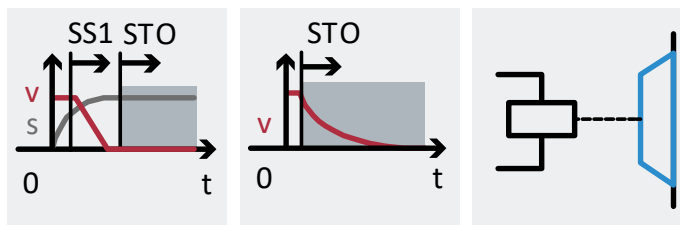


Safety Sub-Function SSB with SS1-t, STO, Cat. 4, up to PL e SB, Cat. 1, up to PL c Servo Drive CMMT-AS-...-S1



Application Note
CMMT-AS-...-S1,
SSB with SS1-t and
SB

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The values stated in the Example circuit are partly assumptions and assessments which do not replace a detailed examination based on EN ISO 13849 part 1 and 2.

The actual characteristic values that can be obtained (especially PL, PFH_D, category, DC, MTT_D, CCF) depend on the components used, as well as their conditions of use in the actual application.

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This document is only suitable for persons with sufficient expertise for machine safety based on EN ISO 12100 and EN ISO 13849. In addition, the following qualifications are required in the project team:

- Specialist in electrical engineering
- Specialist for the programming of control systems and safety switching devices

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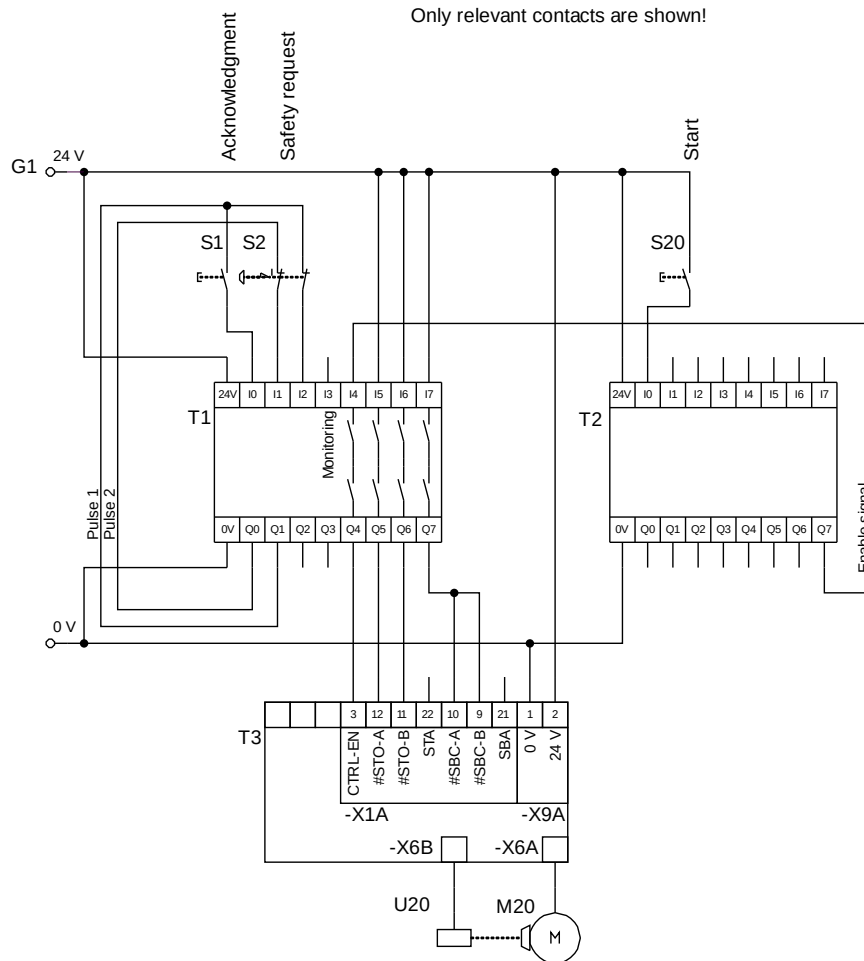
1 Example Circuits

