

SERVOSTAR[®] S600

Stop and Emergency Stop

This document describes the Stop and Emergency Stop response of the SERVOSTAR[®] S600 digital servo amplifier. It describes how these functions can be implemented to meet the applicable regulations.

Stop

The Stop function is used to shut down the machine in normal operation.

Emergency Stop

The Emergency Stop function is used for the **fastest possible shut down** of the machine in a dangerous situation.

The Emergency Stop function can be triggered by the actions of a single person. It must be fully functional and available at all times. You must not have to work out how to operate the mechanism.

Standards and Regulations

Stop to DIN EN 60204 (VDE 0113)

The three categories of the Stop function are defined as:

- Category 0 Shut down by immediately switching off the power supply to the drive machinery (i.e., an uncontrolled shutdown).
- Category 1 A controlled shut down, whereby the power supply to the drive machinery is maintained to perform the shut down and the power supply is only interrupted when the shut down is complete.
- Category 2 A controlled shut down whereby the power supply to the drive machinery is maintained.

Every machine must be equipped with a Stop function to Category 0. Stop functions to Categories 1 and 2 must be provided if the safety and/or functional requirements of the machine make this necessary. Categories 0 and 1 Stops must be operable independently of the operating mode, whereby a Category 0 Stop must have priority. Stop functions must be implemented by **disconnection** of the appropriate circuitry and have priority over assigned start functions.

The Stop Category must be determined by a risk evaluation of the machine. In addition, suitable means must be provided to guarantee a reliable shut down.

If necessary, provision must be made for the connection of protective devices and lock-outs. If applicable, the Stop function must signal its status to the control logic. A reset of the Stop function must not create a hazardous situation.

Emergency Stop Function to DIN EN 60204 (VDE 0113)

In addition to the requirements for the Stop function, the Emergency Stop must fulfill the following requirements:

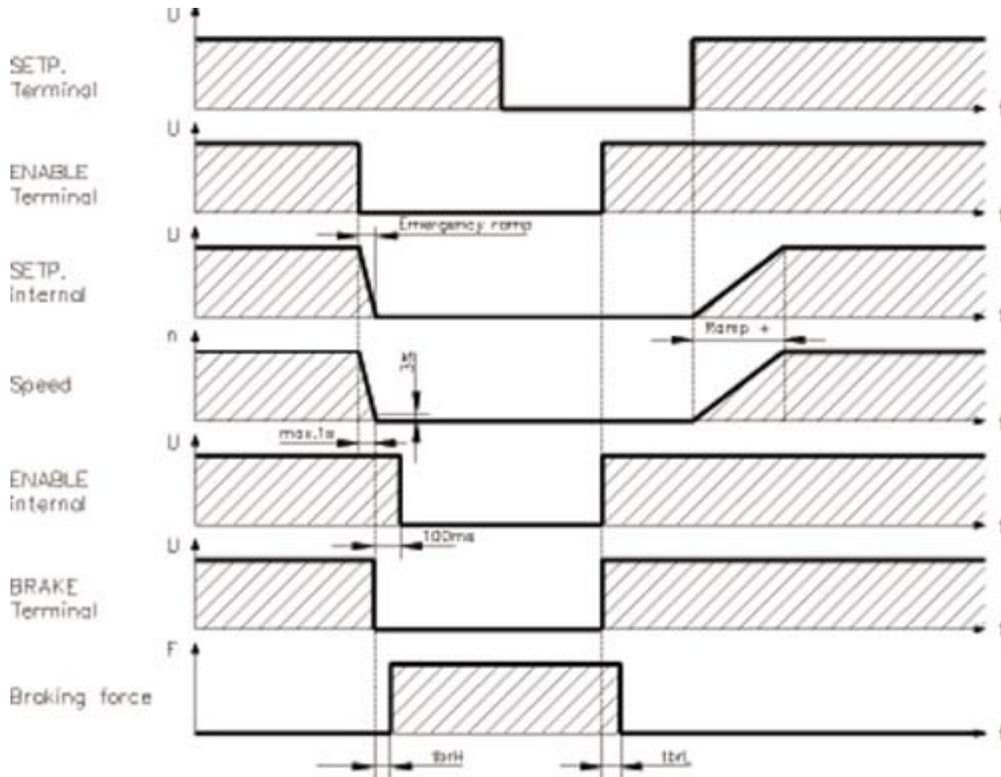
- It must have priority over all other functions and controls in all operating situations.
- The power supply to any drive machinery that could cause dangerous situations must be switched off as fast as possible without causing further hazards (e.g., using mechanical latching devices that do not require an external power supply, by counter-current braking in Stop Category 1).
- The reset must not initiate a restart.

