Leuze electronic

the sensor people

AS-I Safety Monitor

Version V 3.08 with Muting functionality

607023-2009/09

CONNECTING AND OPERATING INSTRUCTIONS

Edition: 01/2010

Edition: 01/2010

Edition: 01/2010

Edition: 01/2010

1 General Information

1.1 Explanation of symbols

The symbols used in this operating manual are explained below.

Attention!
Pay attention to passages marked with this symbol. Failure to observe the provided instructions could lead to personal injury or damage to equipment.

Notice!
This symbol indicates text which contains important information.

1.2 Declaration of Conformity

The AS-i safety monitor has been developed and manufactured in accordance with the applicable European standards and directives.

Notice!
The corresponding Declaration of Conformity and prototype test certificate can be found at the end of this operating manual.

The manufacturer of the product possesses a certified quality assurance system in accordance with ISO 9001.

1.3 Standards

- Draft: Fundamentals for the testing and certification of "Bus systems for the transmission of safety-relevant messages"
- ISO 13849-1:2008 - Safety of machines – safety-related elements of control systems - Part 1: General principles for design
- EN 50295:1999-10 - Low-voltage switching devices; control-system and device interfaces; actuator sensor interface (AS-i)
- EN 60204-1:2006-06 - Safety of machines – electrical equipment for machines – Part 1: general requirements
- EN 60947-5-1:2005-02 - Low-voltage switchgear and controlgear - Part 5-1: control devices and switching elements; electromechanical control devices
- EN 61496-1:2005-01 - Non-contact safety guards
- IEC 61508 1-7:2000 - Functional safety of electric/electronic/programmable electronic systems with safety function

Edition: 01/2010

1.4 Definition of terms

Output switching element (safety output) of the AS-i safety monitor

Element activated by the logic of the monitor which is able to safely switch off the downstream control elements. The output switching element may switch to or remain in the ON state only when all components are functioning as intended.

Output circuit

Consists of the two logically connected output switching elements.

OSSD

The safe AS-i components and functional components assigned to an output circuit. They are responsible for releasing the machine element which generates the hazardous movement.

Integrated slave

Component in which sensor and/or actuator functions are grouped together with the slave to form a unit.

Configuration operation

Operating state of the safety monitor in which the configuration is loaded and checked.

Master

Component for data transmission that controls the logical and temporal behavior on the AS-i line.

Muting

Proper, application-intended, time-limited suppression of the protective field's safety function.

Muting restart

Initiation of the override mode after a Muting fault (flashing Muting indicator).

Parallel Muting

Muting is initiated if 2 defined Muting sensor signals are activated within a defined time.

External device monitoring circuit (contactor monitoring)

The external device monitoring circuit allows the switching function of the contactors connected to the AS-i safety monitor to be monitored.

Sequential Muting

Muting is initiated if 4 Muting sensor signals are sequentially activated in a defined order (Muting sequence).

Edition: 01/2010

Safety output

See output switching element.

Safe input slave

Slave which reads in the safe ON or OFF state of the connected sensor or command device and transmits it to the master or safety monitor.

Safe slave

Slave for connecting safe sensors, actuators and other devices.

Safety monitor

Component which monitors the safe slaves and the correct function of the network.

Slave

Component for data transmission; the master cyclically addresses this component by its address. Only then does it generate an answer.

Standard slave

Slave for connecting non-safe sensors, actuators and other devices.

Synchronization time

The maximum permissible temporal offset between the occurrence of two events which are dependent on one another.

Edition: 01/2010

1.5 Abbreviations

AOPD	Active Optoelectronic Protective Device
AS-i	Actuator Sensor Interface
AOPD	Active Optoelectronic Protective Device
CRC	Cyclic Redundancy Check
EDM	External Device Monitoring
EMC	Electromagnetic compatibility
ESD	Electrostatic Discharge
I/O	Input/Output
OSSD	Output Signal Switching Device
PELV	Protective Extra-Low Voltage
PFD	Probability of Failure on Demand
PLC	Programmable Logic Control

Edition: 01/2010

1.6 Brief description

The actuator-sensor interface (AS-i) has established itself as a system for networking primarily binary sensors and actuators at the lowest level of the automation hierarchy. The high number of installed systems, the ease of use and the reliable operating behavior also make the AS-i interesting in the area of machine safety.

The **safe** AS-i system is intended for safety applications up to Category 4 / PL e in accordance with ISO 13849-1. Mixed operation of standard components and safe components is possible.

The AS-i safety monitor monitors within an AS-i system the safe slaves which have been assigned according to the configuration specified by the user with the configuration software. Depending on the device model, up to two dependent or independent OSSDs, each with external device monitoring circuit, are available. In the event of a stop request or a defect, the AS-i safety monitor safely switches off the system in protective operation mode with a maximum reaction time of 40ms.

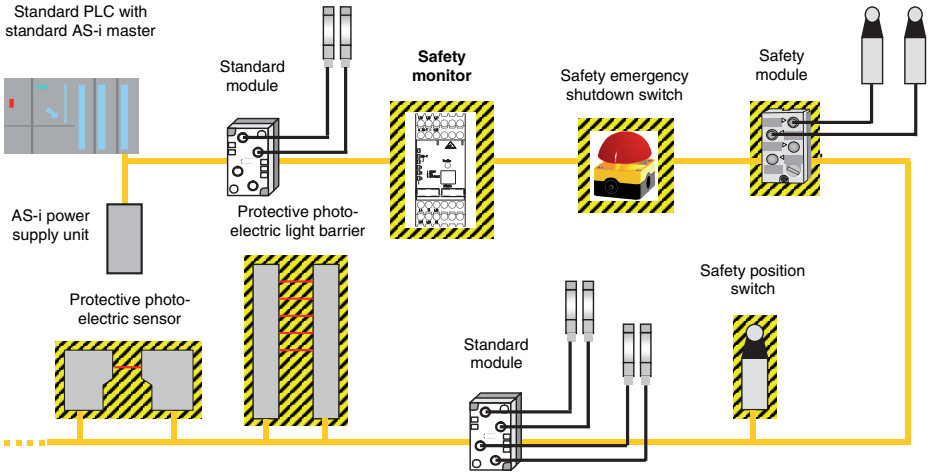


Figure 1.1:Safe and standard components in an AS-i network

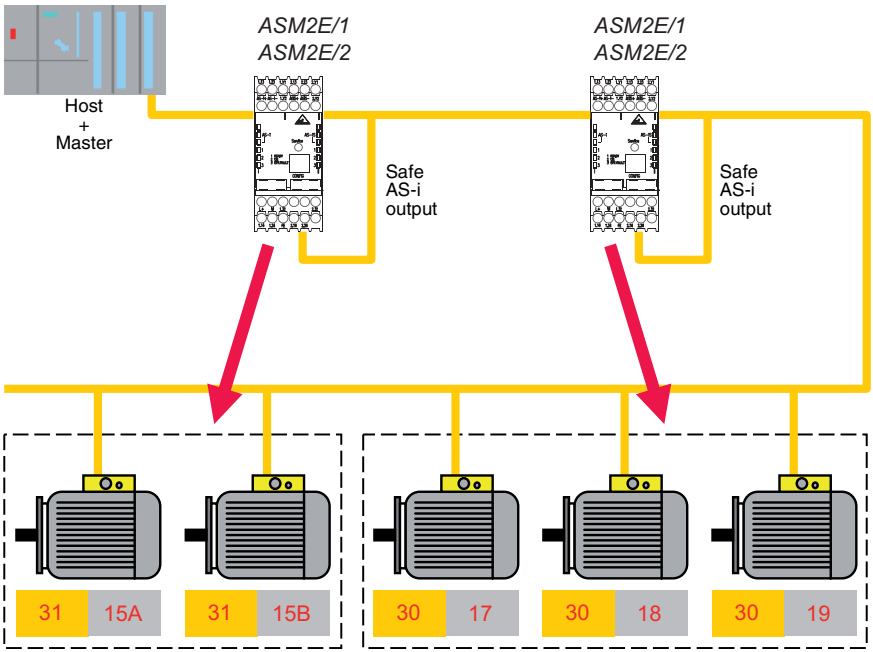
Multiple AS-i safety monitors can be used within an AS-i system. In this way, a safe slave can be monitored by multiple AS-i safety monitors.

Edition: 01/2010

System expansion - decentral, safe AS-i output slaves

With the system expansion focused on the **safe connection of decentral, safe AS-i output slaves** acc. to IEC 61508 SIL 3, additional device models with a **safe AS-i output** are made available. These models (ASM2E/1 / ASM2E/2) are used in the following applications:

1. Safe integration and monitoring of AS-i actuators or AS-i actuator groups, e.g. for enabling motor starters or valve units through the safe AS-i output of the safety monitor.



Safe AS-i actuator/group 1
Safe slave address: 31
Standard A/B slave address: 15A/15B

Safe AS-i actuator/group 2
Safe slave address: 30
Standard A/B slave address: 17/18/19

Figure 1.2:Example - Monitoring of 2 decentral AS-i actuator groups

Notice!
An AS-i safety monitor can only monitor one actuator group.

Edition: 01/2010

2. **Coupling of AS-i networks** for the safe transmission of the state of an AS-i safety monitor from one AS-i network to another AS-i network via the AS-i using the function of the AS-i safety monitor as a safe AS-i input slave. This can be used, for example, for the creation of hierarchal networks for the realization of a system stop which functions across an AS-i network or for the implementation of a system restart from one location.

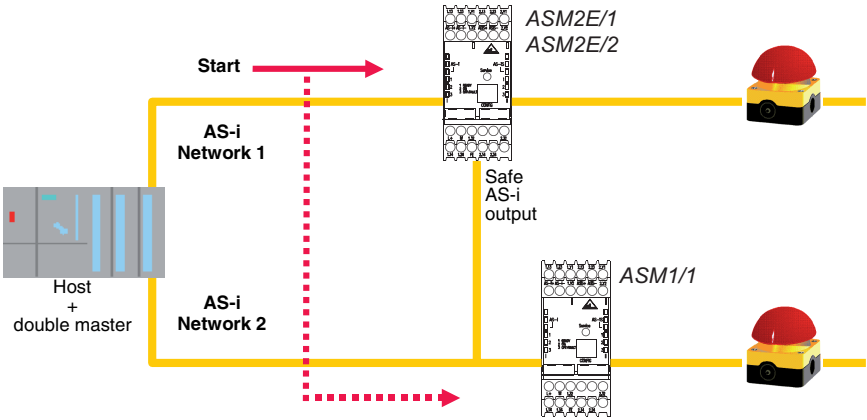


Figure 1.3:Example - Monitoring of 2 decentral AS-i actuator groups

Edition: 01/2010

System expansion - Muting via AS-i

The "Muting" function range of the AS-i safety monitor offers the possibility of the proper, application-intended and time-limited bridging of the protective function of the Safety Light Curtain/Multiple Light Beam Safety Device/Transceiver used for access guarding the danger zone by connecting 2 or 4 Muting sensors, e.g if material is to be transported through the protective field into or out of the danger zone.

The integration of the Muting function in the AS-i safety monitor offers a particularly economical and flexible automation solution: the peripheral sensor equipment required for Muting evaluation of the system, consisting of Muting and protective sensor, can be queried directly via AS-i.

Depending on the number of required AS-i addresses, multiple Muting ranges can be configured and diagnosed on a system via a single AS-i safety monitor. The adjustable Muting modes can be changed at any time by means of the **asimon** configuration software.

Edition: 01/2010

1.7 Different types of AS-i safety monitors

The AS-i safety monitor has been further developed and expanded in functionality since the start of production in 2001.

The safety monitor is available in a total of 6 versions which differ with regard to the functions provided by the operating software and the initial configuration.

Notice!
*A detailed description of all of the functions for the AS-i safety monitor device versions listed in the following can be found in the user manual supplied with the **asimon** configuration software.*

Versions of the operating software, version 2.0

The **"Basic"** and **"Enhanced"** function ranges differ as follows:

	"Basic"	**"Enhanced"**
Number of functional devices at logic level	32	48
OR gates (inputs)	2	6
AND gates (inputs)	no	6
Safe time function, switch-on and switch-off delay	no	yes
Function "button"	no	yes
Safety guard/module with debouncing	no	yes
Safety guard with lock	no	yes
Deactivation of functional devices	yes	yes
Reset of error condition	yes	yes
Diagnosis stop	yes	yes
Support of A/B technology for non-safe slaves	yes	yes
New functional devices (flip-flop, pulse on pos. edge, etc.)	no	yes
Dummy device (NOP)	no	yes

Table 1.1: "Basic" and "Enhanced" function ranges

Notice!
Device versions of operating software 2.0 are backwards compatible with device versions of the first version of the operating software 1.1 with the "Basic" function range.

Edition: 01/2010

New features beginning with Version 2.1 of the operating software

The following new features are included in version 2.1 of the operating software for the AS-i safety monitor:

- New monitoring device **zero sequence detection**
- Expansion of the output device **door lock by means of delay time**: now optionally available with stop category 1 for the first OSSD
- Expansion of the output device **door lock by means of zero-speed relay and delay time**: now optionally available with stop category 1 for the first OSSD
- New start device **activation via standard slave** (level-sensitive)
- New start device **activation via monitor input** (level-sensitive)
- New monitoring device **operational switching by means of monitor input**
- Expansion of monitoring device **double channel dependent with debouncing** for local acknowledgement and startup test
- Expansion of monitoring device **double channel independent** for local acknowledgement and startup test
- Incremental teaching of the code sequences
- Device index assignment
- Display of inverted icon when standard slave is inverted
- Number of simulated slaves can be selected
- Signaling of relay outputs and message outputs via the AS-i

Output configuration

Device types **ASM1/1** and **ASM1E/1**:one switchable output circuit

Device types **ASM1/2** and **ASM1E/2**:two separately switchable output circuits

Features of device versions

		Function range	
		"Basic"	**"Enhanced"**
Number of output circuits	**1**	ASM1/1	ASM1E/1
	2	ASM1/2	ASM1E/2

Table 1.2: Features of device versions ASM1/1 … ASM1E/2

Notice!
Device versions of operating software 2.1 are backwards compatible with device versions of operating software 1.1 and 2.0.

Edition: 01/2010

New features beginning with Version 3.0 of the operating software

In addition to the previous device types ASM1/1 … ASM1E/2, also supported are **two new device types** of version 3 (ASM2E/1 and ASM2E/2) of the AS-i safety monitor **with safe AS-i output**.

The following new features are included in version 3.0 of the operating software for the AS-i safety monitor:

- Support of safe AS-i transmission for **controlling safe AS-i actuators**
- **Coupling of multiple safe AS-i networks** through the function of the safety monitor as a safe input slave (only for new device types with safe AS-i output)
- Monitoring device **Double channel dependent with filtering**
- **Manual entry of the code sequences** for safe AS-i slaves
- Availability of the **standard out bit of the master for the safe slaves and the slaves simulated by the safety monitor** for operational switching tasks (acknowledgements, enabling, unlocking, etc.)

Output configuration

Device types **ASM2E/1** and **ASM2E/2**:two separately switchable output circuits

Features of device versions

			Function range "Enhanced"	
			Output circuit 1	**Output circuit 2**
Number of output circuits	**2**	**ASM2E/1**	Relay	Safe AS-i output
		ASM2E/2	Relay	Relay + safe AS-i output

Table 1.3: Features of device versions ASM2E/1 and ASM2E/2

Notice!
Device versions of operating software 3.0 are backwards compatible with device versions of operating software 1.1, 2.0 and 2.1.

Edition: 01/2010

New features beginning with operating software version 3.08 Muting

Beginning with Version 3.08 of the operating software for the AS-i safety monitor, the "double channel dependent with debouncing" monitoring device is replaced within the device by the "double channel dependent with filtering" monitoring device.

In addition to the previous device types — ASM1E/1 … ASM2E/2 with "Extended" function range — **4 new device types** of version 3 (ASM1E-m/1 … ASM2E-m/2) of the AS-i safety monitor **with Muting functionality** are also supported.

The following new features are included in version 3.08 of the operating software of the AS-i safety monitor with Muting functionality:

- Support of 2-sensor Parallel Muting
- Support of 4-sensor Sequential Muting
- Monitoring of multiple Muting ranges (e.g. entry-exit applications of palleting systems)
- The following adjustment options in Muting mode:
  - Monitorable time difference of the two Muting sensors (2-sensor Parallel Muting only)
  - Direction control of the transport material (4-sensor Sequential Muting only)
  - Forward only
  - Direction change outside and inside of the Muting range
  - Tight Muting sequence (for areas of the conveyor system with very limited space)
  - Premature end of Muting
  - Tolerated interruption time of the Muting sensor signal (signal filter)
  - Monitorable Muting timeout and interruption of the timeout by means of adjustable standard AS-i information
  - Selectable Muting enable by means of adjustable standard AS-i information

Features of device versions

			Function range "Extended with Muting"	
			Output circuit 1	Output circuit 2
Number of output circuits	1	ASM1E-m/1	Relay	–
		ASM2E-m/1	Relay	Safe AS-i output
	2	ASM1E-m/2	Relay	Relay
		ASM2E-m/2	Relay	Relay + safe AS-i output

Table 1.4: Features of device versions ASM1E-m/1 to ASM2E-m/2

Notice!
Device versions of operating software 3.08 with Muting are downward compatible with device versions of operating software 1.1, 2.0, 2.1 and 3.0.

Edition: 01/2010

2 Safety

Before using the Safety Monitor, a risk evaluation must be performed according to valid standards (e.g. ISO 14121, EN ISO 12100-1, ISO 13849-1, IEC 61508, EN 62061). The result of the risk assessment determines the required safety level of the Safety Monitor (see table in section 2.1.1). For mounting, operating and testing, document "AS-i Safety Monitor V 3.08 M" as well as all applicable national and international standards, regulations, rules and directives must be observed. Relevant and supplied documents must be observed, printed out and handed to the affected personnel.