- The circuits specified in this document are principle circuits which cannot be complete due to their clarity and scope. Safety commanding device and safety switching device are not part of this document and are given for information only.
- The abbreviations used for the safety sub-functions refer to the definitions in EN 61800-5-2 [1] for electrical power drive systems:
 - SS1-t: Safe Stop 1 Time Controlled
 - STO: Safe Torque Off
 - SSB: Safe Stopping and Blocking (according VDMA 24584 [5], not part of EN 61800-5-2)
 - SB: Safe Blocking (not part of EN 61800-5-2)
- Category and PL according EN ISO 13849-1 [2].
- To understand this application note, are following documents necessary:
 - Description “Servo drive CMMT-AS-C2/C4-3A-...”. This description is available on the Internet https://www.festo.com/net/en-gb_gb/SupportPortal/Downloads/466851/573769/CMMT-AS-C2_C4-3A_2018-10a_8095049g1.pdf
 - Description “Safety sub-function STO, SBC, SS1” for servo drive CMMT-AS-...-S1. This description is available on the Internet https://www.festo.com/net/en-gb_gb/SupportPortal/Downloads/466859/573777/CMMT-AS_-S1_2018-10a_8096257g1.pdf
- The circuits and the procedure described are recommendations which do not exclude other possibilities.
- This Application Note describes the wiring of the safety sub-function SS1-t for safety switching devices with contact outputs. Further options for wiring the SS1-t safety sub-function are described in Application Note No. 100229 (“Safety Sub-functions SS1-t, STO, Servo Drive CMMT-AS-...-S1”) in the Support Portal. This description is available on the Internet: https://www.festo.com/net/de_de/SupportPortal/Downloads/544820/597074/100229-TS-Application-Note-EN-Ver1.pdf

1.1 SSB with SS1-t and SB for CMMT-AS-...-S1 with holding brake in servo motor

- SS1-t, STO, category 4, up to PL e
- SB, category 1, up to PL c
- Safety switching device with contact outputs
- Without evaluation STA, without evaluation SBA
- Fault exclusion for wiring control cabinet necessary

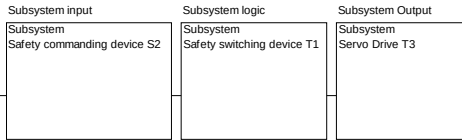
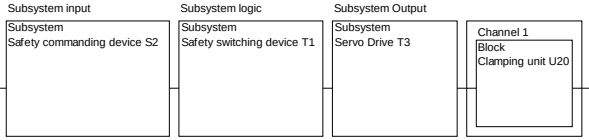
1.1.1 Circuit Diagram



1.1.2 Components

Component	Type (Part Number)	Description / Remarks	Qty.	Mssr.
M20, U20	EMM...-AS...B	Servo motor with holding brake (U20)	1	Festo
S1		Acknowledge push button	1	
S2		Safety commanding device, e.g. emergency stop switch	1	
S20		Start push button	1	
T1		Safety switching device	1	
T2		Functional PLC	1	
T3	CMMT-AS-...-S1	Servo drive	1	Festo

