostic message	Error detection	Possible causes of the problem	Corrective measures
Defective load voltage or load voltage not connected	general	Load voltage 2L+, 3L not connected	Connect 2L+ and 3L+
		Load voltage external error	Replace the module
CRC signature error	general	CRC signature error during communication between the CPU and the module has occurred, for example, due to electromagnetic interference in excess, faults during sign-of-life monitoring error, in case of voltage drop or standard program accesses F-SM.	Eliminate the interference
Timeout of safety message frame monitoring	general	Assigned monitoring time exceeded	Check the monitoring time parameters
		Startup of the fail-safe signal module	—
Message frame error	general	Sign-of-life and/or CRC signature entered in the data message frame	Check the sign-of-life and CRC signature entries in the data message frame for "0" value
Switching frequency too high	general	Switching frequency too high	Reduce the switching frequency

Note

Note that an inductive load connected to the DO channels can induce voltages due to interference of a strong, magnetic field. This situation can result in the diagnostic message short circuit.

Remedy:

- Create a spatial separation of the inductive loads and shield the magnetic field.
- Configure the read-back time of the dark test with 50 ms or greater.

Note

In case of a wire break at an actuator with redundant control by two modules, both modules will report a wire break. The wire break diagnostic will come at a later time.

Note

If the F-SM detects an external P-short circuit on a channel, it will turn off all channels that route "1" signals and are not configured redundantly.

The channels that are actually affected will be determined afterwards; channels without active fault can be reintegrated at this time.

8.7.8 Technical data - SM 326; F-DO 10 x DC 24V/2A PP

Overview

Technical data	
Dimensions and Weight	
Dimensions W x H x D (mm)	40 x 125 x 120
Weight	ca. 330 g
Module-Specific Specifications	
Number of outputs	10
Assigned address area	
• In the I/O input area	6 bytes
• In the I/O output area	8 bytes
Cable length	
• Unshielded	600 m, maximum
• Shielded	max. 1000 m (see note at end of table)
Front connectors	40-pin
Maximum achievable Safety Integrity Level in safety mode	
• According to IEC 61508	SIL 3
• According to EN 954-1	Category 4
• According to ISO 13849:2006	PLe
Fail-safe performance characteristics	SIL 3
• low demand mode (average probability of failure on demand)	< 1.00E-05
• high demand / continuous mode (probability of a dangerous failure per hour)	< 1.00E-09
Proof-test interval	20 years
Voltages, Currents, Potentials	
Rated supply voltage of the electronics 1L+	24 V DC
• Reverse polarity protection	Yes
Rated load voltage 2L+/3L+	24 V DC
• Reverse polarity protection	No
Aggregate current of outputs (per group)	
• Horizontal installation up to 40 °C up to 50 °C up to 60 °C	 max. 10 A max. 7 A max. 6 A
• Vertical installation Up to 40 °C	 5 A, maximum

Technical data	
Electrical isolation	
• Between channels and backplane bus	Yes
• Between channels and the power supply of the electronics	Yes
• Between channels In groups of	Yes 5
Permitted potential difference Between different circuits	75 V DC 60 V AC
Insulation test voltage	370 V AC for 1 min.
Current consumption	
• From backplane bus	100 mA, maximum
• From supply voltage 1L+	100 mA, maximum
• From load voltage 2L+/ 3L+ (no-load)	100 mA, maximum
Power loss of the module	6 W, typical
Status, Interrupts, Diagnostics	
Status display	1 green LED 1 red LED
Interrupts	
Diagnostic interrupt	Programmable
Diagnostics functions	Programmable
Group fault display	Red LED (SF)
Fail-safe mode display	Green LED (SAFE)
Diagnostic information can be read out	Possible
Fail-safe values	Switch to / Keep last valid value
Actuator selection data	
Output voltage	
• For "1" signal	Minimum L+ (-1.0 V)
Output current	
• For "1" signal – Rated value – Approved range	 2 A 7 mA to 2.4 A
• For "0" signal (residual current)	0.5 mA, maximum
Load resistance range	
• Up to 40 °C	12 Ω to 3.4 kΩ
• Up to 60 °C	12 Ω to 3.4 kΩ
Lamp load	5 W, maximum
Parallel switching of 2 outputs	
• For redundant load control	With assigned redundancy
• For power increase	Not possible
Control of a digital input	Possible

Technical data	
Switching frequency	
• With resistive load	25 Hz symmetrical, maximum
• with inductive load (see chapter "Switching capacitive and inductive loads (Page 327)")	25 Hz symmetrical, maximum
• With inductive load in accordance with IEC 60947-5-1, DC 13	0,5 Hz symmetrical, maximum
• With lamp load	10 Hz symmetrical, maximum
Internal limit of the inductive shutdown voltage	type L+ (-33 V)
Short-circuit protection of output	Yes, electronic
• Response threshold	2.6 to 4.5 A
• Response threshold of redundant interconnection	2.6 to 9 A
Actuator timing requirements	Actuator must not respond if: • Dark period < 0.6 ms • Light period < 0,6 ms (refer to chapter "Sensor and Actuator Requirements for F-SMs in Safety Mode (Page 47)")
Time, Frequency	
Internal preparation time for	
• Safety mode	Max. 8 ms
• Redundant safety mode	Max. 8 ms
Acknowledgment time	
• In safety mode	Max. 10 ms

Note

To reach the maximum cable length, it may be necessary to increase the settings for maximum light test time or maximum read-back time dark test.

We also recommend a more detailed consideration of the boundary conditions, such as EMC, cables used, cable guide, etc.