What is the bit pattern test and does module parameterization affect it and what effect does it have?

Product / version / specification / keyword

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1 Introduction

The aim of this document is to demonstrate the function and procedure of the bit pattern test with fail-safe ET 200S modules and explain the effect of parameterization on it.

The advantages of this document for you are that you can better evaluate the behavior of modules used and parameterize more easily as you require.

1.1 Necessity

The F-DO fail-safe output modules regularly run a bit pattern test to detect short-circuits, short-circuits to ground, grounding faults etc. in good time.

In the case of F-DI fail-safe input modules, the sensor supply delivered by the module can be used to detect short circuits between the external sensor supplies and/or the 24V supply or ground.

If a fault is detected, the safety function is triggered to avoid unwanted and dangerous plant statuses.

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1.2 Terms and Functions

Bit pattern test

The **F-DO** modules run this test about every 15 minutes. Here the module places several bit patterns at its outputs in order to detect short-circuits, short-circuits to ground or grounding faults.
If a fault is detected, the test interval is reduced to about 1 minute. If no more faults are detected, the default interval is implemented again.
The bit pattern test consists of a dark test and a light test.

The **F-DI** modules output supply voltage for the connected sensors at their "internal sensor supply" connection.
This power supply voltage also consists of short pulses. This detects short circuits between the external sensor supplies and/or the 24V supply.

Dark test / Dark period

Cycle during the bit pattern test in which for test purposes a 0 signal (FALSE) is switched to the terminals in order to detect a short-circuit against the supply voltage, for example.

An internal feedback checks whether the potential at the output terminal follows the test value.

The time in which the output outputs the 0 signal for test purposes is called the dark period.

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Light test / Light period

Cycle during the bit pattern test in which for test purposes a 1 signal (TRUE) is switched to the outputs in order to detect a short-circuit against ground, for example.

An internal feedback checks whether the potential at the output terminal follows the test value.

The requirement for this cycle is that the light test is enabled in the hardware parameters.

The time in which the output outputs the 1 signal for test purposes is called the light period.

Passivation

If a fault is found on an F-DO module or on a single channel (short-circuit, wire break etc.), a safe output signal is switched to create the safe status. The safe signal is usually a 0 signal (FALSE). This is called passivation of the module or channel.

Whether the entire module or just the affected channel is passivated depends on the parameterization of the module.

Read-back time

The read-back time defines the period of the switch-on/switch-off procedure during the bit pattern test for the channel concerned. In this time the test signal must be recognized correctly by the corresponding internal digital output in order for the test to be completed positively.

1.3 Effect of the Bit Pattern Test on a Single F-DO Channel

This chapter describes how the bit pattern test affects a channel.