1.1.3 Description

Application	Servo drive with servo motor
Triggering event	Safety request (S2), e.g. by emergency stop switch, safety gate
Reaction (Safety function)	Stopping at safety request using the safety sub-function “safe stopping and blocking (SSB)” executed by the safety sub-functions “safe stop 1 time controlled (SS1-t)” with the safe state “safe torque off (STO)” and “safe blocking with friction locking (SB)” Safe state “safe torque off (STO)”, category 4, up to PL e  Safe state “safe blocking with friction locking (SB)”, category 1, up to PL c 
Safe state	The servomotor (M20) is functionally stopped, after an application-specific time the holding brake (U20) frictionally clamps the shaft of the servo motor (M20) and after a further application-specific time no energy is supplied to the servomotor (M20) that can generate a force and a movement. It is presumed that this state of the servomotor (M20) is the safe state. Notes: - Stopping the servo motor (M20) is functional and is not safety-rated, i.e. if the movement is not stopped in the event of a fault, additional measures may be required, e.g. end position damping for linear axes. - For the wiring between safety switching device (T2) and servo drive (T3), fault exclusions on short circuits and cross circuits, e.g. according to ISO 13849-2 [4], Table D.4, are required. The preconditions for these are that the safety switching device (T2) and the servo drive (T3) are located in the same control cabinet and that the control cabinet meets the requirements of EN 60204-1 [3]. - Holding brakes for factory automation are normally only suitable for static clamping. Manufacturers of holding brakes normally do not allow the holding brake to decelerate the movement (braking). If a movement is nevertheless decelerated with a holding brake, e.g. due to a power failure, a functional test of the holding brake for static clamping is necessary due to the increased wear. - Holding brakes are subject to wear. Therefore, a regular check is recommended at least during the maintenance cycle of the machine.
Function of the circuit	Due to the safety request (S2): - The input circuit of the safety switching device (T1) is interrupted. - The output (Q4) of the safety switching device (T1) is then switched off.

	- The input "output stage enable (CTRL-EN)" of the servo drive (T3) is no longer controlled. As a result, the servo drive (T3) functionally decelerates the drive with the quick-stop ramp and lets the holding brake engage functionally. After the end of the braking ramp and after expiry of the parameterizable delay time until the holding brake has applied, the output stage is functionally switched off. This corresponds to a behaviour of stop category 1 according to EN 60204-1 [3]. - The output (Q7) of the safety switching device (T1) is then switched off with a time delay. The required time delay must be determined depending on the specific application. - The inputs "Safe brake control, channel A and B (#SBC-A, #SBC-B)" of the servo drive (T3) are no longer controlled. The activation of the holding brake is safely disabled and the safety sub-function SBC is requested. - The holding brake (U20) is no longer actuated, so that the holding brake frictionally locks the shaft of the servomotor (M20). - The outputs (Q5, Q6) of the safety switching device (T1) are then switched off with a time delay. The required time delay must be determined depending on the specific application. - The inputs "Safe torque off, channel A and B (#STO-A, #STO-B)" of the servo drive (T3) are no longer controlled. This switches off the control of the output stage and requests the safety sub-function STO.
Manual reset function	- After resetting the safety request (S2), e.g. by mechanically unlocking the emergency stop switch or closing the safety gate, the start or restart can be made possible by actuating the acknowledgement button (S1). - The safety switching device (T1) controls via the outputs (Q5, Q6, Q7) the servo drive (T3). This makes it possible to control the power output stage again and the STO and SBC safety sub-functions are no longer active. - The safety switching device (T1) permits the control of the "output stage enable (CTRL-EN)" via the functional control (T2) again via the output (Q5). If the "Enable output stage (CTRL-EN)" is switched on by the functional control (T2), the control of the servo drive (T3) is functionally switched on and the holding brake (U20) is functionally released after the parameterizable delay time has passed. Normal operation is then possible by pressing the start push button (S20).
Diagnosis	The diagnostic output (STA) does not have to be evaluated for the specified category and PL.

