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Programmable Safety Systems
PSS-Range

PSS SB DI8O8
Operating Manual
Item No. 19 964-12



The spirit of safety.

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PSS SB DI8O8

Introduction

This shortform explains the function and operation of the decentralised input/output module PSS SB DI8O8.
The documentation is intended for instruction and should be retained for future reference.

Validity of the documentation

The PSS SB DI8O8 documentation is valid from Version 2.1 onwards. It is valid until new documentation is released. The latest documentation is supplied with the unit.

Overview

The module provides 8 digital inputs, 8 digital outputs and 2 dedicated test pulse outputs. The inputs are suitable for connecting single or dual-channel safety-related input devices, with or without test pulses.
The inputs and outputs are driven from a SafetyBUS p-compatible PSS.
The module's device address is established by setting the address switch on the unit. Inputs on the module can be allocated to two I/O-groups.

There are 6 positive and 2 negative-switching 2 A outputs.
Two of the positive-switching outputs can be used in conjunction with two negative-switching outputs (one each) to form two dual-pole outputs.
Individually, the negative-switching outputs can only be used for non-safety-related applications, in which it is permitted to switch to earth.
All outputs are protected against short circuit, overload and excess temperature. They are suitable for connecting both resistive and inductive loads. Positive-switching outputs are suitable for connecting capacitive loads of up to 1 µF.

The PSS SB DI8O8 requires two 24 V supplies with a common earth. The "Supply" feeds the module electronics and dedicated test pulse outputs. The "Load Supply" feeds the outputs.

The module is galvanically isolated from SafetyBUS p via optocouplers.

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NOTICE
Before installing the module you should read and consider the “PSS SB DI8O8 Installation Manual” and the “SafetyBUS p System Manual”.

Intended use

The PSS SB DI8O8 is a decentralised input/output module which has been designed for use as an input/output device on SafetyBUS p.

System requirements

CPU versions

The PSS SB DI8O8 is supported by all SafetyBUS p-compatible safety systems in the PSS-range.

