BERGER LAHR

Technical documentation

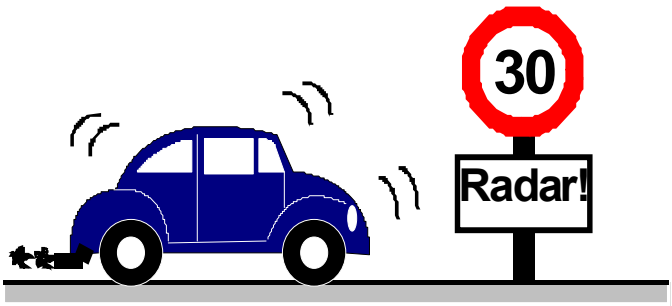
Safety Module for

Twin Line units

SAM

Order no.: 0098441113177

Edition: V1.02, 08.2004



Twin Line

009844113177, V1.02, 08.2004

Table of content

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

Glossaries

Abbreviations

Abbreviation	Meaning
E	Incremental encoder
I/O	Inputs/Outputs
EMC	Electromagnetic compatibility
EC	European Community
EU	European Union
FMEA	Failure Mode and Effects Analysis
HMI	Human-Machine Interface, plug-in hand-held operating unit
Inc	Increment
IT system	I: isolated; T: terre (Fr.), earth System without potential to earth, not earthed
LED	Light Emitting Diode
M	Motor
M1..M4	Module slots of the Twin Line unit
PC	Personal Computer
PELV	Protected Extra-Low Voltage
SAM	Safety Monitor, safety module for Twin Line units
SM	Stepper motor
PLC	Programmable Logic Controller
SUB-D	Multipole connector

0098441113177, V1.02, 08.2004

Product names

Abbreviation	Product designation	Term used
SAM	Safety Monitor Module	Safety module
SAMCT	SAM Configuration Tool	Software for configuration of the SAM module, single parameters can be modified
SAMCLONE	SAM Clone Tool	software for configuration of the SAM module, but only with complete parameter sets.
TLCT	Twin Line Commissioning Tool	Operating Software
TLCxxx	Twin Line Controller xxx Standard unit	Positioning controller
TLCxxxP	Twin Line Controller xxx Version P	Positioning controller Degree of protection IP54
TLHMI	Twin Line HMI	HMI hand-held operating unit
TLHBC	Twin Line Holding Brake Controller	Holding Brake Controller

0098441113177, V1.02, 08.2004

Technical terms

Actual position of the drive system	The actual position of the drive system gives the absolute or relative positions of moving components in the system.
Actual position of the motor	See Angular position of the motor
Angular position of the motor	The angular position of the motor corresponds to the angular position of the rotor in the motor housing, and refers to the zero point or index point of the position sensor.
DC link	The DC link generates the necessary direct current for operating the motor and provides the amplifier with the necessary energy. The DC link acts as a buffer for energy fed back by the motor.
Default values	Preset values for the parameters of the Twin Line unit before initial commissioning, factory settings.
Direction of rotation	Rotation of the motor shaft in a clockwise or anticlockwise direction. A clockwise direction of rotation is defined as the motor shaft rotating clockwise as the observer faces the end of the protruding shaft.
Drive solution	The drive solution comprises the drive system with the Twin Line Unit and motor with the system mechanics forming an integral part of the chain of motion.
Drive system	The drive system consists of the Twin Line Unit and the motor.
Encoder	Sensor for recording the angular position of a rotating element. The encoder is mounted on the motor and signals the angular position of the rotor.
Error class	Response of the Twin Line unit to an operational malfunction corresponding to one of five error classes.
Forcing	To change signal states regardless of the hardware switching status in the unit; with the control tool, for example. The hardware signals remain unchanged.
HIFA-C	Module with Hiperface interface for connecting a Stegmann incremental encoder.
High/open	Signal status of an input or output signal; when no signal is present, signal voltage is high (high level).
HMI	HMI: Human Machine Interface. Human-machine interface handheld unit that can be connected to the Twin Line unit.
Incremental encoder	See encoder.
Internal units	Resolution of the power amplifier with which the motor is directed to the new setpoint. Internal units are given in increments.
Input device	Input device is the device which can be connected to the RS232 interface for the purpose of commissioning; it is either the HMI hand-held operating unit or a PC with the operating software.
Limit switch	Switches that signal an overrun of the permissible travel range.
Low/open	Signal status of an input or output signal; when no signal is present, signal voltage is low (low level).
Module code	Internal electronic code (8 bit) which describes the hardware and the functionality of modules. This code is stored in an EEPROM in every module.
Parameter	Device data and values that can be set by the user.

0098441113177, V1.02, 08.2004

Power amplifier	This is the unit that controls the motor. The power amplifier generates currents for controlling the motor in accordance with the positioning signals from the control unit.
Power controller	See Power amplifier
Quick-Stop	This function is used in the event of faults, the stop command or for fast braking of the motor in an emergency.
Resolver	Analog encoder for determining the angular position of the rotor. It is used for returning the actual position of the motor for phase-accurate control of the motor.
RS232 interface	The RS232 port is the communications interface of the Twin Line unit for connecting a PC or the HMI hand-held operating unit
SAM	SAM: Safety Monitor: optional module for the Twin Line unit for integration of safety functions
User-defined units	A user-defined unit corresponds to the maximum precision at which a distance, speed or acceleration value can be input.
Zero-clamp	Taking over the current actual position as the new setpoint position. It is used with the quick-stop function when the position controller is switched in at zero speed and set to the current position.

009844113177, V1.02, 08.2004

Written conventions and note symbols

Action symbols "▶" This action symbol is used for step-by-step instructions which can be carried out as they are described. If one of the instructions results in a noticeable response from the unit, this will be described after the description of the action to be carried out. This will give you direct confirmation that a particular step has been correctly carried out.

Enumeration symbol "•" The enumeration symbol is used for listing individual points in a given information group in summary form. If the result of steps or sequences is described, the step to be carried out is described first.

Menu paths " ➟ " In the Twin Line Control Tool operating software an action can be launched via 'Menu ➟ Menu item ➟...'. For example, 'File ➟ Save' in the 'File' menu; under the menu item 'Save' saves data from the PC memory to the data storage medium.

This symbol is used for general notes which give additional information about the unit.

Passages preceded by this symbol may have to be discussed in more detail with the local customer service.

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

1 Introduction

1.1 General

Integration and application of safety functions

The SAM safety module (Safety Monitor) can be used to integrate safety functions for personal protection against dangerous movements into the Berger Lahr Twin Line positioning controllers. The safety module offers various operating modes for

- safe monitoring of the motor movement and
- safe removal of the motor power supply

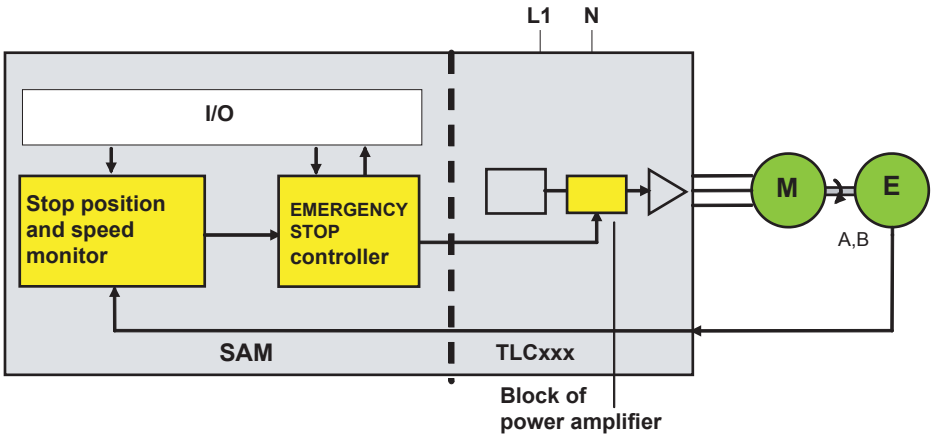


Fig. 1.1 Function blocks

Safe monitoring of the stop position or the reduced speed makes it possible to leave the motor under power, even with the safety door open or the protective devices deactivated. The usual switch off the power, is not required. Time-consuming restart procedures are thus not required. This reduces downtime. This becomes more important the more frequently entry to the danger area is required.

These safety functions enable the more stringent safety requirements for setup mode required by the machine directive to be met

The components required in conventional safety engineering can be replaced with the SAM safety module. These components include:

- additional position sensors (one per axis)
- Stop position and speed monitor (one per axis)
- safety relays (Emergency Stop relays)
- power contactors

0098441113177, V1.02, 08.2004

This reduces the costs for components, installation and also the space required for the system.

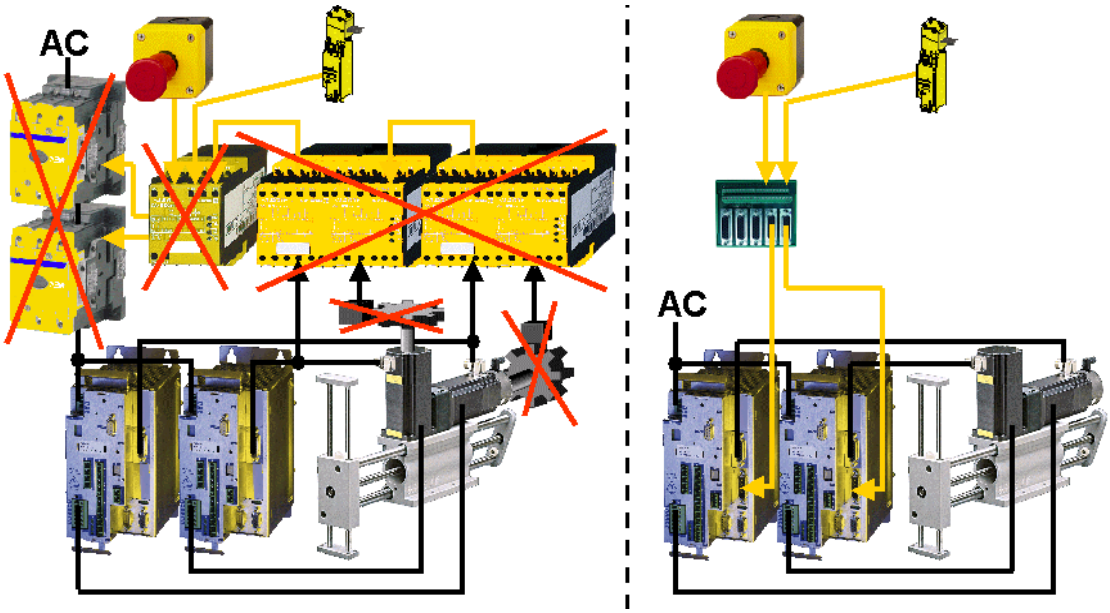


Fig. 1.2 External versus integrated safety engineering

The SAM module is installed in module slot M3 (see figure 1.3) of the Twin Line TLCxxx positioning controllers. The SAM module cannot be used in the TLDxxx units.

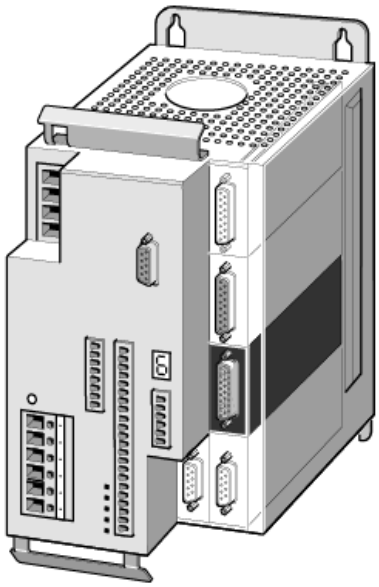


Fig. 1.3 Position of the SAM module in a Twin Line unit

0098441113177, V1.02, 08.2004

Protective circuit

The following system components can be connected to the inputs or outputs of the SAM modules:

- Emergency Stop control devices
- Push button for unblocking the power amplifier
- Safety door position switches or outputs of a optical protection device (e.g. light curtain)
- Push button for safety door confirmation
- Operating mode switch for selecting setup mode
- Enabling devices for enabling motor movements in setup mode
- Power contacts for switching external loads, if necessary with linked contacts
- Electromechanical safety door interlocking
- Inputs of a PLC for status query of the SAM status outputs

Monitoring motor Movement

The motor movements are safely monitored by the SAM module. It does not limit the setpoint defaults for the positioning controller itself. However, it does safely check that the motor position is retained and that the motor speed remains at the preset limit values. The process controller must ensure that these limit values are not exceeded. The SAM triggers the positioning controller internally to initiate a Quick-Stop only if the SAM detects non-allowed motor movements.

Incremental encoder

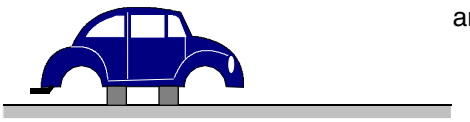
If the SAM module is installed, an incremental encoder must also be used with stepper motor devices. All incremental encoders supported by the Twin Line unit can be used. Additional wiring of the incremental encoder is not required specially for the SAM module, because the connection is established in the Twin Line unit.

0098441113177, V1.02, 08.2004

1.2 Functional description

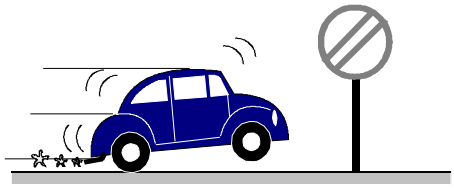
1.2.1 Operating modes

Safe Standstill



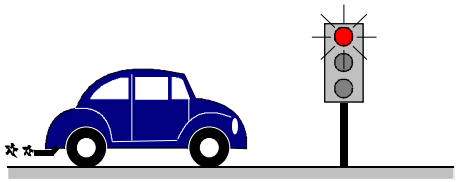
In the ***Safe Standstill*** function the power amplifier controller is blocked and prevents the motor from starting unexpectedly.

Automatic mode



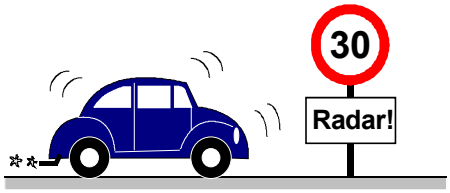
The motor movements are not monitored in ***Automatic mode***, the power amplifier controller is enabled.

Safe Operational Stop



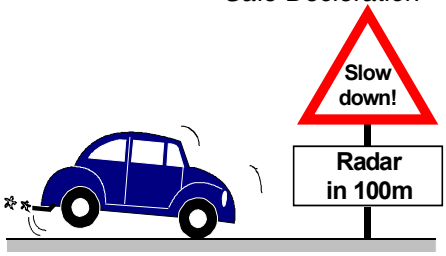
The ***Safe Operational Stop*** function monitors the stop position of the motor to prevent it from starting unexpectedly. The power amplifier controller is unblocked – the control functions can remain active.

Safely Reduced



The ***Safely Reduced*** function monitors whether a preset speed is exceeded. The power amplifier controller is unblocked – the control functions can remain active.
With the SAM module it is distinguished between two operating modes: ***Safely Reduced Setup Speed*** and ***Safely Reduced Automatic Speed.***

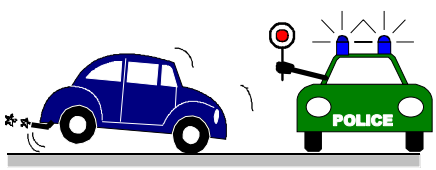
Safe Decleration



The SAM uses the ***Safe Deceleration*** function to monitor controlled braking during a switch to the ***Safe Operational Stop*** or the ***Safely Reduced Setup Speed***. This enables the process controller (e.g. a PLC) to detect the operating mode change requested by the control devices and to apply controlled braking to the drive to slow it to the permissible speed range without initiating an error response.

Without this function, the drive would have to be in the permissible speed range when the request for the new operating mode is made to avoid an error response.

Safe stopping Process



The ***Safe Stopping Process*** function with *safe monitoring of the braking ramp* monitors the controlled braking of the drive after a Quick-Stop request from the SAM module in connection with an error response.

0098441113177, V1.02, 08.2004

1.2.2 Overview of operating mode selection

The safety functions described in this chapter are available when the SAM module is ready for operation (status 6). Details of the various states of the SAM module can be found in the chapter on "Diagnostics and Troubleshooting", page 7-2.

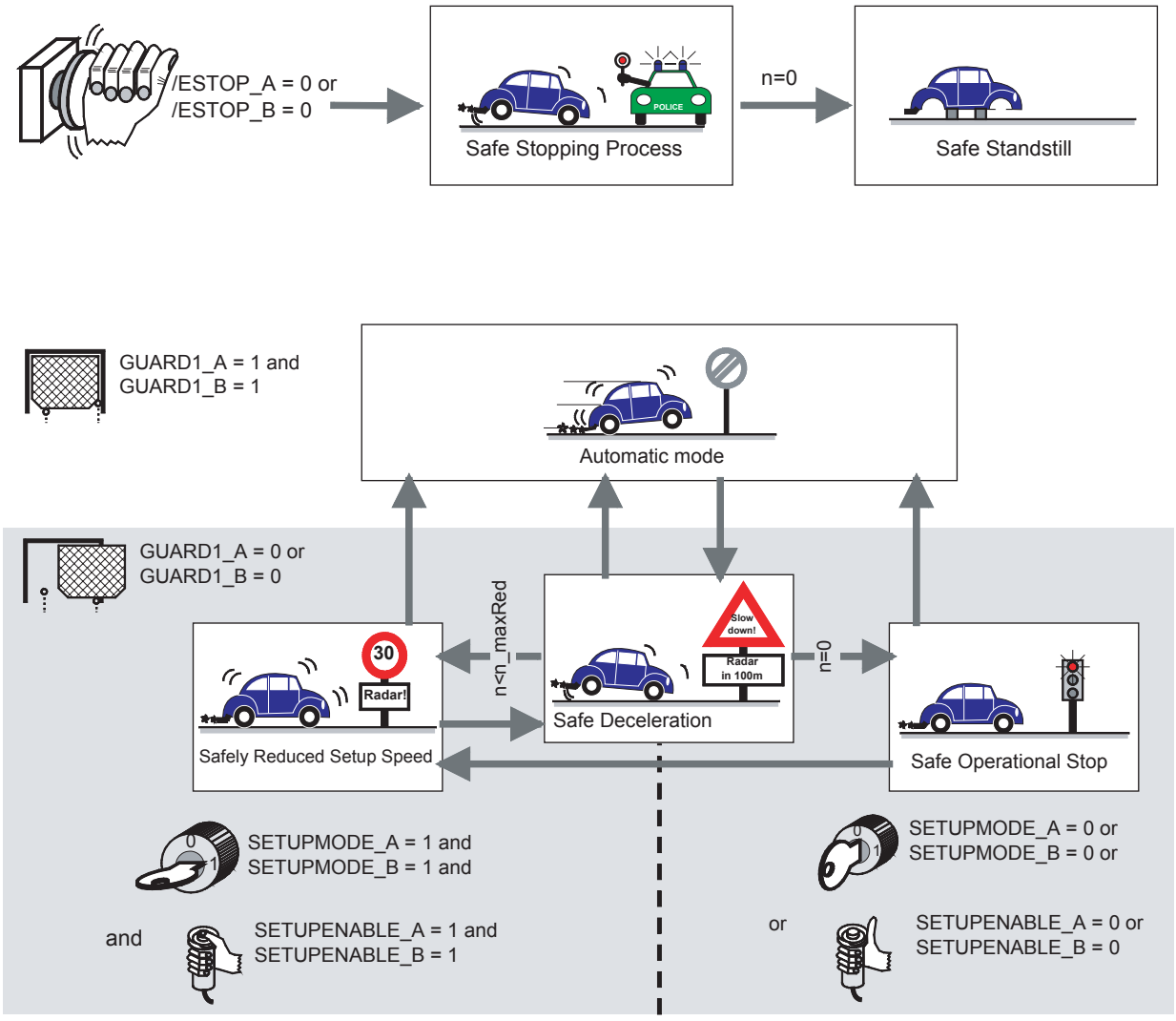


Fig. 1.4 Selecting operating modes

0098441113177, V1.02, 08.2004

1.2.3 Other monitoring functions

Simultaneous switching

If signal pairs switch to another status, the SAM checks whether both inputs switch to the same status within a fixed time window of 10 s. If this does not occur, an error is reported. Possible causes of error can be welded contacts or short circuits to other live conductors.

Test of minimum movement

When the power amplifier controller is unblocking by the SAM module (PowerAmp), the motor must move 2° at least once every 36 hours. This minimum movement is required as a "sign of life" from the incremental encoder. If it does not occur, an error is reported. This applies also for automatic mode.

Test of power supply

If the 24-V power supply exceeds its allowable operating range, an error is reported. The power amplifier and the safety-oriented outputs are switched off immediately.

The power amplifier and the outputs remain switched off until the 24-V power supply is switched off.

Temperature monitoring

The temperature of the SAM module is monitored. If the temperature exceeds or falls below the permissible operating range, the power amplifier and the safety-relevant outputs are switched off immediately.

The power amplifier and the outputs remain switched off until the 24-V power supply is switched off.

Test of outputs

The safety-relevant outputs are tested by being switched off cyclically for ≤0.5ms.

0098441113177, V1.02, 08.2004

1.3 Safety in machine and system design

1.3.1 General

Safety consciousness

The safety consciousness of our society is changing continuously and in part dynamically.
Risks that were acceptable only a few years ago are no longer acceptable after accidents, and methods and solutions are being developed to avoid such accidents. The change in safety requirements is initiating new standards, laws and directives affecting safety engineering. The basic human need for protection against dangers arising from products is demonstrated by the first product liability law, which was passed in the Codex Hammurabi in 1750 B.C. If a building collapses and kills a son of the building owner, a son of the builder must be executed.

The safety requirements of users and operators demands comprehensive risk management by manufacturers of machines and systems. This is applied to determine the following:

- all risks
- the probability of damage occurring
- the degree and significance of the damage
- the possibilities of detecting and avoiding the danger.

Risk management encompasses the entire life cycle of the technical system, assembly, commissioning, fault-free standard operation, fault tracing, setup and adjustment, inspection and cleaning, maintenance and disassembly.

Dangers detected during design of machines and systems, such as in a design FMEA, must be eliminated by removing the causes of the dangers or by encapsulating or protecting against the damgers with safety devices or by organisational measures. The manufacturer must supply comprehensive instructions to allow the user to avoid any remaining residual risks.

Safety-risk danger

Technical systems cannot be used without risk. Risks result from the functions of the technical system, the design of the system, the work processes and the business expense for safety and protective equipment. Technical systems are considered safe when the limit risk is not exceeded. The limit risk is the greatest acceptable residual risk. It is determined by subjective and objective influences, by personal awareness of danger and social acceptance of risks. A technical system is considered dangerous if it poses greater risks than the limit risk.

