OPERATING INSTRUCTIONS

UE4420, UE4450, UE4455, UE4427 and UE4457

IP67 Safety Remote I/Os and Safety Remote Controllers for DeviceNet Safety

GB

SICK
Sensor Intelligence.

QUALITY SYSTEM

certified by DQS according to
DIN EN ISO 9001 Reg. No. 462-03

Contents

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1 About this document

Thank you for purchasing the UE4400 series IP67 remote bus node for DeviceNet Safety. Please read this chapter carefully before working with this documentation and the UE4400.

Note Unless indicated otherwise, the product code UE4400 contained in this document is synonymous to the UE4420, UE4427, UE4450, UE4455 and UE4457 bus nodes. Please refer to separate documentation for DeviceNet Safety IP20 bus node variants (e.g. UE4421).

1.1 Function of this document

These operating instructions are designed to address *the technical personnel of the machine manufacturer* or *the machine operator* with regard to the safe mounting, installation, configuration, electrical installation, commissioning, operation and maintenance of the UE4400.

These operating instructions do not provide instructions for operating machines on which the UE4400 has been, or could be integrated. Information on this is to be found in the appropriate operating instructions of the machine provided by the machine manufacturer.

1.2 Target group

These operating instructions are intended to be used by *planning engineers*, *developers* and the *operators* of plant and systems which are to be protected by one or several safety systems in connection with the UE4400. These operating instructions should also be referenced by people who integrate the UE4400 into a machine/system, initialize its use, or who are in charge of servicing and maintaining the device.

1.3 Scope

Note These operating instructions are applicable to the UE4420, UE4427, UE4450, UE4455 and UE4457 with the following entry in the field *Operating Instructions* on the device type label: “8011217 / R987”

This document is part of SICK part number 8011217 (Operating Instructions “UE4420, UE4450, UE4455, UE4427 and UE4457 — IP67 Safety Remote I/Os and Safety Remote Controllers for DeviceNet Safety” in all available languages).

You will require version 3.5.0 (SP1) or higher of the CDS (Configuration & Diagnostic Software) in order to configure and diagnose these devices. To determine the version of your CDS software version, select the **Info…** option in the **?** menu.

1.4 Depth of information

These operating instructions contain the following information about the UE4400:

- installation and mounting
- electrical installation
- putting into operation and configuration
- integration into other safety systems (examples of circuits)
- care and maintenance
- fault, error diagnosis and troubleshooting
- part numbers
- conformity and approval

Planning and using protective devices such as the UE4400 also requires specific technical skills which may not be detailed in this documentation.

When operating the UE4400, the national, local and statutory rules and regulations must be observed.

General information on health and safety using active optical-electronic protective devices (AOPDs) is contained in the brochure "Safe Machines with opto-electronic protective devices" from SICK.

Note We also refer you to the SICK homepage on the Internet at www.sick.com.

Here you will find information on:

- sample applications
- a list of frequently asked questions about the UE4400
- these operating instructions for viewing and printing

1.5 Abbreviations and definitions

ADO Application Diagnostic Output = configurable signal output that indicates a specific device status (e.g. SICK C4000 safety light curtain).

AOPD Active Optical-Electronic Protective Device, e.g. SICK C4000 safety light curtain (see ESPE)

AOPDDR Active Optical-Electronic Protective Device with Diffuse Reflection, e.g. SICK S3000 safety laser scanner (see ESPE)

CDS SICK Configuration & Diagnostic Software = software for the configuration of the UE4400.

COS Change of State. A device configured to produce a change of state (COS) message will produce data whenever the data changes, or at a base heartbeat rate. This adjustable heartbeat rate provides a way for the consuming device to know that the producer is still alive and active.

EDS Electronic Data Sheet. An electronic file that provides device specific information used in the configuration of a device on to the DeviceNet/DeviceNet Safety network.

EDM External Device Monitoring. A feedback mechanism in which the state of an external device (e.g. contactor) is monitored and compared to the state of the output signal switching devices (OSSDs).

EFI Enhanced function interface = safe SICK device communication

EPI Expected Packet Interval. A parameter in DeviceNet and DeviceNet Safety that defines the frequency of data transmission between two network connections, e.g. devices.

ESPE Electro-sensitive protective equipment, e.g. SICK C4000 safety light curtain.

MAC ID Media Access Code Identifier = The address of a device on DeviceNet or DeviceNet Safety. Available MAC IDs range from 0-63. Each node on the network must have a unique MAC ID in order to function properly.

NC Normally closed contact (e.g. 2NC = 2 normally closed contacts)

NO Normally open contact (e.g. 2NO = 2 normally open contacts)

ODVA Open DeviceNet Vendor Association = A non-profit association of vendors established for the promotion of DeviceNet/DeviceNet Safety.

OSSD Output signal switching device (e.g. PNP semiconductor-based safety output)

PFD The Probability of Failure on Demand in accordance with the functional safety testing requirements outlined in IEC 61508.

PFH The Probability of Failure per Hour in accordance with the functional safety testing requirements outlined in IEC 61508.

SCID Safety Configuration Identifier (Also known as a configuration signature.) = The value of the SCID is a concatenation of the configuration CRC and a Time Stamp. The SCID is used to ensure that a DeviceNet Safety device has the expected configuration.

SDL Safety data link = SICK safety interface (connection of OSSDs and EFI) using devices such as SICK C4000 series safety light curtains or S3000 series safety laser scanners.

SIL Safety Integrity Level in accordance with IEC 61508 standard.

SNCT Safety Network Configuration Tool used for the configuration of DeviceNet Safety-capable devices (i.e. SICK DeviceNet Safety Configurator)

SNN Safety Network Number = A DeviceNet Safety attribute which allows for multiple virtual safety networks on a single physical network.

U_L Uninterrupted supply voltage for use by device logic, safety capable input circuitry (including test/signal outputs) and SDL connections.

U_S Interruptible (switchable) supply voltage for use by safety capable output circuitry.

1.6 Symbols used

Recommendation

Recommendations are designed to give you some assistance in your decision-making process with respect to a certain function or a technical measure.

Notes

Refer to notes for special features of the device.

○, ● Red, ☀ Red

LED symbols indicate the status of an LED on the UE4400:

○	The LED is off.
● **Red**	The LED turns red.
☀ **Red**	The LED flashes red.

8, 8 (flashing), L⇄2

Display indicators show the status of the 7-segment display on the S3000 or the C4000:

8	Constant display of characters, e.g. 8
8 (flashing)	Flashing display of characters, e.g. 8
L⇄2	Changing display of characters, e.g. L and 2

➢ Take action …

Instructions for taking action are shown by an arrow. Carefully read and follow the instructions for action.

WARNING

Warning!

A warning notice indicates an actual or potential risk or health hazard. They are designed to help you to prevent accidents.

Carefully read and follow the warning notices!

Software notes show the location in the CDS (Configuration & Diagnostic Software) where you can make the appropriate settings and adjustments.

Sender and receiver

In drawings and diagrams, symbol ⇥ denotes the sender and symbol ⇥| denotes the receiver of an electro-sensitive protective equipment (ESPE) (e.g. safety light curtain such as SICK C4000).

Trademark

DeviceNet is a registered trademark of the Open DeviceNet Vendor Association, Inc. (ODVA). Other product names and company names referenced in this manual are trademarks or registered trademarks of their respective companies.

2 On safety

This chapter deals with your own safety and the safety of the equipment operators.

➢ Please read this chapter carefully before starting to work with the UE4400 or with machinery that utilizes the UE4400 as part of the machine safeguarding strategy.

2.1 Qualified specialist personnel

The UE4400 and the components connected to it may only be assembled, operated and maintained by qualified specialist personnel. Qualified specialist personnel are defined as persons who …

- have undergone the appropriate technical training and are authorized and responsible to secure safety in each process of the design, installation, operation, maintenance services or disposition of the machine

and

- have been instructed by the machine manufacturer and the machine owner/operator in the operation of the machine and the current valid safety guidelines

and

- have access to the installation and operating instructions for the UE4400 and have familiarized themselves with them

and

- have access to the installation and operating instructions for protective devices (e.g. C4000 or S3000) connected to the UE4400 and have read and familiarized themselves with them.

Prior to the implementation of a UE4400, qualified specialist personnel should conduct a risk assessment on the machine to determine its suitability for the application.

2.2 Safety concept

The UE4400 devices have been third-party certified as safety-rated devices in accordance with the standards and testing criteria current at the time of certification. The safety tests consist of test routines that run during all operating phases of the device.

Applicable standards include, but are not limited to, the following:

- EN 954-1 (UE4400 supports applications to category 4)
- IEC 61 508 (UE4400 supports applications to SIL3)

In general, the UE4400 requires that all safety-relevant input devices have to indicate a normal run by “ON” state. The “OFF” state is considered to be the safe state.

All safety capable inputs and safety capable outputs should be set to **Inactive** when any fault has been detected at a safety capable input, test/signal output, safety capable output or during any safety trip condition.

2.2.1 Functional safety per IEC 61 508

Functional safety of electrical/electronic/programmable electronic (E/E/PE) safety-related devices is now guided by international standard IEC 61 508. Use of these devices involves identifying specific hazardous conditions that may lead to serious consequences and then establishing the maximum tolerable frequency.

IEC 61508 defines functional safety integrity targets for the maximum tolerable failure rate for each piece of equipment, based on that equipment's relative contribution to the hazard being considered. These "safety integrity levels" (SIL) fall into two classifications: Low demand mode of operation and high demand mode of operation. The following table defines the SIL levels for high demand mode of operation.

Tab. 1: SIL definition for high demand modes of operation

Safety integrity level	High demand mode of operation (probability of a dangerous failure per hour, e.g. PFH)
4	$\geq 10^{-9}$ to $< 10^{-8}$
3	$\geq 10^{-8}$ to $< 10^{-7}$
2	$\geq 10^{-7}$ to $< 10^{-6}$
1	$\geq 10^{-6}$ to $< 10^{-5}$

The UE4400 is certified as meeting SIL3 requirements in accordance with IEC 61508 part 1 for both low and high modes of operation.

2.2.2 Risk assessment

A risk assessment must be completed to determine the tasks and hazards associated with a machine and what methods are utilized to reduce or eliminate the hazards associated with each task. Standards and technical reports that describe the process of risk assessment include, but are not limited to, the following:

- ISO 14121 (EN 1050)
- ANSI/RIA R15.06
- ANSI B11.TR3

Risk assessment is an iterative process. After the safeguards used to mitigate the identified hazard are implemented, a new risk assessment must be completed. Residual risks may require additional risk reduction.

WARNING

Before the first commissioning, perform a risk assessment!

Consult your local, regional and national regulations/standards/technical reports for additional details regarding the performance of risk assessment and implementation of risk reduction requirements.

2.2.3 Hardware configuration

The UE4400 is designed to utilize safety-rated input devices that have "normally closed" contacts that indicate a normal run (e.g. ON) state. The OFF state (contact open when operated) is considered to be the safe state.

➢ To ensure safety-rated operation, use only SICK configuration software in conjunction with the corresponding SICK safety-rated device.

➢ Follow the specifications outlined in these operating instructions.

➢ Connect only equipment that can be isolated from the main power source.

WARNING

Never use hardware modules and software components that are not safety rated to carry out safety related task processing!

You may use hardware modules and software components that are not safety-rated to process non-safety-rated signals or to monitor (only) safety-rated signals.

2.2.4 Programming requirements

The UE4400 supports safety capable inputs, test/signal outputs, safety capable outputs and SICK SDL-capable devices. You may only use safety-relevant signals for implementing safety-relevant logic.

Since the UE4400 cannot determine whether standard devices or safety-relevant devices have been connected to the UE4400, the user of the device(s) (e.g. OEM, integrator or end-user) must be sure that the signals used in any safety-relevant control strategy are appropriate and correct.

For the configuration of the UE4400, several tools are available. You may choose to utilize:

- SICK Configuration and Diagnostic Software (CDS) for local device configuration via RS-232
- SICK Configuration and Diagnostic Software (CDS plug-in module for SICK DeviceNet Safety Configurator)

You may use only these SICK tools to configure the UE4400.

2.2.5 Communication

The UE4400 communicates via DeviceNet and DeviceNet Safety using a standard 5-pin MINI connector. See section 5.4 “DeviceNet Safety (MINI 5-pin connector, 7/8 inch)” on page 59 for additional information regarding this connection. Communication parameters will vary based on the type of connection that you prefer to define.

A key parameter of the connection definition is the expected packet interval (EPI). This parameter defines the frequency at which data will be transmitted or received between the UE4400 and a safety Originator device. Valid EPI values for the UE4400 are based on the following:

- Producing data assemblies (e.g. safety capable input assemblies) must be configured in 5 ms increments with a minimum configuration of 5 ms.
- Consuming data assemblies (e.g. safety capable output assemblies) may be configured in 1 ms increments with a minimum configuration of 5 ms.

Consult your safety network configuration tool (SNCT) manual for additional information regarding DeviceNet and DeviceNet Safety configuration parameters. You may specify a different value for the expected packet interval for each I/O connection.

WARNING

Sensor signals must be available for a minimum duration!

In order to guarantee accurate detection of connected sensor signal(s) by the UE4400, you must ensure that the connected sensor signal(s) pulse duration (e.g. off time) is equal to or greater than the configured expected packet interval (EPI) value for the related I/O communication connection (i.e. I/O assembly).

You must ensure that the data that is transmitted via DeviceNet Safety is suitable for your application logic!

Data that is transmitted from the UE4400 to a DeviceNet Safety Originator (e.g. Safety Master) is communicated via a safety rated protocol. It is the user’s responsibility to ensure that the data is utilized by the DeviceNet Safety Originator correctly. The DeviceNet Safety Originator cannot determine whether the device that is attached to the UE4400 is a standard device or a safety-rated device. Therefore, users must ensure that the data utilized for the relevant safety logic is suitable for their application.

2.2.6 Response time

It is imperative that all safety device(s) be implemented to prevent access to all hazards. A key factor in determining device location is the minimum safety distance.

Formulas that describe minimum safety distance vary based on device type, safeguard orientation, resolution, system response time, and more. Consult applicable machine standards and regulations for information regarding safety device implementation requirements.

The response time associated with the UE4400 is described in detail in section 11.2 "Response time" on page 176.

UE4427 and UE4457 devices also have fast shutoff capability to reduce the amount of response time required to turn off the safety capable outputs of the device. Additional information regarding this feature is described in section 3.6.5 "Fast shutoff of safety capable outputs" on page 36.

2.3 Applications of the device

The bus node UE4400 is a decentralized input/output module that allows for the integration of safety components into the DeviceNet Safety bus system via IP67 connection technology. It is certified in accordance with IEC 61508 to SIL3 and EN 954-1 to category 4.

The UE4400 may be used as a DeviceNet Safety Target device in connection with a SICK DeviceNet Safety UE4470 series safety network controller or other DeviceNet Safety Originator device.

The UE4400 may also be used as a DeviceNet slave device in connection with a third-party DeviceNet master device/controller.

The UE4427 and UE4457 also support safety-relevant logic internal to the device. Data from a DeviceNet master and a DeviceNet Safety Originator may also be incorporated into the logic internal to the UE4427 or UE4457.

Safety capable outputs must be controlled by DeviceNet Safety safety-rated devices.

WARNING

You are responsible for assuring that signals generated by any device that is connected to the UE4400 are suitable for associated logic elements!

Since non-safety-rated devices can be connected to the safety capable inputs or safety capable outputs of the UE4400, it is imperative that ...

- all safety capable input signals are suitable for the application when implemented in safety-relevant applications

and

- all safety capable output signals are suitable for the application when implemented in safety-relevant applications.

Verify that all signals generated by devices connected to the UE4400 are suitable for the logic elements associated with the safety-rated control elements or devices. Safety devices must satisfy the rating required for the application (e.g. a type 4 safety light curtain must be implemented to satisfy type 4 machine safeguarding requirements).

You are responsible for implementation of devices on the UE4400. Applications utilizing the UE4400 must meet regulatory requirements!

The UE4400 is suitable for safety-related applications in accordance with IEC 61508 up to Safety Integrity Level (SIL) 3 and up to category 4 in accordance with EN 954-1.

However, you are responsible for ensuring that all devices connected to the UE4400 are suitable for their intended purpose and that the logic, wiring, installation and implementation (including configuration, etc.) of these devices is in accordance with the application requirements, regulations (including local, regional and national) and standards.

2.4 Correct use

The bus node UE4400 must be used only as defined in chapter 2.3 "Applications of the device" on page 15. It must be used only by qualified personnel and only on the machine/ system where it has been installed and initialized by qualified personnel in accordance with these operating instructions.

If the device is used for any other purposes or modified in any way — also during mounting and installation — any warranty claim against SICK shall become void.

SICK shall not be responsible for conformity with any standards, codes or regulations that apply to the combination of products for the application or use of the product.

Upon request, SICK will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information, by itself, is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products.

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, and installation subject to separate industry or government regulations.
- Systems, machines and equipment that could present a risk to life or property.

The user must observe all prohibitions of use applicable to the products.

Before installing the UE4400, the user must ensure that

- the implementation is suitable for the application;
- the implementation addresses the hazards and risks associated with the application;
- units are properly rated and installed for the intended use within the overall equipment or system; and
- the devices that may be connected to this product comply with the product specifications and are in compliance with the applicable standards, rules and regulations of the countries where the product is used.

2.5 General safety notes and protective measures

WARNING

Pay attention to the safety notes!

Please observe the following procedures in order to ensure the correct and safe use of the bus node UE4400.

The local, national and international legislative provisions apply to the installation and use of the UE4400 and the safety components connected to it, e.g. a programmable safety-rated device, a safety light curtain or components with a contact output. These legislative provisions apply also to the commissioning and recurring technical examinations, in particular:

For North America:

- Regulations and requirements administrated by the Occupational Safety and Health Administration (OSHA). These include those regulations outlined in Title 29 of the Code of Federal Regulations Part 1910 Subpart O [29CFR1910 Subpart O].
- Ministry of Labour regulations (Canada)
- Other relevant health and safety regulations

For Europe:

- Machinery Directive 98/37/EEC
- Low Voltage Directive 73/23/EEC
- EMC Directive 89/336/EEC
- Work Equipment Directive 89/655/EEC
- Work safety regulations and safety rules
- other relevant health and safety regulations

For Japan:

- Article 42 of the Industrial Safety and Health Law
- Article 44 of the Industrial Safety and Health Law
- Other relevant health and safety regulations

Note "Type Test" requirements are provided in Article 44 of the Industrial Safety and Health Law. The requirements apply to complete systems and not specifically to a single component within the system. Use of components as a "safety device for press machines or shearing tool" in accordance with Article 42 of the Industrial Safety and Health law requires that the entire system be approved for that purpose.

The UE4400 has been third party certified as compliant with the following:

European Union (EU) legislation compliance

- Machinery Directive 98/37/EEC
- Low Voltage Directive 73/23/EEC
- EMC Directive 89/336/EEC

European standards compliance

- EN 61 508 (SIL1 through SIL3)
- EN 954-1 (category B through category 4)
- EN 61 131-2
- EN 418
- EN 60 204-1

International standards compliance

- IEC 61 508 (SIL1 through SIL3)
- IEC 61 131-2
- IEC 60 204-1
- IEC 61 000-6-2
- IEC 61 000-6-4
- IEC 62 061

North American standards compliance

- ANSI/RIA R15.06
- ANSI B11.19
- UL 508
- UL 1604
- CSA 22.1 No. 14
- CSA 22.2 No. 213

Open DeviceNet Vendor Association Compliance

- DeviceNet Conformance Test
- DeviceNet Safety Conformance Test

General requirements:

Users of the UE4400 (e.g. machine manufacturers and machine operators) are responsible for obtaining and observing all applicable safety regulations and rules.

- You must comply with these operating instructions (e.g. on use, mounting, installation or integration into the machine control system).
- You must also comply the test procedures in the operating instructions of all connected components.
- The testing of the components and overall system must be carried out by qualified personnel as defined in chapter 2.1 "Qualified specialist personnel" on page 11 that have been authorized to perform this function. Testing must be recorded and documented to ensure that the tests can be reconstructed and retraced at any time by third parties.
- The operating instructions must be made available to the personnel operating the machine in which the UE4400 has been implemented.
- The external voltage supply of the device must be capable of buffering brief power/voltage failures of 20 ms as specified in EN 60 204.
- When required by local standards or regulations (e.g. United States), power supplies that have been certifed for "use in class 2 circuits" must be utilized. Regardless of this requirement, current in excess of 8 A must not be allowed to flow in any conductor.

2.6 Environmental protection

The UE4400 is constructed to minimize adverse effects on the environment as much as possible. It uses only a minimum of power and natural resources. Always act in an environmentally responsible manner.

2.6.1 Disposal

Unusable or irreparable devices should always be disposed as per the applicable national regulations on waste disposal (e.g. European waste code 16 02 14). We would be pleased to be of assistance on the disposal of this device. Contact your local SICK representative.

2.6.2 Separation of materials

WARNING

Only appropriately trained personnel are allowed to separate materials!

Caution is required when dismantling devices. There is a risk of injuries.

Before you send the devices for appropriate recycling, it is necessary to separate the different materials in the UE4400. Separate the housing from the rest of the parts (in particular the circuit board). Send the separated parts for recycling as appropriate (see Tab. 2).

Tab. 2: Overview on disposal by components

Components		Recycling
Device	• Circuit boards, cable, connectors • Housing • Electrical connecting pieces	Electronic recycling
Packaging	• Cardboard, paper	Paper/cardboard recycling
	• Polyethylene packaging	Plastic recycling

2.7 Specification changes, errors and omissions

Product specifications and accessories may be changed from time to time based on product enhancements and other reasons. The information in this document has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.

Dimensions and weights presented in this document are nominal values.

3 Product description

This chapter contains information about the special properties of the UE4400 and describes the construction and operating principles of the device.

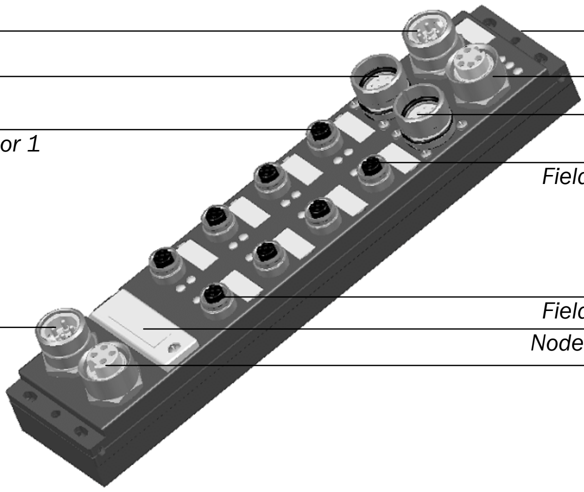
WARNING

Read and understand the installation and operation Instructions in this manual!

In order to properly implement the UE4400, it is imperative that personnel read and understand this chapter before mounting, installing or commissioning the UE4400 or any other safety devices connected to the UE4400.

3.1 Device construction

Fig. 1: Construction of the UE4400



Tab. 3: Connectors of the UE4400

Connector	Function
Auxiliary power In/ Auxiliary power Out	Common voltage supply for UE4400 and the safety components connected to the SDL and field signal connections
SDL connections	For connection of SICK safety devices to UE445x. Provides access to intelligent diagnostics and configuration parameters of SICK SDL-capable devices. Also may be used for OSSD safety capable inputs without intelligent diagnostics.
Field signal connectors 1 to 6	Safety capable inputs and test signal outputs (connector 1 also supports muting lamp monitoring functionality on Test output 1A)
Field signal connectors 7 + 8	Safety capable outputs (bipolar)
Serial port	To directly connect to a PC in order to configure the system using the SICK CDS.
DeviceNet In/ DeviceNet Out	Network connection according to DeviceNet specification

Please refer to chapter 11 “Technical specifications” on page 172 for the data sheet.
A dimensional drawing is included on page 181.

3.2 Operating principle of the device

3.2.1 DeviceNet overview

DeviceNet is a digital, multi-drop network that connects and serves as a communication network between industrial controllers and I/O devices. Each device and/or controller is a node on the network. DeviceNet is a producer-consumer network that supports multiple communication hierarchies and message prioritization. Systems can be configured to operate in a Master-Slave or distributed control architecture using peer-to-peer communication.

3.2.2 DeviceNet Safety overview

DeviceNet Safety is an extension of the DeviceNet protocol that incorporates safety-rated functionality into the DeviceNet network architecture. The DeviceNet Safety architecture allows for extreme flexibility on building complete automation systems, that include both standard and safety device applications. Designers now have the ability to decide which architecture best suits to the application requirements.

DeviceNet and DeviceNet Safety may be combined as a single network architecture or can be implemented separately. The design can even start with separate architecture, and later be upgraded on either side (standard or safety) to include new devices that will mix safety and standard applications.

DeviceNet Safety employs a variety of techniques to ensure a high data integrity level in accordance with IEC 61 508 SIL3.

Note User information about DeviceNet and DeviceNet Safety are available on the internet at the Open DeviceNet Vendor Association website at:

www.odva.org

3.2.3 The operating principle of the UE4400

The UE4400 is a DeviceNet Safety Target device. It processes electrical signals from the components connected and forms an internal process image based on the current signal states. Based on a safety I/O connection between the UE4400 and a DeviceNet Safety Originator device (e.g. safety-rated controller), the process image information is transmitted in an electronic message via DeviceNet Safety I/O protocol.

The DeviceNet Safety Originator takes the data from the electronic message and places it into its own input process image. The safety-rated controller performs safety-relevant data operations (e.g. logic) based on the input process image. The resultant data is then placed into an output process image that is transmitted back to the UE4400.

The UE4400 utilizes the data that was transmitted from the safety-rated controller by converting the new data into signals to the connected components, e.g. by …

- switching a safety capable output

or

- addressing specific functions of the connected safety devices (e.g. SICK SDL-compatible devices).

The following advantages are to be had by using the UE4400:

- Cost-savings on purchase: Standard components may coexist on the same physical media with DeviceNet Safety components without the need for special variants.
- Efficient use of DeviceNet Safety-capacity: Each UE4400 supports the configuration and evaluation of six dual-channel safety capable inputs, two dual-channel safety capable outputs, and up to twelve test/signal outputs using a single node address (MAC ID).

- SICK safety devices with SDL connectivity can be integrated directly onto the UE445x providing advanced diagnostics and configuration of ESPE/AOPD/AOPDDR devices without the need for separate node addresses.
- Field signal connections support both safety-rated and standard input and output signals (e.g. safety capable input and safety capable output).
- UE4427 and UE4457 devices also support safety-rated logic implementation internal to the device. This provides a shorter, deterministic (i.e. known) response time that does not rely on network communication. Additional signals from DeviceNet Master or DeviceNet Safety Originator devices may also be incorporated into the local logic of the UE4427 and UE4457 devices.
- The UE4427 and UE4457 devices may also be utilized in stand-alone mode (no DeviceNet or DeviceNet Safety communication). This mode may be utilized for safety-relevant control applications in which all safety sensors, safety actuators and associated controls (e.g. RESET, external device monitoring [EDM]) can be connected to the device. See chapter 3.6.6 “DeviceNet configuration” on page 41 for additional details.

3.3 Model designation overview

Tab. 4: Model designation overview

Model reference	Safety capable inputs	Safety capable outputs	Suppports in-ternal function block logic	SDL support
UE4420-03DC9F0	12 single (up to 6 dual) channels	2 dual channels	Not available	Not available
UE4427-03DC9F0			Yes	Not available
UE4450-03DC9F0			Not available	Monitoring only
UE4455-03DC9F0			Not available	Monitoring and control
UE4457-03DC9F0			Yes	

3.4 Properties of the UE4400

3.4.1 Common properties of the UE4400

- 8 × 2 field signal connections to connect active and passive safety components up to category 4 according to EN 954-1. Specific connections include:
  - 12 single-channel safety capable inputs (up to six (6) dual-channel),
  - Two (2) dual-channel safety capable bipolar outputs and 12 test/signal outputs
- Easy configuration and diagnosis with the aid of Windows-based CDS software (Configuration & Diagnostic Software) via RS-232c interface or via DeviceNet Safety using the CDS plug-in module for SICK DeviceNet Safety Configurator
- Offline configuration is possible.
- Support for DeviceNet Safety to IEC 61508 SIL3 and EN 954-1 category 4.
- Support for DeviceNet Group 2 slave Change of State (COS), Cyclic, Bitstrobe and Polled messages.

3.4.2 Properties of the UE4420

The UE4420 represents the basic function set which is outlined in the common features of all UE4400 variants.

3.4.3 Properties of the UE4427

The UE4427 extends the basic functionality of the UE4420 by supporting internal safety-rated logic programming. This allows users to utilize function block programming to implement safety-rated logic internal to the UE4427. Additional data may be incorporated from DeviceNet Master and DeviceNet Safety Originator devices via communication from those devices to the UE4427.

3.4.4 Properties of the UE4450

The UE4450 extends the basic functionality set of the UE4420 by supporting two additional connections to active SICK safety components (known as SDL connectors). The input data of the SICK safety components is made available on the DeviceNet Safety network. It is possible to configure and diagnose all components connected to the SDL connections via the configuration interface of the UE4450.

3.4.5 Properties of the UE4455

In terms of functionality the UE4455 corresponds to the UE4450 plus support for control of the SICK safety components on SDL via the network. Examples include changing user modes by sending appropriate data bits to the SDL device.

3.4.6 Properties of the UE4457

The UE4457 extends the basic functionality of the UE4455 by supporting internal safety-rated logic programming. This allows users to utilize function block programming to implement safety-rated logic internal to the UE4457. Additional data may be incorporated from DeviceNet Master and DeviceNet Safety Originator devices via communication from those devices to the UE4457.

3.5 Examples of range of use

The following overview lists examples of several possible uses of the UE4400 in connection with various safety components.

- Door unit:
  The combination of inputs and outputs of access protection units (e.g. C4000, S3000), signal lamps and status indicators, reset button, emergency stop button and door switch
- Muting applications:
  The combination of inputs and outputs of ESPE, muting sensors, muting lamp, swing doors, reset button, start, override, bypass, emergency stop
- Protecting turntables:
  The combination of inputs and outputs of access protection units (e.g. C4000, S3000), limit switches, locking devices and emergency stop button
- Safety Network Controller:
  A combination of inputs and outputs can be monitored by the SICK Safety Network Controller UE447x series for control strategies that use logical function block programming.
- UE4427 and UE4457 logic:
  Local safety inputs can be logically combined using safety-rated function blocks to control safety outputs. Additionally, information from standard programmable logic controllers (e.g. DeviceNet Master devices) and safety-rated programmable logic controllers (e.g. DeviceNet Safety Originator devices) can be incorporated into the local safety logic of the UE4427 and UE4457.

3.6 Hardware configuration

This section describes the hardware functions of the UE4400 which are selectable via software.

WARNING

Test the protective device after any changes!

The entire protective device must be tested for correct operation after each change of the configuration. Please observe the notes in chapter 9.1.3 “General acceptance of the UE4400” on page 155.

3.6.1 Configuration of safety capable inputs

Every safety capable input connector on the UE4400 has two (2) safety capable inputs, two (2) test/signal outputs, one (1) ground (GND) and one (1) functional earth (FE) connection. Safety capable inputs may be configured as outlined in Tab. 5.

Tab. 5: Safety input configuration parameters

Configuration parameter		Valid range of values	Description
Evaluation type	Single-channel	N/A	Generally, this is a Normally Closed (NC) contact with the exception of Reset and Bypass functionality et. al.
	Dual-channel equivalent		Only applicable for dual-channel applications. Both safety capable input signals must be equivalent. For **Active** (e.g. logical 1): A channel = 1 and B channel = 1 For **Inactive** (e.g. logical 0): A channel = 0 and B channel = 0
	Dual-channel complementary		Only applicable for dual-channel applications. Both safety capable input signals must be complementary. For **Active** (e.g. logical 1): A channel = 1 and B channel = 0 For **Inactive** (e.g. logical 0): A channel = 0 and B channel = 1
Signal processing parameters	Slope detection		Only applicable for single-channel configurations. Slope detection is used to evaluate a low to high input transition for a stuck at high condition. The reaction time of the input is delayed due to this additional evaluation. This configuration requires that a test signal be associated with the input.
	B channel reporting		The A channel of a dual-channel input **always** reflects the dual-channel evaluation value. When B channel reporting is enabled, the value of the B channel will also be published as part of the input assembly; otherwise, the value is always zero and the A channel only should be used for safety logic.
	OFF-ON input delay [ms]	0-635 ms in 5 ms increments	Delay between the detection of the signal change and the effective evaluation of the input signal.
	ON-OFF input delay [ms]	0-635 ms in 5 ms increments	Delay between the detection of the signal change and the effective evaluation of the input signal. This parameter directly affects the response time associated with minimum safety distance calculations!
	Discrepancy time	0 to 30,000 ms	When utilizing dual-channel input evaluation of a safety capable input, the discrepancy time is used to allow both input channels to reach a static state. Time delays supported are 0 to 30,000 ms. Additional information follows in this section.

WARNING

Make regular checks of the components fitted with contacts!

When connecting components with contacts to the UE4400, which are only occasionally activated, you must take organizational measures to safeguard that any fault in these components will be detected, e.g. by means of monthly manual checks (corresponds to category 4 according to EN 954-1).

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **I/O configuration**. To define a safety capable input configuration, first place the required input element next to the desired input. Then, double click on the input element you want to configure. When a safety capable input has been utilized as part of UE4427 or UE4457 logic configuration, the element will also be highlighted.

Input error latch time

The safety input error latch time is a global parameter that applies to all safety capable inputs. Any safety capable input error will be latched for this minimum amount of time. If the error is no longer present after the specified time has expired, the error condition may be reset by the module.

The safety input error latch time is specified to ensure that errors can be monitored through external polling of the status information. The default time for the safety input error latch time is 1000 ms, but may be configured by the user from 0 ms to 65,535 ms.

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **General**, **Input Error Latch Time**.

ON-OFF delay and OFF-ON delay

Several unintentional brief signal changes occur when opening or closing a component fitted with contacts as the result of contact bounce. To minimize the influence of contact bounce in the evaluation by the UE4400, you must set the input delay time longer than the bounce time of the components fitted with contacts. Input delay may be adjusted from 0 ms (**Inactive**) to 635 ms in 5 ms increments and is independently configurable for each safety capable input.

Note If you read in a contact without bounce time via the safety capable input, e.g. the switching output (OSSD) of a light grid/light curtain, you must set the input delay to **Inactive** in order to safeguard immediate signal processing.

WARNING

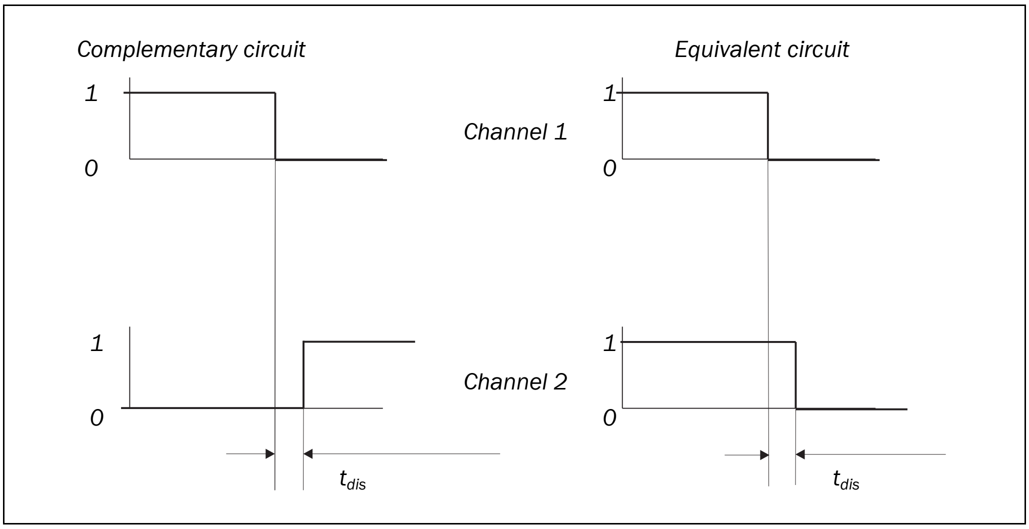
ON-OFF delay and OFF-ON delay affect device response time!

- When you specify an ON-OFF delay value for an input, it directly affects the response time associated with any safety distance calculation.
- When you specify an OFF-ON delay value for an input, it directly affects how the system responds during restart/reset conditions.

Discrepancy time

The discrepancy time t_{dis} is the maximum time in which both inputs of a dual-channel signal evaluation may be found in impermissible states without an error being generated.

Fig. 2: Discrepancy time



Monitoring of the discrepancy time starts with the first state change of the input. The UE4400 identifies an error if, after the discrepancy time has expired, both inputs of the connection …

- are not in equivalent (the same) states for equivalent circuit configuration.
- are not in complementary (opposite) states for complementary circuit configuration.

Notes

- When either input of a dual-channel evaluation changes from **Active** to **Inactive**, the UE4400 reports the change immediately. Therefore the discrepancy time does not affect the response time of the system for transitions from **Active** to **Inactive**.
- The UE4400 will not generate a discrepancy error when the discrepancy time is not monitored (e.g. the checkbox for **Discrepancy Time Monitoring Enabled** is not selected).

Tab. 6: Input signals and process image during discrepancy time monitoring when B-channel reporting is not enabled.

Dual-channel selection	Input signal			Before discrepancy time has expired			After discrepancy time has expired		
				Process image		Discrepancy time overrun diagnosis bit	Process image		Discrepancy time overrun diagnosis bit
	In A	In B	Status	In A	In B		In A	In B	
Equivalent	0	0	Inactive	0	0	0	0	0	0
	0	1	Discrepant	0	0	0	0	0	1
	1	0	Discrepant	0	0	0	0	0	1
	1	1	Active	1	0	0	1	0	0
Complementary	0	0	Discrepant	0	0	0	0	0	1
	0	1	Inactive	0	0	0	0	0	0
	1	0	Active	1	0	0	1	0	0
	1	1	Discrepant	0	0	0	0	0	1

Tab. 7: Input signals and process image during discrepancy time monitoring when B-channel reporting is enabled.

Dual-channel selection	Input signal			Before discrepancy time has expired			After discrepancy time has expired		
				Process image		Discrepancy time overrun diagnosis bit	Process image		Discrepancy time overrun diagnosis bit
	In A	In B	Status	In A	In B		In A	In B	
Equivalent	0	0	Inactive	0	0	0	0	0	0
	0	1	Discrepant	0	0	0	0	0	1
	1	0	Discrepant	0	0	0	0	0	1
	1	1	Active	1	1	0	1	1	0
Complementary	0	0	Discrepant	0	1	0	0	1	1
	0	1	Inactive	0	1	0	0	1	0
	1	0	Active	1	0	0	1	0	0
	1	1	Discrepant	0	1	0	0	1	1

Notes

- When either input of a dual-channel evaluation changes from **Inactive** to **Active**, the UE4400 waits for the discrepancy timer to complete the specified time before reporting the change to the UE4400 process image.
- When a safety capable input transitions from an **Active** state, it must reach an **Inactive** state (e.g. both channels of a dual-channel input must reach an **Inactive** state) before returning to the **Active** state.

- In order to clear a discrepancy-time error, you must reset both inputs to their **Inactive** state.
- Valid values for discrepancy time: Not monitored (e.g. checkbox for **Discrepancy Time Monitoring Enabled** is not selected), 10 ms, 50 ms, 100 ms, 200 ms, 300 ms, 500 ms, 750 ms, 1,000 ms, 2,000 ms, 3,000 ms, 5,000 ms, 10,000 ms, 20,000 ms and 30,000 ms.

The following bulleted items outline the specific behavior of safety capable input signals with regard to discrepancy time:

- **Safety capable input channel A goes from Inactive to Active.** Then safety capable input channel B must achieve **Active** state before the discrepancy time expires. When this condition is satisfied, the dual-channel value for the input pair will be **Active**. If the discrepancy time expires before both channels reach an **Active** state, the dual-channel value for the input pair will be **Inactive** (fault detected state) and will remain in a fault detected state until both channels return to **Inactive**. The converse is also true for safety capable input channel B.
- **Safety capable input channel A goes from Active to Inactive state.** The UE4400 immediately reports the **Inactive** state for the dual-channel evaluation to the process image. Subsequently, safety capable input channel B must achieve an **Inactive** state before the discrepancy time expires. If the discrepancy time expires before both channels reach an **Inactive** state, the dual-channel value for the input pair will be **Inactive** (fault detected state) and will remain in a fault detected state until both channels return to **Inactive**. The converse is also true for safety capable input channel B.

WARNING

Deactivate unused sections of the field signal connections!

If you are not using an input of a field signal connector, you must configure the safety capable input of the corresponding channel as **Not used**. No input element should be connected to the safety capable input connector.

If a signal is present on an input that is defined as **Not used**, the UE4400 may detect this as an error.

You must set discrepancy time in accordance with your application requirements!

When the checkbox for **Discrepancy Time Monitoring Enabled** is not selected (i.e. checked), one of the two signals that are evaluated may be discrepant indefinitely without an error being generated. However, both signals must become **Inactive** (e.g. logical “0”) before both signals may return to the **Active** state (e.g. logical “1”). If this sequence does not occur, the dual-channel evaluation will remain **Inactive** regardless of the current input state.

3.6.2 Test/signal output configuration parameters

Every safety capable input field signal connector supports two (2) test/signal outputs. Test/Signal outputs may be configured per the following table:

Tab. 8: Test/signal output parameter setting description

Parameter	Description	Type
Permanently on	Setting provides U_L (e.g. 24 V DC) power for sensors, pilot devices, etc …	Power supply
Permanently off	This is the setting that should be used when nothing is connected to this signal connection.	OFF
Remotely controlled	Output is used as a standard controller output signal	Signal output
Remotely controlled **plus** muting lamp monitoring	Available only on Channel A of connector 1. Provides current monitoring for muting lamp applications	Muting lamp output
Test signal for safety components fitted with contacts	Used as test signal source for safety devices, e.g. safety door interlock or an emergency stop button	Test/signal output
Test signal for safety components requiring long test gaps	Used as test signal source for safety devices, e.g. testable sensors such as IN4000. Additional parameters are described below	Test/signal output with long test gaps

Tab. 9: Additional test/signal output configuration parameters

Configuration parameter		Valid range of values	Description
Test/signal output with long test gap parameters	Test pulse time	10 to 1275 ms in 5 ms increments	That portion of the test pulse in which the resultant test/signal output is **Inactive**. The value must be greater than the test pulse delay time. See Fig. 3 “Long test gap principle” on page 31.
	Test pulse delay time	0 to 1275 ms in 5 ms increments	Defines the maximum delay time between the signal transition applied at the sensor test signal input and the corresponding transition at the signal switching output. Used to handle signal delays through sensor casacades. See Fig. 3 “Long test gap principle” on page 31.
Period		0 to 1275 ms in 5 ms increments	Used to define the overall long testgap period. The value must be greater than the test pulse time. See Fig. 3 “Long test gap principle” on page 31.

Note When a test/signal output is configured to be **Permanently on**, **Permanently off**, **Test signal for a safety capable input** or as **Test/signal output with long test gaps**, data that may be transmitted via an output assembly regarding the specific test/signal output will be ignored (see section 13.4 “UE4400 I/O assembly summary” on page 194 for additional information). In this case, no errors will be generated to the Originator connection.

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **I/O configuration**. To define test/signal output behavior, place the required output element next to the desired test/signal output (TOut). When a test/signal output has been utilized as part of UE4427 or UE4457 logic configuration, the element will be automatically generated on the I/O Configuration screen and highlighted.

Note When one or more test outputs or safety-capable outputs will be controlled using the logic capability of the UE4427 or UE4457, they must be first selected inside of the logic engine before additional configuration parameters can be accessed.

Use the device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **Logic Configuration** and select the output you wish to use by placing the output on the “canvas” and connecting it to the associated function block. Once this is completed, go back to the **I/O Configuration** tab and then double-click on the output to assign any additional configuration parameters.

Connection of a muting lamp

Safety capable input field signal connector 1 has fault monitoring capability in test/signal output TOutA. This can be used by the UE4400 e.g. to monitor the current consumption of a muting lamp. The error bit is set …

- in case of undercurrent due to a missed connection

or

- when the muting lamp is off

or

- when the test/signal output has an error (stuck at high).

Tab. 10: Monitoring the muting lamp status bit

Value of muting lamp status bit	Description
0	• An error has been detected by the test/signal output • The test/signal output has been set to **Inactive** (fault detected) values • The test/signal output is not configured as Remote output with muting lamp monitoring
1	Current is detected in accordance with the technical specifications (e.g. minimum 25 mA) of a test/signal output that is configured as Remote output with muting lamp monitoring.

The error bit must be evaluated in the safety rated controller logic using appropriate error handling to ensure integrity of the safety-relevant system.

Note The corresponding “muting lamp status bit” will report an error condition if the field signal connector 1 TOutA has NOT been configured for muting lamp output, e.g. as provided in **Instance 776 (0x308) Input assembly data attribute format** (see section 13.4 “UE4400 I/O assembly summary” on page 194 for additional details).

When current monitoring is enabled, permissible muting lamps include:

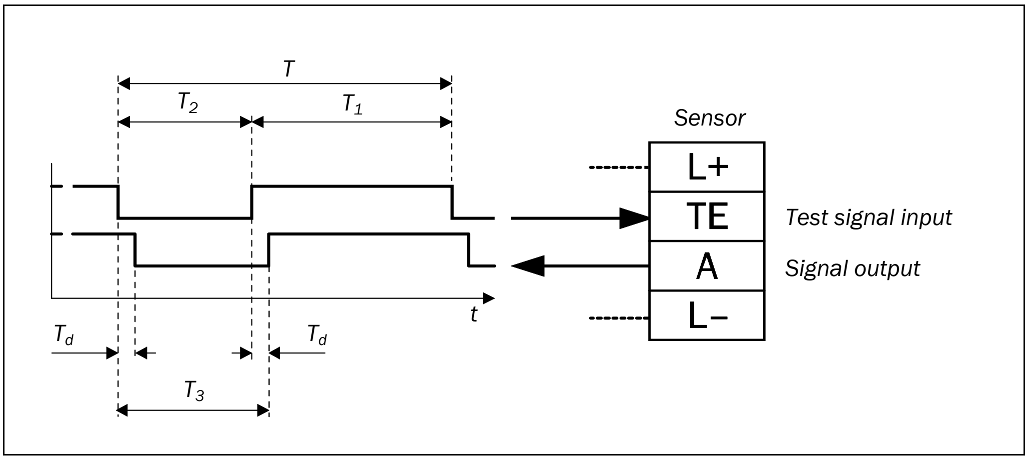
- SICK display lamp (part no. 2017768)
- SICK LED muting lamp (part no. 2019909)
- Lamp 24 V DC/1 W to 15 W rating

To activate fault monitoring, you must configure channel A of the field signal connector accordingly. Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **I/O configuration**. Select **Remote output with muting lamp monitoring** and place the element next to **TOut1A**.

Long test gaps for test/signal outputs

A number of safety relevant sensors require the use of specific test gap sequences to satisfy safety requirements. By implementing test/signal outputs with long test gaps, the specific test gap sequence can be defined.

Fig. 3: Long test gap principle

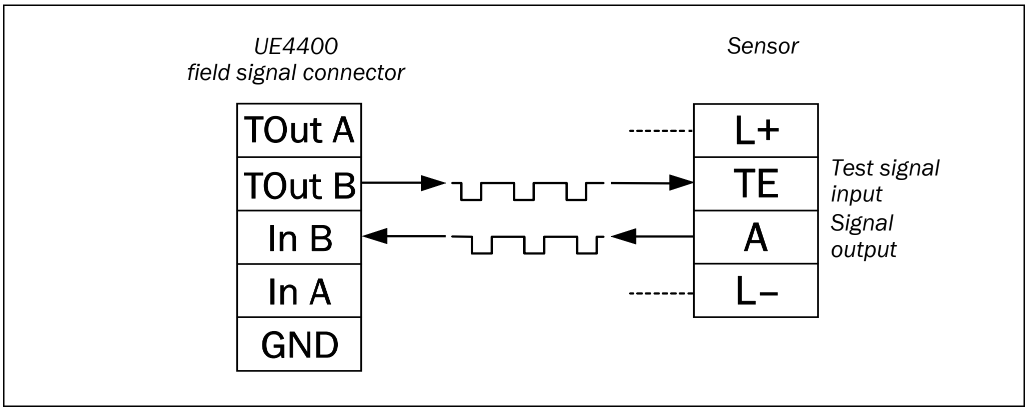


Usually, these safety relevant sensors have a test signal input and a signal switching output. A signal pattern is applied to the sensor test signal input that will be reflected by the sensor at its signal switching output during normal operation.

There is a small delay time (Td, see Fig. 3) between the signal transition applied at the sensor test signal input and the corresponding transition at signal switching output. This delay is known as the **Test pulse delay time**. The **Test pulse time** (T2) describes the period of time in which the applied test signal is **Inactive** (test gap). The **Period** (T) defines the length of time allowed for one complete test pulse sequence (i.e. time required from start at **Inactive** to end of **Active**).

Using UE4400 test/signal outputs with long test gaps

Fig. 4: Connecting UE4400 test/signal outputs with long test gaps



All UE4400 test/signal outputs may be configured individually with long test gaps. A safety capable input may be associated with each test/signal output for signal evaluation. In this case, the signal at the safety capable input is expected to follow the test/signal output signal pattern within the defined parameters.

When a test/signal output configured with long test gaps transitions to an **Inactive** state, the safety capable input monitors the corresponding output signal of the connected sensor to determine whether it transitions to **Inactive** as expected.

Shortly before the test pulse time (T2, see Fig. 3) has expired, the safety capable input signal at the associated safety capable input is checked.

- If the safety capable input signal is **Inactive** at that time, then the test was successful.

- If the safety capable input signal is **Active** at that time, then the test has failed and the safety capable input logical value will be set to **Inactive** (e.g. "0", fault detected).

A fault at the safety capable input will be held until the **Input error latch time** (see section 3.6.1 "Configuration of safety capable inputs" on page 25) has expired.

When the test/signal output configured with long test gaps transitions to the **Inactive** state, the associated safety capable input is not monitoring signal changes until the test pulse time (T2) plus the test pulse delay time (Td) have expired. This period is indicated as (T3) in Fig. 3. This directly affects the response time for the application. When safety capable inputs utilize test/signal outputs with long test gaps, the response time associated with the connected sensors must be calculated correctly. See section 11.2.1 "Response times associated with safety input devices that use test/signal outputs with long test gaps" on page 177.

The **Period** (T) is a global parameter for all test/signal outputs configured with long test gaps. The minimum value for the period must be greater than the value determined as defined in the following:

➢ Add all test pulse times (T2) for each test/signal output configured with long test gaps together.

You must ensure that the sensor is suitable for the period defined above (e.g. SICK IN4000 inductive safety sensors expect a period that is less than 500 ms). When connecting AOPD devices to safety capable inputs with test/signal outputs having long test gaps, the **Input OFF/ON delay time** parameter defined for the safety capable input must be ≥ 80 ms to fulfill minimum off time requirements within a network application.

Note If there are multiple test/signal outputs configured with long test gaps, the lowest test pulse time (T2) value within this group of outputs must be at least 10 ms greater than the largest test pulse delay time (Td) value within this group of outputs.

Test/signal outputs may be configured with long test gaps or standard test gaps. Both test/signal output configurations may coexist in the same application. All configurable parameters such as **Period**, **Test pulse time** and **Delay time** apply to test/signal outputs with long test gaps only. For the normal test gap specification see section 11 "Technical specifications" on page 172.

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **I/O configuration**. Test/signal outputs with long test gaps are configured by placing the element **Test/signal output with Long test gaps** next to the associated test/signal output. The **Delay time** and **Test pulse time** parameters are accessed by double-clicking on the element. The **Period** information is located under device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **General** and should be configured to match device application requirements.

WARNING

Deactivate unused sections of the field signal connections!

If you are not using an output of a field signal connection, you must configure the output of the corresponding channel to **Permanently off** by not connecting any elements to the test/signal outputs.

If a signal is present on an output configured as **Permanently off**, the UE4400 may detect this as an error.

Short circuits to test/signal outputs may cause permanent damage to the UE4400 or unexpected device behavior!

- Short circuits to test/signal outputs which exceed the U_L (i.e. power available for internal logic, test/signal outputs and SDL inputs) specifications of the UE4400 may cause permanent damage to the test/signal outputs on the UE4400.
- A power supply short to test/signal outputs having a simultaneous short of the input supply will also cause damage to the test/signal outputs on the UE4400.
- Do not connect U_L to U_S if you switch off U_S (i.e. power available for safety capable outputs) using a circuit interrupt switch to control the current and voltage provided to the safety capable outputs. This connection must be excluded by separating and protecting the associated cabling.
- When a test/signal output is configured for **Permanently on**, and a short circuit occurs with an external power source, the fault may not be detected. Always ensure that the associated cabling is protected and that this fault condition cannot occur!

You must verify that the test/signal output behavior in CRITICAL FAULT is suitable for your application!

When the UE4400 transitions to CRITICAL FAULT, the test pulses will retain their last values when the test/signal outputs are configured as **Permanently on** or as **Remotely Controlled**. Make sure that this behavior is suitable for your application.

When configured for remote signalling, use test/signal outputs for components not relevant to safety!

The test/signal outputs of the safety capable input field signal connections are not permitted for use with switching of safety-rated devices. These test/signal outputs should only be used for devices such as control lamps, e.g. *Reset required* or to supply power to sensors etc.

Short circuits between test/signal outputs with standard test pulses and long test gaps must be prevented!

Organizational measures must be implemented to prevent short circuits between short (standard) test pulses and test pulses with long test gaps. Measures include wiring these signals separately or using protective cabling.

3.6.3 Configuration of safety capable bipolar outputs

The UE4400 supports two (2) dual-channel bipolar safety capable outputs. Safety capable outputs may be configured as indicated in the following table:

Tab. 11: Safety output configuration parameters

Parameter	Description
Permanently off	This is the default setting and should be used when no devices are connected.
Remotely controlled with test signals	Safety-rated or safety controller output signal in which test signals are included during the **Active** state.
Remotely controlled without test signals	Safety-rated or safety controller output signal in which test signals are not included during the **Active** state.

Notes

- When a safety capable output has been configured as **Permanently Off**, any attempt to control this output via an Originator connection will be ignored. No error will be generated back via the connection.
- When U_S is interrupted (e.g. set to 0 V DC) and then is restored (e.g. returns to 24 V DC), the safety capable outputs must receive a valid **Inactive** I/O message (e.g. OFF) before they are allowed to transition to **Active** (e.g. ON).
- To turn the safety capable outputs ON or OFF, it is mandatory to set both safety capable output control bits (e.g. SOut7A and SOut7B) to an equivalent value. Any complementary control leads to a safety capable output error condition.
- After any safety capable output fault has been cleared, the safety capable outputs must receive a valid **Inactive** state I/O message (e.g. OFF) before they are allowed to transition to an **Active** state (e.g. ON).

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **I/O configuration**. To define safety capable bipolar output behavior, place the required remote safety capable output element next to the desired safety capable bipolar output (SOut). When a bipolar safety capable output has been utilized as part of UE4427 or UE4457 logic configuration, the element will be automatically generated on the I/O Configuration screen and highlighted.

Note When one or more test outputs or safety-capable outputs will be controlled using the logic capability of the UE4427 or UE4457, they must be first selected inside of the logic engine before additional configuration parameters can be accessed.

Use the device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **Logic Configuration** and select the output you wish to use by placing the output on the “canvas” and connecting it to the associated function block. Once this is completed, go back to the **I/O Configuration** tab and then double-click on the output to assign any additional configuration parameters.

Output error latch time

The output error latch time is a global parameter that applies to all safety capable outputs and test/signal outputs. Any output error will be latched for this minimum amount of time. If the error is no longer present after this time, the error condition may be reset by the module. The output error latch time is specified to ensure that errors can be monitored through external polling of the status information.

The default time for the output error latch time is 1,000 ms, but may be configured by the user from 0 ms to 65,535 ms.

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **General**, **Output Error Latch Time**.

WARNING

Deactivate unused sections of the field signal connections!

If you are not using a safety capable output field signal connection, you must configure the safety capable output of the corresponding channel to **Permanently off** by not connecting any output element to the safety output in the **UE4400 device window** under the **I/O configuration** tab.

If a signal is detected on a safety capable output that has been configured as **Not used** (e.g. an element is not associated with the safety capable output), the UE4400 may detect this as an error condition.

You must ensure correct safety category is implemented for your application!

Disabling the test pulses on the safety outputs (e.g. selecting the bipolar outputs as remotely controlled without test signals) is only allowed in certain applications. In this case, the resulting safety category (e.g. safety category 3 or 4) depends on failure detection ensured by sufficient cyclic operation of the outputs or other means.

Complete proof test interval requirements periodically!

Periodically verify that the safety functions are operating in accordance with the application requirements, regulations and standards (e.g. proof test) to maintain the reliability of the safety functions (e.g. monthly).

3.6.4 Stand-alone operation

Stand-alone operation allows you to implement logic control internal to device types UE4427 or UE4457 without a DeviceNet or DeviceNet Safety network connection. This feature is used when all safety-relevant signals can be implemented on the device itself (e.g. safety input devices, safety actuators, reset, restart, external device monitoring feedback [EDM]). In this case, the UE4427 or UE4457 acts as the safety controller for the application.

When using stand-alone mode, the UE4427 or UE4457 …

- does not recognize a MAC ID switch change,
- does not recognize DeviceNet power loss,
- does not establish any DeviceNet connection (neither safety nor standard),
- does not respond to any explicit messages via DeviceNet or DeviceNet Safety,
- does not enter bus-off state associated with the DeviceNet or DeviceNet Safety network.

When the UE4427 or UE4457 is configured to run in stand-alone mode, Auto Execution Mode is also required for the device to enter the EXECUTING state. Otherwise the device remains in the IDLE state and will not perform any logic or signal management.

