pilz

Programmable Safety Systems
PSS-Range

PSS Selective Shutdown
Operating Manual
Item No. 19 577

The spirit of safety.

Version II, 08/01

Contents

Contents

Contents

Introduction

This operating manual forms part of the “PSS Selective Shutdown”. It explains how the programmable safety systems PSS 3000/PSS 3100 with Selective Shutdown function and operate. This manual is divided into the following chapters:

1.) Introduction

2.) Overview
Contains information on the most important features of PSS selective shutdown.

3.) Intended Application
Explains the purpose of selective shutdown and the conditions under which it can be applied. Also gives information on important safety regulations.

4.) Configuring Selective Shutdown
Explains what is configured by PSS selective shutdown and what needs to be considered

5.) Programming Information
Gives information on the operating cycles and communication options with the operating system necessary for programming.

6.) Operation
Describes the PSS operating condition with selective shutdown, as well as how a change in condition can be triggered and what happens when a change occurs, e.g. how the PSS switches from a STOP to a RUN condition.

7.) Additional Measures for Reaction Types ≥ 3
Explains which additional measures must be taken when signal groups are configured with reaction types ≥ 3 and gives examples to show this.

8.) Project Planning
Provides step by step instructions for configuring and programming PSS selective shutdown.

9.) Appendix
Contains an overview of the reaction types, as well as the layout of DB 001 and the configuration data block for selective shutdown.

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Introduction

Definition of symbols

Information in this manual which is of particular importance can be identified as follows:

DANGER!

This warning must be heeded! It warns of a **hazardous situation which poses an immediate threat of serious injury and death,** and indicates preventive measures which may be taken.

WARNING!

This warning must be heeded! It warns of a **hazardous situation which could lead to serious injury or death,** and indicates preventive measures which may be taken.

CAUTION!

This refers to a hazard which can lead to a less serious or minor injury plus material damage, and also provides information on preventive measures which may be taken.

NOTICE
This describes a situation in which the unit(s) could be damaged and also provides information on preventive measures which may be taken.

INFORMATION
This gives advice on applications and provides information on special features, as well as highlighting areas within the text which are of particular importance.

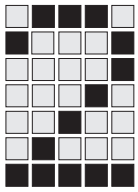
Intended Application

The purpose of PSS selective shudown is identical to that of the PSS 3000 / 3100. Selective shutdown, however, provides increased availability when errors occur at indivdual PSS I/Os. This is managed through appropriate programming.
Selective shutdown configuration must be carried out using programming software PSS SW PG version 3.0 or higher.

Safety guidelines

- The unit must only be installed and commissioned by qualified, competent electronic engineers familiar with the:
  - PSS Selective Shutdown Manual
  - PSS System Manual
  - PSS Installation Manual for the relevant PSS system
  - PSS Safety Manual and Selective Shutdown Safety Manual
  - Basic regulations concerning health and safety/accident prevention

  Ensure VDE, HSE and local regulations are met, especially those concerning safety.
- Opening the housing, modifying the circuit boards, i.e. exchanging a component or carrying out soldering work, will render the warranty, and any approvals, invalid
- The safety regulations and the EMC measures given in the “Installation Manual” must be observed
- Follow all the relevant regulations concerning your plant
- **For plants with safety requirement category 4 in accordance with EN 954-1, the following points are valid:**
  - Only reaction types 0, 1, 2 and 3, as well as 12, 13 and 14 can be used for non safety-related I/Os
  - When using reaction type 3, additional measures are required (see page 7-1 onwards) so that requirements in accordance with EN 954-1, category 4 are met.
    It is not sufficient to monitor a deactivated plant with reaction type 3 through operator or organisational measures.



Notes

Overview

PSS selective shutdown has been developed to significantly increase the availability of the PSS when I/O errors occur on individual modules.

Compared to conventional PSS operation, where an error at an input or output would bring the entire PSS to a STOP-condition, selective shutdown enables inputs and outputs and read/write segments to be assigned to **signal groups**. These signal groups are handled individually should a fault occur and will not influence the operation of other signal groups.
The user can assign a **reaction type** to each signal group. The system response can be determined using a reaction type. There are 13 different reaction types available. Selective shutdown allows a controlled reaction to an I/O error, i.e. an error message about a defective I/O in a signal group, or in certain cases, it can lead to an entire PSS STOP. It is possible, therefore, to connect several machines to one PSS, but control each machine independently.

Single errors are those which can be related to individual I/Os and read/write segments on a module. These include wiring errors such as short circuits to 24 V or earth. The reaction to a single error is specified by the user through the reaction type.

Single errors can be classified as bus errors or module errors.
Bus errors are errors affecting all output modules. These errors will cause the PSS to change to a STOP condition and to “deactivate” all signal groups assigned the reaction type 0 (see chapter 4).

Module errors are errors which affect all inputs or outputs on a slot. These errors cause the slot to be shut down and the outputs overwritten with “0”, i.e. switched-off.

Module errors on slots assigned with inputs will cause the inputs to be overwritten according to their reaction type.

In addition, all represented signal groups on the slot affected by the module error will be “deactivated” according to its reaction type (see “Selecting the reaction types” on page 4-2).

Overview

WARNING!

As the user can determine the system’s response to errors via selecting reaction types, the responsibility for plant safety lies solely with the user. Careful planning, configuration and programming is therefore vital for all selective shutdown applications.

Configuring Selective Shutdown

The configuration for selective shutdown is carried out using the programming device (PSS SW PG version 3.0 or higher) and entered in the configuration data block specific to selective shutdown. The configuration process required is described in the Programming Device Manual.
This chapter shows you what can be configured and what needs to be considered.

Configuring signal groups

Any I/Os and read and write segments can be grouped together in signal groups when the same system response should be triggered if an individual error occurs. How the system reacts is determined via the reaction type of the signal group.

A maximum of 32 signal groups can be specified. The signal group 0 contains all configured I/Os and read/write segments which are not otherwise assigned to a signal group, excluding test pulses. The reaction type of signal group 0 is always 0, i.e. the PSS changes to a STOP condition with each error within this signal group.
The I/Os and read/write segments within the signal groups 1 ... 31 can be selected by the user as well as the reaction type for the signal groups.

Signal groups	I/Os contained within the group	Reaction type
0	All configured inputs and outputs otherwise not assigned a signal group, with the exception of test pulses	0
1 - 31	Can be selected by the user	Can be selected by the user

INFORMATION

- An I/O can be allocated to one signal group only
- Group together all I/Os and read/write segments not used in a single signal group and assign the reaction type 12, 13 or 14. This will prevent the PSS going into a STOP condition should an error occur at one of these I/Os.

Configuring Selective Shutdown

Signal group hierarchy must be programmed by the user as required. If, for example, an error occurs on machine 1 which means machine 2 must be shutdown, but an error occurring on machine 2 does not require machine 1 to be shutdown, then the I/Os of each machine must be grouped together in different signal groups.
If an error occurs at machine 1, a deactivation-OB will be called up during the error handling process. The user can program the shutdown of machine 2 and/or its signal group in this deactivation-OB (see the section “Deactivation organisation block” and “Deactivation flags” on page 5-9).

WARNING!
How the signal groups are arranged is of particular importance for determining the reaction of the PSS should an error occur, together with the safety for the entire plant.
Always ensure that if an error occurs, handling of respective signal groups will not have any critical effects on the safety of other signal groups.

Selecting the reaction types

The selection of reaction types depends on the system response required when errors occur. There is a choice of 13 reaction types:: 0, 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13 and 14. The exact error response to these reaction types is explained fully further on in this chapter.

It is important when selecting a reaction type to know the difference between the terms "**shutdown**" and "**overwrite**".

Only entire sub-slots can be shut down. When a shutdown occurs the outputs will be overwritten with “0” and will be separated safely within the PSS from 24 V.
The separation from 24 V will be monitored constantly by the PSS. If the separation cannot be guaranteed the PSS will go into a STOP condition and all signal groups will be deactivated.

If a single I/O or read/write segment is overwritten, then a predefined value is given to the I/O or read/write segment and written in the corresponding process image.

Outputs are always overwritten with “0”; inputs with “0” or “1” or the last valid signal “Alt” for this input, depending on the reaction type. For read/ write segments, overwrite values can be configured.

Overwritten, non-defective I/Os will be fully tested by the PSS. If all outputs on a sub-slot are overwritten, the sub-slot is shut down and as described on the previous page separation from 24 V is monitored.

If a defective output is not switched off (with reaction type ≥ 3), this will cause reduced safety if **additional measures** have not been designed in (see chapter 7). Defective outputs which are overwritten but not switched off will no longer be tested, and consequently 24 V can be present at an output overwritten with “0” should an error occur.
Whether reduced safety for a given time period is permitted or not will depend on the plant and the relevant safety regulations that apply.

If, during error handling, I/Os within a signal group are overwritten or output modules shut down, the deactivation flag for the signal group will be set and the corresponding deactivation-OB called up. The signal group will be regarded as **deactivated**.

Deactivating a signal group must not cause any safety-critical implications for other plant sections. This must be considered at the planning stage of the application.

Deactivation cannot be cancelled by switching off the PSS and then back on. The signal group must be **reactivated** (see the section “Reactivation” on page 5-5).
If a signal group with reaction type 3 ... 10 assigned was deactivated, it must be reactivated by the user within 100 hours. If this time is exceeded the PSS deactivates the signal group according to reaction type 2.

Configuring Selective Shutdown

WARNING!
The reaction types for the signal groups can be freely selected. This means responsibility for plant safety lies solely with the user, and the following points must be observed:

- Always select a reaction type suitable for the level of safety required
- Deactivating a signal group must not cause any safety-critcal effects to other plant sections or signal groups
- Select the reaction types and signal groups so no chain reaction can occur
- If a signal group with reaction type ≥ 3 is deactivated, this will cause reduced safety. If additional measures are not taken, (see chapter 7) this could pose a threat of danger to both personnel and machinery.

A full listing of reaction types is given in a table in the Appendix from page 9-1 onwards.

Reaction type 0

Any error at an I/O of a signal group with the reaction type 0 will cause the PSS to go into a STOP-condition.
Reaction type 0 is the safest possible of all the reaction types.

It acts in a similar manner to a conventional PSS, the only difference being, all signal groups deactivated will need to be reactivated when the PSS is restarted (see “Reactivation” on page 5-5).

Reaction type 1

Any error at an I/O of a signal group with reaction type 1 will trigger the following reactions:

- All sub-slots containing outputs and write segments from the signal group will be shut down
- Defective inputs of the signal group are overwritten with “0”
- Defective read segments of the signal group are overwritten with the assigned overwrite value
- The signal group is deactivated.

Additional signal groups affected by the error reaction, e.g. because they have outputs on the sub-slot shut down, will be deactivated according to their own reaction type.

Application area:

Control of several independent plant sections. If an error occurs the affected plant section must be shut down safely. Other plant sections must not be affected.

Example:

Machine 1 and machine 2 are connected to one PSS as shown in Fig. 4-1. The outputs of each machines are on separate sub-slots.

Error:

Short circuit of output 3.16+ to 24 V

Reaction:

The sub-slots with the outputs A 2.00 - A 2.15 and A 3.16 - A 3.23 are shut down.

Consequences:

Machine 1 is switched off safely as all sub-slots occupied with these outputs are shut down. Machine 2 continues to run unaffected.

Configuring Selective Shutdown

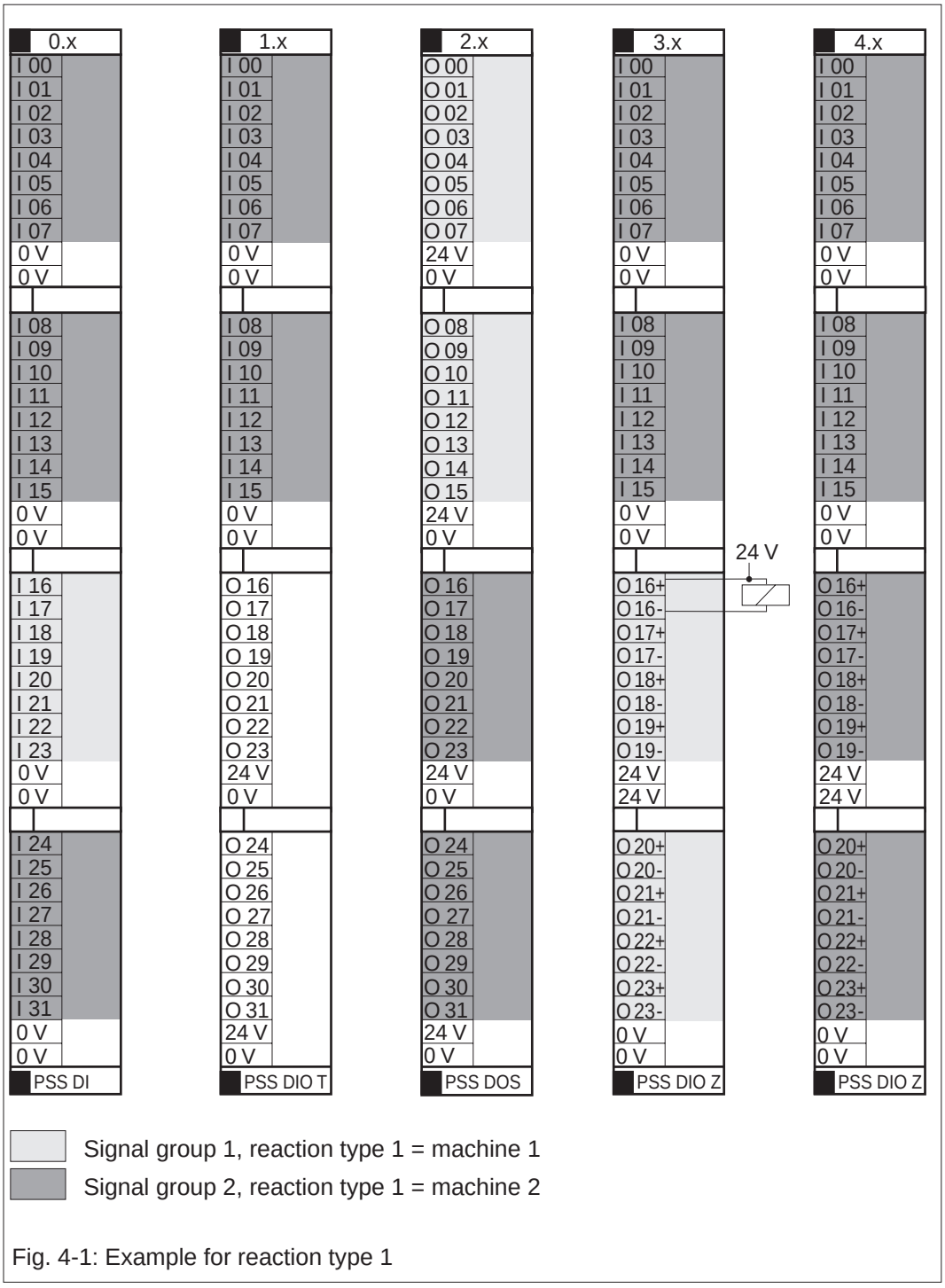


Fig. 4-1: Example for reaction type 1

Reaction type 2

Any error at an I/O of a signal group with reaction type 2 will trigger the following reactions:

- Sub-slots containing the defective outputs of the signal group are shut down
- Non-defective outputs of the signal group are overwritten with “0”
- Word modules which have the signal group with the defective read/write segments are shut down
- Write segments of the signal group which are not defective are overwritten with the assigned overwrite value
- Defective inputs of the signal group are overwritten with “0”
- Defective read segments of the signal group are overwritten with an assigned overwrite value
- The signal group is deactivated

Additional signal groups affected by the error reaction, e.g. because they have outputs on the sub-slot shut down, will be deactivated according to their own reaction type.