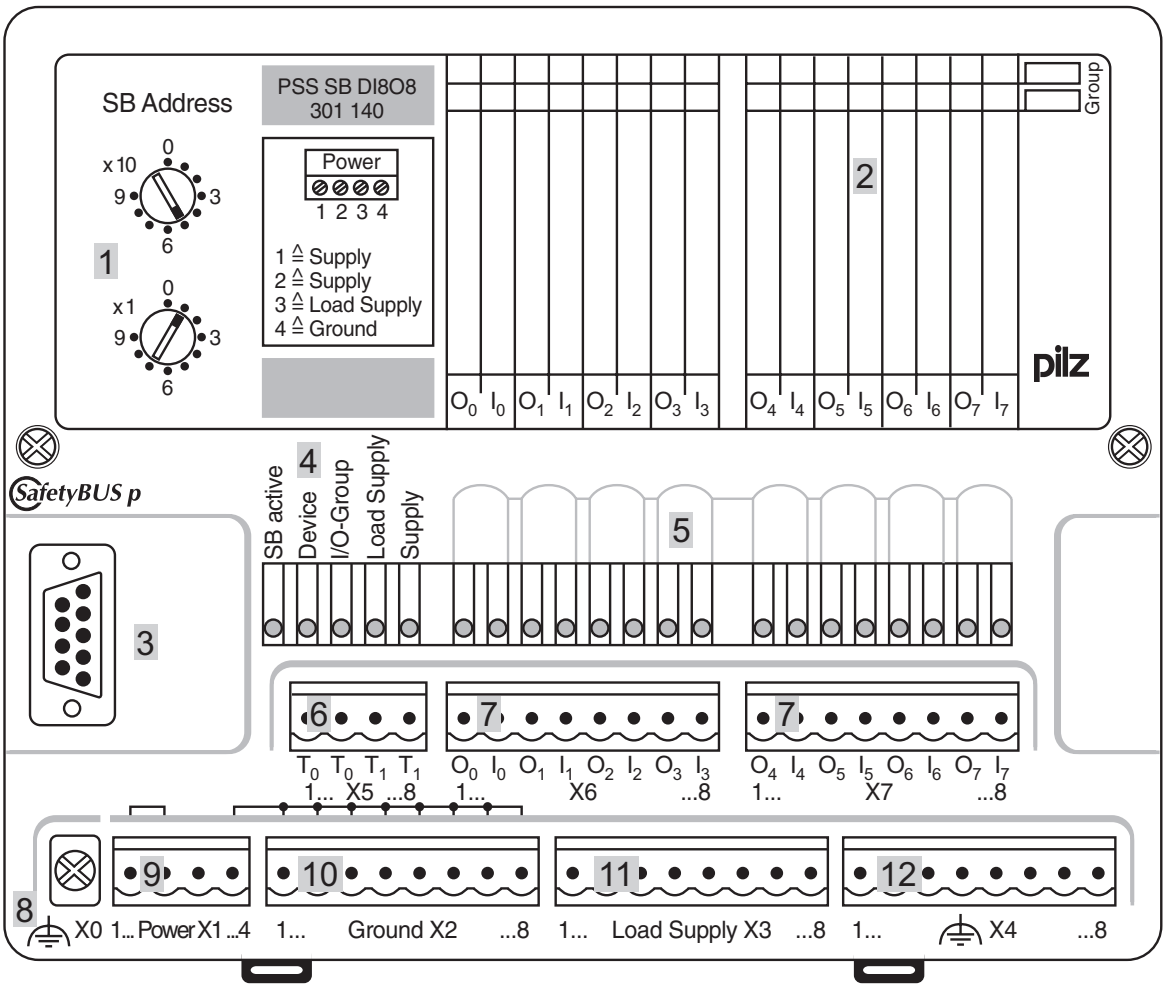
System software versions

The following system software is required in order to configure the module:

- PSS WIN-PRO from version 1.0.0

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PSS SB DI8O8



1: Switch for setting the device address on SafetyBUS p
2: Labelling strip for the I/Os
3: SafetyBUS p interface
4: LEDs for operating status and supply voltage
5: Status LEDs for the I/Os
6: Terminal block for dedicated test pulses
7: Terminal blocks for I/Os
8: Connection terminal for the functional earth
9: Terminal block for the supply voltage
10: Terminal block for “Ground”
11: Terminal block for “Load Supply”
12: Terminal block for the functional earth

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Functions

Inputs

The inputs are suitable for connecting single and dual-channel input devices, with or without test pulses.

Input signals must show a “High” of 24 VDC (+15 ... +30 VDC) and a “Low” of 0 VDC (-3 ... +5 VDC). All inputs have input filters.

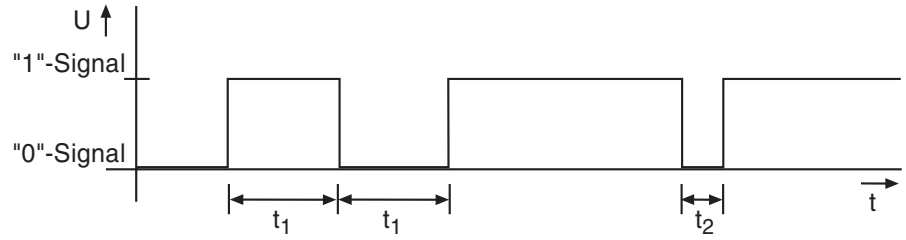
Input status is transmitted to the CPU on the PSS master via SafetyBUS p. Yellow LEDs indicate the status of the inputs. An LED lights up as soon as a “1” signal is present at the input. If the supply is missing, the LEDs will not light.
Diagnostic circuitry checks the function of the inputs, including the input filter. If an error occurs, all the outputs in the affected I/O-group will be switched off and the I/O-group will switch to a STOP condition. An error telegram will then be stored on SafetyBUS p and the error will entered in the PSS SB DI8O8 error buffer.

Where test pulses are not used, inputs with single-channel input devices can be used in applications up to and including category 2 in accordance with EN 954-1; in the case of dual-channel input devices, this extends to category 3 applications. The device should be suitably wired to eliminate the risk of a short circuit in the external wiring between the different inputs and a short to the “Supply” or “Load Supply”.
Test pulses must be used for applications with single-channel input devices above category 2 and applications with dual-channel input devices above category 3.
Connection diagrams can be found in the “PSS SB DI8O8 Installation Manual”.

Detecting signals at the inputs

To guarantee that a signal (“0“-Signal or “1“-Signal) is detected at an input, it must be present for a certain period of time. This time must be longer than the Event Timeout configured in the system software PSS WIN-PRO. The presence of a signal will trigger a corresponding Event Telegram.
The presence of a signal (“0” or “1” signal) will be ignored if it does not exceed the pulse suppression time of 500 µs. In this case, no Event Telegram will be sent.

