

Application Note:

Stop and Emergency Stop functions with SERVOSTAR™ 600

Previously published editions

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Technical changes to improve the performance of the equipment may be made without prior notice !

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I General

This leaflet is devoted to the Stop and Emergency Stop response of the SERVOSTAR™ 600 digital servo amplifier, and describes how these functions can be implemented to meet the applicable regulations.

I.1 Stop function

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

I.2 Emergency Stop function

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. The user must not have to work out how to operate this mechanism.

II Standards and regulations

II.1 Stop function to DIN EN 60204 (VDE 0113)

The Stop function is defined as follows:

There are three categories of Stop functions:

- Category 0: Shut-down by immediate switching-off of the energy supply to the drive machinery (i.e. an uncontrolled shut-down);
- Category 1: A controlled shut-down, whereby the energy supply to the drive machinery is maintained to perform the shut-down, and the energy supply is only interrupted when the shut-down has been completed;
- Category 2: A controlled shut-down, whereby the energy 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/or 2 must be provided if the safety and/or functional requirements of the machine make this necessary. Category 0 and Category 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.

II.2 Emergency Stop function to DIN EN 60204 (VDE 0113)

The Emergency Stop function is defined as follows:

In addition to the requirements for Stop, the emergency Stop must fulfil the following requirements:

- it must have priority over all other functions and controls in all operating situations;
- the energy supply to any drive machinery that could cause dangerous situations must be switched off as fast as possible, without causing any further hazards (e.g. by using mechanical latching devices that do not require an external supply of energy, 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, Para.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 energy supply to the drive machinery must be ensured by electromechanical components. Supplementary Emergency Stop devices may be plugged in.

III Solutions

III.1 Features of the SERVOSTAR™ 600 series of servo amplifiers

The servo amplifiers can detect the failure of one or more mains supply phases through an integrated hardware circuit.

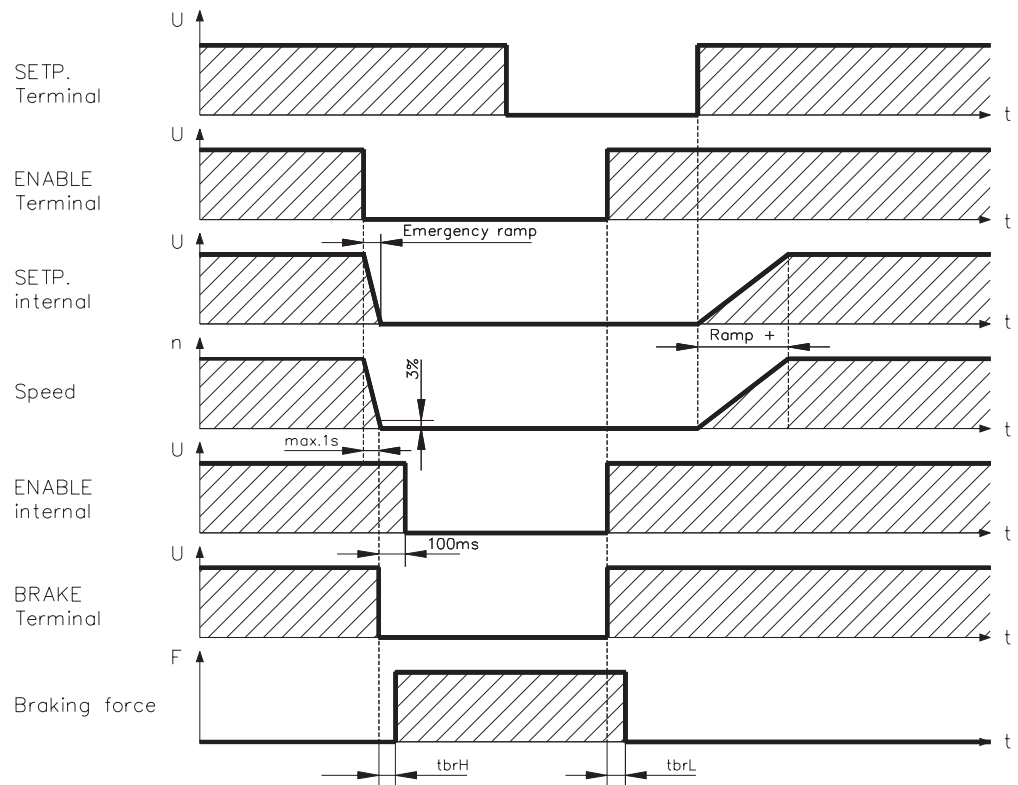
The controlled termination of the present cycle or the initiation of the shut-down of the drive is made possible by evaluating the corresponding error messages “mains phase, F19” and “mains BTB/RTO, F16” at the digital outputs in the higher-level (supervisory) control, if the “mains BTB/RTO” function has been selected.

