Operating instructions for

KL6904

TwinSAFE logic terminal with 4 fail-safe outputs

Version: 2.2.1
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BECKHOFF

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1 Foreword

1.1 Notes on the manual

1.1.1 Intendent audience

It is essential that the following notes and explanations are followed when installing and commissioning these components.

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards. The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

1.1.2 Origin of the document

These operating instructions were originally written in German. All other languages are derived from the German original.

1.1.3 Actuality

Please check whether you have the latest and valid version of this document. On the Beckhoff homepage under the link http://www.beckhoff.de/english/download/twinsafe.htm you may find the latest version for download. If in doubt, please contact the technical support (see chapter 5.1 Beckhoff Support and Service).

1.1.4 Product properties

Valid are only the product properties that are specified in the respectively current user documentation. Other information, which is given on the product pages of the Beckhoff homepage, in emails or other publications is not relevant.

1.1.5 Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics.
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.

1.1.6 Trademarks

Beckhoff®, TwinCAT®, EtherCAT®, Safety over EtherCAT®, TwinSAFE® and XFC® are registered trademarks of and licensed by Beckhoff Automation GmbH.
Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

1.1.7 Patent Pending

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 corresponding applications or registrations in various other countries.

1.1.8 Copyright

1.1.9 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 chapter Product description);
- the TwinSAFE products are only operated in sound condition and in working order (see chapter *Cleaning*).
- 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.

 **DANGER**	**Serious risk of injury!** **Failure** to follow the safety instructions associated with this symbol directly endangers the life and health of persons.
 **WARNING**	**Caution - Risk of injury!** **Failure** to follow the safety instructions associated with this symbol endangers the life and health of persons.
 **CAUTION**	**Personal injuries!** **Failure** to follow the safety instructions associated with this symbol can lead to injuries to persons.
 **Attention**	**Damage to the environment or devices** **Failure** to follow the instructions associated with this symbol can lead to damage to the environment or equipment.
 **Note**	**Tip or pointer** This symbol indicates information that contributes to better understanding.

1.2.4 Documentation issue status

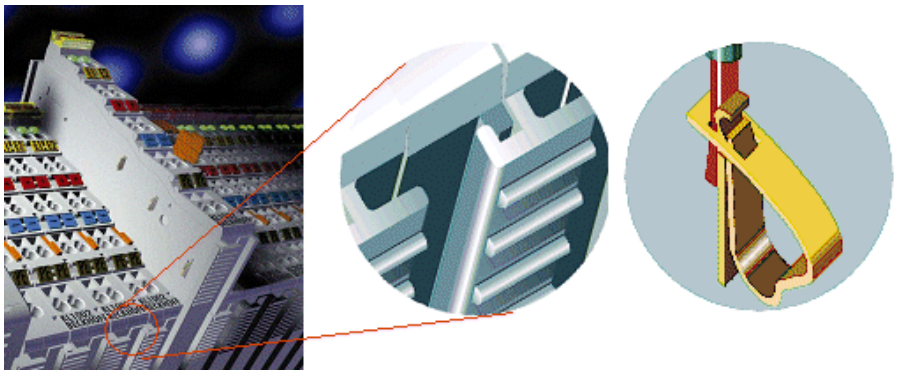
Version	Comment
2.2.1	• Technical data *permissible air pressure* expanded
2.2.0	• Reliability document updated • Safety parameters updated • Foreword overworked
2.1.2	• Reliability document updated
2.1.1	• Certificate updated
2.1.0	• Company address amended • Document origin added • Version history added • EN954 example removed • Safety parameters extended
2.0.1	• Reference to EN 60068-2-29 removed
2.0.0	• Description of the configuration in the TwinCAT System Manager added • Certificates added • Note on test pulses of the outputs added • Tested devices extended
1.1.4	• Diagrams corrected • Flash codes corrected
1.1.3	• Pin assignment corrected
1.1.2	• Technical data updated
1.1.1	• LED and graphics updated
1.1.0	• Technical data extended • Editorial amendments
1.0.3	• Description of LEDs and blink codes updated • TwinSAFE description updated
1.0.2	• Note relating to qualified software tool amended
1.0.1	• LoP list incorporated
1.0.0	• First publication

2 System description

2.1 The Beckhoff Bus Terminal system

The Beckhoff Bus Terminal system is used for decentralized connection of sensors and actuators to a control system. The Beckhoff Bus Terminal system components are mainly used in industrial automation and building management applications. In its minimum configuration, a bus station consists of a Bus Coupler or a Bus Terminal Controller and Bus Terminals connected to it. The Bus Coupler forms the communication interface to the higher-level controller, and the terminals are the interface to sensors and actuators. The whole bus station is clipped onto a 35 mm DIN mounting rail (EN 60715). The mechanical cross connection of the bus station is established via a slot and key system at the Bus Coupler and the Bus Terminals.

The sensors and actuators are connected with terminals via the screwless Cage Clamp© connection system.



Since a wide range of different communication standards are established in industrial automation, Beckhoff offers Bus Couplers for all common bus systems (e.g. BK3120 for PROFIBUS, BK9000 for Ethernet, etc.).

2.1.1 Bus Coupler

Mechanical data

Mechanical data	Bus Coupler
Material	polycarbonate, polyamide (PA6.6).
Dimensions (W x H x D)	47 mm x 100 mm x 68 mm
Mounting	on 35 mm mounting rail (EN 60715) with locking
Attachable by	double slot and key connection

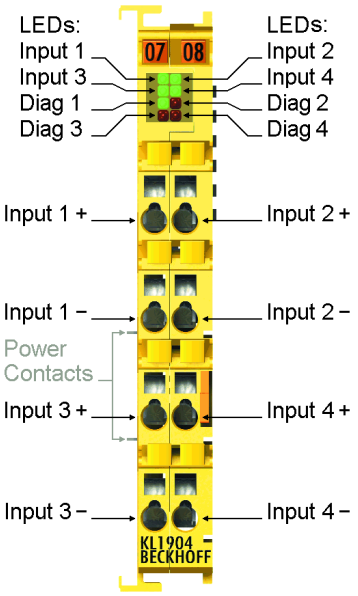
Connection technology

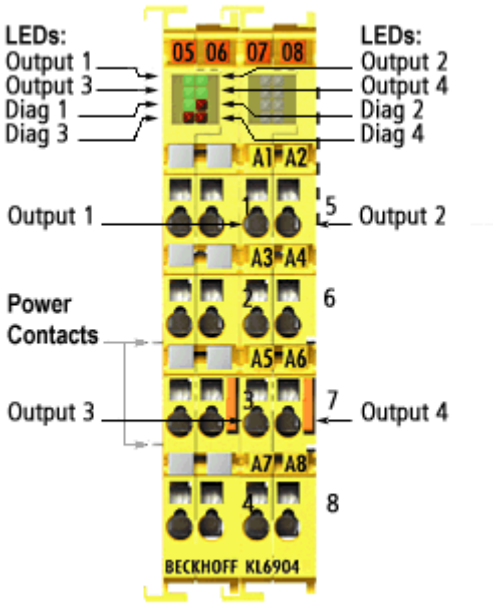
Connection technology	Bus Coupler
Wiring	cage Clamp© spring-loaded system
Connection cross-section	0.08 mm² ... 2.5 mm2, stranded wire, solid wire
Fieldbus connection	depending on fieldbus
Power contacts	3 spring contacts
Current load	10 A
Rated voltage	24 V_{DC}

2.1.2 Bus Terminals

Mechanical data

Mechanical data	Bus Terminal
Material	polycarbonate, polyamide (PA6.6).
Dimensions (W x H x D)	12 mm x 100 mm x 68 mm or 24 mm x 100 mm x 68 mm
Mounting	on 35 mm mounting rail (EN 60715) with locking
Attachable by	double slot and key connection





Connection technology

Connection technology	Bus Terminal
Wiring	cage Clamp© spring-loaded system
Connection cross-section	0.08 mm² ... 2.5 mm2, stranded wire, solid wire
Fieldbus connection	depending on fieldbus
Power contacts	up to 3 blade/spring contacts
Current load	10 A
Rated voltage	depends on Bus Terminal type

2.1.3 K-Bus

The K-Bus is the data path within a terminal strip. The K-Bus is led through from the Bus Coupler through all the terminals via six contacts on the terminals' side walls. The end terminal terminates the K-Bus.

2.1.4 Power contacts

The operating voltage is passed on to following terminals via three power contacts. Terminal strip can be split into galvanically isolated groups by means of potential feed terminals as required. The power feed terminals play no part in the control of the terminals, and can be inserted at any locations within the terminal strip.