1.3.1 P/P-switching Modules

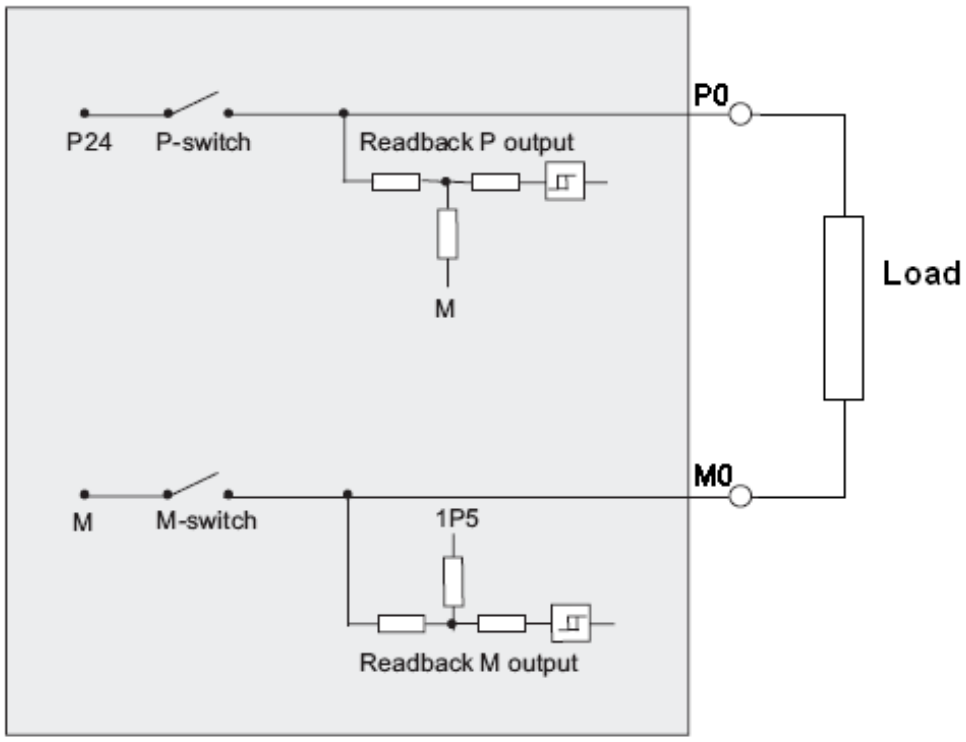
With the P/P-switching F power module the test pulses do not affect the actuators.

1.3.2 P/M-switching Modules

In the case of P/M-switching F power modules and F-DO modules each switch is tested separately. The P-switch and the M-switch are tested one after the other during the bit pattern test.

Fig. 1-1 shows a diagram of the modules. In addition to the load-switching P-switch and M-switch you also see the internal feedback channels (including pull-down and pull-up resistors) used in the bit pattern test.

Fig. 1-1



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Light test

The light test is run only if the current output signal is 0.

- The pulse duration is <= 4 ms, the number of pulses corresponds to the number of channels of the module.
- If the actuator is connected between Px and Mx, it is not enabled by the light test with output value 0.
- If two actuators are connected between Px and ground or P24 and Mx, they are briefly enabled one after the other (if the actuators react to signals <= 4ms).

Dark test

The dark test is run only if the current output signal is 1.

- The pulse duration depends on the load and is at most the parameterized read-back time, the number of pulses corresponds to the number of channels of the module.
- If the actuator is connected between Px and Mx, it is disabled several times by the dark test with output value 0. (If the actuators react quickly enough).
- If two actuators are connected between Px and ground or P24 and Mx, they are briefly disabled several times one after the other.

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Note Px and Mx stand for the outputs of the single channels of the module, P0 and M0 for channel 0 and P1 and M1 for channel 1, etc.

1.4 Effect of the Bit Pattern Test on a Single F-DI Channel

The F-DI module provides a sensor supply.

The sensor supply is pulsed when the short-circuit test is switched on. In this way both a short-circuit against the power supply and against the second sensor supply can be detected.

If the internal sensor supply is used when the short-circuit test is switched on, the must be insensitive to the pulsed power supply.

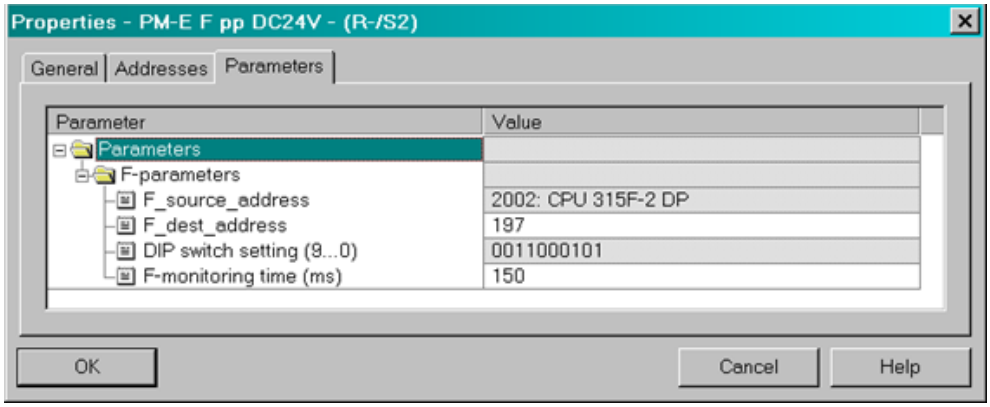
2 PM-E F pp DC24V (6ES7 138-4CF42-0AB0)

With this power module the bit pattern test does not affect the actuator.