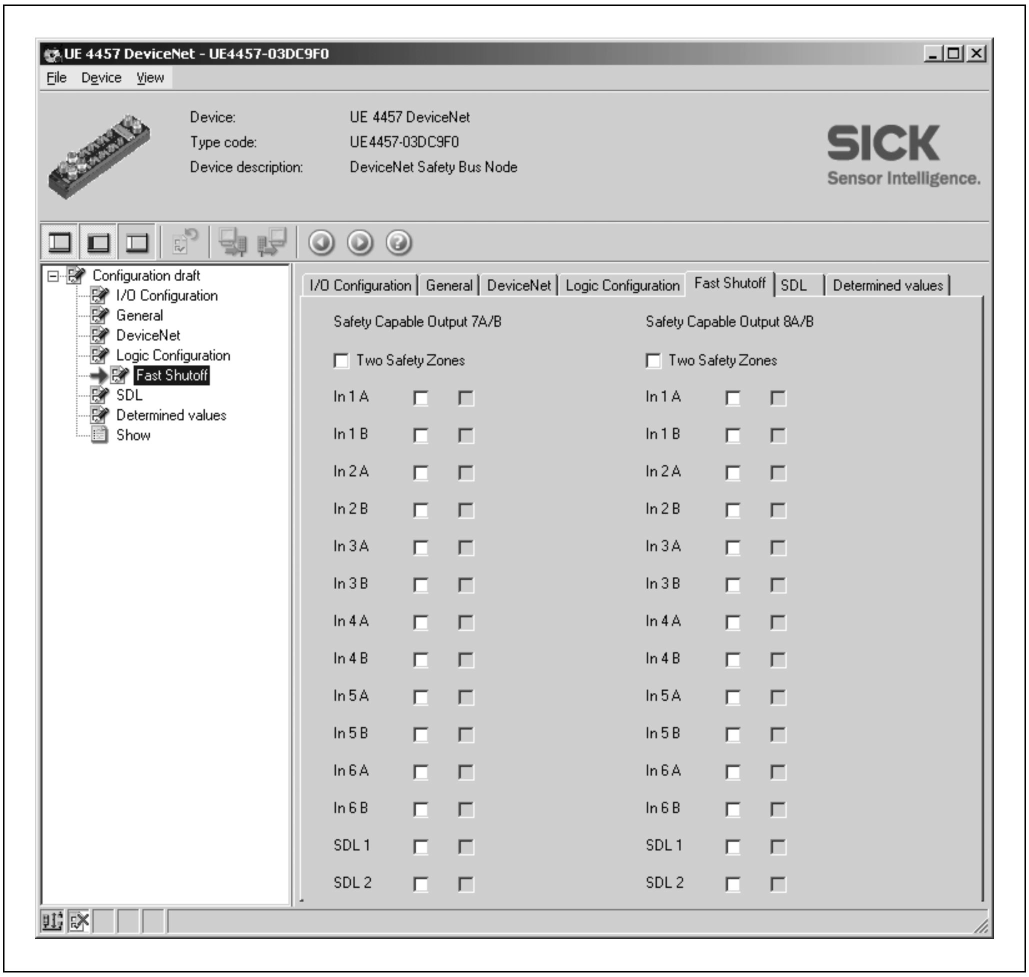
No communication is available via DeviceNet or DeviceNet Safety during stand-alone operation.

To configure the UE4400 for stand-alone operation and auto execution mode, select device symbol **UE4400 DeviceNet**, context menu **Open device window**, **General** tab and select or deselect the corresponding checkboxes.

3.6.5 Fast shutoff of safety capable outputs

In order to minimize response times associated with safety capable inputs and safety capable outputs connected to the UE4427 or UE4457, including logic implementation, special fast shutoff functionality has been incorporated into the device. As shown in the figure below, separate fast shutoff functions are available for each safety capable output.

Fig. 5: Fast shutoff configuration screen

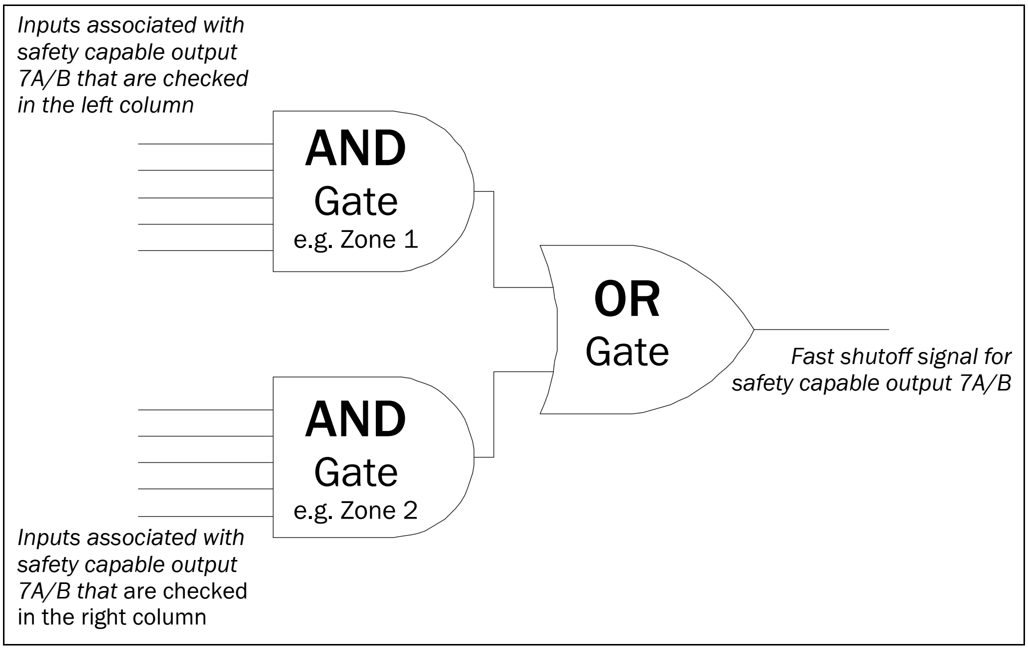


The Fast shutoff configuration checkboxes are:

- Selection of the number of safe zones that will be monitored (one or two)
- Selection of which safety capable inputs will be monitored for each safety zone

There are two columns of safety capable inputs available for each safety capable output. Each column is independent of the other. The selected safety capable inputs (i.e. checked inputs) from a single column are combined using an AND function. If two safety zones are monitored, the second column associated with the safety capable output is monitored with the first column using an OR function.

Fig. 6: Fast shutoff logic for two safety zones



When the UE4427 or UE4457 detects that one of the safety capable inputs that is configured for fast shutoff function transitions from **Active** to **Inactive**, or enters an error state, it will immediately turn off the associated safety capable output. The UE4427 or UE4457 does not recognize this **Active** to **Inactive** transition until the expiration of any configured ON-OFF input delay time at the safety capable input.

The safety capable output may only be switched **Active** again if the following two conditions are satisfied:

- The safety capable inputs which caused the fast shutoff have all returned to an **Active** state in which no errors are detected; and
- The control (e.g. internal logic or DeviceNet Safety Originator communication) of the safety capable output transitions the safety capable output to an **Inactive** state normally.

Notes Fast shutoff is only available in the UE4427 and UE4457.

This functionality only supports safety capable inputs that have a “high” **Active** signal. Only high **Active** signals and the **Active** to **Inactive** transition will lead to a fast shutoff of the UE4427 or UE4457.

Safety capable inputs must be configured in order to utilize the fast shutoff function. When a safety capable input has been selected for fast shutoff, but has not been configured, a plausibility error will occur when attempting to download the configuration to the UE4427 or UE4457.

See chapter 11 “Technical specifications” on page 172 for additional information regarding the response times associated with the fast shutoff function in the UE4427 or UE4457.

Application example

The following application example illustrates how the user may benefit from two safety zones that are configured for fast shutoff function.

In a manual loading station, the movement of the robotic arm is the hazardous motion that must stop when the operator enters the safeguarded area. In this example there is a C4000 series safety light curtain (Sensor 1) installed to detect the presence of an operator in the safeguarded area. The position of the robot is monitored by another safety device (Sensor 2).

When the robot is operating away from the load station, the operator may enter the safeguarded area and place the part into a fixture. When the operator is clear of the fixture and the part is detected (i.e. present), the robot can pick up the part from the fixture and perform any necessary operation on the part.

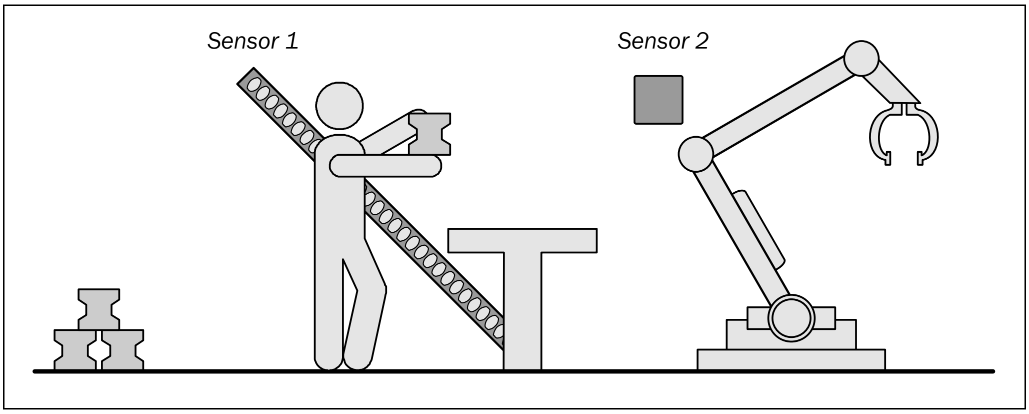
With the OR gate (see Fig. 6 "Fast shutoff logic for two safety zones" on page 37) of the fast shutoff, the system continues to run normally as the safety condition would be met when either the operator is clear of the safeguarded area OR the robot is operating outside of the safeguarded area.

Zone 1 = Sensor 1 e.g. SICK C4000 series safety light curtain

Zone 2 = Sensor 2 e.g. SICK IN4000 inductive safety sensors

Step 1: The operator places a part into the loading station.

Fig. 7: Application example with 2 safety zones, step 1

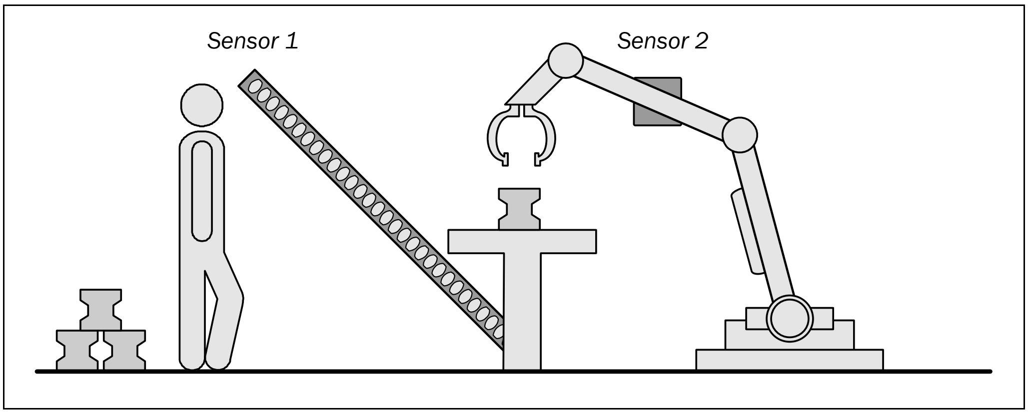


Tab. 12: Truth table for step 1

Sensor 1	Sensor 2
0	1

Step 2: The operator steps out of the safeguarded area. The robot starts to process the material.

Fig. 8: Application example with 2 safety zones, step 2



Tab. 13: Truth table for step 2

Sensor 1	Sensor 2
1	0

Step 3: The operator steps back into the safeguarded area. **The hazardous motion needs to be stopped**.

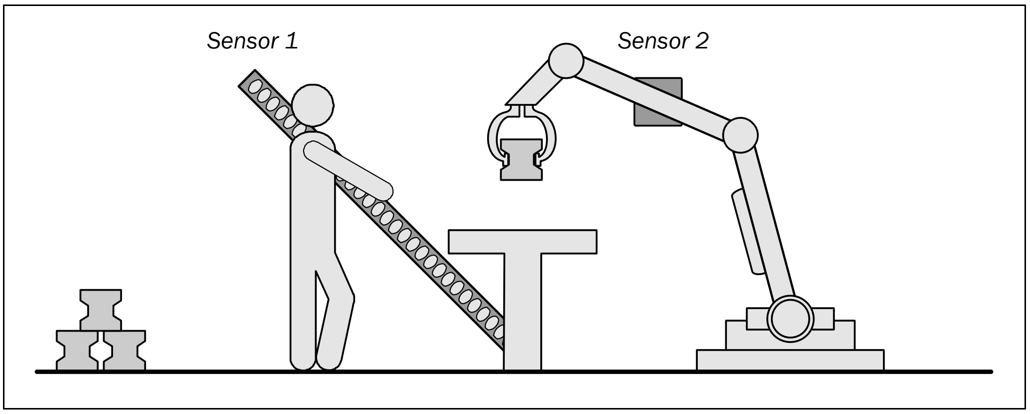


Fig. 9: Application example with 2 safety zones, step 3

Tab. 14: Truth table for step 3

Sensor 1	Sensor 2
0	0

Step 4: The operator steps out of the safeguarded area. After a valid Reset/Restart sequence the robot continues to work on the part again.

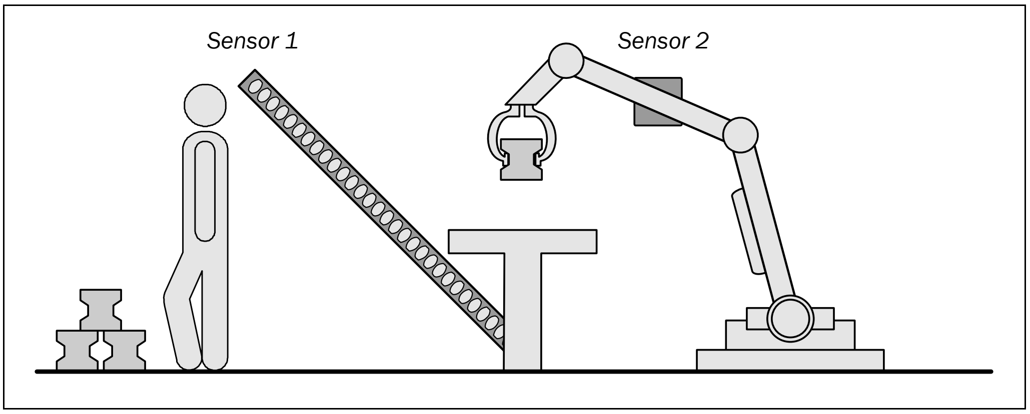


Fig. 10: Application example with 2 safety zones, step 4

Tab. 15: Truth table for step 4

Sensor 1	Sensor 2
1	0

Step 5: The operator is still out of the safeguarded area. The robot is back to its initial position and the sequence starts with step 1 again.

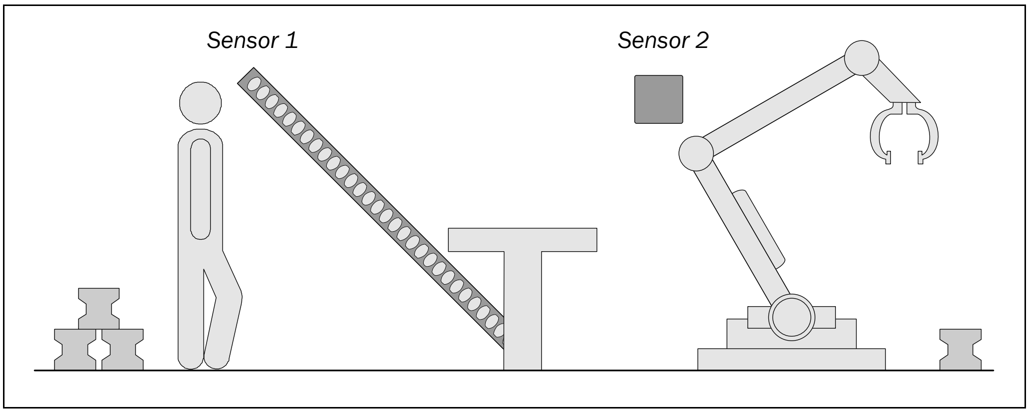


Fig. 11: Application example with 2 safety zones, step 5

Tab. 16: Truth table for step 5

Sensor 1	Sensor 2
1	1

The overall truth table, which is a OR truth table, looks like this:

Tab. 17: Overall truth table

Sensor 1	Sensor 2	Motion
0	1	Go
1	0	Go
0	0	Stop
1	1	Go

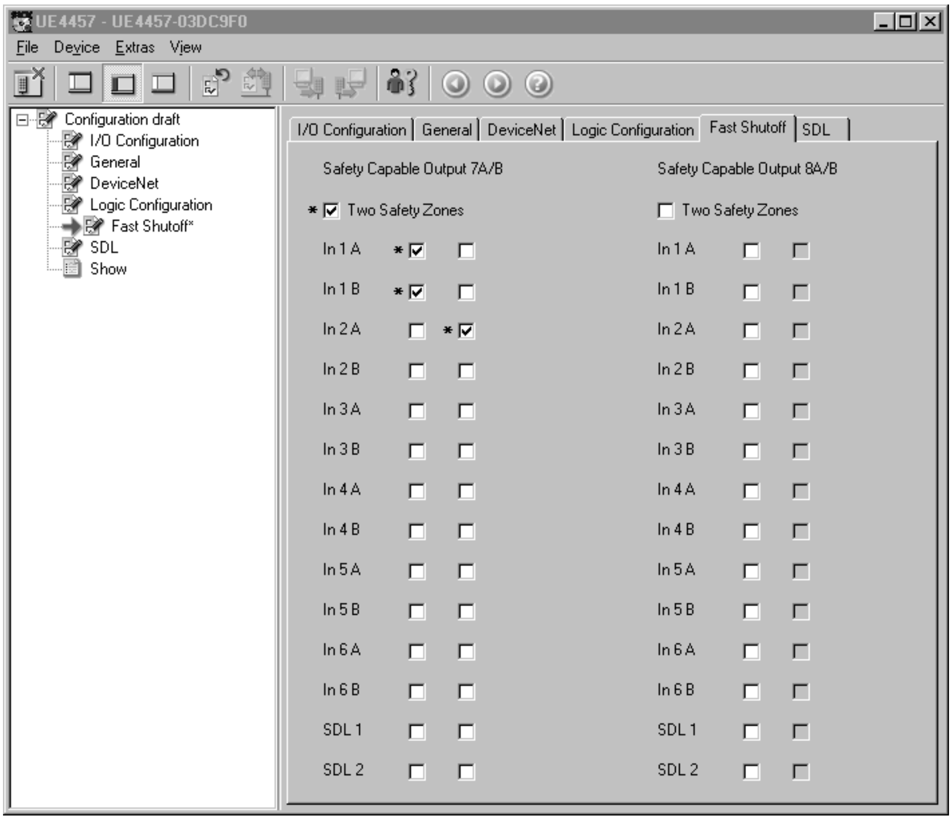
The configuration for this application presumes that the two safety devices are connected to field signal input connectors 1 and 2.

- The C4000 series safety light curtain is connected to safety capable input 1A/1B and configured as a dual-channel equivalent input.
- The IN4000 inductive safety sensor is connected to safety capable input 2A and configured as a single-channel input with an associated test/signal output configured with long test gaps.
- The robot stop signal is controlled by the safety capable output at field signal connector 7A/B.

Additional information regarding test/signal outputs with long test gaps is described in section 3.6.2 "Test/signal output configuration parameters" on page 29ff.

Connection of the IN4000 inductive safety sensor is described in section 6.6 "IN4000 inductive safety sensor" on page 66.

Fig. 12: Fast Shutoff configuration in CDS based on the application example



Note The control functionality associated with this application example also requires that logic is either configured in the UE44x7 device or in an associated DeviceNet Safety safety-rated controller (i.e. Originator device) that is in communication with the UE4400. The logic required for e.g. reset functionality and control falls outside the scope of discussion for this application.

Additional safety devices may be added to each safety zone by incorporating the associated safety capable input signals into the AND function of the fast shutoff. The result of the AND function may be considered what was previously named "Sensor 1" resp. "Sensor 2". The AND functionality is implemented by checking safety capable inputs in each column. The inputs checked in one column are handled independently of the other column.

If a safety sensor affects both zones simultaneously (e.g. emergency stop), the safety capable input should be checked in both columns. If any device is configured for dual-channel operation, only the "A" channel of the safety capable input should be checked as this represents the result of the dual-channel evaluation.

It is important to note that other sensors associated with this application (e.g. position switches, etc.) may also be connected to the UE4400. Values associated with these devices may be communicated via either standard DeviceNet or DeviceNet Safety. The safety relevant control may be implemented in UE44x7 devices allowing for integration of automation control by a standard PLC. Alternately, when communication is not based on the DeviceNet, it is also possible to use a gateway device (e.g. DeviceNet to Profibus) to transmit and receive standard signals.

Note The I/O configuration must be completed for inputs that have been specified to utilize fast shutoff functionality. Incomplete safety capable input configuration will result in a failure when the configuration is downloaded to the device.

To configure the fast shutoff functionality in the UE4400, select device symbol **UE4400 DeviceNet**, context menu **Open device window**, **Fast Shutoff** tab and select or deselect the corresponding checkboxes.

3.6.6 DeviceNet configuration

MAC ID

The Media Access Code Identifier (MAC ID) represents the node address of a DeviceNet or DeviceNet Safety device. By design, nodes in a DeviceNet system are responsible for managing their own identifiers. The MAC ID values range from 0 to 63.

Since lower numbered nodes generally have higher priority, it is advisable to allocate safety-rated components with the lowest MAC ID available. By DeviceNet definition, all devices have MAC ID = 63 as the out of the box default. MAC ID values can be changed via the rotary switches located on the UE4400. If the switches are set to a value greater than 63, the MAC ID is software configured via a network configuration tool or via SICK CDS.

Baud rate/communication speed

The UE4400 supports the following communication rates:

- 125 kBit/second (default setting)
- 250 kBit/second
- 500 kBit/second
- Autobaud detection (attempts communication at each baud rate to determine network baud rate communication setting)

To configure the MAC ID value and/or the communication rate (i.e. baud rate) via software control, select device symbol **UE4400 DeviceNet**, context menu **Open device window**, **DeviceNet**. Enter a valid value (e.g. 0 to 63) in the MAC ID and/or the communication rate (i.e. baud rate) text field.

3.6.7 SDL configuration (UE445x only)

The SDL connection contains safe SICK enhanced function interface (EFI) device communication, two inputs for OSSDs and the voltage supply for the connected sensor. The connections are suitable for e.g. C4000 series safety light curtain receiver units, M4000 Advanced multiple light beam safety device receiver units, S3000 series safety laser scanners and S300 Advanced/Professional series safety laser scanners.

SDL device information may be monitored via the DeviceNet/DeviceNet Safety network using UE445x devices. In addition, UE4455 and UE4457 devices allow information to be written to devices connected at the SDL inputs. This information may be determined by local logic function (i.e. values determined in the UE4457 logic) or by a remote safety controller (e.g. DeviceNet Safety communication).

When using a C4000 safety light curtain, the entry on the type label in the field *Software version* of the safety light curtain must be “3.00” or higher in order to be able to read the OSSD status at the SDL connection.

Within the UE445x documentation and software, the following terminology applies to signals in association with SDL:

- A signal from SDL to any other recepient is called a “**SDL output signal**”.

  SDL output signals may be used as **input to a** (safety) network controller. These SDL output signals are communicated via the “**SDL input assembly**”.

  SDL output signals may be used as **input to** the local UE4457 logic. This is why the SDL output signals can be found on the Logic Editor “**Input**” tab sheet along with the local safety capable input signals or remote input signals.

- A Signal from any (safety) device to a SDL device is called a “**SDL input signal**”.

  SDL input signals can be controlled by an **output from** a (safety) network controller. These SDL inputs are controlled via “**SDL output assembly**”.

  SDL input signals can be controlled by logic results (= outputs) of the local UE4457 logic. This is why the SDL input signals can be found on the Logic Editor “**Output**” tab sheet along with the local safety capable output signals or remote output signals.

Check for SDL device identification/configuration

When configuring the SDL devices, UE445x devices monitor the configuration parameters associated with the connected device. The following parameters are monitored:

- Device type key
- Device serial number
- Device configuration time/date stamp

Once a SDL device has been configured, the UE445x checks for the SDL device parameters outlined above when the UE445x or the SDL device powers up. Once a mismatch is detected, all SDL input information will be set to **Inactive** state as well as that the data sent to the SDL device will be marked as invalid. In this case, the UE445x diagnostics page in the CDS shows which part of the device verification failed.

Device symbol **UE4400 DeviceNet**, context menu **Diagnostics**, context menu **Show**, section **SDL x Diagnostic Information**, line **SDL device identity verification**.

For applications in which a replacement device might be necessary, the user may choose to ignore the serial number and configuration time/date stamp by checking the corresponding checkbox in the CDS.

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **SDL**.

For applications in which the exact device type key, serial number and configuration time/date stamp is required, make sure that the corresponding checkboxes remain unchecked.

SDL input control

With UE4455 and UE4457 devices, SDL inputs can be controlled via EFI. This means that ...

- a safety controller,
- local safety capable input signals,
- logic results (UE4457 only)

can control SDL input signals.

SDL output assemblies provide remote access to SDL inputs for a safety network controller (see chapter 13.4 “UE4400 I/O assembly summary” on page 194). Respective input configuration in the CDS provides local access to SDL inputs, where logic results can be written to SDL inputs within the UE4457 logic editor.

Note Configuration of local control will supersede remote access to a single SDL input. A combination of remote and local access is possible for different SDL inputs.

When using SDL devices (e.g. C4000 safety light curtains, S3000 safety laserscanners, M4000 multiple light beam safety devices) with a UE4455 or UE4457 Remote I/O device, you must either:

- Implement an I/O assembly to establish a connection between the DeviceNet Safety controller and the corresponding SDL output assemblies; or
- Disable this functionality: Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **SDL**. There, select the corresponding **Network Access (write) to SDLx Disabled**.

Failure to perform one of these options will result in passivation (i.e. inactive status) of the SDL device, since remote access to the SDL input is the default configuration: The UE4455/UE4457 expects SDL input data from the network. Passivation of an SDL device is indicated by P on the 7-segment display of the SDL device.

These two options do not apply when the device is used in standalone operation. In this case, none of these two actions has to be taken.

WARNING

Do not use pre-evaluated signals for logical values associated with SDL devices!

SICK SDL-capable devices evaluate all signals that are utilized as logical inputs. It is imperative that these signals are not pre-evaluated e.g. as published values that represent a fault-detected state. In this case, these pre-evaluated signals may lead to unexpected operation of the SDL device. Make sure that each bit communicated to an SDL device directly or via DeviceNet/DeviceNet Safety is the actual value and does not represent pre-evaluated signals.

Hardware OSSD

The OSSD value at an SDL connection may be read in two ways:

- Via the safe SICK device communication: Devices with safe SICK device communication transfer the OSSD status to the UE4400 as software information.
- Directly via the OSSD inputs as “hardware OSSDs”: This means that there is no additional processing time necessary for safe SICK device communication. This decreases the amount of time necessary to transmit OSSD values via DeviceNet Safety.

The method that should be utilized is based on configuration of the UE4400.

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **SDL**, activate or deactivate **HW OSSD on SDL1** or **HW OSSD on SDL2**.

Notes

- The way in which the UE4400 reads the OSSD status influences the system response time (see section 11.2 “Response time” on page 176).
- When a device is connected to the SDL connector that does not support SICK EFI communication, you may elect to monitor the hardware OSSDs only. When monitoring the SDL input assembly, only the OSSD information will be available (see section 13.5 “I/O assemblies” on page 196 for additional information). All other information will be set to **Inactive** values.
- Standard device cables are available for direct connection of the device to the SDL connector. Refer to section 12.2 “UE4400 series bus node accessories” on page 182 for additional information.

Using SDL input and SDL output signals in the logic editor (UE4457 only)

SDL output signals can be used within the local UE4457 logic application.

When a signal from SDL shall be integrated within the logic application of the UE4457, use device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **Logic Configuration** and select the SDL output signal (from the **Input** tab tree view) you wish to use by placing the output on the “canvas” and connecting it to the associated function block input. Once this is completed, back on the **I/O Configuration** tab, an element will be connected to the SDL output, indicating that this output is used within the logic.

SDL input signals (signals to SDL) can be controlled by the local UE4457 logic application.

When the logic application of the UE4457 shall control a SDL input signal, use device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **Logic Configuration** and select the SDL input signal (from the **Output** tab tree view) you wish to use by placing the input on the “canvas” and connecting it to the associated function block output. Once this is completed, back on the **I/O Configuration** tab, an element will be connected to the SDL input, indicating that this input is used within the logic.

Notes

- The SDL output which has been used within the logic application can still be used to control a local UE4457 test output.
- The SDL input which is written by the logic result can not be accessed by any other device neither remotely nor by a local UE4457 input.

All I/O elements which do appear in the I/O configuration when the SDL I/O is used within the logic application can not be removed in the **I/O Configuration** tab, but have to be deleted within the logic editor where they have been placed e.g. used before.

Use device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **Logic Configuration** and select the SDL input or SDL output, do a right click on the element, select delete and acknowledge the notification window.

WARNING

Do not use pre-evaluated signals for logical values associated with SDL devices!

SICK SDL-capable devices evaluate all signals that are utilized as logical inputs. It is imperative that these signals are not pre-evaluated e.g. as published values that represent a fault-detected state. In this case, these pre-evaluated signals may lead to unexpected operation of the SDL device. Make sure that each bit communicated to an SDL device directly or via DeviceNet/DeviceNet Safety is the actual value and does not represent pre-evaluated signals.

Verify correct use of SDL signals within logic application after SDL configuration has changed!

When changes to the configuration of devices connected to SDL connectors on UE445x devices, ensure that any logic that utilizes information related to SDL connections continues to satisfy application requirements as well as local, regional and national regulations.

Note When connecting a SICK Enhanced Function Interface (EFI) gateway (e.g. UE4140, UE1140, UE1840 or UE1940) to the UE445x SDL connector, you must connect the EFI 1 connector of the gateway to the corresponding EFI communication pins on the UE445x SDL 1 connector. In this case, the information from the SDL 2 connector on the UE445x cannot be monitored by the gateway. Consult your local SICK representative for availability of this feature.

3.7 Selection principles

This chapter is intended for production engineers who need information about the electronic interfaces and their internal circuitry to realize their applications.

3.7.1 Safety capable input field signal connections

You may use the field signal inputs to read the status of the following types of outputs that supply electrical power:

- contacts at 24 V DC, e.g. from components with contact outputs that are driven by an allocated test signal output
- tested 24 V DC PNP semiconductor switching outputs, e.g. from SICK FGS, MSL, C2000/M2000, C4000, PLS, S3000, among others
- untested 24 V DC PNP semiconductor switching outputs, e.g. photoelectric switches

Properties

- 6 × 2 safety capable field signal inputs
- 6 × 2 test/signal outputs
- test/signal outputs utilize electrical power from U_L
- Electrical characteristic according to IEC 61 131-2
- Suppression diode is integrated into the UE4400. No external freewheeling diode is required in the case of an inductive load. At full load (700 mA) and switching frequency of 2 Hz the load inductance must not be above 1.5 H.
- ● **Yellow** [A LED/B LED] indicates that input voltage is present at safety capable input (In A/In B respectively)
- ● **Red** [A LED/B LED] indicates that there is an overload at the test/signal output (TOutA/TOutB respectively)

Notes

- If you only use the test/signal outputs to provide electrical power, it is permitted to switch TOutA/TOutB in parallel, in order to double output power (e.g. switching pins 1 and 5 in parallel)
- Only test/signal output (TOutA) on field signal connector 1 is suitable for muting lamp fault monitoring.

Possible error detection on safety capable inputs

Integrated safety mechanisms ensure detection of

- internal errors on safety capable inputs which prevent the inputs from returning to the safe state. An internal error on a safety capable input is a failure of the UE4400 electrical input circuitry,
- discrepancy in case of dual-channel input evaluation (see section Discrepancy time on page 26 for additional information).

When the safety capable input has been configured to be tested by a TOut (A/B) of the UE4400 and the contact between safety capable input and TOut (A/B) is closed, the UE4400 is capable of detecting the following error conditions:

- cross-circuit between safety capable input and a TOut (A/B) which has not been associated to the input during configuration
- stuck at 24 V DC
- short circuit to 0 V DC

WARNING

Reading test/signal outputs safely

Additional measures must be made to address any external errors that cannot be monitored internally by the UE4400. In addition, you must exclude any external errors that could occur due to selected user configuration parameters.

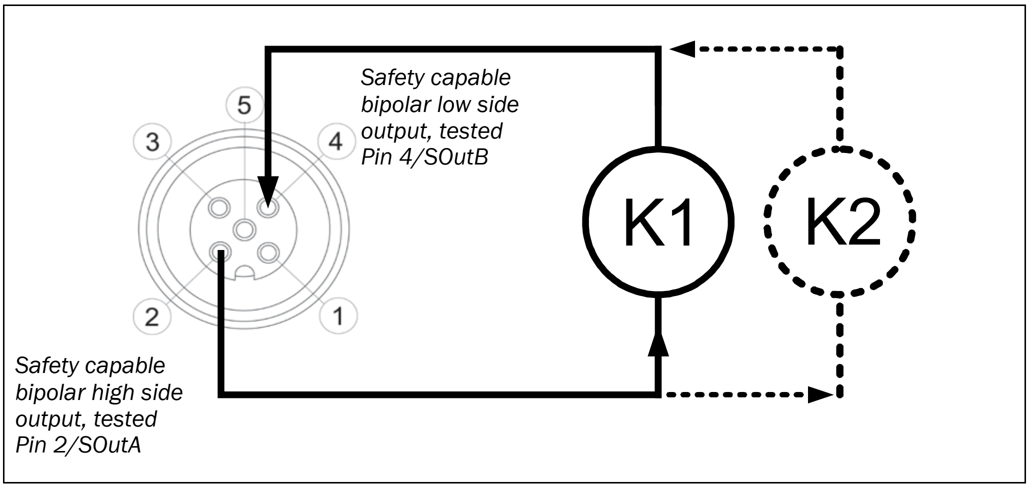
3.7.2 Safety capable output field signal connections

The safety capable output field signal connections are suitable for connecting:

- Safety actuators with current requirements less than 2 A (48 W)
- Standard actuators with current requirements less than 2 A (48 W)

Safety capable outputs are bipolar type circuits consisting of two semiconductor-based paths (P-Switch/N-Switch) as shown in the figure below.

Fig. 13: Safety capable bipolar example where K1 represents the Actuator 1 control coil (e.g. Load 1) and K2 represents the Actuator 2 control coil (e.g. Load 2)



Properties

- 2 × dual-channel bipolar type safety capable outputs — connectors 7 & 8 only
- output utilizes electrical power from U_S
- short circuit detection and overcurrent protection for the connected load

● **Red** [A LED] — Error detected at high-side (e.g. P-switch) or low-side (e.g. N-switch) of safety capable output

● **Yellow** [B LED] — Safety capable output **Active** (ON)

WARNING

Safety capable output connections must be dual-channel bipolar type!

Safety capable outputs are dual-channel bipolar type and cannot be separated into two separate single-channel outputs. The P-switch side cannot be used separately from the N-switch (e.g. using the P-switch from two bipolar safety outputs as a dual-channel "P-switch" shall be not be implemented under any circumstance).

Make regular checks of the components fitted with contacts!

When connecting components with contacts to the UE4400, which are only occasionally activated, you must take organizational measures to safeguard that any fault in these components will be detected, e.g. by means of monthly manual checks (corresponds to category 4 according to EN 954-1).

Check the response time of the protective device!

You must take all response times into account when determining the effective system response time for minimum safety distance and other calculations (see section 11.2 "Response time" on page 176).

Verify that signals and associated safety logic for safety outputs are correct!

Signals and any associated logic that are used to control the safety capable outputs should be suitable for that purpose. Verify that the system performs as expected and that all safety-relevant signals and the associated control logic are correct.

You must connect safety outputs correctly!

In order for safety outputs to operate correctly, you must connect the device that is being controlled as shown in Fig. 13. Connection directly to 24 V DC or to 0 V DC is strictly prohibited.

The electrical connection to the safety capable output field signal connections is described in section 5.3 "Field signal connectors (M12 × 5 + FE)" on page 57.

3.7.3 SDL connections (model UE445x only)

You may utilize the two (2) SDL connectors to connect SICK safety devices, e.g. C4000 series safety light curtain receivers, M4000 Advanced multiple light beam safety device receivers, S3000 series safety laser scanners or S300 Advanced/Professional safety laser scanners. These connectors provide access to configuration of SDL-capable devices. Device status is available to provide users with troubleshooting and diagnostic information.

Properties

- 2 × SDL connectors M23 11-pin + FE
- Connector utilizes electrical power from U_L

● **Red**	Overload display for the power supply output
☼ **Red**	Device communication error at the SDL connection
● **Yellow**	OSSD from connected device **Active**

Possible error detection

The self-test in the UE4400 detects when an OSSD input cannot return to a safe state due to an internal error. Furthermore, the UE4400 can identify the discrepancy of the OSSD inputs.

Reading data safely

The OSSD inputs on the SDL connections enable the 24 V DC PNP-semiconductor outputs of a self-monitoring sensor to be read safely. The sensor itself must detect any error conditions that may occur with its switching outputs with the aid of test signals and execute a safe shutdown of the switching outputs if any error is detected. The OSSD inputs of the UE4400 filter these test signals out again.

WARNING

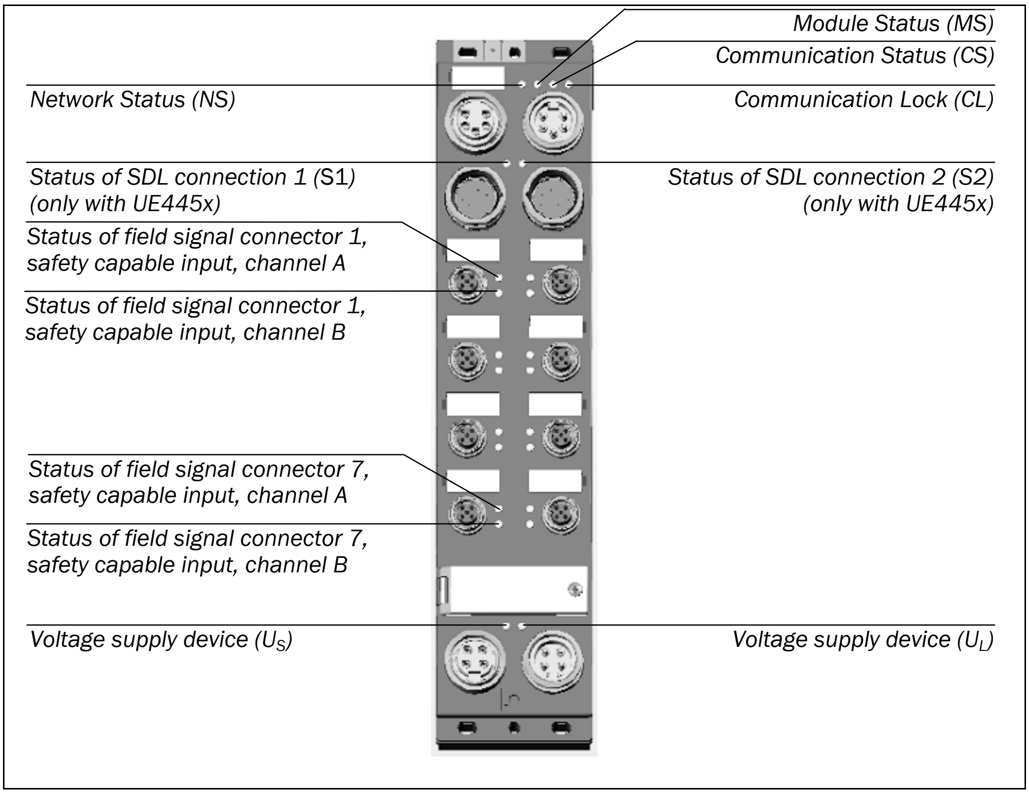
Reading safety capable inputs safely

Additional measures must be made to address any external errors that cannot be monitored internally by the UE4400. In addition, you must exclude any external errors that could occur due to selected user configuration parameters.

3.8 Status indicators

The UE4400 has multicolor operational status indicators for Module Status (MS), Network Status (NS), Communication Status (CS), Configuration Lock (CL), Power Supply Status (U_S and U_L), SDL connection status and individual channel A and channel B input/output field signal connection status. Take note of the displays of the connected devices when the device is operational.

Fig. 14: Status indicators of the UE4400



Tab. 18: Status indicators of the UE4400

Display		**Meaning**
U_S	○	Not powered — no U_S supply voltage to device
	● **Red**	Measured voltage out of operational range
	● **Green**	Voltage supply o.k. (in nominal range)
U_L	○	Not powered — no U_L supply voltage to device
	● **Red**	Measured voltage out of operational range
	● **Green**	Voltage supply o.k. (in nominal range)
Communication status (CS)	○	No activity detected
	☀ **Yellow**	Receiving/transmitting data
Configuration. lock (CL)	○	Invalid configuration
	● **Yellow**	Locked valid configuration. Configuration is successfully applied, validated, verified and locked
	☀ **Yellow**	Unlocked valid configuration. Configuration is successfully applied, validated, verified, but not locked
Module status (MS)	○	There is no power applied to the device
	● **Green**	The device is in EXECUTING state (i.e. the device is operating normally)
	☀ **Green**	The device is in the IDLE state
	☀ **Red**	The device is in ABORT state (i.e. the device has detected a recoverable fault)
	● **Red**	The device is in CRITICAL FAULT state (i.e. the device has an unrecoverable fault and may need to be replaced)
	☀ **Red/ Green**	The device is in SELFTEST state or CONFIGURING state or is WAITING_FOR_TUNID
Network status (NS)	○	The device is not on-line. The device has not completed the duplicate MAC ID test or it may not be powered.
	● **Green**	The device is on-line and has connections in the established state.
	☀ **Green**	The device is on-line, but has no valid standard or safety connections in the established state.
	☀ **Red**	One or more standard or safety connections are in an error state
	● **Red**	Failed communication. The device has detected an error that has rendered it incapable of communicating on the network (e.g. busoff condition or duplicate MAC ID detected).
	☀ **Red/ Green**	Waiting for TUNID
Safety capable input channels A and B (connectors 1-6)	● **Red**	The device has detected an error in the I/O circuit
	● **Yellow**	Safety capable input **Active**
	○	Safety capable input **Inactive**, test/signal output status is normal

Display		**Meaning**
Safety capable output channel A (connectors 7 & 8)	● **Red**	Error detected at the safety capable bipolar output circuit (high or low side)
	○	No errors detected.
Safety capable output channel B (connectors 7 & 8)	● **Yellow**	Safety capable bipolar output **Active** (high side only is monitored)
	○	Safety capable bipolar output **Inactive** or no power to safety capable bipolar output (U_S)
SDL connectors 1 and 2	● **Yellow**	Both switching outputs (OSSD1 and OSSD2) of the connected device are **Active**
	● **Red**	Voltage supply overload at the SDL connection
	☀ **Red**	Device communication error at the SDL connection
	○	Device communication at connection SDL1 or SDL2 is normal. The switching outputs (OSSD) of the connected device are **Inactive**. Or, no SDL devices are configured or installed

4 Installation and mounting

This chapter describes the preparation and completion of the installation of the UE4400. The installation and mounting requires two steps:

- selection of a suitable installation location
- mounting with the aid of four mounting screws (not contained in the delivery)

4.1 Selecting the installation location

The UE4400 supports decentralized functionality within network applications. Suitable installation/assembly locations include the following characteristics:

- Provides a flat assembly surface to avoid housing distortion
- Location does not endanger the user when inspecting UE4400 diagnostic LEDs
- Supports effective prevention of removal or breakage of connecting wires by personnel or equipment;
- Supports minimum time, cost and labor effort in case of device replacement
- Does not have excessive vibration, shock, temperature or air humidity in accordance with specification limits outlined in section 11.1 “Data sheet” on page 172
- Supports short distances for wiring to all connected components
- Supports adequate clearance for cabling, e.g. auxiliary power supply cables, SDL cables and field signal connection cables (see section 11.3 “Dimensional drawings” on page 181).

4.2 Mounting the device

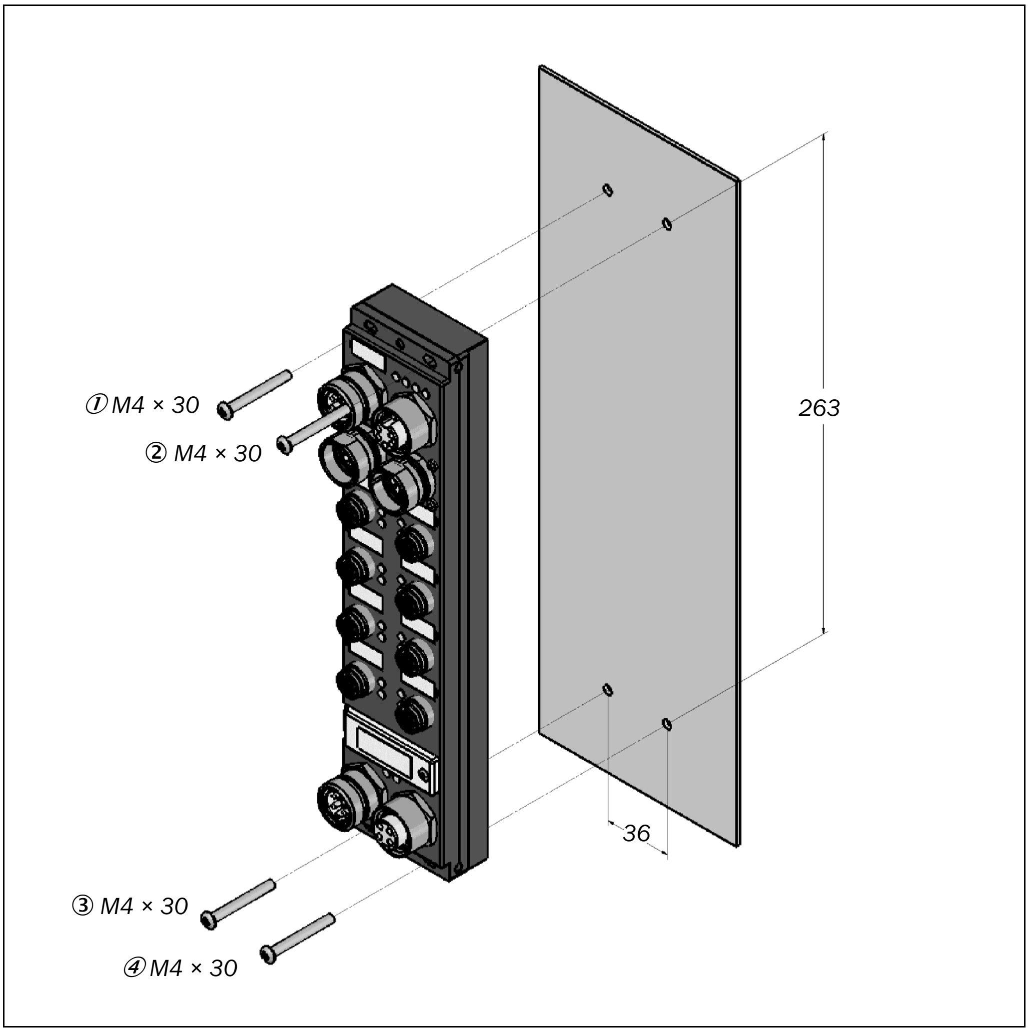
WARNING

Protect the device from being tampered with!

➢ Take suitable measures to ensure that the device cannot be tampered with and that any objects or persons passing by the device cannot damage any connections.

Suitable measures may include: Installation of a protective hood to cover the device and connections or tamper-proof covers over the individual connectors (see section 12.2 “UE4400 series bus node accessories” on page 182).

Fig. 15: Installing the UE4400 (dimensions in mm)



5 Electrical installation

WARNING

Make sure that connection of the UE4400 cannot lead to hazardous situations during installation!

Ensure that connections to the UE4400 cannot lead to a hazardous situation when implementing the unit on to the DeviceNet/DeviceNet Safety network. Prevention of the unintended start-up of equipment during connection of the UE4400 and associated input and output devices is necessary. This may require locking out the machine power. The user must assure that all field signal connections are configured and connected properly.

Notes

- The UE4400 meets the interference suppression requirements (EMC) for industrial use (interference suppression class A). When used in residential areas it can cause interference.
- EMC levels for the UE4400 are in compliance with IEC 61 131-2.
- To safeguard the resistance to disruptions, functional earth FE must be connected.
- The device is configured for protection class III. The voltage supply must satisfy safety extra-low voltage (SELV) requirements[1)].
- The external voltage supply must be capable of buffering brief power voltage failures of 20 ms as specified in EN 60 204[1)].
- When using the UE4400 in accordance with the requirements in UL 508, the power supply must permit “use in class-2 circuits”. Based on satisfying the class 2 criteria, no current may be allowed to flow that is > 8 A (i.e. 4 A on U_L and 4 A on U_S).
- Generally, it is only permitted to make any connection when the power supply is switched off. The connection of the local RS-232 configuration cable, however, may be connected/disconnected while the system is under power.
- Always protect unused connections by using the protective caps which can be obtained as accessories (see section 12.2 “UE4400 series bus node accessories” on page 182). The UE4400 only complies with IP 67 enclosure rating and electromagnetic compatibility (EMC) requirements when …

  – proper cabling has been utilized for connection of field signal devices

  and

  – protective caps are installed on unused connections.

WARNING

Protective covers must be in place to maintain IP67 enclosure integrity!

In order to maintain IP67 enclosure rating the following steps must be implemented:

- Make sure that the cover over the rotary MAC ID switches and RS-232 connector is secured in place.
- Cover all unused connections with protective caps (see section 12.2 “UE4400 series bus node accessories” on page 182). The shipping covers supplied with the UE4400 on the DeviceNet (Safety) and auxiliary power connectors must be replaced with the corresponding protective caps for unused connections.

1) SICK PS50W-24V (24 V DC, 2.1 A output; part number 7028089) and SICK PS95W-24V (24 V DC, 3.9 A output; part number 7028090) series power supplies satisfy the SELV, PELV, Class II, cULus, CE and power buffering requirements indicated above.

If you operate several devices on the UE4400 or use a separate power supply for connected devices, you must prevent earth and/or ground circuits (i.e. ground loops) from occurring as the result of the connection.

WARNING

Test the wiring after any activities have been carried out on the UE4400!

Because the UE4400 has several connections of a similar structural nature, these may result in incorrect wiring, for example if two connection plugs have been connected in reverse to what is expected.

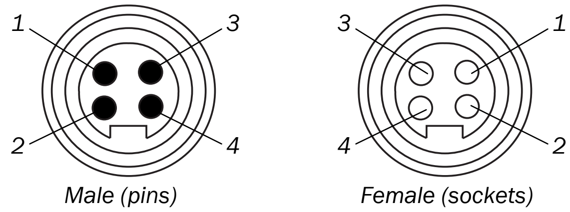
- Mark all connecting wires and connection plugs uniquely to avoid confusion.
- Test to verify that the wiring is still connected correctly after any maintenance or other activities have been carried out on the UE4400.

5.1 Auxiliary power (MINI 4-pin connector, 7/8 inch)

Notes

- The input auxiliary power connector is a sealed MINI-C 7/8" male 4-pin receptacle per CENELEC EN 50 044.
- The output auxiliary power connector is a sealed MINI-C 7/8" female 4-pin receptacle per CENELEC EN 50 044.
- When Class 2 power supply requirements must be adhered to, ensure that the maximum power consumption of the UE4400, including all connected components, does not exceed 4 A at U_S and 4 A at U_L.
- For installations when Class 2 power is not utilized, safeguard external power supplies of the UE4400 using a 10 A fuse (maximum) and limit maximum current to 8 A total for U_L and U_S.
- To satisfy electomagnetic compatibility (EMC) requirements (e.g. immunity), connect functional earth using the auxiliary power connection as well as by the local connection located above the DeviceNet (Safety) connectors.

Fig. 16: Power-supply pin assignment (7/8" connector)



Tab. 19: Power-supply pin assignment (7/8" connector)

CENELEC EN 50 044 Pin	Signal name	Function	Comment
1	U_S	Switchable 24 V DC	Supplies power to safety capable output circuitry.
2	U_L	Uninterrupted 24 V DC	Supplies power to internal logic, safety capable inputs, test/signal outputs and SDL circuits.
3	FE	Functional earth	Connection required to satisfy electromagnetic compatiblity (EMC) requirements.
4	GND	0 V DC common	U_S and U_L common (ground)
Connector housing	FE	Functional earth	Connection required to satisfy electromagnetic immunity requirements.

WARNING

Before connecting auxiliary power, verify that the proper voltages are present!

The UE4400 requires the use of an auxiliary power source for safety capable inputs and test/signal outputs as well as safety capable outputs. U_S and U_L should not exceed 28.8 V DC with respect to Common and FE.

Under certain conditions, externally switching U_S power may not remove power from U_S!

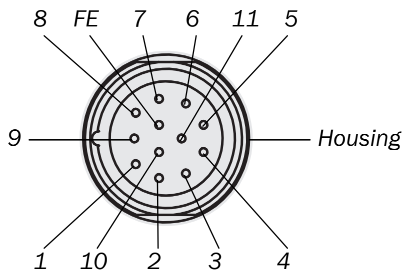
Short circuits from external power sources to U_S can cause power to be available even though U_S has been switched off. In order to ensure that the bipolar safety capable outputs have been de-energized by switching off U_S power, a failure mode and effects analysis (FMEA) must be performed to ensure that no external short circuits to 24 V DC are possible to the bipolar safety capable outputs or to the U_S power source itself.

5.2 SDL connections (M23 × 11 + FE) (UE445x only)

The UE4450, UE4455 and UE4457 have two SDL connections. The SDL connections are provided to connect SICK safety components with safe SICK device communication (EFI), e.g.:

- Safety light curtain C4000 Standard and C4000 Advanced receiver units
- Multiple light beam safety device M4000 Advanced receiver units
- Safety laser scanner S3000
- Safety laser scanner S300 Advanced/Professional

Fig. 17: Pin assignment of SDL connector M23 × 11 + FE



Tab. 20: Pin assignment of SDL connector M23 × 11 + FE

Pin	Signal	Description
1	U_V	24 V DC (voltage supply) of the ESPE
2	GND	0 V DC (voltage supply) of the ESPE
3	$OSSD1_{In}$	Safety capable input for OSSD1 of the ESPE
4	$OSSD2_{In}$	Safety capable input for OSSD2 of the ESPE
5		Not assigned
6		Not assigned
7		Not assigned
8		Not assigned
9	EFI_A	Safe device communication with SICK ESPE
10	EFI_B	Safe device communication with SICK ESPE
11		Not assigned
FE	FE	Functional earth
Connector housing	FE	Functional earth

Notes

- You can obtain suitable preconfigured cables from SICK (see 12.2 “UE4400 series bus node accessories” on page 182).
- Sender units for C4000 Standard series safety light curtains, C4000 Advanced series safety light curtains or M4000 Advanced series multiple light beam safety devices should not be connected to the SDL connectors unless EFI communication (i.e. communication occurring at pins 9 and 10 of the SDL connector) has been disabled e.g. by removing the pins from the mating connector. Alternately, these sender units may utilize one of the M12 field signal connections by connecting test/signal outputs set to Permanently On as the source for 24 V DC and 0 V DC power connections. In this case, you should disable the test input signal at the sender unit via CDS software. See the operating instructions for the device for additional information.

WARNING

No leakage current may be allowed to flow in the case of an error!

Leakage current flow cannot be permitted (even in the event of an error) from the outputs of the connected sensor which may set the field signal input to “1” (see chapter 11 “Technical specifications” on page 172).

5.3 Field signal connectors (M12 × 5 + FE)

The UE4400 has six (6) safety capable field signal connectors and two (2) safety capable bipolar output field signal connections. Each safety capable input connector includes two (2) safety capable inputs (In A/In B), two (2) test/signal outputs (TOutA/TOutB) and ground (GND). TOutA on connector 1 is capable of fault monitoring for muting applications.

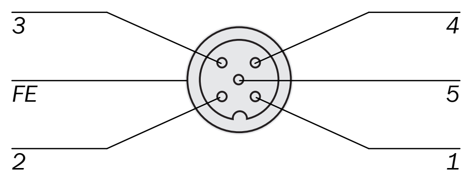
Each safety capable bipolar output connector includes one (1) safety capable bipolar output (SOutA/SOutB). SOutA functions as the high-side P-switch and SOutB functions as the low-side N-switch.

WARNING

Take care when installing cables that require protective separation!

If a test/signal output serves several inputs, e.g. when connecting to an operating mode switch, the cable that you install must be protected. Otherwise, a risk of cross-circuit within the cable is possible that cannot be detected by the UE4400.

Fig. 18: Pin assignment of field signal connectors M12 × 5 + FE



Tab. 21: Pin assignment of safety capable input field signal connectors M12 × 5 + FE, connectors 1 to 6

Pin	Signal	Description
1	TOutB	Test/signal output B
2	In B	Safety capable input B
3	GND	0 V DC
4	In A	Safety capable input A
5	TOutA	Test/signal output A
Connector housing	FE	Functional earth (shield)

Tab. 22: Pin assignment of safety capable output field signal connectors M12 × 5 + FE, connectors 7 and 8

Pin	Signal	Description
1	N.C.	Not connected
2	SOutA	Safety capable output A (P-switch/high side connection)
3	N.C.	Not connected
4	SOutB	Safety capable output B (N-switch/low side connection)
5	N.C.	Not connected
Connector housing	FE	Functional earth (shield)

WARNING

Short circuits on safety capable outputs may cause permanent damage to the UE4400 or unexpected device behavior!

- The P-switch on the bipolar safety capable output must not be short circuited to a negative external power source (e.g. –24 V DC). This may cause the connected device to behave unexpectedly (e.g. turn on) if it is a non-polarized device. This connection must be excluded by taking protective measures, e.g. separated and protective layering of the cables.
- The N-switch on the bipolar safety capable output must not be short circuited to a positive external power source (e.g. +24 V DC). This may cause the connected device to behave unexpectedly (e.g. turn on) if it is a non-polarized device. This connection must be excluded by taking protective measures, e.g. separated and protective layering of the cables.
- The P-switch and N-switch on the bipolar safety capable output must not be shorted simultaneously to supply and ground. This may cause the connected device to behave unexpectedly (e.g. turn on). This connection must be excluded by taking protective measures, e.g. separated and protective layering of the cables.

