Leuze electronic

the sensor people

SMART
**SENSOR**
BUSINESS

# MSI-ix/Rx

## Modular Safety Interface


EN 2015/08 - 603401
Subject to change without prior notice

SAFE IMPLEMENTATION AND OPERATION

Original operating instructions

## Notes on connection and operating instructions

These connecting and operating instructions contain information on the proper use of MSI Safety Interfaces in accordance with its intended purpose.

All the information contained herein, in particular the safety notes, need to be carefully observed.

Notes regarding safety and warnings are marked by this symbol  .

These connecting and operating instructions must be stored carefully. It must be available for the entire operating time of the MSI Safety Interfaces.

**The Leuze electronic GmbH + Co. KG is not liable for damages caused by improper use. Acquaintance with these instructions is an element of the knowledge required for proper use.**



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# 1 System Overview and Range of Applications

## 1.1 General Information

The Modular Safety Interface (MSI) serves as a link between one or more active optoelectronic protective devices (AOPD), Type 2, Type 3 or Type 4, and the machine controls. All MSI safety components include start/restart interlock and external device monitoring functions that can be activated and deactivated. They are also equipped with a series of status outputs and LED displays as well as a diagnosis interface to a PC.

In addition, MSI-ix/Rx offers a selection between guard only operation and cyclical opera-tion. During cyclical operation, the machine is controlled by means of the interruption and subsequent release of the protected field. Special safety regulations for cyclical operation are described in Chapter 2.6 below.

Leuze electronic offers a number of other MSI safety modules with standard or special functions, such as muting (intended suppression of the safety function, e.g. during material transport through the protective field).

All MSI safety modules are equipped with relay outputs. The MSI x-variants allow the additional connection of safety interlocks or emergency-stop buttons regarding category 4.

## 1.2 Approvals

| **Europe** |
|---|
| EC Type Examination<br>DIN EN ISO 13849-1/2<br>GS-ET-20 "Safety relays"<br>IFA<br>Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung<br>D-53757 Sankt Augustin |

## 1.3 Terminology

| | |
|---|---|
| AOPD | Active Optoelectronic Protective Device |
| Clear | Clearance of Cycles, Test |
| Diagn. | Diagnosis Function |
| EDM | External Device Monitoring |
| ESPE | Electro-sensitive Protecting Equipment |
| Fault | Relay Fault |
| Locked | Start/Restart Interlock active |
| N.C. | Normal Closed Contact |
| N.O. | Normal Open Contact |
| OSSD | Safety-related switching output |
| Reset | Start/Restart Interlock Initiator |
| RS 232 | Interface RS 232 |

| | |
|---|---|
| S1 - S4 | Safety input 1 - 4 |
| S1 & S2<br>S3 & S4 | Indication protected fields free/interrupted |
| Select | Selection of Cyclical Operation |
| SSD | Secondary Switching Device<br>(switches to ON state when the MSI is ready for operation) |
| Test | Test Signal Outputs |
| T1, T2 | Test signal output 1, 2 |
| Warn. (Rx Module) | Warning (preset number of switching operations exceeded) |

## 1.4 Nomenclature MSI-ix/Rx

| | |
|---|---|
| MSI | Modular Safety Interface |
| i | with modes of operation Guard only, Single break or Double break |
| x | extended functions<br>The extended version offers the following standard functions for either 2 AOPDs, Type 4, or up to 4 AOPDs, Type 2:<br>– Start/restart interlock<br>– External device monitoring<br>– Diagnosis function<br>and the following special functions for 1 AOPD Type 4 or 1 AOPD Type 2:<br>– Cyclical operation<br>– Displays and status outputs for guard and cyclical operation |
| /Rx | Relay output with extended functions:<br>– two normal open safety contacts, OSSD 1 and OSSD 2<br>– one normal closed safety contact OSSD 3<br>– one normal open contact ”MSI readiness” SSD<br>Additional special function:<br>– Relay operation monitoring with pre-failure message |

# 2 Safety

Before using the Safety Interface Device, a risk evaluation must be performed according to valid standards (e.g. ISO 14121, EN ISO 12100-1, ISO 13849-1, EN 62061). The result of the risk assessment determines the required safety level of the Safety Interface Device (see table in chapter 2.1.1). For mounting, operating and testing, document "MSI-ix/Rx Modular Safety Interface Device" 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 Interface Device, 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

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 Interface Device 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 Interface Device it must be ensured that its safety-related capability meets or exceeds the required performance level PLr ascertained in the risk assessment.

The following table shows the safety-related characteristic parameters of the MSI-ix/Rx modular Safety Interface Devices.

| | |
|---|---|
| Type in accordance with DIN EN IEC 61496-1 | Type 4 |
| SIL in accordance with IEC 61508 | SIL 3 |
| Performance Level (PL) in accordance with DIN EN ISO 13849-1 | PL e |
| Category in accordance with DIN EN ISO 13849-1 | Cat. 4 |
| Mean probability of a dangerous failure per hour ($PFH_d$ ) as a function of the mean number of annual switching cycles of the relay $n_{op}$* | 100% Load $n_{op}$ = 4.800: 1,6 x $10^{-08}$ 1/h<br>60% Load $n_{op}$ = 4.800: 1,3 x $10^{-08}$ 1/h<br>100% Load $n_{op}$ = 28.800: 3,8 x $10^{-08}$ 1/h<br>60% Load $n_{op}$ = 28.800: 1,6 x $10^{-08}$ 1/h<br>100% Load $n_{op}$ = 86.400: 9,5 x $10^{-08}$ 1/h<br>60% Load $n_{op}$ = 86.400: 2,4 x $10^{-08}$ 1/h |

*$n_{op}$ = mean number of annual actuations, see C.4.2 and C.4.3 of DIN EN ISO 13849-1:2008

Use the following formula to calculate the mean number of annual actuations:

$$n_{op} = (d_{op} \cdot h_{op} \cdot 3600\ s/h) \div t_{Zyklus}$$

In doing so, make the following assumptions with regard to the use of the component:
$h_{op}$ = mean operating time in hours per day
$d_{op}$ = mean operating time in days per year
$t_{Zyklus}$ = mean time between the start of two successive cycles of the component (e.g switching of a valve) in seconds per cycle

- The Safety Interface Device is used in combination with one or more Multiple Light Beam Safety Devices or Safety Light Curtains to safeguard danger or hazard areas.
- The control of the machine or system that is to be safeguarded must be electrically influenceable. A switch-off command initiated by an MSI 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) and SSDs (Secondary Switching Device), must not be used for switching safety-relevant signals.
- The Safety Interface Device is designed for installation in a cabinet or a protective housing with a protection rating of at least IP 54.
- The 24 V DC ±20% power supply must guarantee safe isolation from the mains voltage and be able to bridge a power outage period of 20 ms.
- 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 MSI-ix.
- 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 MSI-ix, all warranty claims against the manufacturer of the Safety Interface Device are rendered void.
- 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 Test Monitoring Unit 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 Interface Device 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 Interface Device 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.
- Cross connections between S1 and S2 or S3 and S4 are only detected by the MSI safety device if both time-staggered test signal outputs, T1 and T2, are used for the connected protective device(s) with relay output. AODPs of type 4 with safety-relevant transistor outputs and their own cross circuit monitoring can be directly connected to S1 and S2 or S3 and S4.

### 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

***Attention!***
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 Interface Device and the machine
- has been instructed by the responsible person on the mounting and operation of the machine and of the Safety Interface Device

## 2.3 Responsibility for safety

Manufacturer and operating company must ensure that the machine and implemented Safety Interface Device 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 Interface Device
- 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 (see chapter 2.2 and 2)

## 2.4 Exemption of liability

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

- Safety Interface Device 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 Interface Device

## 2.5 Emergency STOP buttons to be connected

- It must be secured that the EMERGENCY STOP function is always and immediate effective. EMERGENCY STOP buttons must not be connected at sensor inputs which provide for muting or cycling control functions! In Chapter 5, Connection examples, there is a particular example illustrating the connection of an EMERGENCY STOP button.
- When a two-channel Section Emergency Stop button is connected, MSI is able to realize a Section Emergency Stop function. Section Emergency Stop buttons connected to the MSI only affect the safety ciruit that is assigned to the AOPD. For this reason, it is referred to as an Section Emergency Stop. The limited area of effect of the button must be identified for the operating staff in a manner that is cleary visible.