2.1 Parameter Options for the PM-E F pp

There are no channel-specific parameters for in this module.

Figure 2-1



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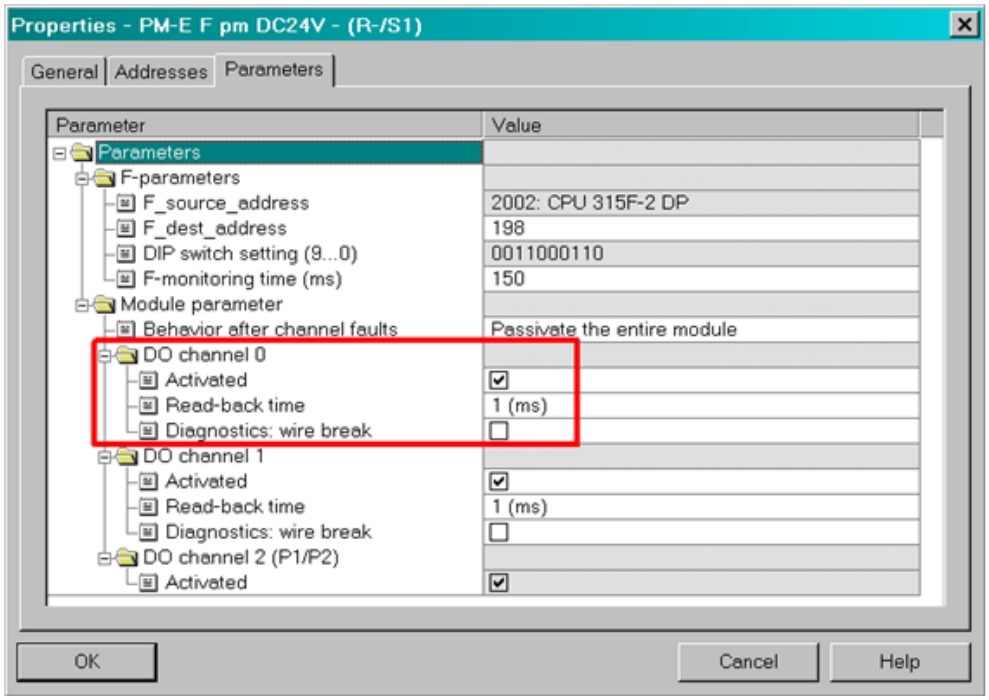
3 PM-E F pm DC24V (6ES7 138-4CF03-0AB0)

3.1 Parameter Options for the PM-E F pm

With this module you have the option of parameterizing both channels.
You can either enable or disable the channels, change the read-back time and enable or disable the wire-break diagnostics.

Figure 3-1



3.2 Parameter-independent Properties of the Bit Pattern Test

Table 3-1

Property	Effect
Test interval	The P-switch and the M-switch are switched on/off twice about every 15 minutes (about every minute if there is a fault). Four test pulses are used.
Number of test pulses	8 test pulses are used per bit pattern test, 4 each for the light and dark test.
Test procedure	The P-switch and the M-switch of a channel are tested one after the other and never simultaneously.
Light test pulse duration	The test pulse for the light test is less than or equal to 4ms.

