



ServoPac-A range

Safe Torque Off specifications

WARNING

This is a specific manual describing the *Safe Torque Off* function of the ServoPac-A amplifier range having output capability suitable for driving AC brushless sinusoidal servo motors.

It must be used in conjunction with the Installation and User manuals of the various ServoPac-A amplifiers (TTA, TTA-CAN, TTA-PRO).

Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the amplifiers operational.

Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.

The conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the amplifier manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.



Any contact with electrical parts, even after power down, may involve physical damage. Wait for at least 5 minutes after power down before handling the amplifiers (a residual voltage of several hundreds of volts may remain during a few minutes).

**ESD INFORMATION (ElectroStatic Discharge)**

TRANSTECHNIK amplifiers are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the amplifiers are not properly stored and handled.

STORAGE

- The amplifiers must be stored in their original package.
- When taken out of their package, they must be stored positioned on one of their flat metal surfaces and on a dissipating or electrostatically neutral support.
- Avoid any contact between the amplifier connectors and material with electrostatic potential (plastic film, polyester, carpet...).

HANDLING

- If no protection equipment is available (dissipating shoes or bracelets), the amplifiers must be handled via their metal housing.
- Never get in contact with the connectors.

**ELIMINATION**

In order to comply with the 2002/96/EC directive of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), all TRANSTECHNIK devices have got a sticker symbolizing a crossed-out wheel dustbin as shown in Appendix IV of the 2002/96/EC Directive.

This symbol indicates that TRANSTECHNIK devices must be eliminated by selective disposal and not with standard waste.

TRANSTECHNIK does not assume any responsibility for any physical or material damage due to improper handling or wrong descriptions of the ordered items.

Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

TRANSTECHNIK reserves the right to change any information contained in this manual without notice.

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Chapter 1 – General description

Safe Torque Off (STO) definition according to the EN 61800-5-2 standard:

"Power, that can cause the rotation of a motor (or displacement in the case of a linear motor), is not applied to the motor. The drive will not provide energy to the motor which can generate torque (or force in the case of a linear motor)".

The STO function corresponds to an uncontrolled stopping in accordance with the stop category 0 of the EN 60204-1 standard.

The STO function may be used where power removal is required to prevent an unexpected start-up.

In circumstances where external influences (with vertical loads for example) are present, additional measures (mechanical brakes for example) may be necessary to prevent any hazard.

The standard output of the drive must not be considered as a safe output. When using a mechanical brake, it will be mandatory to introduce a safe contact from an external device in the brake actuation line.

The STO function cannot be considered as a safe insulation device for the motor. It does not prevent from any voltage on the motor terminal block.

