Document changes and version status

Change date	Affected page(s)	Changes/expansions/corrections	Version
19.12.2013	12 to 12a	Added Standard and Electrical requirements for UL table	1.1
17.02.2016	11	Switching-off inductive loads	1.2
15.05.2017	12	Specifications of maximum allowable output loads refined	1.3
04.12.2017	5, 8, 9, 14 8 14 15	Removed standard IEC 61508 Added amendments „Category 4“ and „EN“ Added chapter „Conformity with EU Standards” Added amendment „EN“ (62061) Added „Cat. 4“ Added unit 1/h on PFH_D value Changed value from 7.05 auf 7.05E-09 geändert Changed EMC resistance to 61000-6-2:2005	1.4
31.01.2018	9	Note Safety outputs protected polarity changed	1.5

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Explanation of Safety Symbols

This symbol identifies important or additional information in relation to the operation of the individual components.

This symbol identifies danger for personnel, the environment or equipment. If safety instructions are not observed, it can result in environmental or equipment damage and/or pose a danger to the life and health of personnel.

Documentation Note

This documentation is intended exclusively for trained personnel in control and automation technology. For installation and the initial start-up of individual modules or the entire Safety application, the instructions and explanations in this documentation must be followed explicitly.

Delivery Condition

The individual SIGMATEK Safety components are delivered in specific hard and software configurations. Any change of this configuration that exceeds the options specified in this documentation, is unauthorized and invalidates the warranty from SIGMATEK GmbH & Co KG.

Operator Due Diligence

The operator must ensure that

- the components are used for their designated purpose only.
- the components are operated in error-free, fully functional condition only.
- only sufficiently qualified and authorized personnel operate the components.
- the documentation is complete and in readable condition and available at the site of operation.

Installation

Before assembling, disassembling or wiring the module, put the entire system in a safe, voltage-free condition. The module must be mounted in a control cabinet or terminal box for operation.

General Instructions for Operating the Safety Modules

In the Safety System handbook, the following topics to be observed are covered:

- System requirements
- Performance level e according to EN ISO 13849 and/or SIL 3 according to EN 62061
- Safety guidelines
- EMVG
- Function and operation

To power the Safety modules correctly, the C-DIAS bus must be used (see below). The construction and structure are shown in the following illustration.

The appropriate module carriers for the C-DIAS bus are, for example, CMB 021/041/081 with 2, 4 or 8 slots for C-DIAS modules respectively. Important is that the connector slot framed in red shown in the picture is intended for a PLC or coupler module.

A C-DIAS IPC (Compact DIAS Industrial PC) is typically used as the PLC, while for example, a CIV 512 can be used as the coupler module. In the latter however, a connection to a PLC over the VARAN bus is required.

The C-DIAS bus and Connector Layout

A	Signal	B	Signal	C	Signal
1	CDIAS_/MS	1	CDIAS_/RES	1	------
2	CDIAS_EE_A2	2	CDIAS_EE_CLK	2	CDIAS_EE_DAT
3	CDIAS_EE_A1	3	CDIAS_SYNC	3	CDIAS_EE_IRQ
4	CDIAS_EE_A0	4	CDIAS_RDY	4	CDIAS_/DEN
5	------	5	CDIAS_/RD	5	CDIAS_/WR
6	------	6	CDIAS_A6	6	CDIAS_A7
7	------	7	CDIAS_A4	7	CDIAS_A5
8	------	8	CDIAS_A2	8	CDIAS_A3
9	------	9	CDIAS_A0	9	CDIAS_A1
10	------	10	CDIAS_D6	10	CDIAS_D7
11	------	11	CDIAS_D4	11	CDIAS_D5
12	------	12	CDIAS_D2	12	CDIAS_D3
13	+24V_CDIAS	13	CDIAS_D0	13	CDIAS_D1
14	+5V_UNFUSED	14	+5V_UNFUSED	14	+5V_UNFUSED
15	GND (internal)	15	GND (internal)	15	GND (internal)
16	GND (external)	16	GND (external)	16	GND (external)