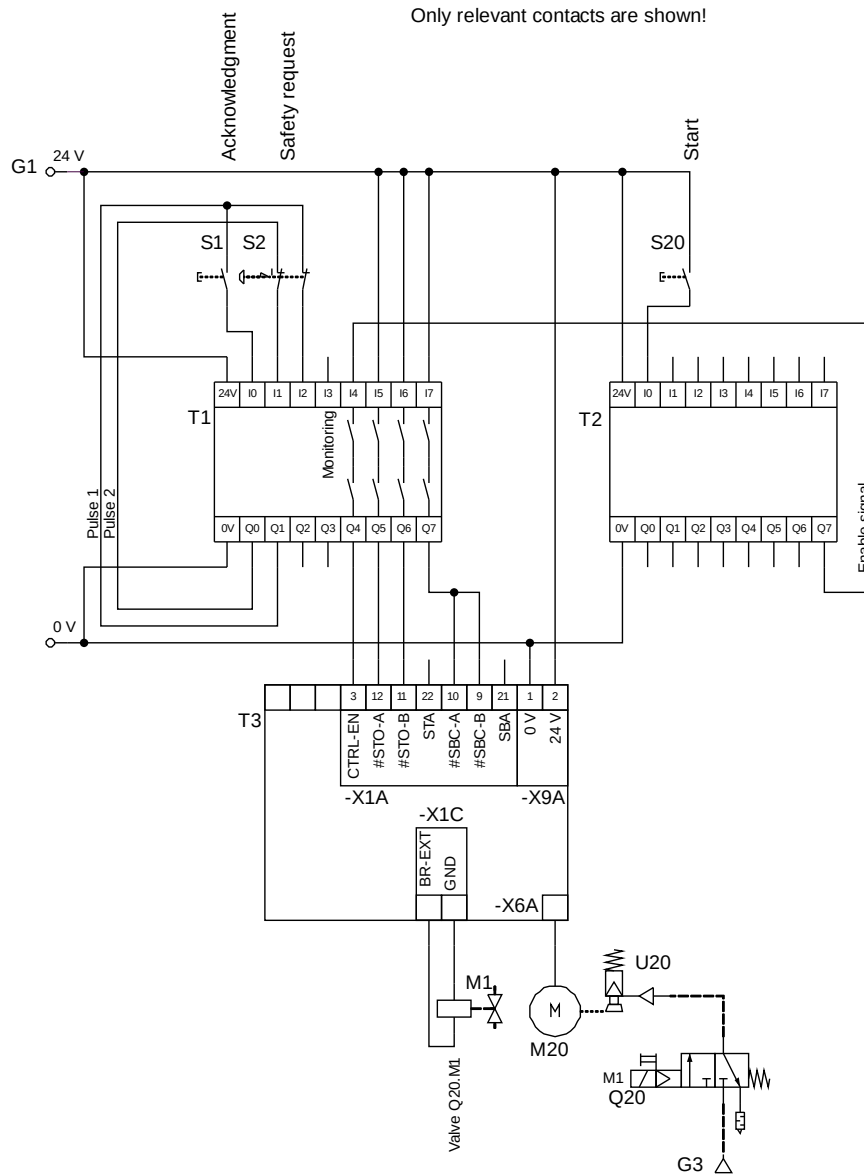
1.1.4 Safety Considerations

Input	Safety considerations must be carried out in accordance with the selected safety commanding device (S2).
Logic	Safety considerations must be carried out in accordance with the selected safety switching device (T1). Notes: - The outputs (Q5, Q6, Q7) of the safety switching device (T1) for switching the signals for the inputs (#STO-A, #STO-B, #SBC-A, #SBC-B) of the servo drive (T3) are contact outputs without short-circuit and cross-circuit detection. - The outputs (Q5, Q6, Q7) of the safety switching device (T1) including the necessary time delay must be suitable for PL e, category 4.
Output	The intended use of the servo drive (T3) includes the safety sub-function STO with category 4, up to PL e and the safety sub-function SBC with category 1, up to PL c. The PL, category and PFH_D values of the servo drive (T3) required to determine the reliability of the overall circuit must be available. Note: For the circuit shown in this document, the safety reference data of the servo drive (T3) "without high test pulses, without or with STA evaluation" can be selected. The intended use of the holding brake (U20) in the servomotor (M20) includes holding by clamping with frictional locking. The holding brake (U20) must be a well-tried component according to EN ISO 13849-1 and comply with the relevant basic and well-tried safety principles. The B10 value required to calculate the MTTF_D value for frictionally locking clamping under load must be available.

