Documentation

EL6900-FB, KL6904-FB

TwinCAT function blocks for TwinSAFE logic terminals

Version: 2.4.1
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BECKHOFF

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1 Foreword

1.1 Notes on the manual

This description is only intended for the use of trained specialists in control and automation technology familiar with the applicable national standards. It is essential that the following notes and explanations are followed when installing and commissioning these components.
The responsible staff must ensure that the application or use of the products described satisfy all the safety requirements, including all the relevant laws, regulations, guidelines and standards.

1.1.1 Disclaimer

This documentation has been prepared with care. The products described are, however, constantly under development. For this reason, the documentation may not always have been fully checked for consistency with the performance data, standards or other characteristics described.
If it should contain technical or editorial errors, we reserve the right to make changes at any time and without notice.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

1.1.2 Brands

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1.1.3 Patents

The EtherCAT technology is patent protected, in particular by the following applications and patents: EP1590927, EP1789857, DE102004044764, DE102007017835 with the corresponding applications and registrations in various other countries.
The TwinCAT technology is patent protected, in particular by the following applications and patents: EP0851348, US6167425 with the corresponding applications and registrations in various other countries.

1.1.4 Copyright

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1.1.5 Delivery conditions

In addition, the general delivery conditions of the company Beckhoff Automation GmbH & Co. KG apply.

1.2   Safety instructions

1.2.1   Delivery state

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

1.2.2   Operator's obligation to exercise diligence

The operator must ensure that
- the TwinSAFE products are only used as intended (see section Product description);

- the TwinSAFE products are only operated in sound condition and in working order.

- the TwinSAFE products are operated only by suitably qualified and authorized personnel.

- the personnel is instructed regularly about relevant occupational safety and environmental protection aspects, and is familiar with the operating instructions and in particular the safety instructions contained herein.

- the operating instructions are in good condition and complete, and always available for reference at the location where the TwinSAFE products are used.

- none of the safety and warning notes attached to the TwinSAFE products are removed, and all notes remain legible.

1.2.3   Description of safety symbols

The following safety symbols are used in these operating instructions. They are intended to alert the reader to the associated safety instructions.

	Serious risk of injury!
DANGER	**Failure** to follow the safety instructions associated with this symbol directly endangers the life and health of persons.

	Risk of injury!
WARNING	**Failure** to follow the safety instructions associated with this symbol endangers the life and health of persons.

	Personal injuries!
CAUTION	**Failure** to follow the safety instructions associated with this symbol can lead to injuries to persons.

	Damage to the environment or devices
Attention	**Failure** to follow the instructions associated with this symbol can lead to damage to the environment or equipment.

	Tip or pointer
Note	This symbol indicates information that contributes to better understanding.

1.2.4 Origin of the document

This documentation was originally written in German. All other languages are derived from the German original.

1.2.5 Documentation issue status

Version	Comment
2.4.1	- Markings removed
2.4.0	- Company address changed
2.3.0	- Document origin and versions added - EDM extended with standard In - MUTING status information expanded - Two-hand diagnostic information expanded
2.2.0	- TwinSAFE connection info data expanded - FB ESTOP info data expanded
2.1.0	- FB OPMODE description expanded - Service/support information modified
2.0.0	- EL6900 blocks added
1.1.1	- Corrections during the translation into English
1.1.0	- Amendments in the application examples
1.0.0	- First released version

2 System description

The TwinSAFE system consists of safe inputs (EL/KL1904), safe outputs (EL/KL2904) and logic modules (KL6904/EL6900). The TwinSAFE logic terminal (KL6904/EL6900) contains function blocks, which can be parameterized and connected to each other and form the safety-related logic. Free programming is not possible. In addition to the non-safety-related logic configuration a fieldbus configuration is required for mapping the TwinSAFE data packets. These functions are realized via the TwinCAT System Manager. The safety-related TwinSAFE Verifier, which is available at the moment as a separate installation, deals with the loading and testing of the TwinSAFE project onto the EL6900/KL6904.

The TwinSAFE logic terminal can communicate, via the fieldbus-independent and certified TwinSAFE-protocol with safe input and output terminals, and also via further logic terminals. The TwinSAFE protocol is a Safety over EtherCAT (FSoE) protocol with one byte of safe user data. It is openly available via the EtherCAT Technology Group (www.ethercat.org).

2.1 TwinSAFE logic terminals EL6900/KL6904

The configuration of a TwinSAFE logic terminal consists of function blocks that are consolidated into one or several TwinSAFE groups. TwinSAFE groups can be started and stopped independently of each other.

The execution sequence of the function blocks corresponds to the TwinCAT System Managers project structure sequence illustrated. This sequence can be changed in the System Manager by Drag'n Drop.

The function blocks have parameters which must be configured by the user.

The inputs and outputs of the function blocks are assigned to the inputs and outputs of the TwinSAFE terminals, to other function blocks or to the input and output variable of the standard PLC by the user.

A TwinSAFE connection involves unambiguous assignment of a TwinSAFE device (EL/KL1904, EL/KL2904, EL6900/KL6904) to TwinSAFE group. Only function blocks which belong to this TwinSAFE group can be linked with the input and outputs of an assigned TwinSAFE connection. The DECOUPLE block can be used if it is necessary for other groups to access the inputs and outputs (see chapter 3.6).

Errors of the TwinSAFE communication within the TwinSAFE group and errors within a function block affect the complete TwinSAFE group. The TwinSAFE group then stops all associated function blocks, which then switch their outputs into a safe state.

Errors in the TwinSAFE Logic result in it switching off completely.

2.1.1 TwinSAFE group

The function blocks are assigned to TwinSAFE groups. These have a characteristic that results in the return of all group outputs to a safe state (a safe state is always a wattless state at the output, corresponding to a logical 0) such as, in case of a communication error of an assigned TwinSAFE connection, in case of an error in assigned function blocks (e.g. excessive discrepancy time) or an error in the local assigned outputs. I.e. the TwinSAFE connection data and thus TwinSAFE input or output terminal are always exactly assigned to a TwinSAFE group.

A communication error is displayed on the output (COM ERR) of the TwinSAFE group and acknowledged on the input (ERR ACK). A function block error is displayed on the output (FB ERR) and acknowledged on the same input (ERR ACK) as the communication error. An error on the local outputs (only KL6904) is displayed on the third output (OUT ERR) and once again acknowledged (ERR_ACK) on the same input. The safe state of the TwinSAFE group outputs is removed once the error is no longer present and has been acknowledged.

The error acknowledgement is not carried out automatically, i.e. the "ERR ACK" input must always be

linked.

Apart from this the TwinSAFE group has an input (RUN), with which the processing of the assigned function blocks can be stopped and started. All TwinSAFE group assigned outputs are in a safe state when stopped.

2.1.1.1   TwinSAFE group inputs and outputs

Table 2-1: TwinSAFE group inputs

Name	Permitted type	Description
RUN	FB-Out Standard-In	TRUE: The function blocks assigned to the TwinSAFE group are executed FALSE: All assigned function blocks of the TwinSAFE group are at a STOP state and thus all associated outputs are in a safe state When the input is not linked it is in the TRUE state
ERR ACK	FB-Out Standard-In	All pending errors in the assigned function blocks and in the TwinSAFE connections are acknowledged by the FALSE->TRUE->FALSE signal sequence.

Table 2-2: TwinSAFE group outputs

Name	Permitted type	Description
FB ERR	TwinSAFE-Out FB-In Standard-Out Local-Out	TRUE: At least one assigned function block has an error FALSE: All assigned function blocks have no errors
COM ERR	TwinSAFE-Out FB-In Standard-Out Local-Out	TRUE: At least one TwinSAFE connection of TwinSAFE group has an error FALSE: All TwinSAFE connections of the TwinSAFE group have no errors
OUT ERR	TwinSAFE-Out FB-In Standard-Out Local-Out	TRUE: At least one local output assigned to the TwinSAFE group has an error FALSE: All of the local outputs assigned to the TwinSAFE group have no errors Always FALSE for EL6900, since the device has no local outputs.

2.1.2 TwinSAFE connection

Each safe communication path between the TwinSAFE logic and TwinSAFE inputs, TwinSAFE outputs or other TwinSAFE logic terminals are referred to as TwinSAFE connection.

A communication partner is thus always the TwinSAFE master, the other the TwinSAFE slave. The TwinSAFE logic is in a TwinSAFE connection to a TwinSAFE input or TwinSAFE output is always TwinSAFE master. The TwinSAFE connection to another TwinSAFE logic can be TwinSAFE slave on the other hand, whereby the TwinCAT System Manager automatically defines this assignment.

Both the TwinSAFE master and the TwinSAFE slave have a FSoE (Safety over EtherCAT) address that can be set on the respective TwinSAFE terminal via a DIP switch in order to ensure that any mix-up of the TwinSAFE data packets is always detected. These FSoE addresses are checked within the TwinSAFE communication and must be unambiguous in the control system. The TwinSAFE Verifier for each TwinSAFE logic terminal checks that. The TwinSAFE logic control system may contain several TwinSAFE logic terminals, although the TwinSAFE Verifier can only be active for one TwinSAFE logic terminal at a time. The user must therefore ensure that multiple allocation of FSoE addresses is avoided.

For each TwinSAFE connection a watchdog time and the corresponding FSoE address for the communication devices can be set. In addition there is a possibility to adjust the SIL level, however this setting is not supported at the moment and has no effects on the safety behavior of the system. In another configuration option a module error in the TwinSAFE communication partner can be set to trigger a communication error in the TwinSAFE group.

2.1.3 System diagnosis

The states of the TwinSAFE groups, FBs and connections can be checked in the System Manager. The diagnostic information can be copied into the cyclic process image.
TwinSAFE groups have inputs and outputs of associated Screenshots assigned offline and which can be considered online.

If the checkboxes 'Map State' and 'Map Diag' are set, the state and diagnostic data for the group are copied into the cyclic process image and can be linked directly with PLC variables. The diagnostic data are currently always 0.

	KL6904
i **Note**	With the KL6904 copying of the diagnostic information to the cyclic process image is only possible to a limited extent. The checkboxes 'Map State' and 'Map Diag' are not available.

Figure 2-1: Inputs/Outputs

Table 2-3: Status information

Value	Status	Description
1	RUN	All function blocks and TwinSAFE connections assigned to the TwinSAFE group operate properly, and all TwinSAFE connections assigned to the TwinSAFE group are up and running
2	STOP	State after initialization
3	SAFE	All function blocks and TwinSAFE connections assigned to the TwinSAFE group operate properly, and at least one of the TwinSAFE connections assigned to the TwinSAFE group is not yet up and running
4	ERROR	At least one assigned function block or one assigned TwinSAFE connection has reported an error
5	RESET	A positive edge (FALSE->TRUE) for acknowledgement of a function block or a TwinSAFE connection error was detected on the ERR_ACK input. The system is waiting for the negative edge of the ERR_ACK input

Figure 2-2: Inputs/Outputs

The status of TwinSAFE FBs is displayed on online summary. The current status data are read from the EL6900/KL6904 via a manual refresh.
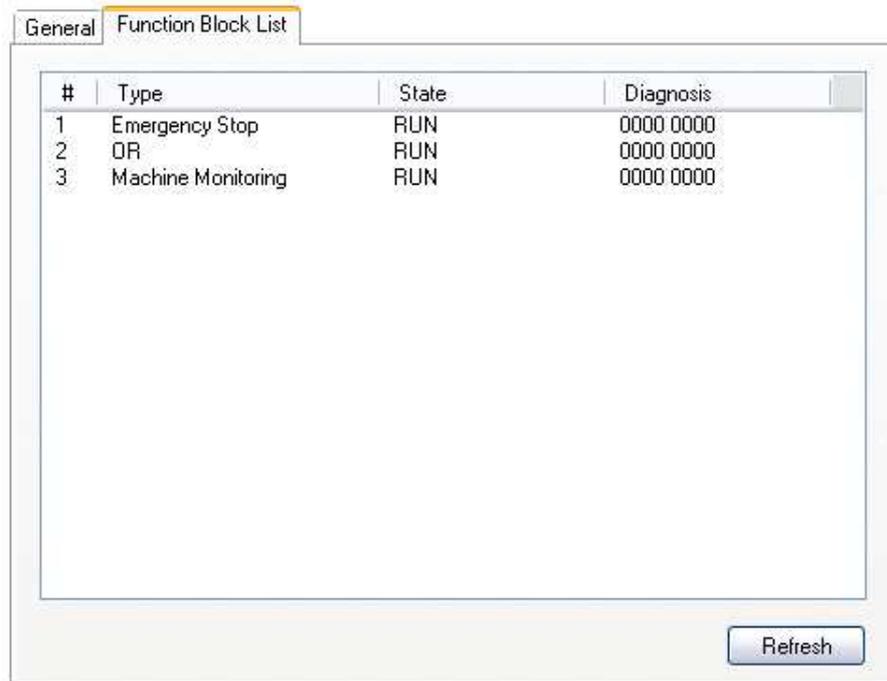
Figure 2-3: Function Block List

If the checkboxes 'Map State' and 'Map Diag' for the individual TwinSAFE FBs are set, the status and diagnostic data for the FBs are copied into the cyclic process image and can be linked directly with PLC variables. The description of the status and diagnostic values can be found under the respective FBs.

ⓘ **Note**	**KL6904** With the KL6904 copying of the diagnostic information to the cyclic process image is only possible to a limited extent. The checkboxes 'Map State' and 'Map Diag' are not available.

Figure 2-4: Emergency Stop

The TwinSAFE connections status is displayed on the TwinSAFE connection list summary under the "Connection List" tab. Diagnostics bits are also set in addition to the status.
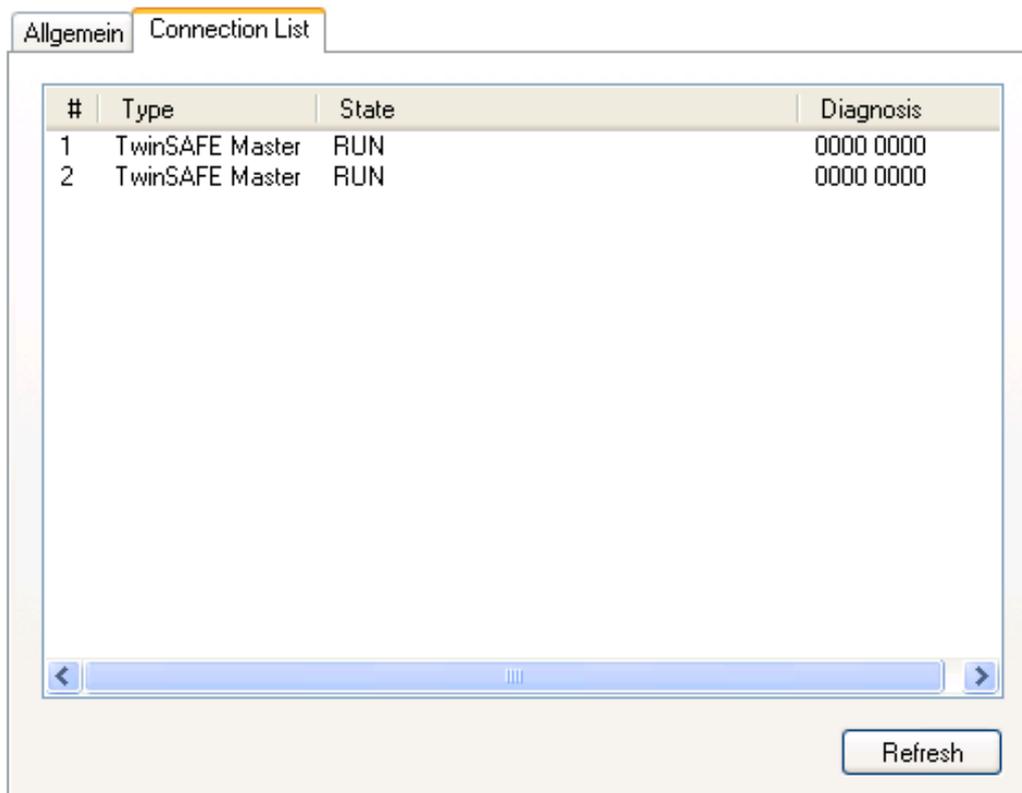
Figure 2-5: Connection List

If the checkboxes 'Map State' and 'Map Diag' for the individual TwinSAFE connections are set, the status and diagnostic data for the connections are copied into the cyclic process image and can be linked directly with PLC variables. In addition, the safe inputs and outputs can be copied into the cyclic process image and used for diagnostic purposes.

ⓘ **Note**	**KL6904** With the KL6904 copying of the diagnostic information to the cyclic process image is only possible to a limited extent. The checkboxes 'Map State', 'Map Diag', 'Map Inputs' and 'Map Outputs' are not available. The button "Com Err Ack" is also not available.
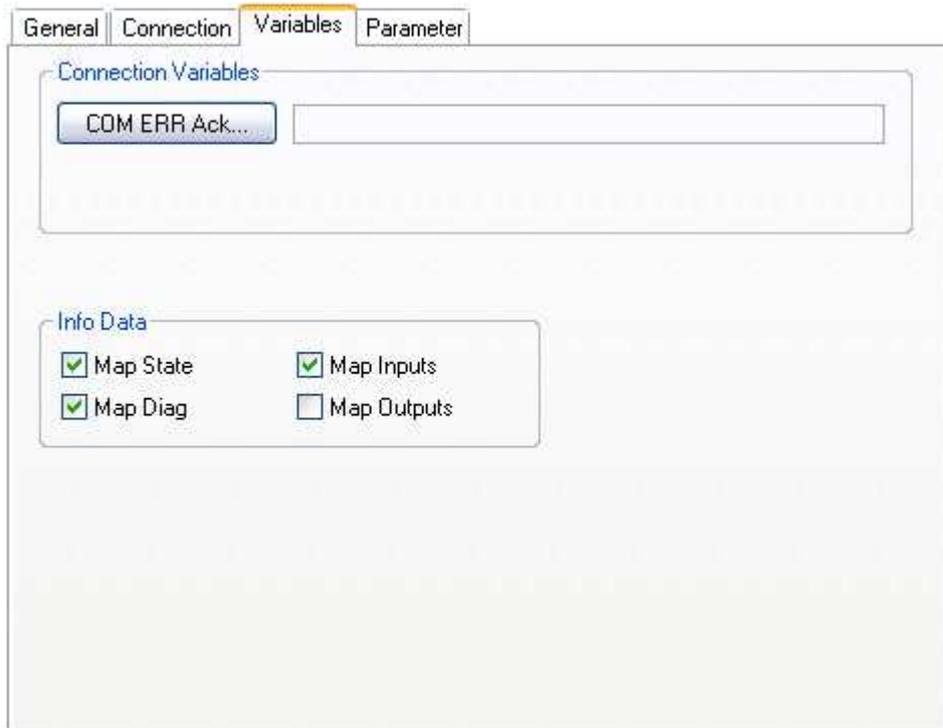
Figure 2-6: Variables

Table 2-4: Diagnostic information for a connection

Value	Description
xxxx 0001	Invalid command
xxxx 0010	Unknown command
xxxx 0011	Invalid connection ID
xxxx 0100	Invalid CRC
xxxx 0101	Watchdog time elapsed
xxxx 0110	Invalid FSoE address
xxxx 0111	Invalid data
xxxx 1000	Invalid communication parameter length
xxxx 1001	Invalid communication parameters
xxxx 1010	Invalid user parameter length
xxxx 1011	Invalid user parameters
xxxx 1100	FSoE master reset
xxxx 1101	Module error detected on slave, with option "Module error is ComError" activated
xxxx 1110	Module error detected on EL290x, with option "Error acknowledge active" activated
xxxx 1111	Slave not yet started, or unexpected error argument
xxx1 xxxx	FSoE slave error detected
xx1x xxxx	FSoE slave reports Failsafe Value active
x1xx xxxx	StartUp
1xxx xxxx	FSoE master reports Failsafe Value active

Table 2-5: Status information for a connection

Value	Description
100 (0x64)	Reset state: The reset state is used to re-initialize the Safety over EtherCAT connection after the power-on or a Safety over EtherCAT communication error.
101 (0x65)	Session state: During the transition to or in the session state a session ID is transferred from the Safety over EtherCAT master to the Safety over EtherCAT slave, which in turn responds with its own session ID.
102 (0x66)	Connection state: In the connection state a connection ID is transferred from the Safety over EtherCAT master to the Safety over EtherCAT slave.
103 (0x67)	Parameter state: In the parameter state safe communication- and device-specific application parameters are transferred.
104 (0x68)	Data state: In the data state Safety over EtherCAT cycles are transferred until either a communication error occurs or a Safety over EtherCAT node is stopped locally.
105 (0x69)	Shutdown state: In the shutdown state the connection was shut down by one of the communication partners.

Further information can be found in the Safety over EtherCAT specification.

3 Function blocks

The function blocks have a specified functionality that still must be configured via a parameter. The inputs or outputs of a function block can be inputs or outputs of a local process image, but function block outputs and inputs can be can be linked.

3.1 The AND function block

3.1.1 Functional description

With the FB AND several input signals can be linked via AND to one output signal. In addition each input can still be set even if the input signal is a normally closed contact (Break contact) or normally open contact (Make contact). A normally open contact means that the corresponding input signal is negated, before it affects the AND.