If necessary, provision must be made for the additional connection of Emergency Stop devices (see VDE 0113, Paragraph 10.7, *Requirements for Emergency Stop Devices*). The Emergency Stop must be effective as a stop of either Category 0 or Category 1. The Emergency Stop Category must be determined by a risk evaluation of the machine. Only hard-wired electromechanical components may be used for an Emergency Stop function to Category 0. The action must not depend on switching logic (hardware or software) or on the transmission of commands through a communications network or a data connection. For Emergency Stop Category 1, the final disconnection of the power supply to the drive machinery must be ensured by electromechanical components. Supplementary Emergency Stop devices may be plugged in.

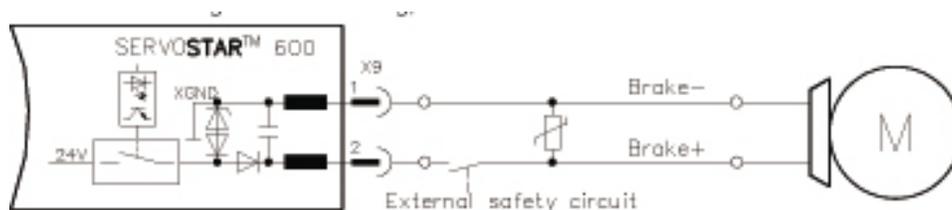
Solutions

The SERVOSTAR S600 amplifiers can detect the failure of one or more mains supply phases through an integrated hardware circuit. The controlled termination of the present cycle or the initiation of the shut down of the drive is made possible by evaluating the corresponding error messages: "mains phase, F19" and "mains BTB/RTO, F16" at the digital outputs in the higher-level (supervisory) control if the "mains BTB/RTO" function is selected. If the voltage in the DC-bus (DC-link) falls below 100 VDC, the output stage is disabled and the drives become torque-free. **To do this, the 24V auxiliary supply to the servo amplifier must remain on.**

If the "mains BTB/RTO" function is not selected, the SERVOSTAR S600 is immediately disabled if there is a mains supply failure so that the motor runs down without control. Instruments with an enabled brake function include a special sequence for switching off the output stage. After the controller enable has been removed (DISABLE), the internal speed setpoint runs down a 10 msec ramp to 0. When the speed has fallen below 3% of the final limit speed that has been set (but after one second at the most), the brake is activated by switching off its supply voltage and the output stage is inhibited 100 ms later.



After shutting down the drive, the Option –AS-, with a positive action safety relay with TÜV approval, can be used to provide personnel protection by shutting off the drive so that, although power is still present, the drive shaft is protected against an unintended restart (restart lock-out). In general, the possibility of malfunction must be considered for the internal brake module, as for all electronic circuitry. The inhibiting of a motor for personnel safety by means of a brake requires an additional electromechanical closing device for locking, and a release mechanism for the brake:



Stop Function Implementation

Category 0

Shut down of the motor by disconnecting and short-circuiting the motor leads and applying a mechanical brake.

The disconnection of the motor leads can be implemented by switching the motor phases over to resistors, using an appropriate electromechanical device. A suggested circuit with a contactor is shown in the Wiring Example.

The values for the required brake resistors can be taken from the table. The switching sequence is unambiguously fixed by the circuit, and must be followed to prevent undesirable error signals and failure of the servo amplifier.

It is not possible to achieve a Category 0 shut down with only the servo amplifier as hard-wired electromechanical components are compulsory for this type of disconnection. A brake built into the motor must have an additional electromechanical control circuit as well as the control through the SERVOSTAR S600 in order to qualify for Category 0.