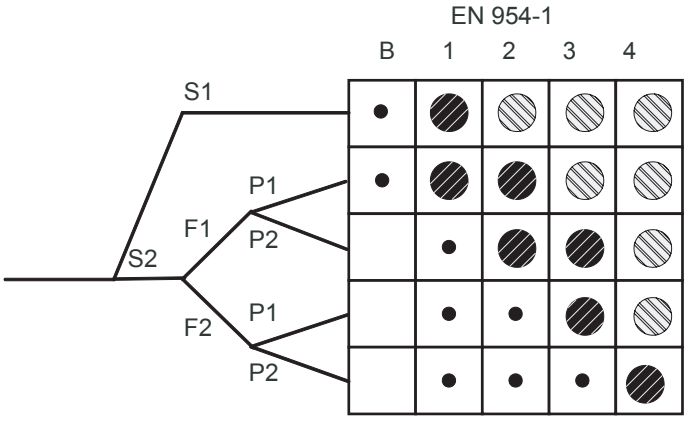
0098441113177, V1.02, 08.2004

1.3.2 Classification of risks

Under the machine directive it is the machine manufacturer's responsibility to determine the required category for safety-relevant parts for the drive solution with Twin Line units as machine components. Quantitative measurement of the risk is generally difficult or impossible. The EN954-1 procedure is only concerned with reducing risk, which is done by the safety-relevant components of the controller. The procedure uses the following three risk parameters for estimating the risk.

- Seriousness of injuries
- Frequency and/or duration of exposure to danger
- Possibilities for avoiding the danger

As shown in figure 1.5, the parameters can be combined to classify the risk on a scale from low to high. Depending on the risk, categories can be derived to which the safety-relevant components of controllers must conform.



S Seriousness of injuries:

S1 slight, generally reversible injury

S2 severe, generally irreversible injury including death

F Frequency and/or duration of exposure to danger:

F1 rare to frequent and/or long duration of exposure

F2 frequently to continual and/or long duration of exposure

P Possibility for avoiding the danger:

P1 possible under certain circumstances

P2 hardly possible

Category:

B, 1,2, 3, 4 Categories for safety-relevant components of controller

Preferred category

Possible categories requiring additional measures

Measures which may be over-dimensioned for the appropriate risk

Fig. 1.5 Risk graph

0098441113177, V1.02, 08.2004

1.3.3 Electronic safety devices in machine and system design

Machine controller components now have safety functions more and more frequently. Such components are referred to as safety-relevant controller components. The general design requirements for safety-relevant controller components are listed in EN 954-1.

The risks arising from a machine can be kept below the tolerable risk with safety-relevant controller components. The SAM safety module integrates safety functions into the Twin Line unit range of positioning controllers and meets the requirements of category 3 in accordance with EN 954-1. This means that the safety function will always remain active if one single error occurs. Some but not all errors are detected.

The integration of safety functions into the positioning controller replaces external safety devices, reduces the total area required, the wiring expense and the cost for the complete system.

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

2 Safety

2.1 Danger categories

Safety notes and general information are indicated by special symbols in the manual. In addition you will find symbols and instructions affixed to your Twin Line unit which warn you of possible dangers and help you to operate the unit safely.

Danger symbols are divided into three danger categories classified by how serious a danger is.. The symbols shown emphasize the danger situation to which the warning applies.

DANGER!
This indicates direct personal danger.
Can lead to serious injuries with fatal consequences if not observed.

WARNING!
Indication of a recognizable danger.
If the warning is ignored, the danger can lead to serious injury with fatal consequences, and to the unit or system parts being permanently damaged.

CAUTION!
Indication of a danger.
If this is ignored, minor personal injury and light damage to the unit or system may result.

Danger of injury
This indicates a danger of injury.

2.2 Safety notes

DANGER!
Electric shock from high voltage!
Follow safety rules when working on electrical systems:

- Switch off the power to the unit.
- Make sure the unit cannot be switched on again inadvertently.
- Confirm that no voltage is present.
- Cover or shield any neighbouring system parts which are live.

DANGER!
Electric shock from high voltage!
Before starting work on the connections of the power unit or on the motor terminals, wait for the 4 minutes discharge time (TLC438 6 minutes) and then measure the residual voltage on the DC-link terminals DC+ and DC-. The residual voltage must not exceed 48 V_{DC} before you start work on the connections.

0098441113177, V1.02, 08.2004

2.3 Intended use

2.3.1 Ambient conditions

Ambient temperature	
TLCxxx:	0° C to + 45° C
TLCxxxP:	0° C to + 45° C
Transport and storage temperature	- 40° C to + 70° C
Relative humidity	
TLCxxx:	15% to 85%
TLCxxxP:	100% (no condensation permissible)
Installation altitude	h < 1000 m above mean sea level
Vibration stress during operation to DIN IEC 68-2-6	
Number of cycles:	10
Frequency range:	10 Hz to 500 Hz
acceleration:	20 m/s^2
Continuous shocks to DIN IEC 68-2-29	
Number of shocks:	1000/direction (X, Y, Z axes, pos. and neg. Direction, total 6000)

Degree of protection

The SAM module and the SAM adapter must be used only under ambient conditions that conform to degree of protection IP54. This is necessary to prevent cross connections and short circuits between clamps, plug connectors, cables, conductors etc. to the safety-relevant circuit components through other components.

2.3.2 Intended use

category of safety-related parts

The SAM module must be used only for technical protection functions up to and including category 3 in accordance with EN 954-1, unless additional measures are implemented.

Configuration

The parameter values for the SAM must be selected to ensure that the required tolerable risk is not exceeded when using the safety function.

Vertical axes

Vertical axes which can be dangerous if their weight causes them to lower unexpectedly must not be operated without additional measures to secure them from lowering in accordance with EN 954-1.

Installing the module

The SAM module is designed for operation with the TLCxxx Twin Line units. The module is installed in slot M3 in servo and stepper motor units. The SAM module is only supplied with a Twin Line unit. If you wish to install the SAM module in an existing Twin Line unit, please contact the service department of your local dealer.

Motors

The use is only admitted with the Berger Lahr Motors VRDM3... and SER3...

0098441113177, V1.02, 08.2004

2.4 Qualifications of personnel

Only technicians who are familiar with the contents of this manual are qualified to configure and commission the SAM module. The technicians must be able to detect potential dangers that may be caused by installation, configuration, changing parameter values and generally by the mechanical, electrical and electronic equipment.

Qualified personnel must be familiar with the current standards, regulations and accident prevention regulations which have to be observed when working on the unit.

0098441113177, V1.02, 08.2004

2.5 Directives and standards

Relevant standards

EN 954-1: Safety of machinery, Safety-related parts of control systems, Part1: General principles for design

EN 60204-1: Safety of machinery, Electrical equipment of machines, Part1: General requirements

EN 50 178 (VDE 0160): Fitting power systems with electronic equipment

DIN VDE 0100: Regulations regarding the installation of power systems with voltages up to 1000 V

DIN VDE 0106-100: Protection against electrical shock; Location of actuation elements in the vicinity of operating resources liable to accidental contact

DIN VDE 0470-1: IP degrees of protection

DIN EN 61000-4-1 (IEC 1000-4-1): Testing and measurement procedures, Section 1: Overview of noise suppression test procedures

DIN EN 61800-3 and prA11: Variable-speed electric drives

0098441113177, V1.02, 08.2004

2.6 Declaration of conformity and CE mark

EC Declaration of Conformity
Year 2004

BERGER LAHR

BERGER LAHR GmbH & Co.KG
Breslauer Str. 7
D-77933 Lahr

☒ according to EC Directive EMC 89/336/EEC
☒ according to EC Directive Low Voltage 73/23/EEC
The above mentioned directives have been changed by CE Marking Directive 93/68/EEC
☒ according to EC Directive on Machinery 98/37/EEC

We declare that the products listed below meet the requirements of the mentioned EC Directives with respect to design, construction and version distributed by us. This declaration becomes invalid with any modification on the products not authorized by us.

Designation:	3 Phase Motor Control Electronics with Safety Module SAM
Type:	TLCx1x, TLCx3x, TLCx1xP, TLCx3xP
Product number:	0x634xxxxxxxx, 0x635xxxxxxxx
Applied harmonized standards, especially:	EN 954-1:1997, category 3 EN 50178:1998 EN 61800-3:2001, second environment according to Berger Lahr EMC test conditions
Applied national standards and technical specifications, especially:	UL 508C Berger Lahr EMC test conditions 200.47-01 EN Product documentation
Company stamp:	Berger Lahr GmbH & Co. KG Postfach 11 80 · D-77901 Lahr Breslauer Str. 7 · D-77933 Lahr
Date/ Signature:	16 February 2004
Name/ Department:	Wolfgang Brandstätter/R & D

0098441113177, V1.02, 08.2004

2.7 BG certification

Prüf- und Zertifizierungsstelle
im BG-PRÜFZERT

BIA
Berufsgenossenschaftliches Institut für Arbeitsschutz

Hauptverband der gewerblichen Berufsgenossenschaften

Baumusterprüfbescheinigung

03 06001
Bescheinigungs-Nummer

Name und Anschrift des Bescheinigungsinhabers: (Auftraggeber)	Berger Lahr GmbH & Co. KG Gewerbestr. 9, 77749 Hohberg-Niederschopfheim
Name und Anschrift des Herstellers:	Berger Lahr GmbH & Co. KG Breslauer Str. 7, 77933 Lahr

Zeichen des Auftraggebers:	Zeichen der Prüf- und Zertifizierungsstelle:	Ausstellungsdatum:
	Apf/Zil/Gre/Zü 1998 24677	17.01.2003

Produktbezeichnung:	Modul zur Integration von Sicherheitsfunktionen im Steuerungs- und Antriebssystem für Servo- und Schrittmotoren der Firma Berger Lahr
Typ:	Sicherheitsmodul SAM Klemmenadapter (optional)
Bestimmungsgemäße Verwendung:	Einsatz auf Steckplatz M3 der Twin Line-Geräte TLCxxx zur Auswertung sicherheitsrelevanter Signale und Realisierung von Sicherheitsfunktionen. Die geprüften Funktionen sind in der Anlage aufgelistet.
Prüfgrundlage:	DIN EN 954-1, 1997-03 DIN V VDE 0801, 1990-01 mit DIN V VDE 0801/A1, 1994-10 Positionspapier des DKE AK 226.03, 1998-06 DIN EN 60204-1, 1998-11 DIN EN 50178, 1998-04 IEC 61800-3, 1996-06
Bemerkungen:	Das vorgestellte Baumuster in Verbindung mit einem TLCxxx Gerät entspricht den Anforderungen der Prüfgrundlagen, nach DIN EN 954-1 der Kategorie 3 und nach DIN V VDE 0801 der Anforderungsklasse 4.

Das geprüfte Baumuster entspricht den einschlägigen Bestimmungen der Richtlinie 98/37/EG (**Maschinen**).

Weitere Bedingungen regelt die Prüf- und Zertifizierungsordnung vom Oktober 1997

Leiter der Zertifizierungsstelle

i.V. .....
(Dr. rer. nat. Dietmar Reinert)

Fachzertifizierer

.....
(Dipl.-Ing. R. Apfeld)

Postadresse: 53754 Sankt Augustin
Hausadresse: Alte Heerstraße 111, 53757 Sankt Augustin
Tel: 0 22 41/2 31-02
Fax: 0 22 41/2 31-22 34

PZB10
10.98

0098441113177, V1.02, 08.2004

2.8 Documentation

Documentation for the Twin Line units on CD-ROM, multilingual
Order no.: 9844 1113 138

Twin Line HMI, manual for the Human-Machine Interface HMI, English
Order no.: 9844 1113 091

Twin Line Control Tool, manual for the operating software, English
Order no.: 9844 1113 095

Installation notes and help for EMC-compliant installation of BERGER LAHR motor drives,
Order no.: 9844 1113 075

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

3 Technical data

3.1 Electrical data

Plug connection	Connection:	High Density SUB-D 26-pin plug M3 screw
Category of safety-related parts	according to EN 954-1	Categorie 3
24V power supply	PELV, DIN 19240,	
	input	
	Voltage range (monitored), reverse-polarity protected	20-30 VDC
	Ripple	< 2 V_{SS}
	Input current (without loading the outputs)	< 0.02 A
Signal interface	digital signal inputs	
		reverse-polarity-protected No electrical isolation debounced, debounce time≥ 1ms
	Time window for simultaneous switching both signals of a signal pair	10s
	DC voltage U_{high}	15V to 30V (I ≥ 3 mA)
	DC voltage U_{low}	≤5V (I ≤ 0.5mA)
	Current at 24 V(5KΩ against GND)	I ≤ 5mA
	Digital signal outputs	inductive loadability (150mH/11W) capacitive loadability (C ≤ 1 μF) short-circuit proof
	DC voltage	≤ 30 V
	Switching current:	
	RELAY_A, RELAY_B, INTERLOCK_OUT	≤ 0.5 A
	SAFETY24VDC_A, SAFETY24VDC_B	≤ 0.3 A
	AUXOUT1, AUXOUT2	≤ 0.1 A
	Voltage drop at 0.5 A	≤ 1 V
	Deactivation time for test	≤ 0.5 ms
	maximum time for detection of cross connections at activated outputs	≤ 5 s
Reaction times	EMERGENCY STOP to start of standstill	≤ 20 ms
	exceeding speed	≤ 20 ms
	overshooting position	≤ 20 ms
	Safe Stopping Process violated	≤ 10 ms
Behavior on errors in power amplifier output	Maximum motor-driven movement	1/2 motor pole pitch
	e.g. stepper motor with 50 pole pairs	3.6°
	servomotor with 3 pole pairs	60°
	servomotor with 4 pole pairs	45°
Motor	Maximum speed	≤ 7000 rpm (depending on drive)

0098441113177, V1.02, 08.2004

3.2 SUB-D plug connector

Pin	Signal	active	default (open)	Usage	I/O
1	**$\overline{\text{ESTOP\_A}}$**	**low**	**low**	**Emergency Stop control devices**	**I**
2	GUARD1_A	high	low	Safety door position switch	I
3	SETUPENABLE_A	high	low	enabling device	I
4	SETUPMODE_A	high	low	operating mode switch	I
5	reserved				
6	reserved				
7	INTERLOCK_IN	high	low	Enable input for safety door interlock logic	I
8	SAFETY24VDC_A	high		Control devices power supply with cross connections dedection	O
9	SAMSTART	high	low	Start signal	I
10	SAM24VDC			SAM module power supply	-
11	SAM24VGND			SAM module power supply	-
12	reserved				I
13	AUXOUT1	high		Status output	O
14	AUXOUT2	high		Status output	O
15	RELAY_A	high		power contactor	O
16	RELAY_B	high		power contactor	O
17	GUARD1CONF	high	low	enabling device	I
18	INTERLOCK_OUT		low	safety door interlock	O
19	$\overline{\text{ESTOP\_B}}$	low	low	Emergency Stop control devices	I
20	GUARD1_B	high	low	Safety door position switch	I
21	SETUPENABLE_B	high	low	enabling device	I
22	SETUPMODE_B	high	low	operating mode switch	I
23	reserved				
24	reserved				
25	reserved				
26	SAFETY24VDC_B	high		Control devices power supply with cross connections dedection	O

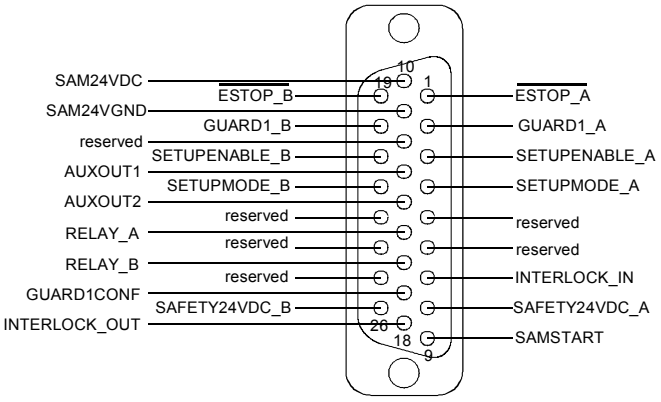


Fig. 3.1 Pin assignment SUB-D plug connector

0098441113177, V1.02, 08.2004

4 Planning

The chapter on planning should be considered as an overview. See the following chapter for details.

4.1 Application cases

Application cases and actions

The following list shows some examples of typical applications. This overview contains design and/or organisational measures that can assist you with the use of the SAM module.

Application	Action	See page
Category of safety-related parts unknown	Determination of category in accordance with EN 954-1	1-8
System with stepper motor drive	Use incremental encoder	1-3
System with enterable danger area	Use push button for safety door confirmation (GUARD1CONF) or use mechanical measures to prevent accidental closure of the safety door	5-5 and 5-23
Residual risk of unexpected startup with *Safely Reduced Setup Speed* not acceptable	Use enabling device	5-17
Connection of power contactors for safety-related switching of other consumers	Use contactors with linked contacts that comply with the relevant requirements (e.g. EN 60947-5-1) and wire mirror contacts to the SAMSTART circuit	5-11
SAM connection cable not only in cabinet	Two-channel wiring with cross-connection detection, e.g. by power supply of control devices with SAFE24VDC.	5-3
SAM wiring not only in cabinet	Two-channel wiring with cross-connection detection, e.g. by power supply to control stations with SAFE24VDC or prevention of short circuits by layout in separate plastic-sheathed cables	5-3
Multi-axis system	Use multi-axis wiring or SAM adapter, install SAM adapter in IP54 ambient – ensure cable guide for SUB-D plug connector	5-6 or 5-6
System with field bus	Status query over field bus possible	5-28
Master safety relay (Emergency Stop)	Connect SAMSTART input to 24 V and configure automatic start	5-14
Vertical axes	Take action to secure against falling in accordance with EN 954-1, if there is a possibility of unwanted lowering causing a hazard	2-2

0098441113177, V1.02, 08.2004

4.2 Wiring

The following system components are designed for connection to the SAM inputs and outputs:

- Emergency Stop control devices
- Push button for unblocking the power amplifier
- Safety door position switches or outputs of a optical protection device (e.g. light curtain)
- Push button for safety door confirmation
- Operating mode switch for selecting setup mode
- Enabling device for enabling motor movements in setup mode
- Power contacts for switching external loads, if necessary with linked contacts
- Electromechanical safety door interlocking
- Inputs of a PLC for status query of the SAM status outputs

The circuit options for use with the SAM adapter are shown in the following diagram.

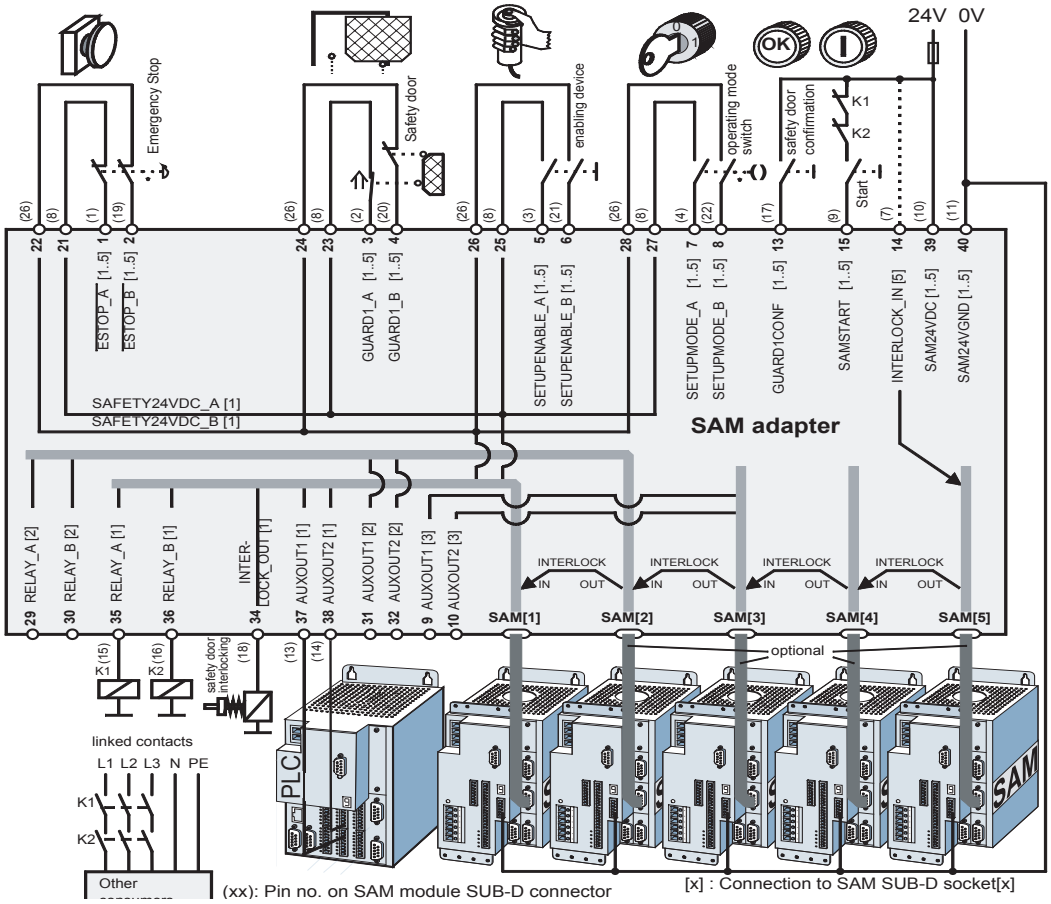


Fig. 4.1 SAM safety module, maximum syfety circuit

0098441113177, V1.02, 08.2004

4.3 Basic calculations for braking times and braking distances

The basic calculations below are also available as an EXCEL program "SAMTEST.xls". Contact your local representative.