Before working with the Safety Monitor, completely read and understand the documents applicable to your task.

In particular, the following national and international legal regulations apply for the start-up, technical inspections and work with safety sensors:

- Machinery directive 2006/42/EC
- Low voltage directive 2006/95/EC
- Electromagnetic compatibility directive 2004/108/EC
- Use of Work Equipment Directive 89/655/EEC supplemented by Directive 95/63 EC
- OSHA 1910 Subpart 0
- Safety regulations
- Accident-prevention regulations and safety rules
- Ordinance on Industrial Safety and Health and Labor Protection Act
- Device Safety Act

Notice!
For safety-related information you may also contact the local authorities (e.g., industrial inspectorate, employer's liability insurance association, labor inspectorate, occupational safety and health authority).

2.1 Approved purpose and foreseeable improper operation

Warning!
A running machine can cause severe injuries!
Make certain that, during all conversions, maintenance work and inspections, the system is securely shut down and protected against being restarted again.

2.1.1 Proper use

- The Safety Monitor must only be used after it has been selected in accordance with the respectively applicable instructions and relevant standards, rules and regulations regarding labor protection and occupational safety, and after it has been installed on the machine, connected, commissioned, and checked by a competent person.
- When selecting the Safety Monitor it must be ensured that its safety-related capability meets or exceeds the required performance level PLr ascertained in the risk assessment.

Edition: 01/2010

The following table shows the safety-related characteristic parameters of the AS-i Safety Monitor.

Type in accordance with IEC/EN 61496	Type 4
SIL in accordance with IEC 61508	SIL 3
PFD[1)] in accordance with IEC 61508, EN 62061 for ASM1/1, ASM1/2, ASM1E/1, ASM1E/2, ASM1E-m/1, ASM1E-m/2	$6{,}1 \cdot 10^{-5}$
PFD[1)] in accordance with IEC 61508, EN 62061 for ASM2E/1, ASM2E/2, ASM2E-m/1, ASM2E-m/2	$7{,}2 \cdot 10^{-5}$
Mean probability of a failure to danger per hour (PFH_d[1)])	$9{,}1 \cdot 10^{-9}$
Performance Level (PL) in accordance with ISO 13849-1: 200	PL e
Category in accordance with ISO 13849-1: 2008	Cat. 4

[1)] The specified PFD and PFHD values refer to the maximum switch-on time of 12 months

- The Safety Monitor is used to monitor the mandatory E-STOP function for all non-hand-operated machines (Stop Category 0 or 1), the dynamic monitoring of the restart function and contactor monitoring.
- Settings and changes of the device configuration via PC and asimon configuration software must only be performed by an authorized safety officer.
- The password for changing a device configuration is to be held under lock and key by the safety officer.
- The Safety Monitor is used in combination with one or more Multiple Light Beam Safety Devices or Safety Light Curtains to safeguard danger areas or points of operation.
- The control of the machine or system that is to be safeguarded must be electrically influenceable. A switch-off command initiated by a Safety Monitor must result in an immediate shutdown of the dangerous movement.
- The "Reset" acknowledgment button for unlocking the start/restart interlock must be mounted in such a way that the entire danger zone can be seen from its mounting location.
- Message outputs (state outputs) must not be used for switching safety-relevant signals.
- The Safety Monitor is designed for installation in a cabinet or a protective housing with a protection rating of at least IP 54.
- Depending on external wiring, dangerous voltages may be present at the switching outputs. In addition to the power supply, these must be switched off and safeguarded against being switched back on prior to all work on the Safety Monitor.
- These operating instructions must be included with the documentation of the machine on which the protective device is installed so that they are available to the operator at all times.
- In the event of changes to the Safety Monitor, all warranty claims against the manufacturer of the Safety Monitor are rendered void.
- The Safety Monitor must be tested regularly by competent personnel.

Edition: 01/2010

- The safety distance between the AOPD and the point of operation is to be maintained. It is calculated according to the formulas for machine-specific C standards or given in the general B1 standard ISO 13855. Both the reaction time of the AS-i Safety Monitor and the braking time of the machine must be taken into account.
- Two switching contacts must always be looped into the switch-off circuit of the machine. To prevent welding, relay switching contacts must be fused/protected externally according to the technical data.
- The Safety Monitor must be exchanged after a maximum of 20 years. Repairs or the exchange of parts subject to wear and tear do not extend the service life.
- The Safety Monitor satisfies the requirements of safety category 4 acc. to ISO 13849-1. If, however, an AOPD of a lower safety category is connected, the total category for the given path of the control cannot be higher than that of the connected AOPD.
- The safety sensor must be disposed of properly. Observe the local regulations regarding disposal of the product.

2.1.2 Foreseeable misuse

Any use other than that defined under the "intended use" or which goes beyond that use is considered improper use!

e.g.

- applications in explosive or easily flammable atmospheres
- use on machines with long periods of downtime

Warning!
Such instances can jeopardize the health and lives of the personnel operating the machinery and/or may cause damage to property.

2.2 Competent personnel

Prerequisites for competent personnel:

- has a suitable technical education
- he knows the rules and regulations for occupational safety, safety at work and safety technology and can assess the safety of the machine
- he knows the instructions for the Safety Monitor and the machine
- has been instructed by the responsible person on the mounting and operation of the machine and of the Safety Monitor

Edition: 01/2010

2.3 Responsibility for safety

Manufacturer and operating company must ensure that the machine and implemented Safety Monitor function properly and that all affected persons are adequately informed and trained.

The type and content of all imparted information must not lead to unsafe actions by users.

The manufacturer of the machine is responsible for:

- safe machine construction
- safe implementation of the Safety Monitor
- imparting all relevant information to the operating company
- adhering to all regulations and directives for the safe starting-up of the machine
- The operator of the machine is responsible for:
- instructing the operating personnel
- maintaining the safe operation of the machine
- adhering to all regulations and directives for occupational safety and safety at work
- regular testing by competent personnel

2.4 Exemption of liability

Leuze electronic GmbH + Co. KG is not liable in the following cases:

- Safety Monitor is not used as intended
- safety notices are not adhered to
- reasonably foreseeable misuse is not taken into account
- mounting and electrical connection are not properly performed
- proper function is not tested
- changes (e.g., constructional) are made to the Safety Monitor

2.4.1 Residual risks (EN ISO 12100-1)

The wiring suggestions shown in this manual have been tested with utmost care. The relevant standards and regulations are adhered to if the shown components and appropriate wiring are used. Residual risks remain if:

- the suggested wiring concept is not adhered to and, as a result, the connected safety-relevant components or protective devices are not or are inadequately integrated into the safety circuit.
- relevant safety regulations specified for the operation, adjustment and maintenance of the machine are not adhered to by the operator. Here, the inspection and maintenance intervals for the machine should be strictly adhered to.

Edition: 01/2010

2.4.2 Areas of application

Examples for the use of the AS-i safety monitor:

The safety monitor is used commercially in machines and systems in which the standard AS-i bus functions as the local bus. Thus, by using the safety monitor as a bus subscriber, existing AS-i bus configurations can be expanded easily and safety elements with corresponding "AS-i safety at work" interface easily integrated. If a safety component does not have an "AS-i safety at work" interface, a so-called coupling module can be used to make the connection. Existing AS-i master and AS-i power supply units can continue to be used.

There are no branch-specific restrictions. Several of the primary areas of application are listed here:

- Machine tools
- Expanded machining machines with multiple control elements and safety sensors for wood and metal applications
- Printing and paper processing machines, cutting machines
- Packaging machines, single and as part of a system
- Food processing equipment
- Piece and bulk material transport systems
- Machinery in the rubber and plastics industry
- Assembly machines and manipulators

2.5 Additional safety notices for the "Muting" special function

- Muting is the suppression of the safety function of an AOPD in accordance with the intended application in order to, for example, allow material flow through the protective field without generating a switching signal. E-STOP command devices must not be muted.
- This AOPD's protective function is disabled while the Muting function is active! Other measures must therefore be taken to ensure that either no access/entry to the point of operation is possible, e.g. because the material transport prevents access to the point of operation, or the danger must not exist during Muting, e.g. during the return movement of a tool.
- The Muting sensors must be arranged in such a way that manipulation with simple means is not possible. They can be mounted as optical sensors, in which case they must, for example, be high enough or far enough apart that they cannot be covered or cannot be simultaneously covered by the operating personnel. For switches, concealed installation is recommended.

2.5.1 Safety Notices for Muting applications

Muting when using optoelectronic protective sensors (AOPD)

Vertically mounted optoelectronic protective sensors, such as Safety Light Curtains or Multiple Light Beam Safety Devices, are used primarily as access guards for danger zones. By means of additional sensor signals, the protective field effect can be suppressed for a limited time (Muting), e.g. during material transport in or out of the danger zone. The monitoring of Muting sensors and protective sensor is performed here by the AS-i Safety Monitor with Muting function range.

Safety Light Curtains with 14 mm resolution detect a finger, hand, arm or body; those with 30 mm resolution detect a hand, arm or body of a person who has entered the danger zone and can, thus, be mounted closer to the danger zone than Safety Light Curtains with 50 mm or 90 mm resolution or Mul-

Edition: 01/2010

tiple Light Beam Safety Devices or so-called Transceivers (transmitter-receiver systems in a device column integrated with Passive Deflecting Mirrors) that, due to their larger beam spacing, only detect the body of a person. Applicable for all version types is the fact that they only detect people during entry, not their presence in the danger zone! Upon interruption of a light beam or multiple light beams by a person, the control must, therefore, reliably lock.

For access guarding, the start-up/restart interlock function is, therefore, mandatory! Here, the start-/restart button for unlocking the start-up/restart interlock or Muting restart function must be located outside of the danger zone in such a way that it cannot be accessed from within the danger zone and so that the entire danger zone can be seen from its mounting location.

Before unlocking the start-up/restart interlock or the Muting restart, the operating person must have assured himself that no one is located within the danger zone.

The Muting sensors must be selected and arranged in such a way that they cannot be simultaneously and unintentionally activated by a single person.

Muting must only be activated temporarily and only as long as the access to the danger zone is blocked by the transport material. If the distance between transmitter and receiver or Transceiver and Passive Deflecting Mirror is greater than the width of the transport material, thereby enabling a person to enter the danger zone alongside the transport material during Muting, measures must be taken to detect entry and bring the dangerous movement to a standstill. PS mats or swing doors monitored with safety switches have been tried, tested and proven here. Such measures prevent injuries caused, for example, by crushing in the access area.

Muting must be automatic; it may not, however, be dependent on a single sensor signal, nor may it be fully dependent on software signals. Alternatively, a combination of sensor signal and independent software signal can be used.

The Muting function must be released immediately after the transport material has passed through, so that anybody passing through behind the transport material will be detected by the protective device.

Acc. to IEC 62046, the bridging of a Muting safety sensor (AOPD) may only be activated shortly before entry of the object that is to be muted and must again be deactivated shortly after passage of the object. The resulting gap (acc. to IEC 62046 max. 200 mm is permissible) must not allow a person to pass through the muted safety system in front of or behind the transport material.

If a signal that is triggered by a PLC is used as the Muting signal (instead of a second, installed Muting sensor), the following conditions then apply:

1. The PLC Muting signal must not be triggered by a person and
2. The PLC Muting signal must be reset before the transport material completes its passage.

The distance d5 measured between the optical axis of the ESPE and the intersection point of the two light beams of the bridging sensors should be as small as practical in order to prevent the undetected entry of persons into the danger area by following directly behind the pallet or transport system. A distance d5 = 200 mm is recommended.

The bridging sensors should be installed close enough to the ESPE that a person who tries to enter the danger area directly ahead of or behind the pallet or transport system (<200 mm) will be detected.

Edition: 01/2010

Muting via AS-i with optoelectronic protective sensors (AOPD)

Muting via AS-i must only be triggered upon activation of 2 independent Muting sensor signals or Muting sensor signals and Muting software signals if, depending on the safety category required for the machine or system acc. to ISO 13849-1, the integration of these Muting signals satisfies:

Integration of the Muting sensor signals via AS-i up to safety category 2 acc. to ISO 13849-1:

- **2-sensor Parallel Muting**

Both Muting sensor signals (MS1, MS2) can be integrated together via a standard AS-i input module (input slave) and transmitted for evaluation through the AS-i safety monitor via AS-i. Alternatively, one signal can be transmitted via a Muting sensor connected to a standard AS-i input module and a second independent software signal can be transmitted directly by the control via the AS-i master (AS-i master output bit).

- **4-sensor Sequential Muting**

The Muting sensor signals (MS1 … MS4) can be integrated together via a standard AS-i input module (input slave) and transmitted for evaluation through the AS-i safety monitor via AS-i. Alternatively, two signals (via MS2, MS3) can be transmitted via a standard AS-i input module and two independent software signals (MS1, MS4) can be transmitted directly by the control via the AS-i master (AS-i master output bits).

Integration of the Muting sensor signals via AS-i for safety categories 3 and 4 acc. to ISO 13849-1:

- **2-sensor Parallel Muting**

The Muting signals of the two required Muting sensors must be integrated by means of separate integration of the two Muting sensors via a standard AS-i input module for each and transmitted via AS-i for evaluation by the AS-i safety monitor. Alternatively, one Muting sensor signal can be transmitted via a standard AS-i input module and a second independent software signal can be transmitted directly by the control via the AS-i master (AS-i master output bit).

- **4-sensor Sequential Muting**

Each of the Muting sensor signals (MS1 … MS4) must be integrated by means of separate integration of two Muting sensors via a standard AS-i input module and transmitted via AS-i for evaluation by the AS-i safety monitor (MS1/MS3, MS2/MS4). Alternatively, two signals (MS2, MS3) can be transmitted via a standard AS-i input module and two independent software signals (MS1, MS4) can be transmitted directly by the control via the AS-i master (AS-i master output bits).

Edition: 01/2010

2.6 Organizational measures

Documentation

All entries in this operating manual must be heeded, in particular those in the sections "Safety Notices" and "Commissioning".

Keep this operating manual in a safe place. It should be accessible at all times.

Safety regulations

Observe the locally applicable legal regulations and the rules of the employer's liability insurance association.

Qualified personnel

Mounting, commissioning and maintenance of the device may only be carried out by qualified personnel.

Work on electrical installations may only be carried out by qualified electricians.

Settings and changes of the device configuration via PC and **asimon** configuration software must only be performed by an authorized safety officer.

The **password** for changing a device configuration is to be held under lock and key by the safety officer.

Repair

Repairs, in particular the opening of the housing, may only be carried out by the manufacturer or a person authorized by the manufacturer.

Disposal

Notice!

Electrical scrap is a special waste product! Observe the local regulations regarding disposal of the product.

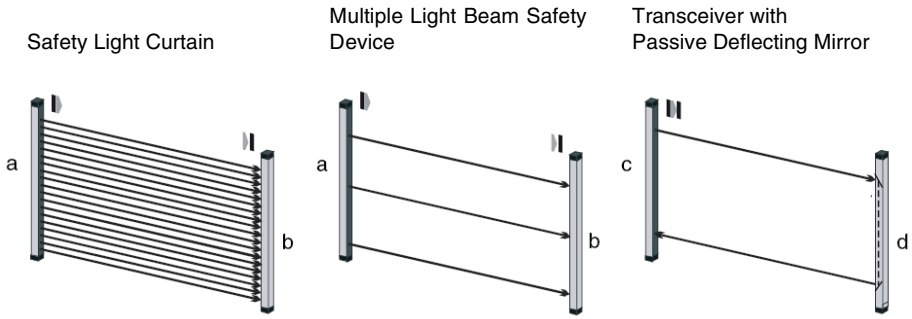
The AS-i safety monitor contains no batteries of any type which would need to be removed prior to disposal of the product.

Edition: 01/2010

3 Muting via AS-i

3.1 Optoelectronic Protective Devices for Muting applications

The protective device consists of a transmitter and a receiver or a transceiver with passive deflecting mirror. Beginning with the first beam (= synchronization beam) after the display field, the transmitter pulses beam for beam in rapid sequence. Synchronization between transmitter and receiver occurs optically.



a Transmitter
b Receiver
c Transceiver
d Passive Deflecting Mirror

Figure 3.1: Variants of the Optoelectronic Protective Device for Muting applications

The receiver/transceiver detects the specially shaped pulse packets of the transmitted beams and opens the corresponding receiving elements in sequence in the same rhythm. In this way, a protective field is created in the area between the transmitter and receiver. The height of the area is determined by the geometric dimensions of the optical protective device; its width is determined by the distance selected between transmitter and receiver within the permissible operating range.

Attention!
For the connection and start-up of Safety Light Curtains and Multiple Light Beam Safety Devices for Muting applications via AS-i, knowledge of the technical description of the used protective sensor (e.g. Safety Light Curtain or Light Beam Safety Device) is necessary in addition to knowledge of the Connecting and Operating Instructions for the AS-i safety monitor.

Edition: 01/2010

3.2 Usage examples

3.2.1 4-sensor Sequential Muting

4-sensor Sequential Muting with Multiple Light Beam Safety Device (up to safety category 2 acc. to ISO 13849-1).

Used components:

Muting safety monitoring unit

- AS-i safety monitor ASM1E-m/1 with one output circuit and extended function range with Muting

Protective sensor

- Multiple Light Beam Safety Device, 3-beam, for access guarding, with integrated AS-i for direct integration with the AS-i network.

Muting sensors MS1 … MS4

- 4 MS1 … MS4 induction loops embedded in the floor. The induction loops are integrated in the AS-i network via a standard AS-i 4E-input module.

Swing doors

- 2 swing doors monitored by protective switches. Integrated in the AS-i network via a safe AS-i input module, they prevent the crushing of people between the conveyor and the support columns.