1.2 SSB with SS1-t and SB for CMMT-AS-...-S1 with external clamping unit

- SS1-t, STO, category 4, up to PL e
- SB, category 1, up to PL c
- Safety switching device with contact outputs
- Without evaluation STA, without evaluation SBA
- Fault exclusion for wiring control cabinet necessary

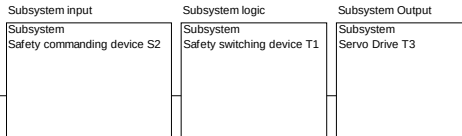
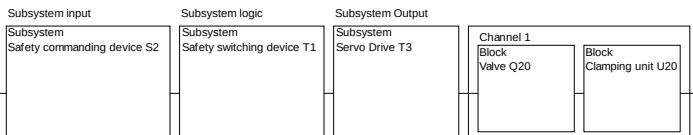
1.2.1 Circuit Diagram



1.2.2 Components

Component	Type (Part Number)	Description / Remarks	Qty.	Mssr.
M20	EMM...-AS	Servo motor	1	Festo
Q20		3/2 directional control valve, monostable	1	Festo
S1		Acknowledge push button	1	
S2		Safety commanding device, e.g. emergency stop switch	1	
S20		Start push button	1	
T1		Safety switching device	1	
T2		Functional PLC	1	
T3	CMMT-AS-...-S1	Servo drive	1	Festo
U20		Clamping unit	1	Festo

1.2.3 Description

Application	Servo drive with servo motor
Triggering event	Safety request (S2), e.g. by emergency stop switch, safety gate
Reaction (Safety function)	Stopping at safety request using the safety sub-function “safe stopping and blocking (SSB)” executed by the safety sub-functions “safe stop 1 time controlled (SS1-t)” with the safe state “safe torque off (STO)” and “safe blocking with friction locking (SB)” Safe state “safe torque off (STO)”, category 4, up to PL e  Safe state “safe blocking with friction locking (SB)”, category 1, up to PL c 
Safe state	The servomotor (M20) is functionally stopped, after an application-specific time the clamping unit (U20) frictionally clamps the shaft of the servo motor (M20) and after a further application-specific time no energy is supplied to the servomotor (M20) that can generate a force and a movement. It is presumed that this state of the servomotor (M20) is the safe state. Notes: - Stopping the servo motor (M20) is functional and is not safety-rated, i.e. if the movement is not stopped in the event of a fault, additional measures may be required, e.g. end position damping for linear axes. - For the wiring between safety switching device (T2), servo drive (T3) and the valve (Q20), fault exclusions on short circuits and cross circuits, e.g. according to ISO 13849-2 [4], Table D.4, are required. The preconditions for these are that the safety switching device (T2), the servo drive (T3) and the valve (Q20) are located in the same control cabinet and that the control cabinet meets the requirements of EN 60204-1 [3]. - Clamping units for factory automation are normally only suitable for static clamping. Manufacturers of clamping units normally do not allow the clamping unit to decelerate the movement (braking). If a movement is nevertheless decelerated with a clamping unit, e.g. due to a power failure, a functional test of the clamping unit for static clamping is necessary due to the increased wear. - Clamping units are subject to wear. Therefore, a regular check is recommended at least during the maintenance cycle of the machine.