Application area:

Control of several plant sections whose I/Os are on common sub-slots. If an error occurs the affected plant sections must be shut down safely. As far as possible no other sections of the plant should be affected.

Example:

Machine 1 and machine 2 are connected to a PSS as shown in Fig. 4-2. Each machine shares a sub-slot on an output module.

Error:

Short circuit of output 3.16+ to 24 V

Reaction:

- The sub-slot with the outputs A 3.16 - A 3.23 is shut down
- A 2.00 - A 2.03 and A 2.08 - A 2.11 are overwritten with “0”
- Inputs are not overwritten.

Configuring Selective Shutdown

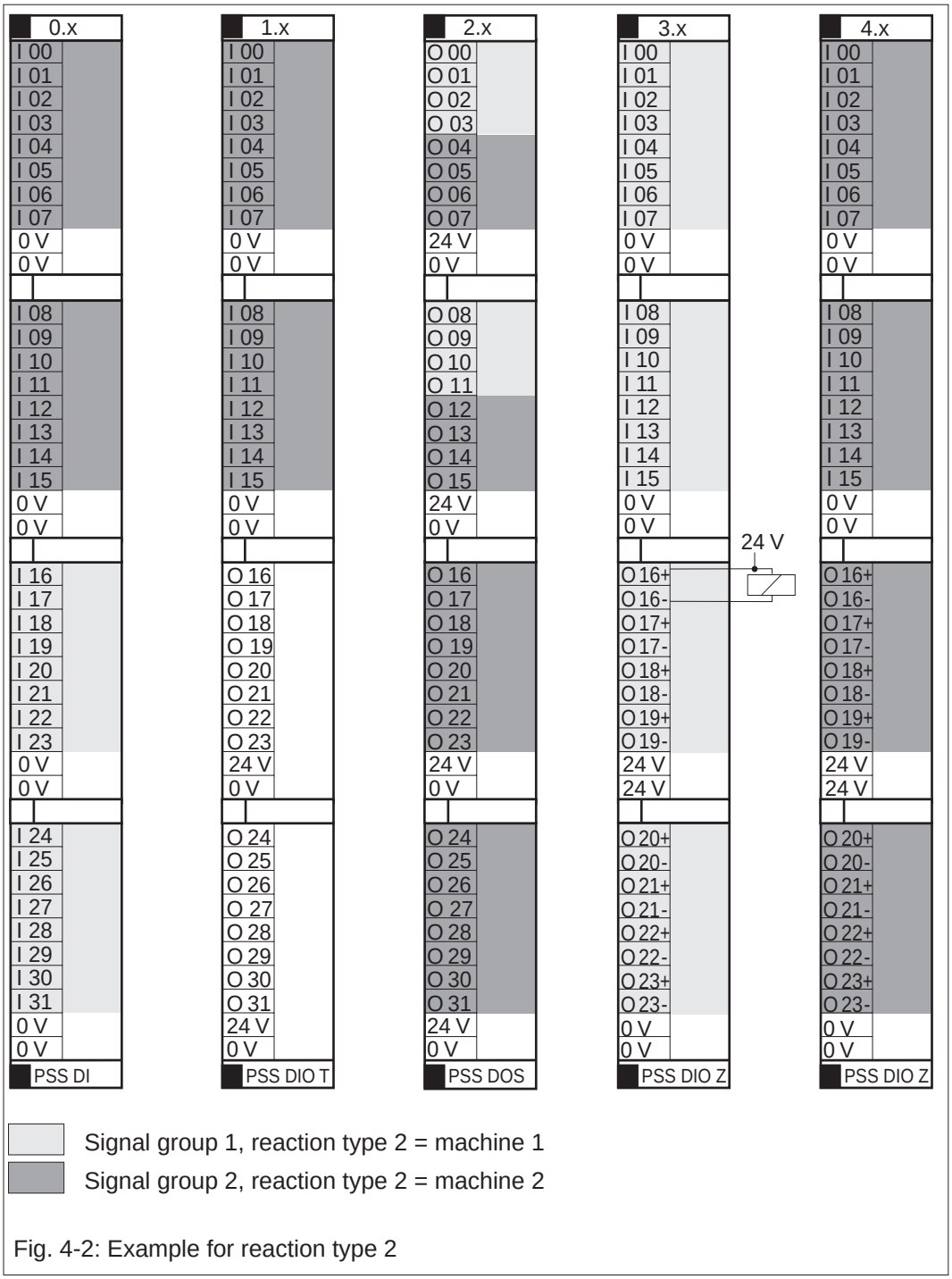


Fig. 4-2: Example for reaction type 2

Consequences:

Machine 1 will be shut down as all the sub-slots with defective outputs are shut down. Machine 2 will continue to run unaffected.

Note:

If an error occurs on the sub-slot A 2.00 - A 2.15, then both machines would be shut down safely.

Reaction type 3

Any error at an I/O of a signal group with reaction type 3 will trigger the following reactions:

- All outputs of the signal group will be overwritten with “0”
- Write segments of the signal group will be overwritten with the assigned overwrite value
- Defective inputs of the signal group will be overwritten with “0”
- Defective read segments of the signal group will be overwritten with the assigned value
- The signal group will be deactivated
- The error timer will be started. Any errors which have occurred must be removed within 100 hours and the signal group reactivated, otherwise the PSS will deactivate all I/Os of the signal group using reaction type 2.

WARNING!

To exclude any possibility of danger to both the operator and machine, additional measures must be taken when using reaction type 3 (see chapter 7). Exception: When a signal group with reaction type 3 only contains inputs. Follow the relevant regulations and safety guidelines given in chapter 2 which apply to the plant.

Application area:

If several plant sections are to be controlled which are not divided between different sub-slots. If an error occurs the affected plant section will be shut down. Other plant sections must not be affected.

Configuring Selective Shutdown

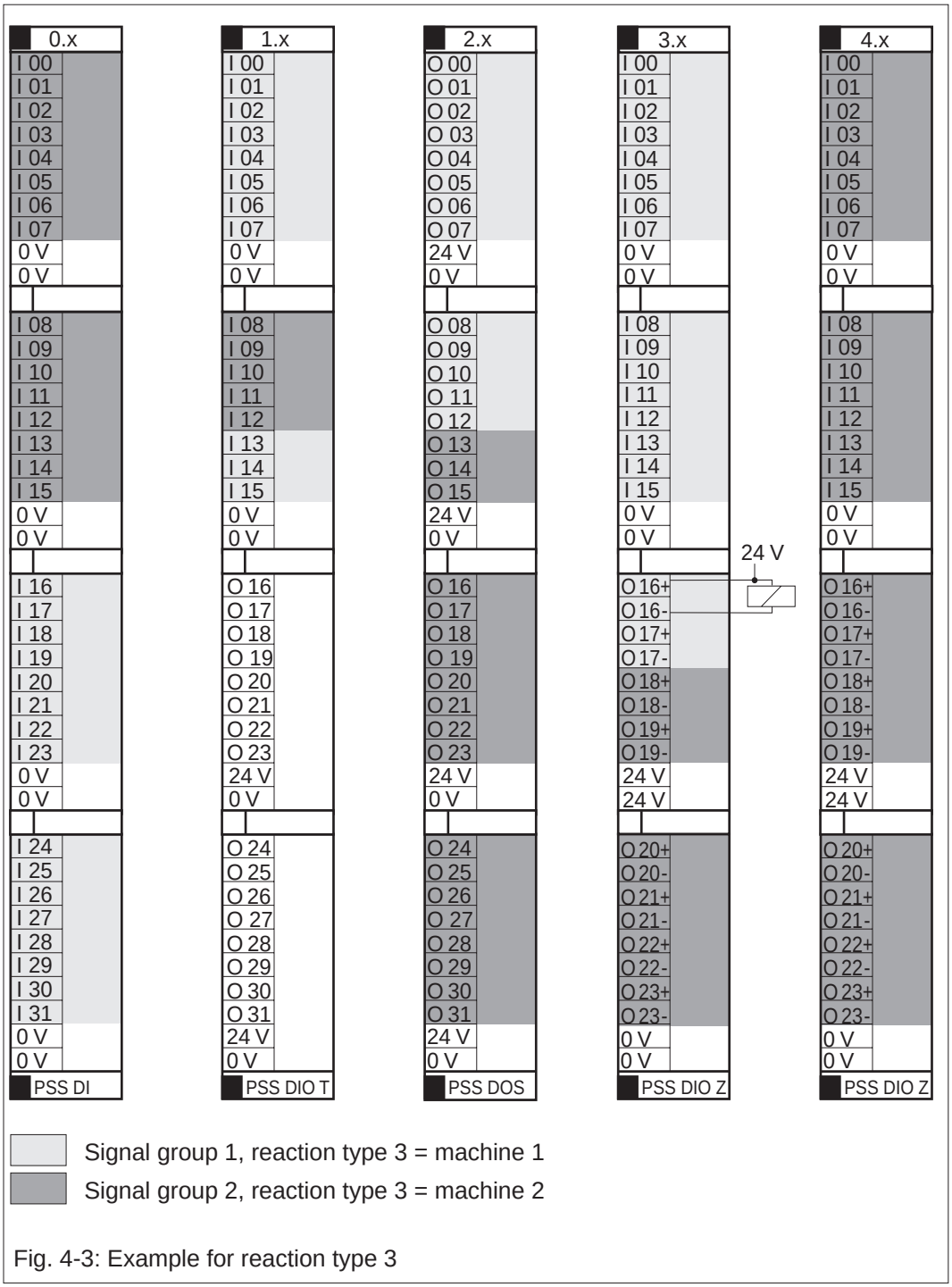


Fig. 4-3: Example for reaction type 3

Example:

Machine 1 and machine 2 are connected to a PSS as shown in Fig. 4-3.

Error:
Short circuit of output 3.16+ to 24 V

Reaction:

- Outputs A 2.00 - A 2.12 and A 3.16 - A 3.17 will be overwritten with “0”
- Inputs will not be overwritten

Consequences:

All outputs for machine 1 are overwritten with “0”. Only outputs which are not defective will be monitored by the PSS, the defective output A 3.16+ is not monitored. “Operation with safe monitoring” is therefore required for machine 1.
The operator has a maximum of 100 hours to rectify the error and reactivate the signal group.
Machine 2 continues to run unaffected.

Reaction types 4, 5 and 6

Any error at an I/O of a signal group with reaction type 4, 5 or 6 will trigger the following reactions:

- Defective outputs of the signal group will be overwritten with “0”
- Defective write segments of the signal group will be overwritten with the assigned overwrite values
- Defective inputs of the signal group with reaction type 4, 5 or 6 will be overwritten as follows
  - reaction type 4 with “0”
  - reaction type 5 with “1”
  - reaction type 6 with “Alt” (last valid signal).
- Defective read segments of the signal groups will be overwritten with the assigned overwrite value
- The signal group is deactivated

- The error timer is started. Any errors which have occurred must be rectified and the signal group reactivated within 100 hours, otherwise the PSS will deactivate all I/Os of the signal group with reaction type 2.

WARNING!

To exclude any possibility of danger to both the operator and machine, additional measures must be taken when using the reaction types 4, 5 and 6 (see chapter 7). Exception: When a signal group with reaction type 4 only contains inputs. Follow the relevant regulations and safety guidelines given in chapter 2 that apply to the plant.

Application area:

If an error occurs, only the defective I/Os are overwritten; other I/Os should remain controllable from the application program.

Example:

A signal group has been configured as shown in Fig. 4-4.

Error:
Short circuit of the output 1.16+ to 24 V

Reaction:

The output A 1.16+ will be overwritten with “0”.

Consequences:

The defective output A 1.16+ will be overwritten with “0”, but no longer monitored by the PSS. “Operation with safe monitoring” is therefore required. The operator has a maximum of 100 hours to rectifiy the error and reactivate the signal group. Outputs which are not defective must be operated from the application program.

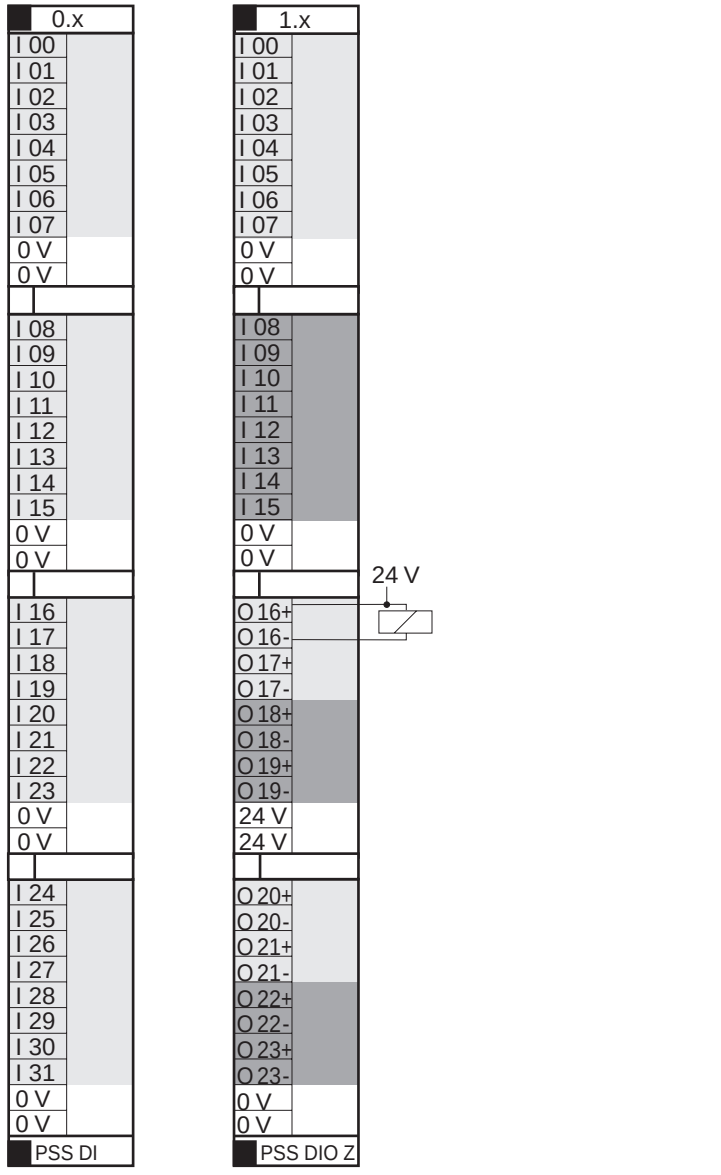


Fig. 4-4: Example for the reaction types 4, 5, 6, 8, 9, 10, 12, 13 and 14

Reaction types 8, 9 and 10

Any error at an I/O of a signal group with the reaction type 8, 9 or 10 will trigger the following reactions:

- For defective outputs of the signal group a “reaction in the application program” must be carried out, i.e. the user must generate the reaction in the application program
- For defective read segments of the signal group a “reaction in the application program” must be carried out
- Defective inputs of the signal group with reaction type 8, 9 or 10 will be overwritten as follows
  - reaction type 8 with “0”
  - reaction type 9 with “1”
  - reaction type 10 with “Alt” (last valid signal).
- Defective read segments of the signal group will be overwritten with the assigned overwrite value
- The signal group is deactivated.
- The error timer will be started. Any errors must be rectified within 100 hours and the signal group reactivated, otherwise the PSS deactivates all I/Os of the signal group with reaction type 2

WARNING!