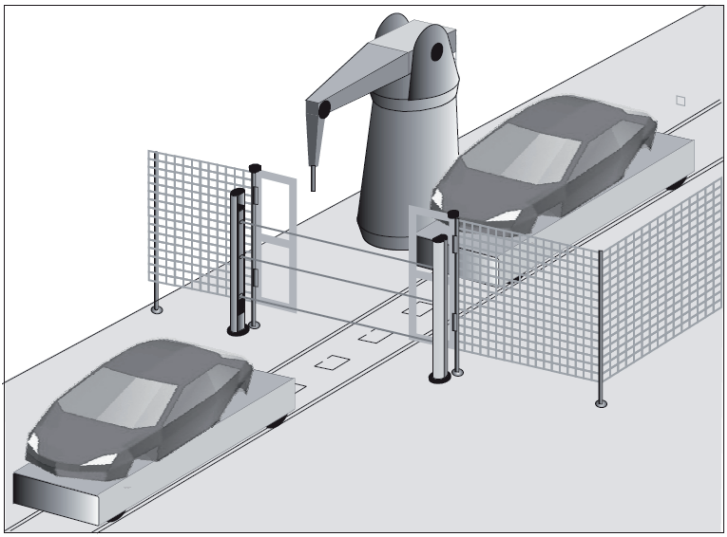


Figure 3.2: 4-sensor Sequential-Muting application at a robot station

Edition: 01/2010

3.2.2 2-sensor Parallel Muting

2-Sensor Parallel Muting with Transceiver system (up to safety category 4 acc. to ISO 13849-1)

Used components:

Muting safety monitoring unit

- AS-i safety monitor ASM1E-m/1 with one output circuit and extended function range with Muting;

Protective sensor

- Multiple Light Beam Safety Device, 2-beam, implemented as transceiver, for access guarding, with integrated AS-i.

Muting sensors MS1 and MS4

- AS-i retro-reflective photoelectric sensors as Muting sensors MS1 and MS2 with reflectors. As a result, the AS-i connections of the sensor system (safety and Muting sensor) are only necessary on one side. This connection technology saves costs in terms of material and time during start-up.

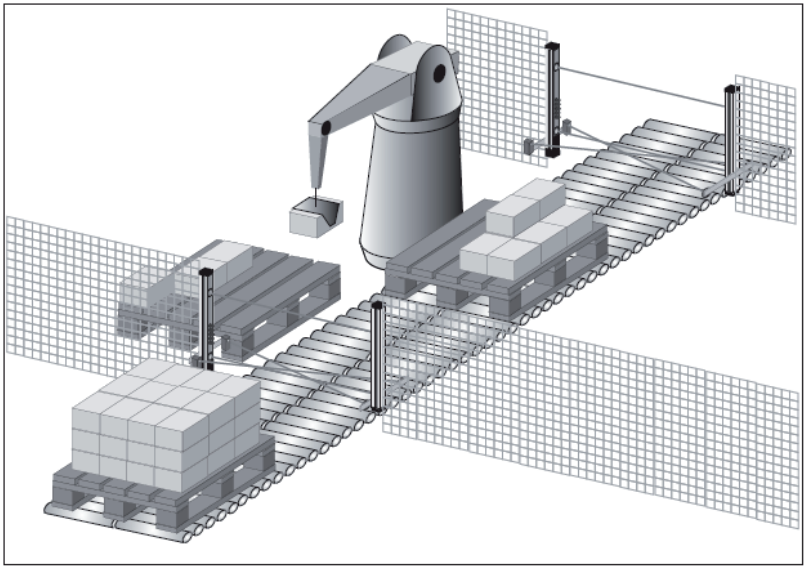


Figure 3.3: 2-sensor Parallel Muting application at a palletizer system

3.3 System design and Muting modes

3.3.1 System design

Edition: 01/2010

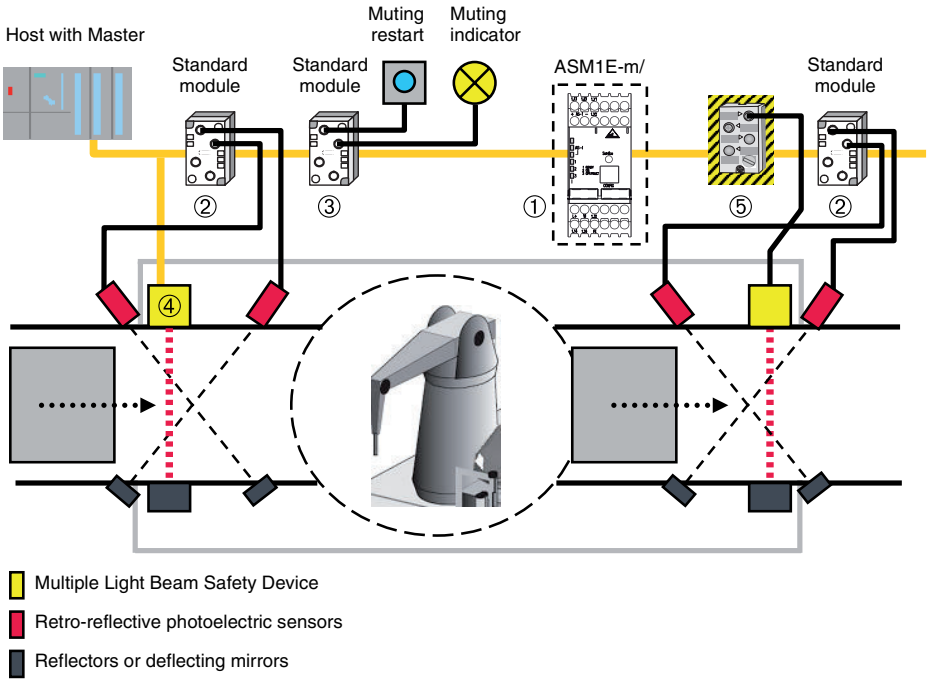


Figure 3.4: Principle system design for Muting via AS-i, 2-sensor Parallel Muting

Used system components:

- AS-i standard peripheral equipment (master device and AS-i power supply unit).
- AS-i safety monitor with Muting function range (①).
- Standard AS-i input modules for connecting the Muting sensors (e.g. retro-reflective photoelectric sensors) (②).
- Standard AS-i input module for connecting a button for the Muting start function (or for override mode) (③) or
- Safe AS-i input module for connecting a key switch for the safe Muting start function.
- Standard AS-i output module for connecting a Muting indicator for signaling the running Muting process.
- Multiple Light Beam Safety Device (e.g. 2-beam for body detection) with integrated AS-i i (④) for direct connection to AS-i or for connecting the sensor via a safe AS-i input module (⑤).

Muting modes

Via the **asimon** configuration software, the Muting type is selected and the available Muting parameters set.

Edition: 01/2010

2-sensor Parallel Muting	Adjustable
4-sensor Sequential Muting	One direction
	Direction change within muting range
	Direction change outside of muting range
	Tight Muting sequence (at least 1 sensor between 2 muting objects must be free)
Muting timeout	With permitted interruption
	Without interruption
Muting Enable	Not used
	Dynamic
End of Muting	Premature end of Muting determined by protective sensor (AOPD)
	Muting end determined by the Muting sensor
Extension of the Muting time	Adjustable

Notice!
*Details on the Muting parameters can be found in the User's Guide for the **asimon** configuration and diagnostics software.*

Muting sensors

Muting is initiated by the Muting sensor signals. Examples of Muting sensors that may be used include:

- Light Beam Devices (transmitter/receiver or retro-reflective photoelectric sensors) whose beam paths intersect behind the protective field within the danger zone.
- Light scanners that scan along the side of the transport material.
- Light Beam Device(s) and an acknowledgment signal from the conveyor drive or a PLC signal, provided both signals are activated within the simultaneity or sequence conditions set with **asimon**.
- Switching signals from induction loops that are activated e.g. by a high-lift truck.

Notice!
Please note that, depending on the degree of expansion of the network, the filter time in the AS-i safety monitor may be as large as 25ms (full expansion of the network) for standard AS-i signal inputs and AS-i masterbit signals (AS-i signal outputs). Thus, this also applies for Muting sensor signals whose brief signal lapses ≤ 25ms are not relevant for Muting processing in the AS-i safety monitor (for full expansion).

Edition: 01/2010

Attention!
In any case, the Muting sensors must be arranged in such a way that a person cannot be in a position to activate the Muting function through simple manipulation.

3.3.2 4-sensor Sequential Muting

4-sensor Sequential Muting requires the connection of 4 Muting sensors and their activation in a specified sequence. It is used primarily if the transport material or the transport equipment always has the same dimensions and there is sufficient space for entry and exit. Sequential Muting is initiated after activation of the second Muting sensor both in the **MS1 –> MS2 –> MS3 –> MS4** sequence as well as in the **MS4 –> MS3 –> MS2 –> MS1** sequence (in setting: **Direction change outside of Muting range**).

Brief lapses in Muting sensor signals with a duration of 0 … 2 s are permissible. The permitted sensor-signal interruption time can be set via **asimon**.

Attention!
Depending on the speed of the conveyor, the sum of the set sensor signal interruption time and the set Muting extension time must not be greater than the Muting process time required by the object upon exit from the Muting range.

Notice!
The advantage of Sequential Muting over Parallel Muting is that only the order of sensor activation/deactivation is detected. The time difference between the sensor signals plays no role here.

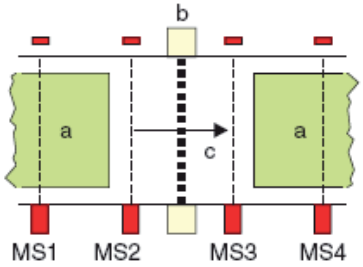
Notice!
To apply the Muting from the input area to the output area of the Muting path, all 4 sensors must be briefly activated simultaneously. The transport material that is to be "muted" must, thus, be sufficiently long.

4-sensor Sequential Muting is ended correctly, i.e. the output switching elements of the AS-i safety monitor (OSSDs) remain in the ON state during passage if, during the expected sequence, the third activated Muting sensor becomes free and, as a result, switches to inactive for a period of time exceeding the sensor interruption time permitted by the configuration.

Edition: 01/2010

4-sensor Sequential Muting is ended incorrectly, i.e. the output switching elements (OSSDs) of the AS-i safety monitor switch off, if

- a Muting sensor switches incorrectly during the Muting process.
- the length of the object is shorter than the distance between Muting sensor 1 and Muting sensor 4.
- the movement direction changes within the Muting path, unless setting **Direction change within Muting range** is selected in the configuration.
- during Muting, a second object enters the Muting path, unless the setting **Tight Muting sequence** is selected in the configuration.
- the set Muting time limit (Muting timeout) has elapsed.



a Muting object
b Protected field
c Danger area

Figure 3.5: System arrangement for 4-sensor Sequential Muting

Edition: 01/2010

Time diagram

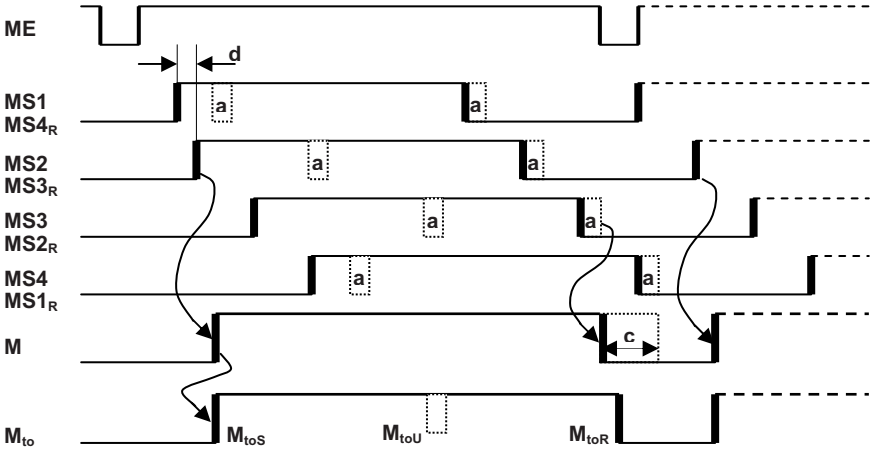


Figure 3.6: Time diagram: 4-sensor Sequential Muting

ME Muting **Enable dynamic**.
One signal interruption caused by the Muting function block is expected during each Muting cycle.

MS# Muting sensor no. #, forward travel

MS#$_R$ Muting sensor no. #, backward travel

M Muting.
Muting is active if the correct sequence MS1 –> MS2 –> MS3 –> MS4 or $MS4_R$ –> $MS3_R$ –> $MS2_R$ –> $MS1_R$ is maintained and at least 2 Muting sensors are active simultaneously.

a Suppression of brief signal interruptions of the Muting sensors (**Tolerated interruption time**; configurable)

c Muting time extension (**Extension time**; configurable).
Muting ends after MS3 or $MS2_R$ is inactive for longer than the permitted signal interruption time and the Muting extension time **c** has elapsed.

d The time difference between the activation of 2 Muting sensors must be at least 2 AS-i cycles.

M_{toS} Start Muting timeout (Muting time limiting).
The Muting timeout control monitors for the adherence of the time required for a Muting event (**Monitoring time** Muting cycle; configurable).

M_{toR} Reset the Muting-timeout monitoring time

M_{toU} Muting-timeout interruption.
By means of a PLC signal (AS-i masterbit; configurable), the timeout monitoring time can be interrupted and reactivated upon removal of the PLC signal.

Edition: 01/2010

3.3.3 2-sensor Parallel Muting

2-sensor Parallel Muting requires the connection of 2 Muting sensors and the activation of each within a specified period of time. If both Muting sensors, MS1 and MS2, are switched within 2.5s (factory setting, time can be adjusted via **asimon**), 2-sensor Parallel Muting is initiated.

This type of Muting is frequently used if the dimensions of the transport material are not constant in the transport direction and/or there is insufficient space in front of the protective device.

Attention!
It is important that the intersection point of the two Muting sensor light beams lies behind the optical protective device, i.e. within the danger zone!

Notice!
Due to sensor signal testing by the AS-i safety monitor, exact simultaneity (time difference ≤ 15ms) of the two Muting sensor signals must be avoided.

Advantages of 2-sensor Parallel Muting are:

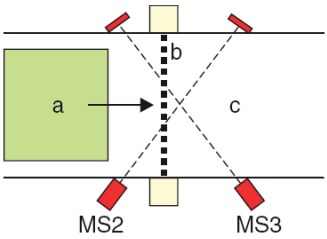
- low expense, as only 2 Muting sensors are required.
- the possibility to move forward and backward within the Muting path.

Once Muting has been initiated, one of the two sensor signals may be briefly interrupted for a period of time not exceeding 100ms (factory setting). 2-sensor Parallel Muting is ended correctly if one of the Muting sensor signals becomes inactive after the protective sensor becomes free.

The output switching elements (OSSDs) of the AS-i safety monitor remain in the ON state during Muting, i.e. as the transport material passes through.

2-sensor Parallel Muting is ended incorrectly, i.e. the output switching elements (OSSDs) of the AS-i safety monitor switch OFF, if

- a Muting signal is inactive during the passage of the transport material for a period of time exceeding 100ms (factory setting).
- the Muting-timeout monitoring time has elapsed.



a Muting object
b Protected field
c Danger area

Figure 3.7: System arrangement for 2-sensor Parallel Muting

Edition: 01/2010

Time diagram

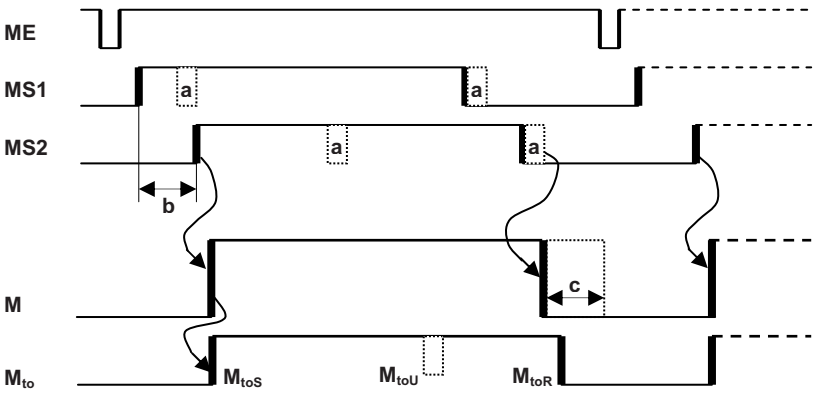


Figure 3.8: Time diagram: 2-sensor Parallel Muting

ME Muting **Enable dynamic**.
One signal interruption caused by the Muting function block is expected during each Muting cycle.

MS# Muting sensor no. #

M Muting.
Muting is active if both Muting sensors, MS1 and MS2, are activated within time period **b** and remain active during the entire Muting cycle.

a Suppression of brief signal interruptions of the Muting sensors
(**Tolerated interruption time**; configurable)

b Muting-sensor simultaneity monitoring.
Configurable time period within which both Muting sensors, MS1 and MS2, must be activated in order to initiate Muting.

c Muting time extension (**Extension time**; configurable).
Muting ends when at least one Muting sensor is inactive for longer than the permissible signal interruption time and the Muting extension time **c** has elapsed.

M_{toS} Start Muting timeout (Muting time limiting).
The Muting timeout control monitors the adherence of the time required for a Muting event (**Monitoring time** Muting cycle; configurable).

M_{toR} Reset of the Muting-timeout monitoring time

M_{toU} Muting-timeout interruption.
By means of a PLC signal (AS-i masterbit; configurable), the timeout monitoring time can be interrupted and reactivated upon removal of the PLC signal.

Edition: 01/2010

3.3.4 Muting time limit – Muting timeout

If the Muting function is activated for longer than 150 s (factory setting), this is detected as a Muting error and is ended by the AS-i safety monitor independent of the selected Muting mode.