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3.3 Effects of Parameter Changes on the Bit Pattern Test

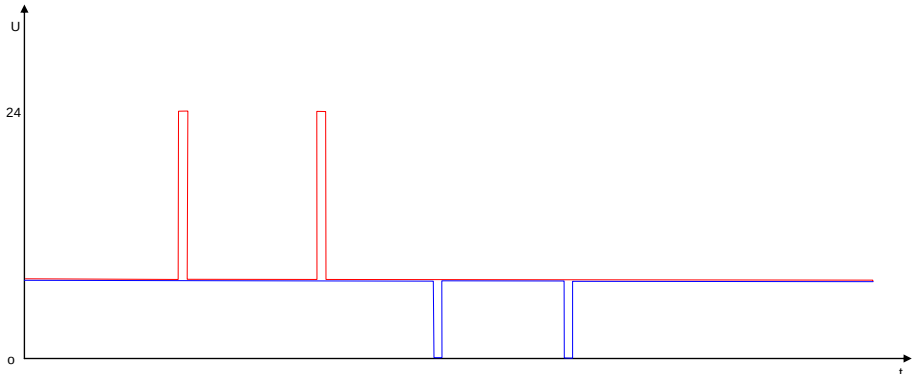
Table 3-2

Parameter	Effect
Wire break	A change of wire-break parameter does not affect the test pulse.
Read-back time	The test pulse duration for the dark test depends on the load and is less than or equal to the parameterized read-back time.

3.4 Effects of the Bit Pattern Test on the Actuator

Light test

Figure 3-2



- If the actuator is connected between Px and Mx, it is not enabled by the light test with output value 0, because both switches are tested one after the other.
- If two actuators are connected between Px and ground or P24 and Mx, they are briefly enabled twice each one after the other (if the actuators react to signals <= 4ms). 4 test pulses are used.

Note Px and Mx stand for the outputs of both channels of the module, P0 and M0 for channel 0 and P1 and M1 for channel 1, etc.

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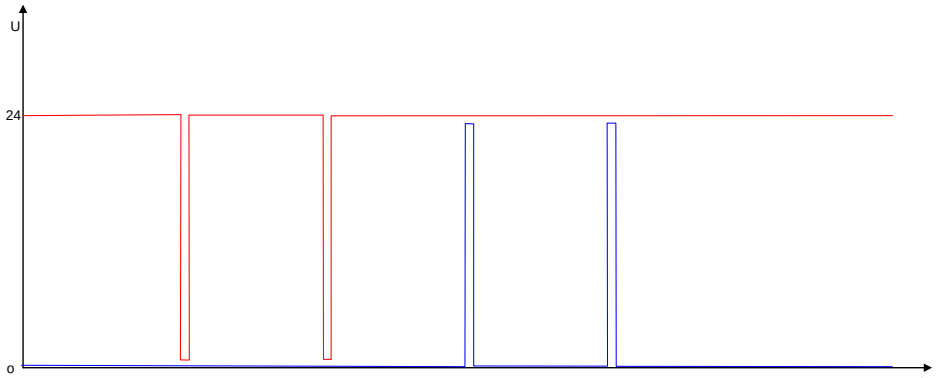
Dark test

Figure 3-3



- If the actuator is connected between Px and Mx, it is disabled briefly four times by the dark test with output value 1 (2x M-switch and 2x P-switch). (If the actuator reacts quickly enough).
- If two actuators are connected between Px and ground or P24 and Mx, they are briefly disabled twice each one after the other. 4 test pulses are used.

Note

Px and Mx stand for the outputs of both channels of the module,
P0 and M0 for channel 0 and P1 and M1 for channel 1, etc.

WARNING

If you use actuators whose reaction time is fast enough to react to the test pulses, you must switch relays in between so that your actuators are not briefly disabled during the dark test.