## 2.6 Additional Safety Precautions for the Special Function ”Cyclical Control”

- Special safety precautions must be followed for controlling protective devices. For example, it must be impossible to step behind the protective device on the side facing the danger point. Stepping into or through the protected field would automatically cause the dangerous movement to be enabled!
- More specific regulations can be found in the European Standard EN ISO 12100-2, Control guards. In addition, the European Standard for Hydraulic Presses EN 693 contains restrictions on the minimum height of the press table and on the maximum dimensions of the access (window) opening. If these stipulations cannot be complied with, additional measures must be taken to reliably monitor the interior of the machine.

# 3 System Configuration and Functions

## 3.1 System Configuration

Two microprocessors handle the redundant processing of the signal sequences within the intelligent Modular Safety Interface MSI. The results of the two processors are continuously compared. If any deviations are found, the safety-related outputs are immediately switched off and the LED indicating an MSI failure lights up.

Sensor signals at inputs S1 and S2 as well as S3 and S4 are checked. Depending on which of the functions (as described below) are selected, when the protected fields of all connected AOPDs are free the MSI outputs switch automatically to the ON state (without start/restart interlock) or remain in the OFF state until the reset button has been pressed and released (with start/restart interlock = standard operating mode).

MSI-ix is available with two output options: the MSI-ix/Rx has two positive-guided normal open contacts and one positive-guided normal closed contact and offers furthermore an additional normal open contact SSD (Secondary Switching Device) which assumes the ON state when the MSI-ix is ready for operation.

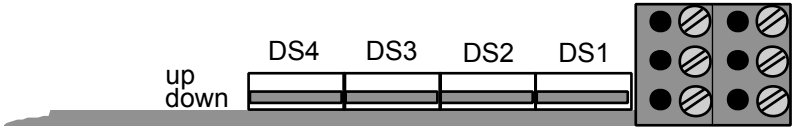
The SSD contact does not open when a protected field is interrupted! It may be used to switch off a second path if the MSI Safety Interface falls into an error condition.

The MSI safety interface comes in a 35 mm-wide slide-in housing that holds the MSI-ix module and the output module. It is suitable for mounting on a grounded 35 mm standard rail.

## 3.2 DIP Switch Settings

### 3.2.1 DIP Switch Settings for the MSI-ix Module

Cut off the voltage supply to the interface (see safety precautions) loosen the subassembly with the imprint MSI-ix and pull this module partly out of the housing before resetting the DIP switches:




Functions **only** in conjunction with external wiring, see Chapter 3.3:

| DIP Switch | DS4 | DS3 | DS2 | DS1 |
|---|---|---|---|---|
| Function | None | Locking | External Device Monitoring | Cycle Time-limit |
| Up | | restart interlock only | Static• - none•• | 30 min. |
| Down | | start/restart interlock* - none** | dynamic | 30 sec. |

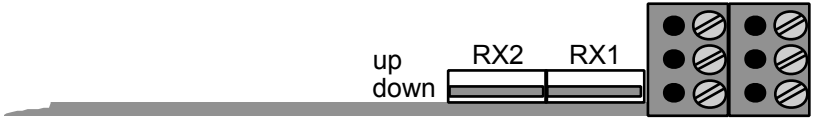
Factory setting: all switches down

* See Chapter 3.3.1.1 – 3.3.1.3

** See Chapter 3.3.1.4
• See Chapter 3.3.1.2
•• See Chapter 3.3.1.3 – 3.3.1.5

### 3.2.2 DIP Switch Settings for the Rx Output

Cut off the voltage supply to the interface (see safety precautions in Chapter 2.6) loosen the subassembly Rx Output and pull it partly out of the housing before resetting the DIP switches:




| DIP Switches | RX2 | RX1 |
|---|---|---|
| Function | Warning: 1,000,000 operations performed | |
| Up | | |
| Down | x | x |

| DIP Switches | RX2 | RX1 |
|---|---|---|
| Function | Warning: 500,000 operations performed | |
| Up | x | |
| Down | | x |

| DIP Switches | RX2 | RX1 |
|---|---|---|
| Function | Warning: 200,000 operations performed | |
| Up | | x |
| Down | x | |

| DIP Switches | RX2 | RX1 |
|---|---|---|
| Function | Warning: 100,000 operations performed | |
| Up | x | x |
| Down | | |

Factory setting: switches down (Warning after 1,000,000 operations)
Recommended setting: See Chapter 3.3.5

## 3.3 Operating Modes and Functions

- MSI-ix/Rx permits the following modes of operation and functions:
- Guard function offers the possibility of combining start/ restart interlock and external device monitoring (see below).
- Five operating modes can be selected by means of external wiring and the DIP switches DS2 and DS3 on the MSI-ix module.
- Cyclical operation as single break or double break operation with guard function. In cyclical operation, the AOPD connected at S1 controls the process. Special safety precautions are required as described in Chapter 2.6, Safety Precautions. Start/restart interlock is a necessary precondition for cyclical operation. Whenever cyclical operation is selected, terminal 13 must be connected to 24 V DC by way of a reset button! See more in Chapter 3.3.3.
  A three-point keyed switch is used to select among the operating modes. Changes at this keyed switch may only be made by trained specialists. If just one of the available operating modes is going to be required, we recommend permanently wiring this mode using a bridge.

### 3.3.1 Operating Modes Interlocking Functions and External Device Monitoring

The following 5 combinations can be selected by externally wiring the MSI Safety interface and/or by changing the settings of the DIP switches DS2 and DS3 in the MSI Module:

| OPERATING MODES | | | |
|---|---|---|---|
| Chapter | Type of Locking | Type of External Device Monitoring | Cyclical Function |
| 3.3.1.1 | With start/restart interlock | with dynamic ext. device monitoring | possible |
| 3.3.1.2 | With start/restart interlock | with static ext. device monitoring | possible |
| 3.3.1.3 | With start/restart interlock | without external device monitoring | possible |
| 3.3.1.4 | Without start/restart interlock | without external device monitoring | not possible |
| 3.3.1.5 | With start/without restart interlock | without external device monitoring | not possible |

The MSI safety interface is factory-set for the operating mode ”with start/restart interlock and dynamic external device monitoring”. If this setting is changed, these functions (i.e. the appropriate safety level) must be guaranteed by other means.

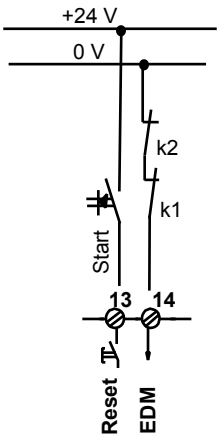
- Types of interlocking functions
  The „start interlock function“ ensures that when the system is switched on or when the supply voltage returns, even if the protected field is free the safety-related output contacts (OSSDs) do not automatically

go into ON state, but rather wait until the reset button has been pressed and let go.
The „start/restart interlock function“ prevents the OSSDs from automatically entering the ON state when the protected fields of one or more of the connected AOPDs are released again after an interruption. Here as well, the reset button must be pressed and let go to initiate the system.
Cyclical operation and muting are not possible if there is no locking (and hence no reset button) since the start button is also used to perform the function of the cyclical and muting reset.

- Types of External Device Monitoring
  The function „dynamic external device monitoring“ monitors the relays connected downstream from the MSI safety interface. Each time before the OSSDs switch to the ON state, a check is made of whether the subsequent circuit elements have closed and reopened. If they have not, the OSSDs of the MSI safety interface remain in the OFF state.
  If the function „static external device monitoring“ is selected, a check is merely made of whether the subsequent circuit elements are in an open state. If they are, the start/restart interlock can be initiated.