A new Muting event is not started until a valid Muting sequence is initiated. The Muting time limit is mandatory. During machine pause times, the Muting time limit can be paused (setting **Timeout interruption** via **asimon**) in order to prevent the AS-i safety monitor from switching to the Muting error state after the Muting time limit elapses and allow the system to be restarted normally.

Attention!
The user accepts responsibility for switching off Muting time monitoring!

Notice!
Muting time monitoring can only be paused while Muting is active (dynamic signal).

3.3.5 Muting restart - Override mode

Operating conditions may require a valid Muting sequence to be interrupted, resulting in the Muting event being terminated by the AS-i safety monitor. To prevent the object (transport material) from being manually removed from the Muting path, the Muting function range of the AS-i safety monitor offers an integrated override mode that allows the transport material to be moved out of the Muting path. Such interruptions occur e.g.

- in the event of failure of the supply voltage while a permissible object passes through the Muting path. Upon return of the supply voltage, the Muting event does not continue automatically, since the expected Muting sequence is not supplied by the already activated Muting sensors.
- if, prior to activation of the second Muting sensor required for Muting due to unfavorable loading of the pallet to be transported, the protective field has already been violated and Muting cannot, thus, become active.

In override mode, the output switching elements (OSSDs) of the AS-i safety monitor are switched on for the set Muting-end extension time or for the tolerated Muting sensor interruption time or if at least one Muting sensor is activated.

Override mode is activated if the Muting-restart button is actuated twice in inching mode. In this case, the start button must be pressed for min. 200 ms and max. 2 s. Between the two actuations, a pause of min. 200 ms and max. 2.5 s must be allowed to pass.

Upon the second release of the Muting restart button, the AS-i safety monitor checks the Muting sensors for a valid assignment. If a valid Muting combination is found to exist (e.g. during 4-sensor Sequential Muting: MS3 follows MS2), the output switching elements (OSSDs) remain in the ON state; the system resumes normal operation;

If, on the other hand, an invalid Muting combination is ascertained when the protective sensor is bridged, the output switching elements (OSSDs) of the AS-i safety monitor remain enabled only as long as the button is pressed. If it is released, the system stops again. This occurs, for example, with misadjusted, soiled or damaged Muting sensors or with improperly loaded pallets.

Edition: 01/2010

Attention!
Override must only be performed if the entire danger zone can be viewed. The error must be examined by a competent person.

Notice!
After the Muting sequence is ended three times in a row by overriding the object with the Muting restart button, it is not possible to override the object again. The error must be corrected! The error state can only be reset by switching off the AS-i safety monitor or by actuating the SERVICE button.

Attention!
It must be ensured that the entire danger zone can be viewed from the mounting location of the Muting restart button.

Notice!
To start the system with free protective sensor, the Muting restart button must be actuated once.

Edition: 01/2010

3.3.6 Muting status

Acc. to IEC EN 61496-1 and IEC 62046, the Muting process must be displayed. This can occur

- through transmission of a Muting status signal to the PLC for further user-specific evaluation or
- through direct display via a connected indicator.

Notice!
It is recommended that a highly visible Muting indicator be installed directly on-site near the Muting application.

This can be used to signal the two following pieces of information to the operating personnel:

- When constantly illuminated, the indicator signals that Muting has been correctly initiated and the protective function is bridged at the AS-i safety monitor during the Muting time.
- When flashing, the indicator signals that a Muting error has occurred (e.g. the Muting time limit has been exceeded)

Controlling an indicator for signaling the Muting status via AS-i

The indicator can be integrated directly into the AS-i network via a standard AS-i input slave or via an integrated AS-i i and cyclically controlled by the PLC and AS-i master call. The Muting diagnostic information for the PLC is transmitted cyclically by the AS-i safety monitor via the AS-i master.

Notice!
*Detailed information on evaluating the **diagnostic data** made available by the AS-i safety monitor via AS-i with extension for the Muting function range can be found in chapter 13.*

Edition: 01/2010

3.4 Mounting the Muting system components

In this chapter you will find important information on mounting the system components necessary for the Muting function range of the AS-i safety monitor (consisting primarily of Muting sensors and Safety Light Curtains or Multiple Light Beam Safety Devices) and whose protective function is only ensured if the following installation guidelines are adhered to.

These installation specifications are based on the respective applicable versions of European standards, such as EN 999, ISO 13855 and EN ISO 13857.

Attention!
When used in countries outside of Europe, the guidelines applicable in the respective country are to be observed as well.

Minimum distances and positions of the components

Optical protective devices can only fulfill their protective function if they are mounted with sufficient safety distance.

The calculation formulas for the safety distances are dependent on the type of safeguarding. In harmonized European standard EN 999, "The positioning of protective equipment in respect of approach speeds of parts of the human body", installation situations and calculation formulas for the safety distance for the aforementioned types of safeguarding are described.

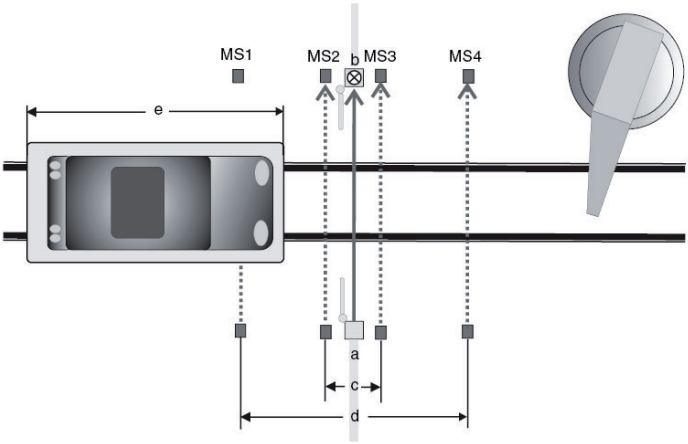
The formulas for the necessary distance to reflecting surfaces are based on European standard prEN EC 61496-2 for "Active opto-electronic protective devices" (AOPD).

Attention!
Safety notice! For the selection of the components and the calculation of the safety distances for Safety Light Curtains or Multiple Light Beam Safety Devices, knowledge of the technical description is necessary.

Attention!
The following applies for all Muting types: it must not be possible to simultaneously activate two Muting sensors, e.g. with a shoe (see figure 3.10)!

Edition: 01/2010

Sensor positions for 4-sensor Sequential Muting



a Transmitter

b Receiver

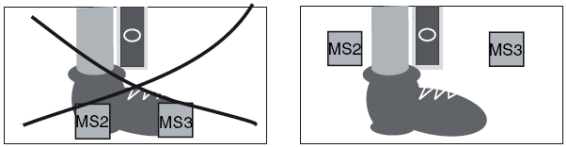
c Distance between MS2 and MS3 symmetric to the protective field. **Attention!** It must not be possible to simultaneously trigger MS2 and MS3, e.g with a shoe (figure 3.10)

d Distance between MS1 and MS4 symmetric to the protective field: as large as possible, but smaller than **e** to ensure that all sensors are occupied before the first sensor that was activated is again released.

e Constant length of transport vehicle

Figure 3.9: Arrangement of the Muting sensors, 4-sensor Sequential Muting

The example shows four dark-switching throughbeam photoelectric sensors as Muting sensors whose receivers switch active high when occupied, this means that they supply +24V to the assigned Muting inputs of the standard AS-i input slave. Inductive buttons or switches can also be used. If there is a risk of crushing between the transport vehicle and the protective device, it is recommend that swing doors, for example, with a width of approx. 500mm and monitored by circuit breaker, be integrated as standard equipment in the release circuit of the AS-i safety monitor independent of the Muting functional device.

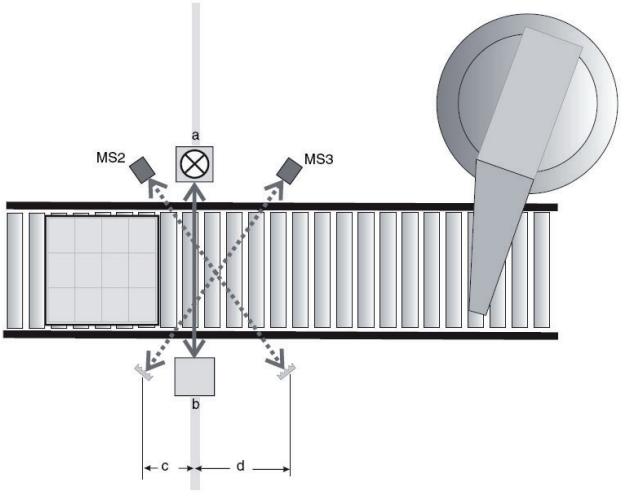


Attention!
The following applies for all Muting types: it must not be possible to simultaneously activate two Muting sensors, e.g. with a shoe!

Figure 3.10: Arrangement of Muting sensors MS2 and MS3

Edition: 01/2010

Sensor positions for 2-sensor Parallel Muting



a Transceiver

b Passive Deflecting Mirror

d>c Asymmetric arrangement, so that the intersection point of the beam path of Muting sensors MS2 and MS3 lies within the danger zone.

Figure 3.11:Arrangement of the Muting sensors, 2-sensor Parallel Muting

By positioning the beam-path intersection point of the Muting sensors within the danger zone, a person entering the area would first interrupt the protective field and then simultaneously interrupt both light beams of the Muting sensors.

In the example above, two dark-switching retro-reflective photoelectric sensors send +24V to the assigned Muting inputs of the standard AS-i input slave upon interruption.

Attention!
The following applies for all Muting types: it must not be possible to simultaneously activate two Muting sensors, e.g. with a shoe (see figure 3.10)!

Notice!
If possible at the installation site, MS2 and MS3 should be mounted at different heights in such a way that the intersection of the beam paths is not point-shaped.

Edition: 01/2010

4 Specifications

4.1 General technical data

Electrical data

Operating voltage U_b	24V DC +/- 15%	
Residual ripple	< 15%	
Rated operating current	ASM1/1, ASM1E/1 and ASM1E-m/1:	150mA
	ASM1/2, ASM1E/2, ASM2E/1, ASM2E-m/1 and ASM1E-m/2:	200mA
	ASM2E/2 and ASM2E-m/2:	250mA
Peak switch-on current [1]	All types: 600mA	
Reaction time [2] (safety-relevant)	< 40ms	
Delay before start-up	< 10s	

1) Simultaneous switch-on of all relays; the current for the message outputs is not taken into consideration
2) Attention! Please observe the notices for calculating the reaction times in chapter 4.2.

AS-i data

AS-i profile	Monitor 7.F
AS-i voltage range	18.5 … 31.6V
AS-i current consumption	< 45mA
Number of devices per AS-i branch	In a fully configured AS-i network with 31 used standard addresses, it is possible to additionally install a maximum of four safety monitors without address. If fewer than 31 standard addresses are used, an additional monitor can be installed for each standard address that is not used. If additional subscribers are installed without address (e.g. earth-fault monitoring modules), the number of installable safety monitors is reduced accordingly. If repeaters are used, this applies for each segment.

Mechanical data

Dimensions (WxHxD)	45mm x 105mm x 120mm	
Housing material	Polyamide PA 66	
Weight	ASM1/1, ASM1E/1 and ASM1E-m/1:	approx. 350g
	ASM2E/1 and ASM2E-m/1:	approx. 420g
	ASM1/2, ASM1E/2, ASM2E/2, ASM1E-m/2 and ASM2E-m/2:	approx. 450g
Mounting	Snap-on mounting on top-hat rail acc. to EN 50022	
Connection		

 Ø 5 ... 6 mm / PZ2	0,8 ... 1,2 Nm 7 ... 10.3 LB.IN
	1 x (0,5 ... 4,0) mm² 2 x (0,5 ... 2,5) mm²
	1 x (0,5 ... 2,5) mm² 2 x (0,5 ... 1,5) mm²
AWG	2 x 20 ... 14

Edition: 01/2010

Configuration i

RS 232	9600 baud, no parity, 1 start bit, 1 stop bit, 8 data bits

Inputs and outputs

"Start" input	Optical coupling input (high active), input current approx. 10 mA at 24 V DC
"External device monitoring circuit" input	Optical coupling input (high active), input current approx. 10 mA at 24 V DC
Message output "safety on" [1]	PNP transistor output, 200 mA, short-circuit and polarity-reversal protection
Safety output	Potential-free make contact, max. contact load: 1 A DC-13 at 24 V DC 3 A AC-15 at 230 V AC
Continuous thermal current (max.)	<u>ASM1/1, ASM1E/1, ASM2E/1, ASM1E-m/1 and ASM2E-m/1:</u> max. total current for all output switching elements: 6 A i.e. output circuit 1: 3 A per output switching element <u>ASM1/2, ASM1E/2, ASM2E/2, ASM1E-m/2 and ASM2E-m/2:</u> max. total current for all output switching elements: 8 A i.e. output circuit 1: 3 A per output switching element output circuit 2: 1 A per output switching element or output circuit 1: 2 A per output switching element output circuit 2: 2 A per output switching element
B10 value with ohmic load acc. to EN 61810-2	At max. contact load: $2 \cdot 10^5$ At $^1/_4$ max. contact load: $4 \cdot 10^5$ At $^1/_{10}$ max. contact load: $2.5 \cdot 10^6$
Safeguarding	External with max. 4 A slow blow
Overvoltage category	3, for rated operating voltage 300 V AC acc. to VDE 0110 part 1

1) The "Safety on" message output is not relevant to safety!

Environmental data

Operating temperature	-20 … +60 °C
Storage temperature	-30 … +70 °C
Protection class	IP 20 (only suitable for use in electrical operating rooms / switching cabinets with minimum protection class IP 54)

Attention!

The AS-i power supply unit for supplying the AS-i components must demonstrate safe mains separation acc. to IEC 60742 (PELV) and the ability to bridge short-term mains failures of up to 20 ms.

The power supply unit for 24 V supply must also demonstrate safe mains separation acc. to IEC 60742 (PELV) and the ability to bridge short-term mains failures of up to 20 ms.

Edition: 01/2010

Notice!

The safety monitor has been tested for interference-free operation acc. to EN 61000-4-2 with 8kV air discharging. The air discharging value of 15 kV stipulated by EN 61496-1 is not relevant for the safety monitor as the safety monitor is installed in a system which is contained either in a protective housing or a switching cab

inet and the monitor can be accessed only by trained personnel. Nevertheless, we recommend that before the user inserts the configuration cable into the safety monitor he perform a discharge (earthing) at a suitable location.

4.2 Safety-relevant characteristic data

Characteristic data, standard	**Value**
Type in accordance with IEC/EN 61496	Type 4
SIL in accordance with IEC 61508	SIL 3
Maximum switch-on time in months in accordance with IEC 61508	12
PFD[1)] in accordance with IEC 61508, EN 62061 for ASM1/1, ASM1/2, ASM1E/1, ASM1E/2, ASM1E-m/1, ASM1E-m/2	$6{,}1 \cdot 10^{-5}$
PFD[1] in accordance with IEC 61508, EN 62061 for ASM2E/1, ASM2E/2, ASM2E-m/1, ASM2E-m/2	$7{,}2 \cdot 10^{-5}$
Mean probability of a failure to danger per hour (PFH_d [1)])	$9{,}1 \cdot 10^{-9}$
Max. system reaction time [2)] in milliseconds	40
Performance Level (PL) in accordance with ISO 13849-1: 2008	PL e
Category in accordance with ISO 13849-1: 2008	Cat. 4

1) The specified PFD and PFHD values refer to the maximum switch-on time of 12 months

2) Regarding the system reaction time:

Attention!
In addition to the system reaction time of max. 40?ms, the reaction times of the safe AS-i sensor slave, of the sensor being used for monitoring, of the safe AS-i actuator slave and of the actuator used for this purpose must still be added. Please note that additional reaction times may likewise arise through the configuration of the safety monitor.

Table 4.1: Safety-relevant characteristic data

Notice!

Refer to the technical data for the slaves as well as to that for the sensors and actuators for the reaction times to be added.

Edition: 01/2010

Attention!
The system reaction times of the daisy-chained AS-i components are added up.

System reaction times – example calculations

System components:

ASI1	AS-i network 1	
ASI2	AS-i network 2	
S1-1	Safe sensor slave	(EMERGENCY-OFF switch: $t_{R\ S1-1}$ = 100ms)
S1-2	Safe sensor slave	(safety light barrier: $t_{R\ S1-2}$ = 18ms)
S2-1	Safe sensor slave	(EMERGENCY-OFF switch: $t_{R\ S2-1}$ = 100ms)
A2-1	Safe actuator slave	(motor starter: $t_{R\ A2-1}$ = 50ms)
SM1-1	Safety monitor ASM2E/1 with one relay output and one safe AS-i output in AS-i network 1	
SM1-2	Safety monitor ASM1/1 with one relay output in AS-i network 1	
SM2-1	Safety monitor ASM2E/1 with one relay output and one safe AS-i output in AS-i network 2	

System configuration - example 1:

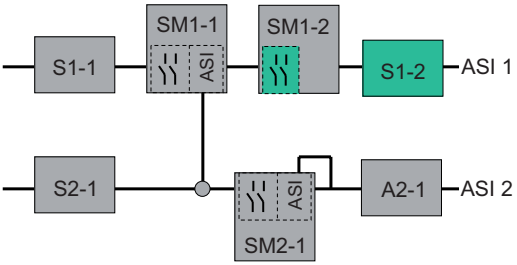


Figure 4.1: Example 1 - Calculation of the system reaction time

Upon activation of safety light barrier S1-2, the relay safety output of safety monitor SM1-2 is controlled.