No leakage current may be allowed to flow in the case of an error!

Leakage current flow cannot be permitted (even in the event of an error) from the outputs of the connected sensor which may set the field signal input to "1" (see chapter 11 "Technical specifications" on page 172).

The following connection errors can result in the destruction of the UE4400:

- External voltage on an output, which is higher than U_L. This also applies when the output is switched off (e.g. **Permanently off** as indicated by no connection to the TOut(A/B) in the UE4400 device window in the **I/O configuration** tab).
- Reversal of the supply voltage with simultaneous short circuit of the test output lines
- Reversal of the supply voltage with freewheeling diodes to the test output from 0 V DC (GND).

Reverse polarization changes the behavior of the field signal outputs!

- On the reversal of the supply voltage, current is applied to components connected to the field signal output in reverse, that is the UE4400 activates the outputs instead of deactivating them.

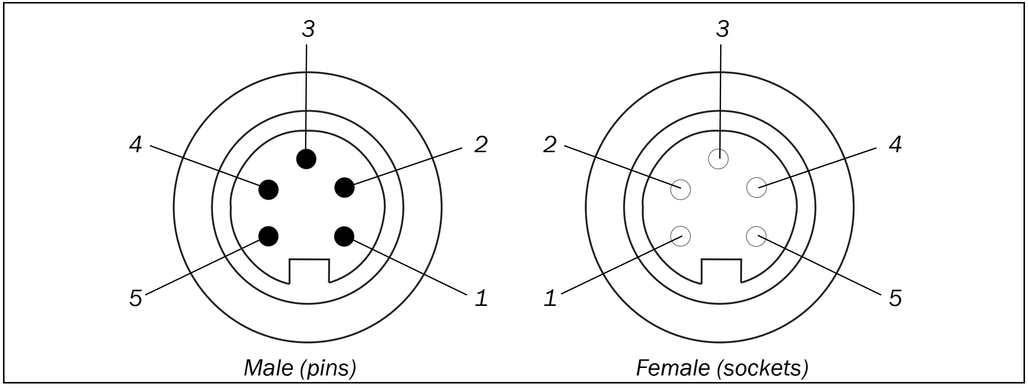
5.4 DeviceNet Safety (MINI 5-pin connector, 7/8 inch)

DeviceNet Safety network connector

The DeviceNet input connector is a sealed MINI-C (7/8") male 5-pin receptacle.

The DeviceNet output connector is a sealed MINI-C (7/8") female 5-pin receptacle.

Fig. 19: Pin assignment of the DeviceNet/DeviceNet Safety connectors (input and output connectors)



Tab. 23: Pin assignment of the DeviceNet/DeviceNet Safety connectors (input and output connectors)

Pin	Signal name	Function
1	Drain	Drain
2	+24 V DC	Bus power supply
3	0 V DC	GND
4	CAN_H	Device communication CANH
5	CAN_L	Device communication CANL
Connector housing	Shield	Shield (connected to Drain)

DeviceNet/DeviceNet Safety cables must satisfy the following requirements:

Tab. 24: DeviceNet communication specifications

	Specification detail			
Communication protocol	DeviceNet/DeviceNet Safety			
Connection method	Multi-drop and T-branch connections can be combined for trunk and drop lines. 120 Ω termination resistors are required at both ends of the trunk line.			
Baud rate	500 kbps, 250 kbps or 125 kbps			
Communication media requirements	5-wire cable including two (2) signal conductors, two (2) power conductors and one (1) shield conductor			
Communication distances	Baud rate	Maximum network length	Maximum drop line length	Maximum total drop line length
	500 kbps	100 m	6 m	39 m
	250 kbps	250 m[2)]	6 m	78 m
	125 kbps	500 m[2)]	6 m	156 m

Additional information regarding DeviceNet and DeviceNet Safety physical media (e.g. trunk lines, drop lines, termination resistors, power supply requirements, etc.) is available from the Open DeviceNet Vendor Association (ODVA). Please consult the ODVA "Planning and Installation Manual" that is available from the ODVA web site at:

www.odva.org.

2) The values presented indicate the maximum network length using DeviceNet thick cables. When using DeviceNet thin cable, reduce the maximum network length to 100 m.

Tab. 25: DeviceNet and DeviceNet Safety communication cable specifications

	Thick Cable		**Thin Cable**	
	Signal Wires	Power Wires	Signal Wires	Power Wires
Conductor cross-section area	0.86 mm^2	2.17 mm^2	0.20 mm^2	0.38 mm^2
Conductor outer diameter	1.21 mm	1.92 mm	0.60 mm	0.80 mm
Color	Blue/white	Red/black	Blue/white	Red/black
Impedance	120 Ω ± 10%	–	120 Ω ± 10%	–
Propagation delay	1.36 ns/ft	–	1.36 ns/ft	–
Attenuation factor	500 kHz: 0.25 dB/ft 125 kHz: 0.13 dB/ft		500 kHz: 0.25 dB/ft 125 kHz: 0.13 dB/ft	
Conductor resistance	6.9 Ω/1000 ft 22.6 Ω/km	2.7 Ω/1000 ft 8.9 Ω/km	28 Ω/1000 ft 91.9 Ω/km	17.5 Ω/1000 ft 57.4 Ω/km
Maximum current	--	8 A	--	3 A
Finished outer diameter	11.2 to 12.1 mm		6.9 mm	

When connecting the UE4400 to DeviceNet or DeviceNet Safety, please take the installation guidelines of the Open DeviceNet Vendor Association (ODVA) into account.

The ODVA “Planning and Installation Manual” is available from the ODVA web site at:

www.odva.org.

Note When using the UE4400 series safety remote I/O devices in DeviceNet or DeviceNet Safety networks, termination resistors shall be utilized appropriately to ensure reliable communication. The terminating resistors shall be installed at the ends of the DeviceNet physical media (i.e. trunk line). DeviceNet termination resistor requirements are: 121 Ω, 1% metal film, 1/4 W.

For applications in which noise is being experienced via DeviceNet or DeviceNet Safety communication lines, the following may assist in reducing noise effects:

- Noise from communication cables can be reduced by installing a ferrite core (data line filter) on the communication cable within 10 cm (4 inches) of the DeviceNet Master or DeviceNet Safety Originator.
- Wire the signals and communication lines internal to the control panel using the shortest cables possible.
- Assure that connections to ground do not exceed 100 Ω.

5.5 MAC ID address and local RS-232c port (M8 × 4 connector)

The RS-232c port is used for local configuration of the UE4400 using the SICK CDS configuration software. The physical interface (connector) is located beside the DeviceNet Safety MAC ID address switches beneath the protective cover on the top of the UE4400.

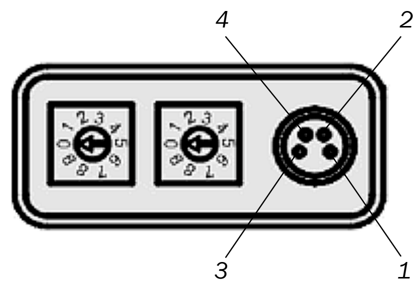
The DeviceNet/DeviceNet Safety node address, e.g. Media Access Control Identifier (MAC ID), of the UE4400 is set using the two rotary DIP switches shown in the diagram below. The MAC ID is configured based on the following values:

Left Rotary Switch	Multiply value by 10 and add to the value associated with the right rotary switch to obtain the MAC ID
Right Rotary Switch	Multiply value by 1 and add to the value associated with the left rotary switch to obtain the MAC ID

If the MAC ID is between 0 and 63, the UE4400 bus node address is this value. If the value for the MAC ID is greater than 63 (e.g. 64 … 99), the MAC ID value is set either via CDS or by a safety network configuration tool, e.g. SICK DeviceNet Safety Configurator with CDS plug-in. Changing the MAC ID switches after the unit is powered will cause the device to enter ABORT (i.e. fault) state.

Note When an error is caused by a change in the MAC ID address, the error may be cleared by setting the switch back to its original value and cycling power to the device. If the MAC ID must be changed intentionally to correspond to network requirements, recommission of the UE4400 is required.

Fig. 20: Pin assignment configuration connector M8 × 4



Tab. 26: Pin assignment configuration connector M8 × 4

Pin	UE4400	PC-side RS-232c SubD (9-pin)
1	Reserved for service	Not assigned
2	RxD	Pin 3
3	0 V DC (power supply)	Pin 5
4	TxD	Pin 2

Notes

- Discharge any electrostatic charge that you may have to functional earth (FE) before placing the configuration cable on the configuration connector. Electrostatic charge can damage the electronics in the UE4400.
- Always remove the connector from the configuration connection when you have concluded the configuration.
- Screw the device's protective cover back onto the device after you have finished configuring it. Otherwise, the UE4400 will no longer comply with the IP 67 enclosure rating.

6 Circuit examples

Numerous applications can be implemented with the UE4400 field signal connectors. This section describes typical circuits and associated configurations.

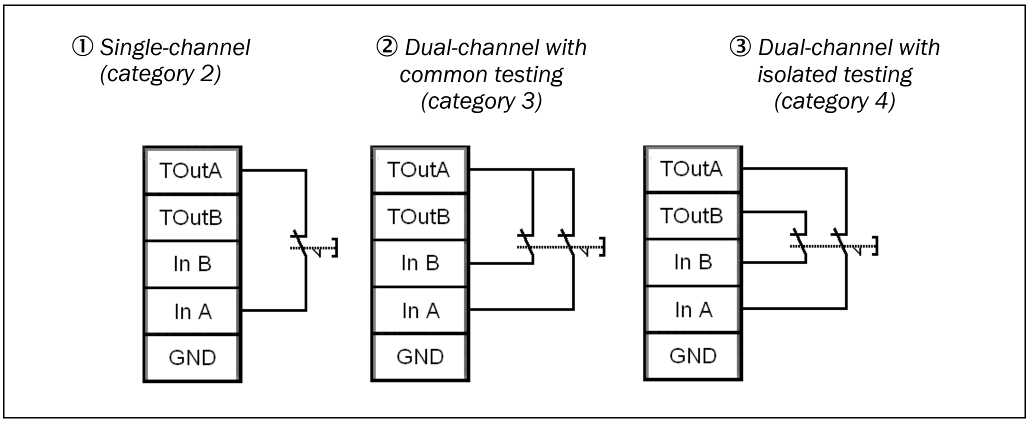
Note The classification of components fitted with contacts (e.g. safety door switches and emergency stops) into a category according to EN 954-1 depends both on the connection type (single-channel/dual-channel) and on the execution (single/redundant, testing type). You always select the appropriate switching element for the required category and switching type.

6.1 Emergency stops and safety door interlocks

Depending on the category required according to EN 954-1, you may realize an emergency stop using

- Single-channel contact, tested (maximum category 2) ①
- Dual-channel contact, both contacts commonly tested (maximum category 3) ②
- Dual-channel contact, both contacts separately tested (maximum category 4) ③

Fig. 21: Example of the emergency stop circuit



Configuration

Based on the category according to EN 954-1 you wish to achieve, the following applies:

Tab. 27: Configuration parameters for emergency stop connection

	In A	TOutA	In B	TOutB
①	Signal input Single-channel	Test signal for In A	Not applicable	Not applicable
②	Signal input Dual-channel Equivalent	Test Signal for In A and In B	Signal input Dual-channel Equivalent	Not applicable
③	Signal input Dual-channel Equivalent	Test signal for In A	Signal input Dual-channel Equivalent	Test signal for In B

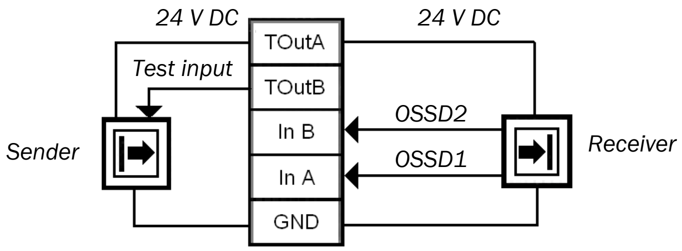
Notes

- In the case of single-channel switching (①) you can use the second input/output (In B and TOutB) for a different application. With the aid of a two-way splitter, you can also drive two separate emergency stop buttons (maximum category 2 according to EN 954-1) on one field signal connector.
- Single-channel safety capable input applications may utilize slope detection. Slope detection ensures that “stuck at high” 24 V DC failures will not be read and transmitted as an **Active** value (e.g. “1”) at the input.

- In the case of a dual-channel connection with common testing (②) the unallocated test signal on the connector may be configured in conjunction with other safety capable input signals or for use as power to standard sensors. Any unused test signals should be configured as **Permanently off**.

6.2 Electro-sensitive protective equipment (ESPE) with safety capable output (OSSD)

Fig. 22: Example of a circuit for electro-sensitive protective equipment on the field signal connector



In the connection of electro-sensitive protective equipment (ESPE), senders (▣) and receivers (▣) can be considered as a system's inputs and outputs. Senders and receivers use the same power supply (test/signal output TOutA, Permanently On 24 V DC). You can use test/signal output TOutB to test the sender, alternatively as an output signal from the safety-rated controller or assigned Permanently On 24 V DC. The switching outputs of the receiver are present on inputs In A and In B.

Configuration

The following configuration applies:

Tab. 28: Configuration parameters for AOPD(DR) connection

	In A	TOutA	In B	TOutB
1	Signal input Dual-channel	24 V	Signal input Dual-channel	Remote out or 24 V

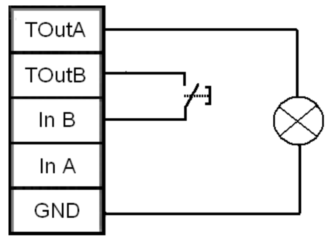
Notes

- Discrepancy time may be specified for this configuration.
- The functional earth of the ESPE is normally provided via the shielded (screened) field signal connectors. However, the functional earth cannot be looped via the two-way splitter. In this case, you must mount the ESPE in such a way that the ESPE housing is grounded on the machine support.
- In order to meet the requirements for category 4 according to EN 954-1, the ESPE must have two tested semiconductor switching outputs and its own short circuit detection.
- Only category 2 is possible when using single-channel switching outputs.
- As shown in the above diagram, TOutB is utilized as a current source for the test input of the ESPE. It must be ensured that the ESPE test input requires a current sinking signal.

6.3 Control switch with indicator display

Control switches with indicators can be connected to the safety capable input field signal connectors for applications such as startup, reset or restart.

Fig. 23: Example of a circuit for a control switch with indicator display



Configuration

Tab. 29: Configuration parameters for control switch connection

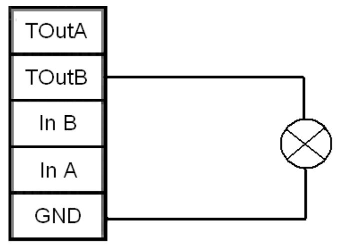
	In A	TOutA	In B	TOutB
1	Not applicable	Remote out	Signal input Single-channel	TOut for In B

Notes

- You may also configure delay time and slope detection for In B.
- You can use the second input (e.g. InA) for a different application.

6.4 Muting lamp

Fig. 24: Connection of a muting lamp



Configuration

Tab. 30: Configuration parameters for muting lamp connection

	In A	TOutA	In B	TOutB
1	Not applicable	Remote out plus muting lamp monitoring	Not applicable	Not applicable

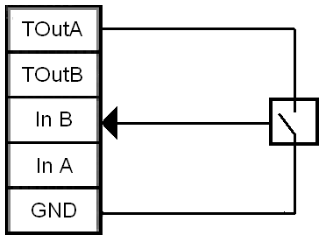
Notes

- It is only permitted to connect a muting lamp to channel A of test/signal output (TOutA) on connector 1. Only this output has fault monitoring capability.
- In the event of an error in the muting lamp (defective or not connected), the UE4400 sets the muting lamp status bit(s) to an error state (e.g. as indicated in instance 776 (0x308) of the device's process image).
- When TOutA of field signal connector 1 is configured for muting lamp, the muting lamp status bit(s) of the process image will reflect the current state of the muting lamp signal (e.g. as indicated in instance 776 (0x308) of the device's process image). When the TOutA on connector 1 is not configured as a muting lamp, the muting lamp status bit will always indicate an error in the muting lamp has occurred.

6.5 Muting sensor (untested)

The following information only applies for applications in which you operate an M4000 Advanced on the SDL connection on the UE4455 or UE4457 and use muting sensors.

Fig. 25: Example of a circuit for an untested muting sensor



You may realize the connection of an untested muting sensor by connecting a reflective photoelectric proximity switch, reflective photoelectric switch, single beam photoelectric switch or magnetic proximity sensor as shown above.

Configuration

Tab. 31: Configuration parameters for untested muting sensor

	In A	TOutA	In B	ToutB
1	Not applicable	Permanently ON (Power supply)	Signal input Single-channel	Not applicable

When used with an M4000 Advanced, M4000 Advanced A/P or M4000 Area device connected to one of the SDL connectors on the UE4455 or UE4457, the following information must also be considered:

Tab. 32: Timing requirements for muting sensors connected directly to the UE4455 or UE4457 when used with M4000 connected to SDL input.

Item	Description	Time
1	Any OFF-ON input delay that is configured for the safety capable input that the muting sensor is connected to	+______ ms
2	Internal processing time of the bus node	+ 15 ms
3	Internal processing time M4000 (including communication between the UE4455 or UE4457 and the M4000)	+ 10 ms
4	Time constant (tx) for calculation of the minimum distance between the muting sensors and the M4000 Advanced device	=______ ms

Tab. 33: Timing requirements for muting sensors connected remotely to the UE4455 or UE4457 (i.e. communicated via DeviceNet Safety) when used with M4000 connected to SDL input.

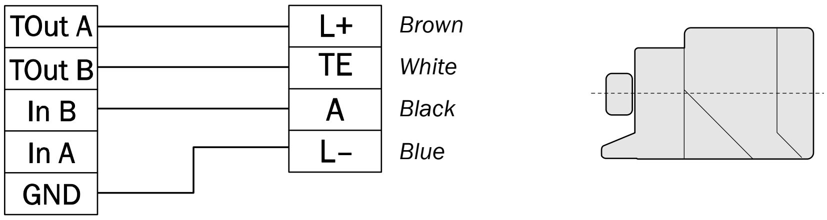
Item	Description	Time
1	Time required to communicate muting sensor information via DeviceNet Safety (i.e. communication time required for muting sensor information to be available at the UE4455 or UE4457)	+______ ms
2	Internal processing time of the bus node	+ 10 ms
3	Internal processing time M4000 (including communication between the UE4455 or UE4457 and the M4000)	+ 10 ms
4	Time constant (tx) for calculation of the minimum distance between the muting sensors and the M4000 Advanced device	=______ ms

Additional information regarding the how the time constant is used to define the location of muting sensors relative to the M4000 Advanced is described in the operating instructions “M4000 Advanced, M4000 Advanced A/P and M4000 Area 60/80” in chapter 4 “Muting”.

6.6 IN4000 inductive safety sensor

SICK IN4000 inductive safety sensors can be connected to the safety capable input connectors. Applications include safety door interlock monitoring, positioning and to establish muting conditions. SICK IN4000 inductive safety sensors can satisfy wiring requirements up to category 4 (in accord. EN 954-1).

Fig. 26: Example of a circuit for SICK IN4000 inductive safety sensors



Configuration

Tab. 34: Configuration parameters for SICK IN4000 inductive safety sensor

	In A	TOutA	InB	TOutB
1	Not applicable	24 V	Signal input Single-channel	TOut for In B using long test gaps

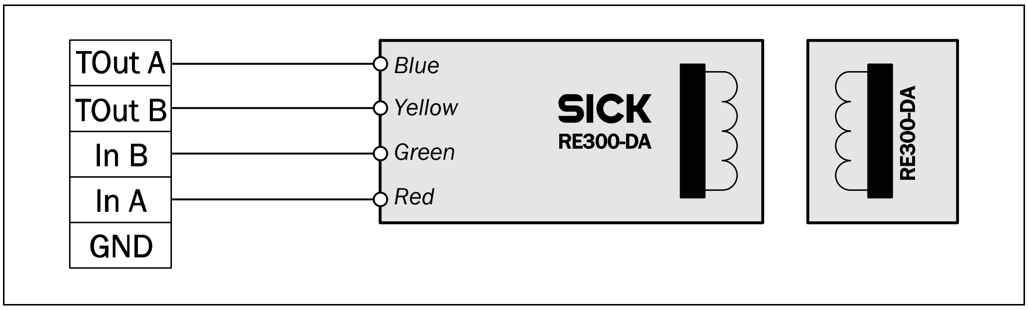
Notes

- The following parameters should be defined for test/signal output B with long test gaps
  - Test pulse period (T): 500 ms
  - Test pulse time (T2): 50 ms
  - Test pulse delay time (Td): 5 ms
- You may also configure delay time and slope detection for In B.
- You can use the second input (e.g. In A) for a different application.
- Response times associated with SICK IN4000 inductive safety sensors are further described in chapter 11.2.1 “Response times associated with safety input devices that use test/signal outputs with long test gaps” on page 177.

6.7 RE300 magnetically actuated non-contact safety switches

SICK RE300 magnetically actuated non-contact safety switches may be connected to the safety capable input field signal connectors. Applications include safety door interlock monitoring as well as positioning up to category 3 (in accord. EN 954-1).

Fig. 27: Example of a circuit for a SICK RE300 magnetically actuated, non-contact safety switch



Configuration

Tab. 35: Configuration parameters for a SICK RE300 magnetically actuated non-contact safety switch

	In A	ToutA	InB	ToutB
1	Signal input Dual-channel complementary	24 V	Signal input Dual-channel complementary	24 V

Notes The following parameters should be defined for safety capable inputs In A and In B

- Dual-channel evaluation type: Complementary
- Discrepancy time monitoring enabled: Checkbox checked
- Discrepancy time value (ms): 800 ms

7 Logic programming — function blocks

Logic programming for the UE4427 or UE4457 is accomplished using function blocks. These function blocks are third party certified for safety relevant functionality when implemented in accordance with safety-relevant standards. The following sections provide important information with regard to the use of the function blocks associated with the UE4427 or UE4457.

WARNING

Always verify that the safety relevant signals used in safety-relevant logic meet applicable standards and regulations!

When used in safety-relevant applications, the function blocks outlined in this section must be implemented in accordance with safety-relevant standards. Safety relevant signals must be utilized for safety capable input and safety output signals used in safety-relevant applications.

It is the user's responsibility to verify that the proper sources for signals used in conjunction with these function blocks and the overall safety logic implementation adhere to relevant safety standards and regulations. Always test the performance of the UE4427 or UE4457 hardware and logic program to verify that the performance is in accordance with the risk reduction strategy.

7.1 Function block overview

The UE4427 or UE4457 utilizes function blocks to define the safety-related logic program. Function blocks can be categorized into two types: Logic function blocks and application specific function blocks. The following table outlines the function blocks that are available:

Tab. 36: Function blocks of the UE4427 or UE4457

Logic function blocks	Application-specific function blocks
• NOT	• Reset
• AND	• Restart
• OR	• Two-Hand Control (THC)
• Exclusive OR (XOR)	• Off-Delay Timer
• Exclusive NOR (XNOR)	• On-Delay Timer
• Routing (ROUTE)	• User Mode Switch (UMS)
• RS Flip-Flop	• External Device Monitoring (EDM)
• Edge Detection	• Multi-Operator
• Clock Generator	• Valve Monitoring
• Event Counter	**Muting function blocks**
	• Muting with parallel sensor orientation
	• Muting with sequential sensor orientation
	• Muting with crossed sensor orientation

Each function block is represented graphically in the logic editor. Graphics associated with each function block is presented below:

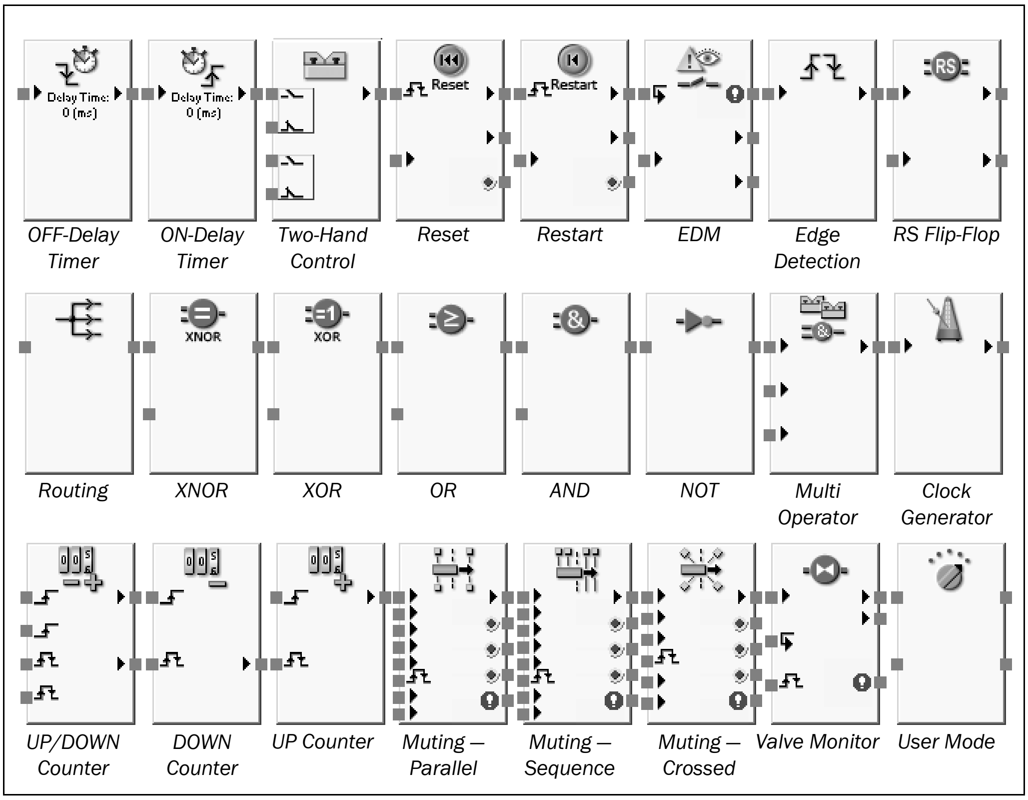


Fig. 28: Graphical representations of function blocks in the logic editor

Logical function blocks are characterized by:

- One or more inputs
- In general, exactly one logical result output
- Logical functions do not have configurable parameters
- Users may route the logical result (e.g. output) to:
  - one or more inputs of a subsequent function block
    or
  - to one physical output (local or remote via DeviceNet Safety).
- Use the **ROUTE** function block when connection to multiple physical outputs is required.

Application-specific function blocks are characterized by:

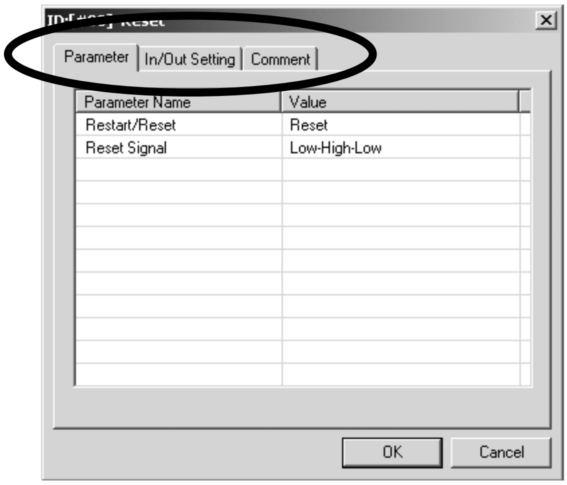
- One or more inputs
- One or more outputs, depending on required functionality
- Configurable parameters
- Users may route an logical result (e.g. output) to:
  - one or more inputs of a subsequent function block
    or
  - to one physical output (local output or remote output via DeviceNet Safety).
- Use the **ROUTE** function block when connection to multiple physical outputs is required.

The UE4427 and UE4457 support up to 32 function blocks in a single application. The number of function blocks is also dependent on the available cycle time of the device. This ensures that the response time is fixed. Therefore it is best to minimize the number of function blocks required for your application.

7.2 Function block properties

Function blocks have a variety of different properties that can be accessed. Configurable parameters will vary from function block to function block. You can access these configurable parameters by double clicking on the function block and selecting which tab is of interest. The example presented below is for the Reset function block:

Fig. 29: Configurable parameters of function blocks



7.3 Function block input and output signal connections

7.3.1 Function block input connections

The UE4427 and UE4457 are SIL3 devices (in accord. IEC 61508) capable of supporting applications to category 4 (in accord. EN 954-1).

Function block inputs may be from:

- A safety-rated device connected locally to the UE4427 or UE4457
  or
- A safety-rated device (e.g. emergency stop button) connected remotely with information communicated from the remote device (e.g. UE4470 Safety Network Controller) via DeviceNet Safety.

Users may select from several input evaluation types (function block dependent). These include:

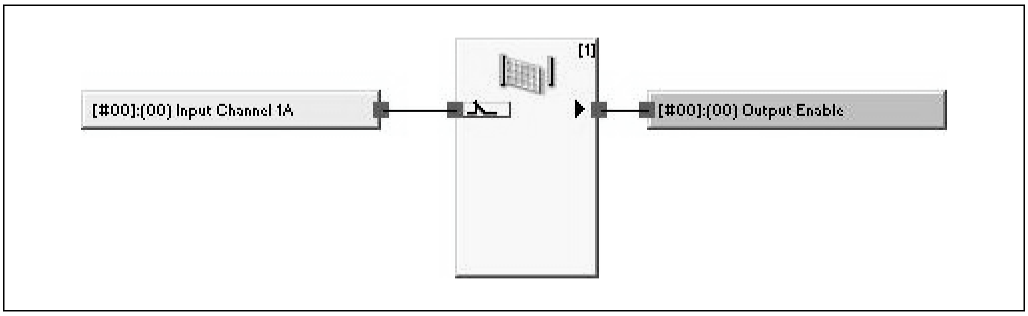
- Single-channel
- Dual-channel:
  - Dual-channel equivalent
  - Dual-channel complementary
  - Two dual-channel equivalent
  - Two dual-channel complementary

The following truth tables outline the internal evaluation for each type of input signal evaluation by the UE4427 or UE4457.

Note Fault present is **Active** when an internal fault is detected by the logic engine of the UE4400.

7.3.2 Single-channel evaluation

Fig. 30: Function block for single-channel evaluation

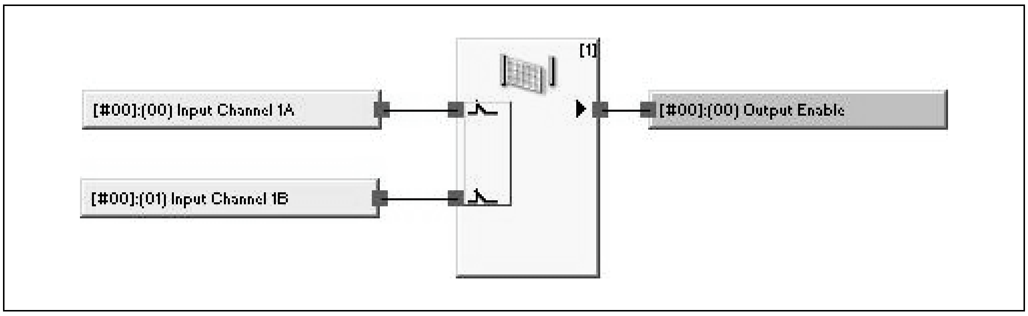


Tab. 37: Single-channel evaluation

Input 1	Fault present	Output 1
0	0	0
1	0	1
x	1	0

7.3.3 Dual-channel equivalent evaluation

Fig. 31: Function block for dual-channel equivalent evaluation

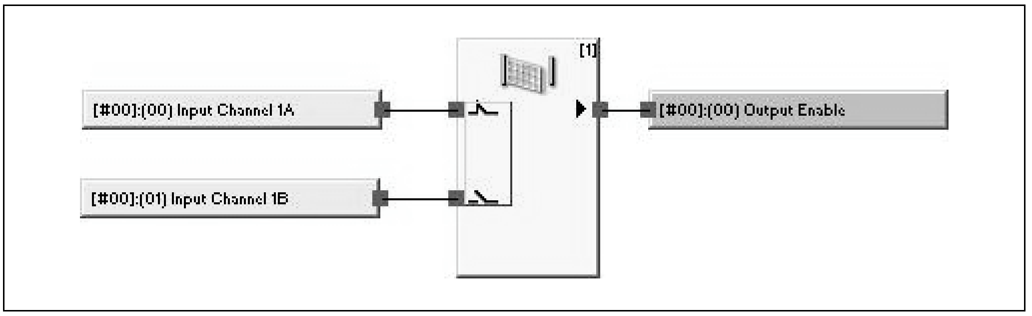


Tab. 38: Dual-channel equivalent evaluation

Input 1	Input 2	Fault present	Output 1
0	0	0	0
0	1	0	0
1	0	0	0
1	1	0	1
x	x	1	0

7.3.4 Dual-channel complementary evaluation

Fig. 32: Function block for dual-channel complementary evaluation

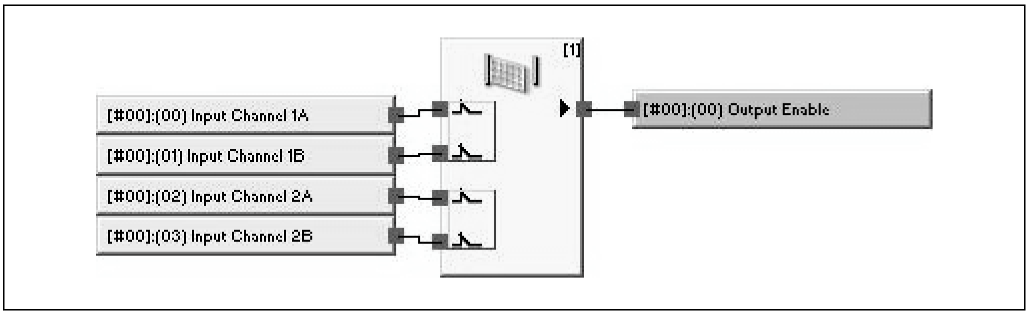


Tab. 39: Dual-channel complementary evaluation

Input 1	Input 2	Fault present	Output 1
0	0	0	0
0	1	0	0
1	0	0	1
1	1	0	0
x	x	1	0

7.3.5 Two dual-channel equivalent evaluation

Fig. 33: Function block for two dual-channel equivalent evaluation



Tab. 40: Two dual-channel equivalent evaluation

Input 1A	Input 1B	Input 2A	Input 2B	Fault present	Output enable
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	0	0	0
0	0	1	1	0	0
0	1	0	0	0	0
0	1	0	1	0	0
0	1	1	0	0	0
0	1	1	1	0	0
1	0	0	0	0	0
1	0	0	1	0	0
1	0	1	0	0	0
1	0	1	1	0	0
1	1	0	0	0	0
1	1	0	1	0	0
1	1	1	0	0	0
1	1	1	1	0	1
x	x	x	x	1	0

7.3.6 Two dual-channel complementary evaluation

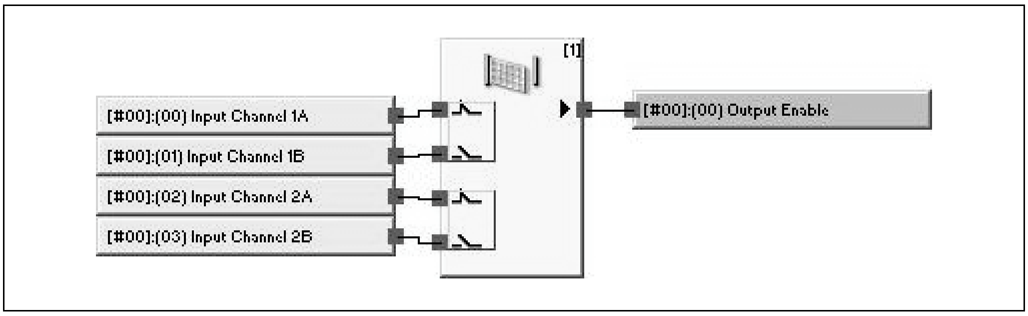


Fig. 34: Function block for two dual-channel complementary evaluation

Tab. 41: Two dual-channel complementary evaluation

Input 1A	Input 1B	Input 2A	Input 2B	Fault present	Output enable
0	0	0	0	0	0
0	0	0	1	0	0
0	0	1	0	0	0
0	0	1	1	0	0
0	1	0	0	0	0
0	1	0	1	0	0
0	1	1	0	0	0
0	1	1	1	0	0
1	0	0	0	0	0
1	0	0	1	0	0
1	0	1	0	0	1
1	0	1	1	0	0
1	1	0	0	0	0
1	1	0	1	0	0
1	1	1	0	0	0
1	1	1	1	0	0
x	x	x	x	1	0

It is important to consider that dual-channel evaluation may already occur in some remote input/output devices. In this case, the remote input/output device may provide the result of this evaluation via a single bit communicated over DeviceNet Safety. The user may elect to configure the function block for single-channel input when this "pre-evaluation" takes place.

Optionally, the user may also connect the same "pre-evaluated" remote input signal bit to both input channels of a function block using a dual-channel input configuration. "Pre-evaluated" signals may occur within the UE4427 or UE4457 local input and output definition or in a remote input/output device. When a single bit address is connected to both inputs on the function block, the UE4427 or UE4457 treats the first connection as the logical result and ignores the second connection.

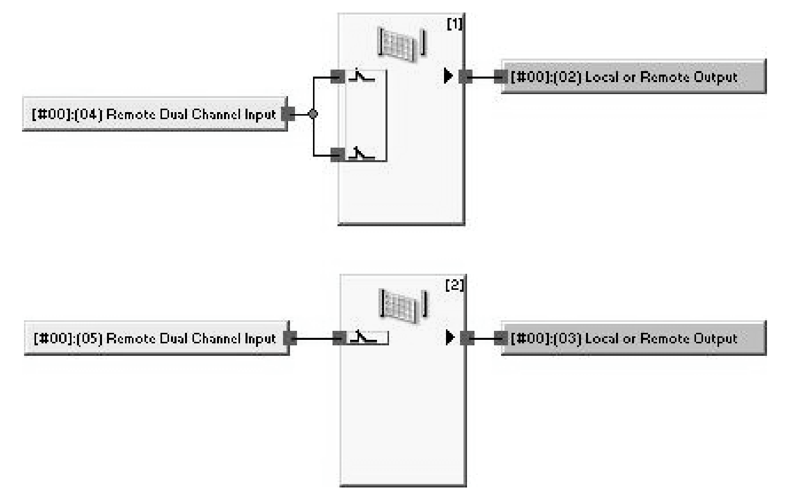
The following function blocks would provide the same output value for a remote dual-channel input signal that was evaluated by a remote device.

WARNING

Connect pre-evaluated signals correctly!

When inputs or outputs have been pre-evaluated, locally or by remote devices, for dual-channel evaluation, make sure to connect the resultant pre-evaluated signal of the dual-channel evaluation as shown in the graphic below. Do not connect both of the pre-evaluated signals to the function block unless the dual-channel evaluation is expected to occur in the function block.

Fig. 35: Remote dual-channel input with single channel safety output



Remote input signals may also have status information available. In some applications, it is important to evaluate this status information to determine the logical function behavior of the UE4427 or UE4457. Input status indicates whether the data that is being communicated from the remote device to the UE4427 or UE4457 is:

- **Inactive** due to the state of the safety device; or
- **Inactive** (e.g. fault detected) due to an existing fault condition at the safety device.

A safety category (in accord. EN 954-1) is not defined for the function block input characteristic since this is based on the connection wiring of the safety device connected to the local or remote inputs rather than the connection(s) to the function block itself. However, the following signals may be realized when connected in accordance with the requirements associated with the category indicated:

- Category 2 input signals using single-channel input with test pulses
- Category 3 input signals using dual-channel input having the same test pulse source for both input channels
- Category 4 input signals using dual-channel input having different test pulse sources for each input channel
- Category 4 input signals using two dual-channel input pairs using different test pulse sources for each input pair

WARNING

Consult regulations and industry standards!

When implementing safety-relevant functionality, you must verify that the control strategy and risk reduction techniques you are using adhere to local, regional and national regulations. Consult these regulations and industry standards to determine the requirements that may apply to your application.

7.3.7 Function block output connections

Several different function block output signal connections may be available for connection to physical outputs (local and remote) or subsequent function blocks. Output signal connections can include (function block dependent):

- Output enable
- Static release
- Discrepancy error detected
- Synchronization error detected

- External device monitoring (EDM) error detected
- Fault present
- Reset required output
- Restart required output
- OSSD 1 (output enable 1)
- OSSD 2 (output enable 2)

An output from a function block cannot be connected to multiple physical outputs, but may be connected to multiple subsequent function blocks. If an output from a function block must be used by multiple physical outputs, use the **ROUTE** function block. Specific output behavior for each of the above outputs is described in the applicable function block description.

Display of error and diagnostic outputs is user selectable. Default output configuration of function blocks is generally limited to Output enable and a few signal required outputs (e.g. Reset required). To display additional error and diagnostic outputs, increase the number of outputs shown in the **In/Out Setting** tab of the function block properties.

Note When one or more test outputs or safety-capable outputs will be controlled using the logic capability of the UE4427 or UE4457, they must be first selected inside of the logic engine before additional configuration parameters can be accessed.

Use the device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **Logic Configuration** and select the output you wish to use by placing the output on the “canvas” and connecting it to the associated function block. Once this is completed, go back to the **I/O Configuration** tab and then double-click on the output to assign any additional configuration parameters.

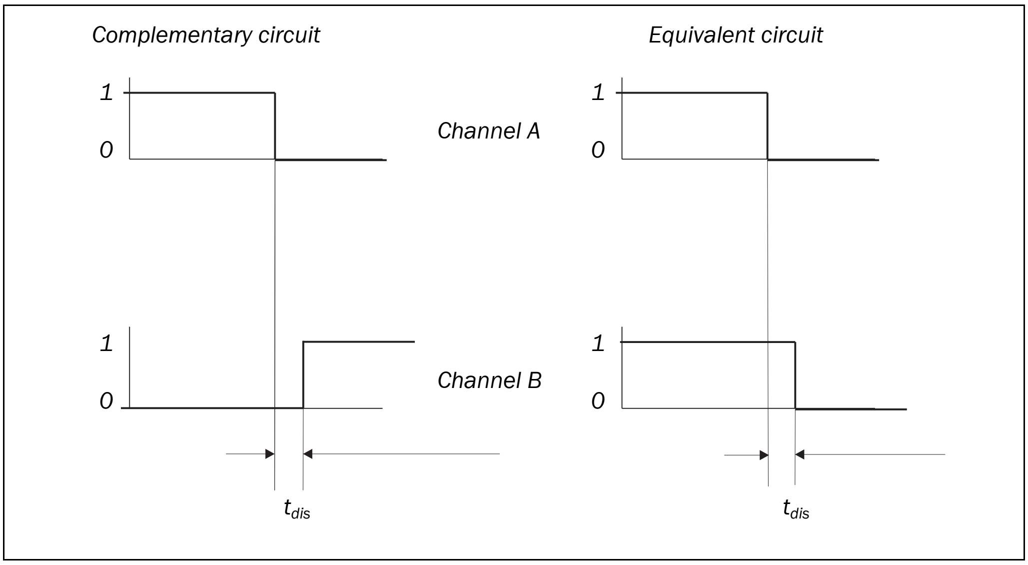
7.4 Function block parameterization

In addition to the input type (e.g. single-channel, dual-channel equivalent, etc.), function blocks may have additional parameters defined in the specific function block properties page as shown in the diagram above.

7.4.1 Discrepancy time

The discrepancy time t_{dis} is the maximum time within which both inputs of a dual-channel connection may be found in impermissible states without the safety-related logic evaluating the condition as an error. In a dual-channel equivalent circuit, both inputs cannot be complementary for longer than the configured discrepancy time. In a dual-channel complementary circuit, both inputs cannot be equal for longer than the configured discrepancy time.

Fig. 36: Discrepancy time



Monitoring of the discrepancy time starts with the first state change of an input. The safety-related logic identifies an error if, after the discrepancy time has expired, both inputs of the connection …

- have not reached an equivalent state when required, or
- have not reached a complementary state when required.

The following truth table describes the discrepancy condition for dual-channel equivalent and dual-channel complementary input evaluation:

Tab. 42: Input signals and process image at the end of the discrepancy time

Dual-channel selection	**Input signal**		
	In A	**In B**	**Status**
Equivalent	0	0	Inactive
	0	1	Discrepant
	1	0	Discrepant
	1	1	Active
Complementary	0	0	Discrepant
	0	1	Inactive
	1	0	Active
	1	1	Discrepant

Input signals must also adhere to the following rules relative to discrepancy time:

- If the input type is single-channel, discrepancy time is not monitored (e.g. **Inactive**) regardless of any parameter settings associated with the function block.
- In order to clear a discrepancy-time error, the dual-channel input evaluation must return to an **Inactive** state (e.g. logical "0"). See table above for description of valid states.
- When one input of the input pair changes state, the other input of the input pair must also change state to a valid value before expiration of the discrepancy time.
- A dual-channel evaluation may only transition to an **Active** state (logical value = "1") from an **Inactive** state in which the discrepancy time has not expired.
- A dual-channel evaluation may **NOT** transition from an **Active** state, to a discrepant state, and then back to an **Active** state, regardless of discrepancy time. The dual-channel evaluation must transition from an **Active** state, to an **Inactive** state before returning to the **Active** state, while still satisfying the requirements associated with discrepancy time.
- Valid values for discrepancy time: **Inactive** (discrepancy time not monitored), 10 ms to 30 000 ms in 10 ms increments. If **Active**, the specified discrepancy time must be greater than scan time of the UE4427 or UE4457.

In the event that a discrepancy error does occur, indication of the error occurs by:

- Setting output enable to **Inactive** (e.g. fault detected); and
- Setting fault present to **Active**; and
- Setting discrepancy error pair 1/2 error (for input 1/2 evaluation); or
- Setting discrepancy error pair 3/4 error (for input 3/4 evaluation).

7.4.2 Synchronization time

In category 4 applications, it may be necessary to assure that two (2) dual-channel input evaluations (e.g. dual-channel input 1/2 and dual-channel input 3/4) reach the same state within a fixed time period.

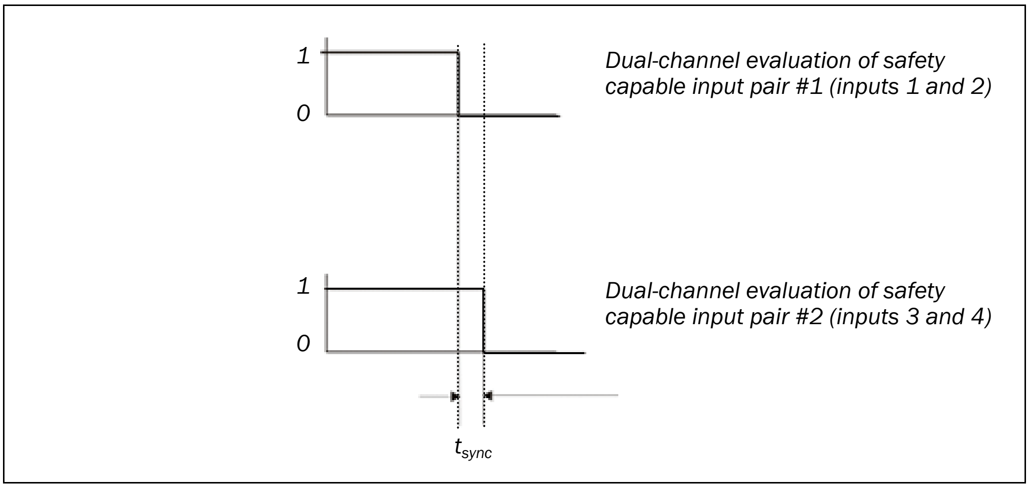
When one dual-channel input pair changes state, the second dual-channel input pair must reach an equivalent state to the first prior to the expiration of a synchronization timer.

There can be no faults or discrepancy errors on either dual-channel evaluation.

If the synchronization time expires before this equivalent condition is reached, the synchronization error output is set **Active**. For function blocks that have the synchronization time parameter (excluding two hand control), the failure to satisfy the synchronization time will also cause the fault present to be set **Active**.

Synchronization time differs from discrepancy time in that it applies to the relationship between two (2) dual-channel evaluations whereas discrepancy time refers to the individual channels of a dual-channel evaluation.

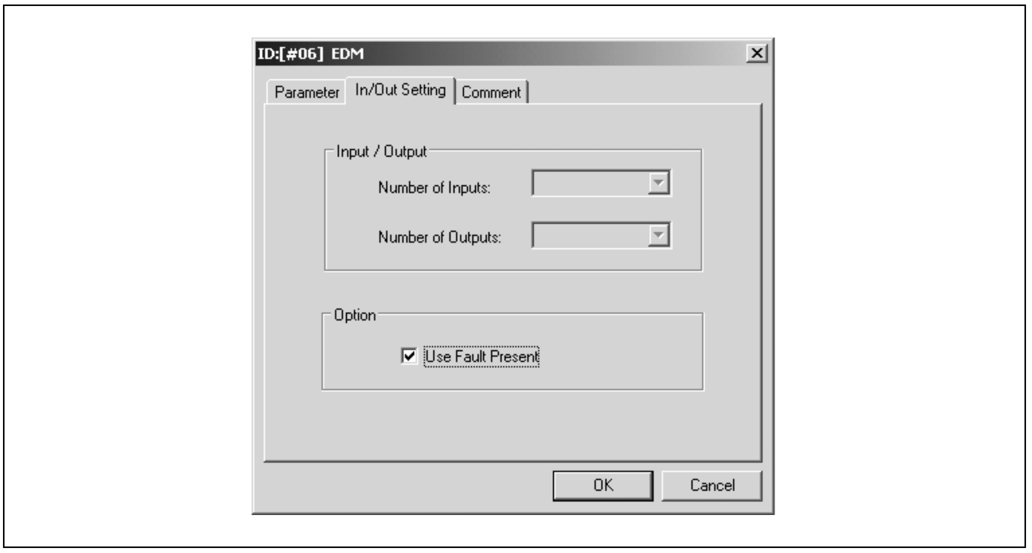
Fig. 37: Synchronization time



7.4.3 Fault Present

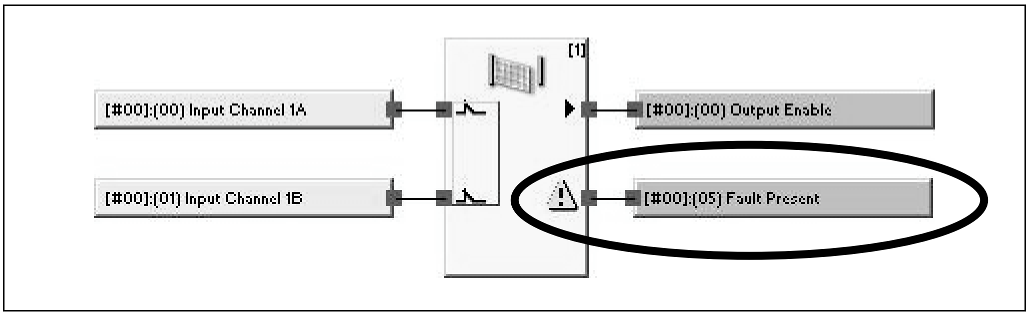
Fault Present is a diagnostic status bit available in several function blocks, when appropriate, by checking the check box located in the **In/Out setting** tab of the function block properties. By checking the Use Fault Present checkbox, an additional "Fault Present" output will be displayed on the function block.

Fig. 38: Configuring Use Fault Present



The Fault Present output provides users with diagnostic information regarding the reason an Output Enable signal may be **Inactive** (e.g. fault detected).

Fig. 39: Fault Present output



Fault Present will be set to **Active** when an error has been detected based on function block configuration of parameters (e.g. discrepancy time error, function test error, synchronization error, etc.).

Status bits associated with data from remote input/output devices are not monitored for "Fault Present" by the UE4427 or UE4457.

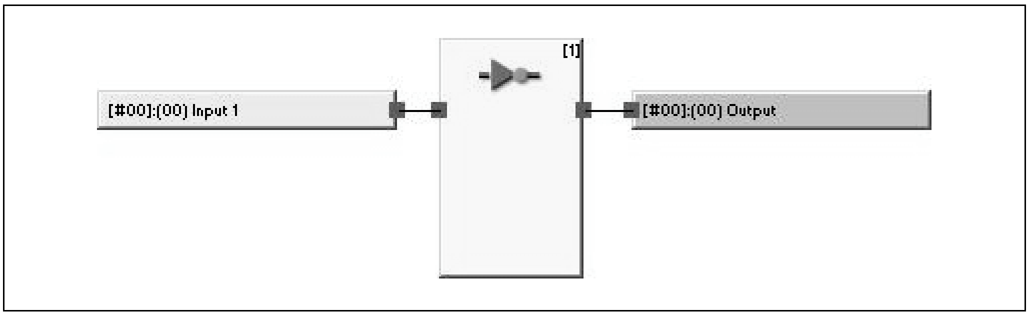
When Fault Present is **Active**, Output Enable will be set to **Inactive** (e.g. fault detected). Clearing of “Fault Present” is described in each applicable function block section.

7.5 Logical function blocks

7.5.1 Function block NOT

Function block diagram

Fig. 40: Function block diagram for function block NOT



General description

Output will be the inverse of input 1. For example, if input 1 is **Active**, then output is set **Inactive**. Only one (1) input may be evaluated using this function block.

WARNING

Never use NOT function blocks to directly control safety output signals!

Always make sure that the use of a NOT function occurs logically before a reset function block in your application to prevent unintended start-up conditions. Never use NOT function blocks to directly control safety output signals.

Truth table for NOT

For the truth tables identified in this section, the following applies:

- “0” means logical low, **Inactive**
- “1” means logical high, **Active**

Tab. 43: Truth table for function block NOT

Input	Output
0	1
1	0

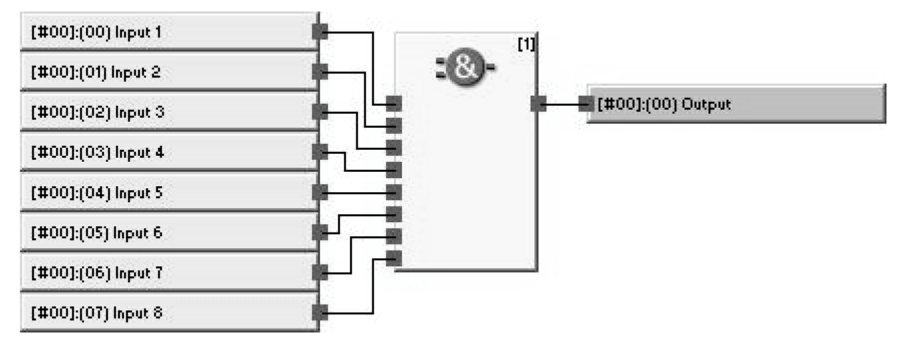
Fault conditions and reset information

Logical functions do not monitor fault conditions.

7.5.2 Function block AND

Function block diagram

Fig. 41: Function block diagram for function block AND



General description

Output will be **Active** when **all** of the inputs being evaluated are all **Active**. Up to eight (8) inputs may be evaluated.

Truth table for one (1) input AND evaluation

Truth tables for one through eight inputs are shown below. For these truth tables, the following nomenclature applies:

- “0” means logical low, **Inactive**
- “1” means logical high, **Active**
- “x” means “don’t care” = “0” or “1”

Tab. 44: Truth table for one (1) input AND evaluation

Input 1	Output
0	0
1	1

Truth table for two (2) input AND evaluation

Tab. 45: Truth table for two (2) input AND evaluation

Input 1	Input 2	Output
0	x	0
x	0	0
1	1	1

Truth table for three (3) input AND evaluation

Tab. 46: Truth table for three (3) input AND evaluation

Input 1	Input 2	Input 3	Output
0	x	x	0
x	0	x	0
x	x	0	0
1	1	1	1

Truth table for four (4) input AND evaluation

Tab. 47: Truth table for four (4) input AND evaluation

Input 1	Input 2	Input 3	Input 4	Output
0	x	x	x	0
x	0	x	x	0
x	x	0	x	0
x	x	x	0	0
1	1	1	1	1

Truth table for five (5) input AND evaluation

Tab. 48: Truth table for five (5) input AND evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Output
0	x	x	x	x	0
x	0	x	x	x	0
x	x	0	x	x	0
x	x	x	0	x	0
x	x	x	x	0	0
1	1	1	1	1	1

Truth table for six (6) input AND evaluation

Tab. 49: Truth table for six (6) input AND evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Output
0	x	x	x	x	x	0
x	0	x	x	x	x	0
x	x	0	x	x	x	0
x	x	x	0	x	x	0
x	x	x	x	0	x	0
x	x	x	x	x	0	0
1	1	1	1	1	1	1

Truth table for seven (7) input AND evaluation

Tab. 50: Truth table for seven (7) input AND evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Input 7	Output
0	x	x	x	x	x	x	0
x	0	x	x	x	x	x	0
x	x	0	x	x	x	x	0
x	x	x	0	x	x	x	0
x	x	x	x	0	x	x	0
x	x	x	x	x	0	x	0
x	x	x	x	x	x	0	0
1	1	1	1	1	1	1	1

Truth table for eight (8) input AND evaluation

Tab. 51: Truth table for eight (8) input AND evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Input 7	Input 8	Output
0	x	x	x	x	x	x	x	0
x	0	x	x	x	x	x	x	0
x	x	0	x	x	x	x	x	0
x	x	x	0	x	x	x	x	0
x	x	x	x	0	x	x	x	0
x	x	x	x	x	0	x	x	0
x	x	x	x	x	x	0	x	0
x	x	x	x	x	x	x	0	0
1	1	1	1	1	1	1	1	1

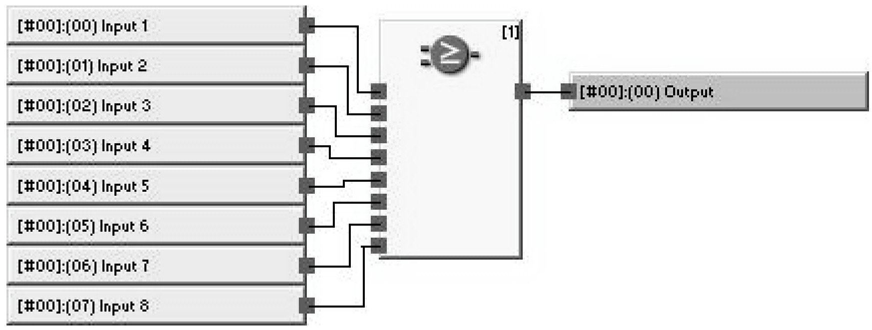
Fault conditions and reset information

Logical functions do not monitor fault conditions.

