Compact safety relays PNOZsigma

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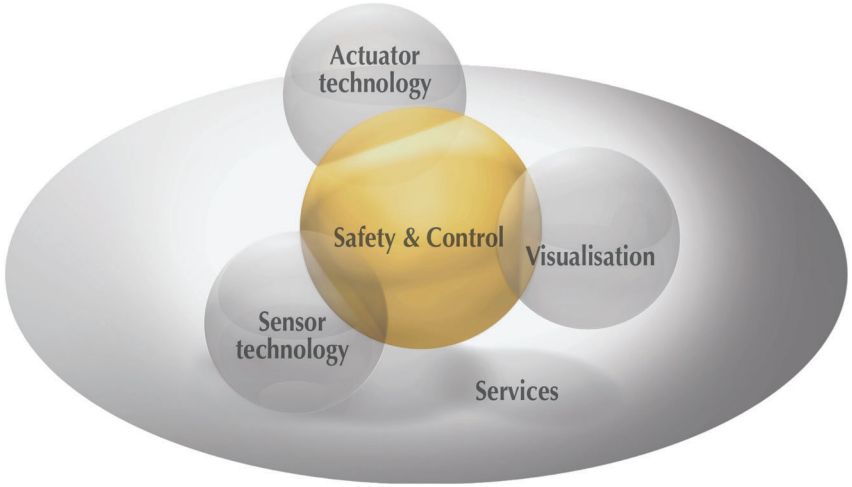
Application examples for project configuration -
PNOZsigma product range

Application manual – December 2006 edition

Safe Automation



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September 2006

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Features

- Single-channel operation
- Manual reset
- Contact expansion through positive-guided contactor
- Feedback circuit to monitor contact expansion
- Up to Category 2 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, the supply voltage on the safety relay PNOZ s1 (K1) is interrupted, the safety contacts on K1 open. Contactor K2 de-energises.

Settings on the unit
- The terminator on the PNOZ s1 (K1) must be connected

Start/reset
The safety relay PNOZ s1 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- Contactor K2 has de-energised.

Feedback loop
The positive-guided N/C contact on contactor K2 is monitored in feedback loop A1-S34 of safety relay PNOZ s1 (K1).

Safety assessment
- Earth fault in the input circuit is detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s1 (K1) can be started when the input circuit (supply voltage) at K1 is closed first, followed by the reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The safety relay PNOZ s1 (K1) is tested in each on/off cycle. The E-STOP pushbutton S1 must be operated at appropriate intervals to perform a function test. This must be recorded in the machine's operating manual (organisational measure). An E-STOP is not a primary safety measure, just a precautionary measure for emergencies (EN ISO 12100-2). A start-up test is therefore not required.
  As the PNOZ s1 cannot be tested automatically, a second shutdown route is required (e.g. via a main switch or a master contactor).

Pilz products

Number	Designation	Order number
1	PNOZ s1	750 101
1	PIT es1.11	400 100
1	PIT esb1.1	400 305

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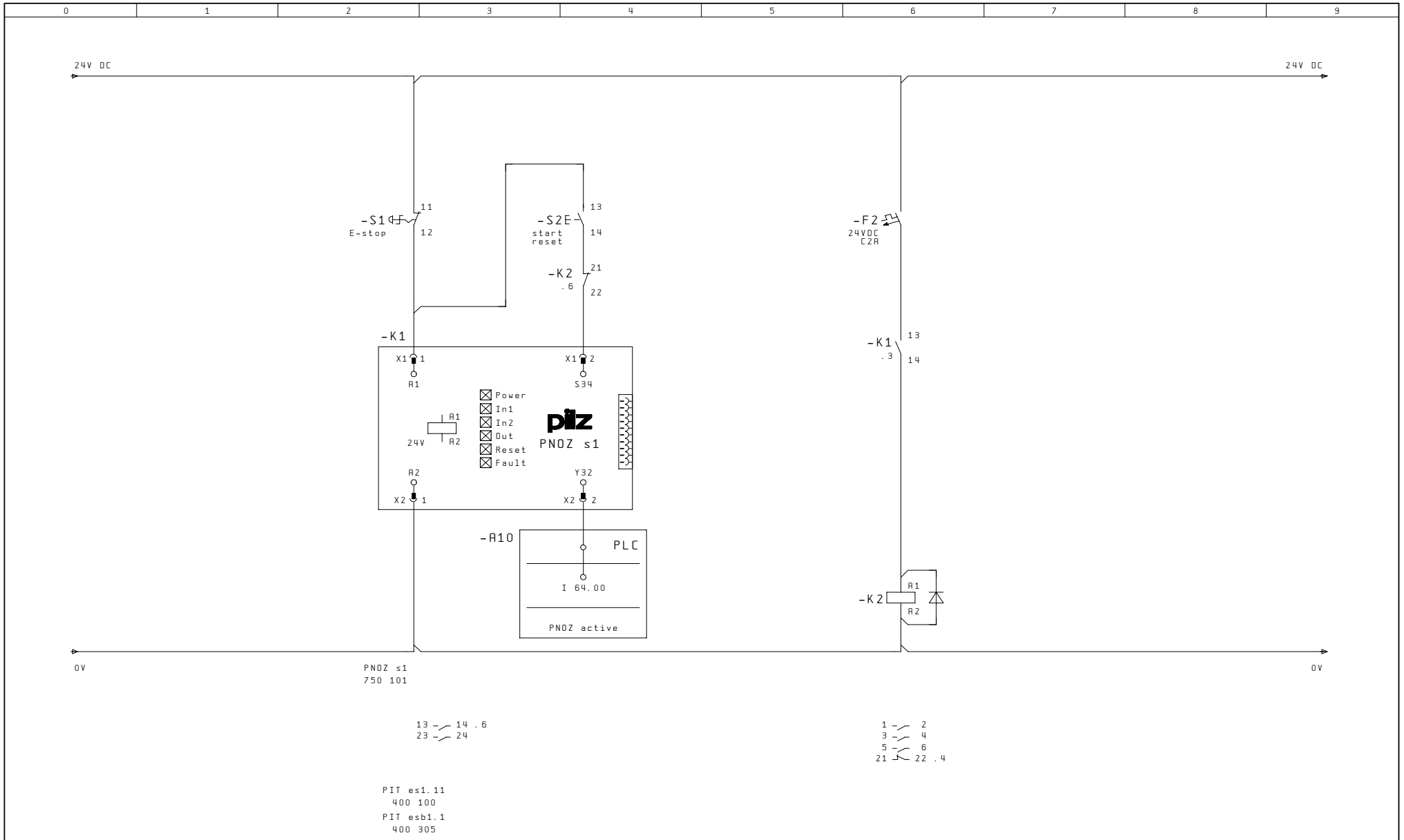
Category 2, EN 954-1

PNOZ s1 - Single-channel operation, contact expansion through contactor

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s1), actuator (contactor K2)
- Performance level: **PL c**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactor K2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN ISO 13849-1 have also to be met (e.g. requirements for avoiding systematic faults, among others).



Revision	20.03.06	Date	07.12.05	Emergency stop application	pilz Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by contactor and manual start	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs1
				Category 2 EN 954-1			Page: 1
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Category 2, EN 954-1

PNOZ s2 – Single-channel operation, contact expansion through contactor

Features

- Single-channel operation
- Monitored reset with rising edge
- Contact expansion through positive-guided contactor
- Feedback circuit to monitor contact expansion
- Up to Category 2 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, the supply voltage on the safety relay PNOZ s2 (K1) is interrupted, the safety contacts on K1 open. Contactor K2 de-energises.

Settings on the unit
- The terminator on the PNOZ s2 (K1) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s2 (K1) must be set to “Monitored reset, rising edge”.

Start/reset
The safety relay PNOZ s2 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- Contactor K2 has de-energised.

Feedback loop
The positive-guided N/C contact on contactor K2 is monitored in feedback loop A1-S34 of safety relay PNOZ s2 (K1).

Safety assessment
- Earth fault in the input circuit is detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s2 (K1) can be started when the input circuit (supply voltage) at K1 is closed first, followed by the reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The safety relay PNOZ s2 (K1) is tested in each on/off cycle. The E-STOP pushbutton S1 must be operated at appropriate intervals to perform a function test. This must be recorded in the machine’s operating manual (organisational measure). An E-STOP is not a primary safety measure, just a precautionary measure for emergencies (EN ISO 12100-2). A start-up test is therefore not required.
  As the PNOZ s2 cannot be tested automatically, a second shutdown route is required (e.g. via a main switch or a master contactor).
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K1 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s2 (K1) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s2	750 102
1	PIT es1.11	400 100
1	PIT esb1.1	400 305

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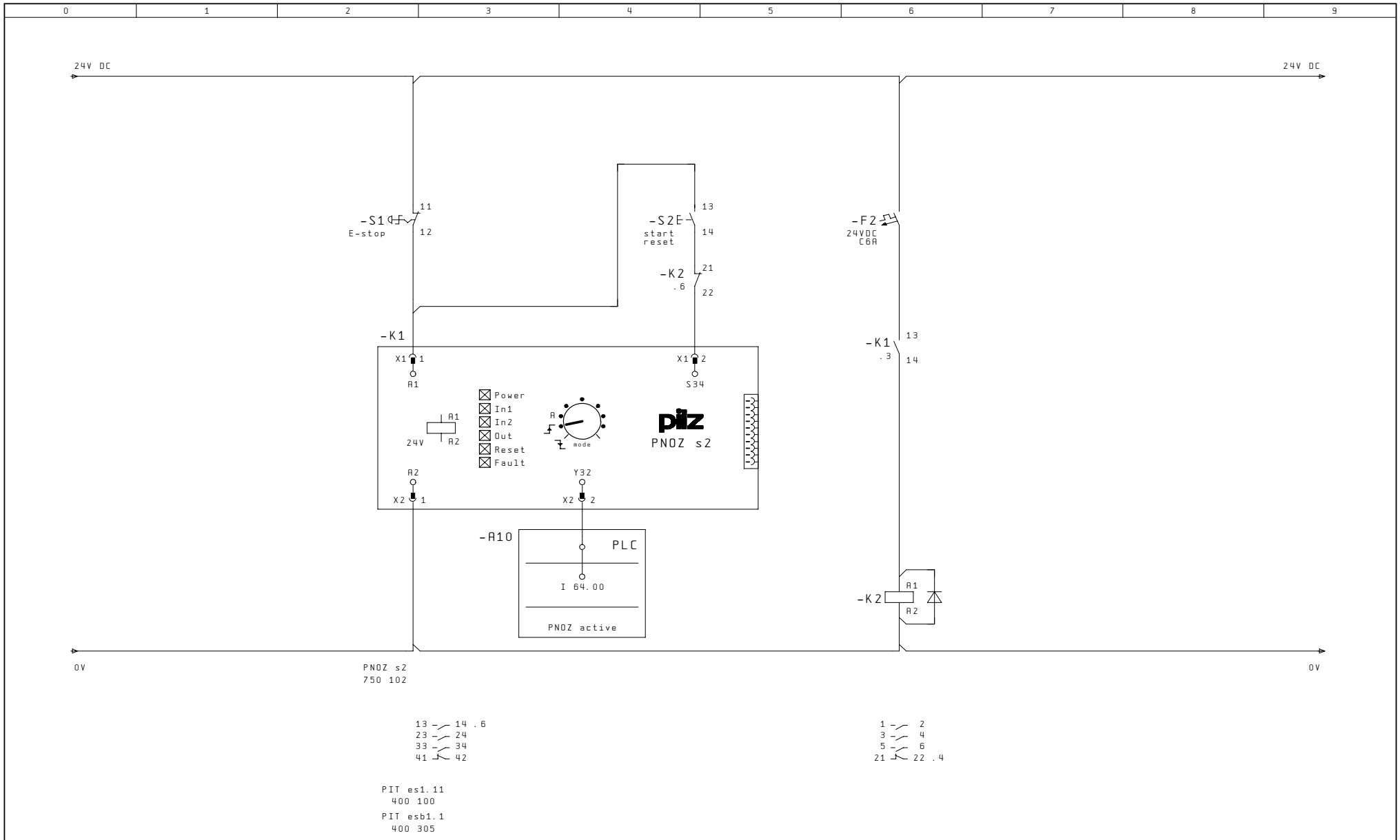
Category 2, EN 954-1

PNOZ s2 – Single-channel operation, contact expansion through contactor

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s2), actuator (contactor K2)
- Performance level: **PL c**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactor K2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN ISO 13849-1 have also to be met (e.g. requirements for avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by contactor and monitored start
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 2 EN 954-1		PNOZs2
		Dep.	CS			Page: 1

Category 2, EN 954-1

PNOZ s2 - Single-channel operation, contact expansion through PZE X4P

Features

- Single-channel operation
- Monitored reset with rising edge
- Contact expansion through PZE X4P (contact expander module)
- Feedback circuit to monitor contact expansion
- Up to Category 2 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S3 is operated, the supply voltage on the safety relay PNOZ s2 (K3) is interrupted, the safety contacts on K3 open. As a result the supply voltage to the contact expander module PZE X4VP (K4) is interrupted, the safety contacts on K4 open.

Settings on the unit
- The terminator on the PNOZ s2 (K3) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s2 (K3) must be set to “Monitored reset, rising edge”.

Start/reset
The safety relay PNOZ s2 (K3) can be started by pressing reset button S4 if:
- E-STOP pushbutton S3 has not been operated and
- Feedback loop Y1/Y2 on contact expander module PZE X4P (K4) is closed.

Feedback loop
The feedback loop on the safety relay PNOZ s2 (K3) is connected to the feedback loop on the contact expander module PZE X4P (K4).

Safety assessment
- Earth fault in the input circuit is detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s2 (K3) can be started when the input circuit (supply voltage) at K3 is closed first, followed by the reset button S4. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The safety relay PNOZ s2 (K3) is tested in each on/off cycle. The E-STOP pushbutton S3 must be operated at appropriate intervals to perform a function test. This must be recorded in the machine’s operating manual (organisational measure). An E-STOP is not a primary safety measure, just a precautionary measure for emergencies (EN ISO 12100-2). A start-up test is therefore not required.
  As the PNOZ s2 cannot be tested automatically, a second shutdown route is required (e.g. via a main switch or a master contactor).
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K3 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s2 (K3) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s2	750 102
1	PZE X4P	777 585
1	PIT es1.11	400 100
1	PIT esb1.1	400 305

Category 2, EN 954-1

PNOZ s2 - Single-channel operation, contact expansion through PZE X4P

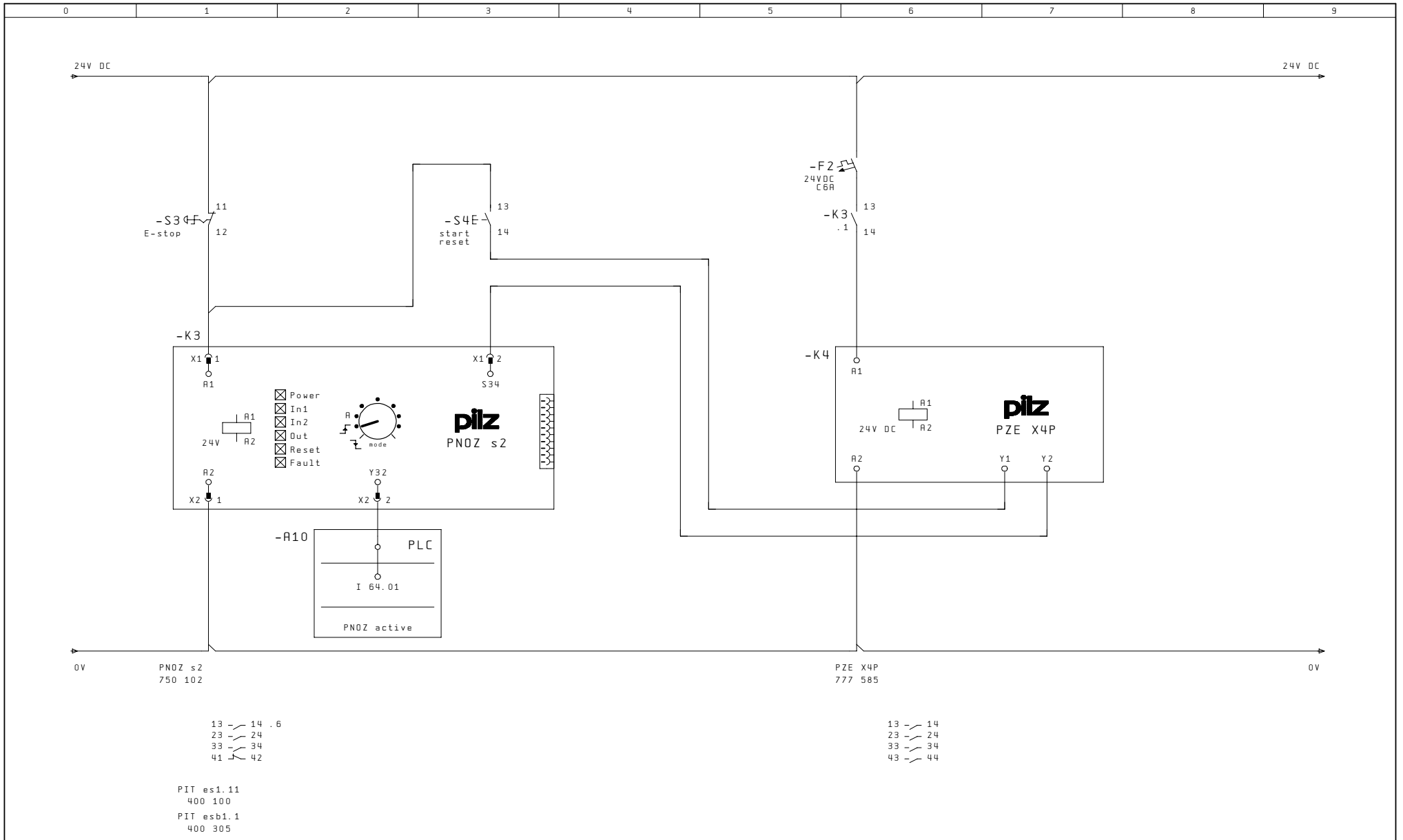
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s2), actuator (PZE X4P)
- Safety integrity level: **SIL 1**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s2), actuator (PZE X4P)
- Performance level: **PL c**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by PZE X4P and monitored start
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
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Category 3, EN 954-1

PNOZ s3 - Dual-channel operation, contact expansion through contactor

Features

- Dual-channel operation
- Monitored reset with rising edge
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 3 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, the input circuit on the safety relay PNOZ s3 (K1) is interrupted, the safety contacts on K1 open. Contactors KM1 and KM2 de-energise.

Settings on the unit
- The terminator on the PNOZ s3 (K1) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s3 (K1) must be set to “Monitored reset, rising edge without detection of shorts across contacts (In2+)”.

Start/reset
The safety relay PNOZ s3 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- Contactors KM1 and KM2 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors KM1 and KM2 are monitored in feedback loop S12-S34 of safety relay PNOZ s3 (K1).

Safety assessment
- Earth fault in the input circuit is detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s3 (K1) can be started when the input circuit at K1 is closed first, followed by reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K1 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s3 (K1) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s3	750 103
1	PITestop Set1.1	400 410

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Category 3, EN 954-1

PNOZ s3 - Dual-channel operation, contact expansion through contactor

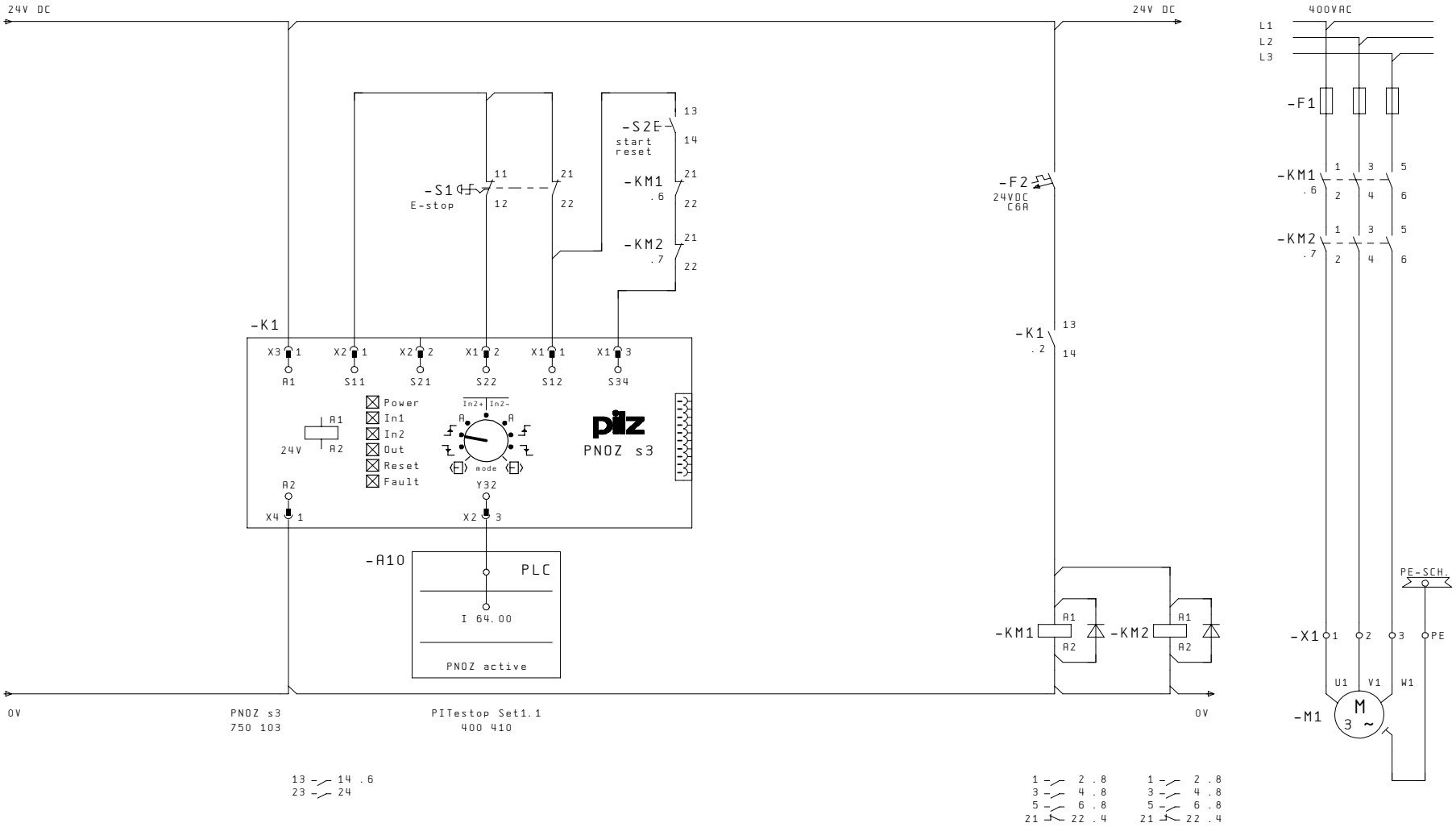
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s3), actuator (contactors KM1 and KM2)
- Safety integrity level: **SIL 2**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s3), actuator (contactors KM1 and KM2)
- Performance level: **PL d**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by contactor and monitored start
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
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		Dep.	CS			Page: 1

Notes

Category 4, EN 954-1

PNOZ s3 - Dual-channel operation, contact expansion through PZE X4.1P

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Contact expansion through PZE X4.1P (contact expander module)
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S5 is operated, the input circuit on the safety relay PNOZ s3 (K5) is interrupted, the safety contacts on K5 open. As a result the input circuit on the contact expander module PZE X4.1P (K6) is interrupted, the safety contacts on K6 open.