Calculating reduced speeds

linear movement	rotary movement
Calculating reduced speeds	
$p_{gear} = \frac{n_{Motor}}{n_{Spindel}}$ *gear factor* $h\left[\frac{mm}{U}\right]$ *stroke / pitch of axis* $v_{lin}\left[\frac{m}{\min}\right]$ *reduced linear speed* $n\_\max \mathrm{Re}\, d\left[\frac{U}{\min}\right] = v_{lin} \cdot \frac{p_{gear}}{h} \cdot 1000$	$p_{gear} = \frac{n_{Motor}}{n_{Spindel}}$ *gear factor* $d[mm]$ *diameter of mechanic* $v_{rot}\left[\frac{m}{\min}\right]$ *reduced circumferential speed* $n\_\max \mathrm{Re}\, d\left[\frac{U}{\min}\right] = v_{rot} \cdot \frac{p_{gear}}{d \cdot \pi} \cdot 1000$
Converting the stopping distances	
$s_{mech}[mm] = s[U] \cdot \frac{h}{p_{gear}}$	$s_{mech}[mm] = s[U] \cdot \frac{d \cdot \pi}{p_{gear}}$

Parameterss required from the SAM:

$Sam.\mathrm{Re}\, dSpeed.n\_\max \mathrm{Re}\, d$ *in* $\frac{U}{\min}$

$Sam.\mathrm{Re}\, dSpeed.n\_\max Auto$ *in* $\frac{U}{\min}$

$Sam.Stopping.dec\_QStop$ *in* $\frac{U}{\min \cdot s}$

$Sam.Decelerati\ on.dec\_NC$ *in* $\frac{U}{\min \cdot s}$

$Sam.Decelerati\ on.t\_NCDel$ *in* *ms*

Parameters required from the positioning controller:

$acc = Motion.acc \cdot \frac{Motion.aNormNum}{Motion.aNormDen}$ *in* $\frac{U}{\min \cdot s}$

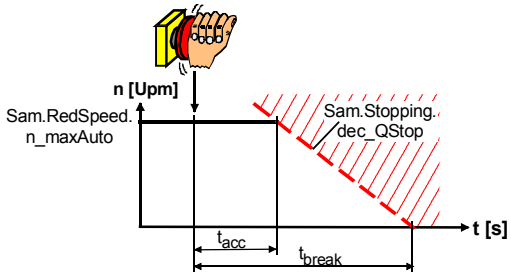
$dec = Motion.dec \cdot \frac{Motion.aNormNum}{Motion.aNormDen}$ *in* $\frac{U}{\min \cdot s}$

0098441113177, V1.02, 08.2004

The calculations are based on the following assumptions:

The motor accelerates in a linear fashion at acceleration acc when the permitted position or speed range is left as a result of a controller error.

Emergency Stop

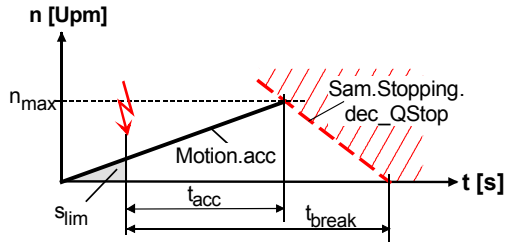


$$t_{acc}\,[s] = 0{,}018 + \frac{50}{dec\_QStop}$$

$$t_{break}\,[s] = t_{acc} + \frac{n\_\max\ Auto}{dec\_QStop}$$

$$s_{break}\,[U] = \frac{1}{120} \cdot \left[2 \cdot n\_\max\ Auto \cdot t_{acc} + \frac{n\_\max\ Auto^{\,2}}{dec\_QStop} \right]$$

Safe Operational Stop



$$n_{Start}\left[\frac{U}{\min}\right] = \sqrt{3 \cdot acc}$$

$$t_{acc}\,[s] = 0{,}012 + \frac{50}{acc + dec\_QStop}$$

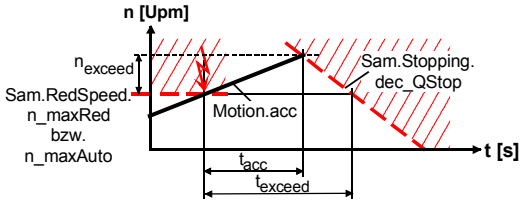
$$n_{\max}\left[\frac{U}{\min}\right] = n_{Start} + acc \cdot t_{acc}$$

$$t_{break}\,[s] = t_{acc} + \frac{n_{\max}}{dec\_QStop}$$

$$s_{break}\,[U] = \frac{1}{120} \cdot \left[(n_{Start} + n_{\max}) \cdot t_{acc} + \frac{n_{\max}^{\,2}}{dec\_QStop} \right]$$

0098441113177, V1.02, 08.2004

Safely Reduced Speed



$$t_{acc}[s] = 0{,}012 + \frac{50}{acc + dec\_QStop}$$

$$n_{exceed}\left[\frac{U}{\min}\right] = acc \cdot t_{acc}$$

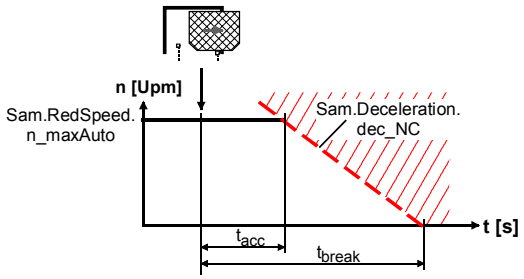
What distance is run in what time whilst exceeding the reduced speed?

$$t_{exceed}[s] = t_{acc} + \frac{n_{exceed}}{dec\_QStop}$$

$$s_{exceed}[U] = \frac{1}{120} \cdot \left[n_{exceed} \cdot t_{acc} + \frac{n_{exceed}^{\ 2}}{dec\_QStop} \right]$$

Open safety door; stopping with Safe Deceleration (by PLC)

If Sam.Deceleration.dec_NC > 0
(function S*afe Deceleration* enabled)



$$t_{acc}[s] = 0{,}008 + \frac{t\_NCDel[ms]}{1000} + \frac{50}{dec\_NC}$$

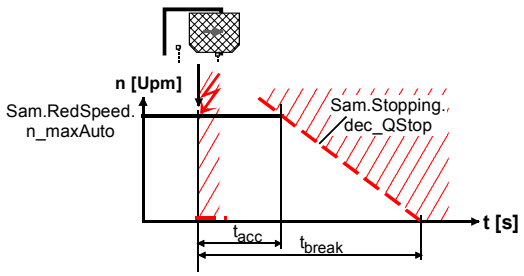
$$t_{break}[s] = t_{acc} + \frac{n\_\max Auto}{dec\_NC}$$

$$s_{break}[U] = \frac{1}{120} \cdot \left[2 \cdot n\_\max Auto \cdot t_{acc} + \frac{n\_\max Auto^2}{dec\_NC} \right]$$

Open safety door; stopping with Safe Stopping Process (by quick-stop)

If Sam.Deceleration.dec_NC=0
(function *Safe Deceleration* disabled)

Values same as with Emergency Stop



0098441113177, V1.02, 08.2004

4.4 Basic calculation for the electrical installation

4.4.1 Power consumption with multi-axis wiring

Current consumption [A]	Number of SAM modules				
	1 SAM	2 SAMs	3 SAMs	4 SAMs	5 SAMs
Total without SAM adapter	0.07A	0.14A	0.21A	0.28A	0.35A
Total with SAM adapter	0.25A	0.36A	0.45A	0.52A	0.59A

The load currents of the connected output must still be added to the table values.

4.4.2 Voltage drops with multi-axis wiring with a SAM adapter

Voltage drop [mV/m] at 0.01786 Ω *mm2/m for Cu			Number of SAM modules 1SAM	2 SAMs	3 SAMs	4 SAMs	5 SAMs	Current load
Voltage drop [mV/m]	Load current	0A	4,5	6.4	8,0	9,3	10,5	see table
SAM24VCD from SAM [1..5]	outputs	1.0A	22,4	24,3	25,9	27,2	10,5	Current consumption
in feed (at 1mm^2)	SAM[1..5]	2.0A	40,2	42,1	43,7	45,0	46,2	
Voltage drop [mV/m]	Load current	0A	4,7	5,8	6,8	7,9	8,9	70mA + 20mA/SAM
SAM24VDC from SAM [1] 1)		1.0A	57,3	58,3	59,4	60,4	61,5	
in the SAM cable (0.34mm^2)	SAM[1]	2.0A	109,8	110,8	111,9	112,9	114,0	
Voltage drop [mV/m] SAFETY24VDC_A or SAFETY24VDC_B in the SAM cable (at 0.34mm^2)			3,7	4,7	5,8	6,8	7,9	20mA/SAM+ 50mA/adapter
oltage drop [mV/m] in the control devices circuit (e.g. Emergency Stop line) (at 1mm^2)			0,1	0,2	0,3	0,4	0,4	5mA/SAM
Voltage drop [mV/m] Input signal line in the SAM cable (at 0.34mm^2)			0,3	0,3	0,3	0,3	0,3	5mA/input

1) The SAM module whose SAFETY24VDC outputs are used for cross-connection detection.

009844113177, V1.02, 08.2004

5 Installation and setup

5.1 Safety instructions for installation and commissioning

Installation

DANGER!
Danger of death from high voltage!
The DC link and power amplifier of the Twin Line unit remain live when switched off by the SAM.
Before carrying out maintenance and installation work, disconnect the drive from the power supply with a system voltage switch, and secure the switch to prevent it from being switched on.

Commissioning

DANGER!
Danger of personal injury and damage to system parts by uncontrolled starting of the system!
Block off the danger zone before starting up the Twin Line unit with SAM module, and ensure that no one is in the accessible area behind the system.

DANGER!
Danger of personal injury and damage to system parts by uncontrolled system startup!
Before commissioning check the wiring of the SAM module. Wiring faults can cause unexpected responses in the system.

DANGER!
Danger of injury and damage to system components from unsuitable parameter values!
Setting parameter values that are not suitable for the system can cause unexpected responses in the system. Calculate the parameter values very carefully.

5.2 Mechanical installation

The SAM module is only supplied with a new Twin Line unit. If you wish to fit a SAM safety module to an existing Twin Line unit, please contact the service department of your local dealer.

0098441113177, V1.02, 08.2004

5.3 Electrical installation

Module interface To the 26-pin SUB-D connector the other safety-relevant system components have to be connected.

BERGER LAHR supplies cables and adapters as accessories that can be used for wiring the system components with the SAM. For more information see "Accessories and spare parts", page 9-1.

5.3.1 Connecting the 24V power supply

Power unit Use only 24V PELV power units fot the power supply of theSAM and the Twin Line unit and earth the 0V terminal.

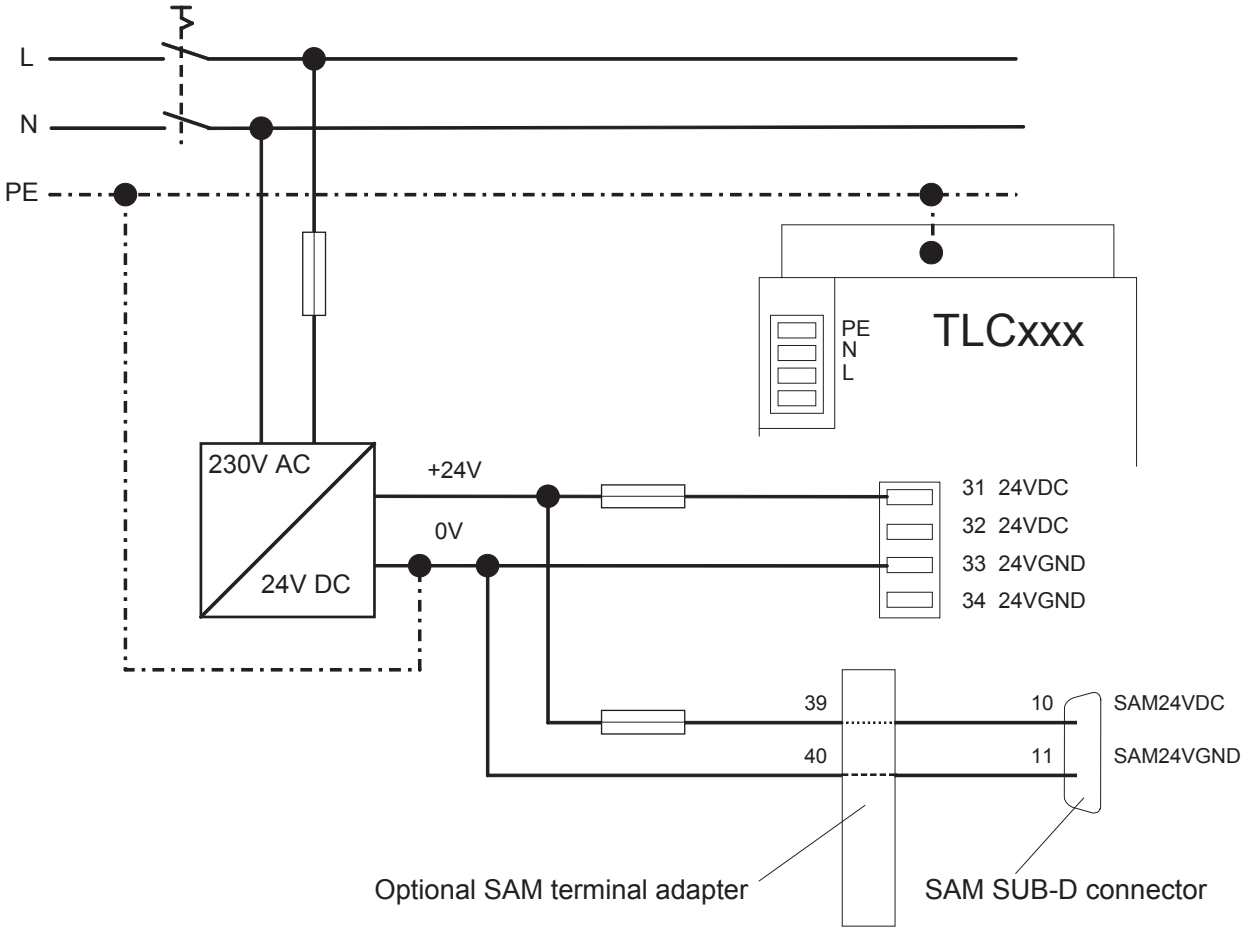


Fig. 5.1 24V terminal

Different power units can be used for the Twin Line unit and SAM module. However, always connect the 0V terminal of the power units together, because the GND terminals are not connected in the unit.

009844113177, V1.02, 08.2004

5.3.2 Detecting cross connections

With the SAFETY24VDC_A and SAFETY24VDC_B outputs the SAM module offers a two-channel 24-V power supply with cross connection detection. With two-channel wiring and supplying power to the control devices with these power outputs cross connections between channels and short circuits to other live conductors can be detected.

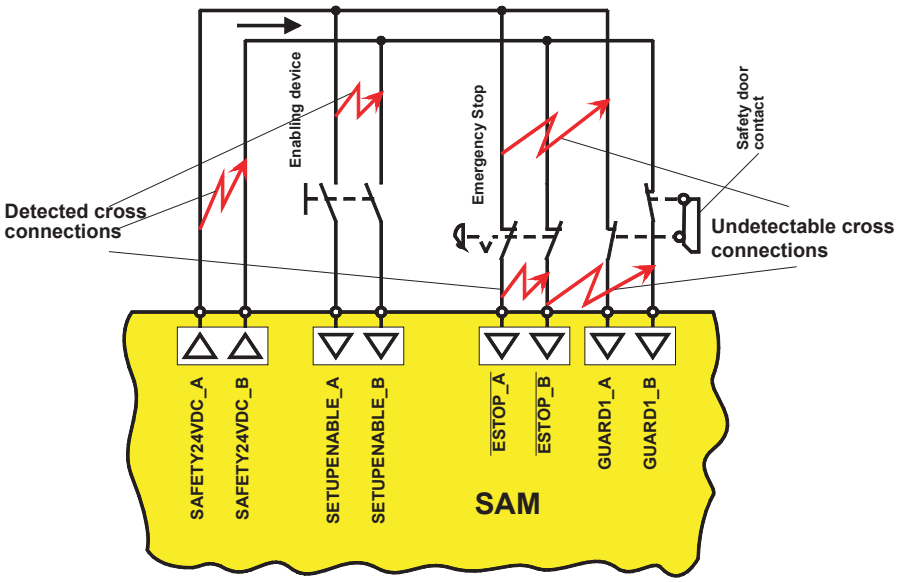
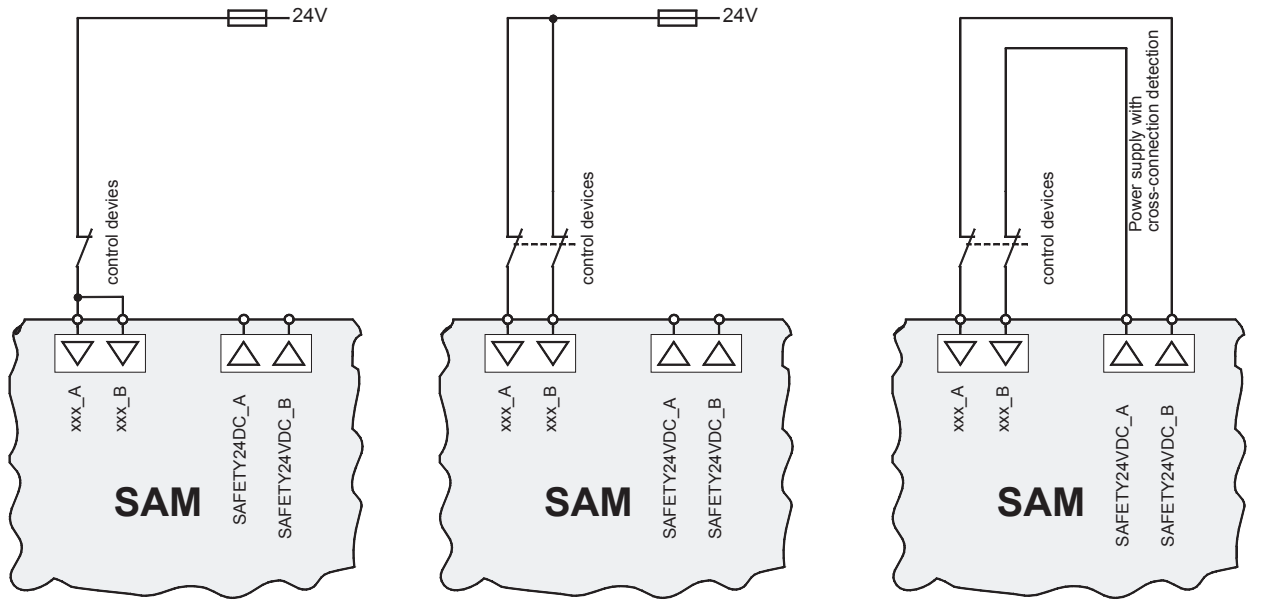


Fig. 5.2 cross-connection detection

Only cross connections from signals with the suffix "_A" to signals with the suffix "_B" that are connected at low resistance to the 24V power supply can be detected. Cross connections within a redundancy group (e.g. "_A" to "_A") cannot be detected; they would be detected by the different input states that occur after opening the corresponding the control devices.

0098441113177, V1.02, 08.2004

5.3.3 Wiring types fpr control devices



Single-channel wiring **two-channel wiring** **Two-channel wiring with cross-connection detection**

Fig. 5.3 Control devices connection types

A single channel control device be sufficient for lower categories according to EN 954-1or with appropriate wiring.

category according to EN 954-1	**Wiring**	
	single-channel	**two-channel**
B, 1, 2	sufficient	possible, but not required
3	possible if wires are laid in protected areas, such as in hard conduit; **not recommended**	sufficient
4	without additional measures not allowed with SAM	without additional measures not allowed with SAM

009844113177, V1.02, 08.2004

5.3.4 Multi-axis wiring

If the safety-relevant control devices is installed in a system for multiple axes with a SAM module, the inputs to the SAM modules must be wired in parallel. However the SAM module outputs must not be wired in parallel.

For parallel wiring of multiple axes and for chaining the inputs and outputs for safety door interlocking the SAM adapter is recommended. For more information see "Accessories and spare parts, SAM adapter", page 9-3.

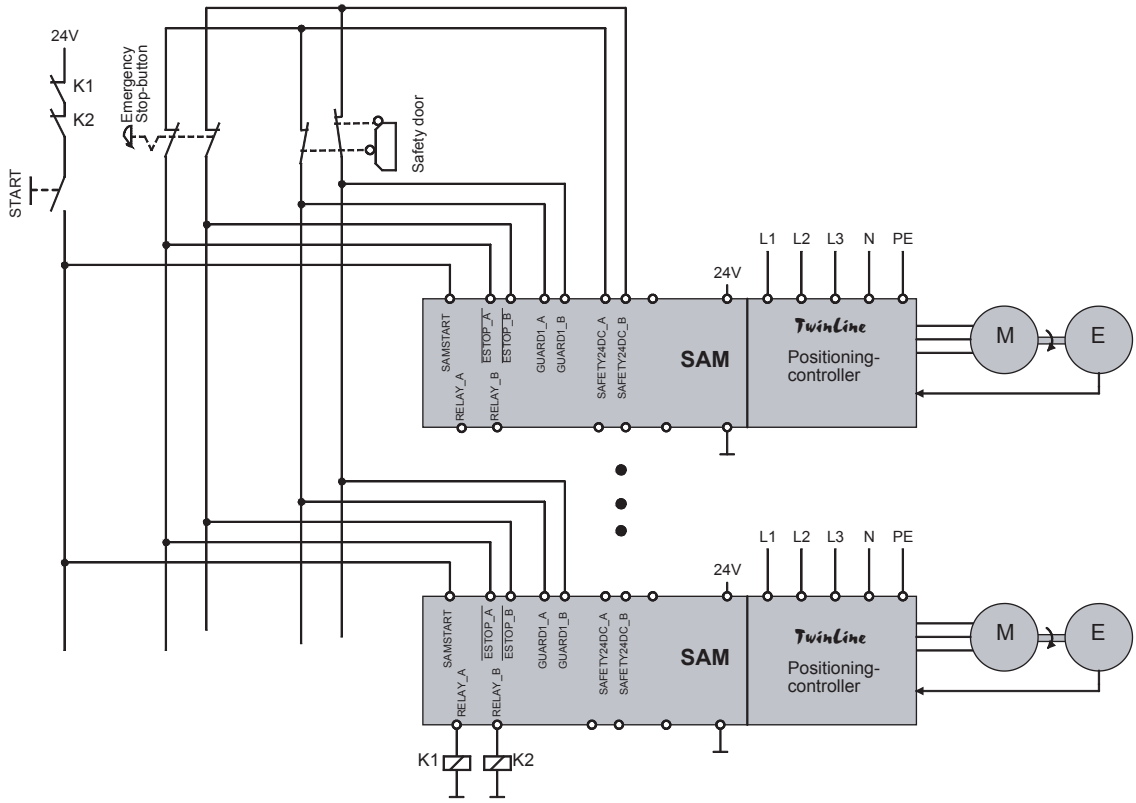


Fig. 5.4 Multi-axis wiring

The power contactors for switching off the external components can be connected to any convenient SAM module.
The control devices for cross-connection detection can also be connected to the SAFETY24DC outputs of any convenient SAM module.

DANGER!
Safety function may be lost if the plugs are swapped!
If the safety-relevant outputs (RELAY, INTERLOCK_OUT) are swapped, this can result in altered switching behaviour with differently configured SAM modules.

- Mark the cables!
- Check the connections!