To exclude the possibility of any danger to both the operator and machine, additional measures must be taken when using the reaction type 8, 9 or 10 (see chapter 7). Exception: When a signal group with reaction type 8 only contains inputs. Follow the relevant regulations and safety guidelines for yourplant as stated in chapter 2.

Application area:

As for reaction types 4, 5 and 6, however a defective output will not be overwritten with “0”, but managed from the application program.

Example:

A signal group was configured as shown in Fig. 4-4 and the reaction type 8, 9 or 10 assigned.

Error:
Short circuit of output 1.16+ to 24 V

Reaction:

Determined in the application program

Consequences:

The defective output A 1.16+ is no longer monitored by the PSS and the application program must respond to the defective output, e.g. switch-off the module. “Operation with safe monitoring” is therefore required for the machine.
The operator has a maximum of 100 hours to rectify the error and reactivate the signal group.

Reaction type 12, 13 and 14

WARNING!

These reaction types must only be selected for non-safety-related I/Os.

Any error at an I/O of a signal group with the reaction type 12, 13 or 14 will trigger the following reactions:

- For defective outputs of the signal group a “reaction in the application program” must be carried out. The defective output is no longer tested.
- For defective write segments of the signal group a “reaction in the application program” must be carried out
- Defective inputs of the signal group with reaction type 12, 13 or 14 will be overwritten as follows
  - reaction type 12 with “0”
  - reaction type 13 with “1”
  - reaction type 14 with “Alt” (last valid signal).
- Defective read segments of the signal group are overwritten with the assigned overwrite value
- The signal group is deavtivated

There are no time restrictions for errors in signal groups having reaction type 12, 13 or 14.

Application area:

For non-safety-related I/Os or I/Os not used

Example:

A signal group was configured as shown in Fig. 4-4 and assigned the reaction type 12, 13 or 14.

Error:

Short circuit of output 1.16+ to 24 V

Reaction:

Determined in the application program.

Consequences:

The defective output A 1.16+ is no longer monitored by the PSS. The application program must respond to the defective output, e.g. shut down the module.

NOTICE

The PSS signals the error of the output or write segments to the application program and continues to run. The defective output is no longer tested.
Defective inputs or read segments will be overwritten.

Increased safety via output pairs

When a signal group with reaction type 3-6 has 2 outputs arranged together as an output pair and AND-connected, these outputs are overwritten and not switched off, and an increased level of safety can be achieved (see chapter 7).

If an error occurs at an output of an output pair, then both outputs are overwritten with “0” by the PSS. The error-free output will continue to be tested. If the second output becomes defective, the PSS shuts down the sub-slot on which the second output is located.
This means the sub-slot is shut down although the outputs belong to a signal group with a reaction type 3-6.

INFORMATION
Managing output pairs has priority over handling signal groups according to their reaction type.

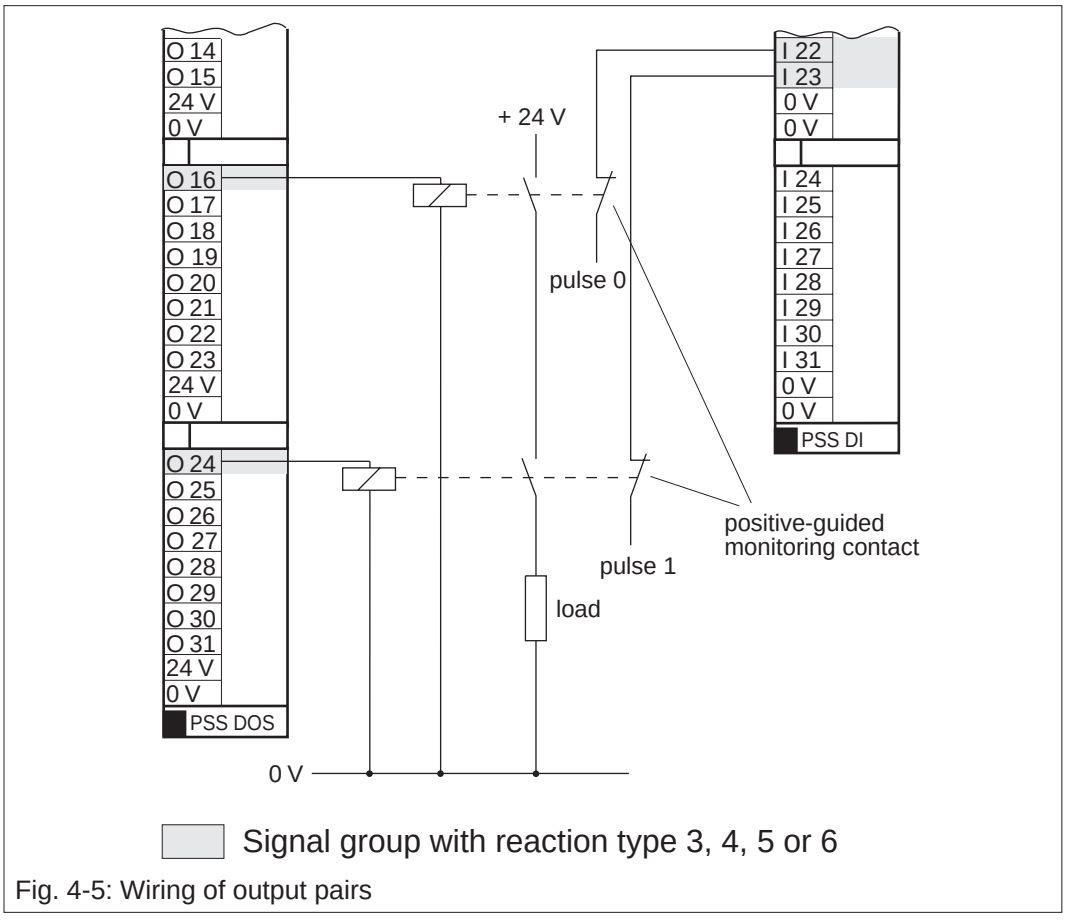


Fig. 4-5: Wiring of output pairs

If both outputs are configured with an AND-connection as shown in Fig. 4-5, the load can still be switched off if an error occurs at one of the outputs. A module shutdown is therefore not required after the first error has occurred. When the load is switched off, safety will depend on the operating safety of the auxiliary contactor or relay

INFORMATION
Should you want to define output pairs:

- Check the function of the auxiliary contactor or relay
- Only use approved auxiliary contactors or relays
- On DOS-modules both outputs of an output pair must be in different groups of 8 or belong on different modules; for DOR-modules they must be adjacent or belong on different modules and for other modules any pair of outputs may be used.
- The outputs of a pair must belong to a common signal group
- Defining output pairs is only significant for signal groups with reaction types 3 - 6. Defining output pairs for signal groups with reaction type 8-13 has no effect on the management of outputs if an error occurs
- If the sub-slot on which the second output of the pair is located is shutdown, it must not have any safety critical effects for the plant as a whole

Output pairs are set in the programming device.

Configuring test pulses

Test pulses are used to test the inputs. Two options are available for configuration :

- Test pulses are not to be assigned to a signal group, not even signal group 0
- Test pulses are assigned to a signal group

If the test pulse is not assigned to a signal group, the advantages are:

- Test pulses will only ever be overwritten with “0”, when it is itself defective

- The test module will not be shut down if an error occurs. An error at a single test pulse output has therefore no effect/feedback on the other signal groups having pulsed inputs
- Inputs belonging to different signal groups can be tested using the test pulse. A defective test pulse output can affect several signal groups at the same time. As in the case of a defective test pulse output, all other inputs tested with the test signal will be regarded as defective.

If a test pulse output is assigned to a signal group, it has the following effects:

- Only those inputs can be tested with the test pulse belonging to the same signal group
- When an error occurs within the signal group the test pulse output is handled according to the reaction type for the particular signal group
- If a test pulse belongs to a signal group with reaction type 1 or 2, and an error occurs within the signal group, all test pulse outputs will be switched off or overwritten and therefore all pulsed inputs will be regarded as defective. As a result, all signal groups with pulsed inputs will be deactivated.
- If a test pulse belongs to a signal group which will be deactivated using reaction type 0, all test pulse outputs will be switched off and therefore, all pulsed inputs will be regarded as defective. As a result, all signal groups with pulsed inputs will be deactivated.

Determining overwrite values

Compared to bit modules where outputs must be overwritten with “0” and inputs with “0”, “1” or “Alt”, depending on the reaction type assigned, on word modules, overwrite values must be set for each read/write segment. The overwrite values are entered in the programming device.

WARNING!

To avoid unwanted system responses due to incorrect overwrite values, ensure you select overwrite values that will trigger a safe reaction if overwrite occurs.
For example, an error at a defective temperature sensor: select an overwrite value that will not cause inadvertent increases in temperature.

Configuring Selective Shutdown

Error and deadman timer

If a signal group with reaction type 3, 4, 5, 6, 8, 9 or 10 is deactivated, the PSS is limited to a maximum operating time of 100 hours due to reduced safety.
An error timer is started for each signal group deactivated.

The PSS stores (retentive) the residual run time of the error timer in maximum of 1 hour intervals (depending on the minimum scan time and configured self test). This means the residual run time is maintained even when the PSS goes into a STOP condition. When the PSS switches from STOP to RUN the error timer begins from its residual run time, but reduced by 1 hour.
The remaining time can be determined using SB 255, function 101.
The error timer cannot be reset by the user.

A deadman timer is started at the same time as the error timer. If the deadman timer is used, it must be acknowledged at regular intervals that the process is running with reduced safety.

The deadman timer run time must be set by the user in the deactivation-OB for the signal group. It should be selected according to the type of plant and the potential for danger present. A maximum of 100 hours (6000 minutes) is possible.

INFORMATION
If the run time for the deadman timer is not specified, the signal group is deactivated immediately with reaction type 2.

A deadman timer can be reset by the user (e.g. by pressing a reset button) or through the application program (SB 255, function 100). If the PSS changes from STOP to RUN, the deadman timer is started from new.
The residual run time of the deadman timer is determined using SB 255, function 101.

INFORMATION
If the time elapses for either the error or deadman timer, without any reaction to the error, the PSS handles all I/Os of the signal group according to reaction type 2.
This can affect other signal groups and must be considered during the configuration stage.

WARNING!
Both the error and deadman timers can be deactivated by the application program using SB 255, function 102. If this function is used you must ensure the plant is in a safe condition and you keep within the guidelines of function 102.

Special features of individual modules

PSS(1) DI and PSS(1) DI 2

- A pulsed input is defective when the test pulse output to which it is connected is also defective or overwritten with 0
- Defective inputs will be overwritten

PSS(1) DIF

- A pulsed input is defective, when the test pulse output to which it is connected is defective or overwritten with 0
- Defective inputs will be overwritten
- Defective DIF-inputs will not trigger any more interrupt signals
- If defective inputs on a DIF module can no longer be overwritten, the interrupt inputs of all DIF modules will be marked as defective and interrupt processing is no longer possible (this will prevent continuous interrupts).

NOTICE
Processing the error list can lead to an increase in the alarm reaction time, however, this will occur once only.

INFORMATION
When using a PSS(1) SF CPU, Version 1.1/1.2/1.3, it is not possible to use test pulses with inputs on the PSS(1) DIF module from Version 2.0, if the inputs are configured as alarms.

Configuring Selective Shutdown

Word modules

- The operating system only detects module errors and errors on word modules by matching the XW-values (tolerance error). Any other errors must be found by the application program and passed to the operating system (SB 255, function 103 or 104) or managed by the application program itself.
- If a word module has 2 or more single errors, it will be shut down and all write segments will be overwritten according to the reaction type
  This is necessary as 2 single errors suggest that a module error is present.
- Related read/write segments on an AI module should belong to the same signal group.

INFORMATION
When using the word module PSS(1) AI U5I1, please observe the guidelines regarding selective shutdown in the “PSS SB AI3” manual.

PSS(1) DOS

- A cyclical monitoring test will be carried out and a configurable switch-on /off test
- If a second error occurs within a group of 8, then the affected sub-slot will be shut down
  This is necessary as the switch-off relay can only switch off the maximum current from 2 defective outputs
- Outputs of a pair must be in different groups of 8 or be on different modules, so that different switch-off relays are used to switch off the outputs

CAUTION!

A short circuit between an output and 24 V cannot be controlled by the PSS, not even by shutting down the module.
24 V is present permanently at the output.

PSS(1) DO

PSS DO outputs must not be used with PSS selective shutdown for safety-related purposes. They may only be assigned to signal groups with reaction types 12, 13 and 14.

INFORMATION
PSS(1) DO modules will always be shut down entirely, i.e. both sub-slots simultaneously.

PSS(1) DIO T

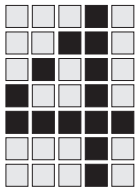
- Pulses on a PSS DIO T work as test pulses for input modules
- Outputs on a PSS DIO T, not used for creating pulses may not be used for safety-related purposes. They may only be assigned to signal groups with the reaction types 12, 13 and 14.

PSS(1) DOR

- A cyclical monitoring test will be carried out. The switch-on/off test will not be used, but if required can be carried out from the application program
- Outputs of a pair must be adjacent or be on different modules

PSS(1) DIO Z

- If a second error occurs at the DIO Z-module, then the module will be shut down
- DIO Z outputs assigned with signal groups having reaction type 0 to 5 must have loads connected.



Notes

Program cycle during errors

If an error occurs the program is interrupted for a “quick reaction”, and at a suitable time the periphery error list is processed.