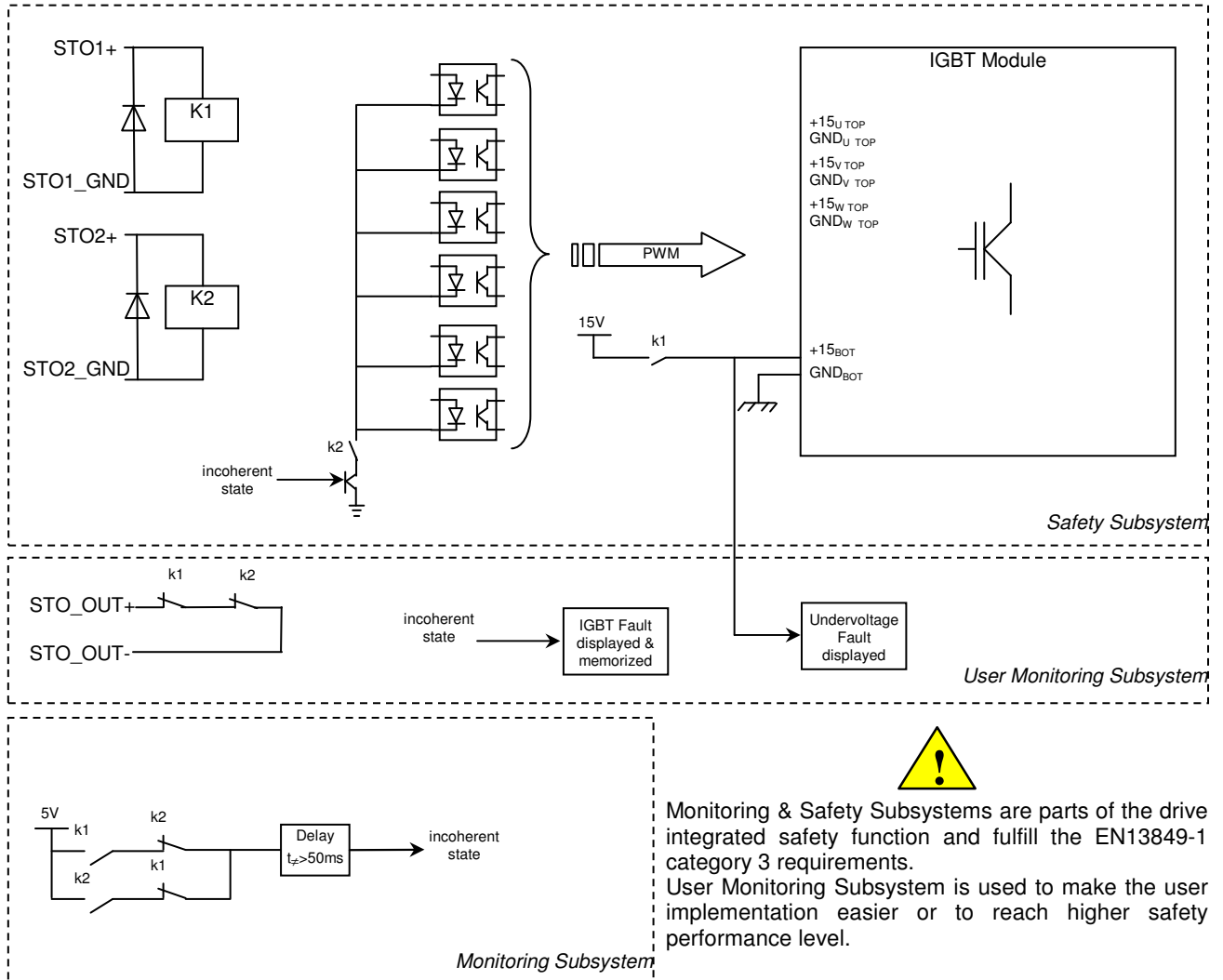
The integrated STO function fulfills the EN13849-1 category 3 requirements.

Chapter 2 – Specifications

1 - FUNCTIONAL DIAGRAM

The "Safe Torque Off" function allows to keep the motor shaft free by avoiding the IGBT module commutation. This is achieved by means of two techniques:

- IGBT command supply removal,
- PWM removal.



2 - COMMAND SYSTEM CONCEPTION

2.1 – SAFETY INSTRUCTIONS

The integration of the STO function must be the result of a risk analysis of the complete machine. All control components must comply with the requirements of this risk analysis.
Installing and commissioning of safety functions must be performed by skilled personnel only.

Short-circuit avoidance:

Install the drive in a control cabinet with a minimum IP54 protection.

Avoid control signals proximity. Any short-circuit between two control signals must be detected:

- the short circuit will either be detected by the circuit-breaking system (fuse for example); in this case, the voltage reference is grounded, and shielded pair cables must be used (shield is connected to the ground), or ribbon cable with all unused wires connected to the ground to prevent proximity with hot potential signals
- or a short-circuit detection device must be integrated.

Take care that, as the STO function performs the motor power removal without shutting down the power supply, electrical risks remain unchanged when the STO function is active or inactive.

In case of applications with vertical axes, additional measures (mechanical brake) may be necessary.

Refer to the EN13849-2 standard for any complementary information.

