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
31.01.2018	5, 8, 9, 13 8 13 14	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 5.13 to 5.13E-09 Changed EMC resistance to 61000-6-2:2005	1.2
05.10.2018	11	Note cable capacitance and cable resistance added	1.3

Contents

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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.

Test Signals for Cross-Circuit Detection

The module sends pulses in cyclic time intervals to detect a crossed circuit in the outputs. When selecting the actuators, keep in mind that these pulses do not activate the actuators or trigger any diagnostic messages. The pulse signals cannot be deactivated or configured.

Cross-Circuit Detection

Please keep in mind that the cross-circuit detection only functions correctly when it is correctly wired and configured. This applies equally to in- and outputs.

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
- Wiring

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. The important thing is that the 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

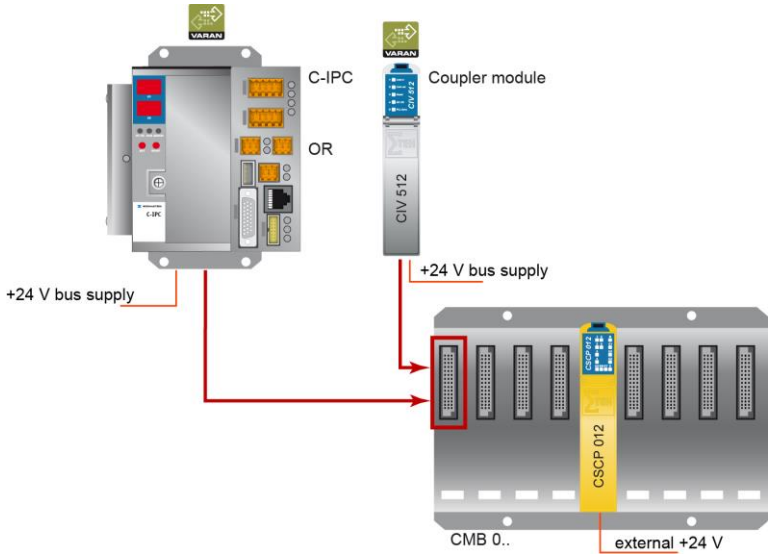


Fig. 1: Example of a minimum system for a safety-related control

The minimal system of a safety-related control, formed as shown above, with a C-IPC a CMB 081 and a Safety CPU type CSCP 012.

The safety-related application is found in the Safety CPU 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 hereto can be found in 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 Input Module CSDI 162

Module Description

The Safety input component series has the Safety integrity level **SIL3** and/or **SIL CL 3** according to (IEC 62061) and/or **Performancelevel e (PL e) / Category 4** (EN ISO 13849). The Safety-CPU component series has:

16 safe inputs (IEC/EN 61131)

Doubled clock output signal (short-circuit proof)

The Safety inputs are used for reading 16 Safety actuator signals (emergency stop, confirmation button etc.).

The Safety input module has 2 non-Safety signal outputs, TA and TB, to test inputs and detect cross-circuit errors (i.e. emergency stop).

Fig. 2: CSDI 162

The Safety input module CSDI 162 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 input 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.

Designated Use

The CSDI 162 Safety module is designed for use in Safety-related applications and meets the required conditions for Safety operation in compliance with Perfomancelevel e (PL 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 CSCP 012 and CSTO 082, 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

