Safely limited speed on PMCprotego DS with PNOZm1p

Product
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Name: PMCprotego D, PMCprotego S2, PNOZm1p
Manufacturer: Pilz GmbH & Co. KG, Safe Automation

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March 2011

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Contents

1. Useful documentation 5
1.1. Documentation from Pilz GmbH & Co. KG 5
1.2. Documentation from other sources of information 5

2. Hardware configuration 6
2.1. Pilz products 6
2.2. Hardware configuration 6

3. Application Task 7
3.1. Description 7
3.1.1. Operating mode selector switch function 8
3.1.2. Enable switch function 9
3.1.3. Wiring of the safety card 10
3.2. Functional safety 13
3.2.1. Safety-related characteristics in accordance with EN ISO 13849-1 13
3.2.2. Safety-related characteristics in accordance with EN 62061 14
3.3. Circuit diagram of the application 15
3.3.1. Circuit diagram 1/8 15
3.3.2. Circuit diagram 2/8 16
3.3.3. Circuit diagram 3/8 17
3.3.4. Circuit diagram 4/8 18
3.3.5. Circuit diagram 5/8 19
3.3.6. Circuit diagram 6/8 20
3.3.7. Circuit diagram 7/8 21
3.3.8. Circuit diagram 8/8 22

Abbreviations

FB	**F**unction **b**lock	
PMC	**P**ilz **M**otion **C**ontrol	
PNOZ	Pilz E-Stop Positive-guided	(de: **P**ilz **NO**T-AUS-**Z**wangsgeführt)
PRG	**P**rogram	

1. Useful documentation

Reading the documentation listed below is necessary for understanding this application note. The availability of the indicated tools and safe handling are also presupposed with the user.

1.1. Documentation from Pilz GmbH & Co. KG

No.	Description	Item No.
1	Pilz international homepage, download section	www.pilz.com
2	Operating manual PNOZ m1p	20878-EN-xx
3	Operating manual PNOZ mo1p	20881-6NL-xx
4	Operating manual PMCprotego D.01…D.24	21 934-EN-xx
5	Operating manual PMCprotego S2	1001432-EN-xx
6	Operating manual PMCtendo AC	21 706-EN-xx