2.2 - STO CONNECTOR: X20

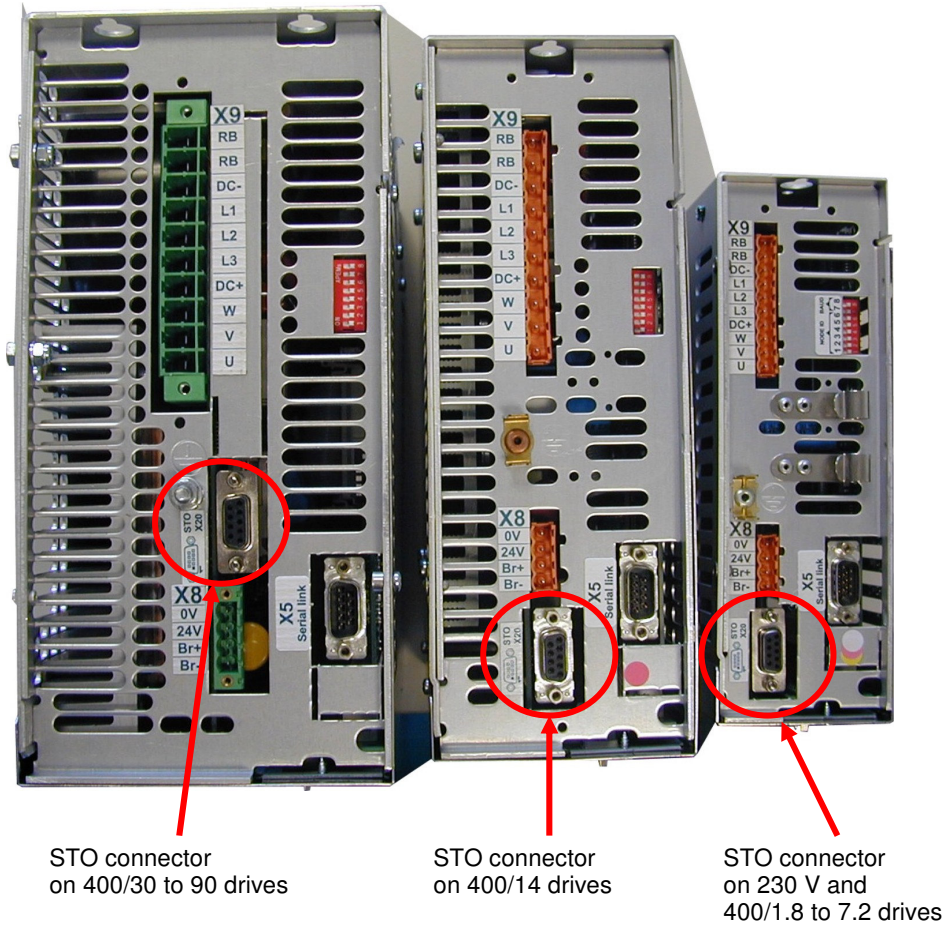
SUB D 9 pins female connector

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	STO1+	I	STO input channel 1	24 Vdc – 720 Ω , STO enabled on low state
2				
3	STO2+	I	STO input channel 2	24 Vdc – 720 Ω , STO enabled on low state
4				
5	STO_OUT+	O	NC contact	24 Vdc – 2A.
6	STO1_GND	I	0V channel 1	
7	STO2_GND	I	0V channel 2	
8				
9	STO_OUT-	O	NC contact	24 Vdc – 2A

During the installation, take care to avoid proximity between any STO signal and high potential.

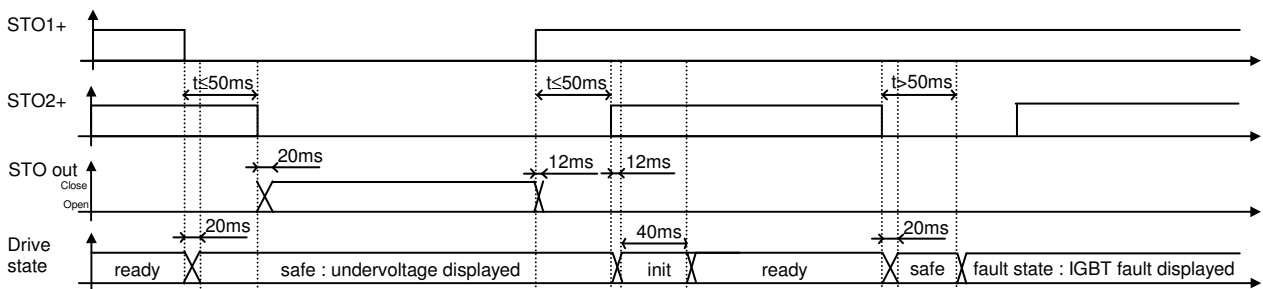
STO connector location

Drive top view



2.3 – TIMINGS

The STO function is based on forcibly guided relays technology. Its response time is given by the typical Operate Time /Release Time of the relay: 12 ms / 20 ms. However, an additional delay of 300ms after STO inputs are high is necessary before enable/inhibit signal activation as mentioned on the following chronogram:



The STO function has two feedbacks: the "STO_OUT" contact and the Undervoltage fault. The Undervoltage fault cannot be used as a safe information. Only the output "STO_OUT" is a safe output. An incoherent state detected between inputs STO1 and STO2 leads to a fault state. The displayed code is "IGBT module fault".