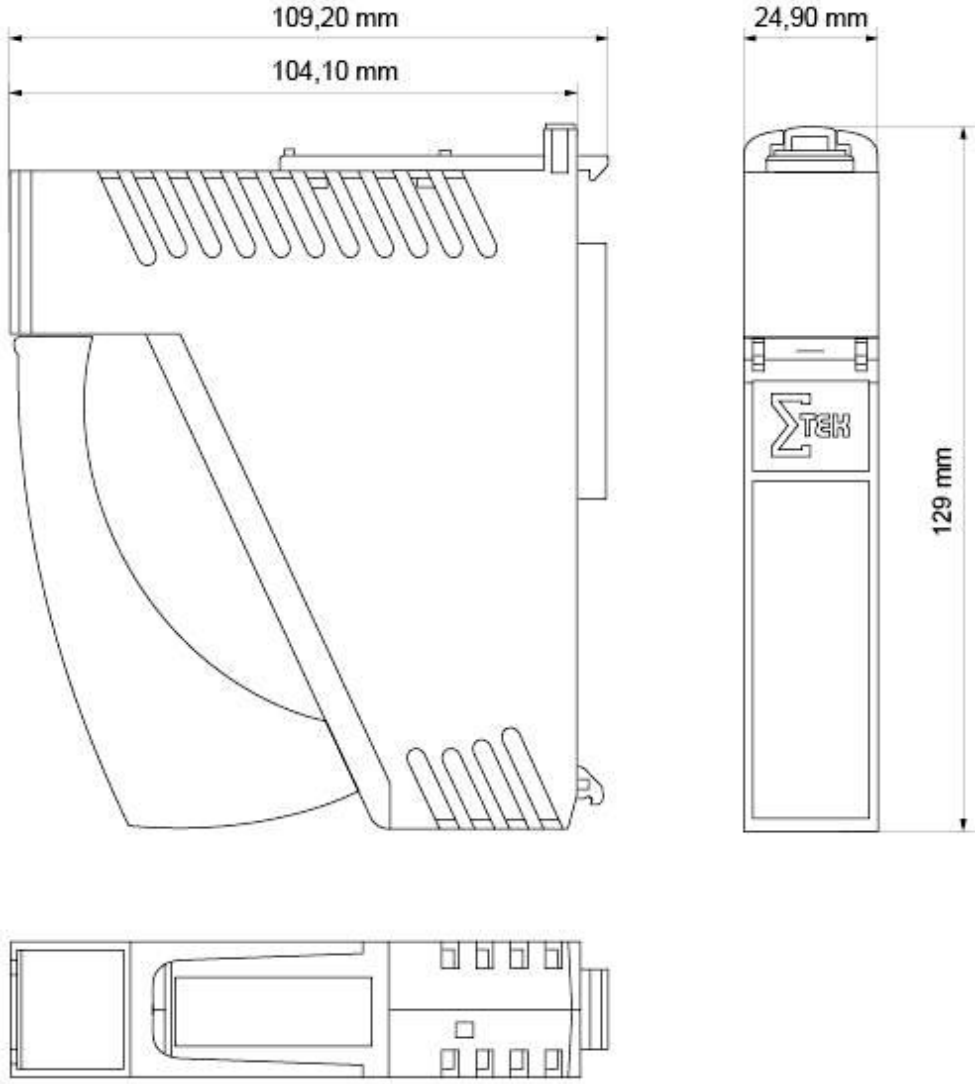


Fig. 3: Mechanical dimensions

Technical Data

Input specifications

The inputs are type 1 according to IEC/EN 61131

Number of …	16	
Input voltage	+24 V DC	
Input voltage range	Minimum +18 V	Maximum +30 V
Signal level	Low: ≤ +5 V	High: ≥ +15 V
Switching threshold	Typically +11 V	
Input current	5 mA at +24 V	
Input delay	Maximum 2.5 ms	

Table 2: Input specifications

Specifications for the cross-circuit detection signal outputs

Number of …	2	
Rated output voltage	+24 V DC	
Output voltage range	Minimum +18 V	Maximum +30 V
Output current	100 mA at +24 V	
Miscellaneous	Short-circuit proof	

Table 3: Clock output specifications

When using the digital inputs with the clock outputs for cross-wire detection for long cable lengths, it must be ensured that the cable capacitance from the clock output to the digital input does not exceed a value of 75 nF in relation to GND and that the cable resistance does not exceed a value of 250 Ω, so that the cross-wire detection does not detect a wiring fault if the wiring is correct.