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t_1: Pulse length for guaranteed signal detection for “1” or “0” signals (> Event Timeout)
t_2: Max. pulse length for pulse suppression on “1” or “0” signals (500 µs)

Signal change behaviour

If a signal change occurs at an input, the module will send an Event Telegram. The module must then wait for the acknowledgement telegram (ACK) from the Master-LD before it can send a new Event Telegram.
If another signal change occurs while the module is waiting for the acknowledgement telegram, the module's response will depend on the configured signal change behaviour.
Two behaviour modes may be defined:

- “Default”:
  The signal change is not registered
- “Fast”:
  Each signal change is stored in a FIFO telegram buffer. If the acknowledgement telegram arrives, the module will send an Event Telegram from the FIFO telegram buffer for each signal change detected.

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Outputs

8 digital outputs are available on the module:

- O_0 ... O_5 are positive-switching (“Load Supply”) 2 A outputs
- O_6 and O_7 are negative-switching (“Ground”) 2 A outputs

Positive-switching outputs are suitable for connecting resistive and inductive loads of 2 A maximum. They have an integral discharge circuit which means they are also suitable for connecting capacitive loads of up to 1 µF. The use of higher capacitive loads will lead to an error (I/O-group stopped). Negative-switching outputs are also suitable for connecting resistive and inductive loads of 2 A maximum. However, individually these outputs can only be used for non-safety-related functions.

Two dual-pole outputs can be configured: output O_4 can form a dual-pole output with O_6 and output O_5 can form a dual-pole output with O_7 . If only one dual-pole output is configured, this must be formed between O_5 /O_7 . Dual-pole outputs are addressed via the address of the positive-switching output (O_4 or O_5). In principle it is also possible to wire outputs O_0 ,O_1 ,O_2 or O_3 to a negative-switching output to form a dual-pole output; both outputs would then have to be managed separately within the user program.

If the PSS master sends a “1” signal to a positive-switching output via SafetyBUS p, the PSS SB DI8O8 will supply approx. 24 VDC to the relevant output, which will show high impedance at a “0” signal. Negative-switching outputs do the opposite. At a “1” signal, approx. 0 VDC will be present at the output; at a “0” signal the output will show 24 VDC with high impedance.
Output status is displayed via green LEDs. The corresponding LED will light as soon as a “1” signal is present at the output.
Diagnostic circuitry tests the function of the outputs. The status of the outputs is constantly compared with the process image of outputs.

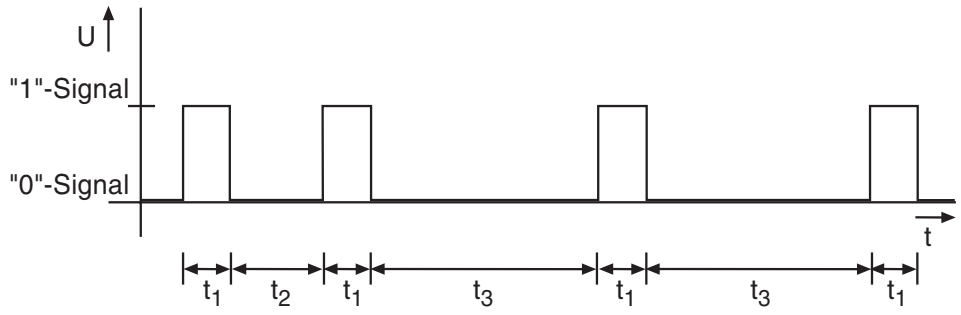
Outputs that are switched on are switched off at regular intervals, to check that the output transistors can be switched. Outputs that are switched off are switched on at regular intervals in order to test the monitoring circuit. A test will also be carried out to check for shorts between the outputs.

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WARNING!
When wiring an output with capacitance, you **must** be aware of the following:

- An output that is switched off is tested by switching it on each cycle, approx. once every 2 minutes.
- The pulse length of a switch-on or switch-off test is 200 µs
- Under certain circumstances, the switch on or switch-off test may be repeated after 6.5 ... 10 ms.
- The internal resistance of an output is 0.35 Ohm

Failure to observe the values for wiring with capacitance may cause the load to switch on unintentionally.



t_1: Pulse length for switch-on test (200 µs)

t_2: Repetition time under certain circumstances (6.5 ... 10 ms)

t_3: Scan time for switch-on test (ca. 2 m)

If an error occurs, all the outputs in the affected I/O group will be switched off and the I/O-group will switch to a STOP condition. An error telegram will then be stored on SafetyBUS p and the error will entered in the PSS SB DI8O8 error buffer.

Outputs O_0, O_2, O_4 and O_1, O_3, O_5 have a common second shutdown route. This means that, with single-channel operation, these outputs can be used for applications up to and including category 3, in accordance with EN 954-1. Please note that the second shutdown route is only tested when the system switches from STOP to RUN.
A feedback loop must be used on safety-related applications. To achieve category 4, dual actuators must be connected to two different outputs.