The AndIn1 input differs from the AndIn2-AndIn8 inputs in such a way that it can also be linked with a standard input. This makes it possible to switch off a safe output using a standard signal. Outputs cannot be switched on but only released using a standard signal, since at least two inputs must always be linked for FB AND (and the second input is a safe one, which prevents switching on).
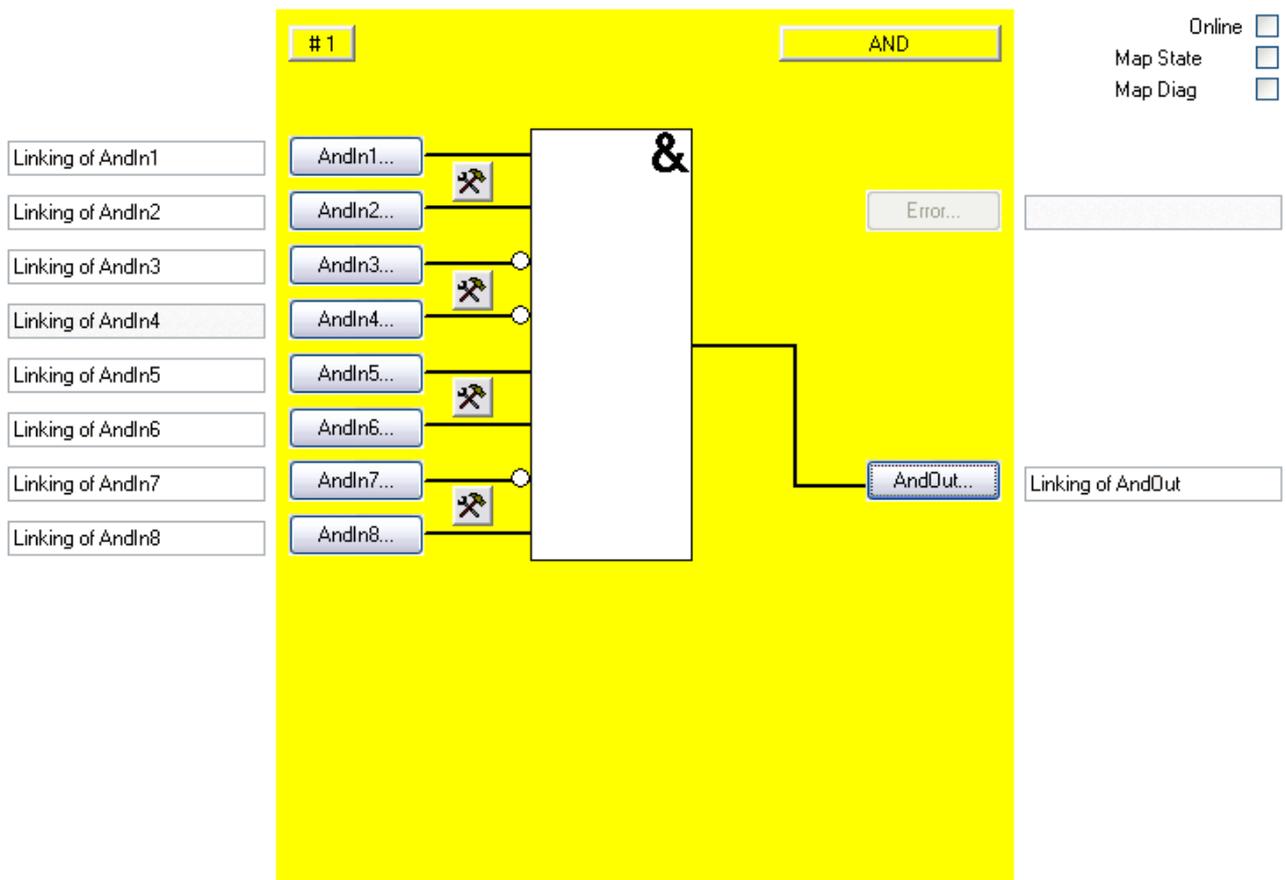
Figure 3-1: AND function block

3.1.2 Signal description

Table 3-1: FB AND inputs

Name	Permitted type	Description
AndIn1	TwinSAFE-In FB-Out Standard-In	1st input channel
AndIn2	TwinSAFE-In FB-Out	2nd input channel
AndIn3	TwinSAFE-In FB-Out	3rd input channel
AndIn4	TwinSAFE-In FB-Out	4th input channel
AndIn5	TwinSAFE-In FB-Out	5th input channel
AndIn6	TwinSAFE-In FB-Out	6th input channel
AndIn7	TwinSAFE-In FB-Out	7th input channel
AndIn8	TwinSAFE-In FB-Out	8th input channel

Table 3-2: FB AND outputs

Name	Permitted type	Description
AndOut	TwinSAFE-Out FB-In Standard-Out Local-Out	Output channel

Table 3-3: FB AND input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input
Local-Out	TwinSAFE output at the KL6904 (not available for EL6900)

3.1.2.1 Diagnostic and status information for FB AND

Table 3-4: Diagnostic information (16-bit value)

Index	Description
0-15	always 0

Table 3-5: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE

i Note	**KL6904** The checkboxes 'Map State' and 'Map Diag' are not available for the KL6904.

3.1.3   FB AND configuration in the TwinCAT System Manager
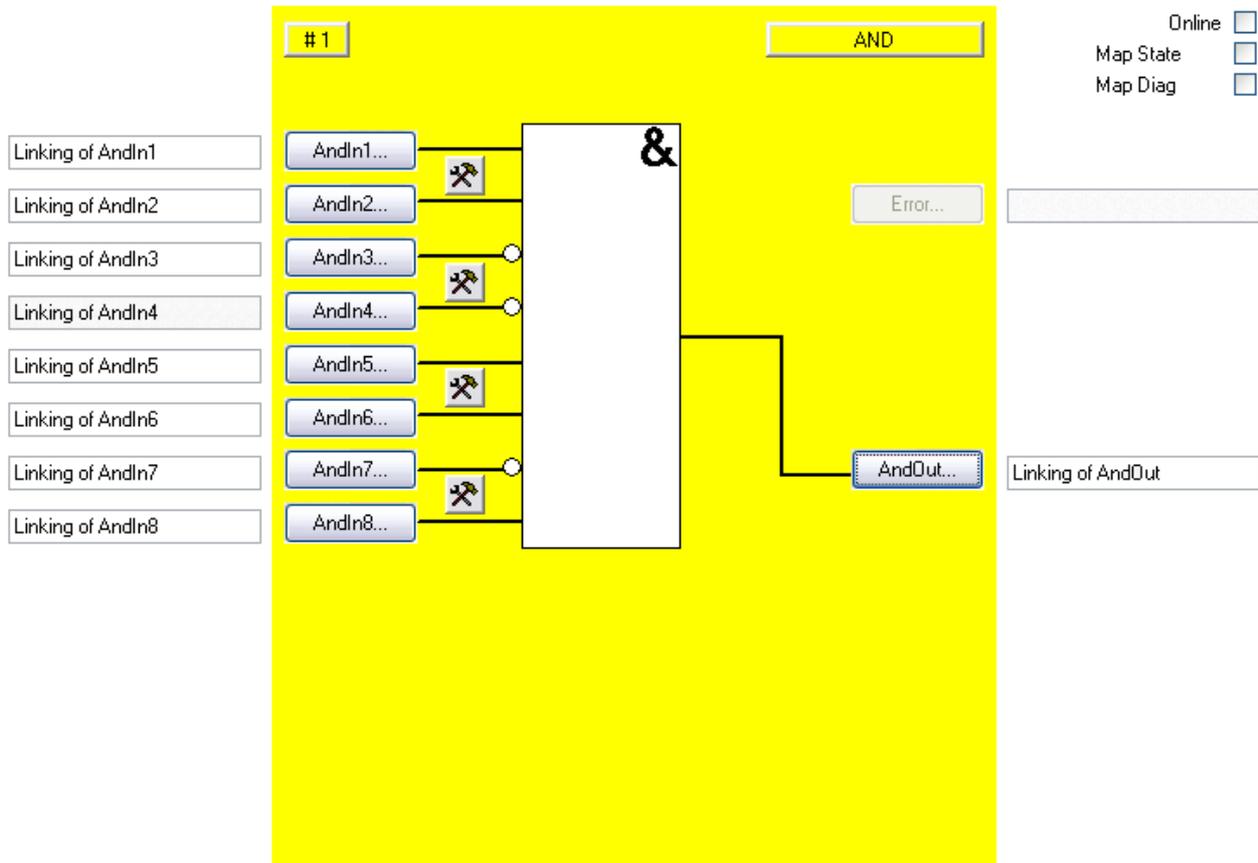
Figure 3-2: FB AND configuration

Their characteristics are configured with the setting buttons on the right near the two AndIn inputs, whereby the inputs are always single-channel ones. A discrepancy monitoring cannot be used for the AND.

The 'AndIn(x)' buttons can only be selected when the corresponding input has been activated. All inputs are deactivated in the default setting.

The FB AND input variables are linked using the 'AndIn(x)' buttons.

The output variable of the FB AND are linked using the 'AndOut' button.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

The FB AND does not supply any error information and therefore the error button is basically deactivated.

3.2 The OR function block

3.2.1 Functional description

With the FB OR several input signals can be linked via OR to one output signal. In addition each input can still be set even if the input signal is a normally closed contact (Break contact) or normally open contact (Make contact). A normally open contact means that the corresponding input signal is negated, before it affects the OR.
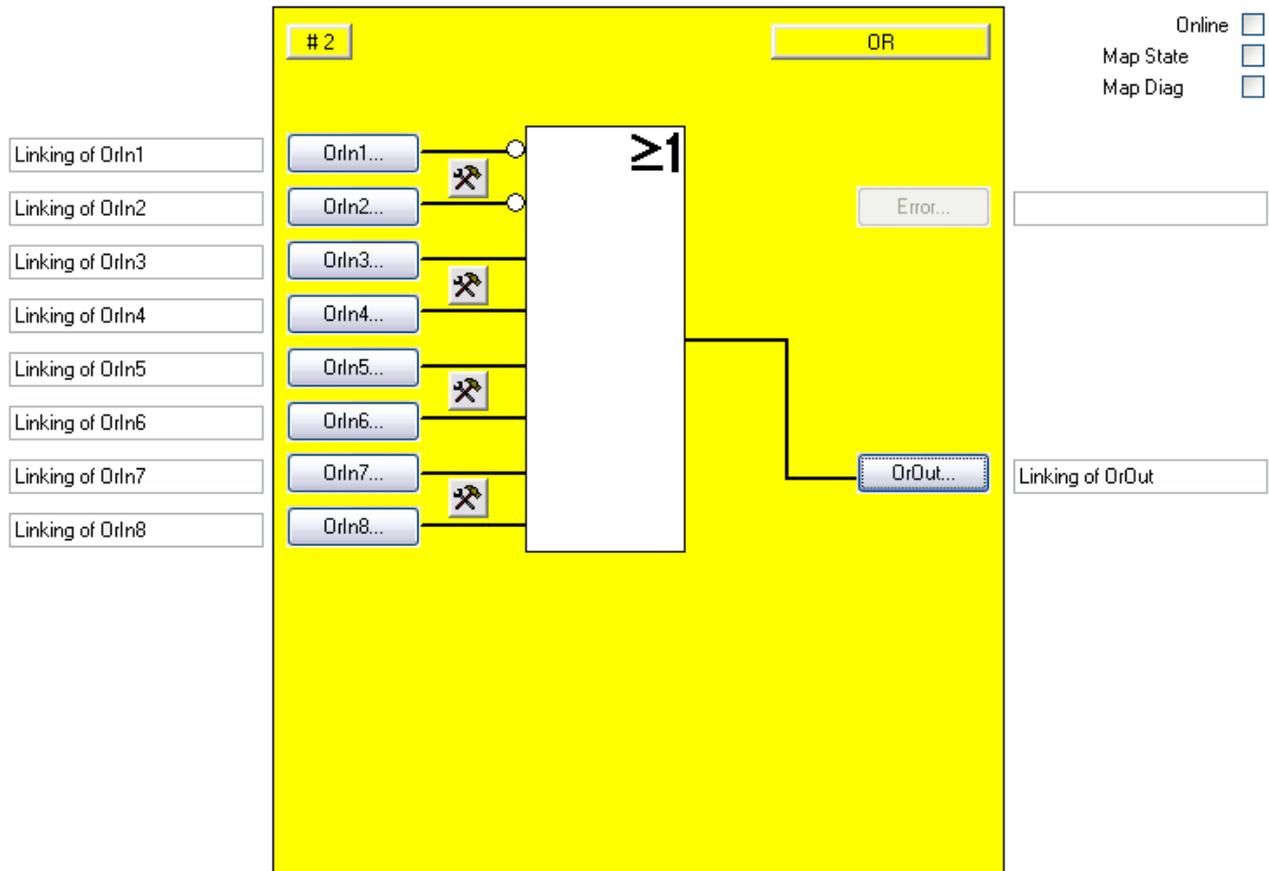
Figure 3-3: OR function block

3.2.2   Signal description

Table 3-6: FB OR inputs

Name	Permitted type	Description
OrIn1	TwinSAFE-In FB-Out	1st input channel
OrIn2	TwinSAFE-In FB-Out	2nd input channel
OrIn3	TwinSAFE-In FB-Out	3rd input channel
OrIn4	TwinSAFE-In FB-Out	4th input channel
OrIn5	TwinSAFE-In FB-Out	5th input channel
OrIn6	TwinSAFE-In FB-Out	6th input channel
OrIn7	TwinSAFE-In FB-Out	7th input channel
OrIn8	TwinSAFE-In FB-Out	8th input channel

Table 3-7: FB OR outputs

Name	Permitted type	Description
OrOut	TwinSAFE-Out FB-In Standard-Out Local-Out	Output channel

Table 3-8: FB OR input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input
Local-Out	TwinSAFE output at the KL6904 (not available for EL6900)

3.2.2.1 Diagnostic and status information for FB OR

Table 3-9: Diagnostic information (16-bit value)

Index	Description
0-15	always 0

Table 3-10: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE

i **Note**	**KL6904** The checkboxes 'Map State' and 'Map Diag' are not available for the KL6904.

### 3.2.3 FB OR configuration in the TwinCAT System Manager
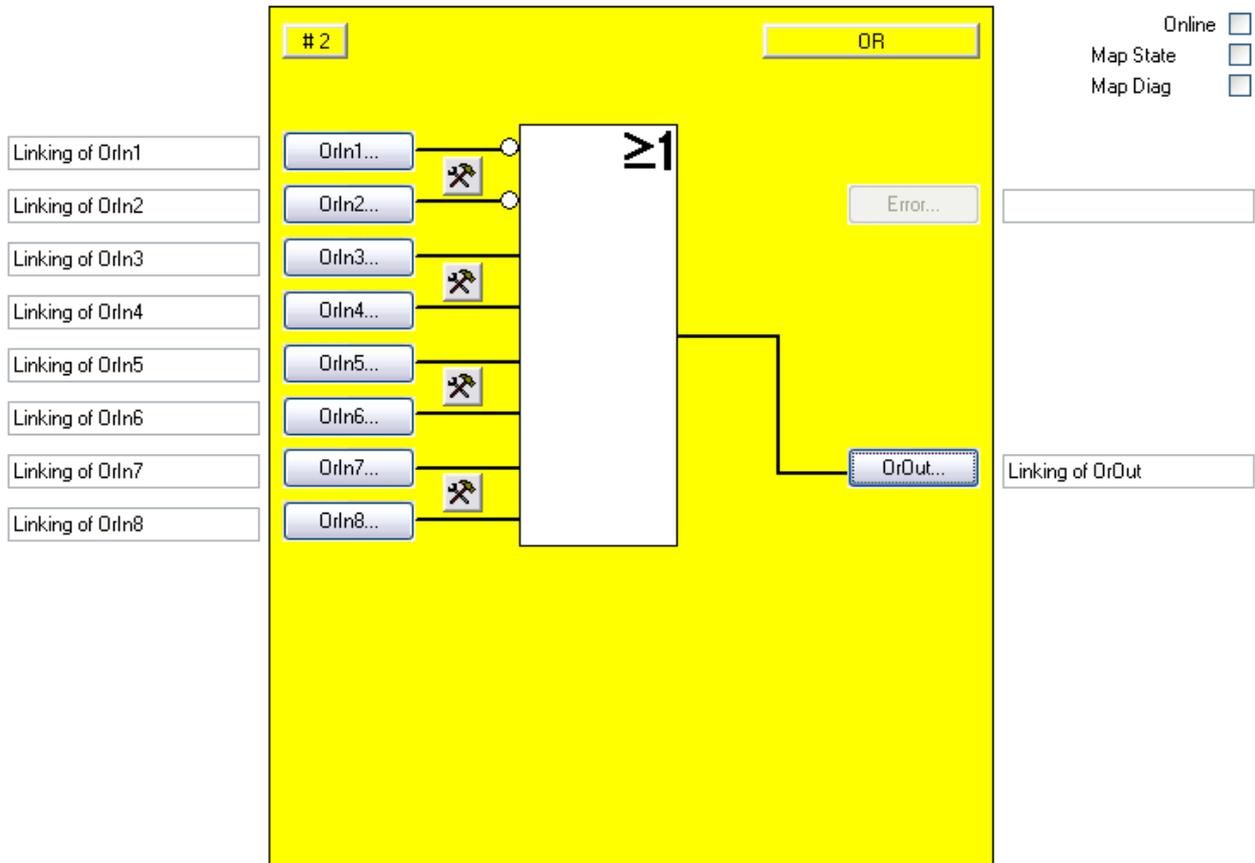
Figure 3-4: FB OR configuration

Their characteristics are configured with the setting buttons on the right near the two OrIn inputs, whereby the inputs are always single-channel. A discrepancy monitoring cannot be used for the OR.

The 'OrIn(x)' buttons are only available once the corresponding input was activated. In the default setting all inputs are disabled.

The FB OR input variables are linked using the 'OrIn(x)' buttons.

The output variable of the FB OR are linked using the 'OrOut' button.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

The FB OR does not supply any error information and therefore the error button is basically deactivated.

3.3 The OPMODE function block

3.3.1 Functional description

Operating mode selectors can be realized with the FB OPMODE. The function block has 8 inputs and 8 outputs, which are looped through one-to-one, whereby up to 8 different operating modes can be selected. The FB OPMODE sets the corresponding output, only when an input is precisely set ("1"), whereby the other outputs remain in a safe ("0") state. All outputs are in a safe state if there is none or more than one input is set. The output safe state can only be exited during start and change of operating modes using a 0->1->0 signal sequence on the restart input, once the restart input is activated. In addition a discrepancy time can be given, with which the change of operating mode can be monitored.
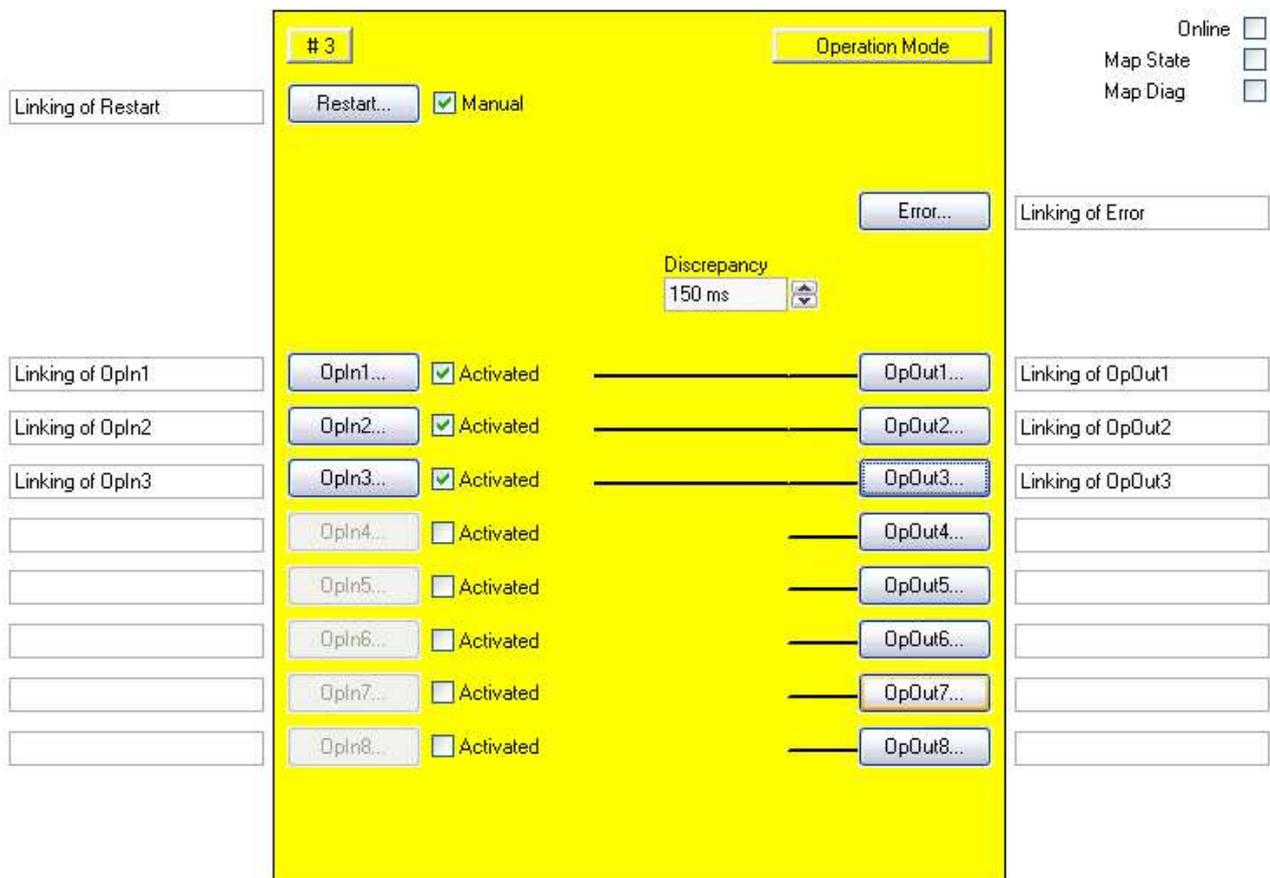
Figure 3-5: Function block OPMODE

	Number of inputs
i **Note**	At least two inputs of FB OPMODE must be connected.

3.3.2   Signal description

Table 3-11: FB OPMODE inputs

Name	Permitted type	Description
Restart	TwinSAFE-In FB-Out Standard-In	The 0->1->0 signal sequence must be detected on the restart input, before the safe state of the outputs can be removed, when starting the FB or when all outputs are switched to the safe state.
OpIn1	TwinSAFE-In FB-Out	1st input channel
OpIn2	TwinSAFE-In FB-Out	2nd input channel
OpIn3	TwinSAFE-In FB-Out	3rd input channel
OpIn4	TwinSAFE-In FB-Out	4th input channel
OpIn5	TwinSAFE-In FB-Out	5th input channel
OpIn6	TwinSAFE-In FB-Out	6th input channel
OpIn7	TwinSAFE-In FB-Out	7th input channel
OpIn8	TwinSAFE-In FB-Out	8th input channel

Table 3-12: FB OPMODE outputs

Name	Permitted type	Description
Error	TwinSAFE-Out FB-In Standard-Out Local-Out	TRUE: The discrepancy time monitoring or the input monitoring has found an error. The acknowledgement of the error must be carried out via the ERR_ACK input of the related TwinSAFE group FALSE: No error was found.
OpOut1	TwinSAFE-Out FB-In Standard-Out Local-Out	1st output channel
OpOut2	TwinSAFE-Out FB-In Standard-Out Local-Out	2nd output channel
OpOut3	TwinSAFE-Out FB-In Standard-Out Local-Out	3rd output channel
OpOut4	TwinSAFE-Out FB-In Standard-Out Local-Out	4th output channel
OpOut5	TwinSAFE-Out FB-In Standard-Out Local-Out	5th output channel
OpOut6	TwinSAFE-Out FB-In Standard-Out Local-Out	6th output channel
OpOut7	TwinSAFE-Out FB-In Standard-Out Local-Out	7th output channel
OpOut8	TwinSAFE-Out FB-In Standard-Out Local-Out	8th output channel

Table 3-13: FB OPMODE input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input
Local-Out	TwinSAFE output at the KL6904 (not available for EL6900)

3.3.2.1 Diagnostic and status information for FB OPMODE

Table 3-14: Diagnostic information (16-bit value)

Index	Description
0	Discrepancy monitoring error

Table 3-15: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE
4	ERROR
5	RESET
6	START

	KL6904
Note	The checkboxes 'Map State' and 'Map Diag' are not available for the KL6904.