7.5.3 Function block OR

Function block diagram

Fig. 42: Function block diagram for function block OR



General description

Output will be **Active** when **any** of the inputs being evaluated are **Active**. Up to eight (8) inputs may be evaluated.

Truth table for one (1) input OR evaluation

Truth tables for one through eight inputs are shown below. For these truth tables, the following nomenclature applies:

- “0” means logical low, **Inactive**
- “1” means logical high, **Active**
- “x” means “don’t care” = “0” or “1”

Tab. 52: Truth table for one (1) input OR evaluation

Input 1	Output
0	0
1	1

Truth table for two (2) input OR evaluation

Tab. 53: Truth table for two (2) input OR evaluation

Input 1	Input 2	Output
0	0	0
1	x	1
x	1	1

Truth table for three (3) input OR evaluation

Tab. 54: Truth table for three (3) input OR evaluation

Input 1	Input 2	Input 3	Output
0	0	0	0
1	x	x	1
x	1	x	1
x	x	1	1

Truth table for four (4) input OR evaluation

Tab. 55: Truth table for four (4) input OR evaluation

Input 1	Input 2	Input 3	Input 4	Output
0	0	0	0	0
1	x	x	x	1
x	1	x	x	1
x	x	1	x	1
x	x	x	1	1

Truth table for five (5) input OR evaluation

Tab. 56: Truth table for five (5) input OR evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Output
0	0	0	0	0	0
1	x	x	x	x	1
x	1	x	x	x	1
x	x	1	x	x	1
x	x	x	1	x	1
x	x	x	x	1	1

Truth table for six (6) input OR evaluation

Tab. 57: Truth table for six (6) input OR evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Output
0	0	0	0	0	0	0
1	x	x	x	x	x	1
x	1	x	x	x	x	1
x	x	1	x	x	x	1
x	x	x	1	x	x	1
x	x	x	x	1	x	1
x	x	x	x	x	1	1

Truth table for seven (7) input OR evaluation

Tab. 58: Truth table for seven (7) input OR evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Input 7	Output
0	0	0	0	0	0	0	0
1	x	x	x	x	x	x	1
x	1	x	x	x	x	x	1
x	x	1	x	x	x	x	1
x	x	x	1	x	x	x	1
x	x	x	x	1	x	x	1
x	x	x	x	x	1	x	1
x	x	x	x	x	x	1	1

Truth table for eight (8) input OR evaluation

Tab. 59: Truth table for eight (8) input OR evaluation

Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Input 7	Input 8	Output
0	0	0	0	0	0	0	0	0
1	x	x	x	x	x	x	x	1
x	1	x	x	x	x	x	x	1
x	x	1	x	x	x	x	x	1
x	x	x	1	x	x	x	x	1
x	x	x	x	1	x	x	x	1
x	x	x	x	x	1	x	x	1
x	x	x	x	x	x	1	x	1
x	x	x	x	x	x	x	1	1

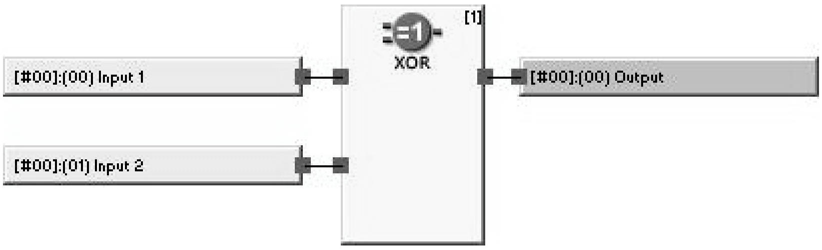
Fault conditions and reset information

Logical functions do not monitor fault conditions.

7.5.4 Function block Exclusive OR (XOR)

Function block diagram

Fig. 43: Function block diagram for function block Exclusive OR (XOR)



General description

Output will be **Active** when the inputs being evaluated are complementary (e.g. different states; one input **Active** (logical “1”) and one input **Inactive**) to one another. Only two (2) inputs may be evaluated.

Truth table for XOR evaluation

For the truth table, the following nomenclature applies:

- “0” means logical low, **Inactive**
- “1” means logical high, **Active**

Tab. 60: Truth table for XOR evaluation

Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	0

Fault conditions and reset information

Logical functions do not monitor fault conditions.

7.5.5 Function block Exclusive NOR (XNOR)

Function block diagram

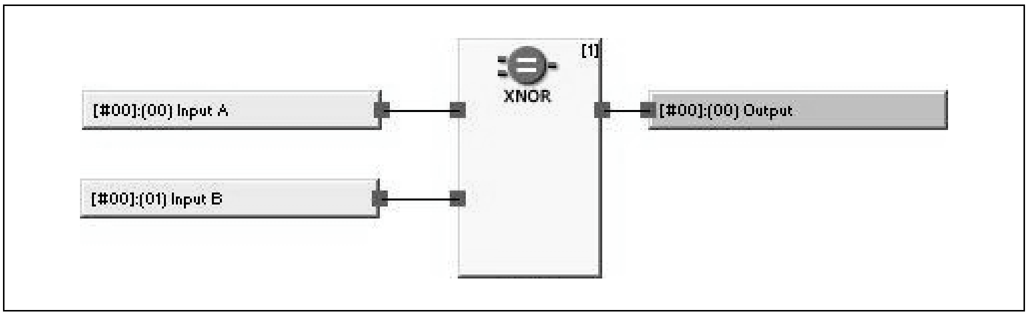


Fig. 44: Function block diagram for function block Exclusive NOR (XNOR)

General description

Output will be **Active** when the inputs being evaluated are equivalent (e.g. both inputs **Active** (logical "1") or both inputs **Inactive**. Only two (2) inputs may be evaluated.

Truth table for XNOR evaluation

For the truth table, the following nomenclature applies:

- "0" means logical low, **Inactive**
- "1" means logical high, **Active**

Tab. 61: Truth table for XNOR evaluation

Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	1

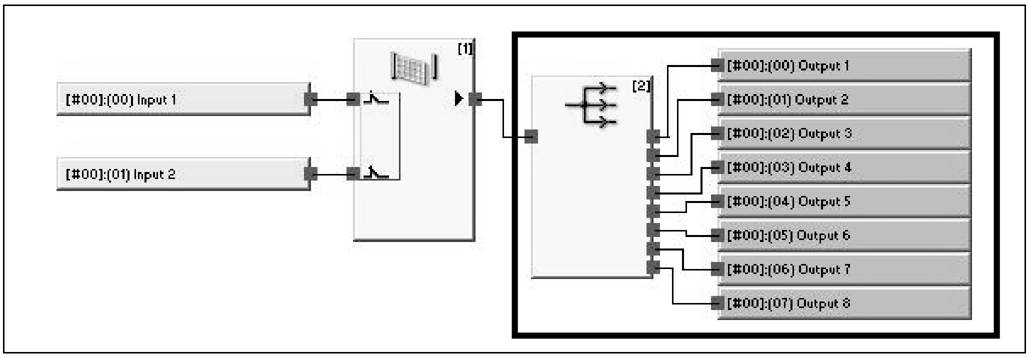
Fault conditions and reset information

Logical functions do not monitor fault conditions.

7.5.6 Function block Routing (ROUTE)

Function block diagram

Fig. 45: Function block diagram for function block Routing (ROUTE)



General description

The ROUTE function block provides the ability to route one (1) input signal from a previous function block to a maximum of eight (8) output signals. The input signal may be from a previous function block or directly from a physical input (either locally on the UE4427 or UE4457 or from a remote input device e.g. UE4470 safety network controller).

Truth table for ROUTE evaluation

For the truth table, the following nomenclature applies:

- "0" means logical low, **Inactive**
- "1" means logical high, **Active**
- "x" means "don't care" = "0" or "1"

Tab. 62: Truth table for ROUTE evaluation

Input 1	Fault present	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6	Output 7	Output 8
0	0	0	0	0	0	0	0	0	0
1	0	1	1	1	1	1	1	1	1
x	1	0	0	0	0	0	0	0	0

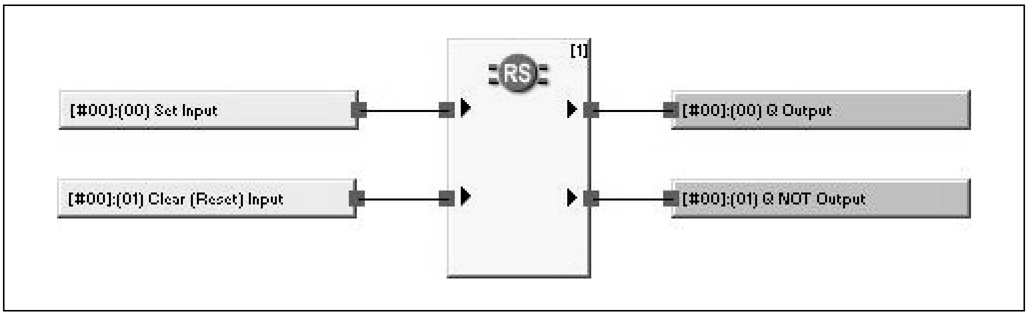
Fault conditions and reset information

Logical functions do not monitor fault conditions.

7.5.7 RS Flip-Flop function block

Function block diagram

Fig. 46: Logic connections for RS Flip-Flop function block



General description

The RS Flip-Flop function block stores the last Set or Clear (Reset) Input value. It is used as a simple memory cell. The Clear (Reset) signal has a higher priority than the Set signal. When the Set Input was last **Active**, the Q Output will be **Active** and the Q Not Output will be **Inactive**. When the Clear (Reset) Input was last **Active**, the Q Output will be **Inactive** and the Q Not Output will be **Active**.

Truth table for RS Flip-Flop function block

For the truth table identified in this section, the following applies:

- "0" means logical low, **Inactive**
- "1" means logical high, **Active**
- "n-1" refers to previous value
- "n" refers to current value

Tab. 63: Truth table for RS Flip-Flop function block

Set Input	Reset Input	Q Output $_{n-1}$	Q Output $_{n}$	Q Not Output $_{n}$
0	0	0	0	1
0	0	1	1	0
0	1	0	0	1
0	1	1	0	1
1	0	0	1	0
1	0	1	1	0
1	1	0	0	1
1	1	1	0	1

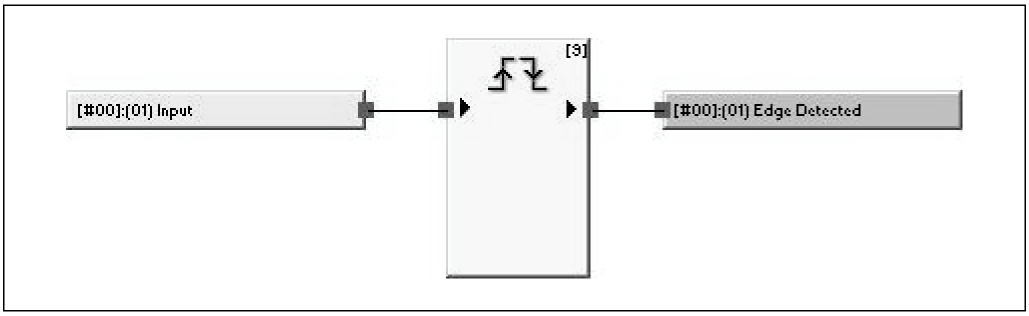
Fault conditions and reset information

This function block does not monitor for fault conditions.

7.5.8 Edge Detection function block

Function block diagram

Fig. 47: Logic implementation for Edge Detection function block



General description

The Edge Detection function block enables users to detect the rising edge or falling edge of the input signal. The function block can be configured to detect a rising edge, a falling edge or both. When an edge is detected according to parameter setting, the Edge Detected output will be **Active** (High) for one controller cycle (= 5 ms).

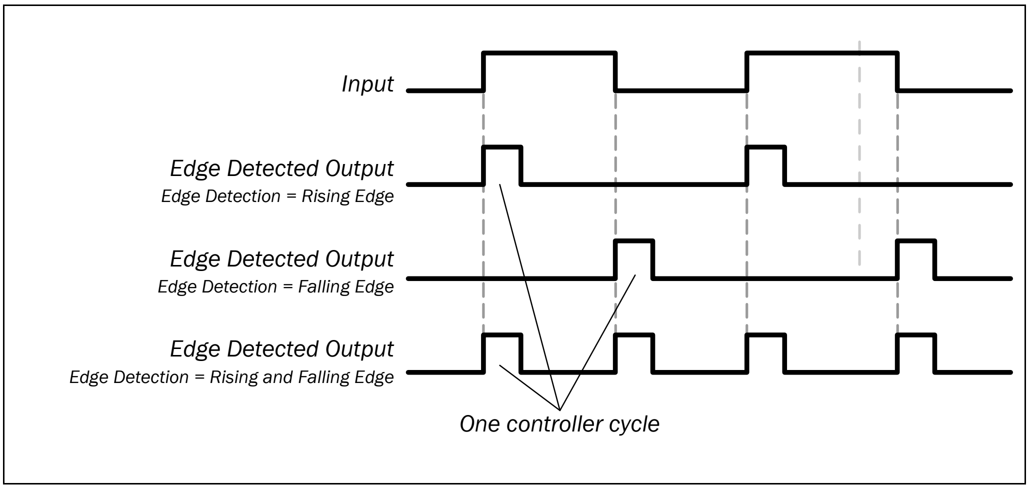
Function block parameters

Tab. 64: Input parameters for Edge Detection function block

Parameter	Possible parameter values	Default configuration
Edge Detection	• Rising edge • Falling edge • Rising and falling edge	Rising edge

Logic/timing diagram

Fig. 48: Edge Detection function block timing diagram



Fault conditions and reset information

The Edge Detection function block does not monitor for fault conditions.

7.5.9 Clock Generator function block

Function block diagram

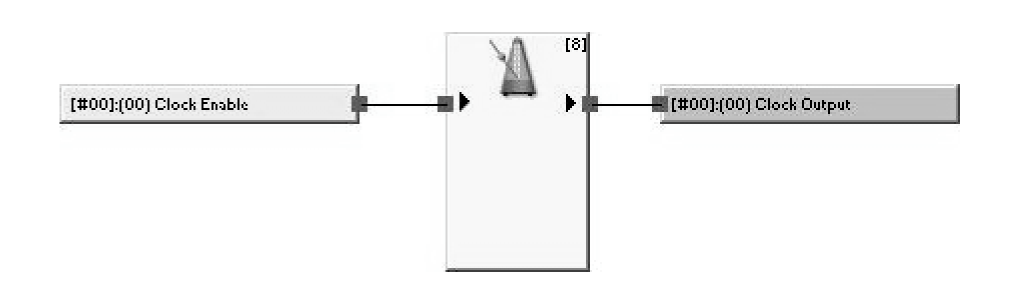


Fig. 49: Logic connections for Clock Generator function block

General description

The Clock Generator function block enables users to define a pulsed clock output. When Clock Enable is **Active** (High) the Clock Output will pulse from **Inactive** (Low) to **Active** (High) according to the function block parameters. The Clock Output will be set **Inactive** (Low) when Clock Enable is **Inactive** (Low) according to the function block parameters.

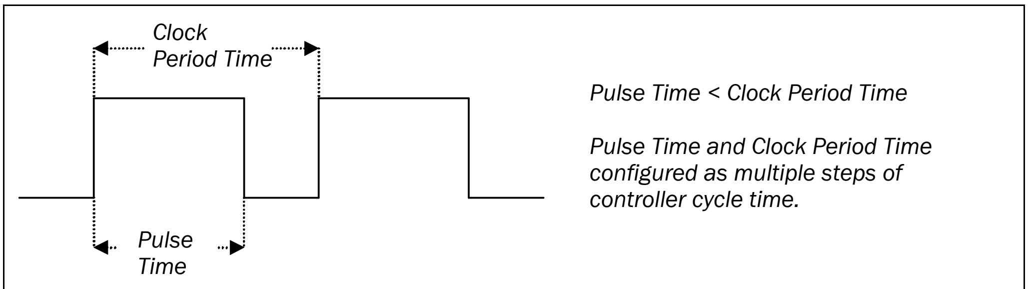


Fig. 50: Clock Generator parameters diagram

Function block parameters

Tab. 65: Input parameters for Clock Generator function block

Parameter	Possible parameter values	Default configuration
Stopping Mode	• Immediately • After last clock cycle	After last clock cycle
Clock Period	A configurable parameter based on multiples of the controller cycle time. Range is from 2 to 65 535 controller cycles.	2 controller cycles
Pulse Time	A configurable parameter based on multiples of the controller cycle time. Range is from 1 to 65 534 controller cycles. The pulse time must be less than the clock period time parameter.	1 controller cycle

Logic/timing diagram

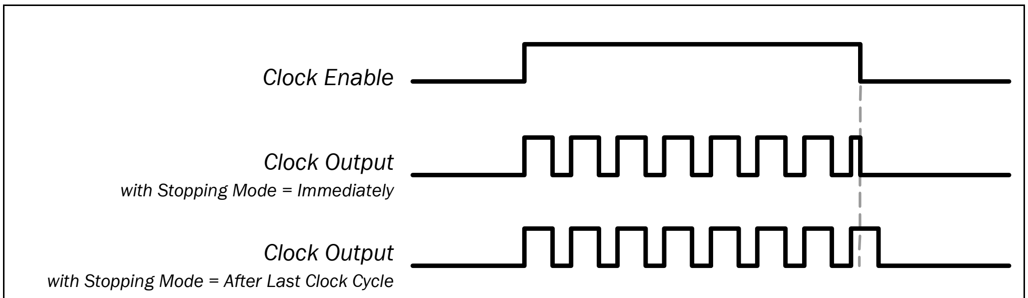


Fig. 51: Clock Generator function block timing diagram

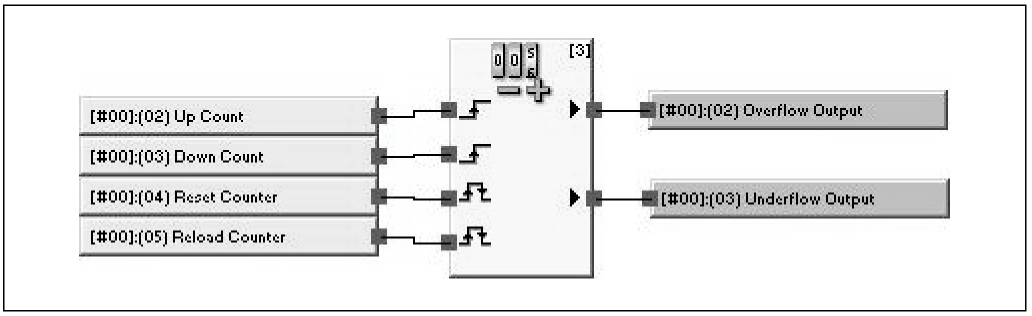
Fault conditions and reset information

The Clock Generator function block does not monitor for fault conditions.

7.5.10 UP, DOWN and UP/DOWN Event Counter function blocks

Function block diagrams

Fig. 52: Logic connections for UP/DOWN Event Counter function block



General description

The UP, DOWN and UP/DOWN Event Counter function blocks each have an internal counter value that counts up or down based on the input states of the Up Count or Down Count inputs. While counting up (i.e. incrementing), the Overflow Output will be set **Active** (High) when the overflow limit value has been reached. When counting down (i.e. decrementing), the Underflow Output will be set **Active** (High) when the internal counter value has reached a value of “0”. Configuration parameters allow the user to define whether the internal counter is automatically reset or reloaded.

A transition from **Inactive** (Low) to **Active** (High) i.e. “rising edge” at the Up Count input increments the internal counter value by “1”.

A transition from **Inactive** (Low) to **Active** (High) i.e. “rising edge” at the Down Count input decrements the internal counter value by “1”.

When a transition from **Inactive** (Low) to **Active** (High) i.e. “rising edge” occurs at both the Up Count and Down Count inputs (applies only to UP/DOWN event counter function block), the internal counter value will remain unchanged.

Function block input parameters

Tab. 66: Parameter values for UP, DOWN and UP/DOWN Event Counter function blocks

Parameter	Possible parameter values	Default configuration
Reset Counter	• Manual reset • Automatic reset	Function block dependent
Reload Counter	• Manual reload • Automatic reload	
Overflow Limit	Integer value from 1 to 65 535. The Overflow Limit value must be greater than or equal to the Reload Value.	
Reload Value	Integer value from 1 to 65 535	
Minimum Reset Pulse Time	• 100 ms • 350 ms	350 ms
Minimum Reload Pulse Time	• 100 ms • 350 ms	350 ms

Reset Counter

The Reset Counter parameter defines what occurs when the Event Counter value reaches the Overflow Limit. When this parameter is configured for automatic reset and the internal count is equal to the Overflow Limit, the Overflow Output will be **Active** (High) for one cycle in the controller and then the internal counter value will be set back to "0".

When the Reset Counter parameter is configured as manual reset and the Overflow Limit has been reached, the Overflow Output is set **Active** (High). When the Reset Counter input transitions from **Inactive** (Low) to **Active** (High) to **Inactive** (Low) in accordance with the Minimum Reset Pulse Time parameter, the counter value will be set back to "0". Any subsequent "Up" counts, prior to a valid Reset Counter input condition, will be ignored.

Note When the Reset Counter input transitions from **Inactive** (Low) to **Active** (High) to **Inactive** (Low) in accordance with the Minimum Reset Pulse Time parameter, the counter value will be set back to "0", regardless of whether or not the Overflow Limit value has been reached.

Reload Counter

The Reload Counter parameter defines what occurs when the Event Counter value reaches "0". When this parameter is configured for automatic reload and the internal count is equal "0", the Underflow Output will be **Active** (High) for one cycle in the controller after which the internal counter value will be set back to Reload Value.

When the Reload Counter parameter is configured as manual reload and the Underflow Limit has been reached, i.e. "0", the Underflow Output is set **Active** (High). When Reload Counter input transitions from **Inactive** (Low) to **Active** (High) to **Inactive** (Low) in accordance with the Minimum Reload Pulse Time parameter, the internal counter value will be set back to Reload Value. Any subsequent "Down" counts, prior to a valid Reload Counter input condition, will be ignored.

Note When the Reload Counter input transitions from **Inactive** (Low) to **Active** (High) to **Inactive** (Low) in accordance with the Minimum Reload Pulse Time parameter, the counter value will be set back to the Reload value, regardless of whether or not "0" has been reached.

Overflow Limit

The Overflow Limit value defines the upper limit of the internal counter. When the internal counter reaches the Overflow Limit value (i.e. upper limit reached), the Overflow output transitions to **Active** (High) until a valid Counter Reset sequence occurs. When the Counter Reset is configured for automatic reset, the Overflow output will be **Active** (High) for one controller cycle. The controller cycle time is calculated by the device configuration tool. Valid values for the Overflow Limit are from 1 to 65 535. Default Overflow Limit value is 1000.

Reload Value

The Reload Value defines the initial value of the internal counter for down counting (decrement) applications. When the internal counter reaches "0" (i.e. lower limit reached), the Underflow output transitions to **Active** (High) until a valid Counter Reload sequence occurs. When the Counter Reload is configured for automatic reload, the Underflow output will be **Active** (High) for one controller cycle. The controller cycle time is calculated by the device configuration tool. Valid values for the Reload Value are from 1 to 65 535. Default Reload Value is 1000.

Minimum Reset Pulse Time

The Minimum Reset Pulse Time defines the minimum length of the **Active** (High) portion of an **Inactive** to **Active** to **Inactive** sequence that resets the internal counter value back to "0". Valid values are 100 ms and 350 ms. The default value is 350 ms. The maximum valid Reset Pulse Time is 30 s (not configurable).

WARNING

Ensure that transitions of Reset and Reload signals satisfy requirements!

In order for the controller to detect a stuck at high (i.e. short to 24 V DC) condition at the Reset or Reload inputs, the Minimum Reset Pulse Time/Minimum Reload Pulse Time must be set to 350 ms and use a test output referenced to the Reset and Reload inputs. This ensures that internal testing verifies that a short circuit has not occurred.

If you elect to utilize 100 ms as the Minimum Reset Pulse Time or the Minimum Reload Pulse Time, you must also ensure that signal transitions caused by a stuck at high condition (e.g. transition from **Inactive** (Low) to **Active** (High) (i.e. short circuit to 24 V DC) to **Inactive** (Low) at the signal input) do not lead to a valid reset or reload sequence. The Reset and Reload inputs cannot be referenced to test outputs in this case.

Minimum Reload Pulse Time

The Minimum Reload Pulse Time defines the minimum length of the **Active** (High) portion of an **Inactive** to **Active** to **Inactive** sequence that reloads the internal counter value with the Overflow Limit value. Valid values are 100 ms and 350 ms. The default value is 350 ms. The maximum valid Reload Pulse Time is 30 s (not configurable).

Truth table for UP and/or DOWN Event Counter function blocks

For the truth table identified in this section, the following applies:

- “0” means logical low, **Inactive**
- “1” means logical high, **Active**
- “↑” refers rising edge detected at the signal input
- “n-1” refers to previous value
- “n” refers to current value
- “Y” refers to the internal counter value
- “X” represents “Don’t care” e.g. Reset has priority over Up and Down states

Tab. 67: Truth table for UP and/or DOWN Event Counter function blocks

Up	Down	Reset	Reload	Counter value $_{n-1}$	Counter value $_n$	Overflow	Underflow
↑	0	0	0	Y	Y+1	0	0
↑	1	0	0	Y	Y+1	0	0
↑	0	0	0	Y	Y+1 = overflow limit	1	0
↑	0	0	0	Y = overflow limit	Y = overflow limit	1	0
0	↑	0	0	Y	Y-1	0	0
1	↑	0	0	Y	Y-1	0	0
0	↑	0	0	Y	Y-1 = 0	0	1
0	↑	0	0	Y = 0	Y = 0	0	1
↑	↑	0	0	Y	Y	0	0
X	X	1	0	Y	Reset to 0	0	0
X	X	0	1	Y	Reload set value	0	0
X	X	1	1	Y	Reset to 0	0	0

Fault conditions and reset information

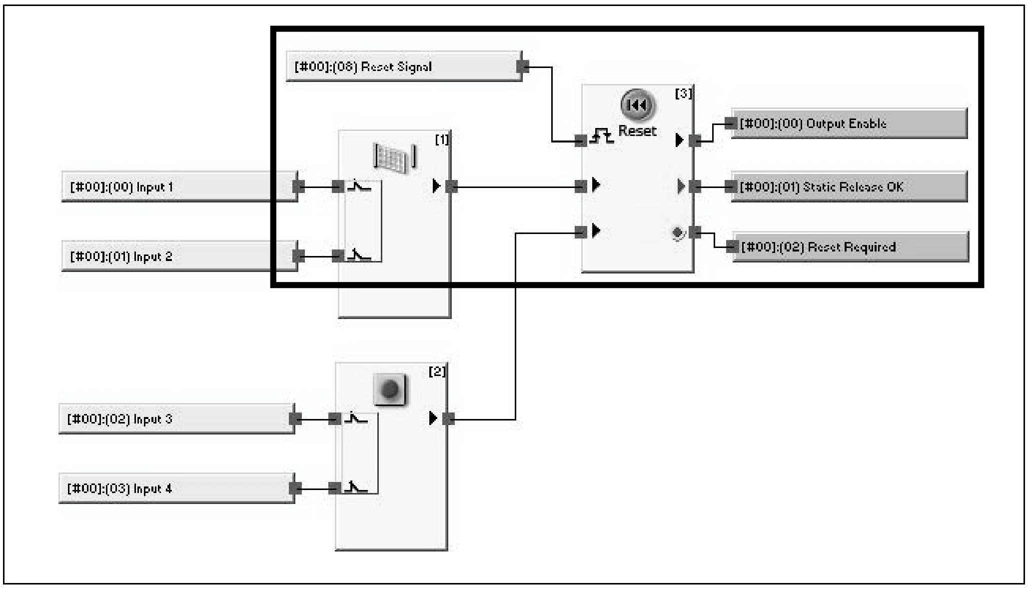
This function block does not monitor fault conditions.

7.6 Application specific function blocks

7.6.1 Function block RESET

Function block diagram

Fig. 53: Function block diagram for function block RESET



General description

To fulfill safety application standards regarding the acknowledgement and clearing of a manual safety stop and the subsequent request for an application restart, a Reset function block should be used in every safety logic chain.

The reset signal should be from a normally open contact with test pulse monitoring.

The above example shows how two safety capable input signals (one from a safety gate (SGATE) function block and one from an emergency stop (ESTOP) function block) are connected to the RESET function block. Required inputs are Reset Signal and one (1) monitored safety capable input signal. An additional six (6) safety capable input signals may also be monitored.

The SGATE and ESTOP signals are internally combined. If any safety capable input signal that is being monitored becomes **Inactive**, Output Enable will also be set to **Inactive** and remain in an **Inactive** state until a successful reset sequence occurs.

When all monitored safety capable input signals return to **Active**, the Static Release OK and Reset Required outputs will be set to **Active** (e.g. logical “1” and 1 Hz pulsed respectively). This indicates that the function block is waiting for a RESET signal sequence.

A successful reset sequence occurs when all monitored safety capable input signals remain **Active** and the Reset Signal transitions from low (e.g. logical “0”) to high (e.g. logical “1”) to low (e.g. logical “0”) subsequent to the Reset Required output becoming **Active**. In this transition sequence, the high signal must be present for a minimum of 350 ms.

WARNING

Ensure that transitions of Reset signals satisfy requirements!

In order for the controller to detect a stuck at high (i.e. short to 24 V DC) condition at the Reset input, the Minimum Reset Pulse Time must be set 350 ms and use a test output referenced to the Reset input. This ensures that internal testing verifies that a short circuit has not occurred.

If you elect to utilize 100 ms as the Minimum Reset Pulse Time, you must also ensure that signal transitions caused by a stuck at high condition (e.g. transition from **Inactive** (Low) to **Active** (High) (i.e. short circuit to 24 V DC) to **Inactive** (Low) at the signal input) do not lead to a valid reset sequence. The Reset cannot be referenced to a test output when 100 ms has been specified.

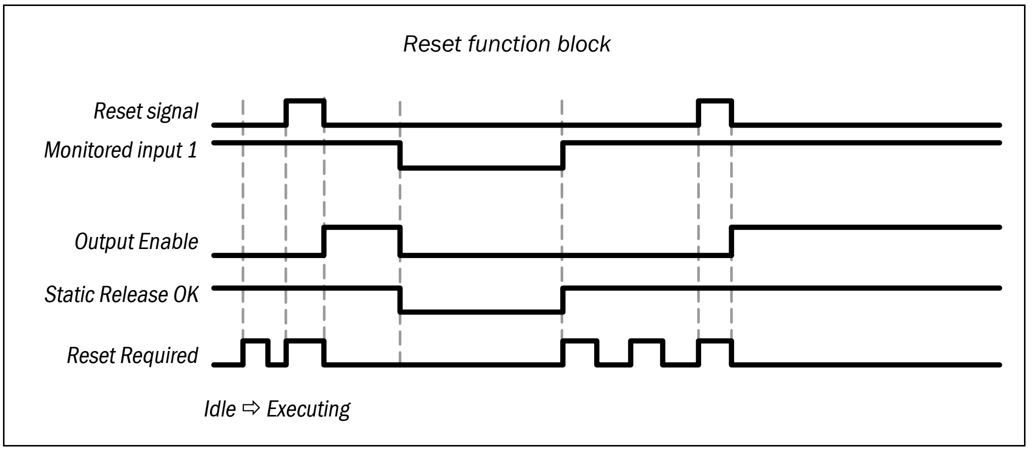
When a successful reset sequence occurs, Output Enable will be set to **Active** and Reset Required output will be set to **Inactive**. Additional specific RESET sequence behavior is identified below. Each defined step must occur sequentially — the UE4427 or UE4457 will not progress to the next step until the conditions outlined in the current step are satisfied.

RESET requirements when monitored safety capable input is Inactive or transition of UE4427/UE4457 from IDLE mode to EXECUTION mode:

1. Output Enable is set **Inactive**.
2. Static Release OK output is set **Inactive**.
3. Reset Required output is set **Inactive**.
4. All monitored safety capable input signals are **Active**.
5. Static Release OK output is set **Active**.
6. Reset Required output is set **Active** (e.g. 1Hz Pulse)
7. A successful Reset sequence occurs (see previous paragraphs).
8. Output Enable is set **Active**.
9. Reset Required output is set **Inactive**.

Logic diagrams/timing diagrams

Fig. 54: Logic diagram/timing diagram for function block Reset



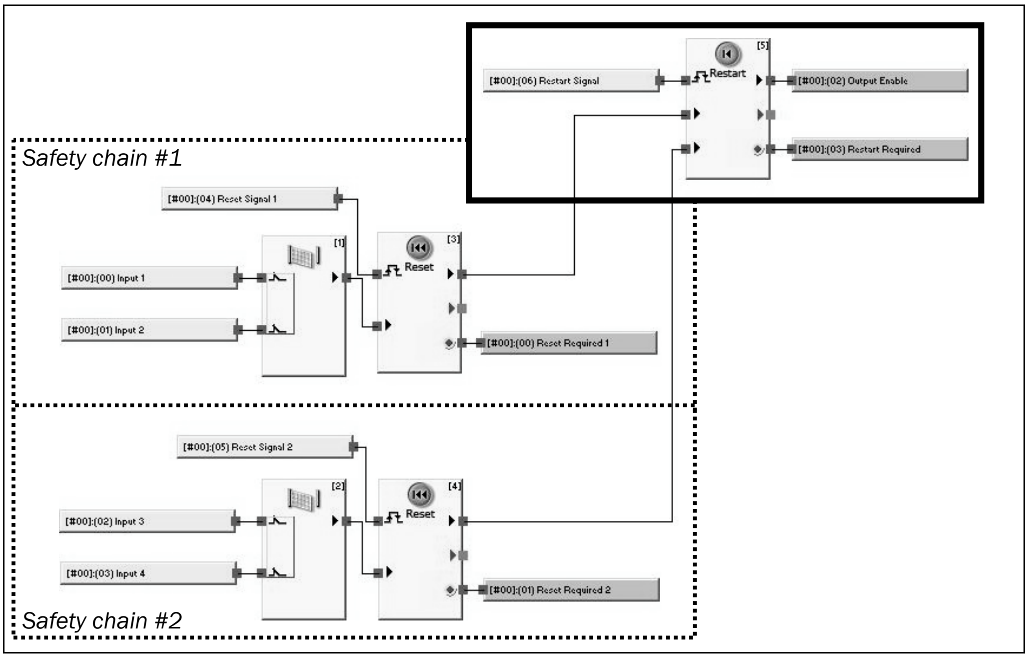
Fault conditions and reset information

Reset and Restart function blocks do not monitor fault conditions.

7.6.2 Function block RESTART

Function block diagram

Fig. 55: Function block diagram for function block RESTART



General description

The internal logic associated with the RESTART function block is functionally equivalent to the RESET function block. The RESTART function block is provided for clarity in satisfying application standards regarding the acknowledgement and clearing of manual restart requirements.

The restart signal should be from a normally open contact with test pulse monitoring.

The above example shows how two manual reset output signals are connected to the safety capable inputs of the RESTART function block. Required inputs are Restart Signal and a minimum of one (1) monitored safety capable input signal e.g. (from RESET function block output). An additional six (6) safety capable input signals may also be monitored.

The RESTART function block input signals are internally combined. If any safety capable input signal that is being monitored transitions to **Inactive**, Output Enable will be set to **Inactive** until a successful restart sequence occurs.

When all monitored safety capable input signals (e.g. RESET function block outputs) return to **Active**, the Static Release OK and Restart Required outputs will be set to **Active** (e.g. logical "1" and 1 Hz pulsed respectively). This indicates that the function block is waiting for a RESTART signal sequence.

A successful RESTART sequence occurs when all monitored safety capable input signals are **Active** and the Restart Signal transitions from low (e.g. logical "0") to high (e.g. logical "1") to low (e.g. logical "0") subsequent to the Restart Required output becoming **Active** (e.g. 1Hz Pulse). In this transition sequence, the high signal must be present for a minimum of 350 ms.

WARNING

Ensure that transitions of Restart signals satisfy requirements!

In order for the controller to detect a stuck at high (i.e. short to 24 V DC) condition at the Restart input, the Minimum Restart Pulse Time must be set to 350 ms and use a test output referenced to the Restart input. This ensures that internal testing verifies that a short circuit has not occurred. If you elect to utilize 100 ms as the Minimum Restart Pulse Time, you must also ensure that signal transitions caused by a stuck at high condition (e.g. transition from **Inactive** (Low) to **Active** (High) (i.e. short circuit to 24 V DC) to **Inactive** (Low) at the signal input) do not lead to a valid restart sequence. The Restart cannot be referenced to a test output when 100 ms has been specified.

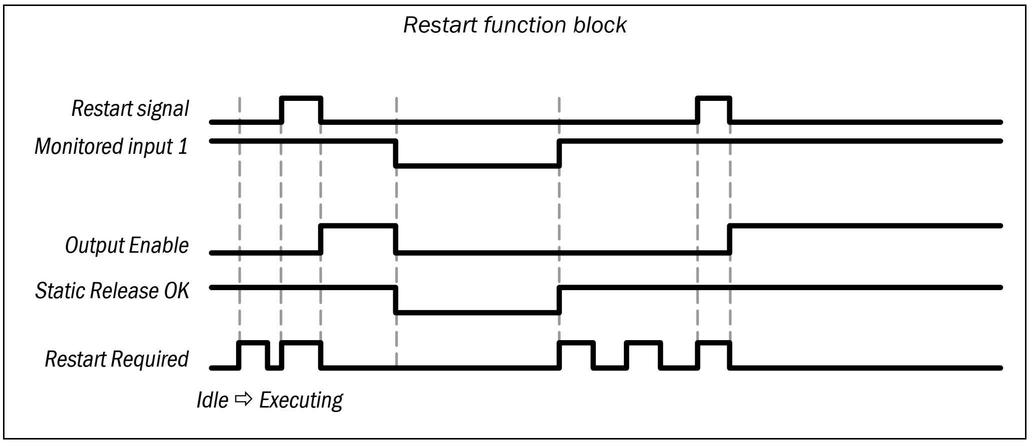
When a successful RESTART sequence occurs, Output Enable will be set to **Active** and Restart Required output will be set to **Inactive**. Additional specific RESTART sequence behavior is identified below. Each defined step must occur sequentially - the UE4427 or UE4457 will not progress to the next step until the conditions outlined in the current step are satisfied.

RESTART requirements when monitored safety capable input is Inactive or transition of UE4427/UE4457 from IDLE mode to EXECUTION mode:

1. Output Enable is set **Inactive**.
2. Static Release OK output is set **Inactive**.
3. Restart Required output is set **Inactive**.
4. All monitored safety capable input signals are **Active**.
5. Static Release OK output is set **Active**.
6. Restart Required output is set **Active** (e.g. 1Hz Pulse)
7. A successful Restart sequence occurs (see previous paragraphs).
8. Output Enable is set **Active**.
9. Restart Required output is set **Inactive**.

Logic diagrams/timing diagrams

Fig. 56: Logic diagram/timing diagram for function block Restart



Fault conditions and reset information

Reset and Restart functions do not monitor fault conditions.

7.6.3 Function block Two-Hand Control (THC)

Function block diagram

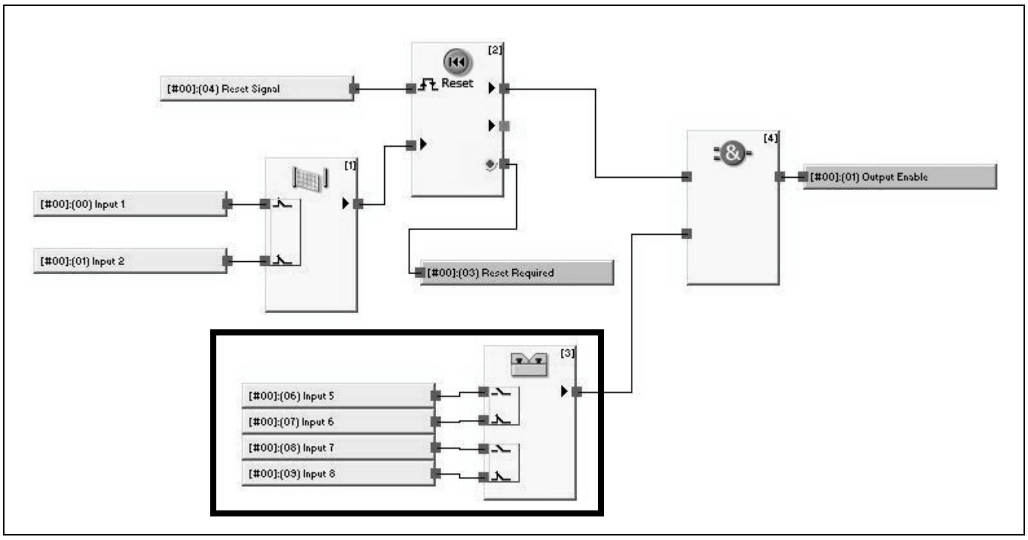


Fig. 57: Function block diagram for function block Two-Hand Control (THC)

General description

The Two Hand Control (THC) function block provides a logical function that monitors the inputs of a two hand control device in accordance with EN 574.

Inputs to this function block are evaluated as pairs. Input 1 and Input 2 are paired for evaluation and must be complementary to one another. Input 3 and Input 4 are paired for evaluation and must also be complementary to one another. Discrepancy time for each of the input pairs may be specified.

The synchronization time, the amount of time in which the evaluation of input pairs is discrepant. As defined in standards and regulations, the synchronization time for two-hand control evaluation cannot exceed 500 ms (synchronization time is a fixed parameter that cannot be changed).

If both inputs of a configured dual-channel input pair are connected with the same input bit, it is assumed that the dual-channel evaluation is performed by a remote input/output device (e.g. internal to the UE4427 or UE4457; see **Device Type UE4400**, tab **I/O Configuration**) rather than by the function block. In this case the following actions are taken by the function:

- The value of the second input is ignored
- Configured discrepancy time for the input pair is ignored

Output Enable will only be **Active** if both dual-channel evaluations are actuated within the synchronization time of 500 ms. If the synchronization time limit of 500 ms is exceeded, then Output Enable remains **Inactive** until both dual-channel evaluations have returned to an **Inactive** state and then both become **Active** within the discrepancy and synchronization time parameters.

Failure to meet the synchronization time parameters is **not** considered a fault.

Failure to meet the discrepancy time parameters is considered a fault.

If the discrepancy time parameters are not met or an input error is present, Output Enable will be set to **Inactive** (e.g., fault detected) and Fault Present will be set to **Active**.

When either dual-channel evaluation transitions to an **Inactive** state (e.g. logical "0"), Output Enable is set to **Inactive** and will remain **Inactive** until both dual-channel evaluations have attained an **Inactive** state. Only after both dual-channel evaluations transition from an **Inactive** state (e.g. logical "0") to an **Active** state (e.g. logical "1") within the discrepancy and synchronization parameters will Output Enable will be set to **Active**.

The THC Function Block requires an **Inactive** to **Active** transition to change the Output Enable to the **Active** state (e.g. logical "1"). If either one or both dual-channel evaluations are **Active** at the Idle -> Executing transition, Output Enable will not become **Active** until both dual-channel evaluations are **Inactive** and then **Active** in accordance with the requirements of the THC function block.

Function block input parameters

Tab. 68: Input parameters for function block Two-Hand Control (THC)

Parameter	Possible parameter values	Default configuration
Input type	Two dual-channel complementary	Two dual-channel complementary
Discrepancy time input pair 1/2	**Inactive** (= 0 ms), 10 ms … 30,000 ms in 10 ms increments. When **Active**, the setting for the discrepancy time must be greater than the scan time of the UE4427 or UE4457	30 ms
Discrepancy time input pair 3/4	**Inactive** (= 0 ms), 10 ms … 30,000 ms in 10 ms increments. When **Active**, the setting for the discrepancy time must be greater than the scan time of the UE4427 or UE4457.	30 ms
Synchronization time	Fixed at 500 ms	500 ms

Additional information regarding these parameters is presented in section 7.3 "Function block input and output signal connections" on page 70 and in section 7.4 "Function block parameterization" on page 77.

Function block output parameters

The following additional error outputs are available:

Tab. 69: Output parameters for function block Two-Hand Control (THC)

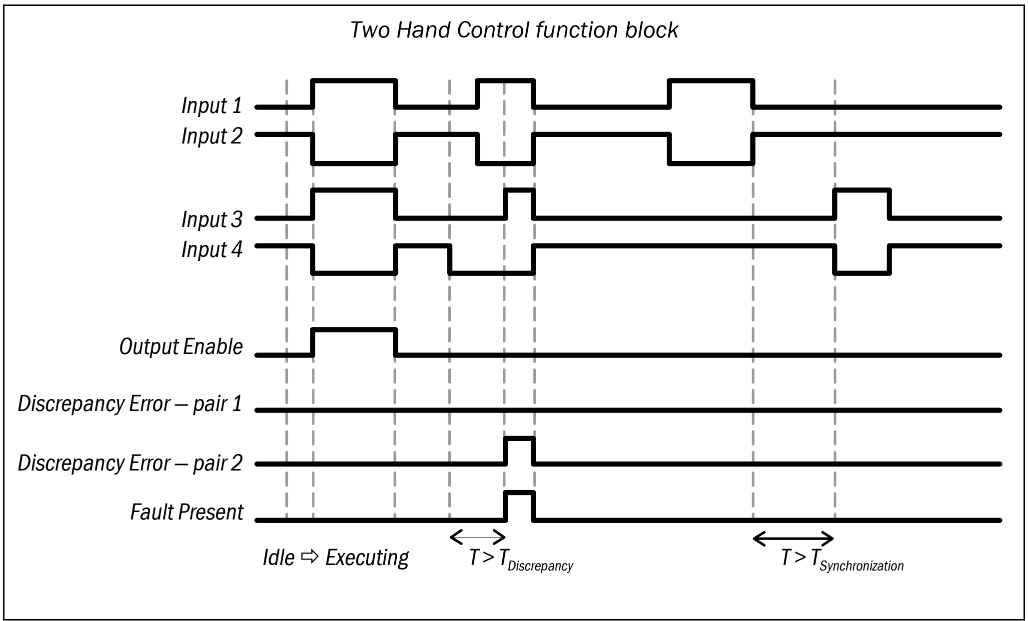
Optional function block output connections
Discrepancy Error — inputs 1/2
Discrepancy Error — inputs 3/4
Fault Present

Access to these output connections is obtained by increasing the number of outputs indicated in the In/Out Setting tab of the function block properties dialog.

Additional information regarding these parameters is presented in section 7.3 "Function block input and output signal connections" on page 70 and in section 7.4 "Function block parameterization" on page 77.

Logic diagrams/timing diagrams

Fig. 58: Logic diagram/timing diagram for function block Two-Hand Control (THC)



Fault conditions and reset information

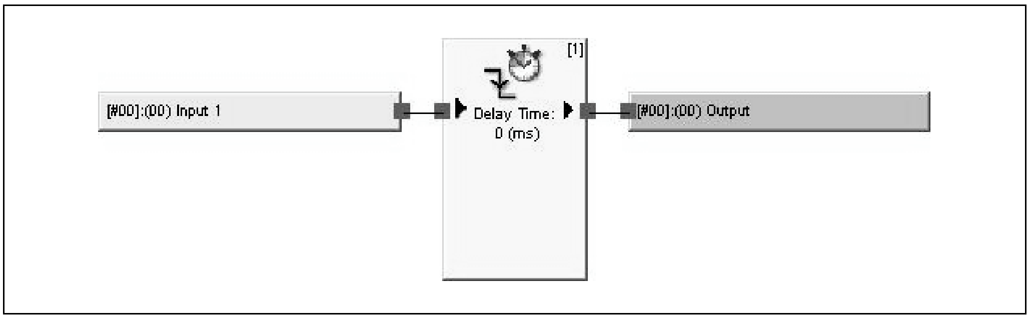
Tab. 70: Fault conditions and reset information for function block Two-Hand Control (THC)

Diagnostic outputs	Fault condition	Reset of fault condition	Comments
Discrepancy Error	**Active**	Before a discrepancy error can be reset, the dual-channel input evaluation must be **Inactive**. Discrepancy Error will be set to "0" when both inputs return to an **Active** state and no fault reason exists.	Output Enable will be **Inactive** and Fault Present will be **Active** when Discrepancy Error is **Active**

7.6.4 Function block OFF-Delay Timer (OFF DELAY)

Function block diagram

Fig. 59: Function block diagram for function block OFF-Delay Timer (OFF DELAY)



General description

The OFF-Delay Timer function block provides the user with the ability to adjust the output signal by a fixed time delay. The range for this delay is from 10 ms to 300 seconds in 10 millisecond increments. A delay time of 0 seconds is also valid and is used for no delay. When specified, the delay time must be greater than the UE4427 or UE4457 scan time.

For OFF-Delay function, the timer will begin its timing sequence when the input changes from **Active** to **Inactive**. When Input 1 is **Active**, Output will also be **Active** and will remain **Active** until the timer has timed for the defined duration after the input has switched to **Inactive**.

Function block input parameters

Tab. 71: Input parameters for function block OFF-Delay Timer (OFF DELAY)

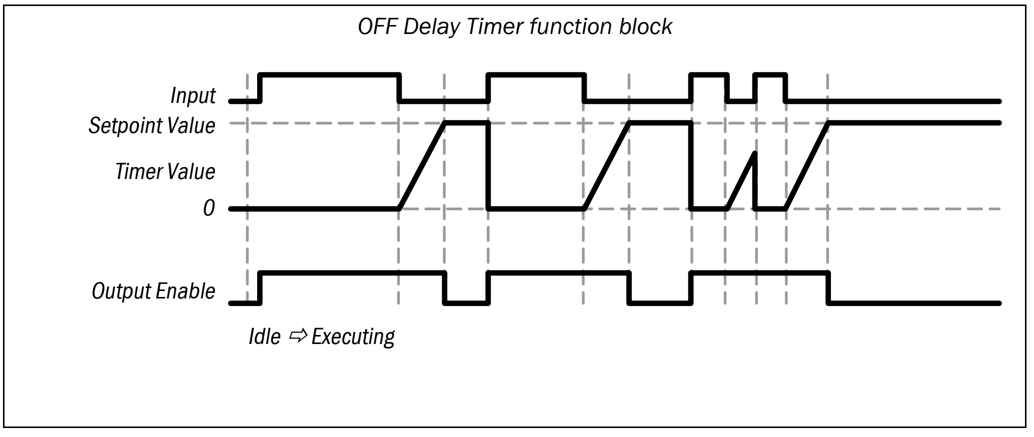
Parameter	Possible parameter values	Default configuration
Off delay time	Off delay time (t): 0 … 300 seconds in 10 ms increments. When **Active**, the off-delay time specified must be greater than the scan time of the UE4427 or UE4457.	0 ms

Function block output parameters

No error outputs are available.

Logic diagrams/timing diagrams

Fig. 60: Logic diagram/timing diagram for function block OFF-Delay Timer (OFF DELAY)



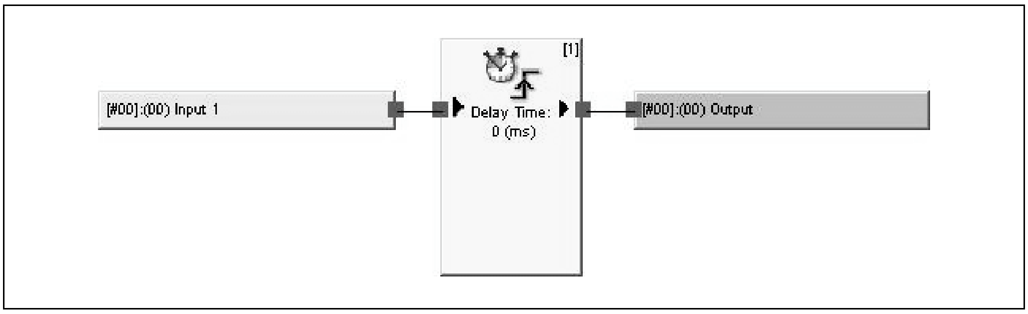
Fault conditions and reset information

Timing functions do not monitor fault conditions.

7.6.5 Function block ON-Delay Timer (ON DELAY)

Function block diagram

Fig. 61: Function block diagram for function block ON-Delay Timer (ON DELAY)



General description

The ON Delay Timer function block provides the user with the ability to adjust the output signal by a fixed time delay. The range for this delay is from 10 ms to 300 seconds in 10 ms increments. A delay time of 0 seconds is also valid and is used for no delay. If **Active**, the delay time must be greater than the scan time of the UE4427 or UE4457.

For ON-delay function, the timer begins its timing sequence when Input 1 becomes **Active**. Once the timing sequence is completed, Output will be **Active** until Input 1 is **Inactive**.

Function block input parameters

Tab. 72: Input parameters for function block ON-Delay Timer (ON DELAY)

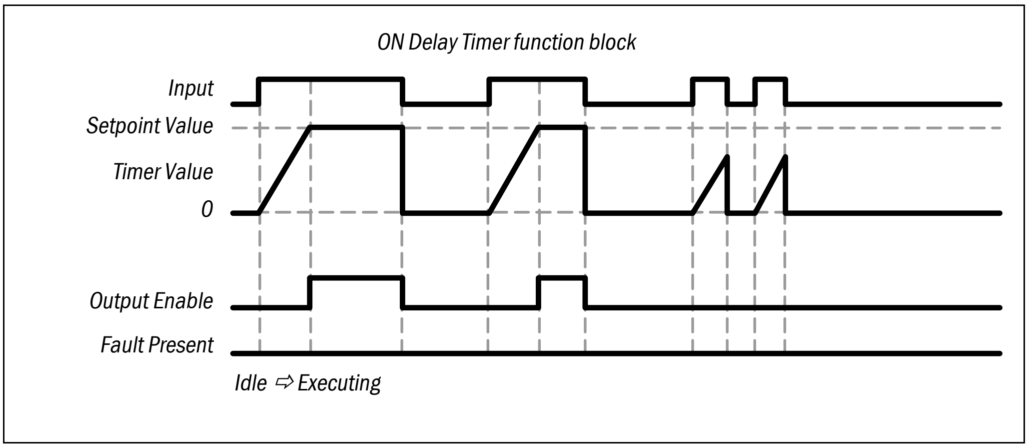
Parameter	Possible parameter values	Default configuration
On delay time	On delay time (t): 0 … 300 seconds in 10 ms increments. When **Active**, the on-delay time specified must be greater than the scan time of the UE4427 or UE4457.	0 ms

Function block output parameters

No error outputs are available.

Logic diagrams/timing diagrams

Fig. 62: Logic diagram/timing diagram for function block ON-Delay Timer (ON DELAY)



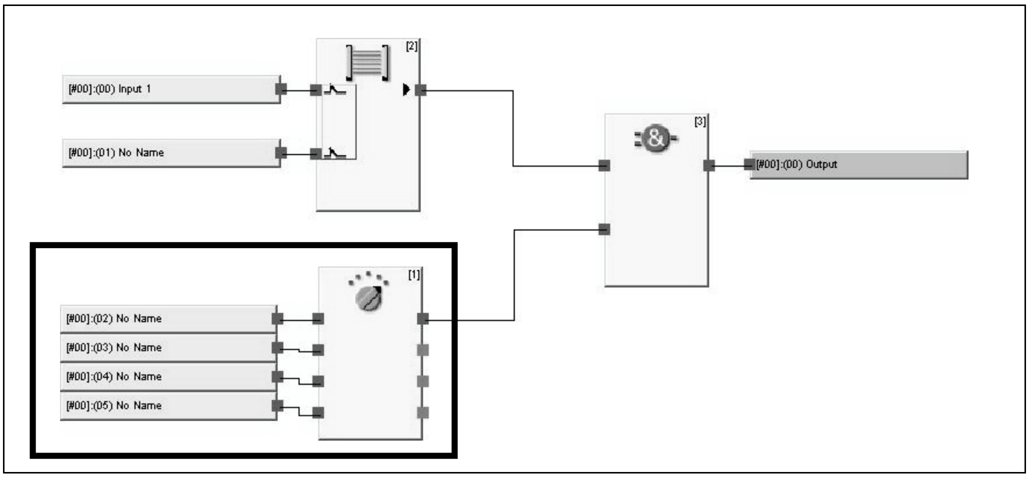
Fault conditions and reset information

Timing functions do not monitor fault conditions.

7.6.6 Function block User Mode Switch (UMS)

Function block diagram

Fig. 63: Function block diagram for function block User Mode Switch (UMS)



General description

The User Mode Switch (UMS) function block provides the ability to have an output selected based on a corresponding input value. Output x is **Active** when Input x is **Active**.

The function block supports a maximum of 8 inputs and their corresponding outputs.
A minimum of 2 inputs must be configured.

Multiple inputs cannot be **Active** at the same time. If more than one input is **Active** at the same time, the corresponding input/output pair that was **Active** first is held for two seconds. After two seconds Fault Present is set **Active** and all outputs will be set **Inactive**. When the UE4427 or UE4457 transitions from IDLE state to EXECUTION state, and there are multiple inputs **Active** during the initial function evaluation, all outputs will remain **Inactive** and after two seconds Fault Present is set **Active** and all outputs will be set **Inactive**.

All inputs cannot be **Inactive** at the same time. If all inputs are **Inactive** at the same time, the corresponding input/output pair that was **Active** last is held for two seconds. After two seconds Fault Present is set **Active** and all outputs will be set **Inactive**.

When configured, Fault Present is an output that can also be monitored via connection to the function block.