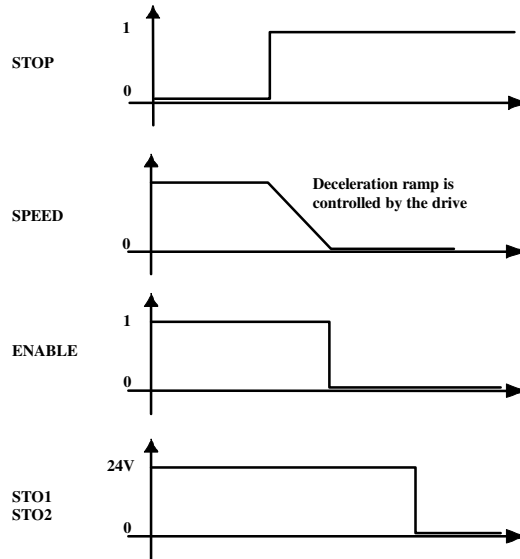


Take care to automatic restart: The undervoltage event prevents TTA-CAN and TTA-PRO in profibus mode to restart automatically when STO1 and STO2 go high. On TTA and TTA-PRO drives in standalone mode, additional measures must be taken to prevent any automatic restart.

Used alone, the STO function corresponds to an uncontrolled stop in accordance with stop category 0 of the EN 60204-1 standard. So, this function is suitable to machines with low inertia or high resistive torque.

When using high inertia or low resistive torque machines, the user should initiate a controlled stop. To achieve a controlled stop in accordance with stop category 1 of the EN 60204-1 standard, the control system of the machine must generate the following sequences:

- Deceleration of the load by means of the drive control 0 speed input of the TTA amplifier or sending of a 0 speed set point by the network,
- When the load is at standstill or almost, shutting down of the PWM by opening “enable/inhibit signal” using digital input or network signal when connected.
- Finally activation of the STO function.



2.4 - PERFORMANCE LEVEL

The **Safe Torque Off** function complies with the EN13849 standard. Detailed features are listed below in an intensive application (180000 cycles/year):

- $MTTF_d = 110$ years \Rightarrow $MTTF_d$ denotation is high,
- $DC_{MOY} = 97\%$ \Rightarrow Diagnostic coverage denotation is medium,
- CCF estimation = 70% \Rightarrow EN13849 prescriptions are fulfilled.

According to these results, the Safe Torque Off function reaches a performance level up to PLe. However, the simplified method for evaluating this performance level limits this value to PLd.

The Safe Torque Off function fulfills category 3 /PLd

(*) see attached certification.

2.5 - PERIODIC INSPECTION ROUTINE

The well-working of the function needs to be checked at least once a year and during the validation of the machine safety functions.

This goal of this procedure is to verify that all subsystems of the safety function are operational. The command system must integrate a checking mode reserved to an operator aware of potential risks due to a bad operation of the safety system.

At each step of the inspection, PWMs have to be allowed by the enable/inhibit signal.

Step N°	Input		State	
	STO1	STO2	STO_OUT	Description
1	1	1	open	The motor is powered, no fault is displayed
2	0	1	open	The motor is free, "IGBT module fault" is displayed and memorized
3	1	1	open	The motor is powered, no fault is displayed
4	1	0	open	The motor is free, "IGBT module fault" is displayed and memorized
5	1	1	open	The motor is powered, no fault is displayed
6	0	0	close	The motor is free, "undervoltage fault" is displayed

At each step, the operator must verify that:

- the motor provides or not torque,
- the STO_OUT contact is in the correct state.

If the drive behavior is different from the one described in the table above, the drive must be replaced.

2.6 - RESIDUAL RISK

In case of a short-circuit between two power transistors, there is a residual risk of motor shaft rotation that can reach: $\frac{360^\circ}{2p}$ (2p: number of motor poles).