Settings on the unit
- The terminator on the PNOZ s3 (K5) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s3 (K5) must be set to “Monitored reset, rising edge with detection of shorts across contacts (In2-)”.

Start/reset
The safety relay PNOZ s3 (K5) can be started by pressing reset button S6 if:
- E-STOP pushbutton S5 has not been operated and
- Feedback loop Y1/Y2 on contact expander module PZE X4.1P (K6) is closed.

Feedback loop
The feedback loop on the safety relay PNOZ s3 (K5) is connected to the feedback loop on the contact expander module PZE X4.1P (K6).

Safety assessment
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s3 (K5) can be started when the input circuit at K5 is closed first, followed by reset button S6. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K5 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s3 (K5) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s3	750 103
1	PZE X4.1P	777 587
1	PITestop Set1.1	400 410

Category 4, EN 954-1

PNOZ s3 - Dual-channel operation, contact expansion through PZE X4.1P

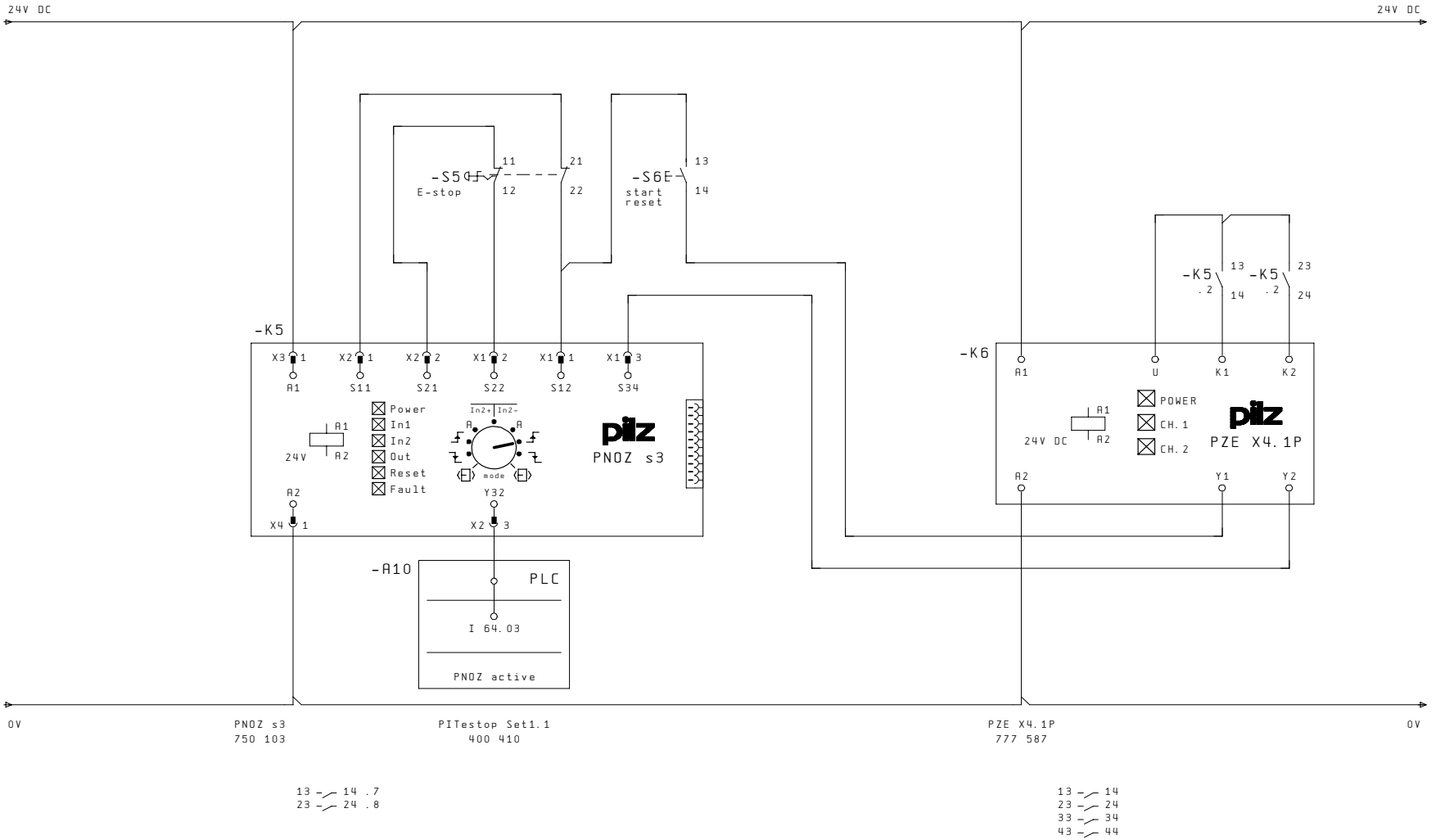
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s3), actuator (PZE X4.1P)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s3), actuator (PZE X4.1P)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by PZE X4.1P and monitored start
Name	WED	Name	WED			
				Category 4 EN 954-1		
		Dep.	CS			

Directory: ..PNOZ\05PIL013
PNOZs3
Page: 3

Notes

Category 4, EN 954-1

PNOZ s4 - Dual-channel operation, contact expansion through contactor

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, the input circuit on the safety relay PNOZ s4 (K1) is interrupted, the safety contacts on K1 open. Contactors KM1 and KM2 de-energise.

Settings on the unit
- The terminator on the PNOZ s4 (K1) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 (K1) must be set to “Monitored reset, rising edge with detection of shorts across contacts (In2-)”.

Start/reset
The safety relay PNOZ s4 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- Contactors KM1 and KM2 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors KM1 and KM2 are monitored in feedback loop S12-S34 of safety relay PNOZ s4 (K1).

Safety assessment
- The safety relay PNOZ s4 (K1) and contactors KM1 and KM2 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s4 (K1) can be started when the input circuit at K1 is closed first, followed by reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K1 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s4 (K1) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
1	PITestop Set1.1	400 410

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Category 4, EN 954-1

PNOZ s4 - Dual-channel operation, contact expansion through contactor

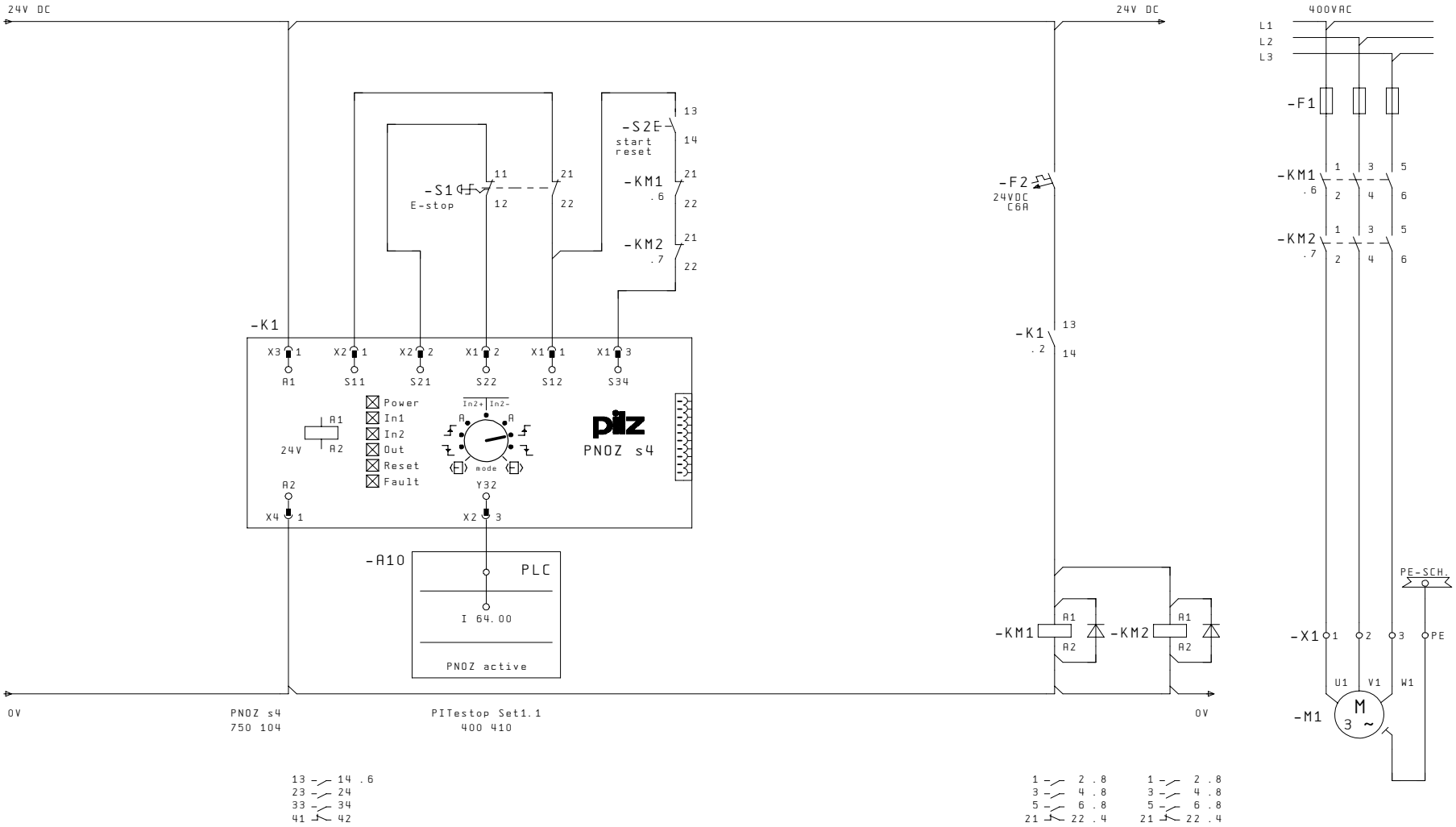
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s4), actuator (contactors KM1 and KM2)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s4), actuator (contactors KM1 and KM2)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by contactor and monitored start
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		Dep.	CS			Page: 1

Category 4, EN 954-1

PNOZ s5 - Safe standstill of one drive

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Safe standstill of one drive after E-STOP
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1
- Stop category 1 in accordance with EN 60204-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, both the drive and the supply to the drive are shut down after a delay time. When the E-STOP pushbutton S1 is operated, the input circuit on the safety relay PNOZ s5 (K1) is interrupted, safety contact 13-14 on K1 opens immediately and triggers a “fast stop” at the drive controller A1.
The delay-on de-energisation safety contact 37-38 switches off contactors KM1and KM2 after a delay. In this way, the drive controller A1 is isolated from the energy supply (mains) after a delay. The delay-on de-energisation time is set on the safety relay PNOZ s5 (K1).

Settings on the unit
- The terminator on the PNOZ s5 (K1) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s5 (K1) must be set to “Monitored reset, rising edge with detection of shorts across contacts (In2-)”.
- The delay time on the safety relay PNOZ s5 (K1) is set using the time selector switch t[s] and the factor selector switch n.

Start/reset
The safety relay PNOZ s5 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- Contactors KM1 and KM2 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors KM1 and KM2 are monitored in feedback loop S12-S34 of safety relay PNOZ s5 (K1).

Safety assessment
- The safety relay (K1) and contactors KM1 and KM2 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s5 (K1) can be started when the input circuit at K1 is closed first, followed by reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The delay time set for the safety relay PNOZ s5 (K1) must be longer than the maximum braking time on the drive regulator A1.
- The time delay must not be able to cause an additional hazard.
- If the position of the operating mode selector switch (mode) or the rotary switch for the time setting is changed during operation, an error message will be triggered; the safety contacts on K1 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s5 (K1) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s5	750 105
1	PITestop Set1.1	400 410

pilz
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safe automation

Category 4, EN 954-1

PNOZ s5 - Safe standstill of one drive

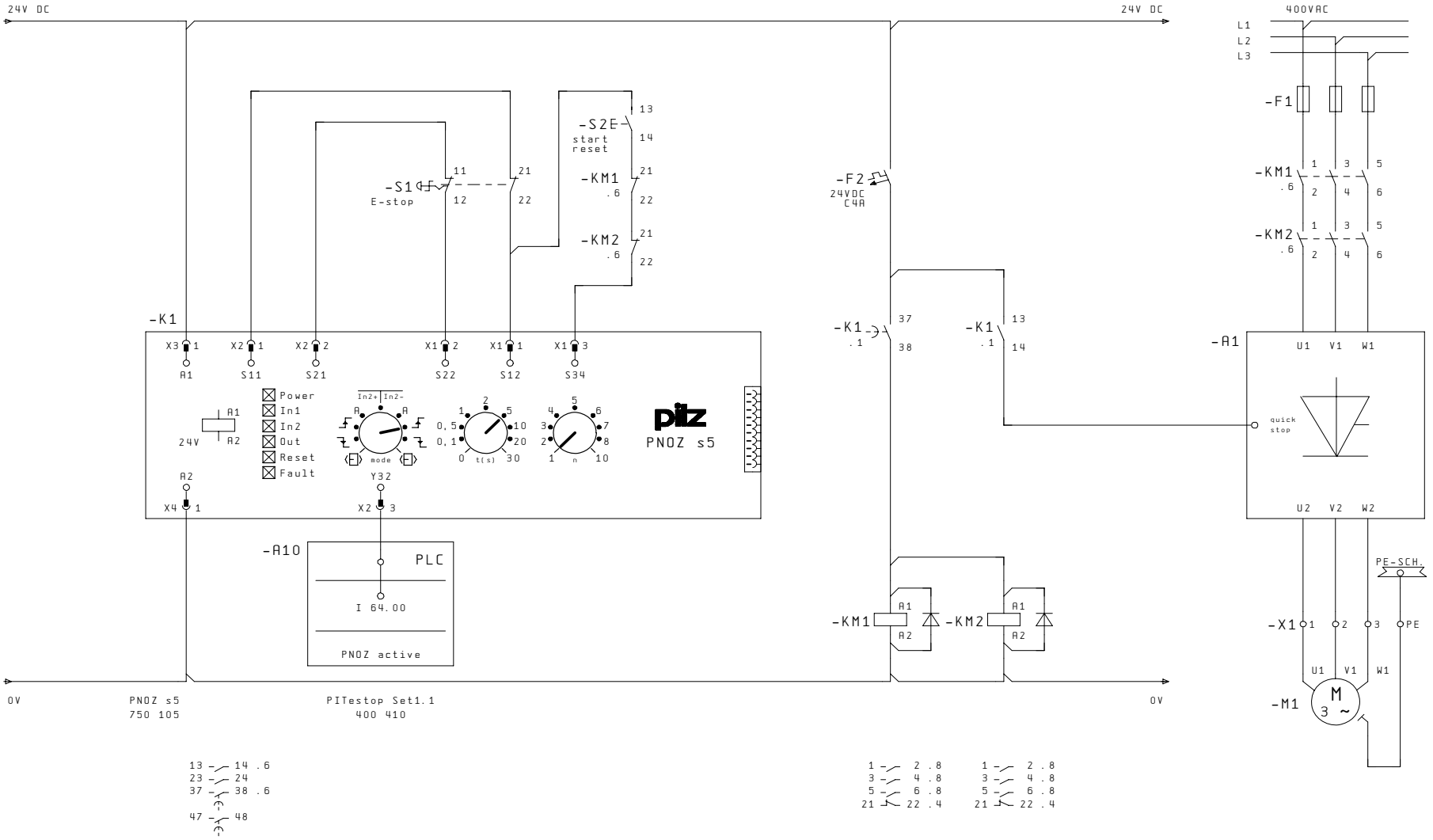
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s5), actuator (contactors KM1 and KM2)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s5), actuator (contactors KM1 and KM2)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	15.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safe stopping of a drive by emenrgency stop
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 4 EN 954-1		PNOZs5
		Dep.	CS			Page: 1

Category 4, EN 954-1

PNOZ s5 - Safe standstill of two drives

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Safe standstill of two drives after E-STOP
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1
- Stop category 1 in accordance with EN 60204-1

Description
Both drive controllers A2 and A3 have different braking times, so it must be possible to separate them from the mains independently in terms of time.

E-STOP function
When the E-STOP pushbutton S3 is operated, both the drives and the supply to the drives are shut down after a delay time. When the E-STOP pushbutton S3 is operated, the input circuit on the safety relay PNOZ s5 (K2) is interrupted, safety contacts 13-14 and 23-24 on K2 open immediately and trigger a “fast stop” at both the drive controllers A2 and A3.

The delay-on de-energisation safety contact 37-38 on K2 switches off contactors KM3 and KM4 after a delay. In this way, the drive controller A2 is isolated from the energy supply (mains) after a delay. The delay-on de-energisation time is set on the safety relay PNOZ s5 (K2). As a result the input circuit on safety relay PNOZ s9 (K3) is interrupted, the safety contacts on K3 switch off after a delay. The delay-on de-energisation contact 17-18 on K3 switches off contactors KM5 and KM6 after a delay. In this way, the drive controller A3 is isolated from the energy supply (mains) after a delay. The delay-on de-energisation time is set on the safety relay PNOZ s9 (K3).

Settings on the unit
- The connector between the safety relays PNOZ s5 (K2) and PNOZ s9 (K3) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s5 (K2) must be set to “Monitored reset, rising edge” with detection of shorts across contacts (In2-).
- The delay time on the safety relays PNOZ s5 (K2) and PNOZ s9 (K3) is set using the time selector switch t[s] and the factor selector switch n.
- The operating mode selector switch (mode) on the safety relay PNOZ s9 (K3) must be set to “Delay-on de-energisation”.

Start/reset
The safety relay PNOZ s5 (K2) can be started by pressing reset button S4 if:
- E-STOP pushbutton S3 has not been operated and
- Contactors KM3, KM4, KM5 and KM6 have dropped out.
- The feedback loop on safety relay PNOZ s9 (K3) is closed.

Feedback loop
The positive-guided N/C contacts on contactors KM3, KM4, KM5 and KM6 are monitored in feedback loop S12-S34 of safety relay PNOZ s5 (K2). The feedback loop on the safety relay PNOZ s5 (K2) is connected to the feedback loop on the safety relay PNOZ s9 (K3).