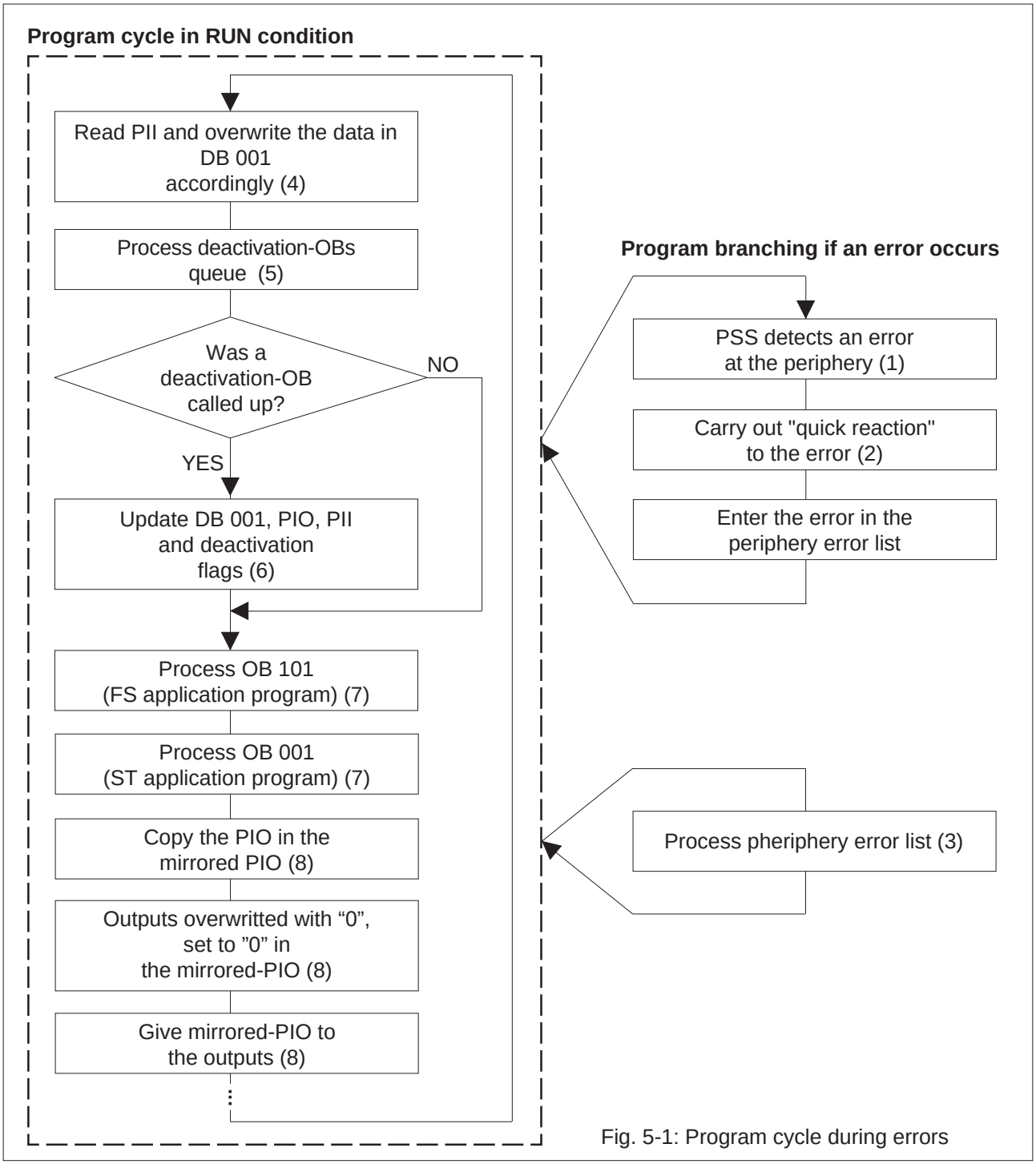


Fig. 5-1: Program cycle during errors

Programming Information

Information relating to the individual sections of the flow diagram:

(1): Errors can be detected by the operating system itself or can be signalled to the operating system from the application program using SB 255, function 103 or 104

(2): Due to time constraints complete error handling cannot be performed at each stage of the cycle, therefore, should an error be detected at the periphery, a quick reaction is carried out initially. A bus error will cause a STOP-condition immediately.
With single and module errors the following occurs:

- Single errors: defective outputs are overwritten according to the reaction type of their signal group
- Module errors: the sub-slot from the defective outputs is shutdown
- Write access to defective outputs is filtered, i.e. accessing will only change the process image of the outputs, and not the output itself
- Read access to defective inputs is bypassed until the processing of the deactivation-OB queue into the PII
- Only defective I/Os are handled, not the entire signal group
- PIO, PII, deactivation flags, DB 001 etc. remain unchanged
- The error is entered into the periphery error list.
  A maximum of 32 entries can be contained in the periphery error.
  If more than 32 errors occur in any one cycle, the PSS goes into a STOP-condition.

(3): As soon as a suitable point in the cycle is reached, the periphery error list is processed:

- It determines to which signal group a defective I/O belongs
- All outputs of the signal group are handled according to the respective reaction types, output pairs are taken into account, the inputs are not handled
- The deactivation-OB is entered in the deactivation-OB queue
- The error timer for the respective signal groups is started if they have the reaction type 3, 4, 5, 6, 8, 9 or 10
- The error is entered in the error stack.

WARNING!

The PSS scan time is increased through processing the periphery error list. This process time can take up to 50 ms.

(4): Inputs from deactivated signal groups are overwritten, i.e. whose deactivation flags must already have been set and their deactivation-OBs called up. Signal groups in which errors were only detected in the last cycle are not yet taken into account.

(5): Processing the deactivation-OB queue

- Deactivation-OBs entered into the deactivation-OB queue will be called up consecutively. After each call-up the deactivation-OB will be deleted from the queue.
  If an error occurs in a signal group already deactivated, the deactivation-OB will be called up again and the error timer is not reset
- Deactivation must be acknowledged using SB 255, function 100 in the deactivation-OB; if this does not occur, the PSS goes into a STOP condition. Once acknowledged the deadman timer is started for signal groups with the reaction type 3, 4, 5, 6, 8, 9 or 10.

(6): If a deactivation-OB was called up in the deactivation-OB queue, the deactivation flag of the signal group is set. The data in DB 001 is updated and the PIO and PII are overwritten with the updated data.

NOTICE
The PII/PIO for a defective I/O is overwritten once the deactivation-OB has been processed

The data from DB 001 and the deactivation flag are stored with retentive memory. This occurs with a time offset of 750 ms, so that errors which occur through switching off the 24 V supply voltage are not stored.

(7): The application program is processed. It should be structured in such a way that any program sections not required are not processed, e.g. a switched-off signal group.

(8): An output overwritten with “0” through error handling or the “quick reaction” cannot be set to “1” via the application program. The application program can only set the output to “1” in the PIO.

Deactivation via the user

If the application program or the operator detects a dangerous condition, e.g. during “operation with safe monitoring”, signal groups can be deactivated in the application program or the reaction type of signal groups already deactivated can be changed.

Deactivation in the application program is carried out by calling up SB 255, function 109.

The user can carry out deactivation with the reaction type already configured for the signal group or a different reaction type (reaction type 0 - 3 is possible).

If the signal group has already been deactivated, the reaction type with which the signal group is to be deactivated, in this case, must be smaller than the reaction type used previously.

The error timer is not reset when a signal group is deactivated again. If, however, the signal group is deactivated with reaction type 0, 1 or 2, the error timer and deadman timer for the signal group will be stopped.

Reactivation

When errors occur causing signal groups to be deactivated, it is not sufficient to just rectify the error in order to clear deactivation.
The deactivated signal groups must be reactivated by the user or through the application program.

There are 3 options available:

- Reactivation via “Load program”
  When loading a new program in the PSS, all existing deactivations are removed
- Reactivation via the user
  - Set the operating mode selector switch from FS to STOP
  - Switch off the voltage to the mains supply
  - Press and hold down the error stack button
  - Switch on the voltage to the mains supply
  - Only release the error stack button when the self test has ended (display must show “****”)
  - Set the operating mode selector switch from FS to RUN.
- Reactivation via the application program
  The method for reactivation via the application program is shown in the flow diagram in Fig. 5-2.

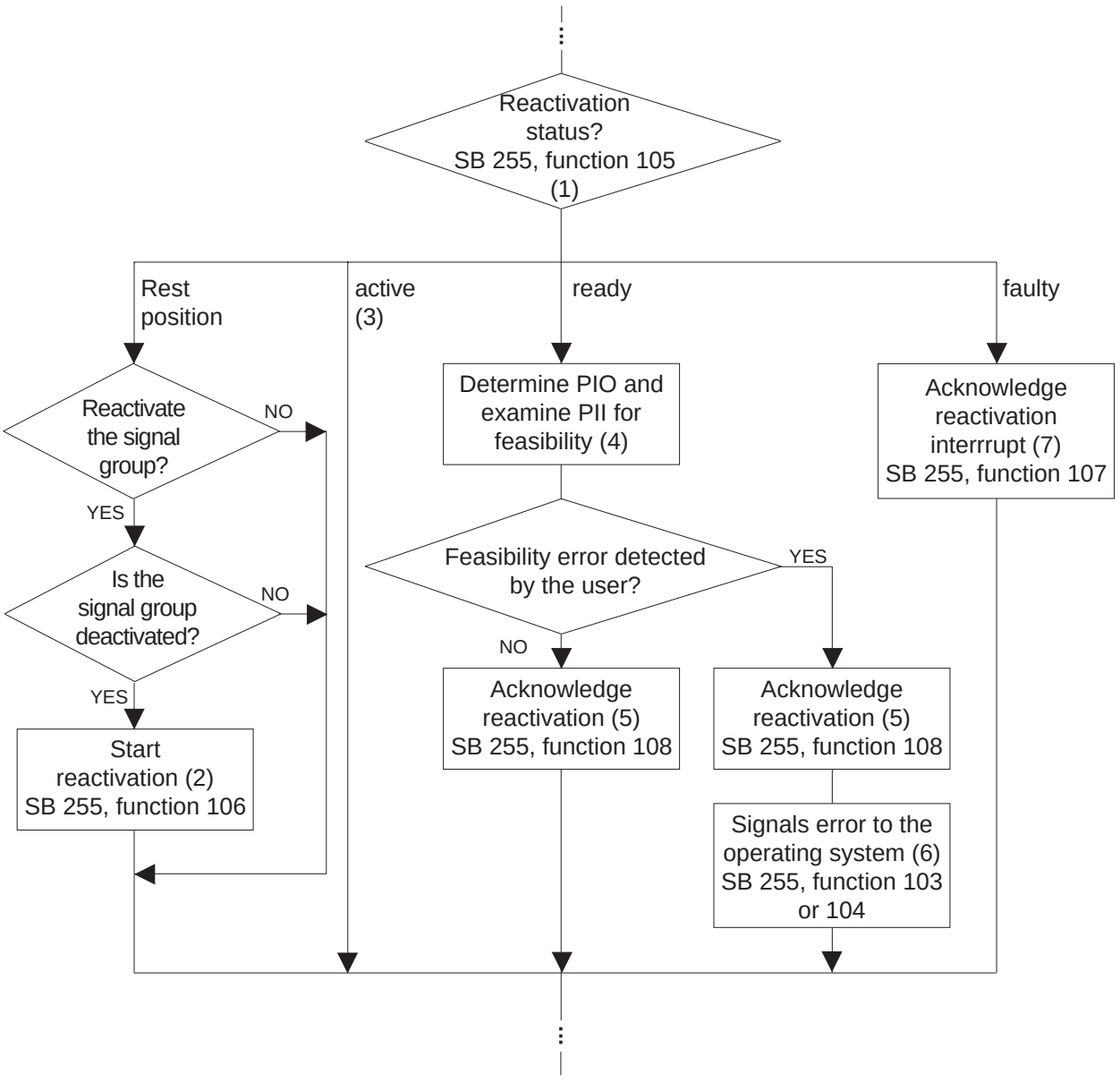


Fig. 5-2: Application program section for reactivating a signal group

(1): Using SB 255, function 105 the reactivation status is polled in the application program

(2): If reactivation is in the rest position it can be started using SB 255, function 106; e.g. initiated by the user using a key switch.
Check whether the signal groups to be reactivated are actually deactivated (poll deactivation flags).

Several signal groups which are to be reactivated can be requested simultaneously.

The following reasons can prevent reactivation:

- Selective shutdown is not configured
- Start is requested in an Alarm-OB
- Start is requested in OB 120
- Reactivation is already active
- Signal group to be reactivated has not been defined
- Signal group to be reactivated has not been deactivated
- A signal group with reaction type 0 is deactivated and is not selected to be reactivated. When a signal group with reaction type 0 has been deactivated, other deactivated signal groups can only be reactivated when the signal group with reaction type 0 is also reactivated
- During reactivation one module must have been switched on to which a signal group with reaction type 1 or 2 is defined and which is not to be reactivated.

INFORMATION

If one of these reasons is present, a programming error has occurred and the PSS changes to a STOP condition. Before starting reactivation check whether the signal group is deactivated.

If reactivation is started from an input, e.g. by activating a key switch, it cannot be triggered if an input is defective.

If reactivation is started successfully, all inputs and outputs of the signal groups to be reactivated are tested. This occurs in time slices of 5 ms at the cycle change.

INFORMATION

The maximum time for a cycle change increases by 5 ms.
Errors which first occur when an output on a DO or DOR module is switched on are not detected by this test.

(3): During reactivation, the status is active and the I/Os of the signal group being reactivated are tested.

NOTICE
During reactivation, the status of the inputs to be reactivated and the data in DB 001 are not defined.
The status of the inputs to be reactivated is only defined again if the “poll status: reactivation” gives a “ready” message.

Outputs are enabled once reactivation has been acknowledged and are written during the cycle change that follows.

(4): During reactivation the operating system tests the I/Os of the signal group being reactivated. Feasibility errors signalled from the application program to the operating system, which led to deactivation, cannot be detected by the operating system. The application program must, therefore, calculate the PII and check for feasibility using the current input status, as well as determining the PIO.

(5): At this stage reactivation must be acknowledged from the application program.
The operating system has already completed reactivation and updated DB 001. Once acknowledged, output values of the reactivated signal group will be presented to the outputs and their deactivation flags reset.

(6): If a feasibility error was detected by the application program: Unless managed by the application program, the error can be signalled to the operating system using SB 255, function 103 or 104 once reaction is acknowledged.

(7): If an error is detected when the signal groups to be reactivated are tested, or signalled to the operating system from the application program: reactivation is cancelled and all signal groups that were to be reactivated remain deactivated, irrespective of whether errors are present or not.
Error handling is carried out as described in the paragraph above.

When reactivation is cancelled, this must be acknowledged from the application program.

Interface to the FS application program

Configuration data block for selective shutdown

In addition to DB 002 a further data block, the configuration data block, is used for configuring selective shutdown
All configuration information for the signal groups, reaction types, overwrite values and output pairs are stored in this block.

INFORMATION
Which data block is used as the configuration data block must be entered in the configurator. DB 010 to DB 255 are valid blocks.
If, however, Pilz standard function blocks are used, DB 010 to DB 019 are reserved for the function blocks and should not be used.

The complete configuration process is carried using the configurator and the method can be found in the Programming Device Manual.
The layout of the configuration data block can be found in the Appendix.

Deactivation-OBs and deactivation flags

When deactivating a signal group the operating system sets the deactivation flag and calls up the deactivation-OB for the signal group.

Deactivation-OB
For each defined signal group the user must create a deactivation-OB, except for signal group 0.

INFORMATION
If a deactivation-OB is missing from a signal group, the program is not linked and cannot be transferred to the PSS.

OB 200 to OB 231 are used as deactivation-OBs.

OB 200 deactivation-OB of signal group 0
OB 201 deactivation-OB of signal group 1
:
OB 231 deactivation-OB of signal group 31

A signal group's deactivation-OB is called up when the signal group is deactivated or if a previously error-free I/O of an already deactivated signal group becomes defective.

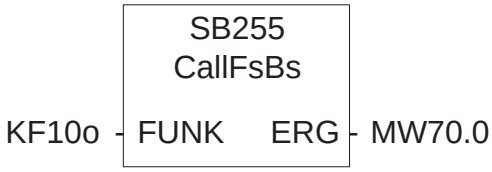
INFORMATION
When a STOP-condition occurs the deactivation-OBs will no longer be called up.

An acknowledgement from the application program must be carried out within the deactivation-OB (SB 255, function 100). For signal groups with the reaction type 3 ... 10, a deadman timer is started when acknowledgement occurs.
Within the deactivation-OB, deactivation of other signal groups can be triggered (SB 255, function 109) and a signal group hierarchy can be formed.

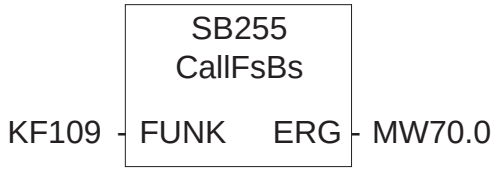
Example of a deactivation-OB:

OB 203

```
A     DB 003
L     KF 003      Deactivation acknowledged
T     DW 200      for signal group 3.
L     KF 120      The deadman timer
T     DW 201      is set to 120 min.
CAL   SB 255
```




```
L     KF 015      Deactivate signal group 15
T     DW 200      with reaction type 2
L     KF 002      (leads to the deactivation-OB
T     DW 201      OB 215 for signal group 15
CAL   SB 255      to be called up)
```



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INFORMATION
The run time for the deactivation-OB increases the run time of the FS application program.
The run time for all deactivation-OBs must be smaller than the maximum permitted run time for the FS application program. If this is not the case, cycle time is exceeded during a change from STOP to RUN when all signal groups are deactivated.