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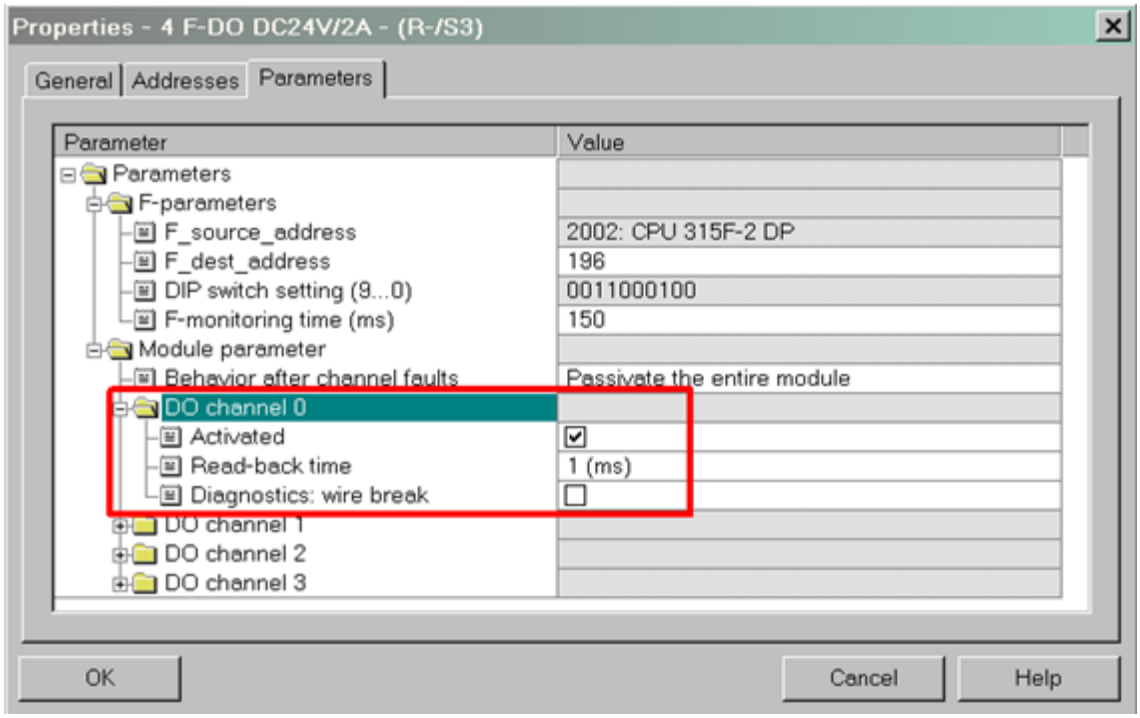
4 4 F-DO DC24V/2A (6ES7 138-4FB03-0AB0)

4.1 Parameter Options for the 4-F-DO DC24V/2A

With this module you have the option of parameterizing four channels. You can either enable or disable the channels, change the read-back time and enable or disable the wire-break diagnostics.

Figure 4-1



4.2 Parameter-independent Properties of the Bit Pattern Test

Table 4-1

Property	Effect
Test interval	The P-switch and the M-switch are switched on/off twice about every 15 minutes (about every minute if there is a fault). Four test pulses are used.
Number of test pulses	32 test pulses are used per bit pattern test, 16 each for the light and dark test.
Test procedure	The P-switch and the M-switch of a channel are tested one after the other and never simultaneously.
Light test pulse duration	The test pulse for the light test is less than or equal to 4ms.

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4.3 Effects of Parameter Changes on the Bit Pattern Test