Safety assessment
- The safety relays PNOZ s5 (K2), PNOZ s9 (K3) and contactors KM3, KM4, KM5 and KM6 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relays PNOZ s5 (K2) and PNOZ s9 (K3) can be started when the input circuit at K2 is closed first, followed by reset button S4. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The delay time set for the safety relay PNOZ s5 (K2) must be longer than the maximum braking time on the drive regulator A2. The delay time set for the safety relay PNOZ s9 (K3) must be longer than the maximum braking time on the drive regulator A3.
- The time delay must not be able to cause an additional hazard.
- If the position of the operating mode selector switch (mode) or the rotary switch for the time setting is changed during operation, an error message will be triggered; the safety contacts on K2 and K3 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s5 (K2) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s5	750 105
1	PNOZ s9	750 109
1	PITestop Set1.1	400 410

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Category 4, EN 954-1

PNOZ s5 - Safe standstill of two drives

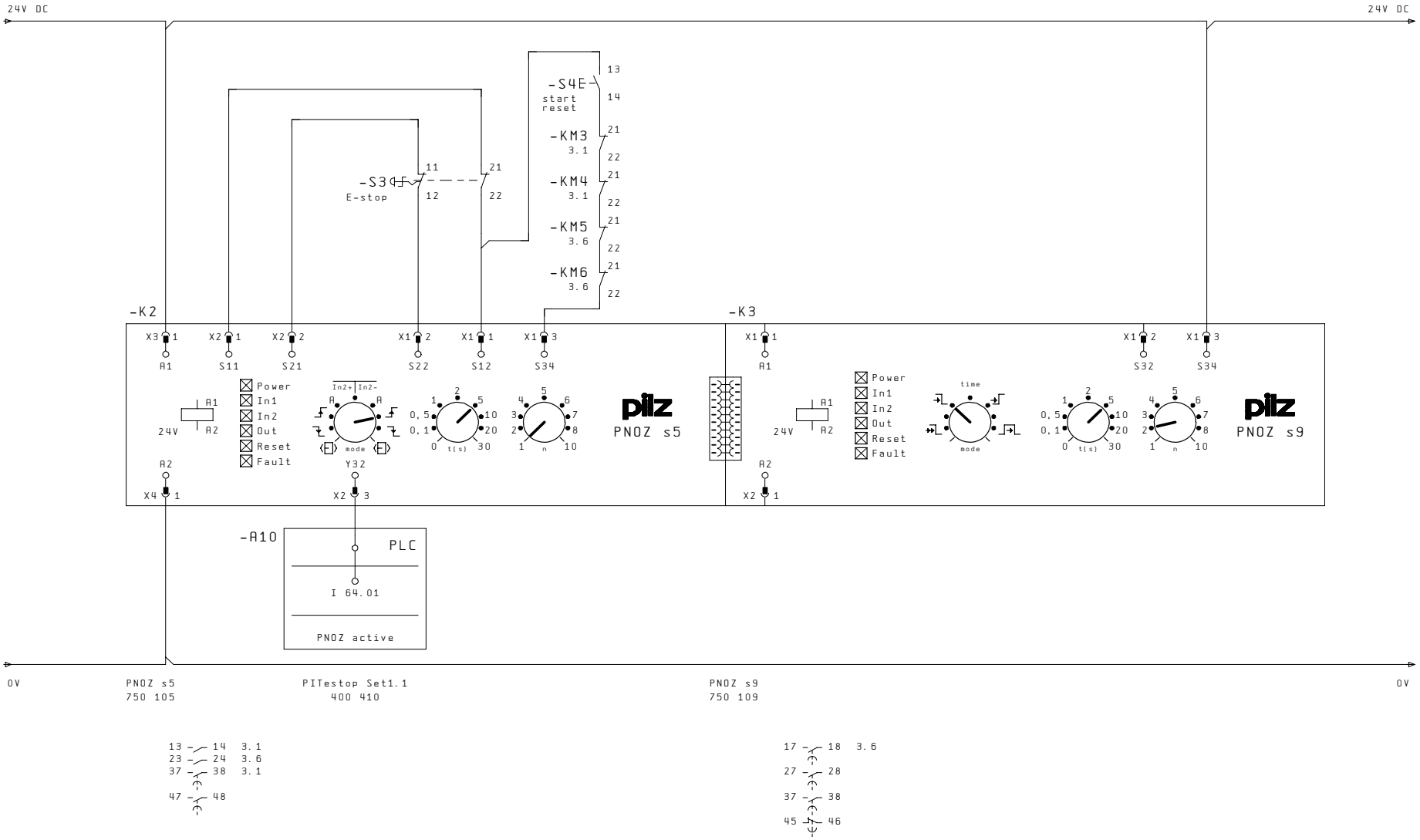
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function 1 (SRCF1): Delayed shutdown of motor M2 via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s5), actuator (contactors KM3 and KM4)
- Safety integrity level: **SIL 3**
- Safety-related control function 2 (SRCF2): Delayed shutdown of motor M3 via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s5 + s9), actuator (contactors KM5 and KM6)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM3/KM4/KM5/KM6 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function 1: Delayed shutdown of motor M2 via E-STOP
- Safety-related parts of the control system (SRP/CS1): Input device (E-STOP button), logic (PNOZ s5), actuator (contactors KM3 and KM4)
- Performance level: **PL e**
- Safety function 2: Delayed shutdown of motor M3 via E-STOP
- Safety-related parts of the control system (SRP/CS2): Input device (E-STOP button), logic (PNOZ s5 + s9), actuator (contactors KM5 and KM6)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



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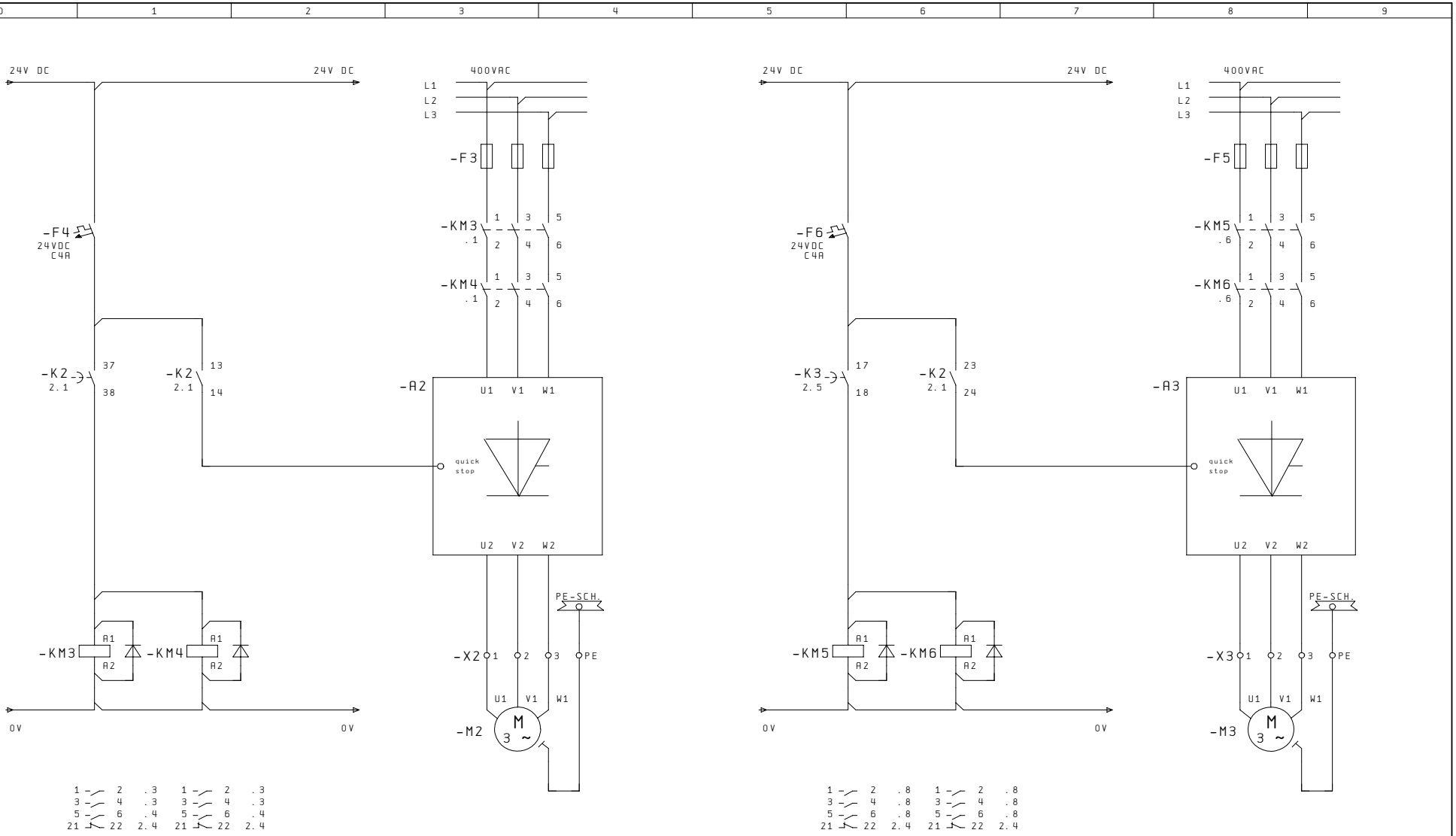
Revision	15.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safe stopping of two drives by emenrgency stop
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 4 EN 954-1		PNOZs5
		Dep.	CS			Page: 2



Page 2 of 2

Revision	15.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safe stopping of two drives by emenrgency stop
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 4 EN 954-1		PNOZs5
		Dep.	CS			Page: 3

Category 4, EN 954-1
PNOZ s5 - Combined with two PNOZ s7

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Contact expansion through two PNOZ s7
- Feedback loop to monitor contact expansion
- No delayed safety contacts (time selector switch t[s] set to “0”)
- Up to Category 4 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S5 is operated, the input circuit on the safety relay PNOZ s5 (K4) is interrupted, the safety contacts on K4 open. As a result the input circuit on the contact expander module PNOZ s7 (K5) is interrupted, the safety contacts on K5 open. As a result the supply voltage on the contact expander module PNOZ s7 (K6) is interrupted, the safety contacts on K6 open.
As the time selector switch t[s] is set to 0, all the safety contacts on the safety relay PNOZ s5 (K4) switch off immediately.

Settings on the unit
- The connector between the safety relays PNOZ s5 (K4) and PNOZ s7 (K5) must be connected.
- The terminator on the PNOZ s7 (K6) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s5 (K4) must be set to “Monitored reset, rising edge with detection of shorts across contacts (In2-)”.
- On the safety relay PNOZ s5 (K4), the time selector switch t[s] must be set to “0” and the factor selector switch n to “1”.

Start/reset
The safety relay PNOZ s5 (K4) can be started by pressing reset button S6 if:
- E-STOP pushbutton S5 has not been operated
  and
- Safety relay PNOZ s7 (K6) has de-energised
  and
- The feedback loop on contact expander module K5 is closed.

Feedback loop
The positive-guided N/C contact on the safety relay PNOZ s7 (K6) is monitored in feedback loop S12-S34 of safety relay PNOZ s5 (K4).

Safety assessment
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relays PNOZ s5 (K4), PNOZ s7 (K5) and PNOZ s7 (K6) can be started when the input circuit at K4 is closed first, followed by reset button S6. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) or the rotary switch for the time setting is changed during operation, an error message will be triggered; the safety contacts on K4 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s5 (K4) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s5	750 105
2	PNOZ s7	750 107
1	PITestop Set1.1	400 410

Category 4, EN 954-1

PNOZ s5 - Combined with two PNOZ s7

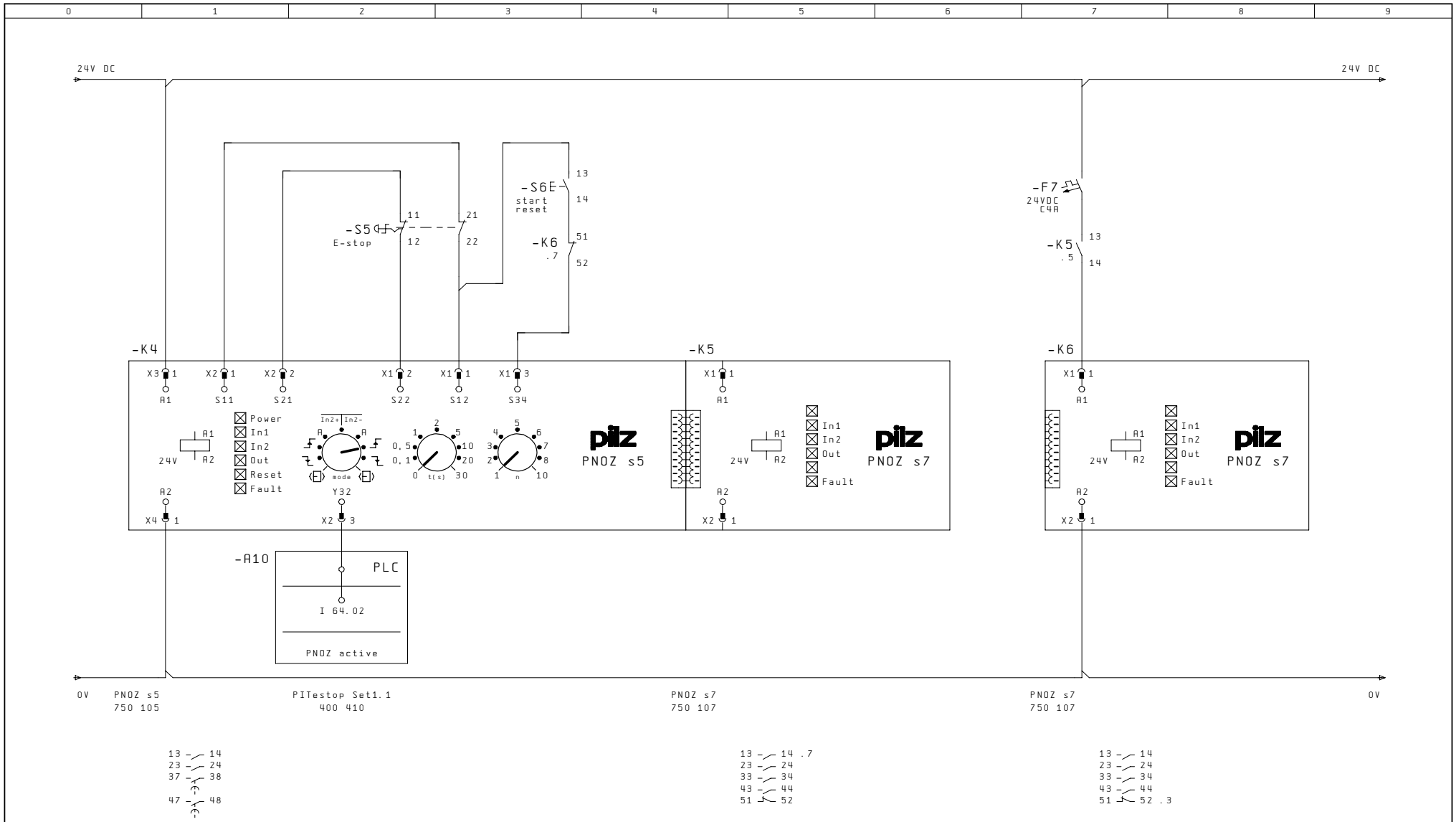
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s5 + PNOZ s7), actuator (PNOZ s7)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s5 + PNOZ s7), actuator (PNOZ s7)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	15.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by two PNOZ s7 and monitored start
Name	WED	Name	WED			
				Category 4 EN 954-1		
		Dep.	CS			

Directory: ..PNOZ\05PIL013
PNOZs5
Page: 4

Category 2, EN 954-1
PNOZ s7 - Combined with PNOZ s2

Features

- Single-channel operation
- Monitored reset with rising edge
- Contact expansion through PNOZ s7 (contact expander module) and positive-guided contactor
- Feedback loop to monitor contact expansion
- Up to Category 2 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, the supply voltage on the safety relay PNOZ s2 (K1) is interrupted, the safety contacts on K1 open. As a result the input circuit on the contact expander module PNOZ s7 (K2) is interrupted, the safety contacts on K2 open. Contactor K3 de-energises.

Settings on the unit
- The connector between the safety relays PNOZ s2 (K1) and PNOZ s7 (K2) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s2 (K1) must be set to “Monitored reset, rising edge”.

Start/reset
The safety relay PNOZ s2 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- Contactor K3 has de-energised and
- The feedback loop on the contact expander module PNOZ s7 (K2) is closed.

Feedback loop
The positive-guided N/C contact on contactor K3 is monitored in feedback loop A1-S34 of safety relay PNOZ s2 (K1).
The feedback loop on the safety relay PNOZ s2 (K1) is connected to the feedback loop on the contact expander module PNOZ s7 (K2).

Safety assessment
- Earth fault in the input circuit is detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relays PNOZ s2 (K1) and PNOZ s7 (K2) can be started when the input circuit (supply voltage) at K1 is closed first, followed by the reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The safety relays PNOZ s2 (K1) and PNOZ s7 (K2) are tested in each on/off cycle. The E-STOP pushbutton S1 must be operated at appropriate intervals to perform a function test. This must be recorded in the machine’s operating manual (organisational measure). An E-STOP is not a primary safety measure, just a precautionary measure for emergencies (EN ISO 12100-2). A start-up test is therefore not required.
  As the safety relays PNOZ s2 and PNOZ s7 cannot be tested automatically, a second shutdown route is required (e.g. via a main switch or a master contactor).
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K1 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s2 (K1) off and then on again.

Pilz products

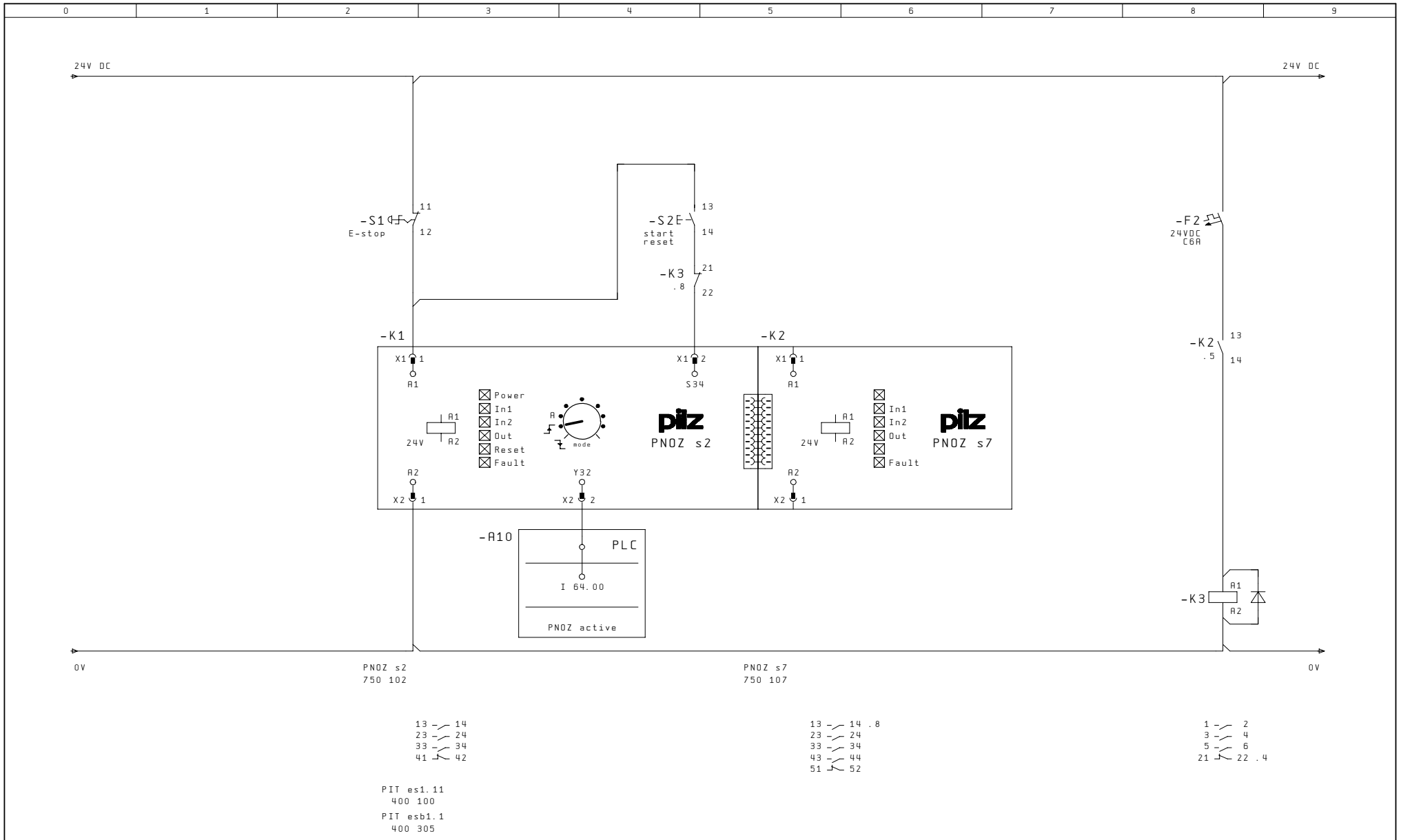
Number	Designation	Order number
1	PNOZ s2	750 102
1	PNOZ s7	750 107
1	PIT es1.11	400 100
1	PIT esb1.1	400 305

Category 2, EN 954-1
PNOZ s7 - Combined with PNOZ s2

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s2 + PNOZ s7), actuator (contactor K3)
- Performance level: **PL c**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactor K3 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN ISO 13849-1 have also to be met (e.g. requirements for avoiding systematic faults, among others).



Revision	20.03.06	Date	07.12.05	Emergency stop application	pilz Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by PNOZ s7 and contactor, monitored start	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs7
				Category 2 EN 954-1			Page: 1
		Dep.	CS				

Category 4, EN 954-1
PNOZ s7 - Combined with PNOZ s4

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Contact expansion through PNOZ s7 (contact expander module) and positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S3 is operated, the input circuit on the safety relay PNOZ s4 (K4) is interrupted, the safety contacts on K4 open. As a result the input circuit on the contact expander module PNOZ s7 (K5) is interrupted, the safety contacts on K5 open. Contactors KM1 and KM2 de-energise.

Settings on the unit
- The connector between the safety relays PNOZ s4 (K4) and PNOZ s7 (K5) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 must be set to “Monitored reset, rising edge with detection of shorts across contacts (In2-)”.

Start/reset
The safety relay PNOZ s4 (K4) can be started by pressing reset button S4 if:
- E-STOP pushbutton S3 has not been operated and
- The safety contacts on the contact expander module PNOZ s7 (K5) are open
- Contactors KM1 and KM2 have de-energised
  and
- The feedback loop on the contact expander module PNOZ s7 (K5) is closed.

Feedback loop
The positive-guided N/C contacts on contactors KM1 and KM2 are monitored in feedback loop S12-S34 of safety relay PNOZ s4 (K4).
The feedback loop on the safety relay PNOZ s4 (K4) is connected to the feedback loop on the contact expander module PNOZ s7 (K5).