#### 3.3.1.1 Operating Mode: With Start/Restart Interlock – With Dynamic External Device Monitoring

External wiring requirements:




| | |
|---|---|
| Terminal 13 ”Reset” | connected to 24 V DC by way of a start button |
| Terminal 14 ”EDM” | connected to 0 V by way of feedback contacts of the positive-guided downstream relay |

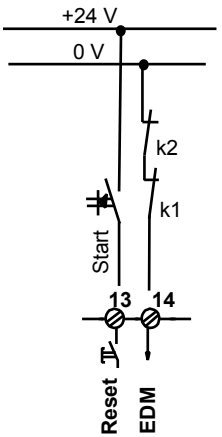
Required DIP switch settings in the MSI module (Chapter 3.2):

| | |
|---|---|
| DS3 down | DS2 down (factory setting at delivery) |

Start/restart interlock is no longer active when the protected fields of all connected AOPDs are free, the downstream relays have returned to their original state, and the reset button is pressed and released.

#### 3.3.1.2 Operating Mode: With Start/Restart Interlock – With Static External Device Monitoring

External wiring requirements:




| | |
|---|---|
| Terminal 13 "Reset" | connected to 24 V DC by way of a start button |
| Terminal 14 "EDM" | connected to 0 V by way of feedback contacts of the positive-guided downstream relay |

Required DIP switch settings in the MSI module (Chapter 3.2):

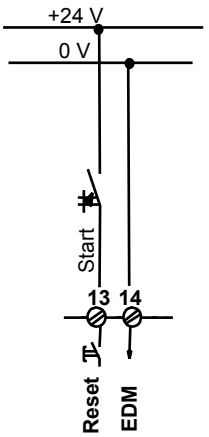
DS3 down DS 2 up

In this operating mode, if the protected fields are free, a check is merely made of whether the downstream circuit elements have returned to their original state. If so, a release is issued by pressing and letting go of the reset button.

The dynamic monitoring of the downstream relays, which may be required in order to maintain the safety category, must be performed by other means.

#### 3.3.1.3 Operating Mode: With Start/Restart Interlock – Without External Device Monitoring

External wiring requirements:




| | |
|---|---|
| Terminal 13 "Reset" | connected to 24 V DC by way of a start button |
| Terminal 14 "EDM" | connected to 0 V |

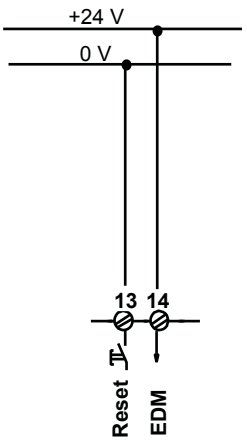
Required DIP switch settings in the MSI module (Chapter 3.2):

DS3 down DS2 up

The dynamic monitoring of the downstream relays, which may be required in order to maintain the safety category, must be performed by other means.

#### 3.3.1.4 Operating Mode: Without Start/Restart Interlock – Without External Device Monitoring

Cyclical operation not possible in this operating mode!




External wiring requirements:

| | |
|---|---|
| Terminal 13 ”Reset” | connected to 0 V |
| Terminal 14 ”EDM” | connected to 24 V DC |

Required DIP switch settings in the MSI module (Chapter 3.2):

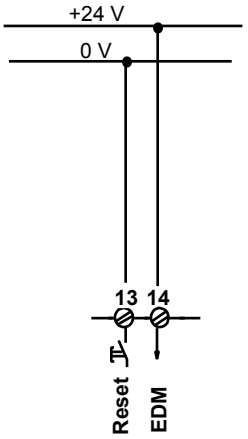
| | |
|---|---|
| DS3 down | DS2 up |

⚠ After the supply voltage is applied, the OSSDs immediately go into the ON state if all of the protected fields of the connected AOPDs are free.

In this case, the start/restart interlock function and the dynamic monitoring of the downstream relays, which may be required in order to maintain the safety category, must be performed by other means.

#### 3.3.1.5 Operating Mode: With Start/Without Restart Interlock – Without External Device Monitoring

Cyclical operation is not possible in this operating mode!




External wiring requirements:

| | |
|---|---|
| Terminal 13 ”Reset” | connected to 0 V |
| Terminal 14 ”EDM” | connected to 24 V DC |

Required DIP switch settings in the MSI module (Chapter 3.2):

| | |
|---|---|
| DS3 up | DS2 up |

After the supply voltage is applied, the OSSDs remain in the OFF state even if all of the protected fields of the connected AOPDs are free.

⚠ When the protected fields of all connected AOPDs are initially free, the OSSDs first enter the ON state when the protected field of the AOPD connected at S1 (for Type 4: S1 and S2) isinterrupted and released. Only then do the rest of the connected AOPDs respond to the interruption and release of their own protected fields by switching the OSSDs directly to the OFF and ON states.

In this case, the start/restart interlock function and the dynamic monitoring of the downstream circuit elements, which may be required in order to maintain the safety category, must be performed by other means.

### 3.3.2 Guard Operation, Test Function

If the protected fields are free, it is possible to simulate an interruption of the protected field of the AOPD connected at S1 (for Type 4: S1 and S2) by way of the "Clear" input. During this procedure, the safety-related outputs will switch to the OFF state. Test is activated if 24 V at Pin 20 is disconnected via a normal closed contact.

If operating mode "Start Interlock only" (as in Chapter 3.3.1.5) is selected, the "Clear" input also serves as the remote start for the AOPD connected at S1 (for Type 4: at S1 and S2). In this case, it is no longer necessary to initiate the first start by interruption the protected field.

### 3.3.3 Cyclical Operation as Single Break or Double Break with Guard Function

Special safety precautions must be taken when the protective device is used to control the machine. These are described in Safety Precautions, Chapter 2.6.

At terminal 21 "Select" you can choose the operating modes "guard only", "single break operation" or "double break operation". Start/restart interlock is a necessary precondition for cyclical operation, which means that terminal 13 must always be connected to 24 V DC by way of the start button. There are some options available with regard to external device monitoring. It can be performed either dynamically or statically, or it can be dispensed with completely if the requirements for maintaining the safety category are fulfilled by other means.

*Cyclical Operation:*
The start interlock ensures that the OSSDs remain in the OFF state after the supply voltage has been switched on. The display "start/restart interlock" (symbol: lock) is constantly lit.

*The following applies for single break operation:*
When the start button is pressed, the readiness for cyclical operation is achieved, and the display "start/restart interlock" emits a single blink which is repeated in short intervals. The controls remain in this condition and wait for a controlling interruption of the protected field for at least 300 ms.

