Safety-M
Programming Manual for the Safety-M modules

Programmng Manual

The Safety-M module and the fieldbus extension modules (BM) are catalogue products.
All other products with the title “SMX” are not catalogue products, but
can be supplied on request.

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Terms

PLC

Programmable **L**ogic **C**ontroller, is equivalent to the German term for **S**peicher**p**rogrammierte **S**teuerung (SPS). The term PLC is exclusively used within the Safety-M system.

SafePLC

Program editor for the graphical preparation of sequencing programs using the functional block method, as well as the parameterization of sensors, actuators and other technological functions used.

Safety-M

Modular safety control with integrated technological functions. The behaviour of the Safety-M system is defined by a user configuration and the associated logic operations.

Function block (functional module)

Module in a PLC-control that influences the program sequence of a PLC-program either physically or logically. A physical (hardware) function block is e.g. a button or an output of the Safety-M module. However, the logic operation (such as “AND” or “OR”) of input and output signals within a PLC is also referred to as a function block.

Function block diagram (function block diagram (FBD) language)

Graphically oriented, function block based, descriptive "programming language" acc. to IEC 1131, serving the purpose of visualizing logic operations of inPorts and outPorts on function blocks of a PLC control. The logic diagram shows the functional modules and their logic operations in a graphical form. (engl. Function Block Diagram FBD)

InPort / OutPort

Location on a function block which can be used for linkage to other function blocks.

Linkage

a named connection between
a.) a function block outPort and a function block inPort.
b.) a PLC inPort and a function block inPort.
c.) a function block outPort and the PLC outPort.

Connector

Connection point between the beginning and the end of a linkage with an inPort and an outPort of a function block

Attribute

Non-graphical feature of a function block. An attribute consists of a designator and a value.

Routes

Horizontal and vertical alignment of linkages in a logic diagram, so that intersections with function blocks are avoided and linkages with identical connector are merged at an early stage (related to distance to the target function block).

Signal list

Signal lines into and out of the PLC, represented in a table.

Signal cell

Selectable area within the signal list, which can be provided with a comment.

PLC input signal list

Signal lines entering into the PLC, represented in form of a table. In ***SafePLC*** the PLC inPorts can be designated by the user. They have an unambiguous number and must be assigned to the inPorts of a function block.

PLC output signal list

Signal lines leaving the PLC, represented in form of a table. In ***SafePLC*** these outPorts can be designated by the user and, just like the inPorts, have an unambiguous identification number.

Instruction list (IL)

Assembler-like programming language that can be loaded into a central Safety-M module. The duty of ***SafePLC*** is the generation of an command list based on defined function blocks, as well as their attributes and linkages.

Compilation

Compilation and verification of the function plan created in SafePLC and the associated parameters.

Function block group

Classification of function blocks according to their positioning ability in the logic diagram (inPort, outPort, logic).

Function block types

More detailed identification of function blocks within a group. (e.g. "Emergency Stop")

Message window

Output window with several lines, embedded in a Windows Toolbar element. This display window is used for the output of errors, warnings and information from the program to the user. The message window can be switched on and off.

Info display

Delayed display of information about a function block, following the Windows Tool Tip mechanism. The mouse pointer must be dragged across an object to display this information.

Configuration

Configuration is the generic term for a monitoring program and the associated parameter for permissible deviations or minimum and maximum values. In this context it is important to note that a monitoring program always comes with further data that the program can refer to.

Mouse and keyboard commands

Mouse dependent actions

- **Left mouse button on a function block** Selected representation (highlight), whereby previous selections become invalid.
  Note: If the CTRL key is pressed while "Setting Markers", the associated "Marker OutPort" blocks will also be selected.
- **Shift + Left mouse button on function block**: Multiple selection (adding to an existing selection).
- **Ctrl + Left mouse button on selected function block**: Deselection of block (removal from selection).
- **Delete key**: Deletes the elements of an existing selection incl. connections!
- **Double-clicking on function block**: Editing of settings.
- **Right mouse button on a function block:** Display of context menu for function block.
- **Right mouse button in drawing area:** Display of context menu for drawing area.
- **Left mouse button on connector**: Highlights the existing linkage(s).
- **Ctrl + movement of mouse pointer over an object**: Display of information data, even if the display has been disabled via menu.
- **Turning the scroll wheel on the mouse**: Dynamic zooming of the logic diagram.
- **Moving the mouse with the scroll wheel is held down**: Moving the logic diagram.

Keyboard commands

- **Ctrl + Q**: Start zoom-in command
- **Ctrl + W**: Start zoom-out command
- **Ctrl + A**: Zoom all command
- **Ctrl + I**: Switch automatic info display on/off
- **Ctrl + O**: Open file
- **Ctrl + S**: Save file
- **Ctrl + M**: Switch notification window on/off
- **Ctrl + N**: New file
- **Esc**: Deselection of marked elements
- **Erase**: Erases selected objects
- **Ctrl+arrow left**: Logic diagram LineScroll left
- **Ctrl+arrow right**: Logic diagram LineScroll right
- **Ctrl+arrow up**: Logic diagram LineScroll up
- **Ctrl+arrow down**: Logic diagram LineScroll down

Brief Description of Procedure

The program SafePLC is a graphically oriented editor for the creation of a PLC-based monitoring program for an Safety-M system.

General note

The program requires write and read permission of the user logged on to the PC that is used for programming. Missing access rights can lead to side effects in logic diagram debugging or cause problems when saving logic diagrams to directories with limited rights.

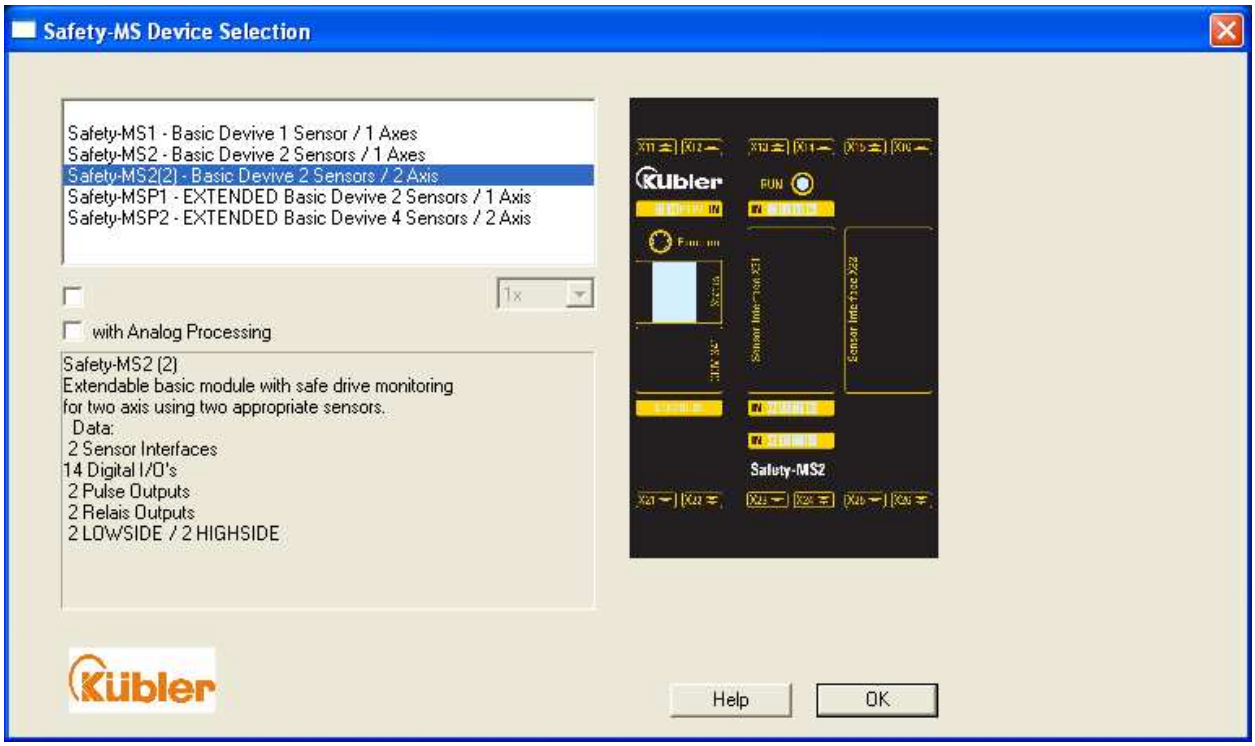
"Push & Pop" when inserting function blocks

Click on an icon in the toolbar or a menu option ("Push") to switch into insert mode. This mode is identified by a different mouse pointer. Simply click on the corresponding location to insert ("Pop") the selected function block. The "Esc"-key cancels this mode.

Please proceed as follows to create an application:

1. Selection of the device type to be programmed

Once ***SafePLC*** has been started, or if a new logic plan is created, the following selection dialog will appear.



In a first step the system resources to be used must be selected on the module level.

- Selection of basic module
- Number of I/O expansion modules See also: Equipment expansion
- For equipment with analog processing set the corresponding switch

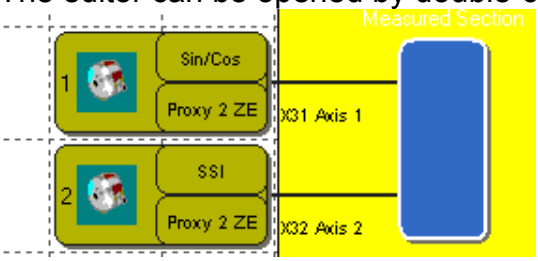
Note:
Due to the associated resources and their management in the programming environment, the set equipment type can no longer be changed at a later date.

2. Determination of periphery in terminal diagram

The terminal diagram represents the connections to sensors and actuators of the Safety-M system.

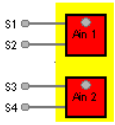
The following procedure is recommended:

- For modules with speed and position monitoring the definitions of sensors used and their parameters are required.
  The editor can be opened by double-clicking on the sensor configuration icon:



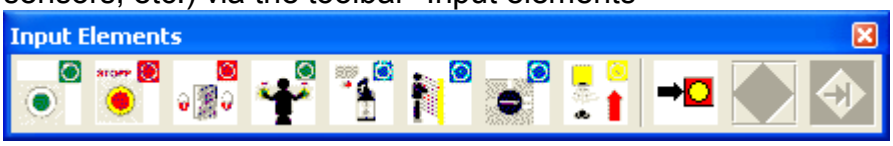
  Note:
  A red icon indicates the missing parameterization.

- For a module with analog processing the interfaces used must be parameterized.

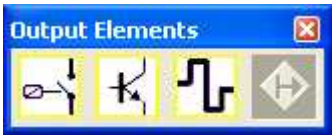


  Note:
  A red icon indicates the missing parameterization.

- Selection of input and periphery modules (Emergency Stop, safety doors, sensors, etc.) via the toolbar "Input elements"



- Selection of required output modules (semi-conductor output, relay output, etc.)



3. Definition of monitoring functions and logic modules in the logic diagram

The logic diagram shows the logic modules and their internal linkage

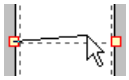
Programming the logic diagram by using:

- Logical and processing elements.

- Monitoring modules for drive monitoring (this is only possible if the associated sensors had been defined).

- Timers, flip-flops (trigger elements) and terminal blocks.

After choosing the required modules, these are subsequently linked with each other.


For this purpose drag the mouse pointer across a "start connector", press the left mouse button and connect via a "target connector" in active state. Conclude this process by releasing the left mouse button.

Programming support by other diagnose and analysis tools.
This includes the info display, signal tracking, display of function block attributes in the message window , as well as quick localizing of modules in the logic diagram by double-clicking on the coloured BlockID in the message window.

4. Compilation of monitoring program

After completion of the programming process the logic diagram is compiled and transformed into a machine-readable format.
This process consists of:

- Examination of open connectors in the logic diagram
- Examination of boundary conditions for the monitoring functions
- Examination of the correct assignment of input signatures
- Creation of a machine readable format for the Safety-M system

5. Program transfer to basic Safety-M module

- Setting the COM outPort

- Transfer of the machine program
- Testing the program on the Safety-M module
- Disabling the logic plan after approval
- Preparation of the configuration report and validation of the configuration

Logic Diagram

SafePLC saves the configuration, the program sequence and the chosen parameterization as a Windows documents with the file name extension "*.plcSMX".
The logic diagram is subdivided into fields, which can take up the function blocks. The function blocks are inserted and displaced within this raster. Overlapping of function blocks is not possible.
Within the logic diagram the two views "terminal diagram" and "logic diagram" are available to the user.
The programmer is able to toggle between the following views as desired:

- **Menu**: View -> Change layout
- **Keyboard**: Crtl + Tab
- Control button in the toolbar **"Drawing Aids"**

Permanent status display:

In the top left corner of the logic diagram is a status display with the following meanings:

- **Active logic diagram view**: Text "terminal diagram" or "logic diagram" in compliance with the chosen context.
- **Actual diagram access**: Padlock symbolizes locked diagram.
- **Compiler status**: The background colour of the status display has the following meaning:
  - **Red**: Logic diagram has not been compiled or is faulty
  - **Green**: Logic diagram has been compiled without faults, diagram can be transferred to the Safety-M system.

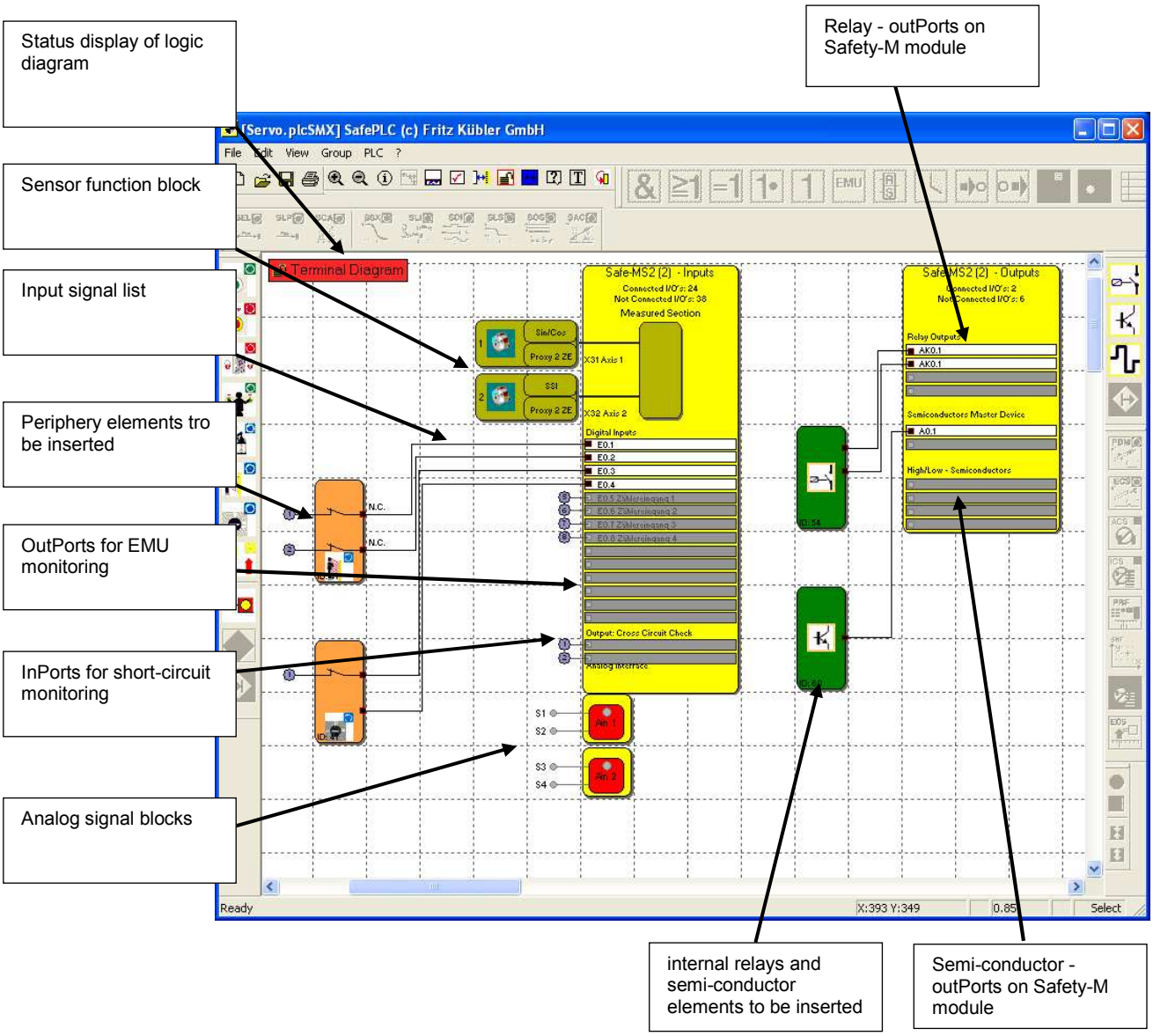
Terminal Diagram

The terminal plan describes the external port assignments in a Safety-M system to the chosen sensors and actuators. When creating a new diagram (File->New...) the terminal diagram shows all available inPorts and outPorts, as well as further sensor interfaces (encoders, analog sensors).

Definition of sensor interface:
Determination and parameterization of sensor interface and analog interface

Definition of inPorts and outPorts:
Selection and parameterization of inPorts and outPorts

When inserting a new, or double-clicking on an already existing function block, the associated attribute editor is opened, and the parameters can be modified.



If function blocks are inserted into the terminal diagram, the elements will automatically be wired. In some instances it may happen, that the connections are unfavourably displayed. However, this does not affect the function! When moving the corresponding block, the connecting wiring will be redrawn and may appear more favourable.

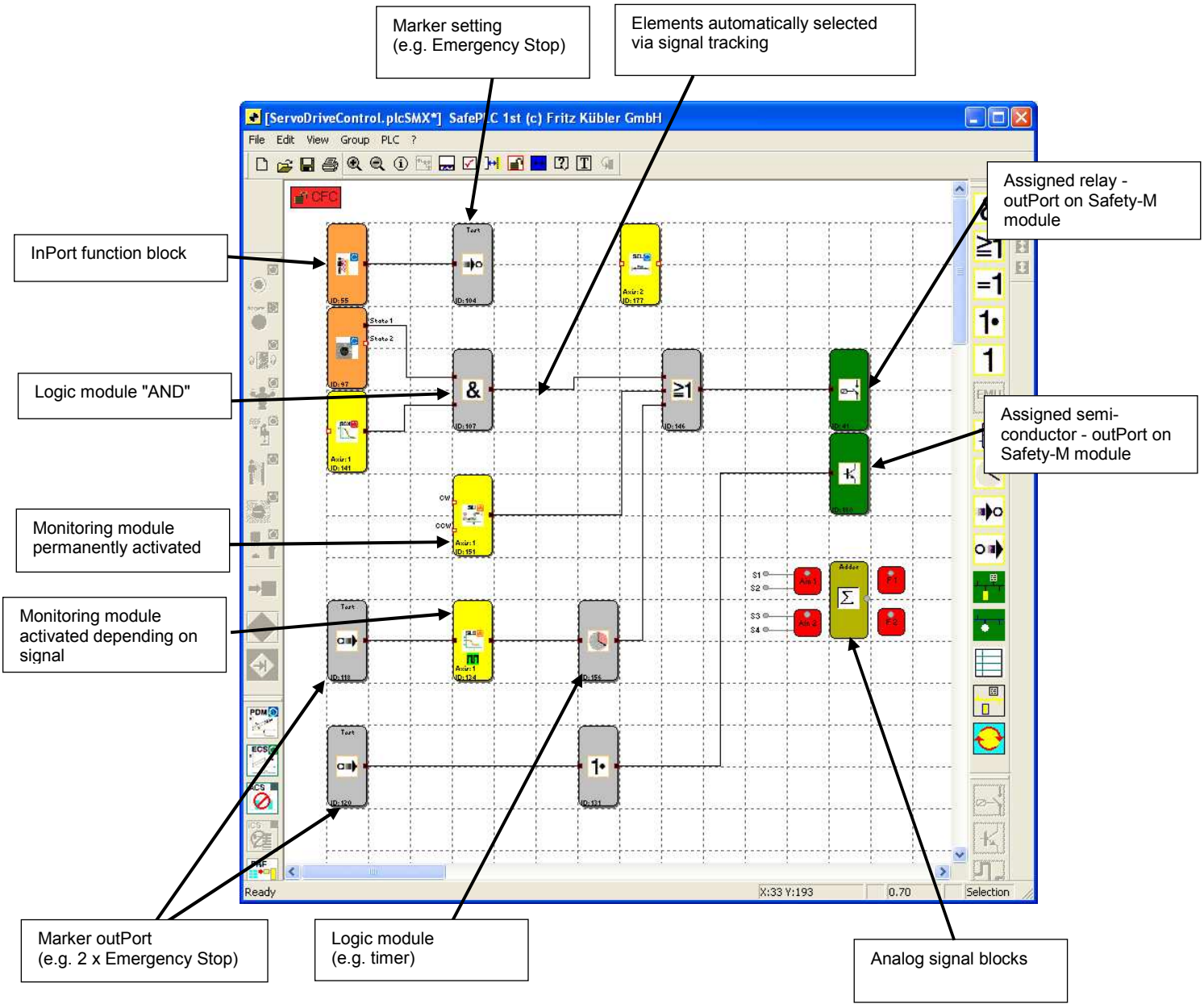
Tip: Start at the left edge of the logic diagram and add modules from top to bottom.

Note: Since no logic elements must be defined in this view, the corresponding commands are disabled.

Logic Diagram

In the logic diagram, linkages take place between inPort, monitoring, outPort and logic modules.
In this respect the outPort connectors on the inPort elements correspond with the input data of the logic diagram. In the same way the inPort connectors of the outPort elements must be viewed as output data of the diagram.

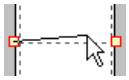
In order to be able to create a clearly structured logic diagram, one can define so-called terminal blocks. These represent a named connection between inPort and outPort connectors of function blocks. One or several marker outPort blocks (outPort terminals) can be defined for a marker setting block (inPort terminal) .



Tip:
Use the comment line for connecting point inPorts. This information simplifies the use of complementary connecting point outPorts. This contributes to clarity!

Note: Parameters of inPort elements cannot be modified in this view.

Preparing the Wiring


The assignments in the logic diagram are created by linking the inPort and outPort connectors of the functional modules. An outPort of a module may, if necessary, be connected with multiple inPorts of other modules, whereby any inPort must only be assigned once. Apart from this, certain module groups cannot be interconnected for technical reasons. In case of an invalid connection the program will display a corresponding message.

Connection set-up:

- Select a start connector with the left mouse button
- Hold the left button activated and position the mouse pointer
- deactivate the button when the pointer is on the target connector

Note: Connections can only be selected with a mouse click or by choosing a connector.

Tip: If all connections of a module are to be deleted, one should delete the associated function block. The connected connections will in this case be automatically deleted.

Automatic connection

The editor routes a new connection automatically. The graphics display can be varied and the overall presentation optimized by simply moving the function blocks. In complex diagrams it may happen that a connecting line will intersect with a function block. This behaviour has no influence on the internal function of the linkage.

User defined connection

A command for the drawing of user-defined connecting lines is also available. These will remain existent, until the dislocation of an associated function block forces the recalculation of the control points (see automatic connection)
A user defined connection is set up as follows

1.) either by selecting the connection to be edited and invoking the command: "User defined connecting points" in the "Edit" menu.
2.) or by opening the context menu (right mouse button) while the mouse pointer is positioned on the corresponding connection and selecting the command "User defined connecting points".
3.) Input of control points for orthogonal connecting lines, i.e. the connecting lines always run horizontally and vertically. The program connects the entered points, until the drawing command is terminated.
4.) Conclusion of command with the enter-key (return) and drawing of the connection by the editor.
Note: The program matches the first and the last control point to the associated function block connector. The inPort and outPort connector is not considered a control point and does therefore not need to be specified.

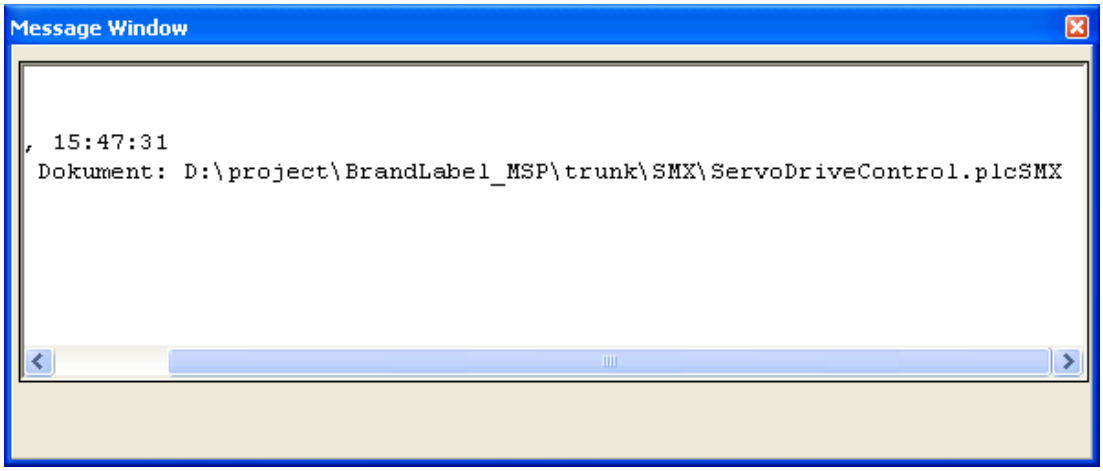
Tip: Visual corrections to the logic diagram should only be made just before the logic diagram is blocked. Only then the layout is complete and the blocks do not need to be displaced any more.

Notification Window

Besides the output of status and error messages as well as the display of results from the examination of the logic diagram, the messages window is also a powerful tool for checking function block data within their context.

Quick Jump

By double-clicking on the colour-coded BlockID's in the message window one can have the associated block centred in the logic diagram window. This enables quick localization of function blocks belonging to an output.



Context menu in message window

Message window Hides an active message window.

Clear window Deletes the contents of the message window.

Select all and copy Copies the entire contents of the message window into the clipboard, making the text available for other Windows programs via the "Insert" command.

Search To find text within the message window.

Help on message window Opens the help page

Docking of message window Two-way switch to enable the message window to dock to the frame of the main program or to position the window freely on the screen.

Note: The "docking" behaviour for the message window of the application can be configured in the menu "File->Settings".

Program Creation

After the program has been finished, the compilation process can be started by invoking the compiler. The compilation process starts the following internal processes.

Verifying for open connectors
SafePLC makes sure that all connections between function blocks can be opened. Unconnected connectors are recognized as faults.

Verifying for unreferenced "Connecting point" Blocks
SafePLC makes sure that all "connecting point" blocks inserted in the logic diagram are used. Unsolved references are recognized as faults.

Verifying the value ranges of the monitoring functions
SafePLC verifies whether the parameters of the monitoring functions comply with the currently chosen value ranges of the sensor interfaces, before the machine-readable code is generated. This verification does not replace the context-related evaluation of data after changes made by the user!

Creation of the instruction list (IL)
The IL-code created on basis of the function blocks is displayed in the message window, where it can also be verified, The code segments associated with the function blocks are identified by the corresponding BlockID.

Creating the OP code
Generation of a machine-readable code for the Safety-M system, which is then transferred together with the parameter data.

Message window
All results of the compilation process are reported in the message window. Should faults be found, the message window will automatically pop up.

Security CRCs
After a successful compiler run a total of three CRC-signatures are made:

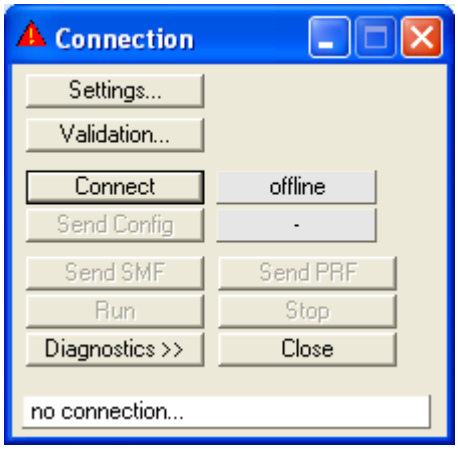
- Equipment configuration CRC: Signature concerning program and parameter data
- Parameter CRC: Signature concerning parameter data
- Program CRC: Signature concerning the program

The calculated CRC-values can be displayed in off-line mode (no connection to module) via the menu "File->Diagram Management".

Important:
This display is only informative and must not be used for the safety related documentation!

Transferring the Program on the Safety-M Module

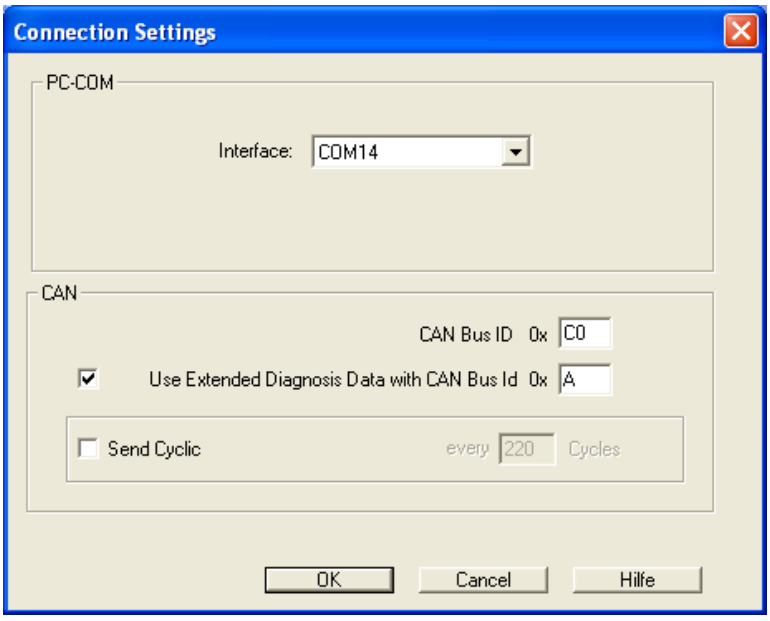
This paragraph describes the data and program transfer to a basic Safety-M module. When starting a connection request ("File-> Connection Dialog" or via the toolbar), the following window is displayed.



Connection settings

In order to be able to set up a connection with a Safety-M system, the transfer parameters must be set accordingly.

Note:
The connection between PC and Safety-M system is based on a USB/RS485 interface. This requires fault-free installation of the correct driver. This driver is included in the scope of delivery and is located in the installation directory of the ***SafePLC*** programming environment (directory `RS485_USB_Treiber`).



PC-COM
The COM interface used by the Windows driver must be set.

CAN Bus
Address setting for diagnostics channel via CAN bus. The setting uses the hex data format.
Address of the 1st CAN telegram: 0x001 to 0x063 or 0x83 to 0x7FF.

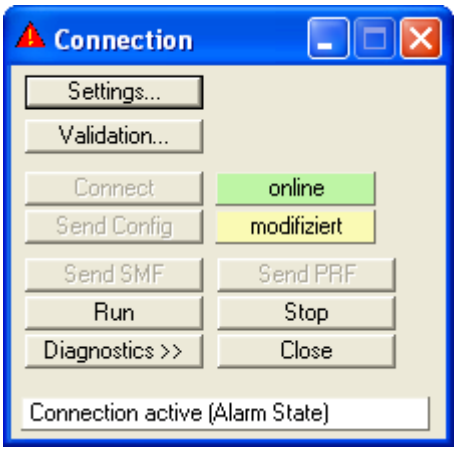
Activating extended data with CAN bus
Address of the 2nd CAN telegram: 0x001 to 0x063 or 0x83 to 0x7FF.
The value must not be the same as the 1st CAN address.

Cyclic transmission
This option can be used to set the Safety-M system transmission interval in cycles (1 cycle = 8ms).

Connection dialog

Connect: Starts the connection to the Safety-M system

Quit: Cancels an active connection.



Send configuration: Transmits the configuration of the logic diagram to the Safety-M system. This is only possible in "Stop" mode.

Start: Starts the sequencing program

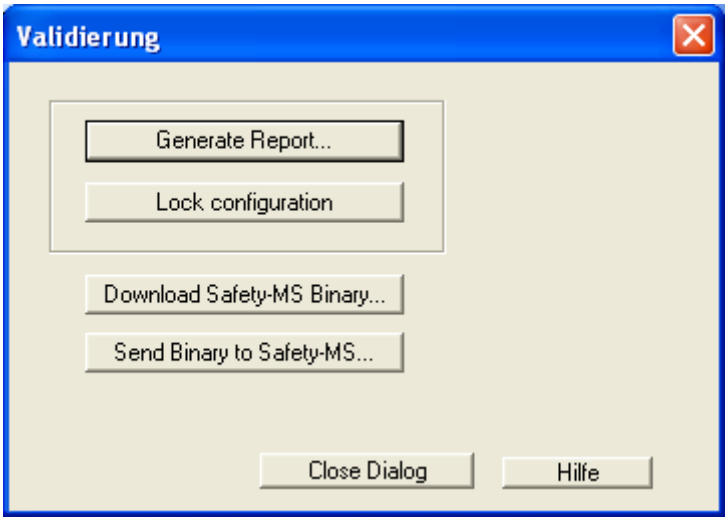
Stop: Stops the sequencing program

Diagnose >>: Extends the dialog by the diagnose function
(see diagnose of a transferred program).

Validation:
Opens the validation dialog

Validation dialog

The proper performance of a validation in conformance with the demanded safety regulations is described in the chapter "Validating an Safety-M system".



Generate report
Generation of a validation report.

Disable configuration
After each transfer of configuration data to an Safety-M system, these data are marked as "not validated". The basic group signalizes this by means of a yellow flashing status LED. The command "Disable configuration" disables access to the configuration data in the basic group. This is indicated by a green flashing status-LED.

Read out binary file from Safety-M…
Reads out the current Safety-M equipment configuration in a machine-readable form. These data are not changed by SafePLC and can be saved to the drive in this form.

Send binary file to Safety-M…
Transfer of a machine readable equipment configuration from the PC drive to the Safety-M system.

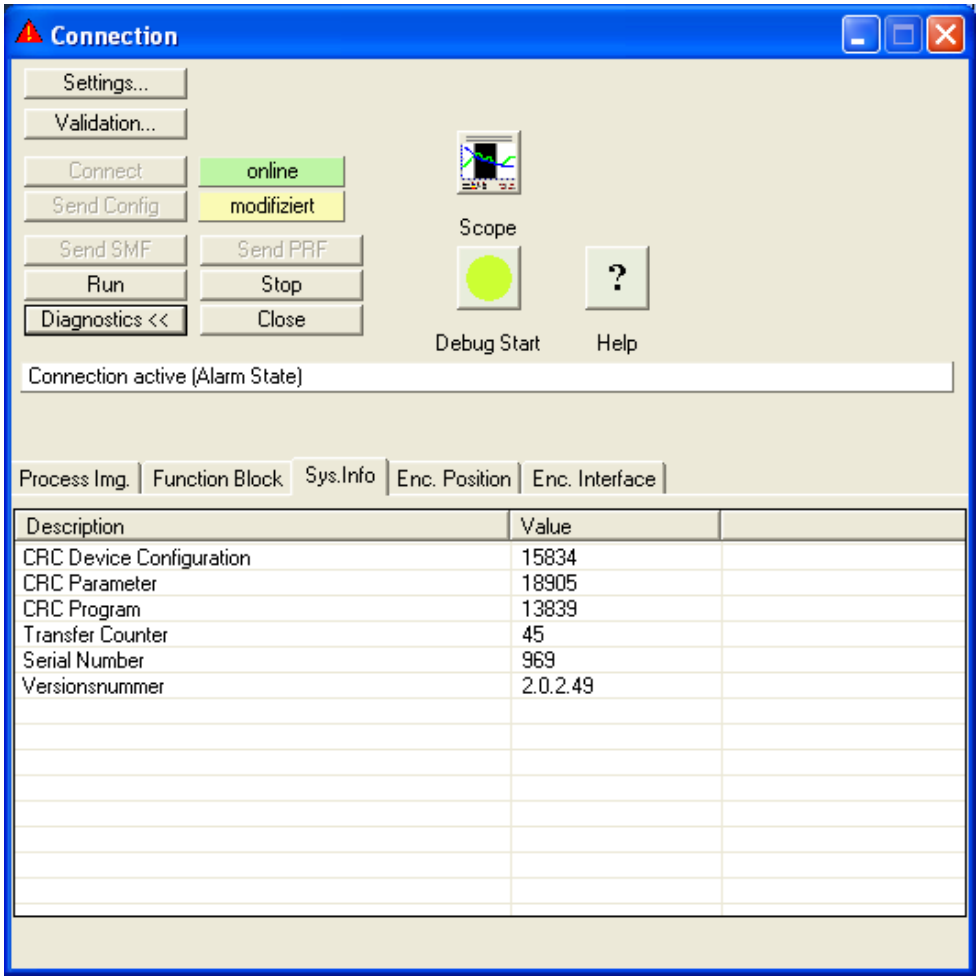
Note:
When transferring machine-readable program and parameter data, organizational measures must be applied to ensure that the currently valid equipment configuration conforms with the safety related documentation of the machine or system.

Diagnostic Functions

When clicking on the diagnostics button the connection dialog is extended by additional diagnostics elements.

Diagnose Start: Two-way switch to start and stop the diagnose: The corresponding mode (= Off = On) is also displayed in the dialog text, so that feedback about the current status is available, even in case of a minimized dialog. After a successful start of the diagnose, the inscription of the switch will change to **"Diagnose Stop"**.

Note: A correct diagnose requires the adjustment of data between logic diagram and equipment configuration. A missing logic diagram or a discrepancy between the available logic diagram and the equipment configuration only permits a limited diagnose. The functionality "Diagnose function modules" is not available in this case.



(Scope): Opens the Scope monitor dialog. This enables the representation of various process data.

Process image: Visualization of the inPort/outPort image of the Safety-M system.

Logic diagram: Enables selective monitoring of memory states of pre-selected function blocks.

System info: System information about the Safety-M module. As follows:

Parameters	Description
CRC equipment configuration	CRC signature concerning program and parameter data
CRC parameters	CRC signature concerning the parameters
CRC program	CRC concerning the program
Transfer counter	Status of an internal transfer counter. This counter is incremented during each transfer action to the Safety-M system and can be used as reference for the purpose of documentation.

Serial number	Current serial number of the equipment
Version number	Firmware version number

Sensor position: Shows the original value of the connected speed/position sensors.

Encoder interface:
Shows the transverse mode voltages of the encoder driver modules interface 1 and interface 2 as well as the status of the inPort bridges in the encoder interface.
If one of the values for the voltage condition is 0, the encoder is defective or not connected.

Voltage values of the two analog voltage inPorts on system A and system B (e.g. SMX 12A) are also shown:

- System A analog pass1: Analogue voltage AIN1
- System B analog pass1: Analogue voltage AIN2
- System A analog pass2: Analogue voltage AIN3
- System B analog pass2: Analogue voltage AIN4
- System A / system B AnalogFilter1: Evaluate voltage AIN1 with AIN2
- System A / system B AnalogFilter2: Evaluate voltage AIN3 with AIN4
- Analogue adder: Voltage after adding circuit

Procedure for logic diagram diagnose

When running a logic diagram diagnose, the current inPort and outPort states of the function blocks are displayed according to their logic condition "0" or "1" on the selected module.

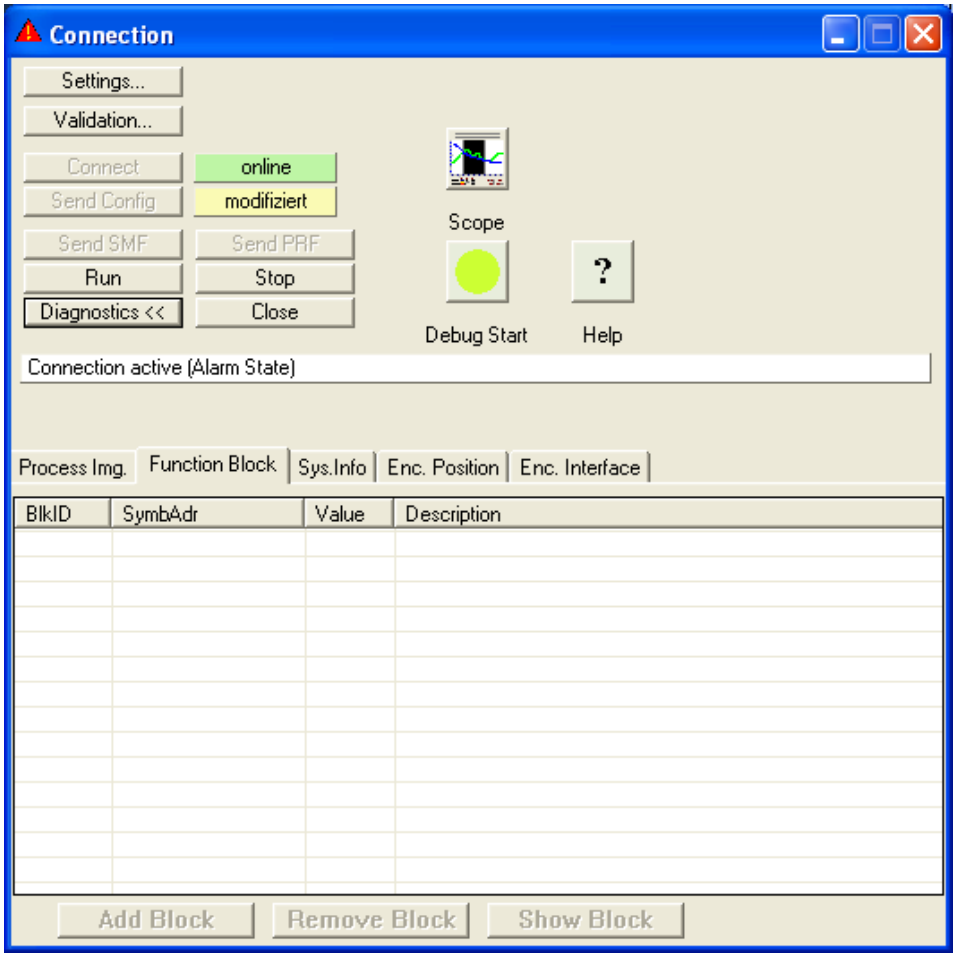
Please proceed as follows:

Step 1: Selecting the diagnostic function
Select the diagnostic function by activating the "function modules" tab via: Connection->Diagnose->Function modules.