Truth table for function block User Mode Switch (UMS)

For the truth table, the following nomenclature applies:

- "0" means logical low, **Inactive**
- "1" means logical high, **Active**
- "x" means "don't care" = "0" or "1"

Tab. 73: Truth table for function block User Mode Switch (UMS)

Inputs									Outputs							
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Fault Present**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
x	x	x	x	x	x	x	x	1	0	0	0	0	0	0	0	0

Function block input parameters

None.

Function block output parameters

The following additional error outputs are available:

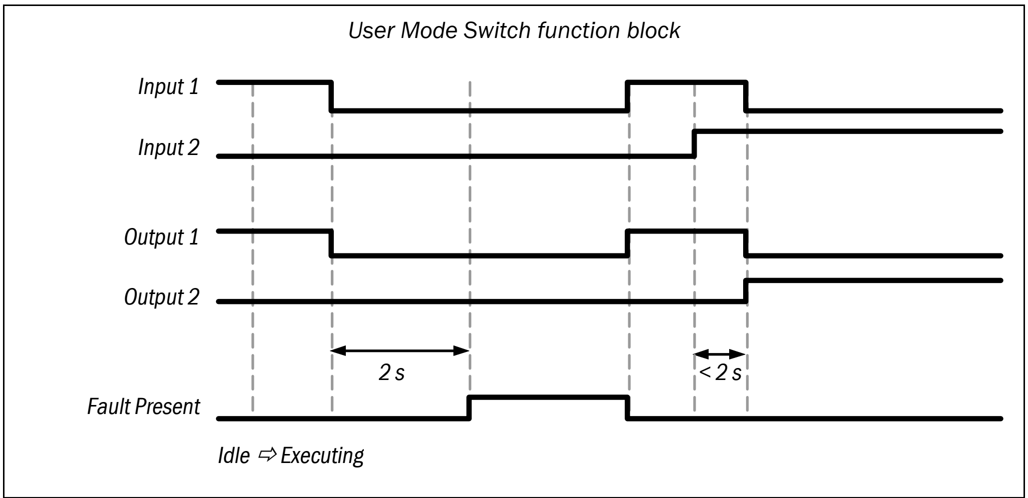
Tab. 74: Output parameters for function block User Mode Switch (UMS)

Optional function block output connections
Fault Present

Additional information regarding Fault Present is presented in section 7.3 "Function block input and output signal connections" on page 70 and in section 7.4 "Function block parameterization" on page 77.

Logic diagrams/timing diagrams

Fig. 64: Logic diagram/timing diagram for function block User Mode Switch (UMS)



Fault conditions and reset information

Tab. 75: Fault conditions and reset information for function block User Mode Switch (UMS)

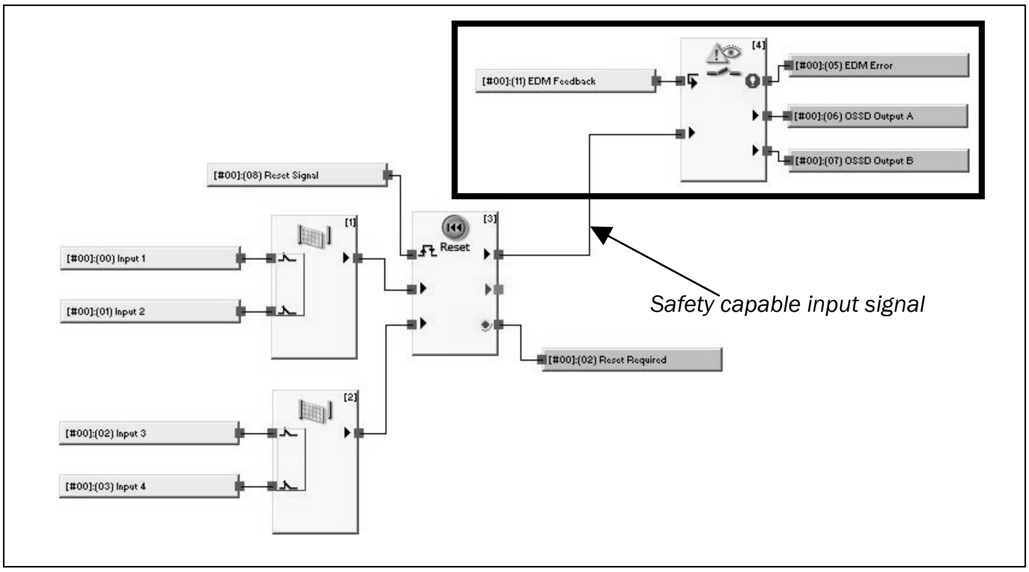
Diagnostic outputs	Fault condition	Reset of fault condition	Comments
Fault Present	More than one input is **Active** for longer than 2 seconds. or: All inputs are **Inactive** for longer than 2 seconds.	Fault Present will be set immediately to "0" when the fault condition no longer exists	Output will be **Inactive** (e.g. fault detected) when Fault Present is **Active**.

Note One method of clearing an input fault from the **Active** input is by disconnecting and reconnecting the corresponding input wire or test output wire. Changing the signal state (high-low-high) will also clear a fault condition associated with an **Active** input.

7.6.7 Function block External Device Monitoring (EDM)

Function block diagram

Fig. 65: Function block diagram for function block External Device Monitoring (EDM)



General description

External Device Monitoring (EDM) checks the feedback signal of an external device via the EDM feedback signal to verify that it corresponds to the state of the EDM function block outputs OSSD Output #1 and OSSD Output #2.

When Fault Present is **Inactive**, the OSSD outputs are set based on the safety capable input value (e.g. from the Safety Light Curtain Monitoring function block shown above). If the safety capable input is **Active**, the OSSD outputs are **Active**. If the safety capable input is **Inactive**, then the OSSD outputs are also **Inactive**.

OSSD Output #1 and OSSD Output #2 are used to control an external device (e.g. a contactor). When the OSSD outputs change state (e.g. from **Active** logical "1" to **Inactive** logical "0"), the EDM Feedback signal must also change state within the defined maximum time (i.e. T_{EDM}). This maximum EDM time delay is configurable from 100 ms to 1000 ms.

EDM Feedback should have the opposite state of the OSSD outputs:

- When the OSSD outputs are **Active**, then EDM Feedback should be **Inactive**;
- When the OSSD outputs are **Inactive**, then EDM Feedback should be **Active**.

When EDM Feedback does not change state corresponding to the change of state of the OSSD outputs within the configured maximum time specified (T_{EDM}), the following occurs:

- EDM Error output is set **Active**
- Fault Present is set **Active**
- OSSD 1 (Output 2) is **Inactive** (fault detected)
- OSSD 2 (Output 3) is **Inactive** (fault detected).

When configured, Fault Present is an output that can also be monitored via connection to the function block. Fault Present will be set to **Active** when the EDM signal is not opposite of OSSD outputs based on timing configuration.

When delayed OSSD output signals are required, utilize a delayed output associated with another function block prior to the EDM function block rather than after the EDM function block. If a delay that affects the OSSD output signals is implemented after the EDM function block, the timing evaluation occurring at the EDM Feedback signal may result in a Fault Present condition.

Function block input parameters

Tab. 76: Input parameters for function block External Device Monitoring (EDM)

Parameter	Possible parameter values	Default configuration
EDM Feedback Maximum Time Delay (T_{EDM})	100 ms … 1000 ms in 10 ms increments	300 ms

Function block output parameters

The following additional error outputs are available:

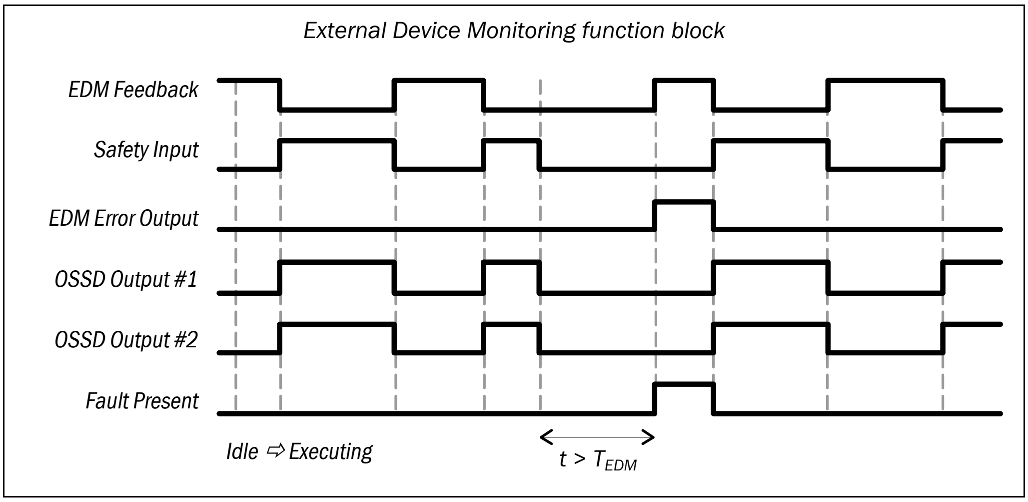
Tab. 77: Output parameters for function block External Device Monitoring (EDM)

Optional function block output connections
Fault Present

Additional information regarding these parameters is presented in section 7.3 "Function block input and output signal connections" on page 70 and in section 7.4 "Function block parameterization" on page 77.

Logic diagrams/timing diagrams

Fig. 66: Logic diagram/timing diagram for function block External Device Monitoring (EDM)



Fault conditions and reset information

Tab. 78: Fault conditions and reset information for function block External Device Monitoring (EDM)

Diagnostic outputs	Fault condition	Reset of fault condition	Comments
EDM Error	**Active** (e.g. logical "1")	EDM Error will be set to "0" when a the safety capable input transitions from **Inactive** to **Active** and no other error exists	OSSD Output #1 and OSSD Output #2 will be **Inactive** and Fault Present will be **Active** when EDM Error is **Active**.

The EDM Feedback signal must be **Active** during the OFF -> ON sequence that is required to clear a fault or EDM error since the OSSD outputs are **Inactive**. After a fault is cleared and the OSSD outputs return to **Active**, the EDM Feedback must return to **Inactive** within the specified EDM Feedback Maximum Time Delay (T_{EDM}) or another EDM error will occur.

If there is a fault on the EDM Feedback signal there are two ways to induce the required **Inactive** to **Active** transition:

- Perform an Idle - Execution transition. This causes the logic to be reset.

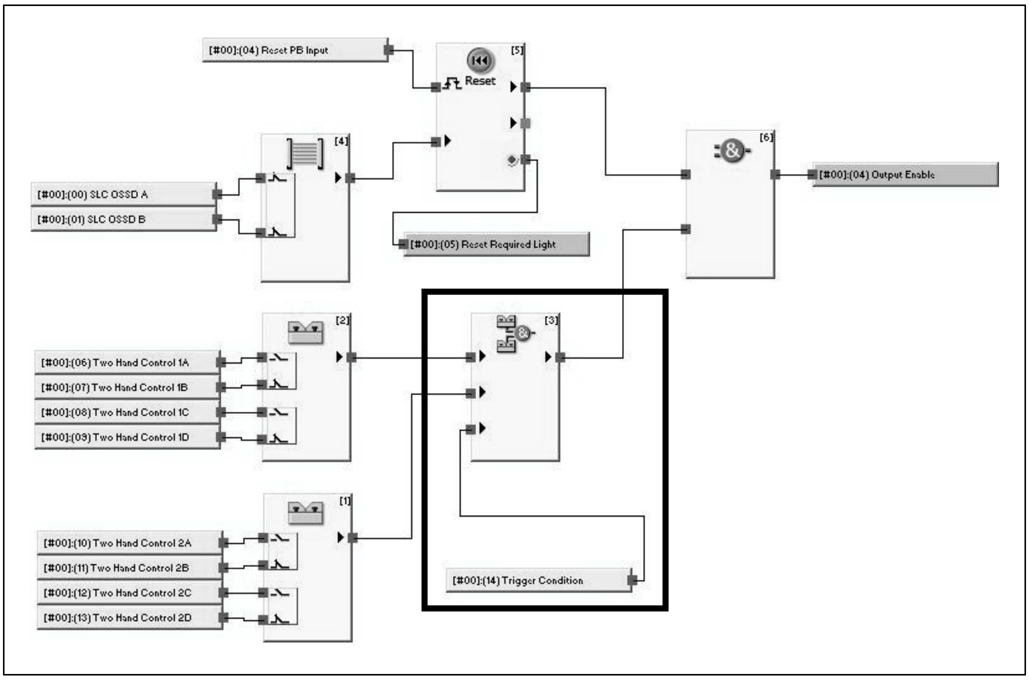
Or:

- Disconnect and reconnect the EDM Feedback signal at the source.

7.6.8 Multi-Operator function block

Function block diagram

Fig. 67: Logic connections for Multi-Operator function block



General description

The Multi-Operator function block provides a means of monitoring for concurrent operation of up to three devices. For example, when more than one operator is attending to a press application, multiple two-hand control stations or foot switches may be required to concurrently actuate the downward motion of the press. The Trigger Condition forces re-activation of the Operator inputs after a rising or falling edge is detected at the Trigger Condition input.

Optionally, Static Release inputs (e.g. safety light curtains) may be connected to ensure that the associated devices are **Active** (High) before Output Enable can become **Active** (High). Reset and Restart are handled externally from the function block.

WARNING

Operator and Static Release inputs must be pre-evaluated signals!

The Multi-Operator function block does not evalute the Operator or Static Release inputs for safety relevance (e.g. dual channel evaluation). Safety relevant evaluation of these inputs must be performed either by another function block (e.g. two-hand control or light curtain monitoring) or as part of the safety input configuration (e.g. inputs configured for dual channel input evaluation).

The following event sequence must occur for Output Enable to be set to **Active** (High):

1. All Operator inputs must be **Inactive** (Low)
2. All Operator inputs must transition to **Active** (High)
3. All Static Release inputs must be **Active** (High)
4. All Operator inputs and Static Release inputs must remain **Active** (High). This causes Output Enable to become **Active** (High).
5. The Trigger Condition transitions in accordance with the configuration of the function block (e.g. falling edge or rising edge detection). The Trigger Condition causes Output Enable to become **Inactive** (Low).
6. All Operator inputs must return to an **Inactive** (Low) state. Each Operator input is handled independently of the other. For example, it is acceptable for Operator 1 to return to **Inactive** (Low) and then return to **Active** (High) before Operator 2 has returned to **Inactive** (Low). However, before Output Enable may be set to **Active** (High), all Operator inputs must have returned to **Inactive** (Low) and then returned to **Active** (High).
7. Go to point 3. above.

Function block parameters

The following function block parameters may be configured:

Tab. 79: Input parameters for Multi-Operator function block

Parameter	Possible parameter values	Default configuration
Trigger condition	• Rising edge • Falling edge	Rising edge
Number of operators	• 2 operators • 3 operators	2 operators
Number of static releases	• No static releases • 1 static release • 2 static releases	No static releases

Fault conditions and reset information

The Multi-Operator function block does not monitor for fault conditions.

Timing/logic diagram

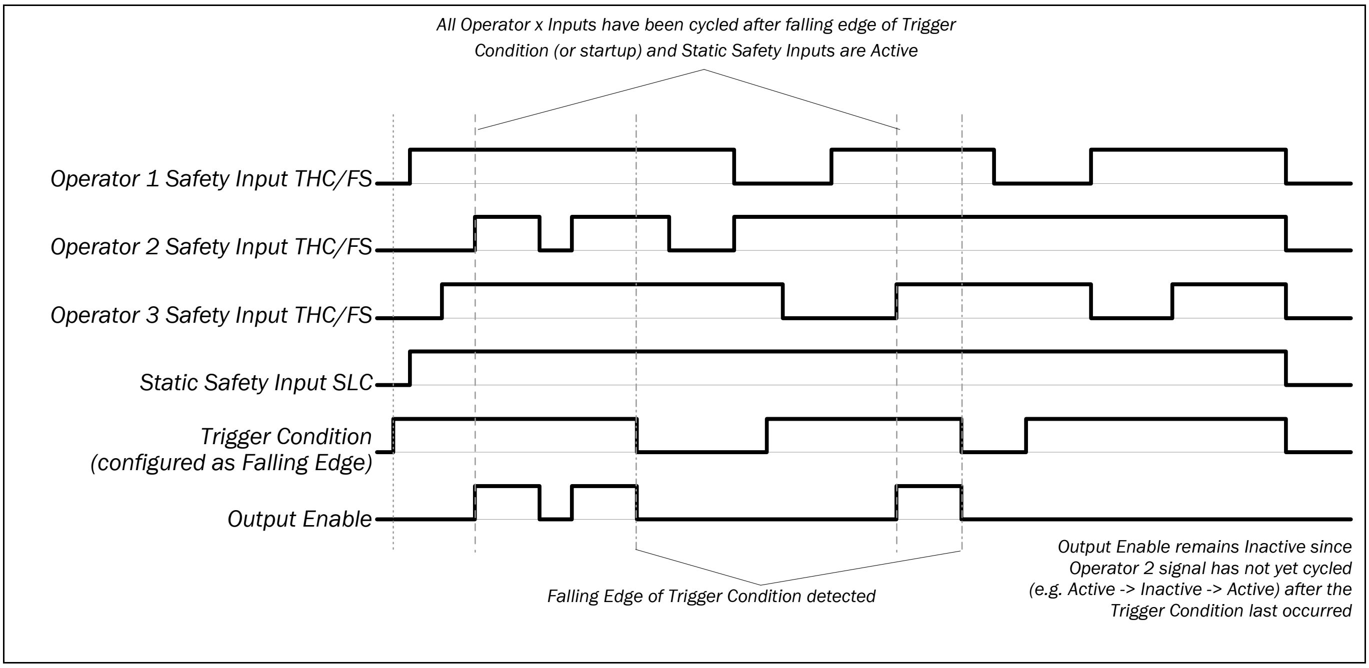
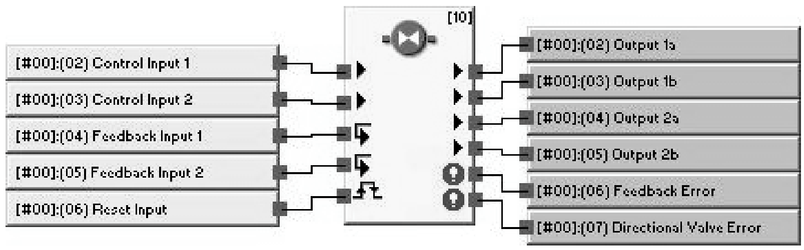


Fig. 68: Multi-Operator timing/logic diagram

7.6.9 Single and Directional Valve Monitoring function block

Function block diagram

Fig. 69: Logic implementation for Valve Monitoring function block configured for a directional valve



General description

The Valve Monitoring function block provides users with the ability to control and monitor outputs related to valve control based on Control Input values. When the valve control outputs change state, the function block monitors for a change of state at the Feedback Input to ensure that the change has occurred at the valve. The Feedback Input must change state in accordance with the On-Delay Time (T_ON) and Off-Delay Time (T_OFF) configuration settings. Two valve modes are available: single and directional.

The number of control and feedback inputs depends on the valve mode selected:

- single valve mode includes inputs Control Input 1 and Feedback 1
- directional valves include inputs Control Input 1, Control Input 2, Feedback 1 and Feedback 2

WARNING

You must connect feedback signals correctly!

Signals for Feedback 1 and Feedback 2 must be protected against short circuits to the outputs (e.g. 1a, 1b, 2a and 2b) as well as preventing short circuits between the two feedback signals (e.g. by using protected wiring or wiring these signals within the control cabinet only).

The number of outputs also depends on the valve mode selected:

- single valve mode includes output 1a (output 1b is optional)
- directional valve mode includes: output 1a and output 2a (output 1b and output 2b are optional)
- output 1b is always identical to output 1a
- output 2b is always identical to output 2a

The Valve Monitoring function block supports manual or automatic reset. When manual reset is configured, a valid reset **Inactive** (Low) to **Active** (High; > 100 ms or 350 ms < 30 s) to **Inactive** (Low) sequence must occur to reset the function block in the event of an error condition (e.g. feedback error or directional valve error). After an error and a valid reset sequence (manual or automatic) the outputs will not be re-activated automatically if the Control Input(s) is currently **Active** (High). The Control Input(s) must transit first to **Inactive** (Low) before outputs can be re-activated (e.g. all Control Input values must be **Inactive** (Low) and all Feedback Input values must be **Active** (High)).

WARNING

Ensure that transitions of reset signals satisfy requirements!

In order for the controller to detect a stuck at high (i.e. short to 24 V DC) condition at the Reset input, the Minimum Reset Pulse Time must be set to 350 ms and use a test output referenced to the Reset input. This ensures that internal testing verifies that a short circuit has not occurred.

If you elect to utilize 100 ms as the Minimum Reset Pulse Time, you must also ensure that signal transitions caused by a stuck at high condition (e.g. transition from **Inactive** (Low) to **Active** (High) (i.e. short circuit to 24 V DC) to **Inactive** (Low) at the signal input) do not lead to a valid reset sequence. The Reset cannot be referenced to a test output when 100 ms has been specified.

The valve monitoring elements check if the Feedback Input signals follow the Control Input values according to the configured On-Delay Time (T_ON) and Off-Delay Time (T_OFF). When the Feedback signals do not follow the Control Input signals according to the parameter configuration, the outputs from the function block are switched off.

When an **Active** (High) signal at the Control Input(s) is shorter than the configured ON-Delay Time, the output(s) will only be **Active** (High) while the Control Input is **Active** (High) and no feedback check will occur.

When an **Inactive** (Low) signal at the Control Input(s) is shorter than the Off-Delay Time, the output(s) will switched to **Inactive** (Low) and locked until the Feedback signal has changed state to reflect the **Inactive** (Low) state of the Control Input. The output(s) may be re-activated to **Active** (High) when the Control Input(s) transition from an **Inactive** (Low) to **Active** (High).

When Directional Valve mode is utilized and both Control Inputs are **Active** (High), the outputs will be set to **Inactive** (Low).

A Feedback Error occurs if:

- When the Control Input(s) change state and the corresponding Feedback Value(s) does not change within the configured ON/OFF Delay Time. The Feedback Value must be **Active** (High) when the corresponding Control Input is **Inactive** (Low) or the Feedback Value must be **Inactive** (Low) when the corresponding Control Input is **Active** (High).
- When the Feedback Value(s) are **Active** (High) when the corresponding Control Input(s) value is also **Active** (High) and the *Continuous Monitoring when Valve is Active* parameter is set to "Yes".
- The Feedback Value is **Inactive** (Low) at the time that the Control Input transitions to **Active** (High).

A Directional Valve Monitoring Error occurs when:

- Both Control Inputs are **Active** (High).

When a feedback or directional valve monitoring error is detected, the following steps must occur in order to clear the error condition:

- A valid reset sequence (manual or automatic) must occur.
- The Control Input(s) value must transition to **Inactive** (Low).
- The corresponding Feedback Value(s) must transition to **Active** (High).

Function block parameters

Tab. 80: Function block parameters for Valve Monitoring

Parameter	Possible parameter values	Default configuration
Reset Condition	• Manual reset • Automatic reset	Manual reset
Continuous monitor when valve is active	• No • Yes	No
Valve mode	• Single • Directional	Single
Max. Switch-on Feedback Delay Time (T_ON)	Configurable from 50 ms to 3 s in multiples of 10 ms increments	50 ms
Max. Switch-off Feedback Delay Time (T_OFF)	Configurable from 50 ms to 3 s in multiples of 10 ms increments	50 ms
Minimum Reset Pulse Time	• 100 ms • 350 ms	350 ms

Function block output parameters

Feedback Error Output

Directional Valve Error (configuration dependent)

Logic/timing diagrams

Fig. 70: Logic/timing diagram for Single Valve Monitoring

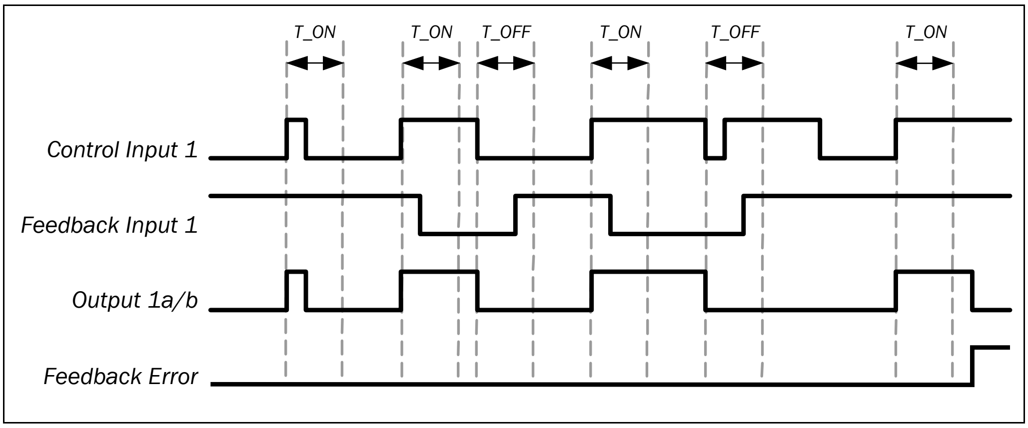
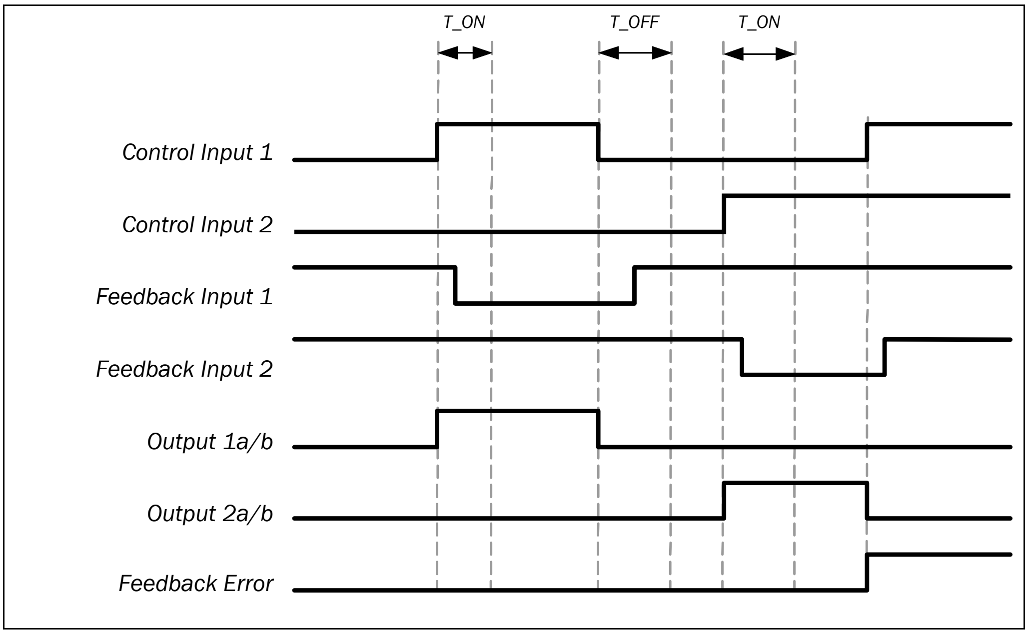


Fig. 71: Logic/timing diagram for Directional Valve Monitoring



Fault conditions and reset information

Tab. 81: Valve monitoring fault conditions and reset information

Diagnostic outputs	Fault Present	Reset of fault condition	Comments
Feedback Error Directional Valve Monitoring Error	**Active**	When manual reset is configured, a valid Reset **Inactive** (Low) to **Active** (High; > 100 ms or 350 ms < 30 s) to **Inactive** (Low) sequence must occur to reset the function block in the event of an error condition (e.g. feedback error or directional valve error). After an error and a valid Reset sequence (manual or automatic) the outputs will not be re-activated automatically if the Control Input(s) is currently **Active** (High). The Control Input(s) must transit first to **Inactive** (Low) before the outputs can be re-activated (e.g. all Control Input values must be **Inactive** (Low) and all Feedback Input values must be **Active** (High).	Output Enable will be **Inactive** and Fault Present will be **Active** when a Feedback or Directional Valve Monitoring Error is **Active**.

7.7 Muting function blocks for parallel, sequential and crossed sensors

7.7.1 General description

Muting is defined as the automatic temporary bypassing of any safety related function(s) of the control system or safety device. The muting function is employed when certain objects, e.g. material pallets, are permitted to pass into the hazardous area. For the duration of this transport through an electro-sensitive protective device (ESPE), e.g. a safety light curtain, the muting function suppresses monitoring by the ESPE.

For the period during which the material is being transported, muting sensors detect its presence. By careful choice of the type of sensors and their arrangement, it is possible to distinguish between objects and persons.

As the conveyed object interacts with the muting sensors and ESPE, it produces a precisely defined signal sequence as it passes into the hazardous area. You must ensure that the entry of a person into the ESPE will always prevent access to the hazard (e.g. hazardous motion should be switched off immediately). It must not be possible for a person to generate the same signal sequence as a conveyed object.

Muting sensor locations are defined by the geometry of the object to be detected. These include, but are not necessarily limited to, the following number of sensor input signals:

- two sensors
- two sensors and an additional signal C1
- four sensors (two sensor pairs)
- four sensors (two sensor pairs) and an additional signal C1

Three different muting function blocks are available:

- muting using two sensors in a crossed-sensing arrangement
- muting using four sensors in a parallel arrangement of two sensor pairs
- muting using four sensors in a sequential arrangement of two sensor pairs

Since muting bypasses the safety functionality of a protective device, there are several requirements that must be maintained in order to satisfy application safety as outlined below.

Notes

- The muting cycle is the defined sequence of all processes that take place during muting.
- The cycle starts when the first muting sensor is activated. The cycle ends based on the configuration of the muting end condition defined in the function block. It is only possible to activate muting again after the previous muting cycle has ended.
- Material can be transported several times during a muting cycle, if the muting condition is maintained continuously, i.e. at least one pair of sensors remains activated continuously.

WARNING

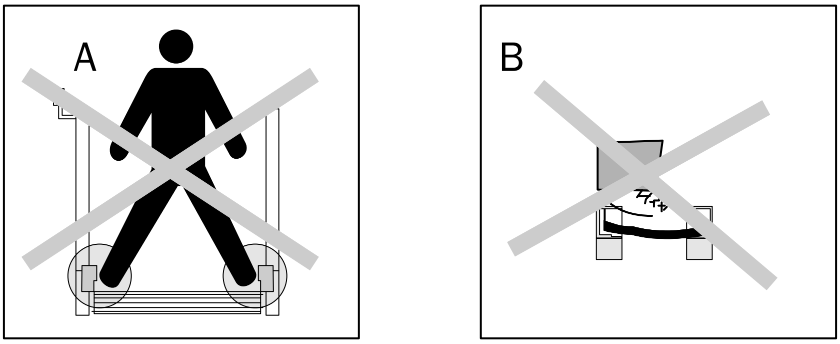
General safety instructions and protective measures must be followed!

When utilizing any muting function, you must adhere to the following points to ensure correct use of the muting function:

- Access to the hazardous area must be reliably detected by the ESPE or prevented by other means. Personnel should not be able to walk around, over, under or through the ESPE undetected. Refer to the operating instructions of the ESPE for correct installation and use of the device.
- Always adhere to applicable local, regional and national regulations and standards that are applicable to your application. Ensure that the solution you are implementing complies with an adequate risk assessment and risk reduction strategy.
- Muting operation must never be used to convey persons into the hazardous area.
- Mount the control switch(es) for reset and override outside the hazardous area such that they cannot be operated by a person inside of the hazardous area. When operating the control switch(es), the operator must have full visual command of the hazardous area.
- The muting sensors must be positioned so that, after interruption of the protective field, the hazardous area can only be reached when the dangerous condition has been eliminated. A prerequisite for this is that required safety distances as specified in EN 999 are employed. At least two independent muting signals are required.
- Muting must only be activated for the period of time during which the object that causes the muting condition to occur blocks access to the hazardous area.
- Muting must take place automatically, but must not be dependent on a single electrical signal.
- The material to be transported must be detected over its entire length, i.e. there must be no interruption in the output signals (refer to Sensor Signal Gap Monitoring).
- Muting must be triggered by at least two independently wired signals (e.g. from muting sensors) and must not depend entirely on software signals (e.g. from a PLC).
- The muting condition must be cancelled immediately after passage of the object so that the protective device returns to its normal, non-muted state (i.e. becomes effective again).

- Muting sensors must be positioned so that the muting function cannot be unintentionally activated by a person (see Fig. 72 below).

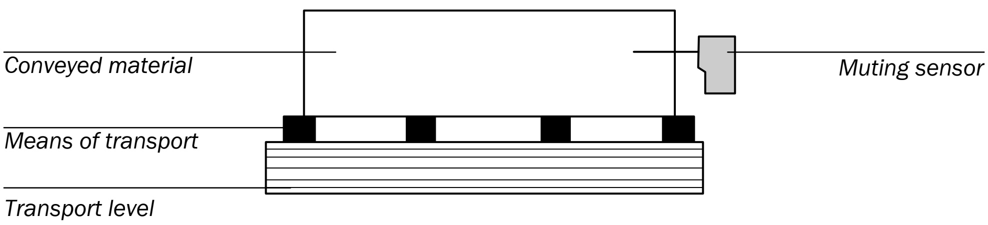
Fig. 72: Safety on mounting of the muting sensors



A: It must not be possible to activate opposing sensors simultaneously.
B: It must not be possible to activate sensors mounted side by side simultaneously.

- Always position the muting sensors such that only the material is detected and not the means of transport (pallet or vehicle).

Fig. 73: Detection of material during muting



- Always position muting sensors such that material can pass unhindered, but people are reliably detected.
- Always position the muting sensors such that, on the detection of the material, a minimum distance to the ESPE detection zone (e.g. light beams of a safety light curtain) is maintained.
- Before and during the activation of an override condition, it must be ensured that no persons are present in the hazardous area.
- Before activation of an override condition, ensure that the equipment is in a proper state, especially the muting sensors (visual control).
- Check the functional capability of the equipment and the muting arrangement when the activation of the override function has been necessary.
- During long muting cycles (e.g. greater than 24 hours) or long periods during which the machine is at a standstill, the correct function of the muting sensors must be checked.
- To signal that a muting or override condition currently exists, the use of a muting and/or override lamp is required. The muting/override lamp may be external to the protective device (ESPE) or integrated into the protective device.
- Always mount the muting/override lamp where it can be clearly seen! The muting/override lamp must be clearly visible from all sides of the hazardous area and for the system operator.
- Always consider time delays associated when safety relevant information (i.e. remote safety input values and/or remote safety output values) is communicated via a safety-relevant fieldbus network. These time delays may directly affect system performance as well as minimum safety distance requirements associated with response times.

- When an override input is configured, the safety input configuration shall not utilize test pulse outputs.
- Sensor signals A1 and A2 (B1 and B2) must utilize different cables.
- Reset and Reset Required signals shall utilize a cable independent of other input signals to prevent unintentional reset of the system. The cable installation shall also be protected.
- Total muting time cannot be set to infinite (**Inactive**) without additional measures. When set to **Inactive**, other measures must be implemented to ensure that personnel cannot gain access to the hazard(s) associated with the muted condition.

7.7.2 Muting sensors

Muting sensors detect material and supply the necessary signals as required by the controller. When the muting conditions are met, the controller can mute the protective device based on the sensor signals.

Muting sensor signals can be generated by the following external sensors:

- optical sensors
- inductive sensors
- mechanical switches
- controller signals

When utilizing optical sensors for muting applications, use sensors that have background suppression to ensure that only the conveyed material satisfies the muting requirements. These sensors will only detect material up to a specific distance. Objects that are beyond this distance are therefore excluded from satisfying muting sensor input requirements.

7.7.3 Muting/override lamp

A muting lamp is used to signal that a muting or an override condition currently exists, the use of a muting and/or override lamp is required. The muting/override lamp may be external to the protective device (ESPE) or integrated into the protective device.

Note Depending on the local, regional and national regulations and standards, it may be necessary to monitor the muting/override lamp(s).

WARNING

Always mount the muting/override lamp where it can be clearly seen!

The muting/override lamp must be clearly visible from all sides of the hazardous area and for the system operator.

7.7.4 Function block parameters

The following parameters (function block dependent) may provide additional configuration associated with the muting function.

Tab. 82: Input parameters for muting function blocks

Parameter	Possible parameter values	Default configuration
Direction Detection	• Disabled (bi-directional movement) • Forward (input pair A1/A2 must actuate first) • Backward (input pair B1/B2 must actuate first)	Typically, disabled. Function block dependent.
Muting Start Condition	• When all muting sensors are **Inactive** (Low) • When the last muting sensor is **Active** (High)	When the last muting sensor is **Active** (High)
Muting End Condition	• When the last muting sensor transitions to **Inactive** (Low) • When ESPE OSSD returns to **Active** (High)	When the last muting sensor transitions to **Inactive** (Low)
Total Muting Time	Inactive, 5 s … 3600 s with a 1 s resolution.	5 s
Additional Muting Time after ESPE is clear	0 ms, 200 ms, 500 ms, 1000 ms	0 ms
Concurrency Monitoring Time	Inactive, 10 ms … 3000 ms with a 10 ms resolution. When active, the value of this parameter must be greater than the scan time.	0 s (inactive)
Sensor Signal Gap Monitoring	Inactive, 10 ms … 1000 ms with a 10 ms resolution. When active, the value of this parameter must be greater than the scan time.	100 ms
Sequence Monitoring	• Enabled • Disabled	Typically, disabled. Function block dependent.
C1	• With • Without	With
Override Input	• With • Without	With
Conveyor Input	• With • Without	With

All function block input parameters are available by double-clicking on the function block and then clicking on the selection box associated with each parameter.

Direction Detection

Direction Detection is used when conveyed material is required to move in a specific direction. The direction is determined based on the sequence that the muting sensors are activated.

The default condition for Direction Detection is **Disabled**. When Direction Detection is disabled, conveyed material may move in either direction in order to satisfy muting requirements. In this case, it is irrelevant as to which sensor pair becomes activated first.

When **Forward** direction has been selected, the muting sensor pairs must be activated in the sequence (A1/A2) before (B1/B2). A muting condition is not possible in the reverse direction. A transition from four active sensors to an inactive “B” sensor pair (0 or 1 sensors active) will stop muting.

When **Reverse** direction has been selected, the muting sensor pairs must be activated in the sequence (B1/B2) before (A1/A2). A muting condition is not possible in the forward direction. A transition from four active sensors to an inactive “A” sensor pair (0 or 1 sensors active) will stop muting.

Muting Start Condition

The Muting Start Condition defines when a valid muting sequence can begin. The Muting Start Condition may be defined for either of the following conditions:

- when all muting sensors have transitioned to **Inactive** (Low), collectively or individually, and the safety device’s (e.g. safety light curtain) OSSDs are **Active** (High) (e.g. the protective field is clear of obstruction)

  or

- when all muting sensors except the last muting sensor are **Inactive** (Low) and the safety device’s (e.g. safety light curtain) OSSDs are **Active** (High) (e.g. the protective field is clear of obstruction)

In circumstances where higher throughput is required, it may be beneficial to allow a subsequent muting sequence to begin after the conveyed material is clear of the safety device and all but the last muting sensor (i.e. “When last muting sensor is **Active** (High)”). The default setting for the Muting Start Condition parameter is “When the last muting sensor is **Active** (High)”.

Muting End Condition

Similar to the Muting Start Condition parameter, the Muting End Condition defines when a valid muting state is over. You may select whether the Muting End Condition occurs:

- after one muting sensor of the last muting sensor pair transitions to **Inactive** (Low; e.g. clear of obstruction)

  or

- after the OSSD of the safety device (e.g. safety light curtain) indicates that the protective field is no longer obstructed i.e. protective field is clear and OSSDs return to an **Active** (High) state

When muting has ended, if the ESPE OSSD input becomes **Inactive** (e.g. caused by infringement on the protective field of the ESPE device) before the next valid muting sequence, the Output Enable signal from the function block will become **Inactive**. The next muting cycle cannot begin until the muting end condition has been satisfied. The default setting for Muting End Condition is “After the last muting sensor transitions to **Inactive**”.

Total Muting Time

The Total Muting Time value is used to limit the maximum duration allowed during the muting sequence. When the value set for Total Muting Time is exceeded, the Muting Error and Fault Present outputs will be set **Active** (High) and Output Enable will be set to **Inactive** (Low).

The Total Muting Time timer starts with activation of the muting function as indicated by the muting status output transitioning to **Active** (High). The Total Muting Time timer is stopped and reset to zero when the muting function transitions to **Inactive**. When utilizing the optional Conveyor Monitoring parameter, the Total Muting Time timer is on hold when the Conveyor Monitoring input is **Active** (High) indicating that the conveyor has stopped.

Values for the total muting time range from 0 to 3600 seconds. When set to “0”, the total muting time is not monitored. The default setting for total muting time is 5 s.

Additional Muting Time after ESPE is clear

The parameter “Additional Muting Time after ESPE is clear” is used when the parameter Muting End Detection has been specified as “Muting End Detection after OSSD free”. If the ESPE does not always accurately detect the end of muting due to irregularities of the material or means of transport, machine availability can be increased by configuring an additional muting time of up to 1000 ms. In this case only, the Additional Muting Time after ESPE is clear parameter defines the amount of additional muting time allowed after the ESPE OSSDs have returned to an **Active** (High) state, e.g. safety light curtain is now clear of obstruction. Valid values are 0 ms, 200 ms, 500 ms and 1000 ms. The default value for this parameter is 0 ms.

Concurrency Monitoring Time

The Concurrency Monitoring Time value is used to verify that the muting sensors are actuating concurrently. This value is the maximum time when both muting sensor inputs used for dual channel evaluation may be in impermissible states without an error condition occurring. For example, (A1 and A2) or (B1 and B2) must reach an equivalent state before the concurrency monitoring time expires.

Monitoring of the concurrency monitoring time starts with the first state change of a muting sensor input. An error occurs when the concurrency monitoring time has expired, both inputs of the connection have not reached an equivalent state.

In the event that a concurrency monitoring time error does occur in at least one input pair, the function block will indicate the error by setting output Muting Error to **Active** (High).

Values for the concurrency monitoring time range from 0 to 3000 seconds. When set to “0”, the concurrency monitoring time is not monitored (inactive). When concurrency monitoring time is not “0”, the value applies to both muting sensor pairs (A1/A2 and B1/B2) and must be greater than the scan time of the UE4400.

Sensor Signal Gap Monitoring

In some instances, muting sensors will periodically have short disturbances in their output signals that are not relevant to the muting condition. By specifying a Sensor Signal Gap Monitoring value, it is possible to filter out these short disturbances without stopping the muting condition.

When Sensor Signal Gap Monitoring is enabled, an **Inactive** (Low) signal from a muting sensor input will be ignored up to the configured Sensor Signal Gap Monitoring value. The function block will interpret this signal as remaining **Active** (High) without any interruption as long as only one sensor per pair A1/A2 or B1/B2 has a sensor signal gap. If a sensor signal gap was detected, a sensor signal gap on another signal during the same time will result in stopping the muting condition.

The Sensor Signal Gap Monitoring value is configurable in a range from 0 ms to 1000 ms. This parameter is disabled when the value is set to "0". When active, the Sensor Signal Gap Monitoring value must be greater than the scan time of the UE4400.

Sequence Monitoring

Sequence Monitoring enables users to define a specific sequence requirement for the **Active** state of muting sensors. Tab. 83 shows the valid sequence of muting sensor input signals. This parameter is only available for configurations that use four muting sensors e.g. parallel muting or sequential muting.

Tab. 83: Sequence Monitoring requirements

Direction Detection	Sequence Monitoring requirement based on muting sensor signal inputs:
Disabled	A1 before A2 before B1 before B2 or B2 before B1 before A2 before A1
Forward only	A1 before A2 before B1 before B2
Reverse only	B2 before B1 before A2 before A1

This parameter is function block dependent. Deviations from the sequence as outlined above will result in a muting error condition as indicated by the Muting Error status bit. Additionally, to avoid downtime, the Sensor Signal Gap Monitoring time should be configured less than the amount of time it takes the conveyed object to pass through a muting sensor pair (e.g. A1/A2 or B1/B2).

C1 input

The C1 Input is used to provide additional reliability against manipulation. When the C1 input is specified, an **Inactive** (Low) to **Active** (High) transition must occur before the first muting sensor pair becomes **Active** (High). The C1 signal must then be held **Active** (High) until both sensors of the muting sensor pair are **Active** (High) in order for a valid muting condition to occur. Failure to meet this requirement will result in a muting error condition as indicated by the Muting Error status bit. The input signal C1 must then transition back to an **Inactive** (Low) state before a subsequent muting cycle will be allowed.

Override/Override Required

An Override input signal allows users to remove conveyed objects that remain in the protective field of the safety device (e.g. safety light curtain) following power failures, activation of emergency stops, muting failures or other similar conditions.

When the following conditions are met, Override Required will transition to **Active** (High) pulsing at 2 Hz.

- The muting cycle is currently **Inactive** (i.e. Muting Status is **Inactive** (Low).
- At least one muting sensor is **Active** (High).
- The ESPE OSSDs are **Inactive** (e.g. safety light curtain obstructed).
- Output Enable is **Inactive**.

When the Override Required output conditions are met and the Override input transitions from **Inactive** (Low) to **Active** (High; > 100 ms but < 3 s) to **Inactive** (Low), the Output Enable signal will be **Active** (High) as though the muting conditions were satisfied. When all muting sensors return to an **Inactive** (Low) state and the ESPE OSSD input is **Active** (High) (e.g. indicating that the protective field of a safety light curtain is now clear of obstruction), a subsequent valid muting cycle is expected. In the event that the next object does not satisfy the muting cycle requirements, but does satisfy the Override Required output requirements, another override cycle may be used to clear the conveyed material. The number of override cycles is limited.

Note A Reset pushbutton may also be suitable for the Override function. Verify your application requirements to ensure safety relevant logic satisfies applicable local, regional, national and international regulatory requirements.

Tab. 84 provides information regarding Override Required and whether or not Override is possible based on the stated conditions.

Tab. 84: Conditions for Override Required and Override possible

Muting status	At least one muting sensor is Active (High)	ESPE OSSD is Active (High)	Override Required output	Override possible
0	No	0	No	No
0	No	1	No	No
0	Yes	0	Flashing, 2/s	Yes, if the max. number of override cycles is not exceeded
0	Yes	1	No	No
1	No	0	No	No
1	No	1	No	No
1	Yes	0	No	No
1	Yes	1	No	No

Fig. 74 provides an example sequence for Override and Override Required.

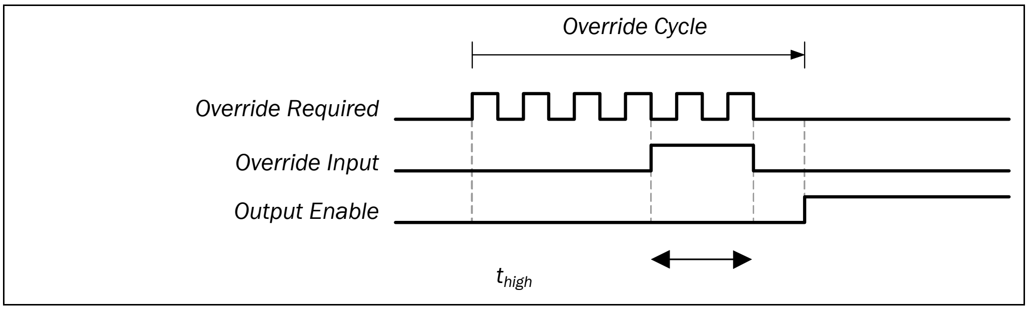


Fig. 74: Override and Override Required logic diagram

Note t_{high} must be greater than or equal to 100 ms but less than or equal to 3 s. If t_{high} is greater than 3 s, the override input will be ignored.

WARNING

When using Override, you must verify that a safe condition exists!

The Override function allows you to activate the safety output (i.e. Output Enable) of the muting function block even though the safety device (e.g. safety light curtain) is indicating that a dangerous situation may exist. The Override input should only be used when the hazardous area has been visually inspected and no personnel are currently in or have access to the hazardous area when the Override input is utilized.

When an Override input is configured, the safety input configuration shall not utilize test pulse outputs.

When an override cycle is used, Output Enable is set to **Active** (High) just like a valid muting sequence. In order to prevent excessive use of the Override function, the number of override cycles that are allowed is limited. The number of allowed override cycles is dependent on the Total Muting Time value and is generally determined by the following formula:

Number of override cycles = 60 minutes/Total Muting Time Monitoring

The following exceptions apply to the number of override cycles possible:

When the Total Muting Time value is less than or equal to 10 s, the number of allowed override cycles is 360.

When the Total Muting Time value is greater than or equal to 15 minutes, the number of allowed override cycles is 5.

Tab. 85 summarizes the number of override cycles available:

Tab. 85: Number of override cycles possible

Total muting time	Number of override cycles	Comments
5 s	360	Maximum number of cycles for total muting time < 10 s is 360.
10 s	360	
20 s	180	Maximum number of cycles possible varies as indicated.
30 s	120	
1 min	60	
5 min	12	
15 min	5	Maximum number of cycles for total muting time > 15 min is 5.
30 min	5	
60 min	5	
Disabled (unlimited)	5	

The number of override cycles is stored in controller memory. This number is triggered by the Override Required output. The value will be reset to "0" after a valid muting cycle has occurred, by a system reset (e.g. using SICK DeviceNet Safety Configurator) or after a transition from IDLE mode to EXECUTING mode.

After the Override Required output becomes **Active** (pulsing, 2 Hz) and a subsequent Override signal becomes **Active** (High), muting starts again and Output Enable will be **Active** (High).

When the muting cycle stops due to an errant muting sensor input signal, the Override Required is **Active** (High) for one cycle when the other conditions for Override Required are satisfied. If the defective muting sensor input returns to an **Active** (High) and then returns to **Inactive** (Low), the muting cycle will stop again and Override Required will become **Active** (High) when the other conditions for Override Required are satisfied.

When a valid override condition exists, Muting Direction, Sequence Monitoring (function block dependent) and Concurrence Monitoring are not monitored for one override cycle.

Conveyor input

When motion ceases during the muting cycle, it is possible to exceed the total muting time and other parameters that will lead to a muting error condition. This may be resolved by using the conveyor input. This input provides the ability to stop timing functions associated with muting when the material that is being transported is no longer in motion.

The conveyor monitoring input must conform to EN 61 131 and has the following characteristics:

0 V DC = conveyor in a stopped condition e.g. **Inactive** (Low)

24 V DC = conveyor in motion e.g. **Active** (High)

The following timers are affected by the conveyor monitoring input value:

Tab. 86: Conveyor monitoring affect on timers

Total muting time monitoring	• When a conveyor stop is recognized, the timer function is suspended. • When the conveyor restarts, the timers continue from the value stored when the timers were suspended plus an additional 3 seconds.
Concurrence time monitoring	

Note Sensor gap monitoring is not affected by a conveyor stop condition.

Output value: Muting Status

Muting Status output indicates the status of the muting function in accordance with the following table:

Tab. 87: Muting Status output values

Condition	**Muting Status output**
Muting cycle currently inactive with no errors	0
Muting cycle currently active with no errors	1
Muting error detected	0
Override currently active with no errors	1

Output value: Muting Lamp

The Muting Lamp output is used as control indicator to indicate an active muting cycle. The value for the Muting Lamp output is based directly on the value for the muting status as indicated in the following table:

Tab. 88: Muting Lamp output values

Function block muting status	Muting Lamp output
Muting status output value of “0”	0
Muting status output value of “1”	1
Override cycle active	1
Override Required	Flashing at 2 Hz

Output value: Muting Error

The Muting Error output is used as control indicator to indicate an error has been detected related to the muting function block. Clearance of a muting error condition requires that all muting sensors return to an **Inactive** (Low) state and the ESPE OSSD signal is **Active** (High). The value for Muting Error will be **Active** (High) when any muting error is detected.

Output value: Output Enable

Output Enable will be **Active** (High) when a valid muting condition exists, a valid override cycle is in progress or when the ESPE OSSD input is clear and no error/fault condition is currently in effect.

7.7.5 Cabling considerations

Faults associated with cabling must be considered when implementing muting functionality. For certain combinations of signals present in a single cable, additional measures must be taken to ensure that the associated signals are correct. Proper organizational measures (e.g. protected cabling) must be taken to ensure that faults associated with this cabling cannot occur.

Signal Description	**A1**	**A2**	**B1**	**B2**	**C1**	**Conveyor**	**OSSD1/2**	**Reset**	**OVR**	**Reset/OVR**	**Reset Required Lamp**	**OVR Lamp**	**Muting Status Lamp**	**Muting OVR Lamp**	**Safety Capable Output**
A1	–	A	B	B	A	A	A	A	A	A	C	C	A	A	A
A2	A	–	B	B	A	A	A	A	A	A	C	C	A	A	A
B1	B	B	–	A	A	A	A	A	A	A	C	C	A	A	A
B2	B	B	A	–	A	A	A	A	A	A	C	C	A	A	A
C1	A	A	A	A	–	A	A	A	A	A	A	C	C	C	A
Conveyor	A	A	A	A	A	–	C	A	A	A	C	C	C	C	A
OSSD1/2	A	A	A	A	A	C	–	A	C	A	C	C	C	C	A
Reset	A	A	A	A	A	A	A	–	A	–	C	C	C	C	A
OVR	A	A	A	A	A	A	C	A	–	–	C	A	C	A	A
Res/OVR	A	A	A	A	A	A	A	–	–	–	C	A	C	A	A
Reset Required Lamp	C	C	C	C	A	C	C	C	C	C	–	C	C	C	A
OVR Lamp	C	C	C	C	C	C	C	C	A	A	C	–	C	–	A
Muting Status Lamp	A	A	A	A	C	C	C	C	C	C	C	C	–	–	A
Muting OVR Lamp	A	A	A	A	C	C	C	C	A	A	C	–	–	–	A
Safety Capable Output	A	A	A	A	A	A	A	A	A	A	A	A	A	A	–

Tab. 89: Muting cabling combinations and conditions
A *The signals indicated cannot be installed in a single cable unless protective cabling is used.*
B *The signals indicated cannot be installed in a single cable unless protective cabling or sequence monitoring are used.*
C *The signals indicated may be installed in a single cable.*
– *Not applicable*

Note Reset, Res/OVR (combined Reset and Override input) and Reset Required signals are only available when a reset function block is used in conjunction with the muting function block.

7.7.6 Transition from IDLE to EXECUTING behavior

When the system transitions from IDLE to EXECUTING mode, the following behaviors may be realized based on the state of the muting sensors and the sensor OSSDs (e.g. safety light curtain safety outputs). Tab. 90 provides details regarding the system behavior during the IDLE to EXECUTING transition.

Tab. 90: IDLE to EXECUTING transition behavior for muting functions

Status after power-up:		System behavior:	
Sensor OSSDs	**State of muting sensors**	**Start**	**Next action**
Active (High) (e.g. no object in field)	All muting sensors are **Inactive** (Low).	A normal muting sequence is possible.	Muting is possible after correct actuation/sequence of muting sensors.
	Muting condition is partially met.		All muting sensors must return to **Inactive** (Low) before sensor OSSDs become **Inactive** (Low). When the sensor OSSDs become **Inactive** (Low) before all muting sensors become **Inactive** (Low), override must be used.
	Muting condition is fulfilled.		
Inactive (Low) (e.g. object detected)	All muting sensors are **Inactive** (Low).	Muting is blocked.	Sensor OSSD must become **Active** (High) before muting can start.
	Muting condition is partially met.	Override is required, when configured.	Either transition to a normal course (at cyclically correct sequence of the sensor states) or the override total time expires.
	Muting condition is fulfilled.		

7.7.7 Fault conditions and reset information

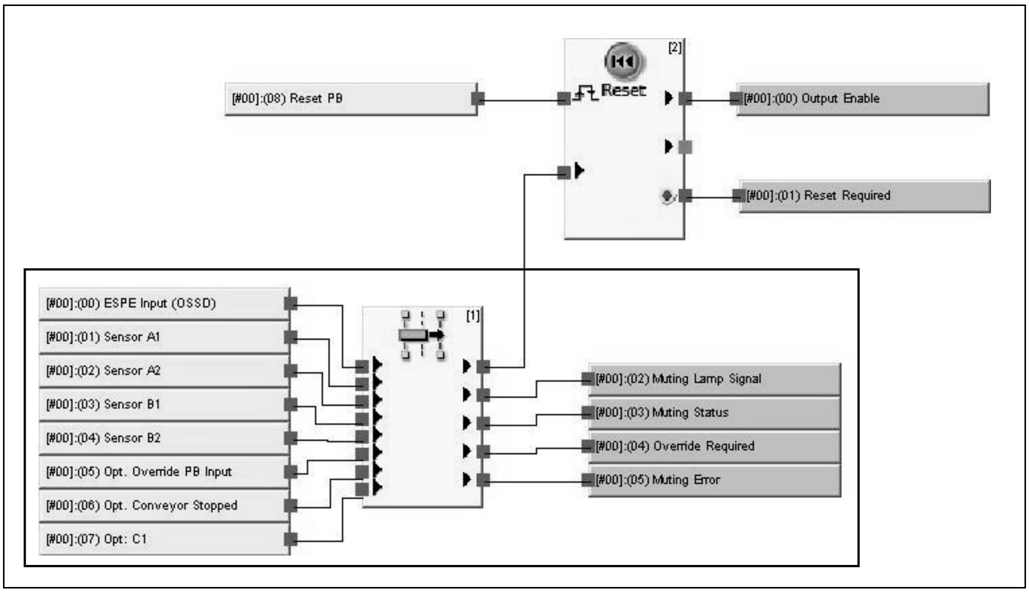
Tab. 91: Fault conditions and reset information for muting function blocks

Diagnostic outputs	Fault present	Reset of fault condition	Comments
Muting Error	**Active**	Before any muting-related error can be reset, a valid muting cycle must be completed. For this to occur, override must be utilized or all muting sensors and the ESPE OSSD safety device must be clear and a subsequent valid muting sequence is completed. When either condition occurs, the muting error output will return to an **Inactive** state, provided no other fault reason exists.	Output Enable will be **Inactive** and Fault Present will be **Active** when a muting related error is **Active.**
Concurrency Time Monitoring Error			
Total Muting Time Monitoring Error			
Direction Detection Error			
Sequence Error Detected			
Sensor Gap Filter Time Error			

7.7.8 Implementing muting using two parallel sensor pairs

Function block diagram

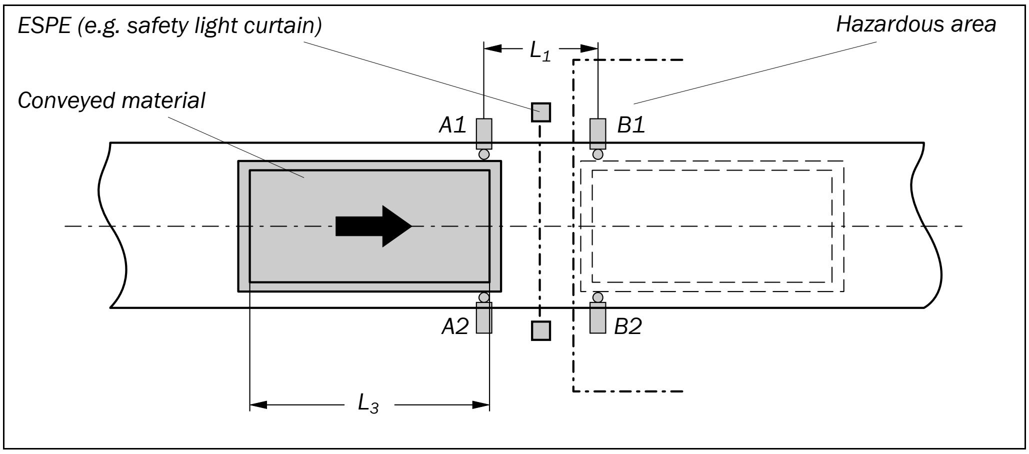
Fig. 75: Logical connections for Muting function block having two parallel sensor pairs and reset



Application layout

Fig. 76 provides an example of sensor locations associated with muting with two parallel muting sensor pairs.

