

# Solutions in *motion*

## EASY

Safe Torque Off



Intelligence Production Movement

**WARNING**

This manual describes a series of servo drives having output capability suitable for driving AC brushless sinusoidal servo motors.

Please see also:

- **EASY Installation Guide** for the hardware installation of the drive (mounting, wiring, ...)
- **EASY User Guide** for the operation of the drive (commissioning, configuration, ...)
- **Gem Drive Studio software Quick Start** manual for the drive parameterization.

**Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the drives 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 drive 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 10 minutes after power down before handling the drives (a residual voltage of several hundreds of volts may remain during a few minutes).

**ESD INFORMATION (Electrostatic Discharge)**

CMZ Sistemi Elettronici S.r.l. drives are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the drives are not properly stored and handled.

**STORAGE**

- The drives 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 drive connectors and material with electrostatic potential (plastic film, polyester, carpet...).

**HANDLING**

- If no protection equipment is available (dissipating shoes or bracelets), the drives must be handled via their metal housing.

**WASTE DISPOSAL**

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 CMZ Sistemi Elettronici S.r.l. devices are labelled with a sticker symbolizing a crossed-out dustbin as shown in Appendix IV of the 2002/96/EC Directive.

This symbol indicates that CMZ Sistemi Elettronici S.r.l. devices shall be eliminated by selective disposal and not with household waste.

CMZ Sistemi Elettronici S.r.l. 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.

CMZ Sistemi Elettronici S.r.l. 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)".

Used alone, 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 (e.g. mechanical brakes) may be necessary to prevent any hazard.

When using a mechanical brake, it will be mandatory to introduce a safe contact from an external device into 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 EN ISO 13849-1:2017 category 1 PLc requirements.**

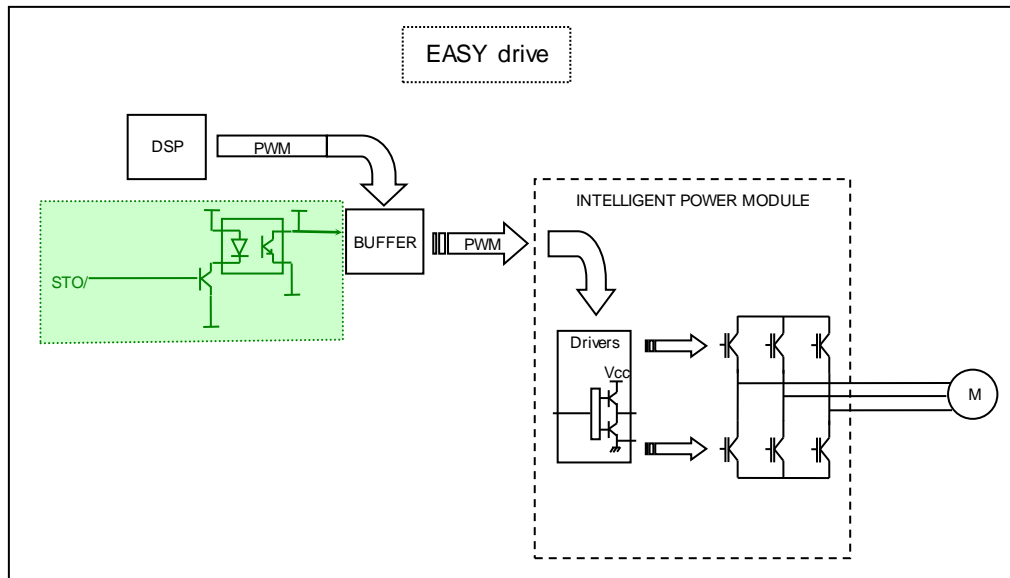
**PLc corresponds to SIL1, according to "Table 4 - Relationship between PL and SIL" of the 13849-1 standard.**

## Chapter 2 - Specifications

### 2.1 - FUNCTIONAL DIAGRAM

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

- IGBT command supply removal,
- PWM removal.