Take care of electrical risks, as the STO function achieves the motor power removal without shutting down the power supply and there is no galvanic insulation.

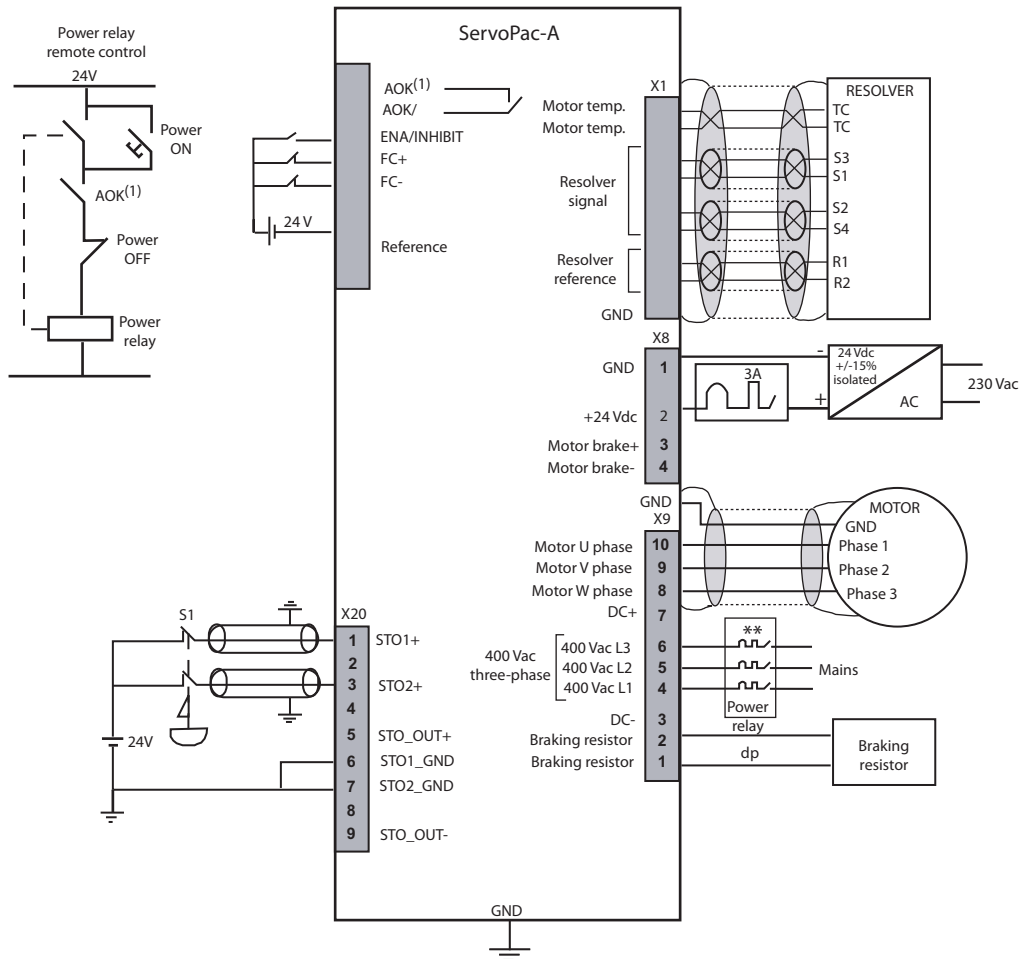
2.7 - CONNECTION DIAGRAM EXAMPLES

Following diagram examples are given to make the integration of the safety function easier. The integration of the STO function must be the result of a risk analysis of the complete machine.

2.7.1 – Example 1: Stop category 0 according to EN 60204-1

(complying with EN13849-1 category 3).

Low inertia axis application / high resistive torque



(1) CAUTION ! $I_{max} = 100 \text{ mA}$ (See AOK output specifications).

⚠ See installation manuals of the ServoPac-A servodrives for the complete connection description

Please note that the motor control must be disabled either by means of a network command or by means of the Inhibit/Enable input.