Safety assessment
- The safety relays K4 and K5 and contactors KM1 and KM2 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relays PNOZ s4 (K4) and PNOZ s7 (K5) can be started when the input circuit at K4 is closed first, followed by reset button S4. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K4 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s4 (K4) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
1	PNOZ s7	750 107
1	PITestop Set1.1	400 410

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Category 4, EN 954-1

PNOZ s7 - Combined with PNOZ s4

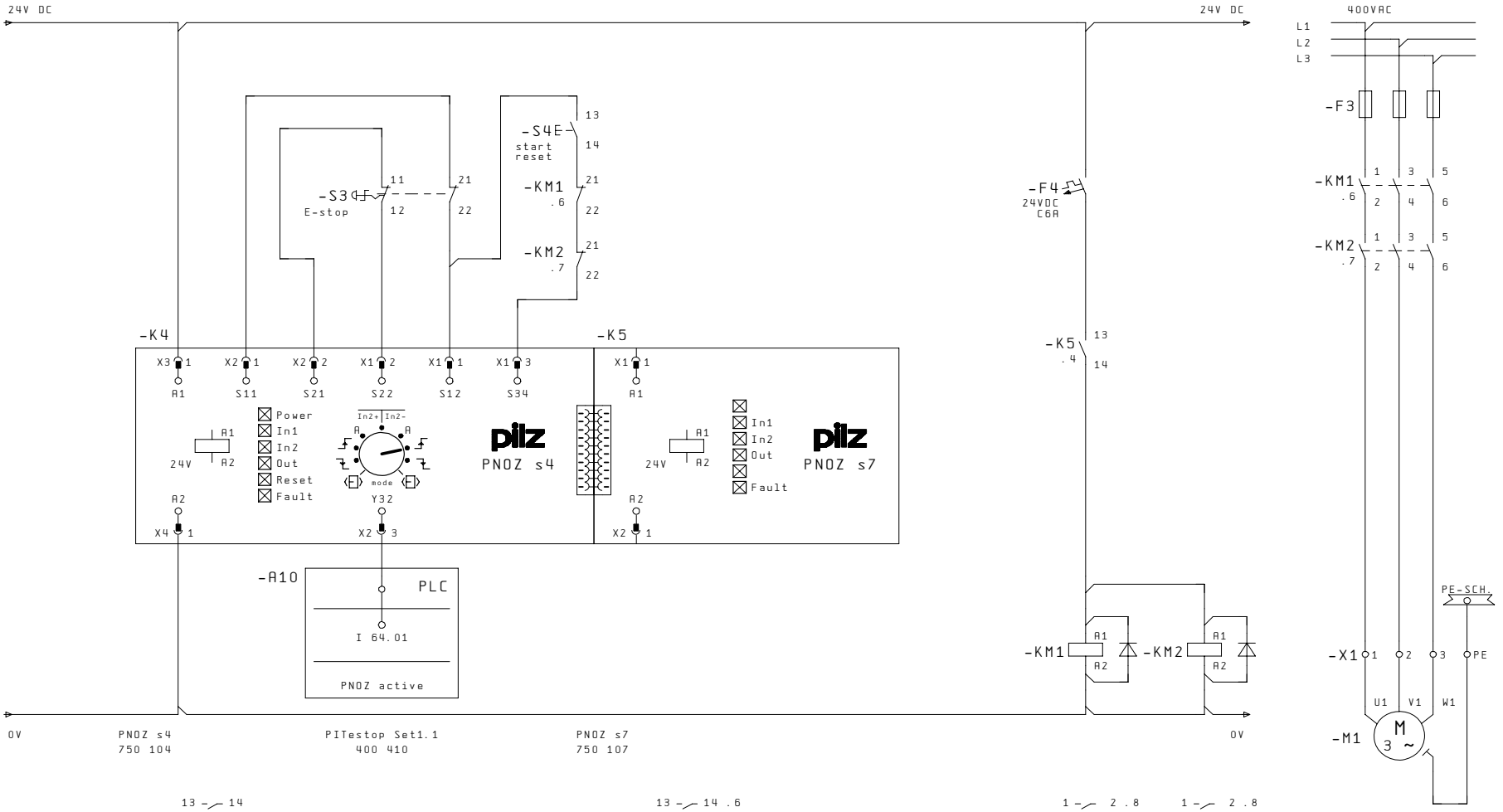
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s4 + PNOZ s7), actuator (contactors KM1 and KM2)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s4 + PNOZ s7), actuator (contactors KM1 and KM2)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by PNOZ s7 and contactor, monitored start
Name	WED	Name	WED			
				Category 4 EN 954-1		
		Dep.	CS			

Directory: ..PNOZ\05PIL013
PNOZs7
Page: 2

Category 2, EN 954-1
PNOZ s8 - Combined with PNOZ s1

Features

- Single-channel operation
- Monitored reset
- Contact expansion through PNOZ s8 (contact expander module) and positive-guided contactor
- Feedback loop to monitor contact expansion
- Up to Category 2 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, the supply voltage on the safety relay PNOZ s1 (K1) is interrupted, the safety contacts on K1 open. As a result the input circuit on the contact expander module PNOZ s8 (K2) is interrupted, the safety contacts on K2 open. Contactor K3 de-energises.

Settings on the unit
- The connector between the safety relays PNOZ s1 (K1) and PNOZ s8 (K2) must be connected.

Start/reset
The safety relay PNOZ s1 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- Contactor K3 has de-energised and
- The feedback loop on the contact expander module PNOZ s8 (K2) is closed.

Feedback loop
The positive-guided N/C contact on contactor K3 is monitored in feedback loop A1-S34 of safety relay PNOZ s1 (K1).
The feedback loop on the safety relay PNOZ s1 (K1) is connected to the feedback loop on the contact expander module PNOZ s8 (K2).

Safety assessment
- Earth fault in the input circuit is detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relays PNOZ s1 (K1) and PNOZ s8 (K2) can be started when the input circuit (supply voltage) at K1 is closed first, followed by the reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The safety relays PNOZ s1 (K1) and PNOZ s8 (K2) are tested in each on/off cycle. The E-STOP pushbutton S1 must be operated at appropriate intervals to perform a function test. This must be recorded in the machine's operating manual (organisational measure). An E-STOP is not a primary safety measure, just a precautionary measure for emergencies (EN ISO 12100-2). A start-up test is therefore not required.
As the safety relays PNOZ s1 and PNOZ s8 cannot be tested automatically, a second shutdown route is required (e.g. via a main switch or a master contactor).

Pilz products

Number	Designation	Order number
1	PNOZ s1	750 101
1	PNOZ s8	750 108
1	PIT es1.11	400 100
1	PIT esb1.1	400 305

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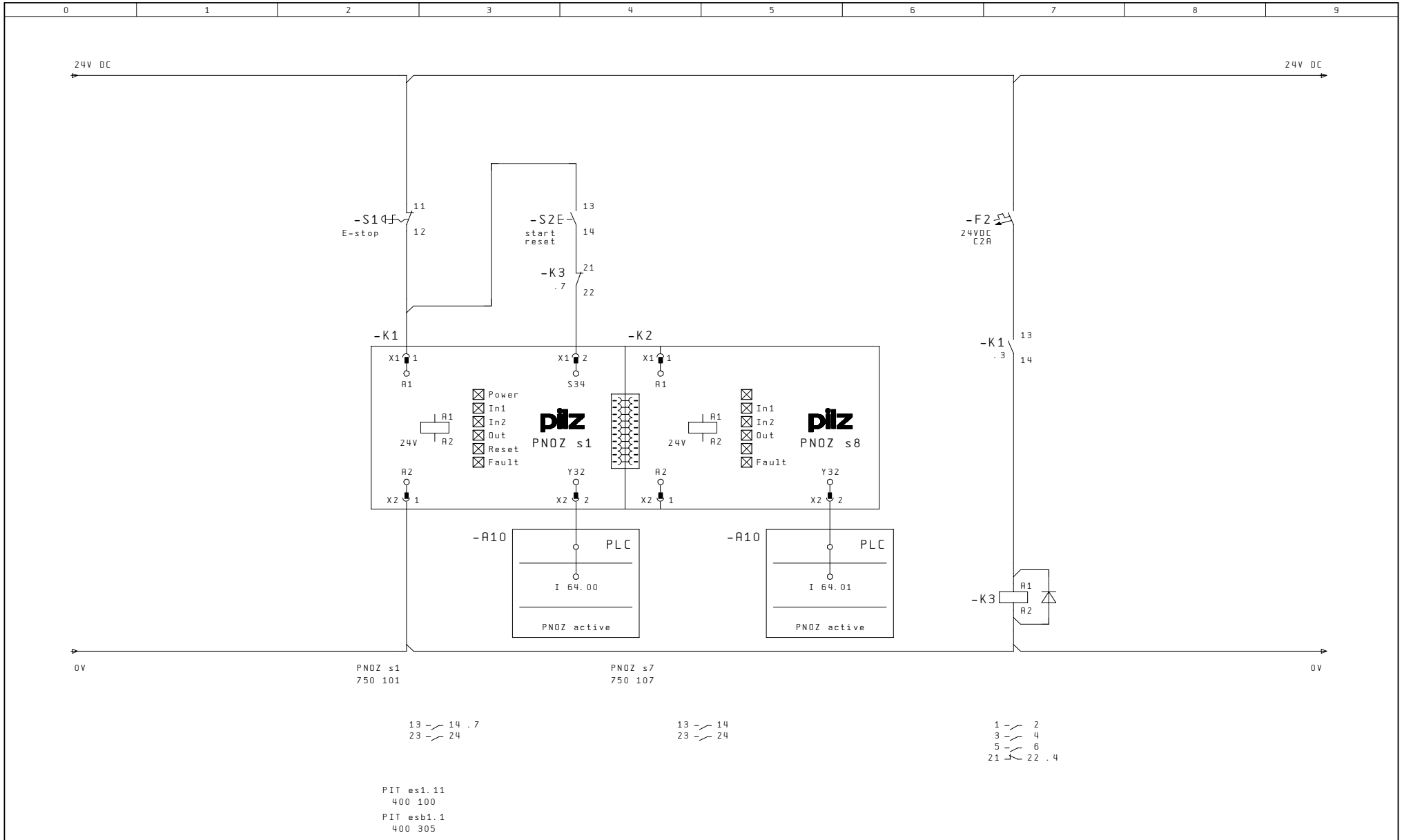
Category 2, EN 954-1

PNOZ s8 - Combined with PNOZ s1

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s1 + PNOZ s8), actuator (contactor K3)
- Performance level: **PL c**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactor K3 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	20.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by contactor and manual start
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 2 EN 954-1		PNOZs8
		Dep.	CS			Page: 1

Category 4, EN 954-1

PNOZ s9 - Combined with PNOZ s4 - safe standstill of one drive

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Safe standstill of one drive after E-STOP
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1
- Stop category 1 in accordance with EN 60204-1

Description

E-STOP function
When the E-STOP pushbutton S9 is operated, both the drive and the supply to the drive are shut down after a delay time. When the E-STOP pushbutton S9 is operated, the input circuit on the safety relay PNOZ s4 (K11) is interrupted, safety contact 14 on K11 opens immediately and triggers a “fast stop” at the drive controller A1.
As a result the input circuit on safety relay PNOZ s9 (K12) is interrupted and the delay-on de-energisation safety contacts on K12 switch off contactors KM1 and KM2 after a delay. In this way, the drive controller A1 is isolated from the energy supply (mains) after a delay. The delay-on de-energisation time is set on the safety relay PNOZ s9 (K12).

Settings on the unit
- The connector between the safety relays PNOZ s4 (K11) and PNOZ s9 (K12) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 (K11) must be set to “Monitored reset, rising edge” with detection of shorts across contacts (In2-).
- The operating mode selector switch (mode) on the safety relay PNOZ s9 (K12) must be set to “Delay-on energisation”.
- The delay time on the safety relay PNOZ s9 (K12) is set using the time selector switch t[s] and the factor selector switch n.

Start/reset
The safety relay PNOZ s4 (K11) can be started by pressing reset button S10 if:
- E-STOP pushbutton S9 has not been operated and
- Contactors KM1 and KM2 have de-energised
  and
- The feedback loop on safety relay PNOZ s9 (K12) is closed.

Feedback loop
The positive-guided N/C contacts on contactors KM1 and KM2 are monitored in feedback loop S12-S34 of safety relay K11. The feedback loop on the safety relay PNOZ s4 (K11) is connected to the feedback loop on the contact expander module PNOZ s9 (K12).

Safety assessment
- The safety relays PNOZ s4 (K11) and PNOZ s9 (K12) and contactors KM1 and KM2 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relays PNOZ s4 (K11) and PNOZ s9 (K12) can be started when the input circuit at K11 is closed first, followed by reset button S10. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- The delay time set for the safety relay PNOZ s9 (K12) must be longer than the maximum braking time on the drive regulator A1.
- The time delay must not be able to cause an additional hazard.
- If the position of the operating mode selector switch (mode) or the rotary switch for the time setting is changed during operation, an error message will be triggered; the safety contacts on K11 / K12 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s4 (K11) / PNOZ s9 (K12) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
1	PNOZ s9	750 109
1	PITestop Set1.1	400 410

Category 4, EN 954-1

PNOZ s9 - Combined with PNOZ s4 - safe standstill of one drive

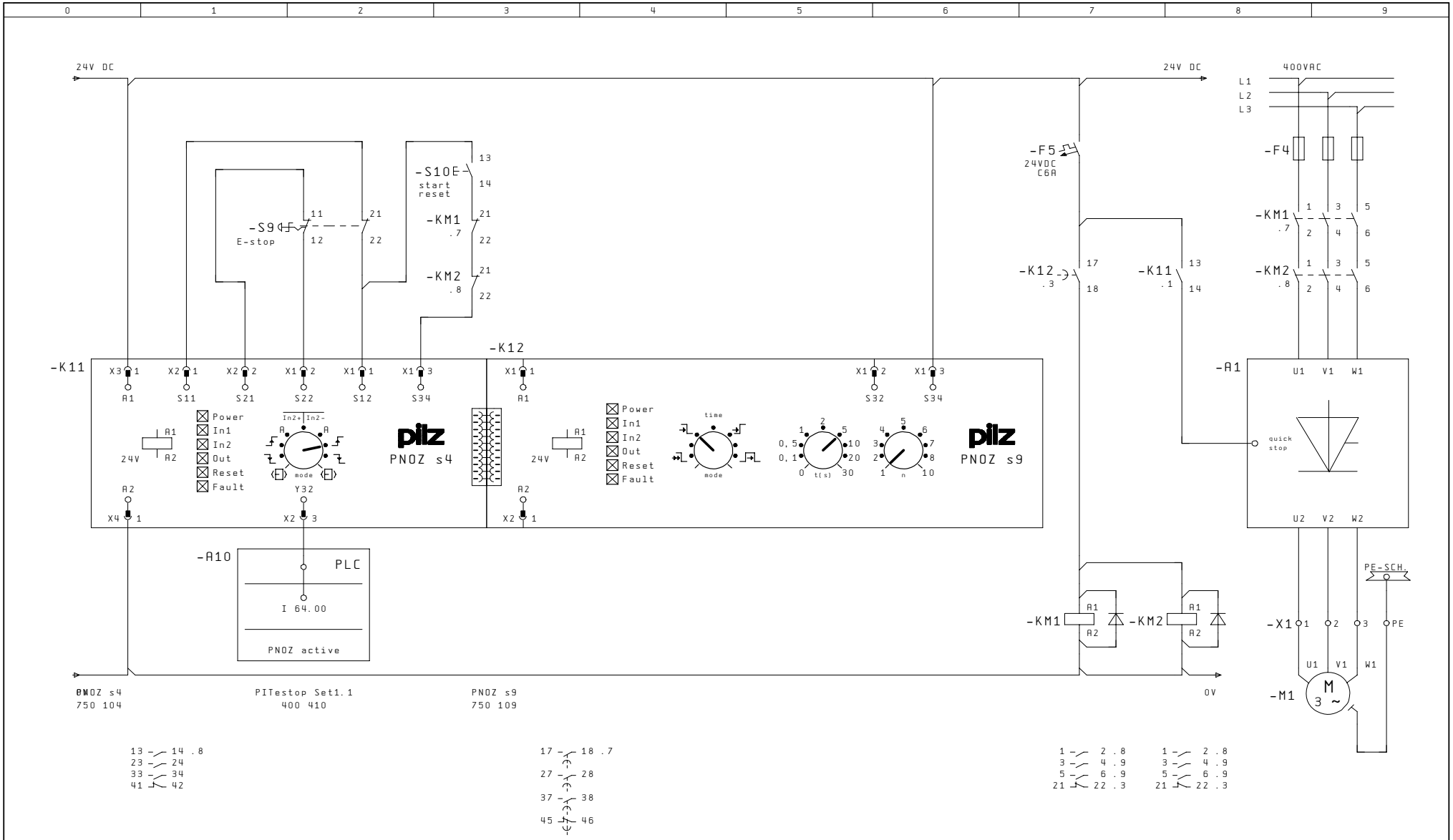
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s4 and PNOZ s9), actuator (contactors KM1 and KM2)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s4 and PNOZ s9), actuator (contactors KM1 and KM2)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device and actuator
  - Contactors KM1/KM2 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	23.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safe stopping of a drive by emenrgency stop
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 4 EN 954-1		PNOZs9
		Dep.	CS			Page: 4

Category 4, EN 954-1
PNOZ s10 - Combined with PNOZ s4

Features

- Dual-channel operation with detection of shorts across contacts
- Monitored reset with rising edge
- Contact expansion through PNOZ s10 (contact expander module)
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

E-STOP function
When the E-STOP pushbutton S1 is operated, the input circuit on the safety relay PNOZ s4 (K1) is interrupted, the safety contacts on K1 open. As a result the input circuit on the contact expander module PNOZ s10 (K2) is interrupted, the safety contacts on K2 open.

Settings on the unit
- The connector between the safety relays PNOZ s4 (K1) and PNOZ s10 (K2) must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 must be set to “Monitored reset, rising edge” with detection of shorts across contacts (In2-).

Start/reset
The safety relay PNOZ s4 (K1) can be started by pressing reset button S2 if:
- E-STOP pushbutton S1 has not been operated and
- The feedback loop on the contact expander module PNOZ s10 (K2) is closed.

Feedback loop
The feedback loop on the safety relay PNOZ s4 (K1) is connected to the feedback loop on the contact expander module PNOZ s10 (K2).

Safety assessment
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relays PNOZ s4 (K1) and PNOZ s10 (K2) can be started when the input circuit at K1 is closed first, followed by the reset button S2. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K1 open. This fault condition can only be rectified by switching the supply voltage on the safety relay PNOZ s4 (K1) off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
1	PNOZ s10	750 110
1	PITestop Set1.1	400 410

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Category 4, EN 954-1

PNOZ s10 - Combined with PNOZ s4

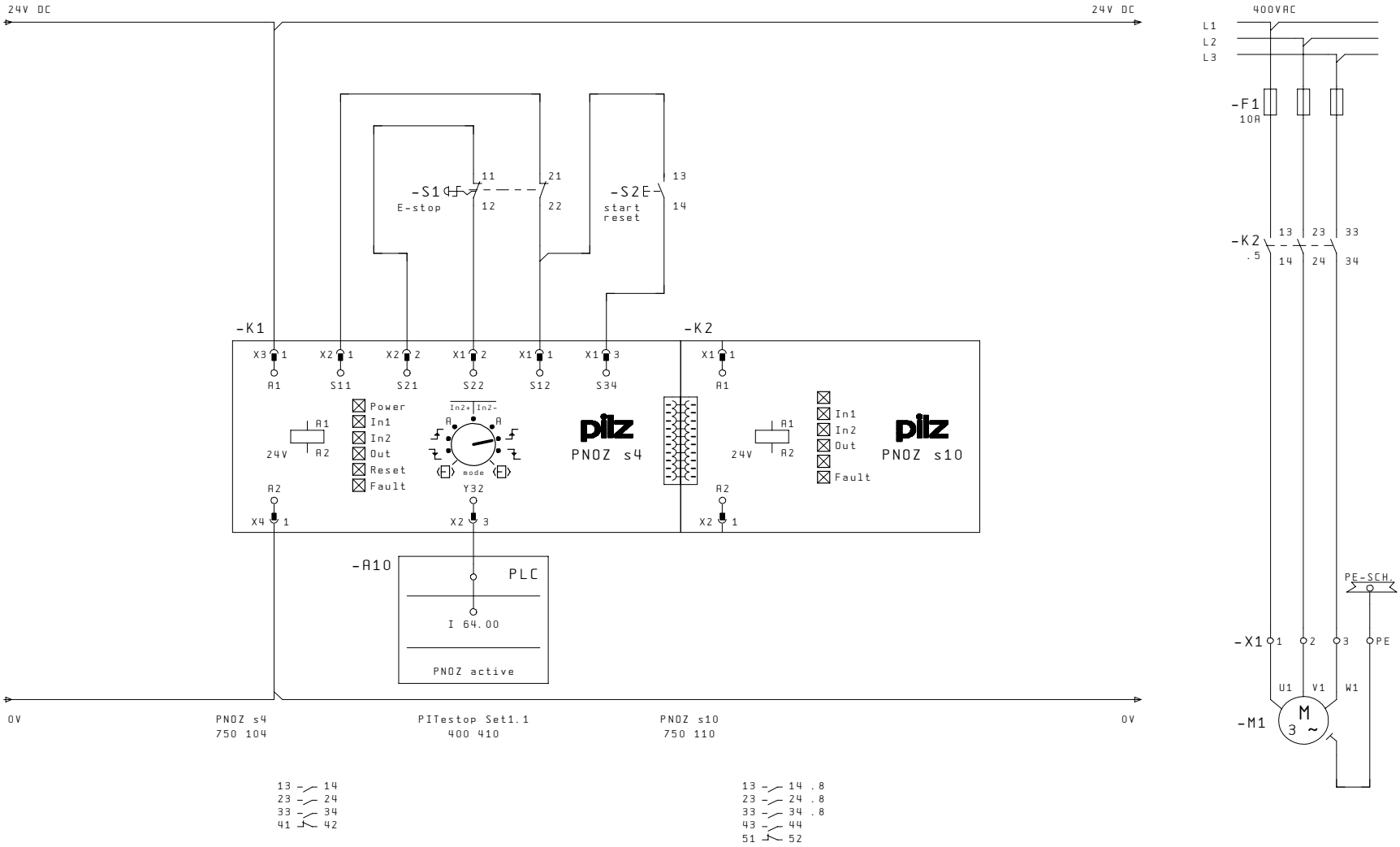
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine via E-STOP
- Subsystems: Input device (E-STOP button), logic (PNOZ s4), actuator (PNOZ s10)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s4), actuator (PNOZ s10)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): One operation per week for input device

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Emergency stop application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Emergency stop, extension contact by PNOZ s10 and monitored start	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs10
				Category 4 EN 954-1			Page: 1
		Dep.	CS				

more than automation
safe automation

Contents **Page**

* in accordance with EN 954-1

Category 4, EN 954-1
PNOZ s3 – Safety switch PSEN cs2.1p

Features

- Dual-channel operation with detection of shorts across contacts via safety switch
- Monitored reset with rising edge
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

Safety gate function
The opening and closing of a safety gate is signalled to the safety relay PNOZ s3 (K2) via the semiconductor outputs on the safety switch PSEN cs2.1p (S3). The semiconductor outputs on safety switch S3 are opened as soon as the safety gate is opened. As a result the the input circuit on the safety relay PNOZ s3 (K2) is interrupted and the safety contacts on the PNOZ s3 (K2) open. Contactors K3 and K4 de-energise.