The different parts of the functional diagram are described below:

- The green part is the channel of the safety function. PWM signals are disabled by inhibiting the buffer commutation.
- The black part is the functional part of the drive which is not used to achieve the safety function.

### 2.2 - COMMAND SYSTEM CONCEPTION

#### 2.2.1 - Safety instructions

The integration of the STO function must be the result of a risk analysis of the global machine. All control components must comply with the requirements of this risk analysis.

Installing and commissioning of safety functions must be performed by a skilled staff only.

Short-circuit avoidance:

Install the drive in a control cabinet with at least an 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 (e.g. fuse); in this case, the voltage reference is grounded and shielded pair cables must be used (shield is connected to the ground) or a 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.

Since the STO function performs the motor power removal without shutting down the power supply, take care that electrical risks are remaining when the STO function is active or inactive.

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

Please, refer to the EN13849-2 standard for any complementary information.

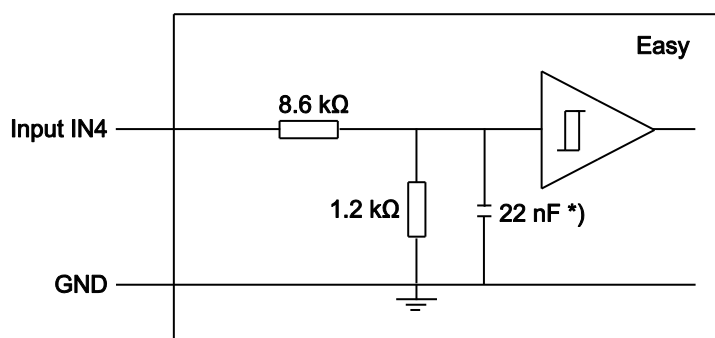
## 2.2.2 - STO connection

### 2.2.2.1 - Inputs - Outputs connector: X2

SUB D 15 PIN MALE HD CONNECTOR

PIN	FUNCTION	I/O	DESCRIPTION
4	STO/	I	All logic inputs are referenced to the ground Vin voltage = 18 V < Vin < 30 V Input impedance Zin = 10 kOhms

### 2.2.2.2 - Specification of logic input IN4

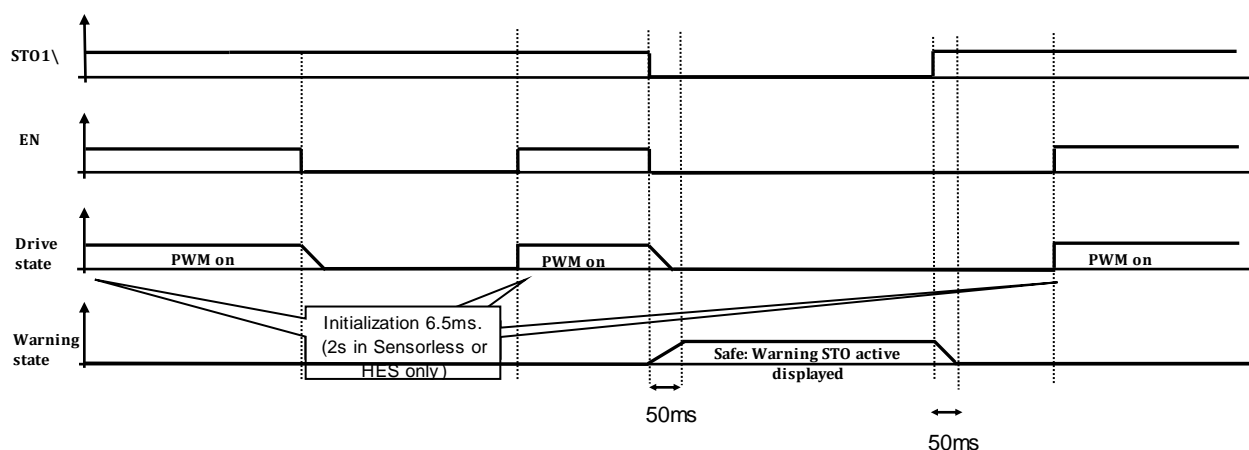


\*) From serial number 11420004, the capacitor value is 10  $\mu$ F for the IN4 input only, in order to support safety relays with test pulse output (for short-circuit detection).