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If the plant is sensitive to the fast on/off switching of the output test, individual outputs may be excluded from the test through the configuration.

NOTICE
In the case of outputs that are excluded from the output test, the PSS checks that their switch status is correct but does not check their actual ability to switch. This means that, under some circumstances, errors will only be detected the next time the output switches on or off. In accordance with EN 954-1, category 2 or higher can be achieved with such an output. An output test can be performed in the user program in order to reduce fault detection time. If the output is switched on, proceed as follows: at a non-critical point in the program, switch the output off and then on again for one PSS-cycle. Follow the process in reverse if the output is switched off. If the output does not switch correctly, the error will be detected and registered by the PSS SB DI8O8 operating system.

NOTICE
During commissioning, an error must be simulated for every safety-related positive-switching output, in order to detect whether an output has been incorrectly excluded from the output test, or to check whether the output test programmed by the user is effective. Wait until the user program sets the output to “1” (output’s LED will light) and then generate a short circuit between the output and 24 V. The required error reaction should then occur.

Test pulse outputs

The two test pulse outputs T_0 and T_1 are fed from the supply voltage and are suitable for testing the wiring of input devices.
Only inputs which operate in accordance with the zero signal principle (on switching off) are permitted for safety-related applications.
Test pulses are allocated to inputs via the configurator in the system software.
Each test pulse has a maximum load capacity of 0.5 A.

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Schematic internal wiring diagram

The diagram on page 12 shows a schematic internal wiring diagram of the PSS SB DI8O8, showing the different output types, two shutdown routes and galvanic isolation from SafetyBUS p, etc.

