

BRIEF OVERVIEW

SAFE STOP – SAFE TORQUE OFF (STO)

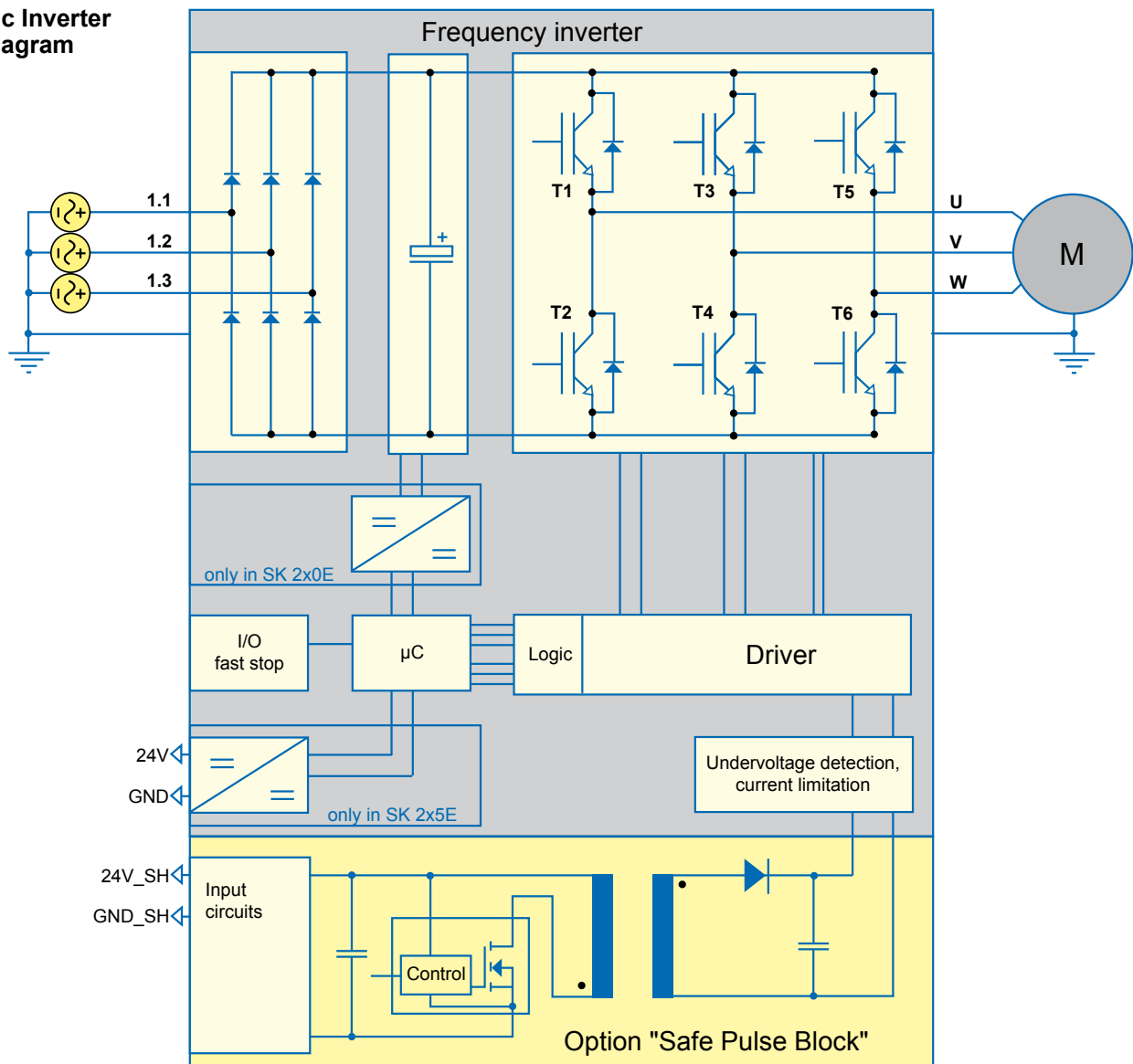
The following brief overview is only valid in association with the operating instruction BU0230 Functional Safety – Supplementary Instructions for SK 200E Frequency Inverters.

Function description

With the "Safe Pulse Block", SK 21xE and SK 23xE frequency inverters provide a safe shut-down method for stopping the drive unit. The semiconductors of the inverter (T1 to T6) are controlled by a pulse pattern. This is generated by the microcontroller (μC) and amplified by the driver. The drivers convert the logic signals on the control voltages of the semiconductor switch. The semiconductor switches are switched via the control voltage and the pulse pattern is amplified and applied to the motor terminals. Due to the low-pass effect of the motor, a three-phase system results from the three-phase pulse-width modulated sine wave voltage. The motor generates a torque from this.

With the safety function **STO (Safe Torque Off)** the driving torque is switched off as quickly as possible and the drive unit runs down to a standstill. Devices equipped with a "Safe Pulse Block" have an additional DC/DC converter, which produces the supply voltage for the driver from a 24 V supply (24V_SH, GND_SH). If this supply voltage is switched off, the DC/DC converter does not transmit any power to the drivers. As the drivers are now no longer supplied with power, no control pulses reach the relevant semiconductor circuits of the inverter. The flow of current in the semiconductor switches and in the motor is interrupted. Therefore, after a certain reaction time of the electronics and the reduction time of the motor current, the motor does not develop a driving torque. This behaviour corresponds to stop category 0 (uncontrolled braking) according to EN 60204-1. An undefined time elapses before the drive unit does not carry out any further hazardous movement and a safe state is achieved. Monitoring of whether or when the drive unit has achieved a safe state is not integrated into the frequency inverter.