Deactivation flags
M 115.00 to M 115.31 are used as deactivation flags. Each signal group is assigned one bit:

M 115.00 belongs to signal group 0
M 115.01 belongs to signal group 1
:
M 115.31 belongs to signal group 31

The meaning of the bit is as follows:

Bit = 0: signal group not deactivated
Bit = 1: signal group deactivated

Using the deactivation flag the application program can check whether a signal group is deactivated and consequently determine whether, for example, to run different program branches.

For error diagnostic purposes the ST section has read access (not set through parameters or indirectly) to the deactivation flags.

Information in DB 001

The PSS stores the following information in DB 001:

- **Overwritten I/Os and read/write segments**
  If all I/Os on a sub-slot are overwritten the corresponding sub-slot is shut down.
- **Defective I/Os and read/write segments**
  With a module error all I/Os or read/write segments of the sub-slots are regarded as defective.
  With bus errors all outputs or write segments will be regarded as defective.
- **Reaction type with which a signal group is deactivated**
  The reaction type for each signal group is entered in DB 001 which was used to deactivate the signal group. For signal groups not deactivated, FF is stated in DB 001.
- **Residual run time of the error timer of a deactivated signal group**
  For each signal group, the run time of the error timer will be entered in DB 001 (maximum 6000 minutes). For those signal groups not deactivated or signal groups with the reaction type 0, 1, 2, 12, 13 or 14 the value entered is FFFF.

The layout of DB 001 is described in the Appendix.

SB 255 - Call ups for selective shutdown

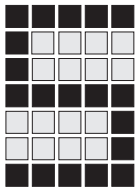
The functions in the table below are only permitted if selective shutdown is configured.

Function code	Function	Not permitted in
100	Acknowledge deactivation and reset deadman timer	
101	Poll status for deadman and error timers	
102	Stop deadman and error timers	
103	Signals periphery errors of a bit module to the operating system	
104	Signals periphery errors of a word module to the operating system	
105	Reactivation status	Alarm-OB
106	Start reactivation	OB120 Alarm-OB
107	Error acknowledgement for reactivation	Alarm-OB
108	Acknowledge reactivation	Alarm-OB
109	Start deactivation	

SB 255, Function 100: "Acknowledge deactivation"

Block	Input	Output	Key
SB 255	Funk = 100		Acknowledge deactivation and start/reset the deadman timer An operating error during acknowledge will lead to a STOP-condition, with entry in the error stack
		ERG = 1	Function carried out
DB 003	DW 200		Signal group number for which the function is to be carried out Value range: 0 ... 31
	DW 201		Deadman timer run time in minutes 0 : deactivate signal group with reaction type 2 immediately 1 ... 6000: run time, after run time has elapsed deactivate signal group with reaction type 2
DB 001		DW 200	Error ID 0: No error 1: Signal group not defined 2: Signal group not deactivated 3: Run time > 6000 minutes

INFORMATION
Error and deadman timers will only be started with the deactivation of signal groups with reaction type 3, 4, 5, 6, 8, 9 or 10.
When deactivating signal groups with the reaction type 0, 1, 2, 12, 13 or 14 the run times in DW 201 have no significance.



SB 255, Function 101: “Poll error and deadman timers”

Block	Input	Output	Key
SB 255	Funk = 101		Determines residual run time for error and deadman timers. An operating error during the status request leads to a STOP, with entry in the error stack.
		ERG = 1	Function carried out
DB 003	DW 200		Signal group number for which the function is to be carried out Value range: 0 ... 31
DB 001		DW 200	Error detection 0: no error 1: signal group not defined
		DW 201	Residual run time of deadman timer in minutes when FFFF: timer not active
		DW 202	Residual run time of the error timer in minutes when FFFF: timer not active

SB 255, Function 102: "Stop timers"

Block	Input	Output	Key
SB 255	Funk = 102		Stop error and deadman timers Operating error when stopping the timers leads to a STOP condition, with entry in the error stack
		ERG = 1	Function carried out
DB 003	DW 200		Number of the signal group for which the function is to be carried out Value range: 0 ... 31
DB 001		DW 200	Error ID 0: No error 1: Signal group not defined 2: Signal group not deactivated

WARNING!

- This function should only be called up if the signal group is switched off safely. An error at an I/O or read/write segment of a signal group must not lead to a dangerous situation on the plant controlled by the signal group.
- Before this function is called up, the application program must check whether the plant controlled by the signal group is also shut down (no voltage applied).

INFORMATION

- If the timers are stopped, the signal group with reaction type 4 is deactivated if not already done so by a higher integrity reaction type
- If a further error occurs within the signal group, the deactivate acknowledgement starts the timers again
- A STOP-RUN transfer starts the timers again
- Resetting the deadman timer (SB 255, function 100) starts the timers again
- Deactivating the signal group with SB 255, function 109 starts the timers again

SB 255, Function 103: "Signals errors on bit modules"

Block	Input	Output	Key
SB 255	Funk = 103		Informs the operating system which bit module is faulty. Operating error leads to a STOP condition, entered in the error stack
		ERG = 1	Function carried out
DB 003	DW 200		Slot number which the defective bit module occupies
	DW 201		Defective I/Os x.0 - x.15 coded bit by bit 0 = Defective 1 = No error found
	DW 202		Defective I/Ox.16 - x.31 coded bit by bit 0 = Defective 1 = No error found
DB 001		DW 200	Error ID 0: No error 1: Slot not occupied 2: Slot occupied with word module

The application program can signal errors to the PSS operating system using this function (e.g. feasibility errors between 2 inputs). On the whole it deals with errors which are in the sensor or the wiring and therefore can also be managed by the user (e.g. withdrawing the start enable of a machine).
These errors must only be signalled to the operating system if the application program does not control them.

SB 255, Function 104: "Signals errors on a word module"

Block	Input	Output	Key
SB 255	Funk = 104		Informs the operating system which read segment or write segment is faulty. Operating error leads to a STOP-condition, with entry in the error stack.
		ERG = 1	Function carried out
DB 003	DW 200		Type of error 1: Read segment defective 2: Write segment defective 3: All read segments defective 4: All write segments defective 5: All read and write segments defective
	DW 201		XW-number for the defective XW-segment
DB 001		DW 200	Error detection 0: No error 1: Slot not occupied 2: Slot occupied with a bit module 3: Segment does not exist 4: Invalid call-up parameter in DW 200

The application program can signal errors to the PSS operating system using this function. On the whole it deals with errors which are in the sensor or the wiring and therfore can also be managed by the user (e.g. withdrawing the start enable of a machine).
These errors must only be signalled to the operating system if the application program does not control them.

SB 255, Function 105: "Reactivation status"

Block	Input	Output	Key
SB 255	Funk = 105		Poll status: Reactivation
		ERG = 1	Reactivation not active rest position
		ERG = 2	Reactivation active
		ERG = 4	Reactivation stopped
		ERG = 16	Error during reactivation
DB 001		DW 200 DW 201 DW 202	If ERG = 16 slot number Bit 0 - 15 Bit 16 - 31 coded bit by bit, the faulty I/O which has led to reactivation being interrupted Bit = 0 : I/O defective Bit = 1 : I/O no error found

This function is not permitted in the Alarm-OB.

SB 255, Function 106: "Starts Reactivation"

Block	Input	Output	Key
SB 255	Funk = 106		Start reactivation Operating error leads to a STOP-condition, entered in the error stack
		ERG = 1	Function carried out
DB 003	DW 200		Bit by bit image of the signal groups to be reactivated Signal groups 0 - 15 Bit = 1 : Reactivate Bit = 0 : Do not reactivate
	DW 201		Bit by bit image of the signal groups to be reactivated Signal groups 16 - 31
DB 001		DW 200	Error ID 0: No error 1: Signal group not defined 2: Signal group not deactivated 3: Reactivation not active 4: One signal group prevents reactivation 5: Reactivation in OB 120 not permitted
		DW 201	Coded bit by bit, which signal group prevents reactivation signal groups 0 - 15 Bit = 1 : prevents reactivation
		DW 202	Coded bit by bit, which signal group prevents reactivation signal groups 16 - 31

This function is not permitted in OB 120 and in an Alarm-OB.

SB 255, Function 107: “Reactivation - error acknowledgement”

Block	Input	Output	Key
SB 255	Funk = 107		Error acknowledgement after a reactivation error Operating error leads to a STOP-condition, entered in the error stack
		ERG = 1	Function carried out
DB 001		DW 200	Error detection 0: No error 1: Reactivation not active 2: Acknowledgement triggered unnecessarily

This function is not permitted in an Alarm-OB.

SB 255, Function 108: “Acknowledge reactivation”

Block	Input	Output	Key
SB 255	Funk = 108		Acknowledges reactivation Operating error leads to a STOP-condition, entered in the error stack
		ERG = 1	Function carried out
DB 001		DW 200	Error ID 0: No error 1: Reactivation not active 2: Reactivation not finished 3: Reactivation signals an error

This function is not permitted in an Alarm-OB.

SB 255, Function 109: "Deactivating signal groups"

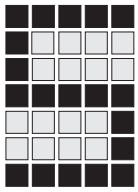
Block	Input	Ouptut	Key
SB 255	Funk = 109		Deactivate signal group Operating error leads to a STOP condition, with entry in the error stack.
		ERG = 1	Function carried out
DB 003	DW 200		Number of the signal group to be deactivated: 1 - 31
	DW 201		Information on reaction type used to deactivate Number 0 - 3 or FFFF, when the configured reaction type is to be used (if the configured reaction type is greater than 3, the PSS goes into a STOP-condition)
DB 001		DW 200	Error ID 0: No error 1: Invalid reaction type number 2: Signal group not defined 3: Invalid reaction type 4: Signal group cannot be deactivated as the reaction type number is too large

Interface to the ST application program

- To carry out error diagnostics, the standard section has read access to the deactivation flags, DB 001, DB 002 and the configuration DB for selective shutdown.
- In FS-STOP, NO_FS and FS_RUN the standard section contains the FS-PII and FS-PIO.
  Note: Defective FS inputs are overwritten from selective shutdown even when the PSS status is STOP or “No FS”.
- The project name, date and the CRC checksums of the linked FS-project are stored in DB 000.

INFORMATION

The standard section scan time can increase to 200 ms once only if the FS section changes from RUN to STOP and if there are several unprocessed errors still present in the periphery error list.



Notes

Operation

This chapter describes the operating conditions for PSS selective shutdown, the changes that occur, what happens during these changes and how they can be triggered.

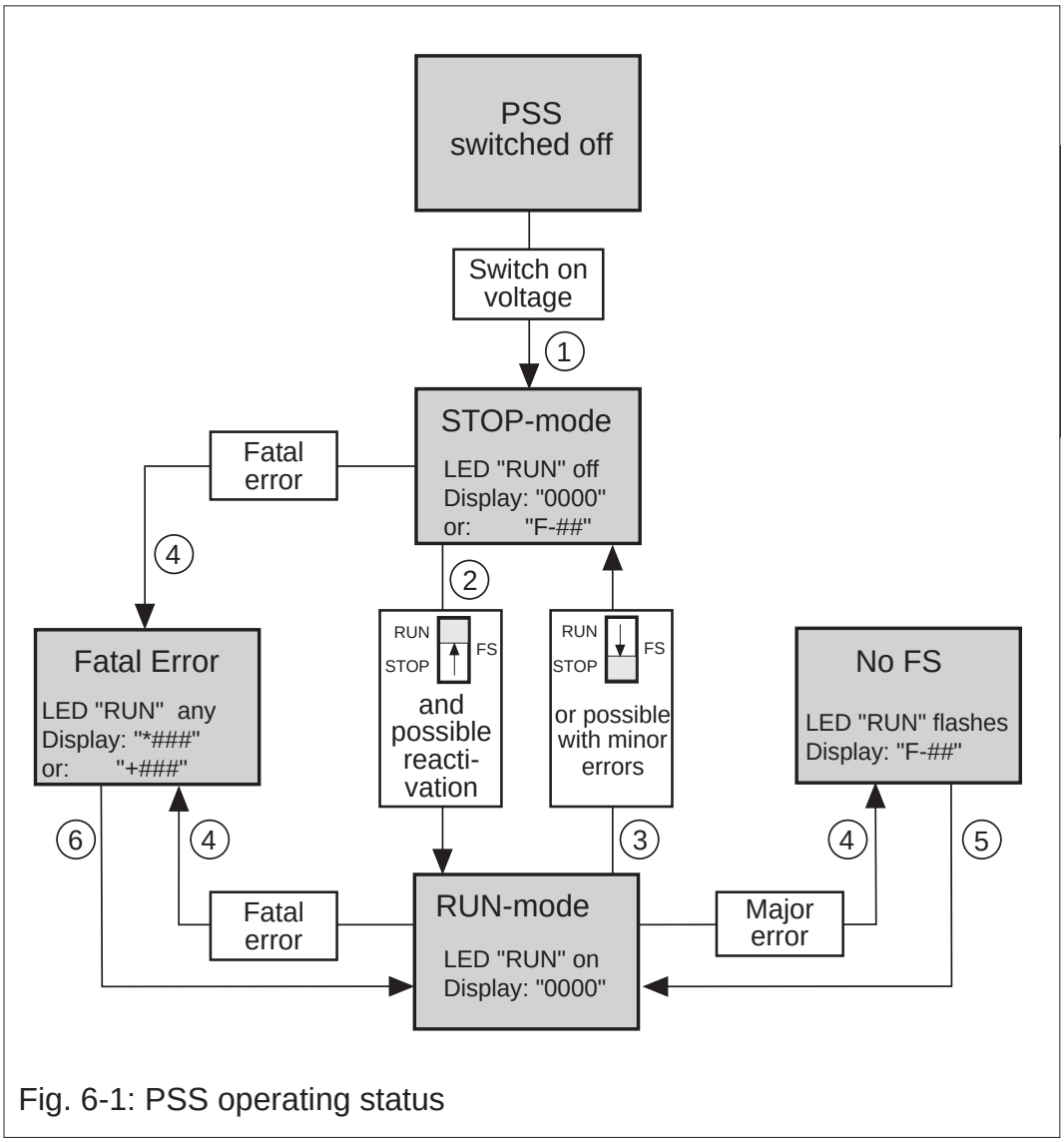


Fig. 6-1: PSS operating status

The numbers indicate a change in status, all of which are described on the following pages.

Operation

STOP

In a STOP-condition:

- The FS application program is not processed
- The ST application program continues and can read the FS-PII and FS-PIO.
- All programming device functions are available.

RUN

In a RUN-condition:

- The FS application program is processed as shown in Fig. 5-1
- The standard application program can read the FS-PII and FS-PIO
- All programming device functions are available
  (Exceptions: Load program and clear program)

“No FS”

After a major error the PSS goes into a "No FS" condition

- The FS application program is not processed
- The operating system reads from the FS-PII and overwrites the defective inputs
- The standard application program continues to run and can read the FS-PII and FS-PIO
- The programming device functions are restricted to read access only

“Fatal Error”

After a fatal error the PSS goes into a "Fatal Error" condition:

- FS and ST section are inoperable
- Communication is not possible with the programming device

If the PSS goes into this condition:

- Establish the conditions under which the errors occurred
- Write down the error message displayed.
- Contact Pilz

Change in the PSS operating condition

Switch on voltage ①

When the voltage is switched on, the PSS is in a STOP-condition and it carries out a self test.

During the self test the retentive data stored for selective shutdown will be tested.