Electrical requirements

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

Rated supply voltage	+24 V DC (C-DIAS bus)	
Supply voltage range including ripple	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 (24 V DC 16 x 5 mA) 16 x 5 mA at +24 V
Output **(General use Ampere Rating)**	Cross-circuit detection signal output

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-relevant parameters

Diagnostic coverage	**DC [%]**	95.7
Probability of failure per hour	**PFH_D [1/h]**	5.13E-09
Mean time to dangerous failure	**MTTFD [years] symmetrized**	472
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	
Environmental 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 26061	
Shock resistance	EN 60068-2-27	15 g
Protection Type	EN 60529	IP 20

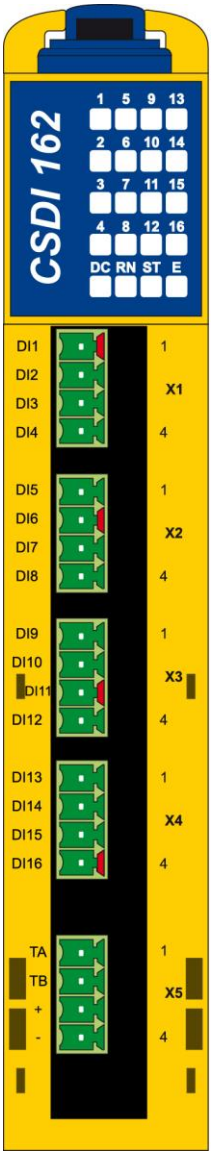
Table 6: Environmental conditions

Miscellaneous

Article number	12-891-162
Hardware version	1.x

Table 7: Miscellaneous

CSDI 162 Circuit



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

X1 4 x digital inputs (group G1)

X2 4 x digital inputs (group G2)

X3 4 x digital inputs (group G3)

X4 4 x digital inputs (group G4)

X5 Clock signal output

X5 +24 V Supply GND

Fig. 4: CSDI 162 circuit

LED Display

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

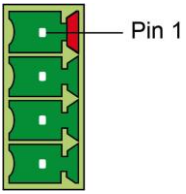
Label	Color	Function	Display
1 – 16	Green	Digital inputs 1 – 16 (connector X1, X2, X3, X4)	Fast blinking frequency (wiring error, cross circuit...)
DC	Green	DCOK +24 V	Indicates that the +24 V supply for the clock signals is within the defined limits.
RN	Green	RUN	Indicates the time-unlimited (LED "ST" off) operational mode
ST	Yellow	Status	- Lights permanently: The module is currently in service mode - Slow blinking frequency: The module is in the Idle or Check configuration (because the mode transition can be very fast, the blinking signal is normal not noticed.
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

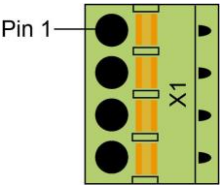
Connector Layout

Module connection	Label	Pin	Function	Connection

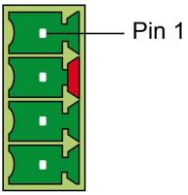
X1: digital inputs (Group G1)



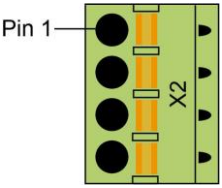
DI1	X1 / 1	Digital Input 1
DI2	X1 / 2	Digital Input 2
DI3	X1 / 3	Digital Input 3
DI4	X1 / 4	Digital Input 4



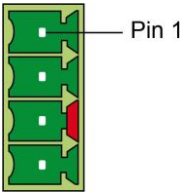
X2: digital inputs (Group G2)



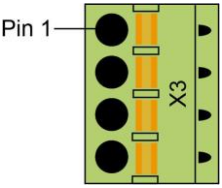
DI5	X2 / 1	Digital Input 5
DI6	X2 / 2	Digital Input 6
DI7	X2 / 3	Digital Input 7
DI8	X2 / 4	Digital Input 8



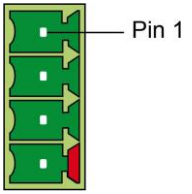
X3: digital inputs (Group G3)



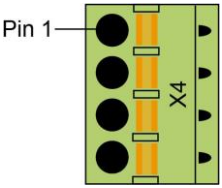
DI9	X3 / 1	Digital Input 9
DI10	X3 / 2	Digital Input 10
DI11	X3 / 3	Digital Input 11
DI12	X3 / 4	Digital Input 12