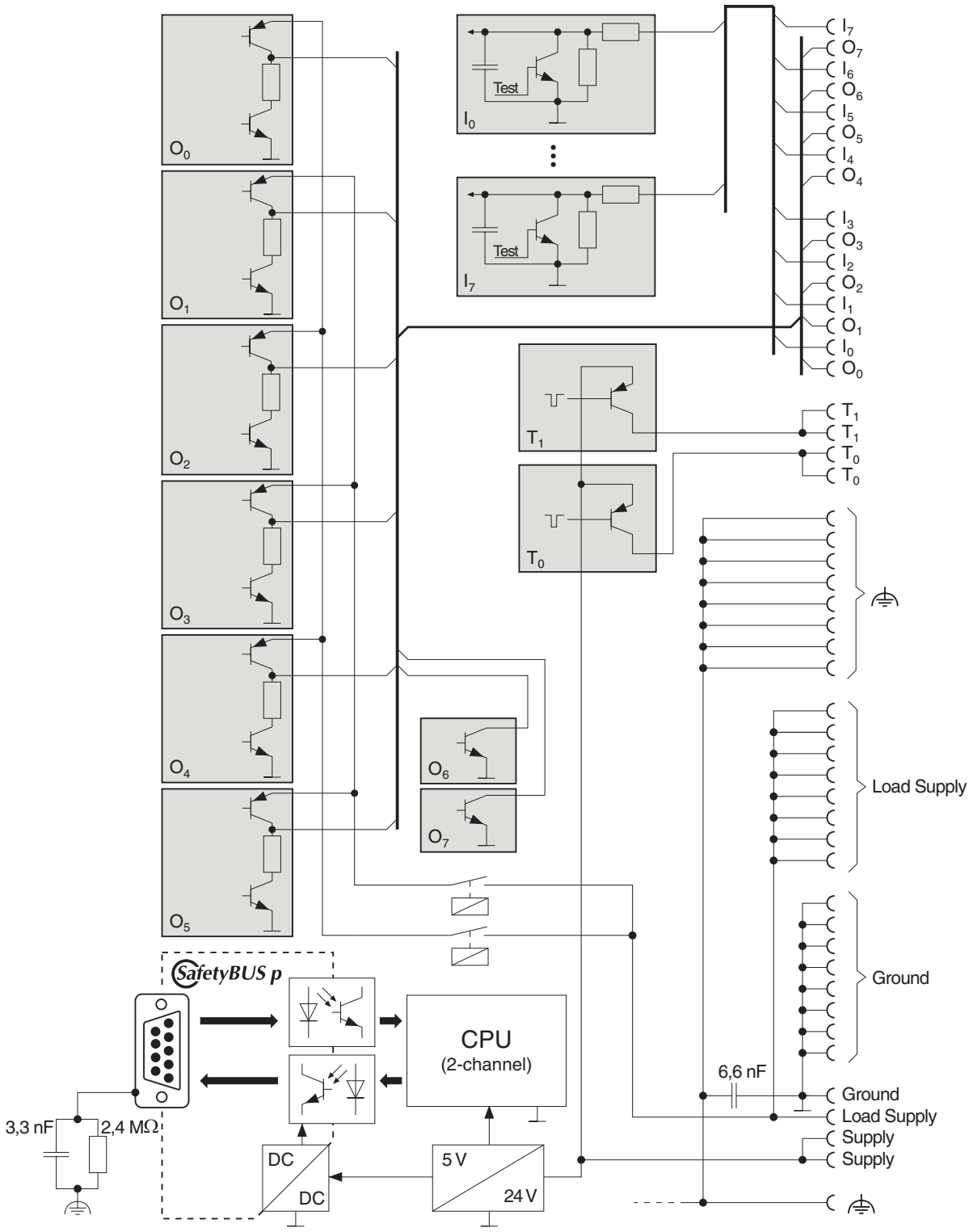
Operation of the module on SafetyBUS p

The connection to SafetyBUS p is made via a male 9-pin D-Sub connector. Fibre-optic couplers from Pilz (like PSS SB SUB-D F0) can be connected to the SafetyBUS p interface.
To enable the module to operate on SafetyBUS p, it must be given the device address set via the configurator in the system software. Device addresses 32_{dec} ... 95_{dec} are permitted if you are using the device in conjunction with a Pilz PSS.
The configurator in the system software is also used to establish which I/O groups the device belongs to.
The module can be divided into Section A and Section B. Section A and Section B may belong to different I/O-Groups. The module itself can either have Section A alone, or both Section A and Section B.
Outputs always belong to Section A. In the system software you can configure a limit value to determine which section inputs will belong to: those with a number below this limit will belong to Section A, those with a higher number will belong to Section B.
The I/O addresses which the PSS master uses to address the I/Os are established according to their membership of Section A or B and the device address.
Under the device address in the process I/O image of the PSS master, I/Os from Section A are addressed as device address and bit number 0 ... 7. Inputs from Section B are addressed under the device address as slot number and bit number 16 ... 23. For example, if input I_6 from Section A is reconfigured to Section B, the address will change from x.6 to x.22. The offset for Section B is 16.
Example: Device address is 36, inputs I_0 to I_4 belong to Section A, inputs I_5 to I_7 belong to Section B.

Formula for calculating Section B addresses:

Address of I_x = Device address **.** [(Input number I_x) + (Offset 16)]

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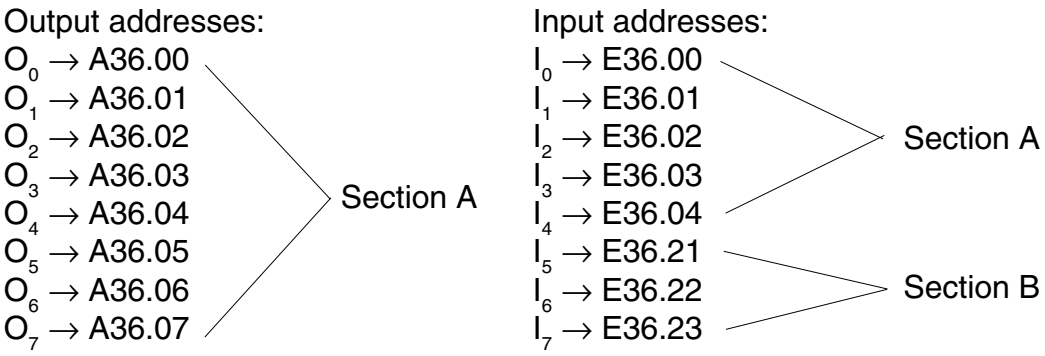


Schematic internal wiring diagram of the PSS SB DI8O8

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Example:
The device address is 36, inputs I_0 to I_4 belong to Section A,
inputs I_5 to I_7 belong to Section B.

So, taking I_5 as an example: Address of I_5 = 36 . [5 + (Offset 16)] = 36.21



Supply voltage

Two supply voltages can be connected to the PSS SB DI8O8: the “Supply” feeds the module electronics and dedicated test pulse outputs, while the “Load Supply” feeds the outputs. Both supply voltages have a common earth.

The “Load Supply” must be connected, even if the outputs on the unit will not be used. If it is not connected, Section A will remain in a STOP condition (see section entitled “Operation of the module on SafetyBUS p”).