The following information is stored (non-volatile):

- Deactivation flags
- Residual run time for the error timer
- Overwritten I/Os and read/write segments
- Defective I/Os and read/write segments
- Reaction types to be used to deactivate signal groups

The diagram below shows what occurs if the PSS detects faulty deactivation data:

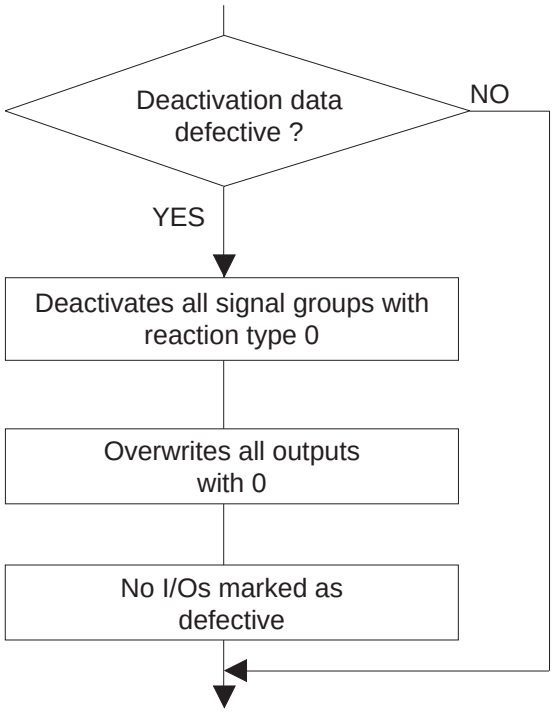


Fig. 6-2: Reaction of the PSS to faulty deactivation data

When faulty deactivation data is detected the user is forced to reactivate all signal groups if signals are to be written to output modules.

Change from STOP to RUN ②

By setting the FS mode selector switch from STOP to RUN the PSS reacts as shown in the flow chart Fig. 6-3.

In each case the PSS goes into a RUN-condition. When a signal group with reaction type 0 is deactivated, all output modules including the test pulses remain switched off. The error-free, non-pulsed inputs can still be read.
This means the user can perform reactivation from the application program.

INFORMATION

- A depleted battery will cause all signal groups with reaction type 0 to be deactivated
- During a STOP-RUN transfer, defective inputs which should be overwritten with “Alt” (last valid signal) according to the reaction type, will be entered with “0” in the PII.

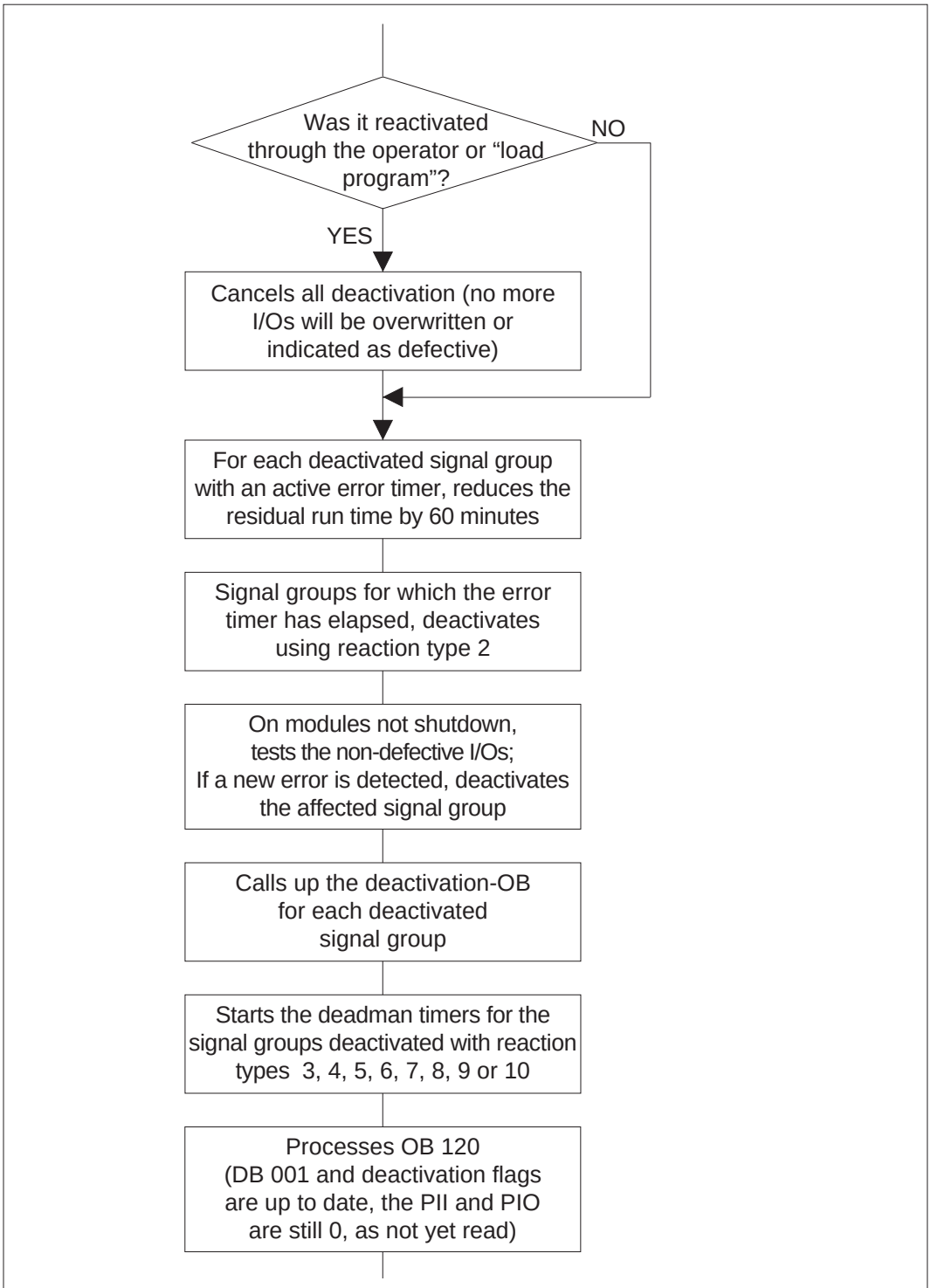


Fig. 6-3: Change from STOP to RUN

Change from RUN to STOP ③

If the FS mode selector switch is set to STOP or the PSS switches to a STOP-condition due to an error reaction, the following occurs:

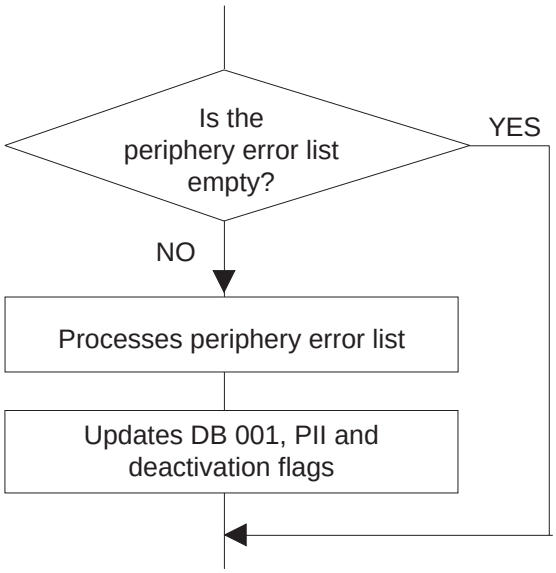


Fig. 6-4: Change from RUN to STOP

INFORMATION

- By processing the error list the ST cycle time can be increased to 200 ms, but only once
- In a STOP-condition the ST section has access to the overwritten input data in the FS section
- Deactivation-OBs are no longer called up when a STOP-condition occurs.

Change from RUN to "No FS" ④

When a major error occurs the PSS goes into "No FS" and clears the non-volatile deactivation data.

In a "No FS" condition the PII will continue to be read in cycles, the PIO overwritten for defective inputs and the ST application program processed.

Change from "No FS" to RUN ⑤

A direct switch from "No FS" to RUN is not possible. If you wish to exit from a "No FS" condition, use the following method:

- Read from the error stack using the programming device
- Switch off the PSS and slide the FS mode selector switch to STOP
- Rectify the error.
- Switch on the PSS and slide the FS mode selector switch to RUN

As the deactivation data was cleared when the PSS changed to a "No FS" condition, all signal groups are deactivated when the PSS is switched on again, as described in the section “Switch-on voltage” on page 6-3. All signal groups must be reactivated in the application program at the same time as the start process.

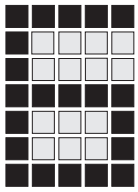
Alternatively reactivation can be carried out via the operator or via “Load program”.

Change from RUN to “Fatal Error” ⑥

When a fatal error occurs, the PSS goes into “Fatal Error”. The PSS clears all non-volatile deactivation data.

Change from STOP to “Fatal Error” ⑦

Any fatal errors are detected by the PSS even in a STOP condition and will cause the PSS to switch to “Fatal Error”.



Notes

Additional Measures with Reaction Types ≥ 3

WARNING!

Deactivating a signal group with reaction type 3, 4, 5, 6, 8, 9 or 10 can reduce the safety of the PSS. (Exceptions: signal groups with reaction type 3, 4 or 8, containing inputs only.)
To avoid the danger to both personnel and machinery, additional measures must be taken and the plant operator made aware of the reduced safety.

Reduced safety on the PSS can occur in the following cases:

- A defective output is overwritten.
  Reason: Defective outputs which are overwritten are no longer tested, so if an error occurs, 24 V can be present at an output overwritten with "0". (This is not valid if the defective output is on a sub-slot that is shut down).
- A defective input is overwritten with "1" or "Alt".
  Reason: The application program of the FS section must be programmed in such a way that the plant must be in a safe condition when a “0” is present at the inputs. E-STOP switches, for example, must be connected in such a way that a “0” is created at the input when the E-STOP switch is operated.
  If defective inputs are overwritten with "1" or "Alt", the safety is reduced accordingly.
- A defective write segment is overwritten
  Reason: The defective write segment is no longer tested by the PSS, i.e. the PSS cannot detect whether the defective write segment really has been overwritten with the overwrite value or not.
- A defective read segment is overwritten
  Reason: Instead of working with the true input value the application program works with the overwrite value. Input information is lost, although the overwrite value can be selected so that a dangerous situation at the plant cannot be triggered.

As none of these cases can be excluded, suitable measures must be taken for each case. Several examples are given on the following pages showing additional measures.

NOTICE
When selecting the measures follow the relevant regulations and safety guidelines for the plant and those stated in chapter 2.

Additional Measures with Reaction Types ≥ 3

NOTICE

When using additional measures, note that:

- To monitor a defective output the monitoring input of the output cannot be set, as this is overwritten according to the reaction type
- If a module is shut down while additional measures are in place, this must not have any safety critical effects on the entire plant.

Example 1: Maintaining safety using output pairs when defective, overwritten outputs are present

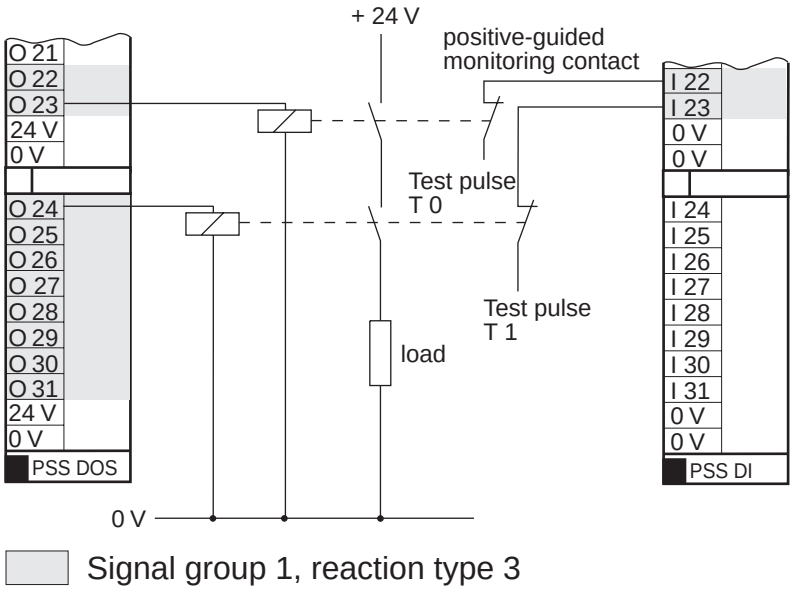


Fig. 7-1: Safe monitoring with an output pair

The outputs O23 and O24 form an output pair and control a load via an AND-connection.

Measures in the application program:
Not required. The operating system carries out the module shutdown as soon as the second output of the pair is defective.

Safety assessment:

Condition:
O24 is defective and gives a “1”.

Result:
O23 and O24 are overwritten with “0”. O24 is no longer tested. O23 continues to be tested, and the load is switched off safely.

Controlling additional errors:
If output O23 is defective, the PSS detects the error and shuts down the sub-slot on which O23 is found. O23 is then “0” and the load is off.

NOTICE

- Shutdown is only as safe as a single shutdown route, as the initial shutdown route has already failed
- As the DOS outputs only switch single-pole, short circuits at the outputs cannot be controlled to 24 V. These must be excluded using appropriate measures
- Check the function of the auxiliary relays with monitoring inputs
- Check monitoring inputs with test pulses.
- Follow the relevant regulations relating to your plant.

Example 2: Maintaining safety via monitoring the elements controlled by the output when a defective overwritten output is present

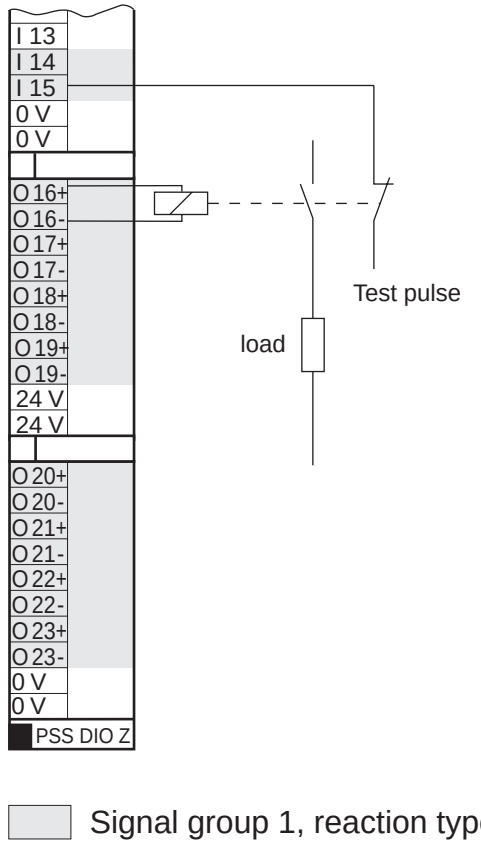


Fig. 7-2: Additional monitoring of the output

Measures in the application program:

With the help of the positive-guided monitoring contact to control the N/O contact, the user is able to detect the measures taken and if required initiate them, e.g. shut down the defective module.