Table 1: C-DIAS bus connector layout

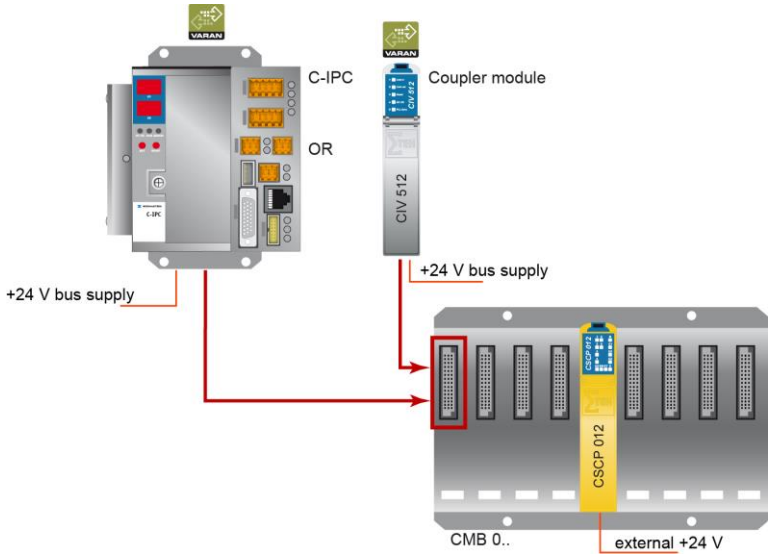


Fig. 1: Example of a minimum system for a safety-related control

The minimum system of a safety-related control with the CSTO 082, as shown above, is formed with a C-IPC a CMB 081 and a Safety CPU or type CSCP 012 for example.

The safety-related application is found in the Safety CPU after configuration and can run independently of the C-IPC. The C-IPC, however, is required to power the bus correctly and cannot be removed. In addition, it is also needed to establish the communication between the Safety CPU and the design tool (SafetyDesigner).

On the C-IPC and coupler modules, connectors are provided over which the C-DIAS bus must be externally supplied with a voltage of 24 V. The external supply for the output and clock drivers should be independent of the external C-DIAS bus supply (see below)

With the help from an SD card with a valid configuration, the Safety CPU can also be configured independently of the design tool (SafetyDesigner). More information can be found in the Safety CPU handbook under the chapter "Handling the micro SD card". With regard to the configuration using the design tool, the SafetyDesign handbook must be consulted.

C-DIAS Safety Digital Output Module CSTO 082

Module Description

The Safety output component series has the Safety integrity level **SIL3** and/or **SIL CL 3** according to (IEC 62061) and/or **Performance level e / Category 4** (EN ISO 13849)

The Safety output component series has:

8 safe outputs (IEC/EN 61131)

The safe outputs are used for the Safety-related output of 8 actuator signals to, for example, control relays, valves, etc.

Fig. 2: CSTO 082

The Safety output module CSTO 082 is suited for use in systems with optional modules and interface variables in accordance with the system hand book version 1.5, sections 1.6, 7.1 and 7.2.

To use the Safety output module in an application, a Safety CPU module that regulates the synchronized communication with the Safety modules using safe bus telegrams is also required. This also includes

- Processing the safe application and
- The distribution of configuration data to remote Safety modules.

When wiring, it is important to note that the output supply of the Safety outputs is not protected against polarity reversal.

If the polarity wired in reverse, the Safety module must be exchanged and sent for repair.

Designated Use

The CSTO 082 Safety module is designed for use in safety-related applications and meets the required conditions for Safety operation in compliance with Performance level e, according to EN ISO 13849 and/or SIL 3 according to EN 62061. It is usually used in conjunction with other Safety modules such as CSDI 162 and CSCP 012, for example.

Installation, mounting, programming, initial start-up, operation, maintenance and discarding of Safety modules can only be performed by qualified personnel.

Qualified personnel in this context are people, who have completed training or have been trained under supervision of qualified personnel and have been authorized to operate and maintain safety-related equipment, systems and facilities in compliance with the strict guidelines and standards of Safety technology. More information on standards etc. can be found in the Safety System Handbook.

For your own safety and the safety of others, Use Safety modules for their designated purpose. Correct EMV installation is also included in the designated use.

Non-designated use consists of

- Any change made to the Safety modules of any kind.
- The use of damaged Safety modules.
- The use of the Safety module outside of the instructions described in this handbook.
- The use of the Safety module outside of the technical data described in this handbook.