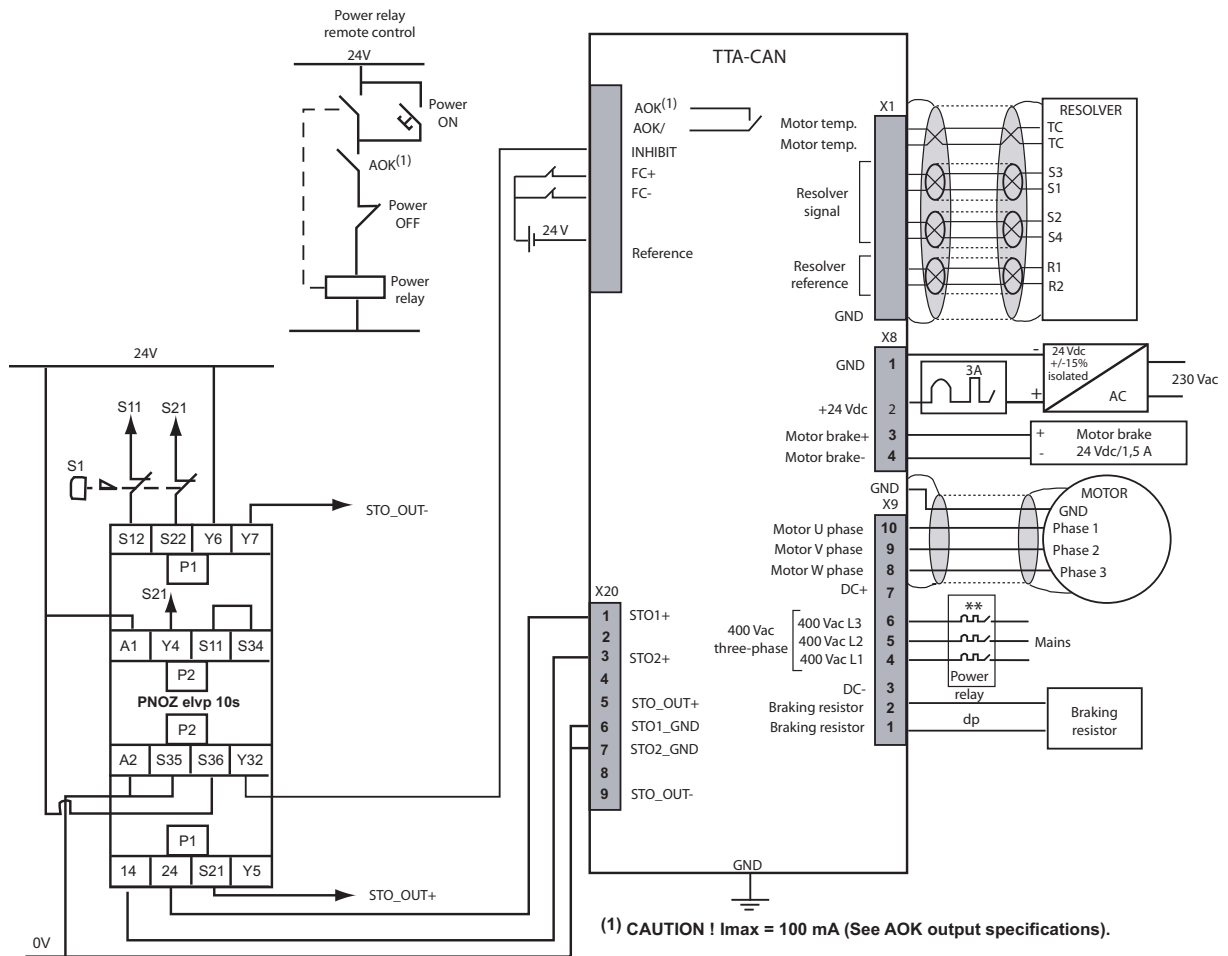
2.7.2 – Example 2: Stop category 1 according to EN 60204-1

(complying with EN13849-1 category 3).

High inertia axis application / low resistive torque

In the following diagram, only the STO integration is safe. The deceleration ramp is not safe according to EN13849-1 because it uses a common drive function.

TTA-CAN connection example:



⚠ For the installation of the safety relay, see PILZ PNOZ e 1vp manuals.
See installation manuals of the ServoPac-A servodrives for the complete connection description.