## 2.2.3 - Timings

The STO function has an activation / release response time of max. 50 ms.

However, an additional delay of 6.5 ms is necessary for initialization before PWM becomes active, and 2 s in "Sensorless" or "HES only" feedback, as mentioned on the following chronogram :



The STO function feedback is available in object:

- 0x3024,0 bit 0: STO active warning.

All these state feedbacks are provided for information purpose only and cannot be used as safe information.

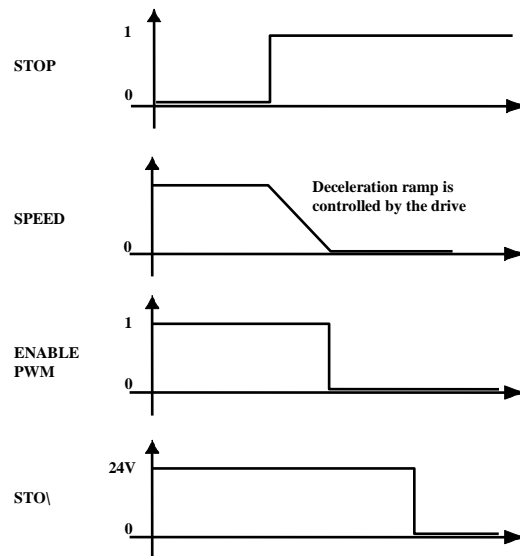


When the STO function is disabled, the restart of the machine should only be possible by an explicit demand of the host controller to prevent unexpected automatic restart.

Used alone, the STO function corresponds to an uncontrolled stop in accordance with stop category 0 of the EN 60204-1 standard (see 3.1 – Example 1: Stop category 0). So, this function is suited for 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 (see 3.2 – Example 2: Stop category 1), the control system of the machine must generate the following sequences:

- Deceleration of the load by means of the drive control,
- Disabling of the PWM when the load is at standstill or almost,
- Finally, activation of the STO function.



## 2.2.4 - Performance level

The **Safe Torque Off** function fulfills **category 1 /PLc** <sup>(1)</sup> requirements of the EN ISO 13849-1:2017 standard. **PLc** corresponds to **SIL1** according to "Table 4 - Relationship between PL and SIL" of the EN ISO 13849-1:2017 standard.

To achieve overall PL by combining safety related parts in series, please refer to section 6.3 of the 13849-1 standard:



PL <sub>Low</sub>	N <sub>Low</sub>	⇒	PL
a	>3	⇒	None, not allowed
	≤3	⇒	a
b	>2	⇒	a
	≤2	⇒	b
c	>2	⇒	b
	≤2	⇒	c
d	>3	⇒	c
	≤3	⇒	d
e	>3	⇒	d
	≤3	⇒	e

**NOTE:** The values calculated for this look-up table are based on reliability values at the mid-point for each PL.

Additional specifications:

- MTTFd = 628 years
- Average diagnostic coverage: None

## 2.2.5 - Periodic inspection routines

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

The 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 wrong operation of the safety system. It is highly recommended to get the operator signing a register in order to sensitize him.

STEP N°	INPUT STO/	STATE	
		MOTOR	DESCRIPTION
1	1	Powered	STO Warning is not displayed.
2	0	Free	STO active warning is displayed.

At each step, the operator must verify whether the motor is providing torque or not.

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

## 2.2.6 - Residual risk

In case of 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 performs the motor power removal without shutting down the power supply and as there is no galvanic insulation.