Normally, a brake in a servo motor functions only as a holding brake. To ensure an Emergency Stop function, the required braking torque must be checked. If the holding brake fulfills the dynamic requirements, it must be taken into account that this application will cause increased wear.

Category 1

Shut down of the motor by disconnecting the mains power supply and electronically controlling braking. The 24V auxiliary supply for the SERVOSTAR S600 must remain on.
SERVOSTAR S600 with a selected brake control function

- The "mains BTB/RTO" function must be activated so the SERVOSTAR S600 does not interpret the disconnection of the mains supply as a fault.
- The control system must be able to recognize the removal of the mains supply.
- The control system must inhibit (DISABLE) the servo amplifier after the detection of the mains disconnection, then shut down the drive according to the method described in the *Solutions* section.



If the preset brake ramp of 10 milliseconds is insufficient, the controls must brake the motor in a controlled manner by applying an external setpoint value. When standstill is reached, a digital output must send the "v_mot<x" signal to the control system so it can immediately inhibit (DISABLE) the controller. If the control system is fit with contour error monitoring, the "v_mot<x" is not required.

SERVOSTAR S600 without a brake control function

If a motor is used without a holding brake, the STOPMODE 1 command must be entered through the terminal window in the operating software for Stop Category 1 implementation. The servo amplifier then behaves as described in the *SERVOSTAR S600 with a selected brake control function* section above.



In the event of an internal fault in the SERVOSTAR S600, the motor can no longer be braked under control, but loses all torque and runs down out of control. Protect the personnel and equipment from injury and damage caused by a free-running load by appropriate precautionary measures (e.g., damper stops, coverings, mechanical braking system).

Category 2

The machine receives the operative Stop command and brakes the drive along the preset braking ramp. When standstill is reached, a digital output must sent the "v_mot<x" signal to the control system so it can immediately inhibit (DISABLE) the controller. If the control system is fit with contour error monitoring, the "v_mot<x" comparison is not required.

Emergency Stop Implementation

Category 0

The servo amplifier is disconnected from the mains supply and disabled.

The drive must be switched off by an electromechanical circuit. The motor leads are disconnected by a changeover switching device (contactor) and short-circuited by resistors connected in a star configuration (see Wiring Example).

If the attached servo motor has a brake, this must also be controlled by an electromagnetic circuit, as Category 0 requirements are only met in this way. Normally, a brake in a servo motor functions only as a holding brake. To ensure an Emergency Stop function, the required braking torque must be checked. If the holding brake meets the dynamic requirements, it must be taken into account that this application will cause increased wear.

Category 1

Shut down of the motor by disconnecting the mains power supply and electronically controlling braking. The 24V auxilliary supply for the SERVOSTAR S600 must remain on.

SERVOSTAR S600 with a selected brake control function

- The "mains BTB/RTO" function must be activated so the SERVOSTAR S600 does not interpret the disconnection of the mains supply as a fault.
- The control system must be able to recognize the removal of the mains supply.
- The control system must inhibit (DISABLE) the servo amplifier after the detection of the mains disconnection, then shut down the drive according to the method described in the *Solutions* section.



If the preset brake ramp of 10 milliseconds is insufficient, the controls must brake the motor in a controlled manner by applying an external setpoint value. When standstill is reached, a digital output must send the "v_mot<x" signal to the control system so it can immediately inhibit (DISABLE) the controller. If the control system is fit with contour error monitoring, the "v_mot<x" is not required.

SERVOSTAR S600 without a brake control function

If a motor is used without a holding brake, the STOPMODE 1 command must be entered through the terminal window in the operating software for Stop Category 1 implementation. The servo amplifier then behaves as described in the *SERVOSTAR S600 with a selected brake control function* section above.



In the event of an internal fault in the SERVOSTAR S600, the motor can no longer be braked under control, but loses all torque and runs down out of control. Protect the personnel and equipment from injury and damage caused by a free-running load by appropriate precautionary measures (e.g., damper stops, coverings, mechanical braking system).

Wiring Example