0098441113177, V1.02, 08.2004

5.3.5 Multi-axis wiring with SAM adapter

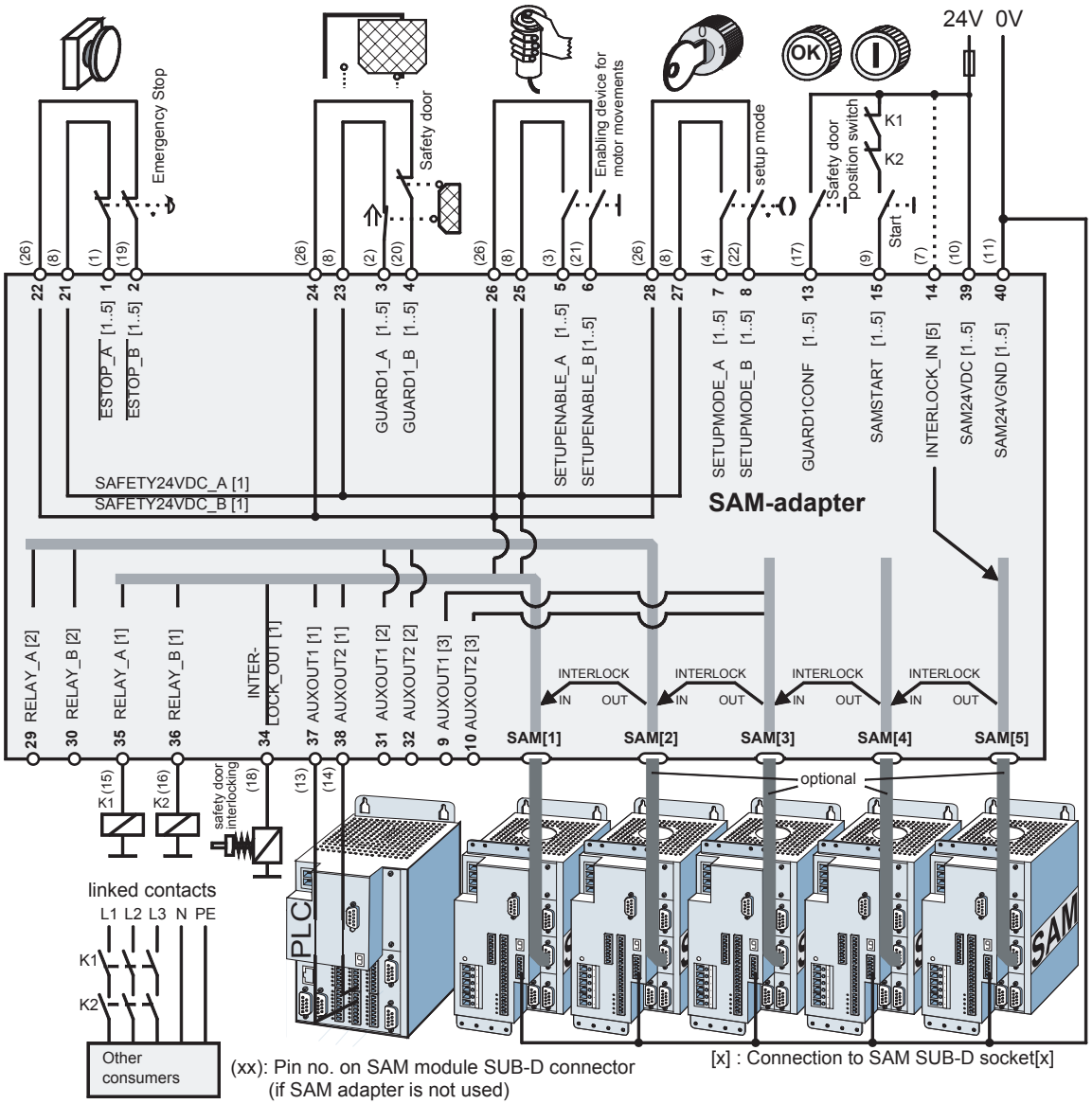


Fig. 5.5 Multi-axis wiring using SAM adapter

The SAM1 slot must always be connected with a SAM module, because the outputs for the power supply for the control devices with cross-connection detection (SAFETY24DC) are accessed from this slot.

For a more detailed description of the SAM adapter see the chapter on "Accessories and spare parts", page 9-3.

009844113177, V1.02, 08.2004

5.4 Stopping in emergency

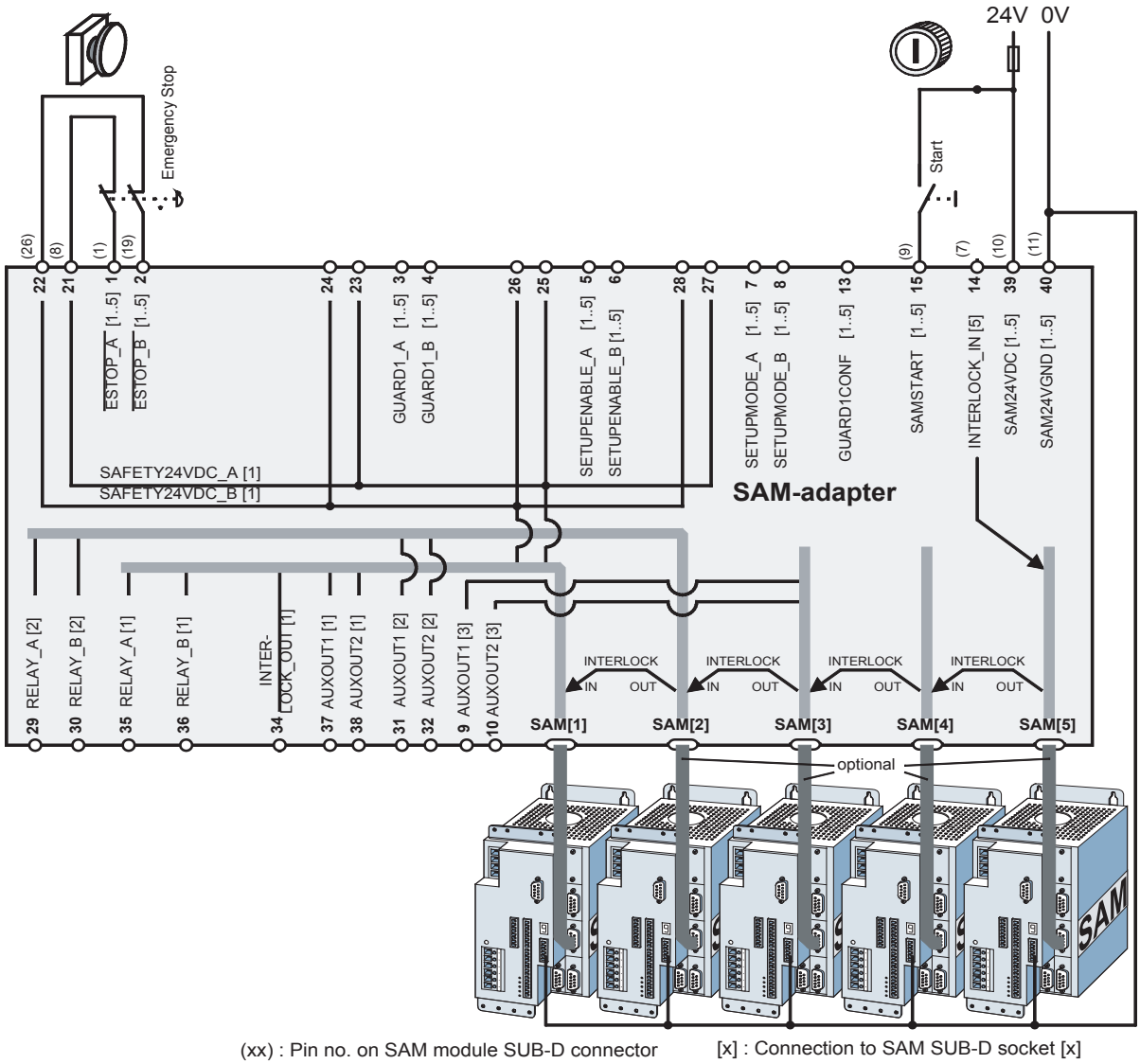
5.4.1 Internal safety relay function

Wiring The Emergency Stop function is the basic function of the SAM module. It unblocks the power amplifier.

The following connections must be wired for this unblocking:

- 24V power supply to SAM24VDC and SAM24VGND
- EMERGENCY STOP control devices to $\overline{\text{ESTOP\_A}}$ and $\overline{\text{ESTOP\_B}}$
- Start button to SAMSTART.

If a system of multiple Twin Line units is operated with a SAM module, up to five SAM modules can be connected by implementation of the SAM adapter. For more information see "Accessories and spare parts", page 9-3.



(xx) : Pin no. on SAM module SUB-D connector (if SAM adapter is not used)

[x] : Connection to SAM SUB-D socket [x]

Fig. 5.6 Emergency Stop circuit with internal safety relay funct

0098441113177, V1.02, 08.2004

Start signal with internal safety relay function

If the internal safety relay function of the SAM module is used, the *Automatic Start* function must be disabled by configuration.

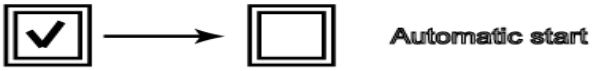


Fig. 5.7 "Automatic Start" control field, disabled

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam.Miscellaneous. MiscModes	10:14	2.9.12	General modes	Bit 0: Automatic Start (SAMSTART) 0: Start button evaluation: Pulse 1: Automatic start: Level	0	R/W rem. 1)

1) can only be written with the SAMCT/SAMCLONE configuration tools

The power amplifier must be unblocked by a start signal to the SAMSTART input. This is always required after

- switching on the 24V power supply,
- after an Emergency Stop command
- and after errors that have caused a shut down (class 2 or 3 errors).

To ensure that the start signal is accepted, the Emergency Stop circuit must be closed (/ESTOP_A and /ESTOP_B to high) and if required a pending SAM error message must be reset.

However, the safety door circuit has not to be closed at the same time.

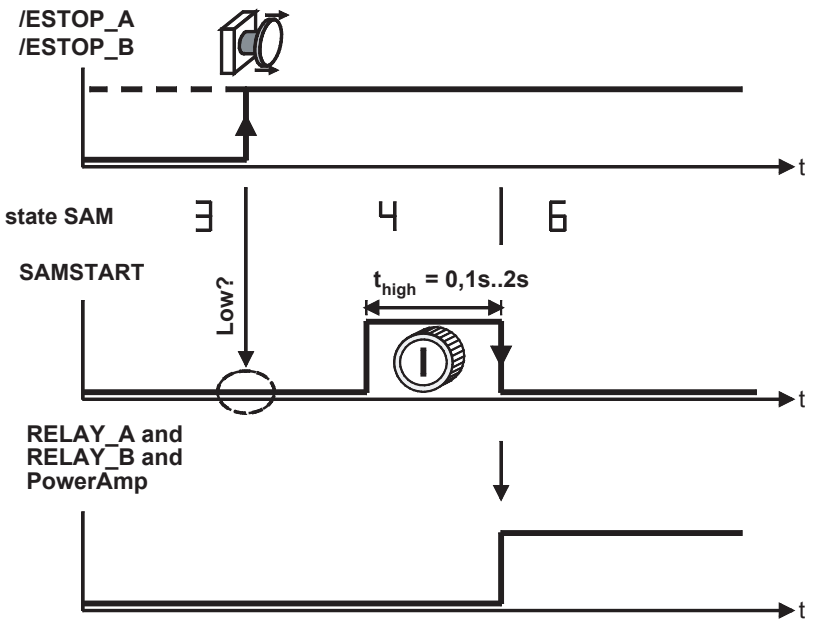


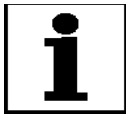
Fig. 5.8 Generating the start signal for *normal* Start

0098441113177, V1.02, 08.2004

To detect any welded contact in the start push button, the SAM module in *Safe Start* mode tests the low level at the SAMSTART input during the status transition 3➟4. The test is done either at

- Closing the Emergency Stop circuit
- Acknowledgment of an error message if the Emergency Stop circuit has already been closed
- Completed bootup if the Emergency Stop circuit has already been closed

The SAM module also checks the pulse duration of the start signal. If the maximum allowable pulse duration is exceeded, the start pulse is ignored and an error response is triggered.



The start signal at SAMSTART only unblocks the power amplifier (PowerAmp=1). To switch on the power amplifier, an enable for the positioning controller is also required.

Status of positioning controller

The positioning controller remains in operating status "3" until the power amplifier control is unblocked, because the blocking of the power amplifier appears to the positioning controller exactly like a DC link voltage that is too low.

Safe Stopping Process after Emergency Stop (ESTOP)

If the ESTOP inputs are no longer powered, the drives are stopped in accordance with STOP of category 1 under EN 60204-1. This means that a controlled stop is initiated before the power to the motor is interrupted by deactivation of the power amplifier enable. This is mostly used for Emergency Stop.

For the stopping process the SAM module initiates a Quick-Stop from the positioning controller and monitors the controlled braking by safe monitoring of the braking ramp.

The positioning controller always carries out a Quick-Stop on request from the SAM module. The selection of the signals for Quick-Stop in the positioning controller have no effect here.

The admissible deceleration ramp is specified with the "Sam.Stopping.dec_QStop" parameter. The drive must decelerate at least with the same steepness of this deceleration ramp in the event of a Quick-Stop request from the SAM module, even under heavy load.

0098441113177, V1.02, 08.2004

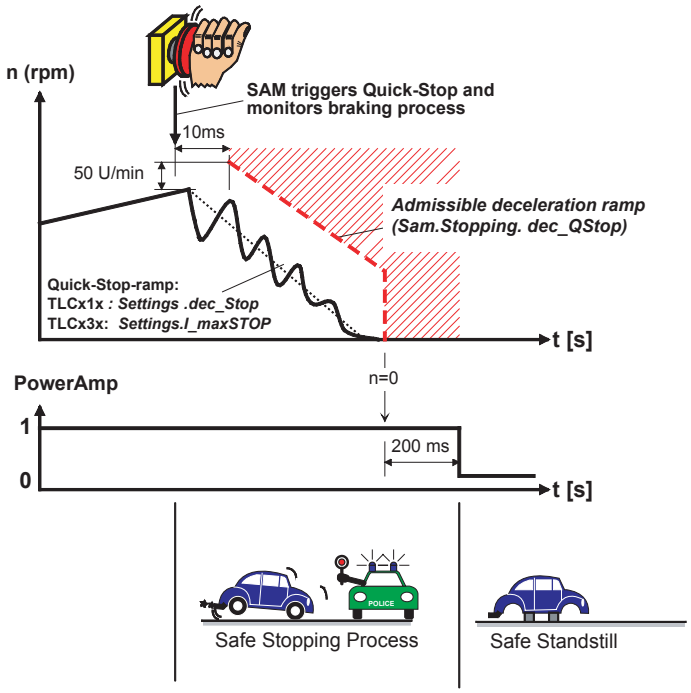


Fig. 5.9 Safe Stopping Process

The braking ramp is not monitored within the first 10 ms. This delay time is available to the positioning controller as a response period.

The greatest speed value that was calculated within the 10ms delay time plus an extra 50 rpm is always used as the start value for monitoring the deceleration ramp. This adapts it to the actual speed situation.

If the stopping procedure was successful because the drive decelerated faster than the admissible deceleration ramp, the stop position is monitored for another 200 ms after the drive has come to a stop. This delay time allows the positioning controller a delayed deactivation of the controller to generate a holding torque until the holding brake is closed before the power amplifier is finally blocked by the SAM module (Safe Standstill).

If the drive does not fulfill the admissible deceleration ramp during a Quick-Stop requested by the SAM module, the power amplifier is blocked immediately and the motor performs an uncontrolled stop. In contrast with the procedure with fixed switch-off deceleration period, this prevents the drive from continuing to run or even accelerating in the event of an error.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Name	Idx:Sidx	TL-HMI			Value	rem.
Sam.Stopping. dec_QStop	10:16	2.9.13	Max. admissible deceleration ramp for Safe Stopping Process (Quick-Stop) [rev/(min*s)]	UINT 32 # 0...32786009	0	R/W rem. 1)

1) can only be written with the SAMCT/SAMCLONE configuration tool

0098441113177, V1.02, 08.2004

The "Sam.Stopping.dec_QStop" parameter should be set as high as possible to guarantee short braking paths and times. The upper limit is oriented to the Quick-Stop braking ramp of the drive system. If the value is set so high that the drive system cannot fulfill the admissible deceleration ramp, the SAM module will block the power amplifier. As a consequence the motor will perform an uncontrolled stop. Servo and stepper motor units have different parameters for the Quick-Stop braking ramp:

unit	Quick-Stop parameters	Setting Sam.Stopping.dec_QStop
TLCx1x	Settings. dec_Stop	Sam.Stopping.dec ≤ Settings.dec_Stop*Motion.aNormNum / Motion.aNormDen
TLCx3x	Settings. I_maxSTOP	Sam.Stopping.dec ≤ Dν/Dτ Dν/Dτ: Calculating the steepness of the Quick-Stop ramp under test with the recording function of the TLCT commissioning software.

Recording the requested deceleration ramp

The braking ramp and the requested deceleration ramp can be recorded with the TLCT commissioning software. To do this select the recording values:

- SamTrace: recording object for data in the SAM module
- n_act: actual speed

SamTrace is zero as long as the deceleration ramp is not monitored. Therefore, this value is appropriate as trigger object:

- recording object for data in the SAM module (23/11)
- unequal 0

If the requested deceleration ramp has not been met 5 times, the SAM module generates an error, which can only be reset by switching the 24V power supply off and on. This allows unwanted subsequent modifications of the Quick-Stop parameters to be detected if they cause the stopping procedure to be unsuccessful and as a result the motor performs an uncontrolled stop.

The *Safe Standstill* does not disconnect the electrical power safely! The power amplifier is not disconnected from the power system. The power switch must be off to ensure that there is no electrical hazard.

Switching other consumers

If additional consumers are to be safely switched with the SAM module or if multiple contacts are required, contactors with linked contacts can be connected to the RELAY_A and RELAY_B outputs. The mirror contacts of the contactors must be connected in series to the start button (SAMSTART). The SAM module can only be switched on if the contacts are correctly released. If mains power is switched with the contactors, they must meet the standards for safe power isolation.

Switch-off time for other consumers

If necessary, the switch-off for the other consumers can be delayed – either after a fixed delay period or when the motor has come to a stop. The switch-off time can be configured with the "Sam.Stopping.t_Relay" parameter.

0098441113177, V1.02, 08.2004

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam.Stopping. t_Relay	10:13	2.9.11	Switch-off time of outputs RELAY see following table	0...10000	0	R/W rem. 1)

1) can only be written with the SAMCT/SAMCLONE configuration tool

Freewheeling diodes The SAM module outputs have integrated protection against induction voltages. This makes an additional circuit with freewheeling diodes unnecessary and this is also not recommended, because it could delay the switch-off behaviour of the contactors.

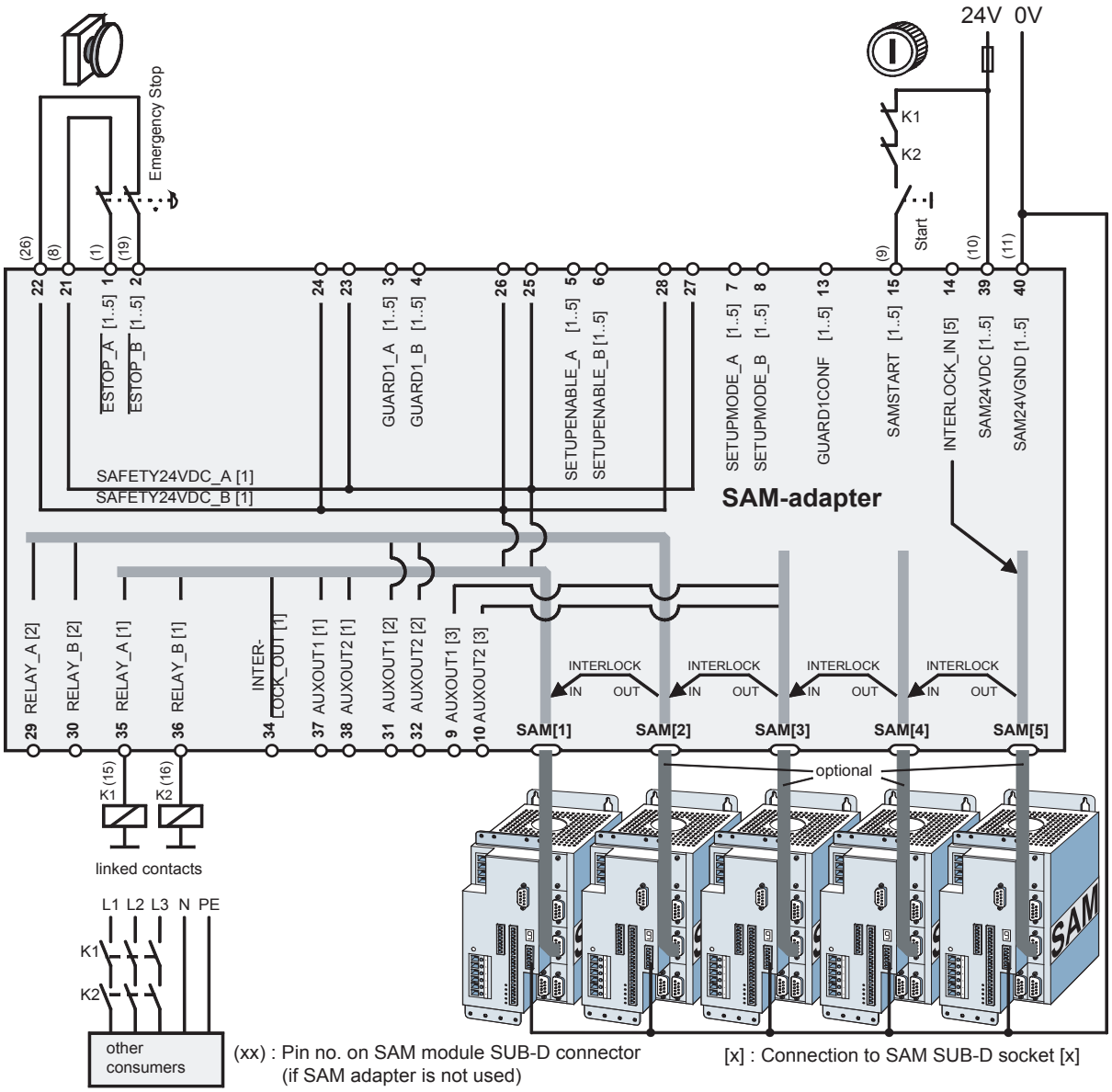


Fig. 5.10 Emergency Stop circuit with internal safety relay function and contactors for additional consumers

009844113177, V1.02, 08.2004

Event	Sam.Stopping.t_Relay	Switch-off time of RELAY outputs
Class 1 error	x	no switch-off
Class 2 error	0 ms	immediately without delay
or EMERGENCY STOP	1 ms	if the motor has come to a stop
	2 ms	if the motor has come to a stop and the potential at the INTERLOCK-IN input is high (i.e. all motors in the daisy chain have come to a stop).
	≥3ms	if the delay time t_Relay [ms] is expired
Class 3 or 4 errors	x	immediately without additional delay

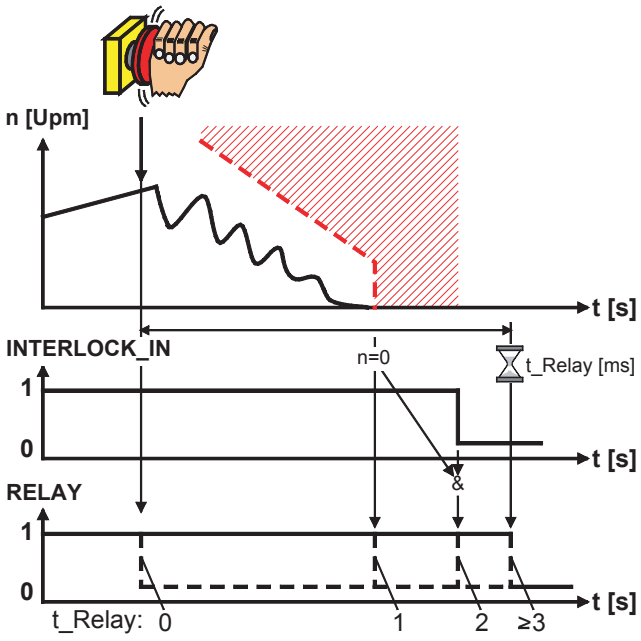


Fig. 5.11 Switch-off time for other consumers

0098441113177, V1.02, 08.2004

5.4.2 External safety relay

If the SAM module is connected to an external safety relay (central master), the "automatic start" function can be selected by configuration.