2.2 TwinSAFE

2.2.1 The I/O construction kit is extended safely

With the TwinSAFE Terminals, Beckhoff offers the option of simply expanding the proven Bus Terminal system, and to transfer the complete cabling for the safety circuit into the already existing fieldbus cable. Safe signals can be mixed with standard signals without restriction. This saves design effort, installation and material. Maintenance is simplified significantly through faster diagnosis and simple replacement of only a few components.

The new KLx9xx series Bus Terminals only include three basic functionalities: digital KL19xx inputs, digital KL29xx outputs and a KL6904 link unit. For a large number of applications, all sensors and actuators can be wired on these Bus Terminals. The required logical link of the inputs and the outputs is handled by the KL6904. For small to medium-sized configurations, the tasks of a fail-safe PLC can thus be handled within the Bus Terminal system.

2.2.2 Safety concept

TwinSAFE: Safety and I/O technology in one system

- Extension of the familiar Beckhoff I/O system with TwinSAFE terminals
- Freely selectable mix of safe and standard signals
- Logic link of the I/Os in the KL6904 TwinSAFE logic terminal
- Safety-relevant networking of machines via bus systems

TwinSAFE protocol (FSoE)

- Transfer of safety-relevant data via any media (“genuine black channel”)
- TwinSAFE communication via fieldbus systems such as EtherCAT, Lightbus, PROFIBUS or Ethernet
- IEC 61508:2010 SIL 3 compliant

Configuring instead of wiring: the TwinSAFE configurator

- Configuration of the TwinSAFE system via the TwinCAT System Manager
- System Manager for editing and displaying all bus parameters
- Certified function blocks such as emergency stop, operation mode, etc.
- Simple handling
- Typical function blocks for machine safety
- Freely selectable fieldbus connection with the KL6904 TwinSAFE logic terminal

KL6904 TwinSAFE logic Bus Terminal

- Link unit between TwinSAFE input and output terminals
- Configuration of a simple, flexible, cost-effective, decentralized safety controller
- No safety requirements for higher-level control system
- TwinSAFE enables networks with up to 1023 TwinSAFE devices
- TwinSAFE logic terminal can establish up to 15 connections (TwinSAFE connections).
- Several TwinSAFE logic terminals are cascadable in a network
- Safety functions such as emergency stop, protective door, etc. are already included
- Safe outputs integrated
- Suitable for applications up to SIL 3 according to IEC 61508:2010

TwinSAFE digital input (KL1904) and output terminal (KL2904)

- All current safety sensors can be connected
- Operation with a TwinSAFE logic terminal
- KL1904 with 4 fail-safe inputs for sensors (24 V_{DC}) with floating contacts
- KL2904 with four safe channels for actuators (24 V_{DC}, 0.5 A per channel)
- conforming to IEC 61508:2010 SIL 3

2.2.3 EL1904, EL2904 - Bus Terminals with 4 fail-safe inputs or outputs

The KL1904 and KL2904 Bus Terminals enable connection of common safety sensors and actuators. They are operated with the KL6904 TwinSAFE logic terminal. The TwinSAFE logic terminal is the link unit between the TwinSAFE input and output terminals. It enables the configuration of a simple, flexible and cost-effective decentralized safety control system.

Therefore, there are no safety requirements for the higher-level controller! The typical safety functions required for the automation of machines, such as emergency stop, protective door, two-hand etc., are already permanently programmed in the KL6904. The user configures the KL6904 terminal according to the safety requirements of his application.

2.2.4 KL6904 TwinSAFE logic terminal with 4 fail-safe outputs

The KL6904 TwinSAFE logic terminal is a digital output terminal with four fail-safe outputs with 0.5 A, 24 V_{DC}. The KL6904 meets the requirements of IEC 61508:2010 SIL 3 and DIN EN ISO 13849-1:2006 (Cat 4, PL e).

2.2.5 The fail-safe principle (Fail Stop)

The basic rule for a safety system such as TwinSAFE is that failure of a part, a system component or the overall system must never lead to a dangerous condition. The safe state is always the switched off and wattless state.

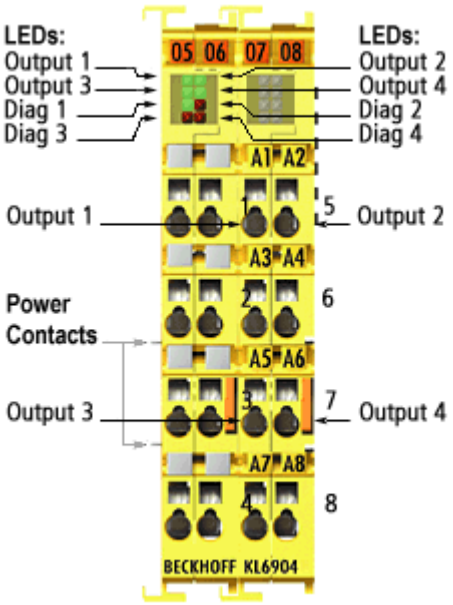
3 Product description

3.1 General description

KL6904 TwinSAFE logic terminal with four fail-safe outputs
The KL6904 is a safe small controller with digital outputs for connecting actuators (contactors, relays, etc.) with a maximum current 0.5 A (24 V_{DC}). The Bus Terminal has 4 fail-safe outputs.

The KL6904 meets the requirements of IEC 61508:2010 SIL 3, DIN EN ISO 13849-1:2006 (Cat 4, PL e), NRTL, UL508, UL1998 and UL991.

The Bus Terminal has the standard design of a Beckhoff Bus Terminal.



3.2 Intended use

 WARNING	**Caution - Risk of injury!** TwinSAFE terminals may only be used for the purposes described below!

The TwinSAFE terminals expand the application range of Beckhoff Bus Terminal system with functions that enable them to be used for machine safety applications. The TwinSAFE terminals are designed for machine safety functions and directly associated industrial automation tasks. They are therefore only approved for applications with a defined fail-safe state. This safe state is the wattless state. Fail-safety according to the relevant standards is required.

The TwinSAFE terminals enable connection of:

- 24 V_{DC} sensors (KL1904) such as
  emergency off pushbutton switches, pull cord switches, position switches, two-hand switches, safety mats, light curtains, light barriers, laser scanner, etc.
- 24 V_{DC} actuators (KL2904, KL6904) such as
  contactors, protection door switches with tumbler, signal lamps, servo drives, etc.

 Note	**Test pulses** When selecting actuators please ensure that the KL6904 test pulses do not lead to actuator switching or diagnostic message from the KL6904. The test pulses of the KL6904 terminal outputs are not configurable and cannot be switched off.

The following modules were developed for these tasks:

- The KL1904 terminal is an input module with digital inputs.
- The KL2904 terminal is an output module with digital outputs.
- The KL6904 terminal is a logic module with digital outputs.

These modules are suitable for operation with

- Beckhoff BKxxxx series Bus Couplers
- Beckhoff BXxxxx series Bus Terminal Controllers (with firmware version ≥ 1.20)
  (Beckhoff BCxxxx series Bus Terminal Controllers are not supported!)
- Beckhoff CXxxxx series Embedded PCs with K-Bus connection

 CAUTION	**Follow the machinery directive** The TwinSAFE terminals may only be used in machines according to the machinery directive.

 CAUTION	**Ensure traceability** The buyer has to ensure the traceability of the device via the serial number.

3.3 Technical data

Product designation		KL6904
Number of inputs		0
Number of outputs		4
Status display		4 (one green LED per output)
Error reaction time		≤ watchdog times
Output current per channel		max. 500 mA, min. 20 mA
Actuators		When selecting actuators please ensure that the output test pulses do not lead to actuator switching.
Cable length between actuator and terminal	(unshielded)	max. 100 m
	(shielded)	max. 100 m
Wire cross section		min. 0.75 mm^2
Input process image		192 byte max.
Output process image		192 byte max.
KL6904 supply voltage		24 V_{DC} (–15% / +20%)
Current consumption from K-bus		max. 250 mA
Power dissipation of the terminal		typically 2 W
Electrical isolation (between the channels)		no
Electrical isolation (between the channels and the K-Bus)		yes
Insulation voltage (between the channels and the K-Bus, under common operating conditions)		insulation tested with 500 V_{DC}
Dimensions (W x H x D)		24mm x 100mm x 68mm
Weight		approx. 100 g
Permissible ambient temperature (operation)		0°C to +55°C
Permissible ambient temperature (transport/storage)		-25°C to +70°C
Permissible air humidity		5% to 95%, non-condensing
Permissible air pressure (operation/storage/transport)		750 hPa to 1100 hPa (this corresponds to a height of approx. -690 m to 2450 m over sea level assuming an international standard atmosphere)
Climate category according to EN 60721-3-3		3K3
Permissible level of contamination		level of contamination 2 (comply with the chapter Cleaning)
Impermissible operating conditions		TwinSAFE terminals must not be used under the following operating conditions: • under the influence of ionizing radiation • in corrosive environments • in an environment that leads to unacceptable soiling of the Bus Terminal
Vibration/shock resistance		conforms to EN 60068-2-6 / EN 60068-2-27
EMC immunity/emission		conforms to EN 61000-6-2 / EN 61000-6-4
Shocks		15 g with pulse duration 11 ms in all three axes
Protection class		IP20
Permitted operating environment		In the control cabinet or terminal box, with minimum protection class IP54 according to IEC 60529
Permissible installation position		horizontal
Approvals		CE