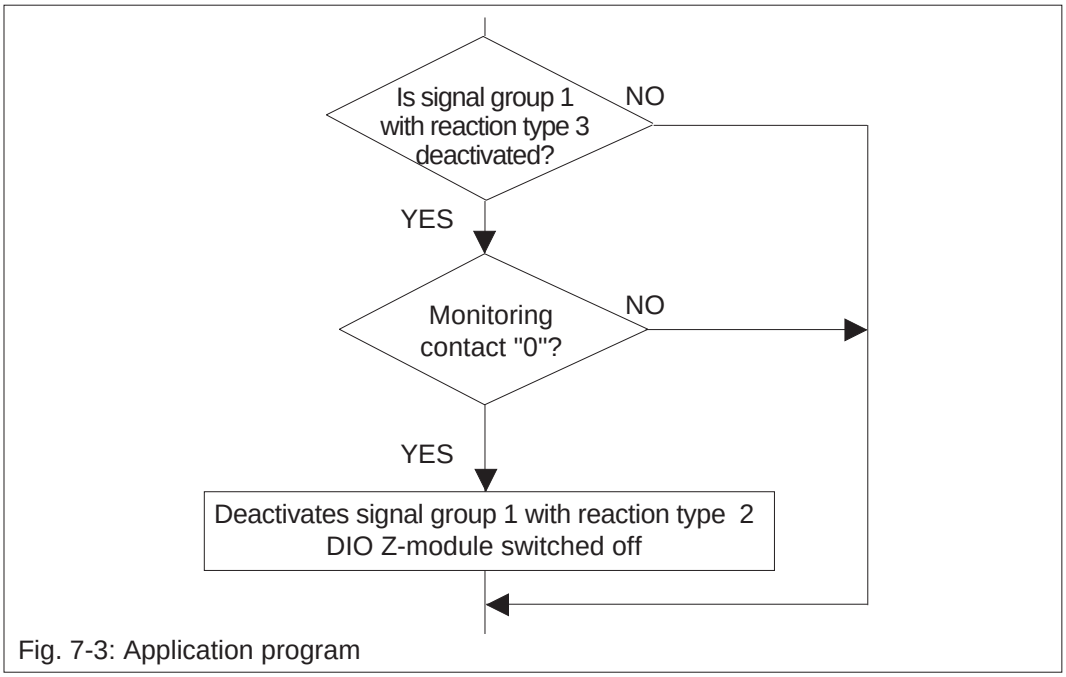


Fig. 7-3: Application program

NOTICE

- The input I15 should be pulsed in order to detect errors in the input module
- Inputs must be pulsed
- Follow the relevant regulations for your plant.

Safety assessment:

Condition:
O16 has a short circuit to 24 V. By deactivating the signal group the output is overwritten with “0”.

Consequence:
As O16 is a dual-pole switching output (DIO Z) it can still be overwritten with “0” despite the short circuit to 24 V .
As the input I15 is tested from the PSS it is assumed that it is not defective

Controlling additional errors:

- If the output O16 is itself defective a 24 V will be present at the input due to the short cirucit. The error is detected by the monitoring contact and

deactivating the signal group with reaction type 2 is triggered.

This will cause the sub-slot from O16 to be shut down and consequently O16 to be connected to earth.
The error is controlled.

- If the monitoring contact is unknowingly defective, this leads to a dangerous situation, even when output O16 is defective.
- If the input I15 is defective, this error is detected by the PSS and the input overwritten with "0". A dangerous situation arises if the output O16 is also defective.

WARNING!

Accumulated errors can still lead to a dangerous situation (Input I15 and output O16 defective simultaneously).

Example 3: Maintaining safety via a supervisory main valve when a defective, overwritten input is present

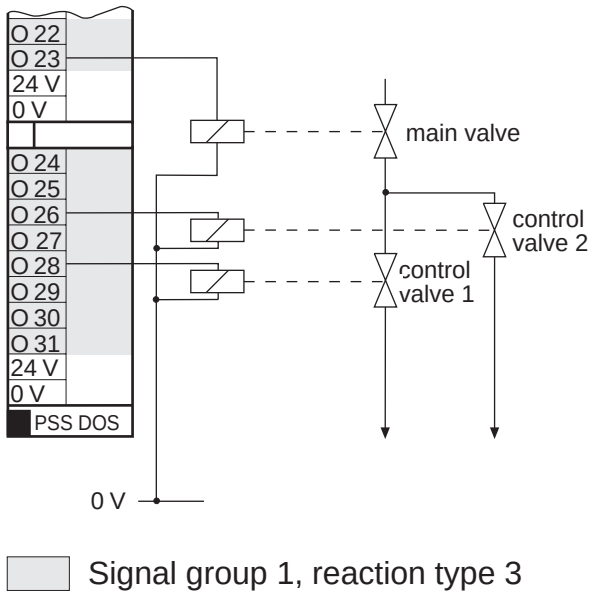


Fig. 7-4: Overriding main switch

A main valve overrides the control valves.
With defective outputs O26 and/or O28 the flow can be stopped using the main valve.

Measures in the application program:

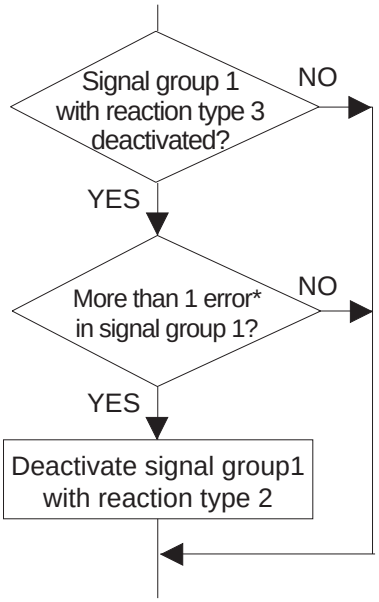


Fig. 7-5: Application program

Safety assessment:

Condition:
O26 is defective. By deactivating the signal group all outputs are overwritten with “0”.

Consequence:
As O26 is defective, it can still be given as overwritten with “1”.
Output O23 and O28 are overwritten with "0". The control valves are closed.

Controlling additional errors:
If the output O23 or O28 are also defective, the control valves 1 and 2 remain switched-off. The DOS-sub slot is shut down from the application program (deactivated with reaction type 2) and the outputs, therefore, safely separated from 24 V.

The error is controlled.

Additional Measures with Reaction Types ≥ 3

WARNING!

Error accumulation can still lead to a dangerous situation (e.g. O23 and O28 have a short circuit to 24 V).

NOTICE

- Check the function of the valve via the monitoring inputs
- Connect the main valve relay and the control valve relays to inputs in different groups of 8 on the DOS module so that when the module is shut down 2 switch-off relays will operate
- Check monitoring inputs with test pulses
- Follow the relevant regulations for your plant

Example 4: Maintaining safety via dual-channel read-in of the input signal when a defective input overwritten with "1" or "Alt" is present

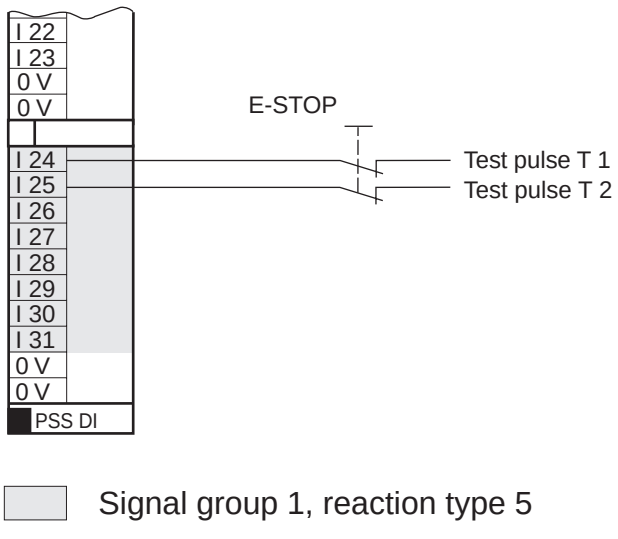


Fig. 7-6: Dual-channel read-in of an input signal

The signal at the E-STOP switch is read-in at the inputs I24 and I25. Both inputs are AND-connected in the application program and results in an enable signal.

Measures in the application program:

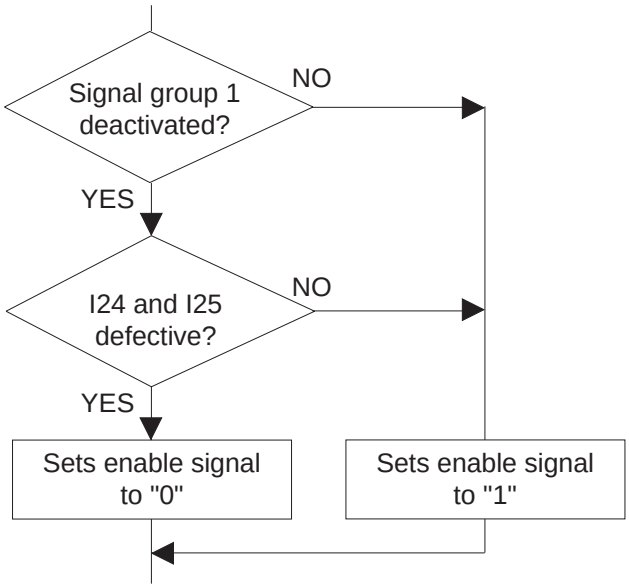


Fig. 7-7: Application program

Safety assessment:

Condition:
I24 is defective and according to reaction type 5 is overwritten with "1".

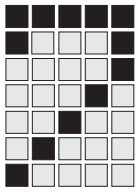
Consequence:
I25 is read correctly and continues to control the outputs

Controlling additional errors:
If I25 is defective, together with I24, both inputs are overwritten with “1”. Via the measures in the application program the outputs will still be overwritten with “0” and the enable signal remains “0”.

WARNING!

During deactivation a single-channel input comes from the dual-channel input. Whether this is permitted for the maximum 100 hours will depend on how the input is controlled. Relevant regulations for the plant must be observed.

NOTICE
The inputs I24 and I25 must be pulsed so that all errors in the input card can be detected



Notes

Configuring Selective Shutdown

This chapter contains step-by-step instructions for configuring selective shutdown. For each step, points of particular importance are indicated and, if necessary, will refer you back to the chapter which contains more detailed information.
Only those aspects affected by selective shutdown will be described. Knowledge of configuring a conventional PSS is assumed.

In the “Application Example” manual, a configuration for a tank installation is described.
You can apply the step-by-step instructions for your own configuration using the application example described.

System analysis

Create a requirement profile for your plant:

- What is to be controlled?
- Which plant sections are to function independently?
  Compile functional units and if necessary function hierarchy
- How should the PSS react to error occurring at I/Os?
  Should the affected plant sections be shut down or, under specific conditions, continue to run?
  Reduce functional units if necessary
- Which safety regulations and guidelines need to be considered?

Signal groups and reaction types

- Group together the I/Os and read/write segments of the individual functional units to signal groups (refer to “Configuring signal groups” on page 4-1).
  Note:
  - A maximum of 32 signal groups can be used: Numbers 0 to 31.
    Signal group 0 contains automatically all I/Os not otherwise assigned a signal group, with the exception of the test pulses.
  - Each I/O may only be assigned to one signal group

  - Reserve one signal group with all I/Os not used allocated to this signal group

- Take into account a button or key switch which the operator can use to start reactivation, if required within the application (page 5-5).
- For each signal group create an overview which lists the elements of the signal group and the number of I/Os
- For each signal group set a reaction type which fulfils the required level of safety (Selection of reaction types, page 4-2).
  Please note:
  - Signal group 0 has the reaction type 0 assigned automatically
  - Establish whether additional measures (chapter 7) are necessary for reaction types selected. If required, for which I/Os are additional switch elements needed
  - Write down the conditions for the layout of the sub-slots resulting from the selection of reaction types
    You must be aware that by deactivating a signal group it must not cause any safety-critical effects to the plant as a whole or other plant sections or signal groups.
  - Are additional switch elements such as a deadman switch required?
  - At this point consider the overwrite values for the read/write segments, if they are required
    (“Determining the overwrite values” on page 4-19).
  - If necessary write down the times for the error timer.

An overview on the different reaction types can be found in the Appendix on page 9-1.

Output pairs

- Check whether, for example, output pairs are required for the additional measures (“Increased safety via output pairs” on page 4-17)
- Establish any set layout conditions required for dividing outputs between modules. On DOS-modules both outputs must belong to different groups

of 8 or be on different modules. On DOR modules the outputs must be adjacent or be on different modules. For other modules there is no set layout for the outputs.

Configuration

- Create a table which shows the number and type of inputs required for each signal group.

Signal group	Inputs	Type
10	12 4	digital analogue
21	5	digital
...	...	...

As there is no set layout for the inputs and read segments on the modules, the sum of the same-type inputs corresponds to the number of modules required

- When deciding the number of output modules required, any set layout of outputs on modules must be considered.
It maybe useful to write things down in a table.

Signal group	Outputs	Layout	Type
10	4	Separate sub-slot	dual-pole
21	2	Sub-slot with signal group 25	sing-pole
25	2	Sub-slot with signal group 21	sing-pole
...	...	...	...

- When selecting modules for special features, refer to page 4-21.
- If necessary, use a module with test pulses.

Configuring Selective Shutdown

Wiring diagram

- Establish the slots for the modules and assign the I/Os accordingly
- Create a diagram of the modules showing the layout and which I/Os have been assigned to which signal group
- Using a diagram check once again whether each signal group can be deactivated without causing safety-critical effects to other signal groups or indeed the entire plant.

Test pulses

- Decide how you would like to configure the test pulses. Should test pulses be allocated to signal groups or not? (refer to the section “Configuring test pulses” on page 4-18)
- Assign test pulses to continuous safety-related inputs

Please note:

- Two adjacent inputs must not be connected to the same test pulse
- If the test pulse is assigned to a signal group, only the inputs of that signal group can be tested using the particular test pulse.

Configuration

Configuration for selective shutdown is carried out in the configurator of the programming device.

The method is described in detail in the “Programming Device” manual. The sequence given below must be followed:

- Select the type of PSS to be used
- Registered hardware setup
- Basic settings
- XW-addresses
- Allocating test pulses
- Alarm configuration
- Configuring output pairs
- Configuring signal groups

Programming

The program must contain the following blocks:

- OB 101 to manage the program sequence
- OB 120 to initialise during the STOP-RUN-transfer
- A deactivation OB for each signal group (see page 5-9)

In the selective shutdown progam as with the conventional PSS program, feasibility checks etc. can be carried out.
In addition, the program can contain a program block for carryng out reactivation.

If additional measures are required, do not forget to program these in (chapter 7).

Commissioning

In addition to normal commissioning the following tests must be carried out:

- Simulate errors for each signal group and check whether the expected reaction occurs. Only at this stage can possible configuration errors be detected
- Test whether the signal groups can be reactivated

INFORMATION
PSS error messages are described in the section “Error messages” in the “PSS System Description” manuals.