Calculation of the AS-i-relevant system reaction time:

$$t_{System\ total\ a)} = t_{R\ S1-2} + t_{R\ system} = 18ms + 40ms = \underline{58ms}$$

Edition: 01/2010

System configuration - example 2:

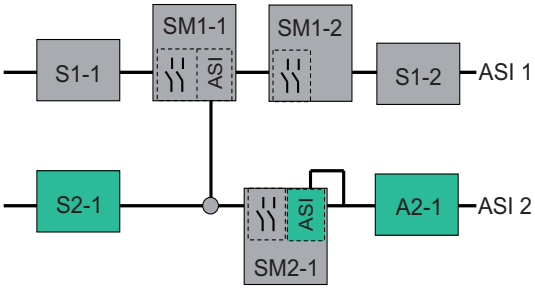


Figure 4.2: Example 2 - Calculation of the system reaction time

Upon locking of the EMERGENCY-OFF switch S2-1, the motor starter is controlled via the safe AS-i output of safety monitor SM2-1.

Calculation of the AS-i-relevant system reaction time:

$t_{System\ total\ b)} = t_{R\ S2\text{-}1} + t_{R\ system} + t_{R\ A2\text{-}1} = 100ms + 40ms + 50ms = \underline{190ms}$

System configuration - example 3:

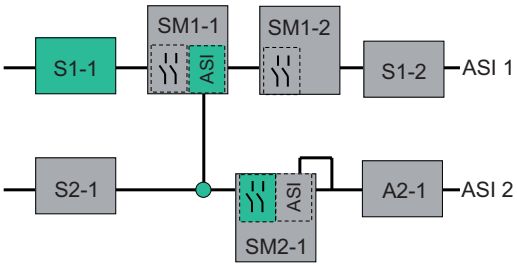


Figure 4.3: Example 3 - Calculation of the system reaction time

Upon locking of the EMERGENCY-OFF switch S1-1, the relay output of safety monitor SM2-1 is controlled via the coupling of the safe AS-i output of safety monitor SM1-1.

Calculation of the AS-i-relevant system reaction time:

$t_{System\ total\ c)} = t_{R\ S1\text{-}1} + t_{R\ system\ ASI1} + t_{R\ system\ ASI2} = 100ms + 40ms + 40ms = \underline{180ms}$

Edition: 01/2010

4.3 Dimensioned drawings

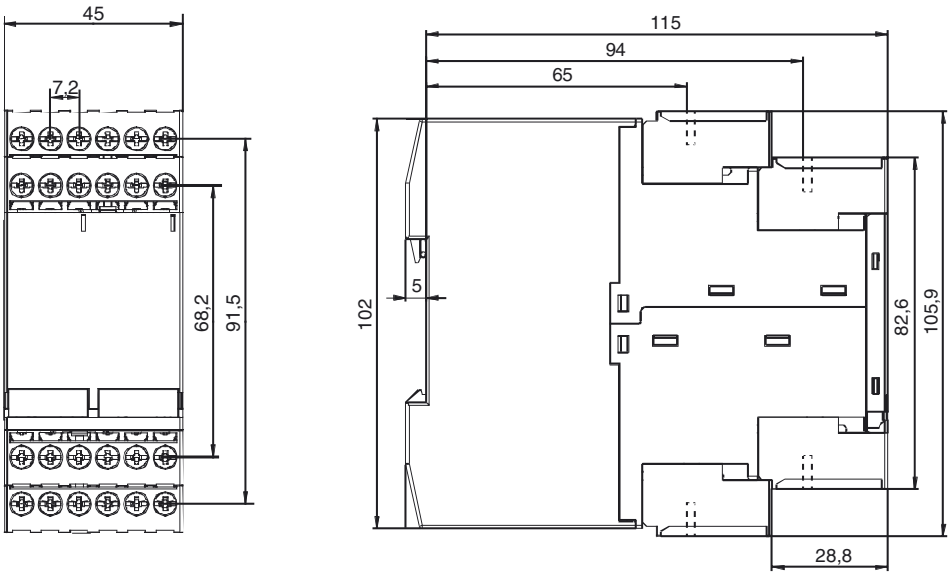


Figure 4.4: Dimensions

4.4 Scope of delivery

The **basic unit** consists of:

- AS-i safety monitor ASM1/1, ASM1/2, ASM1E/1, ASM1E/2, ASM2E/1, ASM2E/2, ASM1E-m/1, ASM2E-m/1, ASM1E-m/2 or ASM2E-m/2

The following **accessories** are available:

- Configuration interface cable (RJ45/SubD 9 pin) for the PC/safety monitor connection
- Software CD with
  - **asimon** communication software for Microsoft® Windows 9x/Me/NT/2000/XP/Vista®
  - operating manual in PDF format
    (Adobe® Acrobat Reader® Version 4.x or newer is required for viewing the files)
- Operating manual
- Download cable (RJ45/RJ45) for the safety monitor/safety monitor connection
- Device front cover for protection and sealing

Edition: 01/2010

5 Mounting

5.1 Mounting in the switching cabinet

The AS-i safety monitor is mounted on 35mm standard rails acc. to DIN EN 50022 in the switching cabinet.

Attention!
The housing of the AS-i safety monitor is not suitable for open wall mounting. Provide a protective housing in all cases when the device is not mounted in the switching cabinet.

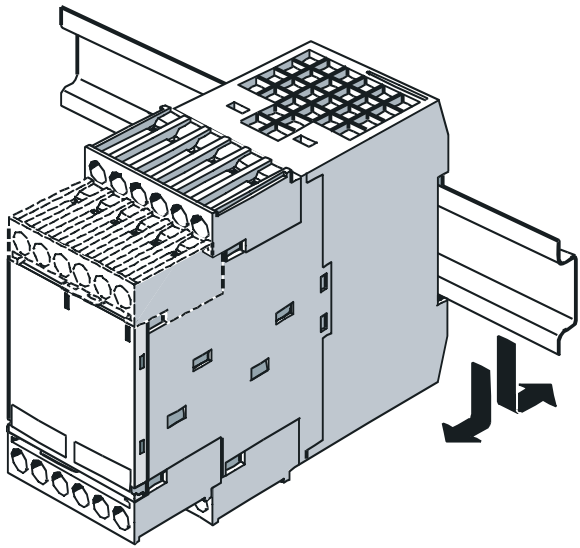


Figure 5.1: Mounting

To mount, position the device on the upper edge of the standard rail and then snap it onto the bottom edge. To remove, firmly press the device against the upper rail guide and lift out.

Notice!
When drilling above the device, cover the AS-i safety monitor. No particles, no metal shavings in particular, should be allowed to penetrate into the housing through ventilation openings as they may cause a short-circuit.

To prevent malfunctions, it is recommended that the operating temperature of the AS-i safety monitor specified in the technical data for switching-cabinet installation be maintained. It is recommended that a minimum spacing of 10mm be maintained between multiple safety monitors and other switching cabinet components.

Edition: 01/2010

Removable connection terminals

The AS-i safety monitor contains encoded, removable connection terminals (**A**, **B**, **C**, **D** in figure 5.2).

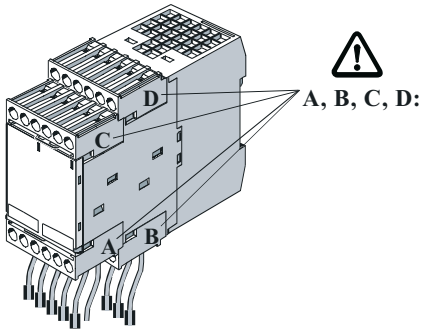


Figure 5.2: Removable connection terminals

To remove the encoded connection terminals, push back the safety spring **a** and pull the terminals out towards the front (figure 5.3). When mounting, the connection terminals must audibly lock into place.

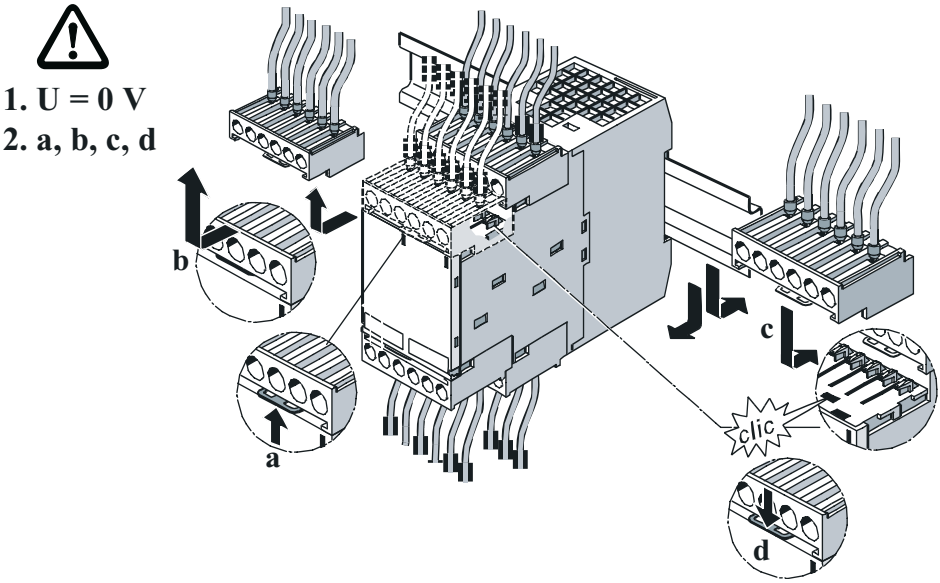


Figure 5.3: Removing and mounting encoded connection terminals

Edition: 01/2010

Mounting accessories

As the AS-i safety monitor is a safety component, it is possible to protect the device from unauthorised access by sealing the **CONFIG** configuration interface and the **Service** button. Included in the delivery contents for the device is a transparent cover with safety hook through which you can pass a lead sealing wire or thread when the device is in its mounted state (see figure 5.4). You must break the safety hook off the cover before using.

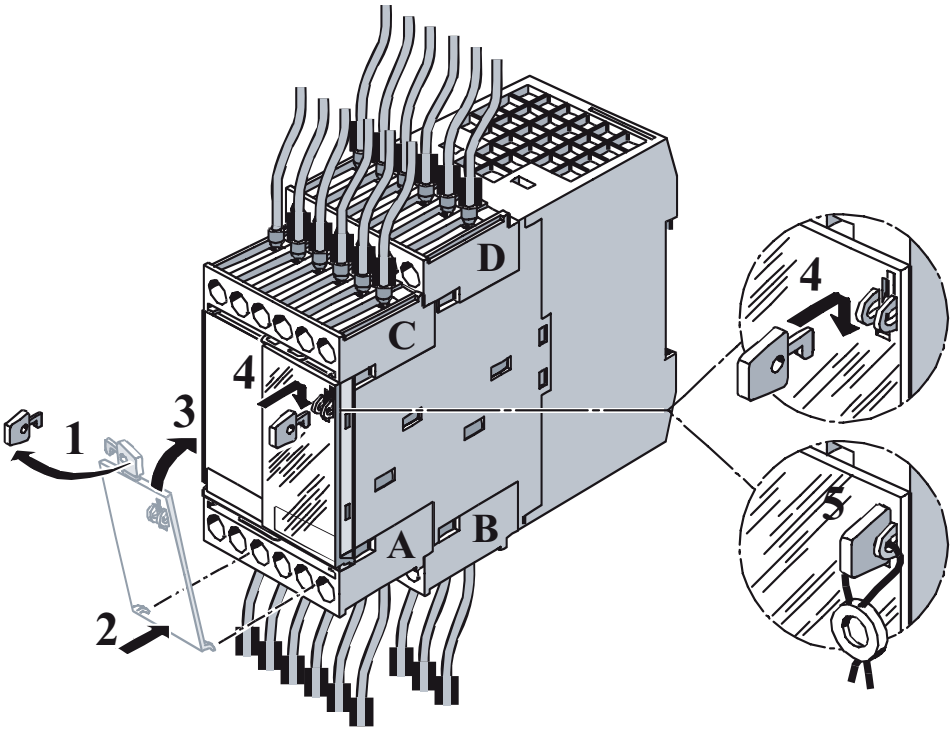


Figure 5.4: Mounting accessories for sealing the device

Notice!

*The transparent cover with safety hook should always be used as they provide good protection against electrostatic discharges (ESD) and the penetration of foreign bodies into the **CONFIG** socket of the AS-i safety-monitor configuration interface.*

The sealing wire is not included in the delivery contents.

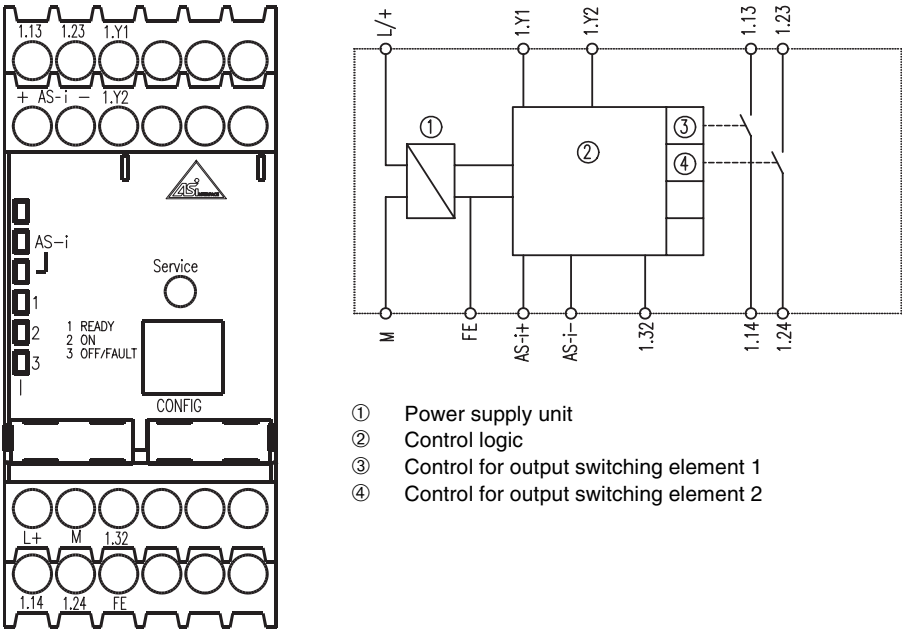
Edition: 01/2010

6 Electrical connection ASM1/1, ASM1E/1 and ASM1E-m/1

Notice!
Work on electrical installations may only be carried out by qualified electricians.

6.1 Terminal assignment

Terminal arrangement / block diagram



① Power supply unit
② Control logic
③ Control for output switching element 1
④ Control for output switching element 2

Figure 6.1: Terminal arrangement / block diagram of AS-i safety monitor ASM1/1, ASM1E/1 and ASM1E-m/1

Edition: 01/2010

Terminal assignment

Terminal	Signal / description
AS-i+	Connection at the AS-i bus
AS-i–	
L+	+24 V DC / supply voltage
M	GND / reference ground
FE	Functional earth
1.Y1	EDM 1 / input of external device monitoring circuit
1.Y2	Start 1 / start input
1.13 [1)]	Output switching element 1
1.14	
1.23 [1)]	Output switching element 2
1.24	
1.32	Message output "safety on"

1) Safeguard according to technical data

Table 6.1: Terminal assignment of AS-i safety monitor ASM1/1, ASM1E/1 and ASM1E-m/1

Notice!
The connection of the earth lead to terminal FE is not necessary if terminal M is connected to earth in the direct vicinity of the device.

Attention!
The AS-i power supply unit for supplying the AS-i components must demonstrate safe mains separation acc. to IEC 60742 and the ability to bridge short-term mains failures of up to 20ms. The power supply unit for 24 V supply must also demonstrate safe mains separation acc. to IEC 60742 and the ability to bridge short-term mains failures of up to 20ms.

Edition: 01/2010

6.2 Connection overview

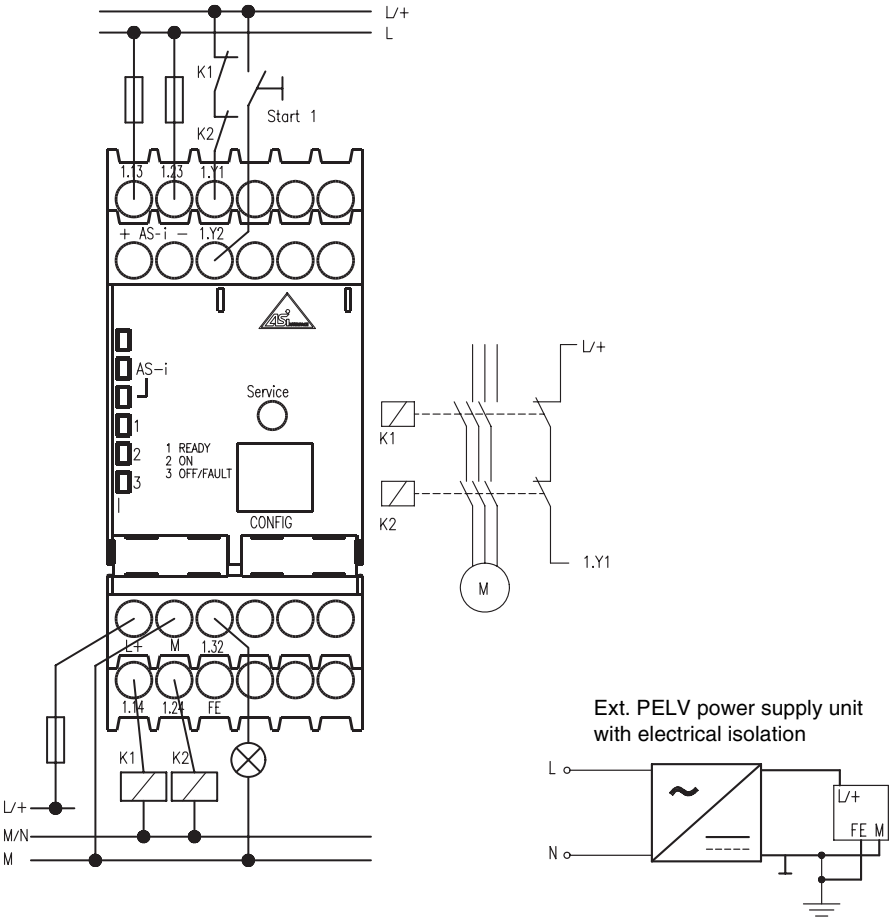


Figure 6.2: Connection overview of AS-i safety monitor ASM1/1, ASM1E/1 and ASM1E-m/1

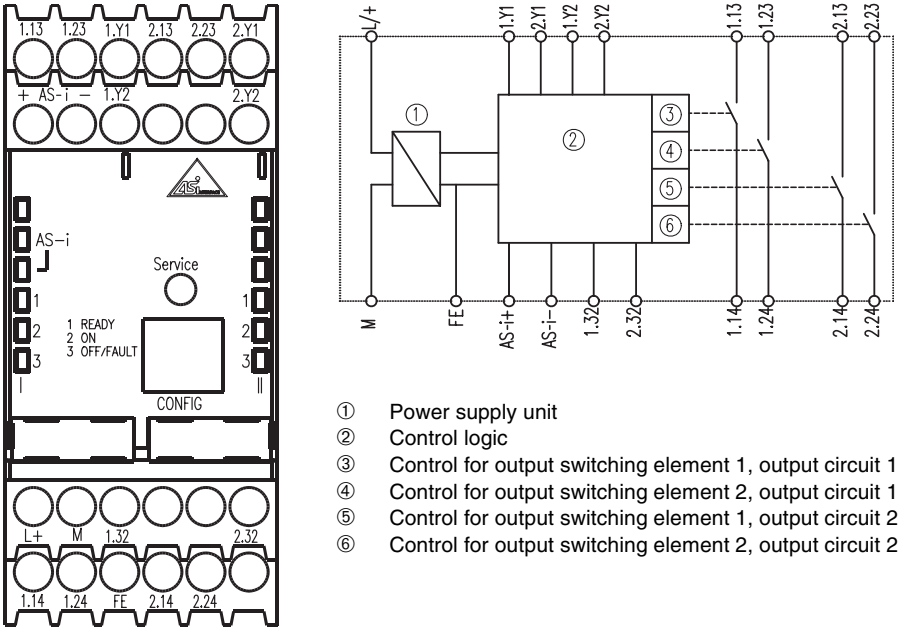
Edition: 01/2010

7 Electrical connection ASM1/2, ASM1E/2 and ASM1E-m/2

Notice!
Work on electrical installations may only be carried out by qualified electricians.