3.4 Safety parameters

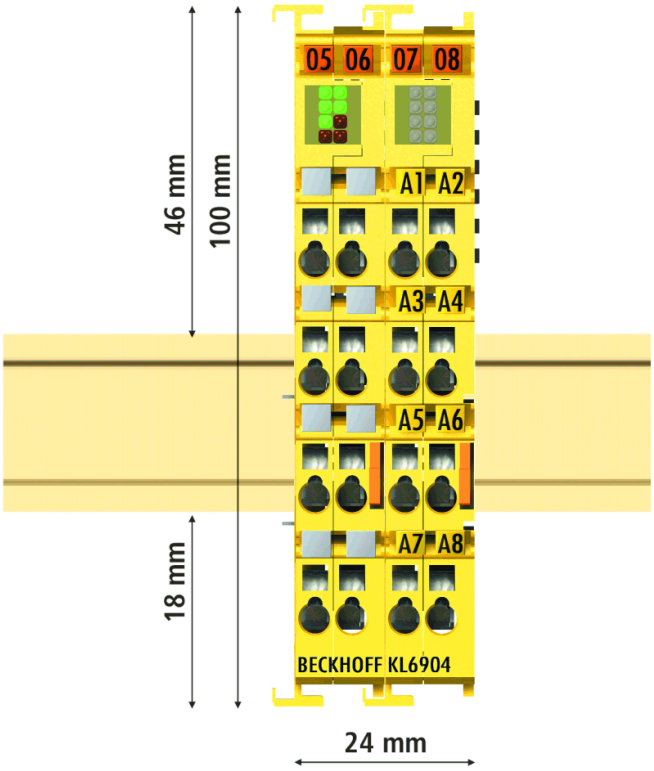
Key figures	KL6904
Lifetime [a]	20
Prooftest Interval [a]	not required [1)]
PFH_D	1.73E-09
%SIL3	1,7%
PFD	1.42E-04
%SIL3	14,2%
$MTTF_d$	High
DC	High
Performance level	PL e
Category	4
HFT	1
Element classification*	Type B

*) Classification according to IEC 61508-2:2010 (see chapter 7.4.4.1.2 and 7.4.4.1.3)

The KL6904 Bus Terminal can be used for safety-related applications within the meaning of IEC 61508:2010 up to SIL3 and EN ISO 13849-1 up to PL e (Cat4).
[1)] Special proof tests are not required during the entire service life of the KL6904 Bus Terminal.

To calculate or estimate the $MTTF_d$ value out of the PFH_D value please refer to the Application Guide TwinSAFE or to the ISO 13849-1:2015 table K.1.

3.5 Dimensions



Width: 24 mm (side-by-side installation)
Height: 100 mm
Depth: 68 mm

4 Operation

Please ensure that the TwinSAFE terminals are only transported, stored and operated under the specified conditions (see technical data)!

 **WARNING**	**Caution - Risk of injury!** The TwinSAFE terminals must not be used under the following operating conditions: • under the influence of ionizing radiation • in corrosive environments • in an environment that leads to unacceptable soiling of the Bus Terminal

4.1 Installation

4.1.1 Safety instructions

Before installing and commissioning the TwinSAFE terminals please read the safety notes in the foreword of this documentation.

4.1.2 Transport / storage

Use the original packaging for transporting or storing the digital TwinSAFE terminals.

 **CAUTION**	**Note the specified environmental conditions** Please ensure that the digital TwinSAFE terminals are only transported and stored under the specified environmental conditions (see technical data).

4.1.3 Mechanical installation

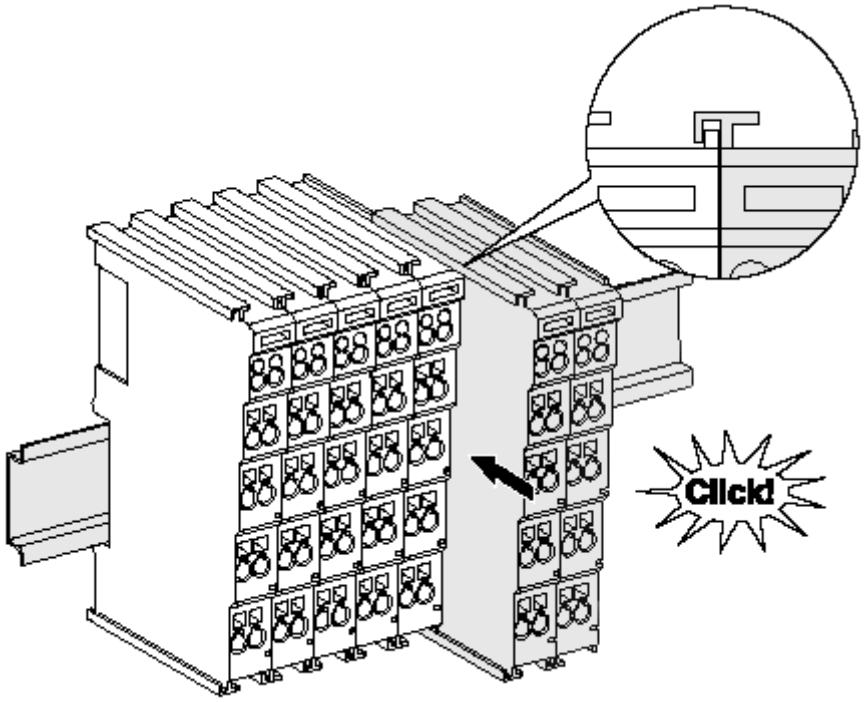
DANGER	**Serious risk of injury!** Bring the bus system into a safe, de-energized state before starting installation, disassembly or wiring of the Bus Terminals!

4.1.3.1 Control cabinet

The TwinSAFE terminals must be installed in a control cabinet or terminal box with IP54 protection class according to IEC 60529 as a minimum.

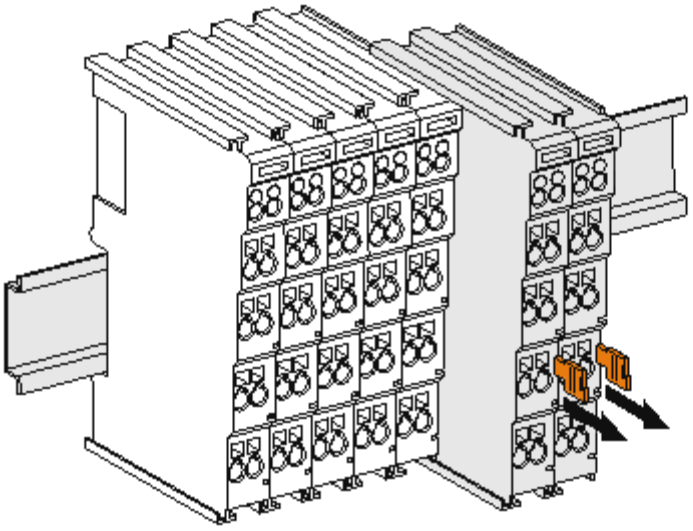
4.1.3.2 Mounting rail installation

Mounting
The Bus Couplers and Bus Terminals are attached to commercially available 35 mm mounting rails (according to EN 60715) by applying slight pressure:



1. First attach the Fieldbus Coupler to the mounting rail.
2. The Bus Terminals are now attached on the right-hand side of the fieldbus Coupler. Join the components with slot and key and push the terminals against the mounting rail, until the lock clicks onto the mounting rail.
   If the terminals are clipped onto the mounting rail first and then pushed together without slot and key, the connection will not be operational! When correctly assembled, no significant gap should be visible between the housings.
3. During the installation of the Bus Terminals, the locking mechanism of the terminals must not come into conflict with the fixing bolts of the mounting rail.

Removal



1. Carefully pull the orange-colored lugs approximately 1 cm out of the disassembled terminal, until they protrude loosely. The lock with the mounting rail is now released for this terminal, and the terminal can be pulled from the mounting rail without excessive force.
2. Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal away from the mounting rail.