Fig. 5.12 "Automatic Start" control field, disabled

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Name	Idx:Sidx	TL-HMI			Value	rem.
Sam.Miscellaneous. MiscModes	10:14	2.9.12	General modes	Bit0, Automatic Start (SAMSTART), 0: Start button evaluation: Pulse 1: Automatic Start: Level	0	R/W rem. 1)

1) can only be written with the SAMCT/SAMCLONE configuration tool

If switching on or resetting the master Emergency Stop module requires a start signal already, an additional start signal evaluation by the SAM module is not required.

009844113177, V1.02, 08.2004

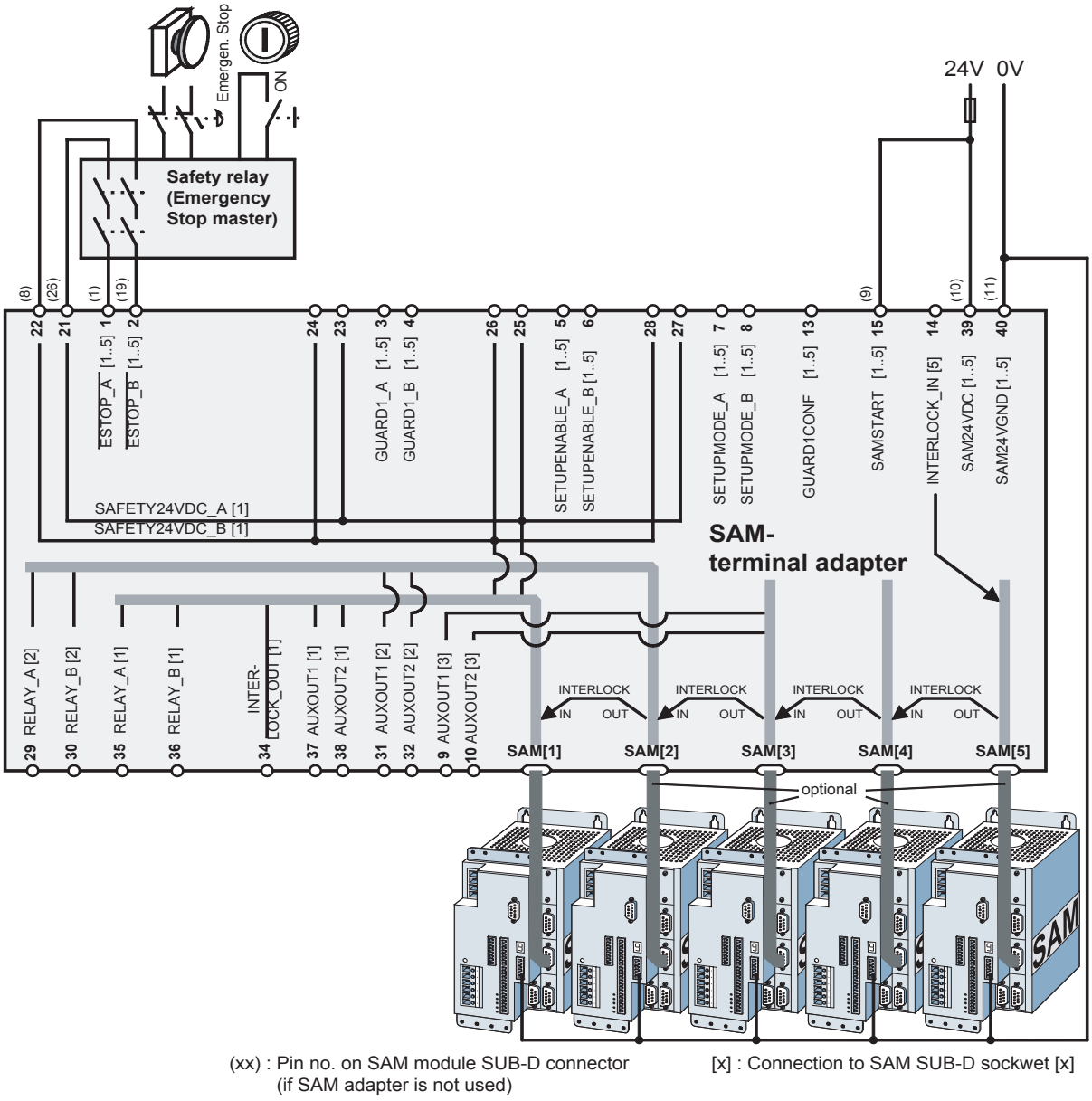


Fig. 5.13 Emergency Stop circuit with external safety relay

0098441113177, V1.02, 08.2004

Start signal for Automatic Start

With the *Automatic Start* function the SAM module does not require a start pulse for starting up but only a static 24V signal at the SAMSTART input.

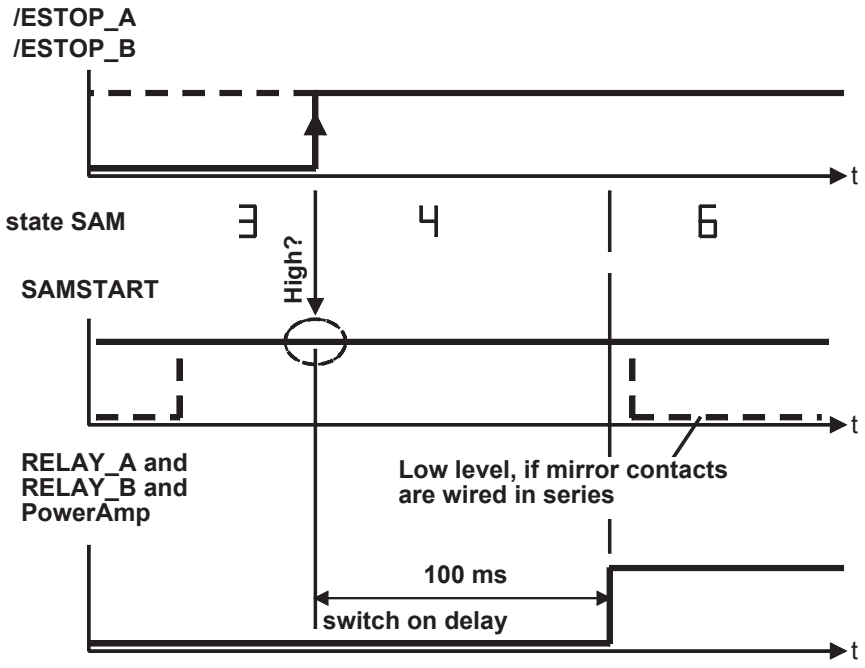


Fig. 5.14 Generating the start signal for Automatic Start

The SAM module in *Automatic Start* mode checks the high level at the SAMSTART input during the status transition 3 ➟ 4.

This check also prevents switch-on during *Automatic Start* if the linked contacts connected in series to the SAMSTART input are not correctly released by the optional contactors.

Switch-on delay during Automatic Start

The fixed switch-on delay ensures that the high level at the SAMSTART input is not disconnected by the linked contacts immediately on detection of the powered Emergency Stop inputs, if they are connected in series for this purpose. This allows other SAM modules, whose inputs may be switched in parallel over the SAM adapter, to detect the high level. If in a multi axis installation the error acknowledgment is not conducted simultaneously, ensure that the error is finally acknowledged at the positioning controller whose SAM module controls the contactors.

0098441113177, V1.02, 08.2004

5.5 Stop position monitoring with protective devices open

Automatic mode

The *Automatic Mode* function is for production operation. While the SAM module is ready for operation (status 6) and the GUARD1_A and GUARD1_B inputs are powered, meaning that the connected safety door is closed, the drive can be traversed without restrictions by the SAM module. There is no movement monitoring. If the safety door is open, *Safe Operational Stop* is activated, unless setup mode has been enabled as described in the next chapter.

Safe Operational stop

The *Safe Operational Stop* safety function monitors the stop position of the motor to prevent it from starting unexpectedly. The power feed to the motor remains on, the power amplifier is unblocked – the control function can remain activated.

This allows access to the danger area without switching off power to the drive. When the safety equipment is enabled again, the machining process can be continued immediately from the point where it was interrupted.

Safe deceleration

The SAM uses the *safe deceleration* function to monitor controlled braking during a switch to the *safe mode stop* or the *safe reduced setup speed* . This enables the process controller (e.g. a PLC) to detect the operating mode switch requested by the control station and to apply controlled braking to the drive to slow it to the permissible speed range without initiating an error response.

Without this function, the drive would have to be in the permissible speed range when the request for the new operating mode is made to avoid an error response.

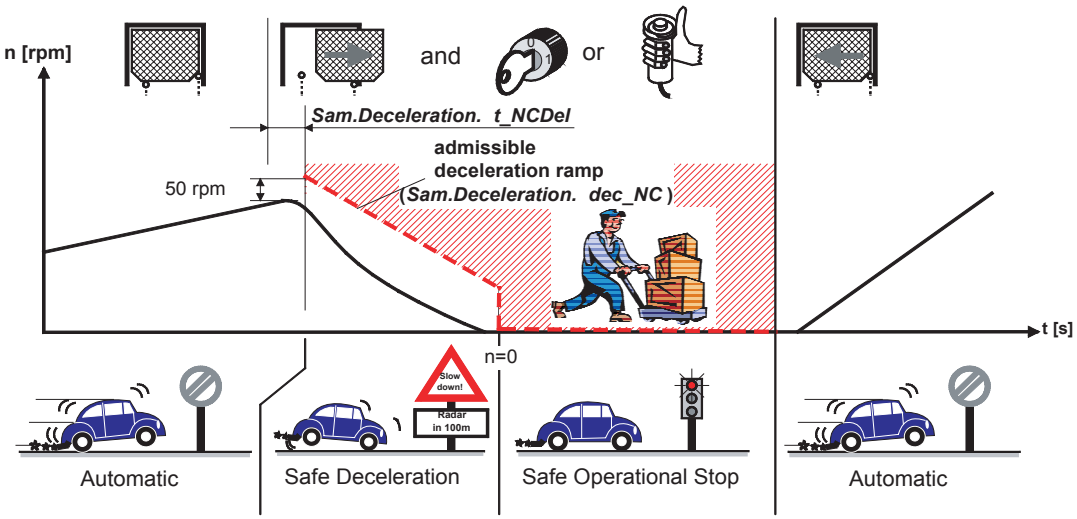


Fig. 5.15 Changing the operating modes

This example shows a mode switch triggered by opening the safety door. The braking ramp is not monitored within the configured delay time "t_NCDel".

0098441113177, V1.02, 08.2004

The SAM module remains in the current mode for this delay time. This delay time is available for the process controller, to detect the opening of the safety door and triggering the braking process. The greatest speed value that was calculated within the delay period plus an extra 50 rpm is always used as the start value for monitoring the deceleration ramp. This adapts it to the actual speed situation. On expiry of the configured delay period, the SAM module begins monitoring the braking ramp, starting from the calculated start value and the configured deceleration ramp "dec_NC".

If the braking process was successful because the drive decelerated faster than with the requested minimum deceleration, the mode switches to *Safe Operational Stop* after the drive has come to a stop.

If the control devices selected setup mode, a mode switch to *Safely Reduced Setup Speed* would have already occurred as soon as the speed is less than the configured setup speed.

If the drive does not meet the admissible deceleration ramp, an error response with *Safe Stopping Process* is sent. The drive is brought to a stop with Quick-Stop and then switches to *Safe Operational Stop after Error*; thus the drive remains active.

Parameter			**Explanation and unit [ ]**	**Range of values**	**Default**	**R/W**
Name	**Idx:Sidx**	**TL-HMI**			Value	rem.
Sam.Deceleration.t_NCDel	10:12	2.9.19	Delay time for safe deceleration (PLC response time) [ms]	**UINT16 # 0...500**	0	R/W [1)]
Sam.Deceleration.dec_NC	10:11	2.9.18	Max. admissible deceleration ramp for safe deceleration (with PLC) [rev/(min*s)]	**UINT32 # 0...32786009** 0: Function switched off (immediate transition to Safe Operational Stop or Speed monitoring	0	R/W [1)]

1) can only be written with the SAMCT/SAMCLONE configuration tool

The status of the inputs, e.g. for the safety door, can be queried by an external controller for evaluation via status outputs or via field bus; see the section on "Status query by an external controller", page 5-28.

0098441113177, V1.02, 08.2004

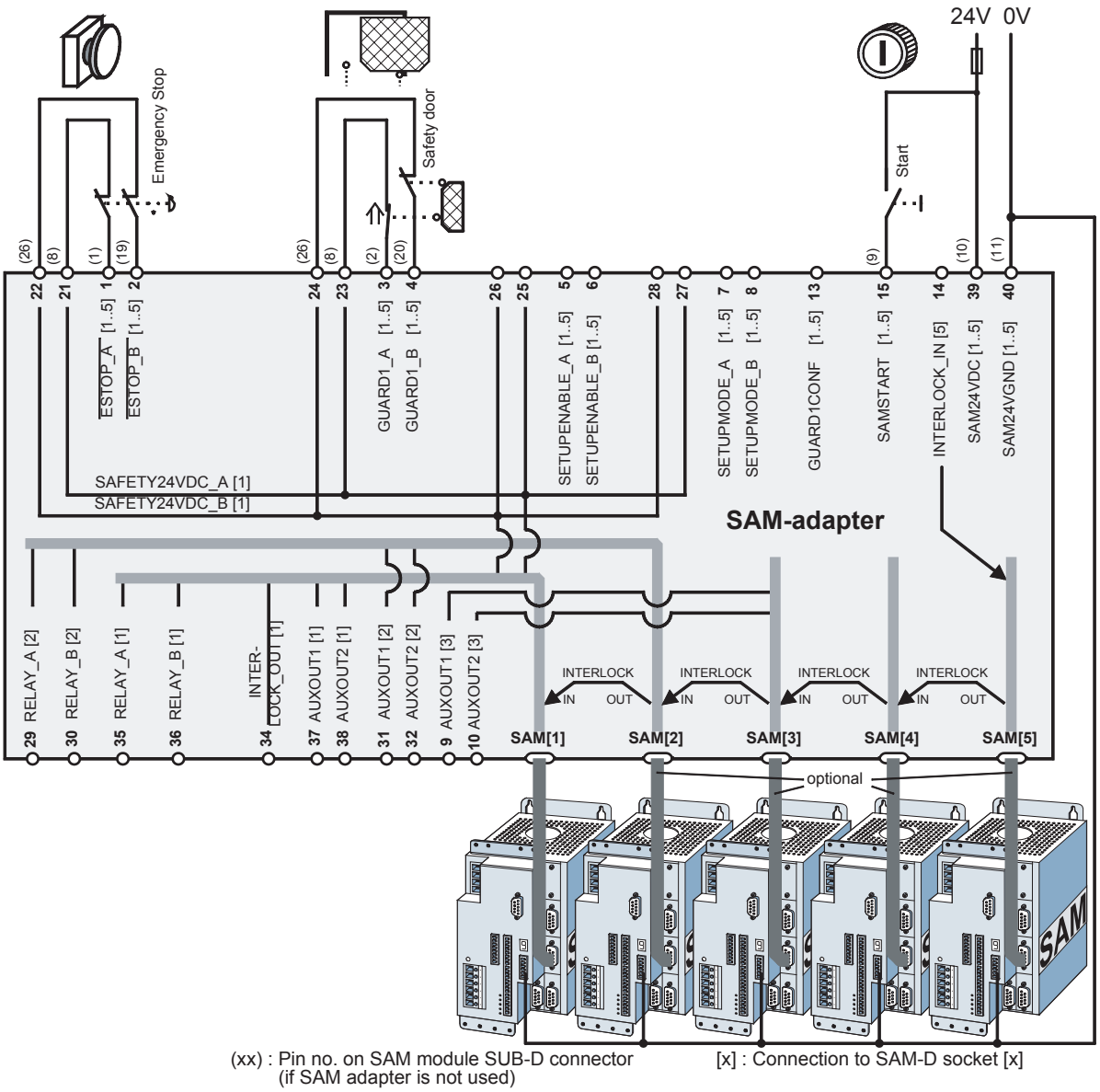


Fig. 5.16 Production mode with access to the danger zone

0098441113177, V1.02, 08.2004

5.6 Reduced speed with deactivated protective devices

If it is necessary to operate the machine during specific work processes with the protective devices deactivated, according to the machine directive dangerous movements are only permitted under more stringent safety conditions, such as reduced speed.

With the function *Safely Reduced Setup Speed* the SAM module ensures that the maximum permitted speed is not exceeded.

Wiring The following connections must be wired for this purpose:

- Operating mode switch to SETUPMODE_A and SETUPMODE_B
- Enabling device to SETUPENABLE_A and SETUPENABLE_B

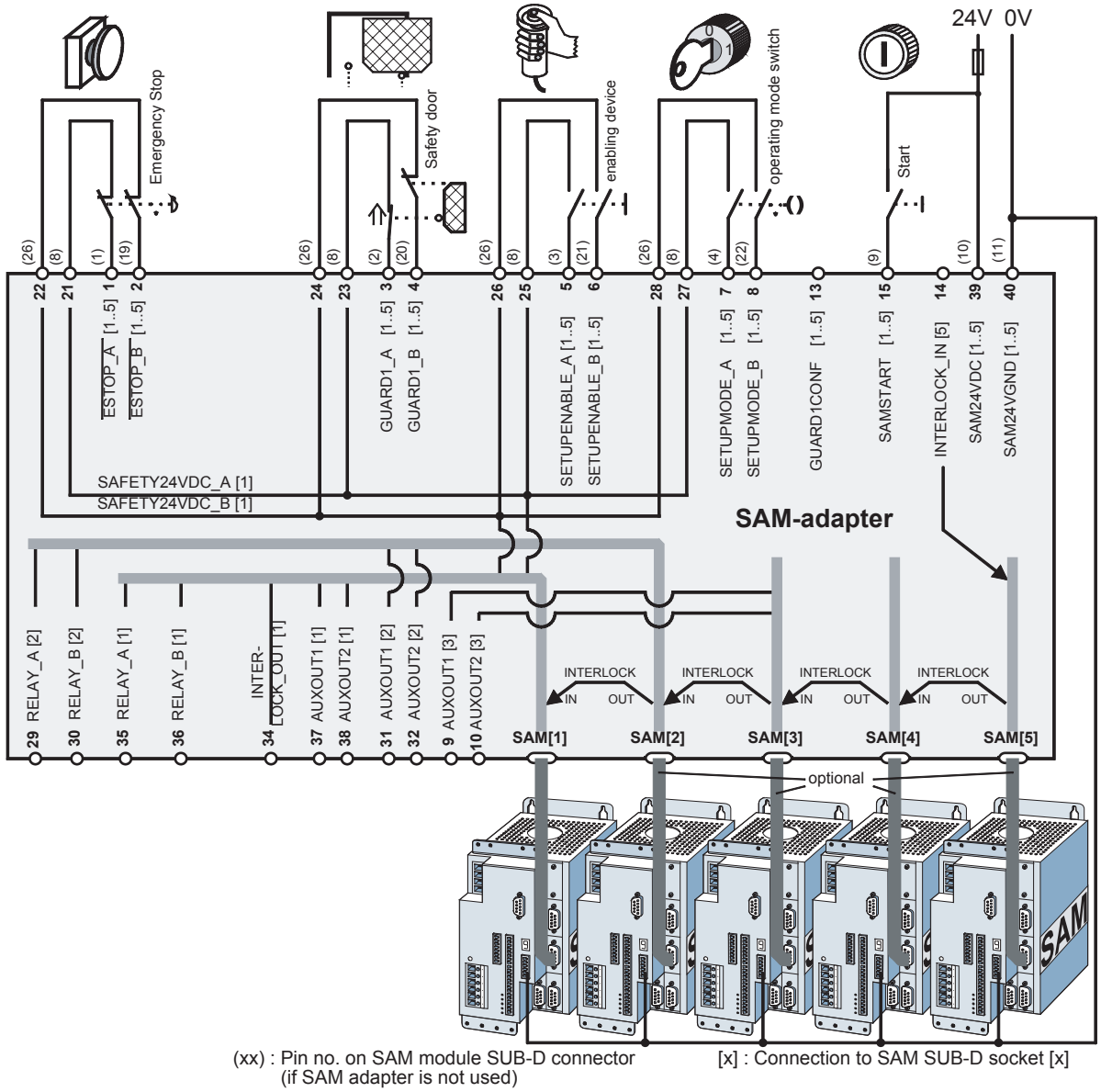


Fig. 5.17 Setup mode wiring

009844113177, V1.02, 08.2004

To select the *Safely Reduced Setup Speed*, power must be applied to the inputs for the operating mode switch and the enabling device, while the inputs for the safety guard are deactivated..

Safely Reduced Setup Speed

If the *Safely Reduced Setup Speed* function is active, the maximum admissible speed of the drive is the setup speed, which is specified in the parameter "SAM.RedSpeed.n_maxRed".

The SAM module does not limit the setpoint values for the speed, this must be done on the process controller side. If the speed is exceeded even so, the SAM module initiates a stopping process ending with *Safe Operational Stop*. The power amplifier is thus not blocked so long as the stopping process initiated by the SAM Quick-Stop request was successful. The setup mode can be continued after resetting the SAM error in the positioning controller.

Spatially Safely Reduced Speed

If the SAM module is to be used for a system that initiates movements in two or three spatial dimensions (cartesian robot), the speeds in the direction of the axes must be added vectorally to a spatial speed when selecting the value for the parameter "Sam.RedSpeed.n_maxRed". This makes the resulting speed greater than the speed in the direction of the individual axes. If a maximum spatial speed is to be set by the *Safe Reduced Setup Speed* function, the value for the parameter "Sam.RedSpeed.n_maxRed" must be specified with the formulas below.

Number of axes	Formula for "Sam.RedSpeed.n_maxRed"
1	n_maxRed = max. allowable spatially speed
2	n_maxRed = max. allowable spatially speed / √2
3	n_maxRed = max. allowable spatially speed / √3

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Name	Idx:Sidx	TL-HMI			Value	rem.
SAM.RedSpeed.n_maxRed	10:18	2.9.14	*Safely Reduced Setup Speed* [rpm]	UINT16# 0...12000	0	R/W rem. 1)

1) can only be written with the SAMCT / SAMCLONE configuration tool

0098441113177, V1.02, 08.2004

Safe Deceleration

With the function *Safe Deceleration* the SAM module monitors the controlled braking during a switch to the *Safe Operational Stop* or the *Safely Reduced Setup Speed*. This enables the process controller (e.g. a PLC) to detect the operating mode switch requested by the control devices and to apply controlled braking to the drive to slow it to the permissible speed range without initiating an error response (see also page 5-17).

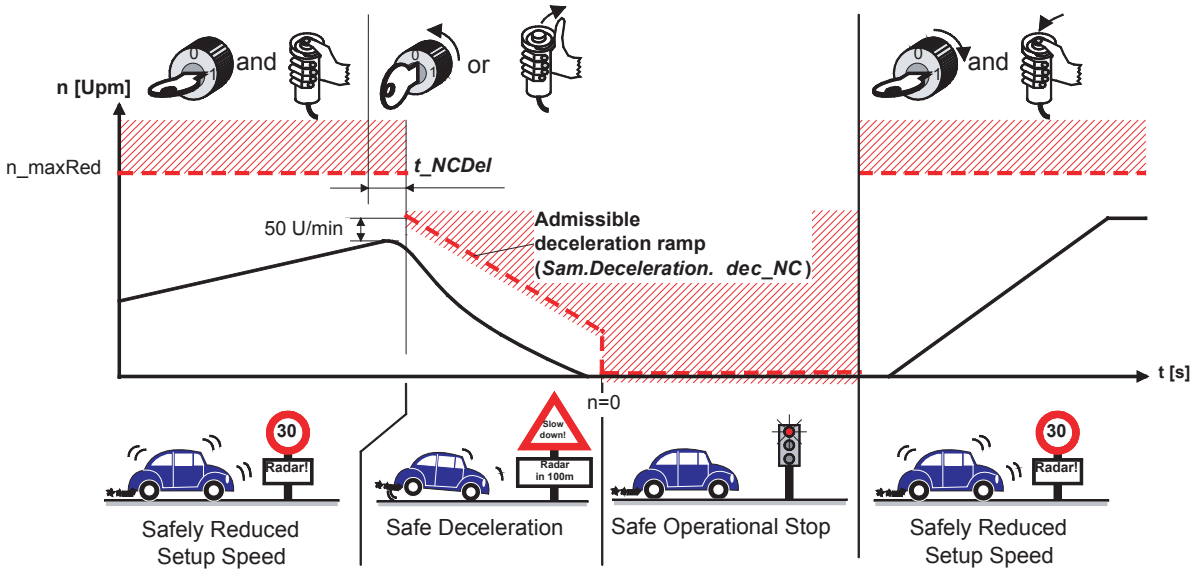


Fig. 5.18 Changing the operating modes

Enabling device

The optional enabling device is used to reduce the residual risk resulting from a possible unexpected startup with the *Safely Reduced Setup Speed*. This is particularly applicable if the motor is stopped and the operator assumes that the drive is in *Safe Operational Stop*. However, if only the *Safely Reduced Speed* function is enabled, the motor may start unexpectedly with reduced speed.

The drive system can only traverse in setup mode with the enter key when the enter key is actuated, otherwise *Safe Operational Stop* is enabled.

If the residual risk resulting from a non-permitted startup at reduced setup speed is acceptable, the SETUPENABLE_A and SETUPENABLE_B inputs can be permanently wired instead of using an enabling device to the active level (24 V or SAFETY24VDC).

The status of the inputs (e.g. safety door, mode selection switch, enter key) can be queried by an external controller for evaluation via status outputs or via field bus; see the section on "Status query by an external controller", page 5-26.

0098441113177, V1.02, 08.2004

5.7 Safety door confirmation

Push button for safety door Confirmation (GUARD1CONF)

Typical applications of the optional push button for safety door confirmation are systems with enterable danger area where the safety door can be closed with persons beeing in the danger area. Such systems present a special safety risk. Accidental closing of the safety door must not result in danger.

This can be done by preventing the safety door from closing by mechanical means or by using the acknowledge key.

The push button for safety door confirmation must be installed outside the safety area in a position where the interior of the danger zone can be seen. Automatic operation will only be possible when the safety door is closed and the push button for safety door confirmation has been actuated.

The closed safety door does not require a special acknowledgment after switching on the 24V power supply. The push button for safety door confirmation must be connected to the GUARD1CONF input.

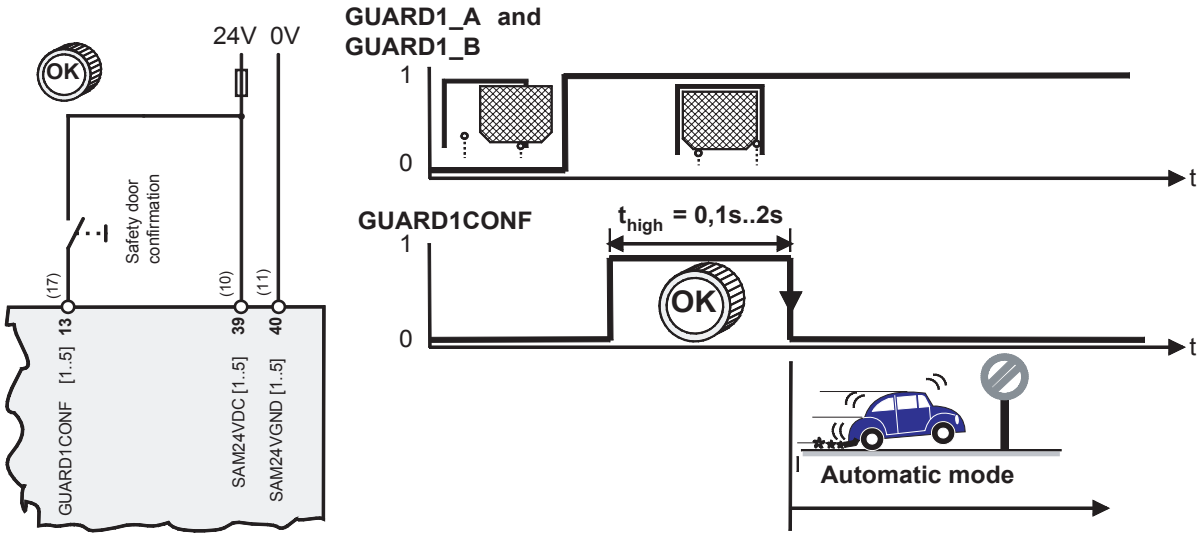


Fig. 5.19 Effect of the push button for safety door confirmation

If the push button for safety door confirmation is used, the safety door without confirmation function must be disabled.

Fig. 5.20 "Safety door without confirmation" control box, disabled

Parameter			Explanationn and unit [ ]		Default	R/W
Name	**Idx:Sidx**	**TL-HMI**			Value	rem.
Sam.Miscellaneous. MiscModes	10:14	2.9.12	General modes	Bit1: Safety door without confirmation (GUARD1CONF), 0: With confirmation button 1: Without confirmation button	0	R/W rem. 1)

1) can only be written with the SAMCT/SAMCLONE configuration tool

0098441113177, V1.02, 08.2004

5.8 Safety door interlocking

Controlling safety door interlocking

Interlocking of the safety door prevents personnel from entering the danger zone during operation. This prevents dangers caused by coasting system components.

There is a safety-oriented single-channel INTERLOCK-OUT output for controlling a safety door interlock. The output is active (24V) if the motor is at a stop or the power amplifier is blocked. The function of the SAM module is designed for a interlock that operates on the spring power principle, i.e. the interlock is actuated without power.

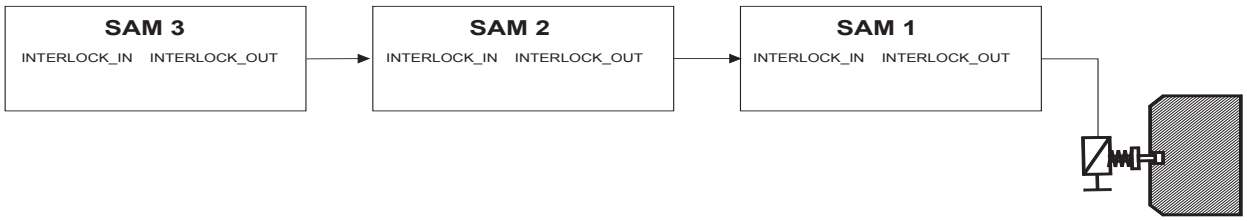


Fig. 5.21 Controlling safety door retention

A daisy-chain for a multi-axis system can be structured by linking INTERLOCK_OUT and INTERLOCK_IN, in which the last SAM module only signals stopped drives if all connected axes are stopped.

If the INTERLOCK_IN input is not used in a daisy-chain, the use of the input can be disabled in the configuration with the "Ignore INTERLOCK_IN" setting.

Fig. 5.22 "Ignoriere INTERLOCK_IN" control box, activated

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Name	**Idx:Sidx**	**TL-HMI**			Value	rem.
Sam.Miscellaneous. MiscModes	10:14	2.9.12	General modes	Bit 3: Ignore INTERLOCK_IN, 0: Safety door interlocking depends on INTERLOCK_IN 1: safety door interlocking is independent of INTERLOCK_IN	0	R/W rem. 1)

1) can only be written with the SAMCT / SAMCLONE configuration tool.

In the SAM adapter, which is available as an accessory for connecting multiple SAM modules, the INTERLOCK_IN and INTERLOCK_OUT signals are wired to build a daisy-chain. See the chapter "SAM Adapter", page 9-3.

0098441113177, V1.02, 08.2004

5.9 Restricting the braking distance

Safely Reduced Automatic Speed

The path required by the drive to come to a stop after opening the safety door depends on the maximum assumed working speed. If the system does not use the full speed range of the drive, the working speed can be safely monitored with the *Safely Reduced Automatic Speed* function "Sam.RedSpeed.n_maxAuto" and this restricts the braking distance. This allows the safety clearances in a system to be minimised.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam.RedSpeed.n_maxAuto	10:19	2.9.15	*Safely Reduced Automatic Speed* [rpm]	UINT16 # 0...12000 0: no speed monitoring in Automatic mode	0	R/W rem. 1)

1) can only be written with the SAMCT / SAMCLONE configuration tool

The SAM module also does not limit the setpoint values for the speed with *Safely Reduced Automatic Speed*.

0098441113177, V1.02, 08.2004

5.10 Status query by an external controller

An external controller can query various states of the SAM module. There are two basic options for this: query via the message outputs or communication over field bus.

5.10.1 Status query via status outputs

The traditional status query is at the controller I/O level. The status of inputs, outputs and error states can be output through the AUXOUT1 and AUXOUT2 outputs. The information given out can be configured separately for each status output.

Note: the status outputs are not approved for safety relevant use!

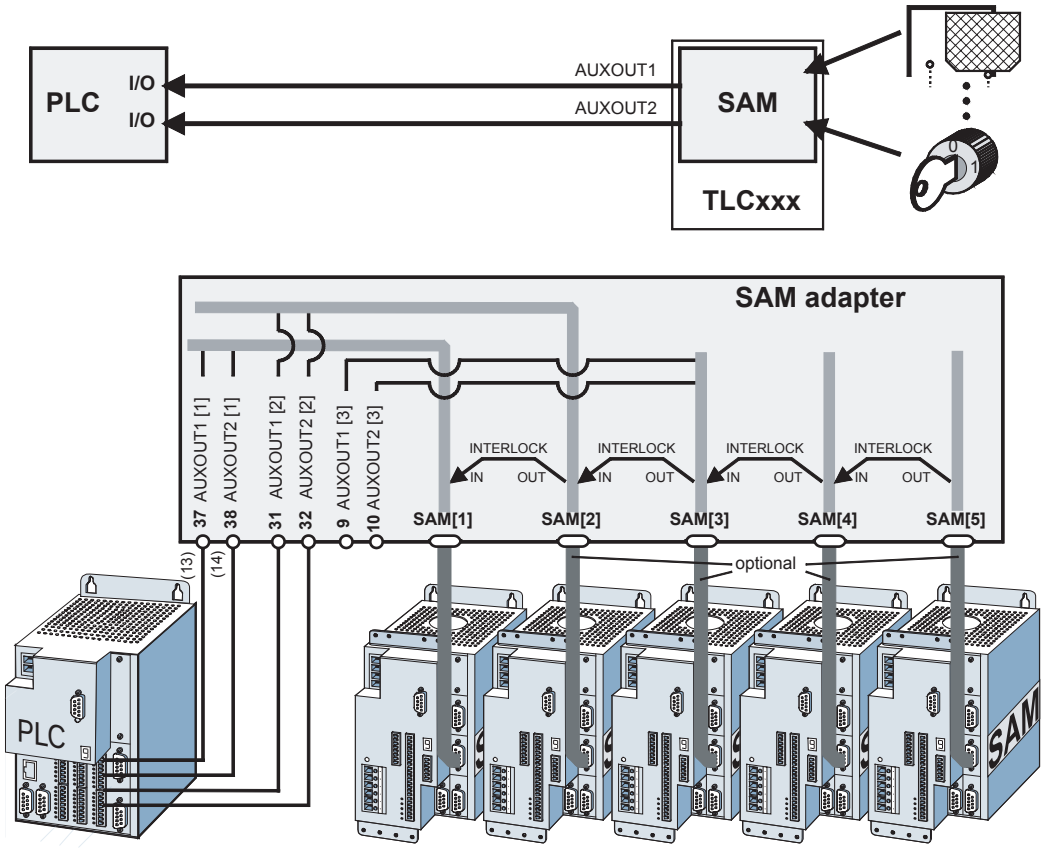


Fig. 5.23 Status query via status outputs

009844113177, V1.02, 08.2004

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam. Miscellaneous. ModeOut1	10:6	2.9.16	Function of the status output AUXOUT1	**UINT32 # 0...4294967295** Bit: 0...14: Selection of status for output 00000001h: /ESTOP 00000002h: GUARD1 00000008h: SETUPMODE 00000010h: SETUPENABLE 00000040h: GUARD1CONF 00000200h: DriveReleased 00010002h: RELAY 00010010h: INTERLOCK_OUT 00010200h: drive stopped (n=0) 00010400h: Setup speed (n<n_maxRed) 0002001Eh: Error class 1...3 Bit 15: Inversion 0: Status not inverted 1: Status inverted	0	R/W 1)
Sam. Miscellaneous. ModeOut2	10:7	2.9.17	Function of the status output AUXOUT2	**UINT32 # 0...4294967295** Bit: 0...14: Selection of status for output 00000001h: /ESTOP 00000002h: GUARD1 00000008h: SETUPMODE 00000010h: SETUPENABLE 00000040h: GUARD1CONF 00000200h: DriveReleased 00010002h: RELAY 00010010h: INTERLOCK_OUT 00010200h: drive stopped (n=0) 00010400h: Setup speed (n<n_maxRed) 0002001Eh: Error class 1...3 Bit 15: Inversion 0: Status not inverted 1: Status inverted	0	R/W 1)

1) can only be written with the SAMCT / SAMCLONE configuration tool

0098441113177, V1.02, 08.2004

5.10.2 Status query via field bus

All parameters of the SAM module can be read via a standard field bus, if one is available. An external controller can query the states of the inputs, outputs and other information from the SAM module without any additional wiring required.

For more information on the SAM parameters see the chapter "SAM Parameters", page 8-4.

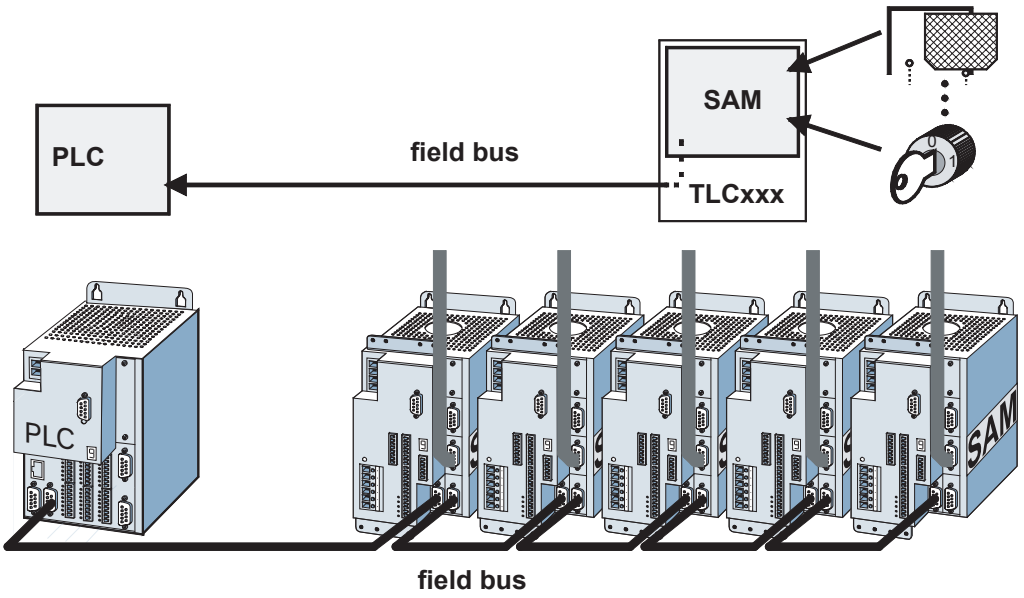


Fig. 5.24 Status query via field bus

0098441113177, V1.02, 08.2004

6 Configuration

6.1 Configuration tools

The SAM module can only be configured with special SAM configuration tools. With TLCT, TL-HMI or, if available, via field bus the SAM module parameters can be read only. Two configuration tools are available:

- SAMCT (SAM Configuration Tool): This is for use by safety representative for running a new configuration.
- SAMCLONE (SAM Clone Tool): This is for use by technicians (e.g. maintenance or service technicians) for duplication of stored parameter sets.

Both SAM configuration tools are strongly oriented to TLCT, the standard commissioning tool, and they are operated similarly. SAMCT and SAMCLONE can be installed on a PC that communicates with the positioning controller via the standard commissioning port (RS232).

Compatibility

SAMCT and SAMCLONE are upwards compatible, i.e. older versions of the SAM module can be configured with newer versions of the tools. Use only SAMCT and SAMCLONE version 1.002 and follow-ups.
If you require a newer version of SAMCT or SAMCLONE, please contact the service department of your local representative.

Status of the positioning controller

The SAM module can only be configured if the positioning controller is in "disabled" unit status (status 3, 4 or 9). To achieve this status, the positioning controller must stop at status 3 when booting up, or it must be switched to status 4 by disabling "ENABLE". Another option is to trigger an Emergency Stop.

0098441113177, V1.02, 08.2004

6.1.1 SAMCT

The parameters of the SAM module can be modified individually with SAMCT.

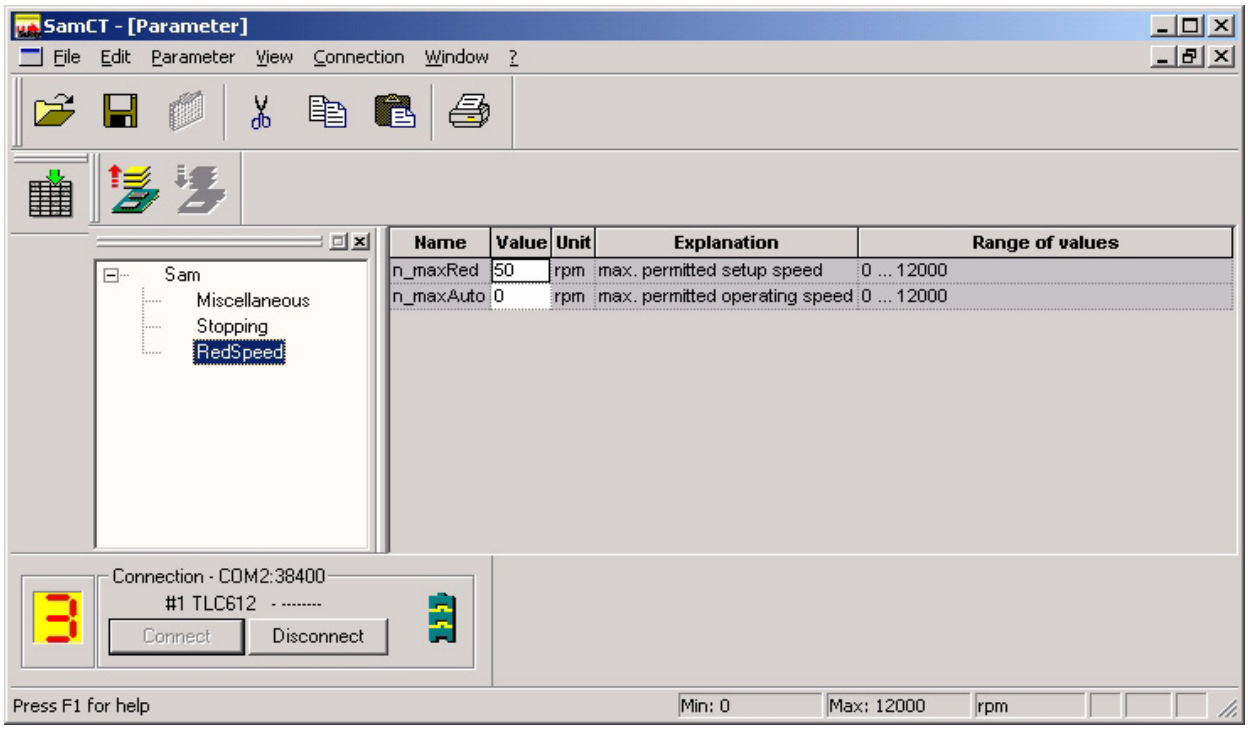


Fig. 6.1 Configuration tool SAMCT

0098441113177, V1.02, 08.2004

Password protection

Parameter writing is password-protected. The factory setting for the password is SAM4SAFE. The password is checked in the SAM module. The password can have up to eight characters and the user can change it in the menu "Parameter ➟ Change configuration password".

Fig. 6.2 Input of password

Commissioning test

After a new configuration or modification of the configuration, an commissioning test must always be run before the system can be operated with the SAM module. See the "Commissionimg test" section in this chapter on page 6-4.

Storage

The SAM parameters can be saved to a PC data medium with the SAMCT program. This must only be done after a successful commissioning test in all circumstances.

6.1.2 SAMCLONE

This tool is provided for configuring the SAM module if a unit is replaced for service. When using SAMCLONE only complete SAM parameter sets can be saved to a data medium and reloaded into a SAM module. If only SAMCLONE is supplied to the service technicians for configuring the SAM module, this means that less qualified technicians can be used, because they will be unable to modify single SAM parameters with this tool. However, technicians must still be informed of the dangers of configuration with an incorrect data set.

DANGER!
Safety functions can be lost if incorrect data are used!

- Check the file name!
- Check the name of the user device name!

User device name

The user device name of the positioning controller are is saved in the SAM parameter file and displayed before loading into the SAM module as a check for identification of the parameter sets.

Password protection

Password key in is not required for configuration with SAMCLONE. The password of the SAM module is set during configuration to be the same as the password on the device from which the data was saved. Therefore, the original password is valid after replacing a unit.

0098441113177, V1.02, 08.2004

6.2 Commissioning test

Target The commissioning test checks that the correct parameters were selected for the SAM module during configuration. The SAM commissioning test does not test the electrical installation.

Maturity date A complete commissioning test must always be run after:

- Initial configuration
- Changes to the values of safety-relevant parameters

DANGER!
Serious injury and damage to system components!
The commissioning test must be conducted by electrical technicians only (see the "Safety", section "Qualifications of Personnel", page Kapitel „Qualifications of personnel“ auf Seite 2-3), who have the technical training, knowledge and experience to assess the work done and to detect and avoid possible dangers.

Commissioning protocol The commissioning test must documented in the form of an commissioning protocol. A template is shown on page 6-5. If EXCEL is available, you can also use the EXCEL program SAMTEST.xls, which enables the commissioning test to be run semi-automatically. See "Accessories and spare parts", page 9-1.

Series units The complete commissioning test does not need to be repeated for series units. The data set that has been verified on one axis can be transferred to systems with identical axes with the SAMCLONE configuration tool. This applies particularly for cases where units are replaced for service.

009844113177, V1.02, 08.2004

Commissioning protocol

SAM Commissioning Protocol

1. General Information

Project: _____
Station: _____
Axis name: _____
Positioniersteuerung: _____
Motor: _____
Liniarachse: _____
Getriebe: _____
Name of tester: _____

Legend: still open: ☐ tested: ☐ not present / not used: ☐

2. Configuration

Sam.Miscellaneous.	ResEnc	☐
	MiscModes	[ ] Automatic start
		[ ] Guard1 without acknowledgment
		[ ] Ignore INTERLOCK_IN
	ModeOut1	☐
	ModeOut2	☐
Sam.RedSpeed.	n_maxred	☐
	n_maxAuto	☐
Sam.Deceleration.	t_NCDel	☐
	dec_NC	☐
Sam.Stopping.	dec_Qstop	☐
	t_Relay	☐

3. Options for electrical circuits

Value read for *Automatic Start* as per planning ☐
Value read for safety door acknowledgment as per planning ☐
Value read for INTERLOCK_IN as per planning ☐

4. Mechanical

Transmission ratio as per planning ☐

5. Safe stopping Process (Emergency Stop)

Standstill successful ☐
Shutoff via RELAY outputs succesful ☐

6. Safe Deceleration (PLC)

Safe Deceleration successful ☐

7. Safely Reduced Speed

Safely Reduced Setup Speed:
setup mode possible (n<n_maxRed) ☐
Correct error response when exceeded (n>n_maxRed) ☐
Safely Reduced Automatic Speed:
Value read as per planning ☐

Date: _____

Signature: _____

Fig. 6.3 Template for the commissioning protocol

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

7 Diagnosis and troubleshooting

7.1 Diagnosis

Status display in the TLCT

The TLCT commissioning tool for the Twin Line units has its own tab in the dialog box for the SAM in the menu item "Twin Line ➟ Diagnosis ➟ Device hardware". This tab shows the status of the inputs and outputs and the operating states of the SAM module.

Status query over field bus

Read access to the status parameters of the SAM module is available via field bus. The access is the same as to the positioning controller parameters.
This allows the status of the inputs and outputs and the SAM module operating status to be read out via field bus. For more information see "Status query via field bus" on page 5-28.

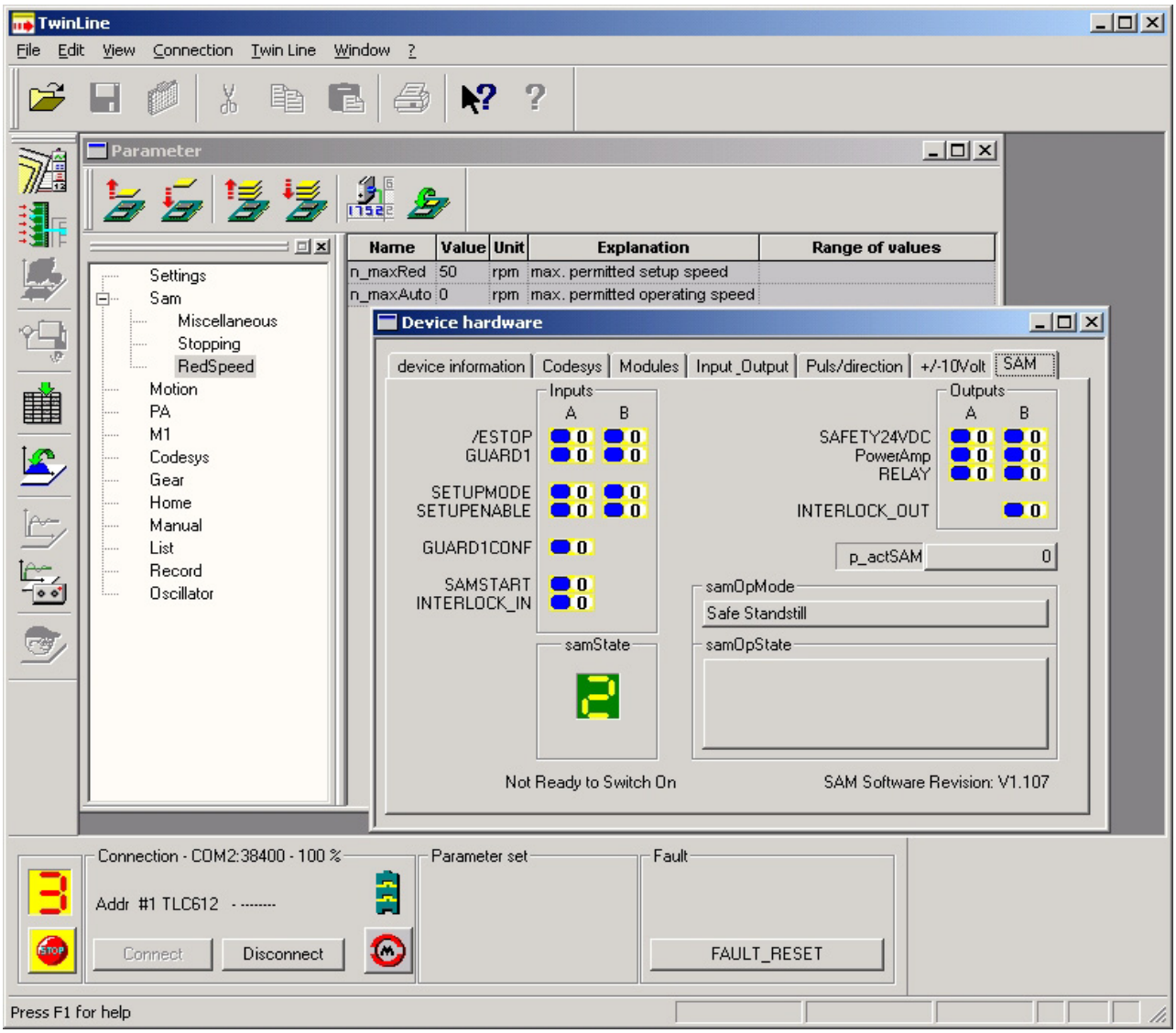


Fig. 7.1 TLCT tab with SAM information

0098441113177, V1.02, 08.2004

7.2 Operating states and transitions

The samState 7-segment display on the SAM tab in the "Twin Line➟Diagnosis➟Device hardware" menu of the TLCT shows the operating status of the SAM module in coded form.

An state machine runs independently of the Twin Line unit in the SAM module. The operating states and transitions are similar to the status display of the Twin Line units.

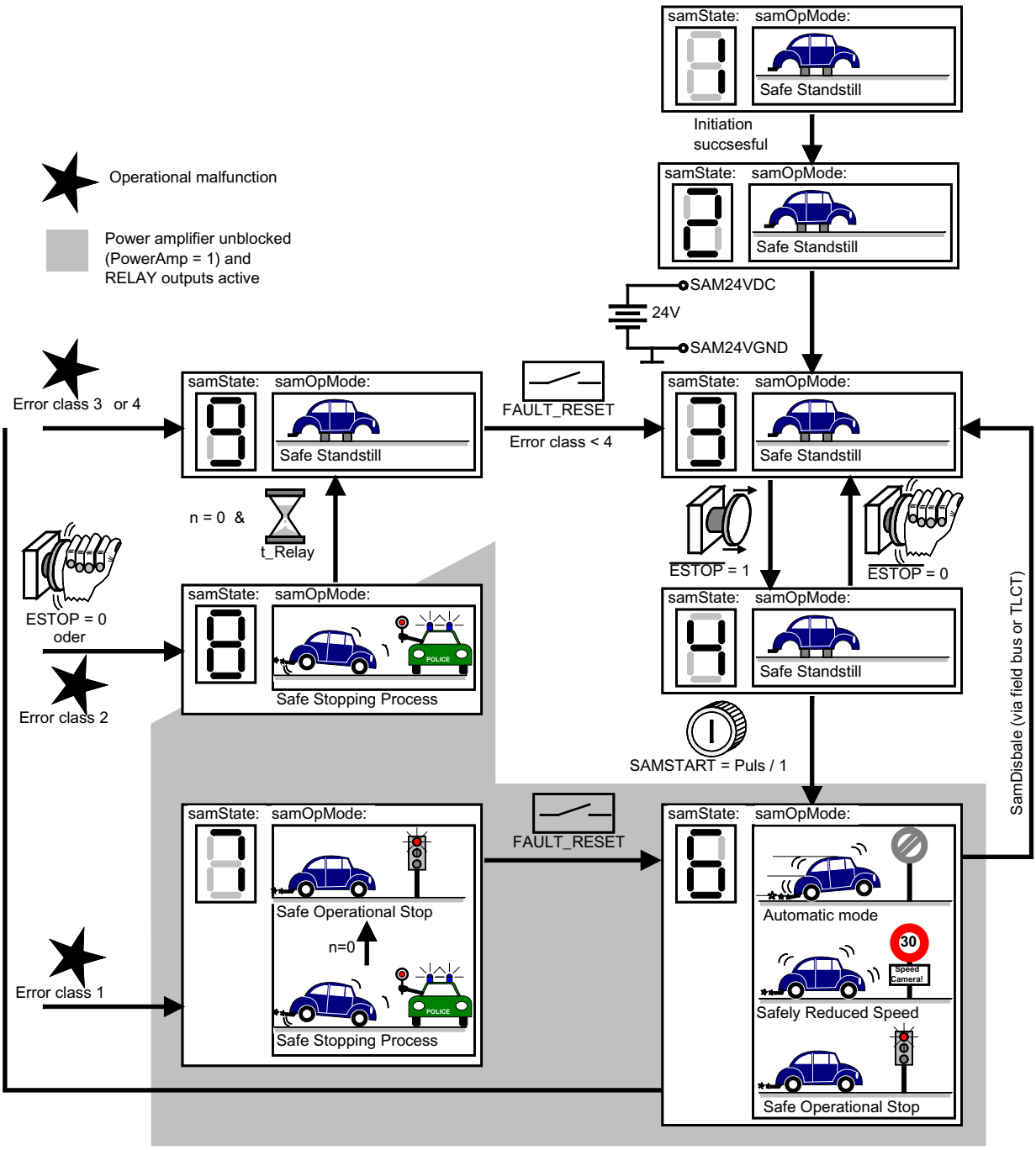


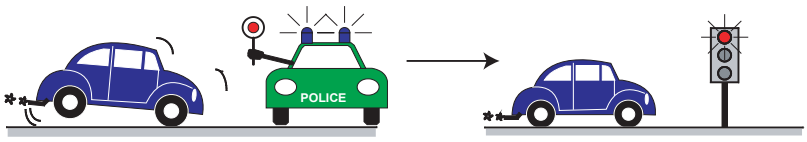
Fig. 7.2 Status displays and transitions of the SAM module

009844113177, V1.02, 08.2004

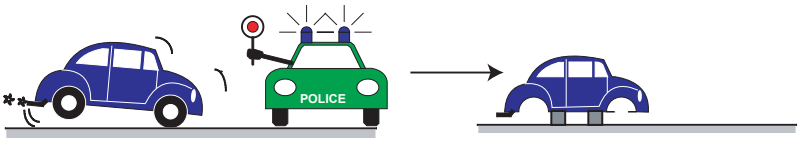
7.3 Error response

The SAM module triggers an error response when a malfunction occurs. Depending on the severity of the malfunction, the SAM module responds in accordance with one of the following error classes and also triggers a corresponding error response in the positioning controller. The following table shows the connection between the stop categories in accordance with DIN EN 60204 and these error responses.

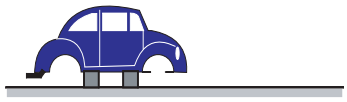
Error class ①	Stop category ②	Meaning
0	-	Message only, no interruption of operation
1	**2**	Safe stopping process (Quick-Stop), when stopped transition to *Safe Operational Stop* after Error mode. (controller remains active). Outputs RELAY_A and RELAY_B are not switched off



2	**1**	Safe stopping process (Quick-Stop), when stopped transition to *Safe Standstill* mode (no power to motor). RELAY_A and RELAY_B outputs switched off, time delayed if necessary.



3,4	**0**	Immediate *Safe Stanstill*, motor performs an uncontrolled stop. Immediate switch-off of RELAY_A and RELAY_B outputs.



① Error class in accordance with Twin Line definition

② STOP categories in accordance with DIN EN 60204-1

0098441113177, V1.02, 08.2004

7.4 Error display and troubleshooting

Error display

A SAM operational malfunction is displayed on the positioning controller 7-segment display:

- Operating state "7": non-admissible movement by SAM detected (status 7 is not only caused by the SAM).
- flashing"F": operational malfunction was triggered by SAM (e.g. by Emergency Stop).
- flashing decimal point:SAM warning (e.g. temperature prewarning)

Additional error displays may be :

- the error response of the positioning controller
- in the TLCT commissioning software within the status bar
- in the error memory log, all SAM module error messages begin with "SAM":
  Error messages that begin with "SAM: system error:" require replacement of the unit.
- bit-coded in the "Status.FltSig" parameter
  Bit 17: SAM error,
  Bit 30: SAM warning

Resetting errors (Fault reset)

When the SAM module malfunction has been corrected, the error message on the positioning controller can be reset

- by setting the FAULT_RESET input signal
- by the operating software with the Reset button
- by switching off the positioning controller 24V power supply

Class 4 errors cannot be reset, i.e. the drive system can return to operation only after the 24V power supply to the Twin Line unit has been switched off and then on again.

0098441113177, V1.02, 08.2004

Troubleshooting

Error	Possible causes	**Troubleshooting**
Automatic mode not possible even with safety door closed	Push button for safety door confirmation not connected / not pressed	Connect / press push button for safety door confirmation at GUARD1CONF!
	Safety door confirmation not switched off, if not required	Change and test SAM configuration (SAMCT): Sam.Miscellaneous.MiscModes: ☑ Guard1 without confirmation!
SAM remains in status 2	24V power supply not connected to SAM	Connect SAM24VDC and SAM24GND!
TLCx1x (stepper motor), error message: E152B: "SAM: error in position detection (unequal values)	Motor "stalls"	Enable follow error monitoring (TLCT): Settings.Motor monitoring: ☑ RM active so the controller detects "stalling" itself.
		Reduce Value for Quick-Stop ramp (TLCT): Settings.dec_Stop. Stopping process must be tested again!
		Reduce acceleration values Motion.acc and Motion.dec! (TLCT)
	Moving axis manually after fault reset	Do not move axis manually after fault reset!
SAM password forgotten	SAM password has been changed or forgotten	Load a data set from another SAM whose password is known into the controller with SAMCLONE. Set the desired configuration with SAMCT and the known password!
Error message: "Error text unknown"	Error text file TwinLine.err not current	Install new version from TLCT!
TLCx1x (stepper motor), error message: E1504 "SAM: error on Safe Stopping Process: insufficient braking ramp (Quick-Stop)" although Sam.Stopping.dec_QStop < Settings.dec_Stop * Motion.aNormNum / Motion.ANormDen	Delay of Quick-Stop caused by jerk filter	Configure Motion.Ruckfilter ≤ 5ms! (TLCT)
	Motor current too low and thus insufficient torque	Increase motor current Settings.I_acc! (TLCT)
Error message: E1506: "SAM: Safely Reduced Setup Speed exceeded "	Setpoint settings for speed too high	Reduce setpoint settings, take calibration factors into account!
	Strongly oscillating mechanics	TLCx1x (stepper motor): (TLCT) Motion.Start-Stop speed lower
		Select setpoint settings for speed up to 20rpm less than Sam.Redspeed.n_maxRed
TLCx1x (stepper motor), error message: E1506: "SAM: Safely Reduced Setup Speed exceeded" after enabling power amplifier	Toggling the motor when enabling power amplifier causes short, quick movements	Enable automatic mode or safe mode stop when enabling power amplifier or disable Settings.SM_toggle. (TLCT)
Error message: "SAM: system error:..."	SAM hardware fault detected	Replace position controller

0098441113177, V1.02, 08.2004

Error classifikation

All errors are assigned to one of five error classes, as listed in the table below.

An error response occurs only in the listed states.

Error	Monitoring active in SAM status	Error class	Remarks
Violating stop position during *Safe Operational Stop*	6	1	
Violating stop position during Safe *Operational* Stop after error	7	3	In the case of error, after Safe Stopping Process
Exceeding speed limit during *Safely Reduced Automatic Speed*	6	1	
Exceeding speed limit during *Safely Reduced Setup Speed*	6	1	
Insufficient braking ramp during Safe Deceleration	6	1	Braking procedure by PLC
Insufficient braking ramp during *Safe Stopping Process*	7,8	3	Braking process with Quick-Stop
Repetative errors (5x) during *Safe Stopping Process*	9	3	Counted since switching on 24VDC
Emergency Stop triggered	6,7	2	Emergency Stop actuated
Minimum movement not retained (min. 2° every 36 hours)	6,7	3	
Configuration error: Incremental encoder resolution or minimum deceleration not configured	6	3	If positioning controller is in status 6
Starting pulse to SAMSTART too long	4	2	If configuration ☐ Automatic Start
No low-level at SAMSTART	3 ➟ 4	2	If configuration ☐ Automatic Start
No high-level at SAMSTART	3 ➟ 4	2	If configuration ☑ Automatic Start
Pulse for safety door confirmation at GUARD1CONF too long	3..7	2	If configuration ☐ safety door without confirmation
No high-Level at INTERLOCK_IN within 10s during Safe Stopping Process	8	3	If SAM.Stopping.t_Relay=2
No Low-Level at INTERLOCK_IN	3...7	2	If configuration ☑ Ignore INTERLOCK
Internal system error, allocatable	3..9	2 ➟ 4 [1)]	e.g. defect in I/O unit
Internal system error, not allocatable	2..9	4	
Cross connection at SAFETY24VDC	3..9	2 ➟ 4[1)]	
Unequal input signals at signal pairs	V	2	after 15 s
Non-permitted operating conditions (temperature, power supply)	2..9	4	
Prewarning operating temperature	2..9	0	

1) First controlled stopping process (class 2 error), then the error changes status so that it cannot reset (class 4 error), because correcting the cause of the malfunction requires the 24V power supply to be switched off.

0098441113177, V1.02, 08.2004

7.5 Table of error numbers for the SAM module

The error numbers and error texts can also be found in the file Twinline.err in the TLCT or SAMCT installation directory.