3.3.3 FB OPMODE configuration in the TwinCAT System Manager
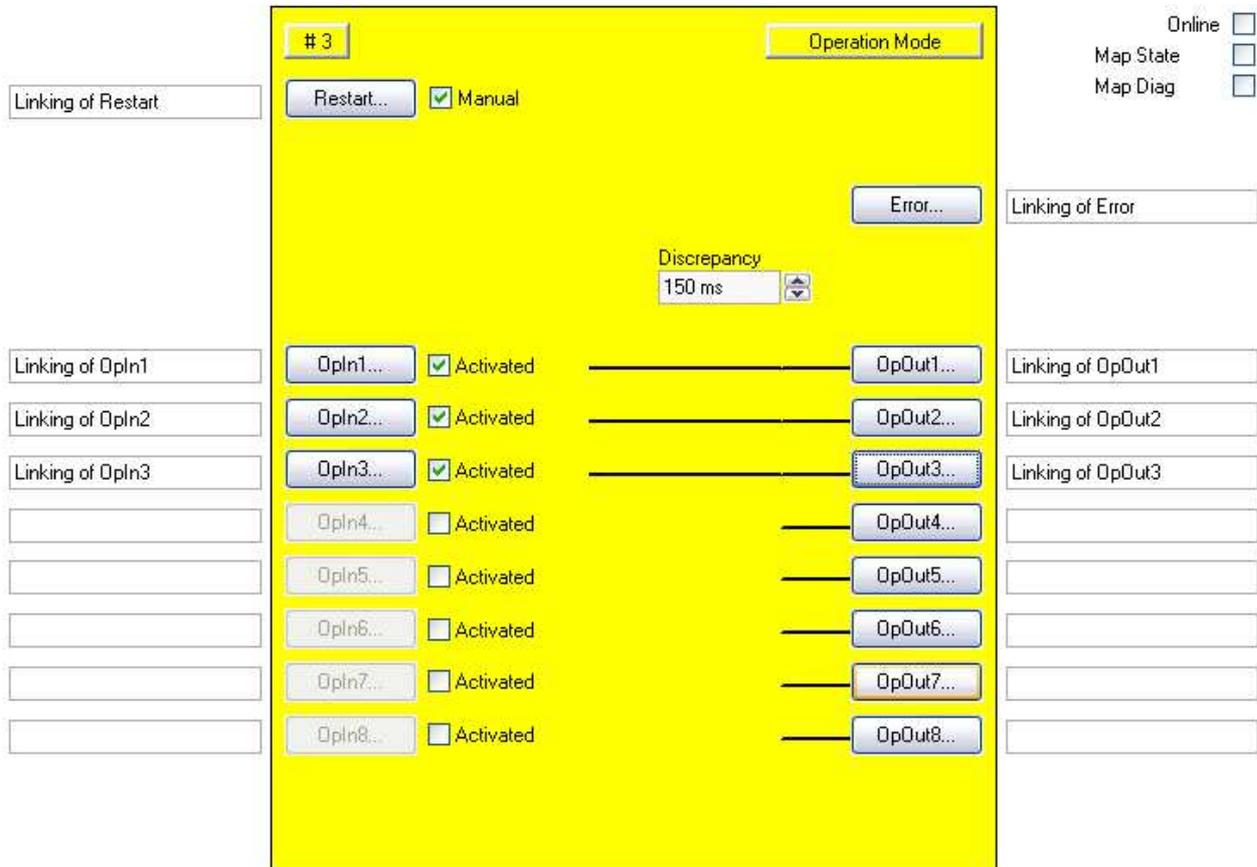
Figure 3-6: FB OPMODE configuration

The manual restart is activated using the "'Activated' " checkbox on the right near the 'Restart' button.

The inputs are activated via the 'Activated' check boxes to the right of the 'OpIn (x)' button.

The 'Restart' or 'OpIn(x)' buttons can only be selected, once the corresponding check box has been selected.

The FB OPMODE input variables are linked using the 'Restart' and 'OrIn(x)' buttons.

The FB OPMODE output variables are linked using the 'Error' and 'OpOut(x)' buttons.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

The discrepancy time is configured using the 'Discrepancy' selection box.

3.4 The ESTOP function block

3.4.1 Functional description

An emergency stop circuit with up to eight emergency stop inputs (EStopIn1-EStopIn8) can be realized with the FB ESTOP. Each of the eight inputs can be used as normally closed contact (Break contact - 0 requests the safe state) or normally open contacts (Make contact - 1 request the safe state). The first output (EStopOut) goes immediately, and the second output (EStopDelOut) after a configurable time delay, into the safe state ("0"), once an input requests the safe state. Several immediate (EStopOut) or delayed switch-off (EStopDelOut) outputs can be realized with only one FB ESTOP, due to the possibility to link the FB output to several outputs. The 0->1->0 signal sequence must be detected on the restart input, before the safe state of the outputs can be exited.
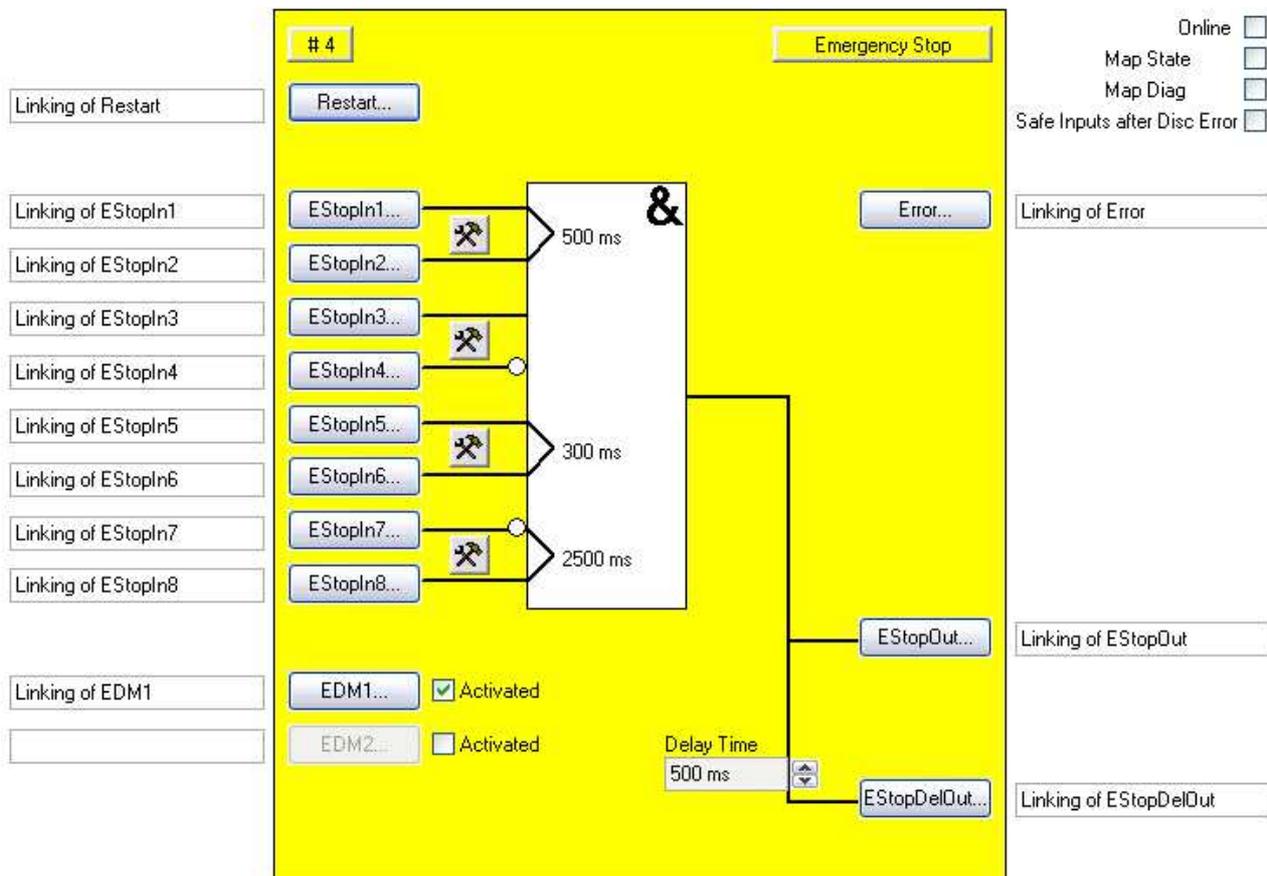
Figure 3-7: Function block ESTOP

Apart from this a feedback loop can be activated for both outputs, whereby the EStopOut output is fed back to the EDM1 input and the EStopDelOut output is fed back to the EDM2 output, using an external circuit. The EDM inputs are tested as soon as the safe state on the restart input should be exited using the 0->1->0 signal sequence. If the EDM inputs don't have the "1" signal state, the FB ESTOP goes into error state and sets the output error to 1. The error state can only be exited again by a 0->1->0 signal sequence on the ERR_ACK input of the related TwinSAFE group.

Furthermore each time 2 inputs (EStopIn1 and EStopIn2, EStopIn3 and EStopIn4, EStopIn5 and EStopIn6 and EStopIn7 and EStopIn8) can be consolidated as input pairs, whereby the signal states of both inputs can only deviate from each other within a configurable discrepancy time. If this discrepancy time is exceeded for an input pair, the FB ESTOP will also go into the error state. The outputs go into the safe state "0" if the FB is in error state. The characteristics for acknowledging a discrepancy error can be set via the checkbox *Safe Inputs after Disc Error*. If the checkbox is set, both inputs of the input group that has caused the discrepancy error have to return logical zero simultaneously before the error can be reset.

3.4.2   Signal description

Table 3-16: FB ESTOP inputs

Name	Permitted type	Description
Restart	TwinSAFE-In FB-Out Standard-In	The 0->1->0 signal sequence must be detected on the restart input, during start (when the related TwinSAFE group is started), or restart (when an input has requested the safe state), before the safe state of the outputs can be removed.
EStopIn1	TwinSAFE-In FB-Out	1st input channel: The parameterization determines, whether the input will be a normally closed contact (Break contact – safe state will be requested by logical 0) or normally open contact (Make contact – safe state will be requested by logical 1).
EStopIn2	TwinSAFE-In FB-Out	2nd input channel, behaves like EStopIn1 If the discrepancy time is not equal 0, the 1st and 2nd input channel are considered to be the 1st input pair and a discrepancy time monitoring is carried out between both channels.
EStopIn3	TwinSAFE-In FB-Out	3rd input channel or 1st input channel of the 2nd input pair, otherwise corresponds with EStopIn1
EStopIn4	TwinSAFE-In FB-Out	4th input channel or 2nd input channel of the 2nd input pair, otherwise corresponds with EstopIn2
EStopIn5	TwinSAFE-In FB-Out	5th input channel or 1st input channel of the 3rd input pair, otherwise corresponds with EStopIn1
EStopIn6	TwinSAFE-In FB-Out	6th input channel or 2nd input channel of the 3rd input pair, otherwise corresponds with EstopIn2
EStopIn7	TwinSAFE-In FB-Out	7th input channel or 1st input channel of the 4th input pair, otherwise corresponds with EStopIn1
EStopIn8	TwinSAFE-In FB-Out	8th input channel or 2nd input channel of the 4th input pair, otherwise corresponds with EstopIn2
EDM1	TwinSAFE-In FB-Out Standard-In	EDM1 is the feedback loop for the non-delayed output channel (EStopOut). If this input is parameterized as active, the safe state of the outputs will only be exited during restart, when the EDM1 supplies the "1" signal.
EDM2	TwinSAFE-In FB-Out Standard-In	EDM2 is the feedback loop for the delayed switching of the output channel (EStopDelOut). If this input is parameterized as active, the safe state of the outputs will only be exited during restart, when the EDM2 supplies the "1" signal.

Table 3-17: FB ESTOP outputs

Name	Permitted type	Description
Error	TwinSAFE-Out FB-In Standard-Out Local-Out	TRUE: The discrepancy time monitoring of an input pair, or one of the feedback loops, has found an error. The error reset must be carried out via the ERR_ACK input of the related TwinSAFE group. FALSE: No error was found.
EStopOut	TwinSAFE-Out FB-In Standard-Out Local-Out	1st output channel, the safe state corresponds to a logical 0.
EStopDelOut	TwinSAFE-Out FB-In Standard-Out Local-Out	2nd output channel, the safe state corresponds to a logical 0. The safe state is output with a delay, which corresponds to the parameterized Delay Time.

Table 3-18: FB ESTOP input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input
Local-Out	TwinSAFE output at the KL6904 (not available for EL6900)

3.4.2.1 Diagnostic and status information for FB ESTOP

Table 3-19: Diagnostic information (16-bit value)

Index	Description
0	Discrepancy error input group 1
1	Discrepancy error input group 2
2	Discrepancy error input group 3
3	Discrepancy error input group 4
4	EDM monitoring error EDM1
5	EDM monitoring error EDM2
6	-
7	-
8	Discrepancy error input group 1 with activated option "Safe Inputs after Disc Error" (set in addition to bit 0)
9	Discrepancy error input group 2 with activated option "Safe Inputs after Disc Error" (set in addition to bit 1)
10	Discrepancy error input group 3 with activated option "Safe Inputs after Disc Error" (set in addition to bit 2)
11	Discrepancy error input group 4 with activated option "Safe Inputs after Disc Error" (set in addition to bit 3)

Table 3-20: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE
4	ERROR
5	RESET
6	START
8	DELAYOUT

i **Note**	**KL6904** The checkboxes 'Map State', 'Map Diag' and 'Safe Inputs after Discrepancy Error' are not available in the KL6904.

3.4.3   FB ESTOP configuration in the TwinCAT System Manager
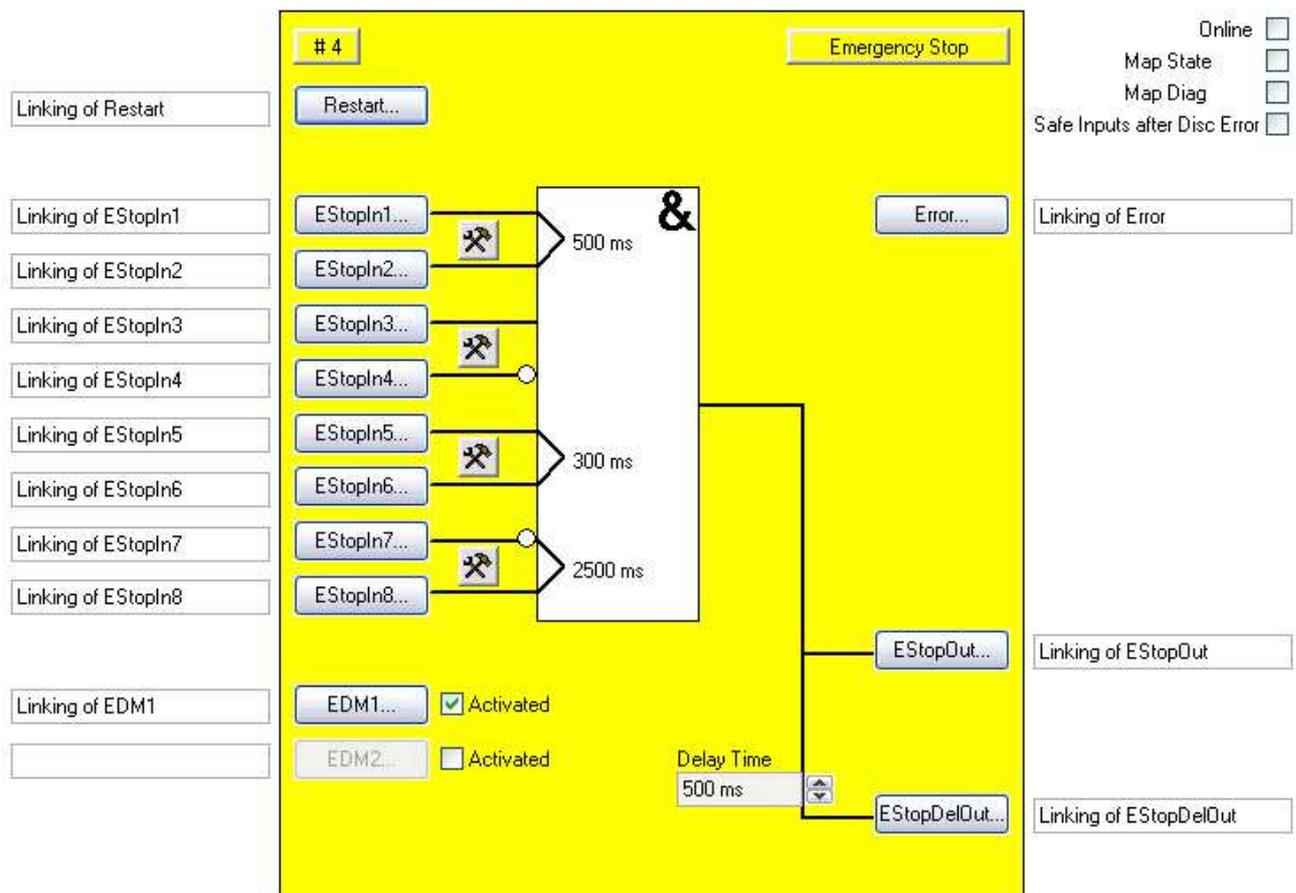
Figure 3-8: FB ESTOP configuration

The characteristics of an input pair are configured with the setting buttons on the right near the two EStopIn inputs of this input pair.

The 'EStopIn(x)' buttons can only be selected when the associated input has been activated. All inputs are deactivated in the default state.

The FB ESTOP input variables are linked using the 'Restart', 'EStopIn(x)' and 'EDM(x)' buttons.

The corresponding feedback loop is activated using the 'Activated' checkbox on the right near the 'EDM(x)' buttons. The 'EDM(x)' button can only be selected, if the associated feedback loop is activated.

The FB ESTOP output variables are linked using the 'Error', 'EStopOut' and 'EStopDelOut' buttons.

The delay time of the 'EStopDelOut' output is configured via the selection box 'Delay-Time'.

The characteristics for acknowledging a discrepancy error can be set via the checkbox 'Safe Inputs after Disc Error'. If the checkbox is set, both inputs of the input group that has caused the discrepancy error have to return logical zero simultaneously before the error can be reset.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.5 The MON function block

3.5.1 Functional description

A safety door circuit with up to four inputs (MonIn(x)) can be realized with the FB MON for example. Each of the four inputs can be used as normally closed contact (Break contact - 0 requests the safe state) or normally open contact (Make contact - 1 request the safe state). The first output (MonOut) goes immediately, and the second one (MonDelOut) after a configurable time delay, into the safe state "0", once an input requests the safe state. Several immediate (MonOut) or delayed switch-off (MonDelOut) outputs can be realized with only one FB MON, due to the linking possibility of the FB output with several outputs.

In addition there are two Secure inputs, with which the request of the safe state can be bypassed through the MonIn inputs. The Secure inputs can also be realized as normally closed contacts (Break contact) or normally open contacts (Make contact).

The FB restart input can be activated. The 0->1->0 signal sequence must be detected on the restart input, in case of an active restart, before the safe state of the outputs is exited. In case of an inactive restart the safe state is exited once the MonIn or Secure inputs no longer request the safe state.
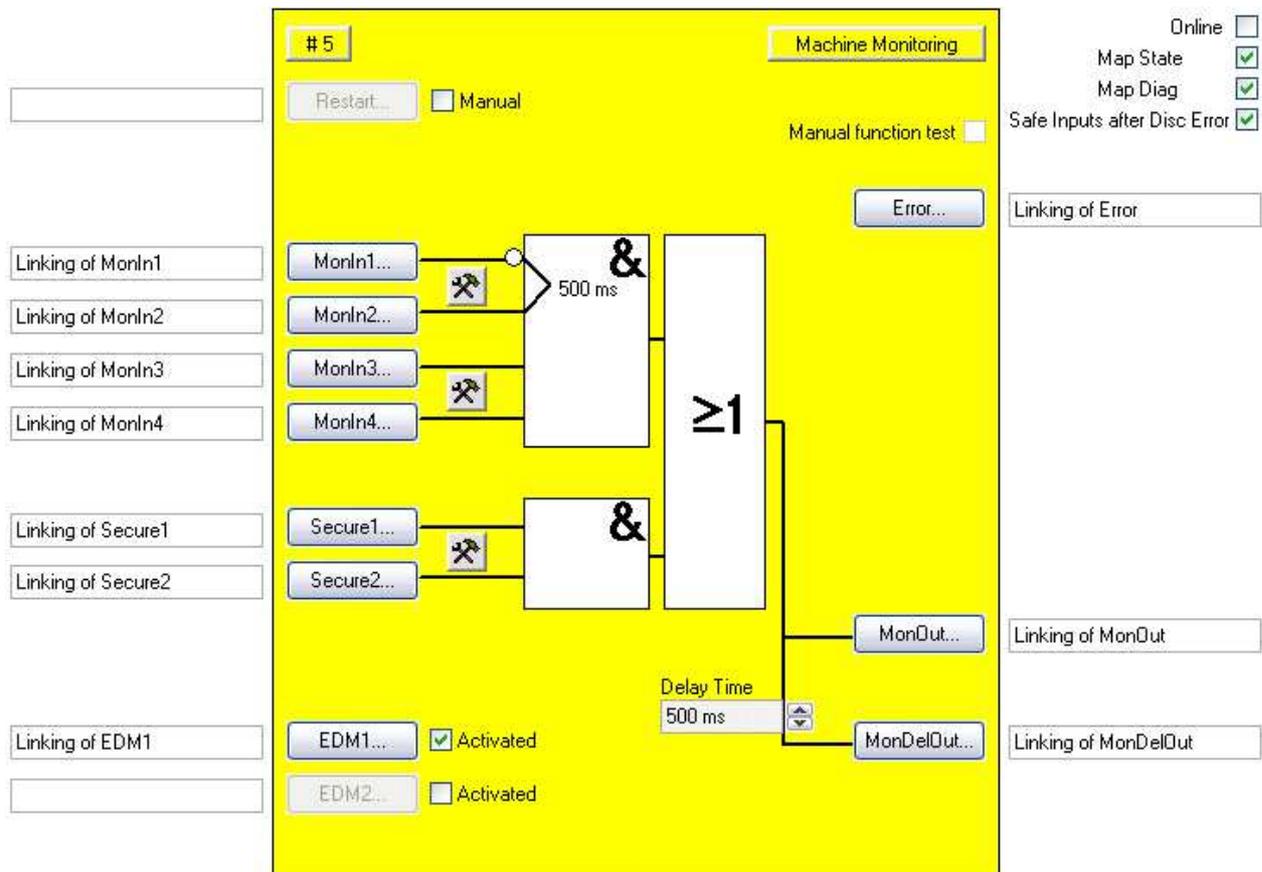
Figure 3-9: MON function block

In addition, a feedback loop can be activated for each output, whereby the MonOut output is fed back to the EDM1 input and the MonDelOut output is fed back to the EDM2 input, using an external circuit. Die EDM-inputs are tested once the safe state should be exited. The FB MON goes into error state in the case of activated restart and sets the output error to 1, when the EDM inputs don't have the "1" signal state. The FB MON remains in the safe state in the case of deactivated restart, when the EDM inputs don't have the "1" signal state at the restart moment. An EDM error can therefore only be detected, when the manual restart is active. The error state can only be exited again by a 0->1->0 signal sequence on the

ERR_ACK input of the related TwinSAFE group.