The advantage in separating the two supply voltages “Supply” and “Load Supply” is best seen in the following example.
Several machines are secured by the same safety devices. Each of these machines is assigned a PSS SB DI8O8 module. One power supply feeds all the “Supply” modules and the general safety devices. Each machine also has a separate supply voltage, “Load Supply”.
Each unit is configured so that I/Os that are specific to a particular machine are combined into one I/O group. Inputs for the safety devices are combined into one I/O group, which is general to all the DI808 modules.
If one of the machines is no longer required or develops a fault, this machine can be switched off individually without affecting the safety devices or stopping the other machines.
If the “Supply” fails or if a general safety device disengages, all the machines will be switched off.

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Display elements

LEDs for status display
Each input and output is assigned an LED for status display.
If the input or output is high, the corresponding LED will light. If it goes low, the LED will go out.

LED “Supply”
Indicates that the supply is present.

LED “Load Supply”
Indicates that the load supply is present.

LED “Device”
This dual-coloured LED indicates the status of the device.

- Red: a device error has occurred. The device error may affect one or both of the I/O groups configured on the module.
- Flashing red: a periphery error has occurred.
- Green: the module is operating without error.
- LED off: a system error is preventing the module from starting up.

LED “SB active”
Indicates a connection between the module and the management device.

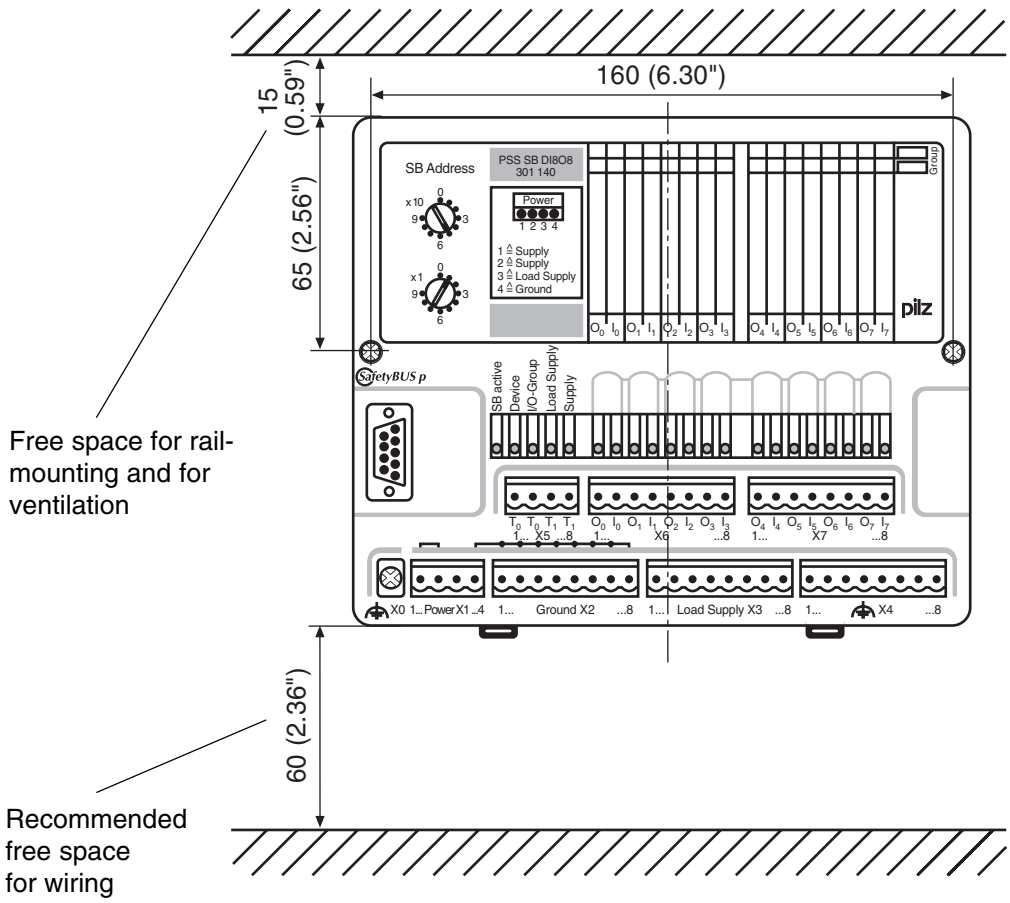
- Green: Successfully connected to management device
- LED off: no connection to SafetyBUS p (faulty wiring or management device not in operation)
- LED flashing: Connection made to SafetyBUS p, but the management device does not recognise the module (invalid device address or configuration)

LED “I/O Group”
Indicates the status of the I/O groups configured on the module.