Mechanical Dimensions

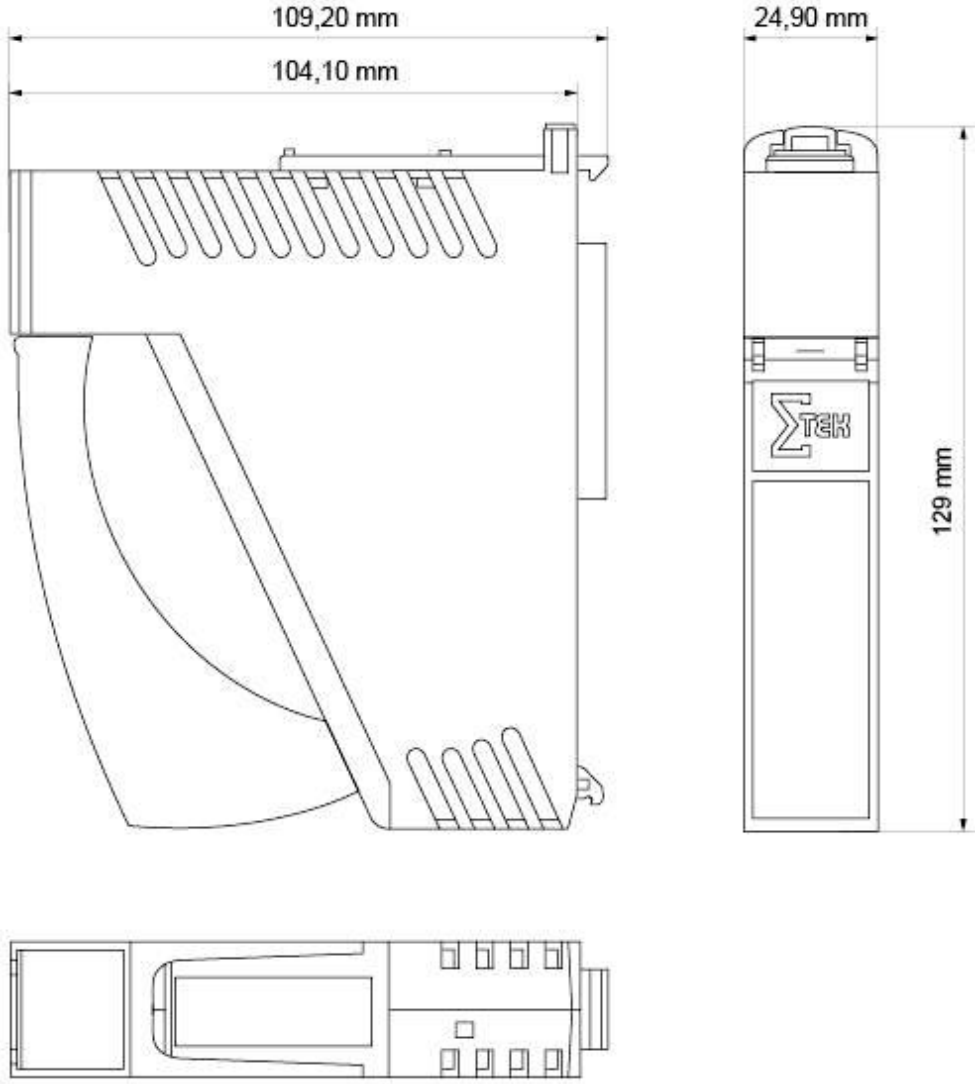


Fig. 3: Mechanical dimensions

Technical Data

Output specifications

All Safety outputs are short-circuit protected and specified according to IEC/EN 61131. The outputs are compatible with input of type 1, 2 and 3.

Number of …	8		
Rated output voltage	+24 V DC		
Output voltage range	minimum +18 V		maximum +30 V
Maximum output current per channel	2 A		
Maximum total current per output group (2 outputs)	2 A		
Maximum total current (complete module)	8 A up to a max. 45 °C ext. temperature	6 A up to a max. 50 °C ext. temperature	4 A up to a max. 55 °C ext. temperature
Brake voltage with switching-off inductive loads	typically 0.85 V		
Maximum switch-off energy of the outputs (inductive load)	maximum 0.4 Joule per channel maximum 1.2 Joule (entire module)		
Turn-on delay	< 200 µs		
Turn-off delay	< 1 ms		
Miscellaneous	short-circuit proof		
Cut-off test signal	< 1.5 ms		

Table 2: Input specifications

Maximum inductive load L (mH) at load current I (A)

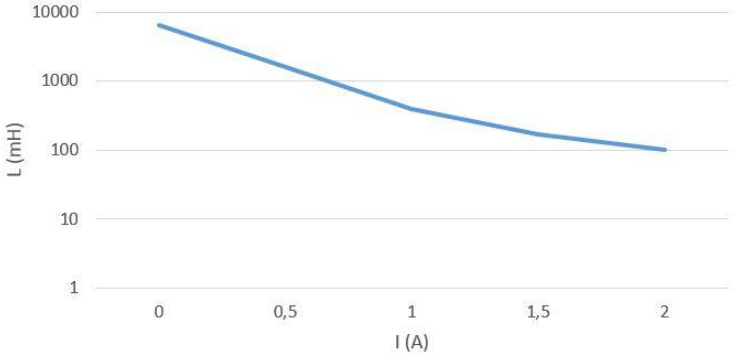


Fig. 4: Inductive load

Maximum capacitive load C (µF) at load current I (A)