Settings on the unit
- The terminator on the PNOZ s3 must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s3 must be set to “Monitored reset, rising edge” without detection of shorts across contacts (In2+).

Start/reset
The safety relay PNOZ s3 (K2) can be started by pressing reset button S4 if:
- The safety gate is closed and
- The semiconductor outputs on the safety switch S3 are closed and
- Contactors K3 and K4 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors K3 and K4 are monitored in the feedback loop S12-S34 of the safety relay K2.

Safety assessment
- Earth faults and shorts between contacts in the input circuit are detected through the safety switch S3.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s3 (K2) can be started when the input circuit at K2 is closed first, followed by reset button S4. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- Increased protection against manipulation is required for hazardous machinery such as presses. In this case we recommend using two safety switches per safety gate.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K2 open. This fault condition can only be rectified by switching the supply voltage on the safety relay K2 off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s3	750 103
1	PSEN cs2.1p	540 100

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Category 4, EN 954-1

PNOZ s3 – Safety switch PSEN cs2.1p

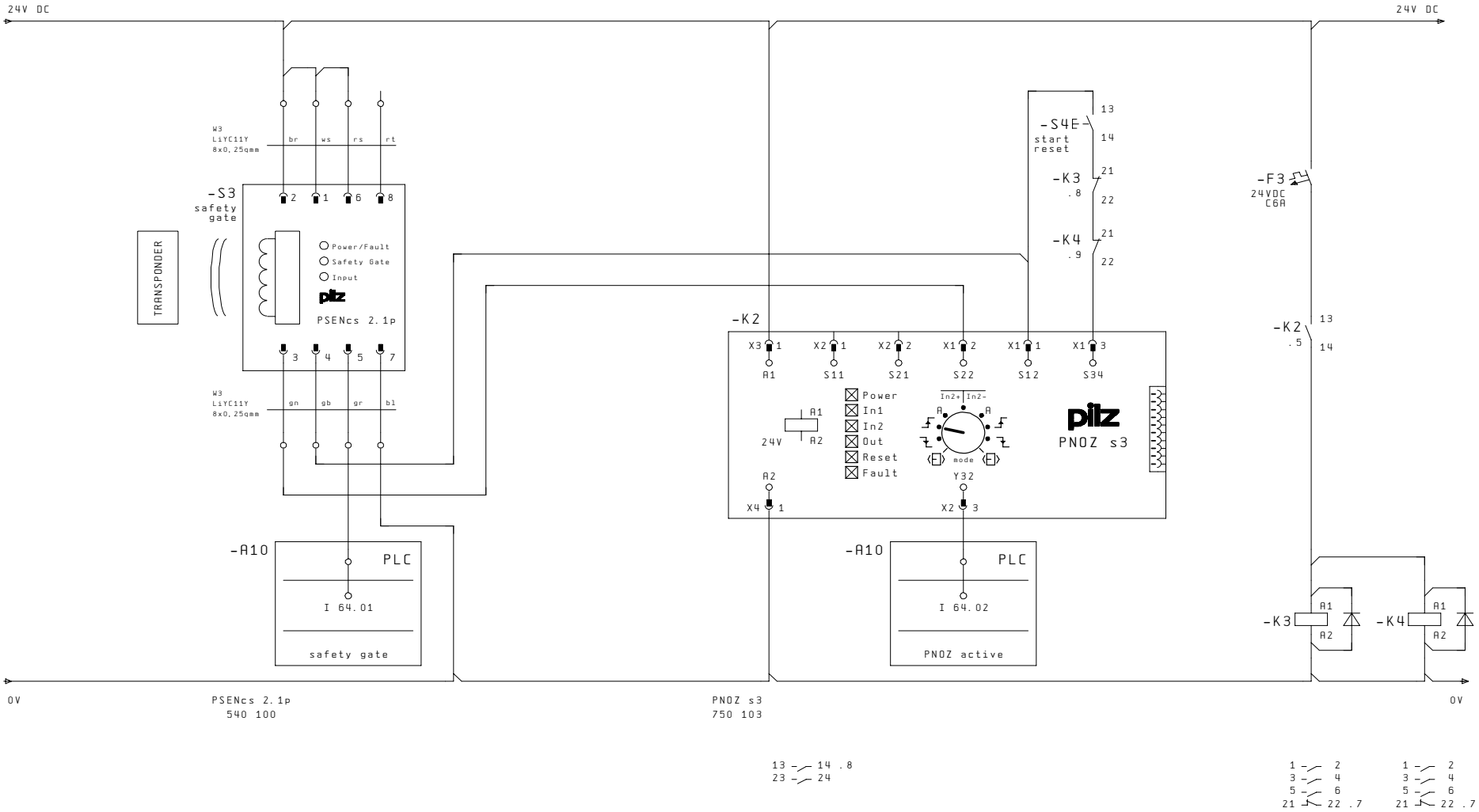
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine when a safety gate is opened
- Subsystems: Input device (E-STOP button), logic (PNOZ s3), actuator (contactors K3 and K4)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactor K3/K4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine via E-STOP
- Safety-related parts of the control system (SRP/CS): Input device (E-STOP button), logic (PNOZ s3), actuator (contactors K3 and K4)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactor K3/K4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Safety gate application	pilz Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safety gate with PSEN cs2.1p and monitored start of PNOZ s3	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs3
				Category 4 EN 954-1			Page: 2
		Dep.	CS				

Category 3, EN 954-1

PNOZ s4 - Connecting four PSEN 1.1p in series

Features
- Dual-channel operation with detection of shorts across contacts
- Series connection of 4 PSEN 1.1p safety switches using the PSEN ix1 interface
- Monitored reset with rising edge
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 3 of EN 954-1

Description

Safety gate function
The opening and closing of several safety gates is signalled to the safety relay PNOZ s4 (K8) via the contacts on the safety switches PSEN 1.1p (S6 ... S9). The PSEN ix1 interface (A2) switches the 4 safety switches in series.
The contacts on one of the safety switches S6 ... S9 are opened as soon as the respective safety gate is opened. The interface PSEN ix1 (A2) interrupts the input circuit on the safety relay PNOZ s4 (K8) and the safety contacts on K8 open. Contactors K14 and K15 de-energise.

Settings on the unit
- The terminator on the PNOZ s4 must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 must be set to “Monitored reset, rising edge” with detection of shorts across contacts (In2-).

Start/reset
The safety relay PNOZ s4 (K8) can be started by pressing reset button S5 if:
- The safety gates are closed and
- The contacts on safety switches S6 ... S9 are closed and
- Contactors K14 and K15 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors K14 and K15 are monitored in feedback loop S12-S34 of safety relay K8.

Safety assessment
- The safety relay PNOZ s4 (K8) and contactors K14 and K15 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s4 (K8) can be started when the input circuit at K8 is closed first, followed by reset button S5. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- Not all faults are detected. An accumulation of undetected faults can lead to the loss of the safety function. With this application, therefore, it is necessary to ensure that only one safety gate is open at a time or that the status of each safety gate is checked. Use of the PSEN ix1 interface reduces the classification in accordance with EN 60947-5-3 from PDF-M to PDF-S.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K8 open. This fault condition can only be rectified by switching the supply voltage on the safety relay K8 off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
4	PSEN 1.1p	504 212
1	PSEN ix1	535 120

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Category 3, EN 954-1

PNOZ s4 - Connecting four PSEN 1.1p in series

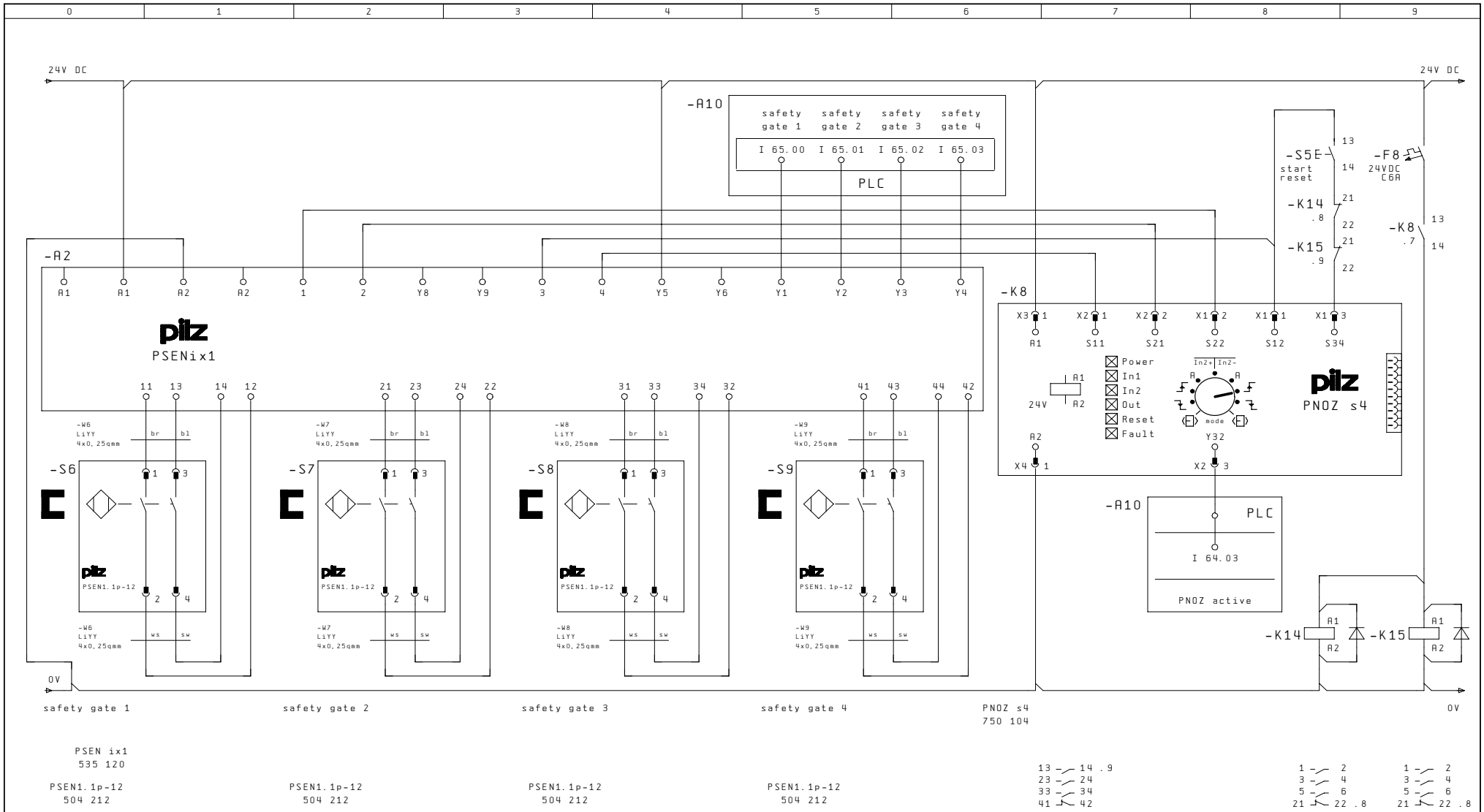
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine when a safety gate is opened
- Subsystems: Input device (PSENmag), logic (PSEN ix1 + PNOZ s4), actuator (contactors K14 and K15)
- Safety integrity level: **SIL 2**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactors K14/K15 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine when a safety gate is opened
- Safety-related parts of the control system (SRP/CS): Input device (PSENmag), logic (PSEN ix1 + PNOZ s4), actuator (contactors K14 and K15)
- Performance level: **PL d**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactors K14/K15 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	14.03.06	Date	07.12.05	Safety gate application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Series connection by 4 safety gates with PSEN 1.1p and PSEN ix1
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 3 EN 954-1		PNOZs4
		Dep.	CS			Page: 4

Category 4, EN 954-1
PNOZ s4 - PSEN me2/2AS

Features
- Dual-channel operation with detection of shorts across contacts
- Safety gate switch with separate actuator
- Automatic reset
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

Safety gate function
The opening and closing of a safety gate is signalled to the safety relay PNOZ s4 (K9) via the contacts on the two safety switches PSEN me2/2AS (S11, S12).
The contacts on safety switches S11, S12 are opened as soon as the safety gate is opened. As a result the input circuit on the safety relay PNOZ s4 (K9) is interrupted and the safety contacts on K9 open. Contactors K10 and K11 de-energise.

Settings on the unit
- The terminator on the PNOZ s4 must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 must be set to “Automatic reset” with detection of shorts across contacts (In2-).

Start/reset
The safety relay PNOZ s4 (K9) starts automatically if
- The safety gate is closed and
- The contacts on safety switches S11 and S12 are closed and
- Contactors K10 and K11 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors K10 and K11 are monitored in feedback loop S12-S34 of safety relay K9.

Safety assessment
- The safety relay PNOZ s4 (K9) and contactors K10 and K11 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K9 open. This fault condition can only be rectified by switching the supply voltage on the safety relay K9 off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
2	PSEN me2/2AS	570 200

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Category 4, EN 954-1
PNOZ s4 - PSEN me2/2AS

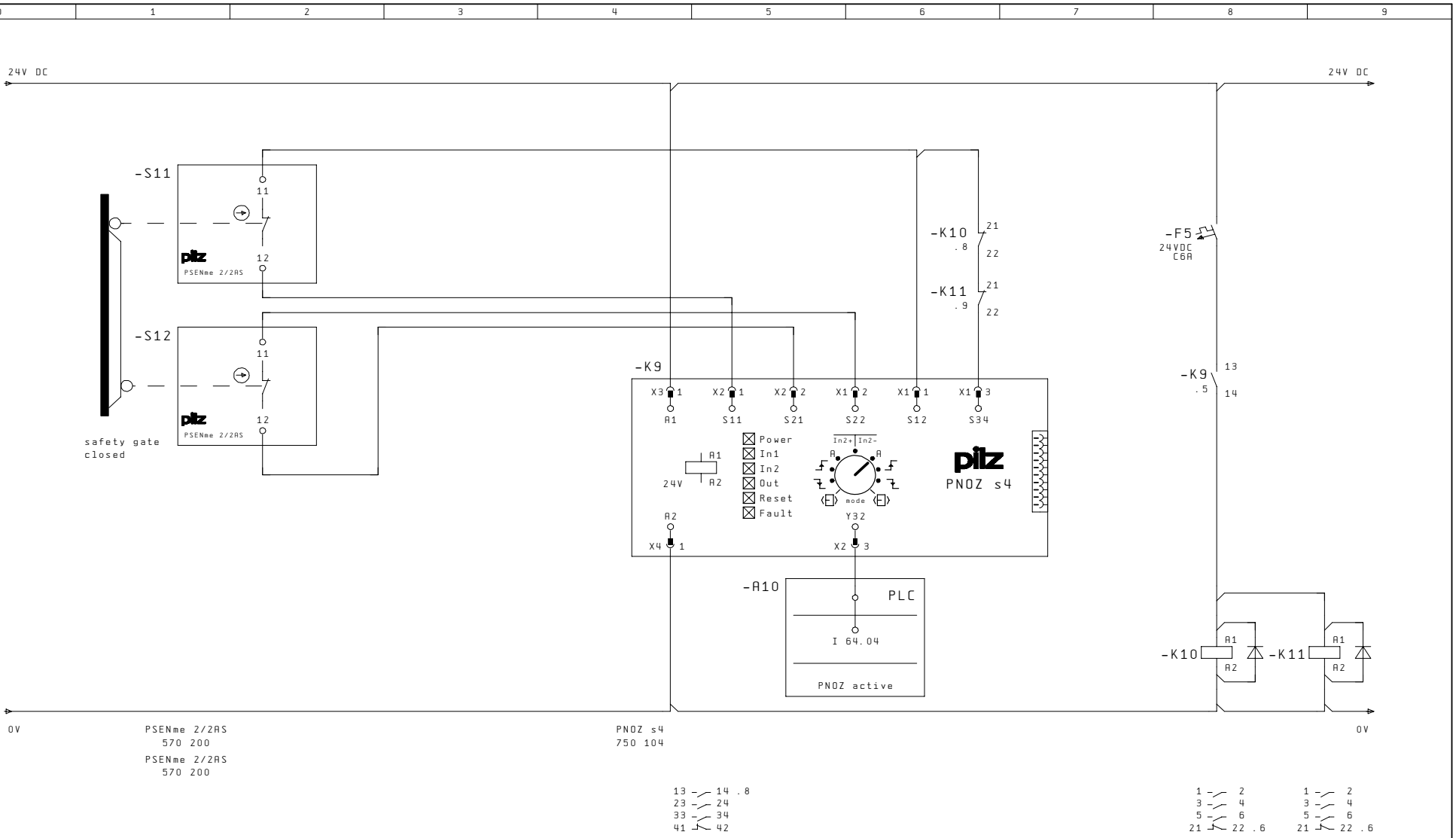
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine when a safety gate is opened
- Subsystems: Input device (PSENmech), logic (PNOZ s4), actuator (contactors K10 and K11)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactors K10/K11 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine when a safety gate is opened
- Safety-related parts of the control system (SRP/CS): Input device (PSENmech), logic (PNOZ s4), actuator (contactors K10 and K11)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactors K14/K15 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	Safety gate application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safety gate with two PSEN me2/2AS and automatic start of PNOZ s4	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs4
				Category 4 EN 954-1			Page: 5
		Dep.	CS				

Notes

Category 4, EN 954-1

PNOZ s4 – PSEN me1S/1AS with guard locking and standstill monitoring

Features
- Dual-channel operation with detection of shorts across contacts
- Safety gate switch with separate actuator and guard locking device
- Second safety gate switch with separate actuator
- Monitored reset with rising edge
- Contact expansion through positive-guided contactors
- Standstill monitoring via PSWZ X1P
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

Safety gate function
The opening and closing of a safety gate is signalled to the safety relay PNOZ s4 (K12) via the contacts on the safety switches PSENme 1S/1AS (S13) and PSENme 2/2AS (S14). Guard locking on safety switch S13 can be released via pushbutton S15. Guard locking will not be released until standstill monitor PSWZ X1P (K13) has detected that motor M1 is at standstill and the contacts at K13 are closed.
The contacts on safety switches S13 and S14 are opened as soon as the safety gate is opened. As a result the input circuit on the safety relay PNOZ s4 (K12) is interrupted and the safety contacts open. Contactors KM3 and KM4 de-energise.
When the simultaneity requirement of the two input channels on the standstill monitor PSWZ X1P (K13) is exceeded, the unit switches to a fault condition. K13 is reactivated by pressing reset button S17.

Settings on the unit
- The terminator on the PNOZ s4 must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 must be set to “Monitored reset, rising edge” with detection of shorts across contacts (In2-).

Start/reset
The safety relay PNOZ s4 (K12) can be started by pressing reset button S16 if:
- The safety gate is closed and
- The contacts on safety switches S13 and S14 are closed and
- Contactors KM3 and KM4 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors KM3 and KM4 are monitored in feedback loop S12-S34 of safety relay K12.