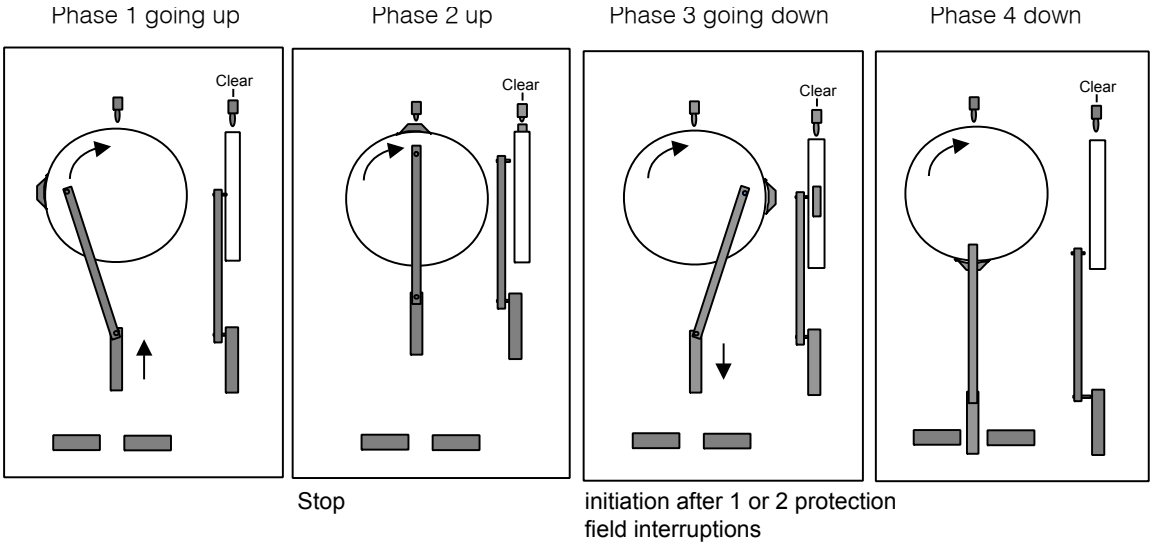
*The following applies for double break operation:*
When the start button is pressed, the readiness for cyclical operation is achieved, and the display "start/restart interlock" emits a double blink which is repeated in short intervals. After the first interruption for at least 300 ms, the display emits a repeated single blink. The controls remain in this condition and wait for the second controlling interruption of the protected field.

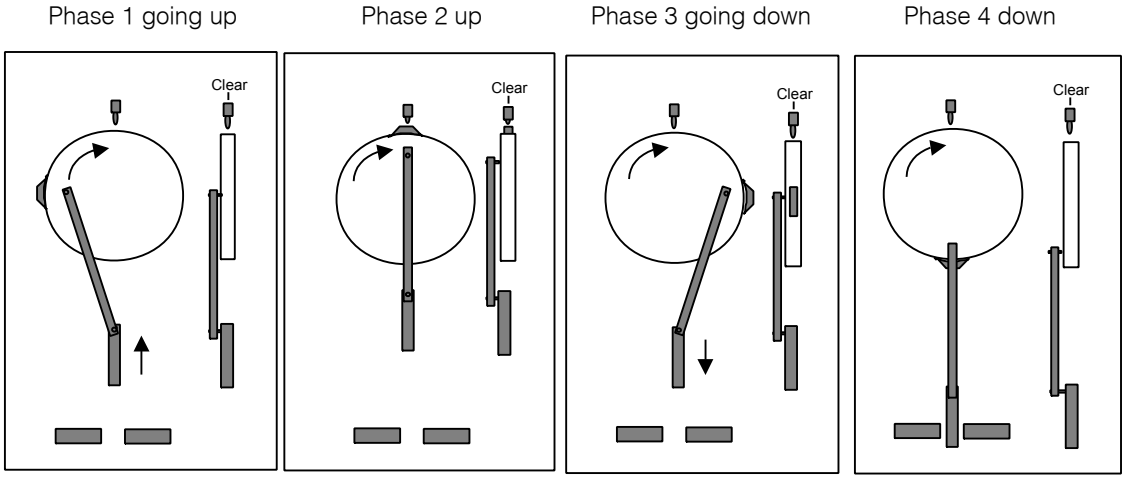
*Cycling Operation Time monitoring*
A time monitoring function prevents other controlling interruptions of the protected field after a period of 30 s following the "readiness" or the last controlling interruption of the protected field. After this 30-second period the start/restart interlocking function is automatically actuated, and the yellow LED lights constantly. By a press of the reset button, the "readiness" for further controlling interruptions may be restored.

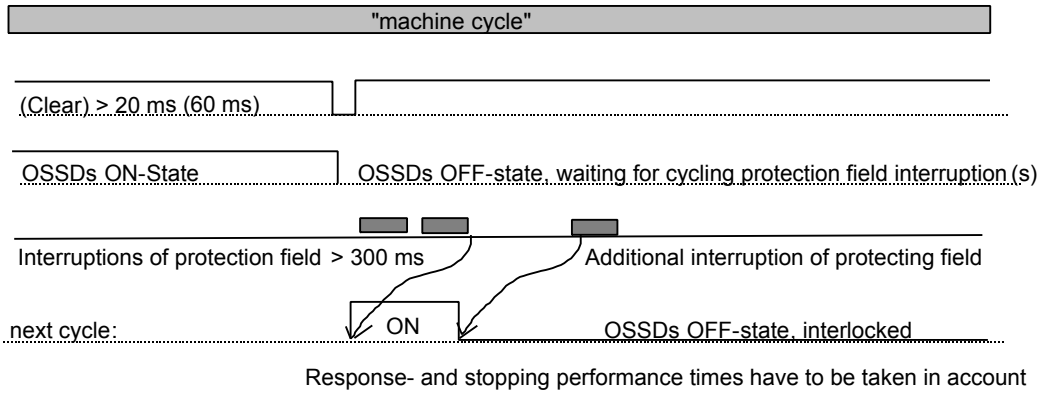
This function safeguards against the unintentional and unexpected initiation of a processing cycle after a longer standstill. In justified cases only, and if this does not create any additional danger to the operating personnel,

the time monitoring function can be switched to 30 min.
by the way of the DIP switch DS1. See Chapter 3.2.1.

### 3.3.4 Cycling operation, Diagram






Response- and stopping performance times have to be taken in account

### 3.3.5 Relay Operation Monitoring Function Pre-failure Message in /Rx Versions

For purposes of preventive maintenance, the /Rx output subassemblies are equipped with a function that counts the number of relay operations and issues a pre-failure message. Four different values can be selected at the DIP switches on the subassembly. Before the DIP switches can be set, the Rx subassembly must be completely disconnected from all power sources. It can then be released from its two holding brackets with a screwdriver and pulled slightly out of the housing.

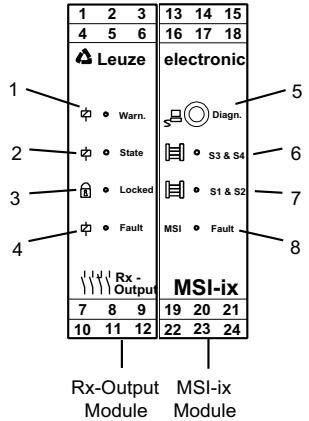
The table below shows the recommended DIP switch settings with respect to the switching current. Switching voltages of up to 60 V DC and 250 V AC are admissible.

| OSSD Switching current<br>(Switching Voltage 60 V DC, 250 V AC max.) | ≤ 0.75 A | > 0.75 A<br>≤ 1.5 A | >1.5 A<br>≤ 3 A | > 3 A<br>≤ 5 A |
|---|---|---|---|---|
| Recommended number of Operations | 1,000,000<br>(factory setting) | 500,000 | 200,000 | 100,000 |

For setting, see Chapter 3.2.2.

## 3.4 Displays

A number of LEDs of various colors indicate the operating status of the MSI modular safety interface. It is also possible to show the LED displays on the PC monitor using the integrated RS 232 interface and diagnosis connector.