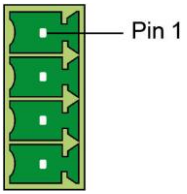
X4: digital inputs (Group G4)



DI13	X4 / 1	Digital Input 13
DI14	X4 / 2	Digital Input 14
DI15	X4 / 3	Digital Input 15
DI16	X4 / 4	Digital Input 16



X5: clock signal outputs



A	X5 / 1	Clock Output A
B	X5 / 2	Clock Output B
+	X5 / 3	+24 V (supply for clock signal output)
-	X5 / 4	GND

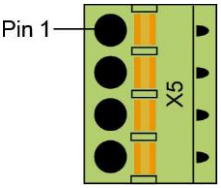


Table 9: Connector layout

The complete C-DIAS connector set (5 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

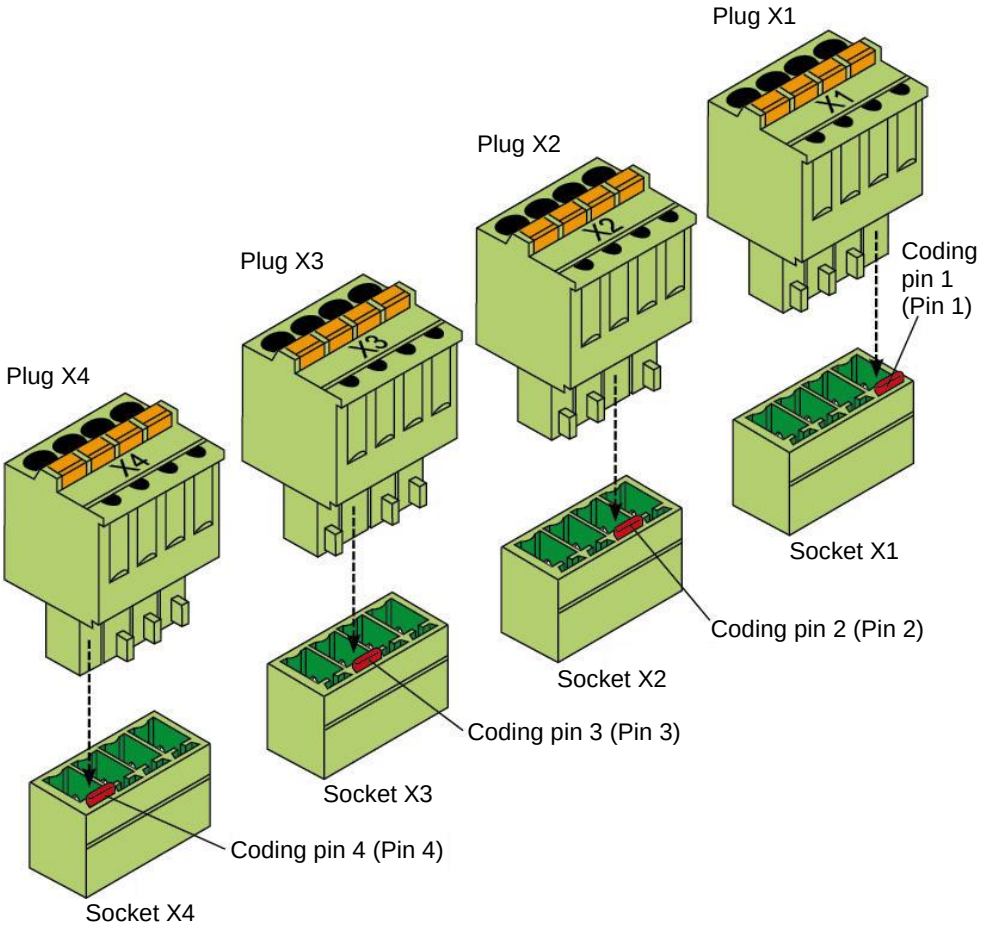


Fig. 5 : Connector plug coding

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
Pin 3 in plug/socket X3
Pin 4 in plug/socket X4

The X5 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 input module during restart.