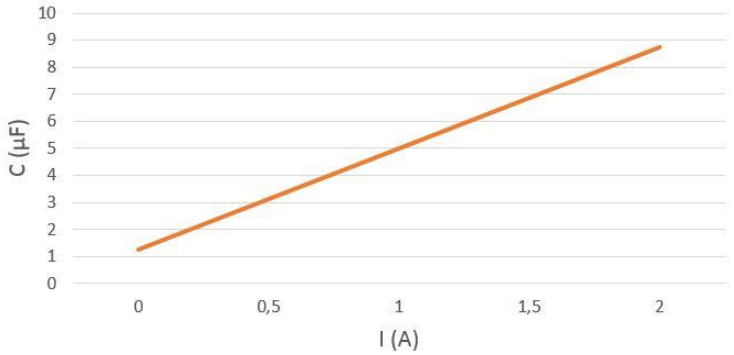


Fig. 5: Capacitive load

I (A)	L (mH)	C (µF)
0	6400	1.25
0.5	1600	3.13
1	400	5
2	100	8.75

Table 3: Allowable output loads

Electrical requirements

The Safety modules' electrical supply must also be provided over the C-DIAS bus in a stand-alone system; another type and method of energy supply is not allowed.
The C-DIAS bus system's external 24 V supply voltage be generated by a PELV power supply.

Rated supply voltage	+24 V DC (C-DIAS bus)	
Supply voltage range	Minimum +18 V	Maximum +30 V
Voltage supply from C-DIAS bus	+5 V	
Current consumption of C-DIAS bus (+5 V supply)	Typically 50 mA	
Current consumption of C-DIAS bus (+24 V supply)	Typically 90 mA	
Maximum interrupt time for voltage interruptions	10 ms	
Standard	UL 508 (E247993)	

Table 4: Electrical requirements

Electrical requirements for UL

IMPORTANT:
The device was tested in accordance with the UL 508 Norm as a low voltage limited power circuit (LVLC - limited voltage/limited current). To meet the standard requirements, the device must be powered by a galvanically isolated source (+24 V DC), which is protected with a UL-certified 4 A fuse (UL 248) in the secondary circuit. If the device is powered by two galvanically isolated sources, one to power the electronics and one for the frequency output, each source must be equipped with a UL-certified 4 A fuse (UL 248) in the secondary circuit.

Input	18 - 30 V DC
Output **(General use Ampere Rating)**	18 - 30 V DC 2 A per channel, 2 A per group, maximum 4 A complete module

Safety Conformity

Conformity with EU Standards

The module has been designed in accordance with the following European Union directives:

2006/42/EG Machinery Directive
2014/30/EU EMC Directive
2011/65/EU RoHS Directive

Functional safety standards

- EN/IEC 62061 SIL 3 or SIL CL 3
- EN ISO 13849 PL e / Cat. 4

Configuration: 2-channel redundant (diverse)

Safety parameters

Diagnostic coverage	**DC [%]**	95.94
Probability of failure per hour	**PFH_D [1/h]**	7.05E-09
Mean time to dangerous failure	**MTTFd [years] symmetrized**	351
Proof Test Interval [years]	**20**	

Table 5: Safety parameters

Please note:

The parameters shown are only applicable with the simultaneous parallel use of two inputs.

Environmental conditions

Storage temperature	-20 to +85 °C	
Operating temperature	0 to +55 °C	
Humidity	0 to 95 %, uncondensed	
EMV stability	According to EN 61000-6-2:2005 (industrial area) Raised requirements according to IEC 62061	
Shock resistance	EN 60068-2-27	15 g
Protection Type	EN 60529	IP 20

Table 6: Environmental conditions

Miscellaneous

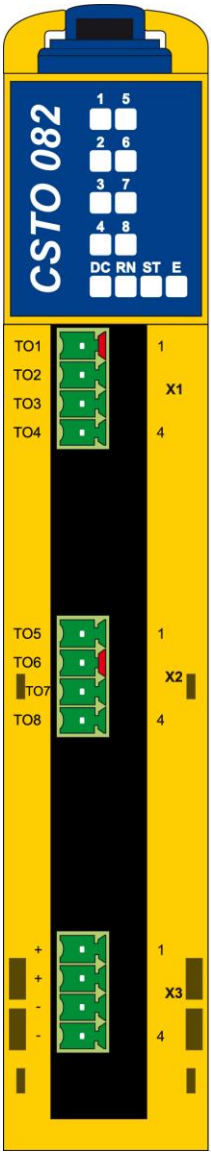
Article number	12-892-082
Hardware version	1.x

Table 7: Miscellaneous

Output Power Supply

So that a short circuit on the supply of the outputs resulting from an error does not cause the PLC to fail, it is recommended that separate power supplies be used for the 24 V C-DIAS bus supply (fed to the C-IPC or CIV) and the supply for the outputs and clock signals.

CSTO 082 Circuit



For the functions and LED display, see the following chapter "LED Displays".

X1 2 x digital outputs (group G1)

X1 2 x digital outputs (group G2)

X2 2 x digital outputs (group G3)

X2 2 x digital outputs (group G4)

X3 +24 V supply voltage

Fig. 6: CSTO 082 circuit

LED Display

The LED display lights continuously to indicate that the in- and outputs are active.

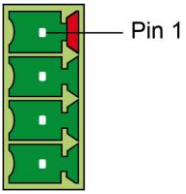
Label	Color	Function	Display
1 - 8	Yellow	Digital outputs 1 – 8 (connector X1, X2)	Fast blinking frequency (wiring error, cross circuit...)
DC	Green	DCOK +24 V	Indicates that the +24 V supply for outputs and clock signals are within the defined limits.
RN	Green	RUN	Indicates the time-unlimited (LED "ST" off) operational mode
ST	Yellow	Status	- Lights permanently: The module is currently in service mode - Slow blinking frequency: The module is currently in Idle or Check Configuration mode
E	Red	Error	- Lights permanently: the module is in error mode - Fast blinking frequency: Serious error; communication with the module is no longer possible (CANNOT be read with the SafetyDesigner

Table 8: LED Display

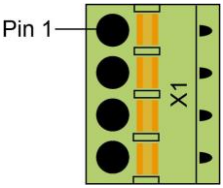
Connector Layout

Module connection	Label	Pin	Function	Connector

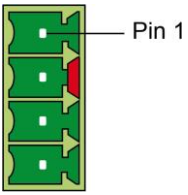
X1: digital outputs (Group G1/G2)



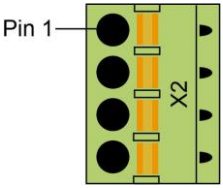
TO1 (group 1)	X1 / 1	Digital output 1
TO2 (group 1)	X1 / 2	Digital output 2
TO3 (group 2)	X1 / 3	Digital output 3
TO4 (group 2)	X1 / 4	Digital output 4



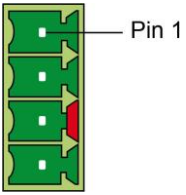
X2: digital outputs (Group G3/G4)



TO5 (group 3)	X2 / 1	Digital output 5
TO6 (group 3)	X2 / 2	Digital output 6
TO7 (group 4)	X2 / 3	Digital output 7
TO8 (group 4)	X2 / 4	Digital output 8



X3: Power supply



+	X3 / 1	+24 V (output supply)
+	X3 / 2	+24 V (output supply)
-	X3 / 3	GND
-	X3 / 4	GND

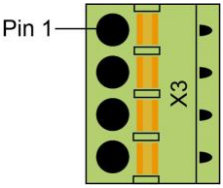


Table 9: Connector layout

The complete C-DIAS connector set (3 connector plugs with spring terminals; Phoenix Contact: FK-MCP 1,5/ 4-ST-3.5) is included in delivery of the C-DIAS module.