4.1.4 Electrical installation

4.1.4.1 Connections within a Bus Terminal block

The electric connections between the Bus Coupler and the Bus Terminals are automatically realized by joining the components:

- The six spring contacts of the K-Bus deal with the transfer of the data and the supply of the Bus Terminal electronics.

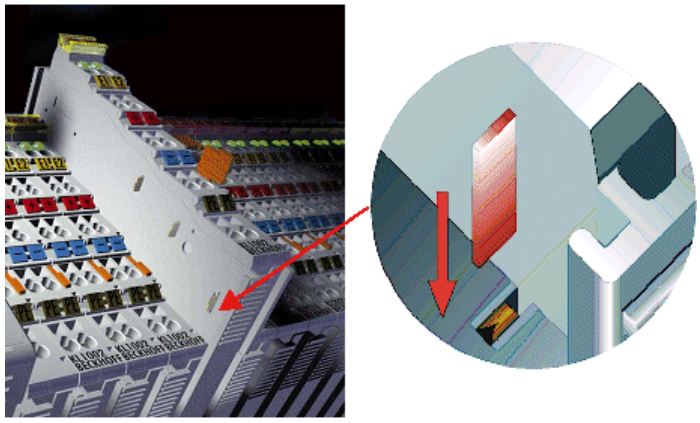
Note	**Note the maximum K-Bus current!** Observe the maximum current that your Bus Coupler can supply to the K-Bus! Use the KL9400 Power Supply Terminal if the current consumption of your terminals exceeds the maximum current that your Bus Coupler can feed to the K-Bus supply.

- The power contacts deal with the supply for the field electronics and thus represent a supply rail within the Bus Terminal block. The power contacts are supplied via terminals on the Bus Coupler.

Note	**Note the pin assignment of the power contacts!** During the design of a Bus Terminal block, the pin assignment of the individual Bus Terminals must be taken account of, since some types (e.g. analog Bus Terminals or digital 4-channel Bus Terminals) do not or not fully loop through the power contacts. Power Feed Terminals (KL91xx, KL92xx) interrupt the power contacts and thus represent the start of a new supply rail.

PE power contact

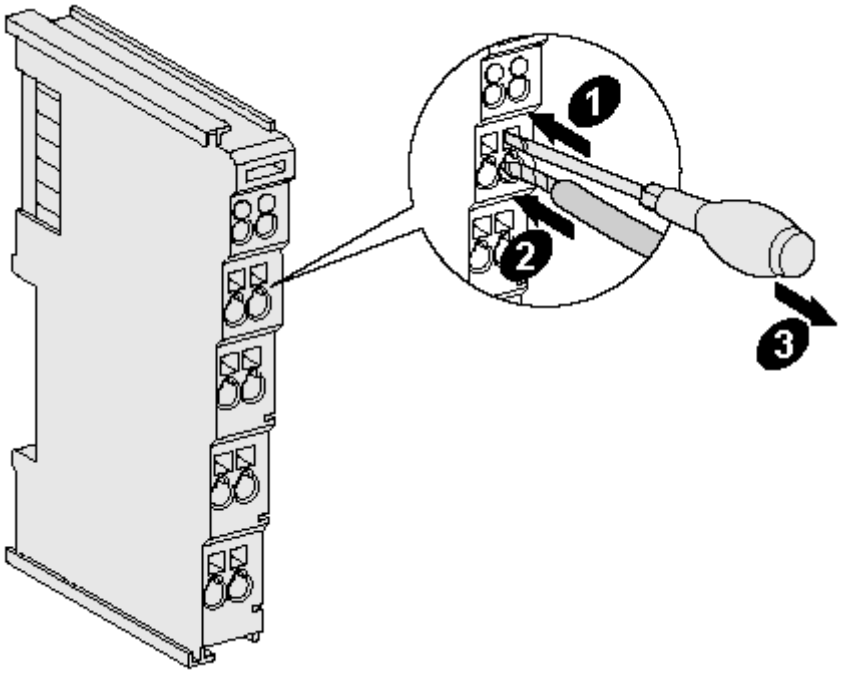
The power contact labelled PE can be used as a protective earth. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A.



CAUTION	**Insulation tests** Note that, for reasons of electromagnetic compatibility, the PE contacts are capacitatively coupled to the mounting rail. This may lead to incorrect results during insulation testing or to damage on the terminal (e.g. disruptive discharge to the PE line during insulation testing of a consumer with a nominal voltage of 230 V). For insulation testing, disconnect the PE supply line at the Bus Coupler or the Power Feed Terminal! In order to decouple further feed points for testing, these Power Feed Terminals can be released and pulled at least 10 mm from the group of terminals.

DANGER	**Serious risk of injury!** The PE power contact must not be used for other potentials!

4.1.4.2 Wiring

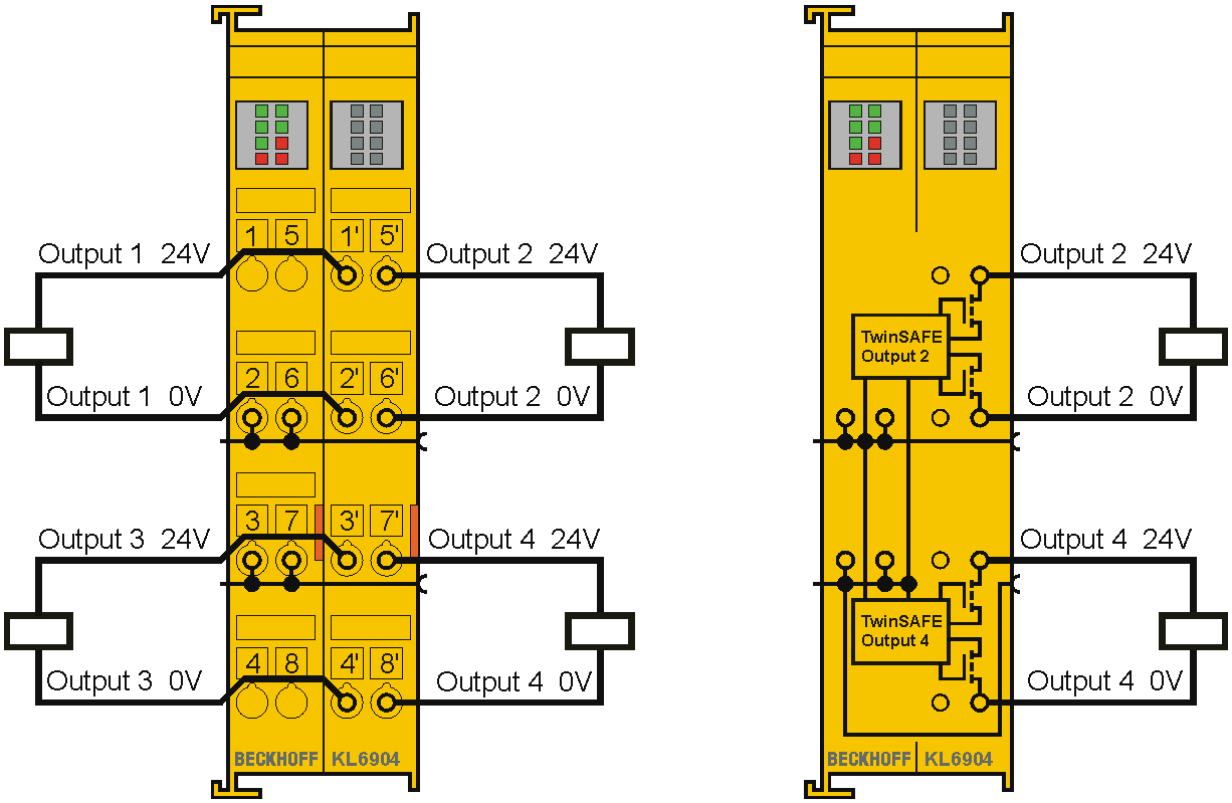


Up to eight connections enable the connection of solid or finely stranded cables to the Bus Terminals. The terminals are implemented in spring force technology. Connect the cables as follows:

1. Open a spring-loaded terminal by slightly pushing with a screwdriver or a rod into the square opening above the terminal.
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal closes automatically when the pressure is released, holding the wire safely and permanently.

Wire cross section	0.08 ... 2.5 mm^2
Strip length	8 mm

KL6904 pin assignment



Terminal point	Output	Signal
1	-	not used, no function
2		positive power contact
3	-	negative power contact
4		not used, no function
5	-	not used, no function
6		positive power contact
7	-	negative power contact
8		not used, no function
1’	1	Output 1+
2’		Output 1-
3’	3	Output 3+
4’		Output 3-
5’	2	Output 2+
6’		Output 2-
7’	4	Output 4+
8’		Output 4-

Note	**Test pulses** When selecting actuators please ensure that the KL2904 test pulses do not lead to actuator switching or diagnostic message from the KL2904. The test pulses of the KL6904 terminal outputs are not configurable and cannot be switched off.

4.1.5 Tested devices

The following list contains devices that were tested the together with the KL2904 TwinSAFE terminal. The results only apply for the current device hardware version at the time of testing. The tests were carried out in a laboratory environment. Modifications of these products cannot be considered here. If you are unsure please test the hardware together with the TwinSAFE terminal.

Manufacturer	Type	Comment
Beckhoff	AX5801	TwinSAFE Drive option card: safe restart lock
Beckhoff	AX2000 AS option	safe restart lock
Beckhoff	KL2964	Three-channel contact extension with feedback
Siemens	SIRIUS series S00 3RT1016-1BB42	Schütz
Telemecanique	LP1K09	Schütz
Dold	LG5929.54/100	Extension module with floating contacts

The tests were carried out as function tests only. The information provided in the respective manufacturer documentation remains valid.

Note	**Recommended protective circuits** We recommend R/C or diode-based protective circuits for these devices. Varistor-based protective circuits should not be used.

4.2 Configuration of the KL6904 in the TwinCAT System Manager

 **CAUTION**	**Do not change the register values!** Do not change the register values for the TwinSAFE terminals. Changes to the register values (e.g. with the KS2000 configuration software or via register communication) sets the terminal permanently in the Fail-Stop state!

4.2.1 Configuration requirements

Version 2.10 build 1302 or higher of the TwinCAT automation software is required for configuring the KL6904. The current version is available for download from the Beckhoff website at www.beckhoff.de. In addition, the TwinSAFE Verifier must be installed. This is available on the Beckhoff Products & Solutions CD. The current installation can also be obtained from Beckhoff Support, if required.

Once the TwinSAFE Verifier was installed successfully, the TwinSAFE Verifier tab is available in the TwinCAT System Manager (further information can be found in section *Loading the project into the KL6904*).

4.2.2 Inserting a Beckhoff Bus Coupler

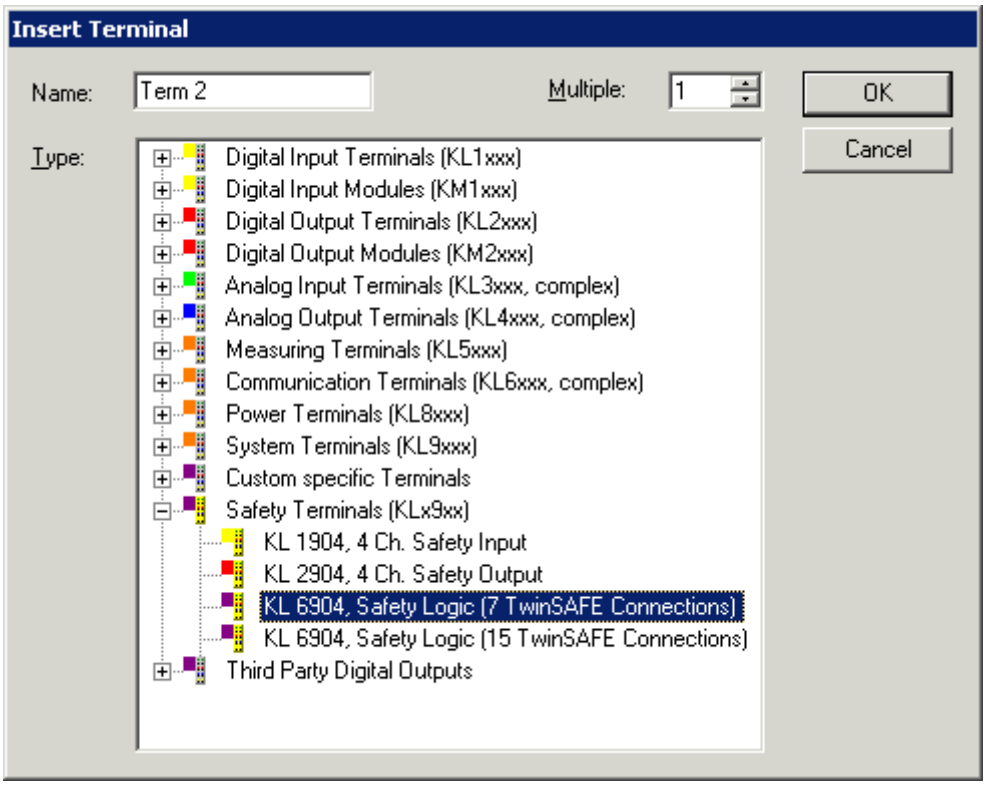
See TwinCAT automation software documentation.

4.2.3 Inserting a Beckhoff Bus Terminal

See TwinCAT automation software documentation.

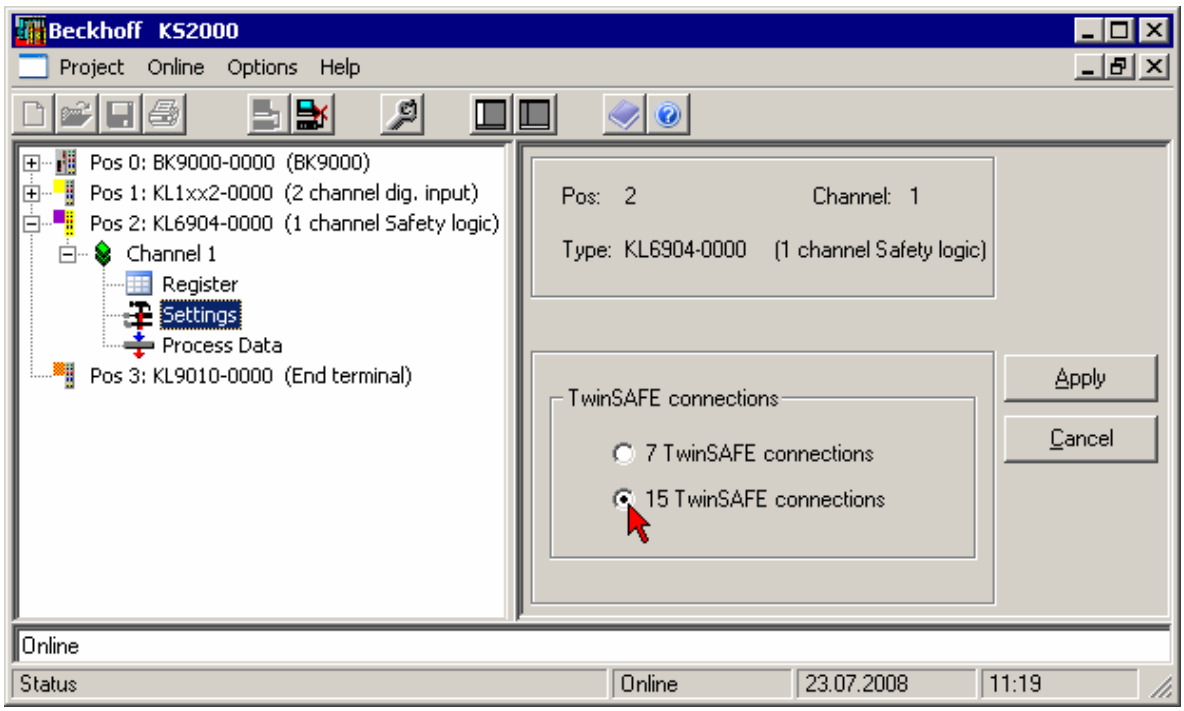
4.2.4 Inserting a KL6904

A KL6904 is inserted in the same way as any other Beckhoff Bus Terminal. In the list open *Safety Terminals (KLx9xx)* and select the KL6904. The KL6904 can be selected with 7 or 15 TwinSAFE connections.



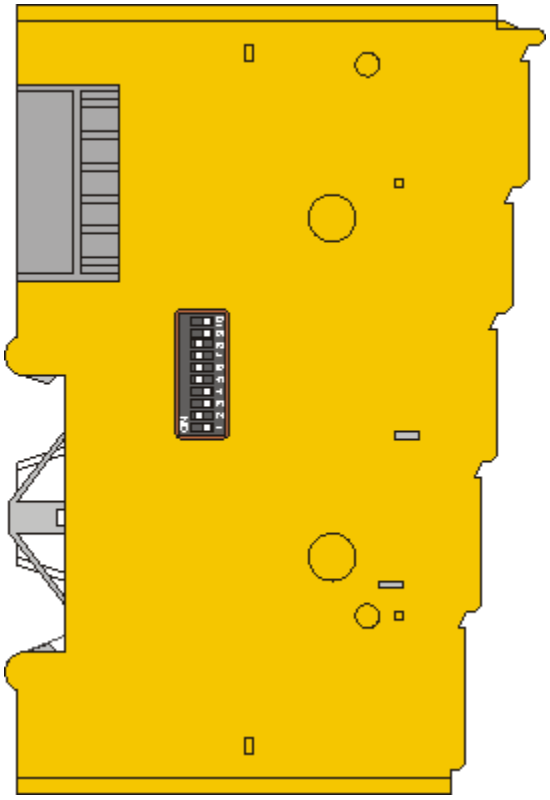
Note	**Size of the process image** The process image should not be unnecessarily large.

If a KL6904 with 15 TwinSAFE connections is inserted, the KL6904 must be configured accordingly, since the KL6904 is delivered with 7 configured connections. The KL6904 can be configured with the KS2000 configuration software from Beckhoff (firmware version 14 or higher).



After the changeover to the new process image the KL6904 must be de-energized and switched on again in order to activate the change.

4.2.5 Address settings on the TwinSAFE terminals



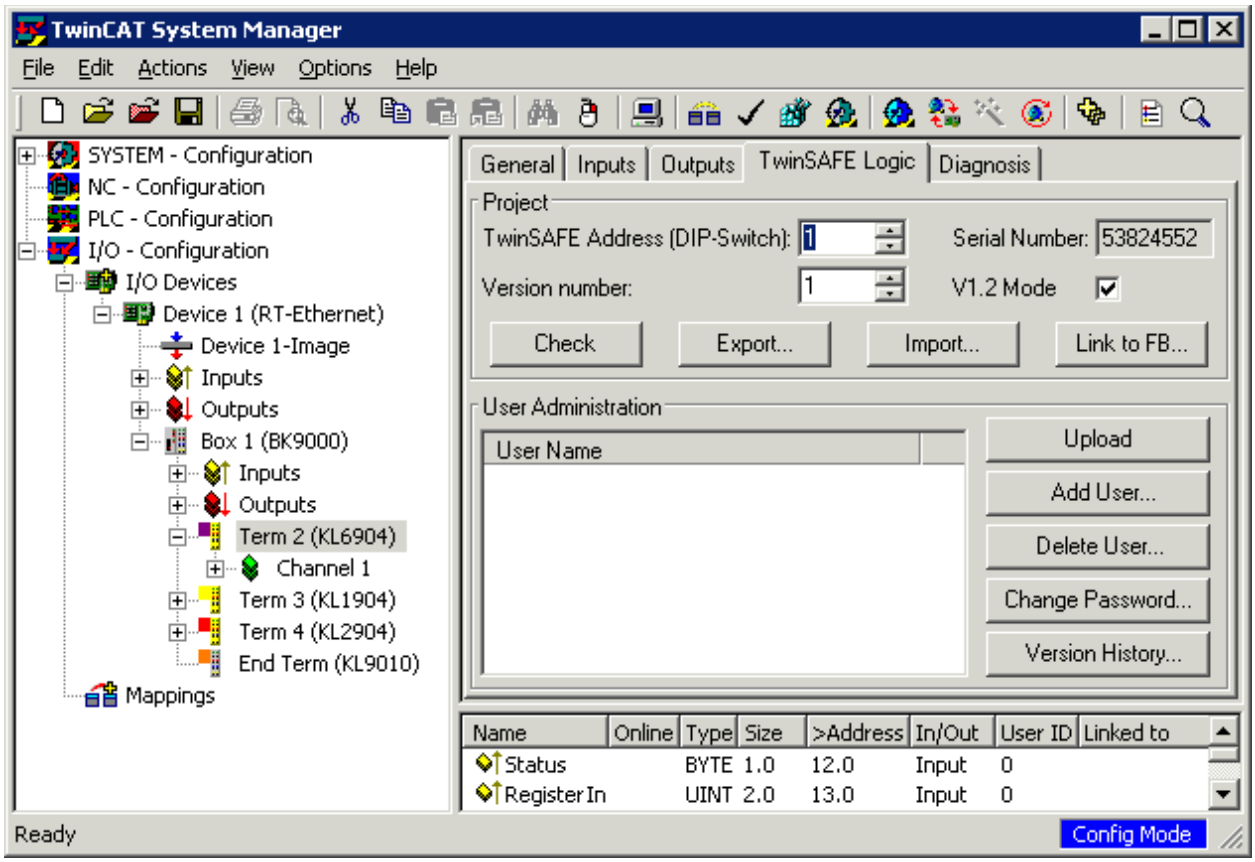
The TwinSAFE address of the terminal is set via the 10-way DIP switch on the left-hand side of the TwinSAFE Bus Terminal. TwinSAFE addresses between 1 and 1023 are available.

DIP switch										Address
1	2	3	4	5	6	7	8	9	10	
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	0
ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	1
OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	2
ON	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	3
OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	4
ON	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	5
OFF	**ON**	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	6
ON	**ON**	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	7
...	...	...	...	...	...	...	...	...	...	...
ON	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	1023

WARNING	**Unique TwinSAFE address** Each TwinSAFE address may only be used once within a network! The address 0 is not a valid TwinSAFE address!

4.2.6 Entering the TwinSAFE addresses in the System Manager

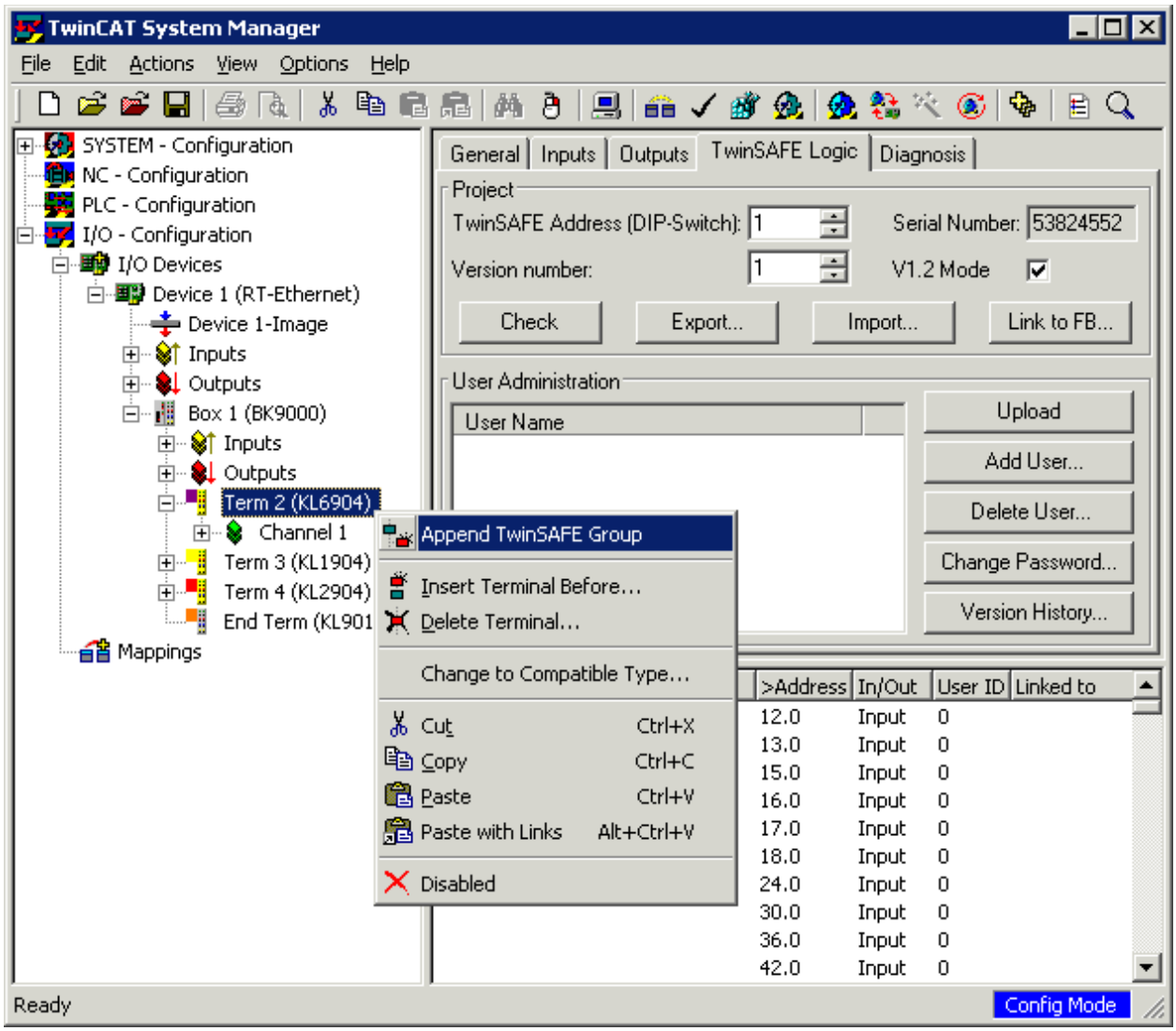
The TwinSAFE address set at the DIP switch must also be entered under the *TwinSAFE Logic* tab (*TwinSAFE address* entry).



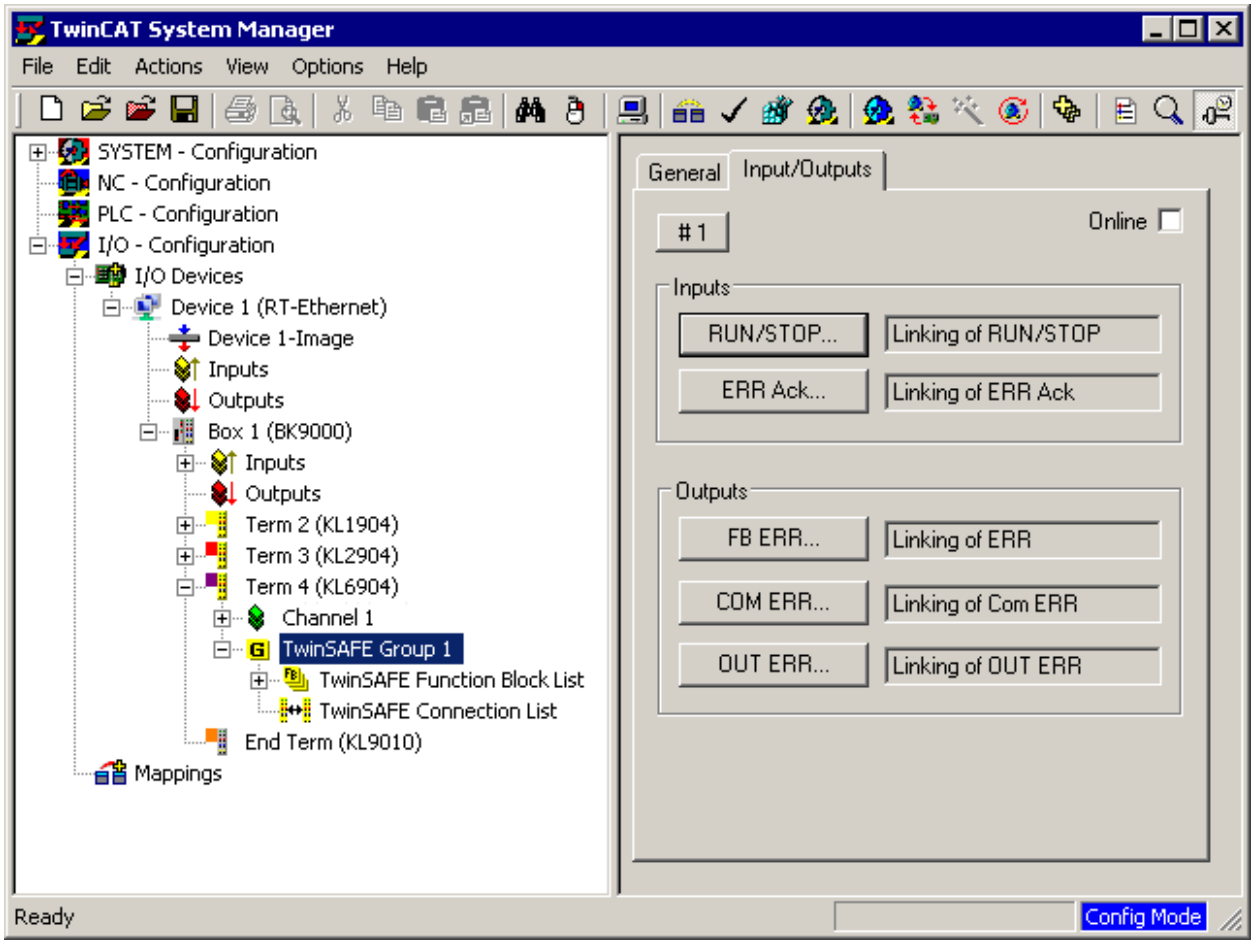
4.2.7 Creating a TwinSAFE group

A TwinSAFE Group is a group of TwinSAFE terminals (inputs and outputs) that are logically linked via a KL6904. Any communication faults in the TwinSAFE connections of this group lead to the whole group being switched off. Other TwinSAFE groups are not affected.

A TwinSAFE Group is added by right-clicking on the associated KL6904 in the tree structure and selecting *Append TwinSAFE Group* in the dialog box (see diagram).



4.2.7.1 TwinSAFE group signals



TwinSAFE group inputs

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

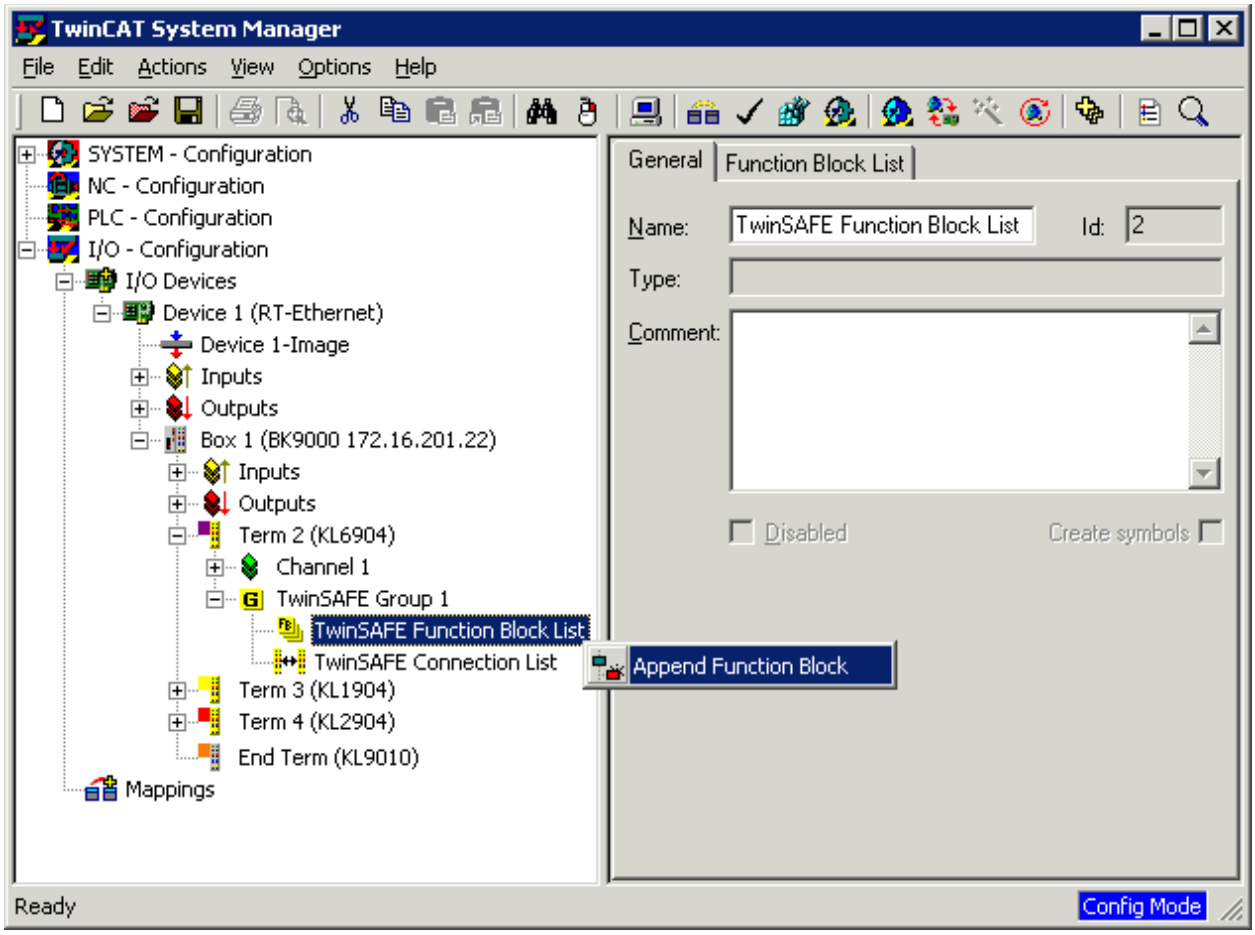
TwinSAFE group outputs

Name	Permitted type	Description	
FB ERR	TwinSAFE-Out FB-In Standard-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	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	TRUE:	At least one locally assigned output of the TwinSAFE group has an error
		FALSE:	All of the locally assigned outputs of the TwinSAFE group have no errors