Fig. 76: Muting with two parallel sensor pairs



In this example, the material moves from left to right. As soon as the first muting sensor pair A1 & A2 is activated, the protection provided by the protective device (ESPE) is muted. The protection remains muted until the muting sensor pair B1 & B2 is clear again.

Muting sensor input requirements

Tab. 92: Conditions for muting with four sensors with sequential sensor placement

Condition	Description
A1 & A2 (or B1 & B2)	Starts muting cycle. The first sensor pair is activated as a function of the direction of transport of the material.
A1 & A2 & B1 & B2	Requirement for transfer of the muting function responsibility to the second sensor pair.
B1 & B2 (or A1 & A2)	Muting applies as long as this condition is met. The second sensor pair is activated as a function of the direction of transport of the material.

Distance calculations and requirements include:

$L_1 \geq v \times 2 \times T_{IN\ Muting\ Sensor}$

$v \times t > L_1 + L_3$

$L_1 < L_3$

$T_{IN\ Light\ Curtain} < T_{IN\ Muting\ Sensor}$

Where …

L_1 = Distance between sensors (placement symmetrical to ESPE's detection)

L_3 = Length of the material on the conveyor

v = Velocity of the material (e.g. of the conveyor belt)

t = Total muting time set [s]

$T_{IN\ Light\ Curtain}$: Response time required for information to be available at the UE4457 process image

$T_{IN\ Muting\ Sensor}$: Response time required for information to be available at the UE4457 process image

Please refer to chapter 11.2 "Response time" on page 176 for further details on the calculation.

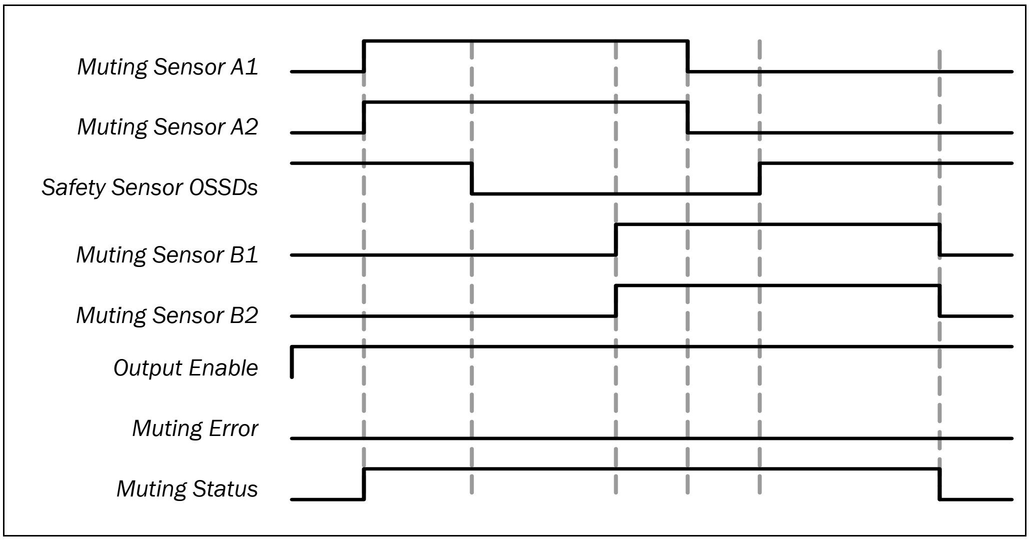
Notes

- Material can flow in both directions or be defined for a fixed direction only by:
  - Using the optional signal C1. When used, C1 must always be activated before both muting sensors in the first sensor pair (e.g. A1 and A2) are **Active**.
  - Using the Direction Detection configuration parameter
- With the parallel placement, the width of the object allowed is also checked due to the position of the muting sensors. The objects must always fit in an identical width to suit the muting sensors.
- For this application, optical proximity sensors and all types of non-optical sensors can be used. Use sensors and proximity sensors with background suppression.
- Avoid mutual interference between the sensors.
- Increase the protection against manipulation and safety using the following configurable functions:
  - concurrence monitoring
  - monitoring of the total muting time
  - end of muting by ESPE
- The electrical connection of devices is described in chapter 5 "Electrical installation" on page 53.

The function block requires that a valid muting sequence occurs. Fig. 77 shows an example of a valid muting sequence based on the default parameters for this function block.

Logic/timing diagram

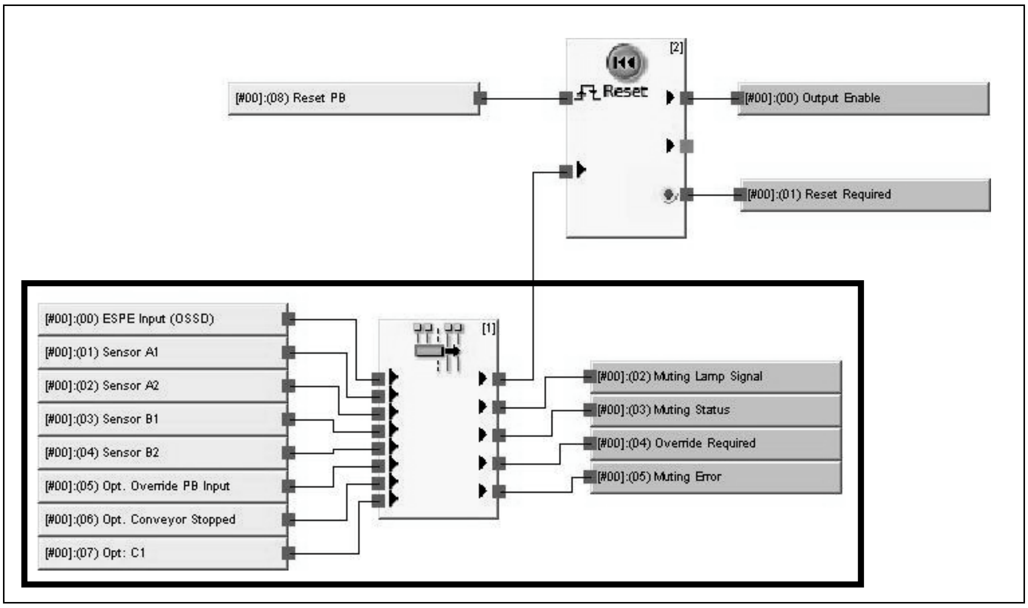
Fig. 77: Valid muting sequence using default configuration values



7.7.9 Implementing muting using sequential sensor pairs

Function block diagram

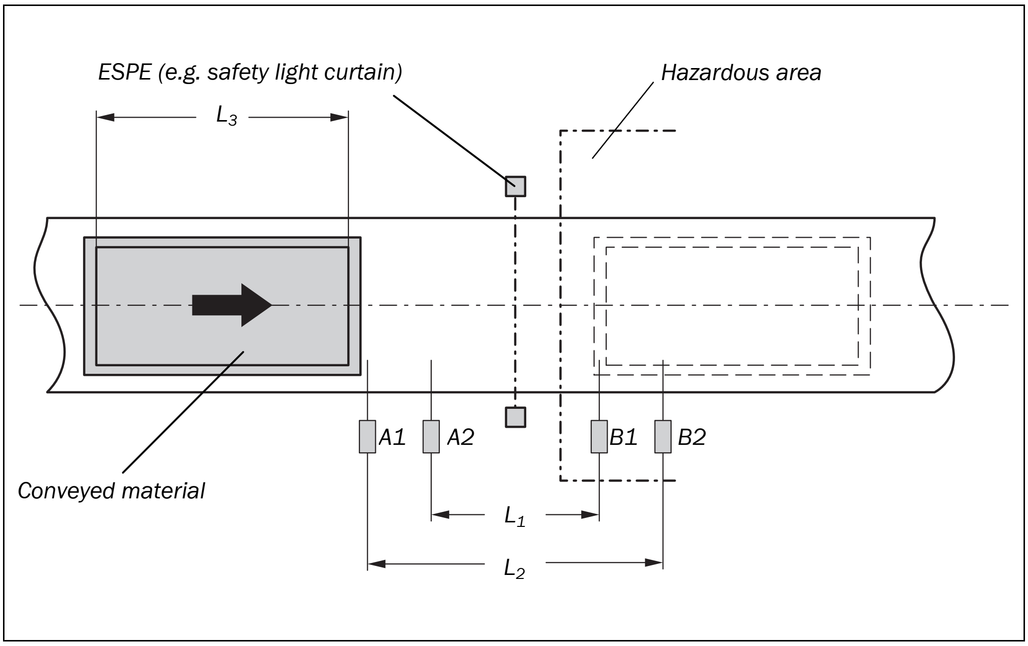
Fig. 78: Logic connections for function block Sequential Muting with Reset



Application layout

Fig. 79 provides an example of sensor locations associated with the Sequential Muting function block.

Fig. 79: Sequential muting sensor layout example



In the example, the material moves from left to right. As soon as the muting sensors A1 & A2 are activated, the protection provided by the protective device (ESPE) is muted. The protection remains muted until one of the sensors in the muting sensor pair B1 & B2 is clear again.

Muting sensor input requirements

Tab. 93: Conditions for muting with four sensors with sequential sensor placement

Condition	Description
A1 & A2 (or B1 & B2)	Starts muting cycle. The first sensor pair is activated as a function of the direction of transport of the material.
A1 & A2 & B2 & B1	Requirement for transfer of the muting function responsibility to the second sensor pair.
B1 & B2 (or A1 & A2)	Muting applies as long as this condition is met. The second sensor pair is activated as a function of the direction of transport of the material.

Distance calculations and requirements include:

$L_1 \geq v \times 2 \times T_{IN\ Muting\ Sensor}$

$v \times t > L_1 + L_3$

$L_2 < L_3$

$T_{IN\ Light\ Curtain} < T_{IN\ Muting\ Sensor}$

Where …

L_1 = Distance between the inner sensors (placement symmetrical to ESPE's detection)

L_2 = Distance between the outer sensors (placement symmetrical to ESPE's detection)

L_3 = Length of the material on the conveyor

v = Velocity of the material (e.g. of the conveyor belt)

t = Total muting time set [s]

$T_{IN\ Light\ Curtain}$ = Response time required for information to be available at the UE4457 process image

$T_{IN\ Muting\ Sensor}$ = Response time required for information to be available at the UE4457 process image

Please refer to chapter 11.2 "Response time" on page 176 for further details on the calculation.

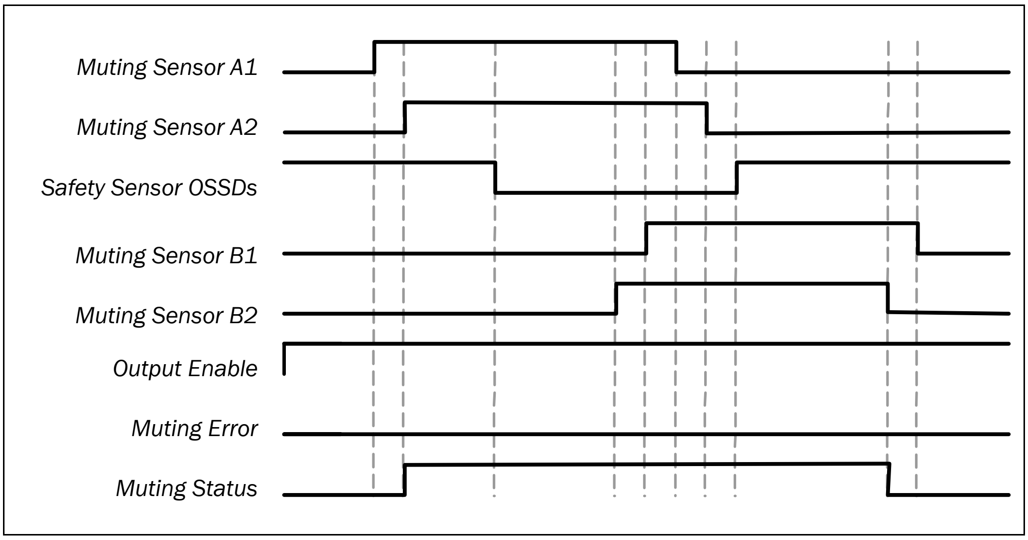
Notes

- For this example, the material can flow in both directions or be defined for a fixed direction only by:
  - Using the optional signal C1. When used, C1 must always be activated before both muting sensors in the first sensor pair (e.g. A1 and A2) are **Active**.
  - Using the Direction Detection configuration parameter
- The sensor placement outlined in this example is suitable for all types of sensors.
- Avoid mutual interference between the sensors.
- Increase the protection against manipulation and safety using the following configurable functions:
  - concurrence monitoring
  - monitoring of the total muting time
  - end of muting by ESPE
  - sequence monitoring
- The electrical connection of devices is described in chapter 5 "Electrical installation" on page 53.

Logic/timing diagram

The function block requires that a valid muting sequence occurs. Fig. 80 shows an example of a valid muting sequence based on the default parameters for this function block.

Fig. 80: Valid muting sequence using default configuration values



7.7.10 Function block Muting with crossed sensors — forward or reverse direction only

Function block diagram

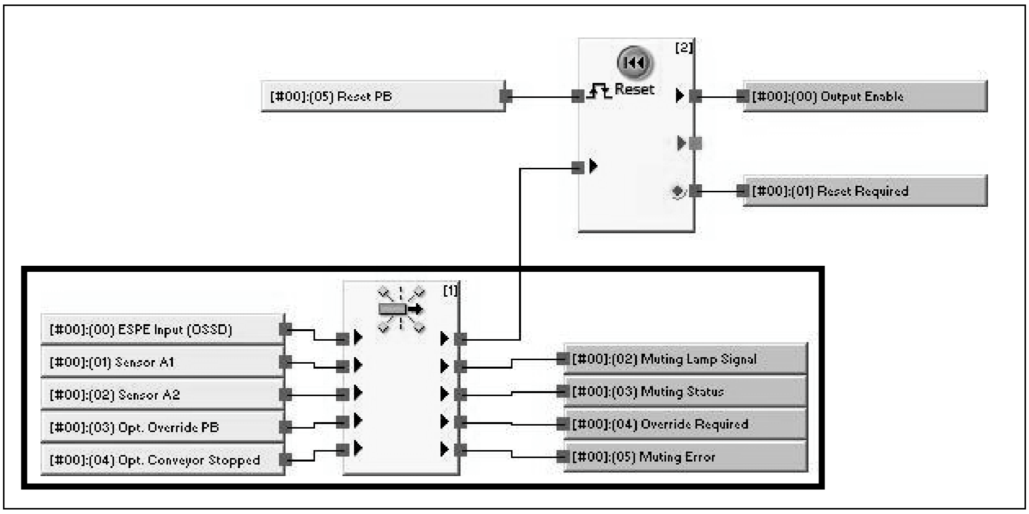


Fig. 81: Logic connections for function block Crossed Muting with Reset

Application layout

Fig. 82 shows an example of the sensor locations used with the Crossed Muting function block. Optional signal C1 is used to provide additional anti-manipulation of the muting system.

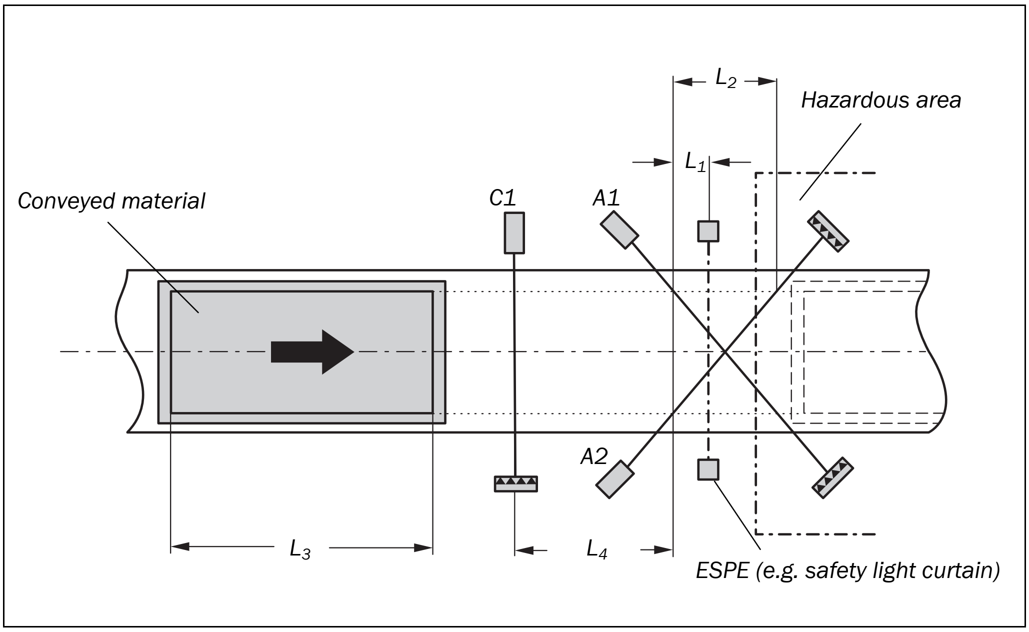


Fig. 82: Muting using crossed sensors and optional signal C1 example

The protection provided by the protective device is muted when the muting sensors are activated in a defined sequence. The muting sensor (signal C1) must always be activated, before **both** muting sensors in the first sensor pair (e.g. A1 and A2) are **Active**.

Muting sensor input requirements

Tab. 94: Conditions for muting with two sensors and optional signal C1, crossed sensor placement

Condition	Description
C1 & A1 & A2	C1 must always be activated before both muting sensors in the first sensor pair (e.g. A1 and A2) are **Active**.
A1 & A2	Muting applies as long as this condition is met and the condition outlined above has been satisfied.

Distance calculations and requirements include:

$L_1 \geq v \times T_{IN\ Muting\ Sensor}$

$v \times t > L_2 + L_3$

$L_3 > L_4$

$T_{IN\ Light\ Curtain} < T_{IN\ Muting\ Sensor}$

Where …

L_1 = Minimum distance between the ESPE's detection line and detection by A1, A2

L_2 = Distance between the two sensor detection lines (sensors activated/clear)

L_3 = Length of the material on the conveyor

L_4 = Maximum distance between C1 and the detection line for A1, A2

v = Velocity of the material (e.g. of the conveyor belt)

t = Total muting time set [s]

$T_{IN\ Light\ Curtain}$ = Response time required for information to be available at the UE4457 process image

$T_{IN\ Muting\ Sensor}$ = Response time required for information to be available at the UE4457 process image

Please refer to chapter 11.2 "Response time" on page 176 for further details on the calculation.

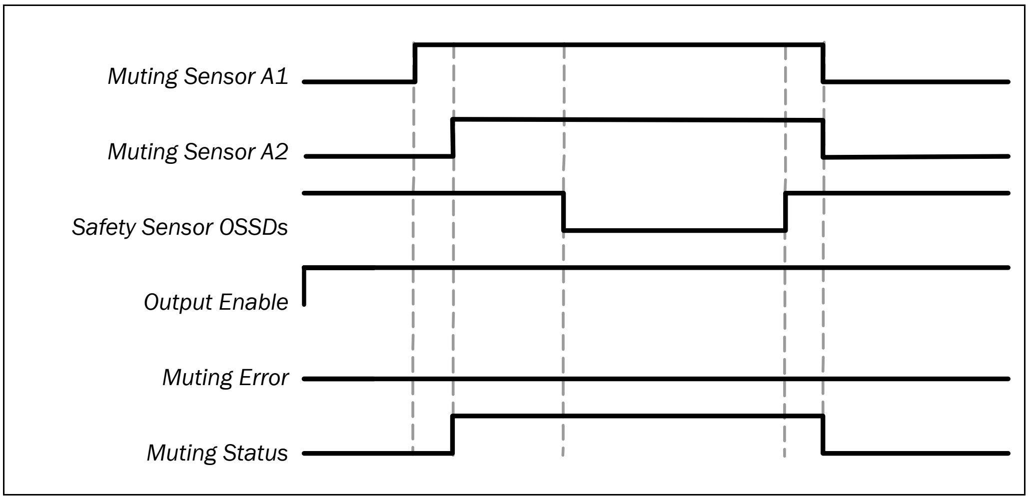
Notes

- For this example, the material can only flow in one direction.
- To move material in both directions (i.e. bidirectional), place the crossover point directly in the ESPE's light beams (see chapter 7.7.11 "Function block Muting with crossed sensors — bidirectional" on page 137).
- The sensor placement outlined in this example is suitable for both through-beam photoelectric switches and photoelectric reflex switches.
- Avoid mutual interference between the sensors.
- Increase the protection against manipulation and safety using the following configurable functions:
  - concurrence monitoring
  - monitoring of the total muting time
  - end of muting by ESPE
- The electrical connection of devices is described in chapter 5 "Electrical installation" on page 53.

Logic/timing diagram

The function block requires that a valid muting sequence occurs. Fig. 83 shows an example of a valid muting sequence based on the default parameters for this function block. Optional signal C1 is not included in the sequence outlined below.

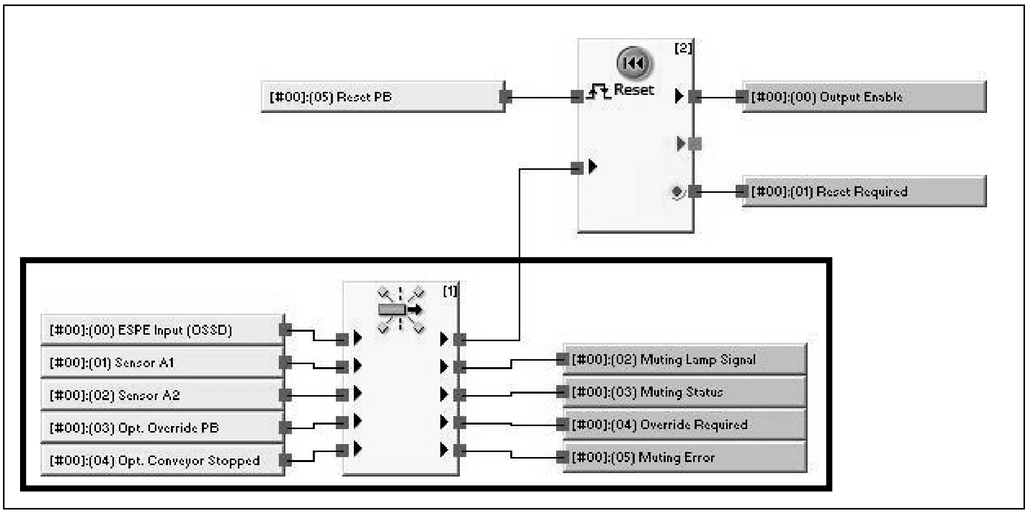
Fig. 83: Valid muting sequence using default configuration values



7.7.11 Function block Muting with crossed sensors — bidirectional

Function block diagram

Fig. 84: Logic connections for function block Crossed Muting with Reset



Application layout

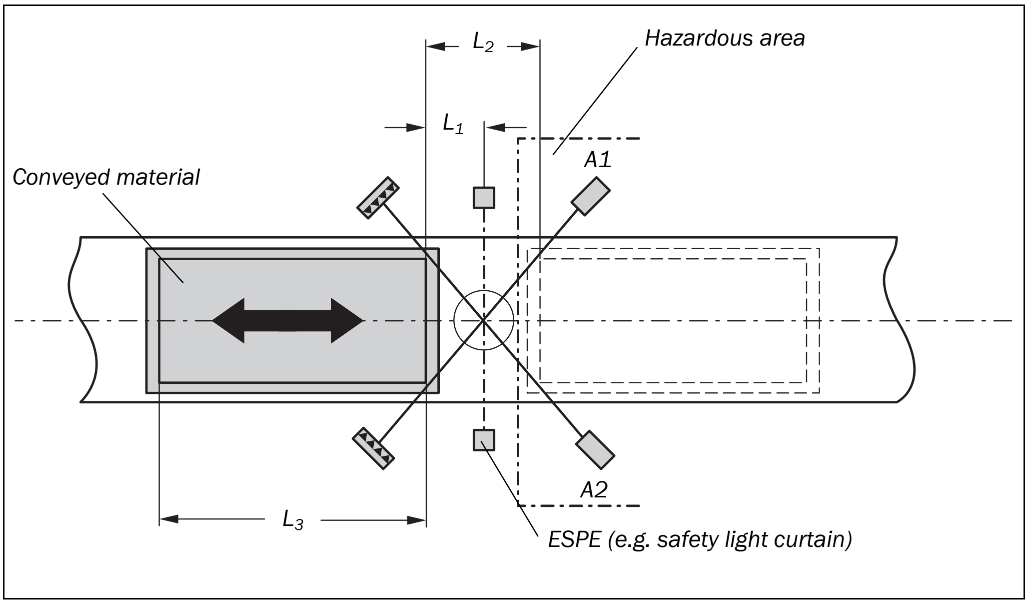
For crossed sensor muting applications in which bidirectional movement of material is required, sensor placement can be implemented in the following manner. Optional signal C1 is not used in this application example.

WARNING

Ensure that muting sensors only detect the conveyed material!

You must ensure that muting sensors are located such that personnel cannot enter the hazardous area by satisfying the muting condition requirements (i.e. triggering both muting sensors to satisfy the muting requirements).

Fig. 85: Muting using crossed sensors for bidirectional movement of material



Muting sensor input requirements

Tab. 95: Conditions for muting with two sensors and optional signal C1, crossed sensor placement

Condition	Description
A1 & A2	Muting applies as long as this condition is met and the condition outlined above has been satisfied.

Distance calculations and requirements include:

$L_1 \geq v \times T_{IN\ Muting\ Sensor}$

$v \times t > L_2 + L_3$

$T_{IN\ Light\ Curtain} < T_{IN\ Muting\ Sensor}$

Where ...

L_1 = Minimum distance between the ESPE's detection line and detection by A1, A2

L_2 = Distance between the two sensor detection lines (sensors activated/clear)

L_3 = Length of the material on the conveyor

v = Velocity of the material (e.g. of the conveyor belt)

t = Total muting time set [s]

$T_{IN\ Light\ Curtain}$ = Response time required for information to be available at the UE4457 process image

$T_{IN\ Muting\ Sensor}$ = Response time required for information to be available at the UE4457 process image

Please refer to chapter 11.2 "Response time" on page 176 for further details on the calculation.

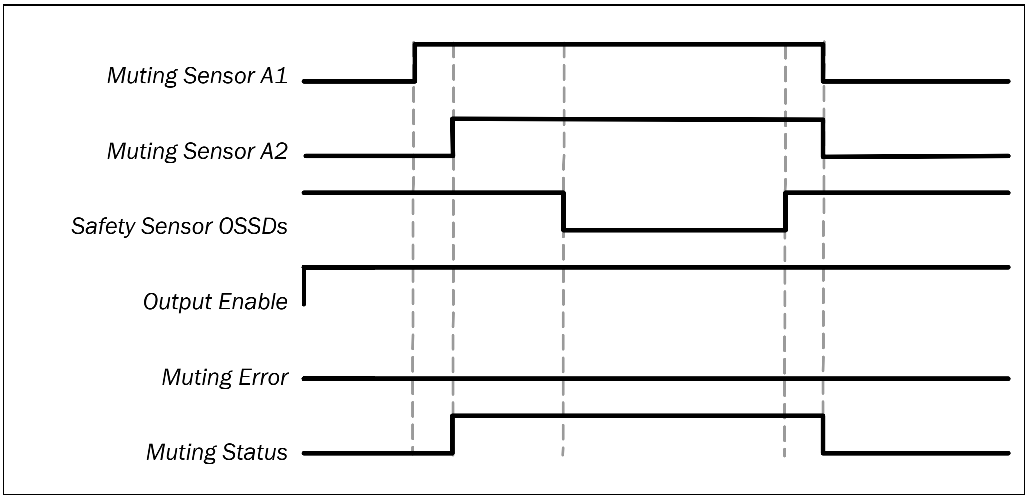
Notes

- For this example, the material can flow in both directions.
- To be able to move material in both directions, place the cross-over point for the muting sensors exactly in the path of the ESPE's light beams.
- To move material in only one direction, place the crossover point behind the ESPE's light beams as seen from the conveyor (see chapter 7.7.10 "Function block Muting with crossed sensors — forward or reverse direction only" on page 134).
- The sensor placement outlined in this example is suitable for both through-beam photoelectric switches and photoelectric reflex switches.
- Avoid mutual interference between the sensors.
- Increase the protection against manipulation and safety using the following configurable functions:
  – concurrence monitoring
  – monitoring of the total muting time
  – end of muting by ESPE
- The electrical connection of devices is described in chapter 5 "Electrical installation" on page 53.

Logic/timing diagram

The function block requires that a valid muting sequence occurs. Fig. 86 shows an example of a valid muting sequence based on the default parameters for this function block.

Fig. 86: Valid muting sequence using default configuration values



7.8 Logic application example

The following example provides insight into possible logic applications using UE4427 or UE4457 devices.

WARNING

You are responsible for implementation of devices on the UE4400. Applications utilizing the UE4400 must meet regulatory requirements!

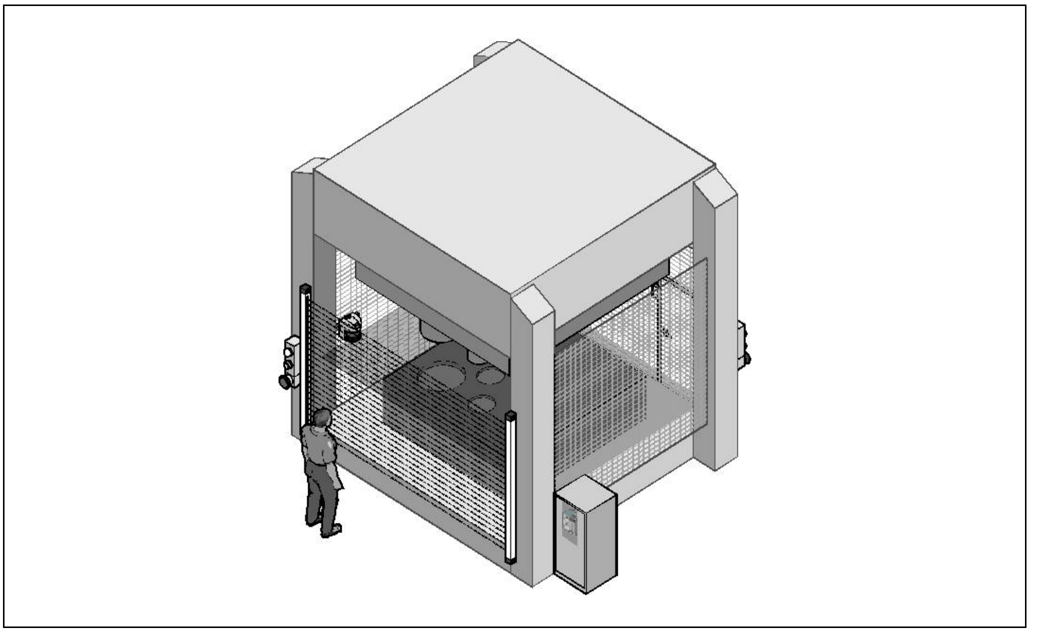
The UE4400 is suitable for safety-related applications in accordance with IEC 61508 up to Safety Integrity Level (SIL) 3 and up to category 4 in accordance with EN 954-1.

However, you are responsible for ensuring that all devices connected to the UE4400 are suitable for their intended purpose and that the logic, wiring, installation and implementation (including configuration, etc.) of the UE4400 is in accordance with your application requirements (including your risk reduction stategy and risk assessment) and applicable local, regional and national regulations.

7.8.1 Implementing logic using standard PLC control of safety outputs

For some applications, it may be possible to utilize the UE4427 or UE4457 as the safety-rated controller for the system. In this case, the UE4427 or UE4457 is configured such that a standard programmable logic controller (PLC) may be used to control an actuator (e.g. downstroke of press ram) that causes hazardous motion.

Fig. 87: Press application using UE4457 and standard programmable logic controller



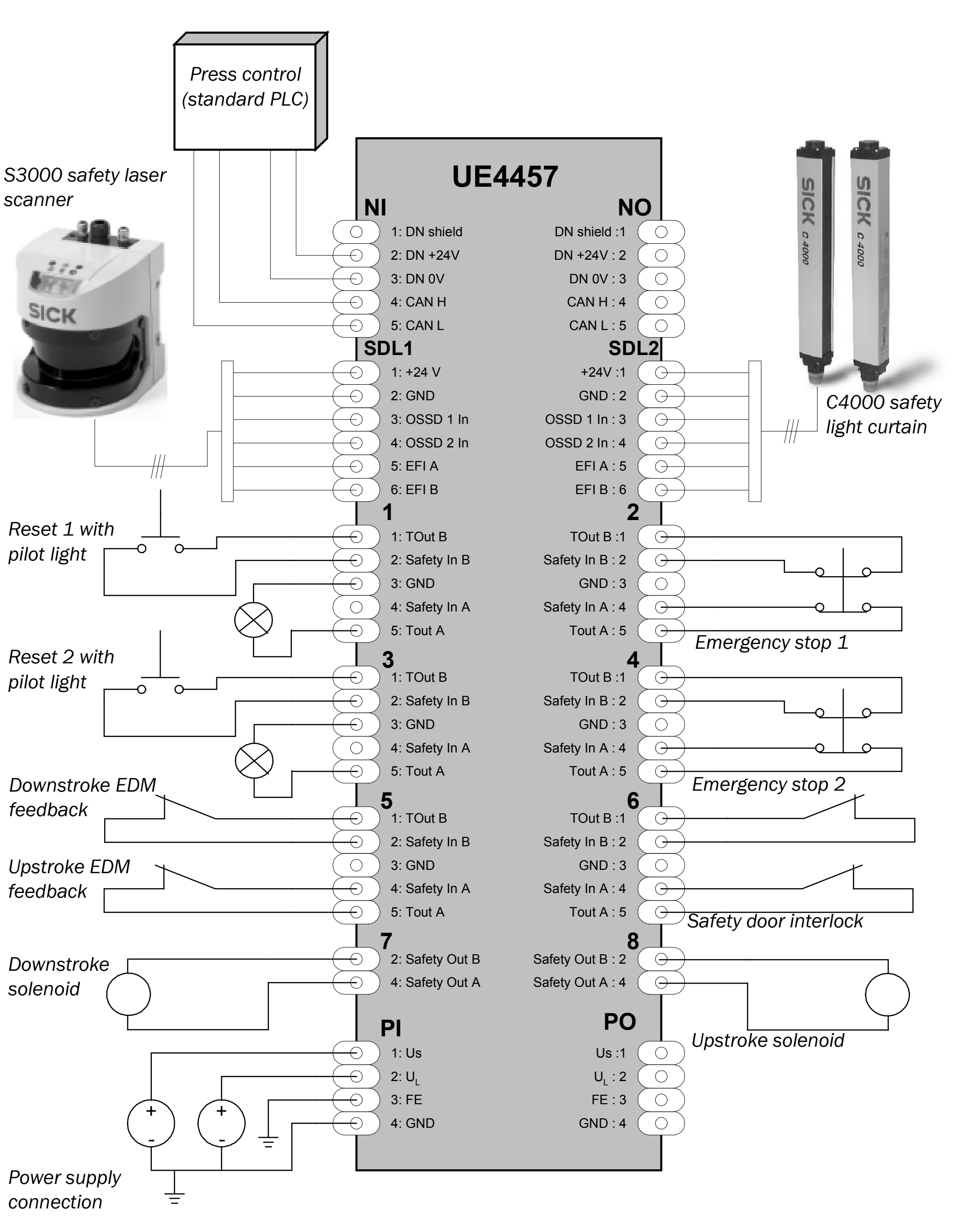
For the downward acting press application shown above, the following signals must be managed relative to the safety of the system:

- C4000 safety light curtain
- S3000 safety laser scanner
- Emergency stop button (2)
- Safety door interlock
- Reset pushbutton (2)
- Reset required pilot light (2)
- Ram Downstroke Output
- Ram Upstroke Output

Hazardous motion only occurs during the downstroke of the press. The upstroke is not viewed as a hazardous motion. Based on this scenario, the safety devices could be connected to the UE4457 as shown in the figure below.

Note The C4000 safety light curtain receiver unit is connected to SDL2. The C4000 sender unit is connected to an external 24 V DC power source.

Fig. 88: Connection of devices to the UE4457 for press control application example



Additionally, the standard PLC (i.e. press control) will interface to the UE4457 via DeviceNet to provide control signals related to motion of the press ram using I/O assemblies.

Assembly 782 (0x30E) provides the means to integrate the following signals from the standard PLC to the UE4457:

- Restart Input (i.e. Remote Input Value 1)
- Ram Down Signal (i.e. Remote Input Value 2)
- Ram Up Signal (i.e. Remote Input Value 3)

Assembly 792 provides the means to integrate the following signals from the UE4457 to the standard PLC:

- Restart Required (e.g. Remote Output Value 1)
- Safety Input values for monitoring purposes

Control of the downstroke and upstroke is accomplished by integrating control bits from the press controller. In this application example, the ram is only allowed to move when all safety sensors are in the safe state, e.g.

- C4000 safety light curtain protective field is not obstructed
- S3000 safety laser scanner protective field is not obstructed
- Emergency stop buttons are not actuated (i.e. are not pressed)
- Safety door interlock indicates the door is closed

A valid reset and restart sequence must be completed before initial ram movement (e.g. on power up) or after the interruption of any safety sensor signal. When a reset is required, both reset required pilot lights are illuminated (1 Hz flashing). The reset input can be implemented by pressing either reset pushbutton. This assumes that the operator has a clear view of the safeguarded space from both reset button locations and that it is safe for press motion to occur (e.g. no one is present within the safeguarded area). Once the reset sequence is completed in accordance with the requirements outlined in the reset function block definition, a restart command from the standard PLC is required before any motion of the press will be allowed.

Signal evaluation (e.g. single-channel versus dual-channel, et. al. parameters) is configured using device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **I/O configuration**.

An example of potential logic implementation for this application is shown below. Again, it is imperative that any use of this or any safety-relevant logic requires that all aspects of the application be considered in accordance with your risk assessment and risk reduction strategy as well as applicable regional, national and international regulations.

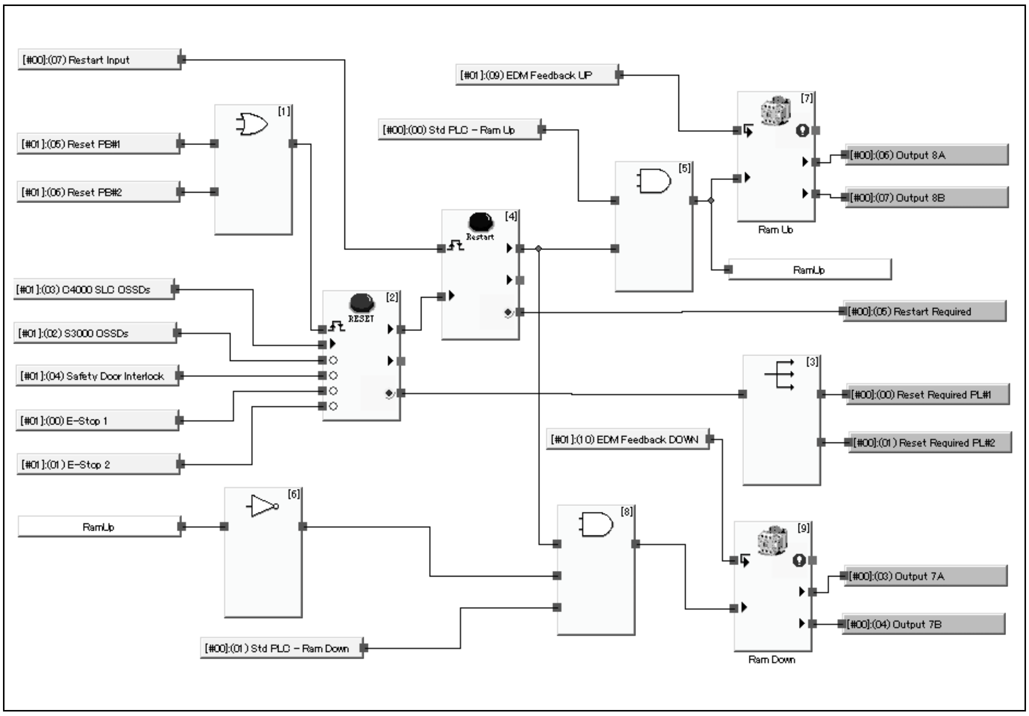


Fig. 89: Press application using UE4457 and standard programmable logic controller — logic diagram

Based on this logic example, the following procedure will allow the safety outputs to be controlled directly by the standard PLC without the need for other safety controller(s):

1. Power-up to system occurs. The UE4457 completes internal self-testing successfully and is configured with the logic shown and is set for auto execution mode.
2. Communication is established via DeviceNet to the press controller (i.e. standard PLC).
3. Safety sensor inputs are all **Active** (e.g. C4000 receiver OSSDs, S3000 OSSDs, both Emergency Stop buttons and the Safety Door Interlock).
4. Reset Required pilot light signals flash at 1 Hz.
5. Reset pushbutton is pressed in accordance with function block requirements.
6. Restart required bit is set to **Active** and sent to the press controller (i.e. standard PLC) for processing.
7. Restart input is set to **Active** by press controller (i.e. standard PLC) and sent to UE4457.
8. Restart sequence is satisfied in accordance with function block requirements.
9. Output of Restart function block (i.e. “Safety Enable” function) is **Active**.
10. Standard PLC can freely control Ram Down or Ram Up movement without further concern for Reset or Restart, provided that the following conditions remain true:
11. All safety inputs (e.g. C4000, S3000, Safety Door Interlock, Emergency Stops) remain **Active**; and
12. External Device Monitoring (i.e. EDM Feedback) signals remain in accordance with EDM function block requirements.
13. When the Ram Up outputs are **Active**, the Ram Down outputs will always be **Inactive**.
14. When power to the unit is cycled, continue with Step 1.
15. When any safety input becomes **Inactive**, continue with Step 3.

8 Configuration

This chapter describes the necessary steps for configuring UE4400 and its integration into the application.

8.1 Delivery status

In its delivery status the UE4400 is configured as follows:

- Device operational state: **Configuration required**
- DeviceNet Safety:
  - DeviceNet address (MAC_ID): **63** (on physical address switch)
  - DeviceNet baud rate: **125 kBit/s**
  - DeviceNet Safety Network Number: **0xFF 0xFF 0xFF 0xFF 0xFF 0xFF**
  - Stand-alone mode: **Not selected**
  - Autoexecution mode: **Not selected**

When the UE4400 is configured using a safety network configuration tool (e.g. SICK DeviceNet Safety Configurator) and an .EDS file or CDS plug-in, the following default conditions will be presented to the user:

- Safety capable input settings:
  - Input type: **Not used**
  - Input test source: **Not Used**
  - Input OFF-ON delay: **0 ms**
  - Input ON-OFF delay: **0 ms**
  - Input slope detection: **No slope detection**
  - Input channel mode: **Not used**
  - Discrepancy time monitoring enabled: **Inactive** (i.e. checkbox is not selected)
  - Channel B reporting values published: **Inactive** (i.e. checkbox is not selected)
- Test/signal output settings:
  - Output type: **Not used**
- Safety capable output settings:
  - Output type: **Not used**
  - Output mode: **Not used**
- SDL connections:
  - No device expected
  - Read hardware OSSD: **Inactive**
- Logic for UE4427 and UE4457:
  - No logic programming implemented

8.2 Overview

Reserve an adequate amount of time for the planning, configuration and integration of the UE4400. Consider that errors may lead to the loss of safety function and, in turn, endanger personnel and equipment. The following requirements must be satisfied before the proceeding with the configuration of the UE4400:

- The application must be fully planned. The planning must contain, among other things:
  - a detailed safety analysis, including risk assessment, of the planned application
  - a full setup of all devices, their connections and the signals supplied by or required by these devices
- The UE4400 must be connected to an auxiliary power supply (see section 5.1 “Auxiliary power (MINI 4-pin connector, 7/8 inch)” on page 54 for additional information).
- The safety components must be electrically connected to the bus node. Please reference section 5 “Electrical installation” on page 53 as well as the corresponding sections of the operating instructions of the devices that you wish to connect to the UE4400 for additional information.

8.3 Planning

The UE4400 has the capability to communicate information to both standard DeviceNet devices and to DeviceNet Safety safety-rated devices. This information includes:

Communication to standard device connections using DeviceNet

- safety capable input monitored values and status
- test/signal output monitored values, status and standard (e.g. non-safety-relevant) control
- safety capable output monitored values and status
- SDL connection input monitored values and diagnostics (UE445x only)
- module status and diagnostics

Communication to safety-rated device connections using DeviceNet Safety

- safety capable input values and status
- test/signal output monitored values, status and control
- safety capable output monitored values, status and control
- SDL connection input values, diagnostics and output control (UE445x only)
- module status and diagnostics

A coherent strategy of both safety and standard components is necessary. It is not sufficient, for example, to establish that a safety light curtain will be required. You must decide which type is to be used from which manufacturer and which functions of the device you wish to use.

Determine user specifications for the devices that you wish to deploy on the UE4400. Start with the devices on the SDL connections. Next, compile a planning schedule of the subsystem for these devices.

Recommendation Section 13.1 “Planning table for the configuration” on page 187 contains a planning table that can be used for documentation and planning the configuration of the UE4400.

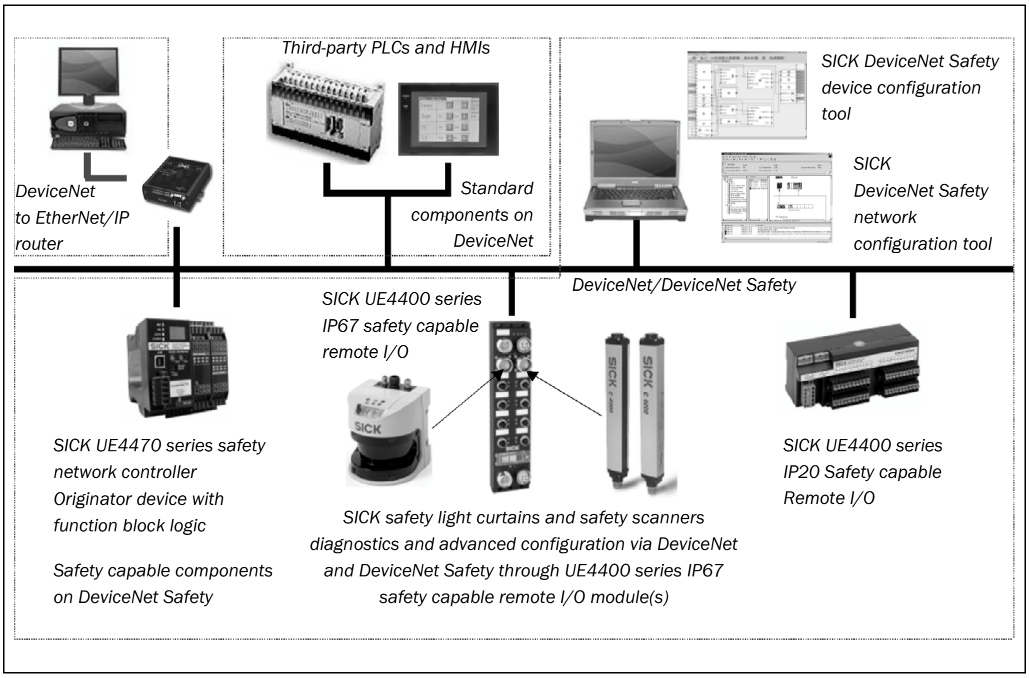
From the previous decisions, select the field devices that will be required to control the SDL devices, e.g. a particular reset button or a suitable type of operating mode selector switch.

Establish the types of all other field devices and the performance of their functions for your application.

If you use SICK devices on the SDL connections, it may be useful to create a corresponding “project” in the CDS as early as the planning phase. At that stage you can use the dialog to establish the available functions and the necessary parameters of the corresponding devices and you can print out a configuration draft.

For example, the following network DeviceNet/DeviceNet Safety topology/architecture is possible. Please note this example is only one of many possible network topologies.

Fig. 90: DeviceNet/DeviceNet Safety topology example



8.4 UE4400 configuration tools

When the planning phase is complete and the necessary devices are available, configuration of the application should begin.

In parallel, planning should begin for starting the safety-related control strategy. The safety-rated controller program accesses the inputs and outputs of the UE4400 via input and output process images.

To configure the UE4400, you will need:

- UE4400
- User manuals for the UE4400 and any attached devices and the chosen configuration tool on CD-ROM.
- PC/Notebook with Windows 2000 and Windows XP. PC/notebook not included.
- When configuring the UE4400 via local RS-232c, connecting cable for the RS-232c connection between PC and UE4400 (SICK part no. 6021195)

- When configuring the UE4400 via DeviceNet/DeviceNet Safety connection, a means of communicating via the network is necessary. When using SICK DeviceNet Safety Configurator, the following options are available
  – USB connection to the network via SICK UE4470 Safety Network Controller
- When using a compatible third party safety network configuration tool, you must purchase the CDS plug-in software separately (SICK part number: 2027422) and follow the instructions of the safety network configuration tool supplier.

Before configuring the device, please read the user manual for the CDS (Configuration & Diagnostic Software) and use the online help function of the program. A summary of the suitability and limitations associated with the different configuration methods of the UE4400 follows below.

Tab. 96: Connection options for the Configuration & Diagnostic Software (CDS)

Connection of the CDS	Limitation	Suitable for
Directly to the configuration connection (RS-232) of the UE4400	Access to UE4400 and devices with SICK device communication (i.e. EFI communication) that are connected to the SDL connectors	Local configuration of the UE4400 and associated SDL devices attached to the UE4400. DeviceNet/ DeviceNet Safety parameters can also be configured.
Via DeviceNet Safety using SICK CDS plug-in for SNCT[3)]		Remote configuration of the UE4400 and attached SDL devices. DeviceNet/ DeviceNet Safety parameters must be compatible with the network in order for communication to occur with the UE4400 (e.g. communication rate and network node address [MACID]).

WARNING

Take organizational measures for protection during configuration!

During the configuration, ensure that no dangerous states may occur in the system or in that part of the system that is being monitored by the devices connected to the UE4400. During configuration, the UE4400 will not establish any I/O communication connections. Safety-relevant controllers (e.g. DeviceNet Safety Originators) that attempt to connect to the UE4400 during configuration are responsible for ensuring that process image information is based on **Inactive** (fault detected) data.

3) SNCT software includes SICK DeviceNet Safety Configuration Tool, Rockwell Automation™/Allen-Bradley™ RSNetWorx™ version 6.0 or later or OMRON Configurator™ version 1.32 or later.

8.5 UE4400 device configuration

You must create a unique project in the CDS for each UE4400 device used in your application. Within the project you then allocate devices that are attached to the UE4400. If the UE4400 unit is a UE442x variant, proceed to section 8.5.2 "Configuration of field signal devices" on page 148.

8.5.1 Configuration of SDL devices

Begin the configuration of the UE445x by specifying any devices connected to the SDL connectors. Make sure to review specific device information that is presented in the operating instructions of the respective device. When both SDL connectors are used, make sure that the configuration of each SDL connector is completed. Make sure that unused SDL connectors are set to **Inactive** or **Permanently off**.

Add devices with safe SICK device communication to UE4400 offline project: Device symbol UE4400 **DeviceNet**, context menu **Add device**, submenu **To SDL 1…** or **To SDL 2…**. Follow the configuration wizard to specify specific device parameters.

Notes

- You may also configure the device(s) by establishing a connection from the CDS to the UE445x. This will enable you to upload an existing configuration of the connected device(s) into the UE445x project
- The UE445x monitors the configuration of the devices on the SDL connection. If you reconfigure or exchange an SDL device, you may need to modify the configuration of the UE445x and retransfer the configuration to the SDL device. See section 3.6.7 "SDL configuration (UE445x only)"on page 42 for additional details.
- You also may obtain additional information about potential configuration errors by evaluating the diagnostic data of the UE4400 (see section 10.10 "DeviceNet/DeviceNet Safety process images and diagnostic information" on page 171) as well as with the aid of the CDS.
- If the device on the SDL connection needs data from the UE445x or from a safety rated controller, but the UE445x has not yet been completely configured, the device can report an error on the SDL connection. If necessary, you should give priority to configuring the UE445x or programming the safety rated controller in order to test the configuration of the device on the SDL connection.

8.5.2 Configuration of field signal devices

- The next step in the configuration of the UE4400 is to specify any devices connected to the field signal connectors. These field signal devices include safety capable inputs, test/signal outputs and safety capable outputs. Configuration for all field signal connectors that are used should be completed in this step. This includes all devices connected to the eight (8) M12 field signal connectors.
- Make sure that all unused connectors are set to **Permanently off** (e.g. **Not used**). Specific device parameters should also be verified for accuracy (e.g. input delay, discrepancy time, etc.). Several circuit examples for field signal devices are presented in section 6 "Circuit examples" on page 62.

Device symbol **UE4400 DeviceNet**, context menu **Open device window**, file card **I/O configuration**.

Note When one or more test outputs or safety-capable outputs will be controlled using the logic capability of the UE4427 or UE4457, they must be first selected inside of the logic engine before additional configuration parameters can be accessed.

Use the device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **Logic Configuration** and select the output you wish to use by placing the output on the "canvas" and connecting it to the associated function block. Once this is completed, go back to the **I/O Configuration** tab and then double-click on the output to assign any additional configuration parameters.

8.5.3 Configuration of DeviceNet parameters

Ensure that all parameters associated with DeviceNet/DeviceNet Safety have been properly configured. These parameters include the network node address (i.e. MAC ID) and communication rate setting.

- Software controlled MAC ID configuration is only possible when the rotary switches are set to a value greater than 63.
- Communication rate (i.e. baud rate) must match the other devices on the network. If the baud rate setting in the UE4400 does not match the other devices on the network, the UE4400 will transition to an abort state (e.g. bus off).

The MAC ID node address and communication rate is set via device symbol **UE4400 DeviceNet**, context menu **Open device window**, file card **DeviceNet**.

8.5.4 Configuration of logic in UE4427 and UE4457 devices

In many applications, local logic can minimize system response times (i.e. make response times short and deterministic) when implementing local safety input devices (e.g. sensors) and control local safety output devices (e.g. actuators). Device types UE4427 and UE4457 allow users to configure logic internal to the device.

Safety-relevant logic programming associated with the UE4427 or UE4457 devices is described in chapter 7 "Logic programming — function blocks" on page 68.

Tab. 97: Parameters associated with safety-relevant logic of UE4427 and UE4457

Maximum number of function blocks	32
Maximum available logic processing time (i.e. logic execution time) when DeviceNet or DeviceNet Safety communication is utilized	300 µs
Maximum available logic processing time (i.e. logic execution time) when UE4400 operates in stand-alone mode	1.5 ms
Control of safety capable outputs	Independent control may be implemented
Function blocks available	AND, OR, Exclusive OR, Exclusive NOR, NOT, Reset, Restart, ROUTE, User Mode Switch, Two-Hand Control, ON-Delay Timer, OFF-Delay Timer

Note Logical function block programming is available for UE4427 and UE4457 devices only.

The logic editor is accessed under **UE4400 DeviceNet**, context menu **Open device window**, file card **Logic**.

8.5.5 Transfer the configuration

After all of the parameters, logic (when available) and physical connections on the UE4400 have been configured and verified for accuracy, transfer the configuration to the UE4400 as described in the CDS online help.

For configuration via the local RS-232 port, remove the programming cable after the configuration has been successfully downloaded to the UE4400.

WARNING

Replace the protective cover after local configuration or MAC ID node address switch setting!

If the protective cover has been removed to gain access to the RS-232c connection or MAC ID address switches, screw the device's protective cover back onto the device after you have finished configuring it. If this step is not done, the device will no longer comply with the stated enclosure rating.

8.5.6 Verify UE4400 device behavior

Once the configuration is downloaded, the user must test and verify the function of each connected device individually before connecting the UE4400 on to DeviceNet/DeviceNet Safety.

WARNING

Validate the UE4400 Configuration!

Under no circumstances should the UE4400 be implemented into any safety-relevant control system prior to verification that all connected devices have been configured correctly and that the safety-related controller program that utilizes data from the UE4400 and other safety relevant devices are operating in accordance with an adequate safety strategy.

8.5.7 Configuration lock

Once the configuration in the UE4400 has been verified and validated, the configuration can be locked to prevent changes from being implemented using the safety network configuration tool (e.g. SICK DeviceNet Safety Configurator). In order to make any changes to the configuration, you must use the safety network configuration tool to unlock the configuration. Consult the safety network configuration tool for additional details regarding configuration lock and unlock parameters.