If the voltage in the DC-bus (DC-link) falls below 100 V DC, then the output stage is disabled, and the drive becomes torque-free.

To do this, the 24V auxiliary supply to the servo amplifier must remain on.

If the “mains BTB/RTO” function has not been selected, the SERVOSTAR™ 600 is immediately disabled if there is a mains supply failure, so that the motor runs down without control.

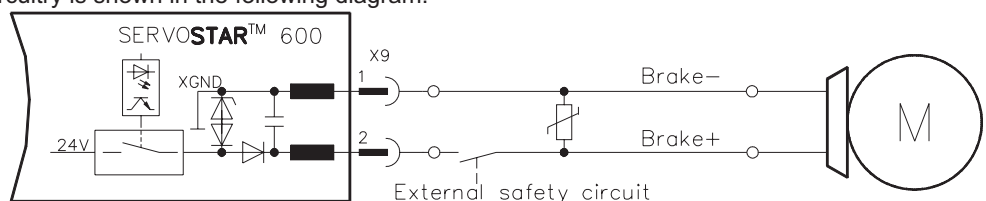
Instruments with an enabled brake function include a special sequence for switching off the output stage. After the controller enable has been removed (DISABLE), the internal speed setpoint runs down a 10 msec ramp to 0. When the speed has fallen below 3 % of the final limit speed that has been set, but at the latest after 1 second, the brake is activated by switching off its supply voltage, and the output stage is inhibited 100msec 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.

The circuitry is shown in the following diagram.



III.2 Implementation of the Stop function

III.2.1 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 Section III.4.

The values for the brake resistors that are required 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 the servo amplifier alone, since hard-wired electromechanical components are compulsory for this type of disconnection.

A brake that is built into the motor must have an additional electromechanical control circuit, as well as the control through the SERVOSTAR™ 600, in order to meet Category 0.

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

III.2.2 Category 1

Shut-down of the motor by disconnecting the mains power supply and electronically controlled braking. The 24V- auxiliary supply for the SERVOSTAR™ 600 must remain on.

a) Servo amplifier with a selected brake control function

- The “mains BTB/RTO” function must be activated, so that the SERVOSTAR™ 600 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, and then shut down the drive according to the method in Section III.1.



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

b) Servo amplifier without a brake control function

If a motor is used without a holding brake, then the command “STOPMODE 1” must be entered through the terminal window in the operating software for the implementation of Stop Category 1. The servo amplifier will then behave as described under a).



Warning !

In the event of an internal fault in the SERVOSTAR™ 600, the motor can no longer be braked under control, but will lose all torque and run down out of control.

Protect the personnel and equipment from injury or damage caused by a free-running load by appropriate precautionary measures (e.g damper stops, coverings, mechanical braking system).

III.2.3 Category 2

The machine receives the operative stop command, and brakes the drive along the preset braking ramp. When standstill has been reached, a digital output must send the “v_mot<x” signal to the control system, so that it can immediately inhibit (DISABLE) the controller. If the control system is fitted with contour error monitoring, then the “v_mot<x” comparison is not required.

III.3 Implementation of the Emergency Stop function

III.3.1 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 Section III.4).

If the attached servo motor has a brake fitted, then this must also be controlled by an electromagnetic circuit, as Category 0 can only be fulfilled in this way.

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

III.3.2 Category 1

Shut-down of the motor by disconnecting the mains supply and electronically controlled braking. The 24V- auxiliary supply for the SERVOSTAR™ 600 must remain on.

a) Servo amplifier with a selected brake control function

- The “mains BTB/RTO” function must be activated, so that the SERVOSTAR™ 600 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, and then shut down the drive according to the method in Section III.1.



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

b) Servo amplifier without a brake control function

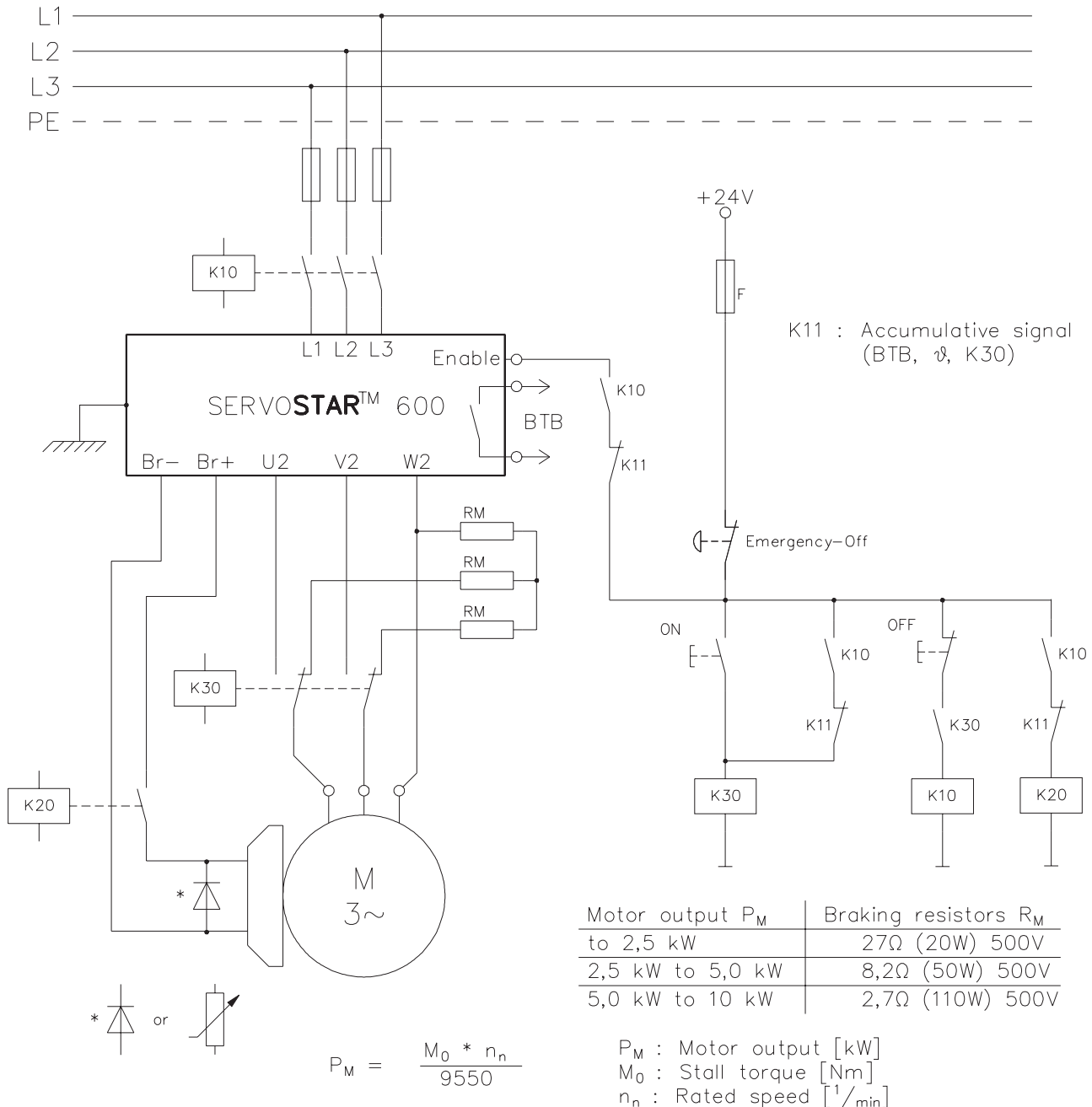
If a motor is used without a holding brake, then the command “STOPMODE 1” must be entered through the terminal window in the operating software for the implementation of Stop Category 1. The servo amplifier will then behave as described under a).



Warning!

In the event of an internal fault in the SERVOSTAR™ 600, the motor can no longer be braked under control, but will lose all torque and run down out of control. Protect the personnel and equipment from injury or damage caused by a free-running load by appropriate precautionary measures (e.g damper stops, coverings, mechanical braking system).

III.4 Wiring example



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