Error number	Error class	Meaning
E1500	-	SAM: class 1 error forced
E1501	-	SAM: class 2 error forced
E1502	-	SAM: class 3 error forced
E1503	-	SAM: class 4 error forced
E1504	3	SAM: Error at Safe Stopping Process; Insufficient Break ramp (Quick Stop)
E1505	1	SAM: safe operational stop disobeyed
E1506	1	SAM: Safely Reduced Setup Speed exceeded
E1507	-	SAM: safe limited increments exceeded
E1508	-	SAM: safe limited absolute position exceeded
E1509	-	SAM: terminal positions exceeded
E150A	2	SAM: Emergency Stop triggered
E150B	0	SAM: not ready for Fault Reset
E150C	0	SAM: not ready for SAM Disbale
E150D	3	SAM: Safe OPerational Stop in fault state disobeyed
E150E	0	SAM: Parameter is not readable
E150F	0	SAM: Parameters not writable in this state
E1510	0	SAM: Wrong password
E1511	0	SAM: timeout at parameterdownload (default values loaded)
E1512	0	SAM: Parameter not existend
E1513	0	SAM: Parameter checksum not writable in this state
E1514	0	SAM: Parameter checksum wrong (default values loaded)
E1515	0	SAM: Warning: low temperature
E1516	0	SAM: Warning: high temperature
E1517	2	SAM: 24 VDC overvoltage
E1518	4	SAM: 24 VDC undervoltage
E1519	2	SAM: short circuit at outputs of channel A to GND
E151A	4	SAM: System error: 5V supply voltage
E151B	4	SAM: System error: 5V supply voltage
E151C	2	SAM: SAM24VDC overvoltage (SW)
E151D	2	SAM: SAMSTART: Max. admissble puls length exceeded
E151E	2	SAM: System error: RAM (cross circuit)
E151F	4	SAM: System error: stack overrun
E1520	4	SAM: System error:program sequence control Communication
E1521	4	SAM: System error:program sequence check (idle Task)
E1522	4	SAM: System error:program sequence check (MS Task)

0098441113177, V1.02, 08.2004

Error code table SAM part 2

Error number	Error class	Meaning
E1523	2	SAM: cross circuit at output
E1524	2	SAM: System error: input
E1525	2	SAM: System error: PROM checksum error
E1526	0	SAM: Parameter value out of range
E1527	2	SAM: Parameter block checksum error
E1528	2	SAM: System error: SPI Framing Error
E1529	2	SAM: Unequal input states
E152A	2	SAM: Cross circuit at output (unequal states)
E152B	2	SAM: Error in position aquisition (unequal values)
E152C	2	SAM: Error in speed aquisition (unequal values)
E152D	2	SAM: Error in IO current monitoring
E152E	2	SAM: System error: Error in SAM24VDC monitoring (unequal values)
E152F	2	SAM: System error: Drive Release / SAM jumper
E1530	2	SAM: System error: SAM24VDC overvoltage cut off unit
E1531	2	SAM: System error: SPI short circuit
E1532	2	SAM: System error: UART short circuit
E1533	0	SAM: EEPROM wrong chechsum (default values loaded)
E1534	0	SAM: SAM module exchanged (default values loaded)
E1535	4	SAM: System error: position aquisition (commutating position)
E1536	2	SAM: Unequal checksum of parameters
E1537	0	SAM: SAM Boot Program: illegal address
E1538	1	SAM: Safely Reduced Operating Speed exceeded
E1539	2	SAM: Input SAMSTART low instead of high (Auto Start)
E153A	2	SAM: Input SAMSTART high instead of low (Safe Start)
E153B	2	SAM: Guard confirmation: Max. admissible puls length exceeded
E153C	2	SAM: System error: Unequal states of SAM state machines
E153D	0	SAM: FAULT RESET not possible (non resetable error)
E153E	2	SAM: wrong voltage at inputs
E153F	2	SAM: Output AUX_OUT_A (cross circuit to other output)
E1540	2	SAM: Output INTERLOCK_OUT_A (cross circuit to other output)
E1541	2	SAM: Output RELAY_A (cross circuit to other output)
E1542	2	SAM: Output SAFETY24V_A (cross circuit to other output)
E1543	2	SAM: Output AUX_OUT_A (cross circuit to 24V)
E1544	2	SAM: Output INTERLOCK_OUT_A (cross circuit to 24V)
E1545	2	SAM: Output Relay_A (cross circuit to 24V)
E1546	2	SAM: Output SAFETY24V_A (cross circuit to 24V)
E1547	2	SAM: System error: Output drive of channel A defective
E1548	2	SAM: System error: Input ESTOP_A

0098441113177, V1.02, 08.2004

Error code table SAM part 3

Error number	Error class	Meaning
E1549	2	SAM: System error: Input GUARD1_A
E154A	2	SAM: System error: Input SETUPENABLE_A
E154B	2	SAM: System error: Input SETUPMODE_A
E154C	-	SAM: System error: Input SAFETY_REF_A
E154D	-	SAM: System error: Input GUARD2_A
E154E	2	SAM: System error: Input INTERLOCK_IN
E154F	2	SAM: System error: Input GUARD1CONF
E1550	2	SAM: Short circuit at output of channel B to GND
E1551	4	SAM: System error: UART Overrun/Framing error
E1552	2	SAM: ResEnc (resolution of encoder) is set to 0
E1553	2	SAM: System error: CPU synchronization
E1554	2	SAM: No motor movement for 36h
E1555	2	SAM: System error: Time out high-priority tests (5 sec)
E1556	2	SAM: System error: Time out low-priority tests
E1557	2	SAM: dec_Qstop (max. admissible break ramp) is set to 0
E1558	-	SAM: Output AUX_OUT_B (cross circuit to other output)
E1559	2	SAM: Output INTERLOCK_OUT (cross circuit to other output)
E155A	2	SAM: Output RELAY_B (cross circuit to other output)
E155B	2	SAM: Output SAFETY24V_B (cross circuit to other output)
E155C	-	SAM: Output AUX_OUT_B (cross circuit to 24V)
E155D	2	SAM: Output INTERLOCK_OUT (cross circuit to 24V)
E155E	2	SAM: Output RELAY_B (cross circuit to 24V)
E155F	2	SAM: Output SAFETY24V_B (cross circuit to 24V)
E1560	2	SAM: System error: Output drive of channel B defect
E1561	2	SAM: System error: Input ESTOP_B
E1562	2	SAM: System error: Input GUARD1_B
E1563	2	SAM: System error: Input SETUPENABLE_B
E1564	2	SAM: System error: Input SETUPMODE_B
E1565	-	SAM: System error: Input SAFEFUNCIN_B
E1566	-	SAM: System error: Input GUARD2_B
E1567	2	SAM: System error: Input INTERLOCK_IN_B
E1568	2	SAM: System error: Input GUARD1CONF
E1569	2	SAM: SAM24VGND not connected
E156A	2	SAM: System error: Temperature sensor
E156B	2	SAM: Difference 24VDC - SAM24VDC to big
E156C	4	SAM: SAM24VDC Overvoltage (HW)
E156D	4	SAM: Switch off temperature (HW)
E156E	2	SAM: System error: Unequal SamOpMode
E156F	2	SAM: System error: AD converter

0098441113177, V1.02, 08.2004

0098441113177, V1.02, 08.2004

8 SAM parameters

8.1 Overview

Parameter table The parameter table contains information required to enable programs such as the TLCT commissioning software or the HMI handheld unit to identify a parameter. The parameter table can also provide information on setting options, presets and parameter properties. Note that the parameters of the Twin Line unit and the SAM module are grouped into functionally similar blocks, referred to as parameter groups. A parameter table has the following features (example):

Parameter Group.Name	Idx:Sidx	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam. RedSpeed. n_maxRed	10:18	Safely reduced setup speed [rpm]	UNIT16 # 0...12000	0	R/W rem. 1)

1) can only be written with the SAMCT / SAMCLONE configuration tool

where:

- **Group.Name:** Parameter designation made up of a combination of the name of the parameter group (="group") and the name of that specific parameter (="name").
- **Idx:Sidx:** ("Idx") and subindex (="Sidx") for identification of a parameter, input options with the TLCT operating software in the "Monitor" window, selection of the parameter in field bus mode.
- **Explanation and unit [ ]:** Detailed explanation of the parameter and its unit
- **Range of values**: Includes the data type, the variable numerical range for the parameter and the bit assignment of the parameter. The data type is significant for operation via field bus.
- **Default value**: Value set by the manufacturer.
- **R/W:** Information on reading and writing the values
  (R:= read and W:= write)
  "R/-" means that values are read-only,
  "R/W" means that values can be read and written
  "R/W 1)" means that values can be read and written, but can only be written with the SAMCT/SAMCLONE
- **rem.:** Information on whether the value is remanent; i.e. it is retained in the memory even after the unit is switched off.
  In the case of the remanent SAM parameters the user does not need to save the data in the remanent memory before switching off the unit.
  "rem." means that values are remanent.

0098441113177, V1.02, 08.2004

8.2 SAM user parameters

Parameter Name	Idx:Sidx	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam. Miscellaneous. ResEnc	10:4	Incremental encoder resolution [inc/rev]	**UINT32 # 0...65535** 4000: Stepper motor 4096: Servomotor	0	R/W [1] rem.
Sam. Miscellaneous. MiscModes	10.14	General modes	**UINT16** # **0...15** Bit 0: Automatic start (SAMSTART) 0: Start button evaluation Pulse 1: Automatic start: Level Bit 1: Safety door without confirmation (GUARD1CONF) 0: With confirmation button 1: Without confirmation button Bit 2: reserved Bit 3: Ignore INTERLOCK_IN 0: Safety door interlocking depends on INTERLOCK_IN 1: Safety door interlocking is independent of INTERLOCK_IN	0	R/W [1] rem.
Sam. Miscellaneous. ModeOut1	10:6	Function of the status output AUXOUT1	**UINIT32 # 0...4294967295** Bit: 0...14: Selection of status for output 00000001h: /ESTOP 00000002h: GUARD1 00000008h: SETUPMODE 00000010h: SETUPENABLE 00000040h: GUARD1CONF 00000200h: PowerAmp 00010002h: RELAY 00010010h: INTERLOCK_OUT 00010200h: Drive stopped (n=0) 00010400h: Setup speed (n<n_maxRed) 0002001Eh: Error class 1...3 Bit 15: Inversion 0: Status not inverted 1: Status inverted	0	R/W [1] rem.
Sam. Miscellaneous. ModeOut2	10:7	Function of the status output AUXOUT2	**UINIT32 # 0...4294967295** Bit: 0...14: Selection of status for output 00000001h: /ESTOP 00000002h: GUARD1 00000008h: SETUPMODE 00000010h: SETUPENABLE 00000040h: GUARD1CONF 00000200h: PowerAmp 00010002h: RELAY 00010010h: INTERLOCK_OUT 00010200h: Drive stopped (n=0) 00010400h: Setup speed (n<n_maxRed) 0002001Eh: Error class 1...3 Bit 15: Inversion 0: Status not inverted 1: Status inverted	0	R/W [1] rem.
Sam. RedSpeed. n_maxRed	10.18	Safely Reduced Setup Speed [rpm = 1/min.]	**UINT16** # **0..0.12000**	0	R/W [1] rem.

0098441113177, V1.02, 08.2004

Parameter Name	Idx:Sidx	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam. RedSpeed. n_maxAuto	10.19	Safely Reduced Automatic Speed [rpm = 1/min.]	**UINT16 # 0...12000** 0: no speed monitoring in automatic mode	0	R/W 1) rem.
Sam. Deceleration. t_NCDel	10:12	Delay time for Safe Deceleration (PLC response time) [ms]	**UINT16 # 0..0.500**	0	R/W 1) rem.
Sam. Deceleration. dec_NC	10:11	Max. admissible deceleration ramp for safe deceleration (with PLC) [rpm*s)]	**UINT32 # 0...32786009** 0: Function switched off (immediate transition to Safe Operational Stop or speed monitoring)	0	R/W 1) rem.
Sam. Stopping. dec_Qstop	10.16	Max. admissible deceleration ramp for safe stopping process (Quick-Stop) [rpm*s)]	**UINT32 # 0...32786009**	0	R/W 1) rem.
Sam. Stopping. t_Relay	10.13	Switch-off time of outputs RELAY	**UINT16 # 0...10000** 0: immediately without delay 1: if drive stopped (n=0) 2: if drive stopped (n=0) and INTERLOCK_IN= high ≥3: if delay time t_Relay [ms] is expired	0	R/W rem. 1)

1) can only be written with the SAMCT / SAMCLONE configuration tool

0098441113177, V1.02, 08.2004

8.3 SAM action and status parameters

Parameter Name	Idx:Sidx	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam. IW0_A	7.18	Input word 0, channel A	**UINT16** Bit 0: /ESTOP_A Bit 1: GUARD1_A Bit 2: reserved Bit 3: SETUPMODE_A Bit 4: SETUPENABLE_A Bit 5: reserved Bit 6: GUARD1CONF Bit 7: reserved Bit 8: SAMSTART Bit 9: INTERLOCK_IN		R/-
Sam. IW0_B	9.18	Input word 0, channel B	**UINT16** Bit 0: /ESTOP_B Bit 1: GUARD1_B Bit 2: reserved Bit 3: SETUPMODE_B Bit 4: SETUPENABLE_B Bit 5: reserved Bit 6: GUARD1CONF Bit 7: reserved Bit 8: SAMSTART Bit 9: INTERLOCK_IN		R/-
Sam. QW0_A	7.20	Output word 0, channel A	**UINT16** Bit 0: SAFETY24VDC_A Bit 1: PowerAmp_A Bit 2: RELAY_A Bit 3: AUXOUT1 Bit 4: INTERLOCK_OUT		R/-
Sam. QW0_B	9.20	Output word 0, channel B	**UINT16** Bit 0: SAFETY24VDC_B Bit 1: PowerAmp_B Bit 2: RELAY_B Bit 3: AUXOUT2 Bit 4: INTERLOCK_OUT		R/-
Sam. SamState	9.22	Status of SAM status automatic machines	**UINT16** Bit 0...7: 0x01: START 0x02: NOT READY TO SWITCH_ON 0x03: SWITCH ON DISABLED 0x04: READY TO SWITCH ON 0x06: OPERATION ENABLED 0x07: QUICK_STOP 0x08: FAULT REACTION ACTIVE 0x09: FAULT		R/-
Sam. p_actSAM	–	Position determined by SAM [inc at 1000 inc/rev]	**INT32**		

0098441113177, V1.02, 08.2004

Parameter Name	Idx:Sidx	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Sam. SamVer	9:15	Revision status of SAM software	**UINT32** Bit 0...11: SAM software revision Bit 12...15: SAM software version Bit 16...27: Bootstrap revision Bit 28...31: Bootstrap version **Example: 0x10011102**: Bootstrap V1.001 SAMSoftw. V1.102		R/-
Sam. SamPrgNo	9:16	Program number	**UINT16** Program number: Bit 4..17: 3-character program number Bit 0.. 3: 1-character program variation **Example: 0x30F0**: PR783-00		R/-
Sam. SamOpMode	9:23	Operating mode	**UNIT 32** Bit 0...15: samOpMode: 0: Safe stop 1: Automatic mode 2: Safe Operational Stop 3: Safely Reduced Setup Speed 4: Reserved 5: Safe Stopping Process 6: Safe Deceleration 7: Safe Operational Stop after error 8: Safely Reduced Automatic Speed Bit 16...31: samOpState Bit 18: GUARD1 confirmed		R/-
Sam. Diagnosis	9:24	Diagnosis data	**UINT 32** Write: Set return value for read access. 1: Operating time [s] 2: Configuration time [s] Read: Specified read value		R/W
Sam. SamDis	9:26	Sam Disable This can be used to suppress an error response if the axis is moved manually in positioning controller status "4". The SAM switches off the power amplifier controller and thus the movement monitoring. This is only possible in status "3" and "4" of the positioning controller!	UINT16 Bit 0: 0: no action 1: Switch SAM status from 6 ➟3		R/W

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

9 Accessories and spare parts

9.1 List of accessories

Accessory parts are:

Qty.	Usage	Order no.
1	**TL-SAM adapter**	
1	SAM cable for connecting SAM module and SAM adapter	6204 2500 220
1	Documentation for Twin Line units including SAM module on CD-ROM, multilingual	6250 1469 xxx [1]
1	SAMCT (SAM Configuration Tool), software for configuration of the SAM module), single parameters can be modified.	9844 1113 138
1	SAMCLONE (SAM Clone Tool), software for configuration of the SAM module, but only with complete data sets.	[2]
1	SAMTEST.xls, EXCEL program for planning the SAM configuration and to carry out a semi-automatic commissioning test.	[2]

1) Cable length xxx:015=1.5 m; 030=3 m; 050=5 m; 100= 10 m
2) This software can be obtained by e-mail on request. It will only be sent to the named safety representative.

SAM cable The SAM cable for 1:1 connection of the SAM module to the SAM adapter is manufactured of PUR and has a SUB-D plug connector at both ends.

Cable data
- Sheath diameter: 13mm
- Wire cross section: 0.34mm^2
- Shielding: none

0098441113177, V1.02, 08.2004

9.1.1 Connector cable

Colour coding

Pin	Signal	Explanation	Colour
1	ESTOP_A	Emergency Stop control devices	**ws**
2	GUARD1_A	Safety door position switch	br
3	SETUPENABLE_A	Enabling device	gn
4	SETUPMODE_A	operating mode switch	ye
5	reserved	reserved	gr
6	reserved	reserved	pk
7	INTERLOCK_IN	Enable input for safety door interlock logic	bl
8	SAFETY24VDC_A	Control devices power supply with cross connections dedection	rd
9	SAMSTART	Start signal	bk
10	SAM24VDC	SAM module power supply	vio
11	SAM24VGND	SAM module power supply	gr/pk
12	reserved	reserved	re/bl
13	AUXOUT1	Status output	wh/gn
14	AUXOUT2	Status output	br/gn
15	RELAY_A	power contactor	wh/ye
16	RELAY_B	power contactor	wh/gr
17	GUARD1CONF	enabling device	gr/br
18	INTERLOCK_OUT	safety door interlock	ye/br
19	$\overline{\text{ESTOP\_B}}$	Emergency Stop control devices	wh/pk
20	GUARD1_B	Safety door position switch	pk/br
21	SETUPENABLE_B	enabling device	wh/bl
22	SETUPMODE_B	operating mode switch	gr/gn
23	reserved	reserved	br/re
24	reserved	reserved	wh/re
25	reserved	reserved	wh/bk
26	SAFETY24VDC_B	Control devices power supply with cross connections dedection	br/bl

009844113177, V1.02, 08.2004

9.2 SAM adapter

The SAM adapter can be used to distribute the input signals of a system over up to five Twin Line units with a SAM module. The outputs for controlling power contactors, RELAY_A and RELAY_B, are connected from SAM modules 1 and 2 only to the adapter board, the others remain unused.

The outputs for detecting cross connections, SAFE24VDC_A and SAFE24VDC_B, are connected from SAM module 1 only to the adapter. The INTERLOCK_OUT output is connected to the INTERLOCK_IN input of the next SAM module. This sets up a daisychain for controlling the safety door interlocking (see chapter "Safety door interlocking", page 5-24).

Installation

The SAM adapter can be mounted on all standard EN mounting rails with foot elements. It must be installed in a an environment that meets the requirements of protection class IP54 . During installation ensure that an installation height of at least 100 mm measured from the mounting plate is available to install the adapter, including the SUB-D connector plug to the five SAM modules. In addition, there must be a free space of approximately 10 mm on the side with the screw terminals to allow the DIN rail feet to be unlocked with a screwdriver.

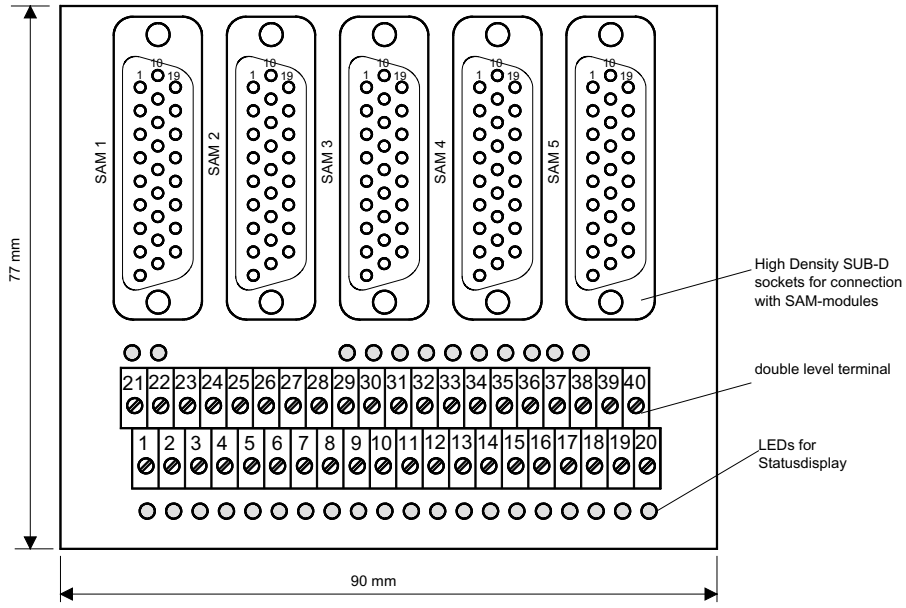


Fig. 9.1 SAM adapter

Terminal strip	Connection data for rigid cable:	0.14 to 1.5 mm^2
	Connection data for flexible cable:	0.14 to 1.0 mm^2
	Tightening torque:	0.22 to 0.25 Nm
	Screwdriver:0.4 x 2.5 mm	
Plug connection	Connection data:	high density SUB-D socket, 26-pin
	Assignment:	as with SUB-D on SAM module see chapter "Technical Data", page 3-2

0098441113177, V1.02, 08.2004

Adapter board pin assignment

Terminal	Signal	Connected with SAM no.
1	$\overline{\text{ESTOP\_A}}$ 1)	1..5
2	$\overline{\text{ESTOP\_B}}$ 1)	1..5
3	GUARD1_A 1)	1..5
4	GUARD1_B 1)	1..5
5	SETUPENABLE_A 1)	1..5
6	SETUPENABLE_B 1)	1..5
7	SETUPMODE_A 1)	1..5
8	SETUPMODE_B 1)	1..5
9	AUXOUT1	3
10	AUXOUT2	3
11	reserved	1..5
12	reserved	1..5
13	GUARD1CONF 1)	1..5
14	INTERLOCK_IN 1)	5
15	SAMSTART 1)	1..5
16	reserved	1
17	reserved	2
18	reserved	3
19	reserved	4
20	reserved	5

Terminal	Signal	Connected with SAM no.
21	SAFETY24VDC_A 1)	1
22	SAFETY24VDC_B 1)	1
23	SAFETY24VDC_A	1
24	SAFETY24VDC_B	1
25	SAFETY24VDC_A	1
26	SAFETY24VDC_B	1
27	SAFETY24VDC_A	1
28	SAFETY24VDC_B	1
29	RELAY_A 1)	2
30	RELAY_B 1)	2
31	AUXOUT1	2
32	AUXOUT2	2
33	reserved	1..5
34	INTERLOCK_OUT 1)	1
35	RELAY_A 1)	1
36	RELAY_B 1)	1
37	AUXOUT1	1
38	AUXOUT2	1
39	SAM24VDC	1..5
40	SAM24VGND	1..5

1) Status display by LED, 10mA at 24VDC

009844113177, V1.02, 08.2004

10 Service, Maintenance and Warranty

10.1 Service address

Contact your local dealer with any questions or problems. Your dealer will be happy to give you the name of a customer service outlet in your area.

Maintenance

The Twin Line unit requires no maintenance. Check the filter in the switch cabinet ventilator regularly. Inspection intervals depend on the ambient conditions on site.

Have repairs to the unit carried out only by your local dealer to ensure that the unit continues to operate reliably.

Warranty

The seal confirms that no unauthorised person has opened the unit. If the unit is opened the warranty is void.

The number of the seal identifies the tester and is not necessarily that shown above.

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

Index

0098441113177, V1.02, 08.2004

009844113177, V1.02, 08.2004

T

W

0098441113177, V1.02, 08.2004

0098441113177, V1.02, 08.2004