Notes

Appendix

Overview of reaction types

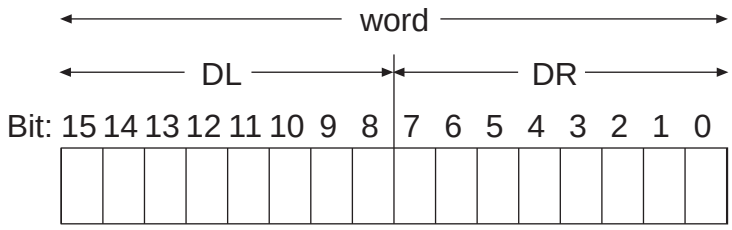
Reaction type	Reaction to individual errors or deactivation	Max. run time
0	• Changes to **STOP** • Deactivates signal group	unlimited
1	• **Shuts down all sub-slots** containing the **defective** outputs or write segments from the signal group • **Overwrites defective inputs** of the signal group **with 0** • Overwrites defective read segments of the signal group with the overwrite value • Deactivates signal group	unlimited
2	• **Shuts down all sub-slots**, containing the **defective** outputs or write segments from the signal group • Overwrites non-defective outputs of the signal group with 0 • Overwrites non-defective write segments of the signal group with the overwrite value • **Overwrites defective inputs** of the signal group **with 0** • Overwrites defective read segments of the signal group with the overwrite value • Deactivates signal group	unlimited
3	• **Overwrites all outputs** of the signal group **with 0** • Overwrites all write segments of the signal group with overwrite value • **Overwrites defective inputs** of the signal group **with 0** • Overwrites defective read segments of the signal group with overwrite value • Deactivates signal group	100 hours (refer to chapter 2 and 7)

Appendix

Reaction type	Reaction to single errors or deactivation	Max. run time
4 5 6	• **Overwrites defective outputs** of the signal group **with 0** • Overwrites defective write segments of the signal group with the overwrite value • **Overwrites defective inputs** of the signal group with **0** **1** **Alt** • Overwrites defective read segments of the signal group with overwrite value • Deactivates signal group	100 hours (refer to chapter 2 and 7)
8 9 10	• **Reaction in the application program** for **defective outputs** of the signal group • Reaction in the application program for defective write segments • **Overwrites defective inputs** of the signal group **with** **0** **1** **Alt** • Overwrites defective read segments of the signal group with overwrite value • Deactivates signal group	100 hours (refer to chapter 2 and 7)
12 13 14	**Warning!** Reaction type 12, 13 and 14 can only be used for **non**-safety I/Os. • **Reaction in the application program** for **defective outputs** of the signal group • Reaction in the application program for defective write segments of the signal group • **Overwrites defective inputs** of the signal group **with** **0** **1** **Alt** • Overwrites defective read segments of the signal group with overwrite value • Deactivates signal group	unlimited

Layout of DB 001

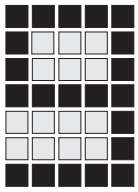
Sub-division of an individual data word:



Data word	Coding	Configuration
0	KH	Number of the read repetitions Value range: 1 ... 50
001		Version ID for the operating system Bit 0 = 1 : OS supports selective shutdown
002 : 199		Free
200 : 220	KH	Reset parameter for FS-operating system call-ups
221 : 249		Free
250 : 267	KH	Overwritten I/Os and read/ write segments Bit = 0 : not overwritten Bit = 1 : overwritten Two data words per slot: DW250: 1st data word of slot 0 DW251: 2nd data word of slot 0 DW252: 1st data word of slot 1 DW253: 2nd data word of slot 1 : DW266: 1st data word of slot 8 DW267: 2nd data word of slot 8

Appendix

Data word	Coding	Configuration
		Bit modules 1st data word: Bit 0 - 15 of the slot 2nd data word: Bit 16 - 31 of the slot Word modules 1st data word: DR = read segment DL = write segment Bit 0 = read segment 0 : Bit 7 = read segment 7 Bit 8 = write segment 0 : Bit 15 = write segment 7 2nd data word: always 0 Note: FFFF : Module is shut down, e.g. due to a module error or because all outputs were overwritten
268 : 299		Reserved
300 : 317	KH	Defectvie I/Os and XW-segments Bit = 0 : not defective Bit = 1 : defective Two data words per slot: DW 300: 1st data word of slot 0 DW 301: 2nd data word of slot 0 DW 302: 1st data word of slot 1 DW 303: 2nd data word of slot 1 : DW 316: 1st data word of slot 8 DW 317: 2nd data word of slot 8



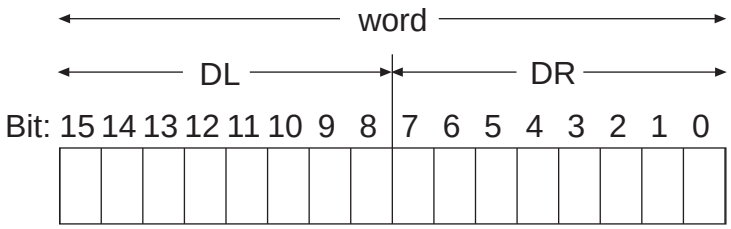
Data word	Code	Configuration
		Bit modules 1st data word: Bit 0 - 15 of the slot 2nd data word: Bit 16 - 31 of the slot Word modules 1. Data word: DR = read segments DL = write segments Bit 0 = read segments 0 : Bit 7 = read segment 7 Bit 8 = write segment 0 : Bit 15 = write segment 7 2nd data word: always 0
318 : 349		Reserved
350 365	KH	Reaction type with which the individual signal groups are deactivated 2 signal groups per data word: DR350 for signal group 0 DL350 for signal group 1 : DR365 for signal group 30 DL365 for signal group 31 Contents of the data byte: 0 ... 14 = Reaction type with which the signal group was deactivated FF = Signal group not deactivated or not defined

Data word	Code	Configuration
366 : 397	KH	Residual run time of the error timer for the individual signal groups: DW 366 for signal group 0 DW 367 for signal group 1 : DW 397 for signal group 31 Contents of the data words: 0 : Error timer elapsed (signal group with reaction type 2 is deactivated immediately and the run time set to FFFF) 1 ... 6000 : Residual run time in minutes FFFF : Error timer not started

Layout of the configuration data block for selective shutdown

Which data block is used as the configuration data block for selective shutdown is set by the user. See configuration DB for selective shutdown on page 5-9.

Sub-division of the individual data words:



Data word	Coding	Configuration
0 : 1	KY	Configuration-DB ID: DR0 = P DL0 = S DR1 = S DL1 = SPACE
2	KH	FFFE = version ID for selective shutdown
3	KH	Reserved
4	KH	PG version, with which the DB was created
5 : 20	KH	Reaction type of the signal group Contents of the data words: 0 ... 14 = reaction type FF = Signal group not defined 2 signal groups per data word: DR005 for signal group 0 DL005 for signal group 1 : DR020 for signal group 30 DL020 for signal group 31

Data word	Code	Configuration
21 : 164	KB	Allocation of I/Os to signal groups 16 data words per slot: Slot 0: DW 021 ... DW 036 Slot 1: DW 037 ... DW 052 Slot 2: DW 053 ... DW 068 Slot 3: DW 069 ... DW 084 Slot 4: DW 085 ... DW 100 Slot 5: DW 101 ... DW 116 Slot 6: DW 117 ... DW 132 Slot 7: DW 133 ... DW 148 Slot 8: DW 149 ... DW 164 **Bit modules:** A data word contains the signal group numbers for 2 I/Os, i.e. DR and DL each contains a signal group number. Content of DR and DL: 0 ... 31 : Signal group number FE : I/O does not exist on the module FF : DIO T-output, which is not allocated to any signal group and is used for test pulses Ex.: DR 021 for input 0 on slot 0 DL 021 for input 1 on slot 0 : DR 036 for input 30 on slot 0 DL 036 for input 31 on slot 0 **Word modules:** A data word contains the signal group numbers for 2 read / write segments, i.e. DR and DL each contains a signal group number

Data word	Code	Configuration
		Data words are assigned in the following way: First 4 data words : allocated for read segments Second 4 data words: allocated for write segments the remaining 8 data words are assigned 0 Contents of the data words: 0 ... 31 : Signal group number FE : Segment does not exist on the module Example for slot 0: DR021 for read segment 0 on slot 0 DL021 for read segment 1 on slot 0 : DR024 for read segment 6 on slot 0 DL024 for read segment 7 on slot 0 DR025 for write segment 0 on slot 0 DL025 for write segment 1 on slot 0 : DR028 for write segment 6 on slot 0 DL028 for write segment 7 on slot 0 DW029 = 0000 : DW036 = 0000
165 : 404	KB	Reserved
405 : 476	KH	Overwrite values for the read segments 8 data words per slot: Slot 0: DW 405 ... DW 412 Slot 1: DW 413 ... DW 420 Slot 2: DW 421 ... DW 428 Slot 3: DW 429 ... DW 436 Slot 4: DW 437 ... DW 444

Data word	Coding	Configuration
		Slot 5: DW 445 ... DW 452 Slot 6: DW 453 ... DW 460 Slot 7: DW 461 ... DW 468 Slot 8: DW 469 ... DW 476 Example for slot 0 (in case segments have all word sizes): DW 405 for read segment 0 DW 406 for read segment 1 : DW 412 for read segment 7 Data words not required for the configuration of the deactivation values are initialised with FFFF
477 : 596	KH	Reserved
597 : 668	KH	Overwrite values for the write segments 8 data words per slot: Slot 0: DW 597 ... DW 604 Slot 1: DW 605 ... DW 612 Slot 2: DW 613 ... DW 620 Slot 3: DW 621 ... DW 628 Slot 4: DW 629 ... DW 636 Slot 5: DW 637 ... DW 644 Slot 6: DW 645 ... DW 652 Slot 7: DW 653 ... DW 660 Slot 8: DW 661 ... DW 668 Example for slot 0 (in case segments have all word sizes): DW 597 for write segment 0 DW 598 for write segment 1 : DW 604 for write segment 7

Data word	Coding	Configuration
		Data words not required for the configuration of the deactivation values are initialised with FFFF
669 : 788	KH	Reserved
789 : 1022	KB	List of output pairs 2 data words per output pair: 1st data word: Output address with lower address DR = output bit address (0 ... 15) DL = sub-slot number 2nd data word: Output address with higher address The list always states the output of the output pair with the lower address first. The list is sorted in ascending address order from the 1st output End ID for the list: 2 data words with FFFF Example: if 2 output pairs are defined DW 789: 1st output, 1st output pair DW 790: 2nd output, 1st output pair DW 791: 1st output, 2nd output pair DW 792: 2nd output, 2nd output pair DW 793: FFFF DW 794: FFFF

Appendix

Amendments to documentation

Changes from version I to version II

Old Page	New page	Change
4-21	4-21	PSS(1) DIF: "INFORMATION" added
4-22	4-22	PSS(1) AI U5I1: "INFORMATION" added

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A

Pilz Ges.m.b.H.
Modecenterstraße 14
1030 Wien
Austria
Telephone (01) 7 98 62 63-0
Telefax (01) 7 98 62 64
E-Mail: pilz@pilz.at

AUS

Pilz Australia
Industrial Automation LP
9/475 Blackburn Road
Mt. Waverley, Melbourne VIC 3149
Australia
Telephone (03) 95 44 63 00
Telefax (03) 95 44 63 11
E-Mail: safety@pilz.com.au

B
L

Pilz Belgium
BC Building
Industriezone III
Industrielaan 4
9320 Erembodegem
Belgium
Telephone (0 53) 83 66 70
Telefax (0 53) 83 89 58
E-Mail: info@pilz.be

BR

Pilz do Brasil Sistemas Eletrônicos Industriais Ltda.
Rua Ártico, 123 - Jd. do Mar
09726-300
São Bernardo do Campo - SP
Brazil
Telephone (11) 43 37-12 41
Telefax (11) 43 37-12 42
E-Mail: pilz@pilzbr.com.br

CH

Pilz Industrieelektronik GmbH
Gewerbepark Hintermättli
Postfach 6
5506 Mägenwil
Switzerland
Telephone (0 62) 8 89 79 30
Telefax (0 62) 8 89 79 40
E-Mail: pilz@pilz.ch

D

Headquarters:
Pilz GmbH & Co.
Felix-Wankel-Straße 2
73760 Ostfildern
Germany
Telephone (07 11) 34 09-0
Telefax (07 11) 34 09-1 33
E-Mail: pilz.gmbh@pilz.de

DK

Pilz Skandinavien KS
Ellegaardvej 25 L
6400 Sonderborg
Denmark
Telephone 74 43 63 32
Telefax 74 43 63 42
E-Mail: pilz@pilz.dk

E

Pilz Industrieelektronik S.L.
Edificio Tilma
Avda. Sant Julià 1
08400 Granollers
Spain
Telephone (93) 8 49 74 33
Telefax (93) 8 49 75 44
E-Mail: central@pilzspain.com

F

Pilz France Electronic
1, rue Jacob Mayer
BP 12
67037 Strasbourg Cedex
France
Telephone 03 88 10 40 00
Telefax 03 88 10 80 00
E-Mail: siege@pilz-france.fr

FIN

Pilz Skandinavien KS
Pakilantie 61
00660 Helsinki
Finland
Telephone (09) 27 09 37 00
Telefax (09) 27 09 37 09
E-Mail: pilz.sk@kolumbus.fi

GB

Pilz Automation Technology
Willow House, Medlicott Close
Oakley Hay Business Park
Corby
Northants NN18 9NF
United Kingdom
Telephone (0 15 36) 46 07 66
Telefax (0 15 36) 46 08 66
E-Mail: sales@pilz.co.uk

I

Pilz Italia Srl
Via Meda 2/A
22060 Novedrate (CO)
Italy
Telephone (0 31) 78 95 11
Telefax (0 31) 78 95 55
E-Mail: info@pilz.it

IRL

Pilz Ireland Industrial Automation
Cork Business and Technology Park
Model Farm Road
Cork
Ireland
Telephone (0 21) 4 34 65 35
Telefax (0 21) 4 80 49 94
E-Mail: sales@pilz.ie

J

Pilz Japan Co., Ltd.
Three One Building 701
3-20-5 Shin-Yokohama
Kohoku-ku
Yokohama 222-0033
Japan
Telephone (0 45) 4 71-22 81
Telefax (0 45) 4 71-22 83
E-Mail: pilz@pilz.co.jp

MEX

Pilz de Mexico S. de R.L. de C.V.
Av. San Ignacio 1079
Col. Jardines de San Ignacio
C.P. 45000
Guadalajara, Jalisco
Mexico
Telephone (0 13) 1 22 16 81
Telefax (0 13) 6 47 81 85
E-Mail: pilz_msolis@infosel.net.mx

...

In many countries we are represented by sales partners. Please refer to our Homepage for further details or contact our headquarters.

www

www.pilz.com

Internet enquiries and orders: www.pilz.com

NL

Pilz Nederland
Postbus 186
4130 ED Vianen
Netherlands
Telephone (03 47) 32 04 77
Telefax (03 47) 32 04 85
E-Mail: info@pilz.nl

P

Pilz Industrieelektronik S.L.
Apartado 2028
2706-909 Colares
Portugal
Telephone (21) 9 28 91 09
Telefax (21) 9 28 91 13
E-Mail: pilz@esoterica.pt

PRC

Pilz China Representative Office
Flat F9/F Huijing Building
134 Siyou Xin Malu
Dongshan District
Guangzhou 510600
China
Telephone (0 20) 87 37 16 18
Telefax (0 20) 87 37 35 55
E-Mail: pilzchn@public.guangzhou.gd.cn

ROK

Pilz Korea Liaison Office
102-1402 Ilsung apt
767, Kyomun-Dong, Kuri-Si
Kyungki-Do 417-715
Korea
Telephone (31) 5 54 12 80
Telefax (31) 5 54 12 80
E-Mail: pilzkr@hotmail.com

S

Pilz Skandinavien KS
Energigatan 10 B
43437 Kungsbacka
Sweden
Telephone (03 00) 1 39 90
Telefax (03 00) 3 07 40
E-Mail: pilz@tripnet.se

SGP

Pilz Industrial Automation Pte Ltd.
61, Kaki Bukit Ave 1, #05-01
Shun Li Industrial Park
Singapore 417943
Singapore
Telephone 8 44 44 40
Telefax 8 44 44 41
E-Mail: sales@pilz.com.sg

USA

Pilz LP
7150 Commerce Boulevard
Canton
Michigan 48187
USA
Telephone (7 34) 3 54-02 72
Telefax (7 34) 3 54-33 55
E-Mail: info@pilzusa.com

Pilz GmbH & Co.
Felix-Wankel-Straße 2, 73760 Ostfildern, Germany
Telephone +49 (7 11) 34 09-0, Telefax +49 (7 11) 34 09-1 33

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