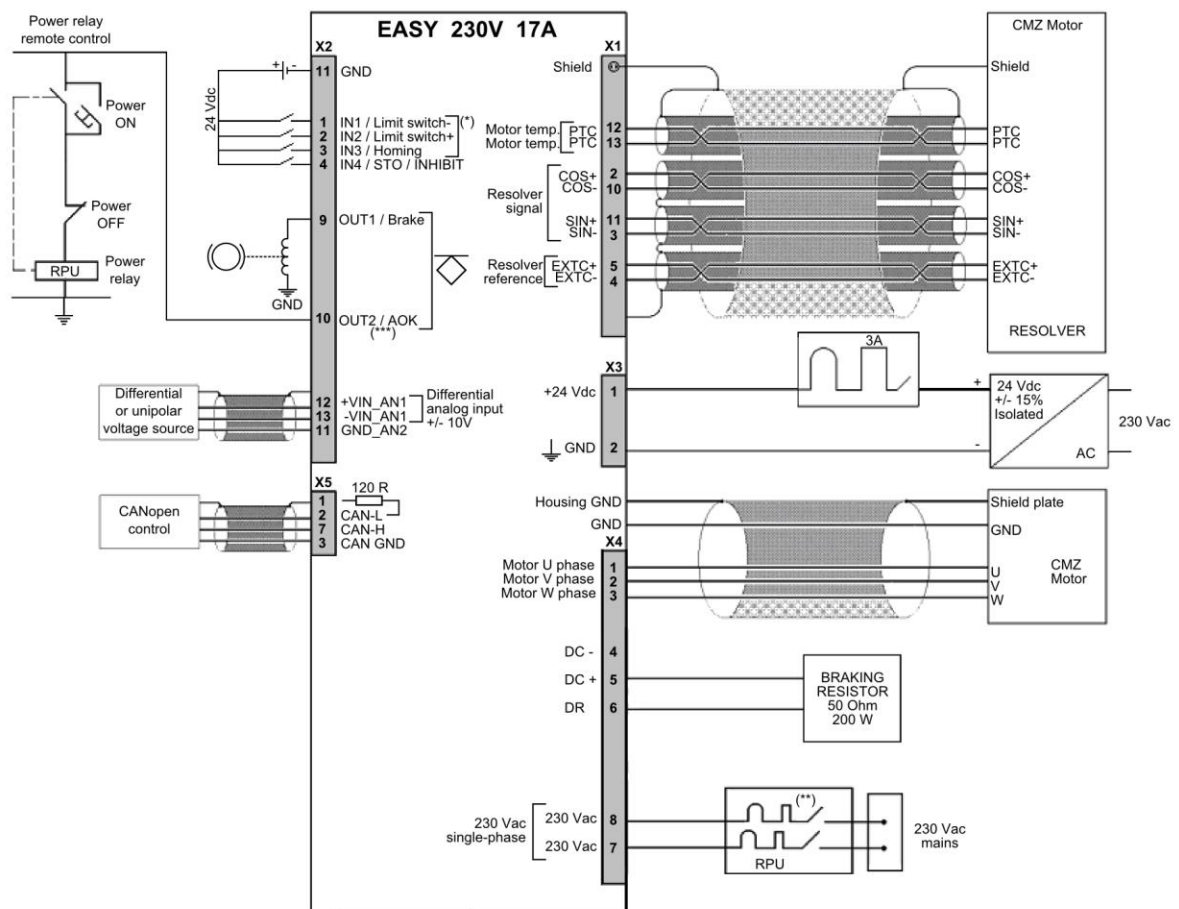
## Chapter 3 - Configuration example

The 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 global machine.

### 3.1 - Example 1: Stop category 0 according to EN 60204-1

#### 3.1.1 - Hardware configuration

*Low inertia axis application / high resistive torque*



(\*) Input default configuration

(\*\*) Curve D circuit-breaker  
 $I_{ts} = 10 \times I_n$

(\*\*\*) See sections 4.1.2 and 4.1.3 of this manual

Use only copper conductors for the wiring terminations.