Connector Plug Coding

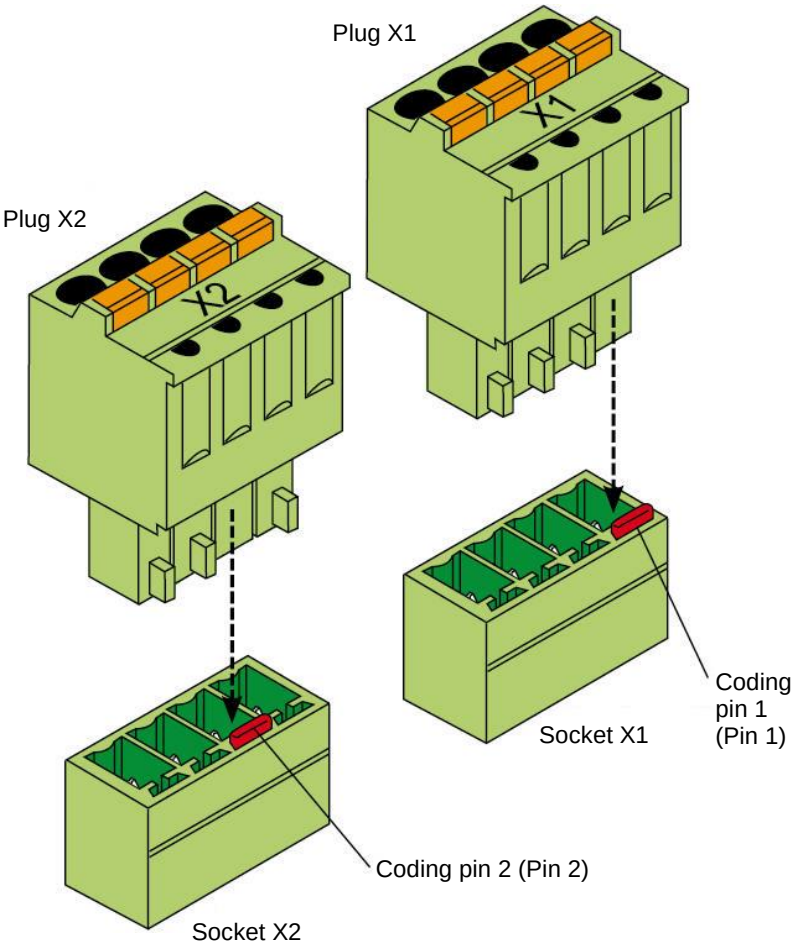


Fig. 7: Connector plug coding

The Phoenix connector sets used are coded at the factory to avoid confusing the connections. A red coding pin is thereby placed in the socket. Concurrently, the protruding "nose" is removed from the corresponding pin in the plug. The respective plug can therefore only be inserted into the corresponding socket.

Connector plug coding: Pin 1 in plug/socket X1
Pin 2 in plug/socket X2

The X3 plug is not coded.

Error Response

In the event of an error, please consult the chapter "LED Displays", as important information on the runtime status of the system can be derived from the status and error display. Since errors in general are of a complex nature, do not perform a diagnosis based on the LEDs alone (consult the corresponding chapter in the Safety System Handbook as well). For an exact error analysis, the SafetyDesigner must be used.

Restart Errors

The following diagram shows the response of the Safety output module during restart.

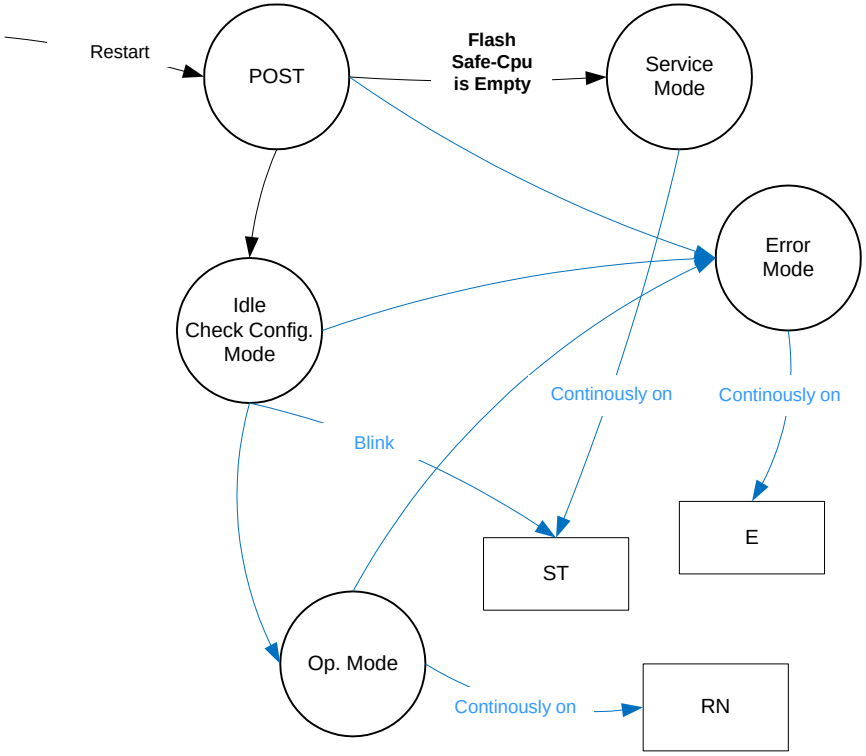


Fig. 8: Simplified status diagram

a) During restart, the Safety output first runs the POST (Power On Self Test). In the POST, whether the Safety output is configured or not is determined. If the Flash memory in the Safety output is empty, it changes to the service mode and switches the status LED (ST) to continuously on.

b) If the Flash memory of the Safety output contains a configuration, it goes into the idle / Check Configuration Mode; the ST LED blinks.

c) When the Safety output remains in the **idle / Check Configuration Mode** for a long period of time (ST-LED blinking) without switching to the **Error mode**, it is an indication that the bus communication is malfunctioning. In this case, the PLC will remain in the error status and must be restarted.

d) A change to the error status can also occur from the **POST** and (Temp.) **OP. mode** if other (internal) errors are detected or errors in remote modules occur. The analysis of these errors however, requires the use of the SafetyDesigner.

Troubleshooting

- Check all modules in the system for completeness and type conformity.
- Check that all modules are error-free
- Check all connector cables
- Canceling errors

If the Safety output module remains in the error status after the ***QUIT_ERROR*** command has been executed, it must be retested using the SafetyDesigner.

Troubleshooting with the SafetyDesigner

Connect the SafetyDesigner
Debug the system using the SafetyDesigner.