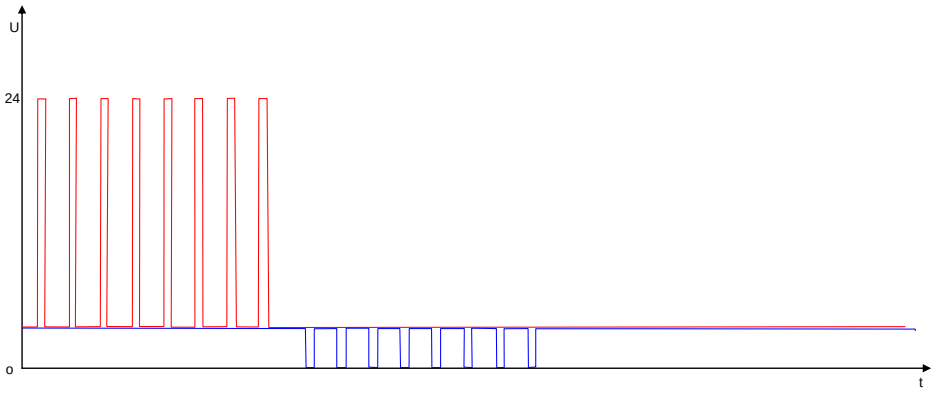
Table 4-2

Parameter	Effect
Wire break	A change of wire-break parameter does not affect the test pulse.
Read-back time	The test pulse duration for the dark test depends on the load and is less than or equal to the parameterized read-back time.

4.4 Effects of the Bit Pattern Test on the Actuator

Light test

Figure 4-2



- If the actuator is connected between Px and Mx, it is not enabled by the light test with output value 0, because both switches are tested one after the other.
- If two actuators are connected between Px and ground or P24 and Mx, they are briefly enabled 8 times each one after the other (if the actuators react to signals <= 4ms). 16 test pulses are used.

Note

Px and Mx stand for the outputs of the four channels of the module,
P0 and M0 for channel 0 and P1 and M1 for channel 1, etc.

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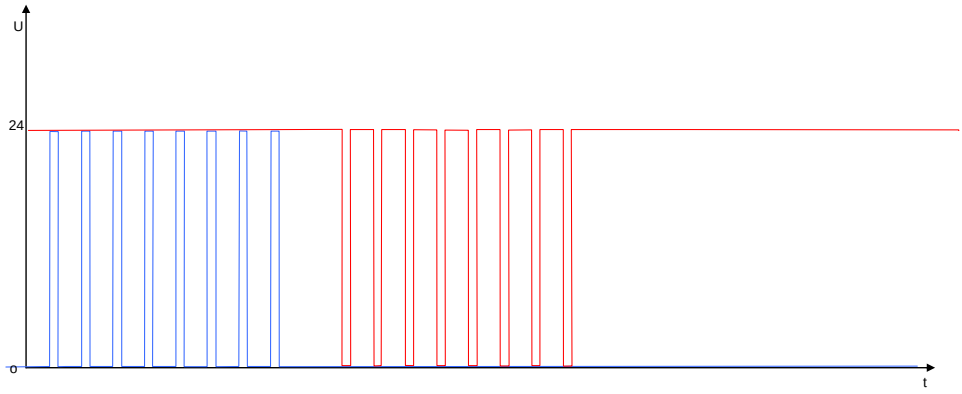
Dark test

Figure 4-3



- If the actuator is connected between Px and Mx, it is disabled briefly 16 times by the dark test with output value 1 (8x M-switch and 8x P-switch). (If the actuator reacts quickly enough).
- If two actuators are connected between Px and ground or P24 and Mx, they are briefly disabled 8 times each one after the other. 16 test pulses are used.

Note

Px and Mx stand for the outputs of the four channels of the module,
P0 and M0 for channel 0 and P1 and M1 for channel 1, etc.

WARNING	**If you use actuators whose reaction time is fast enough to react to the test pulses, you must switch relays in between so that your actuators are not briefly disabled during the dark test.**

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5 4/8 F-DI DC24V (6ES7 138-4FA04-0AB0)