8.5.8 Replacing existing UE4400 devices

When replacing an existing UE4400 device, you must ensure that identical configuration parameters are implemented in the replacement UE4400 device. For network communication to occur, the following parameters must match the existing device parameters:

- Safety Network Number (SNN)
- Media Access Control Identifier (MACID) (i.e. device address)
- Baud rate (i.e. communication speed)

If the replacement device has had a previous configuration stored in the device (e.g. was used in a previous application), make sure that you reset the device to its out-of-box configuration using a safety network configuration tool (e.g. SICK DeviceNet Safety Configurator).

The following steps outline an example procedure for the replacement of an existing device.

1. Set safety network number (SNN) and device address (MACID) to match the existing device. If the system communication speed (e.g. baud rate) does not match the replacement unit baud rate (e.g. default is 125 kBaud), then these parameters may need to be configured via the local RS-232 port on the device and SICK Configuration and Diagnostic Software (CDS) included with the device.
2. Perform an out-of-box reset using a safety network configuration tool (e.g. SICK DeviceNet Safety Configurator).
3. Transfer the configuration into the device via local RS-232 port connection or via network communication using a safety network configuration tool (e.g. SICK DeviceNet Safety Configurator).
4. Connect external field signal devices.
5. Verify that the configuration matches the existing UE4400 system performance and that the overall system continues to operate in accordance with your risk assessment and risk reduction strategy.

WARNING

Revalidate the UE4400 configuration!

Under no circumstances should the UE4400 be implemented into any safety-relevant control system prior to verification that all connected devices have been configured correctly and that the safety-related controller program that utilizes data from the UE4400 and other safety relevant devices is operating in accordance with an adequate safety strategy.

8.6 Safety network requirements

DeviceNet Safety utilizes the same network structure as standard DeviceNet. Additional functionality has been incorporated into DeviceNet Safety devices that provide the safety relevant capability for the DeviceNet Safety network. Since DeviceNet Safety is capable of SIL3 and category 4 according to EN 954-1 safety-rated functionality, the following statements must be adhered to for safety-rated devices that are incorporated into DeviceNet Safety and, when applicable, DeviceNet and stand-alone applications:

- The replacement of safety devices requires that the replacement device be configured properly and operation of the replacement device must be user verified.
- When users choose to configure safety connections with an SCID = 0, they are responsible for ensuring that Originators and Targets have the correct configurations. For additional information regarding safety connection configuration, consult the relevant safety network configuration tool manual.
- Each safety network or safety sub-net should use safety network numbers (SNN) that are unique system-wide.
- When a SIL3 device is configured directly from a workstation, the user must compare the transferred SCID and configuration data with the SCID and configuration data originally viewed in the workstation.
- Validation of device configurations is necessary. Devices can only be validated through the implementation of user tests.
- The device signature should only be considered “verified” (and configuration locked) after user testing has been completed and the configuration is validated.
- Configuring an Originator with connection data and/or Target configuration data must be downloaded to the Target so it can be tested and verified. Only then can SCIDs from the Target be confirmed.
- Before setting the lock attribute in each safety device, the user must …
  - completely test the device’s operation to verify the device configuration is correct and that it exhibits the correct operational behavior.
  - upload and compare the configuration from each affected safety device to that which was sent by the SNCT before setting the lock attribute in those devices.
- Any pre-existing configuration from any safety device must be cleared from the safety device before installing it onto a safety network.
- All safety devices must be configured with MAC_ID (and baud rate if necessary) prior to installing it onto any safety network.
- Safety connection configurations must be tested after they are applied in an Originator to confirm the Target connection is operating as intended.
- LEDs are **not** reliable indicators and cannot be guaranteed to provide accurate information. LEDs should **only** be used for general diagnostics during commissioning or troubleshooting. Do not attempt to use LEDs as operational indicators
- Originators that have an “automatic” SNN setting feature should only use that feature when the safety system is not being relied upon.

For generic DeviceNet and DeviceNet Safety network information, please refer to the Open DeviceNet Vendor Association website at www.odva.org.

9 Commissioning

WARNING

Commissioning requires a thorough check by qualified personnel!

Before operating a system for the first time in which you have deployed the UE4400, make sure that it is first checked and approved by qualified personnel. Please read the notes in chapter 2 “On safety” on page 11.

Commissioning requires that the following steps have already been successfully completed:

- Risk assessment and reduction strategy
- Planning
- Programming and configuration of the UE4400

9.1 Technical commissioning

The configuration of the UE4400 must be completed before proceeding with any technical commissioning. When using UE445x, connection of SDL devices and the associated SDL device configuration must occur in the UE445x before completing the technical commissioning of the device. Refer to section 8 “Configuration” on page 144 for additional information.

9.1.1 Commissioning UE4400 devices

Before commissioning the UE4400, make sure that the configuration has been downloaded to the device (see section 8 “Configuration” on page 144 for additional information). Once this has been completed, follow these steps to commission the UE4400.

1. Connect auxiliary power (U_L, U_S) and verify that the voltage and current conforms to UE4400 specifications.
2. Connect the UE4400 to the DeviceNet (Safety) network in conformance with the specifications outlined in this manual and the ODVA Planning and Installation Manual for DeviceNet Cabling (available on the ODVA web site at www.odva.org).

Note The communication rate setting of the UE4400 must match the communication rate of the network that the UE4400 is connected to.

3. Validate that the MAC ID and Safety Network Number (SNN) of the UE4400 match application and network configuration requirements.
4. Validate the device state after power up. Verify proper network connection by checking that the NS (network status) and MS (module status) LEDs are both as expected (see section 3.8 “Status indicators” on page 48 for additional information). Use diagnostic information from SICK CDS plug-in to assist in validating the device state. The device state shall be either IDLE or EXECUTING.
5. Rectify any error condition (e.g. DeviceNet power loss, MAC ID mismatch, TUNID mismatch, wrong communication rate (baud rate), etc.) that hinders the device to go IDLE or EXECUTING. On completion of this step, return to step 4.
6. When commissioning a UE4420 or UE4427, go to step 9. When commissioning a UE4450, UE4455 or UE4457, go to step 7.

7. For UE4450, UE4455 or UE4457 devices, connect SDL devices to their respective SDL connectors and verify that the functional behavior of each SDL device is as required for the application. Use diagnostic information from SICK CDS, UE4400 SDL LED and the SDL device indicators to assist in validating each SDL connection. Check that the devices connected to the SDL connections are in accordance with the test procedures from the corresponding operating instructions of the connected SDL device.
8. Rectify any fault condition (e.g. miswiring or crossed signals) on each SDL connector before proceeding to the next step.
9. Connect individual field devices to their respective signal connectors and verify that the functional behavior of each safety capable input, test/signal output and safety capable output is as required for the application. Use diagnostic information from SICK CDS and UE4400 LED indicators to assist in validating each field signal. Check whether the switching of the components to the field signal connections complies with the applicable category according to EN 954-1.
10. Rectify any fault condition (e.g. miswiring or crossed signals) on each safety capable input, test/signal output or safety capable output before proceeding to the next step.
11. Validate that the UE4400 DeviceNet (Safety) communication connections to standard and safety-rated devices have occurred. Verify that the data that is received at each device is as expected.
12. For UE4427 and UE4457 devices, verify that any logic that has been implemented performs in accordance with the application requirements and corresponds with the intended risk reduction strategy.
13. Validate the behavior of all remaining DeviceNet (Safety) components.

Once the configuration in the UE4400 has been verified and validated, the configura-tion can be locked to prevent changes from being implemented using the safety network configuration tool (e.g. SICK DeviceNet Safety Configurator). Refer to the operation manual of the safety network configuration tool for additional details.

9.1.2 System self-test after switching on

Immediately after power is present at terminals U_s and U_L, the UE4400 carries out the following steps automatically:

- Internal self-test
- Loading the stored configuration
- Testing whether the loaded configuration is suitable for the connected devices

Note The system will not transit to IDLE or EXECUTION mode if the above steps are not successfully performed. In the event of an error, the UE4400 will only transmit **Inactive** (fault detected) values and UE4400 LED indicators will be illuminated based on the error that has occured (see section 10 “Fault diagnosis” on page 156).

9.1.3 General acceptance of the UE4400

You may only start operating the system when the general acceptance of the UE4400 was successful. Only qualified personnel with the appropriate training are to carry out the general acceptance procedure for the UE4400 (see section 2.1 "Qualified specialist personnel" on page 11).

The general acceptance comprises the following test points:

- Mark all connecting wires and connection plugs on the UE4400 with unique markings to avoid confusion. Because the UE4400 has several connections of similar construction, you must ensure that disconnected connecting wires are not reconnected to the wrong connector.
- Check the UE4400 configuration. Check the signal paths and the correct incorporation into the safety-rated controller (e.g. SICK safety network controller) safety program or the internal logic associated with UE4427 or UE4457 devices.
- Check the correct data transfer from the field signal connectors and/or from the devices attached to the SDL connectors to the safety-rated controller and vice versa.
- Check the safety-rated controller (e.g. internal program of UE4427/UE4457 or external controller e.g. UE4470 Safety Network Controller) program.
- Completely verify the safety functions of the entire system.
- Fully document the configuration of the entire system, the individual devices, the safety-rated controller program and the results of the safety check.

10 Fault diagnosis

This chapter describes how to identify and rectify errors and malfunctions during the operation of the UE4400.

10.1 What to do in case of faults

WARNING

Cease operation if the cause of the malfunction has not been clearly identified!

Stop the machine if you cannot clearly identify or allocate the error and if you cannot safely rectify the malfunction.

Note Some error messages of the UE4400 are caused by connected devices.

- Carry out a diagnosis of the UE4400 with the aid of the CDS.
- In the case of errors, always check whether one or more connected devices display an error.
- If necessary, consult the documentation of the device that is displaying an error in order to resolve it.

10.2 SICK support

If you cannot rectify an error with the help of the information provided in this chapter, please contact your local SICK representative.

10.3 Troubleshooting hints

Tab. 98: Troubleshooting hints

Error	Possible cause	Recitfication
The UE4400 is not visible in the network after a upload had been performed from the SNCT	UE4400 has wrong baudrate. (NS LED red, MS LED red flashing)	➢ Configure safety network configuration tool (e.g. SICK DeviceNet Safety Configurator) or UE4400 to uniform baudrate
The safety capable outputs do not turn on although safety connection established and output LED not red.	Safety capable output configured to be **Not Used**.	➢ Correct the configuration of the safety capable output.
The test/signal outputs do not turn on although connection established and output LED not red.	Test/signal outputs configured to **Not Used**, **Permanently on** or **TOut**.	➢ Correct the configuration of the test/signal output.
MAC ID setting changed and set back to original setting.	ABORT state caused by wrong MAC ID setting	➢ Set MAC ID to correct address and cycle power to UE4400
Dual-channel complementary input is closed but no **Active** signal appears in process image.	Input may be configured to be dual-channel equivalent without discrepancy time monitoring.	➢ Check for error indication by LED. ➢ Check for correct configuration of safety capable input channel.
Safety connection can not be established. (UE4400 Safety Network Controller: D6<-> xx)	EPI setting is invalid. Originator not owner of output assembly.[4]	➢ Check EPI values in the safety network configuration tool (e.g. SICK DeviceNet Safety Configurator) to verify validity. ➢ Check to make sure that only one device is communicating to an output data assembly.
Safety capable output shows error even though the error had been remedied (e.g. stuck at high)	Error condition remains until the safety capable output is set to **Inactive**.	➢ Turn safety capable output off via normal means and then turn back on when suitable.
DeviceNet and/or DeviceNet Safety connection is very unstable (e.g. connection is established and then lost, established and lost, etc.)	Termination Resistor is missing or wrong value. Network load too high, many collisions on the network	➢ Check termination resistors for correct value. ➢ Check Baudrate and network load

[4] Both standard and safety devices may control test/signal outputs. The first device that claims “ownership” of an output assembly retains control, regardless of subsequent requests by other devices. This may occur when an Originator (safety master) device is replaced by another Originator (safety master) device. To clear the previous OUNID/TUNID information, reset the UE4400 using the safety network configuration tool (e.g. SICK DeviceNet Safety Configurator).

Error	Possible cause	Recitfication
When an SDL device (e.g. S3000) is connected to the SDL connector and shows a static 3 on the 7-segment display (i.e. waiting for another device to end its initialization), it cannot be identified by SICK Configu-ration and Diagnostic Software (CDS)	The SDL device (e.g. S3000) has not yet enabled communication at the SDL connector and does not respond to CDS requests via the UE445x.	➢ Configure the SDL device as a stand-alone device first and then reconnect the SDL device to the UE445x. Repeat project identification via SICK Configuration and Diagnostic Software (CDS).

10.4 Error displays of the LEDs

This chapter explains the meaning of the error displays of the LEDs and how to respond. Please refer to section 3.8 “Status indicators” on page 48 for a description.

Tab. 99: Error displays of the LEDs

Display		Possible cause	Rectifying the error
U_S	○	No voltage supply	➢ Check the voltage supply and activate as necessary.
	● **Red**	Voltage not in operational range	➢ Check the voltage supply and adjust, if necessary.
U_L	○	No voltage supply	➢ Check the voltage supply and activate, if necessary.
	● **Red**	Voltage not in operational range	➢ Check the voltage supply and adjust, if necessary.
Configuration lock (CL)	○	Invalid configuration	➢ Check the configuration with the aid of the CDS (Configuration & Diagnostic Software). ➢ Make any necessary corrections to the configuration. ➢ Re-transfer the configuration to the device.

Display		Possible cause	Rectifying the error
Module status (MS)	○	No voltage supply	➢ Check the voltage supply and activate, if necessary.
	Red (flashing)	• DeviceNet power loss • DeviceNet communication error • Wrong communication rate (i.e. baud rate) • MAC ID switch changed • TUNID mismatch	➢ Check for each condition and rectify any errors. ➢ Cycle power and check to see if error condition still exists.
	● **Red**	Critical fault (e.g. internal device error)	➢ Check the device status using the diagnostics function of the CDS. ➢ Resolve any errors. ➢ Briefly disconnect the UE4400 from the supply voltage. ➢ Exchange the UE4400 if the problem persists.
	Red/ Green (flashing)	Device is in SELF-TEST mode or is waiting for configuration/ commissioning (e.g. out of box condition)	➢ Check to make sure that self test sequence has been completed. ➢ If the self-test is complete, make sure that a valid configuration has been downloaded to the device (e.g. with CDS or .EDS configuration tools) ➢ Make any necessary corrections to the configuration. ➢ Re-transfer the configuration to the device

Display		Possible cause	Rectifying the error
Network status (NS)	○	The device is not on-line. The device has not completed the duplicate MAC ID test or the device may not be powered.	➢ Check the voltage supply and activate, if necessary. Check the connection to the DeviceNet/DeviceNet Safety network and verify that other devices are communicating. If the LED remains in the non-illuminated state, troubleshoot network for potential problems.
	Red (flashing)	One or more I/O connections are in the timed-out state.	➢ Check Originator device status ➢ Check Originator and Target network connection configuration ➢ Troubleshoot network for problems (e.g. cable length, terminating resistors, baud rate, etc.) ➢ Briefly disconnect the UE4400 from the supply voltage or cycle DeviceNet power
	● **Red**	Failed communication. The device has detected an error that has rendered it incapable of communicating on the network.	➢ Check Target device connection/ addressing parameters ➢ Check configuration data and make any necessary changes. Retransfer the configuration to the device. ➢ Briefly disconnect the UE4400 from the supply voltage or cycle DeviceNet power
	Red-Green (flashing)	The device is in the process of receiving a TUNID	

Display		Possible cause	Rectifying the error
Safety capable input connectors (1, 2, 3, 4, 5 & 6) Channels A and B	● **Red**	The device has detected an error in the I/O circuit • Capacitive load at TOut too high during power up sequence • TOut stuck at 24 V • TOut overload condition • Safety input to TOut mismatch • Dual-channel safety capable input evaluation error • Muting error	➢ Check the connection cable. ➢ If discrepancy time error was possible, set the input to **Inactive** (0) to reset the input. ➢ Check to be sure correct test signals are used for each input signal, when configured.
Safety capable output connectors (7 & 8) Channel A	● **Red**	Error detected at safety capable output circuit. E.g. safety output is stuck in an **Active** state or **Inactive** state	➢ Check the connecting cable
SDL Status	● **Red**	• Voltage supply overload at the SDL connection • Discrepancy error detected at hardware OSSDs	➢ Check the power consumption of the device connected to the SDL. ➢ Check the connecting cable. ➢ If discrepancy time error was possible, set the input to **Inactive** (0) to reset the input.
	☀ **Red**	Device communication error at the SDL connection	➢ Device not connected. Check the connecting cable. ➢ Wrong device connected (e.g. wrong type key, serial number, time or date and the option to ignore these settings has not been set) ➢ No device-parameter values have been set for the SDL connection. Configure this with the aid of the CDS.

10.5 Additional error displays of the 7-segment display of the C4000

The safety light curtain C4000 has new functions in connection with the UE445x devices and with corresponding safety-rated controller control. This section explains the meaning of the additional error displays of the 7-segment display and how to respond to the messages. You can find a description of the 7-segment display in the chapter titled “Status indicators” of the “C4000 Standard/Advanced Safety Light Curtain” operating instructions.

Tab. 100: Additional error displays of the 7-segment display of the C4000

Display	Possible cause	Rectifying the error
A ↻ 8.	UE4400 configuration is incorrect	➢ Configure the UE4400 with the aid of the CDS. ➢ Check the connection from the C4000 to the UE4400.
c. ↻ 5.	Several operating modes configured, but none selected	➢ Check the connection and the function of the operating mode selector switch. ➢ Check the connection for the operating mode selector switch on the UE4400 or in the safety-rated controller. ➢ Check the configuration of the operating mode selector switch in the UE4400 or in the safety-rated controller.
c. ↻ 6.	Several operating modes selected simultaneously	➢ Check the connection and the function of the operating mode selector switch. ➢ Check the connection for the operating mode selector switch on the UE4400 or on the safety-rated controller for short-circuiting.
c. ↻ 7.	Unconfigured operating mode selected	➢ Configure the operating mode set on the operating mode selector switch, or ensure that this operating mode cannot be selected.
c. ↻ 8.	Key-operated pushbutton for bypass malfunctioning or invalid configuration	➢ Check whether the configuration of the key-operated pushbutton for bypass in the CDS matches the electrical connection. ➢ Check the function of the key-operated pushbutton for bypass and replace it if necessary. ➢ Ensure that both contacts on the key-operated pushbutton for bypass are pressed within 2 seconds.
c. ↻ 9.	Short circuit at the operating mode selector switch	➢ Check the operating-mode inputs of the UE4400 or the safety-rated controller for short-circuiting with 24 V DC.

Display	Possible cause	Rectifying the error
P.	UE4400 is not connected to the network so the SDL device is in a fault detected state or is malfunctioning	➢Check network physical connections. ➢Check network communication connections to other devices on the network. ➢SDL devices must be in an **Active** communication state with valid data ➢Carry out additional fault diagnosis on the UE4400 ➢If SDLx Output I/O assembly communication is not used, then disable communication to the SDL device using device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **SDL**, and selecting the corresponding **Network Access (write) to SDLx Disabled**.
● **Red**	Light path is free and configuration is correct but the C4000 still does not turn green. The C4000 expects data from the UE4400 or from the safety-rated controller.	➢Check whether an error or lock-out has occurred in the bus node or the safety-rated controller. ➢The DeviceNet Safety communication between bus node and safety-rated controller is still not established. ➢Check the C4000 information status with the aid of the CDS.

10.6 Additional error displays of the 7-segment display of the S300

The S300 Advanced/Professional safety laser scanner has new functions in connection with the UE445x when correspondingly controlled by the safety-rated controller. This section explains the meaning of the additional error displays of the 7-segment display and how to respond to the messages. You can find a description of the 7-segment display in the chapter titled “Status indicators” of the “Safety Laser Scanner S300” operating instructions.

Tab. 101: Additional error displays of the 7-segment display of the S300

Display	Possible cause	Rectifying the error
3	Initialization of the device Or Waiting for the end of the initialization of a second device connected to the EFI interface	➢ The display turns off automatically when the UE4400 and the S300 have been initialized and the connection to the safety-rated device has been established. If the display 3 does not turn off: ➢ Check whether the partner device (here: the UE4400) is in operation. ➢ Check the wiring. If no partner device is connected: ➢ Check the system configuration with the CDS. Retransfer the corrected configuration again to the S300.
	SDL device has not yet enabled SDL communication to the UE445x	➢ Configure the SDL device (e.g. S300) as a standalone device first and then reconnect the SDL device to the UE445x and repeat project identification with SICK Configuration and Diagnostic Software (CDS).
E ↻ 4	A second device connected via EFI is malfunctioning.	Check the connected device and the connection.
L ↻ 4	A device connected via EFI or the connection to the device is defective or disrupted.	Check the device and its connection to the SDL connector.
n ↻ 1	Input signal for an undefined monitoring case	➢ For mobile applications, check the path traveled by the vehicle. Or: ➢ Check the operating process of the monitored machine or system. ➢ If necessary, check the configuration of the items being monitored with the CDS.
n ↻ 2	Incorrect sequence in the case of switchover for the items being monitored or: A second device connected via EFI is malfunctioning.	
n ↻ 3	Incorrect function of the control inputs	➢ Check the proper function of the digital control inputs.

Display	Possible cause	Rectifying the error
P.	A device connected via EFI reports a malfunction	➤Check the status of the S300 and verify proper operation. Verify that network communication is also occurring at the UE445x. ➤If SDLx Output I/O assembly communication is not used, then disable communication to the SDL device using device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **SDL**, and selecting the corresponding **Network Access (write) to SDLx Disabled**.

10.7 Additional error displays of the 7-segment display of the S3000

The S3000 safety laser scanner has new functions in connection with the UE445x devices when correspondingly controlled by the safety-rated controller. This section explains the meaning of the additional error displays of the 7-segment display and how to respond to the messages. You can find a description of the 7-segment display in the chapter titled “Status indicators” of the “Safety Laser Scanner S3000” operating instructions.

Tab. 102: Additional error displays of the 7-segment display of the S3000

Display	Possible cause	Rectifying the error
3.	Initialization of the device Or Waiting for the end of the initialization of a second device connected to the EFI interface	➤The display turns off automatically when the UE4400 and the S3000 have been initialized and the connection to the safety-rated device has been established. If the display 3. does not turn off: ➤Check whether the partner device (here: the UE4400) is in operation. ➤Check the wiring. If no partner device is connected: ➤Check the system configuration with the CDS. Retransfer the corrected configuration again to the S3000.
	SDL device has not yet enabled SDL communication to the UE445x	➤Configure the SDL device (e.g. S3000) as a standalone device first and then reconnect the SDL device to the UE445x and repeat project identification with SICK Configuration and Diagnostic Software (CDS).
E. ⟳ 4.	A second device connected via EFI is malfunctioning.	Check the connected device and the connection.
L. ⟳ 4.	A device connected via EFI or the connection to the device is defective or disrupted.	Check the device and its connection to the SDL connector.

Display	Possible cause	Rectifying the error
n. ↻ 1.	Input signal for an undefined monitoring case	➢ For mobile applications, check the path traveled by the vehicle. Or: ➢ Check the operating process of the monitored machine or system. ➢ If necessary, check the configuration of the items being monitored with the CDS.
n. ↻ 2.	Incorrect sequence in the case of switchover for the items being monitored or: A second device connected via EFI is malfunctioning.	
n. ↻ 3.	Incorrect function of the control inputs	➢ Check the proper function of the digital control inputs.
P.	A device connected via EFI reports a malfunction	➢ Check the status of the S3000 and verify proper operation. Verify that network communication is also occurring at the UE445x. ➢ If SDLx Output I/O assembly communication is not used, then disable communication to the SDL device using device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **SDL**, and selecting the corresponding **Network Access (write) to SDLx Disabled**.

10.8 Additional error displays of the 7-segment display of the M4000

The M4000 multiple light beam safety device has new functions in connection with the UE445x devices when correspondingly controlled by the safety-rated controller. This section explains the meaning of the additional error displays of the 7-segment display and how to respond to the messages. You can find a description of the 7-segment display in the chapter titled "Status indicators" of e.g. M4000 Advanced, M4000 Advanced A/P, M4000 Area operating instructions.

Tab. 103: Additional error displays of the 7-segment display of the M4000

Display	Possible cause	Rectifying the error
A ↻ 3	M4000 systems with **firmware ≤ V1.15**: Override time exceeded by 60 minutes **Or:** No completely error-free muting cycle within 60 min after first operation of the control switch for override M4000 systems with **firmware > V1.15**: Permissible number of override cycles exceeded (see Tab. 85 on page 123 as well as the M4000 Advanced operating instructions)	➢ Switch the device off and back on again for at least 3 seconds. If the error continues to occur: ➢ Ensure the muting sensors are correctly positioned and are working correctly and that the muting lamp is in correct working order.
A ↻ 8	Communication error during ongoing operation	➢ Switch the device off and back on again for at least 3 seconds. If the error continues to occur: ➢ Check the connection between M4000 and the switching amplifier or bus node. If necessary, replace defective cables. ➢ Replace switching amplifier or bus node.
c ↻ 0	Invalid configuration of muting sensor B1 or B2	➢ Switch the device off and back on again for at least 3 seconds. If the error continues to occur: ➢ Check whether muting sensor B1 or B2 is connected correctly but is not configured.
c ↻ 1	Invalid configuration of the signals Override/C1/Belt stop	➢ Switch the device off and back on again for at least 3 seconds. If the error continues to occur: ➢ Check whether the signals Override/C1/Belt stop on the switching amplifier or bus node or C1/belt stop on the ESPE are connected correctly, but not configured.

Display	Possible cause	Rectifying the error
c. ⟳ 2.	Invalid configuration of *Reset* or *Reset/Override signal (combined)*	➢ Switch the device off and back on again for at least 3 seconds. If the error continues to occur: ➢ Check whether the Reset or Reset/Override signal (combined) on the external switching amplifier or bus node or ESPE has been connected correctly and configured.
E. ⟳ 4.	Error in external device	➢ Switch the device off and back on again for at least 3 seconds. If the error continues to occur: ➢ Check the connection between the M4000 and the switching amplifier or bus node. If necessary, replace defective cables. ➢ Replace the switching amplifier or bus node.
P.	Fault of a device connected via EFI.	➢ Wait a few seconds. Invalid input signals could still be present on the external switching amplifier or bus node. If the error continues to occur: ➢ Check the sensors/signals connected to the external device. ➢ Check whether the sensor test is configured correctly. ➢ Check the connections to the external devices. If necessary, replace defective cables. ➢ Carry out a fault diagnosis of the device connected with the M4000. ➢ If SDLx Output I/O assembly communication is not used, then disable communication to the SDL device using device symbol **UE4400 DeviceNet**, context menu **Open device window**, tab **SDL**, and selecting the corresponding **Network Access (write) to SDLx Disabled**.
t. ⟳ 0.	Only M4000 systems with **firmware ≤ V1.15**: Override time exceeded by 30 minutes. Override required is signaled	➢ Ensure the muting sensors are correctly positioned and are working correctly and that the muting lamp is in correct working order.

Display	Possible cause	Rectifying the error
t. ⟳ 1.	Total muting time exceeded	If override is configured, *Override required* is displayed. ➢ Check the muting sensors. If necessary, replace them. ➢ Check whether the total muting time is correctly configured and whether the system is working correctly.
t. ⟳ 2.	Concurrence monitoring error	If override is configured, *Override required* is displayed. ➢ Check the muting sensors. If necessary, replace them. ➢ Check whether the concurrence monitoring is correctly configured and whether the system is working correctly.
t. ⟳ 3.	Sequence monitoring error	If override is configured, *Override required* is displayed. ➢ Check the muting sensors. If necessary, replace them. ➢ Check whether the muting sensors are activated and deactivated in the correct sequence.
t. ⟳ 4.	Direction detection error	If override is configured, *Override required* is displayed. ➢ Check the muting sensors. If necessary, replace them. ➢ Check whether the system is working correctly, whether the transport device is functioning correctly and whether the muting sensors are correctly positioned.
t. ⟳ 5.	Sensor gap monitoring error	If override is configured, *Override required* is displayed. ➢ Check whether the sensor gap monitoring is configured correctly and whether the gaps in the goods transported are not too large. ➢ Check the muting sensors. If necessary, replace them.
t. ⟳ 6.	Error after belt stop	If override is configured, *Override required* is displayed. ➢ Check whether the belt stop input signal is working correctly. ➢ Ensure that there are no further state changes at the muting sensors and the ESPE once the belt stop signal is present. ➢ Check the muting sensors. If necessary, replace them.

Display	Possible cause	Rectifying the error
t. ⟲ 7.	Error of the muting lamp	If override is configured, *Override required* is displayed. ➢ Check the muting lamp. If necessary, replace them. ➢ Verify that the muting lamp is connected correctly.

10.9 System performance in the case of malfunctions in connected devices

10.9.1 Effect on devices on the SDL connection

When an SDL device receives invalid data from the network (e.g. due to a network communication error), the corresponding data associated with the SDL device will be set to **Inactive** (fault detected) values.

If the device connected to the SDL connector monitors the incoming data from the UE4400 or requires the incoming data from the UE4400 for the configuration, then the device …

- deactivates its switching outputs.
- displays an error message on the 7-segment display.

Otherwise the device ignores the I/O error and/or UE4400 lock-out.

Note The UE4400 clears the I/O error as soon as the communication error to the safety-rated controller is resolved. Valid I/O data are then exchanged again with the device connected to the SDL connector.

10.9.2 Effect on the UE4400

If the UE4400 detects an error in one of the connected components, e.g. an error in a device attached to the SDL connector or in a sensor on a field signal connector, then the UE4400 …

- remains operational, provided that no critical fault has occurred.
- transmits **Inactive** (fault detected) safety information to the safety-rated controller, i.e. the corresponding bits in the process image are set to logical "0".

10.9.3 Effect on the safety-rated controller/the process image

If the UE4400 detects an error in a device connected to the field signal connector, then the …

- UE4400 provides **Inactive** (fault detected) data for the corresponding channel in the process image.
- other channels and all other field signal connections remain **Active**[5)].
- corresponding status bits for the affected data point(s) are set to an alarm condition (e.g. safety data status bits are set to **Inactive**, standard data status bits are set to **Active**).

WARNING

Program a restart interlock!

In the event of a set error-status bit, the DeviceNet deactivates the process image of the UE4400 for the entire safety-rated controller program. The safety-rated controller programmer must therefore make provision for a restart interlock and error acknowledgment in the safety-rated controller program. The safety-rated controller program may not acknowledge the error until it has been resolved.

Note The bus node deletes the error-status information and the DeviceNet diagnostic message automatically, after the the error no longer exists and error latch time has expired. Valid I/O data in the process image are then again sent to the safety-rated controller. The DeviceNet diagnostic message is always retained for at least two DeviceNet Safety message cycles.

10.10 DeviceNet/DeviceNet Safety process images and diagnostic information

Section 13 "Annex" on page 187 contains a detailed representation of the process images for the UE4400.

10.11 Extended diagnostics

The CDS software supplied with the device includes extended diagnostic options. It allows you to narrow down the problem if the error is non-specific or if you experience usage downtime problems. Detailed information can be found in the …

- Online help for the CDS (Configuration & Diagnostic Software)
- Online help for the CDS plug-in module for SICK DeviceNet Safety Configurator (when used)
- User manual for the CDS
- User manual for the CDS plug-in module for SICK DeviceNet Safety Configurator (when used)

5) If the error that is detected relates to a test/signal output (e.g. TOut) that is stuck at 24 V DC, all test/signal outputs are switched off but not faulted in the process image. All test/signal outputs will return to normal when the error is cleared.

11 Technical specifications

11.1 Data sheet

Tab. 104: Data sheet UE4400

	Minimum	Typical	Maximum
General system data			
Protection class (IEC 61 140:1997)	III		
Enclosure rating (IEC 60 529)	IP 67		
Housing material	Glass-reinforced polybutylene terephthalate (PBT)		
Category	Up to category 4 (EN 954-1) Up to SIL3 (IEC 61 508)		
Housing dimensions (L × W × H)	273 mm × 60 mm × 49 mm		
Weight UE4420/UE4427 UE4450/UE4455/UE4457	 522 g 582 g		
Safety capable inputs			
Input voltage[6)] HIGH	11 V DC	24 V DC	30 V DC
Input current HIGH	3 mA	5 mA	7 mA
Input voltage LOW	–30 V DC	0 V DC	5 V DC
Input current LOW	–0.5 mA	0 mA	2.5 mA[7)]
Input capacitance		5 nF	
Input test pulse filtering[8)] Test pulse rate Test pulse gap			 160/s 700 µs
Input delay (configurable) ON-OFF delay OFF-ON delay	 0 ms 0 ms		 635 ms 635 ms

6) As per IEC 61 131-2, type 2.
7) Maximum leakage current allowed, even in the event of an error or fault condition.
8) These values indicate the filtering capability of the UE4400 series IP67 Remote I/O bus node for evaluating OSSD signals on safety capable inputs without seeing test pulses as temporary shut down (inactive status) of the safety capable input.

	Minimum	Typical	Maximum

Test/signal outputs (in accordance with IEC 61131-2)

	Minimum	Typical	Maximum
Output type	High side output, semiconductor type, short circuit protected, cross circuit monitored		
Switching voltage HIGH (**Active**)	U_L – 0.5 V DC	U_L – 0.1 V DC	U_L
Switching voltage LOW (**Inactive**)	0 V	0 V	3.5 V
Switching current			700 mA
Switching frequency			10/s
Leakage current			0.5 mA
Load capacity with test pulses/remote output			10 nF/mA
Load capacity "Permanently on"			1000 µF
Load inductance at switching frequency of 1 Hz			1 H
Current threshold for failure monitoring at field signal connection TOut1A	25 mA		
Test pulse data **Active**			
Test pulse rate		8/s	
Test pulse width		500 µs	600 µs

Safety capable outputs (in accordance with IEC 61131-2)

	Minimum	Typical	Maximum
Output type	Bipolar semiconductor (high side output, low side output), short circuit protected, cross-circuit monitored		
Switching voltage HIGH side (**Active**)[9]	U_S – 0.9 V DC	U_S – 0.3 V DC	U_S
Switching voltage LOW side (**Active**)[9]	0 V DC	0.3 V DC	0.9 V DC
Differential voltage drop (**Active**)	0 V DC	0.6 V DC	1.8 V DC
Switching current (**Active**)	10 mA		2 A
Switching frequency			3/s
Open circuit differential voltage (**Inactive**)[9]	–1.5 V DC		1.5 V DC
Short circuit differential leakage current (**Inactive**)[10]	–0.5 mA	–0.1 mA	0.5 mA
Load capacity			1 µF
Load inductance			1 H
Test pulse data			
Test pulse rate		2/s	8/s
Test pulse width		400 µs	600 µs

9) Voltage drop information does not consider losses due to cabling.
10) Maximum leakage current allowed, even in the event of an error or fault condition.

	Minimum	Typical	Maximum

SDL connections

	Minimum	Typical	Maximum
Power supply Voltage Current	U_L – 0.5 V DC	U_L – 0.1 V DC	U_L 1.4 A
Input voltage HIGH	11 V DC	24 V DC	30 V DC
Input current HIGH	3 mA	5 mA	7 mA
Input voltage LOW	–30 V DC	0 V DC	5 V DC
Input current LOW	–0.5 mA	0 mA	2.5 mA[10)]
Input capacitance		5 nF	
Input test pulse filtering[11)] Test pulse rate Test pulse gap			 160/s 700 µs
Discrepancy time			4.9 ms

DeviceNet/DeviceNet Safety connection

DeviceNet supply voltage	11 V DC	24 V DC	25.0 V DC
DeviceNet current consumption		50 mA	120 mA
Baud rate	125, 250, 500 kBaud (auto baud rate setting)		
Addressing	2 MAC ID switches (0 to 63), safety network number (software addressed)		
Maximum number of nodes	64 nodes (including SNCT on computer)		
Safety network number	Range: 0x00 0x00 0x00 0x00 0x00 0x00 to 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF Default value = 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF		
Topology	Combination of multi-drop and T-branch connections		
Communication media	Five (5)-wire cables including • two (2) signal conductors • two (2) power conductors • one (1) shield conductor		

11) These values indicate the filtering capability of the UE4400 series IP67 Remote I/O bus node for evaluating OSSD signals on safety capable inputs without seeing test pulses as temporary shut down (inactive status) of the safety capable input.

	Minimum	Typical	Maximum
Operating data			
Supply voltage U_L at device[12)]	19.2 V DC	24 V DC	28.8 V DC
Residual ripple[13)]			5% peak
Current consumption through power-supply connection			8 A
Power consumption	2.0 W		8.7 W
Power up delay		10 s	
Response time[14)]			
SDL message to network[15)]			10 ms[16)]
Local input to network			15 ms
Local input to local output (UE4427 or UE4457 only without Fast shutoff)			17 ms
Local input to local output (UE4427 or UE4457 only with Fast shutoff)			8 ms
Local input to SDL			
– C4000, M4000			15 ms
– S3000, S300			28 ms
SDL to local output			12 ms
Network to SDL			
– Network to C4000, M4000			10 ms
– Network to S300, S3000			23 ms
Network to local output[17)]			12 ms
Operating temperature	–10 °C		+55 °C
Storage temperature	–40 °C		+70 °C
Air humidity (non-condensing)	10 %		95 %
Emissions	Conforms to IEC 61 131-2		
Electromagnetic immunity (EMI)	Conforms to IEC 61 131-2 Zone B		
Vibration resistance	0.35 mm, 10-55 Hz acc. to IEC 60 068-2-6		
Shock resistance	15 g, 11 ms acc. to IEC 60 068-2-27		

12) The external voltage supply must be capable of buffering brief power voltage failures of 20 ms as specified in EN 60 204-1. SICK PS50W-24V (SICK Part Number: 7028089) and PS95W-24V (SICK Part Number: 7028090) series power supplies satisfy these requirements.
13) Within limits of 19.2 V DC to 30.0 V DC.
14) Response time values indicated are based on the response time necessary from when the bus node receives the network communication and signals the SDL or local I/O and vice versa. All other response time components should be considered separately. See section 11.2 "Response time" on page 176 for additional details. Response time values do not include any configured input delays associated with the safety capable inputs.
15) The response time values specified for "SDL message to network" and "Local input to network" also apply for "SDL message to UE4457 logic input process image" and "Local input to UE44x7 logic input process image".
16) The response time of attached SDL devices must be considered separately. The value of 10 ms represents the maximum amount of time necessary to make a valid SDL message available to the network.
17) The response time value specified for "Network to local output" also applies for "Network to UE44x7 logic input process image".

11.2 Response time

The response time of the UE4400 cannot be equated with the overall response time of the system. When considering the response time, you should instead calculate the response time based on the individual signal paths (e.g. from the field signal connection or SDL connection to the safety-rated controller). The individual signals may have a different significance when considering the safety aspects of the entire system.

The following diagram outlines the various network response time components that must be considered with regard to the communication of data from a remote safety input to a controller to a remote safety output.

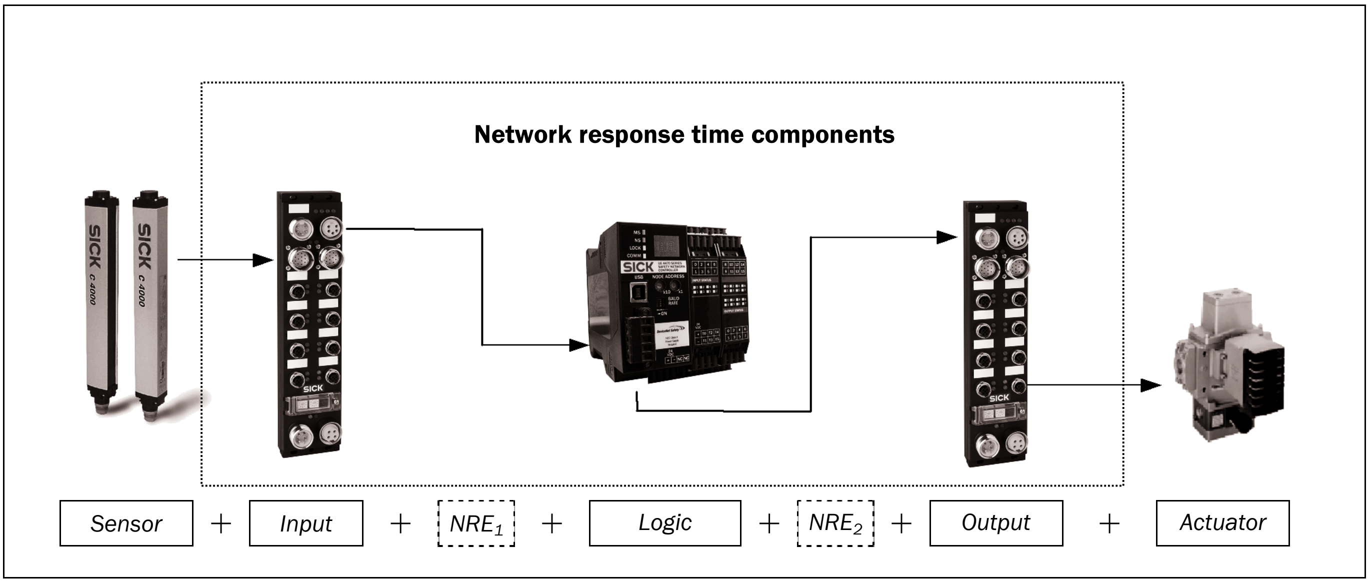


Fig. 91: Network response time components

It follows then that the overall system response time (also known as the system reaction time) can be represented by:

System reaction time = Sensor reaction time + Input reaction time +
Network reaction expectation time (NRE_1) +
Controller reaction time +
Network reaction expectation time (NRE_2) +
Output reaction time + Actuator reaction time

Network reaction expectation time (NRE_1 and NRE_2) is a network dependent variable that is determined by parameterization of other network devices. Consult the safety-relevant controller (e.g. SICK UE4470 series Safety Network Controller) or safety network configuration tool (e.g. SICK DeviceNet Safety Configurator) documentation for additional information.

Values for the UE4400 input reaction time and the UE4400 output reaction time are available in chapter 11.1 "Data sheet" on page 172.

In general, the reaction times of sensors, input devices, logic devices, output devices and actuators are available either via software tool or directly on the type label.

The response time of the entire system may include the following components:

- Safety sensor response time
- Response time necessary for evaluation in the UE4400
- Transmission of this information to a safety-rated controller on to DeviceNet (Safety)
- Response time necessary for evaluation of the signals by the safety-rated controller
- Transmission of the calculated values to the UE4400 via DeviceNet (Safety)
- Response time necessary for evaluation in the UE4400
- Safety actuator/machine stop response time component

WARNING

Consider all potential delays associated with the transmission of safety relevant data!

This list outlined above is provided to establish a general basis for discussion and is not exhaustive. It is imperative that the user considers all delays associated with the acquisition, transmission, evaluation and actuation of safety-relevant signals. This information must then form the basis for calculating the response time of the system to determine the proper usage and implementation of machine safeguards.

The information presented in this section provides users with information regarding the UE4400. Other relevant data must be obtained from other sources of information based on individual device(s) and network configuration.

Using the following calculation schedules you can calculate the response time on a signal path up to the hand-over of the information on the DeviceNet output of the UE4400.

You can find information for calculating the overall response time in the documentation of the safety-rated controller that you are using. You can find information for calculating the (sub-)response time of the devices connected to the UE4400 in the corresponding operating instructions.

11.2.1 Response times associated with safety input devices that use test/signal outputs with long test gaps

When safety capable inputs utilize test/signal outputs with long test gaps, the safety capable input is not sensitive to signal changes while the test is occurring. This results in an extended response time at the safety capable input:

Response time of evaluation = Test pulse time + Test pulse delay time

The response time for safety capable inputs using test/signal outputs with long test gaps must be based on the following example.

For a SICK IN4000 inductive safety sensor that is attached to a safety capable input on a UE4427 with a test/signal output having long test gaps, the following parameters are used:

Test pulse period (T):	500 ms
Test pulse time (T2):	50 ms
Test pulse delay time (Td):	5 ms

The response time component of the IN4000 is:

R_{IN4000} = 20 ms (from type label)

The response time component of the UE4427 in this case is:

R_{UE4427} = Internal UE4427 response time + Response time of evaluation

= 15 ms + [Test pulse time + Test pulse delay time]

= 15 ms + [50 ms + 5 ms] = 70 ms

Therefore, the system response time is:

R_{SYSTEM} = R_{IN4000} + R_{UE4427} = 20 ms + 70 ms = 90 ms

A second example is the use of three WS/WE18-3 sensors wired in series to a single safety capable input configured with a test/signal output having a long test gap. In this case, the following parameters are used:

Test pulse period:	20 ms
Test pulse time:	12 ms (smallest value larger than the test pulse delay time)
Test pulse delay time:	8 ms

The response time component of the WS/WE18-3 is:

$R_{WS/WE18\text{-}3}$ = 500 µs + 2 ms + 2 ms = 4.5 ms

The response time component of the UE4427 in this case is:

R_{UE4427} = Internal response time + Response time of evaluation

= 15 ms + [Test pulse time + Test pulse delay time]

= 15 ms + [12 ms + 8 ms] = 35 ms

Therefore, the system response time is:

R_{SYSTEM} = $R_{WS/WE18\text{-}3}$ + R_{UE4427} = 4.5 ms + 35 ms = 39.5 ms.

Notes

- The response time of evaluation is equal for all sensor chains that are tested by the same test/signal output with long test gaps. The slowest sensor chain defines the response time of evaluation for all sensor chains.
- Safety capable inputs using test/signal outputs with long test gaps do benefit from the fast shutoff feature of UE4427 or UE4457 devices as well. However the fast shutoff response time will be extended by the value based on the result of the following equation:

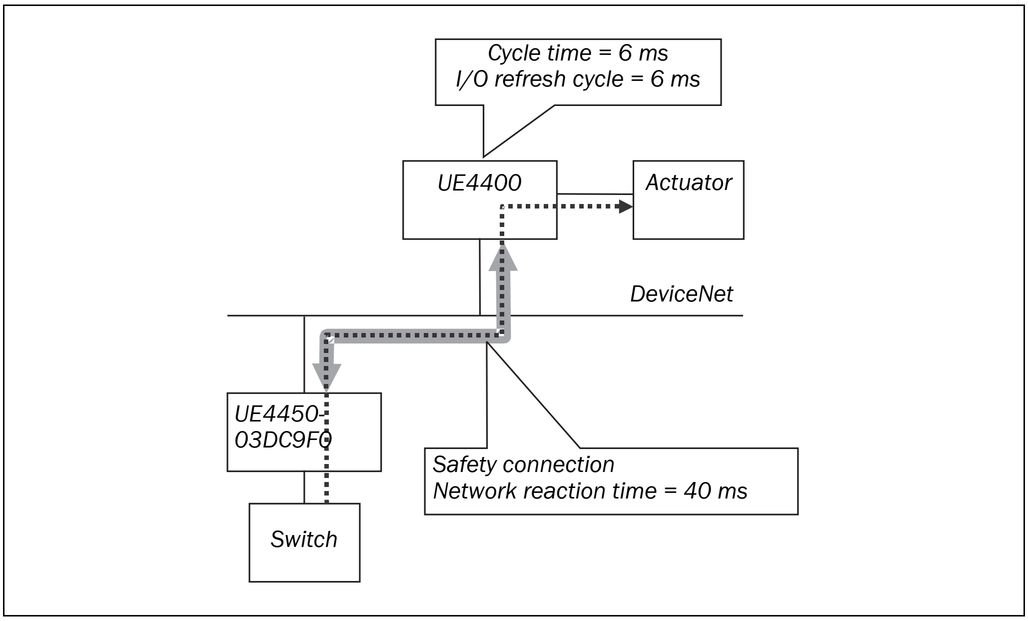
  $R_{UE4427 + sensor}$ (configured for fast shutoff)

  = 8 ms + Test Pulse Time + Test Pulse Delay Time

11.2.2 Response time calculation examples

Example 1: Remote input to local output

Fig. 92: Response time calculation example 1: Remote input — local output



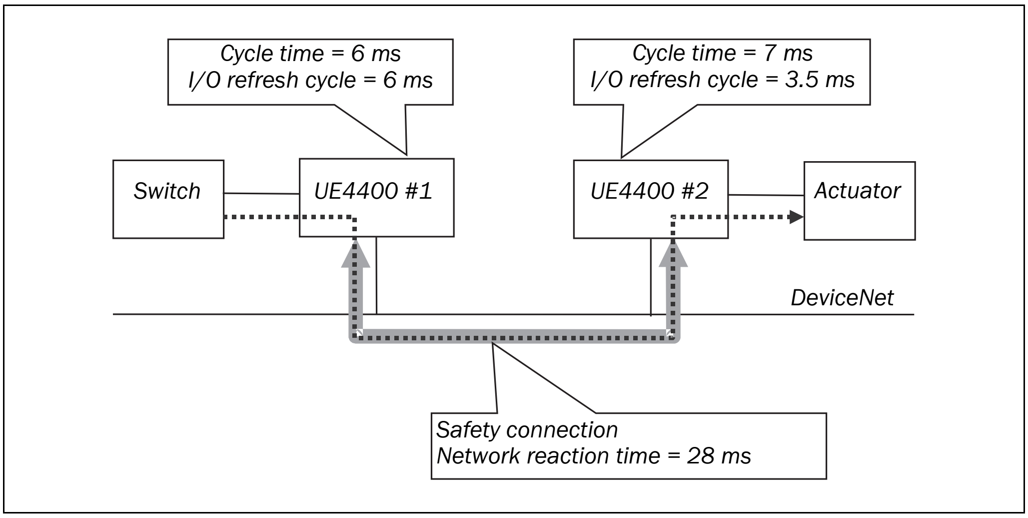
Response time (ms) = Switch response time + UE4450-03DC9F0 response time + Network response time + UE4400 remote input/local output response time + Actuator response time

= Switch response time + ON/OFF delay time (UE4450-03DC9F0) + 15 ms (= Input response time of UE4450-03DC9F0) + 40 ms + 6 ms + 2.5 ms + Actuator response time

= Switch response time + ON/OFF delay time (UE4450-03DC9F0) + 63.5 ms + Actuator response time

Example 2: Local input - remote output

Fig. 93: Response time calculation example 2: Local input — remote output



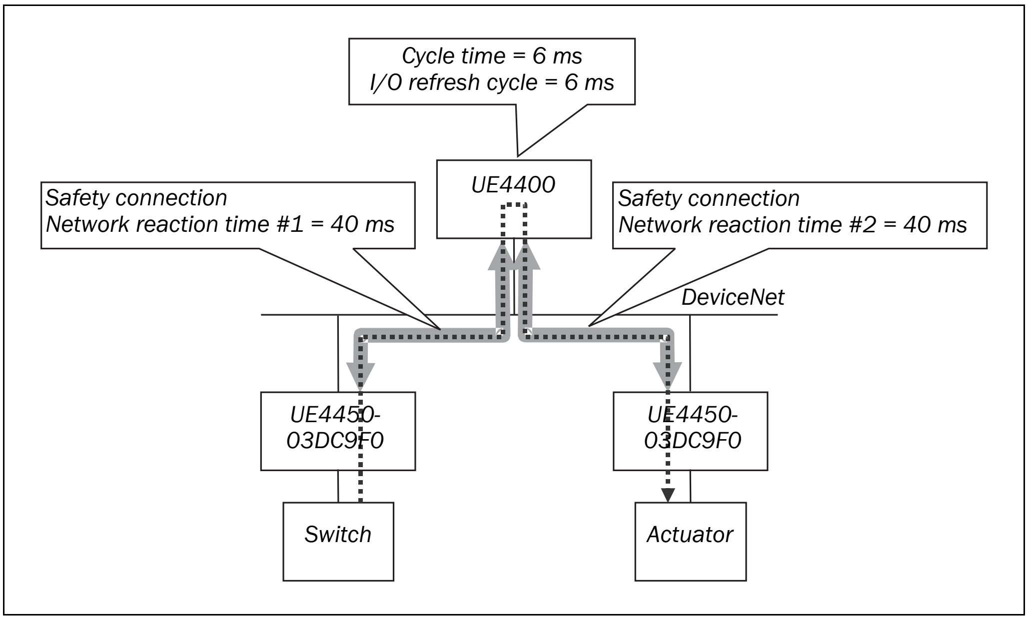
Response time (ms) = Switch response time + UE4400 #1 local input/remote output response time + Network response time + UE4400 #2 remote input/local output response time + Actuator response time

= Switch response time + ON/OFF delay time (UE4400) + 6 + 6 × 2 + 28 + 7 + 3.5 + Actuator response time

= 56.5 + ON/OFF delay time (UE4400) + Switch response time + Actuator response time

Example 3: Remote input - remote output

Fig. 94: Response time calculation example 3: Remote input — remote output



Response time (ms) = Switch response time + UE4450-03DC9F0 input response time + Network reaction time #1 + UE4400 remote input/remote output reaction time + Network reaction time #2 + UE4450-03DC9F0 output response time + Actuator response time #2

= Switch response time + ON/OFF delay time (UE4450-03DC9F0) + 15 ms (UE4450-03DC9F0 input response time) + 40 ms + 6 ms + 40 ms + 12 ms (UE4450-03DC9F0 output response time) + Actuator reaction time

= Switch response time + ON/OFF delay time (UE4450-03DC9F0) + 113 ms + Actuator reaction time

11.2.3 Verifying the response time

Always confirm the response time calculated for each safety chain satisfies the required specifications. If the response time exceeds your application requirements, consider the following items and modify the design of the safety chain so that response time requirements are satisfied.

- The network response time can be reduced by shortening the EPI. This, however, will also reduce the network bandwidth that can be used for other connections.
- The cycle time of the UE4400 is automatically calculated based on factors that include the size of the logic application and the number of I/O connections. The cycle time can be reduced by using separate UE4400 controllers for safety chains that require high-speed response times.

WARNING

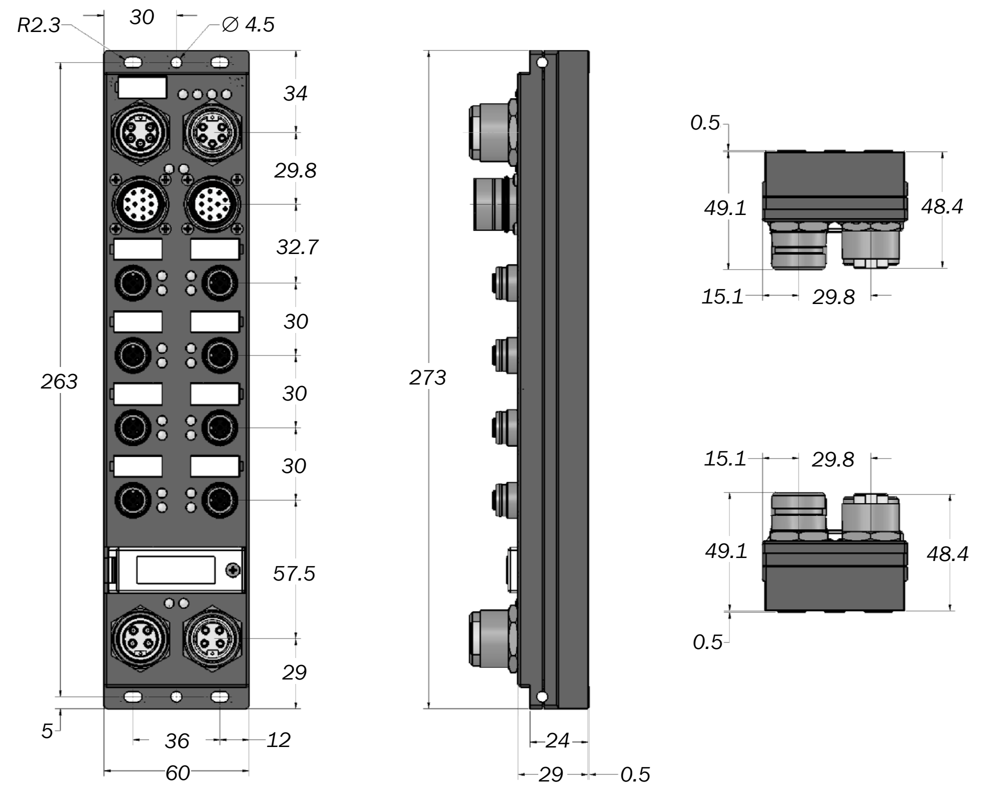
Sensor signals must be available for a minimum duration!

In order to guarantee accurate detection of connected sensor signal(s) by the UE4400, you must ensure that the connected sensor signal(s) pulse duration (e.g. off time) is equal to or greater than the configured expected packet interval (EPI) value for the related I/O communication connection (i.e. I/O assembly).