Furthermore each time 2 inputs (MonIn1 and MonIn2, MonIn3 and MonIn4 and Secure1 and Secure2) can be consolidated as input pairs, whereby the signal states of both inputs can only deviate from each other within a configurable discrepancy time. If this discrepancy time is exceeded for an input pair, the FB MON will also go into the error state. The characteristics for acknowledging a discrepancy error can be set via the checkbox 'Safe Inputs after Disc Error'. If the checkbox is set, both inputs of the input group that has caused the discrepancy error have to return logical zero simultaneously before the error can be reset.

The safe state must have been requested at least once on each active MonIn input after starting the FB MON if the manual function test is active, before an edge of the restart input reacts.

3.5.2 Signal description

Table 3-21: FB MON inputs

Name	Permitted type	Description
Restart	TwinSAFE-In FB-Out Standard-In	The 0->1->0 signal sequence must be detected at the restart input, during the start of the FB or when an input request the safe state, in case a manual restart is active, before the safe state of the outputs is exited. This input is not used if the manual restart is inactive. Both starting and exiting the safe state is carried out automatically, as long as no input requests any longer the safe state.
MonIn1	TwinSAFE-In FB-Out	1st input channel: The parameterization determines, whether the input is linked to a normally closed contact (Break contact – safe state will be requested by logical 0) or normally open contact (Make contact – safe state will be requested by logical 1).
MonIn2	TwinSAFE-In FB-Out	2nd input channel, behaves like MonIn1 If the discrepancy time is activated or used, the 1st and 2nd input channels are considered to be the 1st input pair and a discrepancy time monitoring is carried out between both channels.
MonIn3	TwinSAFE-In FB-Out	3rd input channel or 1st input channel of the 2nd input pair, otherwise corresponds with MonIn1
MonIn4	TwinSAFE-In FB-Out	4th input channel or 2nd input channel of the 2nd input pair, otherwise corresponds with MonIn2
Secure1	TwinSAFE-In FB-Out	If the Secure1 or Secure2 are parameterized as active, the evaluation of the MonIn(x) inputs can be switched off. If Secure1 or Secure2 are parameterized as normally closed contact (Break contact), the MonIn(x) inputs are ignored if Secure1 and/or Secure2 are "1". If Secure1 or Secure2 are parameterized as normally open contact (Make contact), the MonIn(x) inputs are ignored if Secure1 and/or Secure2 are "0". If the discrepancy time is activated or used, Secure1 and Secure2 are considered as an input pair and a discrepancy time monitoring is carried out between both channels.
Secure2	TwinSAFE-In FB-Out	Secure2 is the 2nd channel of the input pair and otherwise corresponds to Secure1.
EDM1	TwinSAFE-In FB-Out Standard-In	EDM1 is the feedback loop for the non-delayed output channel (MonOut). If this input is parameterized as active, the safe state of the outputs will only be exited, when the EDM1 supplies the "1" signal.
EDM2	TwinSAFE-In FB-Out Standard-In	EDM2 is the feedback loop for the delayed switching of the output channel (MonDelOut). If this input is parameterized as active, the safe state of the outputs will only be exited, when the EDM2 supplies the "1" signal.

Table 3-22: FB MON outputs

Name	Permitted type	Description
Error	TwinSAFE-Out FB-In Standard-Out Local-Out	TRUE: The discrepancy time monitoring of an input pair, or one of the feedback loops, has found an error. The error reset must be carried out via the ERR_ACK input of the related TwinSAFE group. FALSE: No error was found.
MonOut	TwinSAFE-Out FB-In Standard-Out Local-Out	1st output channel, the safe state corresponds to a logical 0.
MonDelOut	TwinSAFE-Out FB-In Standard-Out Local-Out	2nd output channel, the safe state corresponds to a logical 0. The safe state is output with a delay, which corresponds to the parameterized Delay Time.

Table 3-23: FB MON input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input
Local-Out	TwinSAFE output at the KL6904 (not available for EL6900)

3.5.2.1 Diagnostic and status information for FB MON

Table 3-24: Diagnostic information (16-bit value)

Index	Description
0	Discrepancy error input group 1
1	Discrepancy error input group 2
2	Discrepancy error in Secure input group
4	EDM monitoring error EDM1
5	EDM monitoring error EDM2

Table 3-25: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE
4	ERROR
5	RESET
6	START
7	ERRORDELAY
8	DELAYOUT
9	FUNCTEST

i **Note**	**KL6904** The checkboxes 'Map State', 'Map Diag' and 'Safe Inputs after Discrepancy Error' are not available in the KL6904.

### 3.5.3 FB MON configuration in the TwinCAT System Manager
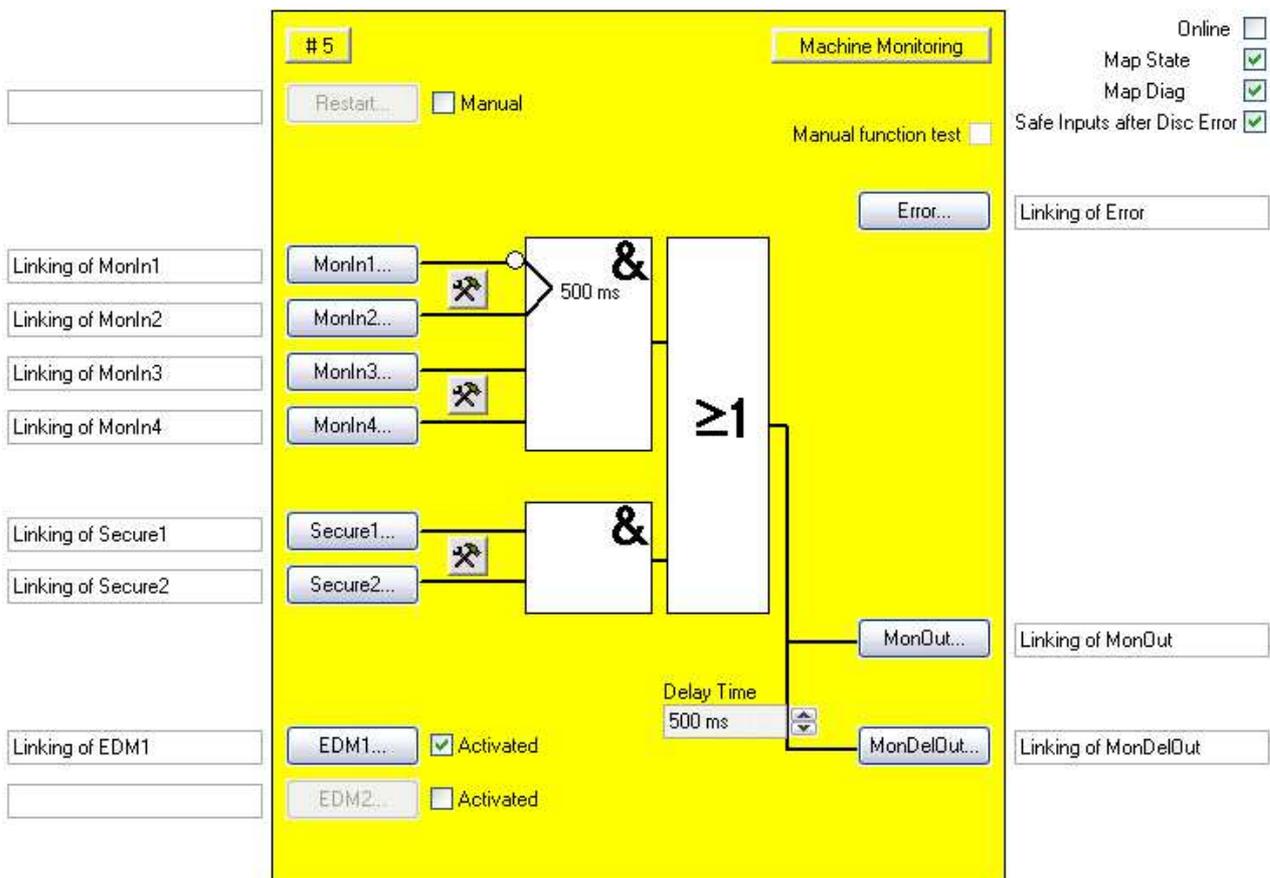
Figure 3-10: FB MON configuration

The manual restart is activated using the "Manual" checkbox on the right near the 'Restart' button. The 'Restart' button can only be selected, if the manual restart is activated.
The characteristics of the input pair are configured with the setting buttons on the right near the two

MonIn or Secure inputs of an input pair. The 'MonIn(x)' or 'Secure(x)' buttons can only be selected when the associated input has been activated. All inputs are deactivated by default.

The corresponding feedback loop is activated using the 'Activated' checkbox on the right near the 'EDM(x)' buttons. The 'EDM(x)' button can only be selected, if the associated feedback loop is activated. The FB MON input variables are linked using the 'Restart', 'MonIn(x)', 'Secure(x)' and 'EDM(x)' buttons. The manual function test is activated using the 'Manual Function Test' checkbox.

The FB MON output variables are linked using the 'Error', 'MonOut' and 'MonDelOut' buttons.
The FB MON output variables are linked using the 'Error', 'MonOut' and 'MonDelOut' buttons.

The characteristics for acknowledging a discrepancy error can be set via the checkbox 'Safe Inputs after Disc Error'. If the checkbox is set, both inputs of the input group that has caused the discrepancy error have to return logical zero simultaneously before the error can be reset.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.6 The DECOUPLE function block

3.6.1 Functional description

The FB DECOUPLE is for uncoupling of signals from a TwinSAFE connection. The function block has 8 inputs and 8 outputs, whereby the inputs are looped one-to-one on the outputs. The associated output must be linked as soon as one of the block inputs is used. The converse is also valid.
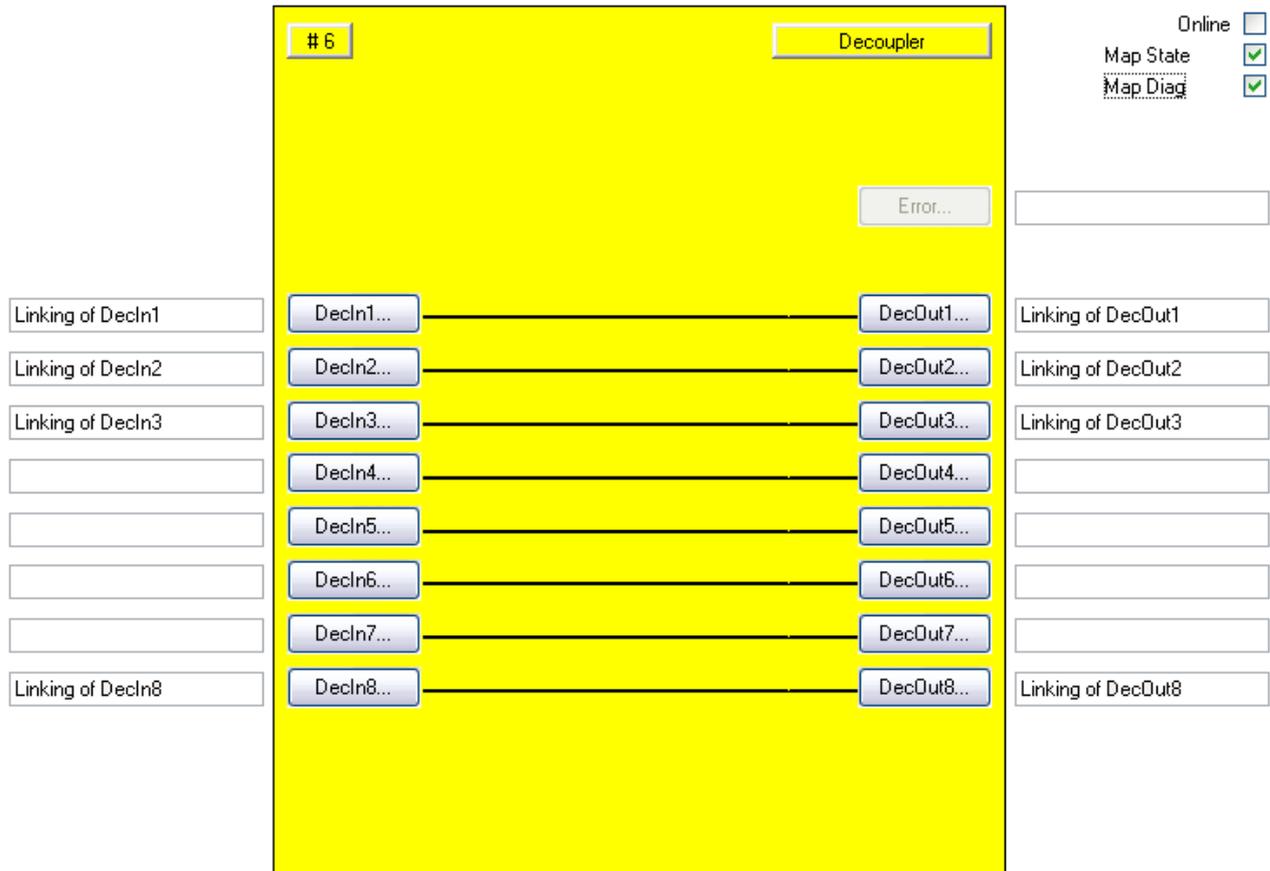

Figure 3-11: DECOUPLE function block

It is possible to subdivide and decouple the signals of a TwinSAFE connection into several TwinSAFE groups, using the FB DECOUPLE, since a TwinSAFE connection is always assigned to a TwinSAFE group. The block within an existing TwinSAFE group can be used to subdivide the signals. The block must be used in a separate TwinSAFE group in case the signals should be decoupled, since all used outputs of the TwinSAFE group can be switched off in case of a connection communication error. The input signals of a TwinSAFE connection can now be linked with the FB DECOUPLE inputs, and the outputs distributed over the different TwinSAFE groups. It operates the same way in the other directions, the outputs of a TwinSAFE connection are linked with the FB DECOUPLE outputs, the FB DECOUPLE inputs can once again come from various TwinSAFE groups.

3.6.2 Signal description

Table 3-26: FB DECOUPLE inputs

Name	Permitted type	Description
DecIn1	TwinSAFE-In FB-Out	1st input channel
DecIn2	TwinSAFE-In FB-Out	2nd input channel
DecIn3	TwinSAFE-In FB-Out	3rd input channel
DecIn4	TwinSAFE-In FB-Out	4th input channel
DecIn5	TwinSAFE-In FB-Out	5sht input channel
DecIn6	TwinSAFE-In FB-Out	6th input channel
DecIn7	TwinSAFE-In FB-Out	7th input channel
DecIn8	TwinSAFE-In FB-Out	8th input channel

Table 3-27: FB DECOUPLE outputs

Name	Permitted type	Description
DecOut1	TwinSAFE-Out FB-In Standard-Out Local-Out	1st output channel
DecOut2	TwinSAFE-Out FB-In Standard-Out Local-Out	2nd output channel
DecOut3	TwinSAFE-Out FB-In Standard-Out Local-Out	3rd output channel
DecOut4	TwinSAFE-Out FB-In Standard-Out Local-Out	4th output channel
DecOut5	TwinSAFE-Out FB-In Standard-Out Local-Out	5th output channel
DecOut6	TwinSAFE-Out FB-In Standard-Out Local-Out	6th output channel
DecOut7	TwinSAFE-Out FB-In Standard-Out Local-Out	7th output channel
DecOut8	TwinSAFE-Out FB-In Standard-Out Local-Out	8th output channel

Table 3-28: FB DECOUPLE input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input
Local-Out	TwinSAFE output at the KL6904 (not available for EL6900)

3.6.2.1 Diagnostic and status information for FB DECOUPLE

Table 3-29: Diagnostic information (16-bit value)

Index	Description
0	always 0

Table 3-30: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP

	KL6904
i **Note**	The checkboxes 'Map State' and 'Map Diag' are not available for the KL6904.

### 3.6.3 FB DECOUPLE configuration in the TwinCAT System Manager
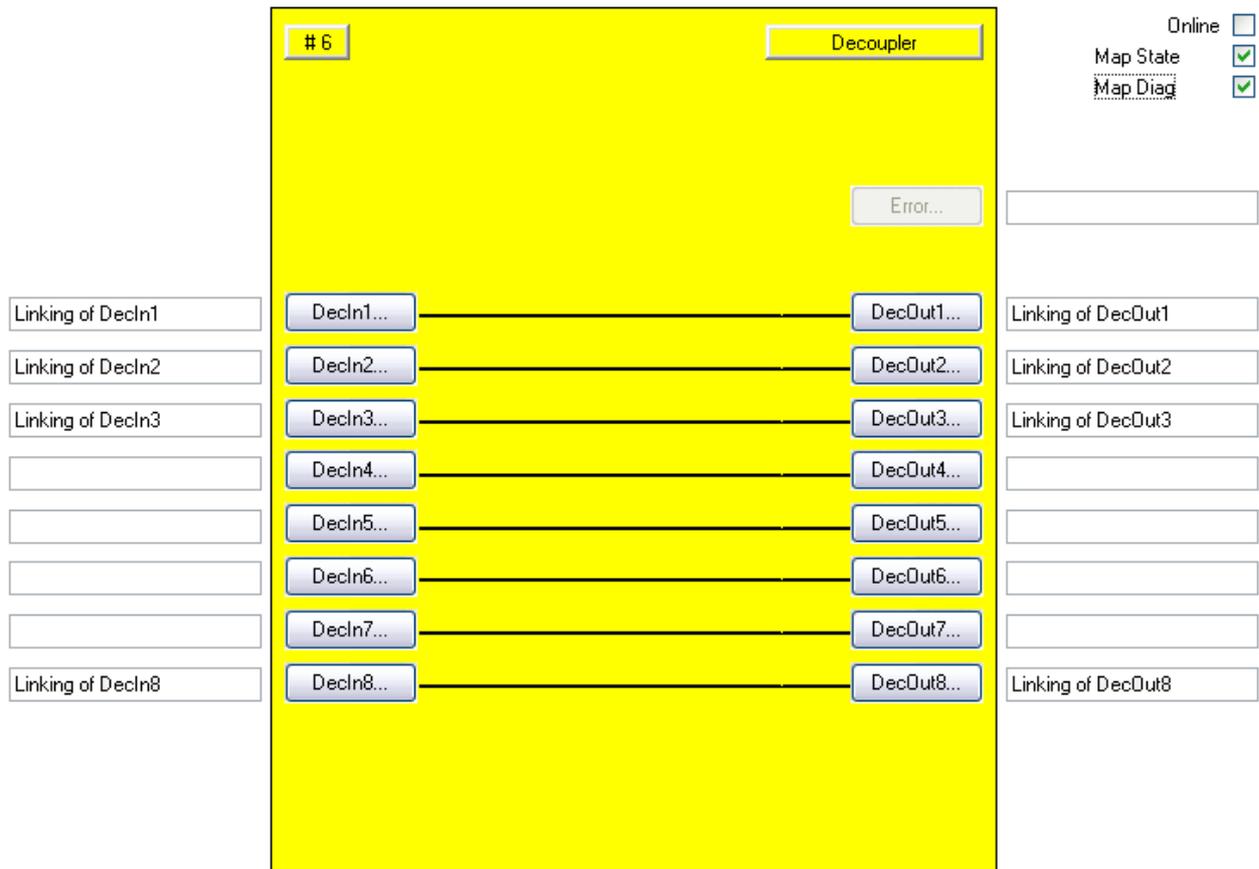
Figure 3-12: FB DECOUPLE configuration

The FB DECOUPLE input variables are linked using the 'DecIn(x)' buttons.

The FB DECOUPLE output variables are linked using the 'DecOut(x)' buttons.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

The FB DECOUPLE does not supply any error information and therefore the error button is basically deactivated.

3.7   The TWO-HAND function block

3.7.1   Functional description

The FB TWO-HAND is used to realize a two-hand control unit in which both input groups have to be operated simultaneously in order to switch the output. Repeated setting of the output is only possible if both input groups were on logic 0 at the same time.