1.2. Documentation from other sources of information

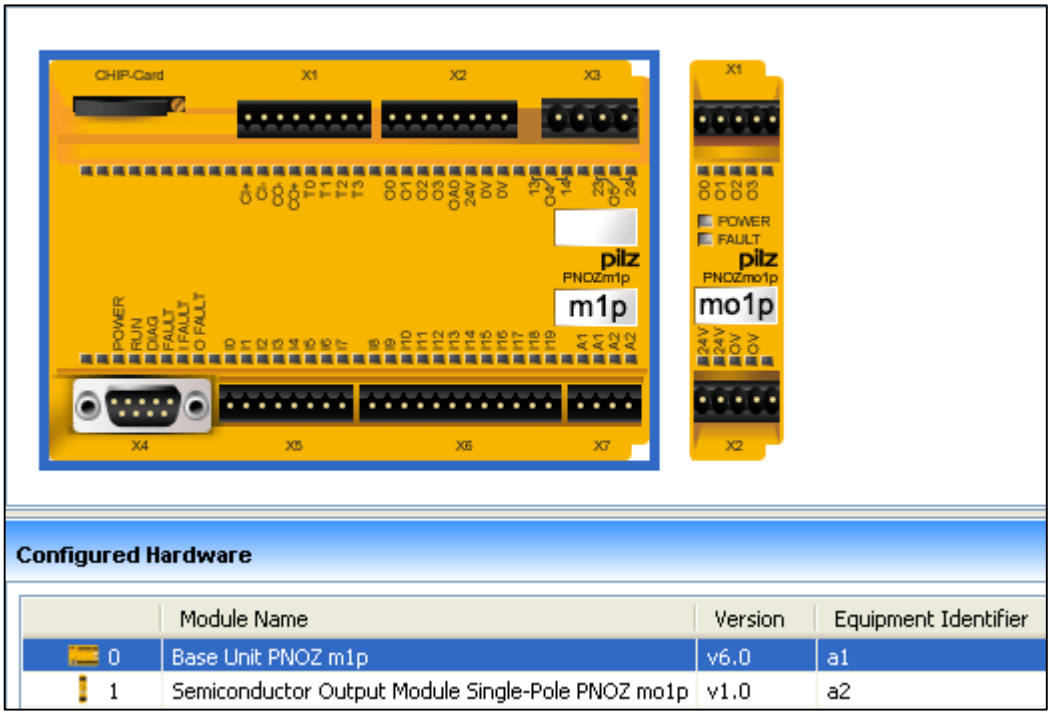
No.	Description	Item No.
1		
2		

2. Hardware configuration

2.1. Pilz products

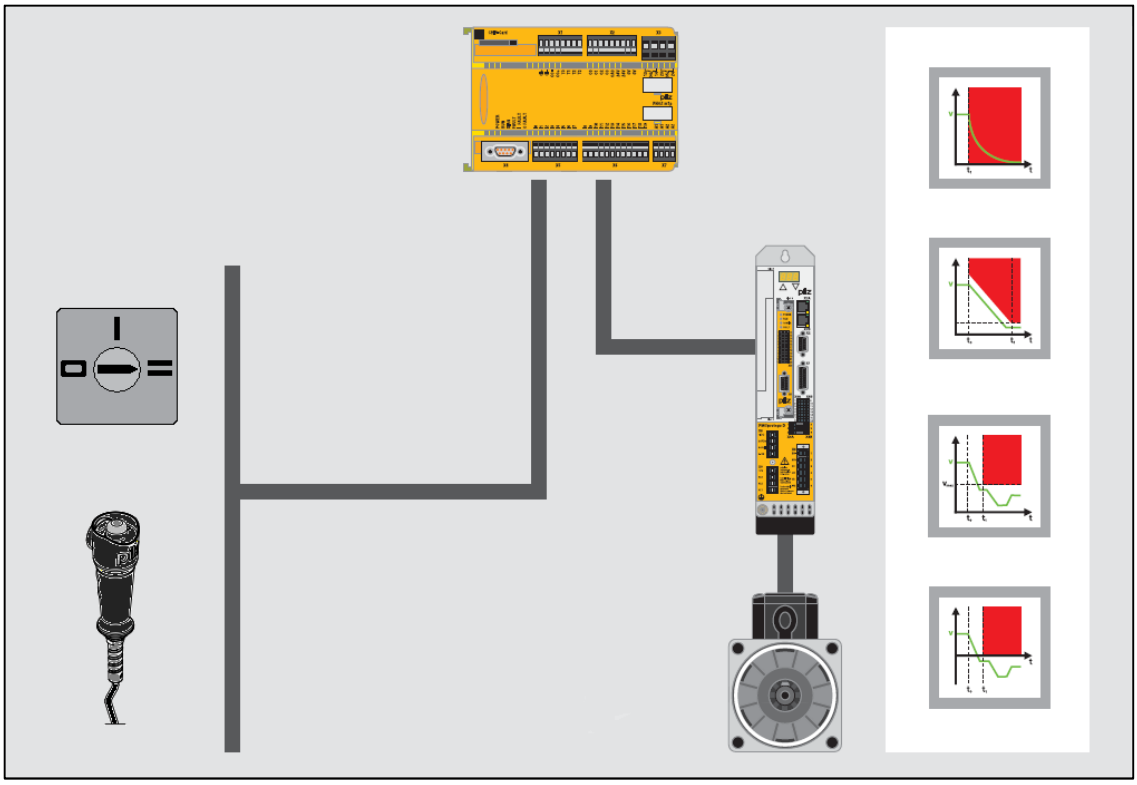
No.	Description	Order number	Version	Number
1	PNOZ m1p	773 100	-	1
2	PNOZ mo1p	773 500	-	1
3	PMC protego D.03/000/0	8176 101	-	1
4	PMC protego S2	8176 106	-	1
5	PMCtendo AC3.32/1/M/1/1/4/H/6	8176 090	-	1
6	Cable Power DD4plug>ACplug:L05m	8165 882	-	1
7	Cable Hiperface DD4plug>ACpluf:L05m	8165 879	-	1
8	PNOZmulti Configurator	-	V7.1.0 build 4	1
9	PASconfig SDrive	-	V1.0.0	1
10	PMCtools	-	V3.2	1

2.2. Hardware configuration



3. Application Task

3.1. Description



The example shows the implementation of the "Setting – Safely limited speed when an enable switch is operated" mode with an operating mode selector switch, an enable switch, a PNOZmulti and a PMCprotego D in combination with a PMCprotego S2 safety card.

The safe control and evaluation of the signals is performed by the Pilz function block

operating mode selector switch , enable switch and emergency stop device

from the element selection (function elements).

3.1.1. Operating mode selector switch function

An operating mode selector switch (S6) with 2 positions, for the modes *Automatic* and *Setting*, is to be monitored on a machine by the PNOZmulti. This example does not analyse automatic mode in any detail. Observations are only specified here for the setting mode with enable function (SS2, SLS, SDI); other operating modes and safety functions are to be observed separately.
The FS function block *operating mode selector switch* is assigned to the operating mode inputs in the user program. The FB monitors the time taken during the changeover process and detects non-feasible operating modes, such as no operating mode selected (all the inputs on the operating mode selector switch are 0). If an error occurs, the enable output on the FB will immediately be reset. The enable output is also reset when the PNOZmulti is stopped and when the PNOZmulti is switched on. The signal at the enable output must be evaluated by the user program and trigger an appropriate reaction.
An entry in the error stack can be used to determine why the enable output was reset.

The way in which the error is reset will depend on the type of error that occurred.
- No input has a 1 signal:
  - Creation of a permitted input signal at the inputs of the FB.
- More than one input has a 1 signal:
  - Creation of a permitted input signal at the inputs of the FB and restart of the PNOZmulti.

The drive is set in motion by selecting the setting mode and operating the start button (S4) with the enable switch (S5) activated.
In setting mode, the SLS (safely limited speed) and SDI (negative or positive safe monitoring of the direction of rotation) safety functions are also activated.
The direction and speed of the monitored axis are selected here in such a way that the worker can always elude the hazardous movement.

If the SLS or SDI function or their configured limit values are violated, the drive changes to STO. Please note that no more holding torque exists with STO and relevant additional measures must be employed to ensure that this behaviour does not lead to a hazardous situation (e.g. with suspended loads).

Operating mode selector switch safety assessment
- A short between 24 VDC and an input without a selected operating mode will be detected as an error by standard function block.
- A short between 24 VDC and an input with a selected operating mode will be detected as an error by standard function block after the next operation.

3.1.2. Enable switch function

In this example the PNOZmulti monitors the dual-channel, three-stage enable switch S5, which has two N/O contacts and two positive-guided N/C contacts.
Within the user program, the stop function with positive separation in stage 3 of the enable switch is assigned to the FS function block *Emergency stop*. The FB detects whether the stop function has been operated, as well as detecting invalid input signals, such as the contact synchronisation time being exceeded.
The FS function block *Enable switch* is assigned to the enable function of the enable switch in the user program. The FB detects whether the enable switch has been operated, as well as detecting invalid input signals, such as the contact synchronisation time being exceeded.
If the enable switch is fully depressed (E-STOP) or an error occurs, the enable output on the FB will immediately be reset.
For this example, an enable switch is required on which it is guaranteed that the enable function in stage 2 does not take effect when resetting from stage 3 to stage 1. This is a requirement for this application.
The signal at the enable output can be evaluated by the user program and trigger an appropriate reaction.

The way in which the error is reset will depend on the operating mode set on the FB.
In this application example, the parameters for the *emergency stop* and *enable switch* function blocks have been set in such a way that:
- when cold started (PSS switched from off to on),
- when warm started (PNOZ transferring from STOP to RUN),
- after releasing the enable switch or
- after fully depressing the enable switch

no reset is required for the enable output to be reset.

The signal of the enable output activates the SS2 function of the safety card by means of a falling edge at the SS2 input of the Protego S safety card. If the configured limit values of the SS2 function are violated, the drive changes to STO.
Please note that no more holding torque exists with STO and relevant additional measures must be employed to ensure that this behaviour does not lead to a hazardous situation (e.g. with suspended loads).

Enable switch safety assessment
- If a contact on the N/O or N/C circuit of the enable switch is overridden, the FB will detect this at the next operation.
- A short between the input circuits of the enable switch is detected as an error by the PNOZ.
- A short between 24 VDC and an input circuit of the enable switch is detected as an error by the PNOZ.
- If the enable switch is fed back from stage 3 to stage 1, the enable function will be suppressed through enable switch.
- Controls for hazardous conditions may not be initiated by the enable switch alone.

3.1.3. Wiring of the safety card

PNOZ Multi project configuration:
The respective safety functions are activated via a falling edge at the inputs of the safety card.