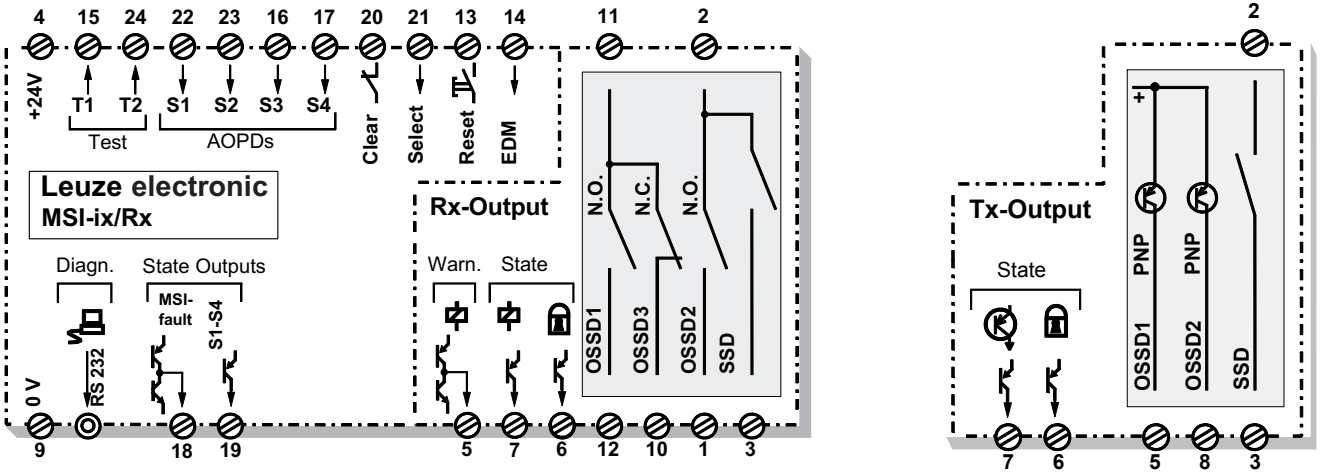



| Output /Rx | | | | | |
|---|---|---|---|---|---|
| Position | Display/Function | Symbol | Status | LED | Color |
| 1 | Preset no. of relay operations (/Rx only) | relay/ Warn | reached<br>not reached | on<br>off | red |
| 2 | Safety-related switch output | relay | on<br>off | on<br>on | green<br>red |
| 3 | Start/restart interlock<br>– Wait for 2 cycles<br>– Wait for 1 cycle | lock | locked<br>locked<br>locked<br>not locked | on<br>blinks 2x<br>blinks 1x<br>off | yellow<br>yellow<br>yellow |
| 4 | Fault in output module | relay | fault<br>no fault | on<br>off | red |

| MSI-ix Module | | | | | |
|---|---|---|---|---|---|
| Position | Display/Function | Symbol | Status | LED | Color |
| 5 | Diagnosis, RS 232<br>See status outputs | jack<br>diagn. | none | none | none |
| 6 | Protected field | AOPDs<br>S3 & S4 | protected field free<br>not free | on<br>off | green |
| 7 | Protected field | AOPDs<br>S1 & S2 | protected field free<br>not free | on<br>off | green |
| 8 | MSI fault | MSI fault | fault<br>no fault | on<br>off | red |

## 3.5 Status Outputs

Status outputs are not allowed to be used as safety-related signals in release circuits (see also Chapter Safety. Operating Conditions and Proper Use).



| Output /Rx | | | | |
|---|---|---|---|---|
| Terminal | Message Function | Symbol | Status | Status Output |
| 5 | preset no. of relay operations (/Rx only) | relay | reached<br>not reached | active low<br>active high |
| 6 | Start/restart interlock<br>– Wait for 2 cycles<br>– Wait for 1 cycle | lock | locked<br>locked<br>locked<br>not locked | active high<br>impulse 2 x<br>impulse 1 x<br>active low |
| 7 | Safety-related switch status | relay | ON<br>OFF | active high<br>active low |

| MSI-ix Module | | | | |
|---|---|---|---|---|
| Terminal | Message Function | Symbol | Status | Status Output |
| Front jack | Diagnosis, RS 232<br>2.5 mm round connector | – | – | connected to PC with Diagnosis program |
| 18 | MSI fault | MSI-fault | no fault<br>fault | active high<br>active low |
| 19 | Protected field(s) | S1 - S4 | free<br>not (all) free | active high<br>active low |

## 3.6 Diagnosis Function

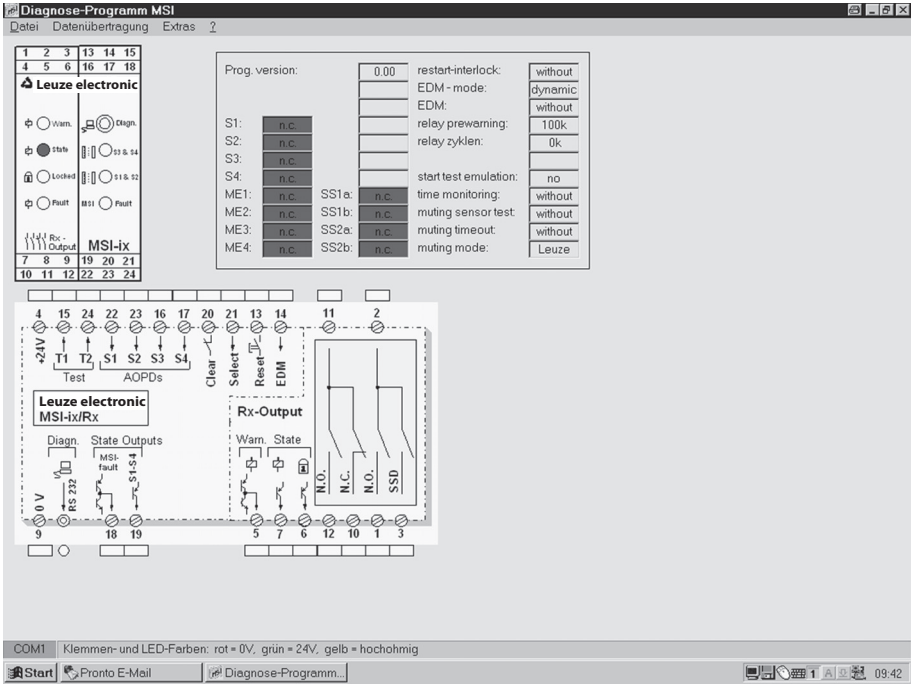
Requirements for running the diagnosis system: a standard PC or laptop operating under Windows (Version 3.1 or higher) and the MSI software, Version 01, as well as a serial connection cable and a 2.5 mm jack plug.

- Simultaneous display of all input and output statuses as well as all LED displays on the MSI

With its diagnosis interface, the intelligent modular safety interface MSI offers a convenient way to visualize all of the input and output statuses simultaneously on the monitor.

The connection circuit diagram as well as display fields in different colors can be shown on the screen via the connection terminals. A graphic representation of the MSI front design with the display elements as described in Chapter 3.4 also appears on the screen.

Example:




This enables the sequences at individual screw-type terminals to be tracked without the use of additional measuring instruments. The diagnosis function is equipped with on-line help and can be operated in either English or German.

# 4 Electrical Connection

## 4.1 Installation Regulations

The general safety precautions must be observed. The electrical installation may be performed only if there is no voltage applied, and it must be performed by trained specialists.

In the /Rx versions, it is possible that high voltages may be present at the output contacts. A no-voltage state is achieved only when the 24 V DC supply voltage as well as the supply lines to the switch contacts are safely switched off and secured against being switched on again.

Coded plug-in terminal blocks allow a connection cross-section of up to 2.5 $mm^2$. The supply voltage must be externally fused against excess current with a fuse of 2.5 AmT. The switch contacts must also be externally fused against excess current with a maximum of 4A gG. This prevents the safety-related contacts from welding together if the current load is too high!

## 4.2 Power Supply Requirements

The supply voltage of 24 V DC must guarantee safe mains separation and be able to bridge an interruption in voltage of 20 ms at full load. The functional earth connection of the MSI is established when snapped onto the grounded metal mounting rail via the rear clamp fixture.

The lead for the supply voltage must be externally fused against excess current with a maximum of 2.5 AmT.

## 4.3 Connecting AOPDs, Type 4 or Type 2

The examples below show possibilities for connecting and combining AOPDs of various safety categories and with various output features (relays, safety-oriented transistor outputs, cross circuit monitoring within and outside the AOPD).

AOPDs Type 4 with transistor outputs and cross connection monitoring function can directly be connected to the safety inputs S1 and S2, respectively to S3 and S4. See Example 1.

**All available safety inputs must be occupied!** In case no components are connected, the remaining inputs must be connected to the corresponding test signal using bridges. In doing so, please note that the odd-numbered test signal must be connected to the odd-numbered safety input via the non-delaying bridge (T1 => S1 or S3) and vice versa (T2 => S2 or S4). See Example 2.

AOPDs Type 4 with relay outputs, safety switches or EMERGENCY STOP buttons must be connected so that the odd-numbered test signal T1 are directed via the non-delaying contacts to an odd-numbered safety input (T1=>S1 or S3) and vice versa (T2=>S2 or S4). See Example 3 and 4.

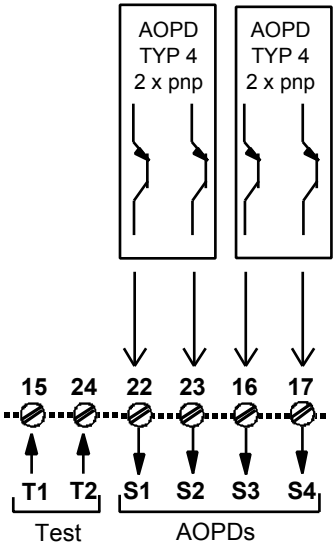
AOPDs Type 2 are periodically tested using the time-displaced test signals T1 or T2. The odd-numbered test signal must be directed to an even-numbered safety input by the way of the time-delaying AOPD (T1=>S2 or S4) and vice versa (T2=>S1 or S3). The AOPD response time to a test request must be in a range of 2 to 18 ms. See Example 5 and 6.

Using both, the safety inputs S1 & S2 and S3 & S4 separate insulated connector cables must be used to avoid undetected cross connections. Cross connections will be detected between S1 and S2 as well as between S3 and S 4, but not between S1 and S3 or S2 and S4!

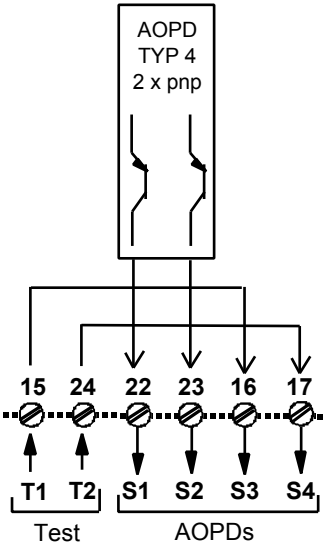
If type 2 AOPDs are connected:

- according to DIN EN IEC 61496-1, only a maximum of PL c or SIL CL 1 can be achieved!
- when cables are laid without protection, a failure detection time of up to 10 s is possible.

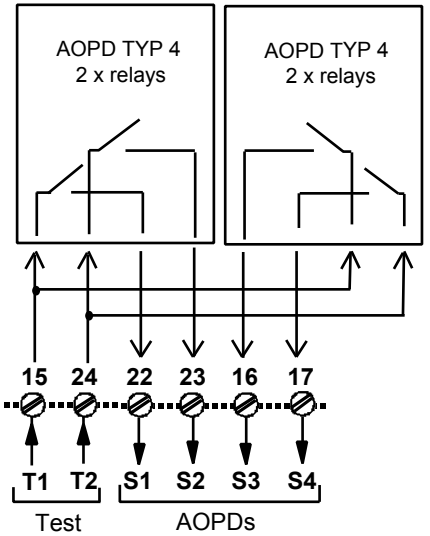
**Example 1**
2 AOPD Type 4 with 2 safety-related transistor outputs and internal cross connection monitoring function each.



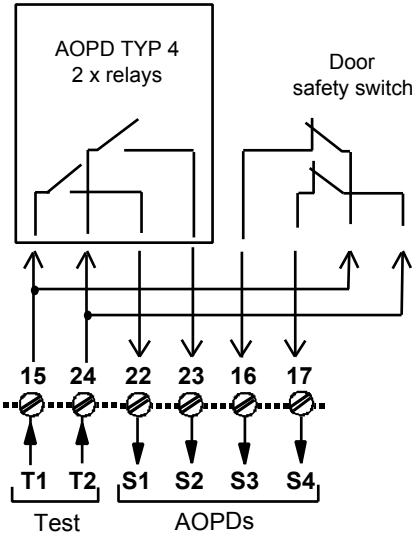

**Example 2**
1 AOPD Type 4 with 2 safety-related transistor outputs and internal cross connection monitoring function.



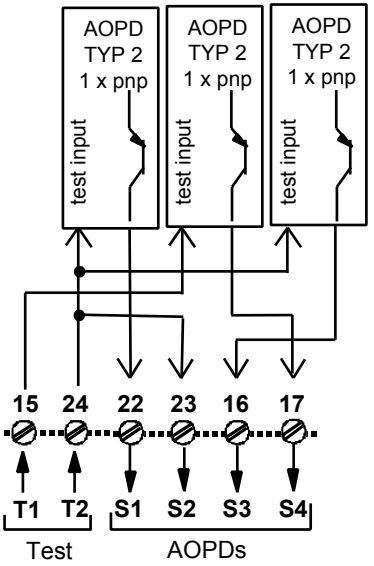

**Example 3**
2 AOPD Type 4 with 2 normally open contacts each. Separated connection cables to the individual AOPDs are required.



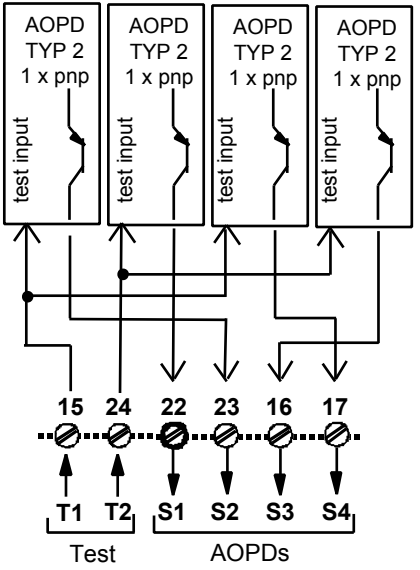
**Example 4**
1 AOPD Type 4 with 2 normally open contacts and 1 safety switch with 2 normally open contacts. Separated connection cables to the individual safety components are required




**Example 5**
3 AOPD Type 2 with 1 safety-related transistor output each. Separated connection cables to the individual AOPDs are required.




**Example 6**
4 AOPD Type 2 with 1 safety-related transistor output each. Separated connection cables to the individual AOPDs are required.



## 4.4 Connecting Machine Controls

The safety-related parts of the controls comprise more than the MSI-ix/Rx described above. They also include successive control elements and even power transmission elements which must be safely and promptly shut down. Particular attention must be paid to maintaining the safety category requirements. Important information in this regard can be found in the harmonized European standard DIN EN ISO 13849-1.

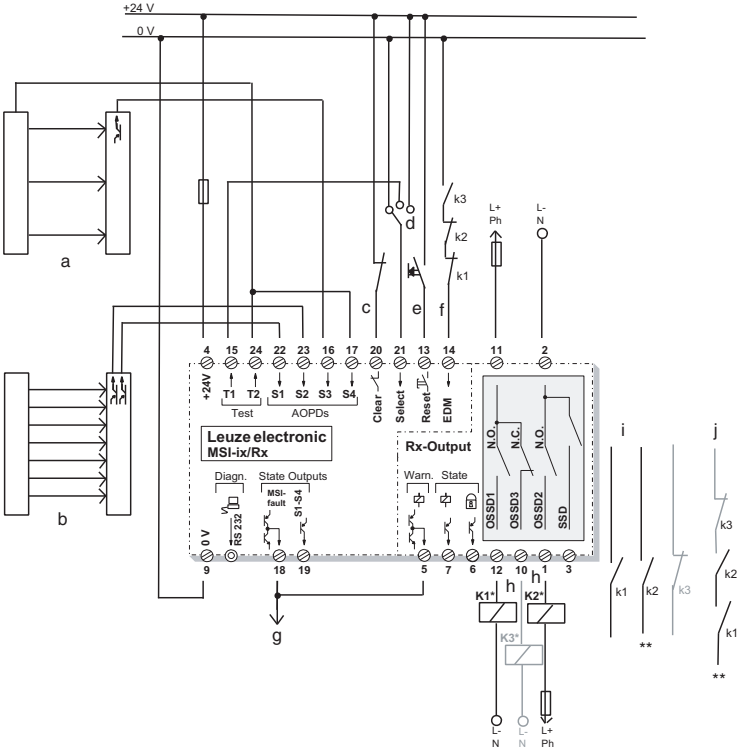
Essential prerequisites for safe operation are the abilities to electrically influence the interruption of the dangerous movement as well to bring the machine to a standstill as quickly as possible. These factors, as well as the response times of AOPDs and the MSI, must be taken into consideration when calculating the safety distance.

The response times depend on the type of AOPD selected (see Chapter 6, Technical Data). Other parameters, such as hand/arm/body approach speed or additional safety distance, depend on the particular application and the resolution of the AOPD being used. The European standard DIN EN ISO 13855 contains equations and examples for a variety of configurations.

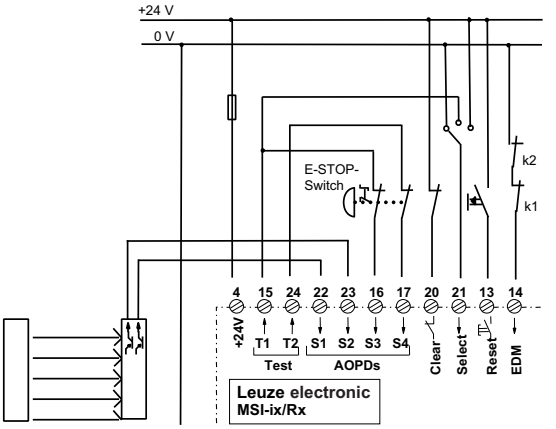
Before starting the next cycle the MSI Safety Interface demands the automatic feedback of the machine cycle. The normal closed contact between 24 V DC and terminal 20 (Clear) must be interrupted for a minimum duration according to the Technical Data below. This causes all fed-in cycles to be cleared. The output contacts enter the OFF state when the cycle clearance procedure is performed.

# 5 Connection Circuit Diagram, Examples

The connection examples below show a wiring suggestion for the MSI-ix/Rx as well as a connection example for an EMERGENCY STOP button.




Connection example MSI-ix/Rx with one AOPD Type 2 and one AOPD Type 4




Example: connection of two-channel EMERGENCY STOP button

| | | |
|---|---|---|
| a | = | AOPD Type 2 with guarding function |
| b | = | AOPD Type 4 with guarding and control function |
| c | = | Normally closed machine contact for cycle clearance |
| d | = | Operating mode keyed switch (guard only = 0 V, single-break = T1, double-break = 24 V) |
| e | = | Command device for releasing the start/restart interlock |
| f | = | Feedback loop for external device monitoring |
| g | = | Possible collective output for warning/error indications (active low) |
| Pin 18 | = | Indicating output "MSI Fault" |
| Pin 19 | = | Indicating output "sensor status" |
| Pin 5 | = | Warning output "prediction of relay failure" |
| Pin 7 | = | Indicating output "status safety outputs" |
| Pin 6 | = | Indicating output "status start/restart interlock" |
| h | = | Output Signal Switching Devices (OSSDs) |
| Pin 3 | = | Secondary Switching Device (SSD) opens in case of MSI failure |
| i | = | Switching off path with two-channel control |
| j | = | Switching off path with one-channel control |
| * | = | Suitable spark suppression required |
| ** | = | In general, both of the contacts must be used in the subsequent machine control path. Use relays or contactors with positive-driven contacts only. |

**All available safety inputs must be occupied!**
See Chapter 4.3.

# 6 Technical Data and Ordering Information

## 6.1 MSI-ix/Rx

| | |
|---|---|
| Version, Type<br>Modular Safety Interface | MSI-ix |
| Type in accordance with DIN EN IEC 61496-1 | Type 4 |
| SIL in accordance with IEC 61508 | SIL 3 |
| Performance Level (PL) in accordance with DIN EN ISO 13849-1 | PL e |
| Category in accordance with DIN EN ISO 13849-1 | Cat. 4 |
| Mean probability of a dangerous failure per hour ($PFH_d$ ) as a function of the mean number of annual switching cycles of the relay $n_{op}$* | 100% Load $n_{op}$ = 4.800: 1,6 x $10^{-08}$ 1/h<br>60% Load $n_{op}$ = 4.800: 1,3 x $10^{-08}$ 1/h<br>100% Load $n_{op}$ = 28.800: 3,8 x $10^{-08}$ 1/h<br>60% Load $n_{op}$ = 28.800: 1,6 x $10^{-08}$ 1/h<br>100% Load $n_{op}$ = 86.400: 9,5 x $10^{-08}$ 1/h<br>60% Load $n_{op}$ = 86.400: 2,4 x $10^{-08}$ 1/h |
| Number of cycles until 10 % of the components have a failure to danger ($B10_d$) | 400,000: 100% of the max. switched current of loading cases AC1..DC13<br>2,500,000: 60% of the max. switched current of loading cases AC1..DC13<br>20,000,000: 60% of the max. switched current of loading cases AC1..DC13 |
| Service life ($T_M$) | 20 years |
| Connectable safety sensors S1-S4 | up to 2 AOPDs, Type 4, Type 3 or up to<br>4 AOPDs, Type 2 (all in accordance with DIN EN IEC 61496-1) |
| Connectable safety switches and command units at S3-S4 | Safety switches according to EN 1088<br>Area Emergency-Stop button according to EN ISO 13850 |
| Test outputs T1 and T2,<br>Test interval<br>Test impulses, time-displaced<br>Response time AOPD Type 2 to a test request | <br>200 ms<br>24 ms each<br><br>2 to 18 ms |

| | |
|---|---|
| Available functions | Start/restart interlock<br>External device monitoring<br>Guard only, single break and double break operation |
| Minimum sensing field interruption for cycling control | 300 ms |
| Control input<br>Start/restart interlock (Reset) | Potential-free normal open contact (button or key button) |
| Control input<br>External device monitoring (EDM) | Feedback of positive-guided contacts from downstream relays (see connection diagram in Chapter 5) |
| Control input<br>Operating mode (Select) | Operating mode keyed switch or<br>bridge for permanent operating mode |
| Control input<br>Cycle clearance (Clear)<br>for AOPDs Type 4 with transistor outputs<br>for AOPDs Type 4 with relay outputs<br>for AOPDs Type 2 | Normal closed contact to +24 V in the machine cycle,<br>at least 20 ms opening time<br>at least 60 ms opening time<br>at least 60 ms opening time |
| Status outputs<br>Status protected fields S1- S4 | pnp – Semiconductor output<br>All protected fields free active high,24 V DC, 60 mA max.<br>not free active low |
| Safety outputs<br>(Technical Data, see below) | Relay outputs via /Rx-Output |
| Supply voltage | 24 V DC, ± 20%, external power supply (PELV) with safe mains separation and equalization for 20 ms voltage interruption required |
| Current consumption | approx. 200 mA without external load |
| External fusing | 2.5 A mT |
| Housing<br>Enclosure rating | IP 20; must be installed in electronics cabinet or housing with an enclosure rating of at least IP 54<br>Mounting at 35 mm DIN standard rail |
| Protective class | II |
| Ambient temperature, Operation | 0 ... + 55 °C. |
| Ambient temperature, Storage | -25 ... + 70 °C |
| Relative humidity | 93 % max. |

| | |
|---|---|
| Connection type (GS-ET-20: 2014) | pluggable, coded screw-type terminals<br>Cable cross-section min., rigid, flexible: 0.14 $mm^2$<br>Cable cross-section max., rigid, flexible: 2.5 $mm^2$<br>Cable cross-section AWG/kcmil, min./max.: 26/14<br>Cable cross-section UL AWG/kcmil: 30-12 |
| Dimensions | See dimensional drawing |