Step 2: Selecting the data to be displayed
Selection of the function blocks desired for diagnose in the current context . The connectors for the highlighted modules are added to the diagnose list via the control button "Add". In contrast to this, entries can also be deleted from the list by selecting them and clicking on the control button "Remove".
Double-clicking on a list entry shows the associated data path in the logic diagram. This functionality can also be achieved by using the control button "Show".

Note: The symbol addresses shown in the list are also used in the compilation and in the validation report.

Tip: The "Select all" command from the context menu (right mouse button) can be used to select all data from the logic diagram.



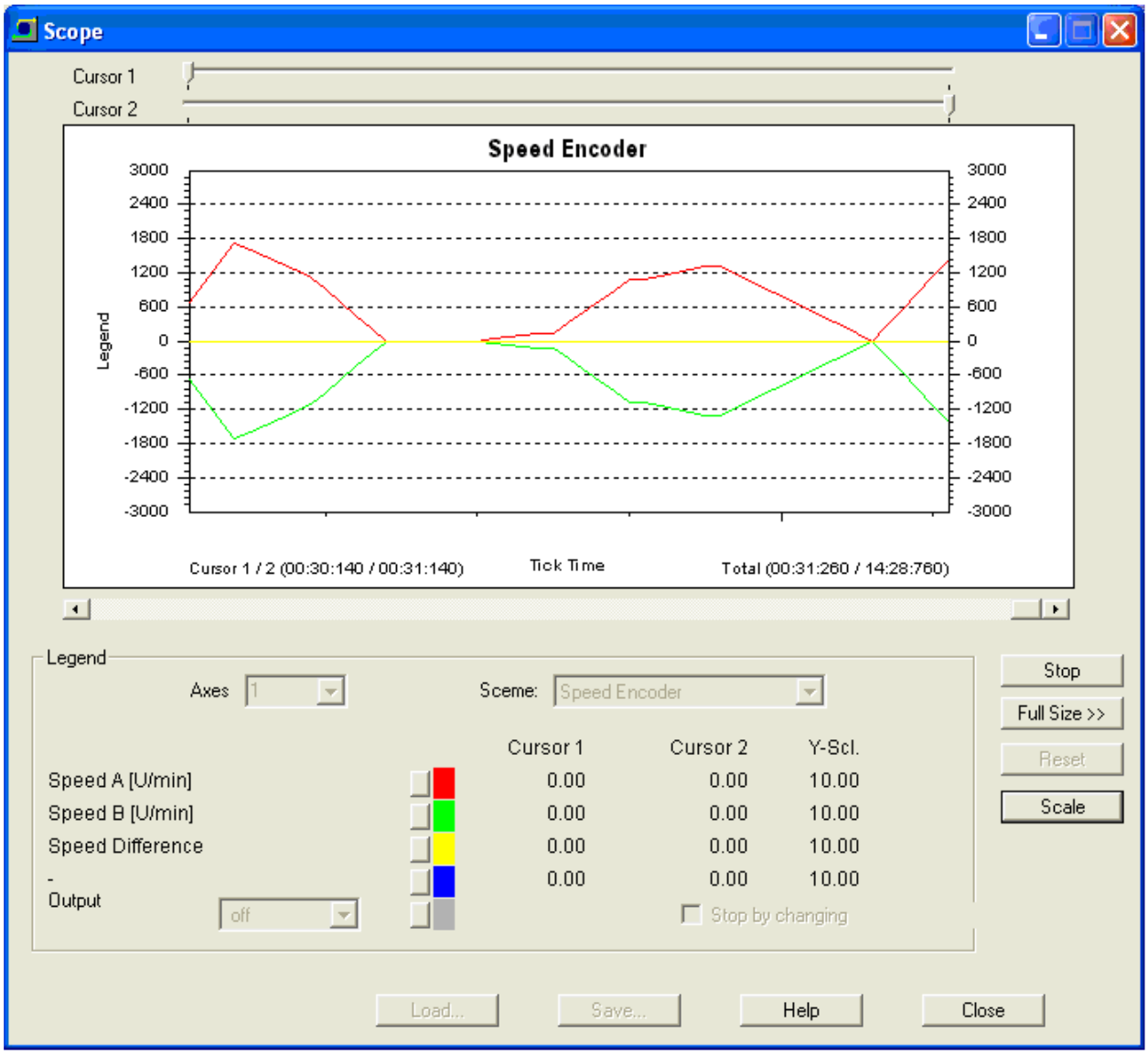
Step 3: Starting the debugger
The selected data can only be diagnosed if the information in the logic diagram corresponds with the information in the actively connected Safety-M system. The adjustment is made by clicking on the control button "Diagnose Start".

Note: The implemented debugging function requires intensive data transfer between Safety-M system and ***SafePLC.*** This results in a temporally delayed display of the data. Quick status changes on module outPorts may therefore not be detectable.

The diagnose is solely available in the operating mode "Run". In any other mode of operation the process image is passivated.

The Scope Monitor

Parameterization of drive monitoring requires exact knowledge of process data in terms of the Safety-M system. Knowledge about the temporal course of speed, acceleration and position is of utmost importance. Only this enables the setting of correct threshold values and limiting parameters.
All available graphics functions read the required process data ONLINE from the active basic Safety-M group through the communication interface for time-based representation. Up-to-date values are inserted at the right border of the Scope Monitor, moved further to the left during recording, until they finally disappear at the left border of the screen. Although these data have disappeared from the visible window, they are still maintained in a buffer memory and can still be moved back into the visible area by sliding the scroll bar below the graphics window.



Note: With an active Scope Monitor the output of debugging of process image and logic diagram is hidden and the diagnostics tabulator is blocked throughout the connection dialog. These data cannot be made available in this mode.

Cursor 1, Cursor 2: With these slide controllers two cursor positions for displaying specific diagram values are available. Changing the position of the slide controller moves a display line in the diagram. The Scope window shows values for the corresponding cursor positions in form of a legend. Time related assignments of the cursor positions are also available.

Scaling
Opens a dialog to scale the displayed diagram function. This enables the adaptation of the Y-values in the individual graphs by means of a multiplication factor.

Start / Stop
Start or stop recording

Maximize >>
Enlarges the Scope Monitor to the complete available screen area. With the control button "Normal <<" the dialog can be reset to standard size.

Scheme:
The "Scheme" function is used to select the current context for the desired visualization. The meaning of the displayed process data, which are displayed in different colours for reasons of clarity, changes in dependence on the selection made. Changing the scheme during a progressing measurement is not possible.

Output
A basic group outPort, if its current status is indicated as HI/LO ("1" or "0") in the monitor, can be selected from this list. This enables the assignment of the drive shut-down to the process data.
For reasons of differentiation the graph of the outPort status has a slightly larger line width.

Stop with change
If the switch "Stop with change" is set, recording will stop 2 seconds after an edge change of the specified outPort (see above). This function enables long-term recording and fault analysis with no operator present.

Save…:
During "Stop" condition, it provides the option to save the current recording in a file.

Load…:
This button can be used to reload a recording into the scope and display it.

Procedure when measuring with the scope

After the Scope Monitor has been started it is still in "Stop" mode, i.e. no cyclic process data are read-in from the Safety-M system.

Note: All applications with increased resource requirements (e.g. mail program) should be quit before starting the recording!

Preparing the measurement

Choose the desired measuring scheme first!

In case of a speed-oriented measurement the current recording time for the corresponding axis is displayed on the X-axis. The measured data for the graph are read by the module, standardized and displayed with the correct time reference. The recording memory takes approx. 15 minutes.
The measuring process is automatically stopped when the buffer memory is full. The previous measurement is automatically saved under "ScopeTempData.ScpXml".

With position-oriented measurement, the configured measuring range of the set axis is displayed on the X-axis. Cursor 1 is in "Actual Position" of the axis and is continuously updated via the data link. Cursor 2 can be displaced as required for the determination of data.

Note: When changing the scheme, any recorded data from previous measurements will be lost.
When changing the dialog size the display data must be rescaled. This requires position-oriented measuring and resetting the data buffer (SSX).

"Start" measurement

The control button "Start" is only available in case of an active connection to the Safety-M system. After clicking on this control button the data will be cyclically transferred to the buffer memory and displayed in the diagram from left to right. Active recording can be stopped with the "Stop" button.

"Stopping" a measurement and viewing data

After completion of the measurement the data can be analysed by moving the slide controllers accordingly.

Measuring schemes

Encoder data

Functionality

- Recording of scaled position values of system A and system B over the course of time.
- Recording of process values for speed and acceleration over the course of time.

Note:
Internally, the position value of system A is used to generate the process value for the position.

Application

- Scaling of the encoder systems A and B in case of position monitoring. In case of a correctly scaled encoder system, there should be no significant deviation between positions A and B, or the deviation should not exceed the "permissible deviation" set in the encoder dialog.
- Analysis and course of encoder signal for diagnostic purposes (e.g. trouble shooting, etc.).
- Acceleration and speed behaviour of the drive.
- Detection of thresholds.

Encoder speed

Functionality

- Recording the current speed of system A and system B over the course of time.
- Recording the difference of speed signals from system A and system B over the course of time.

Note:
Internally, the speed value from system A is used to generate the process value for the speed.

Application

- Scaling of the encoder systems A and B in case of speed monitoring. In case of a correctly scaled encoder system, there should be no significant deviation between speeds A and B, or the deviation should not exceed the permissible "speed threshold" set in the encoder dialog.
- Analysis and course of encoder signal for diagnostic purposes (e.g. trouble shooting, etc.).

SSX data

Functionality

- Recording of process data for speed and acceleration over the course of time.
- Recording of speed limit for the monitoring function over the course of time.

Application

- The diagram shows the dynamic behaviour of the drive by visualizing speed and acceleration.
- With the SSX not activated, the limiting speed remains zero.
- When activating the SSX-function, the limiting speed is taken from the current speed and projected down.
- If the drive with its current speed remains below the limiting speed, the system will not be shut down.

SEL 1 / SEL 2 data

Functionality	• Recording of process data for speed and acceleration over the position or the course of time. • Visualization of current position in form of the parallel-moving cursor. • Visualization of the current stopping distance in form of a trailing pointer.
Application	• The diagram shows the dynamic stopping distance value as minimum value for the braking distance. • Examination of the set parameter values in the SEL-function, examination of the available reserve for shut-down.

Diagram Management

With the diagram management, the logic diagrams can be locked against unintended or unauthorized modifications. It also provides documentation possibilities for program creation.

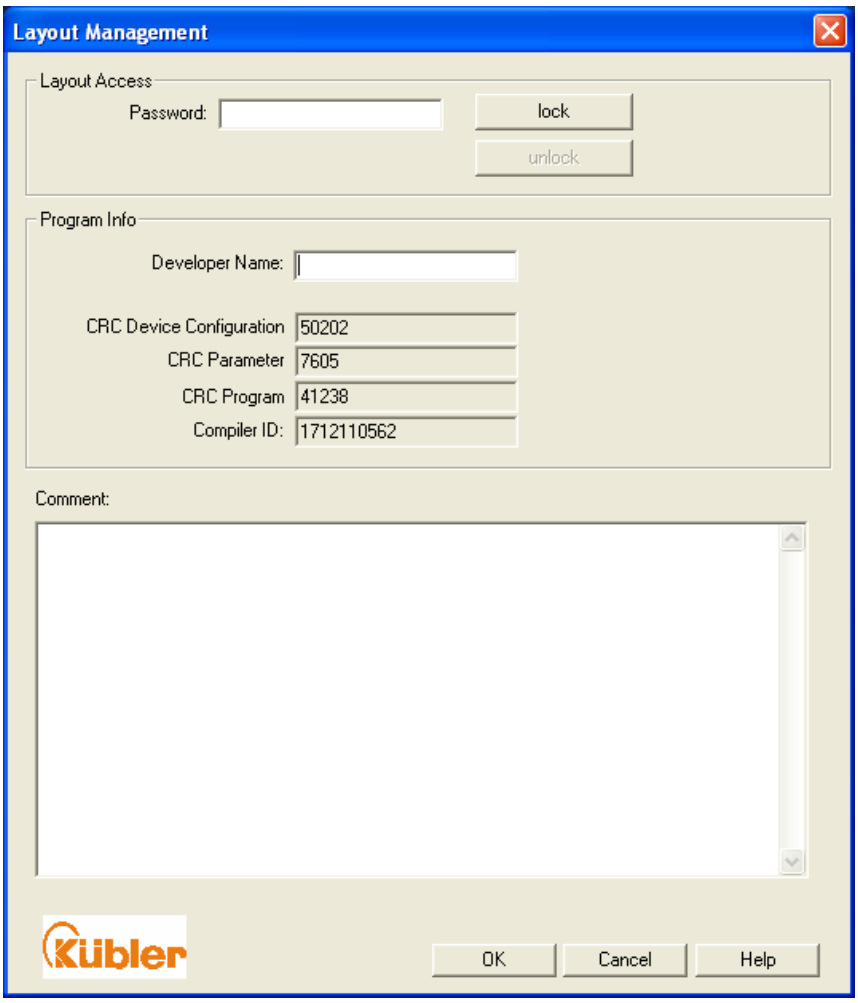


Diagram access

Here, one can disable or enable access to the function blocks in the current logic diagram. This means, that in a locked logic diagram all menu options and toolbars for adding function blocks appear in grey (= locked). Moreover, parameters in function blocks, that had already been added, cannot be changed.
"Unlocking" requires a password. The configured values and the functional modules of a locked diagram may in this case be viewed, but cannot be modified. This functionality make sure that no changes can be made to the logic diagram by unauthorized persons.
When a logic diagram is locked, the dialog "Save File" will appear when exiting the diagram management, so that any changes made, will not be lost.

Note:
Logic diagrams can only be unlocked using the password that was applied when the diagram was locked. A locked logic diagram can no longer be compiled ! However, access to the Safety-M module is still possible.

Program information

This information serves the documentation and identification of the logic diagram.

Programmer:
Name of the responsible programmer.

CRC equipment configuration:
Signature concerning program and parameter data.

Parameter CRC:
Signature concerning parameter data, i.e. adjustment values of sensors, actuators, timers, etc.

Program CRC:
Signature of the PLC-program.

Compiler ID:
Identification of activation dongle.

Indicated CRC on the Safety-M module
Indication of the actually available CRCs on the Safety-M module by operating the "Func" button, in the following sequence

Indication of the actually available CRCs on the Safety-M module by operating the "Func" button (hold down for 1 second) in "RUN" mode:

P xxxxx1 - C xxxxx2 - Lxxxxx3

xxxxx1 -> Signature concerning program and parameter data
xxxxx2 -> Signature concerning parameter data
xxxxx3 -> Signature of the PLC-program

Note:
If the CRC is used for the test report, it is recommended to lock the logic diagram, in order to prevent accidental modification.

Comment:
This input field provides a descriptive field for the input of any text. Here one can document e.g. program or parameter changes during the life cycle of the currently used device.

Configuration Report

SafePLC uses the validation function (Connection->Validation) to create a configuration report for the equipment configuration. This function is only available in case of an active connection to an Safety-M system.
The report is saved in a file and can subsequently be edited.

Attention

The hardcopy file serves as model for the safety related examination!

Note

The report can only be created after the logic diagram has been saved.
The generated text file (*.txt) has the same name and is located in the same directory as the associated logic diagram.

1. **Step: Editing the report header**

   The following fields can be edited in the header.

   Equipment: Code designation of equipment

   Customer: Operator of equipment

   Supplier: Manufacturer of machine / equipment

   Installer: Information about commissioning of equipment

2. Step: Filling in the equipment description

Equipment designation: describes the functionality or field of application of the equipment

Installation location: describes the exact location of the equipment

End customer: Operator of equipment

Short description: safety related equipment features

Description of function: safety related equipment features to be monitored by the safety module.

3. Step: Individual proof

Serial-no. from:	Designation in wiring diagram
Element:	Module type (see label)
Designation:	File name of logic diagram
Place of installation:	Designation of control cabinet that contains the safety module

Manufacturer and type are fixed.

Serial number: Serial-number of the safety module (sticker)

Identical with sticker: must be activated acc. to the entered serial number.

Equipment variant:

PLC-function	: Module without safety bus
Position processing	: Module with position processing (can be set in the encoder dialog)

The CRC-signature of the configuration set must be entered in handwriting after the report has been printed out (CRC is displayed in the "Logic Diagram Management" or in the 7-segment display).

Identical with module: Here, the responsible tester confirms that the CRC's displayed in the programming desktop are identical with the CRC stored in the equipment.
(Note: The CRC in the equipment can be read out via the seven-segment display by simply pressing the function key in "RUN-Mode")

Checking the correct function:

1. The correct program and parameter data must be loaded to be able to generate the validation report!

2. The test engineer must once again validate all configured data in the printed report by providing evidence of the programmed functions on the equipment / machine.

3. All parameterized limiting values of the monitoring functions used must be checked for correctness. Attention must be paid to the response times mentioned in the installation manual.

4. A successfully executed validation should be completed by clicking on the control button "Lock validation".

Note:

If a new configuration is loaded to the Safety-M system, the system LED will, in case of fault-free operation, subsequently light ***YELLOW***. This signalizes a non-validated application! When actuating the control button "Lock validation" while actively connected with the module, the LED will subsequently flash ***GREEN***.

Program Development Aids

Program development aids can be found in the "Drawing Aid" toolbar in the top left corner.

Info display

With the info display activated the attributes of the element touched by the mouse pointer will be displayed. The dynamics of this display can be adapted in the "File settings" dialogue. The info display can also be activated with the "Ctrl"-key. The display will continue, until this key is released again.

Signal tracking

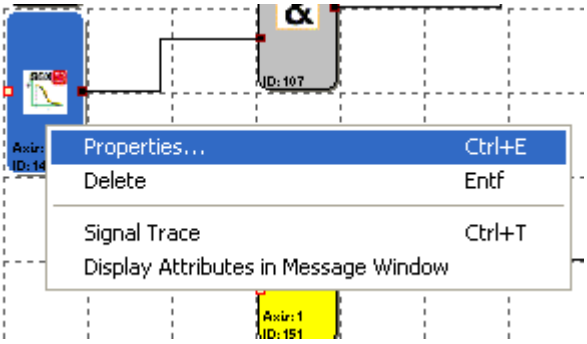
This command selects all other functional modules, which are linked with a currently selected block. This way, all coherent linkages of modules can be represented.

Tip: This function visualizes coherent areas, which are interconnected via connecting points.

Note: This command is only active, when exactly 1 function block has been selected.

Copying attributes into the message window

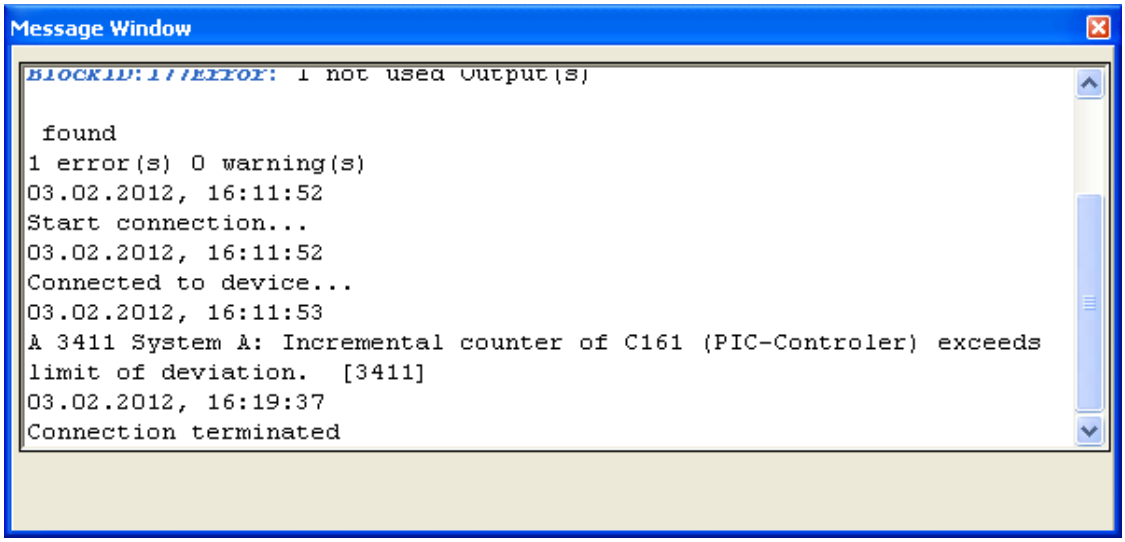
All attributes belonging to a block selection can also be output in the message window. This is possible either with the menu command "Edit->Attributes into Message Window" or via the function block context menu.



Tip: The attributes of all functional modules can be copied using the command "Attributes into Message Window". In this case no functional module must be selected.
Note: When selecting the command via the context menu, the mouse pointer must be positioned on a selected block.

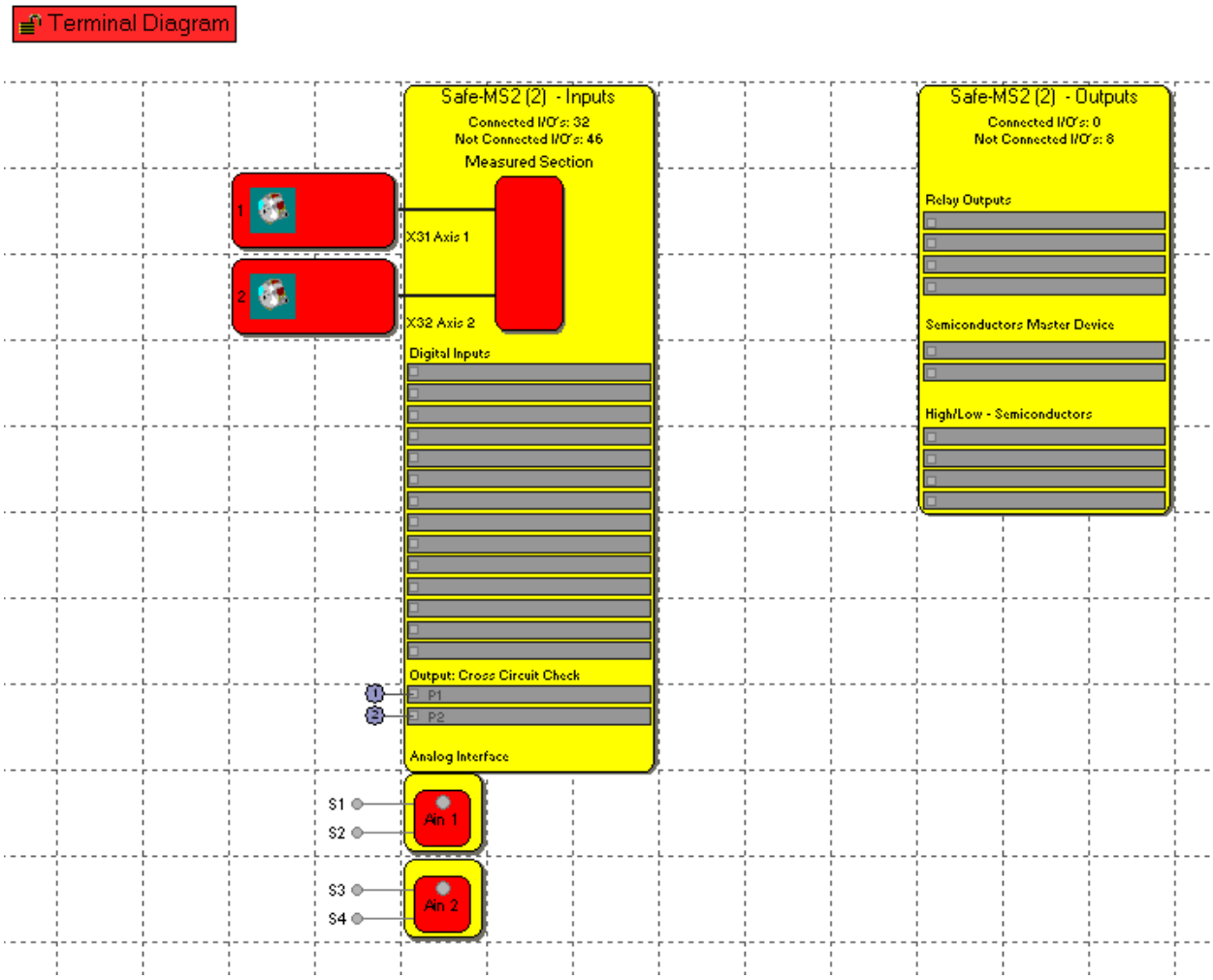
Quick selection

By double-clicking on the colour-coded BlockID's in the message window one can have the associated block centred in the logic diagram window. This enables quick localization of function blocks belonging to an output and to make necessary changes, if this is required.


Message Window
BlockID:177Error: 1 not used Output(s)
found
1 error(s) 0 warning(s)
03.02.2012, 16:11:52
Start connection...
03.02.2012, 16:11:52
Connected to device...
03.02.2012, 16:11:53
A 3411 System A: Incremental counter of C161 (PIC-Controler) exceeds limit of deviation. [3411]
03.02.2012, 16:19:37
Connection terminated

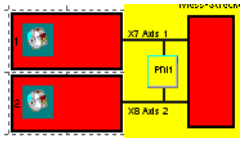
Predefined Function Blocks

Representation of the available inPorts and outPorts of the Safety-M system.



Sensor interface

This block describes the speed and position sensors, the signal list for the digital inPorts and, if available, the analog inPorts. The parameter editor for the individual elements is started by double-clicking, or via the context menu "Properties…".



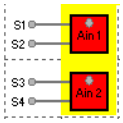
Speed and position sensors

Double-clicking on one of these elements opens the encoder configuration dialogue. The parameters to be entered are described in detail in the section "Encoder configuration".

Visualization of a PDM function used for function control of sensor monitoring

Digital inPorts

Determination of properties for digital input signals. Linkage takes place automatically when inserting the function blocks described below. Double-clicking on a signal list opens a comment window with the possibility of entering a description.



Analog inPorts

Double-clicking on this logic diagram element opens the configuration dialog to determine the analog signal monitoring. (See: Analog signal input).

Safety-M outPorts

This block consists of the signal lists for the freely programmable outPorts, consisting of relay, semi-conductor and auxiliary outPorts. As with the input signals, wiring also takes place automatically when adding the associated function blocks.

Adding InPort Blocks

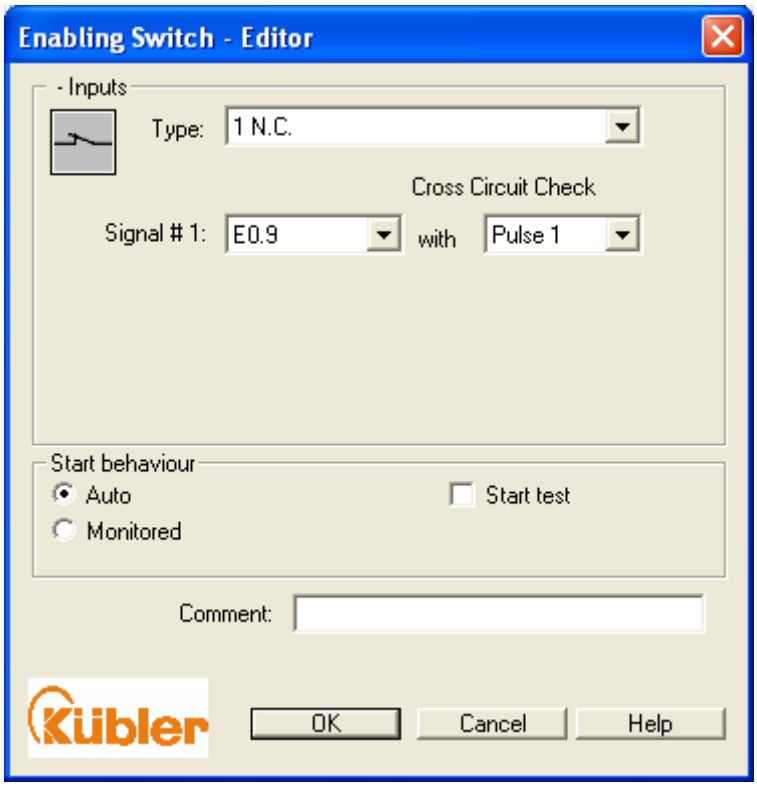
The inPort elements create the digital connection between one or several connected sensors and/or further lower-level switching devices in the ***Safety-M System***. Each inPort element, except for the mode selector switch, provides one logic output signal "0" or "1" for further processing in the PLC.

The inPort elements are added and edited in the "Terminal Diagram" view.

The resource control of the function block elements for the Safety-M system manages the available elements, the number of which may be limited.

If no further elements are available when programming the terminal diagram, the commands for adding the corresponding modules or function blocks will be disabled. This is visualized by menu options or toolbars appearing in grey. These resources can be released again by deleting the corresponding function blocks.

The inPort elements are structured according to their application (example enable button).



Note
The assignment of the selected inPort elements and their parameterization has a direct effect on the performance level to be achieved. The explanations in the installation manual for the ***Safety-M system*** must strictly followed!

The configuration of inPort elements generally takes place in the same way. The parameter editor defining the following properties opens upon selection:

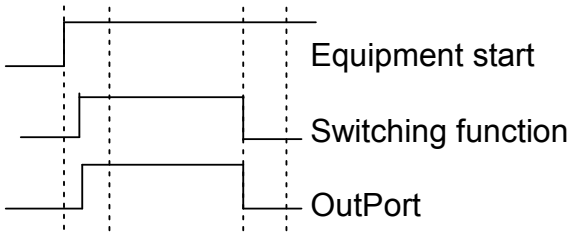
Switch type
Determination of the planned input signals. A logic input signal for further linkage in the PLC may consist of one or several external signal paths. The description of the individual elements lists the respective possibilities and combination in tabular form. For time-monitored signal types, a limited number is available.

Signal-No.
Determination of the external signal to a terminal connection of the Safety-M system. The number of available terminal connections is determined by the actually available Safety-M module configuration. Signals that are already in use no longer appear in the selection dialog. The editor always shows resource limitations within the corresponding context in a message window.

Cross circuit test
Source of the input signal used. Two signal pulses, Pulse1 and Pulse2, are available. The "OFF" option can be alternatively selected. Cross circuits in the external wiring can be detected by using the signatures.

Starting behaviour
Determination of the behaviour of an inPort element when changing the state of the logic output value in the logic diagram from "0" to "1".

automatic
Processing of the defined input signals without further confirmation or acknowledgement.

Start type	Function		Scheme
Automatic start	Automatic start after an equipment reset or after activation of switching function. OutPort of the inPort element becomes "1" when the safety circuit is closed/active acc. to the definition of the switch type		

monitored
Approval of the monitored inPort element in case of descending edge on the specified monitoring inPort. This is required at any time when the monitored inPort element is to be switched.

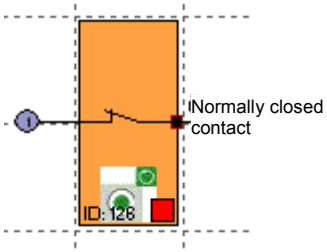
Example: Start of a drive only after this has been confirmed by the operating personnel.

With monitored starting mode an additional connector for linking with a start element is provided. Here one can configure the continuous behaviour for monitoring the inPort element during the start phase.

Start test

Manual starting after equipment reset or interruption of the defined safety circuit, including testing of the connected control station. The control station must trigger once in monitoring direction and switch back on again. Followed by normal operation. This one-time triggering of the inPort element when starting (or resetting) the monitored equipment ensures the function of the inPort element at the time of starting. A start test can be performed for all inPort elements, except the mode selector switch.

An activated start test is indicated by a red rectangle on an added function block.



Comment

Input of a comment text for display on the module.

Enable switch

Switch type	Designation	Comment
1 (eSwitch_1o)	1 normally closed	Enable switch standard
2 (eSwitch_1s)	1 normally open	Enable switch standard
3 (eSwitch_2o)	2 normally closed	Enable switch higher requirements
4 (eSwitch_2oT)	2 normally closed time monitored	Enable switch monitored

Emergency Stop

Switch type	Designation	Comment
1 (eSwitch_1o)	1 normally closed	Emergency Stop standard
3 (eSwitch_2o)	2 normally closed	Emergency stop higher requirements
4 (eSwitch_2oT)	2 normally closed time monitored	Emergency Stop monitored

Door - Monitoring

Switch type	Designation	Comment
3 eSwitch_2o	2 normally closed	Door monitoring higher requirements
4 eSwitch_2oT	2 normally closed time monitored	Door monitoring monitored
5 eSwitch_1s1o	1 normally open + 1 normally closed	Door monitoring higher requirements
6 eSwitch_1s1oT	1 normally open + 1 normally closed time monitored	Door monitoring monitored
7 eSwitch_2s2o	2 normally open + 2 normally closed	Door monitoring higher requirements
8 eSwitch_2s2oT	2 normally open + 2 normally closed time monitored	Door monitoring monitored
9 eSwitch_3o	3 normally closed	Door monitoring higher requirements
10 eSwitch_3oT	3 normally closed time monitored	Door monitoring monitored

Two-hand button

Switch type	Comment	Classification
11 eTwoHand_2o	2 normally open + 2 normally closed	Two-hand button higher requirement type III C
12 eTwoHand_2s	2 normally open	Two-hand button monitored type III A

Note: With these inPort elements a fixed pulse assignment takes place, which cannot be influenced by the user!

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Light curtain

Switch type	Designation	Comment
3 eSwitch_2o	2 normally closed	Light curtain higher requirements
4 eSwitch_2oT	2 normally closed time monitored	Light curtain monitored
5 eSwitch_1s1o	1 normally open + 1 normally closed	Light curtain higher requirements
6 eSwitch_1s1oT	1 normally open + 1 normally closed time monitored	Light curtain monitored

index

Mode selector switch

Switch type	Designation	Comment
13 eMode_1s1o	Selector switch normally closed/normally open	Mode selector switch monitored
14 eMode_3switch	Selector switch 3 steps	Mode selector switch monitored

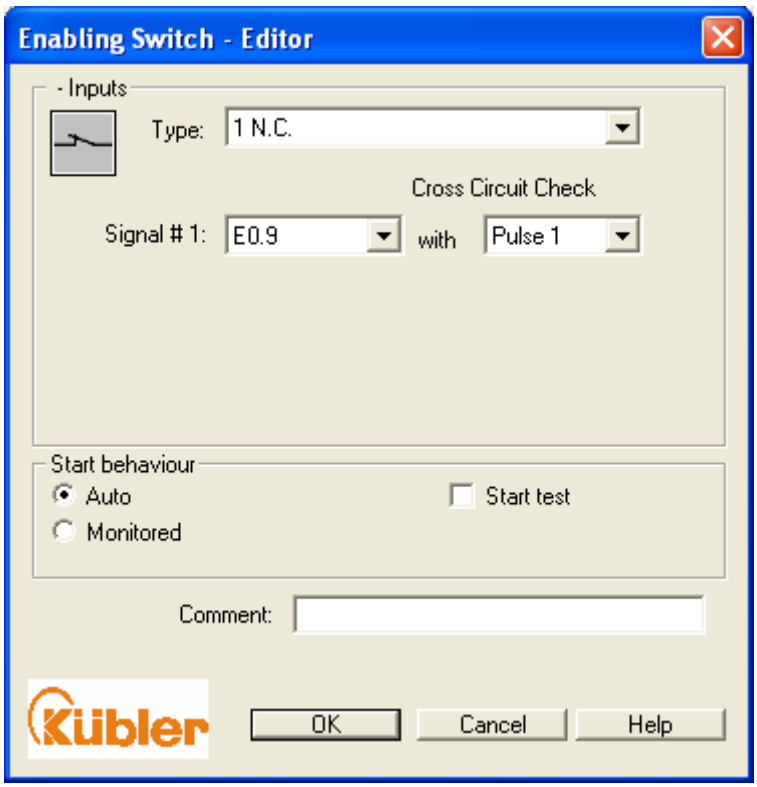
Safety note: When changing the status of the switch the SafePLC program to be created must ensure that the outPorts of the module are deactivated (note: Standard 60204-Part1-Paragraph 9.2.3).

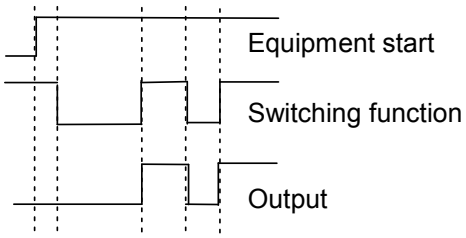
Sensor

1 eSwitch_1o	1 normally closed	Sensor input standard
2 sSwitch_1s	1 normally open	Sensor input standard
3 eSwitch_2o	2 normally closed	Sensor input higher requirements
4 eSwitch_2oT	2 normally closed time monitored	Sensor input monitored
5 eSwitch_1s1oT	1 normally open + 1 normally closed time monitored	Sensor input monitored

Start-up Test

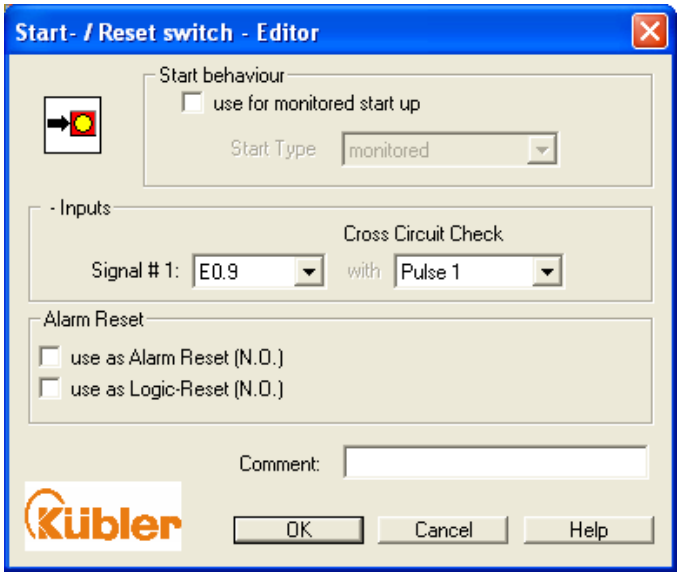
Each switch element has the ability for running an automatic function test (= start-up test). Altogether two switch elements can be configured through start-up test.



Start type	Function	IL	Scheme
Start test	Manual staring after a new start or an alarm reset, including testing of the connected monitoring equipment. The monitoring equipment must trigger once in monitoring direction and switch back on again. Followed by normal operation. E1: Switching function y1: auxiliary marker	LD E1 ST MX.y1 LD NOT MX.y1 ST MEAA_EN.1 LD MX.y1 ST MEAA_EN.2 LD MEA.1 AND MX.y1 ST MX.2	

Start and RESET Element

This inPort element offers both extended monitoring functionality, as well as the possibility to reset an occurring alarm.



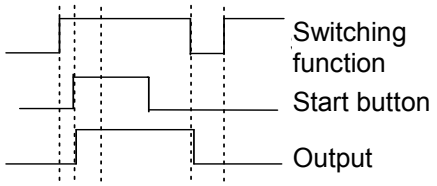
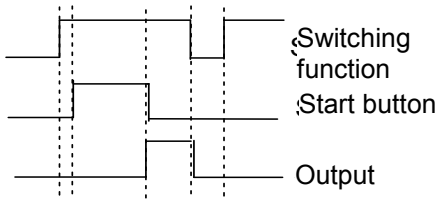
use for start monitoring

With start monitoring activated, an AWL code segment for monitoring an assigned inPort segment during restarting or an alarm reset of the equipment/machine to be monitored is automatically generated.

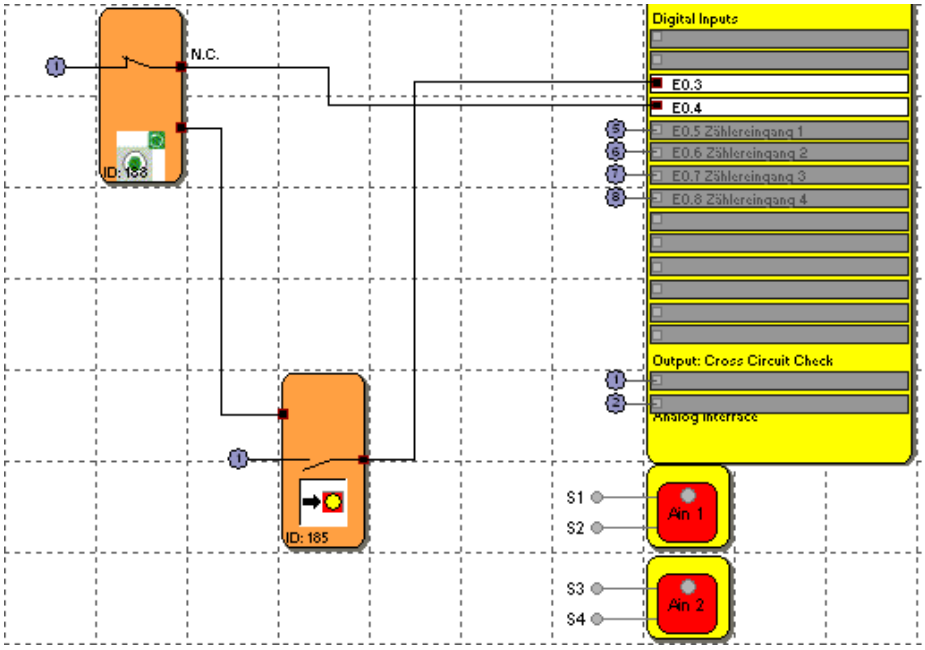
This function-related testing of a periphery element (e.g. actuation of the emergency stop switch) is intended to ensure its functionality when the equipment is started.