Start:
The safe setting mode in which the safely limited speed and the direction are monitored can be started if:

- The setting mode is selected and
- the safety card is ready and
- the enable switch is activated and
- the start button is pressed (only the start button triggers the movement).

PNOZmulti outputs:

SS1 Activate:	Safe stop 1
SS2 Activate:	Safe stop 2
SLS Activate:	Safely limited speed
SDI Neg Activate:	Safe direction turning left
SDI Pos Activate:	Safe direction turning right
SS1 SIL3/Reset:	To achieve SIL3 and to reset the safety card after an error

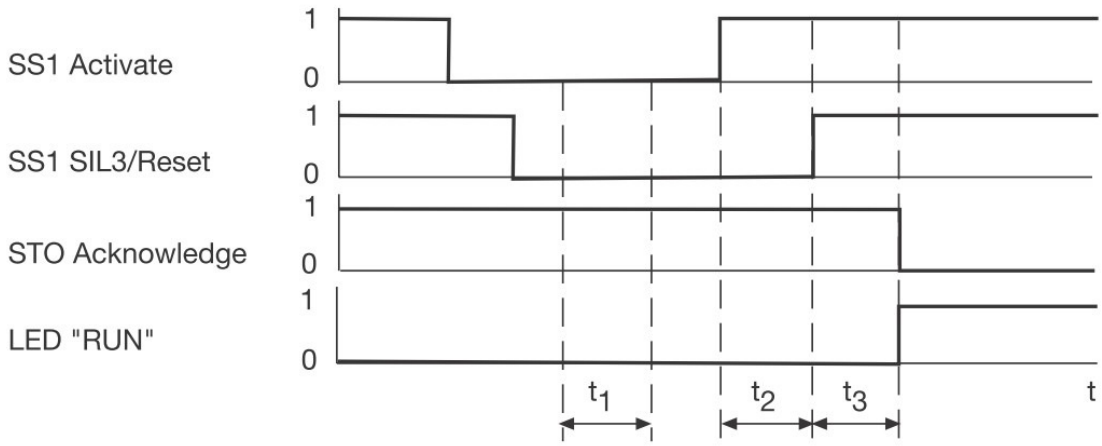
To operate the safety card, the application of the signals SS1 and SS1 SIL3/reset are absolutely necessary.
A reset of the safety card is triggered with these two inputs.
The reset button on the PNOZmulti triggers the necessary signal sequence for the reset at the SS1 and SS1 SIL3/reset of the safety card

Rectify the error, noting:

- The error messages in the error stack
- The LED display.

1. Switch both inputs SS1 activate and SS1 SIL3/reset to 0 V
- The safety card performs the safety function SS1 (Safe Stop 1) and switches to a "STOP" condition. The "FAULT" LED is flashing.

2. Switch both inputs SS1 activate and SS1 SIL3/reset to 24 V.
- The safety card switches to a "STARTUP" condition. The device and the safe pulse disabler are tested. The "RUN" LED flashes.
- The safety card switches to a RUN" condition. The "RUN" LED is lit continuously.



- t1: At least 2 ms; time during which SS1 Activate and SS1 SIL3/Reset must have a "0" signal
- t2: Operating distance SS1 Activate – SS1 SIL3/Reset
- t3: approx. 2 s, safety card's run-up time
- SS1 Activate: Input for safety function SS1
- SS1 SIL3/Reset: Input for SIL3 and reset
- STO Acknowledge: Output for feedback from safety function STO
- “RUN” LED: System is ready

The additional number of outputs depends on the number of safety functions configured on the safety card.

PNOZmulti inputs:

Reset:	Triggers a reset of the safety card.
Start:	Triggers the movement in setting mode.
Ready:	Reads out the operational readiness of the safety card.
STO_ACK:	STO activated.

Inputs for triggering the safety functions:
Depending on the application.

PMC safety assessment

- Hazardous situations must not be allowed to arise due to braking ramps of SS1/SS2 and stopping times.
- The best possible mechanics at the drive (overdimensioning) are assumed (fault exclusion for broken shaft).
- The operator must ensure that the function of the safe pulse disabler is tested periodically, after 8 hours at the latest, by triggering safety functions SS1 or STO:
  - by restarting after safety functions SS1 or STO have been triggered as a condition of operation or
  - by restarting after safety function SS1 has been triggered by the operator (see operating manual).

Overall application safety assessment

- The PNOZmulti and the PMCprotego D and PMCprotego S2 combination must be installed in the same mounting area in order to exclude a short circuit between 24 VDC and a safety input of the card.
- An fault on the PNOZmulti Mini or the PMCprotego D and PMCprotego S2 combination does not lead to the loss of the safety function.

3.2. Functional safety

3.2.1. Safety-related characteristics in accordance with EN ISO 13849-1

No.	Safety function	Performance Level	Safety-related parts of the control system
1	Enable function – releasing or fully depressing the enable switch stops the hazardous movement with Safe Stop2 (SS2) (only specified for setting mode here. Other operating modes are to be observed separately)	PL d	Sensor (enable switch) Sensor (operating mode selector switch) Input (PNOZ m1p) Input (PNOZ m1p) Logic (PNOZ m1p) Output (PNOZ m1p) Actuator (PMCprotego S2)
2	Safely limited speed (SLS) (only specified for setting mode here. Other operating modes are to be observed separately)	PL d	Sensor (operating mode selector switch) Input (PNOZ m1p) Input (PNOZ m1p) Logic (PNOZ m1p) Output (PNOZ m1p) Actuator (PMCprotego S2)
3	Safe direction (SDI) (only specified for setting mode here. Other operating modes are to be observed separately)	PL d	Sensor (operating mode selector switch) Input (PNOZ m1p) Input (PNOZ m1p) Logic (PNOZ m1p) Output (PNOZ mo1p) Actuator (PMCprotego S2)

Prerequisites:

No.	Description		Identification
1	Common cause failure (CCF):		Requirements are considered to be met (must be tested on implementation)
2	Mission time:		20 years
3	Operating interval (electromechanical components)	Sensor	1 operation per 2 hours for enable switch (0.5 per hour)
		Sensor	1 operation per day for operating mode selector switch
4	Enable switch:	B10d	100,000
5	Operating mode selector switch:	B10d	100,000

Please note the further requirements of EN ISO 13849-1, e.g. requirements for avoiding systematic faults.

CAUTION
The calculation of the performance level is only valid when using a PMCtendo motor.

3.2.2. Safety-related characteristics in accordance with EN 62061

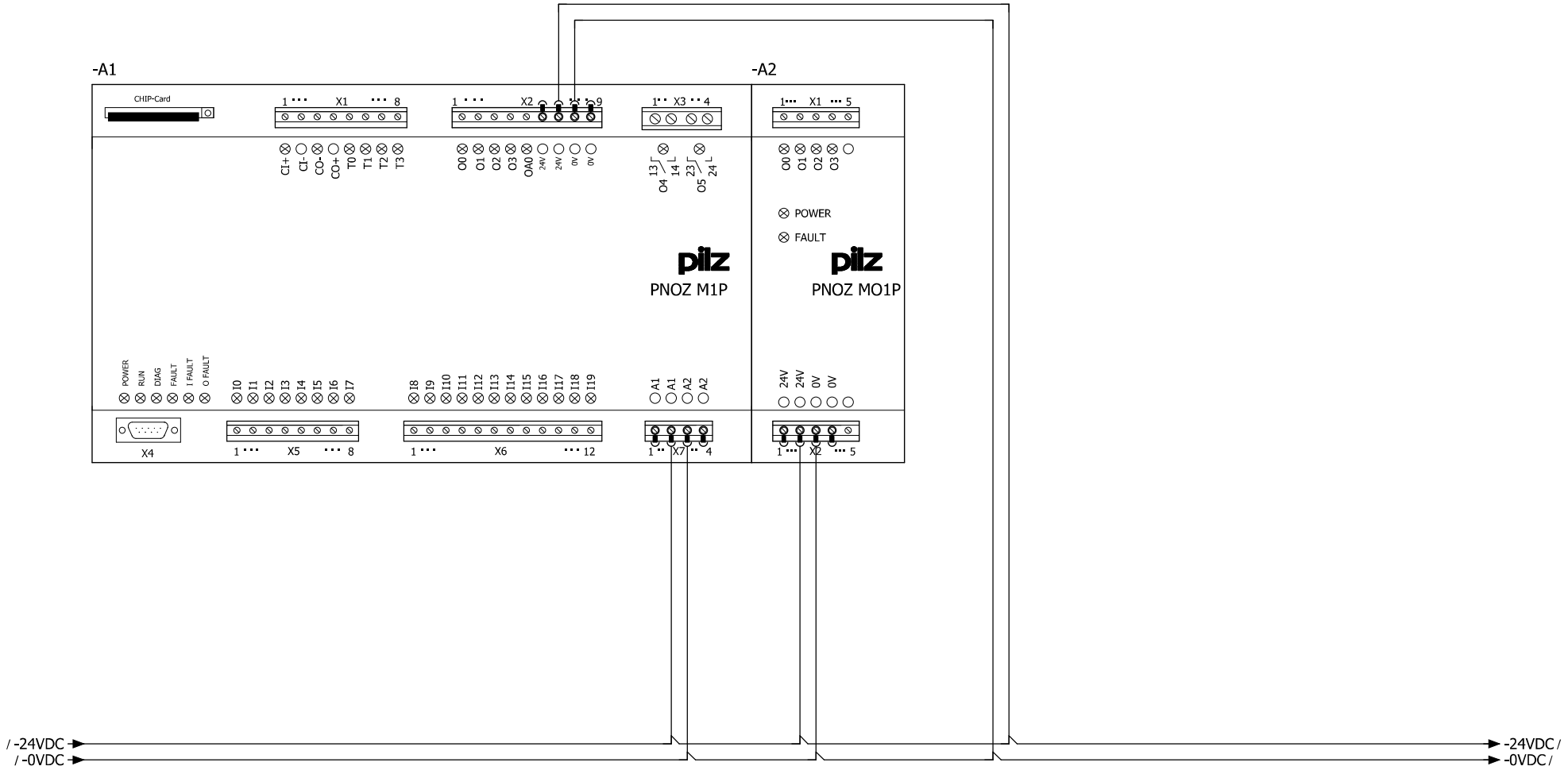
No.	Safety-related control function (SRCF):	Safety Integrity Level	Subsystems
1	Enable function – releasing or fully depressing the enable switch stops the hazardous movement with Safe Stop2 (SS2) (only specified for setting mode here. Other operating modes are to be observed separately)	SIL 2	Sensor (enable switch) Sensor (operating mode selector switch) Input (PNOZ m1p) Input (PNOZ m1p) Logic (PNOZ m1p) Output (PNOZ m1p) Actuator (PMCprotego S2)
2	Safely limited speed (SLS) (only specified for setting mode here. Other operating modes are to be observed separately)	SIL 2	Sensor (operating mode selector switch) Input (PNOZ m1p) Input (PNOZ m1p) Logic (PNOZ m1p) Output (PNOZ m1p) Actuator (PMCprotego S2)
3	Safe direction (SDI) (only specified for setting mode here. Other operating modes are to be observed separately)	SIL 2	Sensor (operating mode selector switch) Input (PNOZ m1p) Input (PNOZ m1p) Logic (PNOZ m1p) Output (PNOZ mo1p) Actuator (PMCprotego S2)

Prerequisites:

No.	Description		Identification
1	Common cause failure (CCF)		ß = 2% (must be tested on implementation)
2	Proof test interval		20 years
3	Operating interval (electromechanical components)	Sensor	1 operation per 2 hours for enable switch (0.5 per hour)
		Sensor	1 operation per day for operating mode selector switch
4	Enable switch:	B10d	100,000
		Dangerous failure rate	50 %
5	Operating mode selector switch:	B10d	100,000
		Dangerous failure rate	50 %

Please note the further requirements of EN 62061, e.g. requirements for systematic safety integrity.

CAUTION
The calculation of the safety integrity level is only valid when using a PMCtendo motor.



Revision	09.03.2011	Date	09.09.2010	EN ISO 13849-1:2006	PL d	Pilz GmbH & Co. KG Felix-Wankel-Strasse 2 D-73760 Ostfildern	Multi supply	Mounting place + AN_1002086_02
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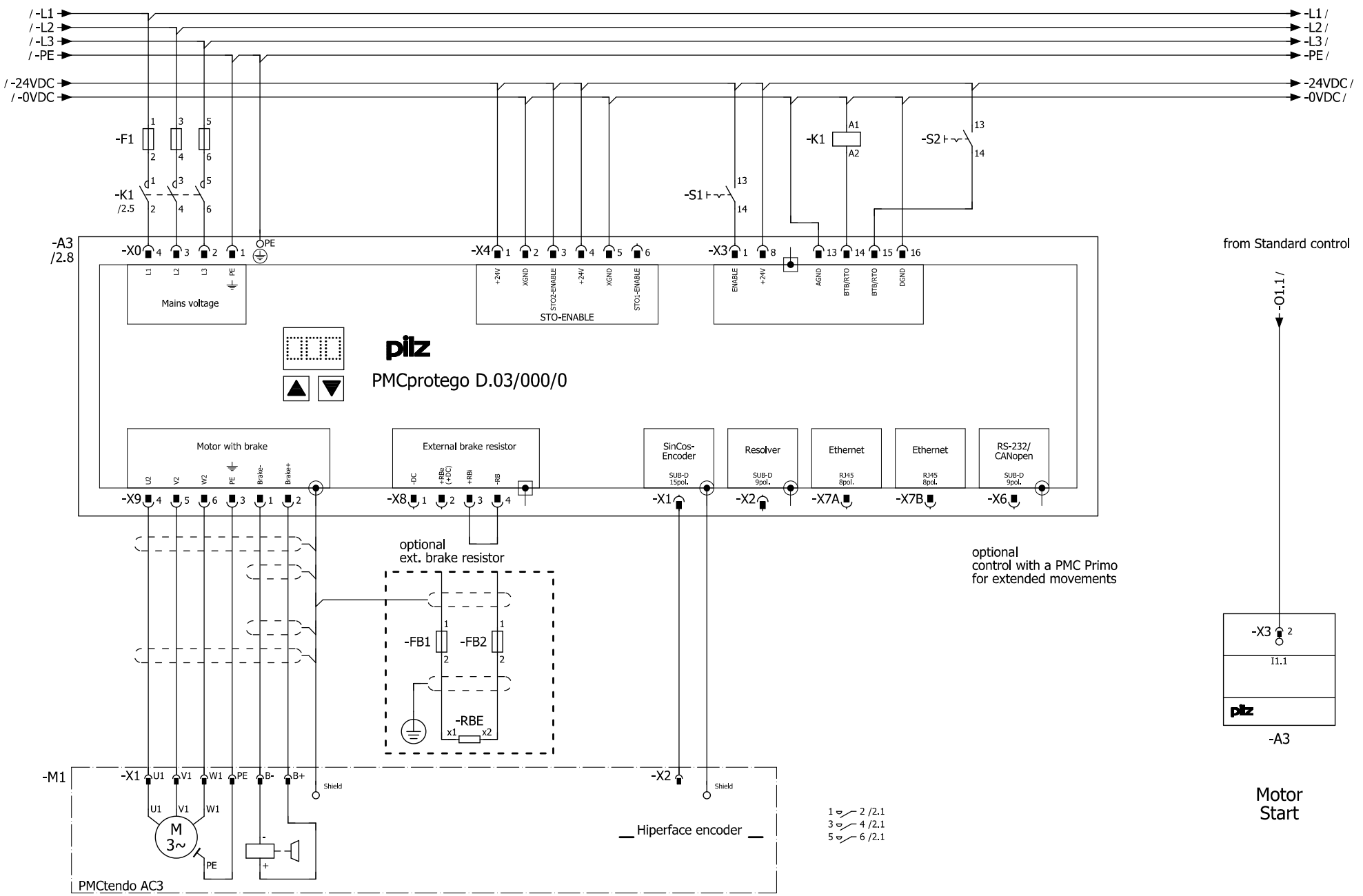
				EN 62061:2005	SIL 2			Page: 1 / 8
		Dep.	CS					



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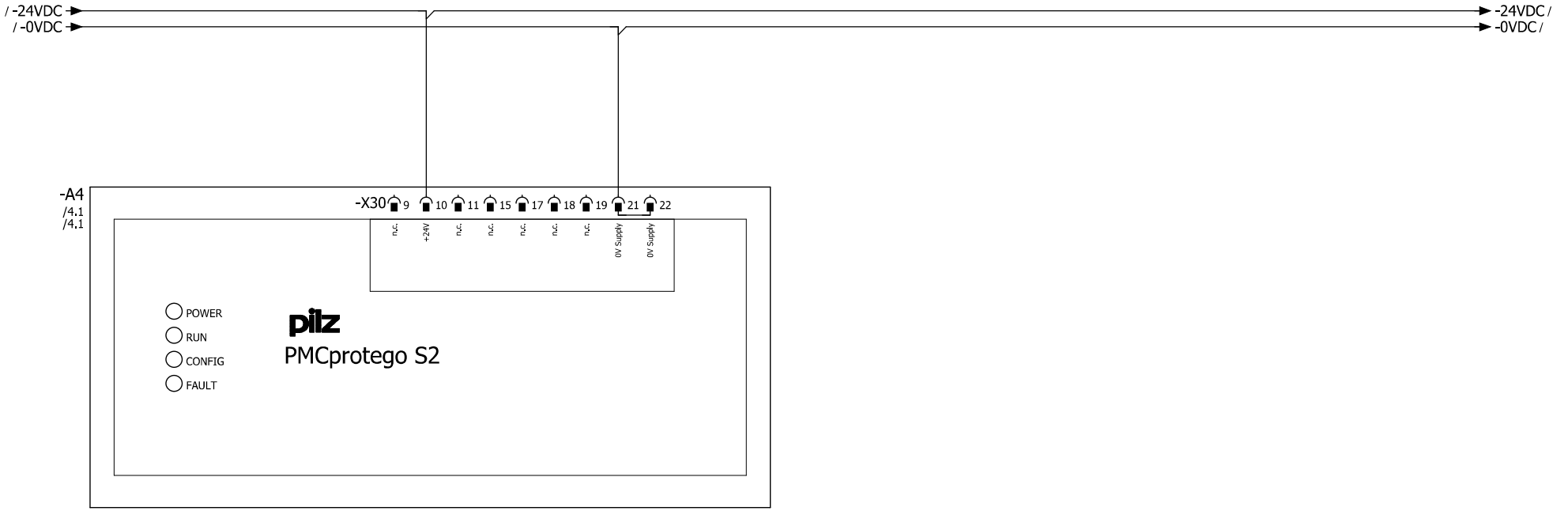

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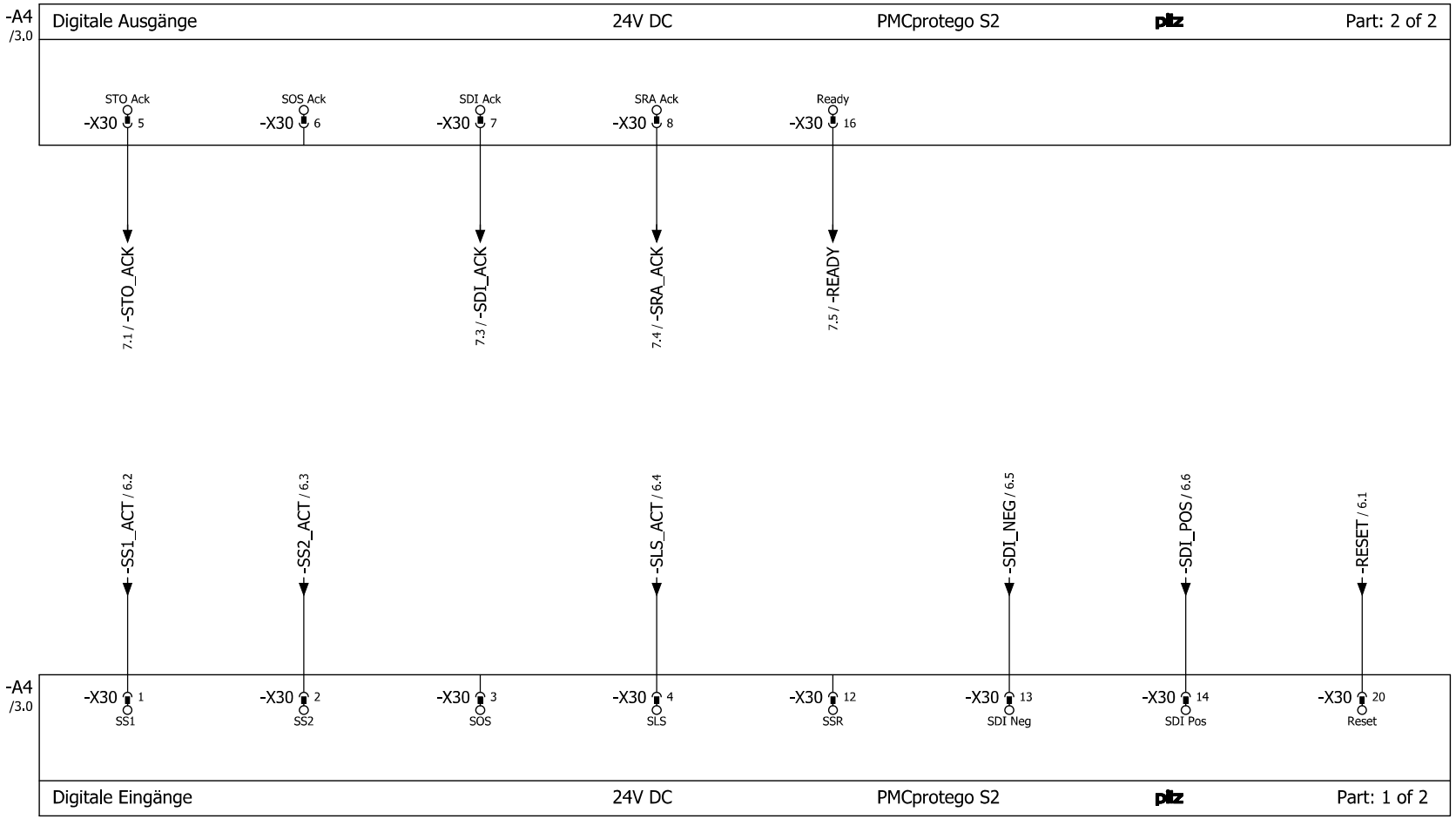

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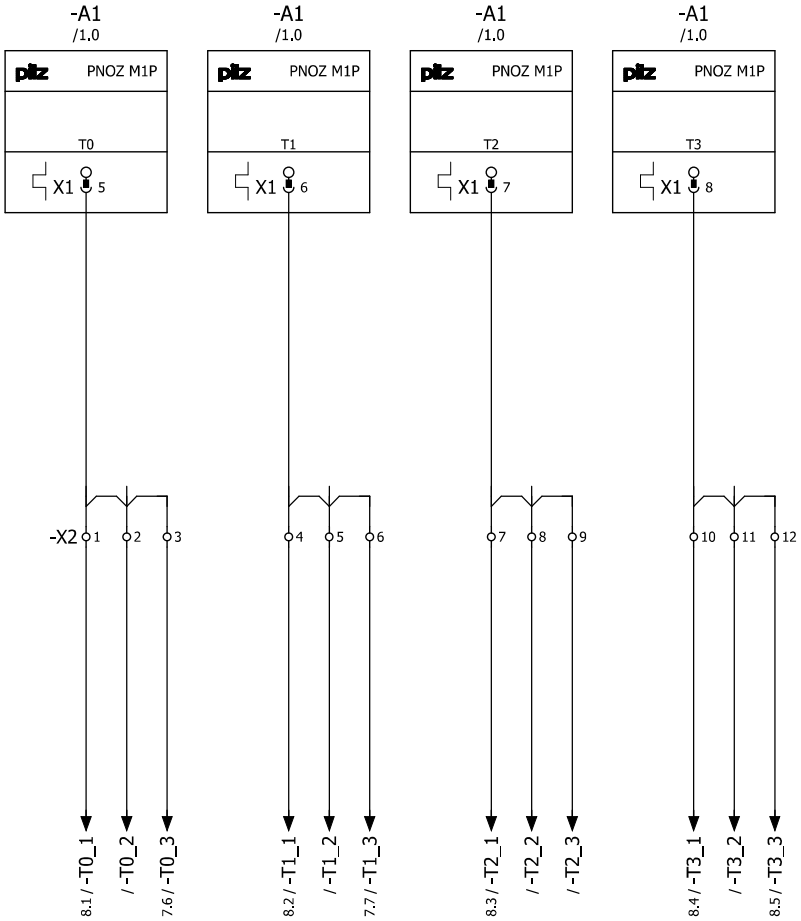