An input group can be configured as a single-channel input, two-channel input or two-channel input with discrepancy time monitoring. In addition, time monitoring up to 2500 ms between the two input groups can be defined. Each input can be configured as normally closed contact (NC) or normally open contact (NO).
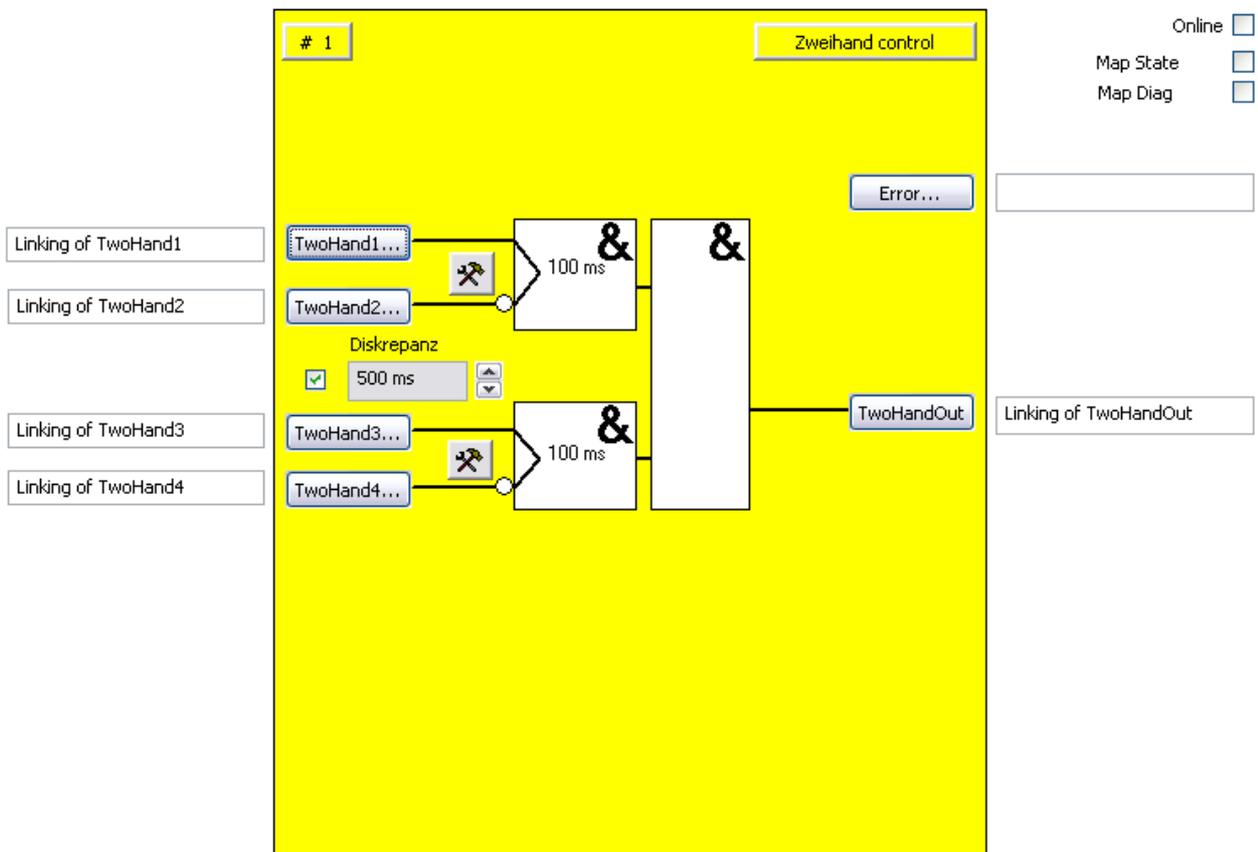

Figure 3-13: TWO-HAND function block

ⓘ **Note**	**KL6904** The two-hand block is not available in the KL6904.

3.7.2 Signal description

Table 3-31: FB TWO-HAND inputs

Name	Permitted type	Description
Twohand1	TwinSAFE-In FB-Out	1st input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).
Twohand2	TwinSAFE-In FB-Out	2nd input channel, behaves like Twohand1 If the discrepancy time is not equal 0, the 1st and 2nd input channel are considered to be the 1st input group and a discrepancy time monitoring is carried out between both channels, if one of the two input channels requests the safe state.
Twohand3	TwinSAFE-In FB-Out	3rd input channel or 1st input channel of the 2nd input group, otherwise corresponds with Twohand1
Twohand4	TwinSAFE-In FB-Out	4th input channel or 2nd input channel of the 2nd input group, otherwise corresponds with Twohand2

Table 3-32: FB TWO-HAND outputs

Name	Permitted type	Description
Error	TwinSAFE-Out FB-In Standard-Out	TRUE: The discrepancy time monitoring for a 2-channel input group has detected an error. The error must be acknowledged via the ERR_ACK input of the corresponding TwinSAFE group FALSE: No error was found
TwoHandOut	TwinSAFE-Out FB-In Standard-Out	1st output channel, the safe state corresponds to a logical 0.

Table 3-33: FB TWO-HAND input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.7.2.1   Diagnostic and status information for FB TWO-HAND

Table 3-34: Diagnostic information (16-bit value)

Index	Description
0	Discrepancy error input group 1
1	Discrepancy error input group 2
2	Discrepancy error between the two input groups
6	Two-hand error

Table 3-35: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE
4	ERROR
5	RESET
6	START
11	1BUTTON
12	2BUTTON
13	RELEASE

### 3.7.3 FB TWO-HAND configuration in the TwinCAT System Manager
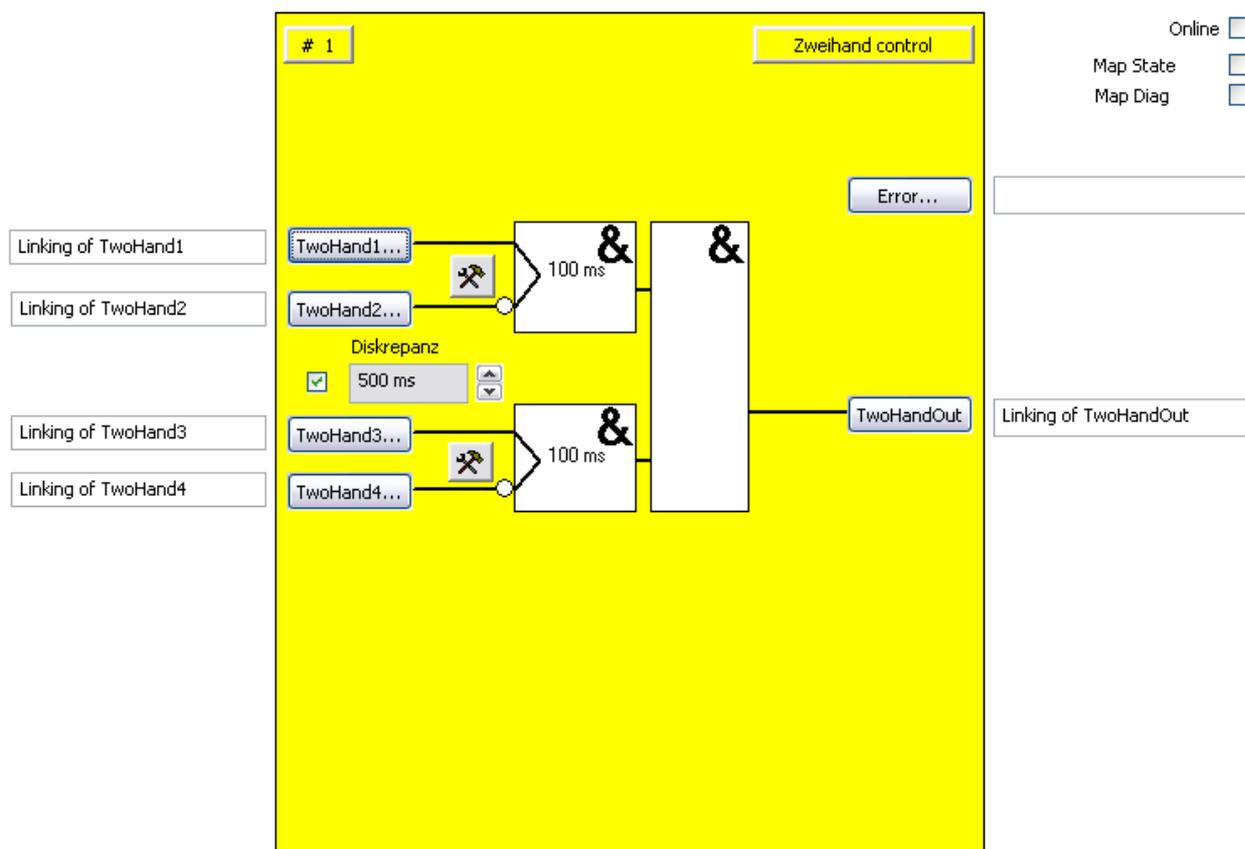
Figure 3-14: FB TWO-HAND configuration

Discrepancy time monitoring for the two input groups is activated via the "Discrepancy" checkbox. The discrepancy time can be set in the selection box next to the checkbox.

The characteristics of the input pair are configured with the setting buttons on the right near the two TwoHand(x) inputs of an input pair. The 'TwoHand(x)' buttons can only be selected when the associated input has been activated. All inputs are deactivated in the default state.

The FB TWO-HAND input variables are linked using the 'TwoHand(x)' buttons.

The buttons 'Error' and 'TwoHandOut' are used to link the output variables of FB Two-hand.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.7.4 Examples of two-hand control types according to DIN EN 574 : 1996
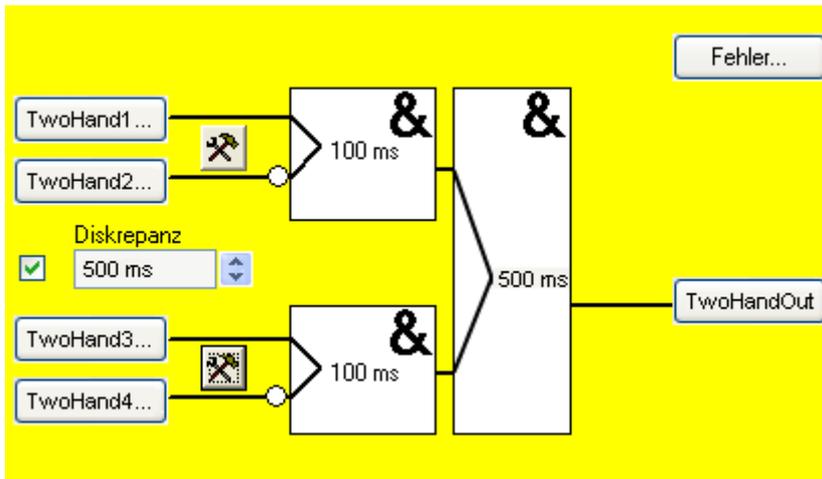

Figure 3-15: Type IIIC - category 4 application according to EN954-1:1996 with synchronous actuation
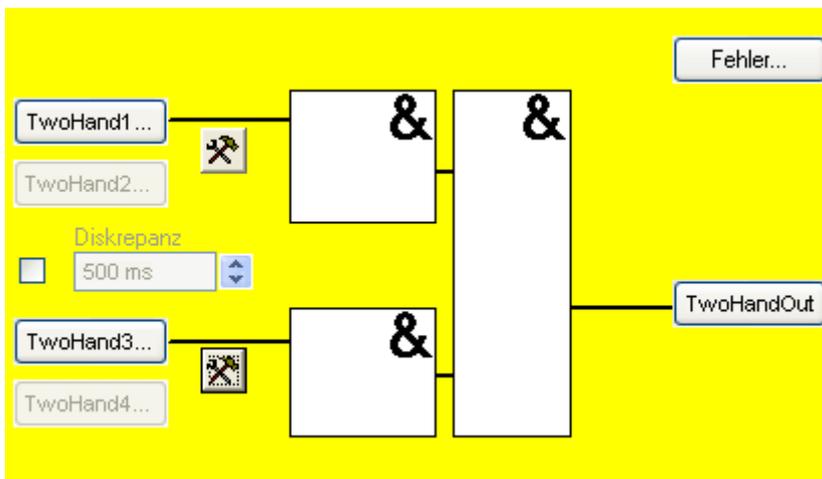
Figure 3-16: Type I - category 1 application according to EN954-1:1996 without synchronous actuation

3.8 The MUTING function block

3.8.1 Functional description

FB MUTING is used to realize specified suppression of the protective function, e.g. for transporting material into the protection zone. The output of the block remains set, despite interruption of the connected sensors.

The muting inputs are used to verify that they are operated in a defined order. Muting can be activated via the Enable input. If the input is logic 0 an interruption of the protective device results in immediate shutdown of the FB output. Otherwise only if the muting sequence is violated. The 'SequentialInputs' input can be used to specified whether 2 inputs are checked in parallel or sequentially. A filter time up to 500 ms can be set for the muting inputs in order to prevent bouncing of the muting signals and therefore violation of the muting sequence. The maximum duration of the muting process can be monitored via the 'Max. MutingTime'. The muting process starts with a logic 1 signal of the first muting input and ends with the logic 0 signal of the last muting input. The value can be set to a maximum of 10 minutes or to 0, which corresponds to deactivation of the monitoring. During this period the 'MutingActive' output of the block is set. The protective device (AOPD - Active Opto-electronic Protection Device), for example a light grid, is connected at the 'OSSDIn(x)' inputs. Feedback signals can be connected at the EDM inputs. In the default setting the inputs are disabled. Direct outputs are connected via the 'MuteOut' button, outputs that are delayed by up to 30 seconds via the 'MuteDelOut' button.
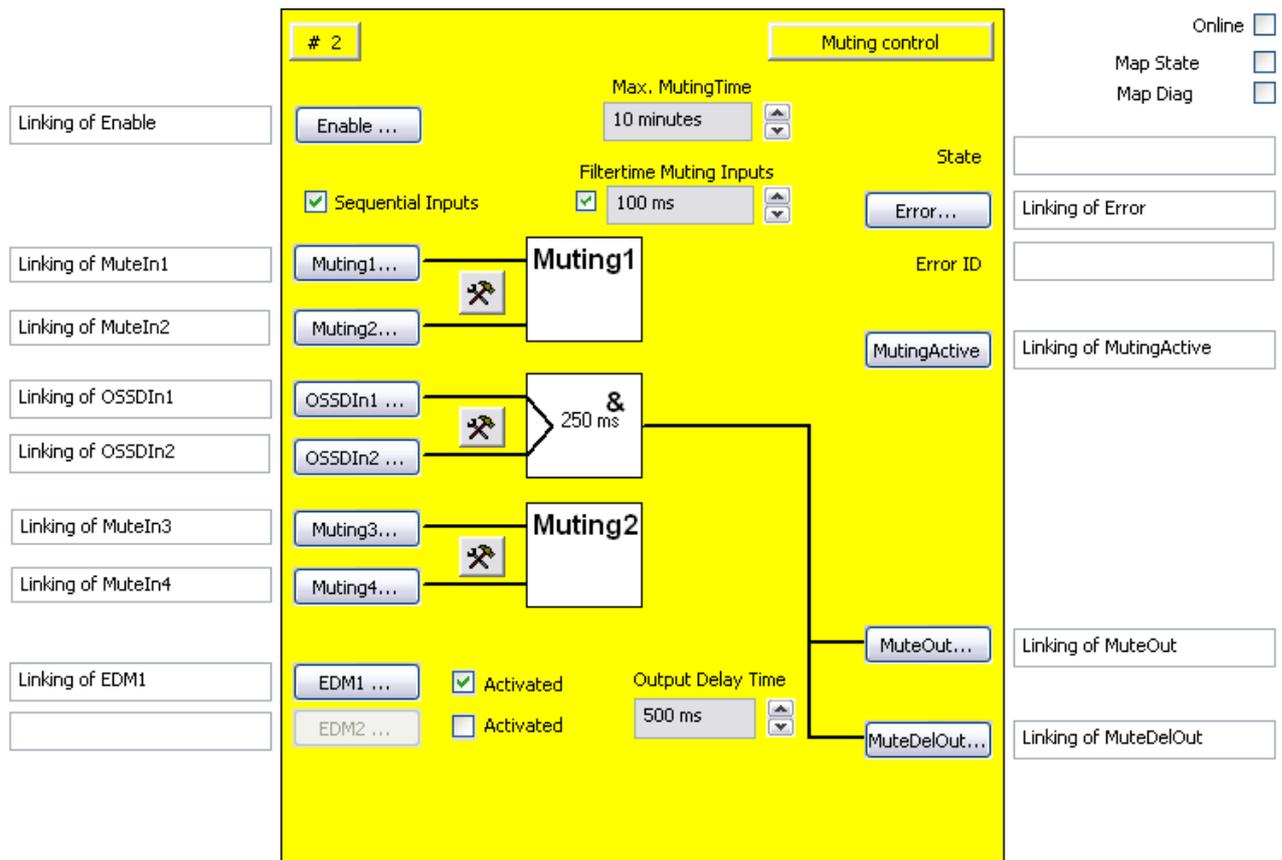

Figure 3-17: MUTING function block

	KL6904
i **Note**	The Muting block is not available in the KL6904.

3.8.2 Signal description

Table 3-36: FB MUTING inputs

Name	Permitted type	Description
Enable	TwinSAFE-In FB-Out Standard-In	Muting can be activated via the Enable input. If the input is logic 0 an interruption of the protective device results in immediate shutdown of the FB output.
MutingIn1	TwinSAFE-In FB-Out	The muting inputs are used to verify that they are operated in a defined order. 1st input channel. The parameterization is used to specify whether the input has to be negated or is used directly.
MutingIn2	TwinSAFE-In FB-Out	2nd input channel, behaves like MutingIn1 If the discrepancy time is not equal 0, the 1st and 2nd input channel are considered to be the 1st input group and a discrepancy time monitoring is carried out between both channels, if one of the two input channels requests the safe state.
MutingIn3	TwinSAFE-In FB-Out	3rd input channel or 1st input channel of the 2nd input group, otherwise corresponds with MutingIn1
MutingIn4	TwinSAFE-In FB-Out	4th input channel or 2nd input channel of the 2nd input group, otherwise corresponds with MutingIn2
EDM1	TwinSAFE-In FB-Out Standard-In	EDM1 is the feedback loop for the outlet channel (MuteOut), which is switched off immediately. If this input as activated, the safe output state is only exited when EDM1 is set to 1.
EDM2	TwinSAFE-In FB-Out Standard-In	EDM2 is the feedback loop for the output channel (MuteDelOut), which is switched off with a delay. If this input as activated, the safe output state is only exited when EDM2 is set to 1.
OSSDIn1	TwinSAFE-In FB-Out	The protective device (AOPD - Active Opto-electronic Protection Device), for example a light grid, is connected at the 'OSSDIn' inputs. 1st input channel. The parameterization is used to specify whether the input has to be negated or is used directly.
OSSDIn2	TwinSAFE-In FB-Out	OSSDIn2 is the 2nd channel for the protective device and otherwise matches OSSDIn1

Table 3-37: FB MUTING outputs

Name	Permitted type	Description
Error	TwinSAFE-Out FB-In Standard-Out	TRUE: The discrepancy time monitoring for a 2-channel input group has detected an error, the muting sequence was violated, or the maximum muting time exceeded. The error must be acknowledged via the ERR_ACK input of the corresponding TwinSAFE group. FALSE: No error was found
MutingActive	TwinSAFE-Out FB-In Standard-Out	1st outlet channel. It indicates the current muting process through logic 1.
MuteOut	TwinSAFE-Out FB-In Standard-Out	1st output channel, the safe state corresponds to a logical 0.
MuteDelOut	TwinSAFE-Out FB-In Standard-Out	2nd output channel, the safe state corresponds to a logical 0. The safe state is output with a delay, which corresponds to the parameterized Delay Time.

Table 3-38: FB MUTING input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.8.2.1 Diagnostic and status information for FB MUTING

Table 3-39: Diagnostic information (16-bit value)

Index	Description
0	Discrepancy error in muting input group 1
1	Discrepancy error in the OSSD input group
2	Discrepancy error in muting input group 2
4	EDM monitoring error EDM1
5	EDM monitoring error EDM2
6	Muting sequence was violated
7	Maximum muting time was exceeded

Table 3-40: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE
4	ERROR
5	RESET
6	not used
7	not used
8	DELAYOUT
9	MUTING1
10	MUTING2
11	MUTING3
12	MUTING4
13	MUTING5
14	MUTING6
15	MUTING7
16	MUTING8
17	MUTING9

## 3.8.3 FB MUTING configuration in the TwinCAT System Manager
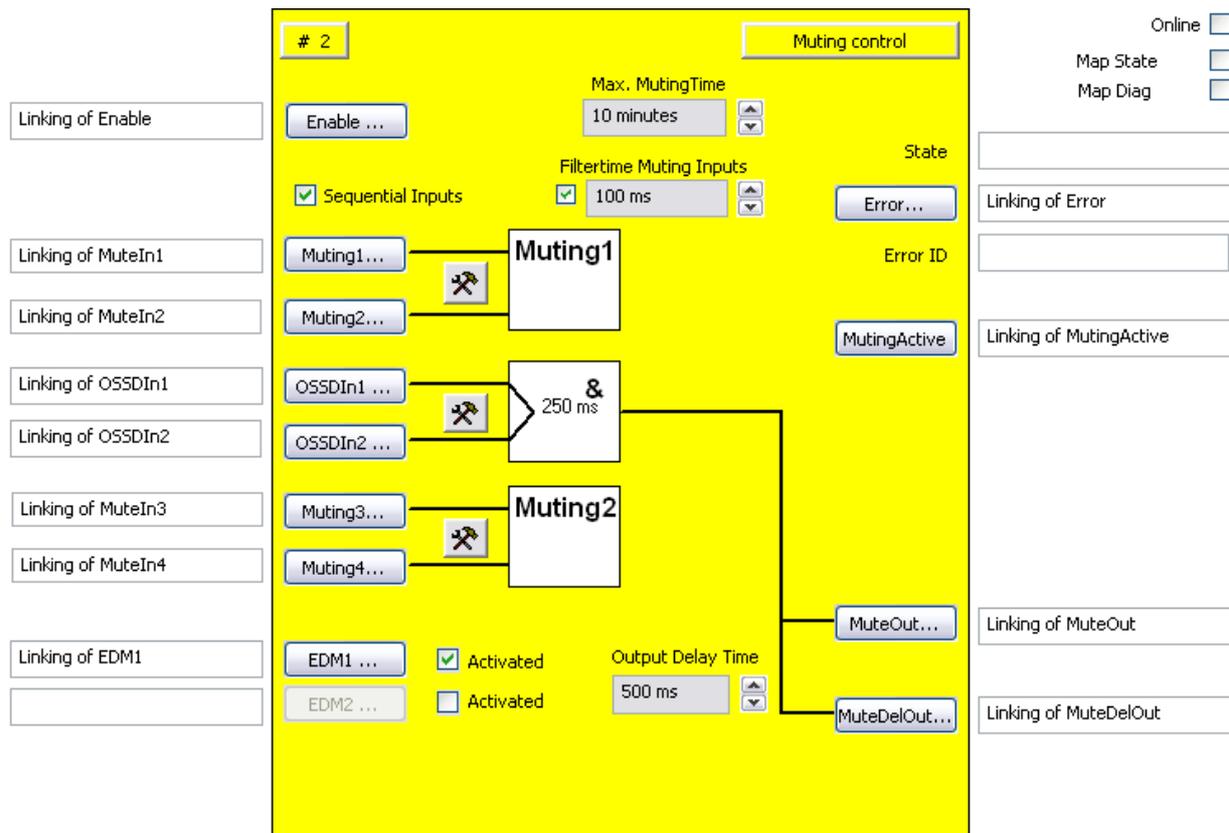
Figure 3-18: FB MUTING configuration

An input through which muting can be enabled can be connected via the 'Enable' button.

The 'Muting(x)' buttons are used to connect the muting sensors to the block. Use the Settings buttons to the right of two muting inputs to configure them. The 'Muting (x)' buttons can only be selected when the corresponding input has been activated. All inputs are deactivated in the default setting. Two-channel evaluation with or without discrepancy time monitoring can be set if the checkbox "Sequential Inputs" is not set. If the "Sequential Inputs" checkbox is set, only single-channel evaluation can be configured via the Settings button. In addition, each input can be configured as a normally closed contact (NC) or as a normally open contact (NO).

The maximum permitted muting period can be set via the 'Max. Muting Time' text box. If this time exceeded the block switches to ERROR state. The maximum muting period is 10 minutes. It the value is set to 0 minutes, monitoring is disabled.

A filter time up to 500 ms can be activated for the Muting(x) inputs via the "Filtertime Muting Inputs" checkbox.

The 'OSSDIn(x)' inputs are connected with the signals from the protective device. Use the Settings button to the right of the OSSDIn inputs to configure them. The setting options include single- or two-channel evaluation or two-channel evaluation with discrepancy time monitoring.

Direct outputs are connected via the 'MuteOut' button, delayed outputs via the 'MuteDelOut' button. The delay time of the 'MuteDelOut' output is configured via the selection box 'Delay-Time'.

The corresponding feedback loop is active using the 'Activated' checkbox on the right near the 'EDM(x)' buttons. The 'EDM(x)' button can only be selected, if the associated feedback loop is activated.

The error state can be connected via the 'Error' button.

Via the 'MutingActive' button a signal can be linked that can be used for a muting lamp, for example.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

### 3.8.3.1 Configuration example with 4 individual muting sensors
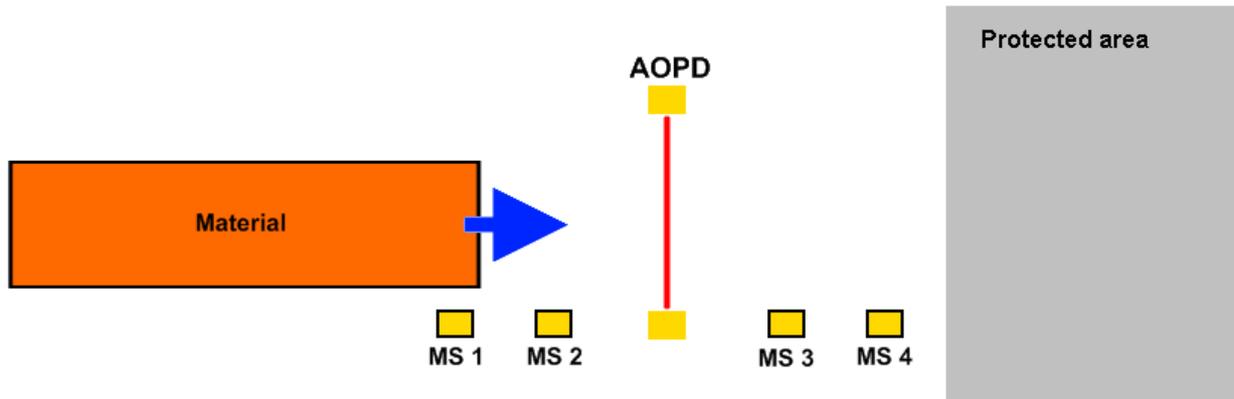
Figure 3-19: Configuration example with FB MUTING

The following screenshot shows the parameterization of FB Muting for this case. The checkbox 'Sequential Inputs' is set, and the 4 muting inputs are configured and connected as single-channel inputs.


Figure 3-20: Muting example
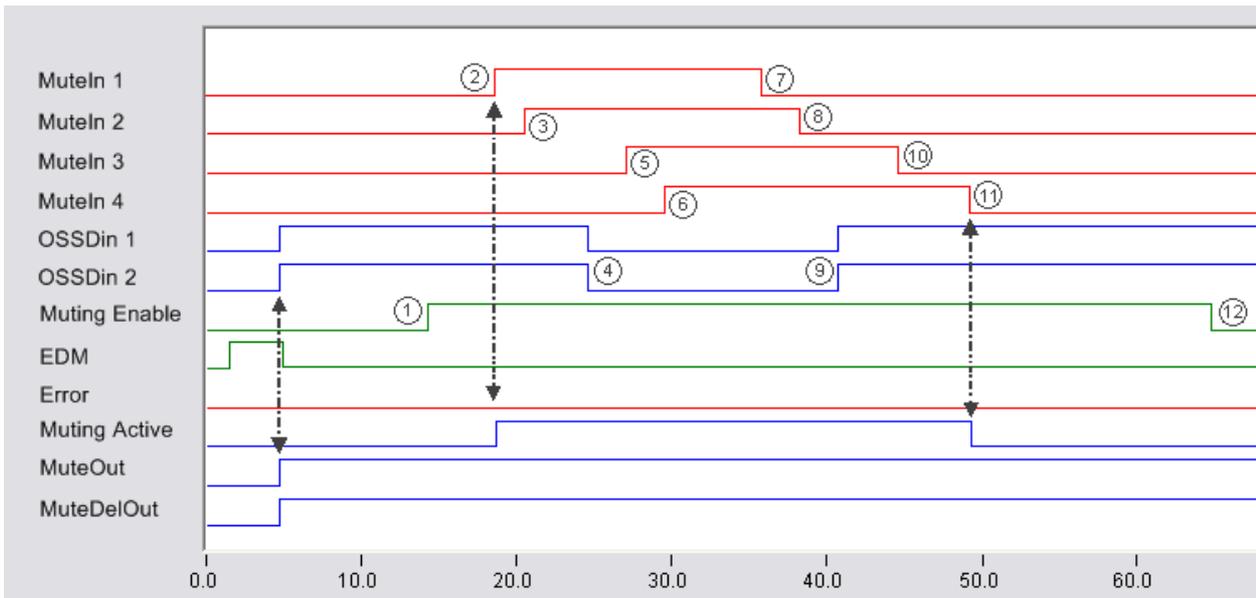
Figure 3-21: Muting FB sequence

### 3.8.3.2 Configuration example with two two-channel muting sensors
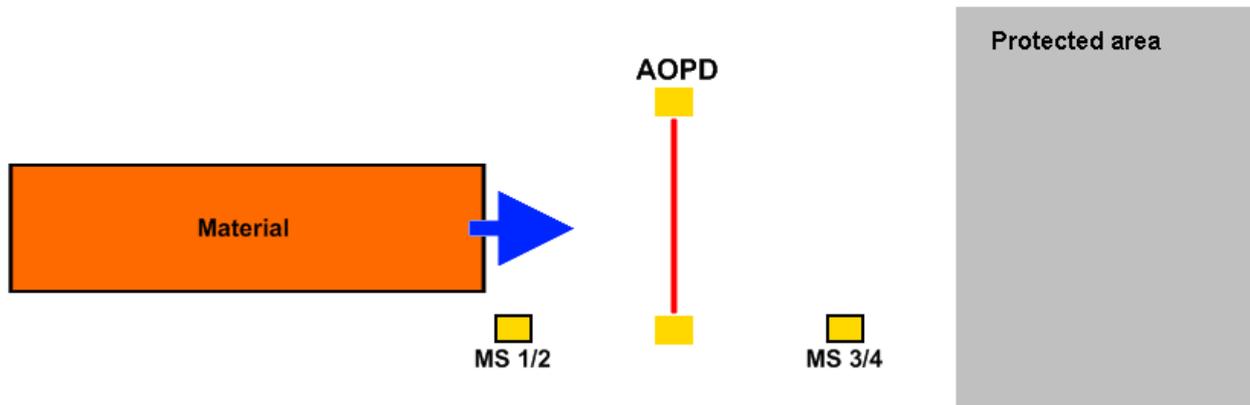
Figure 3-22: Configuration example with two two-channel muting sensors

The following screenshot shows the parameterization of FB MUTING for this case. The checkbox 'Sequential Inputs' is not set, and the 4 muting inputs are configured and connected as two-channel inputs with discrepancy time monitoring.


Figure 3-23: Muting example
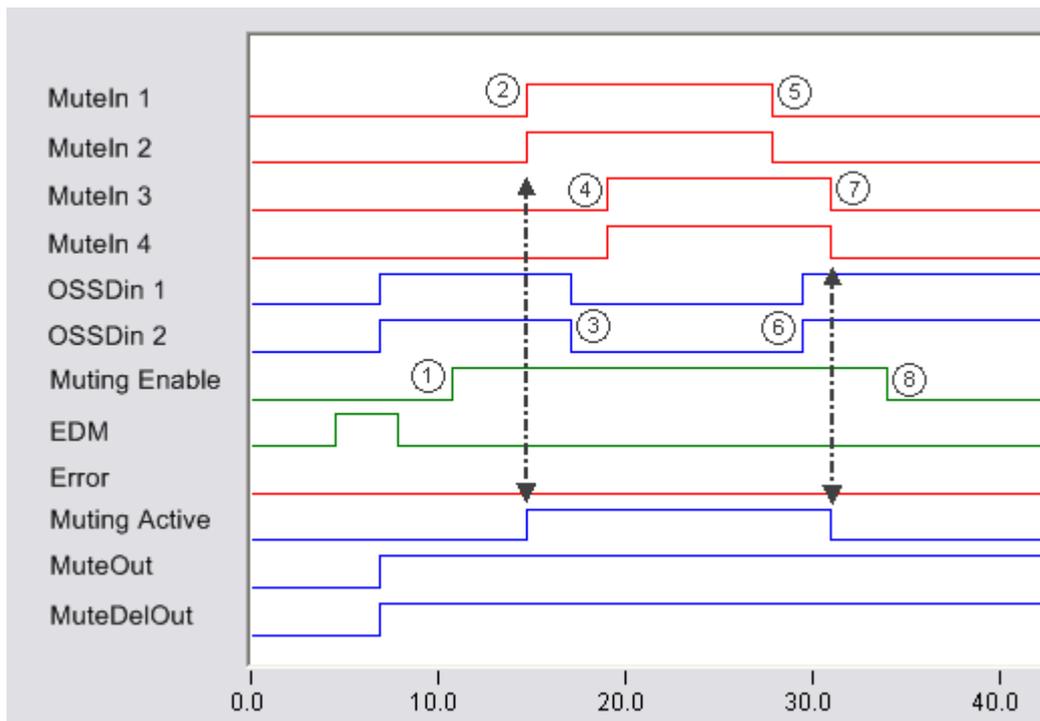
Figure 3-24: Muting FB sequence

3.9 The EDM function block

3.9.1 Functional description

The FB EDM (External Device Monitor) is used for time monitoring of signals Mon1 and Mon2. Switch-on and switch-off monitoring can be configured. Both monitoring functions are inactive by default.

Switch-on monitoring checks whether signal Mon2 is set to 0 within the set time (maximum 10000 ms) following a switch from 0 to 1 of signal Mon1.

Switch-off monitoring checks whether signal Mon2 is set to 1 within the set time (maximum 10000 ms) following a switch from 1 to 0 of signal Mon1.

If the set monitoring time is exceeded the error output for the block is set. It can be reset via the ErrAck signal for the TwinSAFE group.
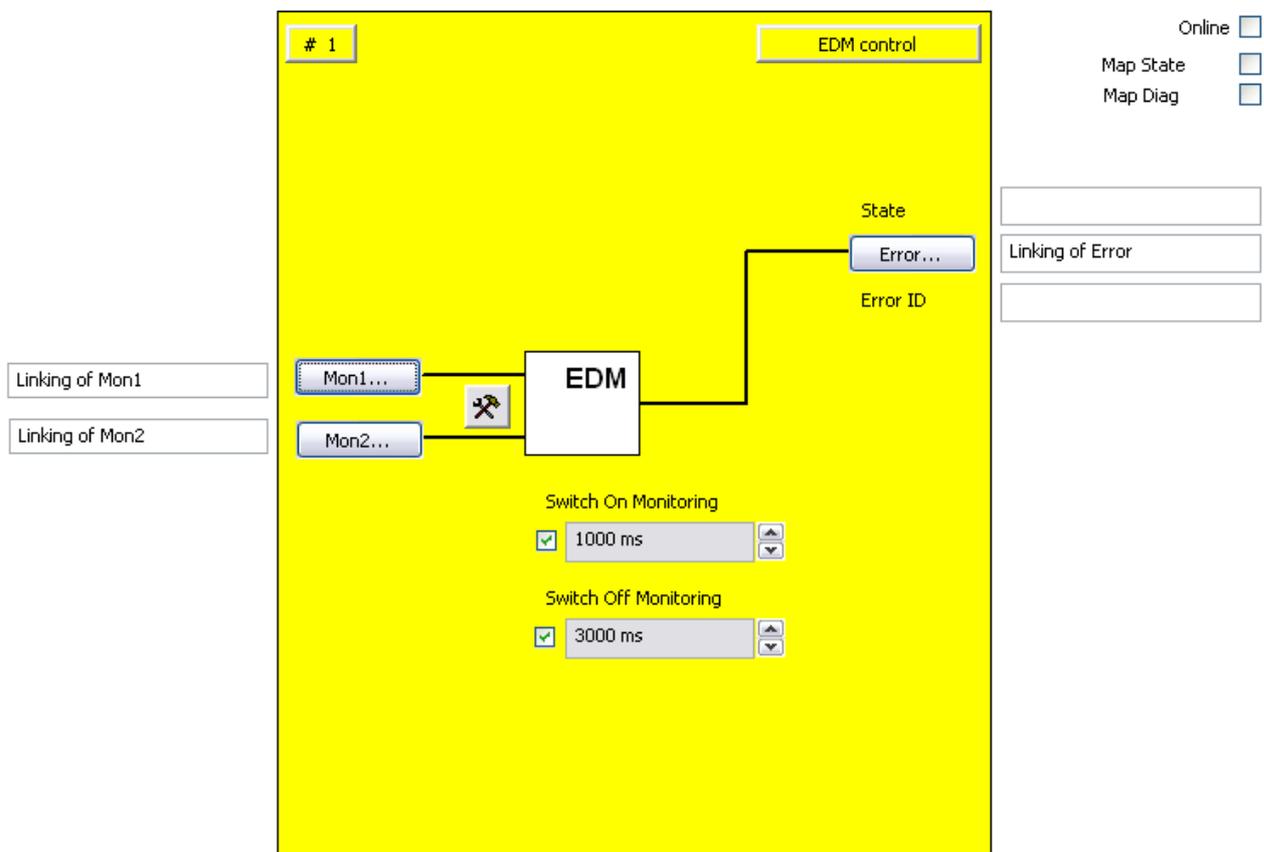

Figure 3-25: EDM function blocks

ℹ️ **Note**	**KL6904** The EDM block is not available in the KL6904.

3.9.2   Signal description

Table 3-41: FB EDM inputs

Name	Permitted type	Description
Mon1	TwinSAFE-In FB-Out Standard-In	1st input. The input can be parameterized as an normally closed contact or an normally open contact.
Mon2	TwinSAFE-In FB-Out Standard-In	2nd input, which has to assume a value opposite to input 1 within the set times.

Table 3-42: FB EDM outputs

Name	Permitted type	Description
Error	TwinSAFE-Out FB-In Standard-Out	TRUE: SwitchOn or SwitchOff times were exceeded. FALSE: No error occurred.

Table 3-43: FB EDM input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.9.2.1   Diagnostic and status information for FB EDM

Table 3-44: Diagnostic information (16-bit value)

Index	Description
0	Switch-OFF timer elapsed
1	Switch-ON timer elapsed

Table 3-45: Status information (8-bit value)

Index	Description
0	undefined
2	STOP
4	ERROR
5	RESET
14	MON_OFF
15	MON_ON

### 3.9.3 FB EDM configuration in the TwinCAT System Manager
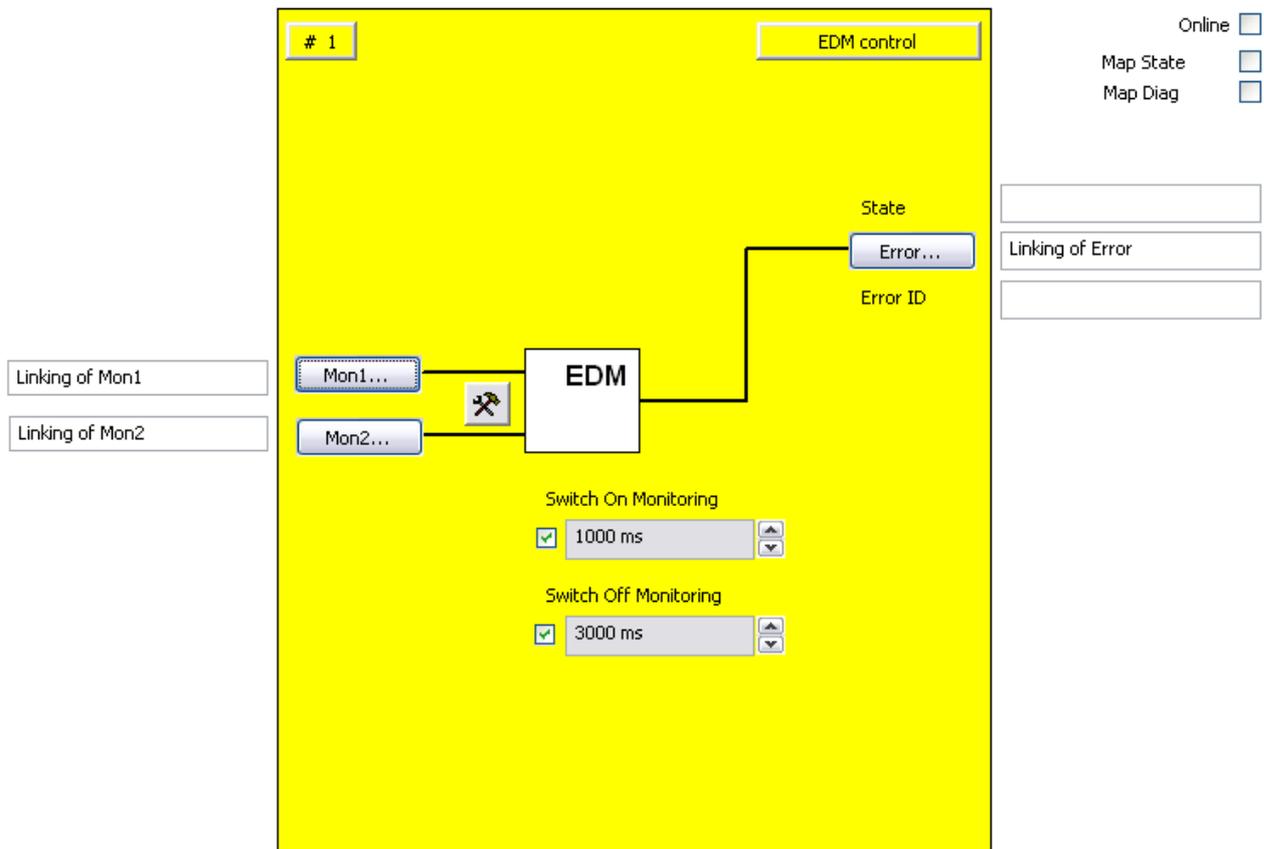
Figure 3-26: FB EDM configuration

The FB EDM input variables are linked using the 'Mon1' and 'Mon2' buttons.

Use the Settings button to right or the two Mon inputs to configure them. Only single-channel evaluation is available. In addition the inputs can be configured as normally open contact (NO) or normally close contact (NC).

Use the 'Switch-On Monitoring' and 'Switch-Off Monitoring' selection boxes to set the switch-on and switch-off delay time. Use the checkboxes to the left of the text fields to activate the corresponding monitoring time. The default state is deactivated.