7.1 Terminal assignment

Terminal arrangement



① Power supply unit
② Control logic
③ Control for output switching element 1, output circuit 1
④ Control for output switching element 2, output circuit 1
⑤ Control for output switching element 1, output circuit 2
⑥ Control for output switching element 2, output circuit 2

Figure 7.1: Terminal arrangement / block diagram of AS-i safety monitor ASM1/2, ASM1E/2 and ASM1E-m/2

Edition: 01/2010

Terminal assignment

Terminal	Signal / description
AS-i+	Connection at the AS-i bus
AS-i–	
L+	+24 V DC / supply voltage
M	GND / reference ground
FE	Functional earth
1.Y1	EDM 1 / input of external device monitoring circuit, output circuit 1
1.Y2	Start 1 / start input, output circuit 1
1.13 [1)]	Output switching element 1, output circuit 1
1.14	
1.23 [1)]	Output switching element 2, output circuit 1
1.24	
1.32	Message output 1 "Safety on", output circuit 1
2.Y1	EDM 2 / input of external device monitoring circuit, output circuit 2
2.Y2	Start 2 / start input, output circuit 2
2.13 [1)]	Output switching element 1, output circuit 2
2.14	
2.23 [1)]	Output switching element 2, output circuit 2
2.24	
2.32	Message output 2 "Safety on", output circuit 2

1) Safeguard according to technical data

Table 7.1: Terminal assignment of AS-i safety monitor ASM1/2, ASM1E/2 and ASM1E-m/2

Notice!
The connection of the earth lead to terminal FE is not necessary if terminal M is connected to earth in the direct vicinity of the device.

Attention!
The AS-i power supply unit for supplying the AS-i components must demonstrate safe mains separation acc. to IEC 60742 and the ability to bridge short-term mains failures of up to 20 ms. The power supply unit for 24 V supply must also demonstrate safe mains separation acc. to IEC 60742 and the ability to bridge short-term mains failures of up to 20 ms.

Edition: 01/2010

7.2 Connection overview

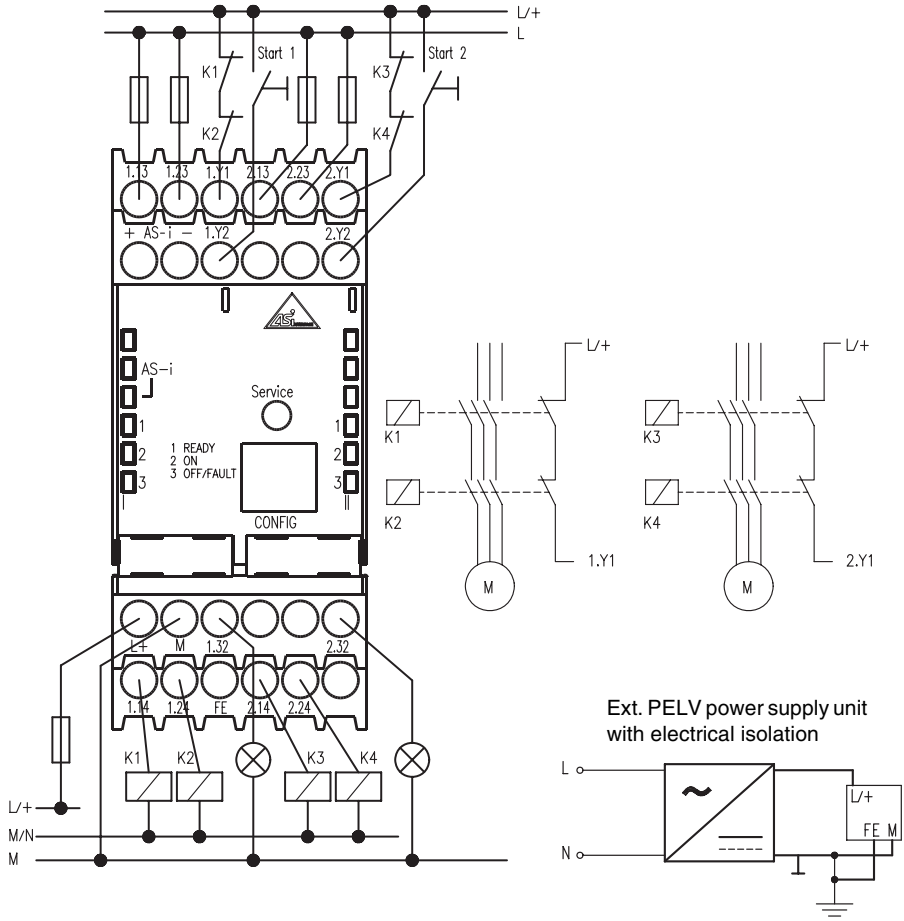


Figure 7.2: Connection overview of AS-i safety monitor ASM1/2, ASM1E/2 and ASM1E-m/2

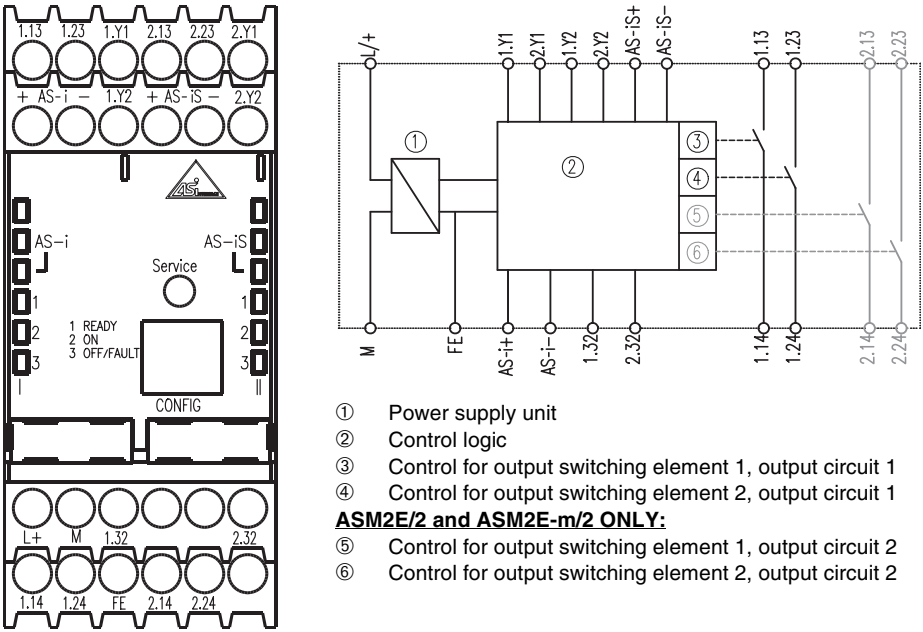
Edition: 01/2010

8 Electrical connection ASM2E/1, ASM2E/2, ASM2E-m/1 and ASM2E-m/2

Notice!
Work on electrical installations may only be carried out by qualified electricians.

8.1 Terminal assignment

Terminal arrangement



① Power supply unit
② Control logic
③ Control for output switching element 1, output circuit 1
④ Control for output switching element 2, output circuit 1

ASM2E/2 and ASM2E-m/2 ONLY:

⑤ Control for output switching element 1, output circuit 2
⑥ Control for output switching element 2, output circuit 2

Figure 8.1: Terminal arrangement / block diagram of AS-i safety monitor ASM2E/1, ASM2E/2, ASM2E-m/1 and ASM2E-m/2

Edition: 01/2010

Terminal assignment

Terminal	Signal / description
AS-i+	Connection at the AS-i bus
AS-i–	
AS-iS+	Safe AS-i output for actuator monitoring or coupling of another AS-i network
AS-iS–	
L+	+24 V DC / supply voltage
M	GND / reference ground
FE	Functional earth
1.Y1	EDM 1 / input of external device monitoring circuit, output circuit 1
1.Y2	Start 1 / start input, output circuit 1
1.13 [1)]	Output switching element 1, output circuit 1
1.14	
1.23 [1)]	Output switching element 2, output circuit 1
1.24	
1.32	Message output 1 "Safety on", output circuit 1
2.Y1	EDM 2 / input of external device monitoring circuit, output circuit 2
2.Y2	Start 2 / start input, output circuit 2
2.13 [1)]	Output switching element 1, output circuit 2 (**ASM2E/2 and ASM2E-m/2 only!**)
2.14	
2.23 [1)]	Output switching element 2, output circuit 2 (**ASM2E/2 and ASM2E-m/2 only!**)
2.24	
2.32	Message output 2 "Safety on", output circuit 2

1) Safeguard according to technical data

Table 8.1: Terminal assignment of AS-i safety monitor ASM2E/1, ASM2E/2, ASM2E-m/1 and ASM2E-m/2

Notice!
The connection of the earth lead to terminal FE is not necessary if terminal M is connected to earth in the direct vicinity of the device.

Attention!
The AS-i power supply unit for supplying the AS-i components must demonstrate safe mains separation acc. to IEC 60742 and the ability to bridge short-term mains failures of up to 20 ms. The power supply unit for 24 V supply must also demonstrate safe mains separation acc. to IEC 60742 and the ability to bridge short-term mains failures of up to 20 ms.

Attention!
Make absolutely certain that terminals AS-iS+ and AS-iS- of the safe AS-i output are properly connected acc. to chapter 8.2.1 or chapter 8.2.2.

Edition: 01/2010

8.2 Connection overview

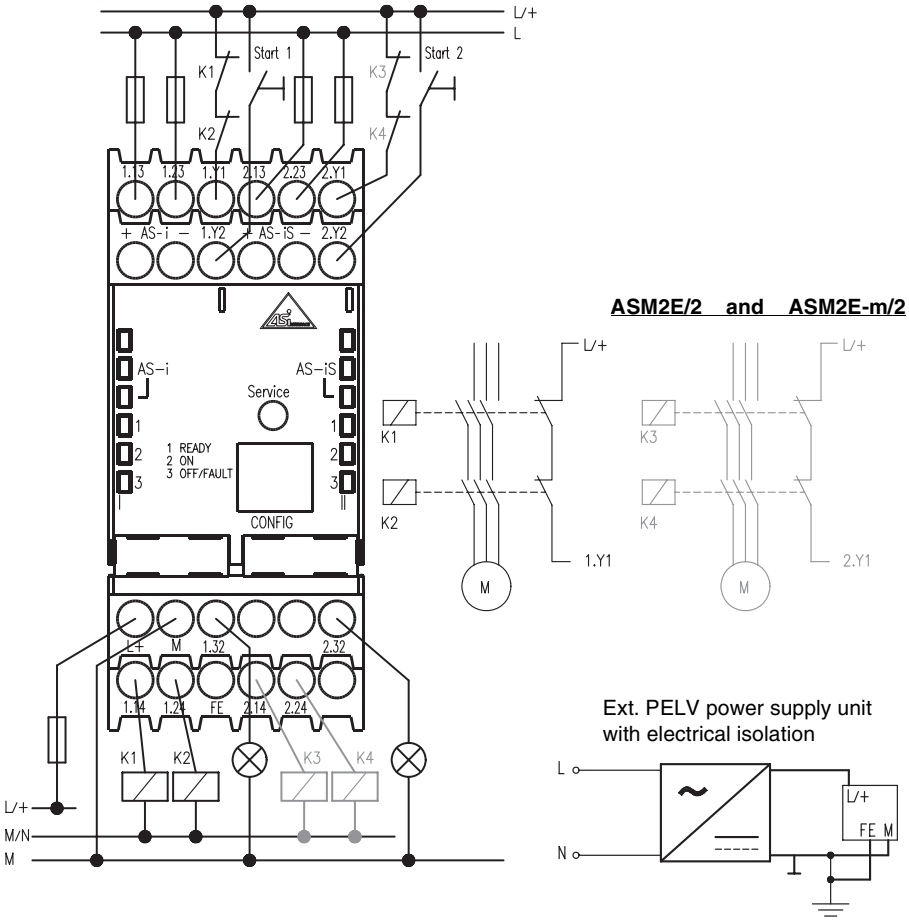


Figure 8.2: Connection overview of AS-i safety monitor ASM2E/1, ASM2E/2, ASM2E-m/1 and ASM2E-m/2

Notice!

With AS-i safety monitor ASM2E/1 and ASM2E-m/1, the inputs for contactor monitoring (2.Y1) and start (2.Y2) as well as message output (2.32) are present in spite of the missing output switching elements for output circuit 2.

Edition: 01/2010

8.2.1 Connection for actuator monitoring

Attention!
*Terminal **AS-iS+** must be connected to **AS-i+** and **AS-iS- must be connected to AS-i- of the same AS-i safety monitor**.*

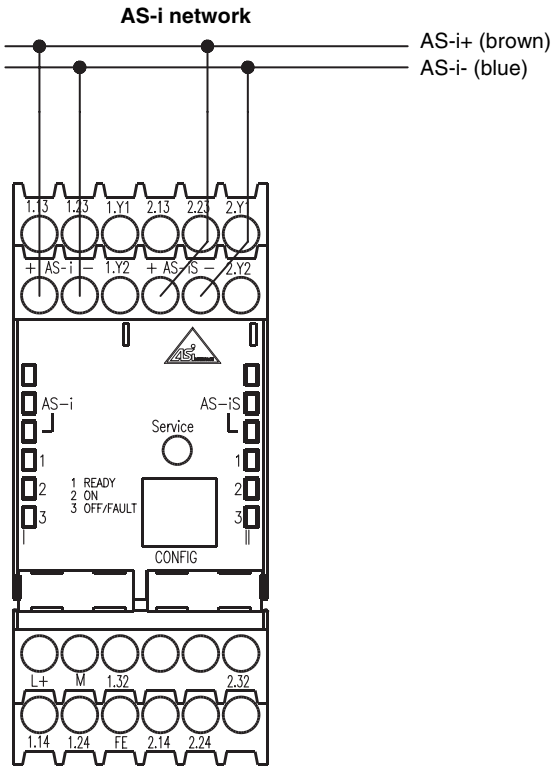


Figure 8.3: Connection of the terminals of the safe AS-i output for actuator monitoring

Edition: 01/2010

8.2.2 Connection for coupling to another AS-i network

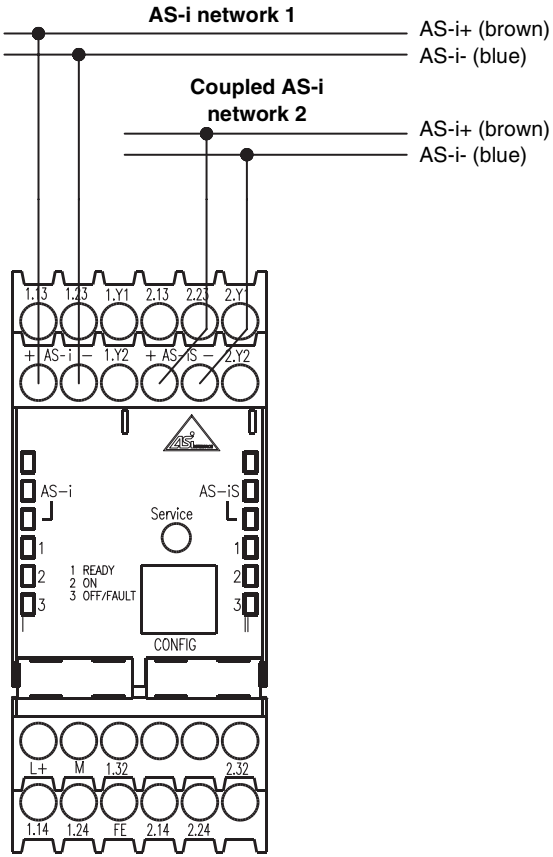


Figure 8.4: Connection of the terminals of the safe AS-i output for network coupling

Edition: 01/2010

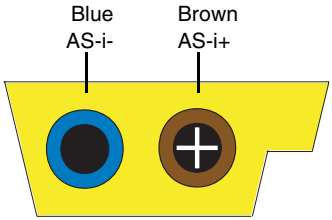
9 Electrical Connection of All Types

Notice!