Safety assessment
- The safety relay PNOZ s4 (K12) and contactors KM3 and KM4 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ s4 (K12) can be started when the input circuit at K12 is closed first, followed by reset button S16. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K12 open. This fault condition can only be rectified by switching the supply voltage on the safety relay K12 off and then on again.
- A break in the actuator on the safety switch PSEN me1S/1AS (S13) must be excluded.
- Fault avoidance measures must be taken to compensate for the lack of redundancy on the locking magnet on safety switch S13; these could include oversizing, protected cable layout, for example.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
1	PSWZ X1P	777 949
1	PSEN me1S/1AS	570 000
1	PSEN me2/2AS	570 200

Category 4, EN 954-1

PNOZ s4 – PSEN me1S/1AS with guard locking and standstill monitoring

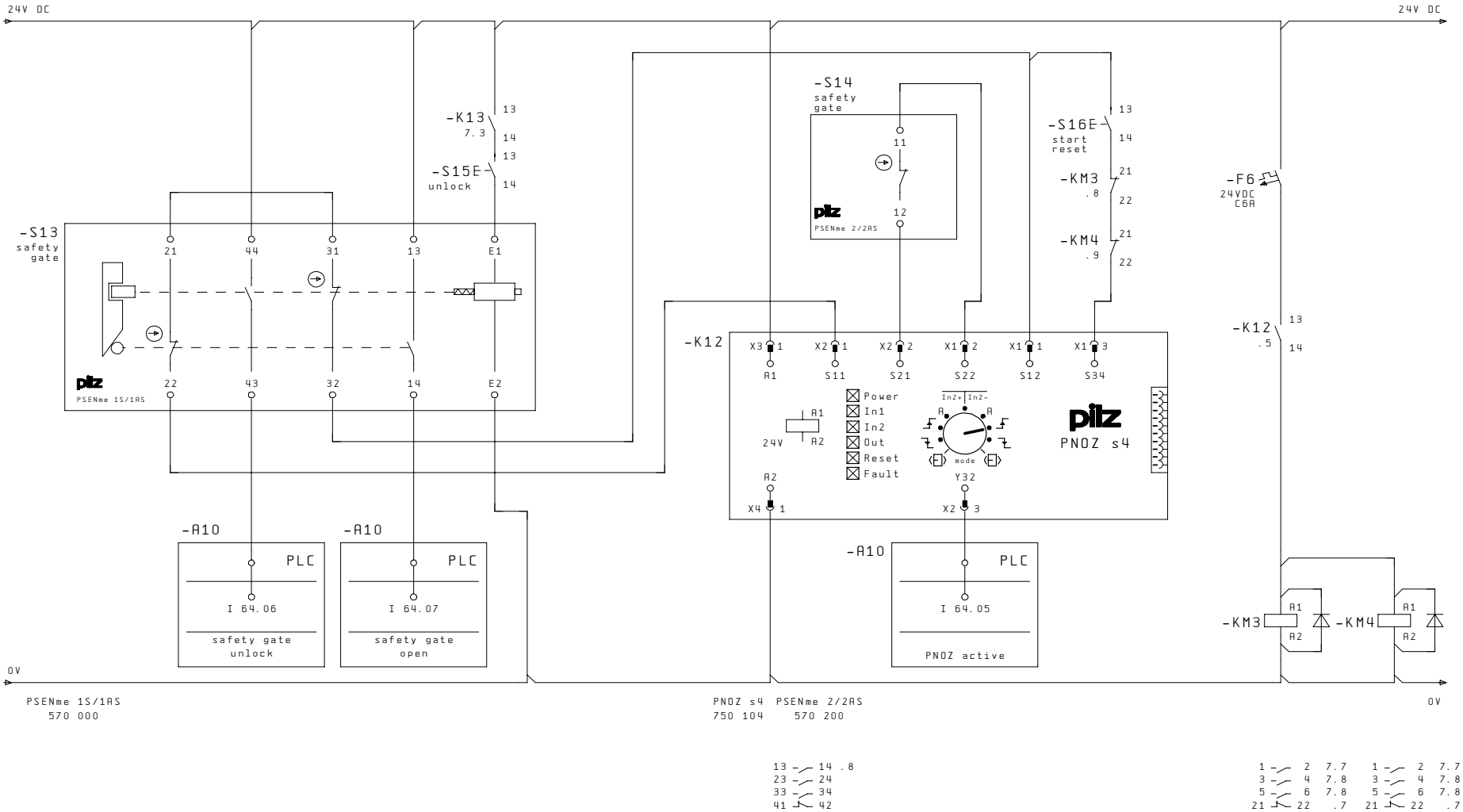
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine when a safety gate is opened
- Subsystems: Input device (PSENmech), logic (PNOZ s4), actuator (contactors KM3 and KM4)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactor KM3/KM4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine when a safety gate is opened
- Safety-related parts of the control system (SRP/CS): Input device (PSENmech), logic (PNOZ s4), actuator (contactors KM3 and KM4)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactor KM3/KM4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



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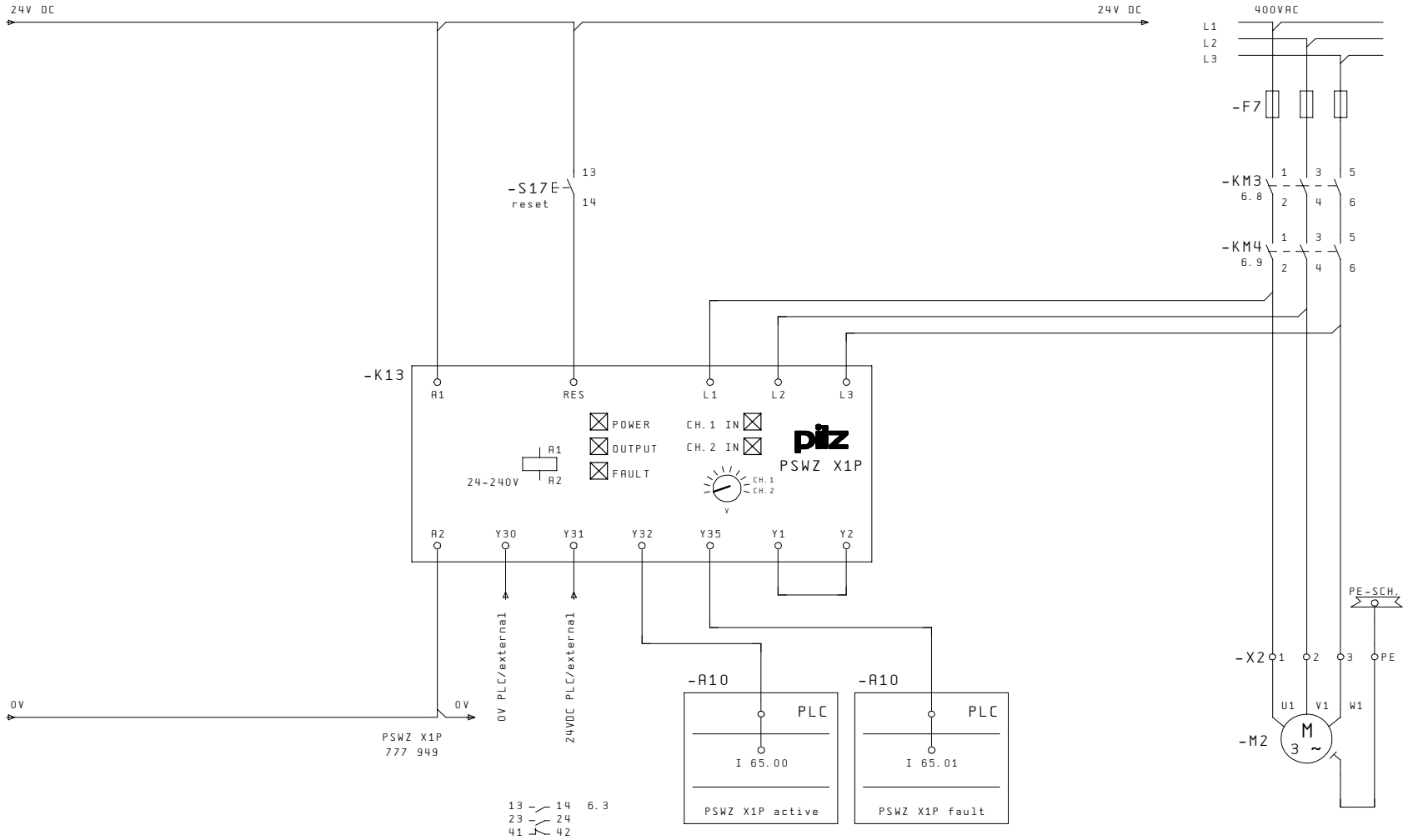
Revision	08.03.06	Date	07.12.05	Safety gate application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safety gate with PSEN me1S/1AS+PSEN me2/2AS standstill monitoring and monitored start of PNOZ s4	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs4
				Category 4 EN 954-1			Page: 6
		Dep.	CS				



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Revision	08.03.06	Date	07.12.05	Safety gate application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safety gate with PSEN me1S/1AS standstill monitoring and monitored start of PNOZ s4	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs4
				Category 4 EN 954-1			Page: 7
		Dep.	CS				

Category 4, EN 954-1

PNOZ s9 – PSEN me1S/1AS with guard locking and PSEN me2/2AS

Features
- Dual-channel operation with detection of shorts across contacts
- Safety gate switch with separate actuator and guard locking device
- Second safety gate switch with separate actuator
- Monitored reset
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

Safety gate function
The opening and closing of a safety gate is signalled to the safety relay PNOZ X3P (K1) via the contacts on the safety switches PSEN me2/2AS (S1) and PSEN me1S/1AS (S10). Guard locking on safety switch S10 can be released via pushbutton S2. Guard locking will not be released until the safety contacts on the contact expander module PNOZ s9 (K2) are closed (delay-on energisation).
The contacts on the safety switch S10 are opened as soon as the guard locking is released via pushbutton S2. The contacts on the two safety switches S1 and S10 are opened as soon as the safety gate is opened. As a result the input circuit on the safety relay PNOZ X3P (K1) is interrupted and the safety contacts on K1 open. Contactors K3 and K4 de-energise.
The input circuit S32 on safety relay PNOZ s9 (K2) is closed as soon as "Stop button" S21 is operated, contactor K20 has de-energised and the N/C contact (21-22) on K20 is closed again. Once the set delay time has elapsed, safety contact (17-18) on the contact expander module PNOZ s9 (K2) will close. Guard locking on safety switch S10 can then be released via pushbutton S2.

Settings on the unit
- The terminator on the PNOZ s9 must be connected.
- The operating mode selector switch (mode) on the contact expander module PNOZ s9 must be set to "Delay-on energisation".
- The delay time on the safety relay PNOZ s9 is set using the time selector switch t[s] and the factor selector switch n.

Start/reset
The safety relay PNOZ X3P (K1) can be started by pressing reset button S3 if:
- The safety gate is closed and
- The contacts on safety switches S1 and S10 are closed and
- Contactors K3 and K4 have de-energised.

The contact expander module PNOZ s9 (K2) starts automatically if
- Contactor K20 has de-energised.

Feedback loop
The positive-guided N/C contacts on contactors K3 and K4 are monitored in the safety relay's feedback circuit S33-S34.

Safety assessment
- The safety relay PNOZ X3P (K1) and contactors K3 and K4 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The safety relay PNOZ X3P can be started when the input circuit at K1 is closed first, followed by the reset button S3. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) or the rotary switch for the time setting is changed during operation, an error message will be triggered; the safety contacts on K2 open. This fault condition can only be rectified by switching the supply voltage on the safety relay K2 off and then on again.
- A break in the actuator on the safety switch PSEN me1S/1AS (S10) must be excluded.
- Fault avoidance measures must be taken to compensate for the lack of redundancy on the locking magnet on safety switch S10; these could include oversizing, protected cable layout, for example.

Pilz products

Number	Designation	Order number
1	PNOZ s9	750 109
1	PSEN me1S/1AS	570 000
1	PSEN me2/2AS	570 200
1	PNOZ X3P	777 310

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Category 4, EN 954-1

PNOZ s9 – PSEN me1S/1AS with guard locking and PSEN me2/2AS

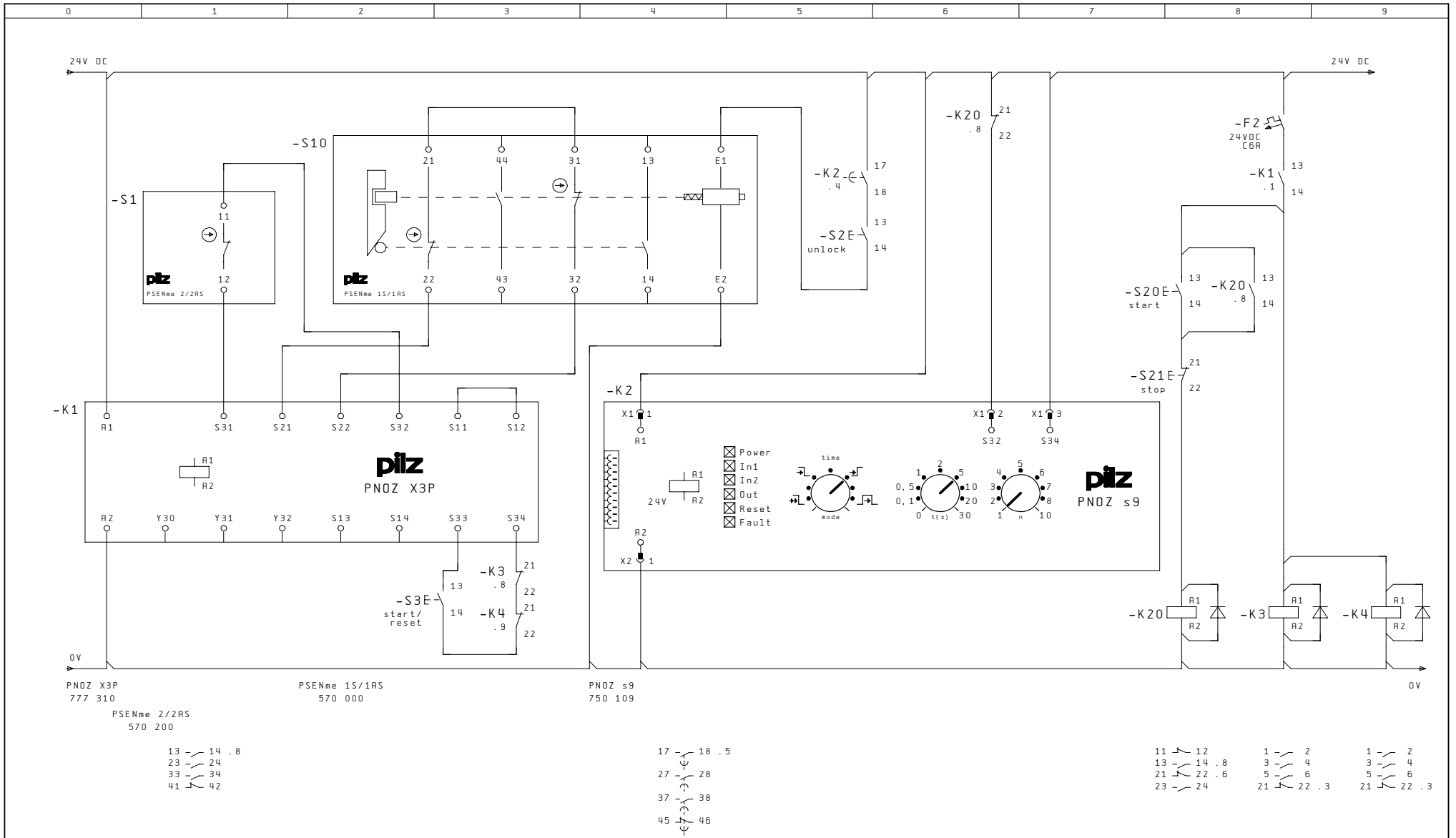
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down machine when a safety gate is opened
- Subsystems: Input device (PSENmech), logic (PNOZ X3P), actuator (contactors K3 and K4)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactor K3/K4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down machine when a safety gate is opened
- Safety-related parts of the control system (SRP/CS): Input device (PSENmech), logic (PNOZ X3P), actuator (contactors K3 and K4)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for input device and actuator
  - Contactor K3/K4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	21.03.06	Date	07.12.05	Safety gate application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Safety gate with PSENme 1S/1AS unlocking time-delayed
Name	WED	Name	WED			
				Category 4 EN 954-1		
		Dep.	CS			

Directory: ..PNOZ\05PIL013
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ESPE applications				
PNOZ s4	–	PSEN op4H light curtain	Category 4*	1.3-2

* in accordance with EN 954-1

Category 4, EN 954-1
PNOZ s4 - PSEN op4H light curtain

Features

- Dual-channel operation with detection of shorts across contacts via light curtain
- Monitored reset with rising edge
- Light curtain with semiconductor output
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Up to Category 4 of EN 954-1

Description

Light curtain function
The interruption of light curtain PSEN op4H (B1/B2) is signalled to the safety relay PNOZ s4 (K2) via the two semiconductor outputs on receiver B2.
The semiconductor outputs on the safety light curtain's receiver B2 are opened as soon as the light curtain is interrupted. As a result the input circuit on the safety relay PNOZ s4 (K2) is interrupted and the safety contacts open. Contactors K3 and K4 de-energise.
The top and bottom DIP switches on the receiver B2 must be set at the same position. For the light curtain to reset automatically, number 4 on both DIP switches must be switched to ON.

Settings on the unit
- The terminator on the PNOZ s4 must be connected.
- The operating mode selector switch (mode) on the safety relay PNOZ s4 must be set to "Monitored reset, rising edge" without detection of shorts across contacts (In2+).

Start/reset
The safety relay PNOZ s4 (K2) can be started by pressing reset button S3 if:
- The light curtain is not interrupted and
- The semiconductor outputs on safety light curtain B1/B2 are closed and
- Contactors K3 and K4 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors K3 and K4 are monitored in feedback loop S12-S34 of the safety relay.

Safety assessment
- The safety relay PNOZ s4 (K2) and contactors K3, K4 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected via the light curtain.
- A fault on the device does not lead to the loss of the safety function.
- A single fault in the light curtain is detected.
- The safety relay PNOZ s4 (K2) can be started when the input circuit at K2 is closed first, followed by reset button S3. This avoids an unwanted reset before the input circuit is closed or as a result of the reset button being overridden.
- If the position of the operating mode selector switch (mode) is changed during operation, an error message will be triggered; the safety contacts on K2 open. This fault condition can only be rectified by switching the supply voltage on the safety relay K2 off and then on again.

Pilz products

Number	Designation	Order number
1	PNOZ s4	750 104
1	PSEN op4H-30-150	630 159

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Category 4, EN 954-1
PNOZ s4 - PSEN op4H light curtain

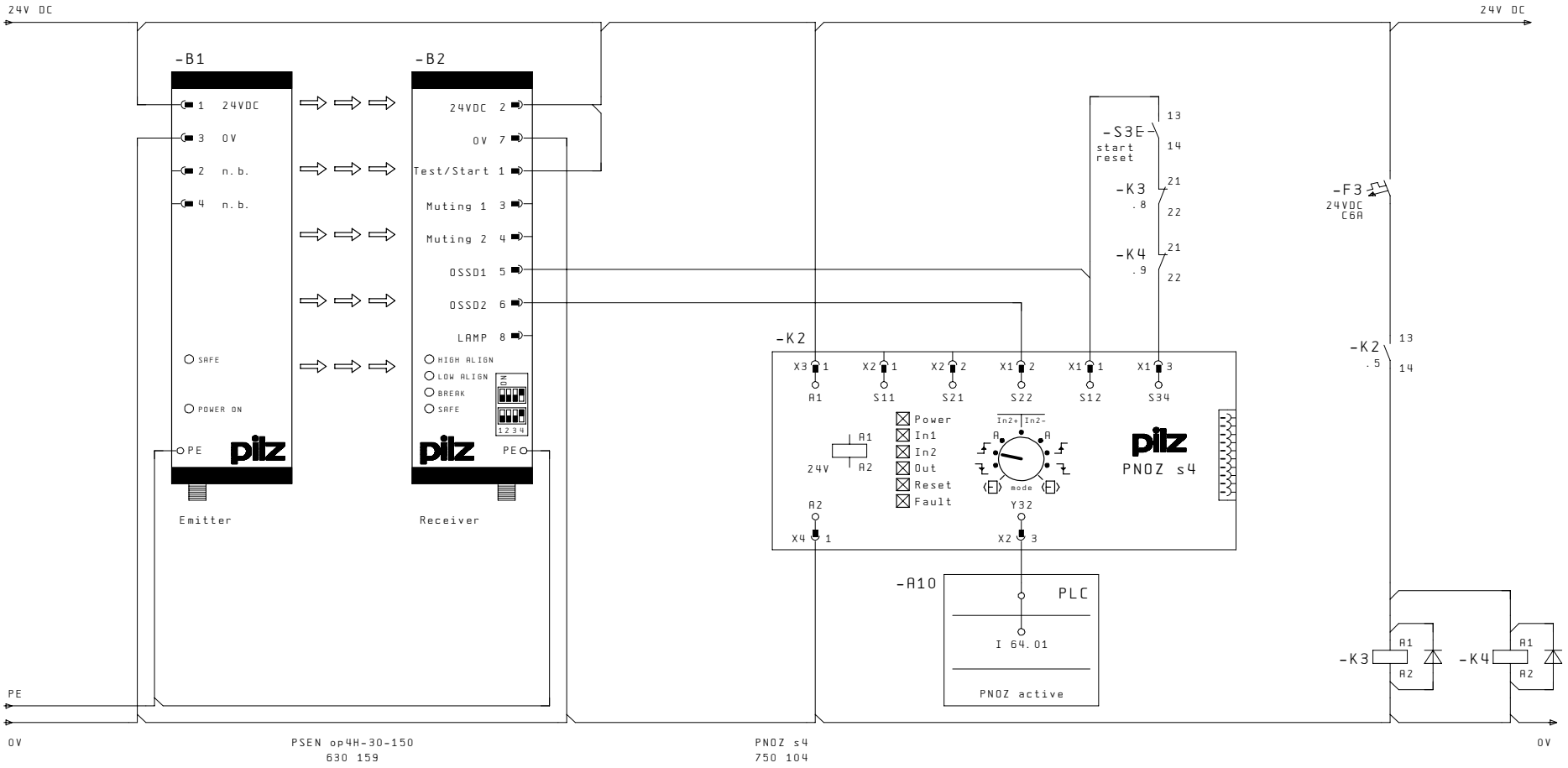
Safety-related characteristics in accordance with EN 62061: 2005

- Safety-related control function (SRCF): Shut down the machine when the safety light curtain is interrupted
- Subsystems: Input device (PSEN op4H), logic (PNOZ s4), actuator (contactors K3 and K4)
- Safety integrity level: **SIL 3**
- SIL information only applies under the following conditions*:
  - Common cause failure (CCF): ß = 10 %
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for actuator
  - Contactor K3/K4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

- Safety function: Shut down the machine when the safety light curtain is interrupted
- Safety-related parts of the control system (SRP/CS): Input device (PSEN op4H), logic (PNOZ s4), actuator (contactors K3 and K4)
- Performance level: **PL e**
- PL information only applies under the following conditions*:
  - Common cause failure (CCF): Requirements are considered to be met (must be tested on implementation)
  - Proof test interval: 20 years
  - Operating interval (electromechanical components): Two operations per hour for actuator
  - Contactor K3/K4 - characteristic data: $B10_d$: 2,000,000; dangerous failure rate: 65 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	08.03.06	Date	07.12.05	ESPE application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	ESPE PSEN op4H with monitored start of PNOZ s4	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs4
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		Dep.	CS				

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Category 4, EN 954-1

PNOZ s6 - Requirements in accordance with EN 574 Type IIIC, contact expansion through contactors

Features

- Dual-channel operation with detection of shorts across contacts
- Simultaneity monitoring
- Contact expansion through positive-guided contactors
- Feedback loop to monitor contact expansion
- Requirements in accordance with EN 574 Type IIIC
- Up to Category 4 of EN 954-1

Description

Function
The two-hand control device PNOZ s6 (K1) is activated by operating both pushbuttons S1 and S2 simultaneously (simultaneity max. 500 ms), the safety contacts on K1 close. Contactors KM1 and KM2 energise. Releasing one or both pushputtons S1 / S2 will interrupt the input circuit on the two-hand control device K1, the safety contacts at K1 open. Contactors KM1 and KM2 de-energise. The safety contacts on the two-hand control device PNOZ s6 (K1) will not reclose until both pushbuttons S1 and S2 have been released and then re-operated simultaneously.

Settings on the unit
The terminator on the PNOZ s6 must be connected.

Start/reset
The two-hand control device PNOZ s6 can be started by operating pushbuttons S1 and S2 simultaneously when contactors KM1 and KM2 have de-energised.

Feedback loop
The positive-guided N/C contacts on contactors KM1 and KM2 are monitored in feedback loop S12-S34 of the two-hand control device.

Safety assessment

- The two-hand control device PNOZ s6 (K1) and contactors KM1 and KM2 must be installed in a single mounting area (control cabinet) in order to exclude a short across the output.
- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The distance of both pushbuttons S1 and S2 from the nearest danger zone must be large enough that if one of the pushbuttons is released, the dangerous movement is interrupted before the operator can reach the danger zone or before the operator can reach into the danger zone (see EN 999 „The positioning of protective equipment in respect of approach speeds of parts of the human body“).

Pilz products

Number	Designation	Order number
1	PNOZ s6	750 106

Category 4, EN 954-1

PNOZ s6 - Requirements in accordance with EN 574 Type IIIC, contact expansion through contactors

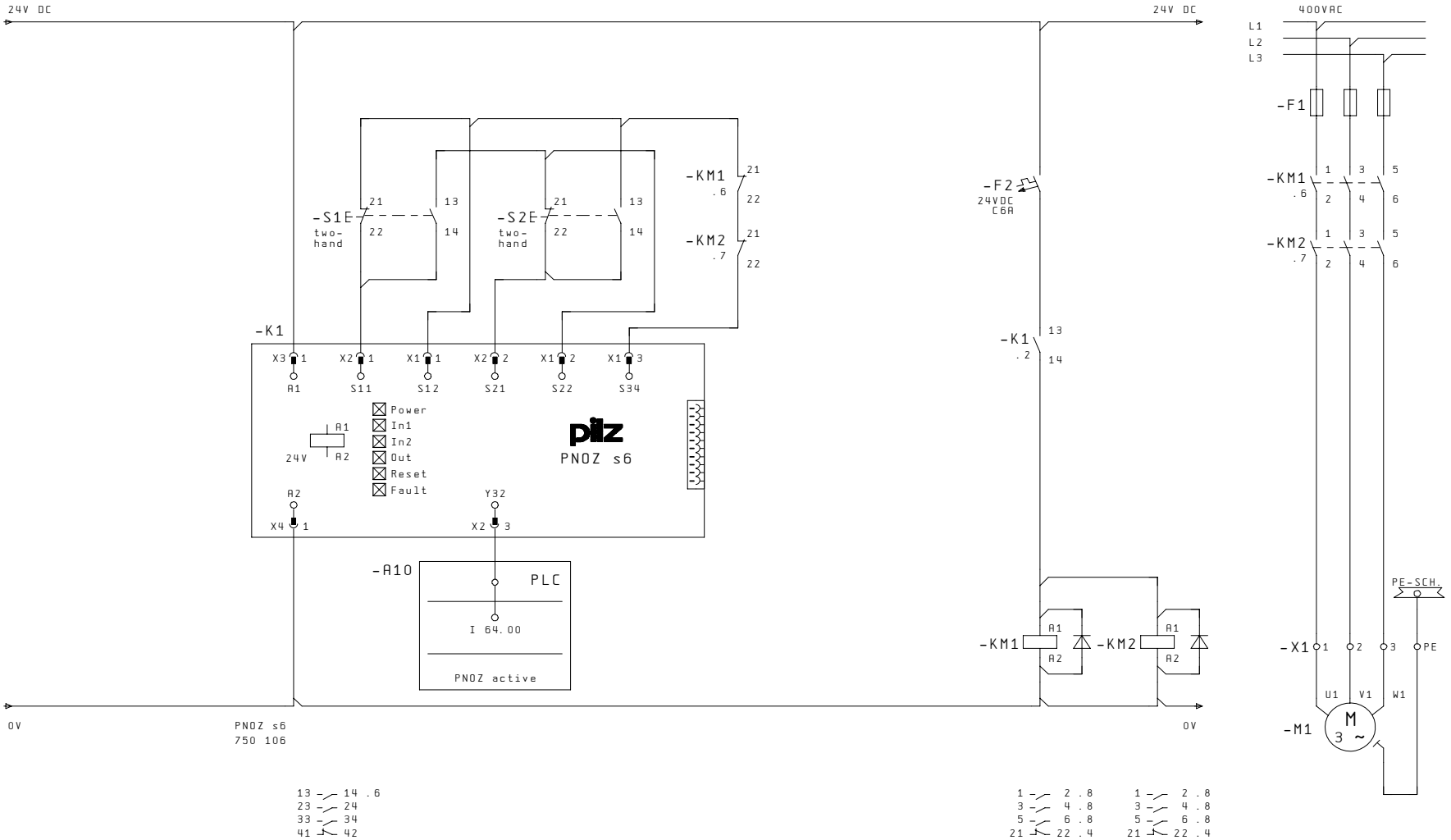
Safety-related characteristics in accordance with EN 62061: 2005

▸ Safety-related control function (SRCF):	If the output signal from a two-hand circuit shuts down in accordance with EN 574 Type IIIC, the actuator technology for shutting down a hazardous movement must shut down.
▸ Subsystems:	Input devices (pushbutton S1, pushbutton S2), logic (PNOZ s6), actuator (contactors KM1 and KM2)
▸ Safety integrity level:	**SIL 3**
▸ SIL information only applies under the following conditions*:	
- Common cause failure (CCF):	ß = 5 % (note increased requirements)
- Proof test interval:	20 years
- Operating interval (electromechanical components):	60 operations per hour for input device and actuator
- Pushbutton S1, S2 - characteristic data:	$B10_d$: 20,000,000; dangerous failure rate: 50 %
- Contactors KM1/KM2 - characteristic data:	$B10_d$: 20,000,000; dangerous failure rate: 65 % (note oversizing)

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

▸ Safety function:	If the output signal from a two-hand circuit shuts down in accordance with EN 574 Type IIIC, the actuator technology for shutting down a hazardous movement must shut down.
▸ Safety-related parts of the control system (SRP/CS):	Input devices (pushbutton S1, pushbutton S2), logic (PNOZ s6), actuator (contactors KM1 and KM2)
▸ Performance level:	**PL e**
▸ PL information only applies under the following conditions*:	
- Common cause failure (CCF):	Requirements are considered to be met (must be tested on implementation)
- Proof test interval:	20 years
- Operating interval (electromechanical components):	60 operations per hour for input device and actuator
- Pushbutton S1, S2 - characteristic data:	$B10_d$: 20,000,000; dangerous failure rate: 50 %
- Contactors KM1/KM2 - characteristic data:	$B10_d$: 20,000,000; dangerous failure rate: 65 % (note oversizing)

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	17.07.06	Date	07.12.05	Two-hand application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Two-hand operation (request class 3C, EN 574) extension contact by contactors
Name	WED	Name	WED			
				Category 4 EN 954-1		
		Dep.	CS			

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PNOZs6
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Notes

Category 4, EN 954-1

PNOZ s6 - Requirements in accordance with EN 574 Type IIIC, contact expansion through PNOZ s10

Features

- Dual-channel operation with detection of shorts across contacts
- Simultaneity monitoring
- Contact expansion through PNOZ s10 (contact expander module)
- Feedback loop to monitor contact expansion
- Meets requirements in accordance with EN 574 Type IIIC
- Up to Category 4 of EN 954-1

Description

Function
The two-hand control device PNOZ s6 (K2) is activated by operating both pushbuttons S3 and S4 simultaneously (simultaneity max. 500 ms), the safety contacts on K2 close. The contact expander module PNOZ s10 (K3) is started.
Releasing one or both pushputtons S3 / S4 will interrupt the input circuit on the two-hand control device K2, the safety contacts at K2 open. The contact expander module K3 shuts down. The safety contacts on the two-hand control device PNOZ s6 (K2) will not reclose until both pushbuttons S3 and S4 have been released and then re-operated simultaneously.

Settings on the unit
The connector between the safety relays PNOZ s6 (K2) and PNOZ s10 (K3) must be connected.

Start/reset
The two-hand control device PNOZ s6 can be started by operating pushbuttons S3 and S4 simultaneously when the feedback loop in the contact expander module PNOZ s10 (K3) is closed.

Feedback loop
The feedback loop on the safety relay PNOZ s6 (K2) is connected to the feedback loop on the contact expander module PNOZ s10 (K3).

Safety assessment

- Earth faults and shorts between contacts in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The distance of both pushbuttons S3 and S4 from the nearest danger zone must be large enough that if one of the pushbuttons is released, the dangerous movement is interrupted before the operator can reach the danger zone or before the operator can reach into the danger zone (see EN 999 „The positioning of protective equipment in respect of approach speeds of parts of the human body“).

Pilz products

Number	Designation	Order number
1	PNOZ s6	750 106
1	PNOZ s10	750 110

Category 4, EN 954-1

PNOZ s6 - Requirements in accordance with EN 574 Type IIIC, contact expansion through PNOZ s10

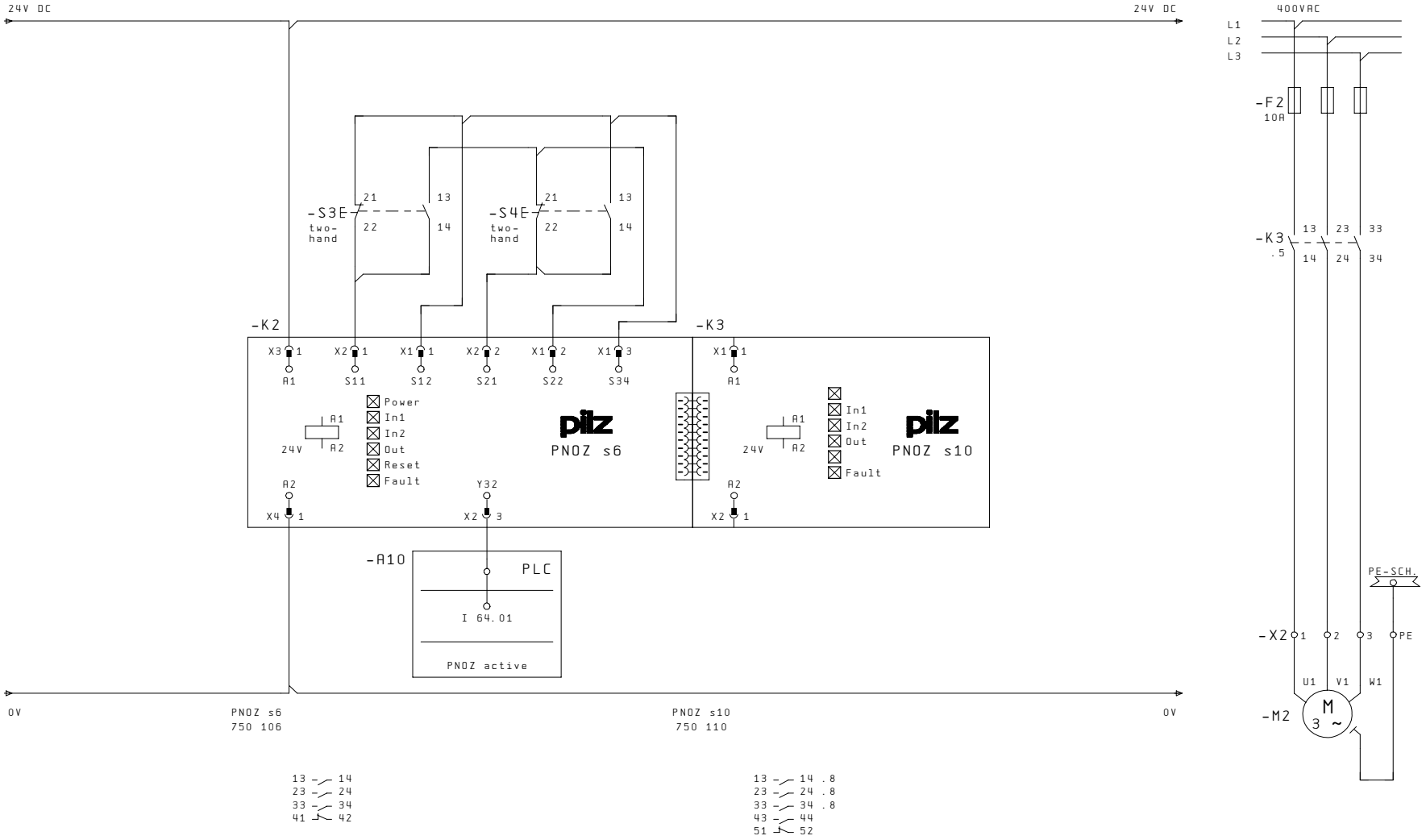
Safety-related characteristics in accordance with EN 62061: 2005

▸ Safety-related control function (SRCF):	If the output signal from a two-hand circuit shuts down in accordance with EN 574 Type IIIC, the actuator technology for shutting down a hazardous movement must shut down.
▸ Subsystems:	Input devices (pushbutton S3, pushbutton S4), logic (PNOZ s6), actuator (PNOZ s10)
▸ Safety integrity level:	**SIL 3**
▸ SIL information only applies under the following conditions*:	
- Common cause failure (CCF):	ß = 10 %
- Proof test interval:	20 years
- Operating interval (electromechanical components):	60 operations per hour for input device
- Pushbutton S3, S4 - characteristic data:	$B10_d$: 20,000,000; dangerous failure rate: 50 %

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

▸ Safety function:	If the output signal from a two-hand circuit shuts down in accordance with EN 574 Type IIIC, the actuator technology for shutting down a hazardous movement must shut down.
▸ Safety-related parts of the control system (SRP/CS):	Input devices (pushbutton S3, pushbutton S4), logic (PNOZ s6), actuator (PNOZ s10)
▸ Performance level:	**PL e**
▸ PL information only applies under the following conditions*:	
- Common cause failure (CCF):	Requirements are considered to be met (must be tested on implementation)
- Proof test interval:	20 years
- Operating interval (electromechanical components):	60 operations per hour for input device
- Pushbutton S3, S4 - characteristic data:	$B10_d$: 20,000,000; dangerous failure rate: 50 %

* Further requirements of EN 62061 and EN ISO 13849-1 have also to be met (e.g. requirements for systematic safety integrity and avoiding systematic faults, among others).



Revision	17.07.06	Date	07.12.05	Two-hand application	pilz Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Two-hand operation (request class 3C, EN 574) extension contact by PNOZ s10	Directory: ..PNOZ\05PIL013
Name	WED	Name	WED				PNOZs6
				Category 4 EN 954-1			Page: 2
		Dep.	CS				

Category 1, EN 954-1

PNOZ s6.1 - Requirements in accordance with EN 574 Type IIIA

Features

- Dual-channel operation
- Simultaneity monitoring
- Contact expansion through positive-guided contactor
- Feedback loop to monitor contact expansion
- Requirements in accordance with EN 574 Type IIIA
- Up to Category 1 of EN 954-1

Description

Function
The two-hand control device PNOZ s6.1 (K1) is activated by operating both pushbuttons S1 and S2 simultaneously (simultaneity max. 500 ms), the safety contacts on K1 close. Contactor KM1 energises.
Releasing one or both pushputtons S1 / S2 will interrupt the input circuit on the two-hand control device K1, the safety contacts at K1 open. Contactor KM1 de-energises. The safety contacts on the two-hand control device PNOZ s6.1 (K1) will not reclose until both pushbuttons S1 and S2 have been released and then re-operated simultaneously.

Settings on the unit
The terminator on the PNOZ s6.1 must be connected.

Start/reset
The two-hand control device PNOZ s6.1 can be started by operating pushbuttons S1 and S2 simultaneously when contactor KM1 has de-energised.

Feedback loop
The positive-guided N/C contact on contactor KM1 is monitored in feedback loop S24-S34 of the two-hand control device K1.

Safety assessment

- Earth faults in the input circuit are detected.
- A fault on the device does not lead to the loss of the safety function.
- The distance of both pushbuttons S1 and S2 from the nearest danger zone must be large enough that if one of the pushbuttons is released, the dangerous movement is interrupted before the operator can reach the danger zone or before the operator can reach into the danger zone (see EN 999 „The positioning of protective equipment in respect of approach speeds of parts of the human body“).
- The two-hand control device PNOZ s6.1 may **not be used on press controllers**. It is only suitable for use where the risk analysis has established a low level of risk.

Pilz products

Number	Designation	Order number
1	PNOZ s6.1	750 126

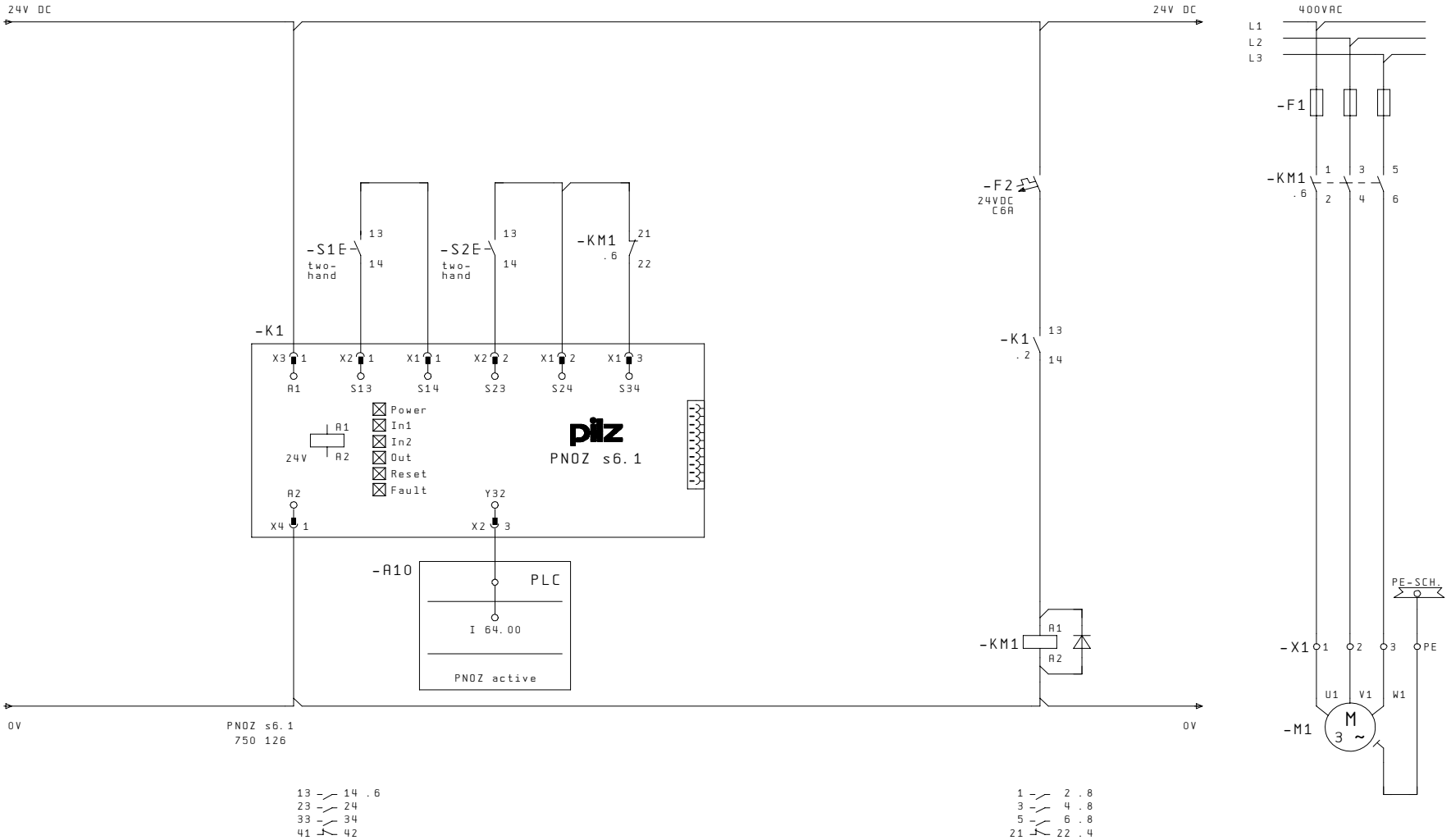
Category 1, EN 954-1

PNOZ s6.1 - Requirements in accordance with EN 574 Type IIIA

Safety-related characteristics in accordance with EN ISO 13849-1: 2006

▸ Safety function:	If the output signal from a two-hand circuit shuts down in accordance with EN 574 Type IIIA, the actuator technology for shutting down a hazardous movement must shut down.
▸ Safety-related parts of the control system (SRP/CS):	Input devices (pushbutton S1, pushbutton S2), logic (PNOZ s6), actuator (contactor KM1)
▸ Performance level:	**PL b**
▸ PL information only applies under the following conditions*:	
- Common cause failure (CCF):	Requirements are considered to be met (must be tested on implementation)
- Proof test interval:	20 years
- Operating interval (electromechanical components):	60 operations per hour for input device and actuator
- Pushbutton S1, S2 - characteristic data:	$B10_d$: 20,000,000; dangerous failure rate: 20 %
- Contactor KM1 - characteristic data:	$B10_d$: 2,000,000; dangerous failure rate: 65 %
- Mission time max.:	Contactor KM1 must be changed after 3.8 years

* Further requirements of EN ISO 13849-1 have also to be met (e.g. requirements for avoiding systematic faults, among others).



Revision	17.03.06	Date	07.12.05	Two-hand application	Pilz GmbH & Co.KG Felix-Wankel-Str.2 73760 Ostfildern	Two-hand operation (request class 3A, EN 574)
Name	WED	Name	WED			Directory: ..PNOZ\05PIL013
				Category 1 EN 954-1		PNOZs6.1
		Dep.	CS			Page: 1

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Standards And Directives	

European directives and status of the standards in Europe

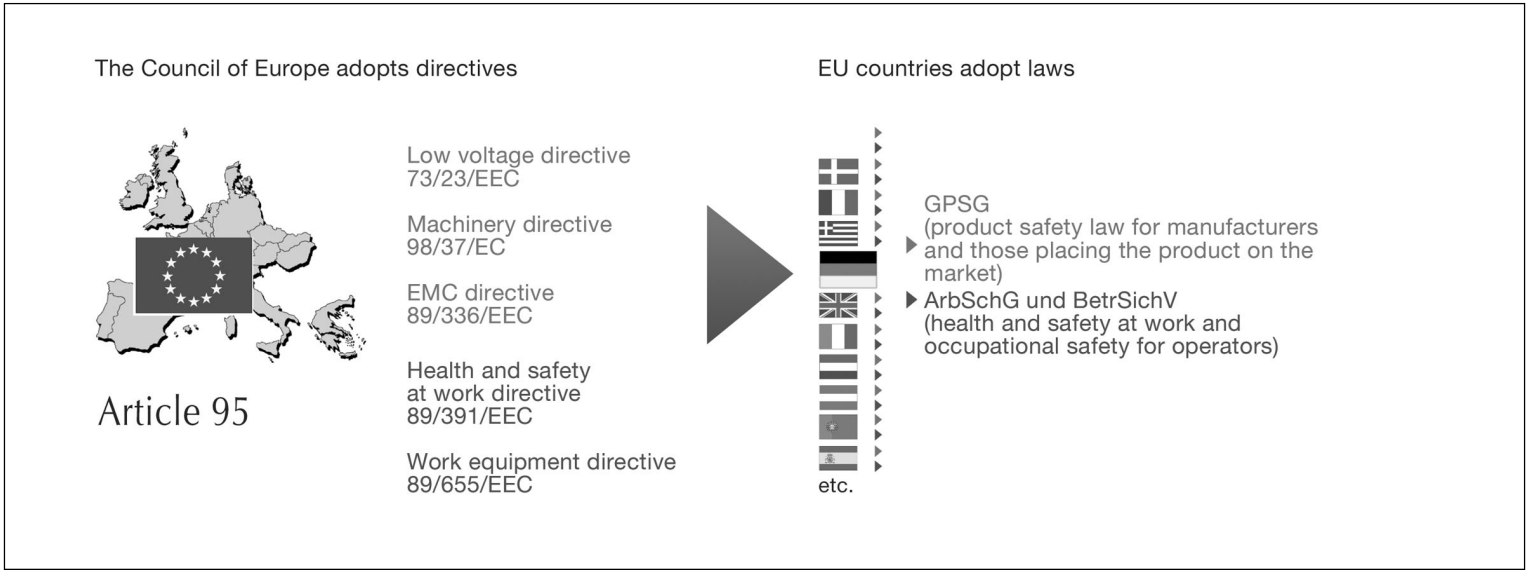

Fig. 1: Incorporation of the directives into domestic law (using Germany as an example)

European directives

The concept of a single European internal market in terms of the “New Approach” can be traced right back to the start of the 70s: The low voltage directive was the first piece of European legislation to take into account the approach towards harmonisation of a common internal market.

Products that are covered by one or more of the following directives have to apply a CE-mark, i.e. the product must be accompanied by a declaration of conformity. With a declaration of conformity, the manufacturer confirms that his product meets all the requirements of the European directives applicable to his product. This means he can launch and sell his product within the scope of the EU without consideration of any national regulations.

Lifts	95/16/EC
Construction products	89/106/EEC
Pressure equipment directive	97/23/EC
EMC directive	89/336/EEC
ATEX	94/9/EC
Appliances burning gaseous fuels	90/396/EEC
Machinery directive	98/37/EC
Medical device directive	93/42/EEC
Low voltage directive	73/23/EEC
Personal protective equipment	89/686/EEC
Safety of toys directive	88/378/EEC

The directives are addressed to member states, who are obliged to incorporate the European directives into domestic law. In Germany, this is normally achieved through the device safety law.

European directives and status of the standards in Europe

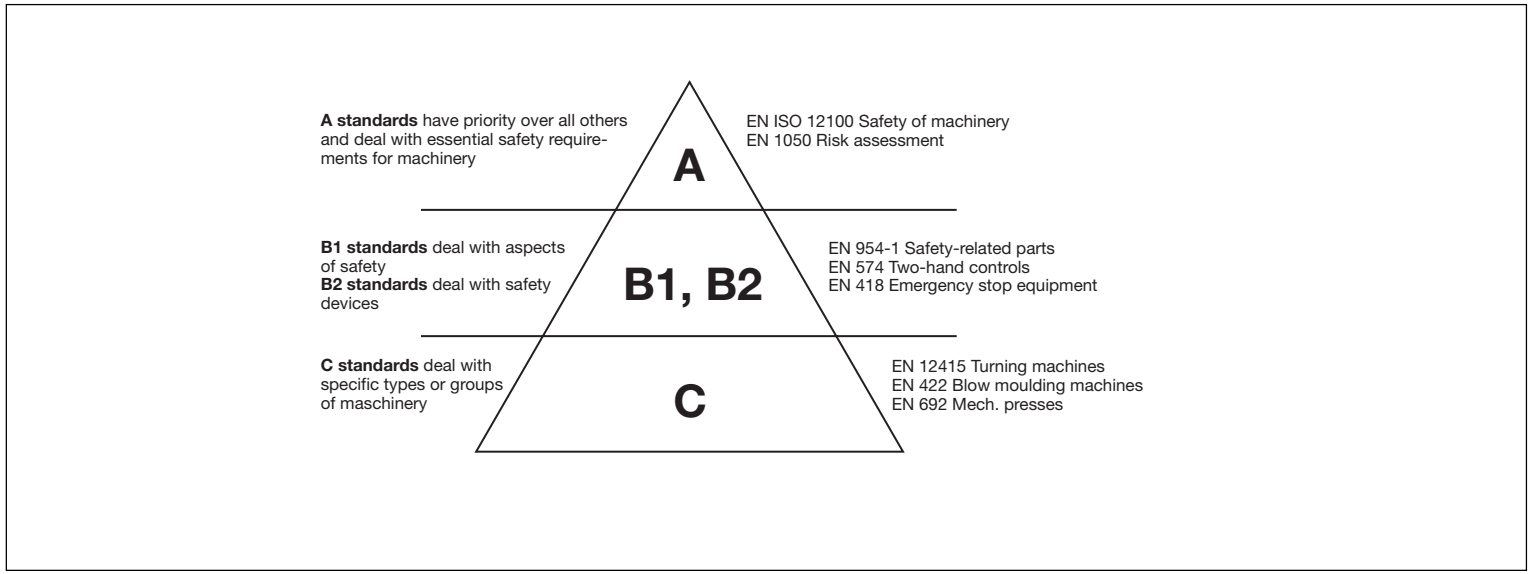

Fig. 2: Standards pyramid

Status of the standards in Europe

The legal status of standards is continuously discussed. Inside Europe, i.e. within the scope of the European directives that are subject to the CE-marking obligation, a manufacturer is not bound by standards or other specifications. He simply needs to comply with the health and safety requirements of the directive(s). The associated benefits of a division between standards and legislation are obvious: it is easier for legislators to agree on the essential requirements than on technical details. Also, the directives do not regularly have to be adapted to the state of technology; member states can use their own legal system for incorporation and the manufacturer is free to select how he implements the requirements of the directive.

So what are the benefits of applying the standards? With so-called harmonised standards with presumption of conformity, there is a shifting of the burden of proof, i.e. if a manufacturer applies these standards, he can assume that he will also comply with the specific requirements of the European directives. It would therefore be up to the regulatory authorities to prove that a manufacturer did not meet the legal requirements.

However, should a manufacturer deviate from the harmonised standards, he himself must prove how he has met the essential safety requirements. This is generally done via a hazard analysis. In practice people endeavour to apply the harmonised standards, unless the products concerned are highly innovative and no harmonised standards yet exist. The standards for which this “presumption effect” applies can be researched in the Official Journal of the EU (e.g. on the Internet). Standards in Europe are subdivided into A, B and C standards.

Legal regulations outside Europe and Standards for functional safety

Legal regulations outside Europe

The situation is somewhat different in the USA: primarily there are two types of standards: ANSI (American National Standards Institute) and OSHA (Occupational Safety and Health Administration). OSHA standards are published by the state and compliance is mandatory. ANSI standards, on the other hand, are developed by private organisations and generally their application is not strictly essential. However, ANSI standards are still quoted as part of a contract. And yet ANSI standards are being taken over by OSHA. You can still come across the NFPA (National Fire Protection Association), which developed NFPA 79 as a counterpart to EN 60204-1, for example. The OSHA standards can be compared with the European directives. Unlike the European directives, OSHA standards are more involved with formulating requirements for technical specifications than with abstract requirements.

The legal foundations in the USA can be seen as a mix of product standards, fire codes (NFPA), electrical codes (NEC) and national laws. Local government bodies have the authority to monitor that these codes are being enforced and implemented.

Russia and the CIS states implemented GOST-R certification some years ago. This means that technical devices falling within a specific product catalogue must undergo a certain certification process. Machinery and any corresponding technical accessories undergo a type approval test through a European notified body, for example. This test is generally recognised by a Russian-based approvals body. From the point of view of safety, the same requirements apply as in Europe.

China, on the other hand, has introduced CCC certification. Similar to the position in Russia, technical products are subject to mandatory certification through a national approvals body in China. In addition, production sites are inspected. If a technical device falls with the scope of the product catalogue, which is subdivided into 19 categories, certification is mandatory, otherwise it will be necessary to supply a type of “declaration of no objection” from a national notified body.

Japan is currently in a transition period: the plan is for Japan to adopt the European “new approach” – in other words, to keep standards and legislation separate. At the moment the international ISO and IEC standards are being directly incorporated into national legislation, which is why people are currently confronted with frequent amendments to laws and lengthy implementation periods.

Standards for functional safety

Different standards may be called upon to observe functional safety on control systems, depending on the application. In the area of machine safety, EN 954-1 is the main standard for safety-related control systems. This applies to the whole chain from the sensor to the actuator, irrespective of the technology. The risk graphs and corresponding risk parameters can be used to estimate the potential risk for danger zones on machinery. The category is initially established without the use of risk-reducing measures.

Risk parameters and categories with EN 954-1

Risk parameters

S = Severity of injury:
1 = Slight (normally reversible) injury
2 = Serious (normally irreversible) injury, including death

F = Frequency and/or exposure to the hazard
1 = Seldom to quite often and/or exposure time is short
2 = Frequent to continuous and/or exposure time is long

P = Possibility of avoiding the hazard
1 = Possible under specific conditions
2 = Scarcely possible

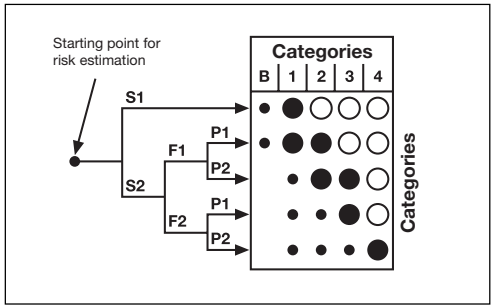

Fig. 3: Risk graph from EN 954

Categories in accordance with EN 954-1

The control system requirements derived from the risk graph are specified as follows:

Category B

Basic category with no special requirements = “good industrial standard”

Category 1

Safety-related parts must be designed and constructed using well-tried components and well-tried safety principles.

Well-tried means: the components have been widely used in the past with successful results in similar applications, or they have been manufactured using principles that demonstrate their suitability and reliability for safety-related applications.

Example: safety switch with forced-opening contacts.

Well-tried safety principles are circuits constructed in such a way that certain faults can be avoided by the appropriate arrangement or layout of components.

Example: avoiding a short circuit through appropriate separation, avoiding component failures that result from over-dimensioning, using the failsafe principle (on switching off).

Note: When a fault occurs it can lead to the loss of the safety function.

Category 2

Safety-related parts of control systems must be designed so that their safety function(s) are checked at suitable intervals by the machine control system. The safety function(s) must be checked: at the machine start-up and prior to the initiation of any hazardous situation; periodically during operation, if the risk assessment and the kind of operation show that it is necessary.

This check may be initiated automatically or manually. Automatically, for example, the check may be initiated by a signal generated from a control system at suitable intervals. The automatic test should be provided by preference. The decision about the type of test depends on the risk assessment and the judgement of the end user or machine builder. If no fault is detected, operation may be approved as a result of the test. If a fault is detected, an output must be generated to initiate an appropriate control action. A second, independent shutdown route is required for this.

Notes: In some cases Category 2 is not applicable because the checking of the safety function cannot be applied to all components and devices. Moreover, the cost involved in implementing Category 2 correctly may be considerable, so that it may make better economic sense to implement a different category. In general Category 2 can be realised with electronic techniques. The system behaviour allows the occurrence of a fault to lead to the loss of the safety function between checks; the loss of the safety function is detected by the check.

Category 3

Safety-related parts of control systems must be designed so that a single fault in any of these parts does not lead to the loss of the safety function.

Whenever reasonably practicable, the single fault shall be detected at or before the next demand upon the safety function. This does not mean that all faults will be detected. The accumulation of undetected faults can lead to an unintended output signal and a hazardous situation at the machine.

Category 4

Safety-related parts of control systems must be designed so that a single fault in any of these parts does not lead to a loss of the safety function; the single fault must be detected at or before the next demand upon the safety functions (e.g. immediately at switch on, at the end of a machine operating cycle).
If this detection is not possible, then an accumulation of faults shall not lead to a loss of the safety function.

Functional safety and legal status of EN/IEC 61508

Functional safety with EN/IEC 61508?

EN/IEC 61508 is regarded as a generic safety standard, which deals with the functional safety of electrical, electronic and programmable electronic systems, irrespective of the application.

One of the main tasks of EN/IEC 61508 is to serve as a basis for the development of application-oriented standards. Standards' committees are currently busy in the areas of machine safety with EN/IEC 62061, and process safety with EN/IEC 61511. Also under revision is EN 954, the standard harmonised under the scope of the machinery directive, which in future will be listed as EN/ISO 13849.

These sector-specific standards are intended to continue the principle approaches of EN/IEC 61508 and to implement the requirements for the relevant application area in a suitably practical manner.

What is the legal status of EN/IEC 61508?

As EN/IEC 61508 is not listed in the Official Journal of the European Communities for implementation as a European directive, it lacks the so-called "presumption effect". If the standard is used on its own, a control system designer cannot assume that the relevant requirements of the specific European directive have been met.

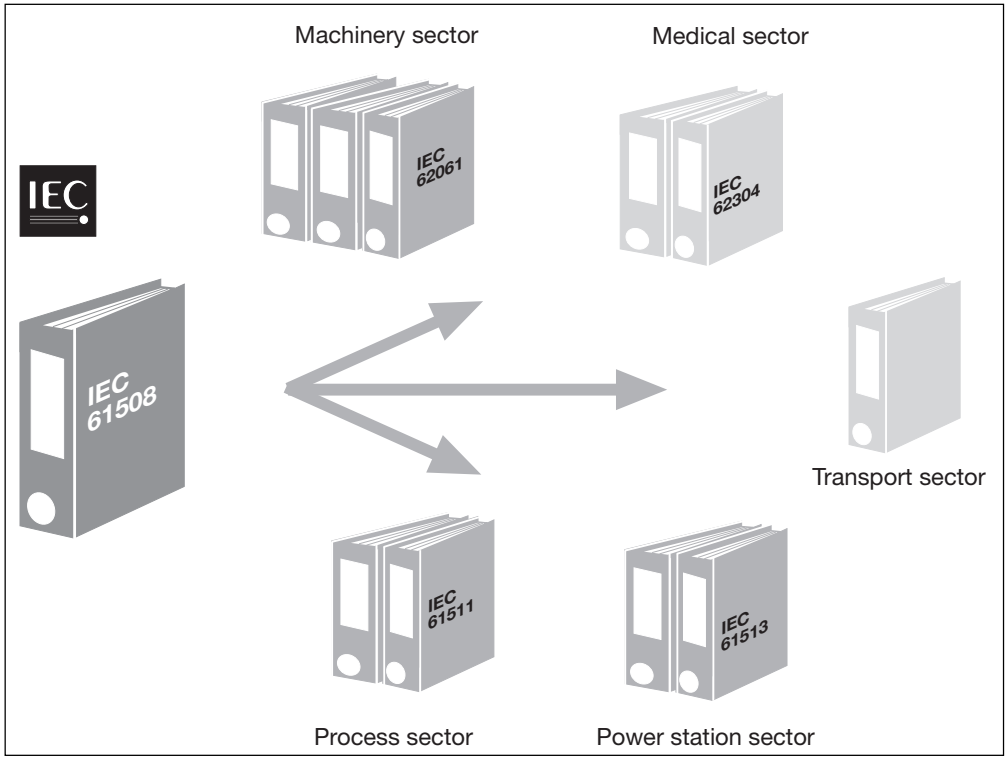

Fig. 4: Sector standards from IEC 61508

Risk analysis

Risk analysis

Under the terms of the machinery directive, a machine manufacturer must carry out a risk analysis in order to identify all the hazards that apply to his machine. This analysis must then be taken into account in the design and construction of the machine. This requirement also applies to operators who act as manufacturers under the terms of the machinery directive. For example, this may occur with machines that are interlinked or for machinery that has been upgraded and substantially modified.

EN 1050 contains “Principles for risk assessment” on machinery. These approaches can be called upon as part of a comprehensive analysis. EN 954-1 expands on EN 1050 with regard to the assessment of safety-related parts of control systems.

The hazards emanating from a machine may be many and varied. For example, it is necessary to consider not just mechanical hazards through crushing and shearing, but also thermal and electrical hazards and hazards from radiation. Risk reduction is therefore an iterative process, i.e. it is carried out before and during the planning phase and after completion of the plant or machine.

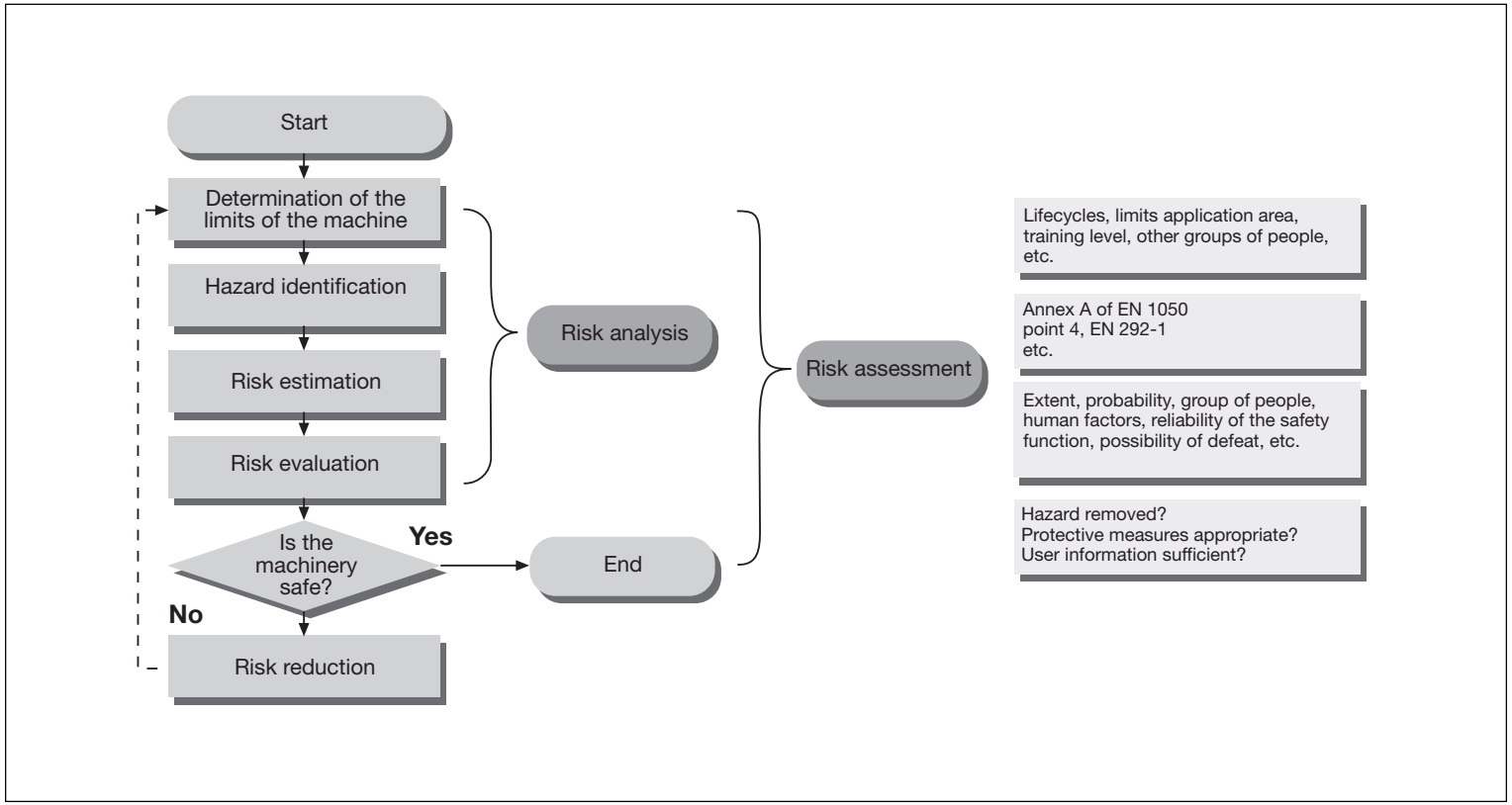

Fig. 5: Iterative process in accordance with EN 1050

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Pre-sales/after sales
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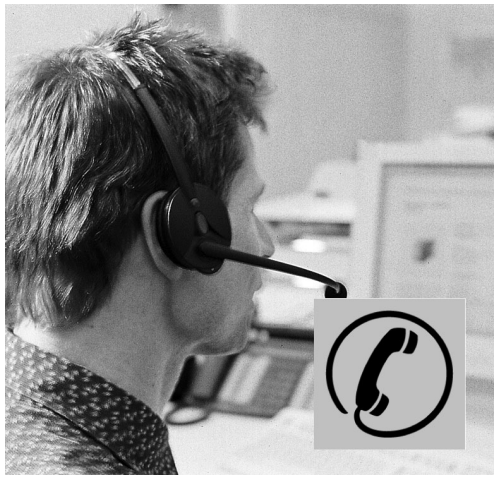

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