- Green: all the I/O groups configured on the module have “RUN” status
- LED off: all the I/O groups configured on the module have “STOP” status
- LED flashes: one of the I/O groups configured on the module has “STOP” status

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Installation



Installing the PSS SB DI8O8, dimensions stated in mm (")

Dimensions in mm ("):
H x W x D: 140 x 170 x 65 (5.51 x 6.69 x 2.56)
The module can be attached to a 35 mm DIN-rail (top hat rail) or can be screwed on to mounting plate using fixing bolts (order no. 311 068).
To affix the module on to a mounting plate, drill 2 x M4 holes (internal thread) in the mounting plate, as shown in the above diagram (tolerance: ± 0.2 mm/0.01").

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Commissioning

General guidelines are given below, but you should always refer to the “PSS SB DI8O8 Installation Manual” (this is part of the “Safety BUS p” System Manual and is also enclosed with every Safety BUS p-compatible PSS):

- Install the module



INFORMATION
If the module is attached to an earthed DIN rail, this will automatically cover the module's functional earth requirements.

- Wire the inputs and outputs
- Connect the module to SafetyBUS p and set the device address
- Connect the supply voltage.



- **NOTICE**
  Every safety-related positive-switching output should undergo an error simulation: wait until the user program sets the output to “1” (output’s LED will light) and then generate a short circuit between the output and 24 V. The required error reaction should then occur. This is the only way to check whether an output has been incorrectly excluded from the output test and whether the output test that has been programmed is effective.

Recommissioning



NOTICE
If the device has to be recommissioned you may experience errors when inserting the terminal blocks, as these are not designed to be exchanged. To ensure such errors are eliminated, always carry out a function test when recommissioning.

Faults

If a module is defective or there is a wiring error, all the outputs in the affected I/O group will be switched off and the I/O-group will switch to a STOP condition. An error telegram will then be stored on SafetyBUS p and the error will entered in the PSS SB DI8O8 error buffer.
An error message will appear on the PSS master’s display. The error stack display in the system software can be used to locate the error (see “SafetyBUS p System Description”).

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Check list for commissioning

	Fill out when designing the plant and its configuration:	*Confirm during commissioning:*
	Information on the device address	Address set
Device address		

Output	Designed as dual-pole output		Safety-related output		Excluded from output test		Required reaktion in case of error	Error simulated for safety-related output[1)]
	yes	no	yes	no	yes	no		
O_0	X	X						
O_1	X	X						
O_2	X	X						
O_3	X	X						
O_4								
O_5								
O_6	X	X						
O_7	X	X						

Date:.....

Signed:.....

Date:.....

Signed:.....

[1)] Wait until the user program sets the output to “1” (output’s LED will light) and then generate a short circuit between the output and 24 V. The required error reaction should then occur.

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Module configuration

The procedure for configuring SafetyBUS p and the PSS SB DI8O8 module is described in the online help of the PSS WIN-PRO system software.

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Technical details

Electrical data	
Supply voltage	"Supply": 24 V DC "Load Supply" 24 VDC
Tolerance	20 ... 30 VDC including residual ripple of max. ± 1.2 V
Input capacitance	570 µF
Power consumtion	"Supply": 150 mA plus load currents from the test pulse outputs and load currents for fibre-optic couplers (25 mA per fibre-optic coupler); "Load supply": max. 10 A
Galvanic isolation	Yes (optocoupler), between inputs/outputs and SafetyBus p
Connection type	Spring-loaded terminals or plug-in screw connectors
SafetyBUS p	
Transmission rate	Max. 500 kBit/s
Cable runs	Max. 3500 m
Transmission type	Differential two-wire cable, Fibre-optic cabale via fibre-optic coupler
Connection	9-pin D-Sub connector
Digital inputs	
Number of inputs	8
Potential isolation	Yes, from SafetyBUS p
Signal level at “1” (high)	+15 ... +30 VDC
Signal level at “0” (low)	-3 ... +5 VDC
Input current	Typ. 6 mA
Input delay	< 1 ms
Pulse suppression	< 500 µs
Status indicator	Yellow LED
Outputs, positive-switching	
Number of outputs	6
Potential isolation	Yes, from SafetyBUS p
Output current at “1” signal	2 A
Permitted range	0 ... 2.5 A
Short circuit protection	Electronic