11.3 Dimensional drawings

11.3.1 Dimensional drawing of the UE4400

Fig. 95: Dimensional drawing UE4400 (mm)



12 Ordering information

12.1 UE4400 series bus nodes

Tab. 105: Part numbers UE4400

Part	Part number
UE4420 (type code UE4420-03DC9F0) Supports 6 dual-channel safety capable inputs, 12 test/signal outputs and 2 dual-channel bipolar safety outputs; includes Configuration and Diagnostic Software (CDS) for local configuration via RS-232 and operating instructions on CD-ROM.	1028302
UE4427 (type code UE4427-03DC9F0) Equivalent to UE4420, with programmable safety-rated logic functionality.	1028304
UE4450 (type code UE4450-03DC9F0) Equivalent to UE4420, with two (2) SDL connectors for intelligent interfacing. Configuration of attached SDL-capable devices is completed through the bus node. Operational communication is limited to status and diagnostics from attached SDL-devices.	1028305
UE4455 (type code UE4455-03DC9F0) Equivalent to UE4450. Operational communication allows for bidirectional communication to set user modes etc. in attached SDL-capable devices.	1028306
UE4457 (type code UE4457-03DC9F0) Equivalent to UE4455, with programmable safety-rated logic functionality.	1028307

12.2 UE4400 series bus node accessories

Tab. 106: Part numbers, accessories

Part	Part number
Field signal connections	
Plug M12 × 5, can be preformed, for wire cross-section max. 0.75 mm²	
Plug straight, screened (shielded)	6024741
Plug straight, unscreened (unshielded)	6022083
Plug angled, unscreened (unshielded)	6022082
Plug M12 × 5 with connecting wires, wire-end prepared for stripping, unscreened (unshielded)	
Plug straight, 2 m	6026133
Plug straight, 5 m	6026134
Plug straight, 10 m	6026135
Plug M12 × 5 with connecting wires, wire-end prepared for stripping, screened (shielded)	
Plug straight, 2 m	6024860
Plug straight, 5 m	6024861
Plug straight, 10 m	6024862

Part	Part number
Plug M12 x 5 with connecting wires, screened (shielded) for connection of e.g. C2000, C4000 ECO, C4000 Micro, M4000 Standard (also requires M12 x 8 mating connector below)	
Plug straight, screened (shielded)	6009719
Plug angled, screened (shielded)	6009720
Plug M12 × 8 field attachable connector, straight, for connection of e.g. C2000, C4000 ECO, C4000 Micro, M4000 Standard (also requires M12 x 5 plug with connecting wires, screened (shielded) shown above)	6028422
Cable for connection of C4000 Standard or C4000 Advanced receiver unit with Hirschmann M26 x 11+FE to M12 x 5 field signal connector	
Plug straight, 2.5 m	2040014
Plug straight, 5 m	2040015
Plug straight, 10 m	2040016
Plug straight, 15 m	2040053
Cable for connection of C4000 Standard or C4000 Advanced sender unit with Hirschmann M26 x 11 + FE to M12 x 5 field signal connector	
Plug straight, 2.5 m	2040017
Plug straight, 5 m	2040018
Plug straight, 10 m	2040019
Plug straight, 15 m	2040056
Cable for connection of C4000 Standard or C4000 Advanced receiver unit (special version) with Interconnectron M23 x 11+FE to M12 x 5 field signal connector	
Plug straight, 0.5 m	2040020
Plug straight, 3 m	2040021
Plug straight, 7.5 m	2040022
Plug straight, 15 m	2040054
Plug straight, 20 m	2040055
Cable for connection of C4000 Standard or C4000 Advanced sender unit (special version) with Interconnectron M23 x 11+FE to M12 x 5 field signal connector	
Plug straight, 0.5 m	2040023
Plug straight, 3 m	2040024
Plug straight, 7.5 m	2040025
Plug straight, 15 m	2040057
Plug straight, 20 m	2040058
Two-way splitter M12 × 5 for the simultaneous connection of two emergency stop buttons (category 2 according to EN 954-1) on one field signal connection	6024744
Protective cap M12 for field signal connection, 10 pieces	2019706
M12 cable sheath/cover for minimizing cable tampering. Qty 10.	5315186

Part	Part number
SDL connections	
Plug M23 × 11 + FE, can be preformed, crimped, for wire cross-section 0.08-0.82 mm²	6024742
Connection cable with male M23 × 11 + FE Interconnectron connector and female M26 × 11 + FE Hirschmann connector. Cable lengths as shown below. Used to connect C4000 series safety light curtains with Hirschmann M26 × 11 + FE connectors to UE4400.	
Plug straight/socket straight, 2.5 m	2029131
Plug straight/socket straight, 5 m	2025634
Plug straight/socket straight, 10 m	2025635
Plug straight/socket straight, 15 m	2025636
Connection cable with male M23 × 11 + FE Interconnectron connector and female M23 × 11 + FE Interconnectron connector. Cable lengths as shown below. Used to connect C4000 series safety light curtains with Interconnectron M23 × 11 + FE connectors to UE4400.	
Plug straight/socket straight, molded both ends, 0.5 m	7029160
Plug straight/socket straight, molded both ends, 3 m	7029161
Plug straight/socket straight, molded both ends, 7.5 m	7029162
Plug straight/socket straight, molded both ends, 15 m	7029163
Plug straight/socket straight, molded both ends, 20 m	7029164
Connection cable (e.g. for the connection of the safety laser scanner S3000). Wire cross-section 12 × 0.75 mm². Order system plug separately — see S3000 operating instructions for additional information regarding accessories.	
Plug straight/stripped, 2.5 m	2029337
Plug straight/stripped, 5 m	2029338
Plug straight/stripped, 10 m	2029339
Plug straight/stripped, 15 m	2029340
Protective cap M23 for SDL connection	5130774

Part	Part number
DeviceNet/DeviceNet Safety connection	
DeviceNet (Safety) 7/8" 5-pin Mini connector, female	6028331
DeviceNet (Safety) 7/8" 5-pin Mini connector, male	6028332
DeviceNet (Safety) 7/8" 5-pin Mini receptacle, female panel mount	6030807
DeviceNet (Safety) 7/8" 5-pin Mini receptacle, male panel mount	6030808
DeviceNet cable, thick (per meter)	6030756
DeviceNet cable, thin (per meter)	6030921
DeviceNet cable, thick, double-ended, male/female with 7/8" 5-pin Mini connectors	
2 m length	6030749
5 m length	6030750
10 m length	6030751
DeviceNet cable, thin, double-ended, male/female with 7/8" 5-pin Mini connectors	
1 m length	6030743
2 m length	6030744
3 m length	6030745
4 m length	6030746
5 m length	6030747
6 m length	6030748
DeviceNet "T" connector (5-pin Mini female/5-pin Mini female/5-pin Mini male)	6030752
DeviceNet terminator, 7/8" 5-pin Mini connector, female	6028329
DeviceNet terminator, 7/8" 5-pin Mini connector, male	6028995
Protective cap 7/8" 4-pin or 7/8" 5-pin Mini connector, female	5315187
Protective cap 7/8" 4-pin or 7/8" 5-pin Mini connector, male	5315188
Auxiliary power supply	
Auxiliary power 7/8" 4-pin Mini connector, female	6030803
Auxiliary power 7/8" 4-pin Mini connector, male	6030804
Auxiliary power 7/8" 4-pin Mini receptacle, female	6030805
Auxiliary power 7/8" 4-pin Mini receptacle, male	6030806
Auxiliary power cable, 4 conductor (per meter)	6030757
Auxiliary power cable with 7/8" 4-pin Mini female/flying leads (single ended cable)	
2 m length	6030753
5 m length	6030754
10 m length	6030755
Protective cap 7/8" 4-pin or 7/8" 5-pin Mini connector, female	5315187
Protective cap 7/8" 4-pin or 7/8" 5-pin Mini connector, male	5315188
IP20 power supply, 120 V AC input, 24 V DC 2.1 A output	7028789
IP20 power supply, 120 V AC input, 24 V DC 3.9 A output	7028790

Part	Part number
Network configuration tools — software	
Safety Network Configuration Tool (SNCT)	2032920
Enables the configuration and diagnosis of the DeviceNet and DeviceNet Safety network. Includes SICK CDS plug-in module for SICK UE4400 and configuration software plug-in for SICK UE4470 Safety Network Controller	
Device configuration tools — software	
CDS (Configuration & Diagnostic Software) for local connection to UE4400 via RS-232c. Includes online documentation and operating instructions in all available languages. Shipped on CD-ROM.	2032314
CDS plug-in for DeviceNet Safety SNCT	2027422
Enables the configuration and diagnosis of the UE4400 and the connected SDL devices via DeviceNet Safety using compatible DeviceNet Safety — Safety Network Configuration Tool	
Connection cable M8 × 4/SubD 9-pin (DIN 41 642); for connecting the configuration interface and the serial interface of the PC	
2 m	6021195
8 m	2027649
Other accessories	
UE4400 accessory kit. Includes 10 labels for UE4400 IP67 Remote I/O bus node and four (4) M12 protective caps.	5315185

13 Annex

13.1 Planning table for the configuration

Use a printout or a copy of the following planning table to plan and document the UE4400 configuration. You can read out and document the final configuration of the UE4400 with the aid of the CDS:

Device symbol **UE4400 DeviceNet**, context menu **Configuration draft**, **Display**.

Tab. 107: Planning table for the UE4400 configuration

Criteria	Configuration	Notes
General		
Project name		Free text. Useful for the placement of the safety planning in the entire project. Can also be stored in the CDS
Application name		The application name designates the configuration within the CDS.
Local name		Record useful data for the placement of the UE4400.
DeviceNet Safety		
DeviceNet MAC ID		Must be unique within the DeviceNet network. Rotary switches (0-63 hardware configured), (64-99 indicates software configured). Factory default is 63.
DeviceNet Safety Safety Network Number (SNN)		Must be unique within the DeviceNet network. Software configured.
Baud rate		Specifies the value for the communication rate of DeviceNet (Safety)
Input error latch time		Specifies how long an input error will remain **Active** after it is detected. This helps to assure that an operator interface or other device is notified of the error.
Output error latch time		Specifies how long an output error will remain **Active** after it is detected. This helps to assure that an operator interface or other device is notified of the error.

Criteria	**Configuration**		**Notes**
SDL connections			
Description	SDL1:	SDL2:	For example “access protection robot 2” or reference to a different planning tool
Connected device			Designation and serial number for the unique identification of the device
Subproject			Name or additional information for the placement of the device in the overall planning
Other connected sensors (guests)			Device designation and serial number. You can use a two-way splitter to work around the voltage supply of the SDL connection e.g. for a C4000 sender so that SDL connector 2 remains unoccupied.
Detection of a change in the connected device	☐ Ignore type key ☐ Ignore serial number ☐ Ignore date/time stamp	☐ Ignore type key ☐ Ignore serial number ☐ Ignore date/time stamp	Allows you to specify how the UE4400 treats a change in the device that is connected to the SDL connector.
Read hardware OSSDs	☐ Enabled ☐ Disabled	☐ Enabled ☐ Disabled	When this function is enabled, there may be a reduction in the connected device’s response time as the UE4400 reads the OSSD status information from the hardware input instead of from the safe SICK-device communication of the device.

Criteria	**Configuration**		**Notes**
Safety capable input field signal connection ☐ **1** ☐ **2** ☐ **3** ☐ **4** ☐ **5** ☐ **6**			
Application	Channel A:	Channel B:	Description of the connected devices and their purpose
Connection	☐ Single-channel ☐ Dual-channel equivalent ☐ Dual-channel complementary		The connection depends, among other things, on the category according to EN 954-1 to be realized.
Safety capable input	☐ Off ☐ Signal input ☐ To safety-rated controller	☐ Off ☐ Signal input ☐ To safety-rated controller	If the input is unused, you must configure the safety input to “Off” by not connecting an element (e.g. single-channel contact) at the input.
ON-OFF input delay	☐ Inactive ☐ ______ ms	☐ Inactive ☐ ______ ms	Delay time between the last signal change and the re-reading of the safety capable input. Maximum of 126 ms is permitted.
OFF-ON input delay	☐ Inactive ☐ ______ ms	☐ Inactive ☐ ______ ms	Delay time between the last signal change and the re-reading of the safety capable input. Maximum of 126 ms is permitted.
Discrepancy time	☐ Inactive ☐ ______ ms		Only relevant for a dual-channel connection. Limits the time during which the plausibility of the dual-channel connection after a signal switch may be violated.
B-channel reporting	Values published: ☐ Yes — checkbox is checked ☐ No — checkbox is unchecked ☐ Not applicable (e.g. single-channel)		For dual-channel evaluation only. When the “values published” checkbox is checked, B-channel reporting occurs and provides the value of the B-channel. When left unchecked, the A-channel represents the value of the dual-channel evaluation and the B-channel should be ignored.
Slope detection	☐ Enabled ☐ Disabled (e.g. not checked)		For single-channel inputs, slope detection is used to determine if the input is “stuck at high”.
Test/signal output	☐ Not used ☐ Permanently on ☐ Associated to safety input ___ ☐ Remote signal output	☐ Not used ☐ Permanently on ☐ Associated to safety input ___ ☐ Remote signal output	Permanently on = 24 V DC Test signals = defined test impulse Signal output: The output can only be configured for a single-channel connection as a signal output. Bit set = 24 V DC

Criteria	**Configuration**	**Notes**
Safety capable output field signal connection ☐ 7 ☐ 8		
Application	Channel A/B:	Description of the connected devices and their purpose
Connection	☐ Bipolar dual-channel	Bipolar High-side and Low-side safety capable outputs (dual-channel) are currently the only possibility.
Function	☐ Permanently off ☐ On with test signals ☐ On without test signals	Permanently off = 0 V DC On with test signals = allows users to attain a maximum rating of category 4 according to EN 954-1 for the application. On without test signals = allows users to attain a maximum rating of category 3 according to EN 954-1 for the application.

WARNING

You must ensure correct safety category is implemented for your application!

Disabling the test pulses on the safety outputs (e.g. selecting the bipolar outputs as remotely controlled without test signals) is only allowed in certain applications. In this case, the resulting safety category (e.g. safety category 3 or 4) depends on failure detection ensured by sufficient cyclic operation of the outputs or other means.

13.2 DeviceNet/DeviceNet Safety connection types

Tab. 108: DeviceNet/DeviceNet Safety connection type summary

Item	Description	Classification
Safety I/O connections		
Originator: Count	Not supported	Safety
Originator: Max. devices	Not supported	Safety
Originator: Max. data size	Not supported	Safety
Target: Number of single-cast/ multi-cast connections	Total 6 connections of any combination single-cast or multi-cast	Safety
Target: Max. number of Originators per multi-cast producer	15	Safety
Target: max data size	In/out = 10 bytes/7 bytes per connection	Safety
Connection types	Single-cast/multi-cast Supports only Target function	Safety
Standard I/O connections		
Number of connections	Max. 3 (all from same standard master)	Standard
Max data size	In/out = 10 bytes/2 bytes per connection	Standard
Connection types	Poll/bitstrobe/change of state (COS)/cyclic Supports only slave functions	Standard
Read access to safety data via standard assembly	Supports reading safety data using explicit message or standard I/O connection	Standard
Explicit messages		
Client: number of outstanding	Not supported	Standard
Server: number of outstanding	4 devices	Standard
Message data size	Max. 290 bytes	Standard
UCMM	Yes	Standard
Proxy function	No	Standard

13.3 Explicit messaging

Explicit messaging is a method of transmitting commands, responses to commands, requests for data and responses to data requests on a DeviceNet/DeviceNet Safety network. Explicit messaging is used to accomplish the following tasks:

- Send configuration data to a device
- Retrieve detailed status and diagnostic information from a device

A device communicating using explicit messaging is categorized by one of the following:

- **Explicit client**: The device from which an explicit message request originates. In an explicit message between a controller and a device, the controller is always the explicit client. The UE4400 does not have explicit client capability.
- **Explicit server**: The device from which an explicit response is being requested. In an explicit message between a processor and a device, the device is always the explicit server. In an explicit message exchange between two devices, the UE4400 is always an explicit server.

The DeviceNet/DeviceNet Safety object model is comprised of various articles that describe specific details of DeviceNet/DeviceNet Safety products. Each of these articles addresses increasingly more specific detail regarding the product. These articles include the following:

- **Object** — a general term that describes some function of a DeviceNet/DeviceNet Safety product.
- **Class** — a subset of objects that behave in a similar manner but contain different data in their respective variables. Several objects that contain common characteristics may fall into a single class. Each object class has a unique hexadecimal identifier called a class code.
- **Instance** — a specific occurrence of a given object. Since there can be several occurrences of the same object within a device model, each instance is designated with a numeric value.
- **Attribute** — one of many possible data elements in a given DeviceNet/DeviceNet Safety object or class that can be written to or read from in an explicit message. Each attribute is assigned a unique identification number.
- **Service** — refers to a function that an object performs as a result of an explicit message request. Services are assigned a unique identifier in hexadecimal and vary from object to object

Knowledge of specific class, instance, attribute and service codes are necessary in order to format an explicit message.

Explicit messages sent from a DeviceNet Master or a DeviceNet Safety Originator to the UE4400 can be used to read or write a variety of parameters in the UE4400. Safety relevant parameters are generally written through DeviceNet Safety-based configuration tools

The basic format of a **Command explicit message block** typically is:

Destination node address	Service code	Class ID	Instance ID	Attribute ID/ data

The destination node address is defined as the node address of the unit that is sending the explicit messages (commands). The value of the destination node address is expressed as a single byte in hexadecimal.

The service code, class ID, instance ID and attribute ID are parameters used for specifying the command, processing object and processing content. The number of bytes designated for these parameters is dependent on the specifications of the master or Originator unit.

Data is used to specify specific parameter settings.

Response explicit message blocks are specified into two types.

The **Normal response block** is characterized by the following:

Destination node address	Service code	Data

The **DeviceNet error response block** is characterized by the following:

Destination node address	Service code: error	Error code	Extended error information

Note The Safety open service uses the CIP common error reporting scheme which is different to the one in DeviceNet. Consult the safety network configuration tool manual for additional information.

When an error response is returned for an explicit message, the number of bytes is always **0004 Hex**.

The **Source node address** is defined as the address of the node from which the command was sent.

The following table outlines values for the service code:

Tab. 109: Service code values

Function	Command service code	Response service code
Get_Attribute_Single	10 Hex	90 Hex
Set_Attribute_Single	0E Hex	8E Hex

Whenever an error response is generated via explicit message, the resulting service code is 94 Hex.

The following table outlines values for standard DeviceNet error codes:

Tab. 110: Error code values

Error code	Error description	Possible error cause
08FF	Service not supported	The service code is incorrect.
09FF	Invalid attribute value	The specified attribute value is not supported. The data written falls outside the specified range.
0CFF	Object state conflict	The specified command cannot be executed due to an internal error.
0EFF	Attribute not settable	An attribute ID has been specified that must be used only with a read service code.
10FF	Device state conflict	The specified command cannot be executed due to an internal error.
13FF	Not enough data	The data is smaller than required.
14FF	Attribute not supported	The specified attribute ID is not supported.
15FF	Too much data	The data is larger than required.
16FF	Object does not exist	The specified instance ID is not supported.
19FF	Store operation failure	The data cannot be stored in memory.
20FF	Invalid parameter	The specified operation command data is not supported
2AFF	Group 2 only server general failure	The specified command or attribute is not supported or the attribute was not set correctly.

The following sections provide additional details for using explicit messages in conjunction with UE4400.

13.4 UE4400 I/O assembly summary

Tab. 111: UE4400 I/O assembly summary

Instance ID (hex)	Description	Used by standard device	Used by safety device	Available for use with				
				UE4420	UE4427	UE4450	UE4455	UE4457
037	Standard output (TOut) values	X	X	X	X	X	X	X
198	Null Value POLL/COS output assembly (0 Bytes)	X	N/A	X	X	X	X	X
563	Safety output value	N/A	X	X	X	X	X	X
605	Safety input data Combined safety input status Combined safety output status	X	X	X	X	X	X	X
768 Vendor specific	Safety input data (incl. SDL OSSDs) Combined input status Combined output status Individual input status Individual safety output status Output monitored value	X	X	X	X	X	X	X
769 Vendor specific	Safety input data (incl. SDL OSSDs) Combined input status Combined output status Safety SDL input data (reduced)	X	X	N/A	N/A	X	X	X
770 Vendor specific	Safety input data (incl. SDL OSSDs) Combined input status Combined output status Safety SDL input data (extended)	X	X	N/A	N/A	X	X	X
771 Vendor specific	SDL 1 input data (2 bytes)	X	X	N/A	N/A	X	X	X

Instance ID (hex)	Description	Used by standard device	Used by safety device	Available for use with				
				UE4420	UE4427	UE4450	UE4455	UE4457
772 Vendor specific	SDL 2 input data (2 bytes)	X	X	N/A	N/A	X	X	X
773 Vendor specific	Diagnostic data (general & connector, no SDL)	X	X	X	X	X	X	X
774 Vendor specific	Diagnostic data (general) SDL diagnostic data	X	X	N/A	N/A	X	X	X
775 Vendor specific	Safety input data (incl. SDL OSSDs) Combined safety input status Combined safety output status TOut status	X	X	X	X	X	X	X
776 Vendor specific	Safety input data (incl. SDL OSSDs) Combined input status Combined output status Muting lamp status	X	X	X	X	X	X	X
777 Vendor specific	Safety input data (incl. SDL OSSDs) Combined safety input status Individual safety output status Safety output monitored values	X	X	X	X	X	X	X
778 Vendor specific	Safety output value SDL 1 safety outputs (2 bytes) SDL 2 safety outputs (2 bytes)	N/A	X	N/A	N/A	N/A	X	X
779 Vendor specific	SDL 1 output data (2 bytes)	N/A	X	N/A	N/A	N/A	X	X
780 Vendor specific	SDL 2 output data (2 bytes)	N/A	X	N/A	N/A	N/A	X	X
782 Vendor specific	Remote input values (1 byte)	X	X	N/A	X	N/A	N/A	X
783 Vendor specific	Safety input data (incl. SDL OSSDs) Combined input status Combined output status Individual input status	X	X	X	X	X	X	X
784 Vendor specific	General diagnostic data	X	X	X	X	X	X	X
785 Vendor specific	Standard output (TOut) values Remote inputs (1 byte)	X	X	N/A	X	N/A	N/A	X
786 Vendor specific	SOut & TOut	N/A	X	X	X	X	X	X
787 Vendor specific	SOut & TOut & SDL Out	N/A	X	N/A	N/A	N/A	X	X
788 Vendor specific	Remote inputs (2 bytes)	X	X	N/A	X	N/A	N/A	X
789 Vendor specific	Standard output (TOut) values Remote inputs (2 bytes)	X	X	N/A	X	N/A	N/A	X
790 Vendor specific	Remote Safety Inputs – 2 Bytes	N/A	X	N/A	X	N/A	N/A	X
792 Vendor specific	Safety input data (incl. SDL OSSDs) Combined input status Combined output status Remote Safety Outputs	X	X	N/A	X	N/A	N/A	X
793 Vendor specific	Safety input data (incl. SDL OSSDs) Combined input status Combined output status	X	X	X	X	X	X	X

13.5 I/O assemblies

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
37 **0x025**	**0**	TOut 4B Value	TOut 4A Value	TOut 3B Value	TOut 3A Value	TOut 2B Value	TOut 2A Value	TOut 1B Value	TOut 1A Value
	1	Reserved				TOut 6B Value	TOut 6A Value	TOut 5B Value	TOut 5A Value

Instance	Byte								
198 **0x0C6**	**0**	Null I/O assembly for POLL/COS (0 Bytes) Specify this assembly when TOut values are controlled by a safety originator device and not a standard Master device.							

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
563 **0x233**	**0**	Reserved				SOut 8B Value	SOut 8A Value	SOut 7B Value	SOut 7A Value

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
605 **0x25D**	**0**	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	Reserved		Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value

Note The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
768 **0x300**	**0**	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SLD2 OSSD Value	SLD1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	Input 4B Status	Input 4A Status	Input 3B Status	Input3A Status	Input 2B Status	Input 2A Status	Input 1B Status	Input 1A Status
	3	Reserved				Input 6B Status	Input 6A Status	Input 5B Status	Input 5A Status
	4	SOut 8B Status	SOut 8A Status	SOut 7B Status	SOut 7A Status	SOut 8B Monitor Value	SOut 8A Monitor Value	SOut 7B Monitor Value	SOut 7A Monitor Value

Notes

- The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.
- When utilizing UE442x devices, values for SDL2 OSSD value (Bit 1.5) and SDL1 OSSD value (Bit 1.4) are always set to 0 (**Inactive**) and should be ignored.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
769 0x301	0	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SLD2 OSSD Value	SLD1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	SDL 1 Input 8	SDL 1 Input 7	SDL 1 Input 6	SDL 1 Input 5	SDL 1 Input 4	SDL 1 Input 3	SDL 1 Input 2	SDL 1 Input 1
	3	SDL 1 Input 16	SDL 1 Input 15	SDL 1 Input 14	SDL 1 Input 13	SDL 1 Input 12	SDL 1 Input 11	SDL 1 Input 10	SDL 1 Input 9
	4	SDL 2 Input 8	SDL 2 Input 7	SDL 2 Input 6	SDL 2 Input 5	SDL 2 Input 4	SDL 2 Input 3	SDL 2 Input 2	SDL 2 Input 1
	5	SDL 2 Input 16	SDL 2 Input 15	SDL 2 Input 14	SDL 2 Input 13	SDL 2 Input 12	SDL 2 Input 11	SDL 2 Input 10	SDL 2 Input 9

Note The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
770 0x302	0	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SLD2 OSSD Value	SLD1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	SDL 1 Input 8	SDL 1 Input 7	SDL 1 Input 6	SDL 1 Input 5	SDL 1 Input 4	SDL 1 Input 3	SDL 1 Input 2	SDL 1 Input 1
	3	SDL 1 Input 16	SDL 1 Input 15	SDL 1 Input 14	SDL 1 Input 13	SDL 1 Input 12	SDL 1 Input 11	SDL 1 Input 10	SDL 1 Input 9
	4	SDL 1 Input 24	SDL 1 Input 23	SDL 1 Input 22	SDL 1 Input 21	SDL 1 Input 20	SDL 1 Input 19	SDL 1 Input 18	SDL 1 Input 17
	5	SDL 1 Input 32	SDL 1 Input 31	SDL 1 Input 30	SDL 1 Input 29	SDL 1 Input 28	SDL 1 Input 27	SDL 1 Input 26	SDL 1 Input 25
	6	SDL 2 Input 8	SDL 2 Input 7	SDL 2 Input 6	SDL 2 Input 5	SDL 2 Input 4	SDL 2 Input 3	SDL 2 Input 2	SDL 2 Input 1
	7	SDL 2 Input 16	SDL 2 Input 15	SDL 2 Input 14	SDL 2 Input 13	SDL 2 Input 12	SDL 2 Input 11	SDL 2 Input 10	SDL 2 Input 9
	8	SDL 2 Input 24	SDL 2 Input 23	SDL 2 Input 22	SDL 2 Input 21	SDL 2 Input 20	SDL 2 Input 19	SDL 2 Input 18	SDL 2 Input 17
	9	SDL 2 Input 32	SDL 2 Input 31	SDL 2 Input 30	SDL 2 Input 29	SDL 2 Input 28	SDL 2 Input 27	SDL 2 Input 26	SDL 2 Input 25

Note The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
771 0x303	0	SDL 1 Input 8	SDL 1 Input 7	SDL 1 Input 6	SDL 1 Input 5	SDL 1 Input 4	SDL 1 Input 3	SDL 1 Input 2	SDL 1 Input 1
	1	SDL 1 Input 16	SDL 1 Input 15	SDL 1 Input 14	SDL 1 Input 13	SDL 1 Input 12	SDL 1 Input 11	SDL 1 Input 10	SDL 1 Input 9

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
772 0x304	0	SDL 2 Input 8	SDL 2 Input 7	SDL 2 Input 6	SDL 2 Input 5	SDL 2 Input 4	SDL 2 Input 3	SDL 2 Input 2	SDL 2 Input 1
	1	SDL 2 Input 16	SDL 2 Input 15	SDL 2 Input 14	SDL 2 Input 13	SDL 2 Input 12	SDL 2 Input 11	SDL 2 Input 10	SDL 2 Input 9

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
773 0x305	**0**	Combined Input Status	Combined Output Status	Network Status	SDL Status	Module Status (binary coded)			
	1	Input 1B Reason for Alarm				Input 1A Reason for Alarm			
	2	Input 2B Reason for Alarm				Input 2A Reason for Alarm			
	3	Input 3B Reason for Alarm				Input 3A Reason for Alarm			
	4	Input 4B Reason for Alarm				Input 4A Reason for Alarm			
	5	Input 5B Reason for Alarm				Input 5A Reason for Alarm			
	6	Input 6B Reason for Alarm				Input 6A Reason for Alarm			
	7	SOut 7B Reason for Alarm				SOut 7A Reason for Alarm			
	8	SOut 8B Reason for Alarm				SOut 8A Reason for Alarm			

Note The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.

Tab. 112: Explanation of data for I/O assembly 773 and 774

Assembly Data	Description of Values
Module Status	0x01: Self-testing state, initialization phase 0x02: Idle mode 0x03: Self test failed 0x04: Normal mode 0x05: Recoverable fault occurred 0x06: Critical fault occurred 0x07: Configuration mode 0x08: Waiting for TUNID
SDL Status Network Status	0x00: OK 0x01: Alarm
Combined Output Status Combined Input Status	0x00: Alarm 0x01: OK
Reason for Alarm	0x00: Normal mode/No Alarm 0x01: Configuration Invalid 0x02: External Test Signal Failure 0x03: Internal Input Failure 0x04: Discrepancy Error/Overrun 0x05: Failure of Associated Dual-channel Input

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
774 0x306	0	Combined Input Status	Combined Output Status	Network Status	SDL Status	Module Status (binary coded)			
	1	SDL 1 Device Reboot	SDL 1 New Config	SDL 1 Device Error	SDL 1 Config Error	SDL 1 OSSD Error	SDL 1 Comm Error	SDL 1 Safe Comm Error	SDL 1 Overload
	2	SDL 2 Device Reboot	SDL 2 New Config	SDL 2 Device Error	SDL 2 Config Error	SDL 2 OSSD Error	SDL 2 Comm Error	SDL 2 Safe Comm Error	SDL 2 Overload
	3	Diag Info 8 SDL 1 Device	Diag Info 7 SDL 1 Device	Diag Info 6 SDL 1 Device	Diag Info 5 SDL 1 Device	Diag Info 4 SDL 1 Device	Diag Info 3 SDL 1 Device	Diag Info 2 SDL 1 Device	Diag Info 1 SDL 1 Device
	4	Diag Info 16 SDL 1 Device	Diag Info 15 SDL 1 Device	Diag Info 14 SDL 1 Device	Diag Info 13 SDL 1 Device	Diag Info 12 SDL 1 Device	Diag Info 11 SDL 1 Device	Diag Info 10 SDL 1 Device	Diag Info 9 SDL 1 Device
	5	Diag Info 24 SDL 1 Device	Diag Info 23 SDL 1 Device	Diag Info 22 SDL 1 Device	Diag Info 21 SDL 1 Device	Diag Info 20 SDL 1 Device	Diag Info 19 SDL 1 Device	Diag Info 18 SDL 1 Device	Diag Info 17 SDL 1 Device
	6	Diag Info 32 SDL 1 Device	Diag Info 31 SDL 1 Device	Diag Info 30 SDL 1 Device	Diag Info 29 SDL 1 Device	Diag Info 28 SDL 1 Device	Diag Info 27 SDL 1 Device	Diag Info 26 SDL 1 Device	Diag Info 25 SDL 1 Device
	7	Diag Info 8 SDL 2 Device	Diag Info 7 SDL 2 Device	Diag Info 6 SDL 2 Device	Diag Info 5 SDL 2 Device	Diag Info 4 SDL 2 Device	Diag Info 3 SDL 2 Device	Diag Info 2 SDL 2 Device	Diag Info 1 SDL 2 Device
	8	Diag Info 16 SDL 2 Device	Diag Info 15 SDL 2 Device	Diag Info 14 SDL 2 Device	Diag Info 13 SDL 2 Device	Diag Info 12 SDL 2 Device	Diag Info 11 SDL 2 Device	Diag Info 10 SDL 2 Device	Diag Info 9 SDL 2 Device
	9	Diag Info 24 SDL 2 Device	Diag Info 23 SDL 2 Device	Diag Info 22 SDL 2 Device	Diag Info 21 SDL 2 Device	Diag Info 20 SDL 2 Device	Diag Info 19 SDL 2 Device	Diag Info 18 SDL 2 Device	Diag Info 17 SDL 2 Device
	10	Diag Info 32 SDL 2 Device	Diag Info 31 SDL 2 Device	Diag Info 30 SDL 2 Device	Diag Info 29 SDL 2 Device	Diag Info 28 SDL 2 Device	Diag Info 27 SDL 2 Device	Diag Info 26 SDL 2 Device	Diag Info 25 SDL 2 Device

Note The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
775 0x307	0	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SLD2 OSSD Value	SLD1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	TOut 4B Status	TOut 4A Status	TOut 3B Status	TOut 3A Status	TOut 2B Status	TOut 2A Status	TOut 1B Status	TOut 1A Status
	3	Reserved				TOut 6B Status	TOut 6A Status	TOut 5B Status	TOut 5A Status

Notes

- The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.
- When utilizing UE442x devices, values for SDL2 OSSD value (Bit 1.5) and SDL1 OSSD value (Bit 1.4) are always set to 0 (**Inactive**) and should be ignored.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
776 0x308	0	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SLD2 OSSD Value	SLD1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	Reserved							Muting Lamp 1 Status

Notes

- The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.
- A value of “0” for the Muting Lamp 1 Status indicates that an error has been detected at the muting lamp.
- When utilizing UE442x devices, values for SDL2 OSSD value (Bit 1.5) and SDL1 OSSD value (Bit 1.4) are always set to 0 (**Inactive**) and should be ignored.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
777 0x309	**0**	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SLD2 OSSD Value	SLD1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	SOut 8B Status	SOut 8A Status	SOut 7B Status	SOut 7A Status	SOut 8B Monitor Value	SOut 8A Monitor Value	SOut 7B Monitor Value	SOut 7A Monitor Value

Notes
- The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.
- When utilizing UE442x devices, values for SDL2 OSSD value (Bit 1.5) and SDL1 OSSD value (Bit 1.4) are always set to 0 (**Inactive**) and should be ignored.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
778 0x30A	**0**	Reserved				SOut 8B Value	SOut 8A Value	SOut 7B Value	SOut 7A Value
	1	SDL 1 Output 8	SDL 1 Output 7	SDL 1 Output 6	SDL 1 Output 5	SDL 1 Output 4	SDL 1 Output 3	SDL 1 Output 2	SDL 1 Output 1
	2	SDL 1 Output 16	SDL 1 Output 15	SDL 1 Output 14	SDL 1 Output 13	SDL 1 Output 12	SDL 1 Output 11	SDL 1 Output 10	SDL 1 Output 9
	3	SDL 2 Output 8	SDL 2 Output 7	SDL 2 Output 6	SDL 2 Output 5	SDL 2 Output 4	SDL 2 Output 3	SDL 2 Output 2	SDL 2 Output 1
	4	SDL 2 Output 16	SDL 2 Output 15	SDL 2 Output 14	SDL 2 Output 13	SDL 2 Output 12	SDL 2 Output 11	SDL 2 Output 10	SDL 2 Output 9

Note For a detailed description of “SDL x Output x” see Tab. 115 “SDL output parameter association” on page 204.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
779 0x30B	**0**	SDL 1 Output 8	SDL 1 Output 7	SDL 1 Output 6	SDL 1 Output 5	SDL 1 Output 4	SDL 1 Output 3	SDL 1 Output 2	SDL 1 Output 1
	1	SDL 1 Output 16	SDL 1 Output 15	SDL 1 Output 14	SDL 1 Output 13	SDL 1 Output 12	SDL 1 Output 11	SDL 1 Output 10	SDL 1 Output 9

Note For a detailed description of “SDL x Output x” see Tab. 115 “SDL output parameter association” on page 204.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
780 0x30C	**0**	SDL 2 Output 8	SDL 2 Output 7	SDL 2 Output 6	SDL 2 Output 5	SDL 2 Output 4	SDL 2 Output 3	SDL 2 Output 2	SDL 2 Output 1
	1	SDL 2 Output 16	SDL 2 Output 15	SDL 2 Output 14	SDL 2 Output 13	SDL 2 Output 12	SDL 2 Output 11	SDL 2 Output 10	SDL 2 Output 9

Note For a detailed description of “SDL x Output x” see Tab. 115 “SDL output parameter association” on page 204.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
782 0x30E	**0**	Remote Input 8 Value	Remote Input 7 Value	Remote Input 6 Value	Remote Input 5 Value	Remote Input 4 Value	Remote Input 3 Value	Remote Input 2 Value	Remote Input 1 Value

Note For a detailed description of “SDL x Output x” see Tab. 115 “SDL output parameter association” on page 204.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
783 0x30F	0	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SLD2 OSSD Value	SLD1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	Input 4B Status	Input 4A Status	Input 3B Status	Input3A Status	Input 2B Status	Input 2A Status	Input 1B Status	Input 1A Status
	3	Reserved				Input 6B Status	Input 6A Status	Input 5B Status	Input 5A Status

Notes

- The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.
- When utilizing UE442x devices, values for SDL2 OSSD value (Bit 1.5) and SDL1 OSSD value (Bit 1.4) are always set to 0 (**Inactive**) and should be ignored.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
784 0x310	0	Combined Input Status	Combined Output Status	Network Status	SDL Status	Module Status (Binary Coded)			

Note The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.

Tab. 113: Explanation of data for I/O assembly 784

Assembly Data	Description of Values
Module Status	0x01: Self-testing state, initialization phase 0x02: Idle mode 0x03: Self test failed 0x04: Normal mode 0x05: Recoverable fault occurred 0x06: Critical fault occurred 0x07: Configuration mode 0x08: Waiting for TUNID
SDL Status Network Status	0x00: OK 0x01: Alarm
Combined Output Status Combined Input Status	0x00: Alarm 0x01: OK

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
785 0x311	0	TOut 4B Value	TOut 4A Value	TOut 3B Value	TOut 3A Value	TOut 2B Value	TOut 2A Value	TOut 1B Value	TOut 1A Value
	1	Reserved				TOut 6B Value	TOut 6A Value	TOut 5B Value	TOut 5A Value
	2	Remote Input 8 Value	Remote Input 7 Value	Remote Input 6 Value	Remote Input 5 Value	Remote Input 4 Value	Remote Input 3 Value	Remote Input 2 Value	Remote Input 1 Value

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
786 0x312	0	Reserved				SOut 8B Value	SOut 8A Value	SOut 7B Value	SOut 7A Value
	1	TOut 4B Value	TOut 4A Value	TOut 3B Value	TOut 3A Value	TOut 2B Value	TOut 2A Value	TOut 1B Value	TOut 1A Value
	2	Reserved				TOut 6B Value	TOut 6A Value	TOut 5B Value	TOut 5A Value

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
787 0x313	0	Reserved				SOut 8B Value	SOut 8A Value	SOut 7B Value	SOut 7A Value
	1	TOut 4B Value	TOut 4A Value	TOut 3B Value	TOut 3A Value	TOut 2B Value	TOut 2A Value	TOut 1B Value	TOut 1A Value
	2	Reserved				TOut 6B Value	TOut 6A Value	TOut 5B Value	TOut 5A Value
	3	SDL 1 Output 8	SDL 1 Output 7	SDL 1 Output 6	SDL 1 Output 5	SDL 1 Output 4	SDL 1 Output 3	SDL 1 Output 2	SDL 1 Output 1
	4	SDL 1 Output 16	SDL 1 Output 15	SDL 1 Output 14	SDL 1 Output 13	SDL 1 Output 12	SDL 1 Output 11	SDL 1 Output 10	SDL 1 Output 9
	5	SDL 2 Output 8	SDL 2 Output 7	SDL 2 Output 6	SDL 2 Output 5	SDL 2 Output 4	SDL 2 Output 3	SDL 2 Output 2	SDL 2 Output 1
	6	SDL 2 Output 16	SDL 2 Output 15	SDL 2 Output 14	SDL 2 Output 13	SDL 2 Output 12	SDL 2 Output 11	SDL 2 Output 10	SDL 2 Output 9

Note For a detailed description of “SDL x Output x” see Tab. 115 “SDL output parameter association” on page 204.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
788 0x314	0	Remote Input 8 Value	Remote Input 7 Value	Remote Input 6 Value	Remote Input 5 Value	Remote Input 4 Value	Remote Input 3 Value	Remote Input 2 Value	Remote Input 1 Value
	1	Remote Input 16 Value	Remote Input 15 Value	Remote Input 14 Value	Remote Input 13 Value	Remote Input 12 Value	Remote Input 11 Value	Remote Input 10 Value	Remote Input 9 Value

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
789 0x315	0	TOut 4B Value	TOut 4A Value	TOut 3B Value	TOut 3A Value	TOut 2B Value	TOut 2A Value	TOut 1B Value	TOut 1A Value
	1	Reserved				TOut 6B Value	TOut 6A Value	TOut 5B Value	TOut 5A Value
	2	Remote Input 8 Value	Remote Input 7 Value	Remote Input 6 Value	Remote Input 5 Value	Remote Input 4 Value	Remote Input 3 Value	Remote Input 2 Value	Remote Input 1 Value
	3	Remote Input 16 Value	Remote Input 15 Value	Remote Input 14 Value	Remote Input 13 Value	Remote Input 12 Value	Remote Input 11 Value	Remote Input 10 Value	Remote Input 9 Value

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
790 0x316	0	Remote Safety Input 8 Value	Remote Safety Input 7 Value	Remote Safety Input 6 Value	Remote Safety Input 5 Value	Remote Safety Input 4 Value	Remote Safety Input 3 Value	Remote Safety Input 2 Value	Remote Safety Input 1 Value
	1	Remote Safety Input 16 Value	Remote Safety Input 15 Value	Remote Safety Input 14 Value	Remote Safety Input 13 Value	Remote Safety Input 12 Value	Remote Safety Input 11 Value	Remote Safety Input 10 Value	Remote Safety Input 9 Value

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
792 0x318	0	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SDL2 OSSD Value	SDL1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value
	2	Remote Output 8 Value	Remote Output 7 Value	Remote Output 6 Value	Remote Output 5 Value	Remote Output 4 Value	Remote Output 3 Value	Remote Output 2 Value	Remote Output 1 Value

Note
- The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.
- When utilizing UE442x devices, values for SDL2 OSSD value (Bit 1.5) and SDL1 OSSD value (Bit 1.4) are always set to 0 (**Inactive**) and should be ignored.

Instance	Byte	.7	.6	.5	.4	.3	.2	.1	.0
793 0x319	0	Input 4B Value	Input 4A Value	Input 3B Value	Input 3A Value	Input 2B Value	Input 2A Value	Input 1B Value	Input 1A Value
	1	Combined Input Status	Combined Output Status	SDL2 OSSD Value	SDL1 OSSD Value	Input 6B Value	Input 6A Value	Input 5B Value	Input 5A Value

Note

- The combined output status reflects the combined status of safety capable outputs. This value does not reflect the status of the test/signal outputs.
- When utilizing UE442x devices, values for SDL2 OSSD value (Bit 1.5) and SDL1 OSSD value (Bit 1.4) are always set to 0 (**Inactive**) and should be ignored.

Bit description[18)]	C4000	M4000	S300	S3000
SDL x Input 1	OSSD (switching output) green	OSSD (switching output) green	OSSD (switching output) green	OSSD (switching output) green
SDL x Input 2	Host OSSD green	Reserved	Warning field	Warning field
SDL x Input 3	OSSD Guest1 green		Object in protective field Used monitoring area	Object in protective field Used monitoring area
SDL x Input 4	OSSD Guest2 green		Object in warning field Used monitoring area	Object in warning field Used monitoring area
SDL x Input 5	Reserved		Reserved	Object in protective field Simultaneous monitoring area
SDL x Input 6	Application diagnostic output	Application diagnostic output	Reserved	Object in warning field Simultaneous monitoring area
SDL x Input 7	Reset	Reset	Reset	Reset
SDL x Input 8	Reset required	Reset required	Reset required	Reset required
SDL x Input 9	Reserved	Reserved	Status of monitored case inputs: InA1	Status of monitored case inputs: InA1
SDL x Input 10			Status of monitored case inputs: InA2	Status of monitored case inputs: InA2
SDL x Input 11			Status of monitored case inputs: InB1	Status of monitored case inputs: InB1
SDL x Input 12			Status of monitored case inputs: InB2	Status of monitored case inputs: InB2
SDL x Input 13			Reserved	Status of monitored case inputs: InC1
SDL x Input 14				Status of monitored case inputs: InC2
SDL x Input 15				Status of monitored case inputs: InD1
SDL x Input 16				Status of monitored case inputs: InD2
SDL x Input 17				Reserved
SDL x Input 18				
SDL x Input 19…32				

Tab. 114: SDL input parameter association

Note When using input data for any of the devices outlined in the table above, you must also consult the operating instructions for the device (e.g. C4000 safety light curtain or M4000 multiple light beam safety device).

18) SDL x = “SDL 1” or “SDL 2” on the UE4400 IP67 Remote I/O bus node

WARNING

C4000 Safety Light Curtain OSSD Information must be interpreted correctly!

When utilizing a C4000 safety light curtain Host-Guest(-Guest) system, take care to implement safety-relevant logic correctly. The guest(s) OSSD values do not reflect the state of the entire Host-Guest(-Guest) system. The OSSD value for the Guest 2 segment does not reflect the value of the Host segment or the Guest 1 segment. The OSSD value for the Guest 1 segment does not reflect the value of the Host segment.

Ensure that your safety-relevant logic incorporates these signals correctly and verify that system operation is in accordance with your application and risk assessment/risk reduction requirements.

Bits associated with the S3000 Simultaneous Monitoring Area must be correctly utilized.

When you have not configured a Simultaneous Monitoring Field in the S3000, make sure that your safety-relevant logic does not utlize the Simultaneous Monitoring Field values presented in Tab. 114. When the Simultaneous Monitoring Field is not configured, the data presented in this table will indicate that the Simultaneous Monitoring Field is clear.

Make sure that you monitor the OSSD values correctly when utilizing the Reset Required signal information of the S300 or S3000!

The Reset Required bit (SDL x Input 8) reflects the current state of the OSSD switching output (green) and does not reflect the state of other SDL input data. When utilizing SDL input signals, take this into account to assure that the system performs in accordance with your application and risk assessment/risk reduction requirements.

<table>
<tr><th>Bit description[19]</th><th>C4000</th><th>M4000</th><th>S300</th><th>S3000</th></tr>
<tr><td>SDL x Output 1</td><td rowspan="6">Operating mode switching</td><td>Restart</td><td rowspan="8">Reserved</td><td rowspan="8">Reserved</td></tr>
<tr><td>SDL x Output 2</td><td>Muting lamp status</td></tr>
<tr><td>SDL x Output 3</td><td>Muting sensor 1</td></tr>
<tr><td>SDL x Output 4</td><td>Muting sensor 2</td></tr>
<tr><td>SDL x Output 5</td><td>Muting sensor 3</td></tr>
<tr><td>SDL x Output 6</td><td>Muting sensor 4</td></tr>
<tr><td>SDL x Output 7</td><td>Activate Teach-in</td><td>Override</td></tr>
<tr><td>SDL x Output 8</td><td>Reserved</td><td rowspan="9">Reserved</td></tr>
<tr><td>SDL x Output 9</td><td>Run-on monitoring</td><td>InA1</td><td>InA1</td></tr>
<tr><td>SDL x Output 10</td><td>MCC-BDC</td><td>InA2</td><td>InA2</td></tr>
<tr><td>SDL x Output 11</td><td>MCC-TDC</td><td>InB1</td><td>InB1</td></tr>
<tr><td>SDL x Output 12</td><td rowspan="3">Reserved</td><td>InB2</td><td>InB2</td></tr>
<tr><td>SDL x Output 13</td><td rowspan="4">Reserved</td><td>InC1</td></tr>
<tr><td>SDL x Output 14</td><td>InC2</td></tr>
<tr><td>SDL x Output 15</td><td>Bypass channel 1</td><td>InD1</td></tr>
<tr><td>SDL x Output 16</td><td>Bypass channel 2</td><td>InD2</td></tr>
</table>

Tab. 115: SDL output parameter association

Note When using input data for any of the devices outlined in the table above, you must also consult the operating instructions for the device (e.g. C4000 safety light curtain or M4000 multiple light beam safety device).

19) SDL x = “SDL 1” or “SDL 2” on the UE4400 IP67 Remote I/O bus node

<table>
<tr><th>Bit description[20]</th><th>C4000</th><th>M4000</th><th>S300</th><th>S3000</th></tr>
<tr><td>SDL x Diagnostic 1</td><td rowspan="6">Reserved</td><td rowspan="6">Reserved</td><td rowspan="6">Reserved</td><td rowspan="6">Reserved</td></tr>
<tr><td>SDL x Diagnostic 2</td></tr>
<tr><td>SDL x Diagnostic 3</td></tr>
<tr><td>SDL x Diagnostic 4</td></tr>
<tr><td>SDL x Diagnostic 5</td></tr>
<tr><td>SDL x Diagnostic 6</td></tr>
<tr><td>SDL x Diagnostic 7</td><td>Contamination</td><td>Contamination</td><td>Contamination</td><td>Contamination</td></tr>
<tr><td>SDL x Diagnostic 8</td><td rowspan="2">Reserved</td><td rowspan="2">Reserved</td><td rowspan="2">Reserved</td><td rowspan="2">Reserved</td></tr>
<tr><td>SDL x Diagnostic 9</td></tr>
<tr><td>SDL x Diagnostic 10</td><td>Device error</td><td>Device error</td><td>Device error</td><td>Device error</td></tr>
<tr><td>SDL x Diagnostic 11</td><td rowspan="2">Operational status of the device:
00 Operation
01 Initialization
10 Configuration mode
11 Lockout</td><td rowspan="2">Operational status of the device:
00 Operation
01 Initialization
10 Configuration mode
11 Lockout</td><td rowspan="2">Operational status of the device:
00 Operation
01 Initialization
10 Configuration mode
11 Lockout</td><td rowspan="2">Operational status of the device:
00 Operation
01 Initialization
10 Configuration mode
11 Lockout</td></tr>
<tr><td>SDL x Diagnostic 12</td></tr>
<tr><td>SDL x Diagnostic 13</td><td rowspan="3">C4000 operating mode selected</td><td rowspan="14">Reserved</td><td>InA1</td><td>InA1</td></tr>
<tr><td>SDL x Diagnostic 14</td><td>InA2</td><td>InA2</td></tr>
<tr><td>SDL x Diagnostic 15</td><td>InB1</td><td>InB1</td></tr>
<tr><td>SDL x Diagnostic 16</td><td>Emergency stop status</td><td>InB2</td><td>InB2</td></tr>
<tr><td>SDL x Diagnostic 17</td><td>Teach In key operated</td><td rowspan="16">Reserved</td><td>InC1</td></tr>
<tr><td>SDL x Diagnostic 18</td><td>Reserved</td><td>InC2</td></tr>
<tr><td>SDL x Diagnostic 19</td><td>Teach In key active</td><td>InD1</td></tr>
<tr><td>SDL x Diagnostic 20</td><td>Reserved</td><td>InD2</td></tr>
<tr><td>SDL x Diagnostic 21</td><td rowspan="2">Diagnostics protective field:
00 Error
01 Invalid PSDI interruption
10 Valid PSDI interruption
11 No object/no PSDI interruption</td><td rowspan="12">Reserved</td></tr>
<tr><td>SDL x Diagnostic 22</td></tr>
<tr><td>SDL x Diagnostic 23</td><td rowspan="3">Reserved</td></tr>
<tr><td>SDL x Diagnostic 24</td></tr>
<tr><td>SDL x Diagnostic 25</td></tr>
<tr><td>SDL x Diagnostic 26</td><td>Status bypass</td></tr>
<tr><td>SDL x Diagnostic 27</td><td rowspan="6">Reserved</td><td>0 = No muting;
1 = Muting active</td></tr>
<tr><td>SDL x Diagnostic 28</td><td rowspan="5">Reserved</td></tr>
<tr><td>SDL x Diagnostic 29</td></tr>
<tr><td>SDL x Diagnostic 30</td></tr>
<tr><td>SDL x Diagnostic 31</td></tr>
<tr><td>SDL x Diagnostic 32</td></tr>
</table>

Tab. 116: Diagnostic assembly SDL parameter association

Note When using diagnostic data for any of the devices outlined in the table above, you must also consult the operating instructions for the device (e.g. C4000 safety light curtain).

[20] SDL x = “SDL 1” or “SDL 2” on the UE4400 IP67 Remote I/O bus node

13.6 .EDS file information

An electronic data sheet (.EDS) file is used to provide information to the (safety) network configuration software (e.g. SICK DeviceNet Safety Configurator) regarding the configuration parameters of DeviceNet and DeviceNet Safety devices. This allows these devices to be configured via the network.

All SICK UE4400 devices utilize an electronic data sheet (.EDS) file for the purpose of defining the configuration of the device. However, the parameterization of logic, safety laser scanners and safety light curtains via an .EDS file is not possible.

The UE4427, UE4450, UE4455 and UE4457 devices utilize an .EDS file that directs the safety network configuration tool to utilize a non-EDS interface (i.e. CDS plug-in) for the purpose of configuration of the device. In this case, the CDS plug-in is a special version of the SICK Configuration and Diagnostic Software (CDS).

When you purchase SICK DeviceNet Safety Configurator, this CDS plug-in is already installed and will allow you to configure all UE4400 devices via DeviceNet Safety network connection. If you utilize a third party safety network configuration tool that supports non-EDS interfaces, SICK's CDS plug-in may be installed to provide the same functionality.

The latest versions of all .EDS files are available at the Open DeviceNet Vendor Association website at www.odva.org.

13.7 Declaration of conformity

SICK

EC Declaration of conformity

en

Ident-No. : 9099619 Q782

The undersigned, representing the following manufacturer

SICK AG
Industrial Safety Systems
Sebastian-Kneipp-Straße 1
79183 Waldkirch
Germany

herewith declares that the product

UE4420/UE4427/ UE4450/UE4455/UE4457

is in conformity with the provisions of the following EC directive(s) (including all applicable amendments), and that the standards and/or technical specifications referenced overleaf have been applied.

Waldkirch, 2006-07-10

ppa. Dr. Plasberg
Management Board
(Industrial Safety Systems)

ppa. Knobloch
Manager Production
(Industrial Safety Systems)

8 006 440.0499 BK - BK II - 16866

Note You can obtain the complete EC declaration of conformity via the SICK homepage on the Internet at: www.sick.com

13.8 Checklist for the manufacturer

SICK

Checklist for the manufacturer/supplier for the installation of the UE4400

The information for the points listed below must at least be available the first time the equipment is commissioned. They depend on the application the requirements of which must be verified by the manufacturer/supplier.

This checklist should be retained and kept with the machine documentation to serve as reference during recurring tests.

1. Have the safety rules and regulations been observed in compliance with the directives/ standards applicable to the machine? Yes ☐ No ☐
2. Are the applied directives and standards listed in the declaration of conformity? Yes ☐ No ☐
3. Does the protective device comply with the required category according to EN 954-1? Yes ☐ No ☐
4. Are the required protective measures against electric shock in effect (protection class)? Yes ☐ No ☐
5. Has the protective function been checked in compliance with the test notes of this documentation? In particular: Yes ☐ No ☐
   – function test of the transmitter, sensor type and actors connected to the UE4400
   – switching path test
6. Are there safeguards that the UE4400 will be subject to thorough testing of its safety functions each time its configuration has been changed? Yes ☐ No ☐

This checklist does not replace the initial commissioning nor the regular inspection by specialist personnel.

13.9 Glossary

Active The logical state of an input or function block that represents a logical "1".

Bipolar output An output derived from the combination of a high side output and low side output pair where the high side output current runs through the low side.

Busoff Indicates status of very high error occurrence on communication cables. Detects problem when the internal error counter counts more errors than the predetermined threshold figure.

C4000 C4000 series safety light curtains from SICK

Connection Logical communication channel between DeviceNet (Safety) nodes. Connections may be e.g. master-slave or Target-Originator.

Cyclic A device configured to produce a cyclic I/O message will produce its data at a precisely defined interval. This type of I/O messaging allows the user to configure the system to produce data at a rate appropriate for the application. Depending on the application this can reduce the amount of traffic on the wire and more efficiently use the available bandwidth.

Dangerous state Used to denote the dangerous state of the machine represented as a movement of a machine part. In practical operation, there may be a number of different dangerous states for a single machine, e.g.

- Machine movements
- Electrical conductors
- Visible or invisible radiation
- A combination of several risks and hazards

DeviceNet A digital, multi-drop field bus network that connects and serves as a communication network between industrial controllers and I/O devices managed by the Open DeviceNet Vendors Association (ODVA) in accordance with EN 50 325-2.

DeviceNet Safety A safety rated version of the DeviceNet field bus communication protocol.

Inactive The logical state of an input or function block that represents a logical "0".

M4000 M4000 series multiple light beam safety devices from SICK.

Multi-cast A DeviceNet Safety connection in which the data producer (e.g. Target device) provides data to multiple consumers (e.g. Originator devices).

Originator A DeviceNet Safety device that configures and requests information from a Target device. An Originator device on DeviceNet Safety corresponds to a master device on standard DeviceNet.

PLC (SPLC) (Safety) Programmable Logic Controller

Polled A slave configured for polled I/O will receive "output" data from the master device in a sequential order that is defined by the master's scan list. The master's polling rate is determined by the number of nodes in the scan list, the DeviceNet baud rate, the size of messages produced by the master and each node in its scan list and the internal timing of the master device. For a given system configuration, this messaging method will provide deterministic behavior. Polled I/O "output" data can be single-cast or multi-cast.

Proof test In order to satisfy the requirements associated with IEC 61 508, a periodic proof test must be performed in which all functions of the UE4400 must be tested. The requirements associated with a proof test are satisfied when power is cycled in the UE4400 device and it completes its initial self-test.

S3000 S3000 series safety laser scanners from SICK

Safe state When an input or output is set **Inactive** based on a safe state of the connected device during normal operation (no error reason exists) in the UE4400.

Safety-rated controller A programmable logic controller third-party certified as a safety rated device (e.g. SICK Safety Network Controller or other third-party safety-rated controller).

SICK Refers to the manufacturer of this device SICK AG, and all SICK AG subsidiary companies

Single-cast A DeviceNet Safety connnection in which the data producer (e.g. Target device) provides data to a single consumer (e.g. Originator device).

Slope detection A method used to test a safety capable input signal to verify that it is not “stuck at high”. This provides an additional level of signal integrity for single-channel signals (e.g. Reset).

Strobe When a scanner module issues a strobe command to all the devices in its scan list, those devices that are configured for strobed messaging will respond with data. Also known as bitstrobe.

Target A connection on DeviceNet Safety in which the Target device responds to an Originator with the information that the Originator device has requested. A Target device on DeviceNet Safety corresponds to a slave device on standard DeviceNet.

UE4400 All IP67 remote I/O bus nodes of the UE4400 family. These are the UE4420, UE4427, UE4450, UE4455 and UE4457 in these operating instructions. In the context of this document, the UE4400 definition does not include the DeviceNet Safety IP20 bus nodes that utilize a similar naming convention (e.g. UE4421).

User The person or persons that implement the UE4400 and all devices connected to UE4400 into a safety-relevant application. “User” generically describes personnel from original equipment manufacturers (OEMs), system integrators and other qualified specialist personnel.

13.10 List of tables

13.11 List of illustrations

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