List of starting types by means of a enable button:

Start type

Start type	Function	IL	Scheme
Manual start (by hand)	Manual start after equipment reset. OutPort of the inPort element becomes 1 when the safety circuit is closed/active acc. to the definition of the switch type and the start button has been pressed 1 x. OutPort becomes 0 after safety circuit is open. E1: Switching function E2: Start button y1: Auxiliary marker 1 y2: Auxiliary marker 2 y3: Auxiliary marker 3	LD E1 ST MX.y1 LD MX.y1 AND E2 S MX.y2 LD NOT MX.y1 R MX.y2 LD MX.y2 AND MX.y1 ST MX.y3	
Start monitored	Manual start after equipment reset with monitoring of start circuit for static 1-signal. OutPort of the inPort element becomes 1 when the safety circuit is closed/active acc. to the definition of the switch type and the start button has been pressed 1 x and released again. OutPort becomes 0 after safety circuit is open. E1: Switching function E2: Start button y1: Auxiliary marker 1 y2: Auxiliary marker 2 y3: Auxiliary marker 2 y4: Auxiliary marker 3	LD E1 ST MX.y1 LD MX.y1 AND E2 S MX.y2 LD NOT MX.y1 R MX.y2 LD MX.y2 AND MX.y1 AND NOT E2 S MX.y3 LD NOT MX.y1 R MX.y3 LD MX.y3 AND MX.y1 ST MX.y4	

The monitoring inPort of the start element must be connected to the outPort of the inPort elements labelled "Start element". Several elements can be monitored.
e.g.:



Note: When editing the associated inPort element, the connection with the start element is deleted and cannot be restored automatically. It must subsequently be supplemented manually.

InPort - Signal No. 1
As with the inPort elements, this selection list is used to determine the inPort to which the button for for the start element is to be connected. This inPort is internally limited to the assignment to a basic module (E0.1 to E0.14). When the AlarmReset option is used, no cross circuit monitoring can be permitted for this inPort. In the dialog the corresponding input field is fixed to "OFF".

use as AlarmReset (normally open)
With this option currently present malfunctions (= ALARM) or triggered monitoring functions can be reset through a connected normally open contact.

The following table is an overview of all monitoring functions and their acknowledgement in triggered state.

Monitoring functions	Acknowledgement required
SEL	Yes
SLP	Yes
SCA	No
SSX	Yes
SLI	Yes
SDI	Yes
SLS	Yes
SOS	Yes
SAC	No
PDM	No
ECS	Yes

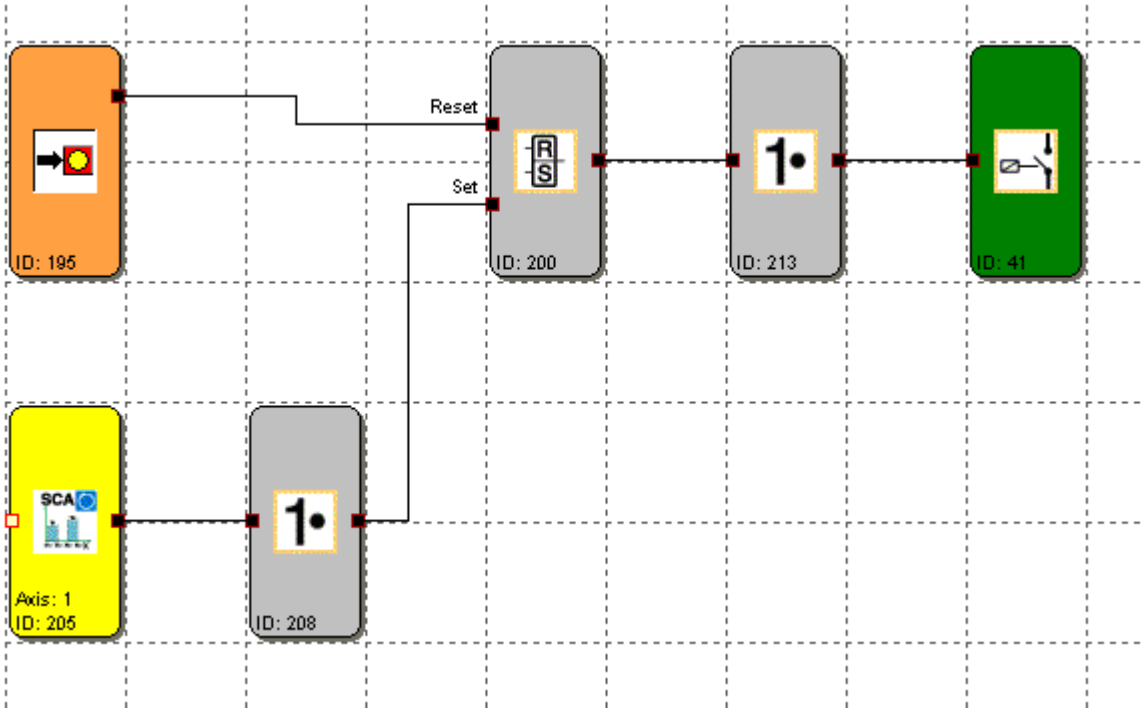
Note

- The same functionality is achieved when using the "Function" button of the basic Safety-M module.
- Error messages of type "FatalError" require a restart of the basic Safety-M module.
- The alarm reset input can be operated with 24V continuous voltage and is edge triggered.

use as Logic Reset (normally open)

This option makes the reset-acknowlegement functionality in the logic diagram available for further processing. In this case a function element is automatically generated, which can be used for linkage with a logic functionality. This logic-reset signal is normally used for the acknowledgement of RS-FlipFlops.

e.g.
saving and resetting of SCA-module errors via RS-FlipFlop.

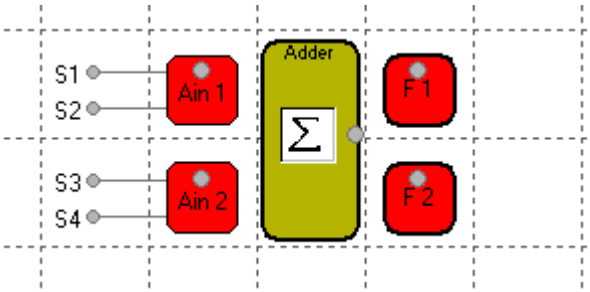


Switch type	Comment	Classification category	Classification SIL
1 normally open	Alarm reset standard (evaluation of edge)	--	--
1 normally open	Logic reset standard	Category 3	SIL 2
1 normally open	Start monitoring standard (optional function)	--	--

Analog interface

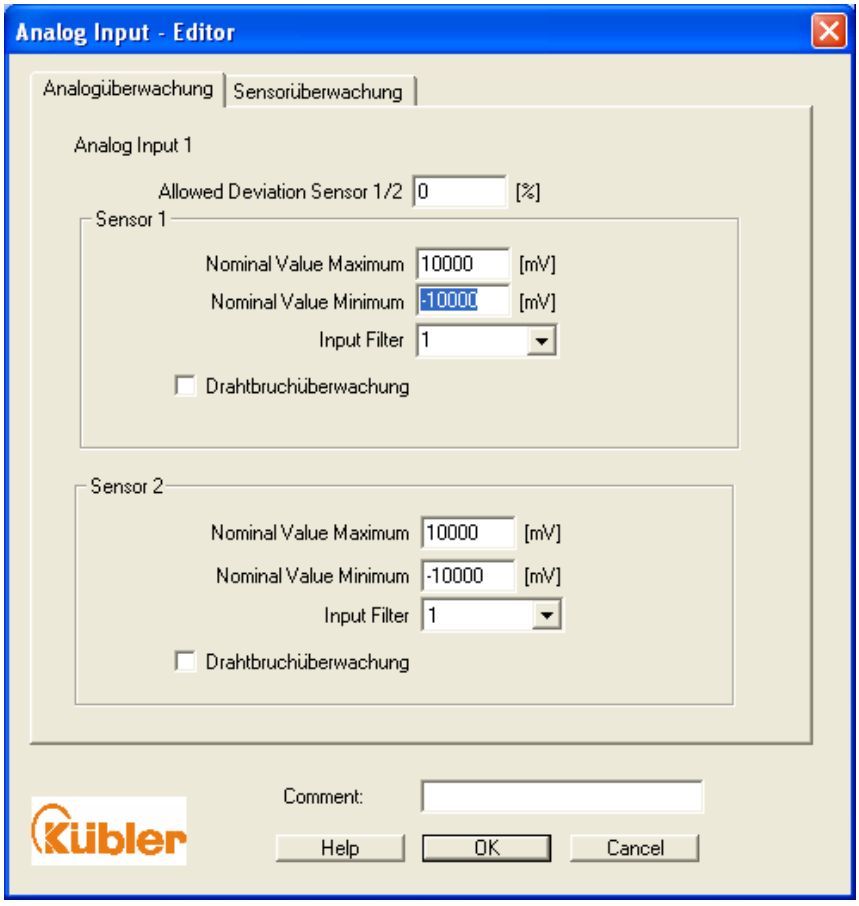
A special parameter editor is available for parameterizing the analog interface. The associated block symbol in the terminal diagram will appear against a red background, as long as this interface has not been parameterized. After parameterization the background colour changes to green.
For safety tasks, two physically analog input signals each are required. These can be scaled according to their signal characteristics and wired with low-pass filters.

In the terminal diagram the analog inPorts and the associated filter modules are shown accordingly. Double-clicking opens the editor for the selected element.



Analog inPort Ain1 / Ain2

This dialog enables scaling of the applied analog sensor signals.
The sensor signals Sensor1 and Sensor2 are used by the ***Safety-M System*** to generate a secure analog information Ain1 for further processing by special monitoring modules. There is also the possibility to use the sensor signals Sensor 3 and Sensor 4 to calculate the secure standardized analog information Ain2.
Safety-M uses a calculation method which transfers an analog input information in a standardized image area ranging from 0 to 100 %.



Perm. deviation sensor 1/2
Max. permissible deviation between the two analog input signals Sensor 1/Sensor 2 or Sensor 3/Sensor 4 respectively. Default value in percent of the standardized maximum signal range.

Nominal value minimum
Lower limit of the input signal in millivolt. After standardization this signal level has a value of 0 %.

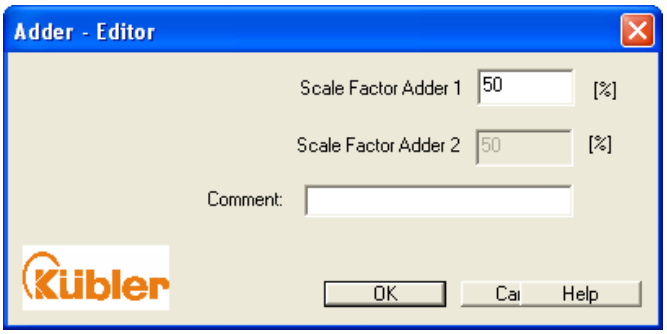
Nominal value maximum
Upper limit of the input signal in millivolt. After standardization this signal level has a value of 100 %.

Input filter
Low-pass filter for the assigned input signal

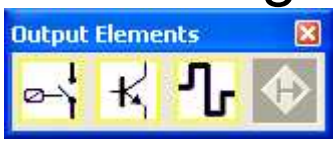
> **Note**
> The filter response times specified in the installation manual must be taken into account!

Analog adder
The analog adder enables weighting of the standardized analog signals.

Two input signals, which have already been standardized, can be added together in a defined ratio to each other. The corresponding signal components are determined in percent.



Inserting OutPort elements

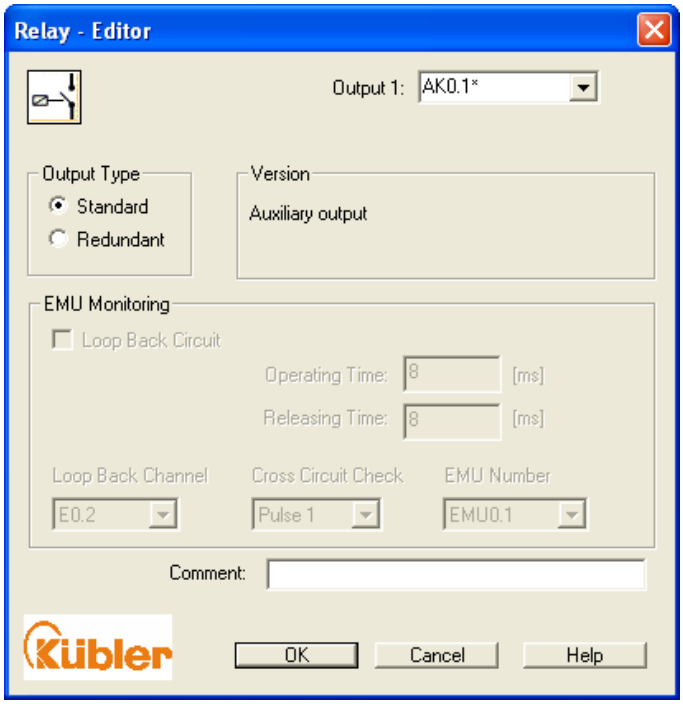


The outPort elements create the digital connection between one or several connected external switching circuits in the ***Safety-M system***. Each outPort element is triggered by a logic input signal "0" or "1" via the logic diagram.

The outPort elements are added and edited in the "Terminal Diagram" view.

The resource control of the function block elements for the Safety-M system manages the available elements.

Relais outPort



OutPort type
Single
2 single relays (K1 to K2) can be selected independently from each other.
Redundant
Two relay outPorts are combined and always switched together.

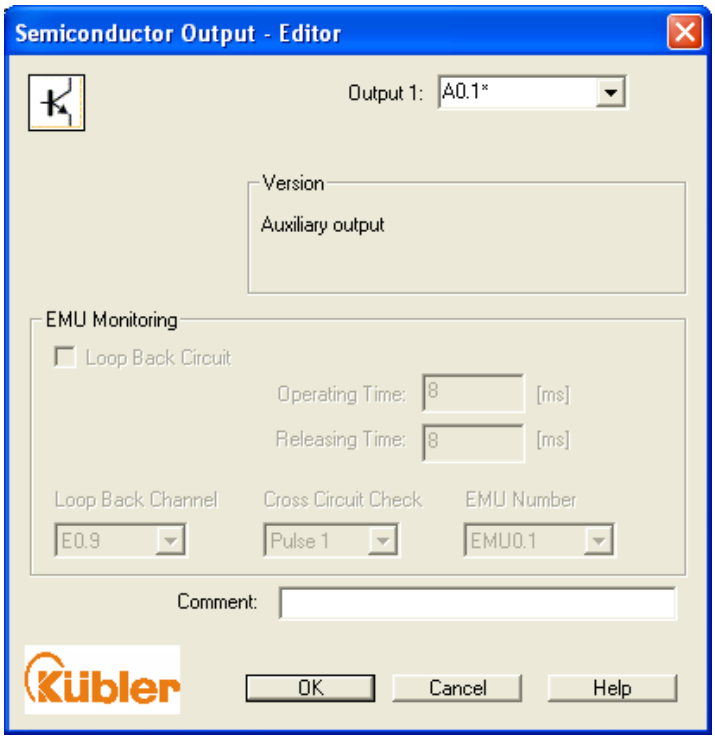
Note
Follow the explanations in the installation manual when using relay outPorts in safety applications.

For exact contact monitoring see chapter EMU-function

Semi-conductor outPort

Semi-conductor outPort as standard outPort

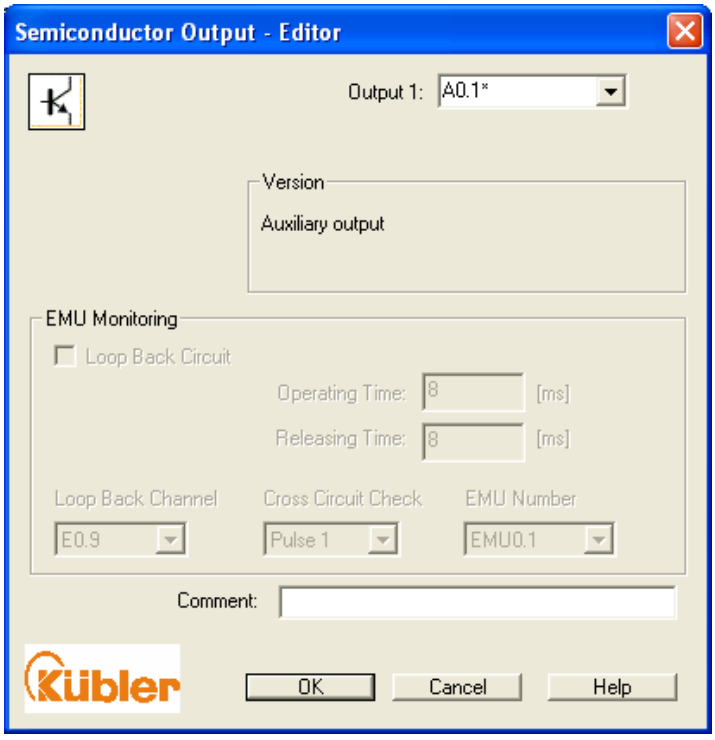
Certain semi-conductor outPorts can solely be used as auxiliary outPorts and are thus not suitable for safety applications (refer to the installation manual for details).
The editor can only be used to set the initial assignment.



Semi-conductor outPort with safety function

Semi-conductor outPorts with safety function are internally structured with two channels and can be combined with external contact monitoring (EMU).

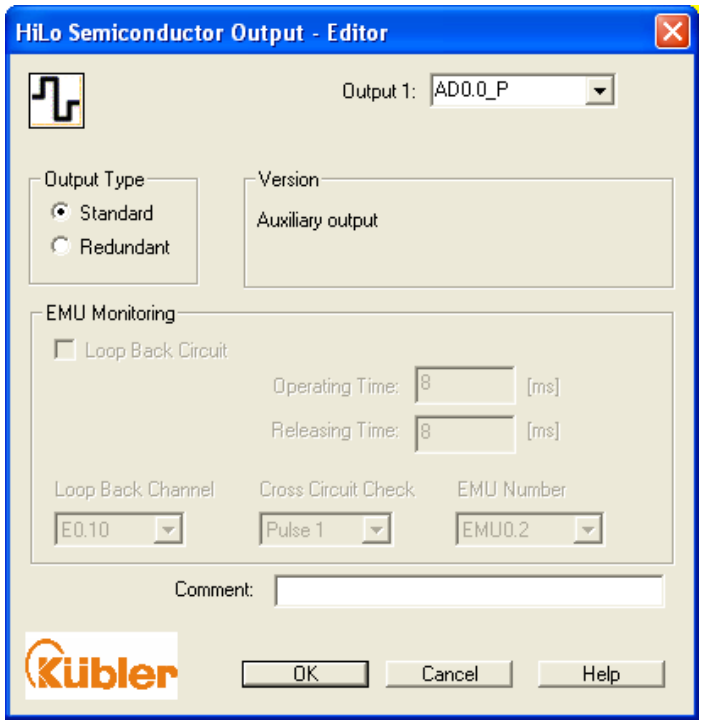
For exact contact monitoring see chapter EMU function



HiLo Outport

Semi-conductor outPort as standard or safety outPort

HiLo semi-conductor outPorts can be used individually as standard outPorts and grouped as safety outPorts (refer to the installation manual for details).
The editor can be used to set the initial assignment.



OutPort type
Single
"HISIDE" (= P-switching) or "LOSIDE" (= M-switching) can be selected as standard outPort. The use of single standard outPorts is not suitable for safety outPorts.
Redundant
With the option "Redundant" the editor compellingly specifies a combination of "HISIDE" and "LOSIDE" outPorts.

For exact contact monitoring see chapter EMU-function

EMU Function

The multiplication of contacts and power normally requires additional switching devices, which are triggered through the outPorts of the ***Safety-M system***. EMU monitoring realizes the "Safety relay" function by processing an external feedback circuit.

Applications with higher safety requirements among others require functional monitoring for these switching devices. For this purpose the switching devices must be equipped with positively driven auxiliary contacts. Contacts to be monitored are switched in series and are closed when in idle state. It is verified whether all contacts are closed when the outPort is not switched on and open in switched on state. Time related expectations can be parameterized. The same sources as for the inPorts are also used to supply the contacts to be monitored.

Note
Details to this subject can be found in the circuitry examples of the installation manual.

Feedback circuit
Switch to activate EMU monitoring

Feedback channel
Digital inPort of the feedback circuit. The outPorts for activation of the external switching function and the feedback circuit are located on the same ***Safety-M system*** module (basic module or expansion module).

Pickup time
Variable time slot (closing delay) for testing the safety contacts
$\text{Min}\{T_{EMU}\}$ = 8 msec
$\text{Max}\{T_{EMU}\}$ = 3000 msec

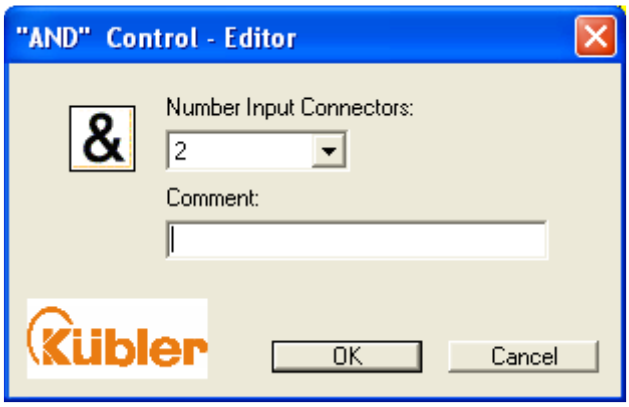
Dropout time
Variable time slot (release delay) for testing the safety contacts
$\text{Min}\{T_{EMU}\}$ = 8 msec
$\text{Max}\{T_{EMU}\}$ = 3000 msec

The Logic Modules

These modules form the basis for creating a program for the safety application. They enable the logic linkage of the inPorts with monitoring functions and with the outPorts. Inserting logic modules is only possible in the "logic diagram" view, otherwise the associated menu commands are disabled. This is the case when the resources for a module are already exhausted, e.g. after all timer modules have been inserted.

Logic AND

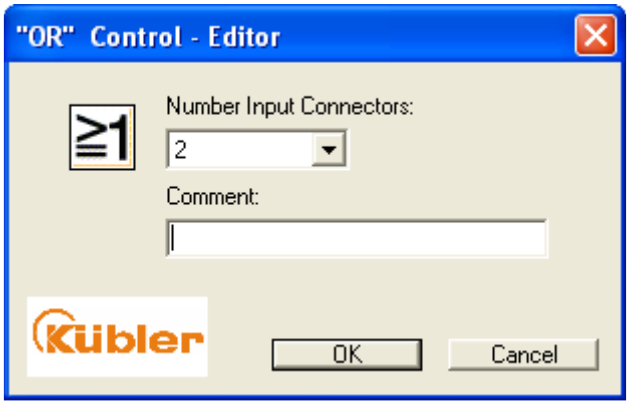
"AND"-operations of maximum 5 output signals from other function blocks. The AND-operation provides the signal state "1" for all input signals "1" as logical result, otherwise "0".



Note: The number of inPort connectors can only be reduced in case of free connectors. If all connectors have linkages assigned, these must be deleted beforehand.

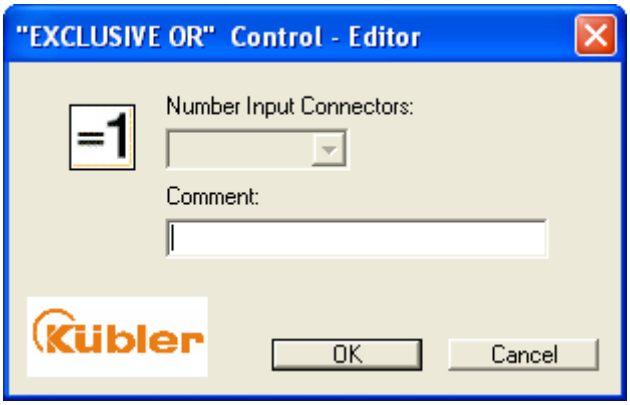
Logic OR

"OR"-operations of maximum 5 output signals from other function blocks. The OR-operation provides the signal state "1" for at least one inPort with signal state "1", otherwise "0".



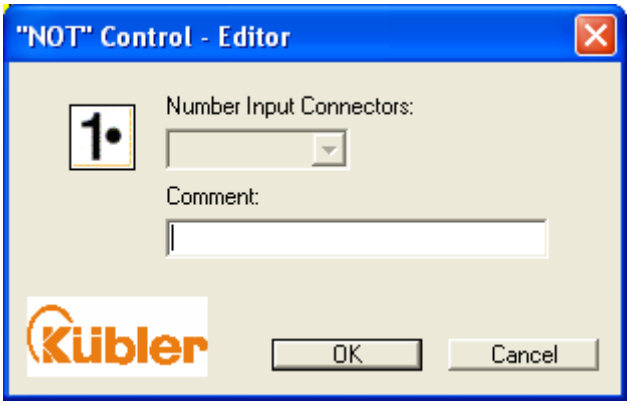
Logic EXKLUSIV OR

=1 "EXCLUSIVE OR"-operations of 2 output signals from other function blocks. The XOR-module provides "1" as logic result, if one inPort has the input signal "1" and the inPort has the input signal "0", otherwise "0".



Logic NOT

1• The logic result of this function block is the negation of the input signal. The term negation means that the logic result is reversed (negated).



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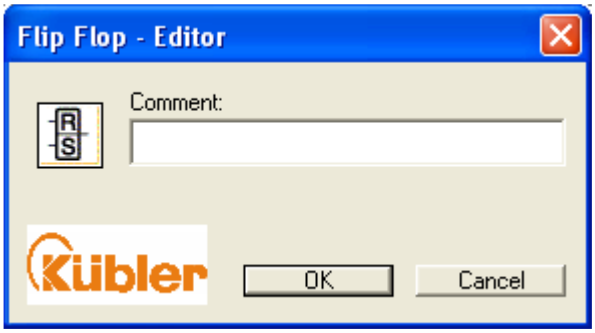
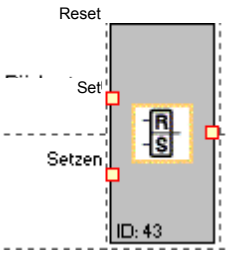
RS Flip Flop

Set / reset contact element. This switching element shows the following characteristics:

- The logic result during initialization of the element is "0".
- The logic result becomes "1", if an edge change from "0" to "1" takes place at the "Set" inPort. The outPort remains at "1", even if the state of the "Set" inPort changes back to "0".
- The logic result becomes "0", if an edge change from "0" to "1" takes place at the "Set" inPort.
- With both inPorts set to "1", the result is "0"!





Note: The desired switching state of this element is only achieved by linking as specified in the labelling.

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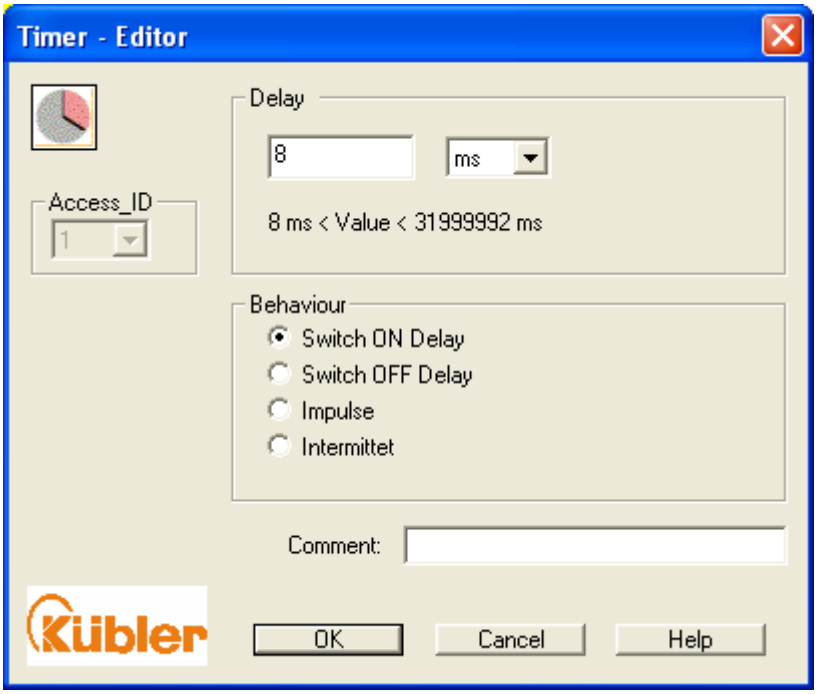
Timer

Function block that starts a counter in the event of an edge change. After the specified temporal delay the logic result will become "1" or "0".



Block ID: Instance of the timer module.
Delay: Parameterized time

T min	= 8 ms
T max	= 533 min (31999992 ms)

Note: The programmable values always correspond with the integer multiple of the Safety-M cycle time of 8 msec!

Characteristic
pickup delayed

InPort	OutPort function
"0"	The outPort continuously remains at "0"
Edge "0" to "1"	Once the parameterized time has expired, the initial status of the timer module will change from "0" to "1".
Status change "1" to "0"	The outPort immediately changes to "0"

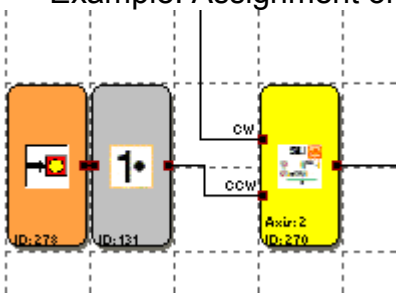
Dropout delayed

InPort	OutPort function
"0"	The outPort continuously remains at "0"
Edge "0" to "1"	The outPort immediately changes to "1" When the counter has run out the outPort will change to "0"
Status change "1" to "0"	The outPort immediately changes to "0"

Permanently logic "1" module

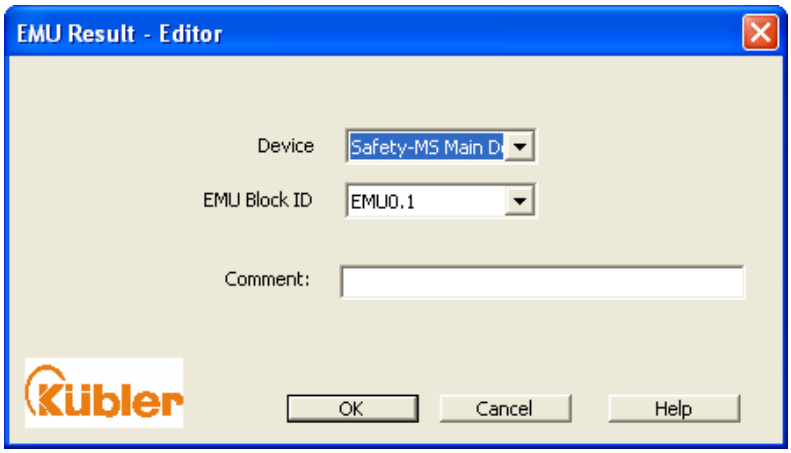
This module constantly provides the value "1". This function can be used to program static states in the logic diagram.

Example: Assignment of an unused inPort on a direction dependent SDI



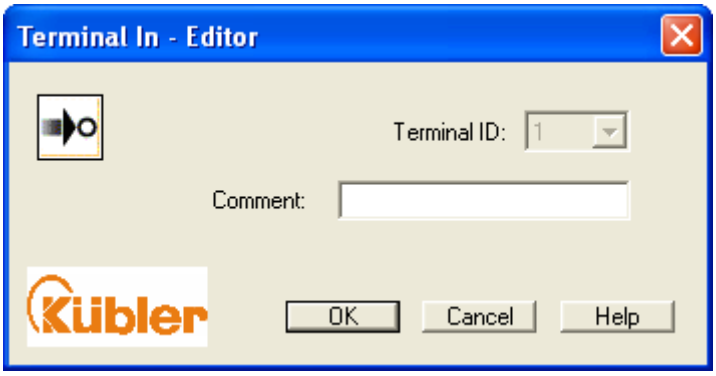
Result of the EMU module

This module delivers the result of the EMU-function that has been parameterized in the outPort module. Fault-free EMU-function is fed back as status "1".



Connecting Point InPort

The "Connecting Point InPort" supports the clearly arranged representation of logic diagrams. These modules provide virtual connections in the logic diagram. The connecting point reference numbers are automatically generated and cannot be changed, but the comment box enables appropriate allocation of the virtual connection. Activating the CTRL-key and selecting a "Connecting Point InPort" also selects the associated "Connecting Point OutPort" modules.



Terminal number: Identification number of the connecting point.

Note: When deleting "Connecting Point InPort" elements, the dependent "Connecting Point OutPort" elements will automatically also be deleted. Before the deletion process the user will be warned.

Tip: The use of a comment line simplifies the assignment of elements.

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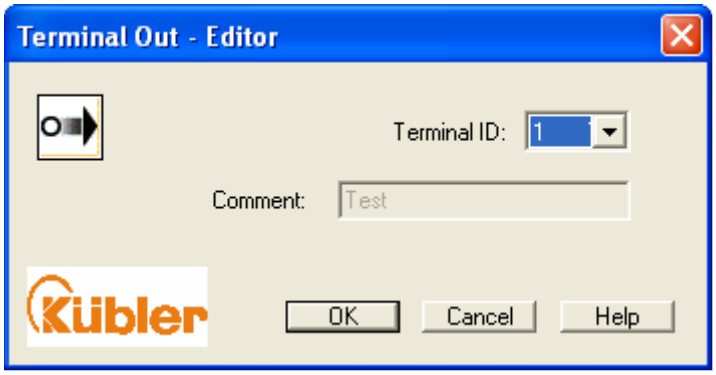
Connecting Point OutPort

This element is the equivalent to the "Connecting Point InPort". Selecting a terminal number sets up a virtual connection to a "Connecting Point InPort" function block.



Terminal number: Identification number of the "Connecting Point InPort" element.

Note: After assignment to a "Connecting Point InPort" element, the comment managed by this point is taken over by the "Connecting Point OutPort" element.

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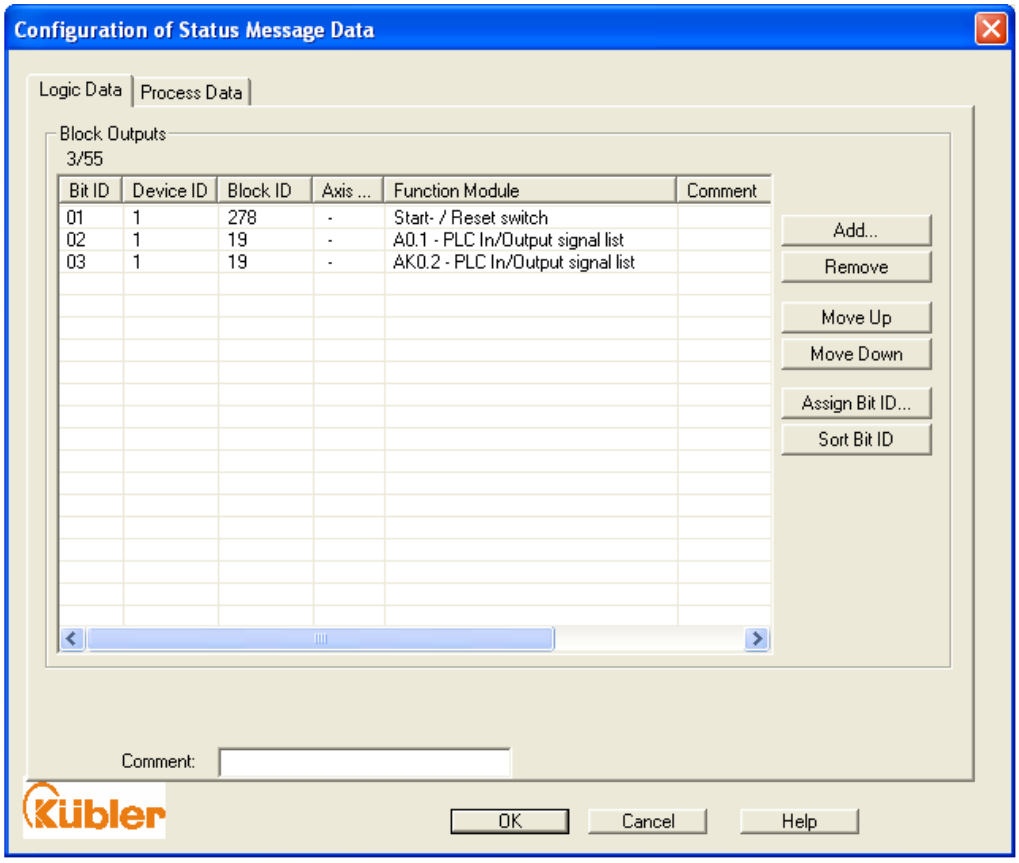
Signal Channel

The signal channel enables the functional transfer of data from the process image to a connected field bus. It is made up of two parts: the first part consists of 56 bit logic data, the second part of a 64 bit wide process data channel. The data to be transferred can be freely assigned via a profile generator.

Logic data

A profile of the data to be transmitted from the logic diagram can be defined using a list:

- The signal channel list contains the references to the selected bit information in the logic diagram.
- Enter the selected bit information at the position of the set ***BitID*** (= bit position in signal channel)
- The bit positions are displayed based on 1
- The DeviceID enables reference to various modules
- ModuleID: Number of function block in logic diagram.
- Module: Further information to the module
- Symbol address: Designation of the connector
- The numbers under the designation "Module outPorts" indicate: Number of status bits used / number of max. possible status bits



Add…
Opens the "Add status bit" dialog. The module selected here is added at the end of the reference list.

Delete
Deletes the currently selected line from the reference list. The BitID's of the following entries remain unchanged.

Up
Changes the currently selected line in the reference list by one line upwards and takes over this line's ***BitID***.

Down
Changes the currently selected line in the reference list by one line downwards and takes over this line's ***BitID***.

Assign BitID
Enables any desired ***BitID*** assignment.
The assignment dialog can only be opened under the following conditions:
- There must still be at least one free ***BitID*** available.
- A line must be selected in the signal channel list

The dialog can also be opened by double-clicking on a line

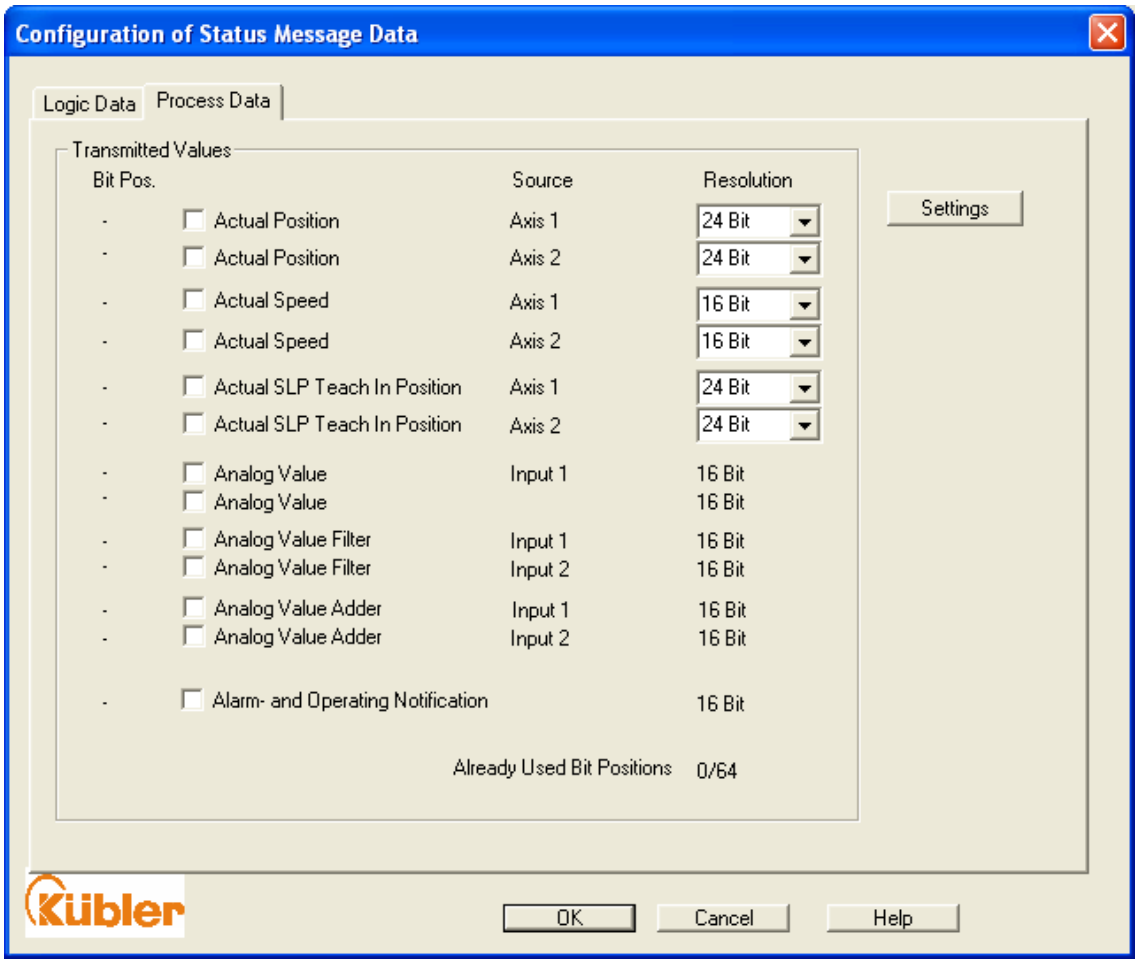
- Setting the new bit position. The numbering system is 1-based.

Sort BitID
Sorts the signal channel list in the sequence of the assigned bit positions.

Note: The assignment of status bits can only take place after a successful compiler run, because the addresses calculated by the compiler must be accepted. These are displayed in the "Symbol addresses" column. The entries in this column remain empty or are not updated, as long as the logic diagram has not been completely compiled.

Process data

This part of the signal channel defines process data which are transferred from the Safety-M system to another field bus. 64 bit are available in total. The values set in the dialog are entered into the signal channel from "top" to "bottom"



Function Groups

Function groups connect several functional modules to a superordinate logic structure. This matching group of modules is created inside the function group frame and connected via this frame.
This grouping gives the logic diagram a much clearer structure and, with the export / import functionality, enables the creation of an own function library.

Creating a function group frame

Inserting a group module

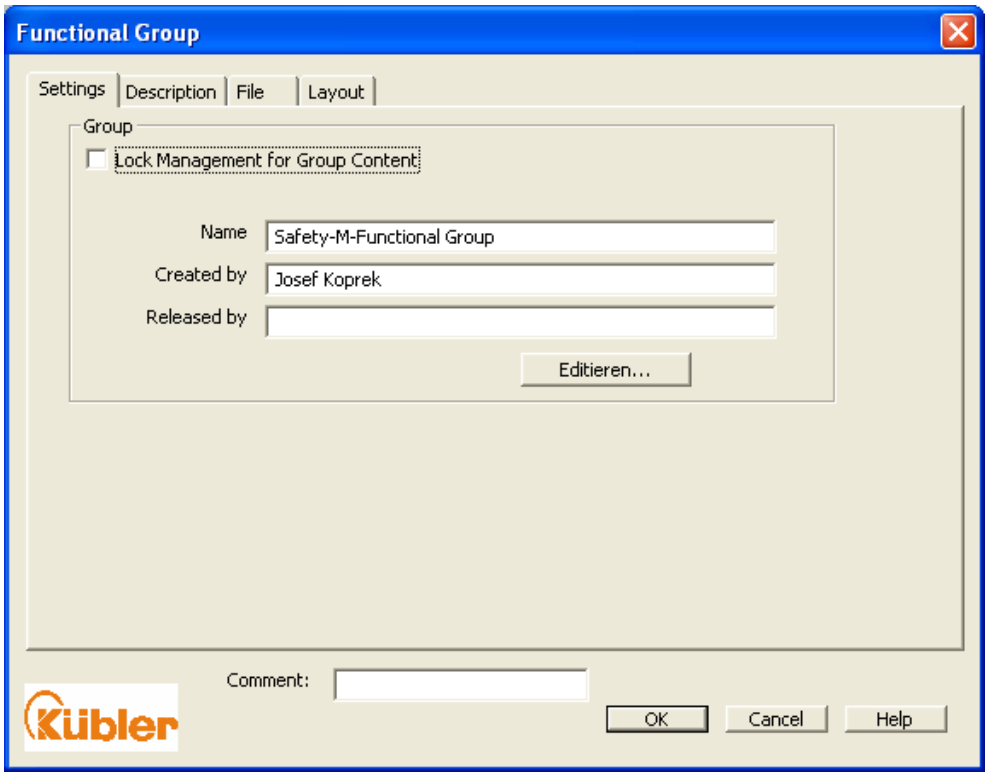
First the command "Insert group frame" is started by clicking on the toolbar button "Insert".
The menu: Group->Insert group frame… can alternatively be invoked.

The size of the group frame is determined with the mouse pointer.

1.) First position the mouse pointer with the left mouse button in the left upper corner of the group frame and hold the mouse button depressed.
2.) Then drag the mouse pointer while holding the left mouse button depressed and determine the bottom corner of the group area.
3.) Releasing the mouse button will insert the group frame and open the group editor.

Opening the group editor

The group editor can optionally be opened by double-clicking in the status line of the group frame, or via the context menu (right mouse button) of a selected module.



The tab-dialogs "Settings" and "Description" contain group related settings, as well as the function related description of the group. The control button "File" can be used to export the group into a file, or to import the group from a file.

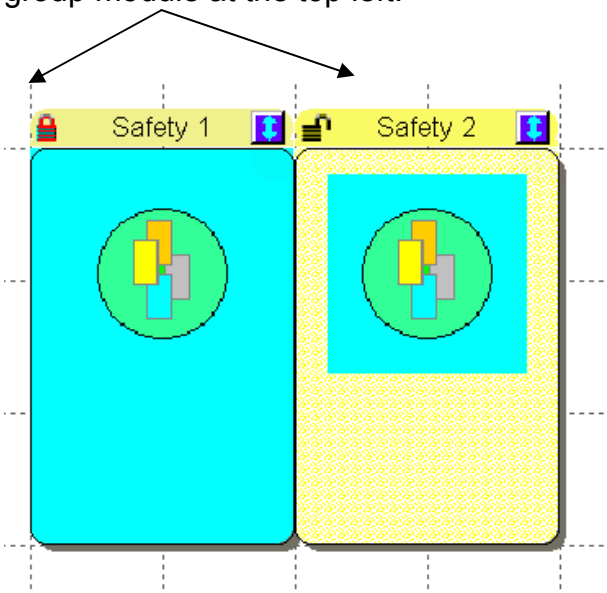
Setting the group management

With the switch "Disable group management" the group modules can be disabled or enabled.

With the switch set, the function block management of the frame is disabled and the modules are tied to the group:

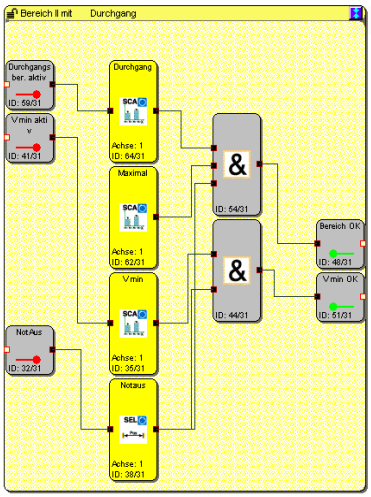
- Modules can no longer be removed from the group, whereby the configuration of parameters is still permitted.
- Deleting a group frame also deletes all group modules.
- No new modules can be added to the group.
- Group members appear "grey shaded".
- When disabled, the group has a time stamp assigned, which is also displayed when the group editor is opened.
- The control buttons for the info fields "Name", "Created by" and "Released by" are disabled.

The group status "disabled" is indicated by the padlock symbol in the status bar of the group module at the top left.



When inserting a new group frame, the switch "Disable group management " is set to unlocked state by default. After closing the group editor, the drawn frame appears in the logic diagram and represents the active area of the group.

Function blocks can be inserted, moved or deleted on this area. The modules will automatically be accepted in the group, unless the group is in disabled state. The functional modules in this case additionally show the number of the function group.



Note:
The following module types cannot be contained in a group. These are filtered out when the modules are moved into the frame area.

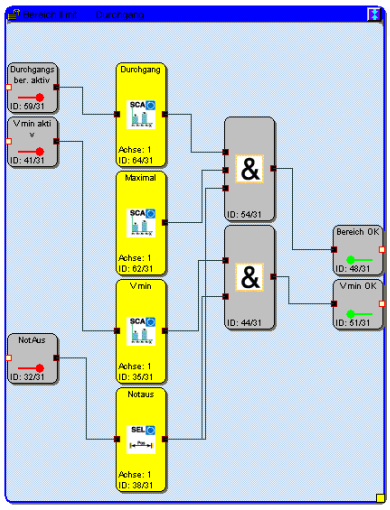
- o InPort modules
- o OutPort modules
- o All function blocks pre-defined in the logic diagram /e.g. encoders, analog modules, filters)
- o Signal channel module

- Terminal blocks

The group is able to accept maximum 200 function blocks.

Changing the size of a group frame

A selected module can be adapted in size via its "Hotspot". For this purpose it is selected with the mouse pointer and changed in size with the left mouse button held depressed.



Showing and hiding functional modules

The modules contained in the group can be shown or hidden be clicking on the control button in the status bar with the mouse pointer. When showing its content, the size of the group module automatically adapts to the elements it contains.

Note:
Do not use the show/hide function while editing modules, as otherwise the available free space may be optimized for further modules. In this case the group needs to be manually enlarged again via the "Hotpoint".

Tip:
The size of the group frame can be fixed by using a text element in the bottom right hand corner.

The visibility of the associated function blocks in the logic diagram can also be set in the group dialog using the switch "Show associated modules".

Show modules
The size of the group module is determined by the position of the functional modules contained therein.

Hide modules
The group module is set to the size of approx. 2 x 3 fields of the logic diagram. The bitmap for the symbol is displayed.

If several function groups are available, all group modules can be shown or hidden by using the symbol in the group toolbar. The same functionality is achieved via the "Group" menu.

Creating the group interface

The group interface modules represent the interface of the function group to the elements outside the group. Connections to function blocks outside the group can only be made via this interface module.

Inserting a group interface module is started by clicking on the button in the group toolbar (alternatively menu: Group->Insert interface module...) After placing a module inside a group frame, the group interface editor is opened.

Setting the usage

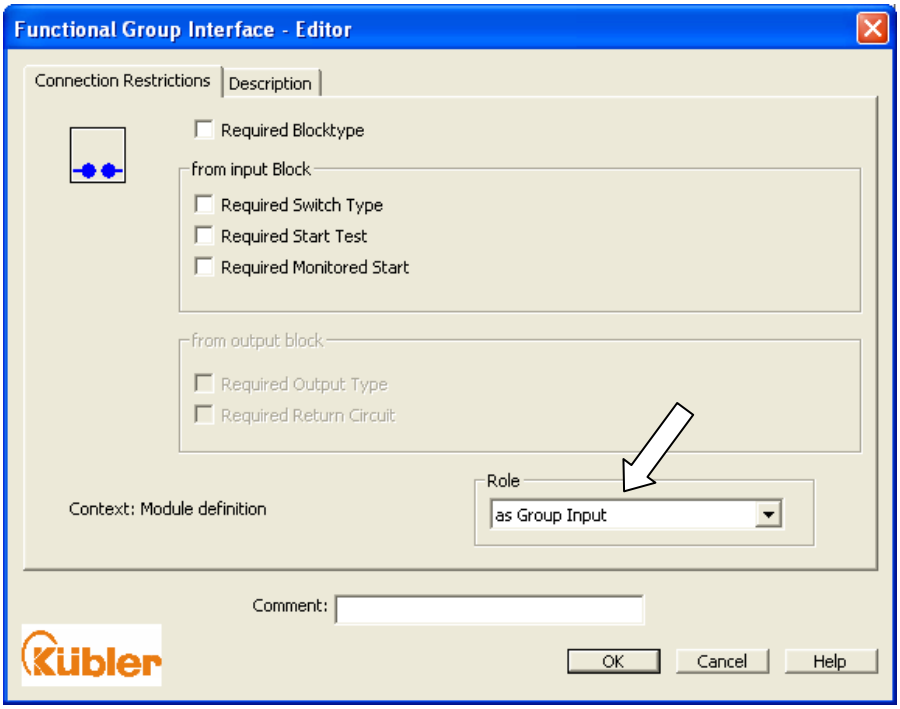
This setting is used to determine the connection properties of the module as inPort or outPort.

"as group inPort"

This element represents the connection of function blocks outside the group to the external group elements. The module should be positioned on the left side of the group area, if this is possible. The outPort connector must be wired further inside the group.

"as group outPort"

This module transfers a result from the group to externally located logic diagram elements.



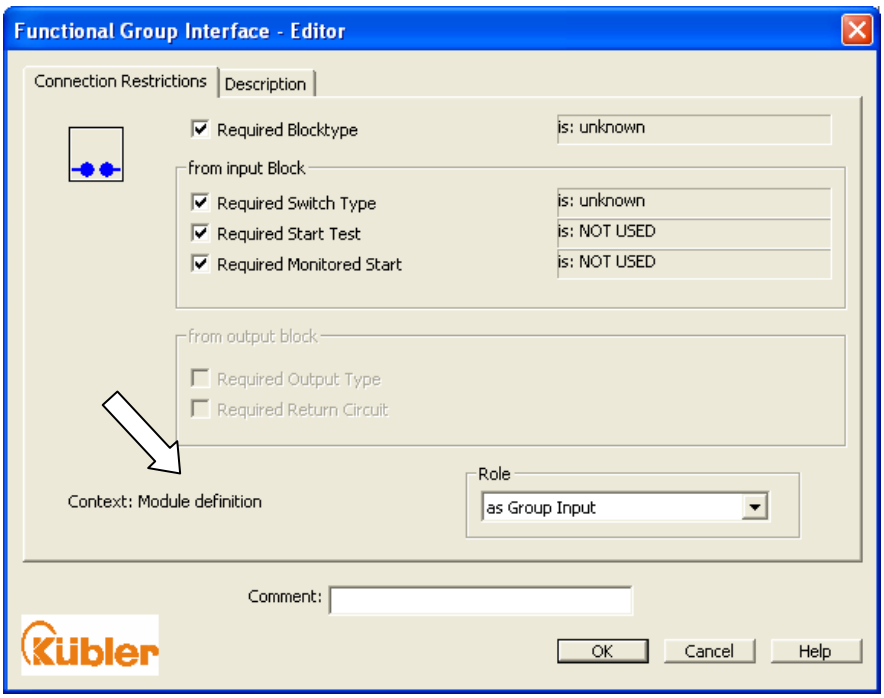
Restrictions

The dialog "Connection restrictions" can be used to set switches for group inPort and group outPort elements and prevent impermissible allocations.

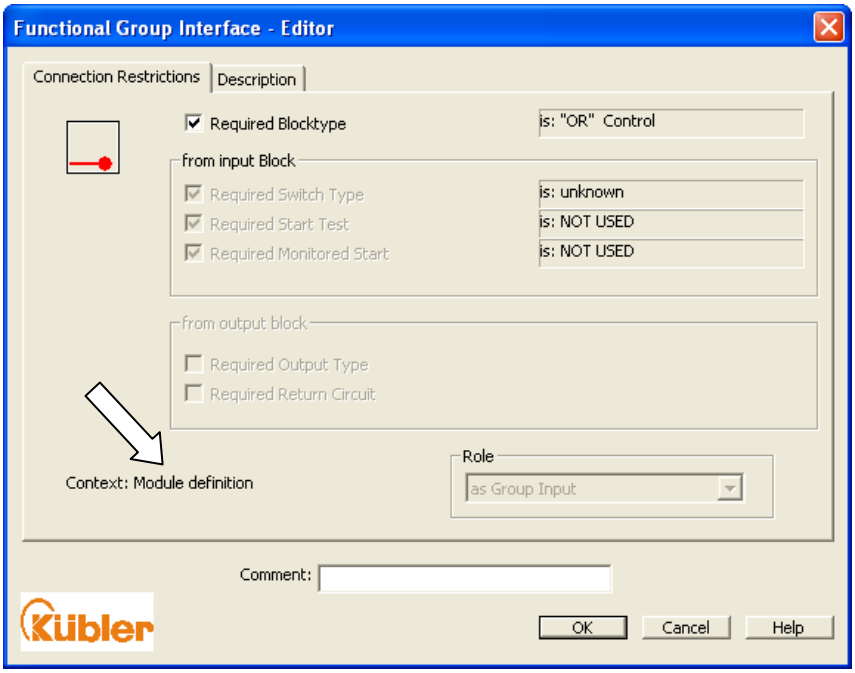
Note: When reusing group elements, these restrictions prevent faulty or unintended connection of external function elements. Restrictions should always only be set after complete definition of the group context.

Context: Defining a module:
The interface module reads the type and the restriction criteria of the connected module and offers these as restriction. The restriction is shown when the associated switching element is set.

Example: A mode selector switch is connected to the group interface module. In user mode, the group module always expects to be connected with the function block type "Mode selector switch"



Context: Using a module
When connecting to an external functional module, the interface module expects the set restriction criteria. If these are not fulfilled, a compiler error will occur and the program cannot be compiled.


Functional Group Interface - Editor
Connection Restrictions
Description
Required Blocktype
is: "OR" Control
from input Block
Required Switch Type
is: unknown
Required Start Test
is: NOT USED
Required Monitored Start
is: NOT USED
from output block
Required Output Type
Required Return Circuit
Context: Module definition
Role
as Group Input
Comment:
OK
Cancel
Help

Procedure for Creating a Function Group

A function group is created via a group frame. Function blocks within the colour contrastive area of a group frame are assigned to this group. As long as a group module is still enabled, functional modules can be added to or deleted from the area of the group frame. A module contained in a function group indicates this status by showing the message "Contained in function group: No." in the info-display.

Tips:

- The function groups should remain in enabled condition for as short a time as possible.
- If possible, only edit one group in the logic diagram.
- Do not move enabled groups unnecessarily in the logic diagram.
- Disable groups before saving!
- Set up connections inside the function group as late as possible.
- Ensure a sufficient size of the group frame.

1. Step: Adding interface modules

The functional modules contained in a group can only be linked with the function elements outside the group frame via the interface modules described above. In these interface modules restrictions can be set as required, which will demand the same connection constellation when importing the group into another logic diagram. The interface modules enable a description of the input and output parameters of the function group. The setting of restrictions should be documented in the description tab.

2. Step: Adding functional modules to the group

Functional modules can only be added to the group frame in enabled condition. This is indicated by the symbol in the status bar.
If function blocks are to be added to a group, a module must either be inserted within the group area, or it must be moved into this area.

Note:

- No function blocks can be inserted by simply moving the group frame. Function blocks will only be accepted if these modules are moved in from outside.
- Only logic modules and monitoring modules can be accepted in the group. InPort and outPort modules, pre-defined elements such as signal lists, analog modules or encoder modules are not permitted.
- Existing connections inside the functional modules are deleted upon transition into the group element

3. Step: Set up connection

4. Step: Connect group interface

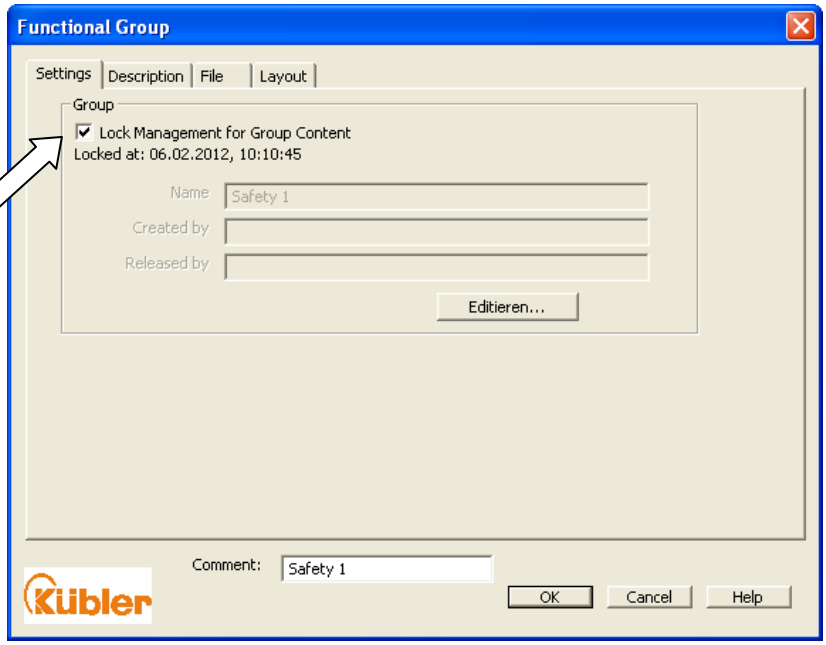
5. Step: Set connection restrictions

Testing function groups

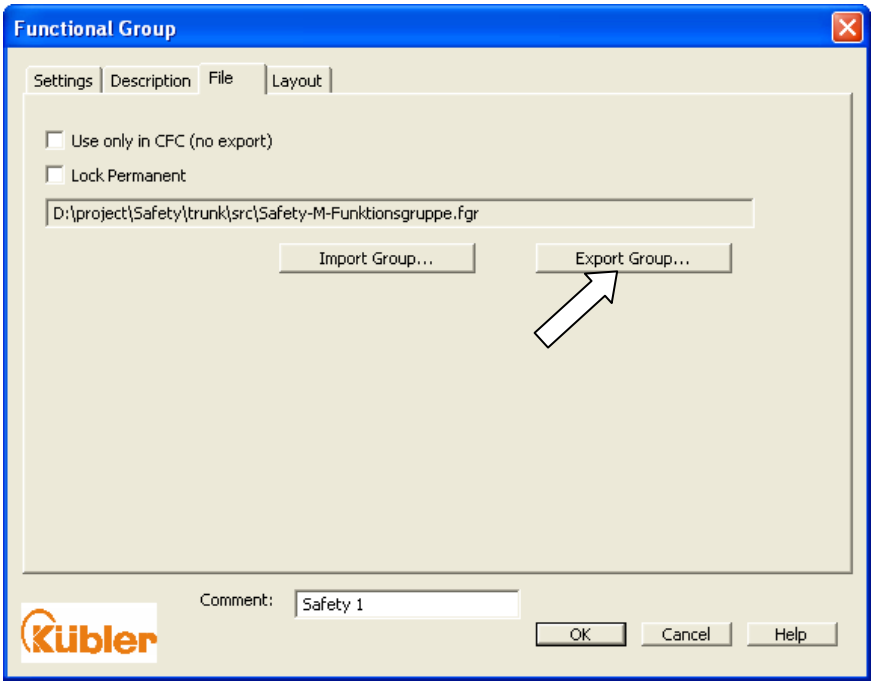
Imported group elements do not have a safety signature! Within the application, the function of the group element must be proven and verified by means of the validation process.

Disabling a function group

When disabling a function group, the functional modules contained in this group are tied to the group module. The modules can, in this case, no longer be deleted individually and only moved via the group module.



Exporting a function group



The modules of a group can be exported into a *.fgr file. An exported group can be imported into another group frame. This enables the creation of a library with pre-defined function groups, which can then be imported into new projects.

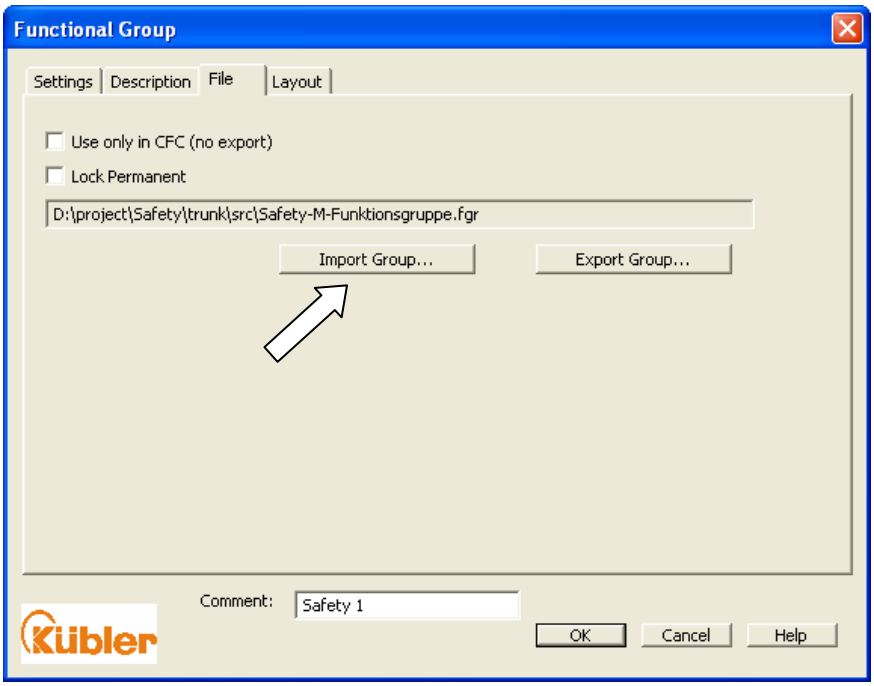
Note:
The function library should only be considered an editing aid, but does not relieve the user from the necessity of validating the group elements used in the application.

The switch "Disable permanently" is a special export feature. If this option is set, the group can no longer be modified after it has been imported.

Please note:
If this option remains set and the dialog is quit with OK, the group is disabled within the logic diagram and the dialog element "Disable group management" is permanently hidden.
It is highly recommended to make a backup copy of the still enabled function group.
After the option "Disable permanently" has been set, the structure of the function group can no longer be changed!

Importing a function group

A function group file can only by imported using an already inserted group frame. For this purpose start the group editor and start the function "Import group..."



Note: Modules, already available in the group, will be deleted.

The import process includes the verification of the sensor configuration and the still existing resources in the logic diagram. The group can only be imported if all resources needed for the modules are available. The necessary sensor settings must be checked, particularly in case of position-dependent monitoring modules.

If a resource is no longer available, this is indicated by an error message and the import is not possible.

The Safety Functions

The safety functions are an essential functionality of the Safety-M system. Pre-defined functions for:

- speed monitoring
- position detection
- monitoring of limits and target positions
- functional emergency stop monitoring
- standstill monitoring
- direction monitoring
- function monitoring of external shut-down devices
- rest functions

are available.

The functionality for monitoring position, speed and shut-down is only activated after successful encoder configuration in the terminal diagram. For each monitoring functionality, a limited number of modules is available. If these are used up, the menu entry for the corresponding function block is disabled.

Function name acc. to EN 61800–5–2	Number of modules
SLS - Safe Limited Speed	8
SOS - Safe Operational Stop	1 per axis
SDI = Safe Direction Indication	1 per axis
SSX = Safe Stop 1/2	4
SLI = Safe Limited Increment	1 per axis
SCA = Safe Cam	16
SEL = Safe Emergency Limit	1 per axis
SLP = Safe Limited Position	2
ECS – Encoder Supervisor	1 per axis
SAC = Safe Analog Control	8
EMU – Emergency Monitoring Unit	2
PDM – Position Deviation Mode	1 per axis

Note: If no position monitoring is activated in the encoder configuration, the dependent control elements are disabled in the dialogs.

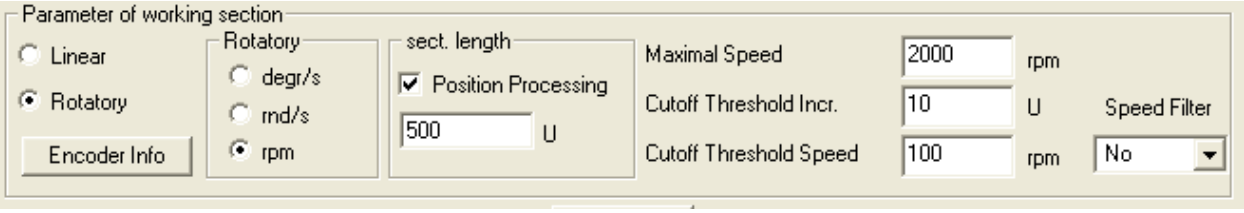
Position and Speed Sensors

Selection of encoder type and measuring section as well as the parameterization of both sensors for position and speed detection takes place via the "Sensor Interface" input mask.

Note:

The parameterization of the sensors must always be defined by starting with one of the two connected signal sources. For the second sensor possibly available, transmission ratios of gearboxes or similar system components must be taken into consideration.

Parameterization of the measuring section



The following options and inputs are possible in the field "Parameters of measuring section"

Linear:	The measuring section has a linear characteristic. The unit for the position in this case is "mm" and the speed can be given either in "mm/sec" or in "m/sec".
Rotational:	The measuring section has a rotational characteristic, i.e. the movement is a rotation. The position is processed in "mgrd" or in "revolutions", the speed in "mgrd/sec", "revolutions/sec" or in "revolutions/min".
Activating position processing:	Processing of an absolute measuring section. This functionality is only available for selection if an absolute sensor has been parameterized beforehand! With position processing activated, all position related monitoring functions are enabled.
Measuring length:	Specification of the max. measuring length for the position in mm, m or mgrd, rev. With position processing activated, the application must always be maintained within the limits of the set measuring length. Each actual position outside the defined measuring length causes an alarm of the Safety-M axis.
Maximum speed:	Specification of the max. speed of the reference axis given in the currently selected unit. The permissible maximum speed describes the highest speed that can possibly be reached with the current technological system configuration. Here one should enter the max. value that may possibly be reached by the axis to be monitored. This may, under certain circumstances, only refer to a theoretical maximum speed of the actual application. The parameterized value does not refer to the safety-related shut-down (e.g. shut-down via SLS), but to the reliability, i.e. consistency of encoders or consistency of the mechanical situation. Exceeding this value triggers an alarm with shut-down and error / alarm status. This is no planned shut-down because of safety-relevant speeding,

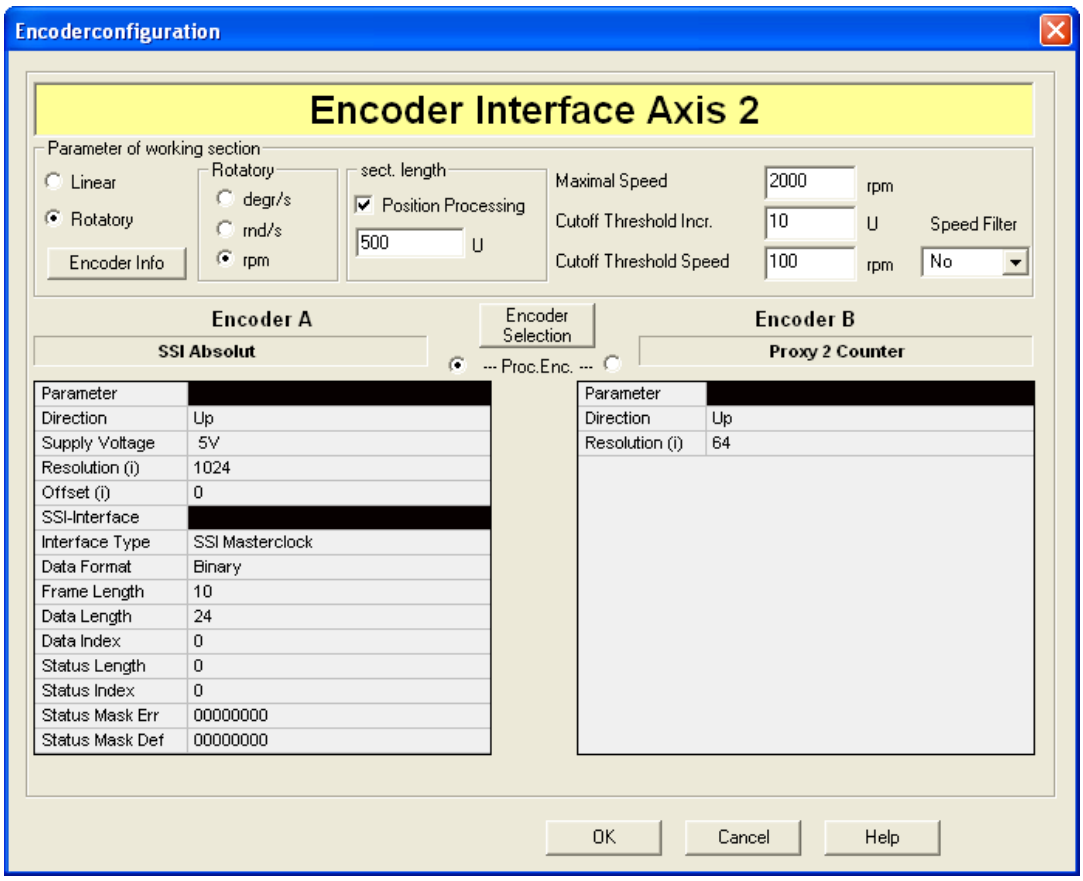
	but the reliability of the encoders or the mechanical situation is in doubt (encoder fault, electric power converter fault,...), because this speed can normally not be achieved under drive technological aspects. Should this occur, the Safety-M module will change into alarm state and switch off all outPorts. This means, that the "maximum speed" must always be higher than the shut-down speed of a safety function. It serves the purpose of detecting a fault on the safe axis by means of measuring systems. The value that is entered into this field, at the same time changes the dimensioning of the encoder consistency in regard to the "Increment shut-down threshold" and the "Speed shut-down threshold". A higher maximum speed permits higher shut-down thresholds between the encoders. The maximum value should therefore not be chosen too high, as otherwise the shut-down thresholds could be to high for the reliability of the sensors amongst each other. The "Info field sensors" value table shows these calculated limiting values for the variables V_max, V_min.
Shut-down thresholds	The shut-down threshold defines the tolerable speed/position deviation between the two detection channels / encoder channels. It may be dependent on the arrangement of the sensors and the maximum mechanical play (e.g. gearbox and spring rate) between the two detection locations. The lowest possible value, at which monitoring is not yet triggered in normal operation, should be chosen under due consideration of the dynamic processes (e.g. load/play in gearbox).
Speed filter:	Average filter covering the detected speed values of the encoder to dampen peak speeds in case of low resolution or variance of the connected sensor. With the filter switched on, the specified response time of the overall system will increase by the set time. The filter has an effect on the speed related parameters of the monitoring modules.

Note:

- Determining the characteristic of the measuring length as linear or rotational, generally influences all position and speed inputs in the other input masks of the monitoring functions. It generally changes the input from mm, m or mm/s, m/s to mgrd, rev or mgrd/s, rev/s or rev/min and vice versa.
- The specification of max. measuring length and max. speed is mandatory. A missing or incorrect entry can cause undesired responding of the monitoring functions.
- In general sensor 1 has the function of a process sensor and sensor 2 acts as a reference sensor. For the combination of absolute/incremental sensor the absolute system is always used as process sensor. If sensors with different resolutions are used, the sensor with the higher resolution should be configured as process sensor.

Sensor 1 or Sensor 2

These two option and input fields are used to parameterize the sensors.



The following options and inputs are possible:

Encoder type

Selection of function type of sensor:

- **None**
  No sensor connected

- **Incremental**
  Incremental encoder

- **SIN / COS**
  SineCosine encoder Absolute
- **Absolute**
  Absolute value encoder

  Selecting an absolute value encoder enables further parameters:
  - **Data format**
    - **SSI binary**
      Serial **S**ynchronous **I**nterface in binary encoding
    - **SSI-GrayCode**
      Serial **S**ynchronous **I**nterface in GrayCode encoding
    - **SSI-WCS**
      Way **C**oding **S**ystem (Manufacturer Pepperl & Fuchs)
      By choosing this file format the data width is a fixed **Offset**
      Relative offset in relation to the specified sensor position
- **Proxi Switch 1Z**
  1-channel incremental counting signal

- **Proxi Switch 2Z 90°**
  2-channel incremental counting signal with 90-degree phase

Direction of rotation

Selection of sensor counting direction

Resolution

Encoder resolution referring to the measuring axis in the pre-defined context (linear or rotational)

Note: For position monitoring at least one of the two sensors must be designed as absolute encoder. If none of the two sensors is of the "Absolute" type, the position input fields in all other input masks of the monitoring function are inactive.

With the "Incremental" type an impulse multiplication takes place inside the device. The resolution of the sensor must always be entered into the "Resolution" field as pulses per revolution (PPR) The multiplication depends on the set sensor configuration and runs internally automatically. Further information can be found in the installation manual.

Sensor info field

After successful parameterization an info field with various selection and result data related to the currently used sensors can be displayed by simply clicking on the button "Sensor Info Field".

Axle area

Column name	***Meaning***
Class-ID	Unambiguous ID of axis configuration
General flags	Reserved for internal processing
Modes	Reserved for internal processing
Axis CFG ID	Reserved for internal processing
Measuring length	Measuring length of position processing
PosFactor	Internal multiplication factor for position
FactorSpeed	Internal multiplication factor for speed
MaxSpeed	Maximum standardized speed
Shut-down thresh. pos.	Shut-down threshold value incremental in system units
Shut-down thresh. speed	Shut-down threshold value speed in system units
Unit	Reserved for internal processing

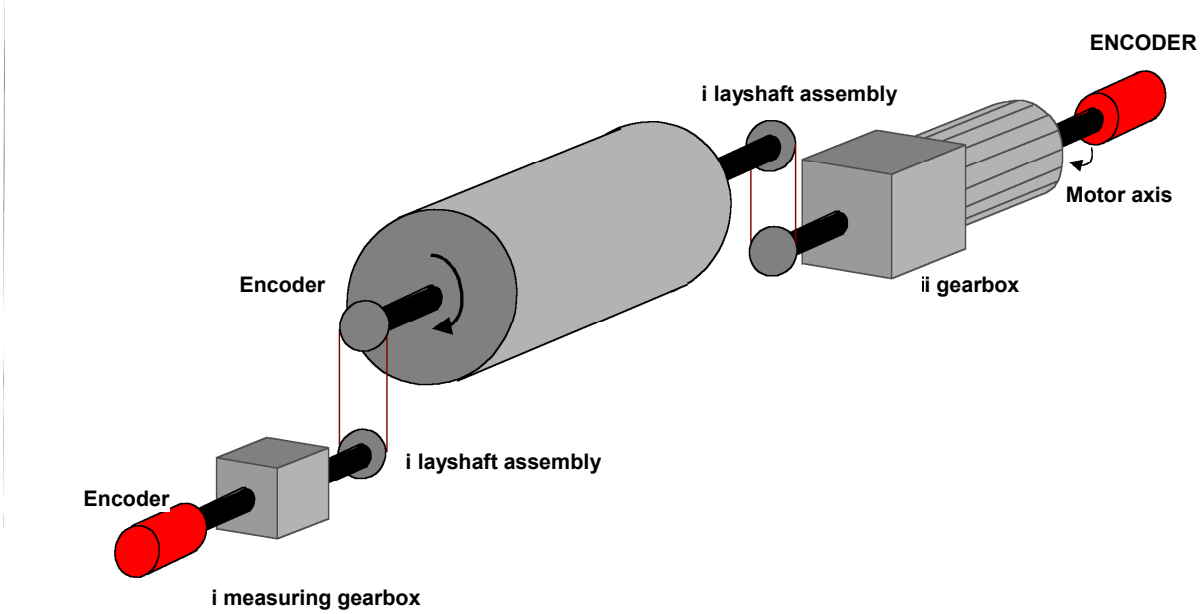
Area sensor

Column name	*Meaning*
Class-ID	Reserved for internal processing
General flags	Reserved for internal processing
Modes	Reserved for internal processing
EXT-Modes	Reserved for internal processing
V_Standardization	Standardization value for speed (internal calculation value)
PosStandardization	Standardization value for position (internal calculation value)
ShiftvalPos	Interger exponent for basis 2. Internal calculation value for position standardization.
ShiftvalSpeed	Interger exponent for basis 2. Internal calculation value for speed standardization.
Offset	Corresponds with the input field ***Offset*** in the sensor interface
Resolution	Corresponds with the input field ***Resolution*** in the sensor interface
FilterTime	Reserved for internal processing
Data width	Input field for data width in sensor interface
Cycle time	Cycle time of the Safety-M module
V_max	Maximum value for speed in the monitoring dialogs. Defined via "Maxium speed encoder dialog" x factor 1.5
V_MinUsed	Internal minimum speed for standardization calculation
V_min	Minimum value for speed in the monitoring dialogs.
Measuring length	Defined measuring length.
Pos_MinUsed	Minimum internal position for standardization calculation
Pos_min	Minimum internal position for parameterization of monitoring dialogs

Note:
The displayed values serve the purpose of technical support of the encoder configuration and are used of the standardization calculation in the Safety-M module!

Determination of the Resolution with Regard to Different Characterized Measuring Lengths:

Rotational measuring length



Reference axis	*Input values*		*Resolution related to measuring length*
Feed axis (process axis)	Encoder 1: Resolution Gb 1 i measuring gearbox i layshaft assembly	A_Gb1 in [steps/rev] I_MG I_VG	$Gb1 = I_MG \cdot I_VG \cdot A_Gb1$
	Encoder 2: Resolution Gb 2 i gearbox i layshaft assembly for drive	A_Gb2 in [steps/rev] I_G I_VA	$Gb2 = I_G \cdot I_VA \cdot A_Gb2$
Motor axis	Encoder 1: Resolution Gb 1 i measuring gearbox i layshaft assembly ∅ measuring gear i gearbox i layshaft assembly	A_Gb1 in [steps/rev] I_MG I_VG D_MR in [mm] I_G I_VA	$Gb1 = \frac{I_MG \cdot I_VG \cdot A_Gb1}{I_G \cdot I_VA}$

Input example 1

In a manufacturing device, the speed of certain manual processes is to be monitored for a safe reduced value, as well as standstill and movement direction. The movement to be actively monitored is a rotary movement. The drive works with an electric motor with integrated motor feedback system and intermediate gear.

Selecting the module

Selecting the encoder type

No monitoring of positions requested -> Absolute encoders are not required, speed detection by means of incremental encoders is quite sufficient.

Determination of the measuring length

The axis of rotation of the manufacturing device is selected as reference axis. The following parameters are selected:

- Rotational
- Measuring length unknown
- Reference axis is rotational axis => designation = mgrd

Determination of parameters for Sensor1

Sensor 1 is directly connected with the output axis of the gearbox = load axis A sensor with the data: Pulse generator A/B-track, 5000 pulses/revolution is used.
The following parameters are selected:

- Encoder type incremental
- Resolution:

Sensor 1:	
Resolution Gb 1	5000 [steps/rev]
i measuring gearbox	1
i layshaft assembly	1

$$Gb1 = I_MG \cdot I_VG \cdot A_Gb1 = 1 \cdot 1 \cdot 5000 = 5000$$

Determination of parameters for Sensor2

The existing motor feedback system is used as sensor 2. The motor is connected to the rotational axis of the manufacturing device by means of an intermediate gear.
The sensor interface is connected to the pulse outPorts of the power converter. The sensor data are as follows: SIL3, 1024 I/rev. According to the data sheet of the power converter manufacturer the sine/cosine tracks of the SIL3 encoder are output in the fom of pulses -> emulated encoder on the pulse outPort of the power converter = pulse generator, A/B-track, 1024 I/rev. The following parameters are selected:

- Encoder type incremental
- Resolution:

Sensor 2:	
Resolution Gb 2	1024 [steps/rev]
i gearbox	350
i layshaft assembly for drive	1

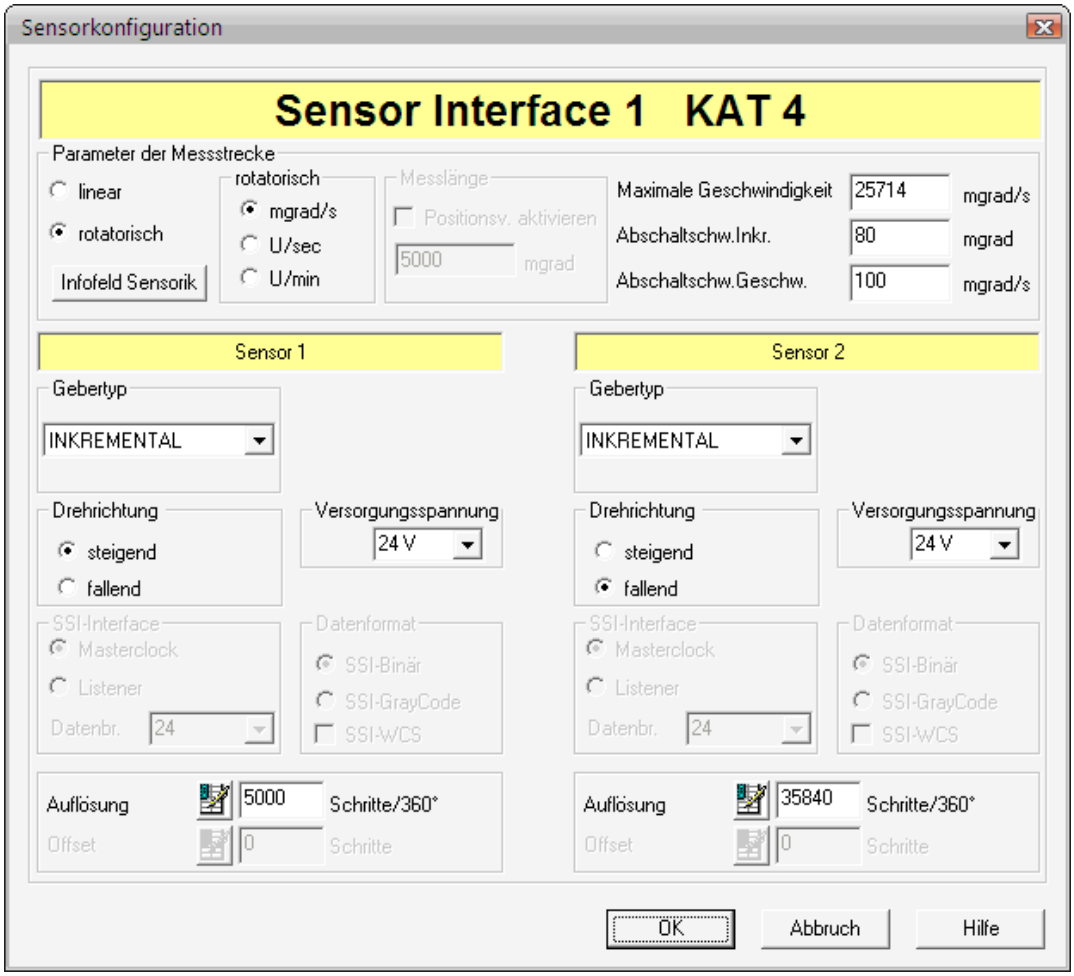
Specification of max. speed

$Gb2 = I_G \cdot I_VA \cdot A_Gb2 = 1024 \cdot 350 \cdot 1 = 35840$om the max. motor speed. In rev./s related to the load axis and with Nmax = 1500 rev./min it is

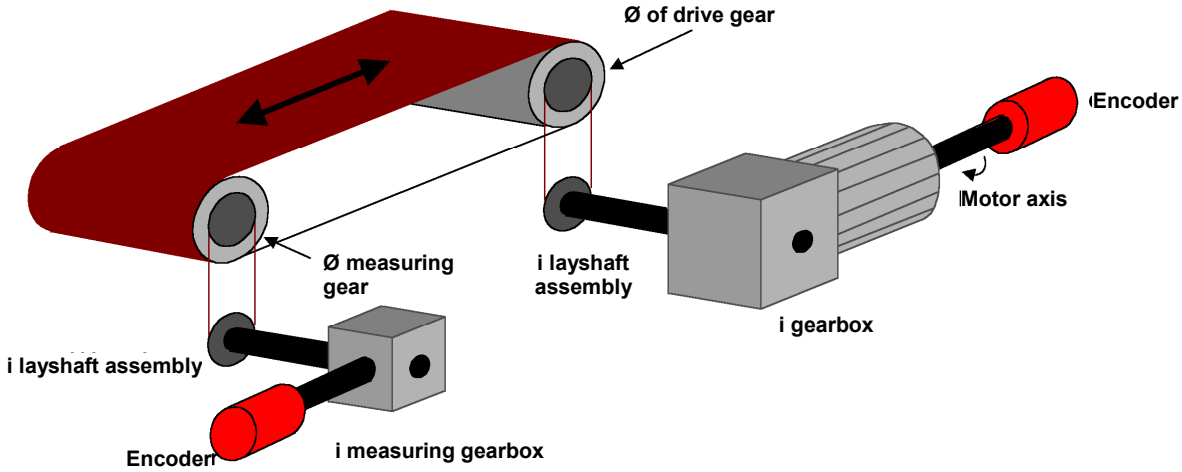
(1500 [rev./min] / 60 [s]) / 350 = 0,
Converted to mgrd/s this results in 0.07142 [1/s] * 360 *10³ [mgrd] = 25 714 [mgrd/s]

Input of max. deviation

The empirical measurement reveals a maximum difference between both detection points of 80 mgrd. A value of 100 mgrd is chosen.



Linear measuring length



Reference axis	***Input values***		***Resolution related to measuring length***
Feed axis (process axis)	Sensor1: Resolution Gb 1 i measuring gearbox i layshaft assembly ∅ measuring gear	A_Gb1 in [steps/rev] I_MG I_VG D_MR in [mm]	$Gb1 = \frac{1000}{D_MR \cdot \pi} \cdot I_MG \cdot I_VG \cdot A_Gb1$
	Sensor 2: Resolution Gb 2 i gearbox i layshaft assembly for drive ∅ drive gear	A_Gb2 in [steps/rev] I_G, I_VA, D_AR in [mm]	$Gb2 = \frac{1000}{D_AR \cdot \pi} \cdot I_G \cdot I_VA \cdot A_Gb2$
Motor axis	Sensor 1: Resolution Gb 1 i measuring gearbox i layshaft assembly ∅ measuring gear i gearbox i layshaft assembly for drive ∅ drive gear	A_Gb1 in [steps/rev] I_MG I_VG D_MR in [mm] I_G I_VA D_AR in [mm]	$Gb1 = \frac{\frac{1000}{D_MR \cdot \pi} \cdot I_MG \cdot I_VG \cdot A_Gb1}{\frac{1000}{D_AR \cdot \pi} \cdot I_G \cdot I_VA}$

Input example 2

On a manufacturing machine, access to the working area is to be enabled at certain positions of the main feed axis for manual feeding or setup work. The drive remains active in this position and is only monitored for standstill. The limits of the working stroke are variable and are to be monitored electronically in safety-relevant mode, as a replacement of the mechanical safety limit switch. The movement to be actively monitored is a linear movement. An absolute encoder is positively connected with this main drive axis of the linear length measuring system. The drive works with an electric motor with integrated motor feedback system and intermediate gear. The output shaft of the intermediate gear is connected with a drive gear ∅ 31.83 mm (= 100 mm circumference).

Selecting the module

Selecting the encoder type

Monitoring of positions is requested -> Absolute encoder required, for the second encoder an incremental detection + reference switch is sufficient.

Determination of the measuring length parameters

The main axis of the machine is selected as reference axis. The following parameters are selected:

- Linear
- Measuring length = 600 mm
- Reference axis is rotational axis => designation = mm

Determination of parameters for sensor 1

Sensor 1 is directly connected to the drive axis. A sensor with the data: Absolute encoder SSI, 4096 steps/rev. is used.
The following parameters are selected:

- Encoder type absolute
- Data format SSI
- Resolution:

Sensor 1:	
Resolution Gb 1	4096 [steps/rev]
i measuring gearbox	1
i layshaft assembly	1
∅ drive gear	31.83

$$Gb1 = \frac{1000}{D_MR \cdot \pi} \cdot I_MG \cdot I_VG \cdot A_Gb1 = \frac{1000}{31{,}83 \cdot \pi} \cdot 1 \cdot 1 \cdot 4096 = 40960$$

Determination of parameters for sensor 2

The existing motor feedback system is used as sensor 2. The motor is connected with the drive gear via an intermediate gearbox. The ratio of the gearbox is 4.51 times the Ø of the drive gear 31.831 mm.
The sensor interface is connected to the pulse outPorts of the power converter. The sensor data are as follows: SIL3, 1024 I/rev. According to the data sheet of the power

converter manufacturer the sine/cosine tracks of the SIL3 encoder are output in the form of pulses -> emulated encoder on the pulse outPort of the power converter = pulse generator, A/B-track, 1024 I/rev.
The following parameters are selected:

- Encoder type incremental
- Resolution:

Sensor 1:	
Resolution Gb 2	1024 [steps/rev]
i gearbox	4.51
i layshaft assembly	1
∅ drive gear	31.83

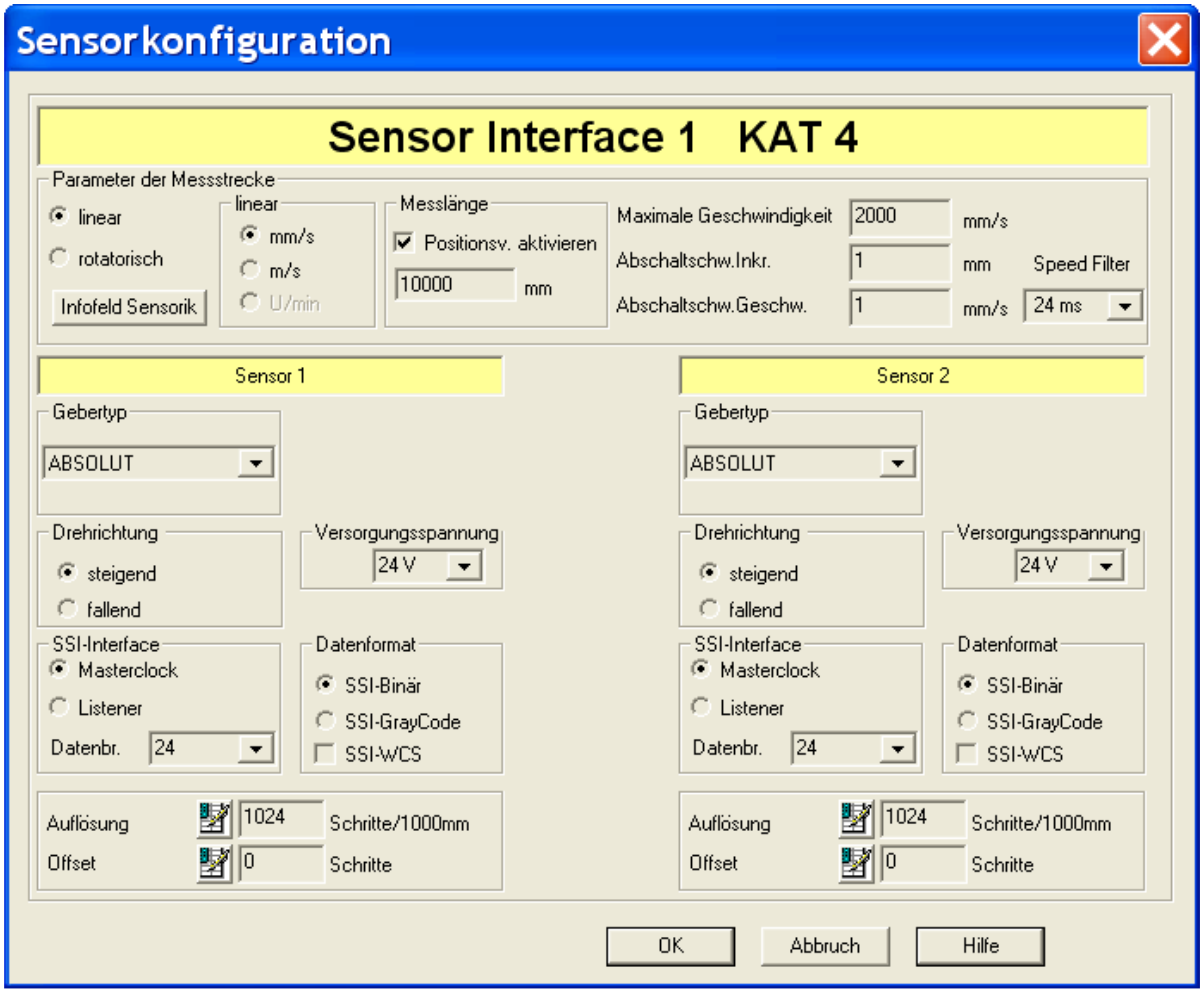
$$Gb2 = \frac{1000}{D_AR \cdot \pi} \cdot I_G \cdot I_AV \cdot A_Gb2 = \frac{1000}{31{,}83 \cdot \pi} \cdot 4{,}51 \cdot 1 \cdot 1024 = 46182;$$

Specification of max. speed

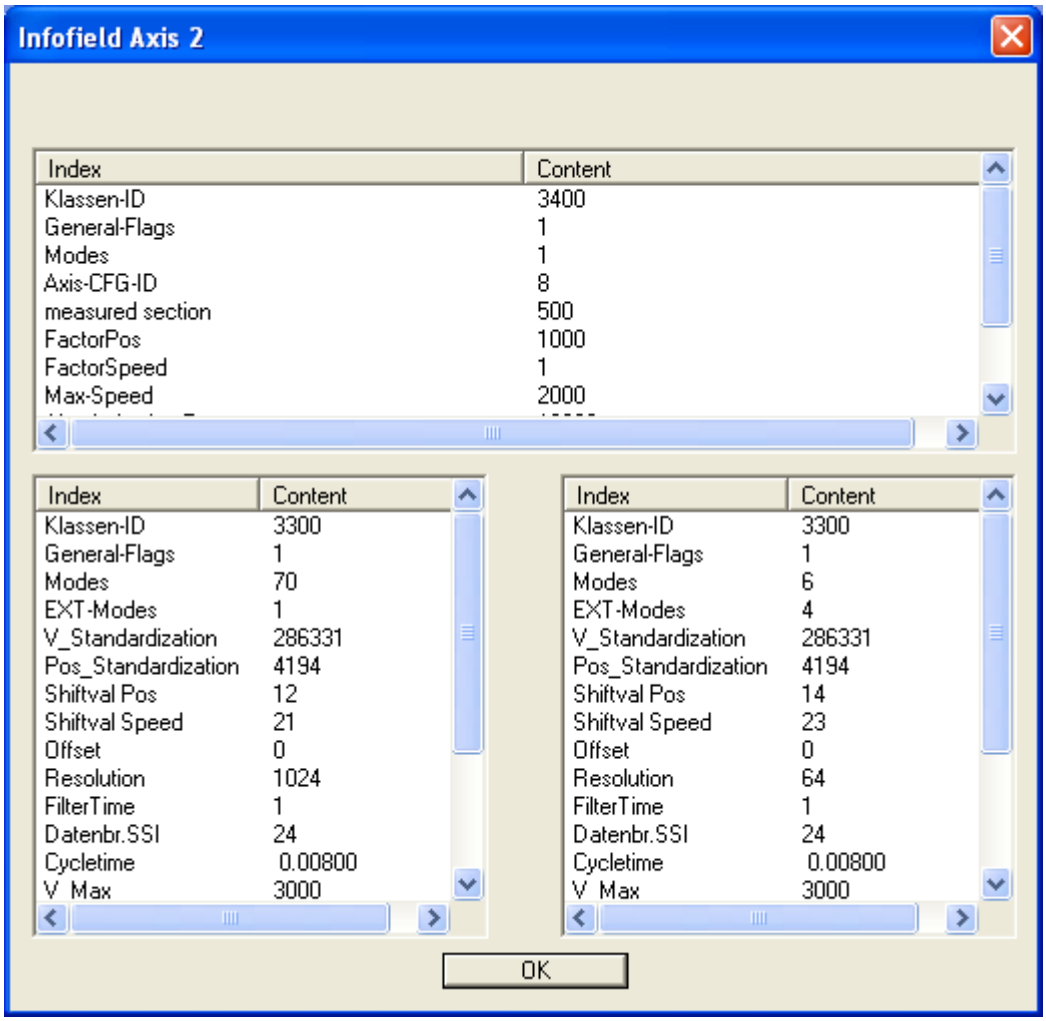
The max. speed of the output axis is derived from the max. motor speed. In rev./s related to the load axis and with Nmax = 1500 rev./min it is
(1500 [rev/min] / 60 [s]) * 0.012 [m] = 0.3 [m/s] = 300 [mm/s].

Input of max. deviation

The empirical measurement reveals a maximum difference on <1 mm between both sensing points on motor axis and movement axis. The value chosen is 1 mm.


Sensorkonfiguration
Sensor Interface 1 KAT 4
Parameter der Messstrecke
linear
rotatorisch
Infofeld Sensorik
linear
mm/s
m/s
U/min
Messlänge
Positionsv. aktivieren
10000
mm
Maximale Geschwindigkeit
2000
mm/s
Abschaltschw.Inkr.
1
mm
Speed Filter
Abschaltschw.Geschw.
1
mm/s
24 ms
Sensor 1
Sensor 2
Gebertyp
ABSOLUT
Drehrichtung
steigend
fallend
Versorgungsspannung
24 V
SSI-Interface
Masterclock
Listener
Datenbr.
24
Datenformat
SSI-Binär
SSI-GrayCode
SSI-WCS
Auflösung
1024
Schritte/1000mm
Offset
0
Schritte
OK
Abbruch
Hilfe

The Sensor Info Field shows the following result entries:

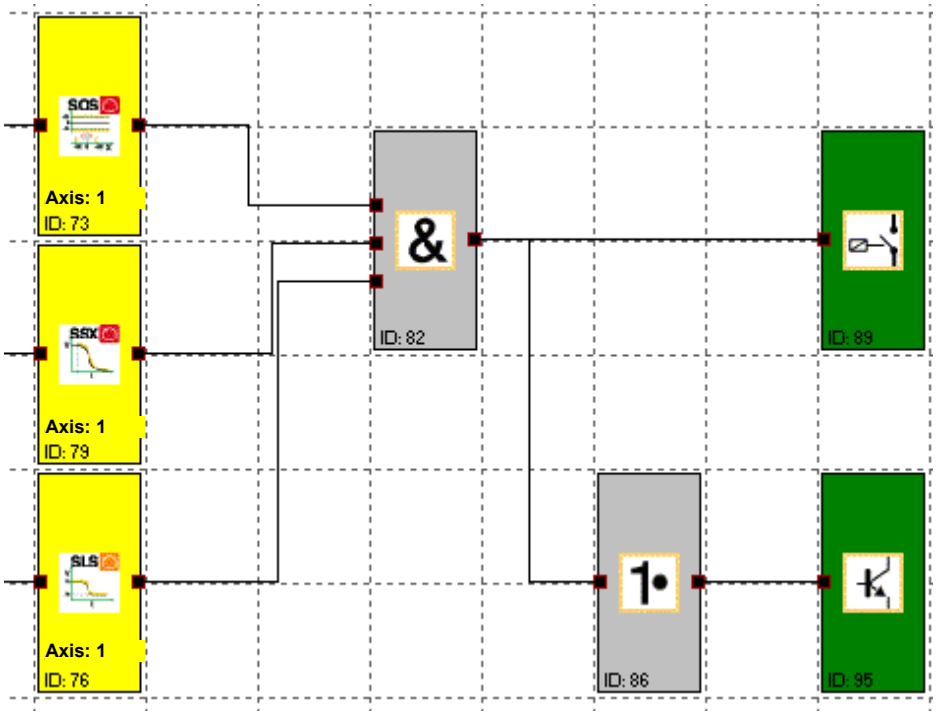


These can be switched to the second axis by clicking on the "Axis Change" button.

Safety Modules

The monitoring functions are calculated within the cycle time of the Safety-M system and deliver a 1-bit result at the outPort. The result can be interconnected with logic operators, all the way to an outPort.

Example for a logic linkage of monitoring functions.



SEL (Safe Emergency Limit)

Monitoring of the maximum movement range

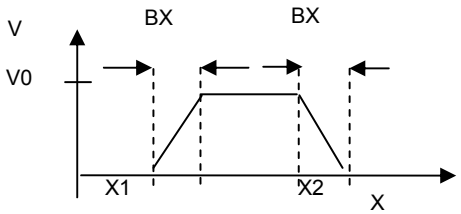
Number:	2
Access-ID:	Identification of function element
Axis assignment:	maximum 1 function per axis
Function:	Monitoring of the permissible speed related to the relative distance to the maximum limit of the movement or adjustment range. This function replaces the conventional safety limit switches!
InPort:	Standardized position signal X from the encoder interface
RESET-function:	The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via: ▪ RESET function in the group of inPort elements ▪ Function key on the front side of a basic module

Description of function:

- Calculation of actual speed V using position signal X
- Determination of the stopping distance related to the current status of acceleration and speed
  => Cyclic determination of the $Stop_Distanz_{Akt.}$ = f (V, a) with a = acceleration
- Comparison: $Pos_{Akt.}$ + $Stop_Distanz_{Akt.}$ < Ziel_Pos + Overtravel

A trapezoidal or S-shaped speed profile serves as basis for the calculation. For a trapezoidal speed profile, the limit curve is the result of the parameterized acceleration, whereas an S-shaped speed profile additionally uses the change in acceleration for the calculation.

Trapezoidal speed profile:

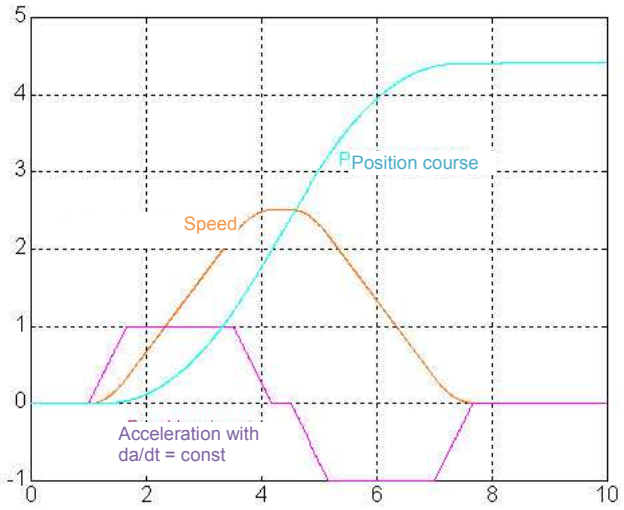


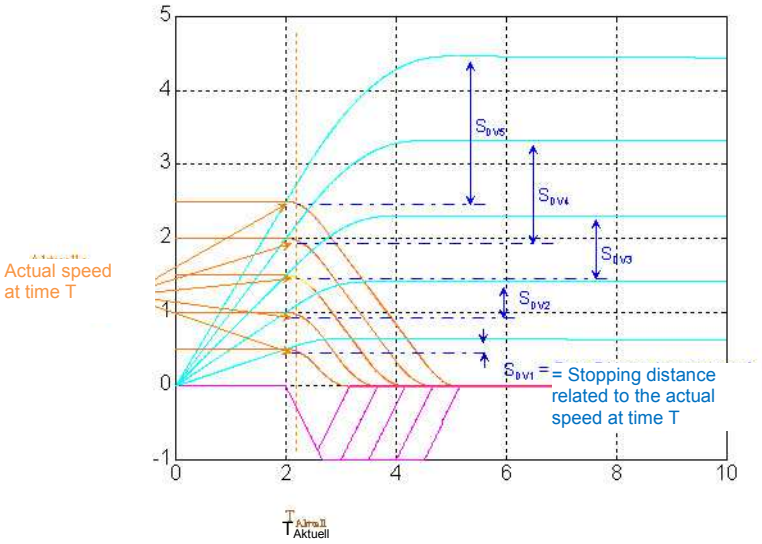
X1 = Min. position
X2 = Max. position
V0 = Maximum speed for (X1 + BX) < X < (X2 – BX)
F= Type of speed profile (trapezoidal or S-shaped)

Trapezoidal
BX = Braking/approaching range

S-shaped
AM= Maximum acceleration
DA = Type of acceleration

S-shaped speed profile

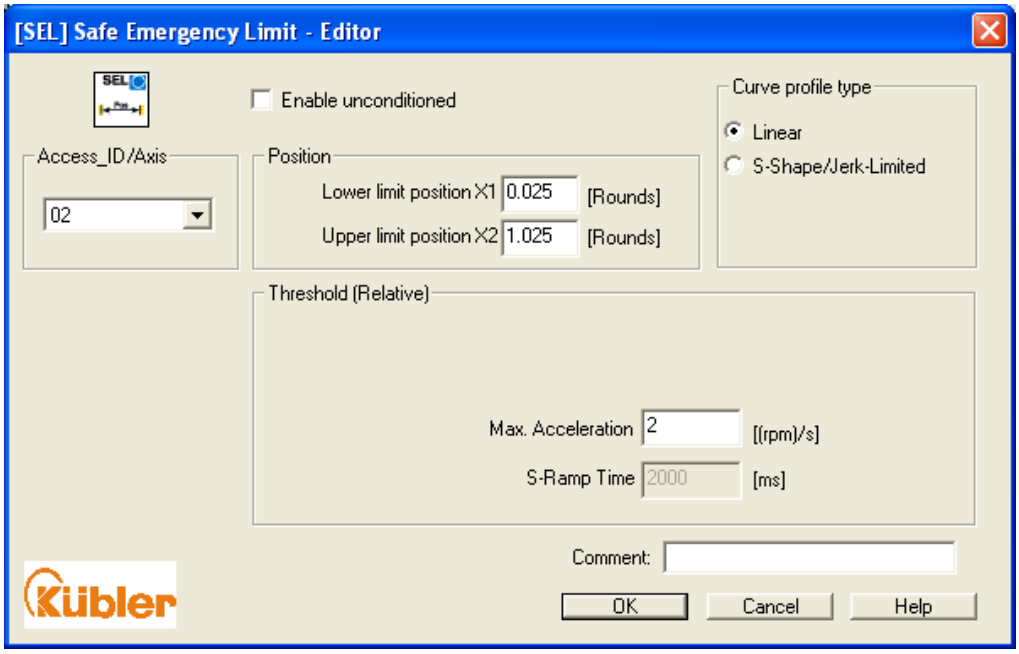




OutPort function

Range		HI	LO
X < X1 X > X2	OR		X
X >= X1 X <= (X1 + BX) V < Limit curve	AND AND	X	
X >= (X2 – BX) X <= X2 V < Limit curve	AND AND	X	
X >= X1 X <= (X1 + BX) V >= Limit curve	AND AND		X
X >= (X2 – BX) X <= X2 V >= Limit curve	AND AND		X

Limit curve = Speed profile derived from the actual parameterization



Parameters:

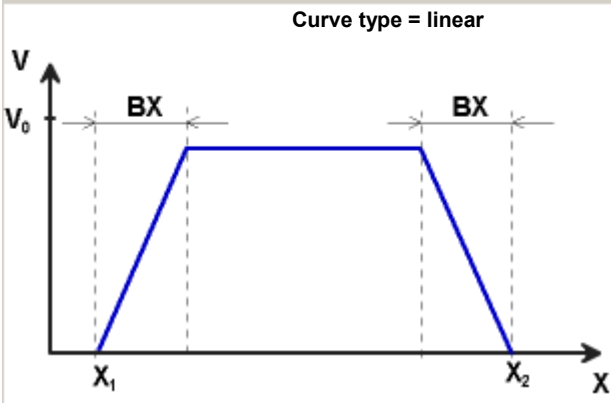
Activate permanently
The monitoring function is permanently active and has no inPort connector.

Lower limit position X1
Lower limit position

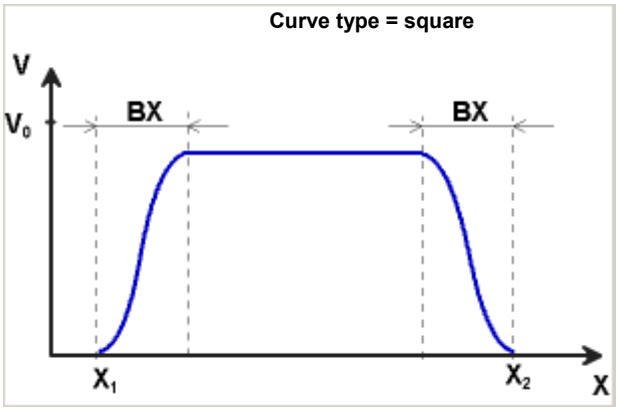
Upper limit position X2

Upper limit position

Curve type linear
Linear calculation method for the stopping distance with respect to the limit position



Curve type S-shaped
Square calculation method for the stopping distance with respect to the limit position



Max. acceleration
Max. acceleration value within BX

Max. change in acceleration
Max. value of acceleration change within BX

Input example 1

On a manufacturing machine, access to the working area is to be enabled at certain positions of the main feed axis for manual feeding or setup work. The drive remains active in this position and is only monitored for standstill. The limits of the working stroke are variable and are to be monitored electronically in safety-relevant mode, as a replacement of the mechanical safety limit switch. The movement to be actively monitored is a linear movement. An absolute encoder is positively connected with this main drive axis of the linear length measuring system. The drive works with an electric motor with integrated motor feedback system and intermediate gear.

1. Limit position

The reference zero point of the main drive axis is located in the top dead centre. The mechanical trailing distance subordinate is = X1 = -5mm.
The lower end position is at 600mm + 5 mm safety limit.
=> X2 = 605mm

2. Form of speed selection

The drive/position controller uses a ramp limitation (jolt limitation) for the acceleration with resultant S-slip of the speed, in order to minimize deviations and processing marks
=> Select S-form option

3. Limit value selection

All other limit values are taken from the machine parameterization.
Maximum acceleration = 1000 mm/s²
Maximum change of acceleration = 3000 mm/s³

SLP = (Safe Limited Position)

GOTO monitoring

Number: 2

Access-ID: Identification of function element

Axis assignment: maximum 1 function per axis

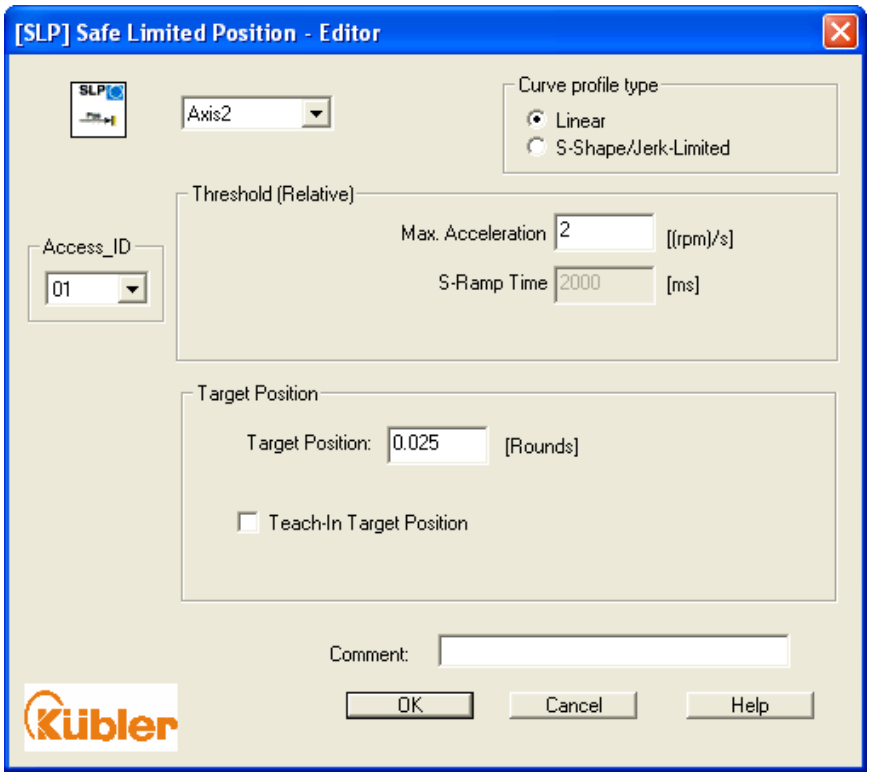
Function: Monitoring of the permissible speed related to the relative distance to a parameterized Teach-In recorded target position.

InPort: Standardized position signal X from the encoder interface

RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:
- RESET function in the group of inPort elements
- Function key on the front side of a basic module

Description of function:

- Calculation of actual speed V using position signal X
- Determination of the stopping distance related to the current status of acceleration and speed
  => Cyclic determination of the $Stop_Distanz_{Akt.}$ = f (V, a) with a = acceleration
- Comparison: $Pos_{Akt.}$ + $Stop_Distanz_{Akt.}$ < Ziel_Pos + Overtravel



Parameters:

Target position
Absolute position value of target position

Curve type linear
Linear calculation method for the stopping distance with respect to the target position

Curve type S-shaped
Square calculation method for the stopping distance with respect to the target position

Max. acceleration
Max. acceleration value within BX

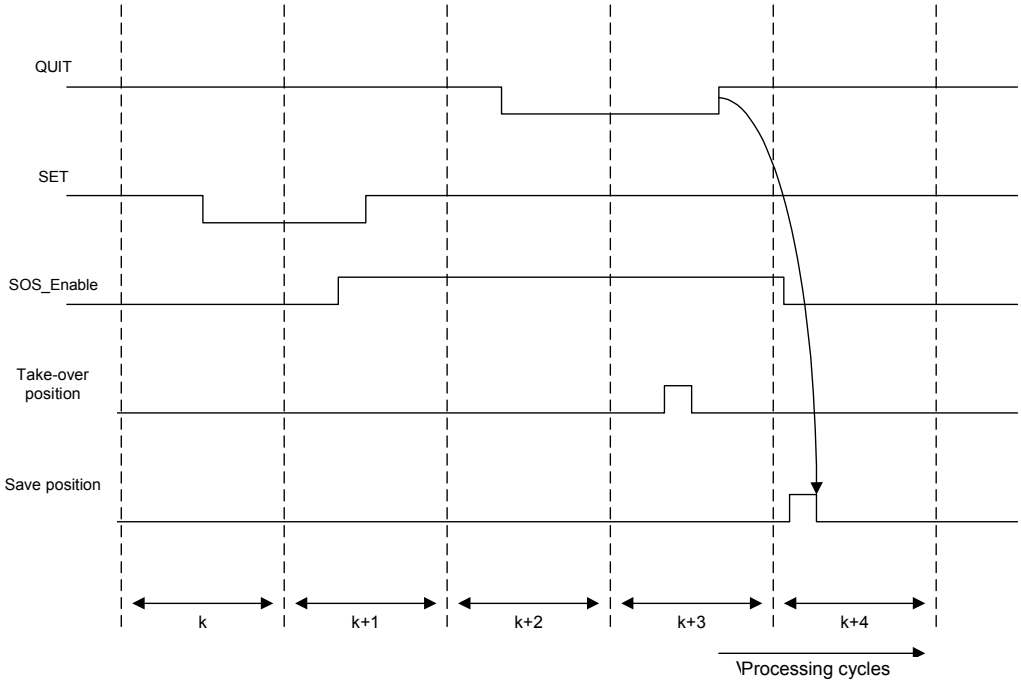
Max. change in acceleration
Max. value of acceleration change within BX

Recording the target position using Teach-In
The "Teach-In" option can be used to have the target position recorded by the Safety-M system without the need of manual subsequent parameterization. This requires the following steps:

- Activating the switch "Teach-In" changes the input field "Target position" to "Position tolerance". At same time the input dialog increases by the SOS-functionality.
- Recording a position using the "Teach-In" option can only take place at standstill and with the SOS-function activated.

- Recording a position requires the two signals "SET" and "QUIT". These appear when activating the TEACH-IN option as inPort connector of the functional module.
- The QUIT signal can only be directly connected with an inPort module

Time characteristic of the SET/QUIT process:



The sequence is time-monitored and triggers an ALARM if the expectations are exceeded.

The maximum time slot is 3 seconds !

Position tolerance
Tolerance window of the accepted Teach-In value

Note: When using the Teach-In function, the monitoring threshold is extended by the value of the position tolerance. Without the Teach-In functionality the value of the position tolerance is zero.

Parameters of the SOS-dialog: See SOS-function

SCA (Safe Cam)

Monitoring of position range with rotational speed/speed monitoring

Number: 16

Access-ID: Identification of function element

Axis allocation: any

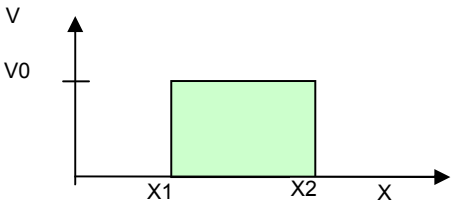
Function: Monitoring of a parameterizable position range with allocated minimum and maximum limits. Additional monitoring of the maximum rotational speed/speed in the permissible range.

InPort: Standardized position and speed signal X and V from encoder interface

RESET-function: Violation of the permissible monitoring range is not saved. No RESET acknowledgement required.

Description of function:

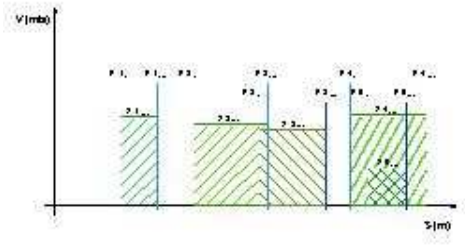
- Comparison of actual position with the parameterized range limits
- Comparison of actual speed with the parameterized range limit
- Comparison of actual acceleration with the parameterized range limit
- Monitoring of the position limits using a ramp function
- Direction dependent release
- Permanent activation of the module

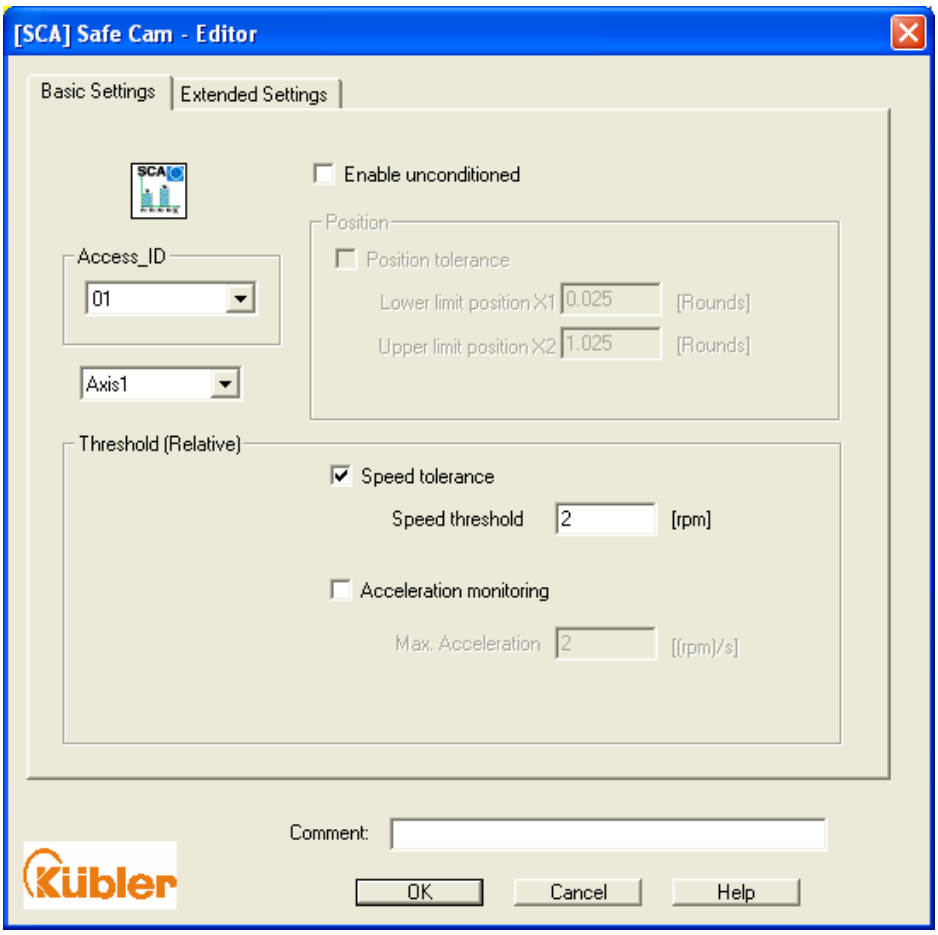


OutPort function

Range		HI	LO
X < X1 X > X2	OR		X
X >= X1 X <= X2 V < V0	AND AND	X	
X >= X1 X <= X2 V >= V0	AND AND		X

Ranges can be defined as overlapping and nested.





Parameters:

Control button for basic settings

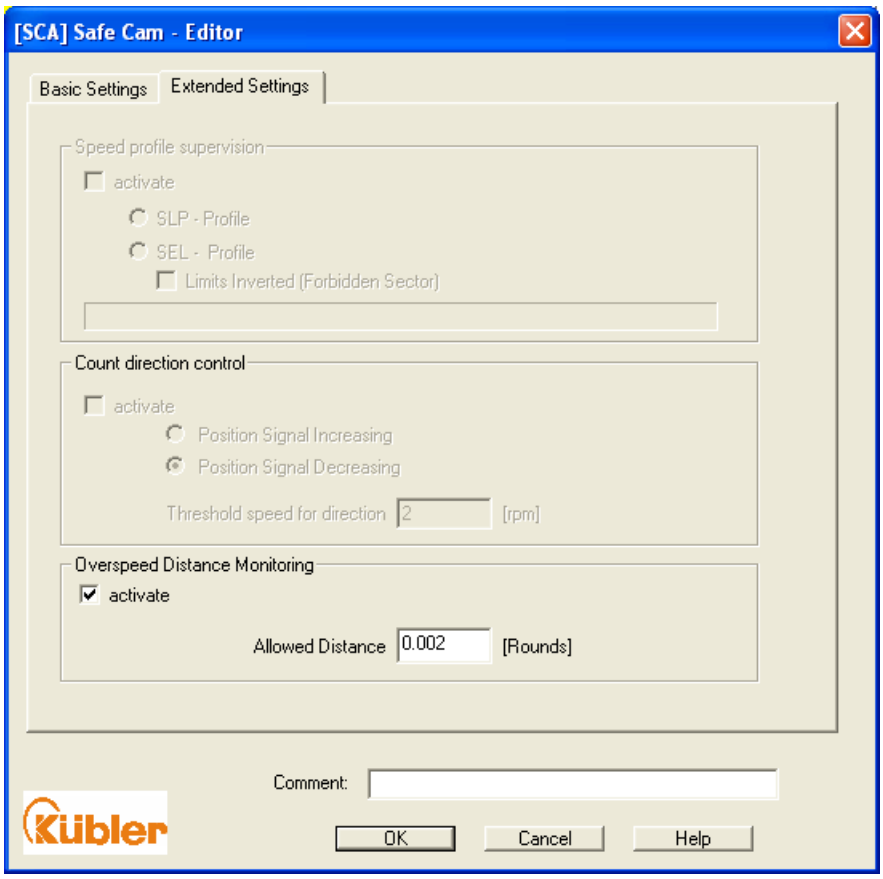
Activate permanently
The monitoring function is permanently active and has no inPort connector.

Lower limit position X1
Lower limit position

Upper limit position X2
Upper limit position

Speed threshold
Maximum permissible speed in the parameterized position range

Max. acceleration
Maximum permissible acceleration in the parameterized position range



Extended monitoring

Direction dependent release
Enables the activation of downstream functional modules in dependence on the direction. This functionality can only be utilized without speed and acceleration monitoring.

Position signal rising:
Functional module delivers the output value = "1" for a rising position signal

Position signal falling:
Functional module delivers the output value = "0" for a falling position signal

Activation speed direction release
The evaluation of the direction dependent release only takes place from the specified limit. Below this speed threshold the output value is = 0;

Travel curve monitoring
Monitoring of speed at the limits using the monitoring characteristics parameterized in SEL or SLP. This switch can only be activated with the SLP or SEL function block inserted.

Fault distance monitoring
This additional functionality enables filtering of peak speeds in case of irregular travel operation (speed peaks in signal).
Further information see SLS-function.

Attention:
When using this function, the response behaviour of the application will change. In this case, strictly follow the explanations in the installation manual.

Input example:

On a manufacturing machine, access to the working area is to be enabled at certain positions of the main feed axis for manual feeding or setup work. The drive remains active in this position and is only monitored for standstill. The limits of the working stroke are variable and are to be monitored electronically in safety-relevant mode, as a replacement of the mechanical safety limit switch. The movement to be actively monitored is a linear movement. An absolute encoder is positively connected with this main drive axis of the linear length measuring system. The main axis serves as reference axis for the Safety-M module.

1. Selecting the range
Position monitoring is to be used to monitor the position of the main axis in top zero position. Top zero position also serves as reference zero position in the length measurement of the feed axis. If the range is recognized, a protective device is released for opening.

Range limit X1 = top position = 0mm
Range limit X2 = lower tolerance limit for position = 2 mm
Speed = tolerated speed to maintain position= 3 mm/s
Acceleration = tolerated acceleration to maintain position= 5 mm/s

SSX (Safe Stop 1/ Safe Stop 2)

Function monitoring for emergency stop

Number: 4

Access-ID: Identification of function element

Axis allocation: any

Function: Monitoring of an EMERGENCY STOP function

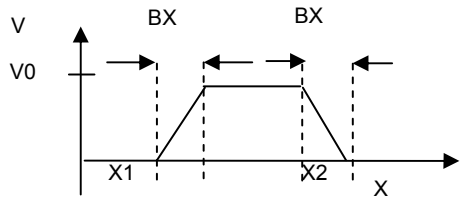
InPort: Standardized position signal X from the encoder interface

RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:

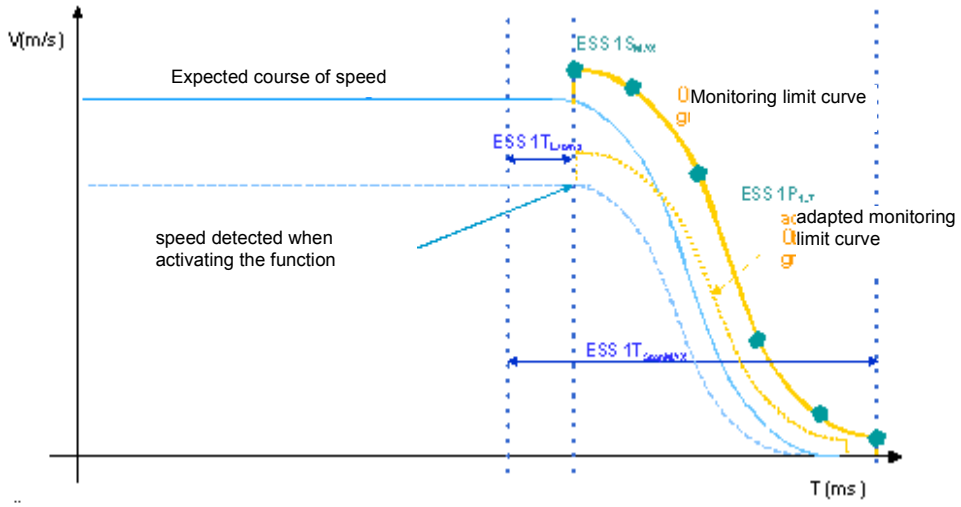
- RESET function in the group of inPort elements
- Function key on the front side of a basic module

Description of function:

Monitoring the sequence of a controlled EMERGENCY STOP by comparing the speed drop with a parameterizable monitoring curve over the course of time. The monitoring curve is a result of latency, max. speed distance to the limit curve, as well as their characteristic, calculated on the basis of acceleration and acceleration change. After activating the monitoring function, the course of the limit curve is calculated on the basis of the current speed.



Trapezoidal course of speed



Monitoring limit curves with S-shaped course of speed

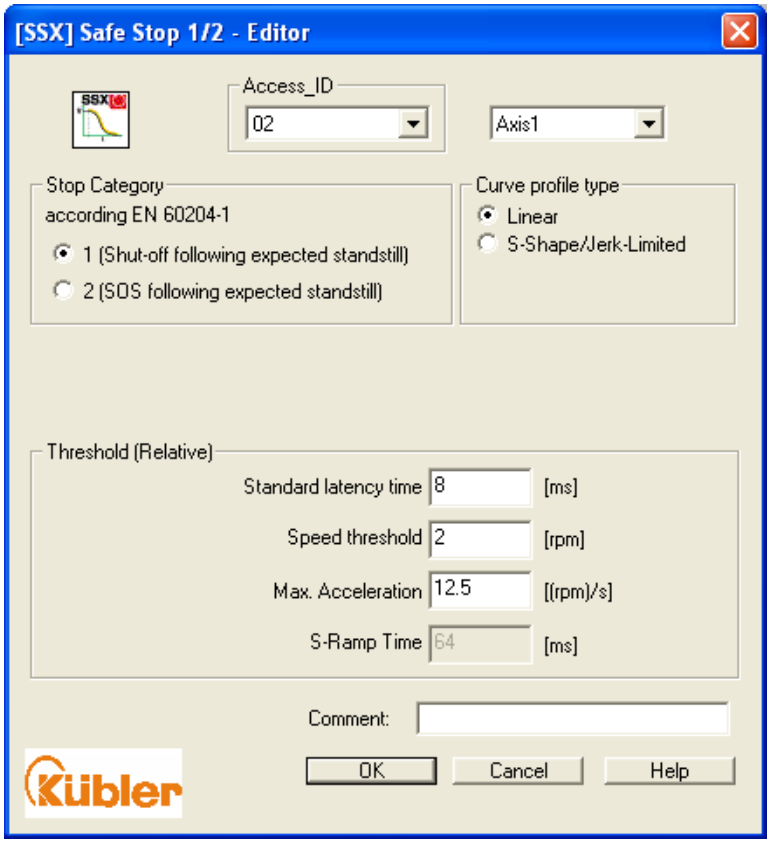
OutPort function

Range		HI	LO
$T < T_{Latency}$		X	
$T > T_{Latency}$ $V < V_{Limit\ curve}$	AND	X	
$T > T_{Latency}$ $V > V_{Limit\ curve}$	AND		X

Each function block can be parameterized to stop category 1 or 2. In stop category 2 the SOS-function is automatically activated after the expected standstill.

Reset characteristic:
The violation of the permissible monitoring range is saved and requires a RESET functionality. This occurs alternatively via:

- "Alarm Reset" module
- Function key on the front side of a basic module



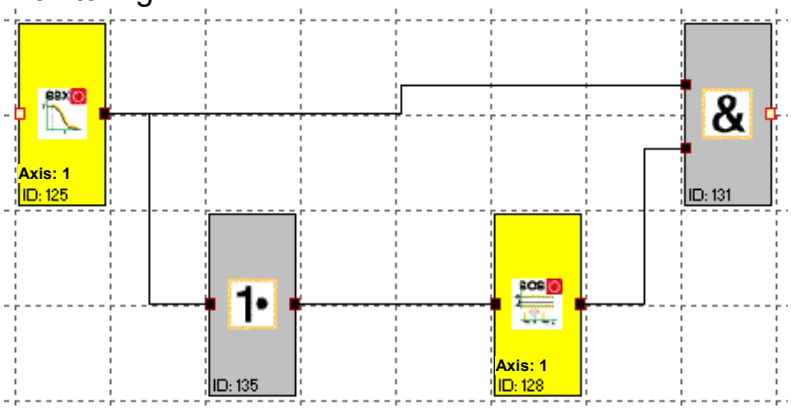
Parameters:

Stop category 1
This option realizes monitoring of the controlled EMERGENCY STOP acc. to EN 60604. According to the normative definition the energy supply should here be disconnected after the drive has come to a halt. This is supported by a transition of the SSX-function output value from "1" to "0".

Stop category 2 (SOS after expected standstill)
This option realizes monitoring of the controlled EMERGENCY STOP acc. to EN 60604. After the ramp monitoring has expired, the drive is stopped without disconnection from the energy supply (Safe Operational Stop = Standstill). For this reason the output value remains at "1" after the SSX-limit curve has expired.

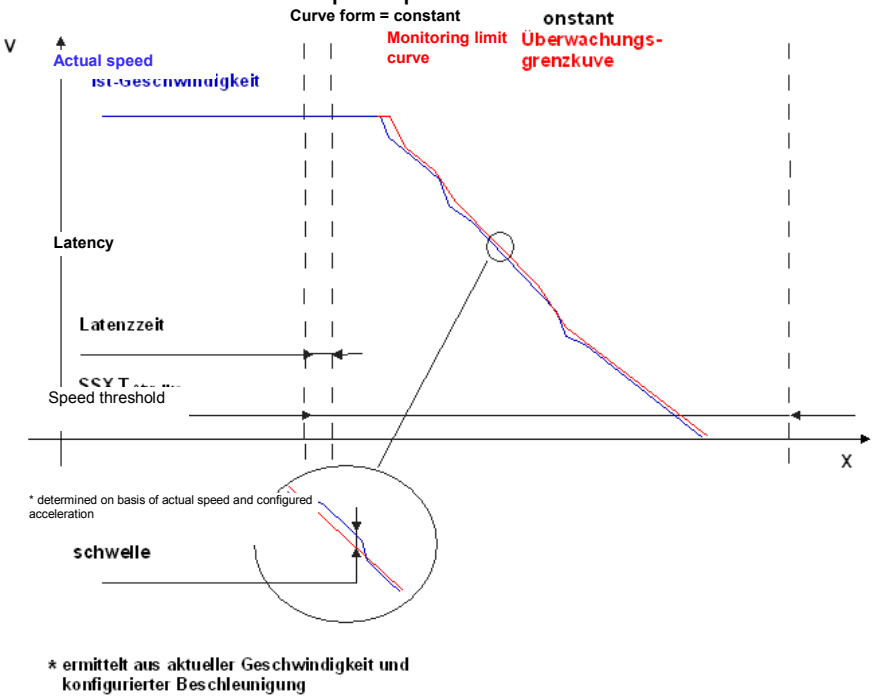
If no SOS-module has yet been defined in the logic diagram, the SSX-dialog is extended by this function. All parameters required for the SOS-function, can thus be entered immediately. If an SOS-element is inserted into the logic diagram at a later date, the dialog in the SSX-mask is omitted.

Note:
If the SSX-function is used in connection with SOS, the following circuitry must be used. If standstill is detected, the operating system will automatically activate the SOS-monitoring.

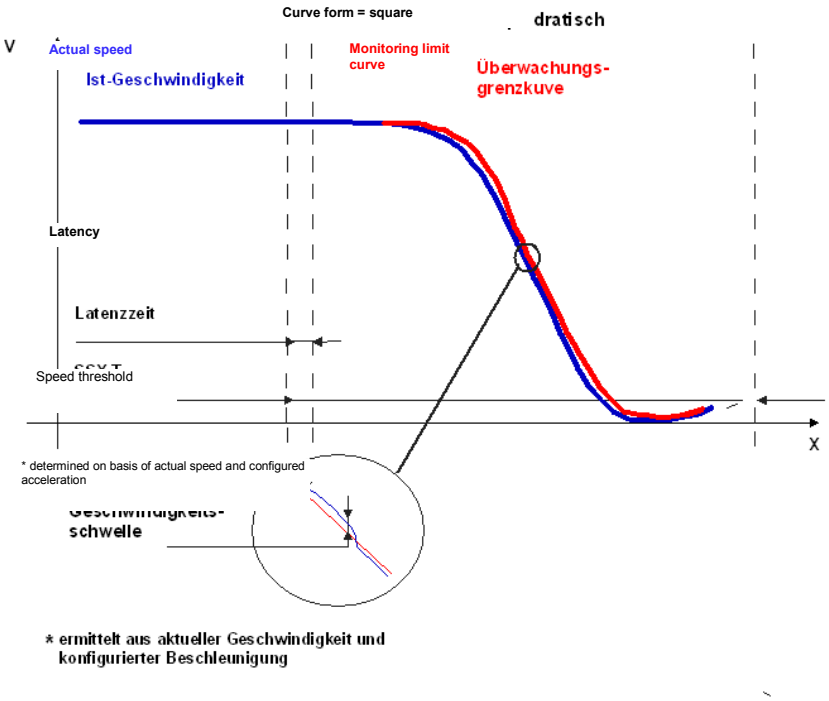


Curve type linear

Linear curve for the stop sequence



Curve type S-shaped
Square monitoring curve for the stop sequence



Standard latency
Latency until the occurrence of active deceleration

Max. speed (speed threshold)
Relative speed over the calculated limit curve.

Max. acceleration
Default acceleration value to calculate the limit curve.

Max. acceleration change
Default acceleration change value to calculate the limit curve.

Axis assignment
Input of axis assignment.

Input example:

On a manufacturing machine, access to the working area is to be enabled at certain positions of the main feed axis for manual feeding or setup work. The drive remains active in this position and is only monitored for standstill. The limits of the working stroke are variable and are to be monitored electronically in safety-relevant mode, as a replacement of the mechanical safety limit switch. The movement to be actively monitored is a linear movement. An absolute encoder is positively connected with this main drive axis of the linear length measuring system. The drive works with an electric motor with integrated motor feedback system and intermediate gear.

1. Selecting the stop category
In order to keep times of standstill and restart as short as possible, the stop category 2 acc. to DIN 60604-1 (controlled stop with drive subsequently actively controlled to V=0) is to be used => Selection stop category 2

2. Form of speed selection
The drive/position controller uses a ramp limitation (jolt limitation) for the acceleration with resultant S-slip of the speed, in order to minimize deviations and processing marks => Select S-slip option

3. Limit value selection
For the purpose of monitoring one must enter the worst-case latency starting with the occurrence of the Emergency Stop event, until the start of the braking process, which is executed with the standard control. The program sequence time of the standard control results in: Latency = cycle time*2 = 50 ms

All other limit values are taken from the machine parameterization.
Maximum feed speed = 300 mm/s²
Maximum acceleration = 1000 mm/s²
Maximum change of acceleration = 3000 mm/s³

SLI (Safe Limited Increment)

Monitoring of the max. step measurement

Number: 2

Access-ID: Identification of function element

Axis assignment: maximum 1 function per axis

Function: Monitoring of the max. permitted step measurement

InPort: Standardized position / speed signal V and X from encoder interface. Direction indication LEFT/RIGHT

RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:
- RESET function in the group of inPort elements
- Function key on the front side of a basic module

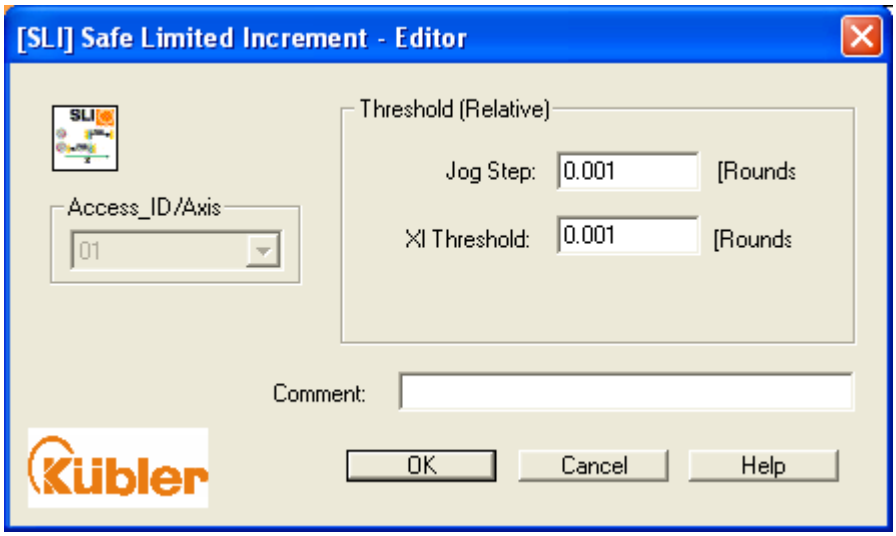
Description of function:

- Monitoring of the max. permitted step measurement = relative travel range for uninterrupted travelling in jog mode.
- Calculation of the current sense of rotation RX on basis of position / speed signal X

- Determination of the relative travel after the start of the movement.
- Monitoring for compliance with the predetermined direction and the max. relative travel

OutPort function

Range		HI	LO
V < 0 DIRECTION MARKER = LEFT relative travel < max. step measurement	AND AND	X	
V >= 0 DIRECTION MARKER = RIGHT relative travel < max. step measurement	AND AND	X	
V < 0 (DIRECTION MARKER = RIGHT relative travel > max. step measurement	AND OR		X
V > 0 (DIRECTION MARKER = LEFT relative travel > max. step measurement	AND OR AND		X



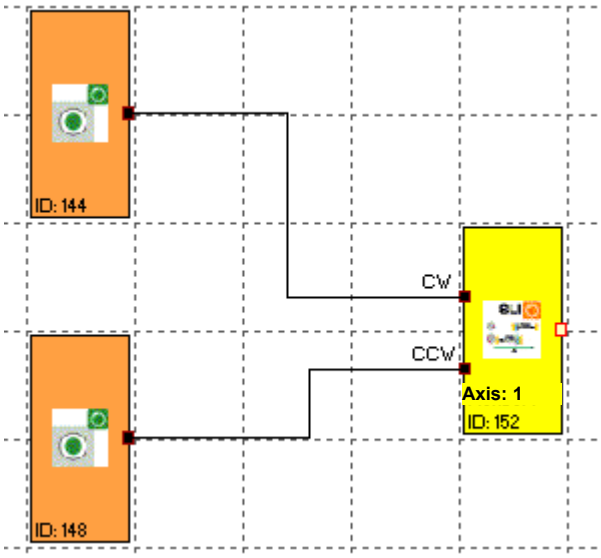
Parameters:

Step measurement
Maximum relative travel after activating the monitoring function

XI threshold
Tolerance threshold for monitoring the travel in opposite direction

Axis assignment
Input of axis assignment.

Activation example:



Input example:

The max. travel in the material feed system of a manufacturing facility is to be safely monitored in jog mode. According to the risk analysis this travel is max. 50 mm. A faulty travel in opposite direction is to be monitored.

1. Step measurement
The relative travel (only incremental encoder present) is monitored => input of the max. permissible travel acc. to risk analysis with tolerance = 55 mm

2. Travel direction monitoring
Tolerable travel in opposite direction (=creeping motion of drive) = 1 mm/s

3. Monitoring inPort
The monitoring module has two inPorts to specify the direction. An active direction signal activates the monitoring function.

Note:
Both input signals "1" are detected as non-permitted condition, causing an alarm message.

SDI (Safe Direction Indication)

Direction detection

Number: 2

Access-ID: Identification of function element

Axis assignment: maximum 1 function per axis

Function: Monitoring the pre-defined sense of rotation / direction of movement

InPort: Standardized position / speed signal X from encoder interface.
Direction marker LEFT/RIGHT

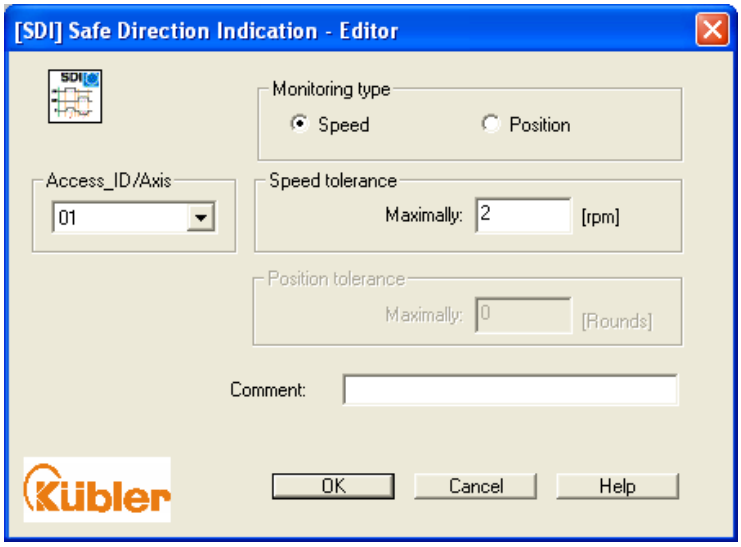
RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:

- RESET function in the group of inPort elements
- Function key on the front side of a basic module

Description of function:

OutPort function

Range	HI	LO
V < 0 AND DIRECTION MARKER = LEFT	X	
V >= 0 AND DIRECTION MARKER = RIGHT	X	
V < 0 AND DIRECTION MARKER = RIGHT		X
V > 0 AND DIRECTION MARKER = LEFT		X

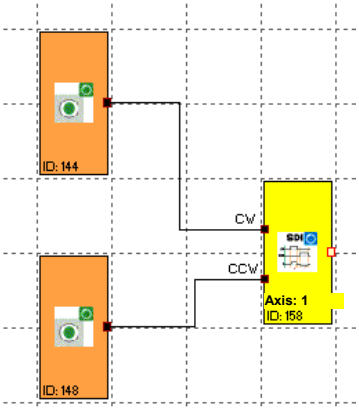


Parameters:

Maximum
Tolerance threshold for position or speed in opposite direction

Axis assignment
Input of axis assignment.

Activation example:



Input example:

In a manufacturing device, the speed of certain manual processes is to be monitored for a safe reduced value, as well as standstill and movement direction. The movement to be actively monitored is a rotary movement. The drive works with an electric motor with integrated motor feedback system and intermediate gear.

1. InPort for monitoring function
Monitoring of speed (only incremental encoder present)
=> Speed

2. Speed monitoring
Tolerable speed in opposite direction (=Creeping of drive) from machine parameter = 1 mm/s

Monitoring inPort
The monitoring module has two inPorts to specify the direction. An active direction signal activates the monitoring function.

Note:
Both input signals "1" are detected as non-permitted condition, causing an alarm message.

SLS (Safe Limited Speed)

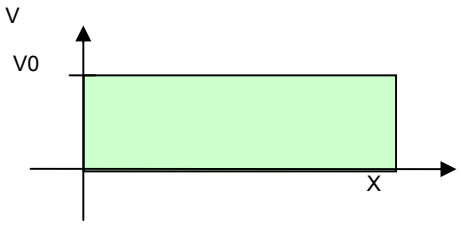
Monitoring of a minimum speed

Number:	8
Access-ID:	Identification of function element
Axis allocation:	any
Function:	Monitoring of a minimum speed
InPort:	Standardized position signal X from the encoder interface
RESET-function:	The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via: ▪ RESET function in the group of inPort elements ▪ Function key on the front side of a basic module

Description of function:

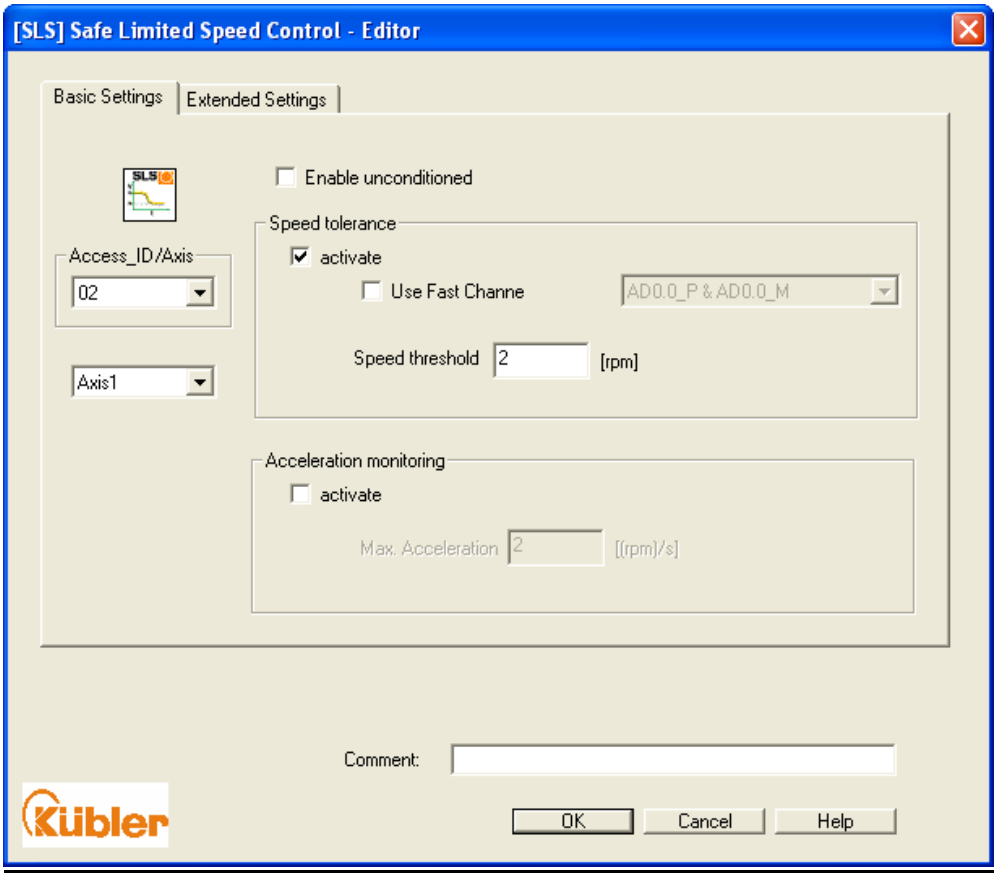
- Monitoring the maximum speed or rotational speed of a drive.
- Calculation of the current speed V on basis of position or digital speed signal X
- Comparison of the actual speed with the parameterized speed threshold
- Monitoring of a speed transition from fast to slow.

Description of function:



OutPort function

Range	HI	LO
V < V0	X	
V >= V0		X



Parameters:

Activate permanently
The monitoring function is permanently active and has no inPort connector.

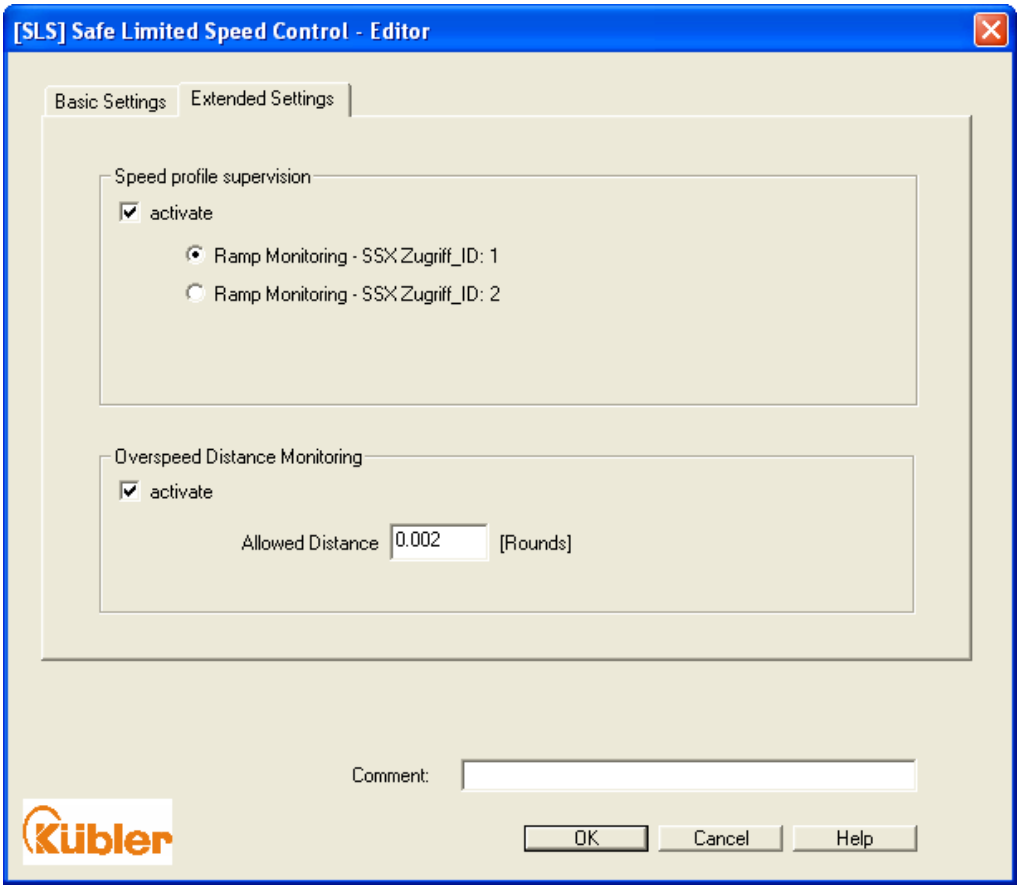
Speed tolerance switch
To activate speed monitoring

Use fast channel
The "Fast Channel" option can be used to achieve a shorter response time of the system. The two semi-conductor outPorts can alternatively be chosen in combination as shut-down channel.

Attention: Response time see installation manual !

Speed threshold
Specification of maximum speed, alternatively max. rotational speed.

Max. acceleration
Specification of the max. acceleration



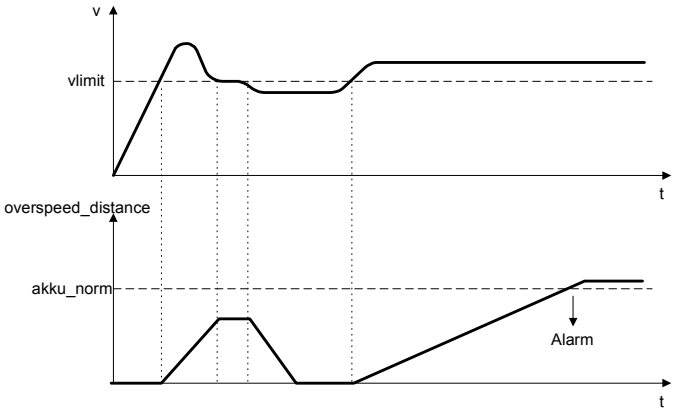
Ramp monitoring
This option monitors the transition of speed from fast to slow by using an SSX-functionality. The selected SSX-element must be available in the logic diagram.

Fault distance monitoring
This additional functionality enables filtering of peak speeds in case of irregular travel operation (speed peaks in signal).

The path integer is calculated on basis of the difference between the current speed and the parameterized speed monitoring value and compared with the entered value. If the entered value is exceeded, the monitoring function is triggered.
The function can only be activated if the acceleration monitoring function is switched off.

Example of fault distance monitoring:

The graph shows an example for fault distance monitoring. A drive exceeds the threshold "vlimit", which is parameterized in the SLS-function. By exceeding this value, the speed above the threshold is integrated (= akku_norm). If the current speed drops below the threshold, the integer will also decrease below the limitation. During the continuing process the speed will rise again and remain above the parameterized threshold. As a consequence the integer will also increase again, triggering an alarm when it exceeds the fault distance (= integrated speed proportion). The course of the fault integrator can be visualized with the SCOPE-function.



Attention:
When using this function, the response behaviour of the application will change. In this case strictly follow the explanations in the installation manual.

Input examples:

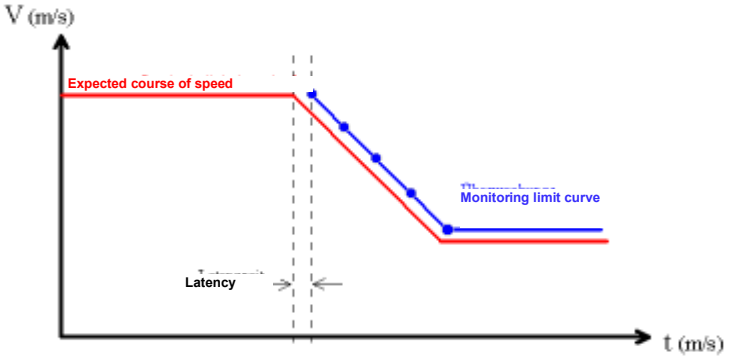
In a manufacturing device, the speed of certain manual processes is to be monitored for a safe reduced value, as well as standstill and movement direction. The movement to be actively monitored is a rotary movement. The drive works with an electric motor with integrated motor feedback system and intermediate gear.

1. Speed monitoring
The safely reduced speed in manual mode is to be monitored => speed monitoring active with max. value from machine parameter = 50

2. Acceleration monitoring
The safely reduced acceleration in manual mode is to be monitored => acceleration monitoring active with max. value from machine parameter = 100

3. Ramp monitoring

Speed monitoring and ramp monitoring acc. to SSX must be activated. In this case the SSX used must already be inserted or configured in the project. The transition from a fast to a slower (= parameter max. speed) speed can now be monitored (see graph).



When activating the SLS, the parameterized SSX is automatically activated via the SLS. The SSX monitors the ramp course of the speed. If the actual speed is lower than the SLS threshold, the SLS will take over the further monitoring, until the SLS is deactivated again.
The ramp course can be diagnosed with the SCOPE monitor as a diagnostic function.

Notes:

- If the SSX used is activated during "SLS ramp monitoring" (i.e. normal EMERGENCY STOP function via SSX-enable), the parameterized SSX-connection is always prioritized.
- The SSX-function is always activated by the SLS, if the current speed is higher than the SLS-threshold.
- The SLS threshold must be higher than 0!
- If the calculated speed profile is exceeded when changing the speed from fast to slow, this is saved in both monitoring functions SLS and SSX.
- If several SLS-functions with ramp monitoring are activated, the lowest parameterized SLS-threshold value is used as threshold value for the SSX-ramp.

SOS (Safe Operating Stop)

Standstill monitoring

Number: 2

Access-ID: Identification of function element

Axis assignment: maximum 1 function per axis

Function: Standstill monitoring

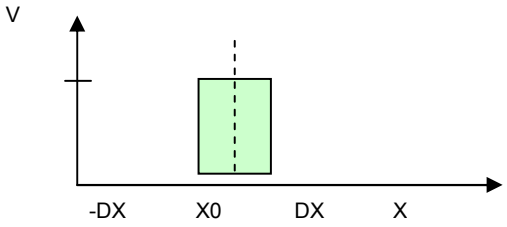
InPort: Standardized position / speed signal V and X from encoder interface.

RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:

- RESET function in the group of inPort elements

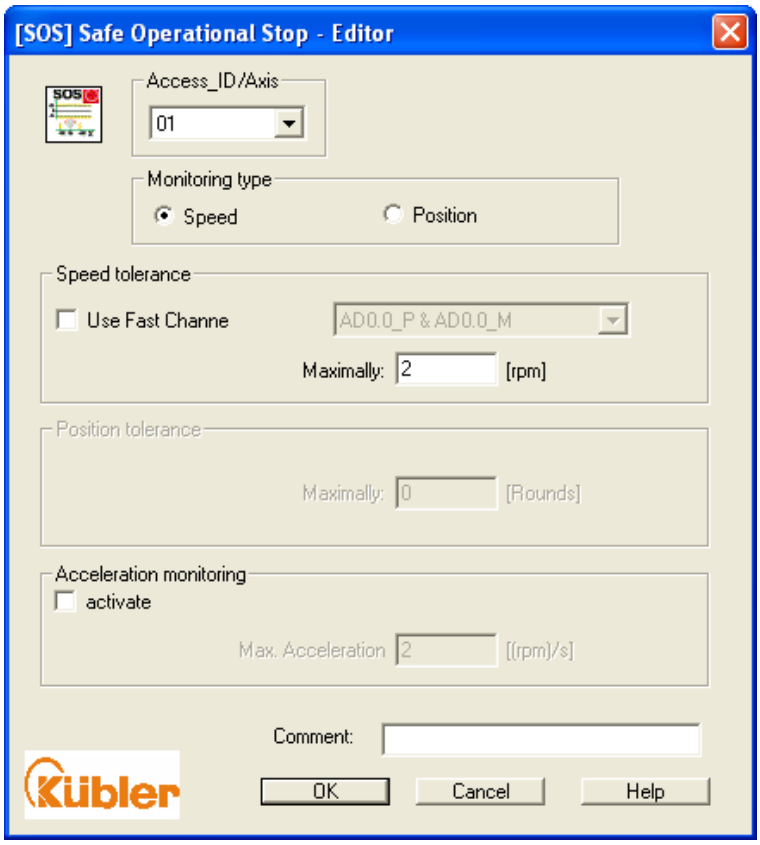
Description of function:

- Standstill monitoring of drive at the current position with drive enabled and possibly activated position controller.
- Calculation of the current speed V on basis of position or digital speed signal X
- Comparison of the actual speed with the parameterized monitoring slot



OutPort function

Range	HI	LO
X > (X0 – DX) AND X < (X0 + DX)	X	
X <= (X0 - DX)		X
X >= (X0 + DX)		X



Type of monitoring
Determination of the monitoring type for standstill to a minimum speed threshold or a position slot

Maximum
Minimum speed or a permissible relative deviation from the actual position at the time when the SOS-functionality is activated.

Use fast channel
The "Fast Channel" option can be used to achieve a shorter response time of the system. The two semi-conductor outPorts can alternatively be chosen in combination as shut-down channel.

Attention: Response time see installation manual !

Acceleration monitoring
Optional maximum value for acceleration monitoring during an active SOS-function.

Input example 1

In a manufacturing device, the speed of certain manual processes is to be monitored for a safe reduced value, as well as standstill and movement direction. The movement to be actively monitored is a rotary movement. The drive works with an electric motor with integrated motor feedback system and intermediate gear.

1. Selecting the type
Only the speed is monitored (e.g. by means of incremental encoder) => speed monitoring

2. Speed monitoring
Specification of the tolerable speed monitoring value

Input example 2

On a manufacturing machine, access to the working area is to be enabled at certain positions of the main feed axis for manual feeding or setup work. The drive remains active in this position and is only monitored for standstill. The limits of the working stroke are variable and are to be monitored electronically in safety-relevant mode, as a replacement of the mechanical safety limit switch. The movement to be actively monitored is a linear movement. An absolute encoder is positively connected with this main drive axis of the linear length measuring system. The drive works with an electric motor with integrated motor feedback system and intermediate gear.

1. Selecting the type
The position is monitored (absolute encoder available) => position monitoring

2. Position monitoring
Specification of the tolerable position monitoring value

SAC (Safe Analog Control)

Monitoring of an analog input signal

Number: 8

Access-ID: Identification of function element

Axis allocation: none

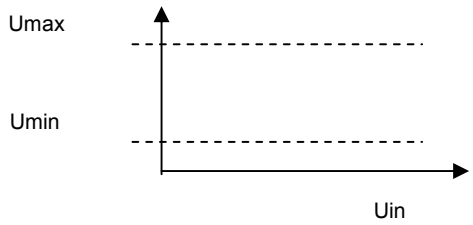
Function: Monitoring of an analog threshold value

InPort: Standardized input signals Uin1 and Uin2

RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:

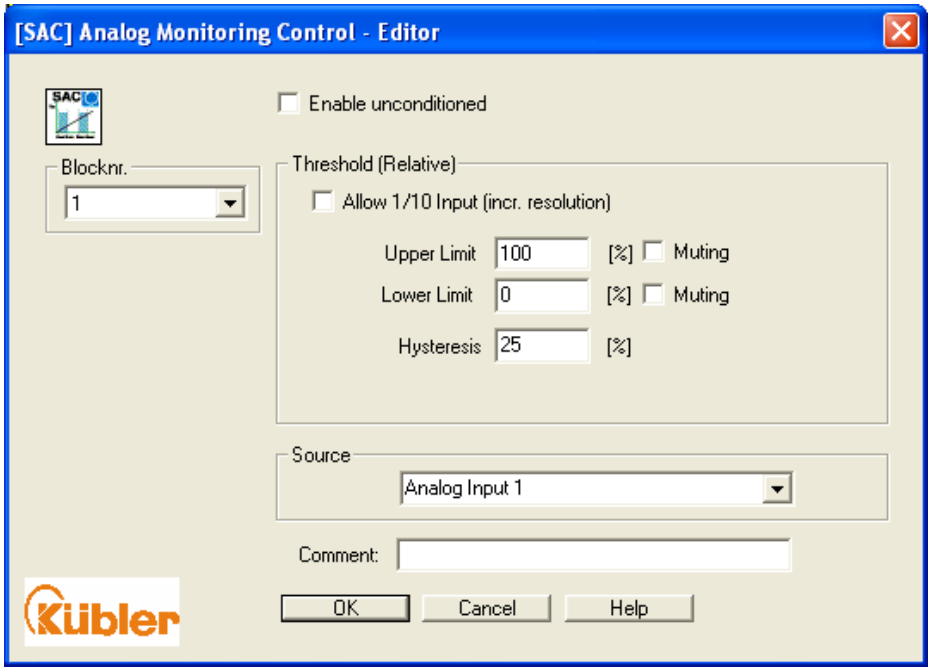
- RESET function in the group of inPort elements

Description of function:



OutPort function

Range	HI	LO
Uin > Umin	X	
Uin < Umax	X	
Uin <= Umin OR Uin >= Umax		X



Parameters:

Activate permanently
The monitoring function is permanently active and has no inPort connector.

Lower limit
Minimum value - threshold

Upper limit
Maximum value - threshold

Hysteresis
Hysteresis for threshold values

Source
Adjustable analog signal source

- Analog signal 1
  Ain1 is made up of input signals from sensor1 and sensor2 of the interface.
- Analog signal 2
  Ain2 is made up of input signals from sensor3 and sensor4 of the interface.
- Filtered values of analog signals Ain1 and Ain2
- Add Ain1 and Ain2

Attention:

When using filter functions the response times specified in the installation manual must be taken into account !

PDM (Position Deviation Muting)

Temporal hiding of the 2-channel sensor evaluation in case of encoder position deviation or an encoder "RESET"

Number: 2

Access-ID: Identification of function element

Axis assignment: maximum 1 function per axis

Function: Hiding (muting) the encoder diagnostics

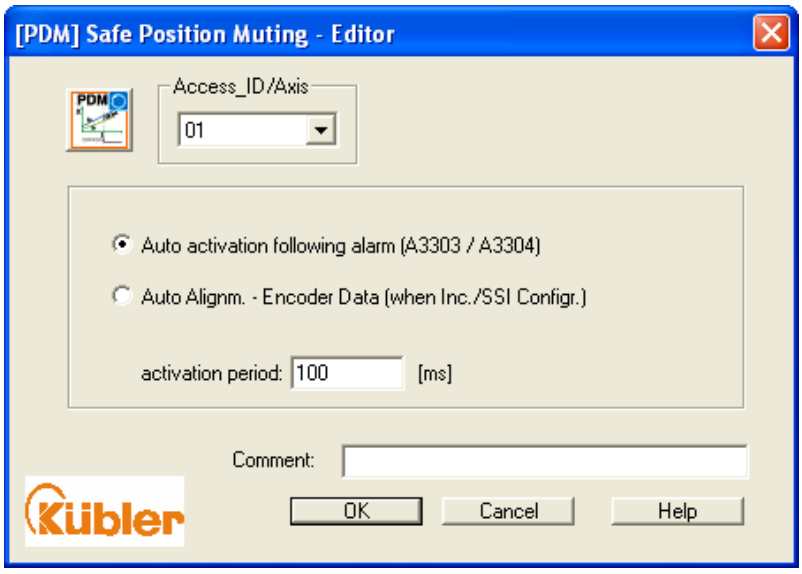
Note:

This function may have a considerable effect on the safety of an application. One must make absolutely sure that the use of the PDM-function will not cause any situations that may adversely affect safety!

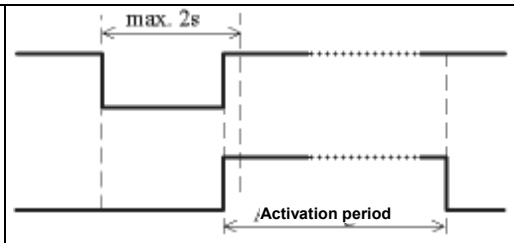
Description of function:

- **Automatic activation in case of an alarm**
  Switching off the encoder diagnostics for an existing A3303/A3304

- **Autom. adjustment of encoder data (in case of Incr./SSI Configr.)**
  The encoder diagnostics is suppressed over the parameterized activation period



InPort:
The PDM-function should be activated by means of a safety-directed button or a similar facility.
In normal condition the activation signal for the PDM-function is "1". The inPort is time monitored and needs to execute an edge change from "1" to "0" and from "0" to "1" within two seconds. Only then is the PDM-function available.

Making behaviour	
InPort	
Output	

OutPort
In deactivated condition this function sends the result "0" and in activated condition a "1" to the process image.

Parameters:

Automatic activation in case of alarm A3303/A3304
Suppression of the plausibility test for speed and position over the duration of the activation time from a fault A3303/A3304.

Application example: e.g. lifting platform with 2 encoder systems
A lifting platform is equipped with two drive systems and assigned encoder systems (both SSI-encoders). The encoders are connected with the Safety-M module and monitor the horizontal position of the platform. If the platforms drifts to a slanted position (position deviation of encoders) the alarm triggered by this condition can not be reset. By activating this PDM-function the user is able to bring the platform back to horizontal position.

Notes:

- Perhaps a speed fault (A3301/A3302) is first detected in case of an encoder deviation. After resetting the fault with the drive at standstill, the position deviation fault A3303/A3304 is then displayed.
- When activating this function the encoder monitoring is switched off for the configured period of time. In this case the user must ensure that the moved drive does not pose any danger to persons or property.

Automatic adjustment of encoder data
Suppression of the plausibility test for speed and position over the duration of the activation time without any further pre-conditions.

Application example: Compensation of position drifting in a friction wheel application
A drive system is equipped with a position encoder with friction wheel drive. After several operation cycles, a difference in form of an incremental feedback occurs between absolute encoder and second channel. The absolute encoder needs to be reset at a defined position, but the drive system is to remain active (= RUN) during that time. Resetting the encoder during operation would possibly result in high speed or acceleration values, which would cause a shut-down, even though the drive is already at rest at the time of the encoder preset.

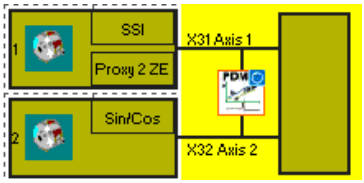
Notes:

- The user needs to ensure that the drive is at standstill when the encoder is preset.
- In a "Preset" the encoder can only be set to a value range 0 < x < measuring length!

Activation period
Time in milli-seconds after which the suppression is automatically removed.

Input range: 100ms … 25s

***Note**: Once the monitoring function can be temporarily deactivated with the help of this function, particular attention must be paid when it is used!*



PDM-representation in the terminal diagram

ECS (Encoder Supervisor)

User defined evaluation of encoder status.

Number: 2

Access-ID: Identification of function element

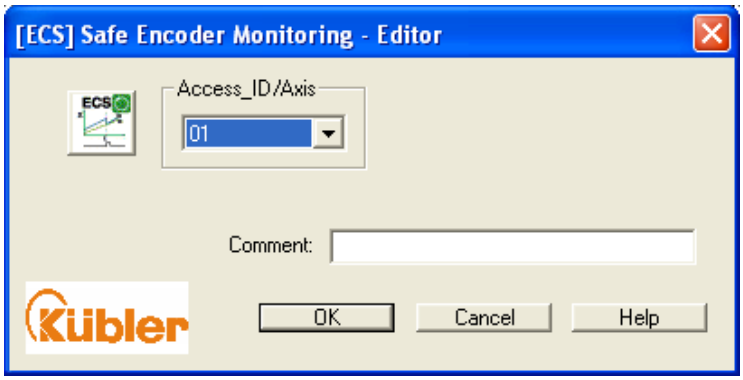
Axis assignment: maximum 1 function per axis

Function: Evaluation of the encoder status using the PLC-function

RESET-function: no RESET required

Note:

This function may have a considerable effect on the safety of an application. One must make absolutely sure that the use of the ECS-function will not cause any situations that may adversely affect safety!

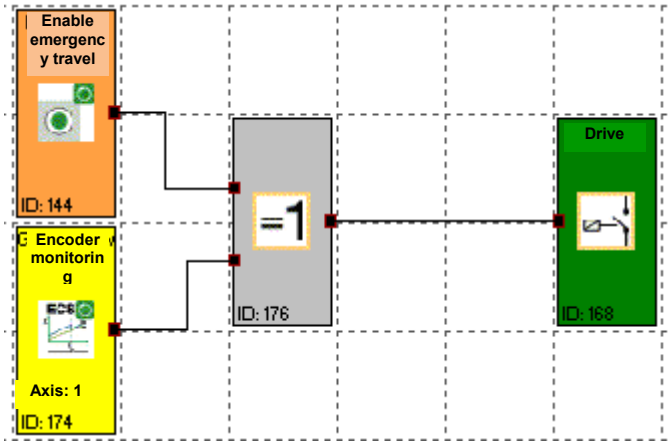


Description of function:

The detection of safe speed and position is based on a multitude of measures and various fault reactions in the form of alarm messages. Without the use of an ECS–element the operating system will switch the Safety-M system to status **RUN → ALARM** when a speed/position fault is detected. All outPorts will be blocked immediately.

Inserting an ECS-element into the logic diagram suppresses this state change and the operating system remains in **RUN** condition. The PLC-program now needs to use the status of the ECS-element to trigger the required measures to avoid dangerous conditions in the application. Alarm messages of the encoder interface with identical reference number are identified with the prefix "E".

Example for the use of the ECS-function:



The ECS-Function mutes following encoder alarm functions:

System A	System B	Diagnosis function
3209	3210	Monitoring of encoder voltage X31
3213	3214	Monitoring of encoder voltage X32
3229	3230	Plausibility test of encoder voltage (Dynamic Test)
3237	3238	Test of analog sensor AIN1
3239	3240	Test of analog sensor AIN2
3309	3302	Diagnosis speed monitoring of maximal speed (1.axis)
3329	3322	Diagnosis speed monitoring of maximal speed (2.axis)
3301	3304	Speed monitoring (comparison) of both sensors (1.axis)
3321	3324	Speed monitoring (comparison) of both sensors (2.axis)
3303	3308	Position monitoring (comparison) of both sensors (1. axis)
3323	3328	Position monitoring (comparison) of both sensors (2. axis)
3307	3310	Monitoring of measuring distance for valid area (1. axis)
3327	3330	Monitoring of measuring distance for valid area (2. axis)

System A	System B	Diagnosis functionality
3317	3318	Monitoring of counting signal for track A
3337	3338	Monitoring of counting signal for track A X32
3313	3314	Monitoring of SSI encoder values for not allowed value increase (1.axis)
3333	3334	Monitoring of SSI encoder values for not allowed value increase (2.axis)
3407	3408	Differential level monitoring (1.axis)
3409	3410	Differential level monitoring (2.axis)
3411	3412	SIN/COS plausibility monitoring (1.axis)
3413	3414	SIN/COS plausibility monitoring (2.axis)
3415	3416	Level check of proxy
3451	3452	Frequency check of reference signals
3453	3454	Check of transmission ratio of reference signal/ measured signal
3457	3458	Check of reference voltage on extended board
3459	3460	Diagnosis amplitude monitoring
3461	3462	General diagnosis status PIC faulty
3463	3464	Diagnosis signal level
3465	3466	Form factor analysis of measured signal
3469	3470	Monitoring of permissible quadrant
3471	3472	Monitoring of power supply
3473	3474	Monitoring input signal level
3475	3476	Monitoring of counting signal separate for track A/B
3551	3552	Error in 1. status bit of SSI_Ext encoder (1.Achse)
3553	3554	Error in 2. status bit of SSI_Ext encoder (1.axis)
3555	3556	Error in 3. status bit of SSI_Ext encoder (1. axis)
3557	3558	Error in 4. status bit of SSI_Ext encoder (1. axis)
3559	3560	Error in 5. status bit of SSI_Ext encoder (1. axis)
3561	3562	Error in 1. status bit of SSI_Ext encoder (2. axis)
3563	3564	Error in 2. status bit of SSI_Ext encoder (2. axis)
3565	3566	Error in 3. status bit of SSI_Ext encoder (2. axis)
3567	3568	Error in 4. status bit of SSI_Ext encoder (2. axis)
3569	3570	Error in 5. status bit of SSI_Ext encoder (2. axis)
System	**System**	**Diagnosis functionality**

A	B	
3571	3572	Error in 1. status bit of SSI encoder
3573	3574	Error in 2. status bit of SSI encoder
3575	3576	Error in 3. status bit of SSI encoder
3577	3578	Error in 4. status bit of SSI encoder
3579	3580	Error in 5. status bit of SSI encoder

DEM (Dynamic Encoder Muting)

Number: 2

Access ID: Identification of the function element

Axis assignment: maximum 1 function per axis

Function: Muting of the alarm from encoder diagnostics functions starting from a programmable limit speed

RESET function: no RESET required

The function element DEM can be used – as with all other safety modules– in applications up to SIL 3 and PL e.

It is only possible to use the DEM function for axes that solely have speed processing. The DEM function is disabled for axes where position processing is activated in the parameter field “Measuring section”.

The function is activated when a logic “1” signal is applied to the input.

When the function is active and the programmed limit speed exceeded, alarm messages from encoder diagnostics of the assigned axis will be muted.

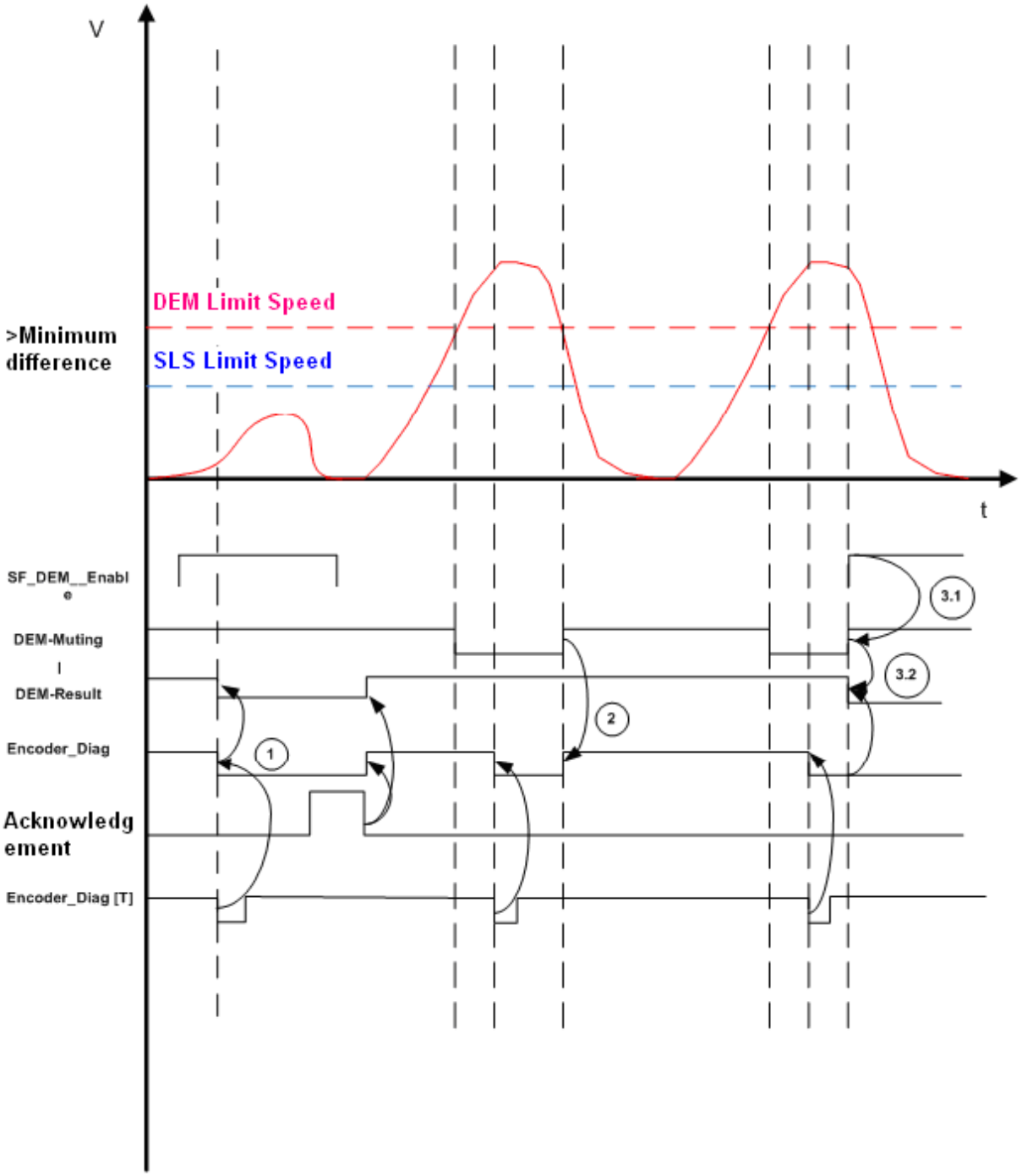
If a safety function relating to the assigned axis is activated, then DEM will automatically be deactivated.

The fault status of the encoder diagnostics is stored internally. The status FALSE (encoder fault) will only be cleared during the transition Muting -> inactive provided that all safety functions are inactive.

When a safety function is activated, the stored fault status will be applied as the alarm status of the encoder.

DEM is not available when position processing (input parameter in the encoder mask) is activated.

The chronological interrelationship between the functions can be seen in the following diagram:


V
DEM Limit Speed
>Minimum difference
SLS Limit Speed
t
SF_DEM__Enable
DEM-Muting
DEM-Result
Encoder_Diag
Acknowledgement
Encoder_Diag [T]
1
2
3.1
3.2

Function description:

Parameters:

The module has the following parameters:

Permanent activation:

If this field is selected, the function will be permanently activated; the input connector of the module is deleted.

Limit Speed:

The muting function is activated, when the limit value that has been preset in this field is exceeded. If permanent activation has been deselected, then in addition the status of the module input will be linked.

Note:

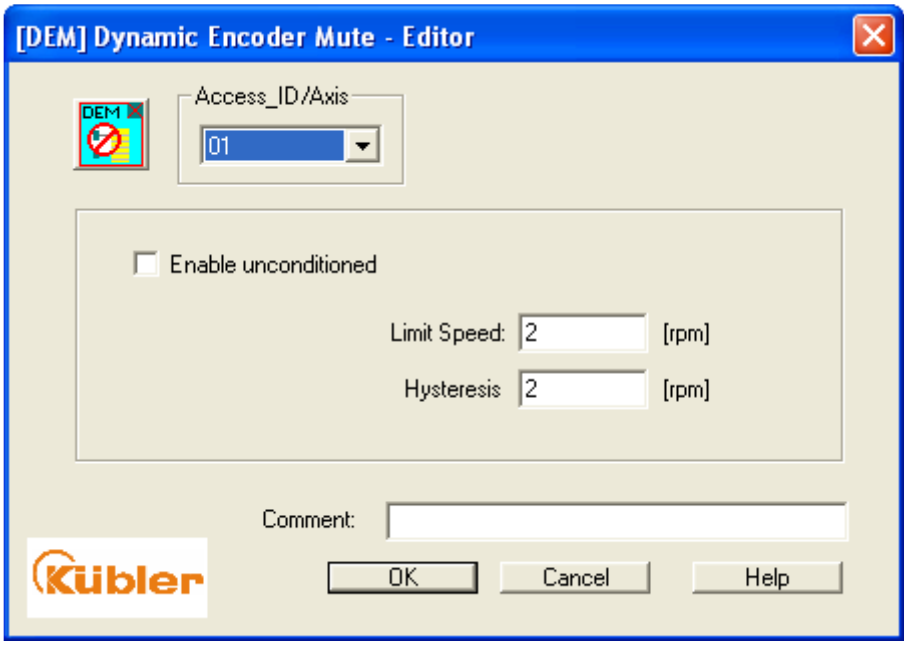
'Limit Speed' defines at the same time the maximum input values for the limit speeds in the functions SLS, SOS, SLI and SCA. Their input values must respectively be less than the Muting limit speed.

Hysteresis:

A hysteresis value can be preset in order to prevent toggling during switching. The following applies here:

Activation speed Muting:
Muting limit speed + Hysteresis value

Deactivation speed Muting: Muting limit speed



Inputs:

The condition for controlling the function element is defined by means of an input connector.
Muting only takes place when the input is active. If the input is inactive the function has no action.

Outputs:

The module comes with a status output. This is used primarily for expanded diagnostics. The output corresponds to the variable DEM Result, i.e. any faults that have been detected by the diagnostics function are always indicated. Depending on the Muting function the status will always be cleared during transition to inactive Muting.

⚠ Safety Precautions:

- The limit speed of the DEM function must be selected so that it is always higher than and with a sufficient separation distance to the limit speeds in safety functions of the assigned axis.

- The status output of the DEM function should be evaluated. If it operates too frequently, appropriate measures are to be taken to eliminate the causes. Note: the evaluation is not safety-critical and can also be carried out in the standard control system.

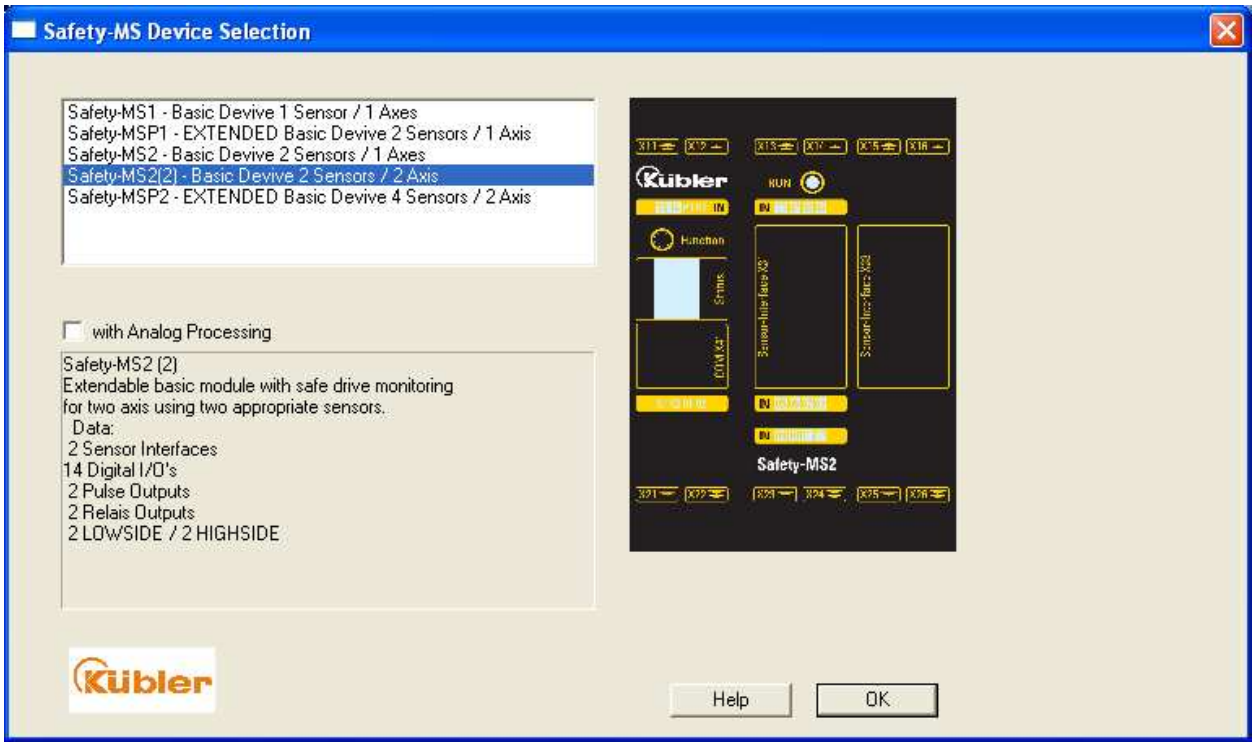
- The signal path employed for the activation of the DEM function must fully conform to the highest SIL or PL safety function used in the assigned axis.

  Example:
  DEM function in one axis with SLS function corresponding to PL_d and SOS function with PL_e. The DEM function is activated when the access door is shut. The closed condition is monitored via a door contact.
  - ⇨ Highest PL = PL_e, signal path must conform to PL_e
  - ⇨ Door contact path must conform to PL_e
  - ⇨ 2-pole positively-driven door contact, conforming to PL_e in both electrical and mechanical versions, routed to Safety-M input interface, with activated cross-circuit monitoring.

I/O Module Extension SMX31

Equipment selection

In the Compact series Safety-M, a basic module can be combined with up to two I/O-extensions. This is only possible when opening a new equipment diagram. This option is used to extend the available inPort/outPorts.



Management of additional inPorts/outPorts

Each SMX31 extends the number of available I/Os as follows:

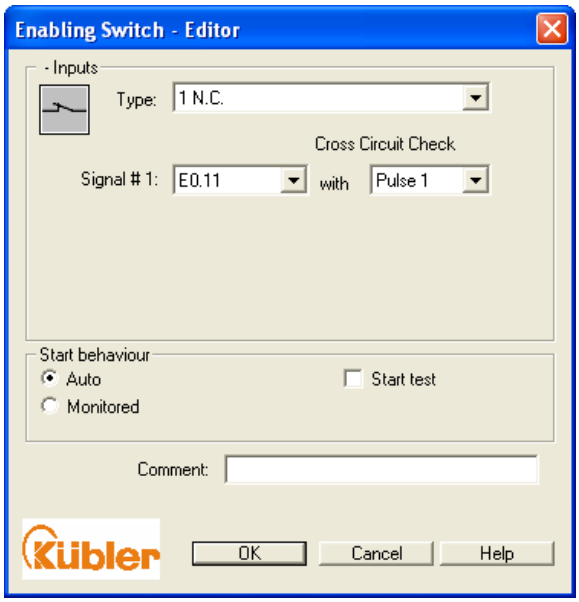
- 12 digital inPorts
- 2 auxiliary outPorts
- 10 I/O that can be configured as inPorts or outPorts

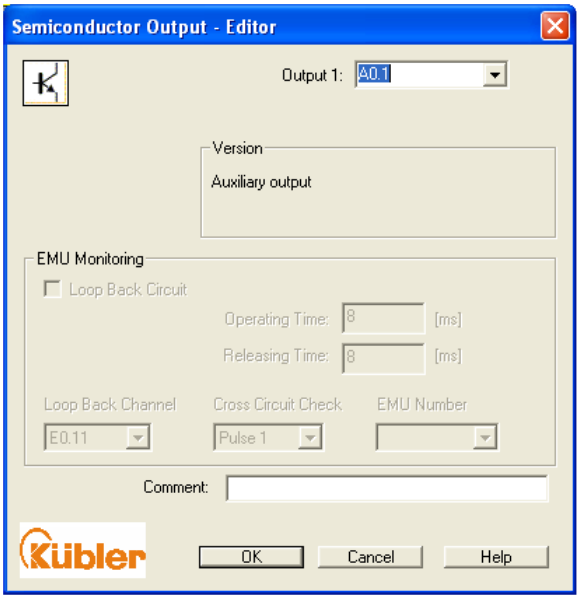
Note:

I/Os can only be used as inPort or outPort once and have a common terminal to the outside!

Selection of inPorts and outPorts

By using an SMX31 module you increase the number of available inPort/outPort elements.





Identification of inPorts:

E0.1 .. E0.14	Digital inPort basic unit
E1.1 .. E1.12	Digital inPort SMX31 – unit 1
EAE1.1 .. EAE1.10	Digital SMX31 I/O used as inPort – unit 1
E2.1 .. E2.12	Digital inPort SMX31 – unit 2
EAE2.1 .. EAE2.10	Digital SMX31 I/O used as inPort – unit 2

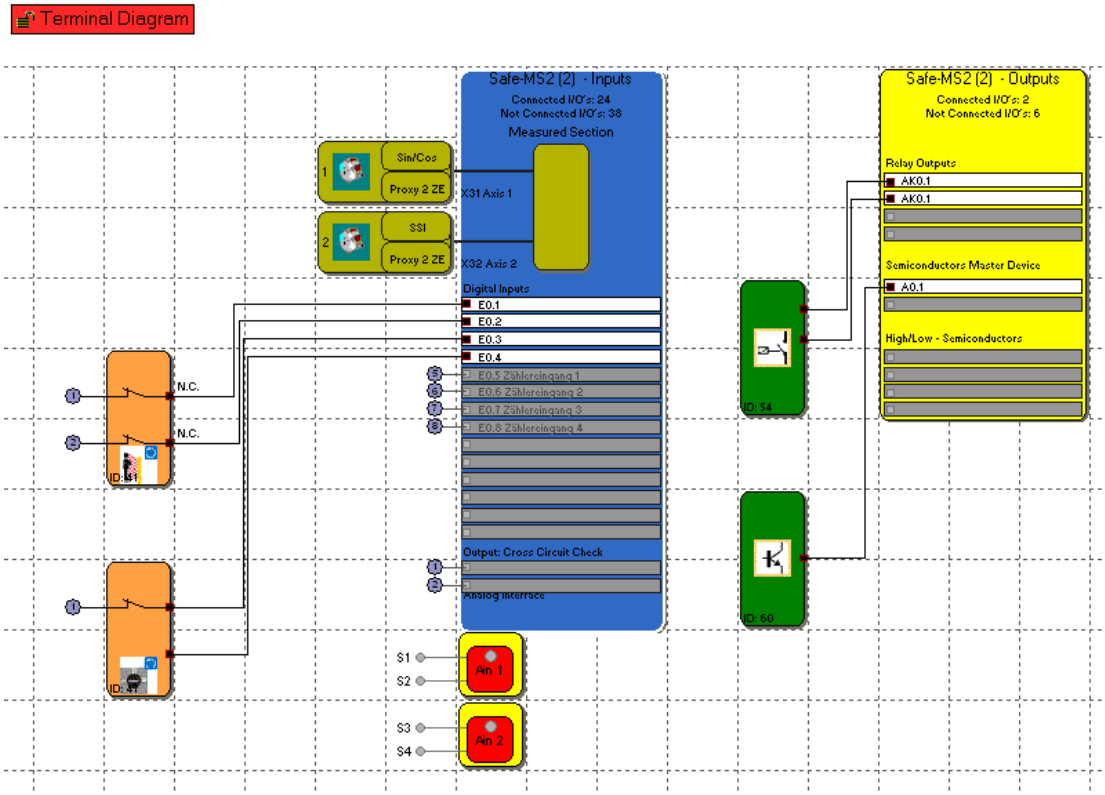
Identification of outPorts:

A0.1 .. A.0.2	Digital standard outPort basic unit
A1.1 .. A1.2	Digital standard outPort SMX31 – unit 1
A2.1 .. A2.2	Digital standard outport SMX31 – unit 2
EAA1.1 .. EAA1.10	Digital SMX31 I/O used as outPort – unit 1
EAA2.1 .. EAA2.10	Digital SMX31 I/O used as outPort – unit 2
AK01 .. AK0.2	Relay outPort basic unit
AD0.0_P .. AD0.1_M	Digital HI/LO outPort basic unit

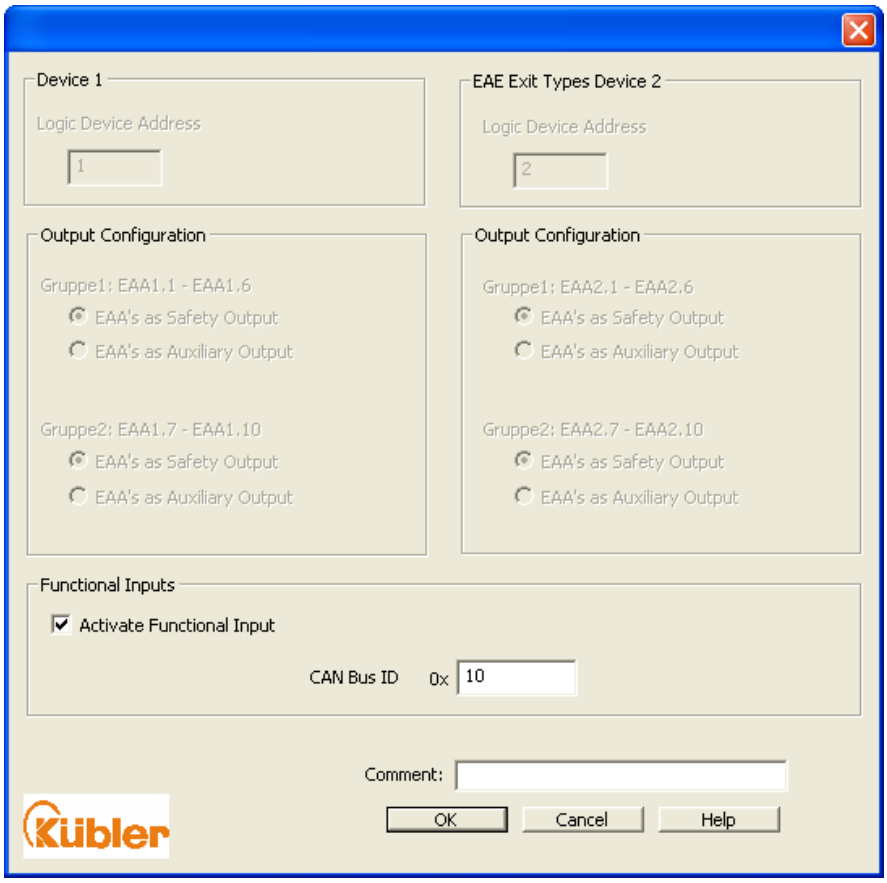
Input of Logic Address for Communication

The allocation of addresses to the physical unit in the logic diagram takes place via the logic address. This is entered in the multiple equipment configuration dialog.

The dialog is invoked by double-clicking on the signal list (blue selected in the illustration).



The following dialog appears



Parameters

Logic address SMX31 unit 1 or 2
Input of logic address for extension unit 1 or 2. This address must correspond with the address deposited in the module.

OutPorts group 1 or 2
The digital I/O outPorts of the module SMX31 can either be used as standard or as safety outPorts.

Note:

The term safety outPort in any case refers to the classification as a safe function for application up to PI e acc. to EN ISO 13849-1 or SIL3 acc. to EN 61508. Follow the explanations in the installation manual for classifying the outPorts.

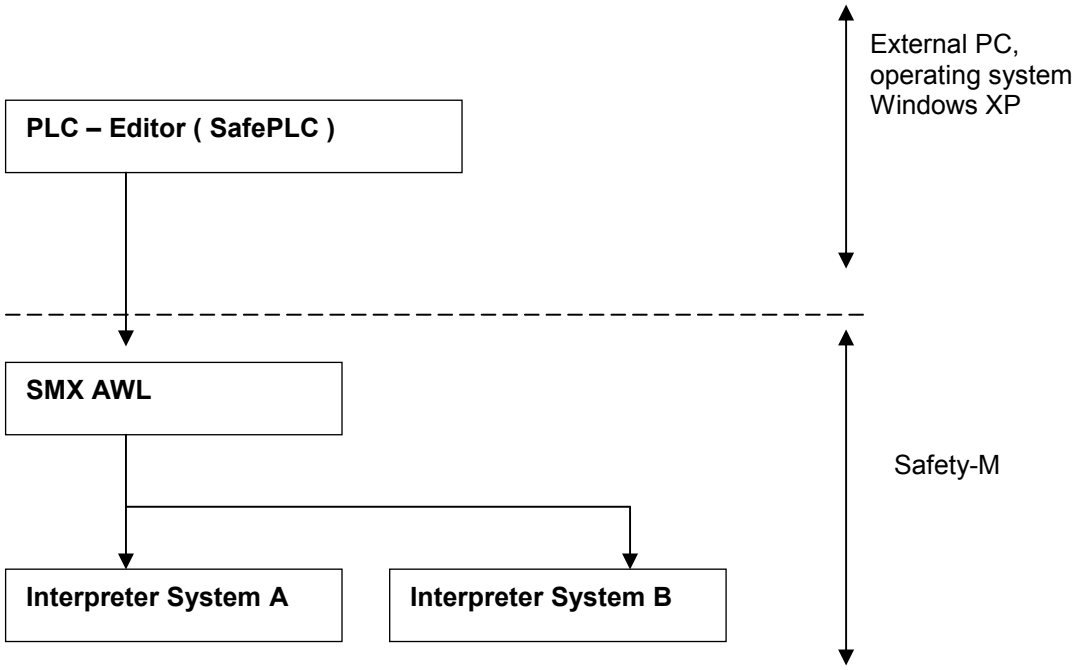
Standard outPorts are not permitted for safety related duties and can only be used for functional tasks. The EMU-function is not available for standard outPorts.

Appendix Process Image

Introduction

The Safety-M system is able to execute interpreter code saved in the module with PLC-functionality in real-time.

With an external, not safety related PLC-editor (***SafePLC***) a program can be created in function block representation as specified in IEC 61131, compiled and saved in the format **SMXA*WL***. The same program adds the **SMXAWL -** instructions to the configuration data and transmits the data to the module Safety-M, SMX10/12A.



Evidence of the correct assignment of inPorts and outPorts must be provided by the user within the scope of a safety documentation (validation report).

The SMX AWL-CODE is executed by both systems in each cycle. For this purpose the input variables used in the program are linked in compliance with the interpreter code. The result of the interpreter run is obtained by:

- setting/deleting one or several variables in the initial process image
- enabling/disabling monitoring functions
- setting/deleting outPorts
- setting/deleting markers
- starting and stopping timers

The AWL-code generated by the compiler must be verified within the validation process. Exceptions are the so-called MACRO-functions, which are internally 2-channel tested by the Safety-M system. In the MACRO-function, only the connection of inPorts must be verified. MACRO-functions refer e.g. to two-hand operation.

Description of Function Elements

The following description is required for executing the application validation.

PLC – Commands

The following list contains all commands used within the Safety-M system:

Operator	Operand	Description
LD	all inPort and outPort operands	Equates current result with operand
LD NOT	all inPort and outPort operands	Equates current result with operand and inverts the operand
ST	only outPort operands	Saves current result to operand address
AND	all inPort and outPort operands	Boolean AND
AND NOT	all inPort and outPort operands	Negated Boolean AND
OR	all inPort and outPort operands	Boolean OR
OR NOT	all inPort and outPort operands	Negated Boolean OR
XOR	all inPort and outPort operands	Boolean Exclusive OR
NOT	all inPort and outPort operands	Inverts the accumulator value
SET MARKER	PLC_MARKER in output image	Sets marker
RESET MARKER	PLC_MARKER in output image	Resets marker
SET	all inPort and outPort operands	Sets operand to 1
RESET	all inPort and outPort operands	Sets operand to 0

MACRO_INFO	Description of macro element	Operand field: 2 byte for macro identification
MACRO_CRC	CRC the previous macro field	Operand field: 1. Operand: CRC_LO (8 Bit) 2. Operand: CRC_HI (8 Bit)
INFO	Info field	Operand field: 1. Operand: reserved free ! 2. Operand: reserved free !

Designation of safety functions

The designation of safety functions are as follows:

Function	Function name acc. to EN 61800–5–2 or Safety-M - designation
SLS	Safe Limited Speed
SOS	Safe Operational Stop
SDI	Safe Direction Indication
SSX	Safe Stop 1 or 2
SLI	Safe Limited Increment
SCA	Safe Cam
SEL	Safe Emergency Limit
SLP	Safe Limited Position
SEC	Safe external circuit
PDM	Position Deviation Muting (Safety-M function)
ECS	Encoder Monitoring Status (Safety-M function)

Input variables in logic diagram

Note: The output values of the monitoring functions must be considered as inputs in the process image!

Index	*PAE-variable*	*Bit Pos.*	*Bit-variable*	*Description*
1	Config_ID			0x3001 fixed
2	DriveBASE	0 1 2 3 4 5		0 .. 2 always "1" 3 Reset monitoring functions 4 ECS result axis 1 5 ECS result axis 2
3	DriveSLI	0 1	SLI.0 SLI.1	Results SLI
4	EA2_In8	0 .. 7	EA2.1 .. EA2.8	Extension inPorts
5	DriveEMU	0 1	EMU.1 EMU.2	Results EMU
6	DriveSCA	0 .. 7 0 .. 7	SCA.1 .. SCA.8 SCA.9 .. SCA.16	Results SCA
7	DriveSSX	0 1 2 3	SSX.1 SSX.2 SSX.3 SSX.4	Results SSX
8	DriveSOS	0 1	SOS.1 SOS.2	Results SOS
9	DriveSLP	0 1	SLP.1 SLP.2	Results SLP
10	DriveSEL	0 1	SEL.1 SEL.2	Results SEL
11	DriveSLS	0 .. 7	SLS.1 .. SLS.8	Results SLS
12	DriveSDI	0 1	SDI.1 SDI.2	Results SDI
13	DriveSAC	0 .. 7	SAC.1 .. SAC.8	Results SAC
14	DriveSF	0 1	PDM_EN.1 PDM_EN.2	Results PDM
15	DI8	0 .. 7	E0.1 .. E0.8	Hardware inPorts basic group 1 .. 8
16	DI16	0 .. 7	E0.9 .. E0.16	Hardware inPorts basic group 9 .. 16
17	DI24	0 .. 7	E1.1 .. E1.8	Hardware inPorts SMX31 Extension with log. address 1 inPorts 1 – 8
18	DI32	0 .. 7	E1.9 .. E1.12	Hardware inPorts SMX31 Extension with log. address 1 inPorts 9 – 12 and extension with log. address 2 inPorts 9 - 12
19	PLCTimer16	0 .. 7	PLCT.9 .. PLCT.16	Results PLC Timer
20	Reserve1			Reserve
21	StartTimer	0 .. 1 2 .. 3 4 .. 5 6 .. 7	MET.1 MET.2 MET.3 MET.4	OutPort start element with time

22	Outp2HandTimer	0	MEZ.1	OutPort two-hand with time
23	Start element	0	MES.1	OutPort starts element
24	Start-up Test	0 1	MEA.1 MEA.2	OutPort start-up test
25	PLC Timer	0 .. 7	PLCT.1 .. PLCT.8	Results PLC_Timer
26	DriveTTS	0 1 2 3	EAE2.7 EAE2.8 EAE2.9 EAE2.10	
27	AIn1			Analog inPort 1
28	AIn2			Analog inPort 2
29	AIn3			Analog inPort 3
30	AIn4			Analog inPort 4
31	SysACC Axis1		SysAcc[0]	current system acceleration axis 1
32	SysACC Axis2		SysAcc[1]	current system acceleration axis 2
33	Limit20Axis1		Limit20[0]	Limit for GOTO monitoring axis 1
34	Limit20Axcis2		Limit20[1]	Limit for GOTO monitoring axis 2
35	Pos20Axis1		Position20[0]	Current position axis 1
36	Pos20Axis2		Position20[1]	Current position axis 2
37	BG20Axis1		BG20[0]	Range limit axis 1
38	BG20Axis2		BG20[1]	Range limit axis 2
39	StopDistAxis1		StopDistanz20[0]	Current stop distance axis 1
40	StopDistAxis2		StopDistanz20[1]	Current stop distance axis 2
41	SysSpeed Axis1		SysSpeed[0]	Current speed axis 1
42	SysSpeed Axis2		SysSpeed[1]	Current speed axis 2
43	AnalogAdder			Analog adder
44	EA_IN8	0 .. 7	EAE1.1 .. EAE1.8	Extension inPorts SMX31 with log. address 1
45	EA_IN16	0 .. 7	EAE1.9 .. EAE1.10 EAE2.1 .. EAE2.6	Log. address 1 Log. address 1 Log. address 2 Log. address 2
46	Start element Timer2	0 1 2 3	MET.5 MET.6 MET.7 MET.8	OutPort start element with time
47	EMU 31 1 1	0 1 2 3 4 5 6 7	EMU31_1.1 EMU31_1.2 EMU31_1.3 EMU31_1.4 EMU31_1.5 EMU31_1.6 EMU31_1.7 EMU31_1.8	EMU results SMX31 with log. address 1
48	EMU 31 1 1	0 1	EMU31_1.9 EMU31_1.10	EMU results SMX31 with log. address 1
49	EMU 31 1 2	0 1 2 3 4 5 6 7	EMU31_2.1 EMU31_2.2 EMU31_2.3 EMU31_2.4 EMU31_2.5 EMU31_2.6 EMU31_2.7 EMU31_2.8	EMU results SMX31 with log. address 2

50	EMU 31 1 2	0 1	EMU31_2.9 EMU31_2.10	EMU results SMX31 with log. address 2
51	Reserve3 PAE			Reserve
52	Reserve			Reserve
53	Reserve			Reserve
54	Reserve 2_0 PAE			Reserve
55	Reserve 2_1 PAE			Reserve
56	Reserve 2_2 PAE			Reserve
57	Reserve 2_3 PAE			Reserve
58	Reserve 2_4 PAE			Reserve
59	Reserve 2_5 PAE			Reserve

PLC Processing

PLC - Syntax

The PLC-program is CRC-protected and part of the Safety-M configuration data. Each PLC-command is identically structured as follows:

Syntax of list entry:

Size of list entry = 4 byte

Byte index	0	1	2	3
Assignment	PLC – Command	Byte-Address Operand	Bit-Address	Downcount 0..255

Comment:

Downcount = (number of AWL-commands) – (line number of list entries - 1)
At 256 the counter jumps back to 0.

PLC – Commands

Operator	Operand	OPCODE	Description
LD	all inPort and outPort operands	02	Equates current result with operand
LD NOT	all inPort and outPort operands	04	Equates current result with operand and inverts the operand
ST	only outPort operands	06	Saves current result to operand address
AND	all inPort and outPort operands	08	Boolean AND
AND NOT	all inPort and outPort operands	10	Negated Boolean AND
OR	all inPort and outPort operands	12	Boolean OR
OR NOT	all inPort and outPort operands	14	Negated Boolean OR
XOR	all inPort and outPort operands	16	Boolean Exclusive OR
NOT	all inPort and outPort operands	18	Inverts the accumulator value
SET MARKER	PLC_MARKER in output image	20	Sets marker
RESET MARKER	PLC_MARKER in output image	22	Resets marker
SET	all inPort and outPort operands	24	Sets operand to 1
RESET	all inPort and outPort operands	26	Sets operand to 0
MACRO_INFO	Description of macro element	28	Operand field: 2 byte for macro identification
MACRO_CRC	CRC the previous macro field	30	Operand field: 1. Operand: CRC_LO (8 Bit) 2. Operand: CRC_HI (8 Bit)
INFO	Info field	32	Operand field: 1. Operand: reserved free ! 2. Operand: reserved free !

PLC – Elements (I/O)

The PLC inPort and outPort elements are defined in the document "TS-37350-340-02 Switch Types PLC"!

InPort elements

I/O	Type
ESwitch_1O	1
ESwitch_1S	2
ESwitch_2O	3
ESwitch_2OT	4
ESwitch_1S1O	5
ESwitch_1S1OT	6
ESwitch_2S2O	7
ESwitch_2S2OT	8
ESwitch_3O	9
ESwitch_3OT	10
TwoHand_2O	n/a
TwoHand_2S	n/a
Mode_1S1O	13
Mode_3Switch	14

OutPort elements

I/O	Type
DO.0_P	1
DO.0_M	1
DO.1_P	1
DO.1_M	1
DO.2_P	1
DO.2_M	1

PLC - Output variables

Output variables for the PLC-system are identified by:

- Affiliation to the system image of the Safety-M system
- the unambiguously determined address (byte index in system image, bit index in entry of system image).
- PAEOFFS = Size of segment **PAE = 96**
- by the 1-bit value of the input variable (TRUE or FALSE)

Syntax and addressing:

Index	*PAE-variable*	*Bit Pos.*	*Bit-variable*	*Description*
1	Config_ID			0x3002 fixed
2	DriveBASE	0 1 2 3 4 5		DRB_STAT.1 = ESTOP external DRB_STAT.2 = RUNNING DRB_STAT.3 = LOCK DRB_STAT.4 = RESET
3	DriveSLI	0 1	SLI_EN.1 SLI_EN.2	Activation SLI
4	DriveEMU	0 1	EMU_EN.1 EMU_EN.2	Activation EMU
5	DriveSCA	0 .. 7 0 .. 7	SCA_EN.1 .. SCA_EN.8 SCA_EN.9 .. SCA_EN.16	Activation SCA
6	DriveSSX	0 1 2 3	SSX_EN.1 SSX_EN.2 SSX_EN.3 SSX_EN.4	Activation SSX
7	DriveSOS	0 1	SOS_EN.1 SOS_EN.2	Activation SOS
8	DriveSLP	0 1	SLP_EN.1 SLP_EN.2	Activation SLP
9	DriveSEL	0 1	SEL_EN.1 SEL_EN.2	ActivationSEL
10	DriveSLS	0 .. 7	SLS_EN.1 .. SLS_EN.8	Activation SLS
11	DriveSDI	0 1	SDI_EN.1 SDI_EN.2	Activation SDI
12	DriveSAC	0 .. 7	SAC_EN.1 .. SAC_EN.8	Activation SAC
13	DriveSummary	0 1	PDM_EN.1 PDM_EN.2	Activation PDM
14	DO8	0 1 2 3 4 5 6 7	DO.0_P DO.0_M DO.1_P DO.1_M K.1 K.2 EAA1.9 EAA1.10	Semi-conductor outPort HISIDE1 Semi-conductor outPort LOSIDE1 Semi-conductor outPort HISIDE2 Semi-conductor outPort LOSIDE2 Relay K1 Relay K2 Semi-conductor outPort SMX31 log. addr 1 Semi-conductor outPort SMX31 log. addr 1

15	HW_Output	0 1 2 3 4 5 6 7	A0.1_O A0.2_O A1.1_O A1.2_O A2.1_O A2.2_O EAA2.9 EAA2.10	Auxiliary outPorts Safety-M Auxiliary outPorts Safety-M Auxiliary outPort SMX31 log. addr 1 Auxiliary outPort SMX31 log. addr 1 Auxiliary outPort SMX31 log. addr 2 Auxiliary outPort SMX31 log. addr 2
16	PLC_Marker	0 .. 7	M.1 .. M.8	
18	PLCTimer_EN	0 .. 7	PLCT_EN.1 .. PLCT_EN.8	
19 – 64	MX8 MX16 MX 24 .. MX368	Each 0 .. 7	MX.1 .. MX.368	PLC_MX Marker
65	Diag 17_24	0 .. 7		Diagnostic Bit 16 .. 23
66	Diag25_32	0 .. 7		Diagnostic Bit 24 .. 31
67	EnableEingangTimer	0 1 2 3 4 5 6 7	META_EN.1 METB_EN.1 META_EN.2 METB_EN.2 META_EN.3 METB_EN.3 META_EN.4 METB_EN.4	Activation of inPort element with time monitoring
68	EnableEingangZweihandTimer	0 .. 2	MEZ_EN.1 .. MEZ_EN.3	Activation of two-hand button
69	EnableStartelement	0 1	MES_EN.1 MES_EN.2	Activation of start element
70	EnableAnlauftest			
71	EAA1_8	0 .. 7	EAA1.1 .. EAA1.8	Extension outPort SMX31 log. addr 1
72	EAA2_8	0 .. 7	EAA2.1 .. EAA2.8	Extension outPort SMX31 log. addr 2
73	Diag_1_16			Diagnostic Bit 0 .. 15
74	Diag_33_40			Diagnostic Bit 30..39
75	Diag_41_48			Diagnostic Bit 40..47
76	Diag_49_56			Diagnostic Bit 48..55
77	EnableEingangTimer2	0 1 2 3 4 5 6 7	META_EN.5 METB_EN.5 META_EN.6 METB_EN.6 META_EN.7 METB_EN.7 META_EN.8 METB_EN.8	Activation of inPort element with time monitoring
78	Reserve1			Reserve
79	Reserve2			Reserve
80	Reserve3			Reserve
81	Reserve4			Reserve
82	Reserve5			Reserve
83	Reserve6			Reserve
84	Reserve7			Reserve
85	Reserve8			Reserve
86	Reserve9			Reserve
87	Reserve10			Reserve
88	Reserve11			Reserve
89	Reserve12			Reserve

PLC - Processing elements

Number = 8

PLC-markers can be set and reset with the commands "S" or "R". PLC-markers are part of the process outPort image "OutPorts". The user can only address markers through the macro "RS-Flipflop".

PLC - Timer

The runtime system of PLC-processing holds a total of 8 PLC-timers available. These have the following properties:

- Generation of time events 1…31.999.992ms
- Downwards counter limited to ZERO, starts from configured initial value (part of configuration data)
- In the system image the timers only occupy 2 bits for ENABLE and RESULT (TRUE = timer elapsed, i.e. internal value at ZERO). Start of timer by setting ENABLE. ENABLE = FALSE resets the timer to the initial value (initial value = FALSE).

ENABLE	Timer value	Initial value	Activity
FALSE	Initial value on configuration	FALSE	Counter inactive
TRUE	1 ... < INITIAL VALUE	FALSE	Counter active
TRUE	ZERO	TRUE	Counter inactive

PLC-Timer - ENABLE can only be started or disabled with the command "ST". Release and status of timers are part of the process image. The initial values of the timers are saved in the configuration data in the PLC segment.

PLC - Processing list

The PLC-instruction list consists of a header and a linear list of single PLC-instructions, consisting of operator and operands, in the format specified under 2.2.1.

Contents	Index	Contents	Description
Header	0	ID_PLC	Identification of the PLC-list
	2	CRC	CRC over the structure
	4	Date1	Date of creation/change
	6	Date2	
	8	PLC_Len	Number of AWL-instructions
	10	free	
	12	free	
	14	free	

PLC-Timer	16	Timer 1	Time events from 1 Tcyc to 3.999.999 Tcyc Each timer occupies 4 bytes
	.....		
	44	Timer 8	
Reserve	48	free	
	50	free	
	52	free	
	54	free	
AWL – List	56	Instruction 1	AWL acc. to format section 2.2.1)
	.....		
	48 + (PLC_Len*4) –4	Instruction no. PLC_Len	
Reserve	1056	free	
	1058	free	

Assignment of resources

Element	In	Out	Qty. MX	IN/OUT Process image	PLC-Code	Qty. IL
AND2	2	1	1	0	LD x1.y1 AND x2.y2 ST MX.z	3
						…
AND5	5	1	1	0	LD x1.y1 AND x2.y2 AND x3.y3 AND x4.y4 AND x5.y5 ST MX.z	6
OR2 .. OR5					Analog AND	3 … 6
XOR 2					Analog AND	3
NOT	1	1	1	0	LD x1,y1 NOT ST MX.z	3
RS-Flipflop	2	1	0	Output = 1	LD x1.y1 (source S) S M.z LD x2.y2 (source R) R M.z	4
Timer	1	1	0	Output = 1	Timer enable : LD x1.y1 ST PLCT_EN.z	2
Monitoring functions	1	1	0	Output = 1	Monitoring function enable : LD x1.y1 ST uuu_EN.z	2
Semi-conductor outPort Single	1	1	0	Output = 1	LD x1.y1 ST DO.x_y	2
Semi-conductor outPort Redundant	1	2	0	Output = 2	LD x1.y1 ST DO.x_P ST DO.x_M	3

Processing of inPort elements see document TS-37330-340-02 PLC switch types!

APPENDIX Encoder Combinations

Version: Safety-MS1 / Safety-MS2 in 2-axis operation

Type	Encoder A			Encoder B			Disabled Modes	Configurable axis	Entry Info field	
	Type	Pulse multiple	Enable direction	Type	Pulse multiple	Enable direction			Fault exclusion/comment	PI
0	NC	0	No	NC	0	No	all	1 and 2		B
1	Incremental	2	No	NC	2	No	ZSC, DMC, ELC, OLC, PSC(position),JSS	1 and 2	Fault exclusion mech. shaft breakage, positive encoder shaft connection required.	d
2	SINCOS	4	Yes	NC	4	No	ELC, OLC, PSC(position)	1 and 2	Fault exclusion mech. shaft breakage, positive encoder shaft connection required.	d
3	Incremental	2	Yes	Proxi sw. 1 count. inp.	1	No	ZSC,DMC, JSS,ELC, OLC, PSC(position)	1 and 2		e
4	SINCOS	4	Yes	Proxi sw. 1 count. inp.	1	No	ELC, OLC, PSC(position)	1 and 2	(not implemented in phase 1)	e
5	Incremental	4	Yes	Proxi sw. 2 count. inp. w. 90° - signal	4	Yes	ELC, OLC, PSC(position)	1		e
6	SINCOS	4	Yes	HTL/incremental	4	Yes	ELC, OLC, PSC(position)	1		e
7	SSI	1	Yes	Proxi sw. 1 count. inp.	1	No		1	(not implemented in phase 1)	d
8	SSI	1	Yes	Proxi sw. 2 count. inp. w. 90° - signal	4	Yes		1		e
9	Proxi sw. 1 count. inp.	1	No	Proxi sw. 1 count. inp.	1	No	ZSC, DMC, ELC, OLC,JSS, PSC(position)	1		d
10	Proxi sw. 2 count. inp. w. 90° - signal	4	Yes	Proxi sw. 2 count. inp. w. 90° - signal	4	Yes	ELC, OLC, PSC(position)	1		d
11	Proxi sw. 2 count. inp. w. 90° - signal	4	Yes	Incremental	4	Yes	ELC, OLC, PSC(position)	2		e
12	HTL/incremental	4	Yes	SINCOS	4	Yes	ELC, OLC, PSC(position)	2		e
13	Proxi sw. 1 count. inp.	1	No	SSI	1	Yes		2	(not implemented in phase 1)	d
14	Proxi sw. 2 count. inp. w. 90° - signal	4	Yes	SSI	1	Yes		2		e

Version: Safety-MS2 in single axis operation

Type	Encoder A			Encoder B			Disabled Modes	Configurable axis	Entry Info field	
	Type	Pulse multiple	Enable direction	Type	Pulse multiple	Enable direction			Fault exclusion/ comment	PI
32	Incremental	4	Yes	Incremental	4	Yes	ELC, OLC, PSC(position)	1		e
33	SINCOS	4	Yes	Incremental	4	Yes	ELC, OLC, PSC(position)	1		e
34	SINCOS	4	Yes	SINCOS	4	Yes	ELC, OLC, PSC(position)	1		e
35	Incremental	4	Yes	SSI	1	Yes		1		e
36	SINCOS	4	Yes	SSI	1	Yes		1		e
37	SSI	1	Yes	SSI	1	Yes		1		e

Fault types Safety-M

The Safety-M generally differentiates between two types of faults as per assignment below:

Fault type	Description	Effect on the system	Reset condition
Fatal Error	Severe exceptional error caused by the program run in the Safety-M. Cyclic program sequence is no longer possible for safety related reasons. The last active process is the operation of the 7-segment display by system A. System B is in stop mode.	All outputs are switched off!	Reset possible by switching the Safety-M(POR) off/on.
Alarm	Functional fault, caused by an external process. Both systems continue to run cyclically and serve all requests from the communication interfaces. Sensing of the external process is also maintained.	All outputs are switched off!	Reset via parameterizable inPort
ECS-Alarm	When using the ECS function in the programming desktop, the encoder alarm messages are marked "E" instead of "A".	ECS function block delivers "0" as a result.	Reset via parameterizable inPort

Recognizing faults system, A and system B:

- System A: odd-numbered
- System B: even numbered

Display of Fault Types

There are two possible ways of displaying the fault number

Safety-M .. without expansion modules

F,A or E __ __ __ __
Fault number

Safety-M .. with expansion modules

F,A or E __ __ __ __ __
1) Fault number

Note 1) 0: Base module
1: Expansion module with logic address 1
2: Expansion module with logic address 2

Alarm list Safety-M

Alarm code	A 2101 / A 2102
Alarm message	Timeout receive message SMX31 (address 1)
Cause	Message from expansion module not received in time
Remedy	Check connection to expansion module

Alarm code	A 2105 / A 2106
Alarm message	CRC fault transmission message SMX31 (address 1)
Cause	Transmission message faulty
Remedy	Check configuration of SMX31 serial number

Alarm code	A 2107 / A 2108
Alarm message	CRC fault transmission message
Cause	Transmission message faulty
Remedy	• Check configuration of SMX31 serial number • Check connection to expansion module

Alarm code	A 2109 / A 2110
Alarm message	CRC fault receive message
Cause	Receive message faulty
Remedy	• Check configuration of SMX31 serial number • Check connection to expansion module

Alarm code	A 2111
Alarm message	Timeout communication with expansion module SMX31 (address 1)
Cause	Installation of expansion module faulty
Remedy	• Check connection to expansion module

Alarm code	A 2113
Alarm message	Expansion module SMX31 (address 1) present, but not configured
Cause	Faulty configuration
Remedy	• Check configuration

Alarm code	A 2121 / A 2122
Alarm message	Timeout receive message SMX31 (address 2)
Cause	Message from expansion module not received in time
Remedy	Check connection to expansion module

Alarm code	A 2125 / A 2126
Alarm message	CRC fault transmission message SMX31 (address 2)
Cause	Transmission message faulty
Remedy	Check configuration of SMX31 serial number

Alarm code	A 2131
Alarm message	Timeout communication with expansion module SMX31 (address 2)
Cause	Installation of expansion module faulty
Remedy	• Check connection to expansion module

Alarm code	A 2133
Alarm message	Expansion module SMX31 (address 2) present, but not configured
Cause	Faulty configuration
Remedy	• Check configuration

Alarm code	A 3031 / A 3032
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.1
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3031 / A 3032
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.1
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3033 / A 3034
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.1
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3035 / A 3036
Alarm message	Faulty 24V signal on EAEx.1
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3037 / A 3038
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.2
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3039 / A 3040
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.2
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3041 / A 3042
Alarm message	Faulty 24V signal on EAEx.2
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3043 / A 3044
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.3
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3045 / A 3046
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.3
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3047 / A 3048
Alarm message	Faulty 24V signal on EAEx.3
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3049 / A 3050
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.4
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3051 / A 3052
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.4
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3053 / A 3054
Alarm message	Faulty 24V signal on EAEx.4
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3055 / A 3056
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.5
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3057 / A 3058
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.5
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3059 / A 3060
Alarm message	Faulty 24V signal on EAEx.5
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3061 / A 3062
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.6
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3063 / A 3064
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.6
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3065 / A 3066
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.7
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3067 / A 3068
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.7
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3069 / A 3070
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.7
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3071 / A 3072
Alarm message	Faulty 24V signal on EAEx.7
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3073 / A 3074
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.8
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3075 / A 3076
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.8
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3077 / A 3078
Alarm message	Faulty 24V signal on EAEx.8
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3079 / A 3080
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.9
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3081 / A 3082
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.9
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3083 / A 3084
Alarm message	Faulty 24V signal on EAEx.9
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3085 / A 3086
Alarm message	Pulse1 plausibility fault on expansion inlet EAEx.10
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3087 / A 3088
Alarm message	Pulse2 plausibility fault on expansion inlet EAEx.10
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3089 / A 3090
Alarm message	Faulty 24V signal on EAEx.10
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3101 / A 3102
Alarm message	Pulse1 plausibility fault on input DI1
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3103 / A 3104
Alarm message	Pulse1 plausibility fault on input DI2
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3105 / A 3106
Alarm message	Pulse1 plausibility fault on input DI3
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3107 / A 3108
Alarm message	Pulse1 plausibility fault on input DI4
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3109 / A 3110
Alarm message	Pulse1 plausibility fault on input DI5
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3111 / A 3112
Alarm message	Pulse1 plausibility fault on input DI6
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3113 / A 3114
Alarm message	Pulse1 plausibility fault on input DI7
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3115 / A 3116
Alarm message	Pulse1 plausibility fault on input DI8
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3117 / A 3118
Alarm message	Pulse2 plausibility fault on input DI1
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3119 / A 3120
Alarm message	Pulse2 plausibility fault on input DI2
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3121 / A 3122
Alarm message	Pulse2 plausibility fault on input DI3
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3123 / A 3124
Alarm message	Pulse2 plausibility fault on input DI4
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3125 / A 3126
Alarm message	Pulse2 plausibility fault on input DI5
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3127 / A 3128
Alarm message	Pulse2 plausibility fault on input DI6
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3129 / A 3130
Alarm message	Pulse2 plausibility fault on input DI7
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3131 / A 3132
Alarm message	Pulse2 plausibility fault on input DI8
Cause	No Pulse2 voltage applied to this input
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3133 / A 3134
Alarm message	Pulse1 plausibility fault on input DI9
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3135 / A 3136
Alarm message	Pulse1 plausibility fault on input DI10
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3137 / A 3138
Alarm message	Pulse1 plausibility fault on input DI11
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3139 / A 3140
Alarm message	Pulse1 plausibility fault on input DI12
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3141 / A 3142
Alarm message	Pulse1 plausibility fault on input DI13
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3143 / A 3144
Alarm message	Pulse1 plausibility fault on input DI14
Cause	Configured Pulse1 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3147 / A 3148
Alarm message	Pulse2 plausibility fault on input DI9
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input DI9 acc. to planning and circuit diagram • Check wiring

Alarm code	A 3149 / A 3150
Alarm message	Pulse2 plausibility fault on input DI10
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input DI10 acc. to planning and circuit diagram • Check wiring

Alarm code	A 3151 / A 3152
Alarm message	Pulse2 plausibility fault on input DI11
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input DI11 acc. to planning and circuit diagram • Check wiring

Alarm code	A 3153 / A 3154
Alarm message	Pulse2 plausibility fault on input DI12
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3155 / A 3156
Alarm message	Pulse2 plausibility fault on input DI13
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3157 / A 3158
Alarm message	Pulse2 plausibility fault on input DI14
Cause	Configured Pulse2 voltage not applied to this input.
Remedy	• Check the configuration of the digital input acc. to planning and circuit diagram • Check wiring

Alarm code	A 3159 / A 3160
Alarm message	Faulty 24V signal on DI1
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3161 / A 3162
Alarm message	Faulty 24V signal on DI2
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3163 / A 3164
Alarm message	Faulty 24V signal on DI3
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3165 / A 3166
Alarm message	Faulty 24V signal on DI4
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3167 / A 3168
Alarm message	Faulty 24V signal on DI5
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3169 / A 3170
Alarm message	Faulty 24V signal on DI6
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3171 / A 3172
Alarm message	Faulty 24V signal on DI7
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3173 / A 3174
Alarm message	Faulty 24V signal on DI8
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3175 / A 3176
Alarm message	Faulty 24V signal on DI9
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3177 / A 3178
Alarm message	Faulty 24V signal on DI10
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3179 / A 3180
Alarm message	Faulty 24V signal on DI11
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3181 / A 3182
Alarm message	Faulty 24V signal on DI12
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3183 / A 3184
Alarm message	Faulty 24V signal on DI13
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3185 / A 3186
Alarm message	Faulty 24V signal on DI14
Cause	No permanent 24V voltage applied to this input
Remedy	• Check the voltage on the digital input! • Check wiring • Check whether Pulse1 or Pulse2 is applied

Alarm code	A 3191 / A 3192
Alarm message	Short-circuit fault digital inPorts
Cause	Short circuit between the digital inPorts within a module
Remedy	Consult the manufacturer

Alarm code	A 3197 / A 3198
Alarm message	Faulty OSSD input test
Cause	OSSD test faulty
Remedy	• 24V check the input voltage on all OSSD inputs

Alarm code	A 3209 / A 3210
Fault message	Encoder supply voltage X31 faulty.
Cause	• Encoder supply voltage does not comply with configured threshold • Component fault in module
Remedy	• Check configuration! • Check encoder supply voltage • Switch device off/on.

Alarm code	A 3213 / A 3214
Fault message	Encoder supply voltage X32 faulty.
Cause	• Encoder supply voltage does not comply with configured threshold • Component fault in module
Remedy	• Check configuration! • Check encoder supply voltage • Switch device off/on.

Alarm code	A 3225 / A 3226
Fault message	Deviation Ain1 to AIn2 too big
Cause	• Different voltages on both inputs • configured threshold too low
Remedy	• Check voltages on Ain1! • Check configuration of threshold/input filter • Switch device off/on.

Alarm code	A 3227 / A 3228
Fault message	Deviation Ain3 to AIn4 too big
Cause	• Different voltages on both inputs • configured threshold too low
Remedy	• Check voltages on Ain1! • Check configuration of threshold/input filter • Switch device off/on.

Alarm code	A 3229 / A 3230
Fault message	Plausibility test for encoder voltage faulty
Cause	• Encoder voltage value
Remedy	• Check encoder voltage supply • Check wiring of encoder voltage supply

Alarm code	A 3231 / A 3232
Fault message	Plausibility test for analog inputs faulty
Cause	• Fault in analog input signal
Remedy	• Check connection of analog inputs • Analog input voltage out of range

Alarm code	A 3233 / A 3234
Fault message	Open-circuit monitoring AIN1 has triggered
Cause	• Open-circuit monitoring activated (< 1000mV)
Remedy	• Check configuration of activation/sensor • Check sensor connection

Alarm code	A 3235 / A 3236
Fault message	Open-circuit monitoring AIN2 has triggered
Cause	• Open-circuit monitoring activated (< 1000mV)
Remedy	• Check configuration of activation/sensor • Check sensor connection

Alarm code	A 3301 / A 3302
Alarm message	Plausibility fault speed sensing axis 1
Cause	The difference between the two speed sensors is higher than the configured speed shut-down threshold
Remedy	Check the theory of the distance once again using the data set in the encoder configuration Check the speed sensor Use the SCOPE function to adjust superimposable speed signals

Alarm code	A 3303 / A 3304
Alarm message	Plausibility fault position sensing axis 1
Cause	The difference between the two position sensors is higher than the configured incremental shut-down threshold
Remedy	Check the theory of the distance using the configured data or the sensor setting Check the position signal Are all signals correctly connected to the 9-pole encoder plug? Check the encoder plug for correct wiring. If proximity switches are used, these are correctly connected. Use the SCOPE function to adjust superimposable position signals

Alarm code	A 3307 / A 3308
Alarm message	Plausibility fault position range axis 1
Cause	The current position is outside the configured measuring length
Remedy	Check the theory of the distance using the configured data or the sensor setting Check the position signal, if necessary correct the offset Use the SCOPE function to read out the position and to set into relation to configured values

Alarm code	A 3309 / A 3310
Alarm message	Plausibility fault because of faulty speed axis 1
Cause	The current speed is outside the configured maximum speed
Remedy	The drive moves outside the permissible and configured speed range Check configuration Use the SCOPE function to analyse the course of speed

Alarm code	A 3311 / A 3312
Alarm message	Configuration fault: Acceleration axis 1
Cause	The current acceleration is outside the configured acceleration range
Remedy	The drive has exceeded the permissible acceleration range Check the configuration of maximum speed Use the SCOPE function to analyse the course of speed/acceleration

Alarm code	A 3313 / A 3314
Fault message	SSI sensor fault
Cause	• Encoder step change SSI-value within a cycle too big
Remedy	• Check encoder wiring • Check encoder configuration

Alarm code	A 3321 / A 3322
Alarm message	Plausibility fault speed sensing axis 2
Cause	The difference between the two speed sensors is higher than the configured speed shut-down threshold
Remedy	Check the theory of the distance once again using the data set in the encoder configuration Check the speed sensor Use the SCOPE function to adjust superimposable speed signals

Alarm code	A 3323 / A 3324
Alarm message	Plausibility fault position sensing axis 2
Cause	The difference between the two position sensors is higher than the configured incremental shut-down threshold
Remedy	Check the theory of the distance using the configured data or the sensor setting Check the position signal Are all signals correctly connected to the 9-pole encoder plug? Check the encoder plug for correct wiring. If proximity switches are used, these are correctly connected. Use the SCOPE function to adjust superimposable position signals

Alarm code	A 3327 / A 3328
Alarm message	Plausibility fault position range axis 2
Cause	The current position is outside the configured measuring length
Remedy	Check the theory of the distance using the configured data or the sensor setting Check the position signal, if necessary correct the offset Use the SCOPE function to read out the position and to set into relation to configured values

Alarm code	A 3329 / A 3330
Alarm message	Plausibility fault because of faulty speed axis 2
Cause	The current speed is outside the configured maximum speed
Remedy	The drive moves outside the permissible and configured speed range Check configuration Use the SCOPE function to analyse the course of speed

Alarm code	A 3331 / A 3332
Alarm message	Configuration fault: Acceleration axis 2
Cause	The current acceleration is outside the configured acceleration range
Remedy	The drive has exceeded the permissible acceleration range Check the configuration of maximum speed Use the SCOPE function to analyse the course of speed/acceleration

Alarm code	A 3333 / A 3334
Alarm message	Plausibility fault of SinCos encoder
Cause	Wrong encoder type connected
Remedy	Check configuration Check encoder assignment

Alarm code	A 3407 / A 3408
Alarm message	Difference level RS485Treiber1 fault INC_B or SSI_CLK faulty
Cause	• No encoder connection • Wrong encoder type connected
Remedy	• Check encoder connection • Check encoder wiring

Alarm code	A 3409 / A 3410
Alarm message	Difference level RS485Treiber2 fault INC_A or SSI_DATA faulty
Cause	• No encoder connection • Wrong encoder type connected
Remedy	• Check encoder connection • Check encoder wiring

Alarm code	A 3411 / A 3412
Fault message	Fault Sine/Cosine plausibility X31
Cause	• Plausibility monitoring of individual tracks faulty
Remedy	• Check encoder wiring • Sine- to Cosine- track must be linear

Alarm code	A 3413 / A 3414
Fault message	Fault Sine/Cosine plausibility X32
Cause	• Plausibility monitoring of individual tracks faulty
Remedy	• Check encoder wiring • Sine- to Cosine- track must be linear

Alarm code	A 3505 / A 3506
Fault message	Read head fault WCS encoder system axis 1
Cause	• WCS read head has detected a fault
Remedy	• Read out fault types from WCS encoder system

Alarm code	A 3507 / A 3508
Fault message	Read head fault WCS encoder system axis 1
Cause	• WCS read head has detected a fault
Remedy	• Read out fault types from WCS encoder system

Alarm code	A 4001 / A 4002
Alarm message	CCW and CW rotation monitoring SDI1 activated at the same time
Cause	Multiple activation
Remedy	In programming make sure that only one "Enable" is activated

Alarm code	A 4003 / A 4004
Alarm message	CCW and CW rotation monitoring SDI2 activated at the same time
Cause	Multiple activation
Remedy	In programming make sure that only one "Enable" is activated at a time

Alarm code	A 4601 / A 4602
Alarm message	Monitoring range left and right of SLP1 activated at the same time
Cause	Multiple activation
Remedy	In programming make sure that only one "Enable" is activated at a time

Alarm code	A 4603 / A 4604
Alarm message	Monitoring range left and right of SLP2 activated at the same time
Cause	Multiple activation
Remedy	In programming make sure that only one "Enable" is activated at a time

Alarm code	A 4605 / A 4606
Alarm message	SLP1 Teach In status fault
Cause	SET and QUIT input have a faulty switching sequence

Remedy	Check input configuration Check switching sequence

Alarm code	A 4607 / A 4608
Alarm message	SLP 2 Teach In status fault
Cause	SET and QUIT input have a faulty switching sequence
Remedy	Check configuration Check switching sequence

Alarm code	A 4609 / A 4610
Alarm message	SLP1 Teach In position fault
Cause	Teach In position outside measuring range
Remedy	Check transfer position

Alarm code	A 4611 / A 4612
Alarm message	SLP2 Teach In position fault
Cause	Teach In position outside measuring range
Remedy	Check transfer position

Alarm code	A 4613 / A 4614
Alarm message	SLP1 Teach In SOS activation fault
Cause	The drive moved during Teach In (SOS fault)
Remedy	The drive must be stopped when using the Teach In function Check whether SOS has already triggered

Alarm code	A 4615 / A 4616
Alarm message	SLP 2 Teach In SOS activation fault
Cause	The drive moved during Teach In (SOS fault)
Remedy	The drive must be stopped when using the Teach In function Check whether SOS has already triggered

Alarm code	A 4901 / A 4902
Alarm message	CCW and CW rotation monitoring SLI1 activated at the same time
Cause	Multiple activation
Remedy	In programming make sure that only one "Enable" is activated at a time

Alarm code	A 4903 / A 4904
Alarm message	CCW and CW rotation monitoring SLI2 activated at the same time
Cause	Multiple activation
Remedy	In programming make sure that only one "Enable" is activated at a time

Alarm code	A 5001 / A 5002
Alarm message	Test deactivation of digital inputs 1...14 faulty
Cause	Inputs are still active after deactivation
Remedy	Check wiring of digital inputs

Alarm code	A 6701 / A 6702
Alarm message	Timeout fault MET
Cause	Input element with time monitoring is faulty
Remedy	Check wiring of input element Input element faulty

Alarm code	A 6703 / A 6704
Alarm message	Timeout fault MEZ
Cause	Two-hand control element with time monitoring is faulty
Remedy	Check wiring of input element Input element faulty

Fatal Error list Safety-M

Fatal Error Code	F 1001
Fault message	Configuration data were incorrectly loaded into the monitoring device
Cause	Disturbed connection when loading the program into the monitoring device.
Remedy	Reload the configuration data, then switch module off/on.

Fatal Error Code	F 1003
Fault message	Configuration data invalid for software version of module!
Cause	Module configured with incorrect software version of the programming desktop.
Remedy	Parameterize the module with the approved version of the programming desktop, the switch the module off/on.

Fatal Error Code	F 1007
Fault message	Device not programmed with the correct programming desktop
Cause	Program or configuration data transferred to the device using the wrong programming desktop
Remedy	Check the module design and parameterize again with a valid programming desktop. Then switch device off/on.

Fatal Error Code	F 1307
Fault message	Error when deleting configuration data from the Flash Memory

Fatal Error Code	F 1311 / F1312
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1330
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1401 / F 1402
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1403 / F 1404
Fault message	CRC of configuration data invalid!
Cause	Configuration data were incorrectly transferred
Remedy	Transfer the configuration data again

Fatal Error Code	F 1406
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1407 / F 1408
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1501 / F 1502
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1503 / F 1504
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1505 / F 1506
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 1601 / F 1602
Fault message	Range test of device description is faulty.

Fatal Error Code	F 1603 / F 1604
Fault message	Range test of Access Data faulty

Fatal Error Code	F 1605 / F 1606
Fault message	Range test of EMU faulty

Fatal Error Code	F 1607 / F 1608
Fault message	Range test SCA faulty

Fatal Error Code	F 1609 / F 1610
Fault message	Range test SSX faulty

Fatal Error Code	F 1611 / F 1612
Fault message	Range test SEL faulty

Fatal Error Code	F 1613 / F 1614
Fault message	Range test SLP faulty

Fatal Error Code	F 1615 / F 1616
Fault message	Range test SOS faulty

Fatal Error Code	F 1617 / F 1618
Fault message	Range test SLS faulty

Fatal Error Code	F 1619 / F 1620
Fault message	Range test SDI faulty

Fatal Error Code	F 1621 / F 1622
Fault message	Range test SLI faulty

Fatal Error Code	F 1623 / F 1624
Fault message	Range test of PLC faulty

Fatal Error Code	F 1625 / F 1626
Fault message	Range test of shut-down channel faulty

Fatal Error Code	F 1627 / F 1628
Fault message	Range test of outputs faulty

Fatal Error Code	F 1629 / F 1630
Fault message	Range test of digital inputs faulty.

Fatal Error Code	F 1631 / F 1632
Fault message	Range test of analog input

Fatal Error Code	F 1633 / F 1634
Fault message	Range test of encoder type faulty

Fatal Error Code	F 1635 / F 1636
Fault message	Range test of encoder processing faulty

Fatal Error Code	F 1637 / F 1638
Fault message	Range test of encoder position faulty

Fatal Error Code	F 1639 / F 1640
Fault message	Range test of PDM faulty.

Fatal Error Code	F 1641 / F 1642
Fault message	Range test of adder circuitry faulty

Fatal Error Code	F 1645 / F 1646
Fault message	Range test of axis management faulty

Fatal Error Code	F 1647 / F 1648
Fault message	Range test of expansion modules faulty

Fatal Error Code	F 1649 / F 1650
Fault message	Range test of PLC timer faulty

Fatal Error Code	F 1651 / F 1652
Fault message	Range test of system faulty

Fatal Error Code	F 1653 / F 1654
Fault message	Range test connection table faulty

Fatal Error Code	F 1655 / F 1656
Fault message	Range test SAC faulty

Fatal Error Code	F 1657 / F 1658
Fault message	Range test of diagnose faulty

Fatal Error Code	F 2001 / F 2002
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 2003 / F 2004
Fault message	Timeout when transmitting configuration and firmware data

Fatal Error Code	F 2005
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 2007
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 2009
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 2011
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 2013 / F 2014
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3001 / F 3002
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3201 / F 3202
Fault message	Processor voltage 2.5V outside defined range
Cause	• Supply voltage for module not correct! • Component fault in module
Remedy	• Check device supply voltage! • Switch device off/on.

Fatal Error Code	F 3203
Fault message	Supply voltage 24V module faulty.
Cause	• Supply voltage for module not correct! • Component fault in module
Remedy	• Check device supply voltage! • Switch device off/on.

Fatal Error Code	F 3204
Fault message	Internal supply voltage 5.7V faulty
Cause	• Supply voltage for module not correct! • Component fault in module
Remedy	• Check device supply voltage! • Switch device off/on.

Fatal Error Code	F 3217 / F 3218
Fault message	Internal supply voltage 5V faulty
Cause	• Supply voltage for module not correct! • Component fault in module
Remedy	• Check device supply voltage! • Switch device off/on.

Fatal Error Code	F 3306
Alarm message	Plausibility fault position switching axis 1
Cause	During position switching SOS, SLI or SDI is permanently activated.
Remedy	• Check activation of SOS • Check activation of SLI • Activation of SDI (only for monitoring via position)

Fatal Error Code	F 3316
Fault message	Fault in encoder alignment axis 1
Cause	• Incorrect position triggering by system A
Remedy	• Check encoder configuration • Switch device off/on.

Fatal Error Code	F 3326
Fault message	Plausibility fault position switching axis 2
Cause	During position switching SOS, SLI or SDI is permanently activated.
Remedy	• Check activation of SOS • Check activation of SLI • Activation of SDI (only for monitoring via position)

Fatal Error Code	F 3336
Fault message	Fault in encoder alignment axis 2
Cause	• Incorrect position triggering by system A
Remedy	• Check encoder configuration • Switch device off/on.

Fatal Error Code	F 3603 / F 3604
Fault message	Faulty switching of relay K1
Cause	Internal triggering of relay faulty
Remedy	Switch device off/on

Fatal Error Code	F 3605 / F 3606
Fault message	Faulty switching of relay K2
Cause	Internal triggering of relay faulty
Remedy	Switch device off/on

Fatal Error Code	F 3609
Fault message	Faulty switching of "0V" driver DO1_L
Cause	Switching state of output faulty
Remedy	Switch device off/on

Fatal Error Code	F 3610
Fault message	Faulty switching of "24V" driver DO1_H
Cause	Switching state of output faulty
Remedy	Switch device off/on

Fatal Error Code	F 3611
Fault message	Faulty switching of "0V" driver DO2_L
Cause	Switching state of output faulty
Remedy	Switch device off/on

Fatal Error Code	F 3612
Fault message	Faulty switching of "24V" driver DO2_H
Cause	Switching state of output faulty
Remedy	Switch device off/on

Fatal Error Code	F 3613
Fault message	Faulty switching of "0V" driver DO1_L
Cause	Short-circuit of outPort with "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3614
Fault message	Faulty testing of "24V" driver DO1_H
Cause	Short-circuit of outPort with "24V"
Remedy	Switch device off/on

Fatal Error Code	F 3615
Fault message	Faulty testing of "0V" driver DO2_L
Cause	Short-circuit of outPort with "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3616
Fault message	Faulty testing of "24V" driver DO2_H
Cause	Short-circuit of outPort with "24V"
Remedy	Switch device off/on

Fatal Error Code	F 3617
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3618
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3619
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3620
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3621
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3622
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3701 / F 3702
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3821
Fault message	Faulty switching of output EAAx.1
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3823
Fault message	Faulty switching of output EAAx.2
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3825
Fault message	Faulty switching of output EAAx.3
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3827
Fault message	Faulty switching of output EAAx.4
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3829
Fault message	Faulty switching of output EAAx.5
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3831
Fault message	Faulty switching of output EAAx.6
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3833
Fault message	Faulty switching of output EAAx.7
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3835
Fault message	Faulty switching of output EAAx.8
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3837
Fault message	Faulty switching of output EAAx.9
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3839
Fault message	Faulty switching of output EAAx.10
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3841 / F 3842
Fault message	Faulty testing of output EAAx.1
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3843 / F 3844
Fault message	Faulty testing of output EAAx.2
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3845 / F 3846
Fault message	Faulty testing of output EAAx.3
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3847 / F 3848
Fault message	Faulty testing of output EAAx.4
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3849 / F 3850
Fault message	Faulty testing of output EAAx.5
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3851 / F 3852
Fault message	Faulty testing of output EAAx.6
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3853 / F 3854
Fault message	Faulty testing of output EAAx.7
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3855 / F 3856
Fault message	Faulty testing of output EAAx.8
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3857 / F 3858
Fault message	Faulty testing of output EAAx.9
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3859 / F 3860
Fault message	Faulty testing of output EAAx.10
Cause	Short-circuit of outPort with "24V" or "0V"
Remedy	Switch device off/on

Fatal Error Code	F 3872
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3874
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3892
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 3894
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 4503 / F 4504
Alarm message	Faulty calculation of SSX limit curve
Cause	Faulty calculation of SSX limit curve
Remedy	• Check configuration • Consult the manufacturer

Fatal Error Code	F 4501 / F 4502
Alarm message	Faulty calculation of SSX brake ramp
Cause	Faulty configuration
Remedy	• Check SSX configuration • Consult the manufacturer

Fatal Error Code	F 6801 / F 6802
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 6803 / F 6804
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 6805 / F 6806
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 6807 / F 6808
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 6809 / F 6810
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 6811 / F 6812
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 6813 / F 6814
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8205 / F 8206
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8207 / F 8208
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8213 / F 8214
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8220
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8221 / F 8222
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8223 / F 8224
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8225
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8227
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 8228
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 9001 / F 9002
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 9007 / F 9008
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 9009 / F 9010
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 9011 / F 9012
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 9013 / F 9014
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 9015 / F 9016
Fault message	Internal error – please contact the manufacturer!

Fatal Error Code	F 9017 / F 9018
Fault message	Internal error – please contact the manufacturer!

Last Review	When	Reviewer
Overall document	17.Febr. 2012	Kop