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Limitation of inductive switch-off	Approx. U B - 60 VDC
Simultaneity	100 % at max. 10 A, all outputs
Residual current at “0” signal	0 mA
Signal level at the outputs “0” signal “1” signal and 2.5 A load	 0 VDC U_B - 1 VDC
Minimum output switch delay	< 50 µs
Off time during self test	< 200 µs
On time during self test	< 200 µs
Status indicator	Green LED
Outputs, negative-switching	
Number of outputs	2
Potential isolation	Yes, from SafetyBUS p
Output current at “1” signal	2 A
Permitted range	0 ... 2.5 A
Short circuit protection	Electronic
Limitation of inductive switch-off	Approx. 60 VDC
Simultaneity	100 %
Residual current at “0” signal	0 mA
Signal level at the outputs “0” signal “1” signal and 2.5 A load	 U_B < 1 VDC
Output switch delay	< 50 µs
Off time during self test	< 200 µs
On time during self test	< 200 µs
Status indicator	Green LED
Dedicated test pulses	
Supply	From the module supply
Number	2 (one terminal pair per test pulse)
Output current at “1” signal	Max. 0.5 A per terminal
Total load capacity	Max. 0.5 A per terminal pair
cable length	between test pulse output and input max. 200 m

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Environmental data	
Protection type (EN 60529)	IP20
Mounting position	Any
Ambient temperature (EN 60068-2-14)	0 ... 60 °C
Storage temp. (EN 60068-2-1/-2)	-25 ... +70 °C
Climatic suitability (EN 60068-2-78)	Max. 95 % r.h.
Condensation	Not permitted
Vibration (EN 60068-2-6)	Frequency range: 10 ... 150 Hz max. 1g
Vibration resistance (EN 60068-2-27)	15g, 11 ms
EMC	EN 61000-6-2 EN 55011 A
Mechanical data	
Weight	530 g
Dimensions (H x W x D)	140 x 170 x 65 mm

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The version of the standards current at 2004-04 shall apply.

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Changes in the documentation

Changes from version I to version II

Old p. no.	New p. no.	Change
2	2	Description of the positive-switching outputs
6	6	Description of the tests to be carried out by the user on outputs that are excluded from the output test
10	10	Function of the LED “SB active”
15	15	How groups are displayed in the programming device
18	18	Information added on the on time during self test

Changes from version II to version III

Old p. no.	New p. no.	Change
3	3	The layout of the switch for setting the device address was amended.
14	14	Procedure when adding a module to the bus structure was amended.

Changes from version III to version IV

Old p. no.	New p. no.	Change
3	3	Labelling strip for inputs and outputs
4, 5, 12	4, 5, 12	If an error occurs, outputs are switched off first and then the error telegram is sent.
6	6	Category 2 in accordance with EN 954-1 can be achieved using outputs excluded from the output test.
11	11	Installation using fixing bolts
17	17	Information on “Supply” amended
18	18	Information on test pulses amended
18	18	Length of off time during self test reduced (< 200 µs)

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Changes from version IV to version V

Old p. no.	New p. no.	Change
14 ff.	14 ff.	Procedure when configuring test pulses and outputs using system software PSS SW PG, from version 4.1.
18	20	Condensation is not permitted.

Changes from version V to version VI

Old p. no.	New p. no.	Change
7	7	Internal wiring diagram was amended.

Changes from version VI to version VII

Old p. no.	New p. no.	Change
---	4	New: section “Detecting signals at the inputs” All subsequent sections moved forward
---	5	New: information on device's reaction when using capacitive loads > 1µF
---	6	New: section under “WARNING” with timing diagram
20	20	New: version information under “Transmission rate”

Changes from version VII to version VIII

Old p. no.	New p. no.	Change
4	4	Pulse length for guaranteed signal detection > Event Timeout

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Changes from version VIII to version IX

Old p. no.	New p. no.	Change
9	9	fibre-optic couplers can now be connected to the SafetyBUS p interface
21	22	cable length between test pulse output and input max. 200 m

Changes from version IX to version X

Old p. no.	New p. no.	Change
-	2	Validity of the documentation
-	6	signal change behaviour
20	21	signal change behaviour
21	22	Power Consumtion "Supply"
21	22	fibre-optic couplers can now be connected to the SafetyBUS p interface

Changes in version 19 964-11

Old p. no.	New p. no.	Change
		pulse suppression: 500 µs

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Changes in version 19 964-12

Old p. no.	New p. no.	Change
		Norms updated
-	3	New: section „System requirements“
6	-	INFO deleted
17-21	17	Module configuration
20	20	Technical details was amended
-	20	New: "The version of the standards current at 2004-04 shall apply."

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