The torque values of the wiring terminations must comply with the certified block terminal.

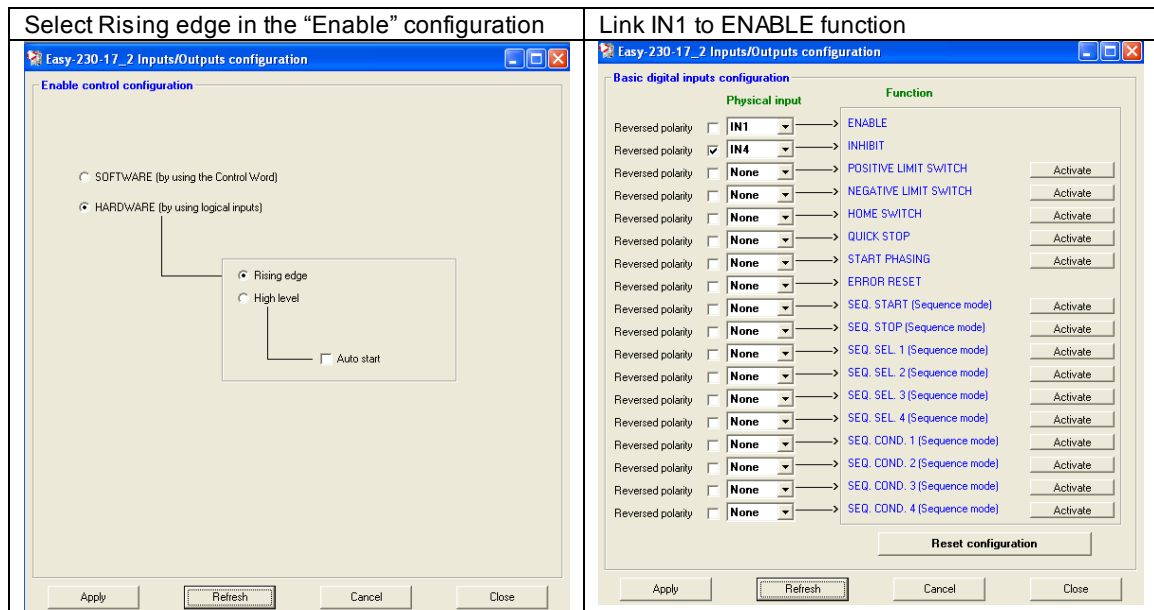
**Note:** The 24 V and power supply protection on source side must be ensured by the user.

Please note that the motor control must be disabled before activating the STO function.

In the example above, the "Enable" function is allocated to digital input IN1 to disable the PWM control.

### 3.1.2 - Gem Drive Studio configuration

#### Inputs/Outputs configuration:



#### Notes:

- IN4 is not configurable.
- Rising edge must be selected when IN4 is used as STO channel