Correcting a wiring error

When a wiring error is determined, a controlled deactivation of the system is required, which must then be turned off.

The system can only be rewired when no power is applied.

Output Circuit

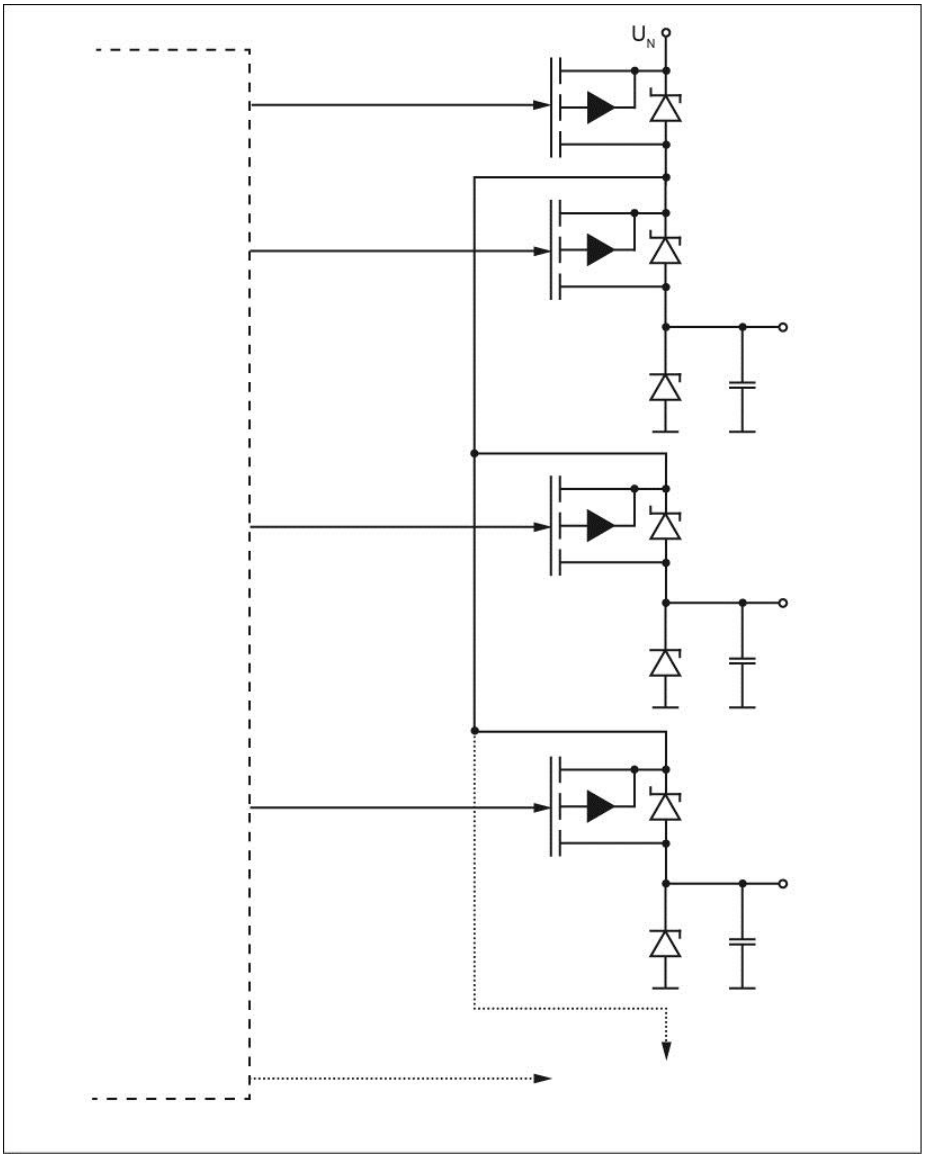


Fig. 9: Output circuit structure

Practical Example of a Circuit

The following diagram shows the schematic for a processing machine. To implement the application, the following basic requirements must be met.

Requirements

R1 The installation can only be started manually with the start button S1. For cross-circuit detection, the start button S1 should have a 2-channel connection.

R2 The signal lamp P1 should turn on immediately after pressing the start button S1. To activate the signal lamp P1, a safe output can be used.

R3 For the power train control of the processing machine, a Safety output should be used on the relay K1. The K1 relay should be set 500 ms after pressing the start button S1.

R4 When the Emergency Stop switch S2 is triggered , the power train control of the machine must be turned off within 50 msec.