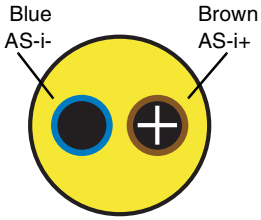
Work on electrical installations may only be carried out by qualified electricians.

Unused terminals must remain unoccupied and must not be used for other functions!

9.1 AS-i bus connection



Yellow AS-i ribbon cable



Two-conductor AS-i round cable (recommended: flexible power cable H05VV-F2x1.5 acc. to DIN VDE 0281)

Figure 9.1: AS-i cable variants

Edition: 01/2010

9.2 Serial interface

The serial RS 232C interface **CONFIG** is used for communication between PC and device and is permanently set to a baud rate of 9600 baud.

The interface is provided on the AS-i safety monitor as an RJ45 socket. A matching interface cable with 9-pin subD connector is available as an accessory.

Attention!
Use only the optional interface cable. The use of other cables may lead to functional disturbances or damage to the connected AS-i safety monitor.

Configuration interface RS 232C

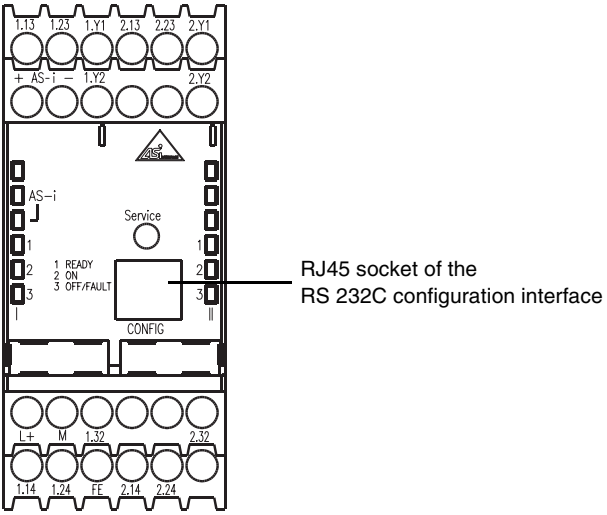


Figure 9.2: Location of the RS 232C configuration interface

Edition: 01/2010

10 Function and Commissioning

The configuration and commissioning of the AS-i safety monitor is performed using a PC/notebook with the **asimon** configuration software.

Notice!
The description of the **asimon** *software and the commissioning of the AS-i safety monitor can be found in the "asimon - AS-i safety monitor configuration software for Microsoft®-Windows®" manual.*

The software manual is an important part of the operating manual for the AS-i safety monitor. Configuration and commissioning of the AS-i safety monitor is not possible without the **asimon** *software.*

Configuration may be performed only by a safety officer. All commands relevant to safety are protected by a password.

10.1 Function and operating modes

With the AS-i safety monitor, a distinction is made between 3 operating modes:

- Start-up operation
- Configuration operation
- Protective operation

10.1.1 Start-up operation

After switching on, the microcontrollers in the AS-i safety monitor first perform a system test of the hardware and internal software. If an internal device error is detected, the other device initialisation processes are stopped and the output switching elements remain switched off.

If all internal tests are completed successfully, the AS-i safety monitor checks whether a valid, validated configuration is stored in the internal configuration memory.

If yes, this configuration is loaded, the necessary data structures assembled and the device switches to protective operation. Depending on the configuration, the output switching elements are then switched on or remain switched off.

If either no configuration or a faulty configuration is detected in the configuration memory, the device switches to configuration operation. The output switching elements remain switched off.

Edition: 01/2010

10.1.2 Configuration operation

In configuration operation of the AS-i safety monitor, a command processing module is activated which communicates via the serial configuration interface with the **asimon** software installed on the PC/notebook (see the "asimon - AS-i safety monitor configuration software for Microsoft®-Windows®" manual). Data transmission is monitored for transmission errors and, if necessary, repeated.

It is possible to switch to configuration operation by

- sending the password-protected command **stop** while in protective operation from the **asimon** software. Configured shutdown delay times are to be taken into account here.
- sending the command **stop** while in protective operation from the **asimon** software without entering a password. This is only possible if there is no communication on the AS-i line. You can ensure that this is the case by, for example, directly disconnecting the AS-i line from the monitor.
- detecting a missing or faulty configuration in start-up operation.
- pressing the **Service** button for the first time when replacing a defective safe AS-i slave (see chapter 12.4 "Replacing defective safe AS-i slaves").

10.1.3 Protective operation

Protective operation is the normal operating mode of the AS-i safety monitor. In this mode the output switching elements are activated and deactivated depending on the operating state of the monitored safe AS-i slaves and configured functional components.

In protective operation, the AS-i safety monitor continuously transmits diagnostic data via the serial configuration interface. This data is processed by the **asimon** software.

If an internal error function is detected during protective operation of the AS-i safety monitor, the output switching elements are switched off immediately and without regard to any set delay times. The AS-i safety monitor then performs a self test again. If the error no longer exists, the AS-i safety monitor returns to protective operation. If the error still exists, this state is error-locked and can be exited only by switching the AS-i safety monitor back on.

It is possible to switch to protective operation by

- sending the command **start** while in configuration operation from the **asimon** software.
- detecting a valid, validated configuration in start-up operation.
- pressing the **Service** button for the second time when replacing a defective safe AS-i slave (see chapter 12.4 "Replacing defective safe AS-i slaves").

Edition: 01/2010

10.2 Display and operating elements

The LED indicators on the front side of the AS-i safety monitor provide information about the operating mode and the device state.

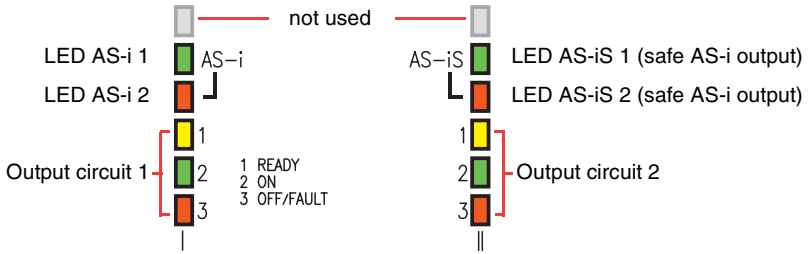


Figure 10.1: Overview of device LEDs

Meanings of the LED indicators in protective operation

LED	Colour		Meaning
AS-i 1		off	no supply
		green, continuous	AS-i supply present
AS-i 2		off	normal operation
		red, continuous	communication error
AS-iS 1		off	no supply
		green, continuous	AS-i supply present
AS-iS 2		off	normal operation
		red, continuous	communication error
1 READY (per output circuit)		off	–
		yellow, continuous	start-up/restart-disable active
		yellow, flashing	external test necessary / acknowledgement / delay before start-up active

Edition: 01/2010

LED	Colour		Meaning
2 ON (per output circuit)		off	contacts of the output switching element open
		green, continuous	contacts of the output switching element closed
		green, flashing	delay time runs in event of Stop Category 1
3 OFF/FAULT (per output circuit)		off	contacts of the output switching element closed
		red, continuous	contacts of the output switching element open
		red, flashing	error on level of the monitored AS-i components
1 READY 2 ON 3 OFF/FAULT (per output circuit)		simultaneously flashing rapidly	internal device error, error message can be queried by means of **asimon** software
			
			

Notice!
*Pressing the **Service** button is acknowledged by a one-time, brief illumination of all device LEDs.*

Attention!
*Actuation force for the **Service** button: max. 1N!*

10.3 Switching on the device

As soon as the supply voltage is present at the device, the internal system test begins. This operating status is indicated by the switching on of all LEDs installed in the device (see chapter 10.1.1 "Start-up operation").

10.4 Device configuration and parameterisation

For the device configuration and parameterisation, you require the software program **asimon**.

The **asimon** software is responsible for the following tasks:

- Configuring the AS-i safety monitor
- Documentation of the device configuration
- Commissioning the AS-i safety monitor
- Diagnosis of the AS-i safety monitor

Edition: 01/2010

Notice!
*The description of the **asimon** program can be found in the separate software manual.*

Configuration operation (chapter 10.1.2) is indicated by sequential illumination of LEDs 1 … 3 of the output circuit 1.

Proceed as follows:

- Install the program on your PC.
- Apply the supply voltage to the AS-i safety monitor.

Notice!
We recommend that before the user inserts the configuration cable into the safety monitor he perform a discharge (earthing) at a suitable location.

- Use the interface cable (RJ45/SubD 9-pin) to connect the PC to the AS-i safety monitor (see chapter 2.1.2 "Connection between the AS-i safety monitor and the PC" of the software manual).
- Configure the AS-i safety monitor and put it into operation as described in the software manual.
- The AS-i safety monitor is ready for operation following commissioning.

Attention!
*Before commissioning the device you **must** adapt the device configuration to your application. To do this, configure the AS-i safety monitor as described in the software manual in such a way that the given danger area is protected by the device.*

10.5 Technical safety documentation for the application

Attention!
The validated configuration log signed by the safety officer must be filed with the safety documentation of the user application.

Notice!
The detailed description of the technical safety documentation for the configuration of your application can be found in the separate software manual.

Proceed as follows:

- Create the AS-i safety monitor configuration for your application.
- Validate the configuration (to be performed by the safety officer).
- Print out the final configuration log and, optionally, the configuration overview (see chapter 5.8 "Configuration documentation" of the software manual).
- Sign the final configuration log (to be performed by the safety officer).
- File the log together with the other technical safety documentation for your application (machine documentation) and store in a safe location.

Edition: 01/2010

11 Maintenance

11.1 Checking for safe shutdown

The proper function of the AS-i safety monitor within the system to be secured, i.e. the safe shutdown following the triggering of an assigned safe sensor or switch, is to be checked at least annually by the safety officer.

Attention!
This is to be performed by activating each safe AS-i slave at least once per year and visually inspecting the switching behaviour of the output circuits of the AS-i safety monitor.

Attention!
The specified PFD and PFH_D values refer to a maximum switch-on time of 12 months and a maximum lifespan of 20 years acc. to ISO 13849-1.

Edition: 01/2010

12 Status Display, Errors and Error Rectification

12.1 Status display on the device / error diagnosis on the PC

An internal or external error is indicated by the red flashing LED **OFF/FAULT** on the AS-i safety monitor (see chapter 10.2 "Display and operating elements").

Notice!
*A more exact diagnosis of the error is possible via the configuration interface using the **asimon** software (see software manual).*

12.2 Troubleshooting tips

Error	Possible cause	Remedy
LED AS-i 1 is off	No AS-i supply	• Check line connections • Check AS-i power supply unit
LED AS-i 2 illuminates red	Communication on the AS-i bus is faulty	• Check line connections • Check AS-i master
LED AS-iS 1 is off	No AS-i supply	• Check line connections • Check AS-i power supply unit
LED AS-iS 2 illuminates red	Communication on the AS-i bus is faulty	• Check line connections • Check AS-i master
LED 3 OFF/FAULT flashes red	error on level of the monitored AS-i components	• Perform diagnostics with **asimon** • If necessary, replace defective AS-i components
LEDs 1 … 3 simultaneously flashing rapidly	Internal device error	• Note down the error numbers displayed by **asimon** in the error message window and contact the manufacturer

12.3 Error release with the "Service" button

An error-locked safety monitor (red LED **3 OFF/FAULT** flashes) can be released by pressing the "Service" button. The device with the error is reset when the button is pressed. A start test must be performed on this device after the reset.

Notice!
*Pressing the **Service** button is acknowledged by a one-time, brief illumination of all device LEDs.*

Edition: 01/2010

12.4 Replacing defective safe AS-i slaves

12.4.1 Replacing a defective safe AS-i slave

If a safe AS-i slave is defective, it is possible to replace it without a PC and without reconfiguring the AS-i safety monitor by using the **Service** button on the AS-i safety monitor.

Attention!
*Actuation force for the **Service** button: max. 1N!*

Notice!
*When the **Service** button is pressed, the safety monitor switches from protective operation to configuration operation. The output circuits are therefore deactivated in all cases.*

*Pressing the **Service** button is acknowledged by a one-time, brief illumination of all device LEDs.*

Proceed as follows:

1. Disconnect the defective AS-i slave from the AS-i line.
2. Press the **Service** button for approx. 1 second on all AS-i safety monitors which use the defective safe AS-i slave.
3. Connect the new safe AS-i slave to the AS-i line.
4. Press the **Service** button again for approx. 1 second on all AS-i safety monitors which use the replaced safe AS-i slave.

The first time the **Service** button is pressed, the monitor determines whether exactly one slave is missing. This is noted in the error memory of the AS-i safety monitor. The AS-i safety monitor switches to configuration operation. The second time the **Service** button is pressed, the code sequence of the new slave is read in and checked for correctness. If the code sequence is OK, the AS-i safety monitor returns to protective operation.

Attention!
After replacing a defective safe slave, make certain to check the new slave for correct function.

12.4.2 Replacing several defective safe AS-i slaves

If more than one safe AS-i slave on an AS-i branch is defective, the devices must be replaced in the following way:

Notice!
*When the **Service** button is pressed, the safety monitor switches from protective operation to configuration operation. The output circuits are therefore deactivated in all cases.*

*Pressing the **Service** button is acknowledged by a one-time, brief illumination of all device LEDs.*

Edition: 01/2010

Attention!
*Actuation force for the **Service** button: max. 1N!*

1. Disconnect all defective AS-i slaves from the AS-i line. Connect all new, **already addressed** safe AS-i slaves **except one** to the AS-i line (Auto_Address does not function in this case).
2. Activate all newly connected slaves so that no code sequences are sent by the slave (actuate emergency shutdown, open door, break light barrier, etc.).

Notice!
The error detection function integrated in the monitor only accepts a new slave if point 2 is fully observed.

3. Press the **Service** button for approx. one second on all AS-i safety monitors which used the defective safe AS-i slaves.
4. Connect the last missing and already addressed slave to the AS-i line.
5. Press the **Service** button for approx. one second on all AS-i safety monitors which used the defective safe AS-i slaves.
6. Disconnect one of the replaced and not yet taught AS-i slaves from the AS-i line.
7. Press the **Service** button for approx. one second on all AS-i safety monitors which used the defective safe AS-i slaves.
8. Reconnect the previously disconnected AS-i slave to the AS-i line.
9. Activate the newly connected slave. The code sequence is now transmitted to the AS-i safety monitor and stored there.
10. Press the **Service** button for approx. one second on all AS-i safety monitors which used the defective safe AS-i slaves.
11. Repeat the procedure from step 6 onwards until all replaced AS-i slaves have been taught.

The first time the **Service** button is pressed, the monitor determines whether exactly one slave is missing. This is noted in the error memory of the AS-i safety monitor. The AS-i safety monitor switches to configuration operation. The second time the **Service** button is pressed, the code sequence of the new slave is read in and checked for correctness. If the code sequence is OK, the AS-i safety monitor returns to protective operation.

Attention!
After replacing the defective safe slaves, make certain to check the new slaves for correct function.

Edition: 01/2010

12.5 Replacing a defective AS-i safety monitor

If an AS-i safety monitor is defective and must be replaced, the replacement device does not necessarily need to be reconfigured using the **asimon** software. It is possible instead to transfer the configuration from the defective device to the replacement device using the download cable (optional accessory).

Requirements:

- A download cable must be available (see accessories in chapter 4.4).
- The replacement device must not have a valid configuration stored in its configuration memory.

Notice!
If an AS-i safety monitor which was previously used somewhere else is now to be used as a replacement device, you must replace the existing old configuration with a new configuration which, however, you should not validate.

AS-i safety monitor version < V2.12:

Proceed as follows:
- Disconnect the defective AS-i safety monitor from the supply.
- Use the download cable (RJ45/RJ45) to connect the defective device to the replacement device.
- Apply the supply voltage to the replacement device.
- The configuration of the defective device is now automatically transferred to the replacement device.
  Active transmission is indicated by the continuous illumination of the yellow **READY** LED. Conclusion of a successful transmission is indicated by the continuous illumination of the yellow **READY** LED and the green **ON** LED.
- Disconnect the new AS-i safety monitor from the supply and disconnect the download cable from both devices. The replacement device can now directly be used in the place of the defective device.

AS-i safety monitors version ≥ V2.12:

Proceed as follows:
- Disconnect the defective AS-i safety monitor from the supply and uninstall it.
- Install the new AS-i safety monitor and connect it (connections L+, M and FE as well as AS-i+ and AS-i- as well as additional connections as necessary).
- Switch on the supply voltage for the new AS-i safety monitor. The AS-i safety monitor enters configuration operation.
- Connect the defective AS-i safety monitor, which is not connected to voltage, to the new AS-i safety monitor via the download cable (RJ45/RJ45) and press the **Service** button.
- The AS-i safety monitor restarts (LED test) and the configuration is transferred. During transfer, the **1 READY** yellow LED illuminates.
- When the **1 READY** yellow LED goes out, transfer has concluded. Disconnect the two AS-i safety monitors from one another and press the **Service** button again.
- The AS-i safety monitor restarts and now operates with the transferred configuration.

Attention!
After replacing a defective AS-i safety monitor, make certain to check the new AS-i safety monitor for proper function.

Edition: 01/2010

12.6 What to do if you forget the password

Attention!
Only the responsible safety officer is permitted to retrieve a lost password in the way described below!