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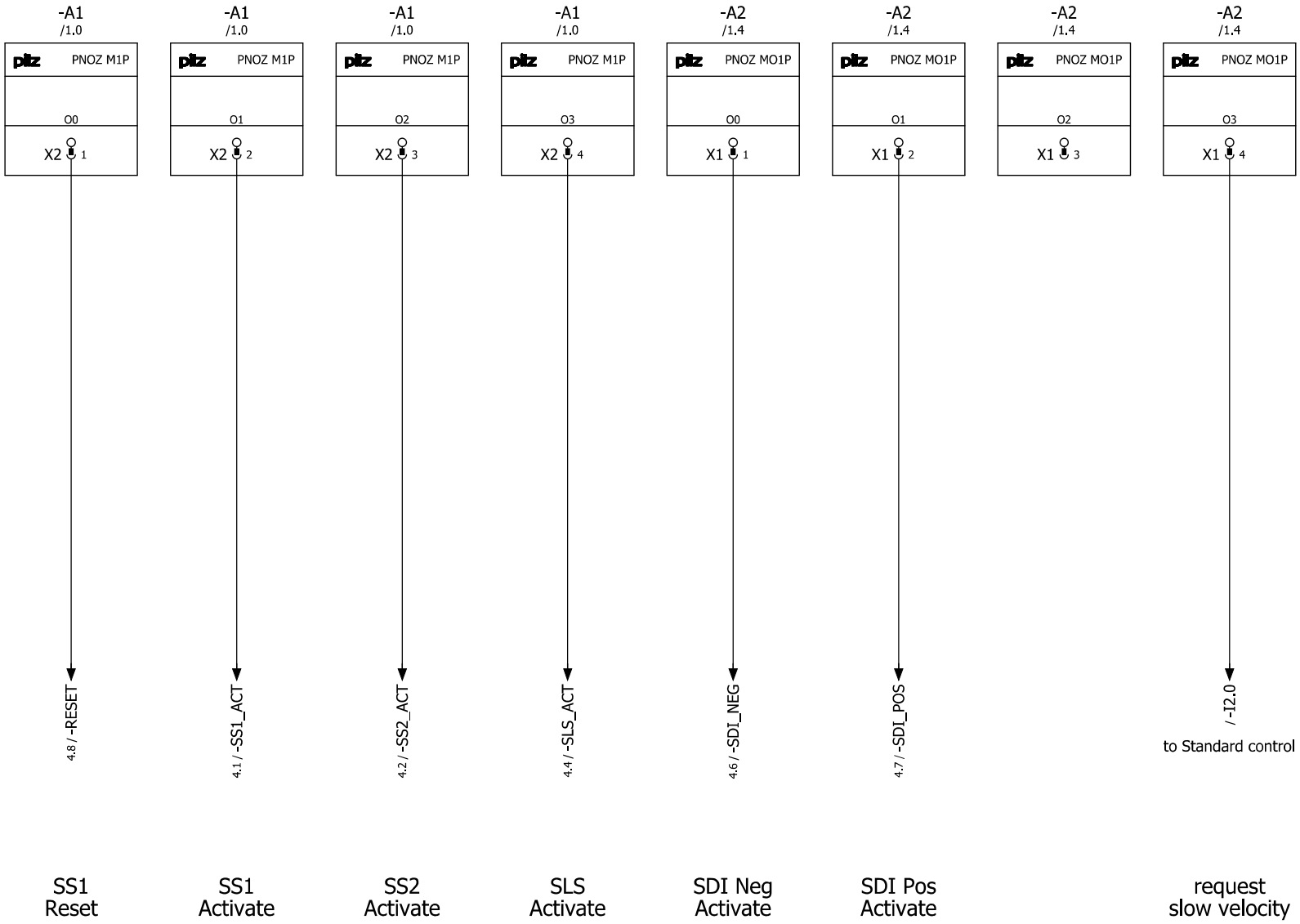

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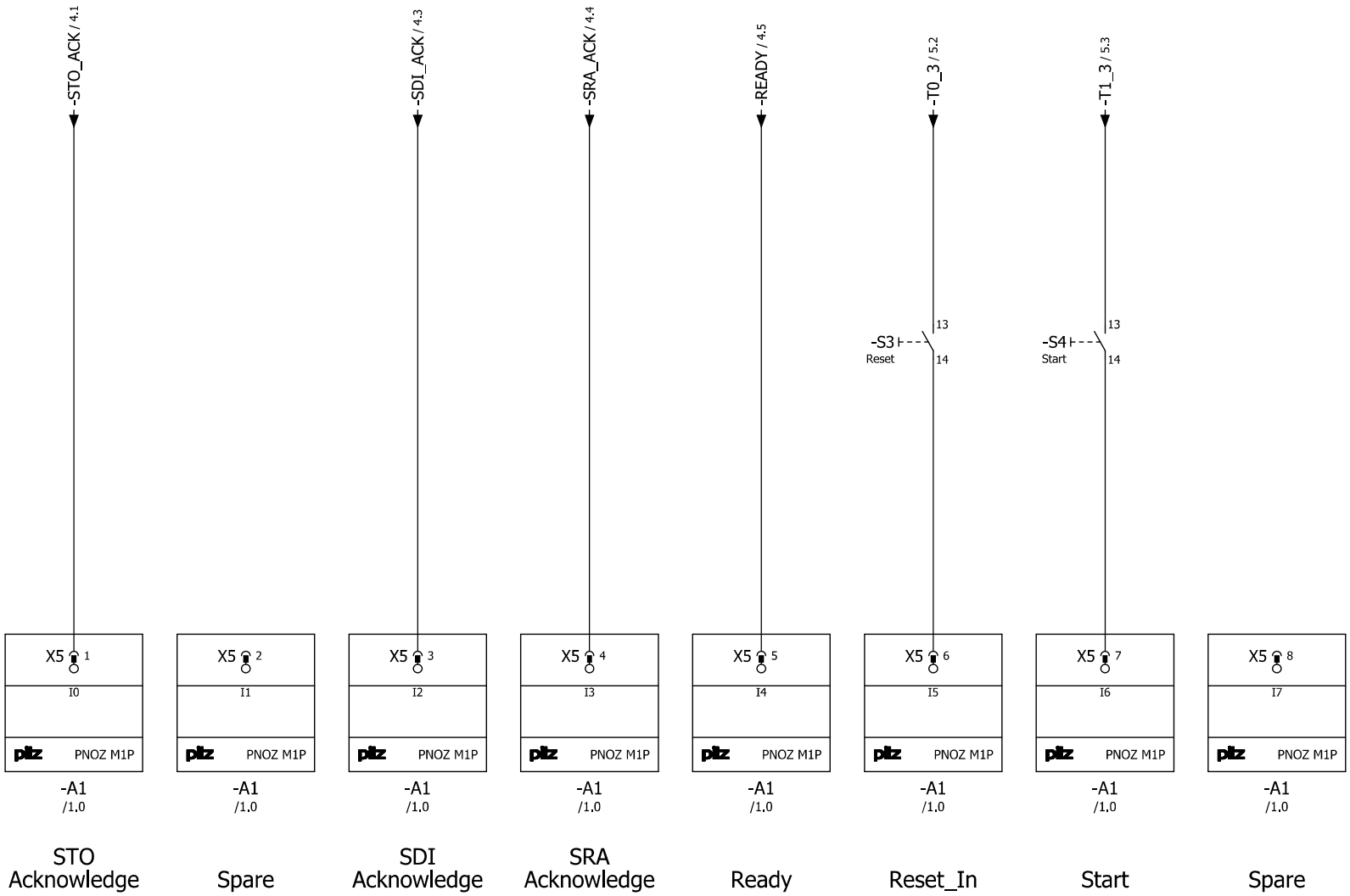