Function of the circuit	Due to the safety request (S2): 1. The input circuit of the safety switching device (T1) is interrupted. 2. The output (Q4) of the safety switching device (T1) is then switched off. 3. The input “output stage enable (CTRL-EN)” of the servo drive (T3) is no longer controlled. As a result, the servo drive (T3) functionally decelerates the drive with the quick-stop ramp and switch off the valve (Q20) functionally. This lets the clamping unit (U20) engage functionally. After the end of the braking ramp and after expiry of the parameterizable delay time until the clamping unit has engaged, the output stage is functionally switched off. This corresponds to a behaviour of stop category 1 according to EN 60204-1 [3]. 4. The output (Q7) of the safety switching device (T1) is then switched off with a time delay. The required time delay must be determined depending on the specific application. 5. The inputs “Safe brake control, channel A and B (#SBC-A, #SBC-B)” of the servo drive (T3) are no longer controlled. The activation of the valve (Q20) and therefore of clamping unit is safely disabled and the safety sub-function SBC is requested. 6. The valve (Q20) and the clamping unit (U20) are no longer actuated, so that the clamping unit frictionally locks the shaft of the servomotor (M20). 7. The outputs (Q5, Q6) of the safety switching device (T1) are then switched off with a time delay. The required time delay must be determined depending on the specific application. 8. The inputs “Safe torque off, channel A and B (#STO-A, #STO-B)” of the servo drive (T3) are no longer controlled. This switch off the control of the output stage and requests the safety sub-function STO.
Manual reset function	1. After resetting the safety request (S2), e.g. by mechanically unlocking the emergency stop switch or closing the safety gate, the start or restart can be made possible by actuating the acknowledgement button (S1). 2. The safety switching device (T1) controls via the outputs (Q5, Q6, Q7) the servo drive (T3). This makes it possible to control the power output stage again and the STO and SBC safety sub-functions are no longer active. 3. The safety switching device (T1) permits the control of the “output stage enable (CTRL-EN)” via the functional control (T2) again via the output (Q5). If the “Enable output stage (CTRL-EN)” is switched on by the functional control (T2), the control of the servo drive (T3) is functionally switched on and the valve (Q20) is controlled and therefore the clamping unit (U20) is functionally released after the parameterizable delay time has passed. Normal operation is then possible by pressing the start push button (S20).
Diagnosis	The diagnostic output (STA) does not have to be evaluated for the specified category and PL.

1.2.4 Safety Considerations

Input	Safety considerations must be carried out in accordance with the selected safety commanding device (S2).
Logic	Safety considerations must be carried out in accordance with the selected safety switching device (T1). Notes: • The outputs (Q5, Q6, Q7) of the safety switching device (T1) for switching the signals for the inputs (#STO-A, #STO-B, #SBC-A, #SBC-B) of the servo drive (T3) are contact outputs without short-circuit and cross-circuit detection. • The outputs (Q5, Q6, Q7) of the safety switching device (T1) including the necessary time delay must be suitable for PL e, category 4.
Output	The intended use of the servo drive (T3) includes the safety sub-function STO with category 4, up to PL e and the safety sub-function SBC with category 1, up to PL c. The PL, category and PFH_D values of the servo drive (T3) required to determine the reliability of the overall circuit must be available. Note: • For the circuit shown in this document, the safety reference data of the servo drive (T3) “without high test pulses, without or with STA evaluation” can be selected.

	The intended use of the clamping unit (U20) in the servomotor (M20) includes holding by clamping with frictional locking. The clamping unit (U20) must be a well-tried component according to EN ISO 13849-1 and comply with the relevant basic and well-tried safety principles. The B10 value required to calculate the $MTTF_D$ value for frictionally locking clamping under load must be available. The valve (Q20) must be a well-tried component according to EN ISO 13849-1 and comply with the relevant basic and well-tried safety principles. The B10 value required to calculate the $MTTF_D$ value must be available.
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2 Literature

- [1] DIN EN 61800-5-2:2017-11 - Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional (IEC 61800-5-2:2016); German version EN 61800-5-2:2017
- [2] DIN EN ISO 13849-1:2016-06 - Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015); German version EN ISO 13849-1:2015
- [3] DIN EN 60204-1:2007-06 - Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2005, modified); German version EN 60204-1:2006
- [4] DIN EN ISO 13849-2:2013-02 - Safety of machinery - Safety-related parts of control systems - Part 2: Validation (ISO 13849-2:2012); German version EN ISO 13849-2:2012