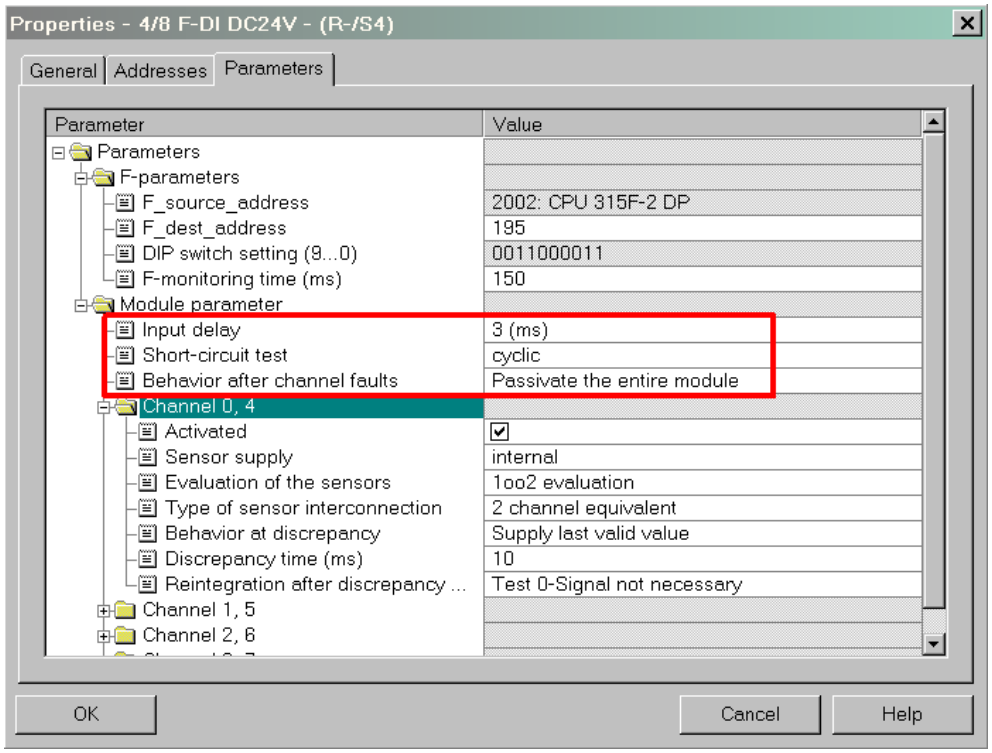
The F-DI module provides a sensor supply. The sensor supply is pulsed when the short-circuit test is switched on. In this way both a short-circuit against the power supply and against the second sensor supply can be detected.

If the internal sensor supply is used when the short-circuit test is switched on, the must be insensitive to the pulsed power supply.

5.1 Parameter Options for the 4/8 F-DI DC24V

Only the module parameter "Input delay" and the channel parameter "Sensor supply" are relevant for the test pulses.

Figure 5-1



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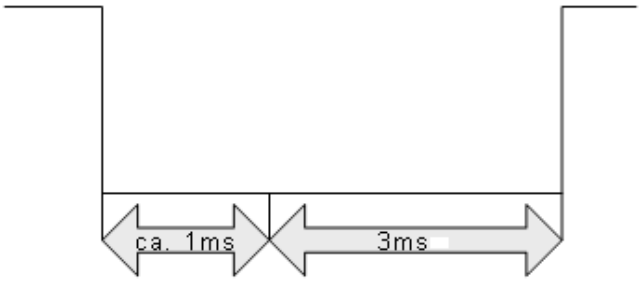
5.2 Effects of Parameter Changes on the Internal Sensor Supply

5.2.1 Input delay

This parameter directly affects the test pulse duration of the sensor supply.
The length of a test pulse is approx. 1ms plus the parameterized input delay time.

Figure 5-2 shows you a diagram of a single pulse of the sensor supply with a read-back time of 3 ms.

Figure 5-2



If you change the parameter to 15ms, you get a pulse length of approx. 16 ms.

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5.2.2 Sensor supply

- This parameter has no direct effect on the test pulses. These are always available independent of the parameterized sensor supply.
- This parameter switches the evaluation of the test pulses on and off.

If the internal sensor supply is selected, then the test pulses of the assigned sensor supply must be recognized with a 1 signal at a digital input. If no test pulses or those of another sensor supply are recognized, this is taken as a fault and the channel (or module depending on the parameterization) is passivated.

6 History

Table 6-1

Version	Type of change
V1.0	Creation
V1.1	Revised text in section 1.4 and chapter 5

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