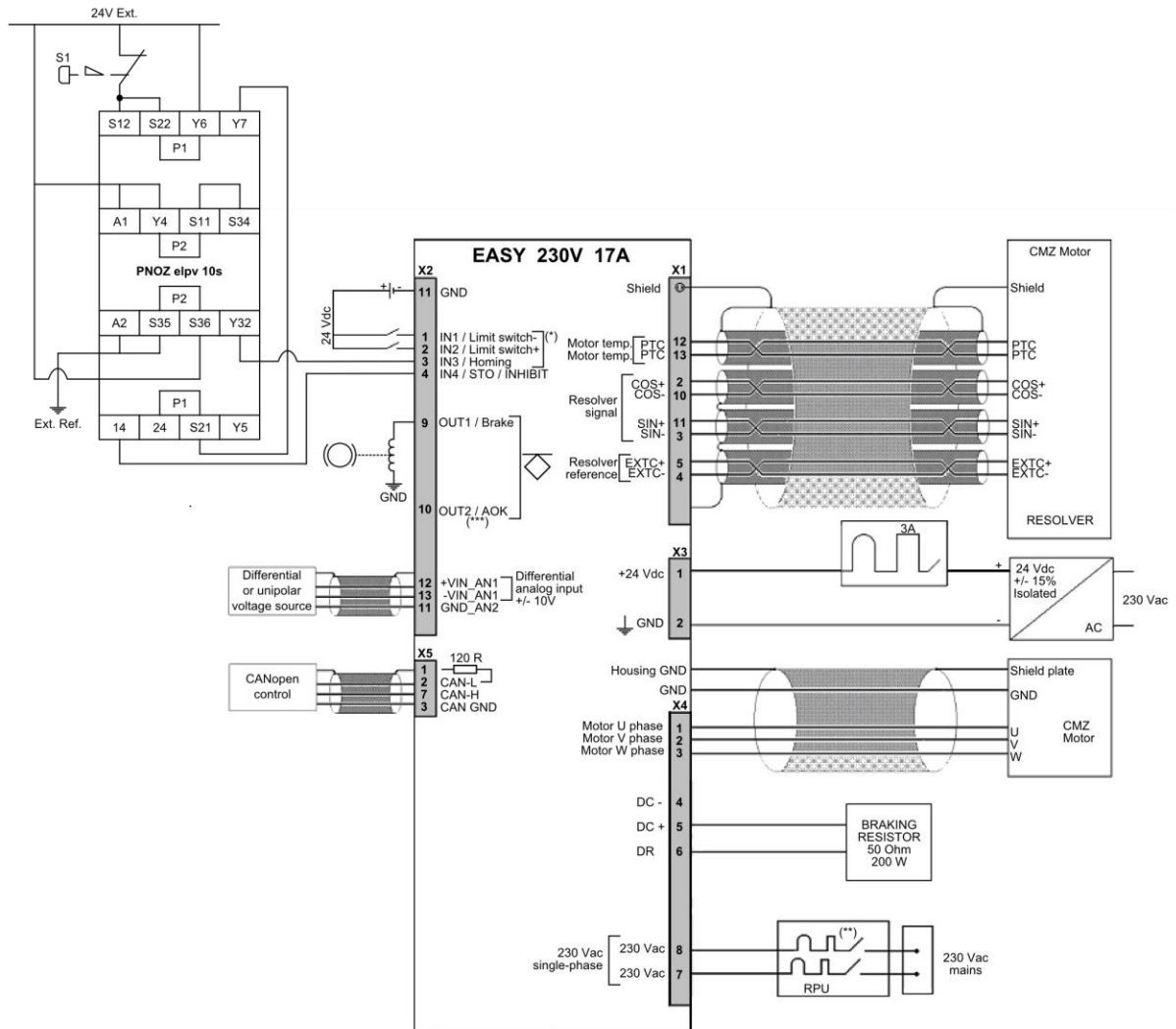
Stop category 0 is performed when IN4 STO\ is low.

## 3.2 - Example 2: Stop category 1 according to EN 60204-1

### 3.2.1 - Hardware configuration

*High inertia axis application / low resistive torque*

In the following example, a safe Stop 1 is performed. The delay between the deceleration ramp and the STO activation is safe. The deceleration ramp is not safe according to EN13849-1 because it uses a common drive function.



(\*) Input default configuration

(\*\*) Curve D circuit-breaker  
 $I_{ts} = 10 \times I_n$

(\*\*\*) See sections 4.1.2 and 4.1.3 of this manual

Use only copper conductors for the wiring terminations.