Use the 'Error' button to transfer a block error to the connected output variable. In online mode the state and error IDs are filled with corresponding information.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.10 The RS function block

3.10.1 Functional description

The FB RS realizes a reset / set functionality. Logic 1 at input Set and logic 0 at input Reset leads to logic 1 at the output. Logic 0 at input Set and logic 1 at input Reset leads to logic 0 at the output. If both inputs are set to logic 1, the Reset signal is dominant and leads to logic 0 at the output. If both inputs are logic 0, the output remains in its current state.
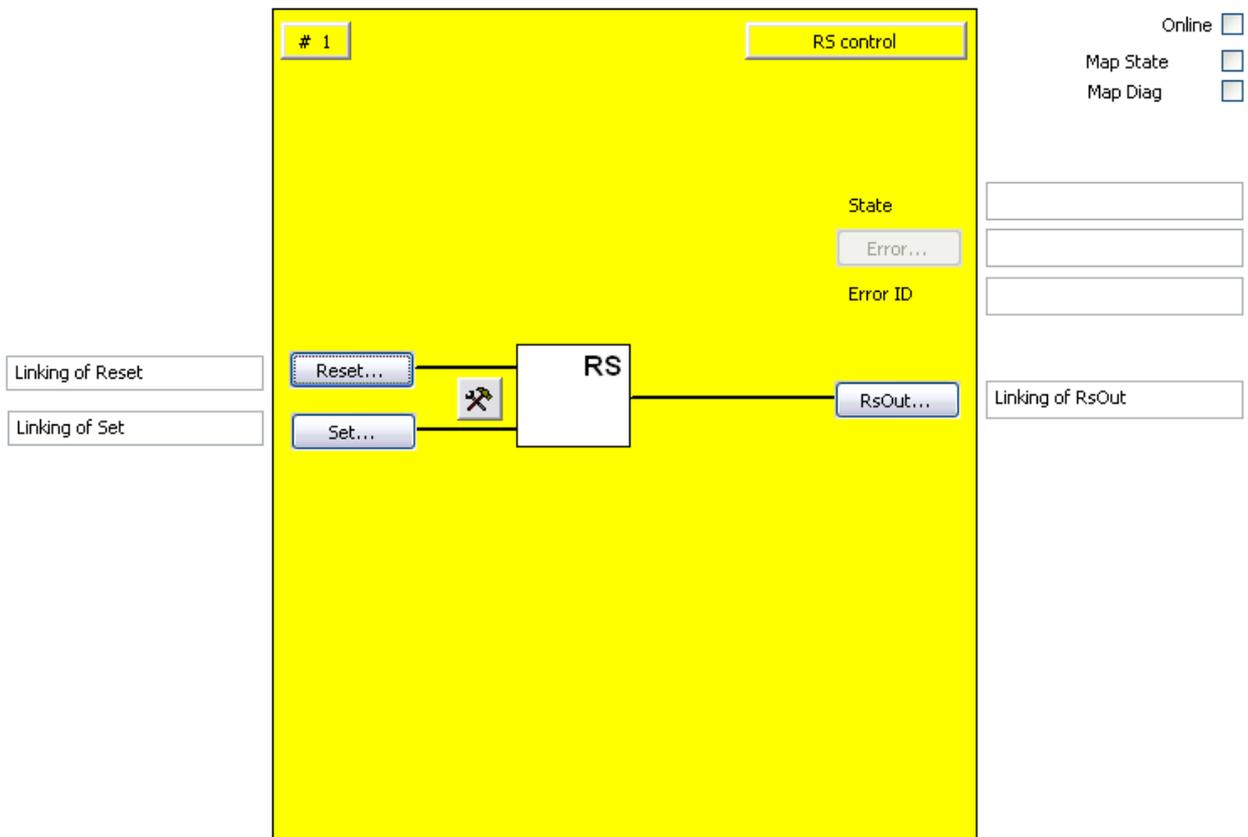

Figure 3-27: RS function block

	KL6904
i **Note**	The RS block is not available in the KL6904.

3.10.2 Signal description

Table 3-46: FB RS inputs

Name	Permitted type	Description
Reset	TwinSAFE-In FB-Out	1st input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).
Set	TwinSAFE-In FB-Out	2nd input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).

Table 3-47: FB RS outputs

Name	Permitted type	Description
RsOut	TwinSAFE-Out FB-In Standard-Out	1st output channel, the safe state corresponds to a logical 0.

3.10.2.1 FB RS input and output types

Table 3-48: FB RS input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.10.2.2 Diagnostic and status information for FB RS

Table 3-49: Diagnostic information (16-bit value)

Index	Description
0-15	always 0

Table 3-50: Status information (8-bit value)

Index	Description
0	undefined
2	STOP
3	SAFE
9	SET

## 3.10.3 FB RS configuration in the TwinCAT System Manager
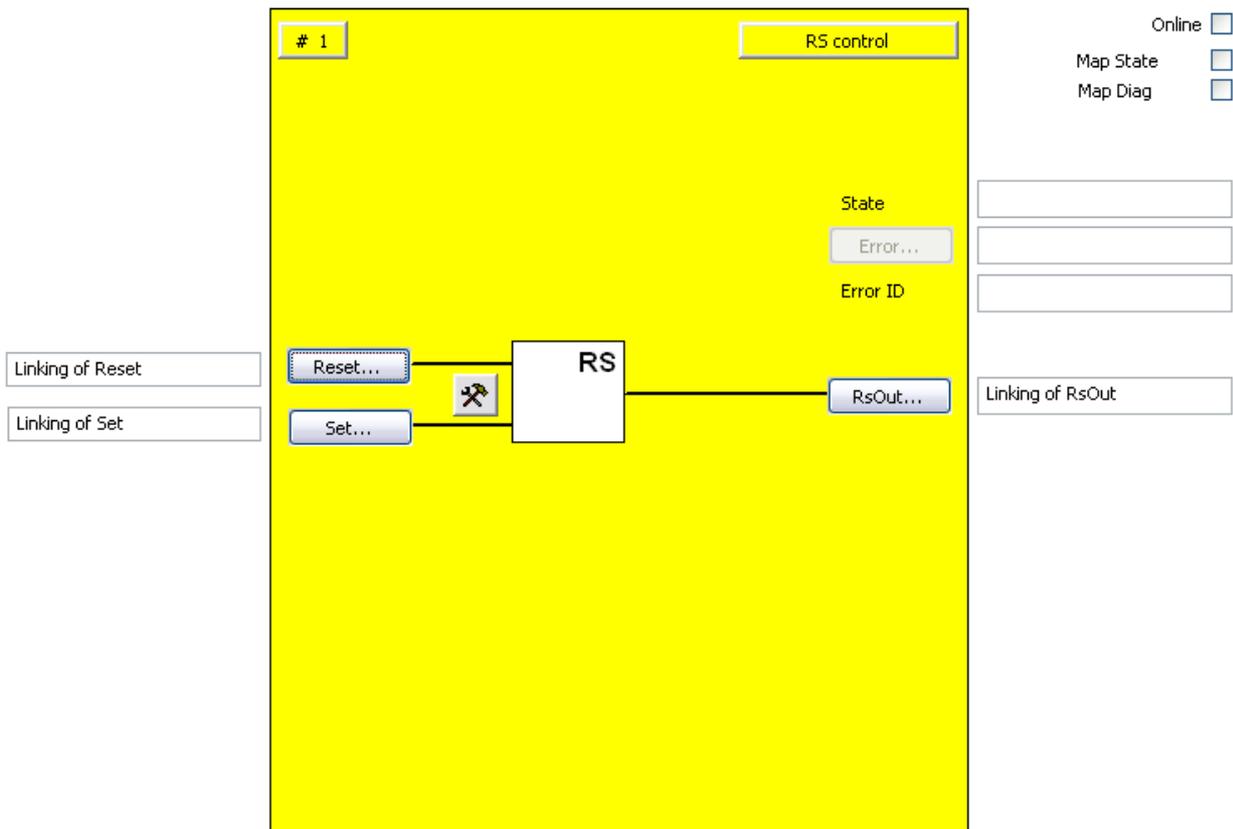
Figure 3-28: FB RS configuration

Use the Reset and Set buttons to connect the corresponding signals for setting and resetting the RsOut output.

Use the RsOut button to connect the required output signal.

Use the Settings button to the right of the Reset and Set inputs to activate the input signals and configure them as normally open contact (NO) or normally closed contact (NC).

The error output is inactive since FB RS reports no error.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.11 The SR function block

3.11.1 Functional description

The FB SR realizes a set / reset functionality. Logic 1 at input Set and logic 0 at input Reset leads to logic 1 at the output. Logic 0 at input Set and logic 1 at input Reset leads to logic 0 at the output. If both inputs are set to logic 1, the Set signal is dominant and leads to logic 1 at the output. If both inputs are logic 0, the output remains in its current state.
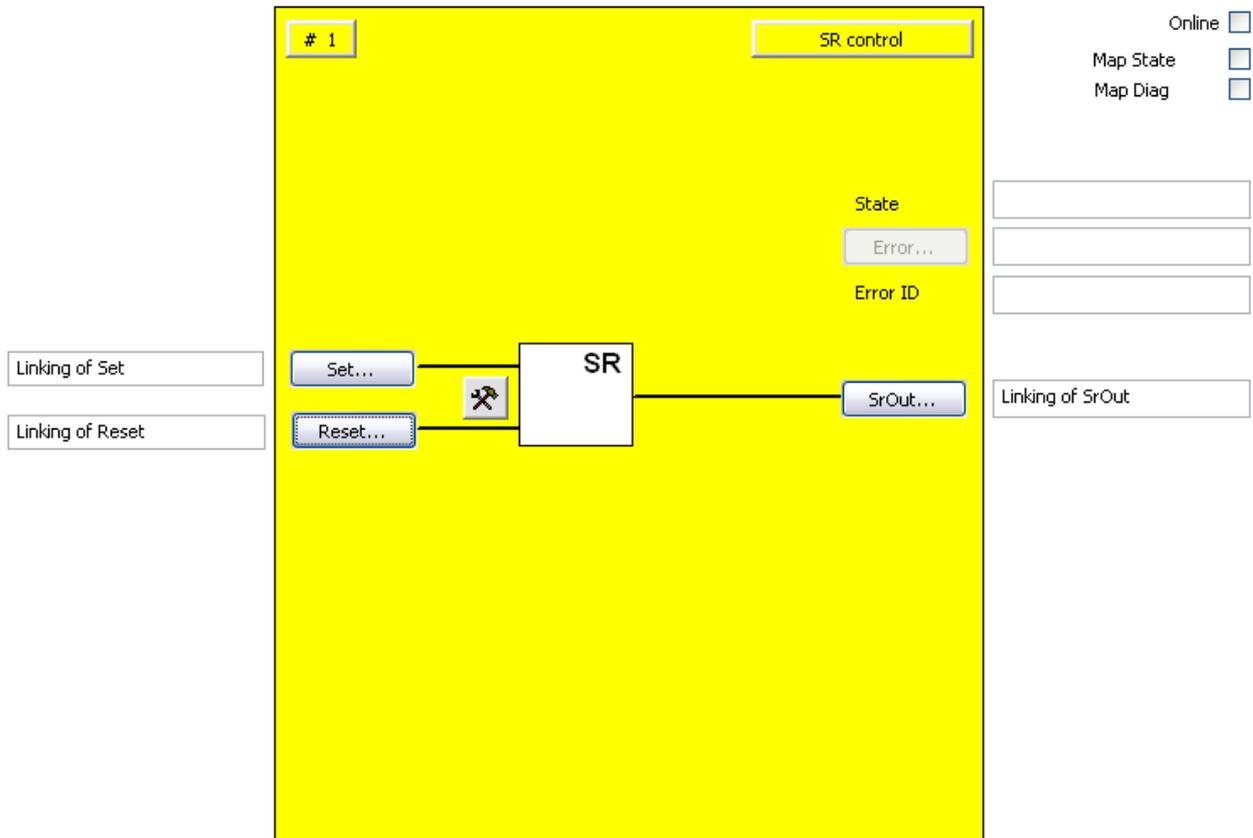

Figure 3-29: SR function block

	KL6904
i **Note**	The SR block is not available in the KL6904.

3.11.2 Signal description

Table 3-51: FB SR inputs

Name	Permitted type	Description
Set	TwinSAFE-In FB-Out	1st input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).
Reset	TwinSAFE-In FB-Out	2nd input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).

Table 3-52: FB SR outputs

Name	Permitted type	Description
SrOut	TwinSAFE-Out FB-In Standard-Out	1st output channel, the safe state corresponds to a logical 0.

3.11.2.1 FB SR input and output types

Table 3-53: FB SR input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.11.2.2 Diagnostic and status information for FB SR

Table 3-54: Diagnostic information (16-bit value)

Index	Description
0-15	always 0

Table 3-55: Status information (8-bit value)

Index	Description
0	undefined
2	STOP
3	SAFE
9	SET

### 3.11.3 FB SR configuration in the TwinCAT System Manager
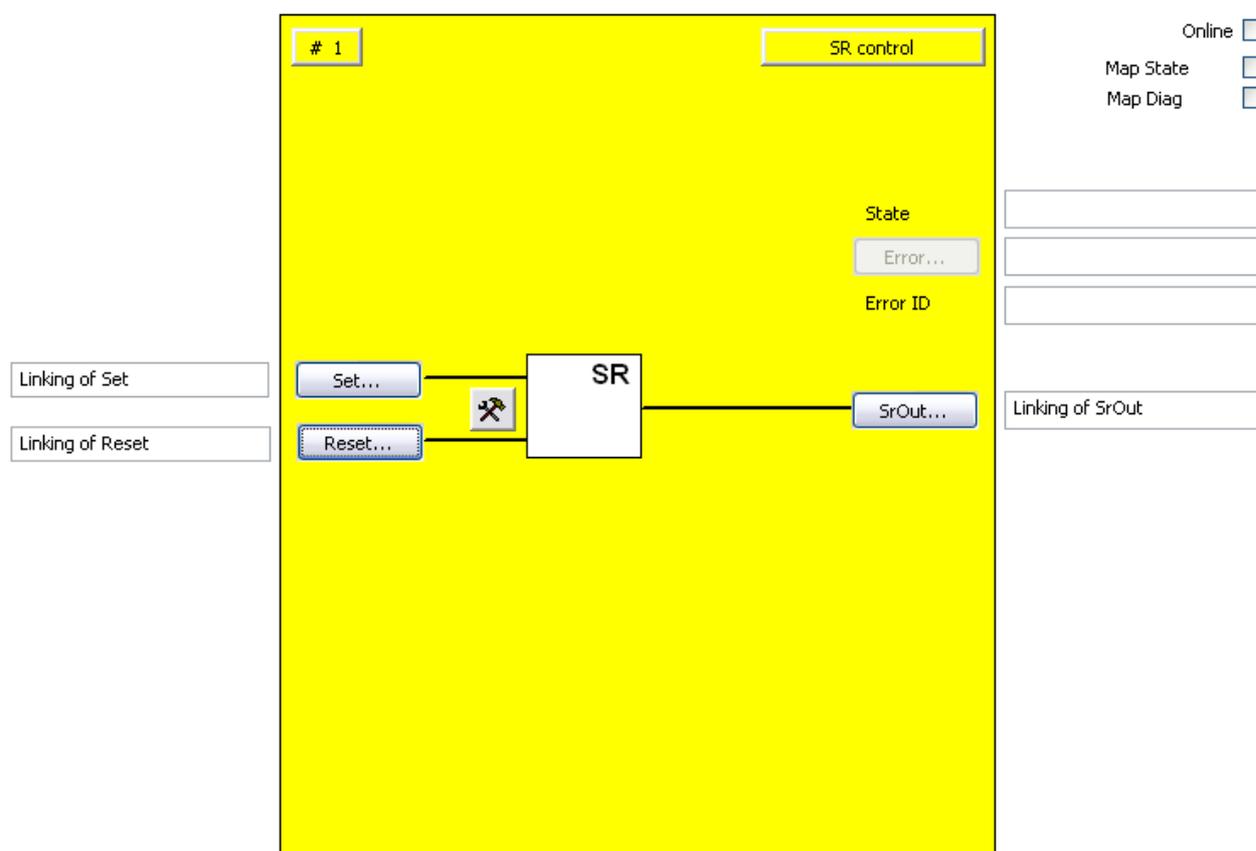
Figure 3-30: FB SR configuration

Use the Set and Reset buttons to connect the corresponding signals for setting and resetting the SrOut output.

Use the SrOut button to connect the required output signal.

Use the Settings button to the right of the Set and Reset inputs to activate the input signals and configure them as normally open contact (NO) or normally closed contact (NC).

The error output is inactive since FB SR reports no error.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.12 The TON function block

3.12.1　Functional description

FB TON is used to realize a switch-on delay. Logic 1 at input TonIn is transferred to the output with a set delay time. The output is not activated if the input is set to 0 again before the delay time has elapsed. The error output is inactive since the block sets no errors.

The maximum switch-on delay is 6000 x 100 ms (10 minutes).
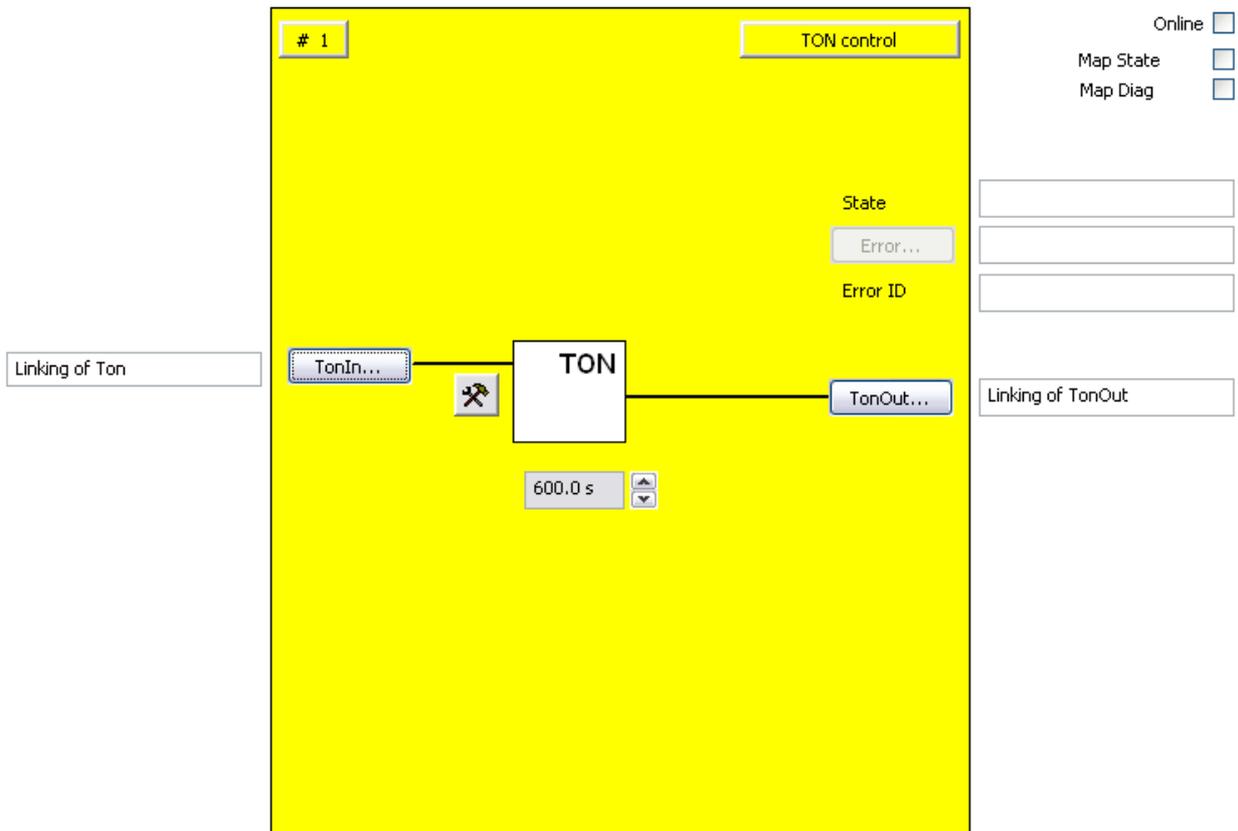
Figure 3-31: TON function blocks

ⓘ Note	**KL6904** The TON block is not available in the KL6904.

3.12.2 Signal description

Table 3-56: FB TON inputs

Name	Permitted type	Description
TonIn1	TwinSAFE-In FB-Out	1st input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).

Table 3-57: FB TON outputs

Name	Permitted type	Description
TonOut	TwinSAFE-Out FB-In Standard-Out	1st output channel, the safe state corresponds to a logical 0.

Table 3-58: FB TON input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.12.2.1 Diagnostic and status information for FB TON

Table 3-59: Diagnostic information (16-bit value)

Index	Description
0-15	always 0

Table 3-60: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE
9	DELAY_IN

### 3.12.3   FB TON configuration in the TwinCAT System Manager
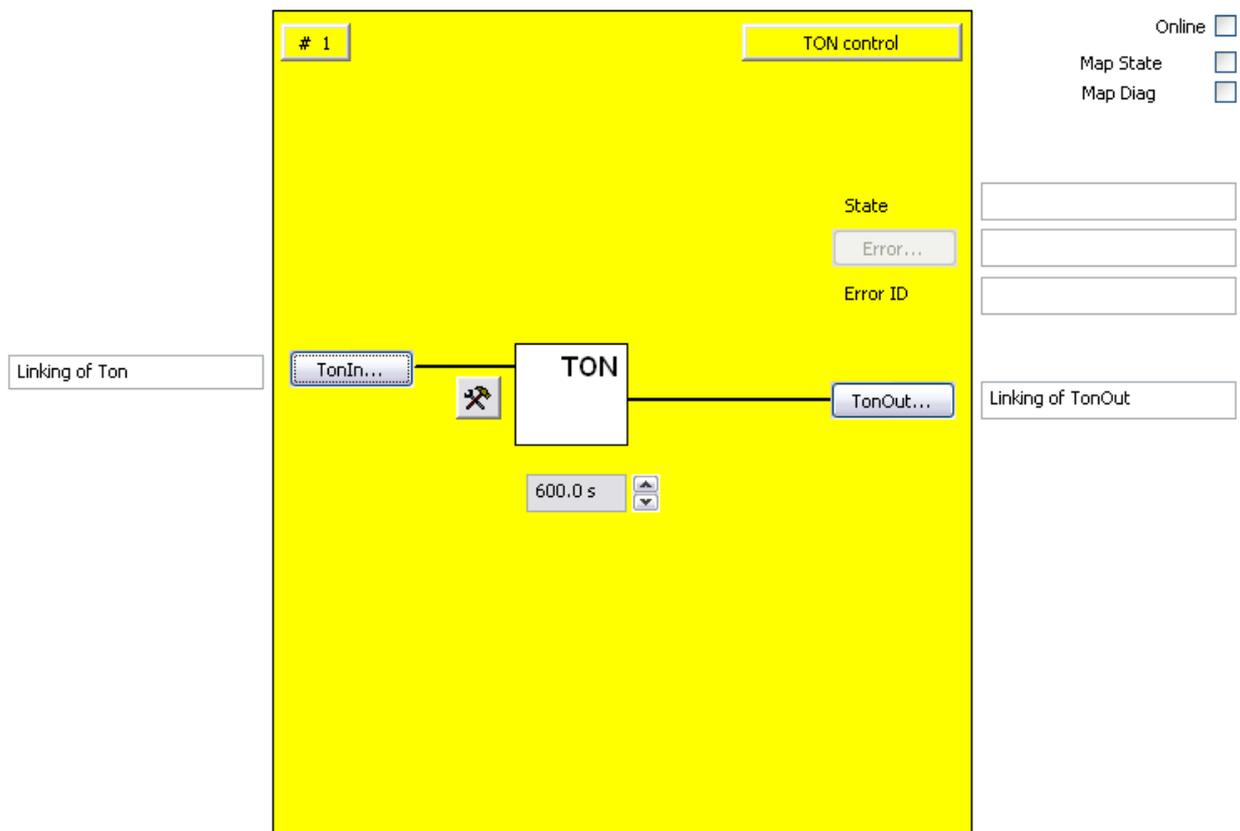
Figure 3-32: FB TON configuration

Use the TonIn button to connect the input signal. Use the Settings button to the right of the TonIn button to configure the input as normally open contact (NO) or normally closed contact (NC).