Schematic Inverter Circuit Diagram



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Connection scheme

The switch-off of the 24 V supply (24V_SH, GND_SH) must be carried out by a fail-safe switching device. For this, either the connection 24V_SH (Terminal 89) or the

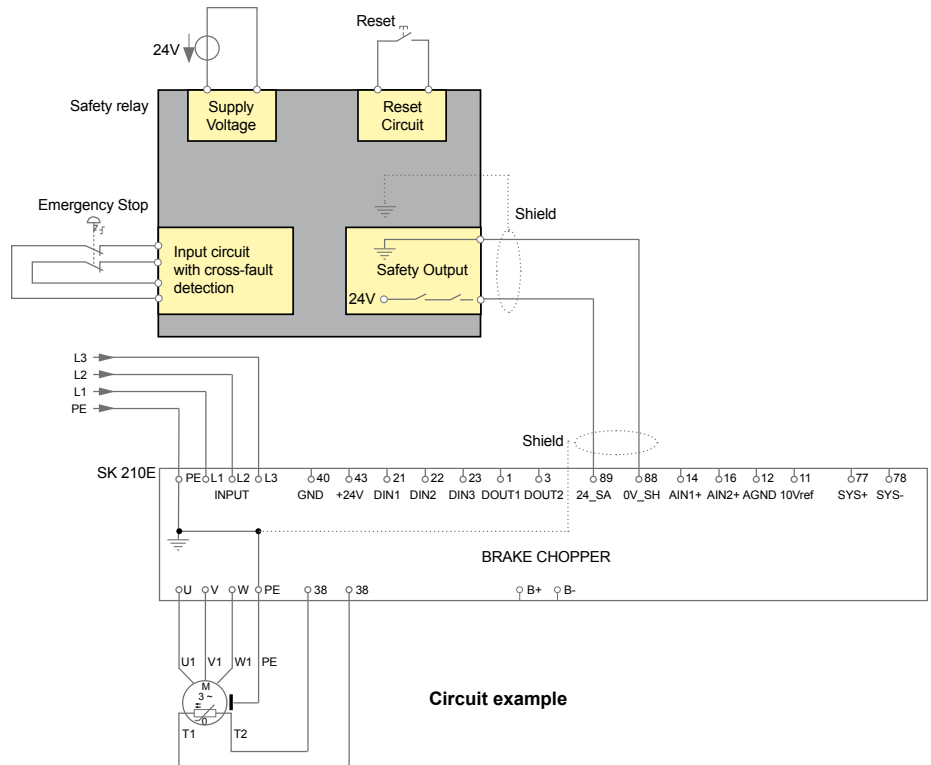
connection GND_SH (Terminal 88) may be disconnected from the 24 V source. For preference, the 24V_SH connection is disconnected.

In this example, Safety Category 4 as per DIN EN ISO 13849-1 can be achieved.

The prerequisite for this is that the emergency stop button, the protective switching device and the wiring fulfil the requirements for Category 4.

For example, this can be achieved as follows:

- Redundant protective switching device with self-monitoring
- Dual-channel input circuit with cross-wire recognition (and corresponding emergency stop button)
- Safety output with periodic switch-off tests (OSSD)
- Elimination of errors as per DIN ISO 13849-2 for the wiring between the switching device and the input terminals of the safe shut-down method used, by use of a shielded cable and connection of the shield at both ends



Technical Data

A two-wire shielded cable must be used for the Safe Pulse Block. The shield must be applied on both sides! The voltage drop in the cable must not exceed $\Delta U_{\text{cable}} \leq 3 \text{ V}$ for mechanical safety circuit devices and must not exceed $\Delta U_{\text{cable}} \leq 1 \text{ V}$ for electronic safety switching devices. The peak current for Sizes 1 to 4 must be used for the calculation.

Input voltages: (24V_SH – GND_SH)

- 24 V +/- 25 % = 18 V ... 30 V
- 24 V – 20 % + 25 % = 19.2 V ... 30 V for operation with OSSD

Sizes 1 to 3:

- 125 mA (AV) 500 mA (peak) after switch-on or after a test pulse from an OSSD

Size 4:

- 40 mA (AV) 250 mA (peak) after switch-on or after a test pulse from an OSSD

The "Safe Pulse Block" is specially designed for use with an OSSD. The capacity between the wires (including the shield capacities) must not exceed a value of 20 nF for each inverter connected.

Reaction time:

- Typical < 65 ms, max. 300 ms – "Safe Pulse Block"

Depending on the switching equipment used and the use of a safe shut-down method, an STO function with Safety Category 4, PL e as per DIN EN ISO 13849-1 can be implemented.

Parameter settings:

- Evaluation of the "Safe Pulse Block" is performed exclusively by the hardware. Therefore no parameters need to be changed.

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