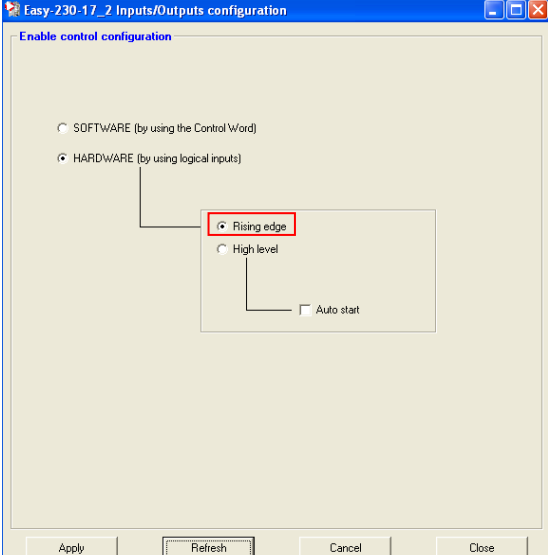
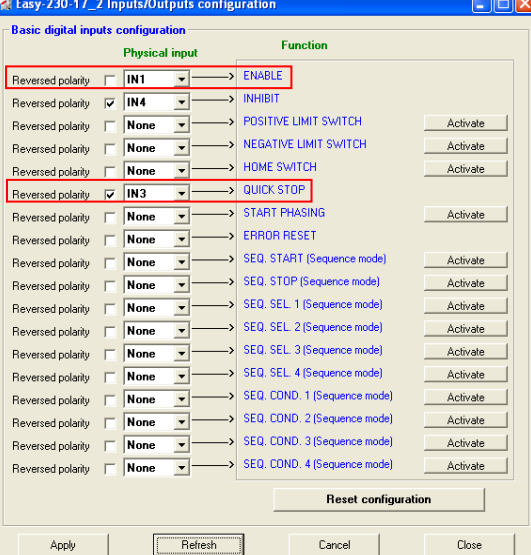
The torque values of the wiring terminations must comply with the certified block terminal.

**Note:** The 24 V and power supply protection on source side must be ensured by the user.

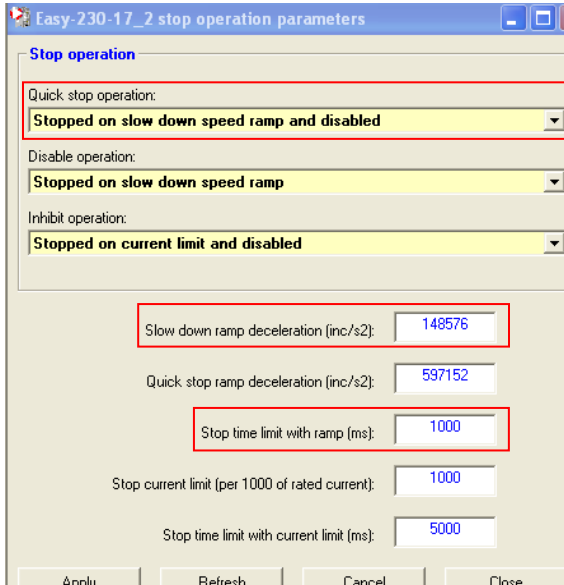
In the connection diagram example above, the PILZ safety relay orders the drive to decelerate via the QUICK STOP signal (assigned to digital input IN3). After a safety delay of 0.5 s, it activates the STO function of the drive. Please, note that the drive behavior on the QUICK STOP signal activation has to be setup in the appropriate mode (e.g. speed ramp deceleration) before any stop procedure. The output used for generating the QUICK STOP signal does not need to be a safe one.

### 3.2.2 - Gem Drive Studio configuration

#### Inputs/Outputs configuration

<p>Select Rising edge in the “Enable” configuration</p>	<p>Link IN1 to ENABLE function Link IN3 to QUICK STOP function and select Reversed polarity (STOP is activated with a logical “0”)</p>
	

#### Stop operation parameters:



#### Notes :

- IN4 is not configurable.
- Rising edge must be selected when IN4 is used as an STO channel.

Stop category 1 is performed when IN3 Quick STOP is low, according to the Stop Operation parameters.

**FACTORY AND  
HEADQUARTERS**

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