*$n_{op}$ = mean number of annual actuations, see C.4.2 and C.4.3 of DIN EN ISO 13849-1

Use the following formula to calculate the mean number of annual actuations:

$$n_{op} = (d_{op} \cdot h_{op} \cdot 3600\ s/h) \div t_{Zyklus}$$

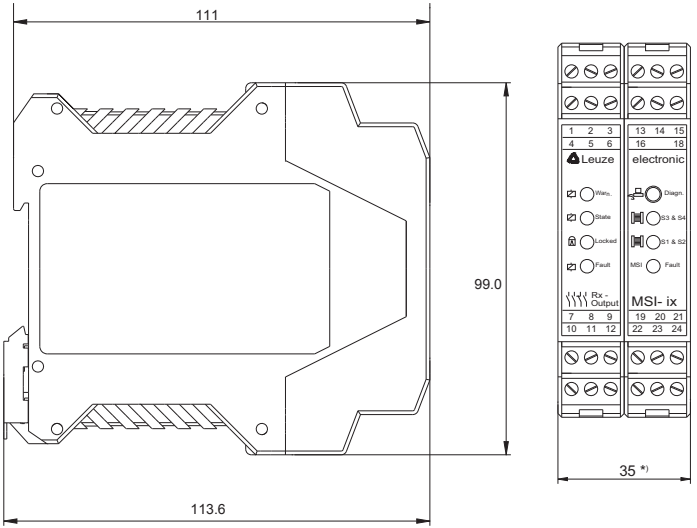
In doing so, make the following assumptions with regard to the use of the component:
$h_{op}$ = mean operating time in hours per day
$d_{op}$ = mean operating time in days per year
$t_{Zyklus}$ = mean time between the start of two successive cycles of the component (e.g switching of a valve) in seconds per cycle

## 6.2 /Rx-Output

| | |
|---|---|
| OSSD safety outputs<br>switching voltage/switching current | 2 safety-related normal open contacts, 60 V DC, 250 V AC, 5 A max.<br>1 safety-related normal closed contact, 60 V DC, 250 V AC, 5 A max.<br>Minimum switching current 20 mA |
| OSSD external fusing (EN 60269-1) | 4A gG D-fuse |
| Contact currents (IEC EN 60947-5-1) | AC15, 3A<br>DC13, 2A |
| OSSD response time MSI<br>(without AOPD) | for AOPD Type 4, transistor outputs 22 ms<br>for AOPD Type 4, relay outputs 64 ms<br>for AOPD Type 2 64 ms<br>for safety switches (electro mechanical) 64 ms |
| OSSD reset time | 100 ms |

| | | | | |
|---|---|---|---|---|
| OSSD suitable spark extinguishing over the coils of the down-stream relays | Required | | | |
| SSD secondary switching device<br>(closes after successful start-up test, opens in case of fault)<br>switching voltage/switching current | 1 normal open contact,<br><br>60 V DC, 250 V AC, 5 A max. / minimum switching current 20 mA | | | |
| SSD external fusing<br>⚠ SSD (Secondary Switching Device) not to be used for safety circuit! | 5 A mT | | | |
| ⚠ Status output "Status switch outputs" not to be used for safety circuit! | pnp switch output<br>OSSDs ON-state:<br>OSSDs OFF-state: | | active high, 24 V DC, 60 mA max.<br>active low | |
| Status output<br>"Status start/restart interlock" | pnp switch output<br>OSSD locked:<br>OSSD not locked: | | active high, 24 V DC, 60 mA max.<br>active low | |
| | pnp switch output: wait for 2 cycles<br>OSSD locked:<br>OSSD not locked: | | impulse 2x<br>active low | |
| | pnp switch output: wait for 2 cycles<br>OSSD locked:<br>OSSD not locked: | | impulse 1x<br>active low | |
| OSSD currents over the contacts<br>at 230 V AC switching voltage | ≤ 0.75 A | > 0.75 A<br>≤ 1.5 A | > 1.5 A<br>≤ 3 A | > 3 A<br>≤ 5 A |
| Recommended limit of operations by way of DIP switch of Rx Module (factory setting 1,000,000) | 1,000,000 | 500,000 | 200,000 | 100,000 |
| Status output<br>"Warning – preset no. of operations reached" | Push-pull semiconductor output<br>Operations not reached:<br>Operations reached: | | active high, 24 V DC 60 mA max.<br>active low | |

## 6.3 Dimensional Drawing




*) Stringing together without distance possible

## 6.4 Ordering Information

| Typ | Part No. |
|---|---|
| MSI-ix/Rx | 549903 |
| MSI diagnosis software | 549930 |
| PC cable 3 m | 549953 |
| PC cable 5 m | 549955 |
| /Rx output subassembly (replacement part) | 509211 |

Leuze electronic
the sensor people

| EG-KONFORMITÄTS-ERKLÄRUNG (ORIGINAL) | EC DECLARATION OF CONFORMITY (ORIGINAL) | DECLARATION CE DE CONFORMITE (ORIGINAL) |
|---|---|---|
| Der Hersteller | The Manufacturer | Le constructeur |
| | **Leuze electronic GmbH + Co. KG<br>In der Braike 1, PO Box 1111<br>73277 Owen, Germany** | |
| erklärt, dass die nachfolgend aufgeführten Produkte den einschlägigen Anforderungen der genannten EG-Richtlinien und Normen entsprechen. | declares that the following listed products fulfil the relevant provisions of the mentioned EC Directives and standards. | déclare que les produits identifiés suivants sont conformes aux directives CE et normes mentionnées. |
| Produktbeschreibung: | Description of product: | Description de produit: |
| **Sicherheits-Interface zur Auswertung sicherheitsrelevanter Signale und Erzeugung sicherheitsgerichteter Abschaltsignale auf Basis einer zweikanaligen Mikroprozessorsteuerung Sicherheitsbauteil nach 2006/42/EG Anhang IV<br>MSI (Modulares Sicherheits-Interface)<br>(-s, -sx), (-i, -ix), (-m, -mx), (-mE, -mxE)<br>Seriennummer siehe Typschild** | **Safety interface device to evaluate safety related signals and to create safety related output switching signals based on two micro-processors safety component in acc. with 2006/42/EC annex IV<br>MSI (Modular Safety Interface)<br>(-s, -sx), (-i, -ix), (-m, -mx), (-mE, -mxE)<br>Serial no. see name plates** | **Interface de sécurité pour l'exploitation de signaux relatifs à la sécurité et la génération de signaux de coupure sécuritaires sur la base d'une commande à microprocesseur à deux canaux Èlément de sécurité selon 2006/42/CE annexe IV<br>MSI (Module d'interface de sécurité )<br>(-s, -sx), (-i, -ix), (-m, -mx), (-mE, -mxE)<br>N° série voir plaques signalétiques** |
| Angewandte EG-Richtlinie(n): | Applied EC Directive(s): | Directive(s) CE appliquées: |
| **2006/42/EG<br>2004/108/EG** | **2006/42/EC<br>2004/108/EC** | **2006/42/CE<br>2004/108/CE** |
| Angewandte Normen: | Applied standards: | Normes appliquées: |
| **DIN EN 62061:2013, DIN EN ISO 13849-1:2008; DIN EN ISO 13849-2:2013; GS-ET-20 :10/2014<br>EN 60204:2007; EN 61496-1:2013** | | |
| Benannte Stelle / Baumusterprüfbescheinigung: | Notified Body / Certificate of Type Examination: | Organisme notifié / Attestation d'examen CE de type: |
| **Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung IFA<br>Alte Heerstr. 111<br>D-53757 St. Augustin<br>Europäisch notifizierte Stelle Nr. 0121** | / | **1001187** |
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