If you have lost the password for your configuration, proceed as follows:

1. Find the valid configuration log (printout or file) of the AS-i safety monitor for which you no longer have a password. In the configuration log, find a four-digit code in line 10 (Monitor Section, Validated).
   - If the configuration log is unavailable and the AS-i safety monitor is not to be switched to configuration operation, connect the AS-i safety monitor for which you no longer have a password to the PC and start the **asimon** software.
   - Select a neutral configuration and start the diagnostic function in **asimon** with **Monitor -> Diagnose**. Now wait until the current configuration appears on the screen. This can take up to five minutes.
   - Open the **Information about monitor and bus** window (menu item **Edit -> Information about monitor and bus …**). In the **Title** tab you will again find the four-digit code in the **Download time** window area.
2. Contact the technical support department of your supplier and state the four-digit code.
3. A **master password** can be generated from this code. This password allows you to access to the stored configuration again.
4. Use the master password to stop the AS-i safety monitor and to enter a new user password. To do so, select **Change password…** in the **Monitor** menu of the **asimon** configuration software.

Attention!
*Please note that accessing the configuration stored in the AS-i safety monitor can affect the reliability of the system. Changes to validated configurations should only be made by authorised personnel. All changes must be made in accordance with the instructions given in the user manual supplied with the **asimon** configuration software.*

Notice!
If no valid configuration has yet been stored in the AS-i safety monitor, the default password "SIMON" is valid.

Edition: 01/2010

13 Diagnostics via AS-i

13.1 General procedure

Notice!
*The assignment of an **AS-i slave address for the AS-i safety monitor** is a prerequisite for diagnosing the AS-i safety monitor on the AS-i master.*

Using the AS-i bus, diagnosis of the AS-i safety monitor and configured devices is possible from the AS-i master, normally a PLC with master module.

However, to ensure reliable transmission and efficient evaluation of the diagnostic data, a series of requirements must be satisfied:

- Relatively long telegram propagation times may occur, particularly when using an additional bus system between PLC and AS-i. Owing to the asynchronous transmission in the master in the case of two successive, identical data calls, the PLC may not necessarily know when the AS-i safety monitor is responding to the new call. Thus, the answers to two successive, different data calls should differ by at least one bit.
- The diagnostic data must be consistent, i.e. the status information sent by the AS-i safety monitor must match the actual device states, especially if the propagation time to the PLC is longer than the updating time in the AS-i safety monitor (approx. 30 … 150ms).
- Whether a deactivated relay of an output circuit represents the normal state depends on the operating mode of the AS-i safety monitor. The diagnostics in the PLC should only be called in the event of a deviation from the normal state.

The diagnostic procedure described below satisfies these requirements and should therefore always be followed.

Diagnostic procedure

The PLC always queries the AS-i safety monitor alternately with two data calls (0) and (1). These data calls return the basic information (state of the output circuits, protective/configuration operation) to allow a diagnosis. The AS-i safety monitor answers the two calls with the same user data (3 bit, D2 … D0). Bit D3 is a control bit, similar (but not identical) to a toggle bit. D3 is 0 for all even data calls (0); D3 is 1 for all odd data calls (1). This enables the PLC to detect whether the answer has changed.

Data calls (0) and (1) return the answer X000 if the normal state exists (protective operation, everything OK). For devices with only one output circuit and with two dependent output circuits, output circuit 2 is always marked as OK. With two independent output circuits, an unconfigured circuit is also marked as OK. In order to be able to interpret what is OK and what is not OK, the user must be familiar with his configuration.

If the data call changes from (0) to (1), the data set is stored in the AS-i safety monitor. Bit D3 in the answer, however, remains reset until the process is concluded. As a result, the PLC thinks it has received answers to data call (0). If D3 is set, a consistent data set exists.

Edition: 01/2010

If, with the bit D3 set, the answer from the AS-i safety monitor signals deactivation of an output circuit, detailed diagnostic information can now be queried in the stored state with the specific data calls (2) … (B). Depending on the setting in the configuration of the AS-i safety monitor, data calls (4) … (B) return device diagnostic information sorted according to output circuit (see section 13.2.2) or unsorted (see section 13.2.3).

Notice!
If the AS-i safety monitor is in configuration operation, it is not possible to query the detailed diagnostic information using the data calls (2) … (B).

A fresh data call (0) cancels the stored state again.

13.2 Telegrams

13.2.1 Diagnosis of AS-i safety monitor

State of output circuits, operating mode

Notice!
The alternate sending of data calls (0) and (1) is essential for consistent data transmission.
see "Diagnostic procedure" on page 74.

*The **binary values of the data calls relate to the AS-i level** and may possibly be inverted at PLC level.*

Data call / Value	Answer D3 … D0	Meaning
(0) / 1111 State of monitor	0000	Protective operation, everything OK (unavailable, unconfigured or dependent output circuits are displayed as OK).
	0001	Protective operation, output circuit 1 off.
	0010	Protective operation, output circuit 2 off.
	0011	Protective operation, both output circuits off.
	0100	Configuration operation: Power On.
	0101	Configuration operation
	0110	Reserved / not defined
	0111	Configuration operation, fatal device error, RESET or device exchange required.
	1XXX	No up-to-date diagnostic information available, please wait.

Edition: 01/2010

Data call / Value	Answer D3 … D0	Meaning
(1) / 1110 Store diagnostic information (state of monitor)	1000	Protective operation, everything OK (unavailable, unconfigured or dependent output circuits are displayed as OK).
	1001	Protective operation, output circuit 1 off.
	1010	Protective operation, output circuit 2 off.
	1011	Protective operation, both output circuits off.
	1100	Configuration operation: Power On.
	1101	Configuration operation
	1110	Reserved / not defined
	1111	Configuration operation, fatal device error, RESET or device exchange required.

State of device LEDs

Data calls (2) and (3) return a simplified indication of the output circuit LEDs (see chapter 10.2) on the AS-i safety monitor.

If answer to data call (1) = 10XX:

Data call / Value	Answer D3 … D0	Meaning
(2) / 1101 State of LEDs of output circuit 1	0000	Green = contacts of output circuit closed
	0001	Yellow = startup/restart-disable active
	0010	Yellow flashing or red = contacts of output circuit open
	0011	Red flashing = error on level of the monitored AS-i components
	01XX	Reserved

Data call / Value	Answer D3 … D0	Meaning
(3) / 1100 State of LEDs of output circuit 2	1000	Green = contacts of output circuit closed
	1001	Yellow = startup/restart-disable active
	1010	Yellow flashing or red = contacts of output circuit open
	1011	Red flashing = error on level of the monitored AS-i components
	11XX	Reserved

Edition: 01/2010

Colour coding

Notice!
*The colour of a device corresponds to the colour of the virtual LEDs in the diagnostic view of the **asimon** configuration software. A device which is not assigned to any output circuit is always shown in green.*

Code CCC (D2 … D0)	Colour	Meaning
000	green, continuous	Device is in the ON state (switched on)
001	green, flashing	Device is in the ON state (switched on), but already in the process of being switched to the OFF state, e.g. switch-off delay
010	yellow, continuous	Device is ready, but is still waiting for another condition, e.g. local acknowledgement or start button
011	yellow, flashing	Time condition exceeded, action must be repeated, e.g. synchronisation time exceeded
100	red, continuous	Device is in the OFF state (switched off)
101	red, flashing	The error lock is active, release by means of one of the following actions: • Acknowledge with the service button • Power OFF/ON • AS-i bus OFF/ON
110	grey, off	No communication with the AS-i slave

Table 13.1: Colour coding

Notice!
During proper protective operation, there are also devices which are not in the green state. When searching for the cause of a shutdown, the device with the lowest device index is the most important. Others may just be subsequent effects (example: when the emergency shutdown button is pressed, the start device and timer are also in the OFF state).

By appropriately programming the functional component in the PLC, the user can be guided to the primary cause of the error. Detailed knowledge of the configuration and the function of the AS-i safety monitor are necessary for the interpretation of additional information.

Because the device numbers can be shifted if the configuration is changed, we recommend using the diagnosis index assignment.

Edition: 01/2010

Coding of the colors for Muting/Muting start devices

Notice!
*The colour of a device corresponds to the colour of the virtual LEDs in the diagnostic view of the **asimon** configuration software. A device which is not assigned to any output circuit is always shown in green.*

Muting devices

Code CCC (D2 … D0)	Colour	Meaning
000	green, continuous	Muting device is in the ON state (switched on)
001	green, flashing	Muting device is in the ON state (switched-on), Muting is active
010	yellow, continuous	Muting device is in the ON state (switched on), Muting error
011	yellow, flashing	Muting device is in the OFF state (switched off), Error during Muting time limiting (timeout)
100	red, continuous	Muting device is in the OFF state (switched off)
101	red, flashing	Muting device is in the OFF state (switched off), Muting error

Table 13.2: Coding of the colors for Muting devices

Muting start devices

Code CCC (D2 … D0)	Colour	Meaning
000	green, continuous	Muting start button was actuated for the first time
001	green, flashing	Muting start button was actuated for the second time
010	yellow, continuous	Muting start device is ready
011	yellow, flashing	Pause after first actuation of the Muting start button
100	red, continuous	Muting start button was pressed too long
101	red, flashing	Muting start button is pressed continuously

Table 13.3: Coding of the colors for Muting start devices

Edition: 01/2010

13.2.2 Diagnosis of devices, sorted according to OSSD

With the appropriate configuration setting, data calls (4) … (B) return device diagnostic information sorted according to output circuit.

Notice!
Make sure that the correct diagnosis type is set for the AS-i safety monitor in the ***Information about monitor and bus*** *window of the* ***asimon*** *configuration software.*

The values returned in calls (5) and (6) as well as (9) and (A) refer to the device diagnosis index in the configuration program and not to an AS-i address.

Always execute data calls (4) … (7) and (8) … (B) together in sequence for each device.

Sorted device diagnosis, output circuit 1

If answer to data call (1) = 10X1:

Data call / Value	Answer D3 … D0	Meaning	
(4) / 1011 Number of devices not green, output circuit 1	0XXX	XXX = 0: XXX = 1 … 6: XXX = 7:	no devices, answers to data calls (5) … (7) not relevant number of devices in output circuit 1 number of devices is > 6 in output circuit 1

Data call / Value	Answer D3 … D0	Meaning	
(5) / 1010 Device address HIGH, output circuit 1	1HHH	HHH = I5,I4,I3:	diagnosis index of device in output circuit 1 of configuration (HHHLLL = diagnosis index)

Data call / Value	Answer D3 … D0	Meaning	
(6) / 1001 Device address LOW, output circuit 1	0LLL	LLL = I2,I1,I0:	diagnosis index of device in output circuit 1 of configuration (HHHLLL = diagnosis index)

Data call / Value	Answer D3 … D0	Meaning
(7) / 1000 Colour of device, output circuit 1	1CCC	CCC = colour (see table 13.1 on page 77)

Edition: 01/2010

Sorted device diagnosis, output circuit 2

If answer to data call (1) = 101X:

Data call / Value	Answer D3 … D0	Meaning	
(8) / 0111 Number of devices not green, output circuit 2	0XXX	XXX = 0: XXX = 1 … 6: XXX = 7:	no devices, answers to data calls (5) … (7) not relevant number of devices in output circuit 2 number of devices is > 6 in output circuit 2

Data call / Value	Answer D3 … D0	Meaning	
(9) / 0110 Device address HIGH, output circuit 2	1HHH	HHH = I5,I4,I3:	diagnosis index of device in output circuit 2 of configuration (HHHLLL = diagnosis index)

Data call / Value	Answer D3 … D0	Meaning	
(A) / 0101 Device address LOW, output circuit 2	0LLL	LLL = I2,I1,I0:	diagnosis index of device in output circuit 2 of configuration (HHHLLL = diagnosis index)

Data call / Value	Answer D3 … D0	Meaning
(B) / 0100 Colour of device, output circuit 2	1CCC	CCC = colour (see table 13.1 on page 77)

Notice!
Data calls (C) 0011 to (F) 0000 are reserved.

Edition: 01/2010

13.2.3 Diagnosis of devices, unsorted

With the appropriate configuration setting, data calls (4) … (B) return unsorted device diagnostic information for all devices.

Notice!
Make sure that the correct diagnosis type is set for the AS-i safety monitor in the ***Information about monitor and bus*** *window of the* ***asimon*** *configuration software.*

The values returned in calls (5) and (6) as well as (9) and (A) refer to the device diagnosis index in the configuration program and not to an AS-i address.

Always execute data calls (4) … (7) and (8) … (B) together in sequence for each device.

Unsorted device diagnosis, all devices

If answer to data call (1) = 1001, 1010 or 1011:

Data call / Value	Answer D3 … D0	Meaning	
(4) / 1011 Number of devices not green, continuous	0XXX	XXX = 0: XXX = 1 … 6: XXX = 7:	no devices, answers to data calls (5) … (7) not relevant. number of devices not green. number of devices not green is > 6 (for colours, see table 13.1 on page 77).

Data call / Value	Answer D3 … D0	Meaning	
(5) / 1010 Device address HIGH	1HHH	HHH = I5,I4,I3:	diagnosis index of device of configuration (HHHLLL = diagnosis index).

Data call / Value	Answer D3 … D0	Meaning	
(6) / 1001 Device address LOW	0LLL	LLL = I2,I1,I0:	diagnosis index of device of configuration (HHHLLL = diagnosis index).

Data call / Value	Answer D3 … D0	Meaning
(7) / 1000 Colour of device	1CCC	CCC = colour (see table 13.1 on page 77).

Data call / Value	Answer D3 … D0	Meaning
(8) / 0111	0XXX	not used

Edition: 01/2010

Data call / Value	Answer D3 … D0	Meaning
(9) / 0110 Device address HIGH	1HHH	HHH = I5,I4,I3: diagnosis index of device of configuration (HHHLLL = diagnosis index).

Data call / Value	Answer D3 … D0	Meaning
(A) / 0101 Device address LOW	0LLL	LLL = I2,I1,I0: diagnosis index of device of configuration (HHHLLL = diagnosis index).

Data call / Value	Answer D3 … D0	Meaning
(B) / 0100 Assignment to output circuit	10XX	XX = 00: device from pre-processing XX = 01: device from output circuit 1 XX = 10: device from output circuit 2 XX = 11: device from both output circuits

Notice!

Data calls (C) 0011 to (F) 0000 are reserved.

Edition: 01/2010

13.3 Example: Querying with diagnosis sorted according to OSSD

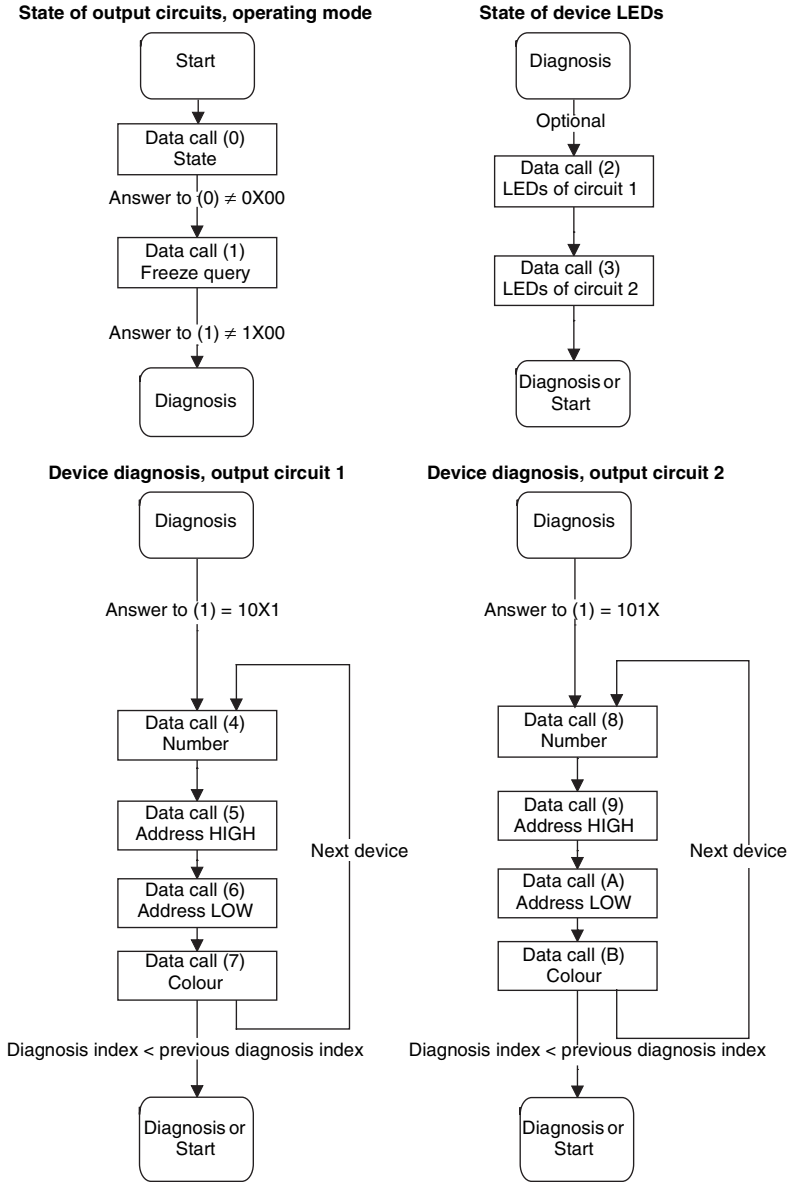


Figure 13.1: Querying with diagnosis sorted according to output circuit

Edition: 01/2010

14 EC Declaration of Conformity

Leuze electronic GmbH + Co. KG
In der Braike 1
D-73277 Owen - Teck / Germany

The manufacturer declares that the safety components of series AS-i safety monitor ASM1 / ASM1E / ASM2E (Part No see name plate) in the form in which they are marketed by us conform with the relevant, basic safety and health requirements of the EC directives[1] and that the standards[1] were used in their design and construction.

Owen, 20.08.09

Dr. Harald Grübel
General Manager

1. You can also download this EC Declaration of Conformity from the Internet under: http://www.leuze.com/mld/

Edition: 01/2010