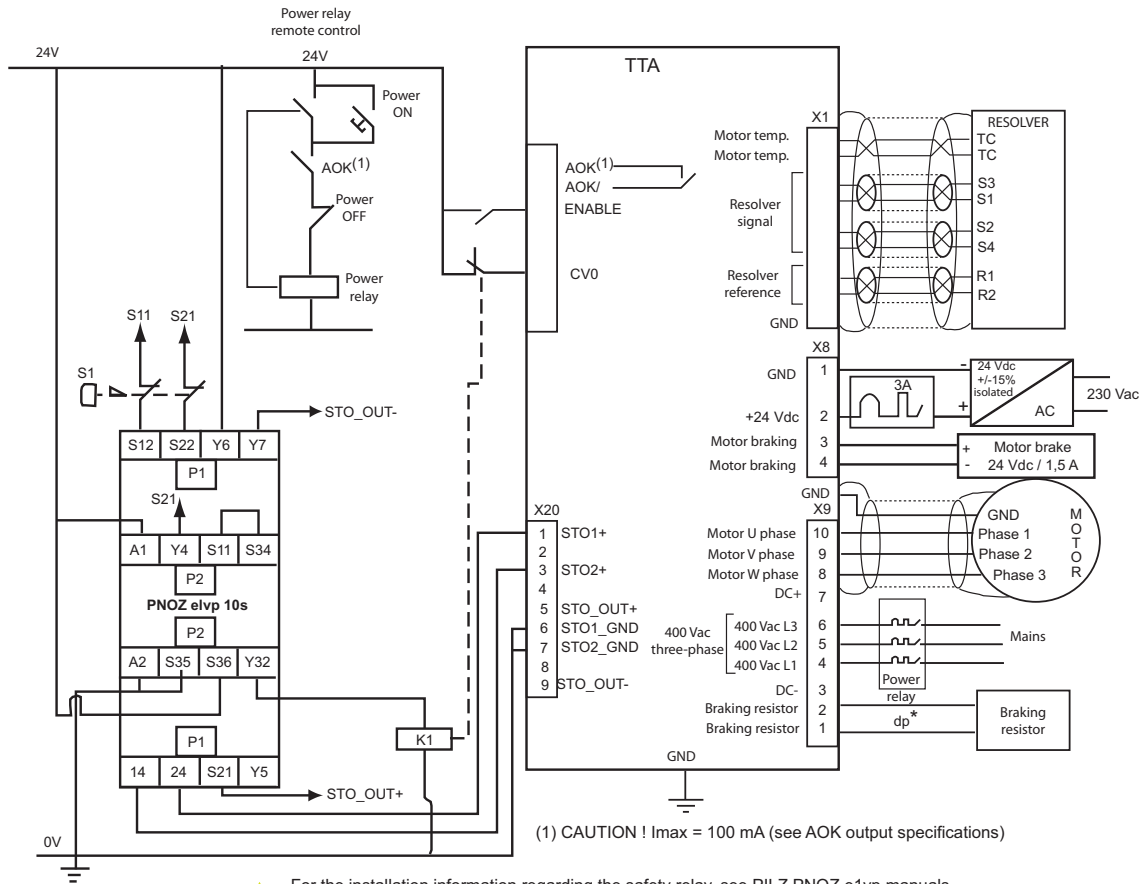
In the connection diagram example above, the PILZ safety relay orders the servodrive to decelerate by the INHIBIT signal, and after a safety delay of 0.5 s, it activates the STO function of the drive.

Note that the behavior of the servodrive on the INHIBIT signal activation has to be setup in the appropriate mode (i.e. speed ramp deceleration) prior to any stop procedure.

In this example diagram, the user does not need to use shielded cables because the PILZ safety relay detects short-circuits.

The output used to generate the Inhibit/Enable signal does not need to be a safety one because only the STO function is safe according to EN13849-1 category 3.