Use the TonOut button to connect the switch-on delayed signal.

Use the text box to set the switch-on delay time. The smallest unit is 0.1 s.

The error output is inactive in the default setting, since FB TON reports no error.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.13 The TOF function block

3.13.1 Functional description

FB TOF is used to realize a switch-off delay. Logic 1 at input TofIn is transferred to the output with a set delay time. The output remains activated if the input is set to 1 again before the switch-off delay time has elapsed. The error output is inactive since the block sets no errors.

The maximum switch-off delay is 6000 x 100 ms (10 minutes).
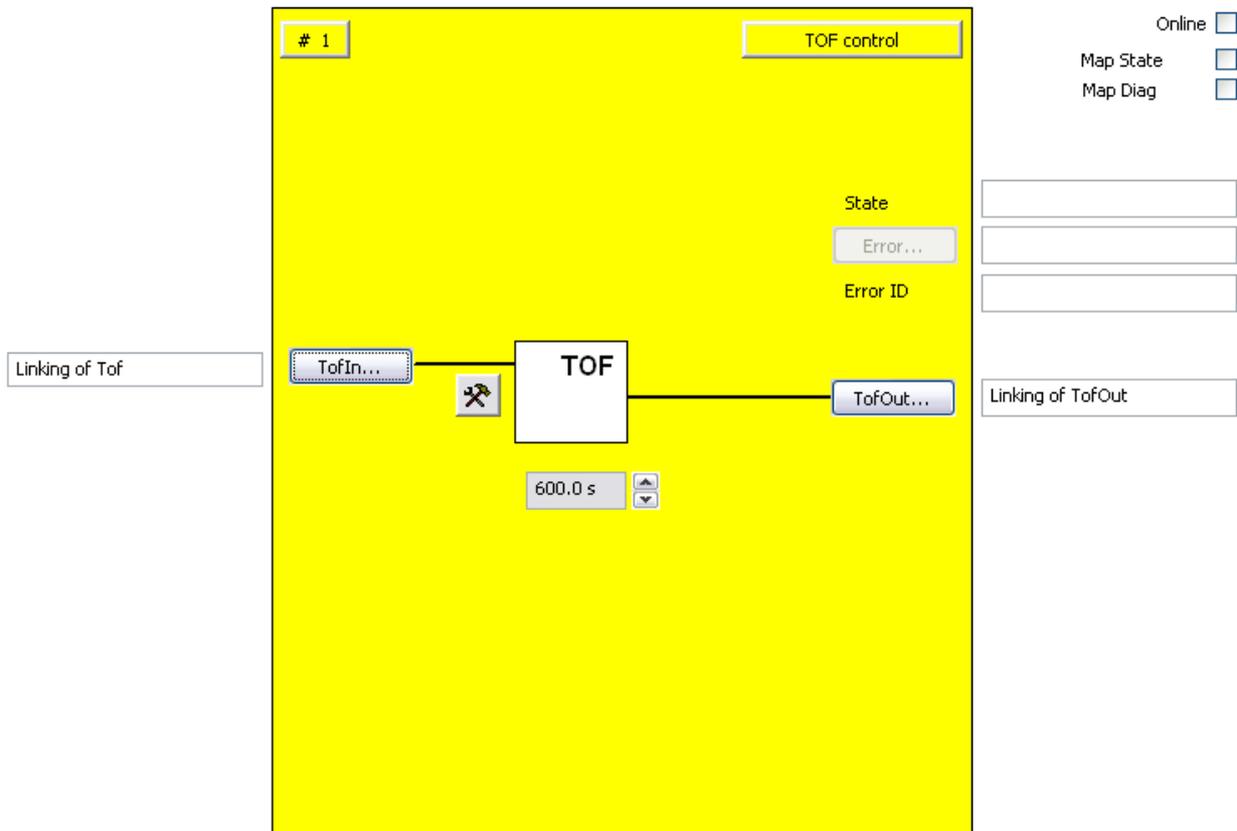
Figure 3-33: TOF function block

i Note	KL6904
	The TOF block is not available in the KL6904.

3.13.2 Signal description

Table 3-61: FB TOF inputs

Name	Permitted type	Description
TofIn1	TwinSAFE-In FB-Out	1st input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).

Table 3-62: FB TOF outputs

Name	Permitted type	Description
TofOut	TwinSAFE-Out FB-In Standard-Out	1st output channel, the safe state corresponds to a logical 0.

Table 3-63: FB TOF input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.13.2.1 Diagnostic and status information for FB TOF

Table 3-64: Diagnostic information (16-bit value)

Index	Description
0-15	always 0

Table 3-65: Status information (8-bit value)

Index	Description
0	undefined
1	RUN
2	STOP
3	SAFE
8	DELAY_OUT

### 3.13.3 FB TOF configuration in the TwinCAT System Manager
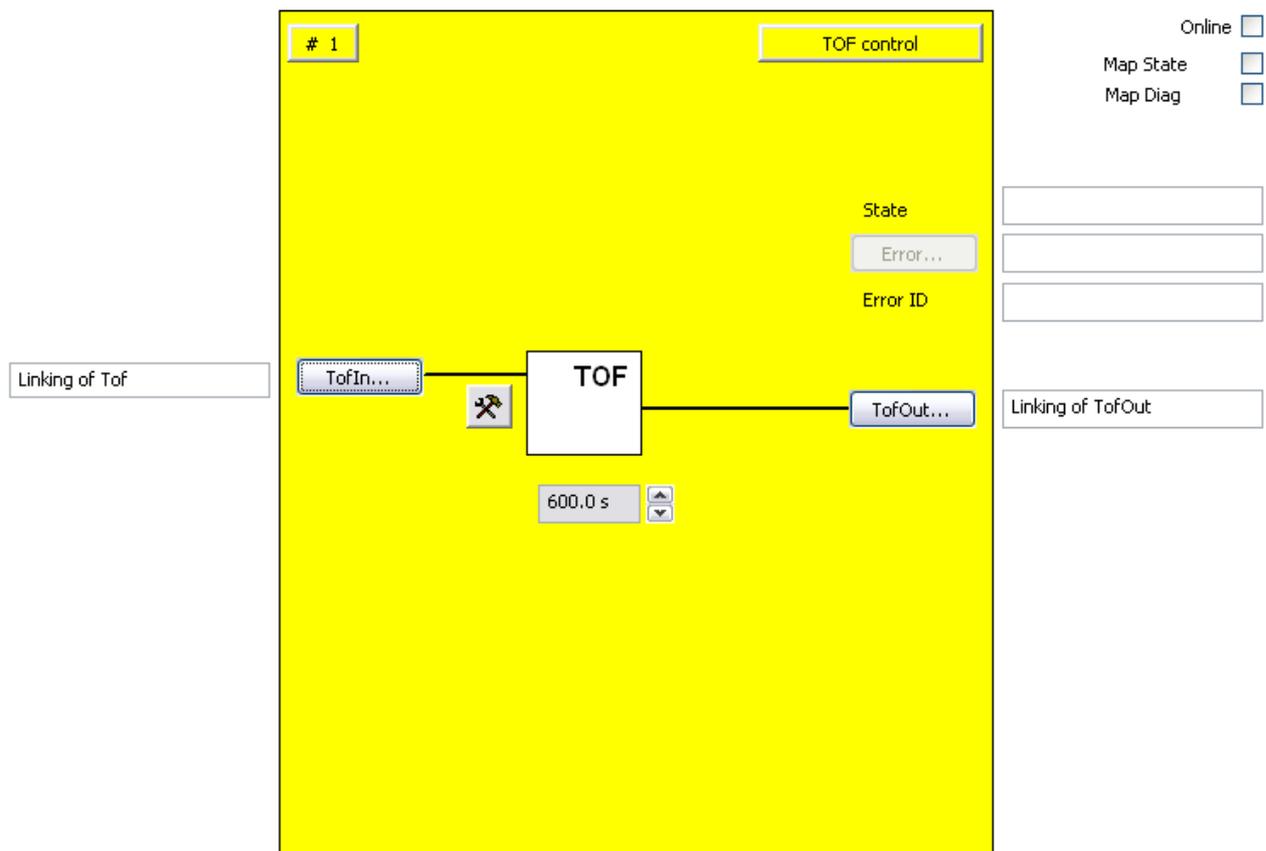
Figure 3-34: FB TOF configuration

Use the TofIn button to connect the input signal. Use the Settings button to the right of the TofIn button to configure the input as normally open contact (NO) or normally closed contact (NC).

Use the TofOut button to connect the switch-off delayed signal.

Use the text box to set the switch-off delay time. The smallest unit is 0.1 s.

The error output is inactive since FB TOF reports no error.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

3.14 The CONNECTION SHUTDOWN function block

3.14.1 Functional description

FB CONNECTION SHUTDOWN is used to deactivate TwinSAFE connection. If the block input becomes active, the connection is closed, a shutdown command is sent to the FSoE partner, and feedback is sent to the output. The connection is closed and the output is set if the communication partner receives a shutdown command.

The output is only reset when the connection to the FSoE partner is in DATA state again.

The FSoE master will attempt to re-establish the connection and the FSoE slave will respond to the connection again when the block input is no longer active.

This block is required for modular safety concepts required involving machine components installed on a temporary basis. This functionality is also required for machines involving tool changes.
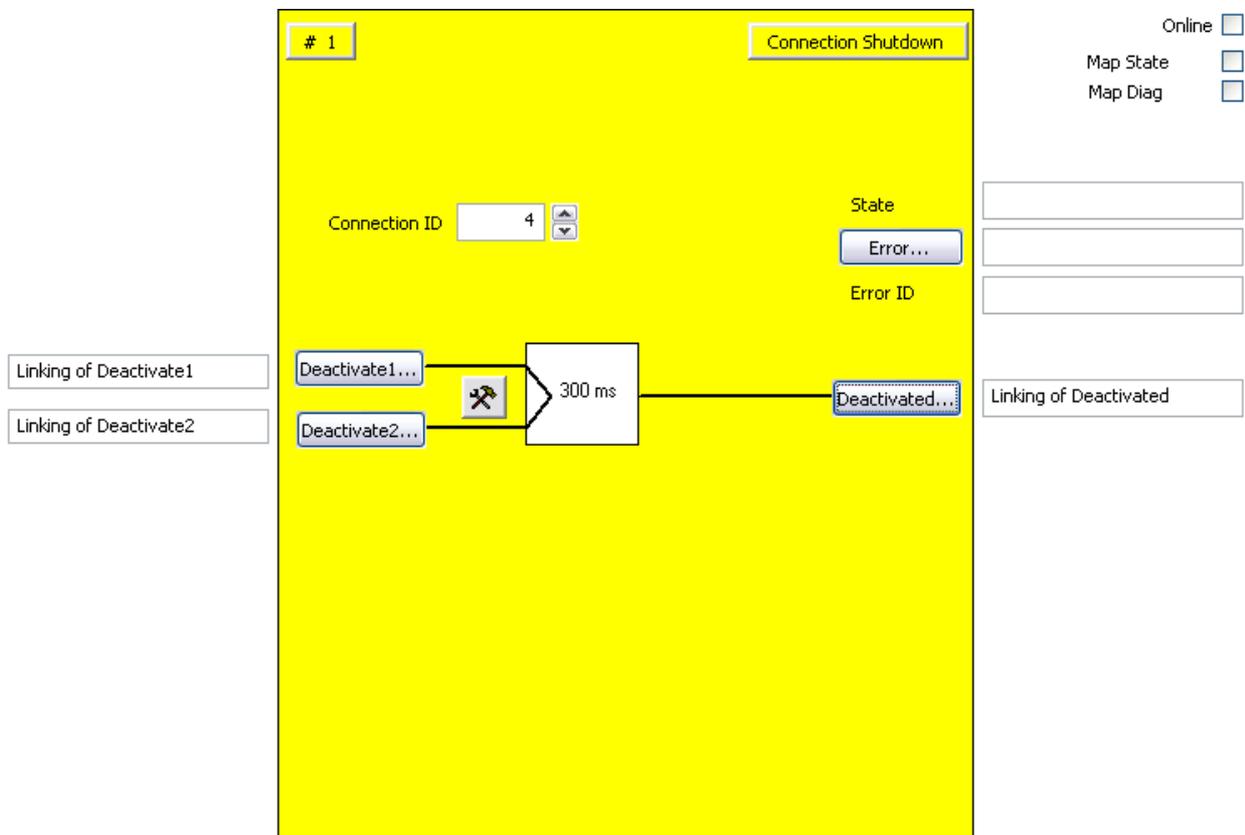

Figure 3-35: CONNECTION SHUTDOWN function block

	KL6904
[i] Note	The Connection Shutdown block is not available in the KL6904.

On the opposite side the block is called without connected inputs. The output Deactivated is set when the connection is terminated due to a shutdown command from the communication partner.
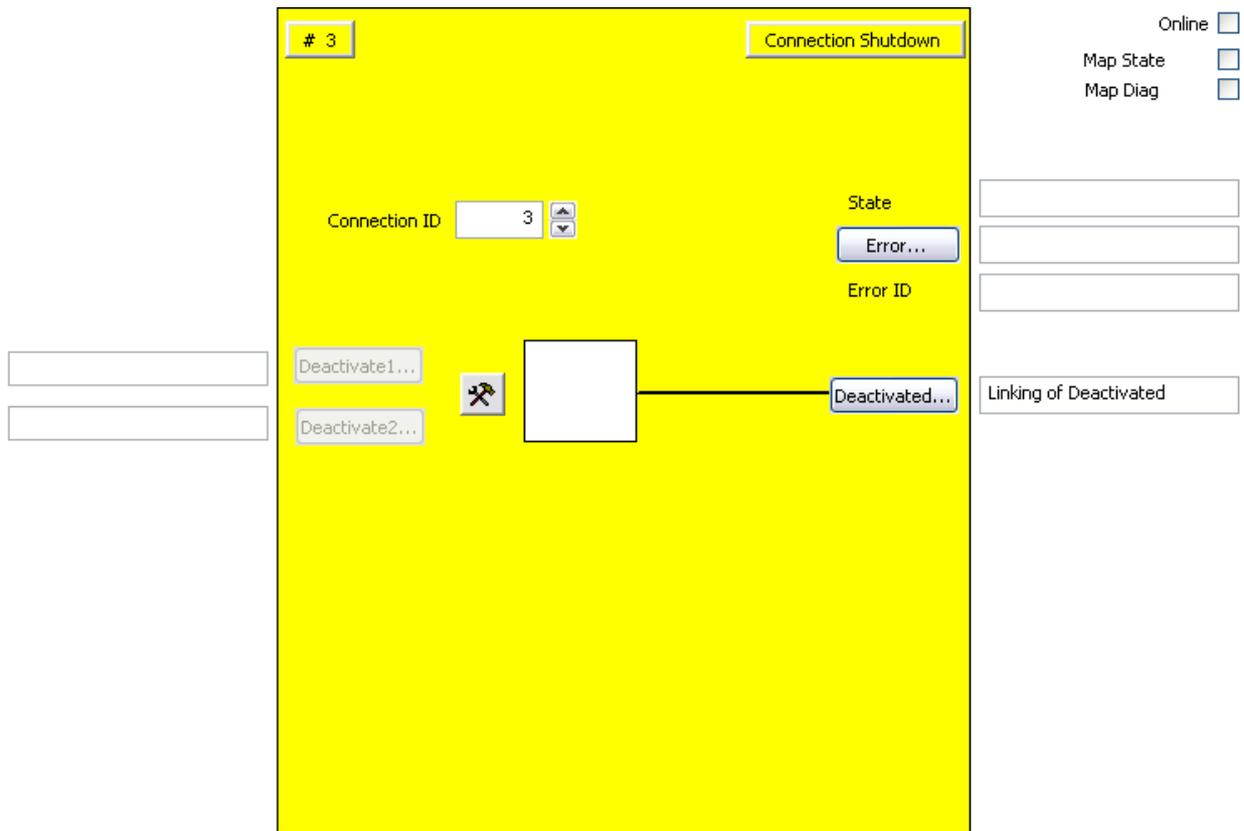

Figure 3-36: Function block CONNECTION SHUTDOWN on the opposite side

3.14.2 Signal description

Table 3-66: FB CONNECTION SHUTDOWN inputs

Name	Permitted type	Description
Deactivate1	TwinSAFE-In FB-Out	1st input channel. The parameterization determines, whether the input is linked to a normally closed contact (safe state will be requested by logical 0) or normally open contact (safe state will be requested by logical 1).
Deactivate2	TwinSAFE-In FB-Out	2nd input channel, behaves like Deactivate1 If the discrepancy time is not equal 0, the 1st and 2nd input channel are considered to be the 1st input group and a discrepancy time monitoring is carried out between both channels, if one of the two input channels requests the safe state.

Table 3-67: FB CONNECTION SHUTDOWN outputs

Name	Permitted type	Description
Error	TwinSAFE-Out FB-In Standard-Out	TRUE: The discrepancy time monitoring for a 2-channel input group has detected an error. The error must be acknowledged via the ERR_ACK input of the corresponding TwinSAFE group FALSE: No error was found
Deactivated	TwinSAFE-Out FB-In Standard-Out	1st output channel, the safe state corresponds to a logical 0. The output is set once the connection is terminated.

Table 3-68: FB CONNECTION SHUTDOWN input and output types

Type	Description
TwinSAFE-In	TwinSAFE input at an EL1904/KL1904
Standard-In	Standard PLC variable (output in the PLC %Q*)
FB-Out	TwinSAFE FB output
TwinSAFE-Out	TwinSAFE output at an EL2904/KL2904
Standard-Out	Standard PLC variable (input in the PLC %I*)
FB-In	TwinSAFE FB input

3.14.2.1 Diagnostic and status information for FB CONNECTION SHUTDOWN

Table 3-69: Diagnostic information (16-bit value)

Index	Description
0	Discrepancy error input group 1

Table 3-70: Status information (8-bit value)

Index	Description
0	undefined
2	STOP
3	SAFE
4	ERROR
5	RESET
10	ACTIVE
11	DEACTIVE

### 3.14.3 FB ConnectionShutdown configuration in the TwinCAT System Manager
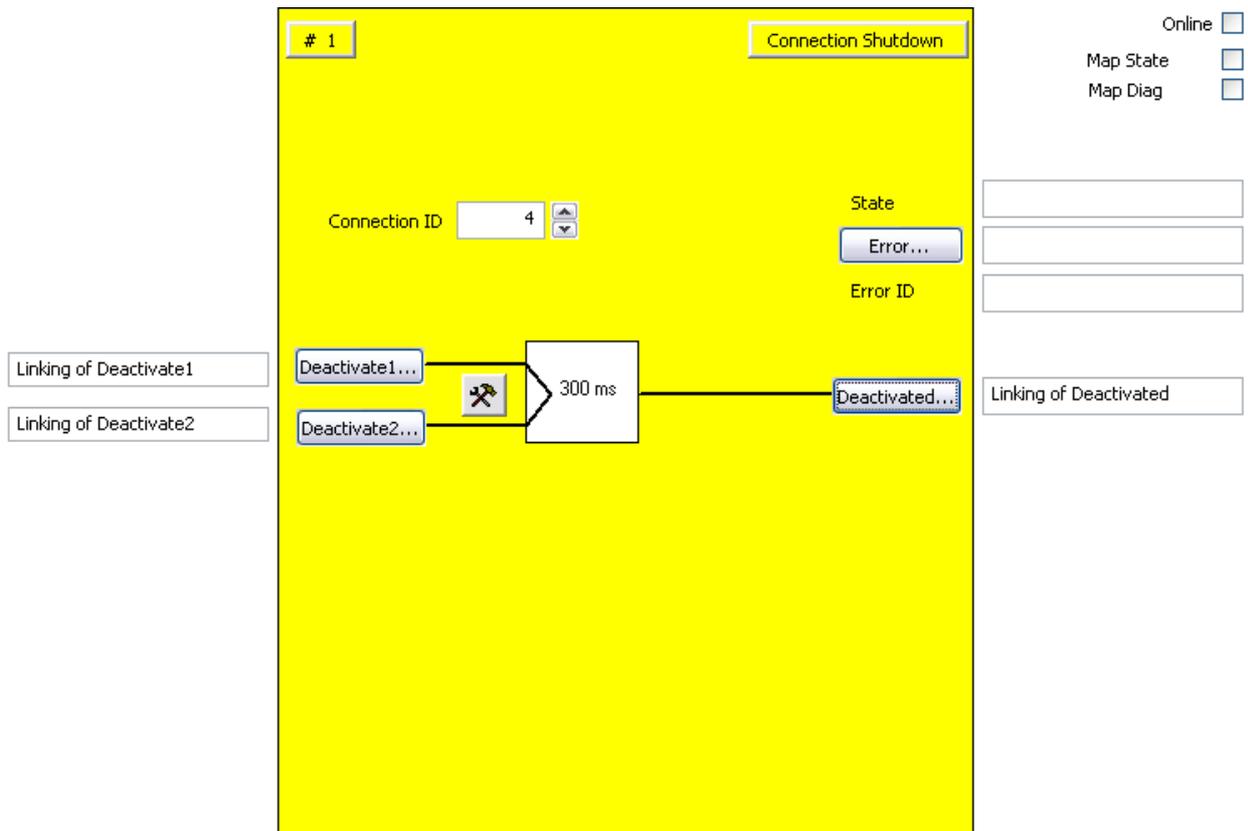
Figure 3-37: FB CONNECTION SHUTDOWN configuration

Use the buttons Deactivate1 and Deactivate2 to connect the input signals. Use the Settings button to the right of the Deactivate(x) buttons to configure the inputs as normally open contact (NO) or normally closed contact (NC).

Use the Deactivated button to connect the signal that indicates that the connection has been terminated.

Use the 'Connection ID' edit box to specify the connection ID of the connection to be terminated via the block. The block uses the Connection ID, not the connection no. of the TwinSAFE connection.

The error state can be connected via the 'Error' button.

The 'MapState' and 'MapDiag' checkboxes are used to specify which FB diagnostic functions are mapped to the cyclic process image.

4 Appendix

4.1 Beckhoff Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

4.1.1 Beckhoff branches and partner companies Beckhoff Support

Please contact your Beckhoff branch office or partner company for local support and service on Beckhoff products!
The contact addresses for your country can be found in the list of Beckhoff branches and partner companies: www.beckhoff.com. You will also find further documentation for Beckhoff components there.

4.1.2 Beckhoff company headquarters

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