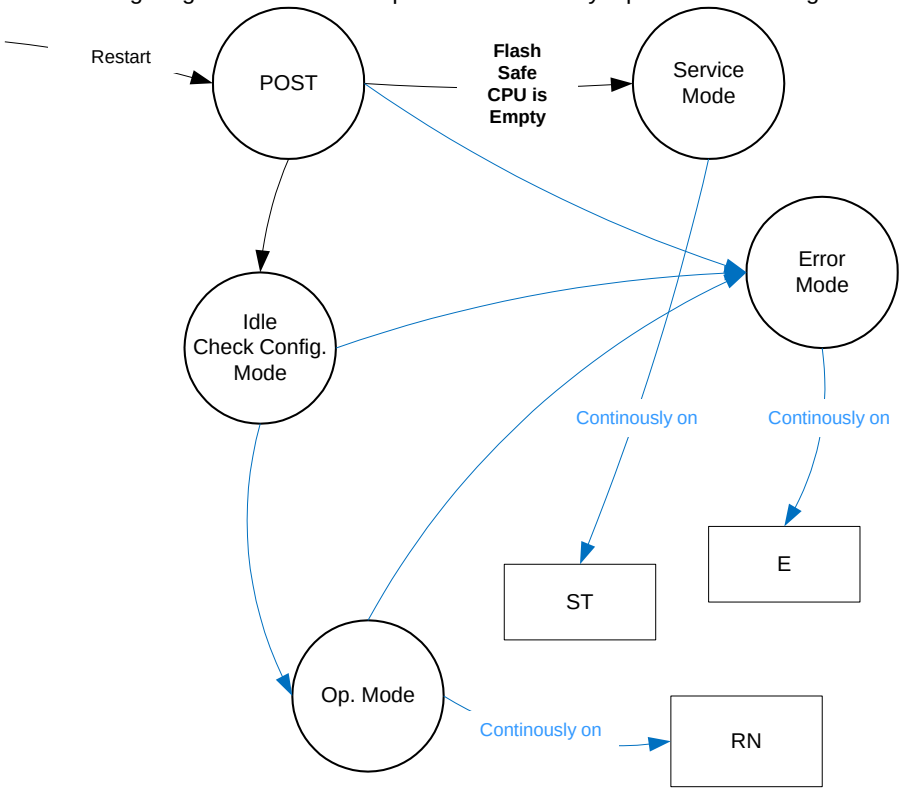


Fig. 6: Simplified status diagram

a) During restart, the Safety input first runs the POST (Power On Self Test). In the POST, whether the Safety input is configured or not is determined. If the Flash memory in the Safety input 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 input contains a configuration, it goes into the idle / Check Configuration Mode. The transition into the OP mode occurs so fast that the blinking of the ST LED is not seen.

c) 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
- Cancel the error with the QUIT_ERROR command

If the Safety input 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.

Input Circuit

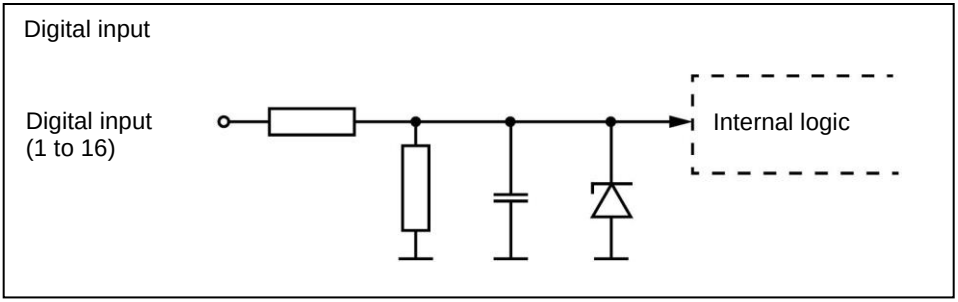


Fig. 7: Input circuit structure

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.