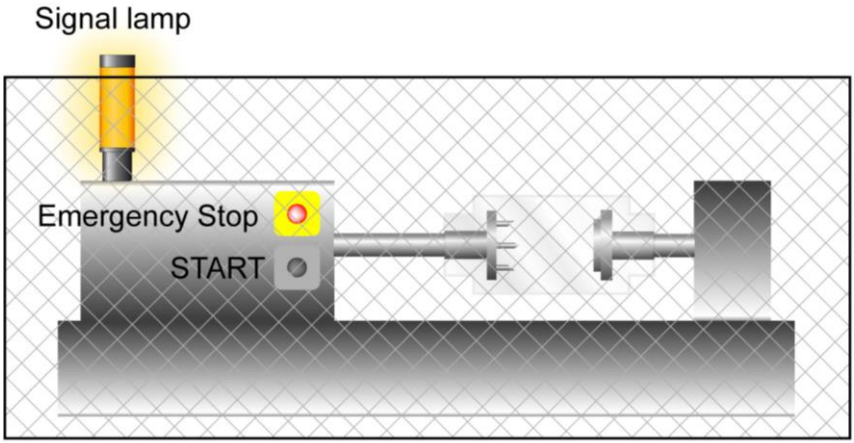


Fig. 10: Simplified representation of the processing machine

Implementation

- For switch S1, the start button and S2, the Emergency Stop switch, 2 safe inputs are required for each.
- Two safe outputs are needed for control of the relay K1 and the signal lamp P1.
- The normally open contacts of the start button S1 are connected to the signal outputs A and B over 2 channels (cross-circuit detection) and wired to 2 safe inputs.
- The normally closed contacts of the Emergency Stop switch S2, are connected to the signal outputs A and B over 2 channels (cross-circuit detection) and wired to 2 safe inputs.
- The monitor contact of the K1 relay switch is otherwise read back.

The following block diagram shows the implementation of the circuit with help from a CSTO 082 Safety output module, a CSCP 012 Safety CPU and the previously mentioned external components. Here, it is assumed that the both modules are mounted on a correctly installed C-DIAS module carrier.

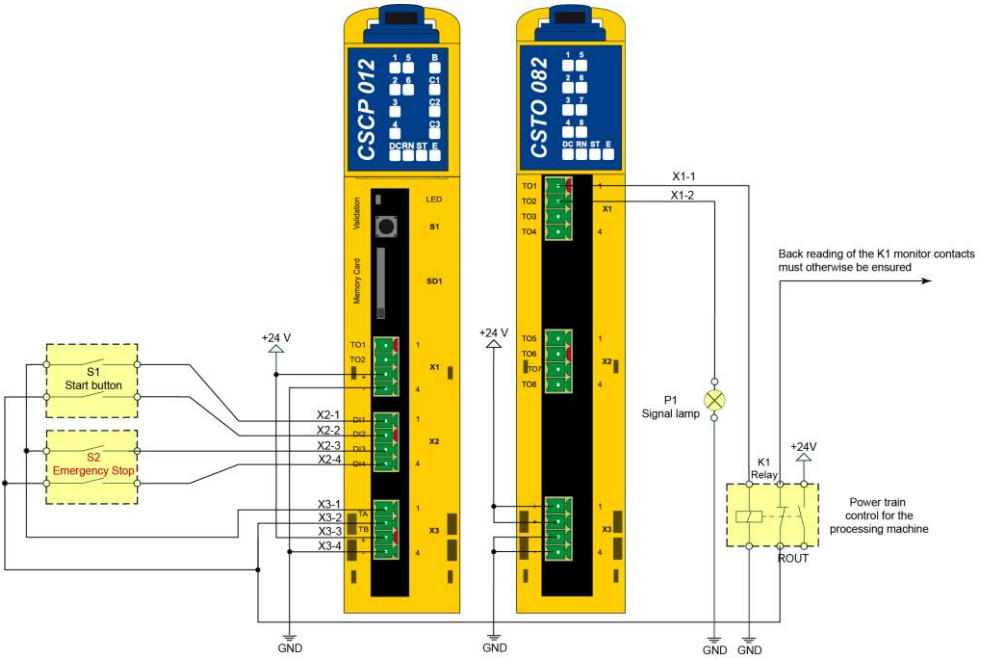


Fig. 11: Example structure diagram

The following schematic shows the corresponding block diagram for the wiring in tabular form.

Connection Diagram

Central wiring Control configuration	CSCP 012		
	Con-nectors	**Pin**	**Connection**
	X2	1	Normally open start button S1 (B)
		2	Normally open start button S1 (B)
		3	Normally closed Emergency Stop S2 (A)
		4	Normally closed Emergency Stop S2 (b)
	X3	1	Output A
		2	Clock output B
		3	+24 V
		4	GND

Central wiring Control configuration	CSTO 082		
	Con-nectors	**Pin**	**Connection**
	X1	1	Control relay K1
		2	Control signal light P1
		3	---
		4	---
	X3	1	+24 V
		2	+24 V
		3	GND
		4	GND

Table 10: Connection diagram example