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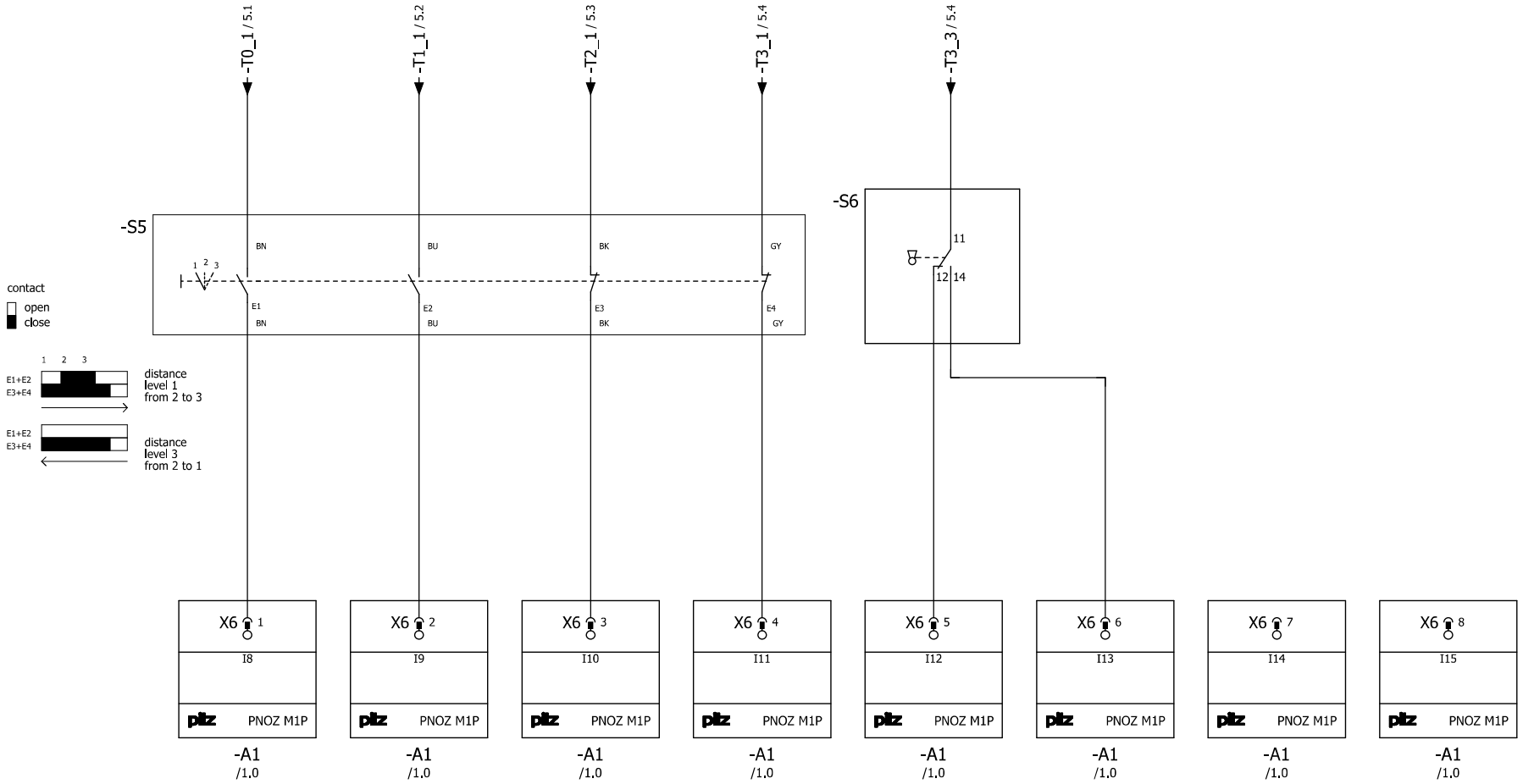

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				EN 62061:2005	SIL 2		Page: 8 / 8
		Dep.	CS				

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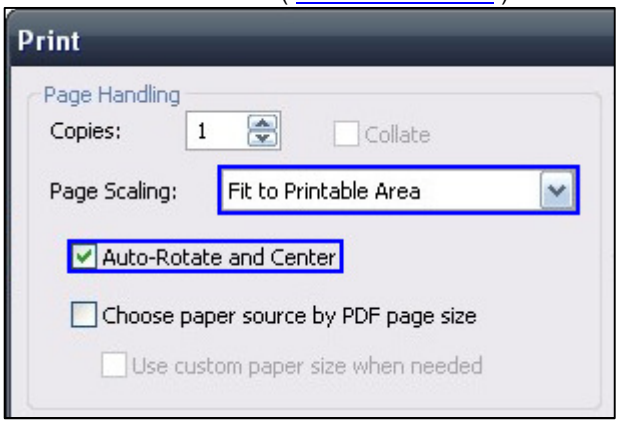
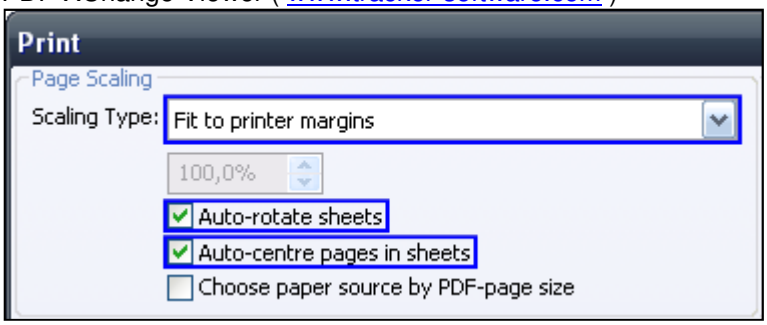
Recommended printer settings

Adobe Acrobat Reader (www.adobe.com)



PDF-XChange Viewer (www.tracker-software.com)



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