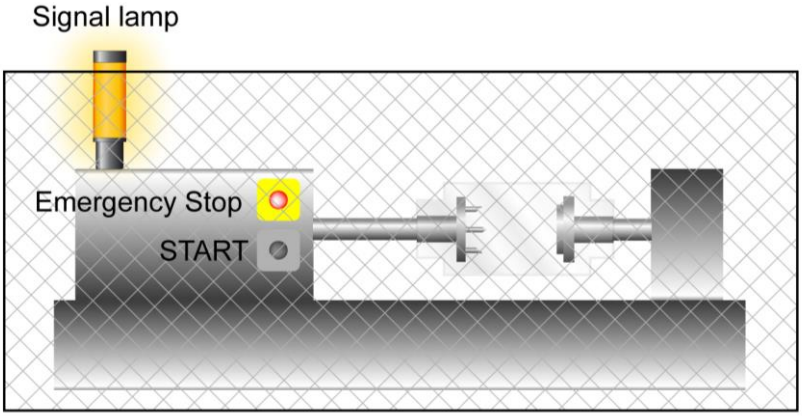


Fig. 8: Simplified representation of the processing machine

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 read back.

The following block diagram shows the implementation of the circuit with help from a CSDI 1621 Safety input module and a single CSCP 012 Safety CPU the previously mentioned external components. Here, it is assumed that the both modules are mounted on a correctly installed C-DIAS module carrier.

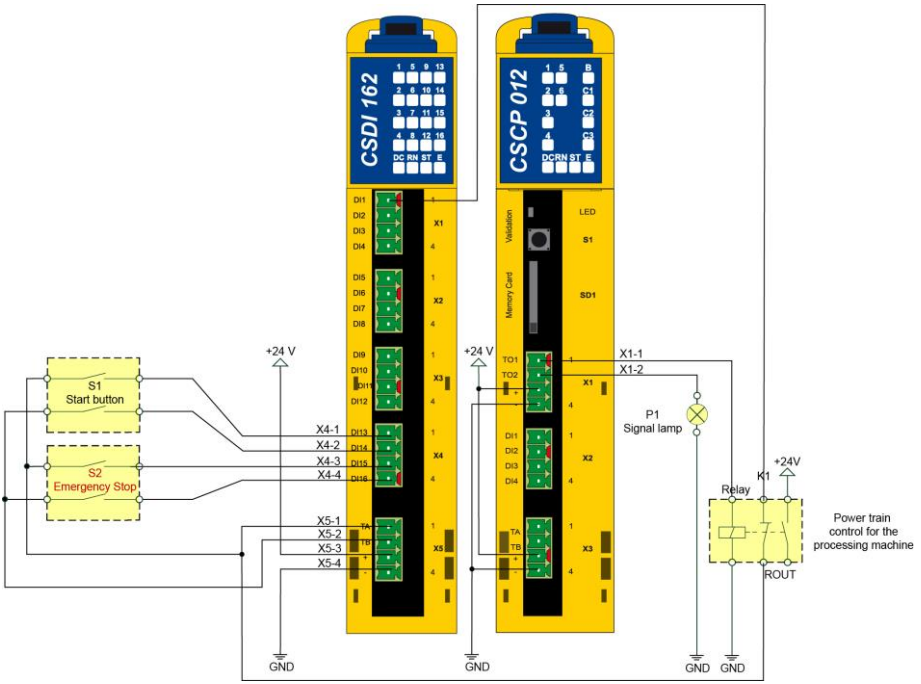


Fig. 9: Example structure diagram

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**
	X1	1	Control relay K1
		2	Control signal light P1
		3	+24 V
		4	GND
	X3	1	---
		2	---
		3	+24 V
		4	GND

Central wiring Control configuration	CSDI 162		
	Con-nectors	**Pin**	**Connection**
	X1	1	Auxiliary contact relay K1
		2	---
		3	---
		4	---
	X4	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)
	X5	1	Output A
		2	Clock output B
		3	+24 V
		4	GND

Table 10: Example schematic