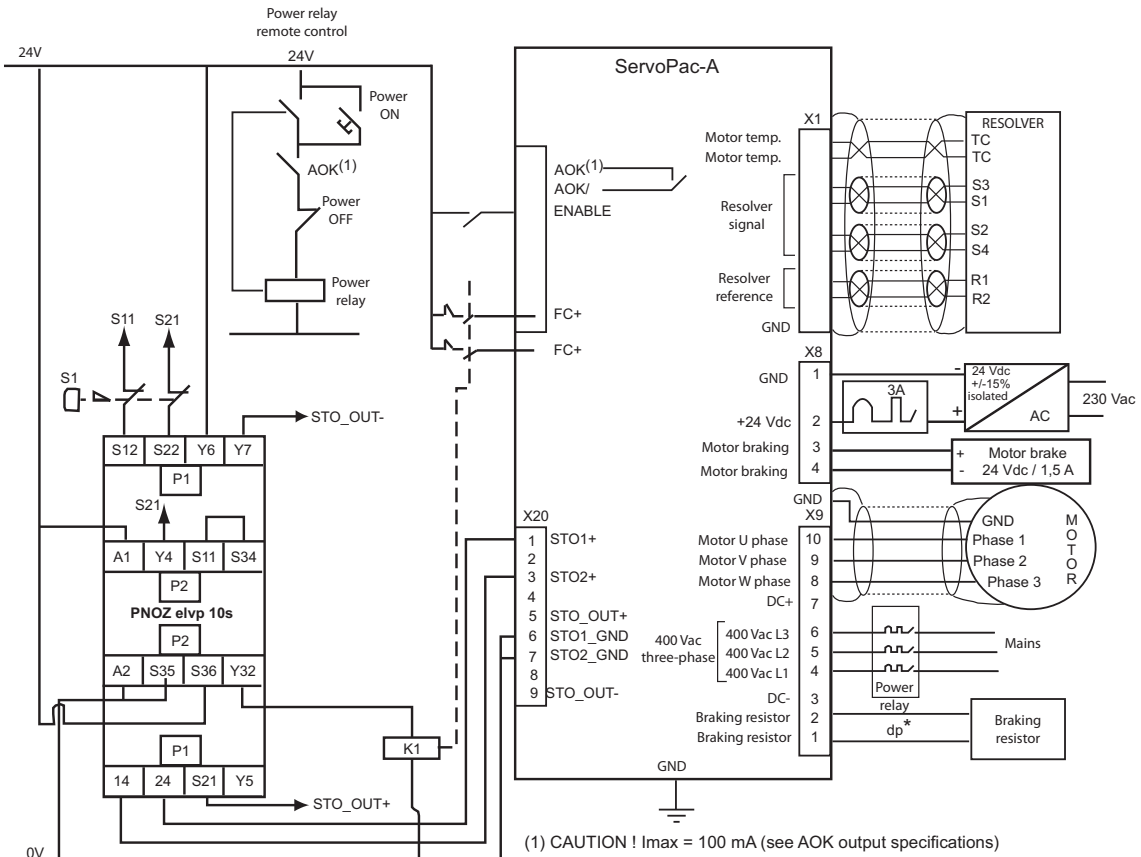
TTA connection example:



For the installation information regarding the safety relay, see PILZ PNOZ e1vp manuals.
See installation manuals for the complete connection description of the ServoPac-A servodrives.

In the above connection diagram, the PILZ safety relay gives the servodrive the instruction to decelerate by the CV0 signal, and after a safe delay of 0.5 s it activates the drive STO function.
On an TTA drive, the CV0 input can be used to generate the deceleration ramp. However, this input has a different function from the Inhibit/Enable input of the other drives. Take care to setup the deceleration ramp time before any stopping procedure.
In this example, the user does not need to use shielded cables because the PILZ safety relay detects short-circuits.
The auxiliary K1 N/C relay does not need to be a safety relay because only the STO function is safe according to EN13849-1 category 3.
Please note that the motor control must be disabled either by means of a network command or by means of the Enable input.

TTA, TTA-CAN and TTA-PRO connection example:



For the installation information regarding the safety relay, see PILZ PNOZ e1vp manuals.
See installation manuals for the complete connection description of the ServoPac-A servodrives.

In the above connection diagram, the PILZ safety relay gives the servo-drive the instruction to decelerate by the FC+ and FC- signals, and after a safe delay of 0.5 s it activates the drive STO function. On ServoPac-A drives, these inputs can be used to generate the deceleration ramp at I_{max} . In this example, the user does not need to use shielded cables because the PILZ safety relay detects short-circuits.

The auxiliary K1 N/C relay does not need to be a safety relay because only the STO function is safe according to EN13849-1 category 3.

Please note that the motor control must be disabled either by means of a network command or by means of the Enable input.

Chapter 3 – Appendix

1 – ORDERING CODE

Single-axis version:

