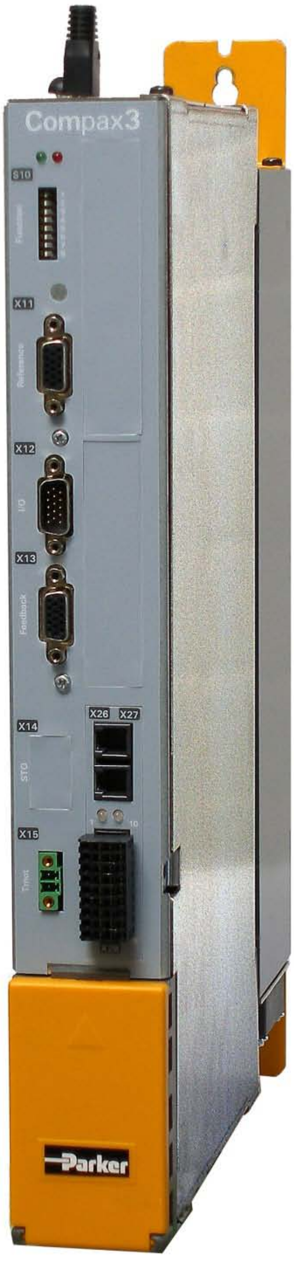
Programming Manual for the SDC Module



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1 Terms

1.1 PLC

Programmable **L**ogic **C**ontroller, equals the German designation for **S**peicher**p**rogrammierte **S**teuerung (SPS). The term PLC is exclusively used within the SDC module.

1.2 SafePlcGRP

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

1.3 SDC

Safety **D**rive **C**ore, modular fail-safe control system with integrated technology functions. The behaviour of the SDC module is defined by a user configuration and the associated logic operations.

1.4 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. an emergency stop or an input or output on the SDC module. However, a function block is also the logic operation (e.g. AND or OR) of input and output signals within the PLC.

1.5 Logic diagram (function module language)

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

1.6 Input / Output

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

1.7 Linkage

A named connection between:
a.) a function block output with a function block input.
b.) a PLC input with a function block input.
c.) a function block output with the PLC output.

1.8 Connector

Connecting point between the beginning and the end of a linkage with an input and an output of a function module

1.9 Attribute

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

1.10 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).

1.11 Signal list

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

1.12 Signal cell

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

1.13 PLC input signal list

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

1.14 PLC output signal list

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

1.15 Instruction list (IL)

Assembler-like programming language that can be loaded into a SDC module. The duty of ***SafePlcGRP*** is the generation of an instruction list based on defined function blocks, as well as their attributes and logic operations.

1.16 Compilation

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

1.17 Function block group

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

1.18 Function block type

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

1.19 Message window

Multi-line output window, 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.

1.20 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.

1.21 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, the program can refer to.

1.22 SDDC
Safe Device To Device Communication
Safe bus communication between SDC devices.

2 Mouse and keyboard commands

2.1 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 Output” 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 logic operation(s).
- **Ctrl + movement of mouse pointer over an object**: Display of information data - even if the display has been disabled via the menu.
- **Turning the scroll wheel on the mouse**: Dynamic zooming of the logic diagram.
- **Moving the mouse with the scroll wheel depressed**: Moving the logic diagram.

2.2 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 message window on/off
- **Ctrl + N**: New file
- **Esc**: Deselection of marked elements
- **Erase**: Erases selected objects
- **Arrow left**: Logic diagram LineScroll left
- **Arrow right**: Logic diagram LineScroll right
- **Arrow up**: Logic diagram LineScroll up
- **Arrow down**: Logic diagram LineScroll down

3 Brief Description of Procedure

The program SafePlcGRP is a graphically oriented editor for the creation of a PLC-based monitoring program for a SDC module.

3.1 General note

The program requires write and read rights of the user logged in 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.

3.2 "Push & Pop" when inserting function blocks

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

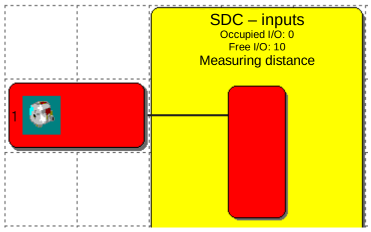
Please proceed as follows to create an application:

1. Determination of periphery in the terminal diagram

The terminal diagram represents the connections to sensors and actuators of the SDC module.

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.

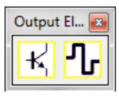
  

  Note:
  A red icon indicates the missing parameterization.

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

  Selection of the required semi-conductor output modules

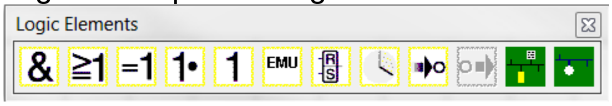
  

2. Definition of monitoring functions and logic modules in the logic diagram

The logic diagram shows the logic modules and their internal logic operation.

Programming of the logic diagram by using:

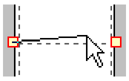
- Logical and processing elements.



- 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 deactivating 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.

3. 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 for 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 SDC module

4. Program transfer to the SDC module

- Setting the COM output
- Transfer of the machine program
- Testing the program on the SDC module
- Disabling the logic plan after approval
- Preparation of the configuration report and validation of the configuration.

4 Logic Diagram

SafePLCGRP saves the configuration, the program sequence and the chosen parameterization as a Windows documents with the file name extension “*.plcGRP“.
The logic diagram is subdivided into field, 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 for the user.
The programmer is able to toggle between these views as desired:

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

Permanent status display: 

In the left upper corner of the logic diagram you find 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 SDC module.

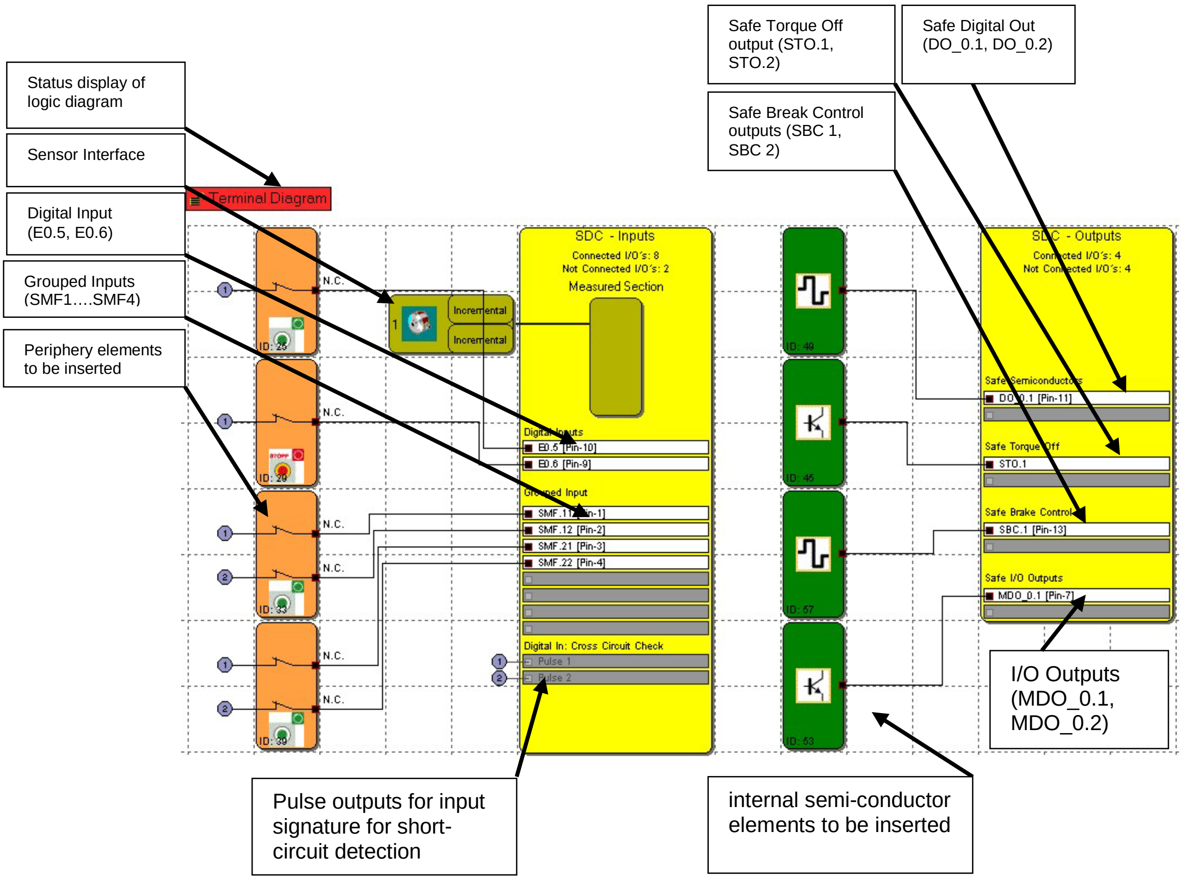
5 Terminal diagram

The terminal plan describes the external port assignments of a SDC module-system to the chosen sensors and actuators. When creating a new diagram (File->New...) the terminal diagram shows all available inputs and outputs.

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

Definition of inputs and outputs:
Selection and parameterization of inputs and outputs

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 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 distinctly.

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

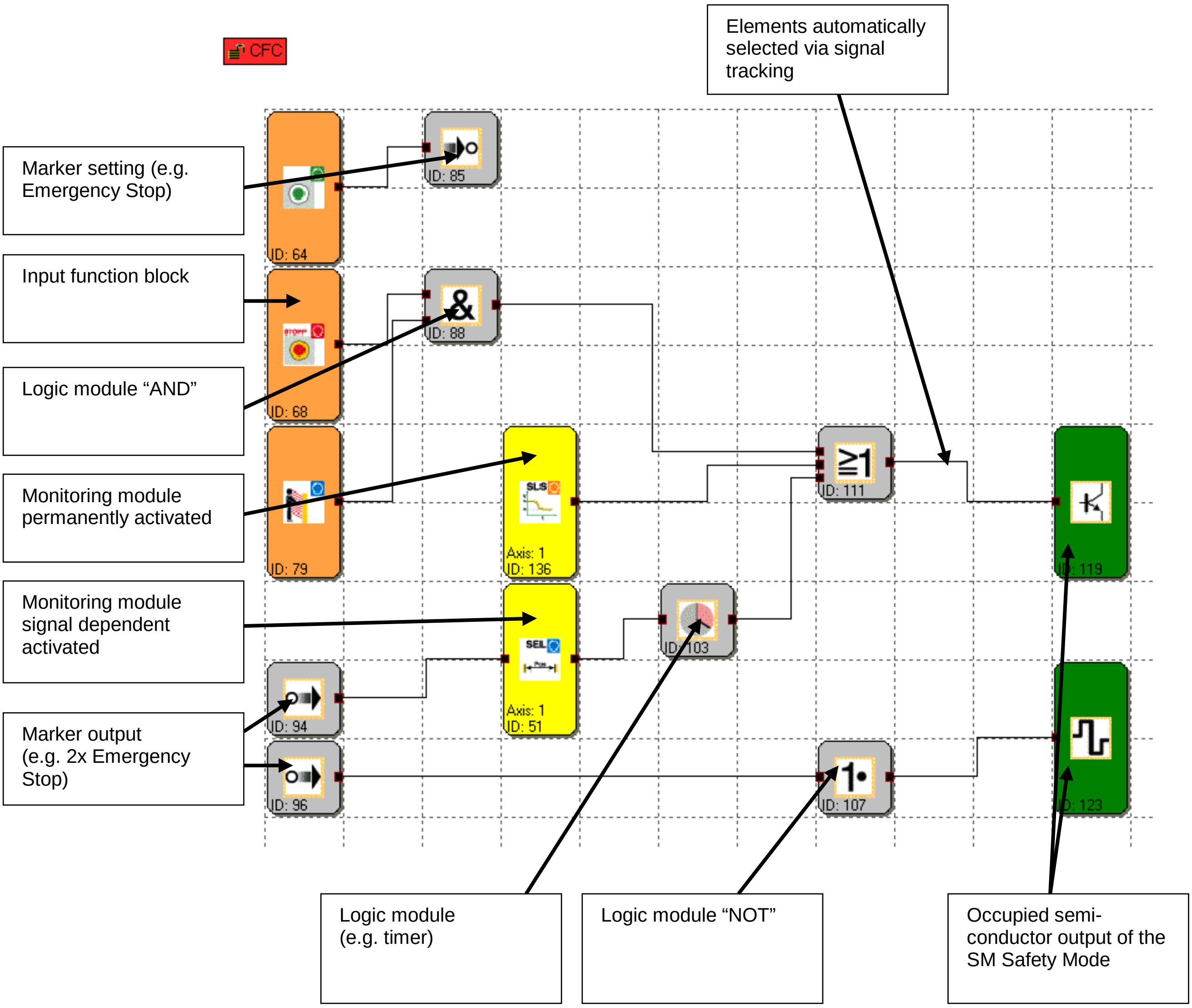
Note: Since no logic elements must be defined in this view, the corresponding commands are disabled.

6 Logic Diagram

In the logic diagram a logic operation take place between input, output, monitoring, and logic modules.

In this respect the output connectors on the input elements correspond with the input data of the logic diagram. In the same way the input connectors of the output elements must be viewed as output data of the diagram.

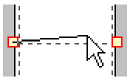
In order to be able to create a clearly structured logic diagram, one can define so-called terminal blocks. These represent a named connection between input and output connectors of function blocks. One or several marker output blocks (output terminals) can be defined for a marker setting block (input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



Tip:
Use the comment line for connecting point inputs.
This information simplifies the use of complementary connecting point outputs.

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

7 Preparing the Wiring



The assignments in the logic diagram are created by linking the input and output connectors of the functional modules. An output of a module may, if necessary, be multiply connected with inputs on other modules, whereby any input 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.

<u>Automatic connection</u>
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.

<u>User defined connection</u>
A command for the drawing of user defined connecting lines is additionally 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” 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”.
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.) Termination 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 input and output connector is not considered a control point and does therefore not need to be specified.

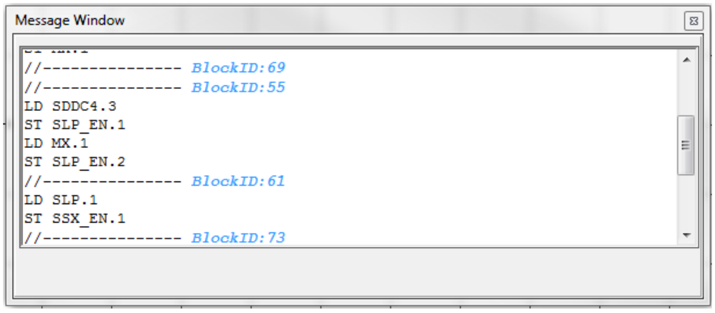
Tip: Visual corrections to the logic diagram should only be made just before the logic digram is blocked. Only then the layout is complete and the blocks do not need to be displaced any more.

8 Message 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 also is 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 the message window (click with right mouse button on text field)

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”.

9 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
SafePlcGRP makes sure that all connections between function blocks can be opened. Unconnected connectors are recognized as faults.

Verifying for unreferenced “Connection point” Blocks
SafePlcGRP 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
SafePlcGRP 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 test does not replace the context related evaluation of data after a change made by the user!

Creation of the instruction list (IL)
The IL-code created on basis of the function blocks is output 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 SDC module, 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.

Backup 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

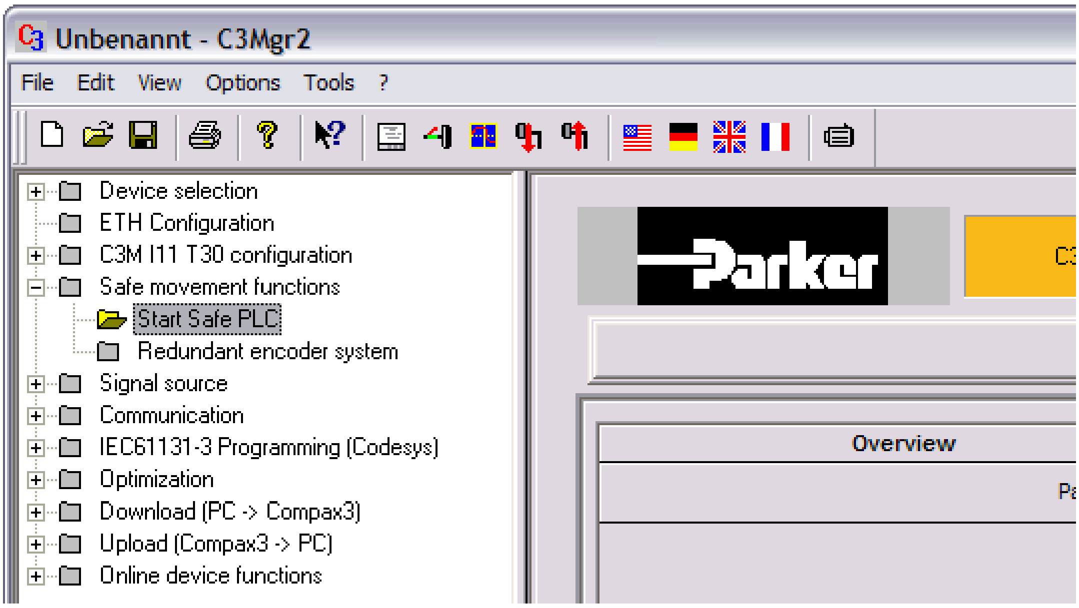
The calculated CRC-values can be displayed in off-line mode (no connection to module) via the menu “File->Layout Management”.

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

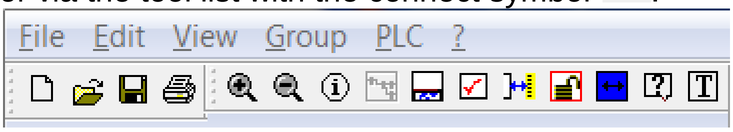
10 Testing the program on the SDC module

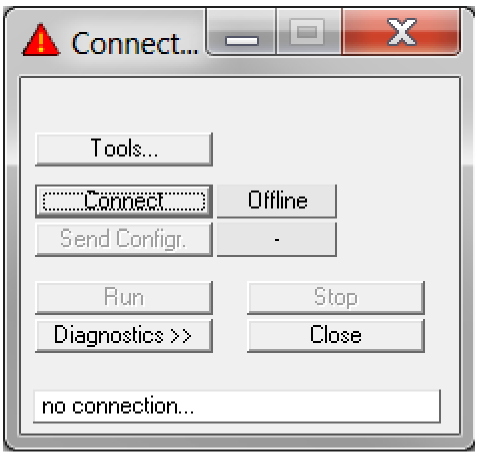
This paragraph describes the data and program transfer to a basic SDC module.

SafePLC must first be started via the C3 servo manager, so that a SafePLC program (Safety I/O Profile) can be created for drive or loaded into the drive.

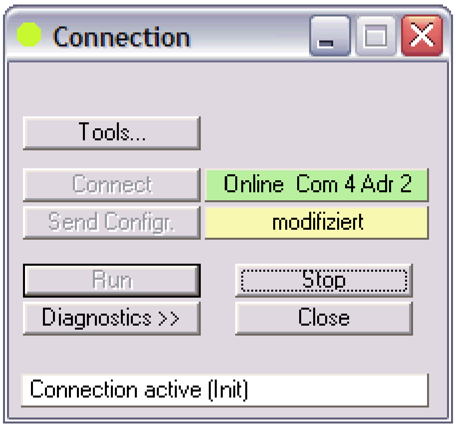


The start of the connection request takes place via “File -> ´Open Connecting Dialog” or via the tool list with the connect symbol .





10.1 Connecting dialog



Connect: Starts the connection to the SDC module

Quit: Cancels an active connection.

Send config.: Transfers the configuration of the logic diagram to the SDC module. This is only possible in "Stop" mode.

Start: Starts the sequencing program

Stop: Stops the sequencing program

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

Validation:
Calling the validation dialog via the "Tools" button

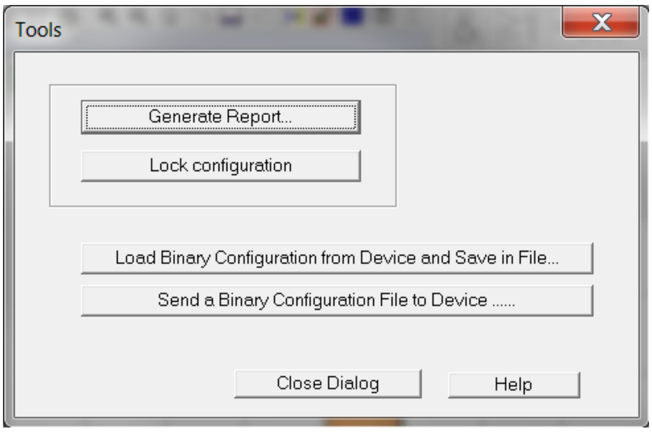
10.2 Tools

10.2.1 Validation dialog

The proper execution of a validation in conformance with the demanded safety regulations can be taken from the installation manual.

10.2.1.1 Creating a report

Generation of the validation report.



10.2.2 Locking the configuration

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

Note:
A detailed description of the LED-display can be found in the installation manual chapter 9.2.

10.2.3 Reading out a binary file from the SDC module…

Reads out the current SDC device configuration in a machine readable form. These data are not changed by SafePlcGRP and can be saved to the drive in this form.

10.2.4 Sending a binary file to the SDC module…

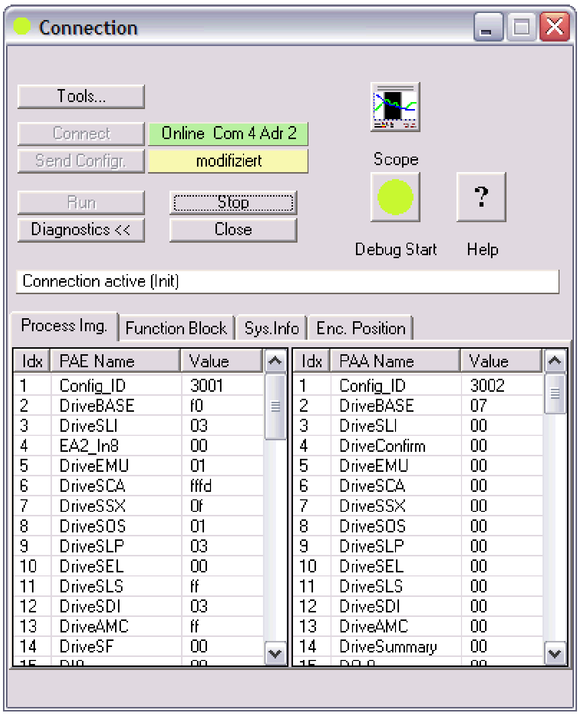
Transfer of a machine readable device configuration from the PC drive to the SDC module.

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.

11 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 successful starting 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 function block or a discrepancy between the available logic diagram and the device configuration only permits a limited diagnose. The functionality "Diagnose Function Blocks" is in this case not available.

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

Process image: Visualization of the input/output image of the SDC module.

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

System info: System information about the SDC module. As follows:

Parameters	Description
CRC device 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 SDC module and can be used as reference for the purpose of documentation.
Version number	Firmware version number

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

Note:
THis value is the non-standardized raw value.

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

11.1 Procedure for logic diagram diagnose

When running a logic diagram diagnose, the current input and output 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 Blocks” tab via: Connection->Diagnose->Function Blocks.

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 marking these and clicking on the control button “Remove Block”.
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.

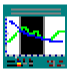
Tip:
The “Select all” command from the context menu (right mouse button) can be used to select all data from the logic diagram.

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 SDC module. The adjustment is made by clicking on the control button “Debug Start”.

Note: The implemented debugging function requires intensive data transfer between SDC module and ***SafePlcGRP.*** This results in a temporally delayed display of data. Quick status changes on module outputs may therefore not be detectable.

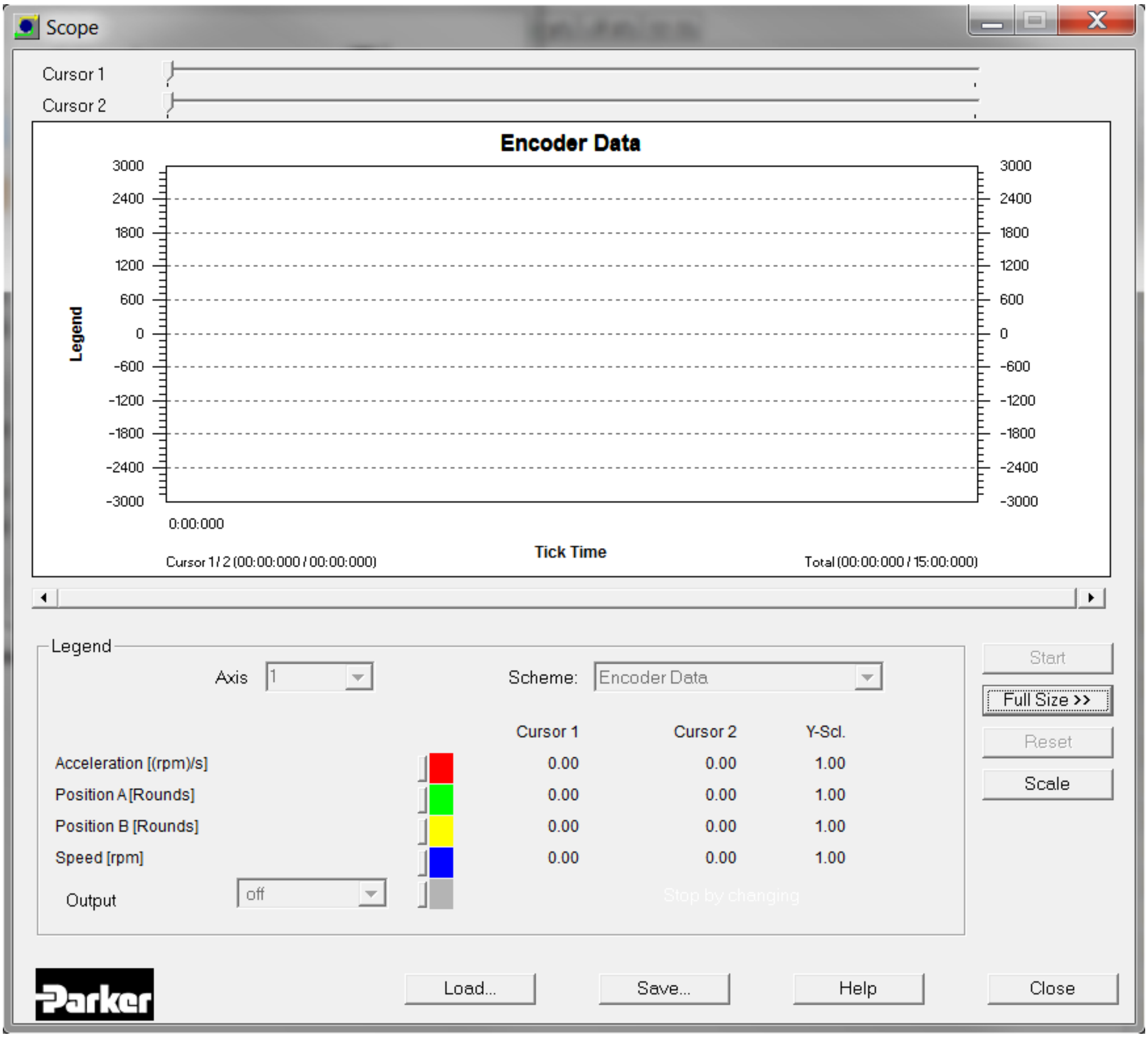
The diagnose is solely available in operating mode “Run”. In any other mode of operation the process image is passivated.

11.2 The Scope Monitor



Parameterization of drive monitoring requires exact knowledge of process data when viewed from the SDC module. 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 SDC module 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 process image and logic diagram debugging 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 controllers moves a display line in the graph. 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.

<u>Maximize >></u>
Enlarges the Scope Monitor to the complete available screen area. With the control button “Smal Size <<” the dialog can be reset to standard size.

<u>Scheme:</u>
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.

<u>Output</u>
A basic group output, the current status of which 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 output status has a slightly higher line weight.

<u>Stop with change</u>
If the switch “Stop by changing” is set, recording will stop 2 seconds after an edge change of the specified output (see above). This function enables long-term recording and fault analysis with no operator present.

<u>Save...:</u>
In “Stop” condition provides the possibility to save the current recording in a file.

<u>Load...:</u>
This button can be used to reload a recording into the scope and the display.

11.2.1 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 SDC module.

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

11.2.2 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 measuring data for the graph are read by the module, standardized and displayed with the correct time reference. The recording memory is 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. For position oriented measuring this requires the resetting of the data buffer (SSX).

11.2.3 “Start” measurement

The control button “Start” is only available in case of an active connection to the SDC module. 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” control button.

11.2.4 “Stopping” a measurement and viewing data

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

11.2.5 Measuring schematics

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. If no position detection is activated, the system can only measure to a relative extent (saw tooth waveshape).
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 the 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 the encoder signal for diagnostic purposes (e.g. trouble shooting, etc.).

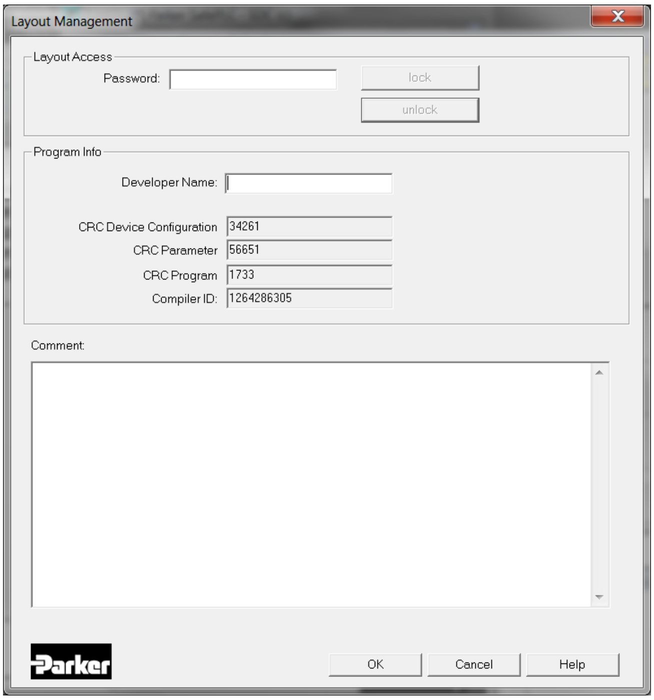
SSX data

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 via the visualization of 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.

12 Diagram Management



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

12.1 Diagram access

Here one can disable or enable access to the function blocks in the current logic diagram. This means, that in a disabled logic diagram all menu options and toolbars for adding function blocks appear in grey (= disabled). 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 disabled 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 disabled, the dialog “Save File” will appear when exiting the diagram management, so that possible changes will not be lost.

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

12.2 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.

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.

Note:
If the CRC is used for the test report, it is recommended to disable the logic diagram, since this prevents accidental modification!

13 Configuration Report

SafePlcGRP uses the validation function (Connection->Tools) to create a configuration report for the device configuration. This function is only available in case of an active connection to an SDC module.
The report is saved in a file and can subsequently be edited.

Attention

The printed out 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 plant description**

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

   Place of installation: 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: Drive type (see sticker)

   Designation: File name of logic diagram

   Place of installation: Designation of control cabinet that contains the drive

   Manufacturer and type are fixed.

   Device 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 hand writing after the report has been printed out (CRC is displayed in the "Layout Management").

   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.

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 SDC module, the system LED will, in case of fault-free operation, subsequently flash ***GREEN-YELLOW***. This signalizes a non-validated application! When actuating the control button "Lock validation" while actively connected with the module, the LED will subsequently light permanently ***GREEN***.

14 Program Development Aids

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

14.1 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” dialog. The info display can also be activated with the “Ctrl”-key. The display will continue, until this key is released again.

14.2 Signal tracking

This command selects all other functional modules, which are linked with a currently selected block. This way all coherent logic operations 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.

14.3 Copying attributes into the message window

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

Tip: The attributes of all function modules can be copied using the command “Attributes in Message Window”. In this case no function module must be selected.

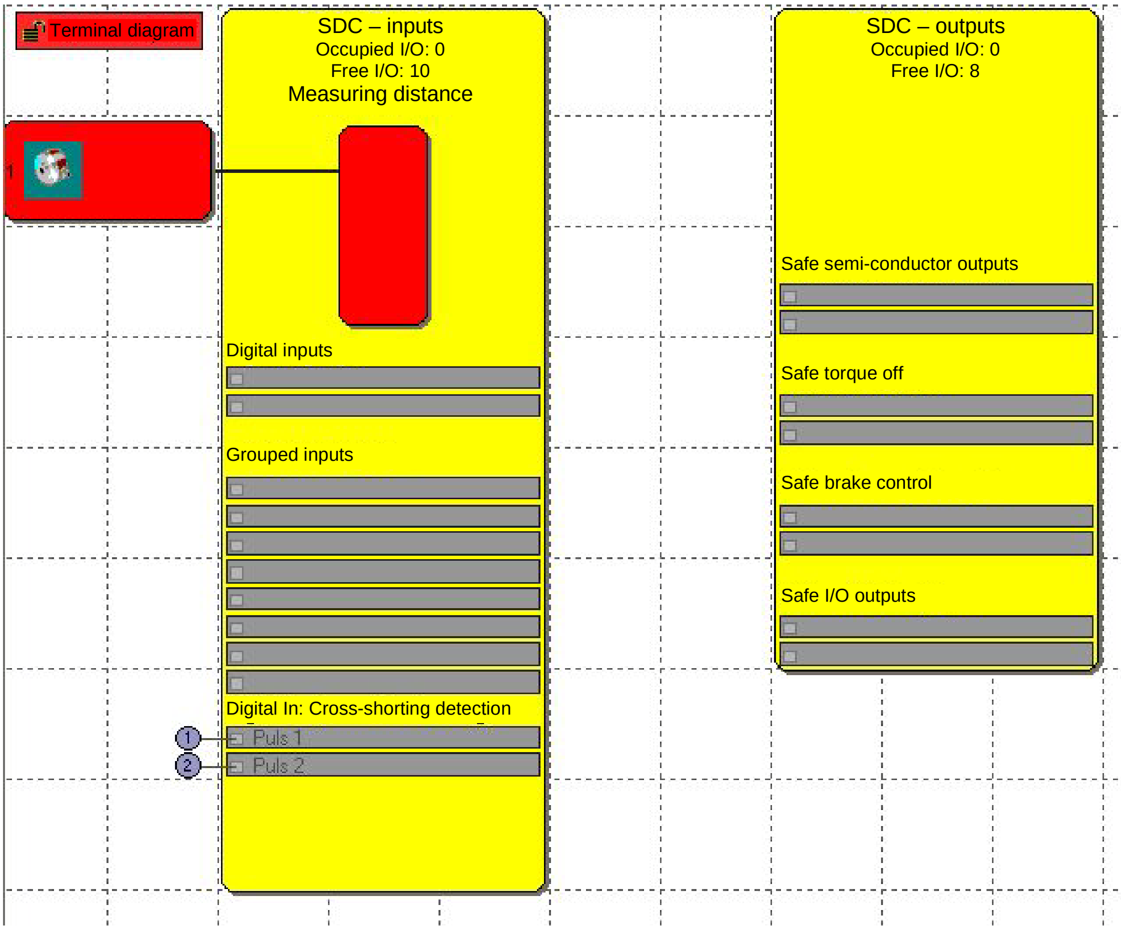
Note: When selecting the command via the context menu, the mouse pointer must be positioned on a selected block.

14.4 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.

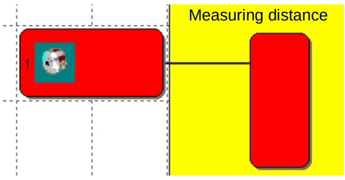
15 Predefined Function Blocks

Representation of the available inputs and outputs of the SDC module.



15.1 Sensor interface

This block describes the speed and position sensors, the signal list for the digital inputs and, if available, the analog inputs. 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 dialog. The parameters to be entered are described in detail in the section “Sensor Configuration”.

15.2 Digital inputs

Determination of properties for digital input signal E0.5 and E0.6.

Logic operation takes place automatically when inserting function blocks as described below. Double-clicking on a signal list opens a comment window with the possibility of entering describing text.

15.3 Grouped Input

Determination of properties for the 4x2* Grouped Inputs.
The assignment of inputs takes place in pairs in the input and periphery modules, logic operation occurs automatically.
In the input/periphery modules the types Equivalent (2xnormally closed, 2xnormally open, ...), Equivalent - Time Monitored, Complementary (1xnormally closed + 1xnormally open, ...) and Complementary Time Monitored are available for selection.

+1x2 Grouped Inputs (SMF41/SMF42) can optionally also be configured as 2 HiSide outputs (DIO_0.1/DIO_02) - in this case only 3.2 Grouped Inputs would be available.

15.4 Safety outputs

This block consists of the signal lists for the freely programmable outputs, consisting of semi-conductor outputs and two Safe Brake Control (SBC) outputs. As with the input signals wiring also takes place automatically when adding the associated function blocks.

16 Inserting Input blocks

The input elements create the digital connection between one or several connected sensors and/or further lower-level switchgear in the ***SDC module***. Each input element, except the mode selector switch, provides one logic output signal “0” or “1” for further processing in the PLC.

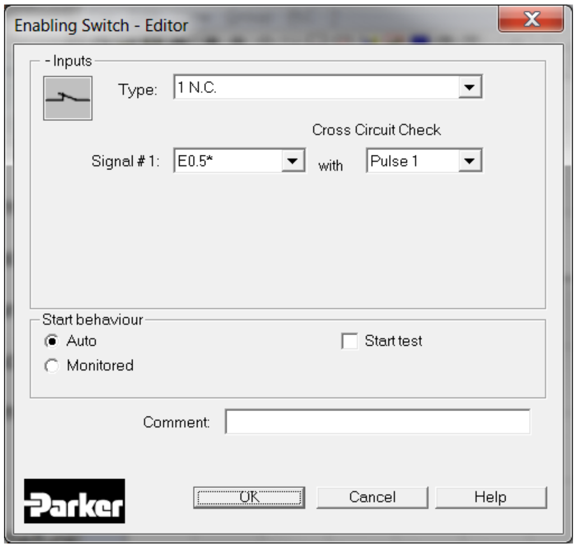
The input elements are added and edited in the “Terminal Diagram” view.

The resource control of the function block elements for the SDC module 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 input elements are structured according to their application (example enable button).

Note
The assignment of the selected input elements and their parameterization has a direct effect on the performance level to be achieved. The explanations in the installation manual for the ***SDC module*** must for this purpose be strictly followed!



The configuration of input elements generally takes place in the same way.
The parameter editor to define 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-out monitored signal types a limited number is available.

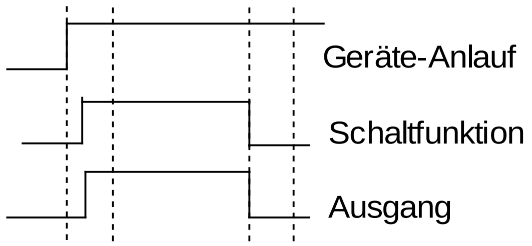
Signal-No.
Determination of the external signal to a terminal connection of the SDC module. The number of available terminal connections is determined by the actually available SDC module configuration. Signals that are already in use no longer appear in the selection dialog. The editor always shows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

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

16.1 Starting behaviour

Determination of the behaviour of an input 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 confirmation or acknowledgement.

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

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

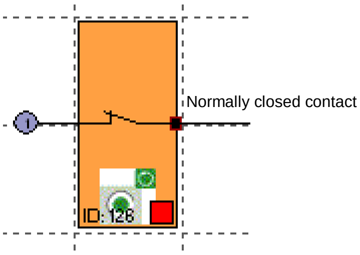
Example: Start of a drive only after this has been confirmed by the operating personnel.

With monitored starting mode an additional connector for linking to a Start element is made available. Here one can configure the continuous behaviour for monitoring the input element during the start phase.

16.2 Start test

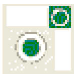
Manual starting after equipment reset or interruption of the defined safety circuit, including testing of the connected control station. The control station must trigger once in monitoring direction and switch back on again. Followed by normal operation. This non-recurrent triggering of the input element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

16.3 Enable switch

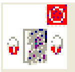


Switch type	Designation	Comment
1 (eSwitch_1o)	1 normally closed	Enable switch standard
2 (eSwitch_1s)	1 normally open	Enable switch standard
3 (eSwitch_2o)	2 normally closed	Enable switch higher requirements
4 (eSwitch_2oT)	2 normally closed time monitored	Enable switch monitored

16.4 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

16.5 Door - Monitoring

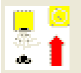


Switch type	Designation	Comment
3 eSwitch_2o	2 normally closed	Door monitoring higher requirements
4 eSwitch_2oT	2 normally closed time monitored	Door monitoring monitored
5 eSwitch_1s1o	1 normally open + 1 normally closed	Door monitoring higher requirements
6 eSwitch_1s1oT	1 normally open + 1 normally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

16.6 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

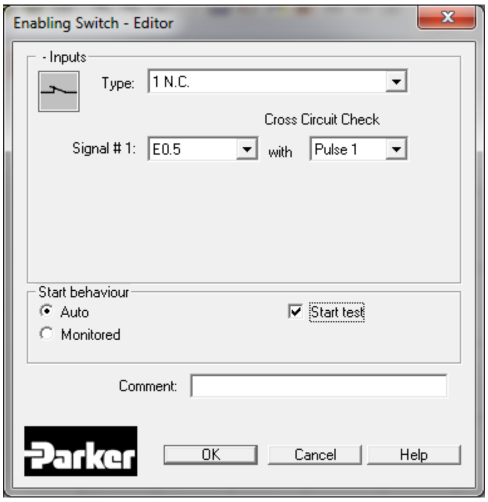
16.7 Sensor



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

16.8 Start-up Test

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

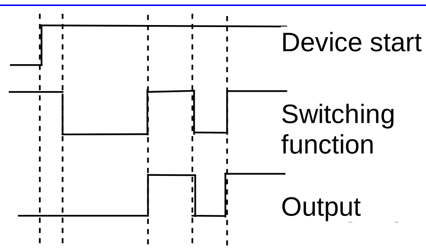


<table>
<tr><th>Start type</th><th>Function</th><th>IL</th><th>Scheme</th></tr>
<tr><td>Start test</td><td>Manual staring after a new start or an alarm reset, including testing of the connected monitoring equipment.
The monitoring equipment must trigger once in monitoring direction and switch back on again.
Followed by normal operation

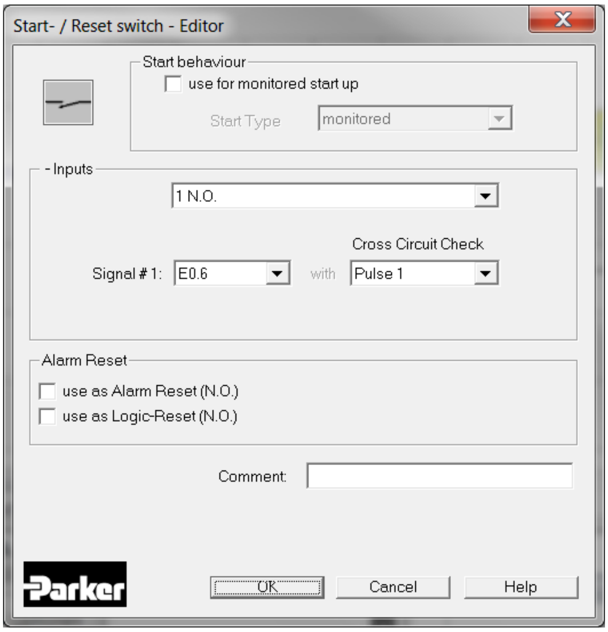
E1: Switching function
y1: Auxiliary marker</td><td>LD E1
ST MX.y1

LD NOT MX.y1
ST MEAA_EN.1

LD MX.y1
ST MEAA_EN.2

LD MEA.1
AND MX.y1
ST MX.2</td><td>
</td></tr>
</table>

16.9 Start and RESET Element



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

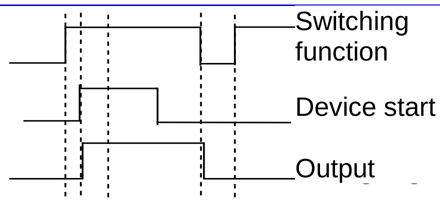
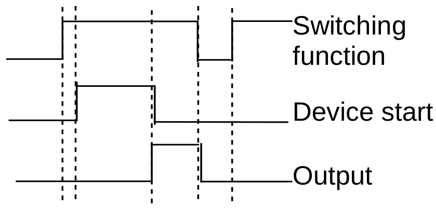
use for start monitoring

With start monitoring activated, an AWL code segment for monitoring an assigned input 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.

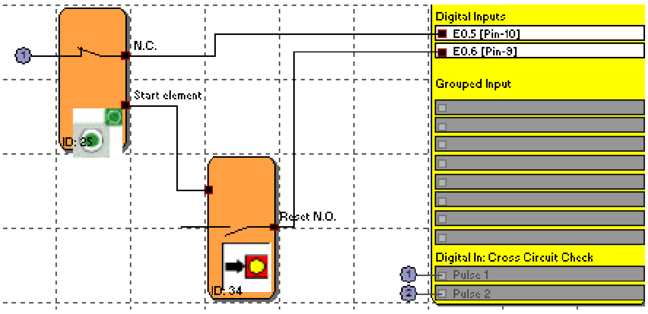
List of starting types by means of a enable button:

Start type

Start type	Function	IL	Scheme
Manual start (by hand)	Manual start after device reset. Output of the input 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. Output 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	
Monitored start	Manual start after equipment reset with monitoring of start circuit for static 1-signal. Output of the input 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. Output 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 input of the start element must be connected to the output labelled “Start element” of the input elements. Several elements can be monitored.

e.g.



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

Input - Signal No. 1 (E0.1)
As with the input elements, this selection list is used to determine the input to which the button for the start element is to be connected. This input is internally limited to the assignment of a Grouped Input (SMF.11, SMF.21, SMF.31, SMF.41). When the Alarm Reset option is used, no cross-shorting monitoring can be permitted for this input. 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 shows 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
ECS	Yes

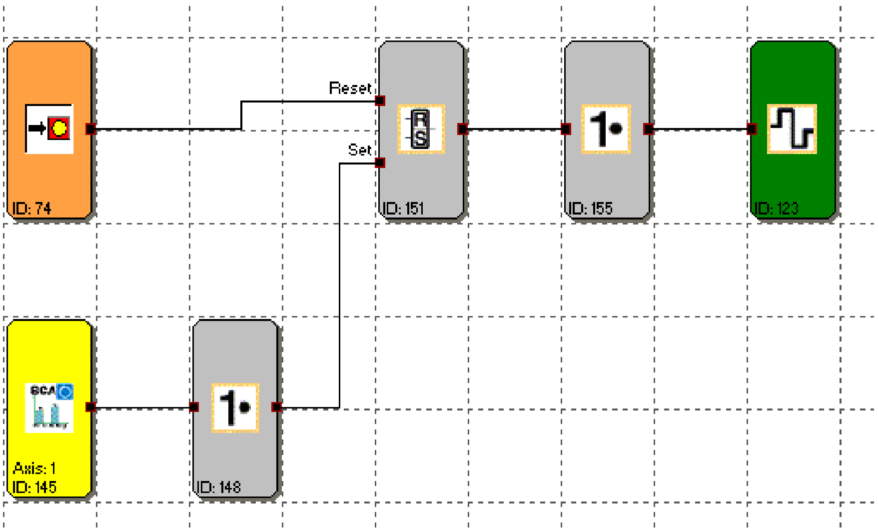
Note

- Error messages of type “Fatal Error” require a restart of the SDC module.
- The alarm reset input can be operated with 24V continuous voltage and is edge triggered.

<u>use as Logic Reset (normally open)</u>

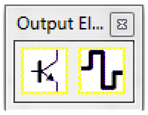
This option makes the reset-acknowledgement functionality in the logic diagram available for further processing. In this case a function element is automatically generated, which can be used for linkage with a logic functionality. This logic reset signal is normally used for the acknowledgement of RS-FlipFlops.

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



Switch type	Comment	Category	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)	--	--

16.10Inserting output elements elements

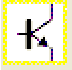


The output elements create the digital connection between one or several connected external switching circuits in the ***SDC module***. Each output element is triggered by a logic input signal “0” or “1” via the logic diagram.

The output elements are added and edited in the “Terminal Diagram” view.

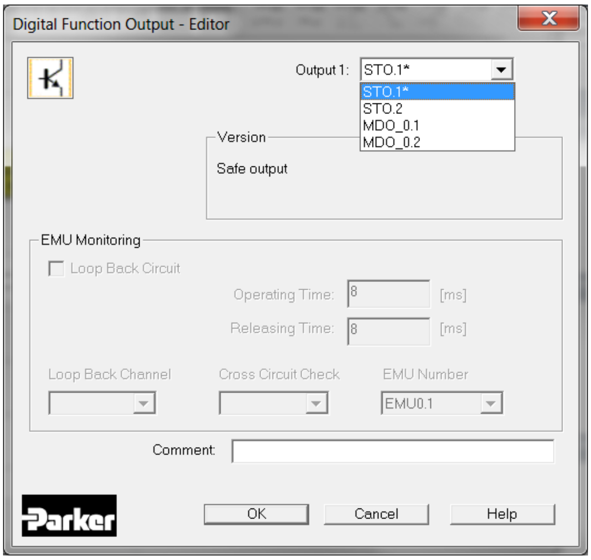
The resource control of the function block elements for the SDC module manages the available elements.

16.10.1 Semi-conductor output

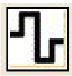


<u>Semi-conductor output with safety function</u>
Semi-conductor outputs with safety function are internally structured with two channels and can be combined with external contact monitoring (EMU).

For exact contact monitoring see chapter EMU-function



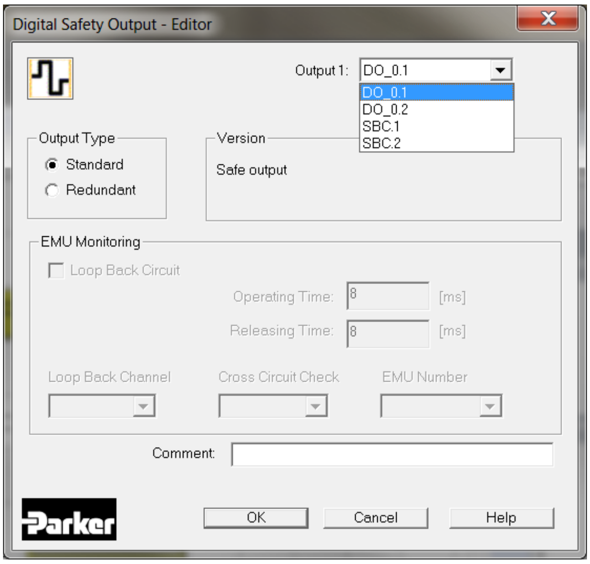
16.10.2 Digital safety outputs



<u>Digital safety output</u>
The semi-conductor outputs can be used grouped as safety outputs (refer to the installation manual for details).
The editor can be used to set the initial assignment.

<u>*Output type*</u>
Single
"HISIDE" (= P-switching) can be selected as standard output. The use of single standard outputs is not suitable for safety outputs.

Redundant
With the option "Redundant" the editor compellingly specifies a combination of "DO_0.1" and "DO_0.2" outputs.



For exact contact monitoring see chapter 'EMU-function'.

16.10.3 EMU Function

EMU The multiplication of contacts and power normally requires additional switching devices, which are triggered through the outPorts of the ***SDC module***. 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 switchgear 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 output is not switched on and open in switched on state. Time related expectations can be parameterized. The same sources as for the inputs 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.

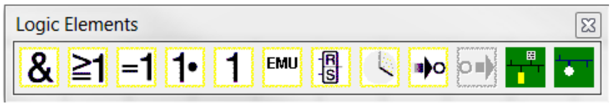
Feedback circuit
Switch to activate EMU monitoring

Feedback channel
Digital input of the feedback circuit. The outputs for activation of the external switching function and the feedback circuit are located on the same ***SM SWafety Module*** (basic module or expansion module).

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

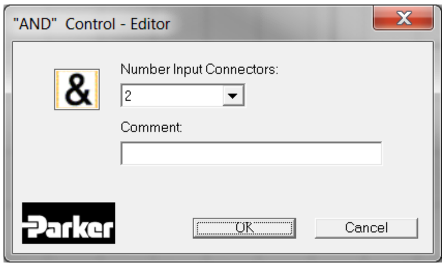
Dropout time
Variable time slot (switch-off delay) for testing the safety contacts
$Min\{T_{EMU}\}$ = 8 ms
$Max\{T_{EMU}\}$ = 3000 ms

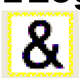
17 The Logic Modules



These modules form the basis for creating a program for the safety application. They enable the logic linkage of the inputs with monitoring functions with and the outputs. Inserting logic modules is only possible in the “logic diagram” (CFC) 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.

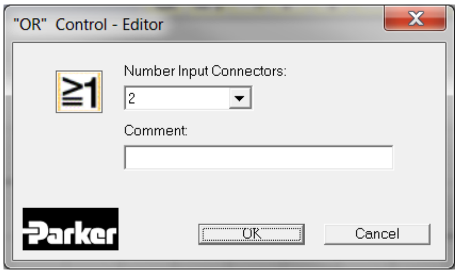
17.1 Logic AND



“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”.

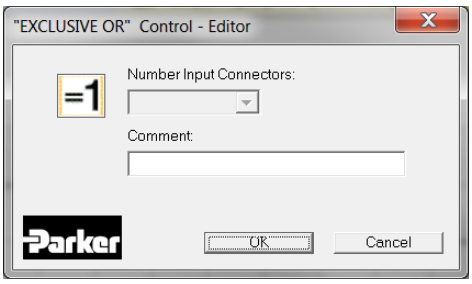
Note: The number of input connectors can only be reduced in case of free connectors. If all connectors have linkages assigned, these must be deleted beforehand.

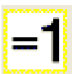
17.2 Logic OR



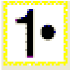
 “OR”-operations of maximum 5 output signals from other function blocks. The OR-operation provides the signal state “1” for at least one input with signal state “1”, otherwise “0”.

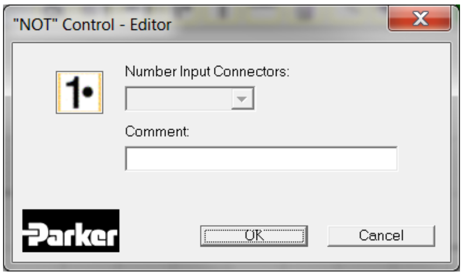
17.3 Logic EXCLUSIV OR



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

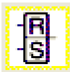
17.4 Logic NOT





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).

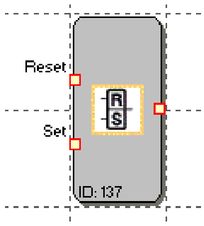
17.5 RS Flip Flop



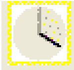
Set / reset contact element. This switching element shows the following characteristics:

- 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” input. The output remains at “1”, even if the state of the “Set” input changes back to “0”.
- The logic result becomes “0”, if an edge change from “0” to “1” takes place at the “Set” input.
- With both inputs 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.



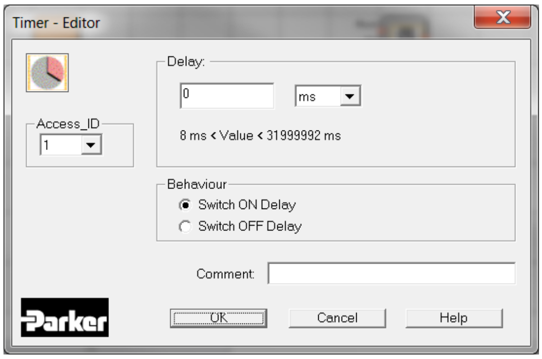
17.6 Timer



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 SDC module cycle time of 8 msec!



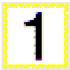
Characteristic
Pickup delayed

Input	Output function
“0”	The output 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 output immediately changes to “0”

Dropout delayed

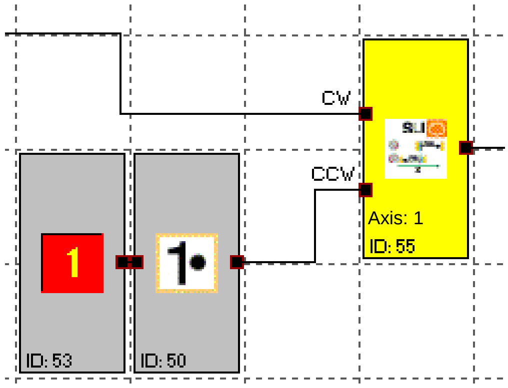
Input	Output function
“0”	The output continuously remains at “0”
Edge “0” to “1”	The output immediately changes to “1”. When the counter has run out the output will change to “0”
Status change “1” to “0”	The output immediately changes to “0”

17.7 Permanently logic "1" block

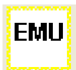


This module constantly provides the value "1". This function can be used to program static states in the logic diagram.

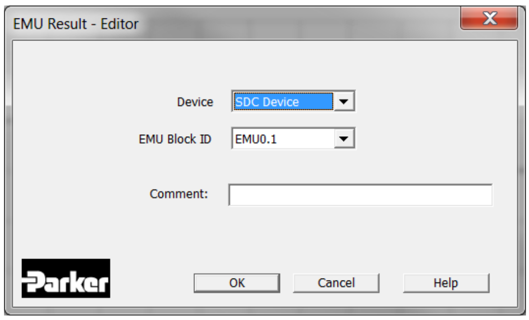
Example: Assignment of an unused input on a direction dependent SDI



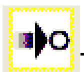
17.8 Result of the EMU module



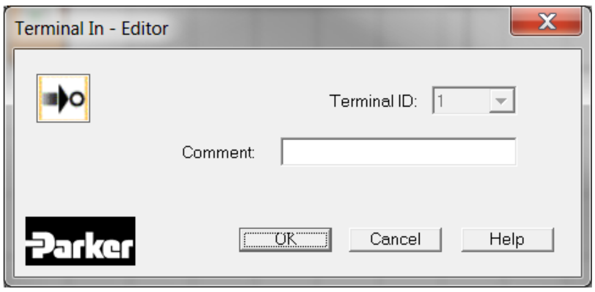
This module delivers the result of the EMU-function that has been parameterized in the output module. Fault-free EMU-function is fed back as status "1".



17.9 Connecting Point input



The "Connecting Point Input" 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 Input" also selects the associated "Connecting Point Output" modules.

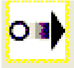


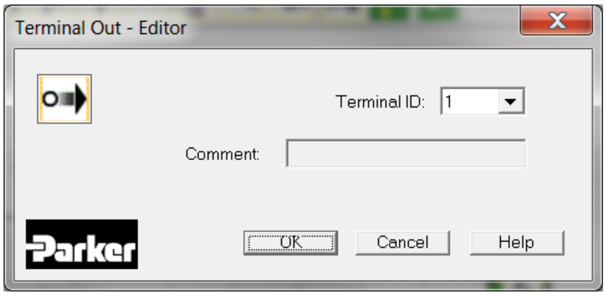
Terminal number: Identification number of the connecting point.

Note: When deleting "Connecting Point Input" elements the dependent "Connecting Point Output" 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.

17.10 Connecting Point Output





This element is the equivalent to the “Connecting Point Input”. Selecting a terminal number sets up a virtual connection to a “Connecting Point Input” function block.

Terminal number: Identification number of the “Connecting Point Input” element

Note: After assignment to a “Connecting Point Input” element, the comment managed by this point is taken over by the “Connecting Point Output” element.

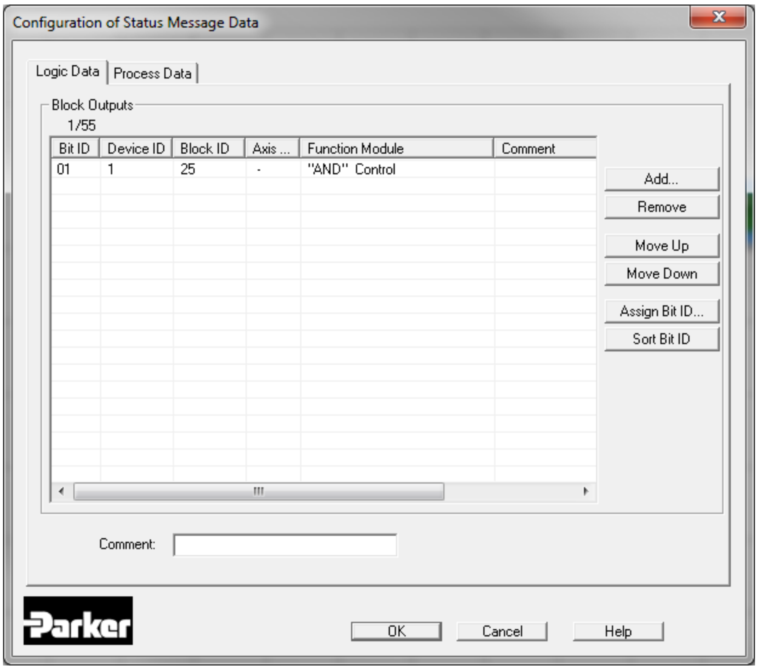
17.11Signal Channel

The signal channel enables the functional transfer of data from the SDC process image to the standard processor of the drive up to the IEC 61131 programming level.' It consists of two parts: The first part consists of 55 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.

17.11.1 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 Device-ID enables reference to various modules
- Module-ID: Number of function block in logic diagram
- Module: Further information about the module
- Symbol address: Designation of the connector
- The numbers under the designation “Block Outputs” indicate: Number of status bits used **/** number of max. possible status bits



Add...

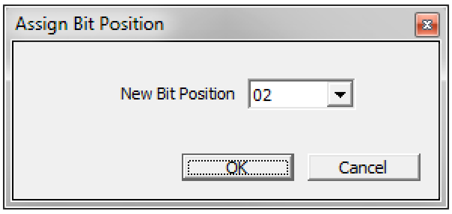
Opens the “Add Status Bit” dialog. The module selected here is added at the end of the reference list.

Delete
Deletes the currently selected line from the reference list. The Bit ID remains unchanged in case of the following entries.

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



Note: The dialog can also be opened by double-clicking on a line in the signal channel list*.*

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

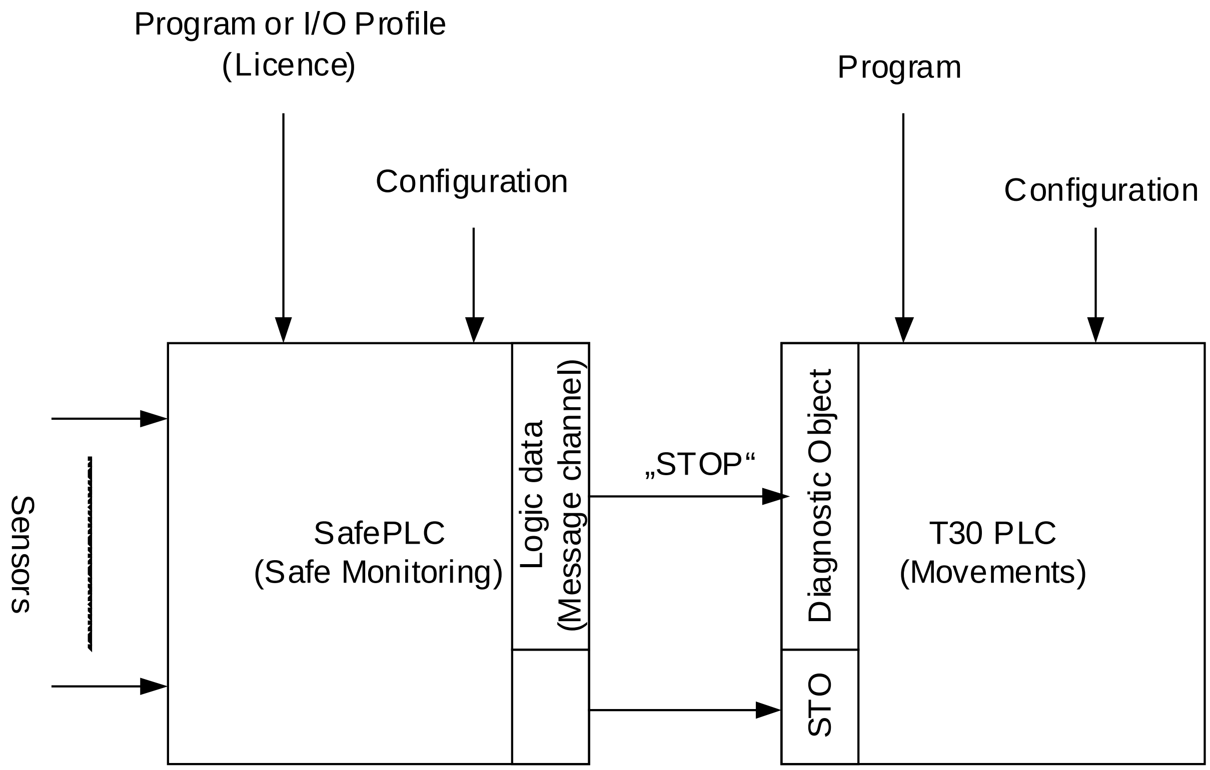
Note: The assignment of status bits can only take place after a successful compiler run, because the addresses calculated by the compiler must be accepted. These are displayed in the “Block Id” column. The entries in this column remain empty or are not updated, as long as the logic diagram has not been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

The following table describes the assignment of logic data in the signal channel to the 4 C3 objects SafetyMonitor Diagnostics bits 0..15, SafetyMonitor Diagnostics bits 16..31, SafetyMonitor Diagnostics bits 32..47 and SafetyMonitor Diagnostics bits 48..55.

Logic conditions Signal channel block	**C3 object**	**Bit**
Bit 1	SafetyMonitor Diagnostics bits 0..15 [814.13]	0
Bit 2	SafetyMonitor Diagnostics bits 0..15 [814.13]	1
Bit 3	SafetyMonitor Diagnostics bits 0..15 [814.13]	2
Bit 4	SafetyMonitor Diagnostics bits 0..15 [814.13]	3
Bit 5	SafetyMonitor Diagnostics bits 0..15 [814.13]	4
Bit 6	SafetyMonitor Diagnostics bits 0..15 [814.13]	5
Bit 7	SafetyMonitor Diagnostics bits 0..15 [814.13]	6
Bit 8	SafetyMonitor Diagnostics bits 0..15 [814.13]	7
Bit 9	SafetyMonitor Diagnostics bits 0..15 [814.13]	8

Logic conditions Signal channel block	C3 object	Bit
Bit 10	SafetyMonitor Diagnostics bits 0..15 [814.13]	9
Bit 11	SafetyMonitor Diagnostics bits 0..15 [814.13]	10
Bit 12	SafetyMonitor Diagnostics bits 0..15 [814.13]	11
Bit 13	SafetyMonitor Diagnostics bits 0..15 [814.13]	12
Bit 14	SafetyMonitor Diagnostics bits 0..15 [814.13]	13
Bit 15	SafetyMonitor Diagnostics bits 0..15 [814.13]	14
Bit 16	SafetyMonitor Diagnostics bits 0..15 [814.13]	15
Bit 17-31	SafetyMonitor Diagnostics bits 16..31 [814.14]	16-30
Bit 33-48	SafetyMonitor Diagnostics bits 32..47 [814.15]	32-47
Bit 49-56	SafetyMonitor Diagnostics bits 48..55 [814.16]	48-55

Consequential actions like accident management or the active movement of the motor axis must be programmed via IEC-program (T30, T40). If a stop has been triggered on the drive, e.g. because of a danger (SLS-threshold exceeded or external emergency stop d3evice was actuated), one must make sure in programming, that this instruction is correctly processed through these 4 objects (see image below).

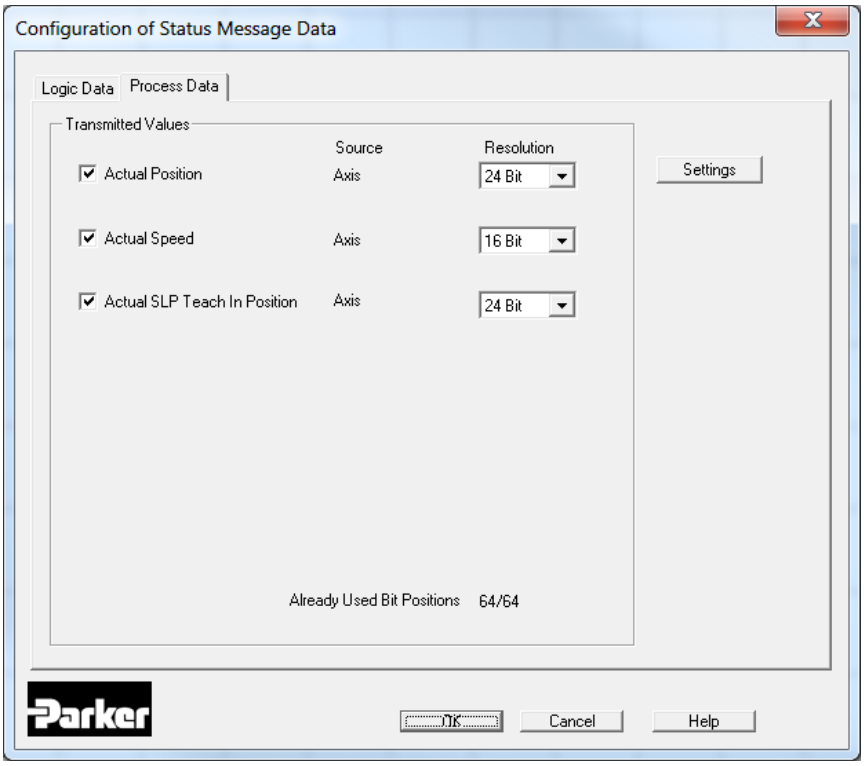


The only exception is the STO shut-down. This is performed independently by the T30 program.

17.11.2 Process data

This part of the signal channel defines process data which are transferred from the SDC module to the standard processor of the drive. Here these are made available in form of an object in the status display of the C3 servo manager, or for the IEC programming.

Even if only a status value is required, a correct transfer of process data requires the activation of all values with their corresponding maximum resolution.



Only after complete activation these are then available as follows:

SafePLC – SDC option S3		C3 IEC - status value		
Current position	24 bit	SDC position	o814.25	U32Bit
Current speed	16 bit	SDC speed	o814.22	U16Bit
Current SLP Teach In position	24 bit	SDC SLP Teach position	o814.26	U32Bit

Note:
- The position/speed is represented with the factor Pos/factor Speed as SDC value. For correct further processing the object values must once again be divided by the corresponding factor. Factors see chapter 20.1.2.
- In case of a fault the process data will not be updated.

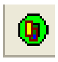
All data apply for O814.2=1280.

18 Function Groups

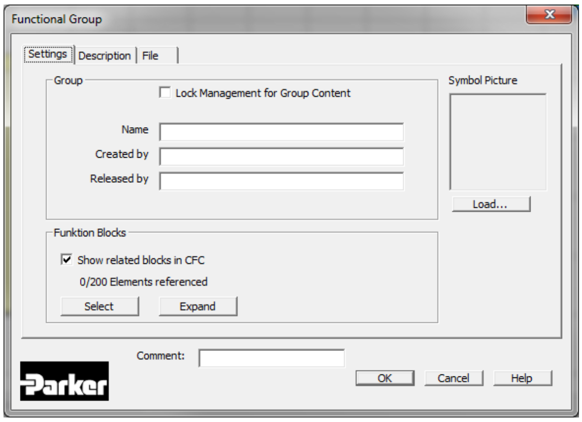
Function groups connect several functional modules to a superordinate logic structure. This matching group of modules is created inside the function group frame and connected via this frame.
This grouping gives the logic diagram a much clearer structure and, with the export / import functionality, enables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

18.1 Creating a function group frame

18.1.1 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 <u>and hold the mouse button depressed</u>.
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.

18.1.2 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.

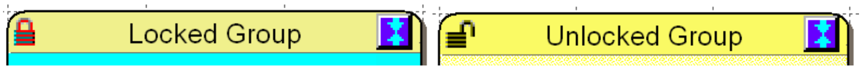
18.1.3 Setting the group management

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:

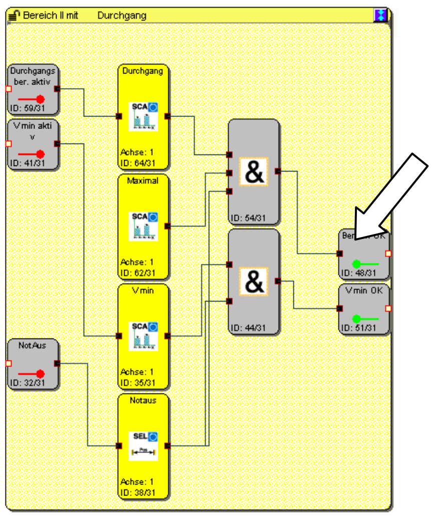
- Modules can no longer be removed from the group, whereby the configuration of parameters is still permitted.
- Deleting a group frame also deletes all group modules.
- No new modules can be added to the group.
- Group members appear “grey shaded”.
- When disabled, the group has a time stamp assigned, 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 “Lock Management for Group Content” 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:

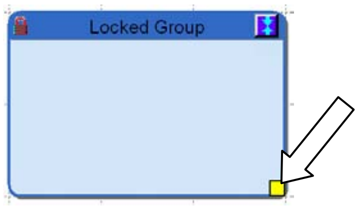
The following block types cannot be contained in a group. These are filtered out when the modules are moved into the frame area:

- Input modules
- Output modules
- All function blocks pre-defined in the logic diagram /e.g. encoders, analog modules, filters)
- Signal channel module
- Terminal blocks

The group is able to accept maximum 200 function blocks.

18.1.4 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. Locked groups can also still be changed in size.



18.1.5 Showing and hiding function 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.

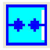
The visibility of the associated function blocks in the logic diagram can also be set in the group dialog using the switch “Show associated modules”.

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 a 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.

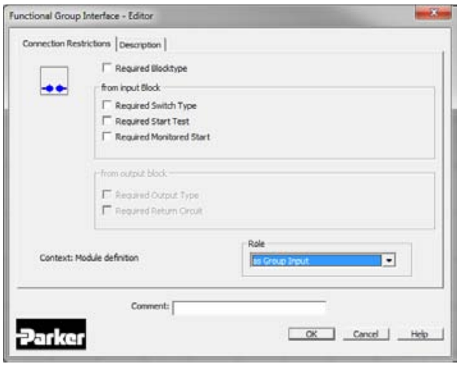
18.2 Creating the group interface

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.

18.2.1 Setting the usage

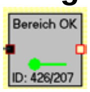
This setting is used to determine the connection properties of the module as input or output.



“as group input”

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 output connector must be wired further inside the group.

“as group output”



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

18.2.2 Restrictions

The dialog “Connection Restrictions” can be used to set switches for group input and group output 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 “Operating Mode Switch”.

Context: Using a module

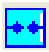
When connecting to an external functional module, the interface module expects the set restriction criteria. If these are not fulfilled a compiler error will occur and the program cannot be compiled.

18.3 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 “Included in Functional 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.

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.

18.3.1 Step: Adding function 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 taken in 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. Input and output modules, pre-defined elements such as signal lists, analogue modules or encoder modules are not permitted.
- Existing connections inside the functional modules are deleted upon transition into the group element

18.3.2 Step: Create connections
18.3.3 Step: Connect group interface
18.3.4 Step: Set connection restrictions

18.3.5 Test function group
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.

18.3.6 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.

18.4 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 a editing aid, but does not relieve the user from the necessity of validating the group elements used in the application.

The switch “Lock Permanent” 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 “Lock Management for Group Content” is permanently hidden.
It is highly recommended to make a backup copy of the still enabled function group. After the option “Lock Permanent” has been set, the structure of the function group can no longer be changed!

18.5 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.

19 The Safety Functions

The safety functions are an essential functionality of theSDC module. 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
- reset function

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	Quantity Modules
SLS - Safe Limited Speed	8
SOS - Safe Operating Stop	1
SDI = Safe Direction Indication	1
SSX = Safe Stop	4
SLI = Safe Limited Increment	1
SCA = Safe Cam	16
SEL = Safe Emergency Limit	1
SLP = Safe Limited Position	2
ECS – Encoder Supervisor	1
EMU – Emergency Monitoring Unit	2

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

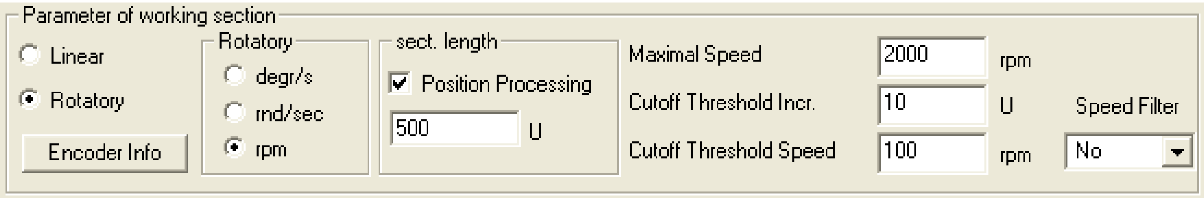
20 Position and Speed Sensors

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. Transmission ratios due to gears or similar system components must be accounted for.

20.1 Parameterization of the measuring section:



The following options and inputs are possible in the field "Parameter of working 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/s" or in "m/s".

Rotational: The measuring section has a rotational characteristic, i.e. the movement is a rotation. The position is processed in "U" (Rounds), the speed in "degr/s", "rnd/sec" or in "rpm".

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 also stay inside the limits of the adjusted measuring length. Each actual position outside the defined measuring length causes an alarm of the SDC modules.

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 SDC module will change into alarm state and switch off all outputs.
This means, that the “Maximal 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 “Cutoff Threshold Speed”. 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 too high for the reliability of the sensors amongst each other. The “Encoder Info” 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.

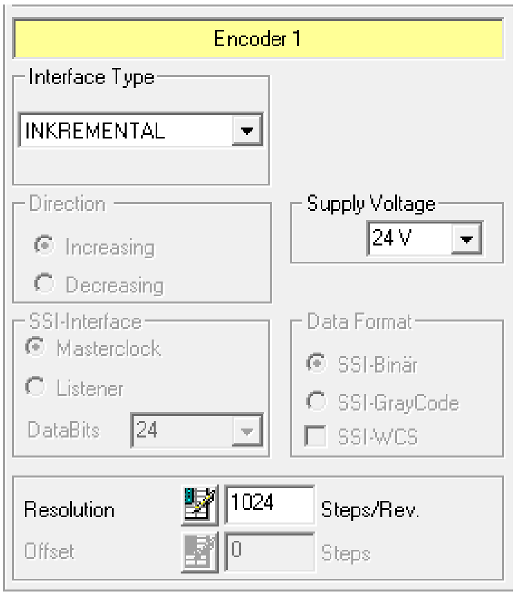
Note:

- 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 Grad, rev or degr/s, rnd/sec or rpm 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 Sensor1 has the function of a process sensor and Sensor2 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.
- Only positive numerical values are processed for position monitoring. The parameterization of the measuring distance to be monitored must be designed accordingly.
- During the initial, coarse commissioning, one should not select the max. measuring length and the max. speed too low. Otherwise ony may be confronted with unnecessary alarm messages, which could cause a shut-down of the drive.

20.1.1 Sensor 1 or Sensor 2

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

The following options and inputs are possible:



20.1.1.1 Interface Type

Selection of function type of sensor:

20.1.1.1.1 None
No sensor connected.

20.1.1.1.2 Incremental
Incremental sensor (TTL-sensor)

20.1.1.1.3 SIN / COS
Sine/Cosine sensor

20.1.1.1.4 Absolute
Absolute value encoder (only SSI Listener Interface permitted!)

Selecting an absolute value encoder enables further parameters:

Data format

20.1.1.1.4.1 SSI binary

Serial **S**ynchronous **I**nterface in binary encoding

20.1.1.1.4.2 SSI-Gray-Code

Serial **S**ynchronous **I**nterface in GrayCode encoding.

20.1.1.1.5 Proxi Switch 1Z
1-channel incremental counting signal via digital input E0.5

20.1.1.2 Direction of rotation
Selection of sensor counting direction

20.1.1.3 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 “Absolut” type, the position input fields in all other input masks of the monitoring function are inactive.

With the “Incremental” type a pulse 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.

20.1.2 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 “Encoder Info”.

20.1.2.1 Axis 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
FactorPos	Internal multiplication factor for position
FactorSpeed	Internal multiplication factor for speed
MaxSpeed	Maximum standardized speed
Shut.down threshold Pos	Shut-down threshold value incremental in system units
Shut.down threshold Speed	Shut-down threshold value speed in system units
Unit	Reserved for internal processing

20.1.2.2 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 the SDC module
V_max	Maximum value for speed in the monitoring dialogs. Defined via “Maximum 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 in the monitoring dialogs

Note:
The displayed values assist the Technical Support in the encoder configuration and are used for the standardization calculation in the SDC module!

20.1.3 Integrated SinCos encoder combinations

Parker Hannifin offers synchronous motors with integrated SINCOS encoders type SRS50S, SRM50S, SKS36S or SKM36S from the company Sick-Stegmann. These are ,most suitable for safety applications up to PL d, Cat. 3 without a second encoder.
The installation of a corresponding encoder can be recognized via the motor ordering key or the motor type designation **Sx**.

S1 = Encoder Stegmann SRS50S, SINCOS Hiperface Singleturn, resolution 1024 increments per revolution.
S2 = Encoder Stegmann SRM50S, SINCOS Hiperface Multiturn 4096 revs., resolution 1024 increments per revolution.
S3 = Encoder Stegmann SKS36S, SINCOS Hiperface Singleturn, resolution 128 increments per revolution.
S4 = Encoder Stegmann SKM36S, SINCOS Hiperface Multiturn 4096 revs., resolution 128 increments per revolution.

The following table shows the possible combinations.

SMx motor types	Encoder **S1**	Encoder **S2**	Encoder **S3**	Encoder **S4**
SM_60….	X	X	X	X
SM_82….	X	X	-	-
SM_100….	X	X	-	-
SM_115….	X	X	-	-
SM_142….	X	X	-	-

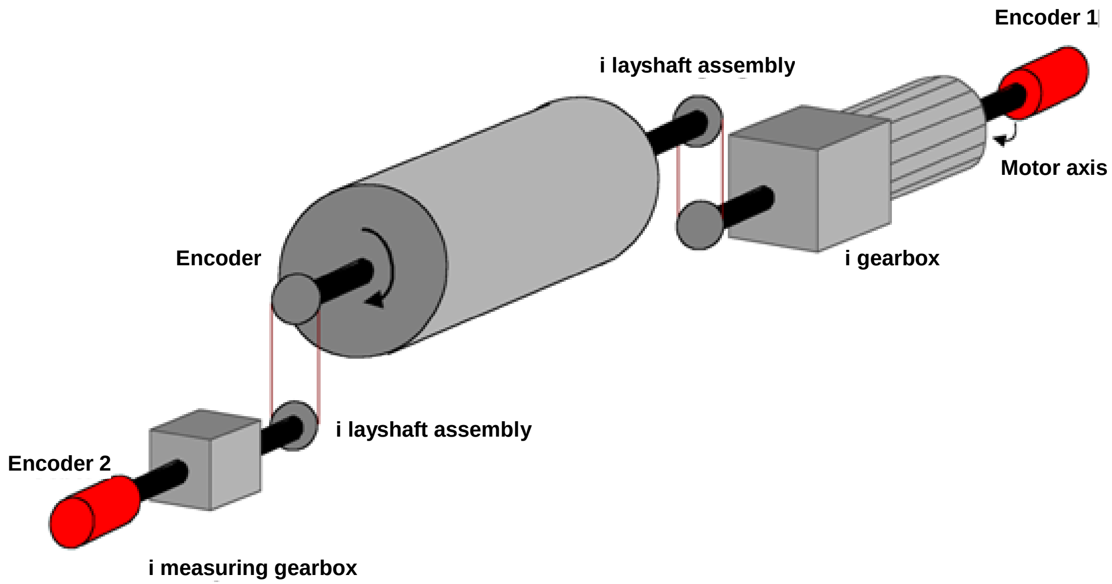
Motor order code regarding encoders	Sincos type	Resolution	MTTFd	Dcavg	PFHd
S1	SRS50S-HGV0-K21	1024	100 (1073)	90%	1.00E-08
S2	SRM50S-HGA0-K21	1024	100 (1073)	90%	1.00E-08
S3	SKS36S-HFA0-K02	128	100	90%	1.30E-08
S4	SKM36S-HFA0-K02	128	100	90%	1.30E-08

When using this encoder one must make sure that only F11 must be used as Compax3 drive type. During the encoder configuration in SafePlcGRP, the supply voltage must then be configured to 10V.
When using other encoders for single-encoder applications, the encoder manufacturer must check whether the encoder complies with the latest requirements concerning safety applications. Attention: Single-encoder applications are only permitted for synchronous motors.

With the Compax3 type F12 one must make sure that the encoder voltage supply monitoring is always wired through the sense lines Pin1 and Pin 2 on the feedback interface X13. In SafePlcGRP a supply voltage of 5V must be configured for this encoder.
Only a RS422 incremental encoder or a RS422 absolute value encoder is permitted as second or redundant encoder on X11. Only encoders that can be supplied with 24V are permitted as second encoders. In SafePlcGRP a supply voltage of 24V must be configured for these encoders.

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

20.2.1 Rotational measuring length



Reference axis	***Input values***		***Resolution related to measuring length***
Feed axis (process axis)	Encoder 2: Resolution Gb 2 i measuring gearbox i layshaft assembly	 A_Gb2 in [steps/rev] I_MG I_VG	$Gb2 = I\_MG \cdot I\_VG \cdot A\_Gb2$
	Encoder 1: Resolution Gb 1 i gearbox i layshaft assembly for drive	 A_Gb1 in [steps/rev] I_G I_VA	$Gb1 = I\_G \cdot I\_VA \cdot A\_Gb1$
Motor axis	Encoder 2: Resolution Gb 2 i measuring gearbox i layshaft assembly ∅ Measuring wheel i gearbox i layshaft assembly	 A_Gb2 in [steps/rev] I_MG I_VG D_MR in [mm] I_G I_VA	$Gb2 = \frac{I\_MG \cdot I\_VG \cdot A\_Gb2}{I\_G \cdot I\_VA}$

20.2.2 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.

20.2.2.1 Selecting the encoder type

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

20.2.2.2 Determination of parameters 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

20.2.2.3 Determination of parameters for Sensor1

The existing motor feedback system is used as sensor 1. 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 outputs of the power converter. The sensor data are as follows: Hiperface, 1024 I/rev. According to the data sheet of the power converter manufacturer the sine/cosine tracks of the Hiperface encoder are output in the form of pulses -> emulated encoder on the pulse output 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 1	1024 [steps/rev]
i gearbox	350
i layshaft assembly for drive	1

$$Gb2 = I\_G \cdot I\_VA \cdot A\_Gb2 = 1024 \cdot 350 \cdot 1 = 358400$$

20.2.2.4 Determination of parameters for Sensor2

Sensor 2 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 2:	
Resolution Gb 2	5000 [steps/rev]
i measuring gearbox	1
i layshaft assembly	1

$$Gb1 = I\_MG \cdot I\_VG \cdot A\_Gb1 = 1 \cdot 1 \cdot 5000 = 5000;$$

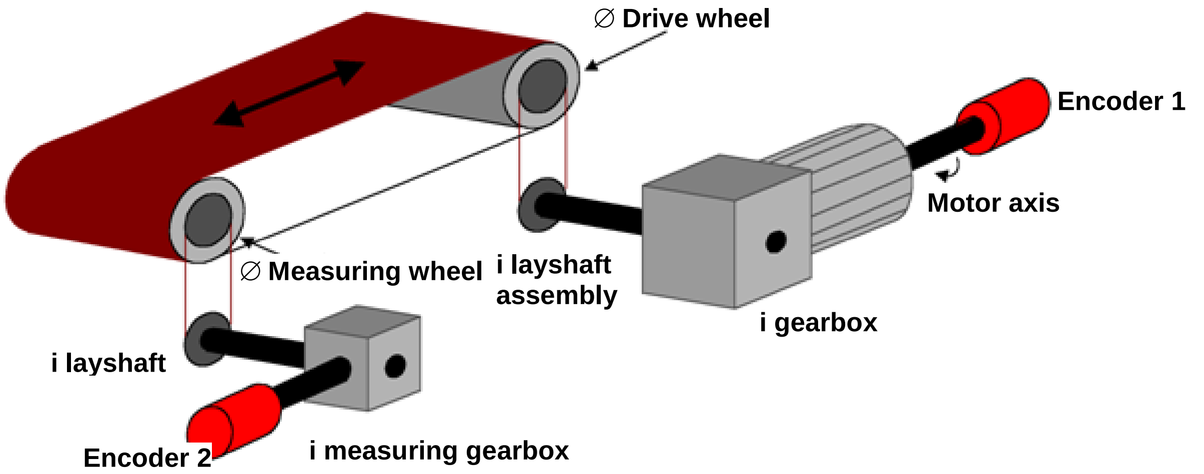
20.2.2.5 Specification of max. speed

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]) / 350 = 0.07142
Converted to mgrd/s this results in 0.07142 [1/s] * 360 *10^3 [mgrd] = 25 714 [mgrd/s]

20.2.2.6 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.

20.2.3 Linear measuring length



Reference axis	***Input values***		***Resolution related to measuring length***
Feed axis (process axis)	Sensor2: Resolution Gb 2 i measuring gearbox i layshaft assembly ∅ Measuring wheel	A_Gb2 in [steps/rev] I_MG I_VG D_MR in [mm]	$Gb2 = \frac{1000}{D\_MR \cdot \pi} \cdot I\_MG \cdot I\_VG \cdot A\_Gb2$
	Sensor 1: Resolution Gb 1 i gearbox i layshaft assembly for drive ∅ Drive wheel	A_Gb1 in [steps/rev] I_G, I_VA, D_AR in [mm]	$Gb1 = \frac{1000}{D\_AR \cdot \pi} \cdot I\_G \cdot I\_VA \cdot A\_Gb1$
Motor axis	Sensor 2: Resolution Gb 2 i measuring gearbox i layshaft assembly ∅ Measuring wheel i gearbox i layshaft assembly for drive ∅ Drive wheel	A_Gb2 in [steps/rev] I_MG I_VG D_MR in [mm] I_G I_VA D_AR in [mm]	$Gb2 = \frac{\frac{1000}{D\_MR \cdot \pi} \cdot I\_MG \cdot I\_VG \cdot A\_Gb2}{\frac{1000}{D\_AR \cdot \pi} \cdot I\_G \cdot I\_VA}$

20.2.4 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 one intermediate gear. The output shaft of the intermediate gear is connected with a drive gear ∅ 31.83 mm (= 100 mm circumference).

20.2.4.1 Selecting the encoder type

Monitoring of positions is requested -> Absolute encoder required, for the 1. encoder an incremental detection + reference switch is sufficient.

20.2.4.2 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

20.2.4.3 Determination of parameters for sensor 2

Sensor 2 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 2:	
Resolution Gb 2	4096 [steps/rev]
i measuring gearbox	1
i layshaft assembly	1
∅ Drive wheel	31.83

$$Gb1 = \frac{1000}{D\_MR \cdot \pi} \cdot I\_MG \cdot I\_VG \cdot A\_Gb1 = \frac{1000}{31{,}83 \cdot \pi} \cdot 1 \cdot 1 \cdot 4096 = 40960$$

20.2.4.4 Determination of parameters for sensor 1

The existing motor feedback system is used as sensor 1. The motor is connected with the drive gear via an intermediate gearbox. The ratio of the gearbox is 4.51 times the ∅ of the drive gear 31.831 mm.

The sensor interface is connected to the pulse outputs of the power converter. The sensor data are as follows: Hiperface, 1024 I/rev. According to the data sheet of the power converter manufacturer the sine/cosine tracks of the Hiperface encoder are output in the form of pulses -> emulated encoder on the pulse output 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 1	1024 [steps/rev]
i gearbox	4.51
i layshaft assembly	1
∅ Drive wheel	31.83

$$Gb2 = \frac{1000}{D\_AR \cdot \pi} \cdot I\_G \cdot I\_AV \cdot A\_Gb2 = \frac{1000}{31{,}83 \cdot \pi} \cdot 4{,}51 \cdot 1 \cdot 1024 = 46182;$$

20.2.4.5 Specification of max. speed

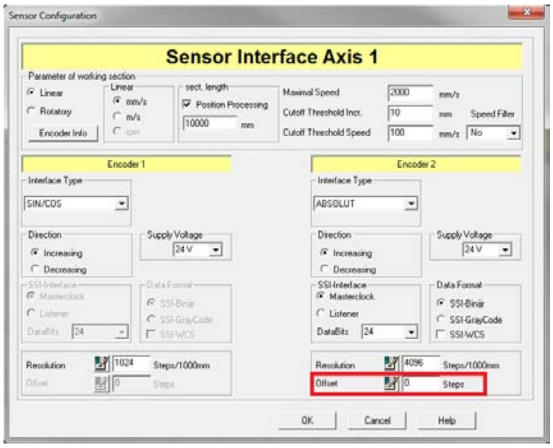
The max. speed of the output axis is derived from the max. motor speed. In rev./s related to the load axis and with Nmax the speed is = 1500 rev./min;

- ➔ 1500 [rev/min] = 25 [rev/s]
- ➔ After gear ratio: 25 [rev/min] / 4.51 = 5.54 [rev/s]
- ➔ Circumference of drive wheel: 5.54 [rev/s] * (0.1[m] / [rev]) = 0.554 [m/s] = 554 [mm/s]

20.2.4.6 Input of max. deviation

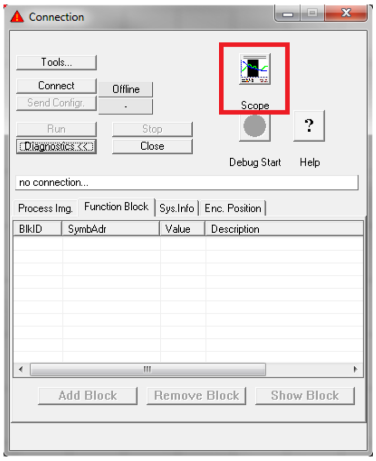
The empirical measurement reveals a maximum difference of <1 mm between both sensing points on motor axis and movement axis. The value chosen is 1 mm.

20.3 Offset compensation for position monitoring

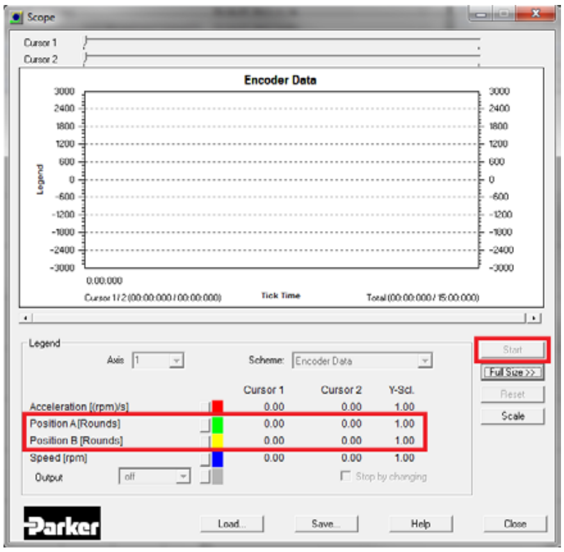


The “Offset” window gives the user the chance to make an offset correction between the actual detection system of the motor control and the safety relevant position detection (SDC). The following procedure is thereby recommended.

1. In the first step the offset in the encoder configuration must be set to 0.



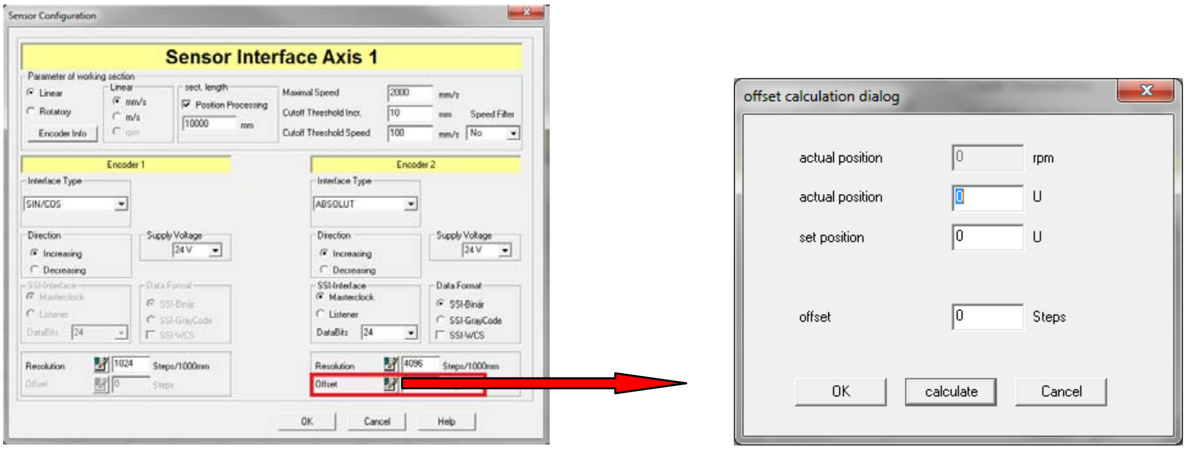
2. After downloading the configuration via the connection dialog, the actual value of the position can be represented in the scope separately for the two encoders.



3. Position A represents the actual value of the feedback encoder on X13. Position AB represents the actual value of the absolute value encoder on X11. If the position A is unequal the actual detection system of the motor control, the axle must be moved, until 0 revolutions is displayed at position A. This can e.g. be performed with the help of the commissioning window in the C3 servo manager. It is recommended to determine this zero point also via the C3 servo manager as C3 machine zero.

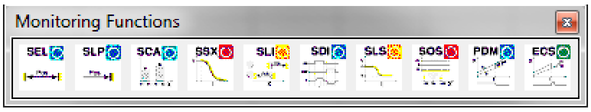
4. After this the offset calculation for position B must be requested by using the button in the encoder configuration (see red field below).

The following wizard will pop up.



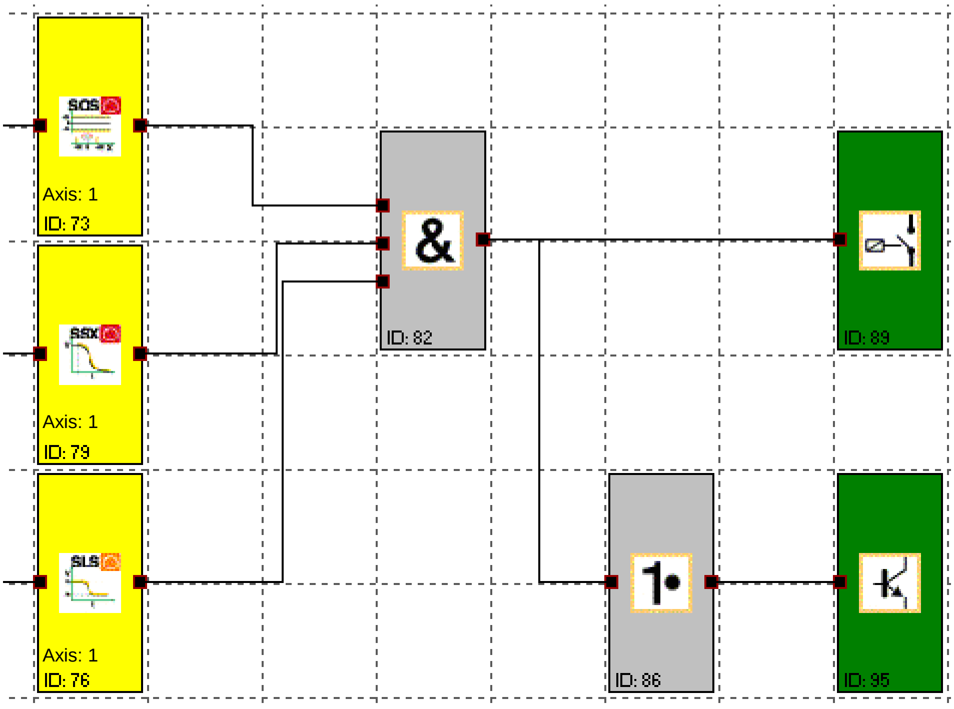
The scope value of position B must be entered into the field “actual position”.
In the field of the target position is entered in the "physical" value. Then you must click on the button “Calculate”. By confirming the dialog with "OK", the calculated value is used as an offset. Now the configuration only needs to be compiled and downloaded again. In scope now must be the desired position value at position B.

21 Safety Modules



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

Example for a logic linkage of monitoring functions:



21.1 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!

Input: Standardized position signal X from the encoder interface

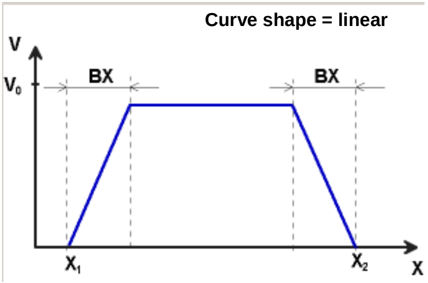
RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:
- RESET function in the group of input elements

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

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:
(Trapezoidal shape)



BX = Braking/approaching range
X_1 = Min. position
X_2 = Max. position
V_0 = Maximum speed for $(X_1 + BX) < X < (X_2 – BX)$

S-shaped speed profile
(S-shape)

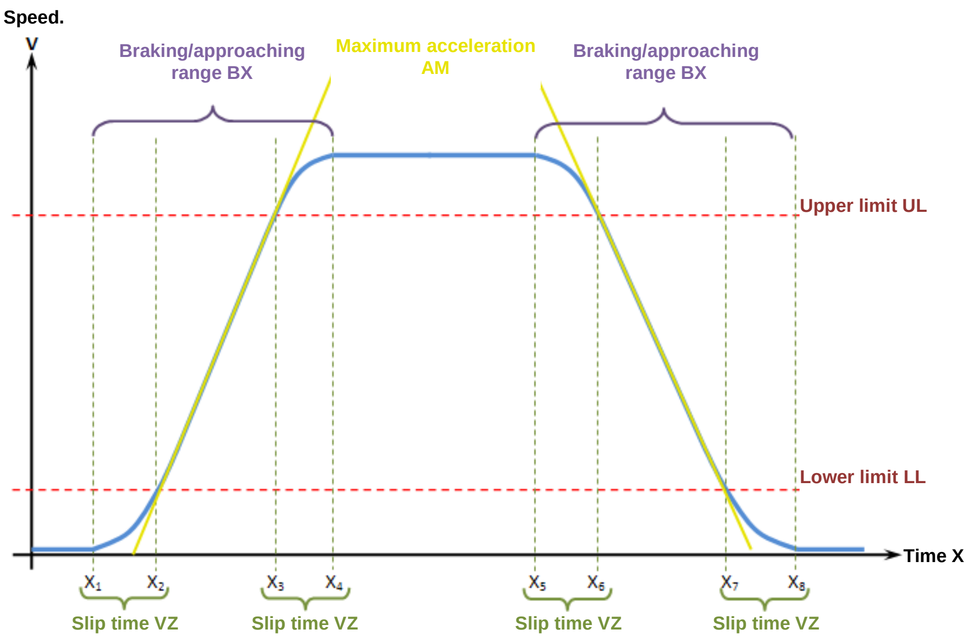


Image S-slip time

The S-shaped speed profile shows the changes to or the course of speed over time.

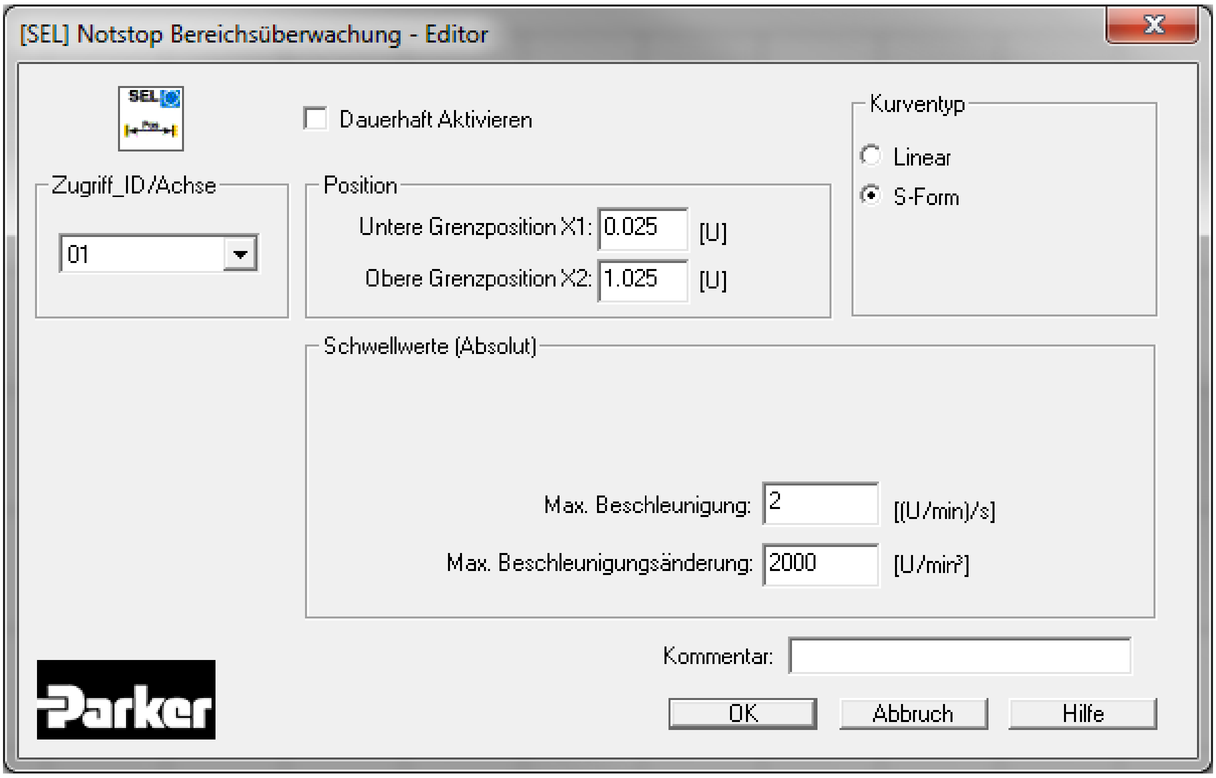
The slip time VZ designates the period of time in which the speed changes in a non-linear fashion, or the time period for changing the acceleration from a=0 to $a=a_{max}$ or vice-versa.

Maximum acceleration AM:
Maximum value of acceleration after the slip time has expired

Output 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 input 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

Maximum acceleration AM
Max. acceleration value within BX

Slip time VZ
The slip time VZ designates the period of time in which the speed changes in a non-linear fashion, or the time period for changing the acceleration from a=0 to $a=a_{max}$ or vice-versa.

21.1.1 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/s^2
Maximum change of acceleration = 3000 mm/s^3

21.2 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

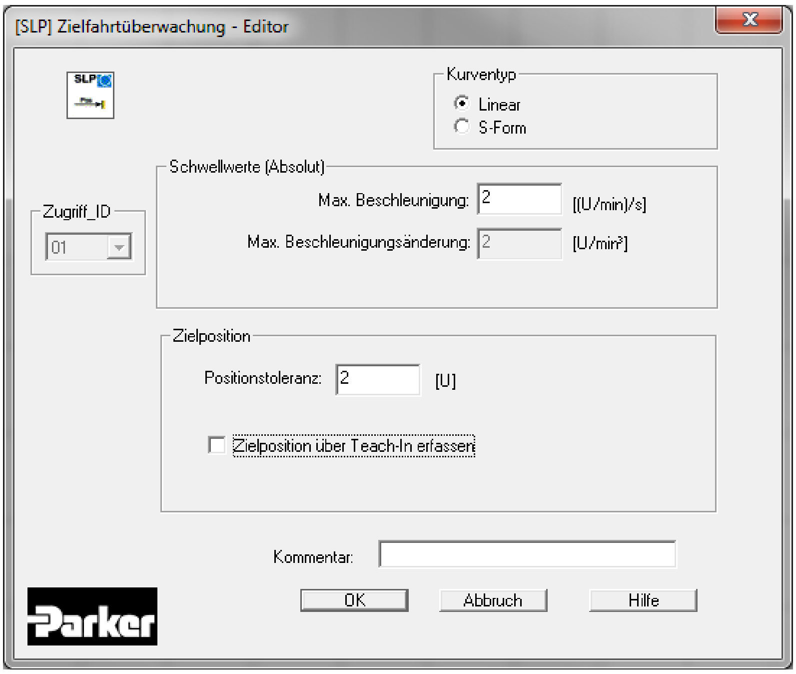
Input: Standardized position signal X from the encoder interface

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 input elements

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.

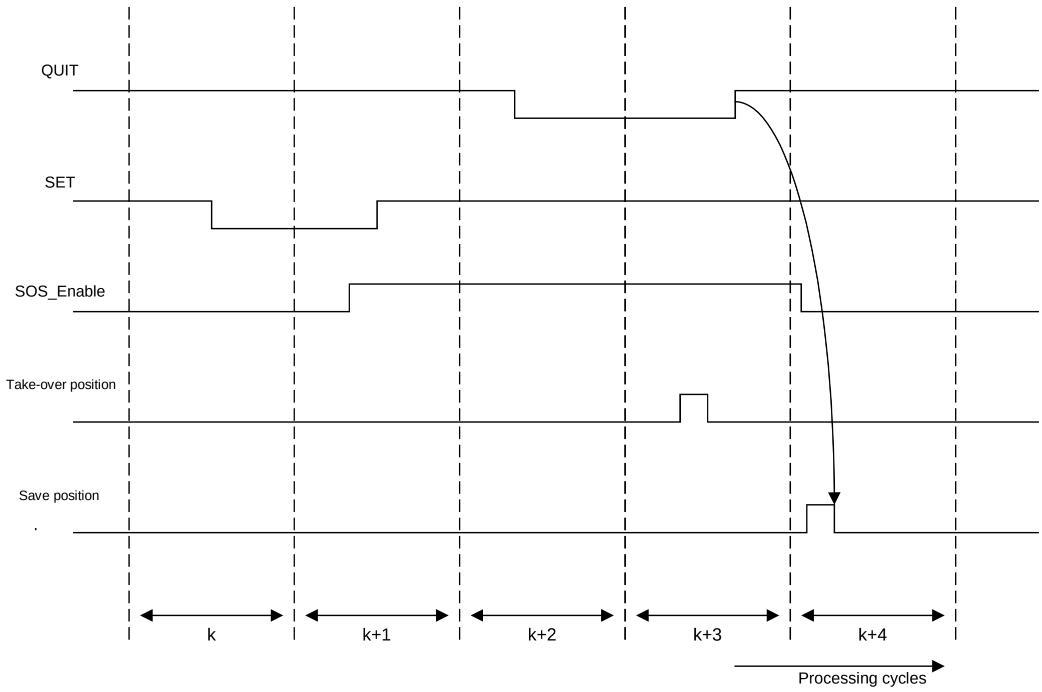
Max. acceleration
Max. acceleration value within BX

Max. acceleration change
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 SDC module 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 input connector of the functional module.
- The QUIT signal can only be directly connected with an input module

Time characteristic of the SET/QUIT process:



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

The max. time window 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

21.3 SCA (Safe Cam)

Monitoring of position range with rotational speed/speed monitoring

Number: 16

Access-ID: Identification of function element

Axis allocation: any

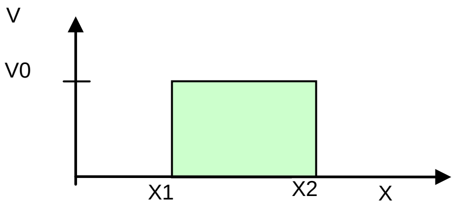
Function: Monitoring of a parameterizable position range with allocated minimum and maximum limits. Additional monitoring of the maximum rotational speed/speed in the permissible range.

Input: 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:

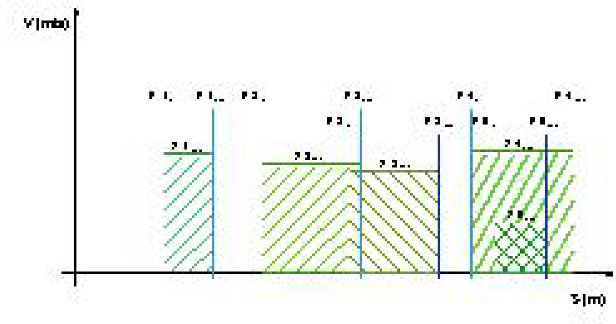
- Comparison of actual position with the parameterized range limits
- Comparison of actual speed with the parameterized range limit
- Comparison of actual acceleration with the parameterized range limit
- Monitoring of the position limits using a ramp function
- Direction dependent release
- Permanent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



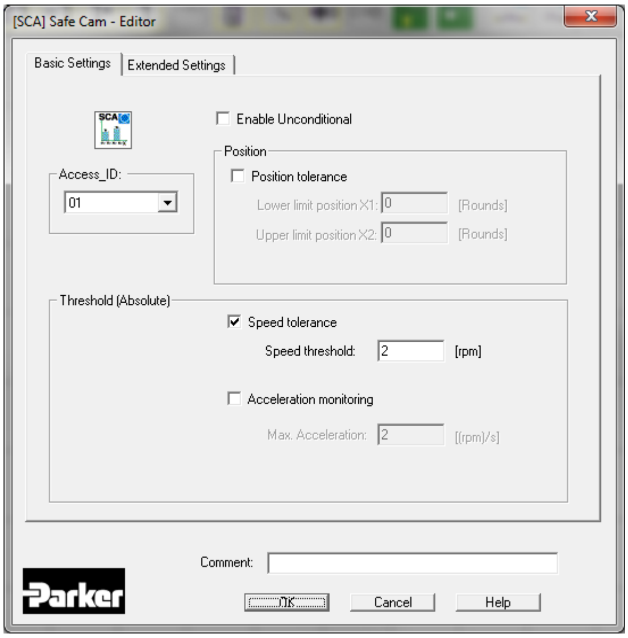
Output function:

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

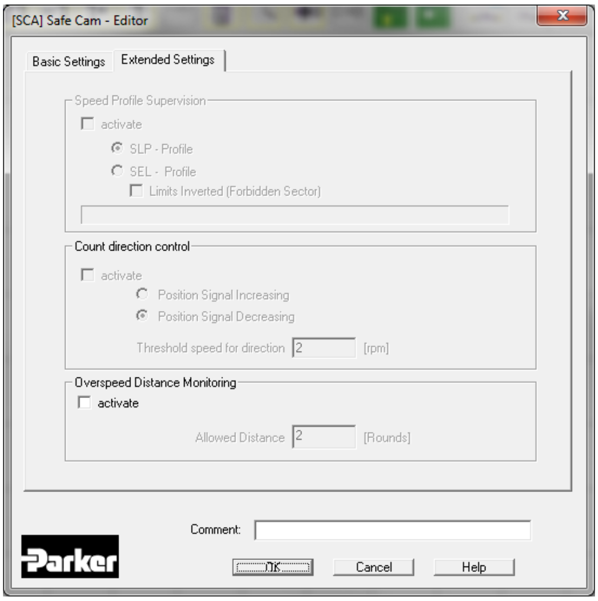
Lower limit position X1
Lower limit position

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. Release of direction
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 with SEL and SLP. This switch can only be activated with 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!

21.3.1 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.

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 = 0 mm
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

21.4 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

Input: Standardized position signal X from the encoder interface

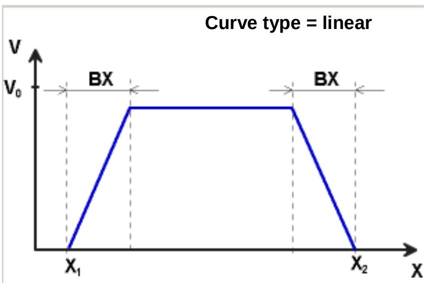
RESET-function: The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:

- RESET function in the group of input elements

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.

Linear curve type



BX = Braking/approaching range
X_1 / X_2 = Time for a ramp function sequence

V_0 = Start speed of the ramp fuinction

S-shaped speed profile (S-shape)

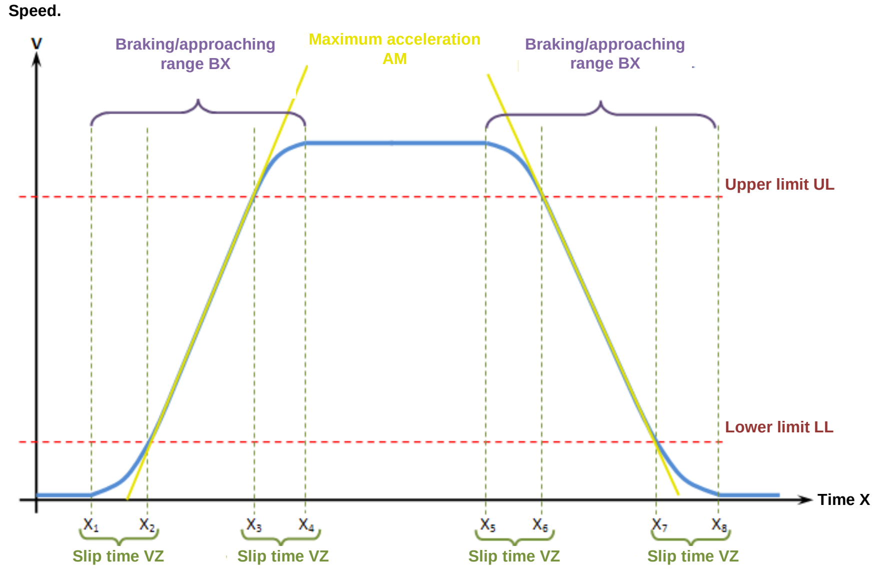


Image S-slip time

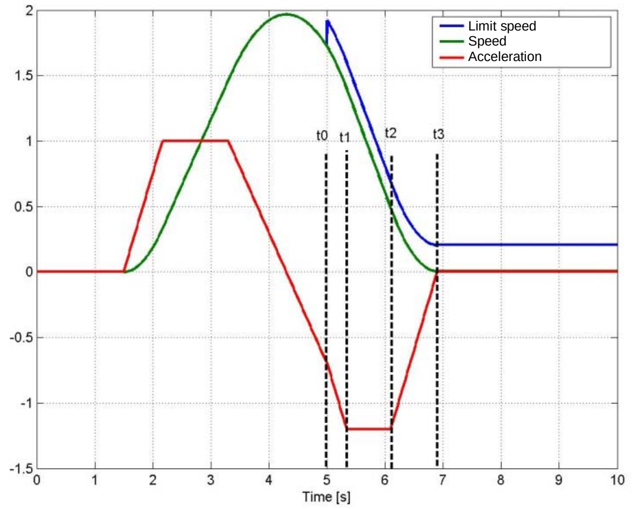
The S-shaped speed profile shows the changes to or the course of speed over time.

Maximum acceleration AM

Max. acceleration value within BX

Slip time VZ

The slip time VZ designates the period of time in which the speed changes in a non-linear fashion, or the time period for changing the acceleration from a=0 to $a=a_{max}$ or vice-versa



Monitoring limit curves with S-shaped course of speed

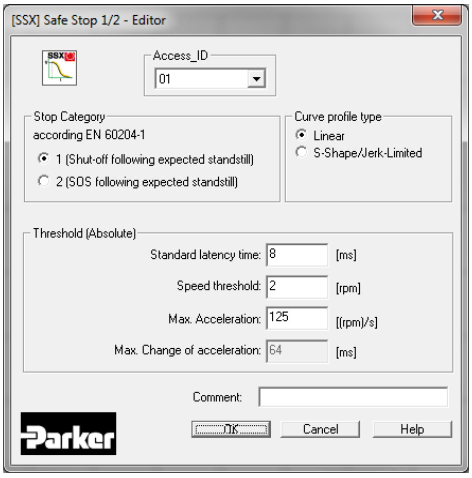
Output function

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 behaviour:
The violation of the permissible monitoring range is saved and requires a RESET functionality. This alternatively takes place via the "Alarm Reset" module.

Parameters:

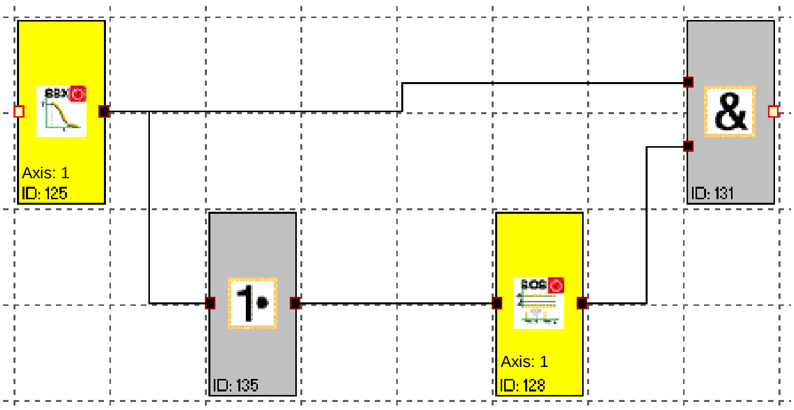


Stop category 1
This option realizes monitoring of the controlled EMERGENCY STOP acc. to EN 60204. According to the normative definition the energy supply should here be disconnected after the drive has come to a halt. This is supported by a transition of the SSX-function output value from "1" to "0".

Stop category 2 (SOS after expected standstill)
This option realizes monitoring of the controlled EMERGENCY STOP acc. to EN 60204. After the ramp monitoring has expired, the drive is to be stopped without disconnection from the energy supply (Safe Operational Stop = Standstill). For this reason the output value remains art "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.

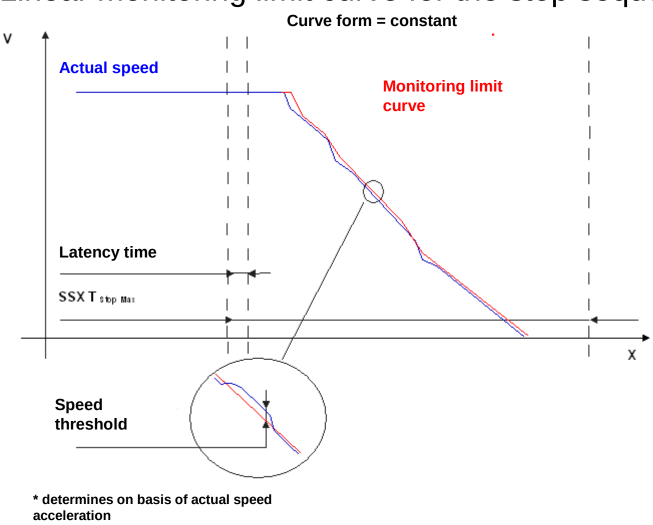
Note:
If the SSX-function is used in connection with SOS, the following circuitry must be used. If standstill is detected, the operating system will **automatically** activate the SOS-monitoring.



With the “Terminal In / Out” modules  it is possible to use the SOS activation or the SOS result also at other points in the logic diagram.

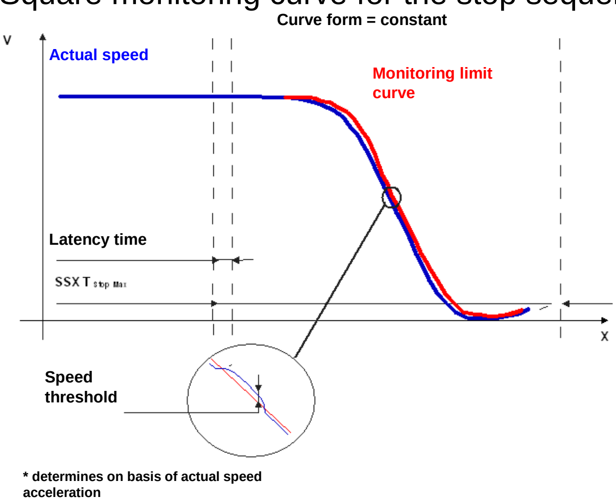
Curve type linear

Linear monitoring limit curve for the stop sequence



Curve type S-shaped

Square monitoring curve for the stop sequence



Standard latency time
Latency time 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.

21.4.1 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 60204-1 (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 (Jerk 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 time = 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

21.5 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

Input: 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 input elements

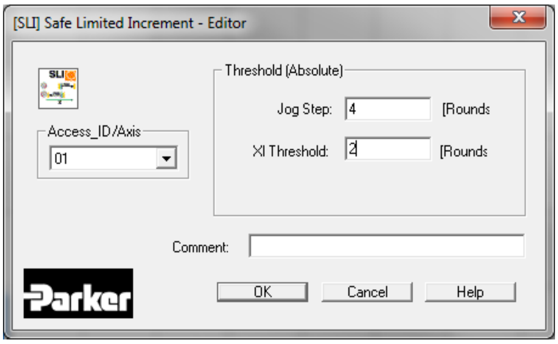
Description of function:

- 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

Output function:

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

<u>Parameters:</u>

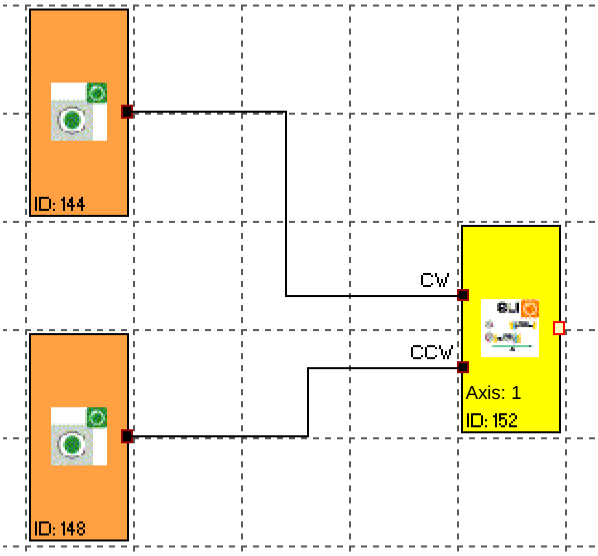


Step measurement
Maximum relative travel after activating the monitoring function

XI threshold
Tolerance threshold for monitoring the travel in opposite direction

Axis assignment
Input of axis assignment.

21.5.1 Activation example:



21.5.2 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

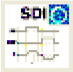
Tolerable travel in opposite direction (= creeping motion of drive) = 1 mm

3. Monitoring input

The monitoring module has two inputs to specify the direction. An active direction signal activates the monitoring function.

<u>Note:</u>
Both input signals “1” are detected as non-permitted condition, causing an alarm message.

21.6 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

Input: 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:

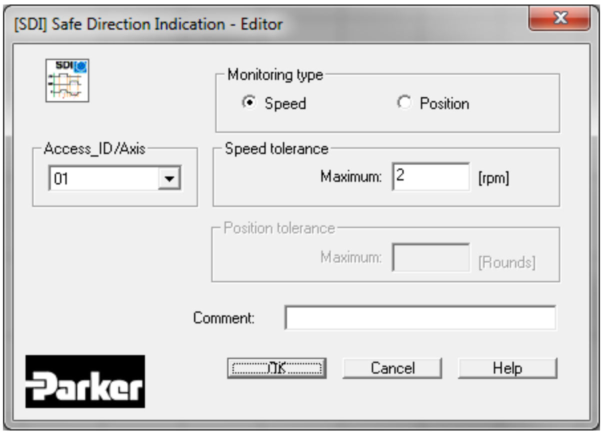
- RESET function in the group of input elements

Description of function:

Output 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

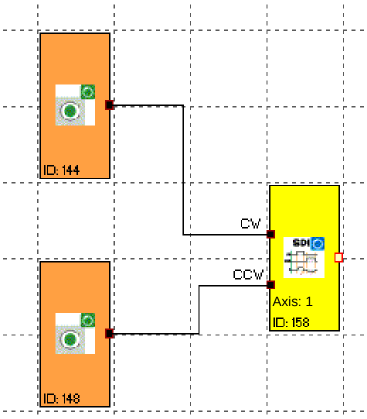
Parameters:



Maximum
Tolerance threshold for position or speed in opposite direction

Axis assignment
Input of axis assignment.

21.6.1 Activation example:



21.6.2 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. Input 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 input

The monitoring module has two inputs 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.

21.7 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

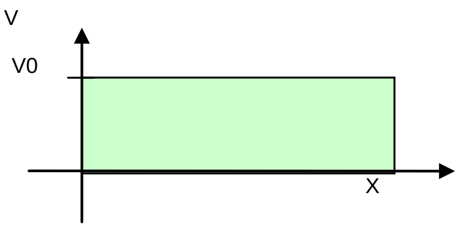
Input: Standardized position signal X from the encoder interface

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 input elements

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.

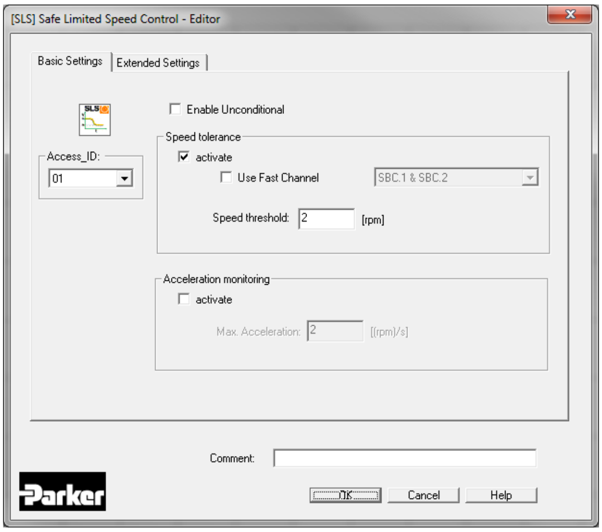
Description of function:



Output function:

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

<u>Parameters:</u>



Activate permanently
The monitoring function is permanently active and has no input 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 outputs can alternatively be chosen in combination as shut-down channel.

<u>Attention:</u> Reaction time see installation manual chapter 8.2!

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

Max. acceleration
Specification of the max. acceleration

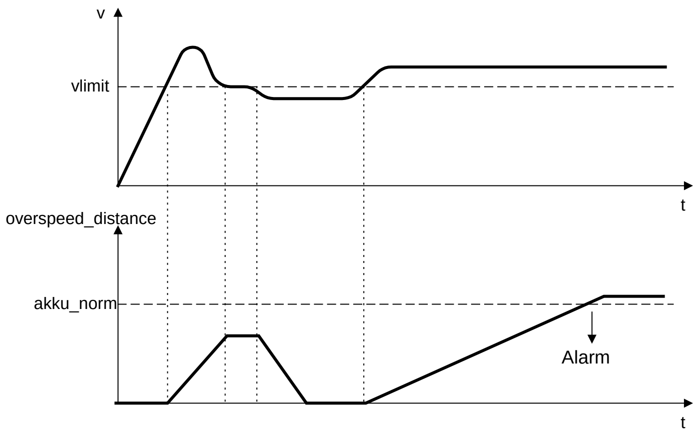
Ramp monitoring
This option monitors the transition of speed from fast to slow by using an SSX-functionality. The selected SSX-element must be available in the logic diagram.

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.

<u>Example of fault distance monitoring:</u>

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 down 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!

21.7.1 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

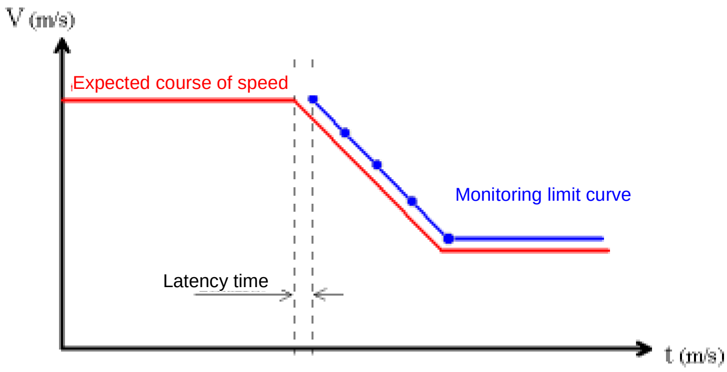
The safely reduced speed in manual mode is to be monitored => speed monitoring active with max. value from machine parameter = 50

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! Only absolute speeds without preceeding sign will be processed.
- 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.

21.8 SOS (Safe Operating Stop)

Standstill monitoring

<u>Number:</u> 1

<u>Access-ID:</u> Identification of function element

<u>Axis assignment:</u> maximum 1 function per axis

<u>Function:</u> Standstill monitoring

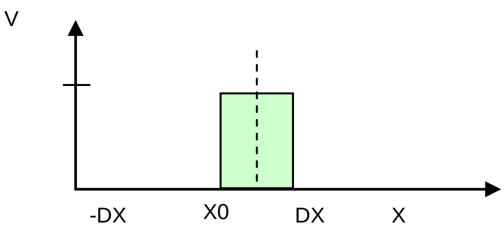
<u>Input:</u> Standardized position / speed signal V and X from encoder interface

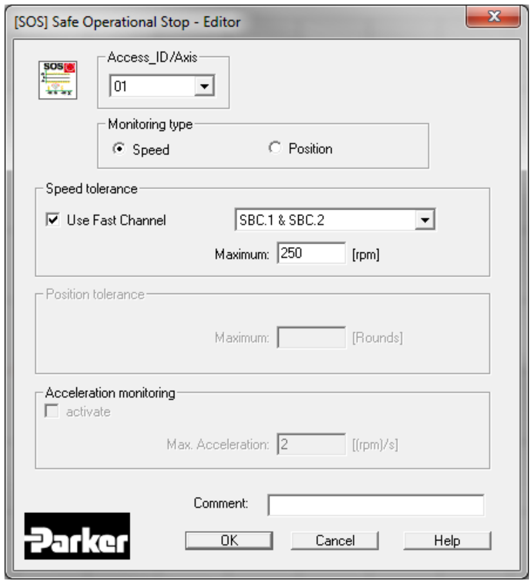
<u>RESET-function:</u> The violation of the permissible monitoring range is saved and requires a RESET acknowledgement. This occurs alternatively via:

- RESET function in the group of input elements

<u>Description of function:</u>

- 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





<u>Output function:</u>

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 outputs can alternatively be chosen in combination as shut-down channel.

Attention: Reaction time see installation manual chapter 8.2!

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

21.8.1 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

21.8.2 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

21.9 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

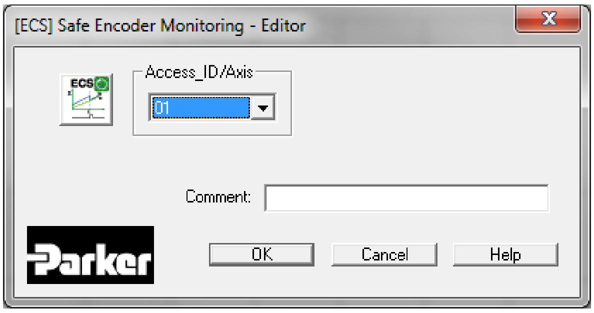
RESET-function: no RESET required

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!

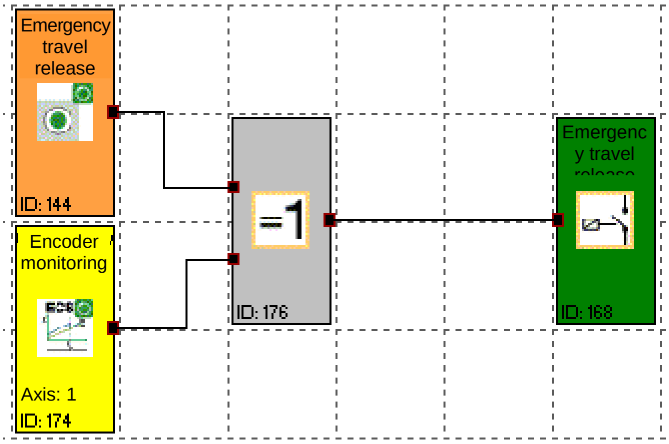
Description of function:

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 SDC module to status **RUN →ALARM** when a speed/position fault is detected. All outputs 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”.

<u>Example for the use of the ECS-function:</u>

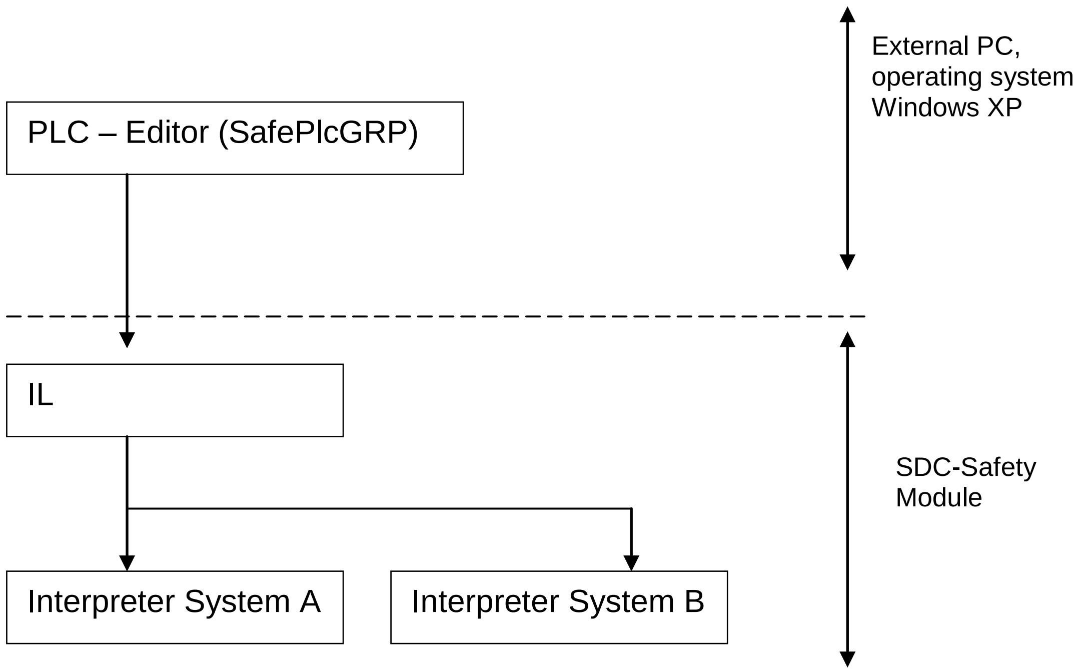


22 Process image

22.1 Introduction

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

With an external, not safety related PLC-editor (***SafePlcGRP***) a program can be created in function block representation as specified in IEC 61131, compiled and saved in the format **A*WL***. The same program adds the **AWL -** instructions to the configuration data and transmits the data to the module SDC module.



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

The 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 outputs
- 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 SDC module. In the MACRO-function only the connection of inputs must be verified. MACRO-functions refer e.g. to two-hand operation.

22.2 Description of Function Elements

The following description is required for executing the application validation.

22.2.1 PLC – Commands

The following list contains all commands used within the SDC module:

Operator	Operand	Description
LD	all input and output operands	Equates current result with operand
LD NOT	all input and output operands	Equates current result with operand and inverts the operand
ST	only output operands	Saves current result to operand address
AND	all input and output operands	Boolean AND
AND NOT	all input and output operands	Negated Boolean AND
OR	all input and output operands	Boolean OR
OR NOT	all input and output operands	Negated Boolean OR
XOR	all input and output operands	Boolean Exclusive OR
NOT	all input and output 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 input and output operands	Sets operand to 1
RESET	all input and output 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 Bi) 2. Operand: CRC_HI (8 Bit)
INFO	Info field	Operand field: 1. Operand: reserved free! 2. Operand: reserved free !

22.2.2 Designation of safety functions

The designations of safety functions are as follows:

Function	Function name acc. to EN 61800–5–2 or SDC module 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
SLP	Safe Limited Position
ECS	Encoder Monitoring Status (SDC module function)

22.2.3 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 inputs
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	not used
14	DriveSF			not used
15	DI8	0 .. 7	E0.1 .. E0.6	SMF11/12 SMF21/22 SMF31/32 SMF41/42 E0.5 E0.6
16	DI16			not used
17	DI24			not used
18	DI32			not used
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	Output start element with time
22	Outp2HandTimer	0	MEZ.1	Output two-hand with time
23	Start element	0	MES.1	Output start element
24	Start-up Test	0 1	MEA.1 MEA.2	Output start-up test

Index	*PAE-variable*	*Bit Pos.*	*Bit-variable*	*Description*
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			not used
28	AIn2			not used
29	AIn3			not used
30	AIn4			not used
31	SysACC Axis1		SysAcc[0]	current system acceleration axis 1
32	SysACC Axis2			not used
33	Limit20Axis1		Limit20[0]	Limit for GOTO monitoring axis 1
34	Limit20Axcis2			not used
35	Pos20Axis1		Position20[0]	Current position axis 1
36	Pos20Axis2			not used
37	BG20Axis1		BG20[0]	Range limit axis 1
38	BG20Axis2			not used
39	StopDistAxis1		StopDistanz20[0]	Current stop distance axis 1
40	StopDistAxis2			not used
41	SysSpeed Axis1		SysSpeed[0]	Current speed axis 1
42	SysSpeed Axis2			not used
43	AnalogAdder			not used
44	EA_IN8	0 .. 7	EAE1.1 .. EAE1.8	E1.1 to E1.5 analog Grouped Inputs
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	Output start element with time
47	EMU 31 1 1			not used
48	EMU 31 1 1			not used
49	EMU 31 1 2			not used
50	EMU 31 1 2			not used
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

22.3 PLC Processing

22.3.1 PLC - Syntax

The PLC-program is CRC-protected and part of the SDC module configuration data. Each PLC-command is 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 IL-commands) – (line number of list entries - 1)
At 256 the counter jumps back to 0.

22.3.2 PLC – Commands

Operator	Operand	OPCODE	Description
LD	all input and output operands	02	Equates current result with operand
LD NOT	all input and output operands	04	Equates current result with operand and inverts the operand
ST	only output operands	06	Saves current result to operand address
AND	all input and output operands	08	Boolean AND
AND NOT	all input and output operands	10	Negated Boolean AND
OR	all input and output operands	12	Boolean OR
OR NOT	all input and output operands	14	Negated Boolean OR
XOR	all input and output operands	16	Boolean Exclusive OR
NOT	all input and output operands	18	Inverts the accumulator value
SET MERKER	PLC_MARKER in output image	20	Sets marker
RESET MERKER	PLC_MARKER in output image	22	Resets marker
SET	all input and output operands	24	Sets operand to 1
RESET	all input and output 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 Bi) 2. Operand: CRC_HI (8 Bit)
INFO	Info field	32	Operand field: 1. Operand: reserved free! 2. Operand: reserved free!

22.3.3 PLC – Elements (I/O)

The PLC input elements are described in detail in the SDC installation manual, chapter 17 “Switch types”!

22.3.3.1 Input elements

E	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

22.3.3.2 Output elements

A	Type
SBC1	1
SBC2	1
STO1	1
STO2	1
DO1	1
DO2	1
MDO0.1	1
MDO0.2	1

22.3.4 PLC - Output variables

Output variables for the PLC-system are identified by:

- Affiliation to the system image of the SDC module
- 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 position***	***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	Activation SEL
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	not used
13	DriveSummary			not used
14	DO8	0 1 2 3 4 5 6 7	SBC1 STO1 SBC2 STO2 DO1 DO2	Semi-conductor output Semi-conductor output Semi-conductor output Semi-conductor output Semi-conductor output Semi-conductor output not used not used

15	HW_Output	0 1 2 3 4 5 6 7	MDO0.1 MDO0.2 A1.1_O A1.2_O A2.1_O A2.2_O EAA2.9 EAA2.10	Semi-conductor output SMF41 Semi-conductor output SMF42 not used not used not used not used not used not used
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 input element with time monitoring
68	EnableEingangZweih andTimer	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			not used
72	EAA2_8			not used
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 input 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

22.3.5 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 output image “Outputs”. The user can only address markers through the macro “RS-Flipflop”.

22.3.5.1 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…31.999.992 ms
- 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.

22.3.6 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 22.2.1)
	….		
	48 + (PLC_Len*4) – 4	Instruction no. PLC_Len	
Reserve	1056	free	
	1058	free	

22.3.7 Assignment of resources

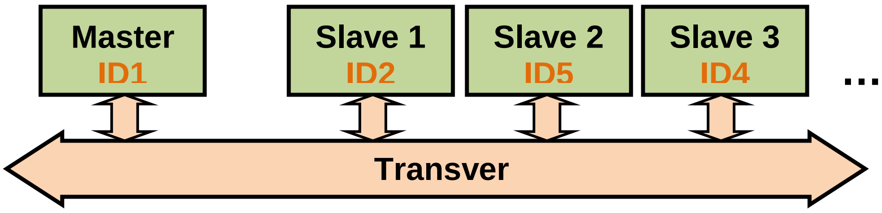
Element	In	Out	Qty. MX	IN/OUT Process image	PLC-Code	Qty. IL
AND2	2	1	1	0	LD x1.y1 AND x2.y2 ST MX.z	3
						…
AND5	5	1	1	0	LD x1.y1 AND x2.y2 AND x3.y3 AND x4.y4 AND x5.y5 ST MX.z	6
OR2 .. OR5					Analog AND	3 … 6
XOR 2					Analog AND	3
NOT	1	1	1	0	LD x1,y1 NOT ST MX.z	3
RS-Flipflop	2	1	0	Output = 1	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 output Single	1	1	0	Output = 1	LD x1.y1 ST DO.x_y	2
Semi-conductor output Redundant	1	2	0	Output = 2	LD x1.y1 ST DO.x_P ST DO.x_M	3

Processing of input elements see SDC installation manual, chapter 17 “Switch types”!

23 CAN Transverse bus communication

23.1 Fundamentals

The CAN Transverse bus communication is the connection of a Master with one or several Slave modules via transverse bus.



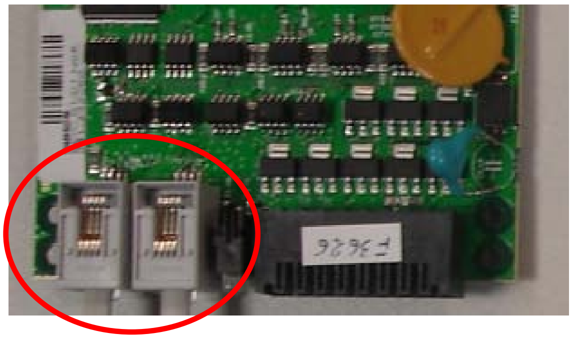
Up to 7 Slave modules, which all need to be addressed with an unambiguous ID, can be operated on a transverse bus together with the Master.
The Master always has the ID1.
The Slave IDs can be chosen from 2 to 8 – however, these IDs must always be set identically within the system – here e.g. ID2, ID5, ID4. The order of Slaves is of no significance when connecting to the transverse bus.

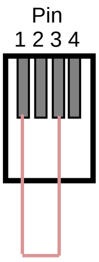
The Slave data are taken on by the process image of the Master and can be displayed or used.

For this purpose all modules must be individually programmed.

23.2 Connecting the modules

The modules have two 4pole RJ bus interfaces each. These are interfaces for the transverse bus and connect the individual modules among each other.

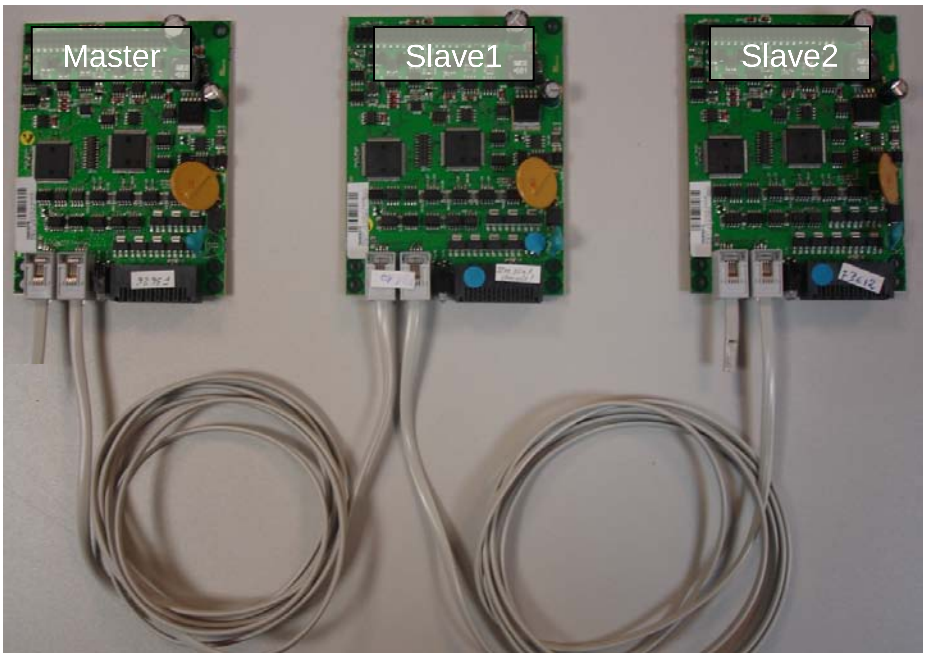




The left bus interface can be used as bus connection.
Pin 1 and Pin 3 must be bridged externally for this purpose – this activates the terminating resistor (120Ω) on the printed circuit board.
The bus is to be terminated on both sides (first and last circuit board), so that signal reflections are ruled out.

(here shown open)

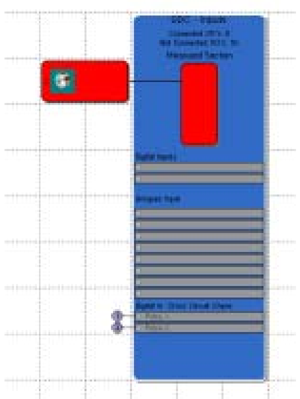
A possible variant is shown hereafter: Master with two Slaves

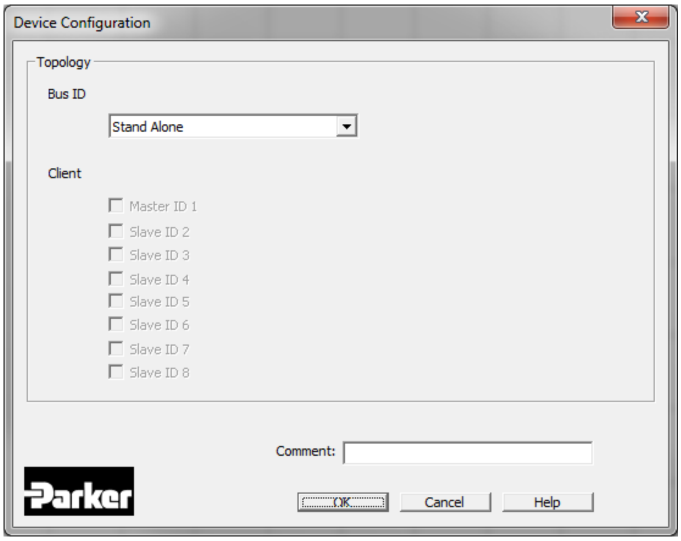


The terminating bridge (on the left plug) is installed on the left module (Master). The modules are linked with standard data cables. The right module (Slave 2) also contains the terminating bridge (on the left plug) to terminate the bus.

23.3 Parameterization of modules

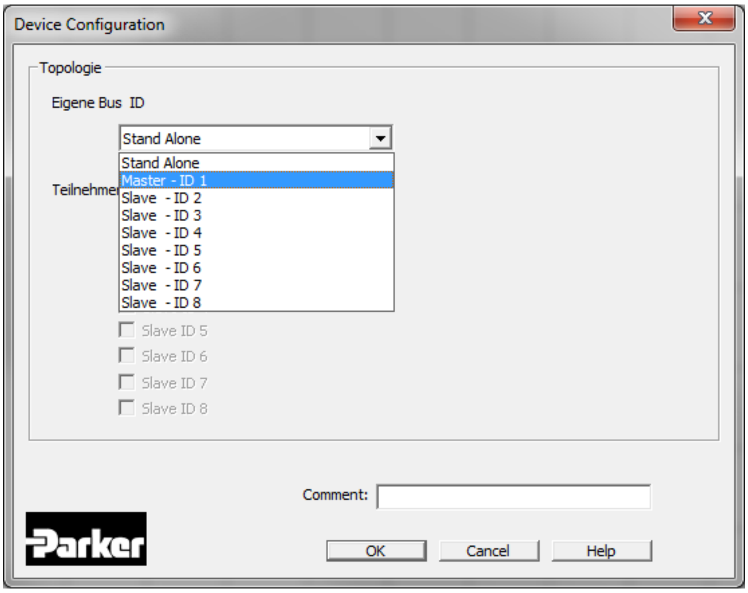
Clicking on the input block in SafePLC opens the parameterizing window.





The type of module can be chosen under “Own Bus ID”:

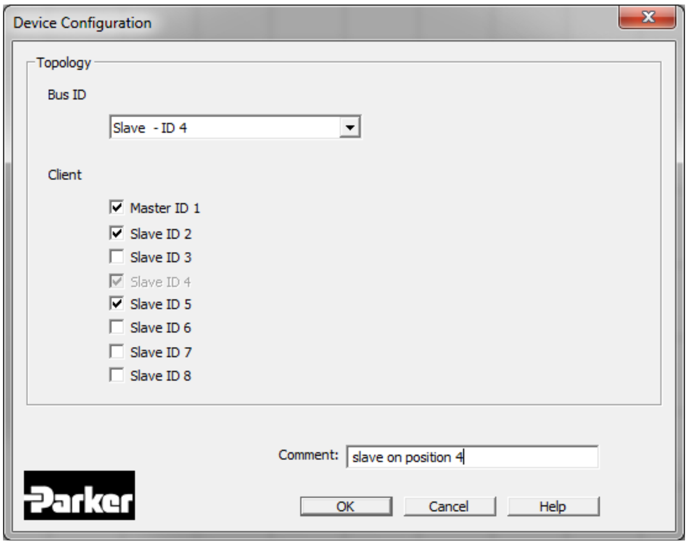
- **Stand Alone** – should be chosen when the module is used on its own – without transverse bus
- **Master – ID 1** – should be chosen for the Master module
- **Slave – ID x** – should be chosen for each Slave connected to the transverse bus



The Master thereby also has the ID 1.
The IDs for the Slaves can be freely chosen.

In the “Client” field one can subsequently specify all communication subscribers connected to the transverse bus. If an ID is left out, a gap will be at this place. (e.g. Slave 2, 5, 4)

When parameterizing the Slaves, the corresponding (own) ID appears in grey.
Then all subscribers must be selected (in case of a Slave also the Master).



The “Comment” field can be filled with comments, such as e.g. “slave on position 4”.

Clicking on “OK” saves the settings.
Once all subscribers have been programmed and are in “Run” mode, the Slave data are transferred to the Master and are there available in the process image.

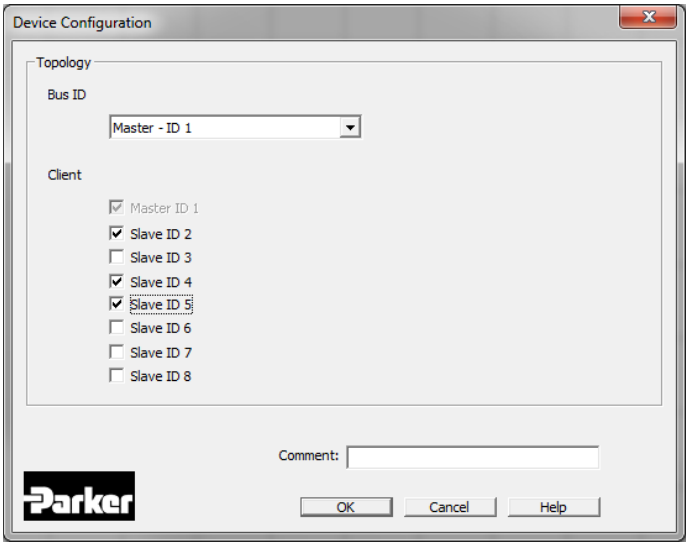
All inputs of the modules connected to the transverse bus (Master and Slave) can then be invoked by any of the modules.

23.4 Inclusion of SDDC inputs

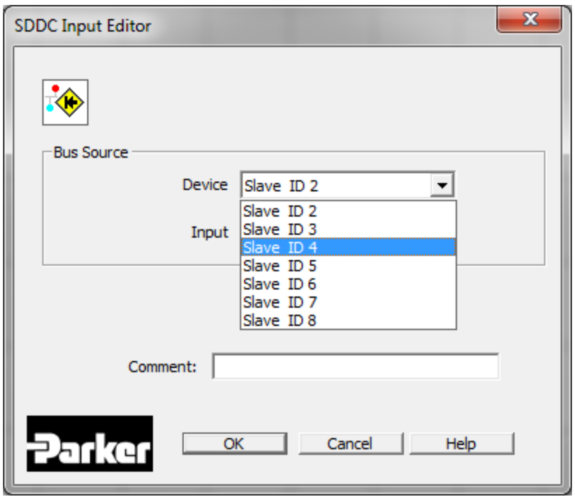
In the terminal diagram one can select SDDC inputs.

After placing the symbol, the editor window will automatically pop up.

In the editor window one can then select the corresponding module to be included



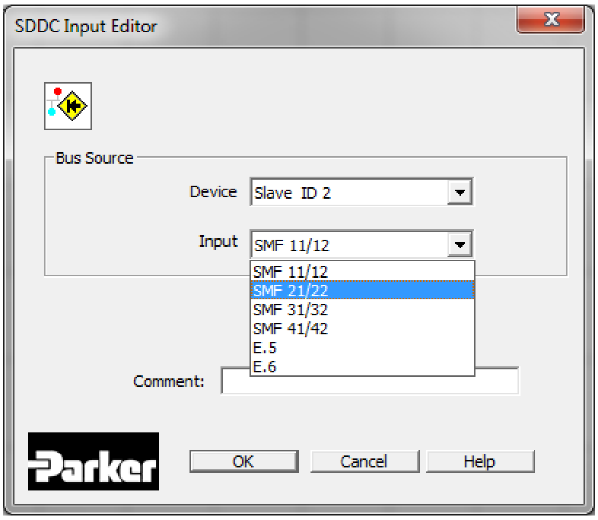
under “Device”.



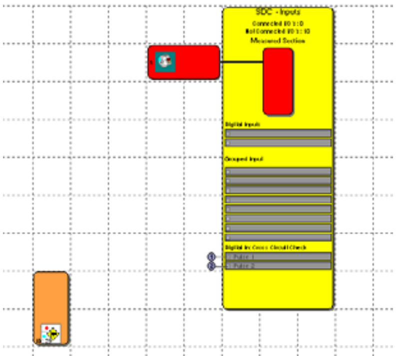
In this example the Slave input on the Master with ID4 is used.

In the “Input” field one can specify the desired input of the included module.

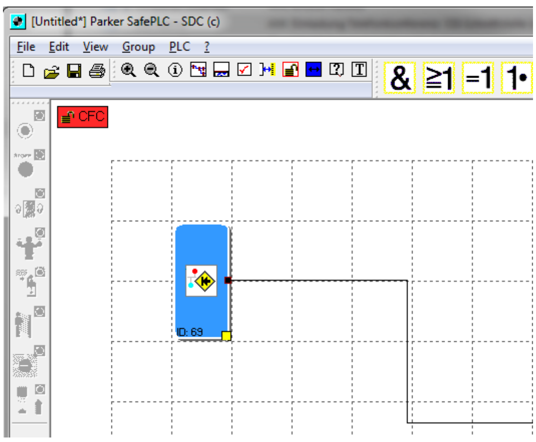
Under “Comment” one can enter any comments.



A module (without inputs or outputs) is subsequently generated in the terminal diagram, which confirms, that an “external” input is available.

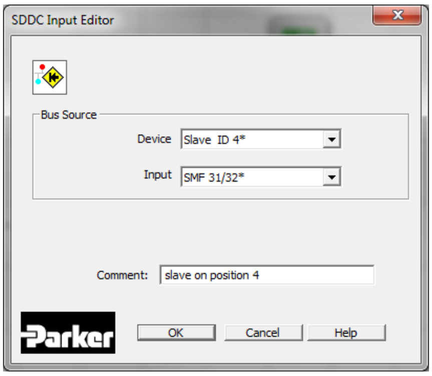


An input module is then available in the circuit diagram (CFC), with a Connector for connection. It can be wired and used just like an own input.



The settings can be changed by simply double-clicking on the module – in the terminal diagram and in the circuit diagram.

The change is accepted with the “OK” button:



24 APPENDIX

24.1 Encoder types

Type	*Encoder A*			*Encoder B*			**Safety functions**
	Type	*Pulse multipl.*	*VCC Encoder monitor*	*Type*	*Pulse multipl.*	*VCC Encoder monitor*	
2	SINCOS	4	+10V at X13 (F11) Pin 4	NC	n.a.	n.a.	SS1, SS2, SLA, SLS, SOS, SDI, SLI
3	RS422-Incre-mental	4	+5V at X13 (F12) Pin 4, Sense Pin 1 & 2 must be wired	One counting input (Proximity switch)	n.a.	n.a.	SS1, SLA, SLS, SDI, SLI
4	SINCOS	4	+10V at X13 (F11) Pin 4 or +5V at X13 (F12) Pin 4, Sense Pin 1 & 2 must be wired	One counting input (Proximity switch)	n.a.	n.a.	SS1, SS2, SLA, SLS, SOS, SDI, SLI
6	RS422-Incre-mental	4	+5V at X13 (F12) Pin 4, Sense Pin 1 & 2 must be wired	RS422-Incre-mental	4	+24V at X11 (F12) Pin 1	SS1, SS2, SLA, SLS, SOS, SDI, SLI
7	SINCOS	4	+10V at X13 (F11) Pin 4	RS422-Incre-mental	4	+24V at X11 (F11) Pin 1	SS1, SS2, SLA, SLS, SOS, SDI, SLI
8	SINCOS	4	+10V at X13 (F11) Pin 4	SSI absolute encoder (300kB)	n.a.	+24V at X11 (F11) Pin 1	SS1,SS2, SLA, SLS, SOS, SDI, SLI, SLP, SCA

Please pay attention that the encoder used is specified for the supply voltage as listed in the column 'VCC Encoder monitor'.