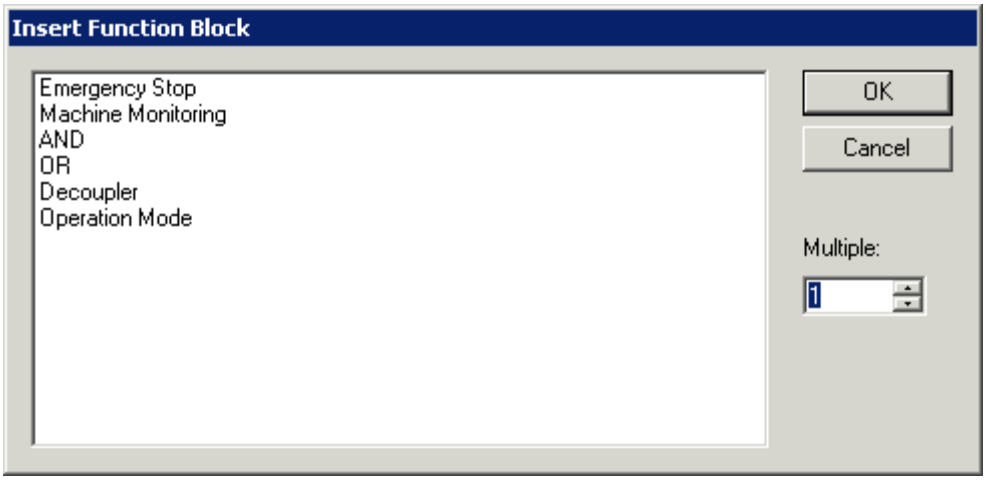
4.2.8 Append a function block

The KL6904 TwinSAFE logic terminal features the following blocks: Emergency Stop, Machine Monitoring, AND, OR, Decoupler, Operation Mode, etc.

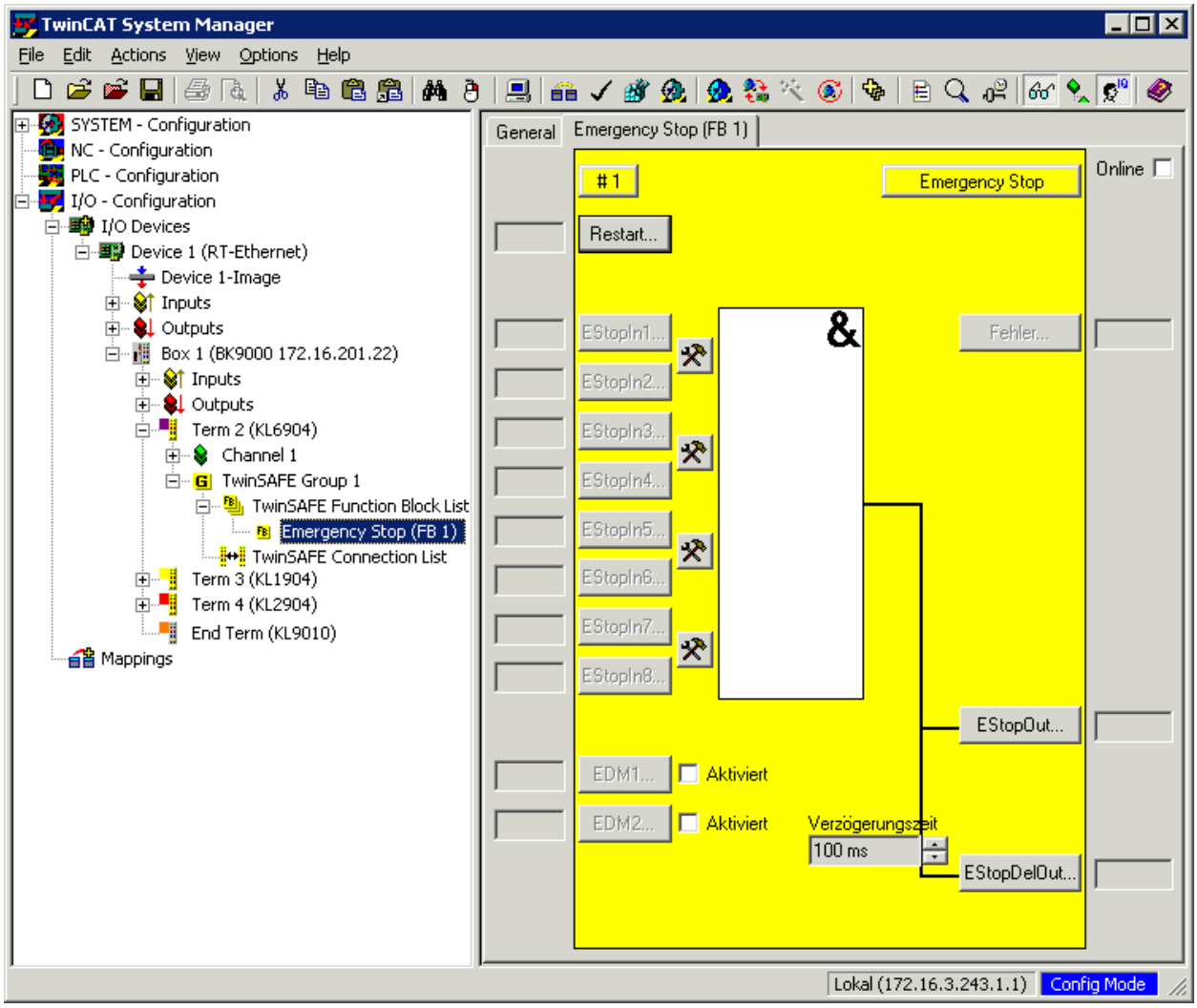
A function block is added by right-clicking on the associated *TwinSAFE function block list* in the tree structure and selecting *Append Function Block* in the dialog box with the left mouse button (see diagram).



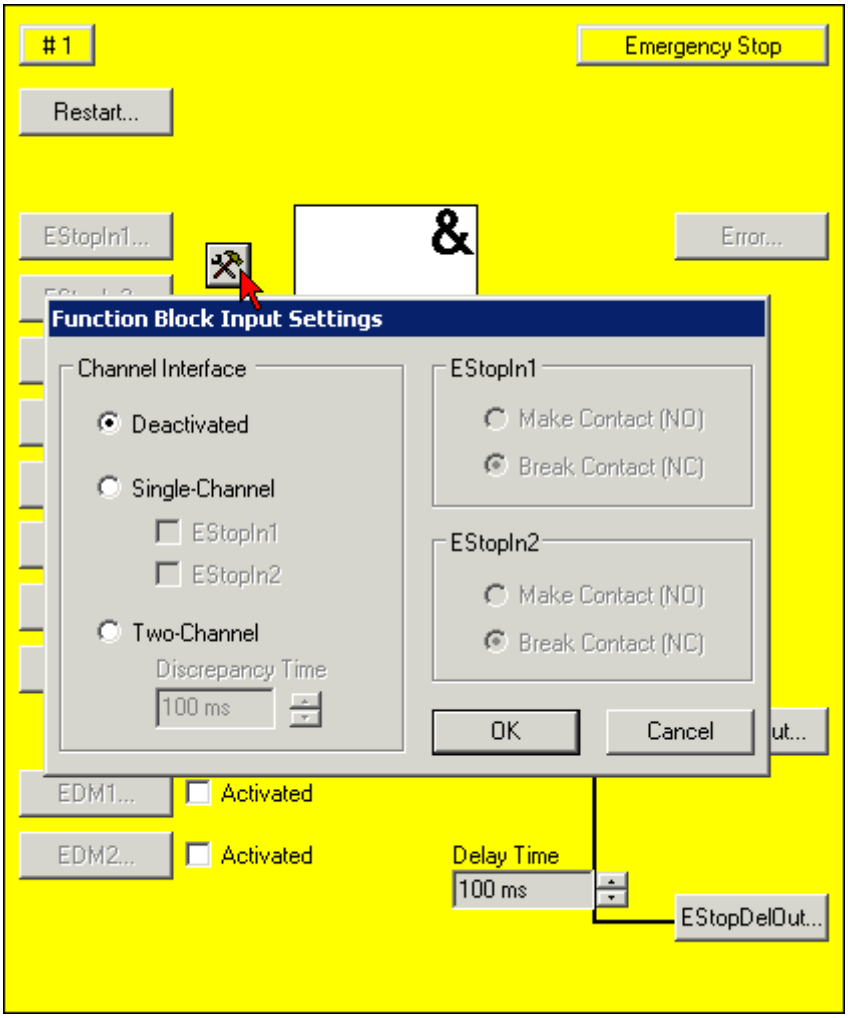
The required function block can then be selected from the following window.



Appended Emergency Stop block



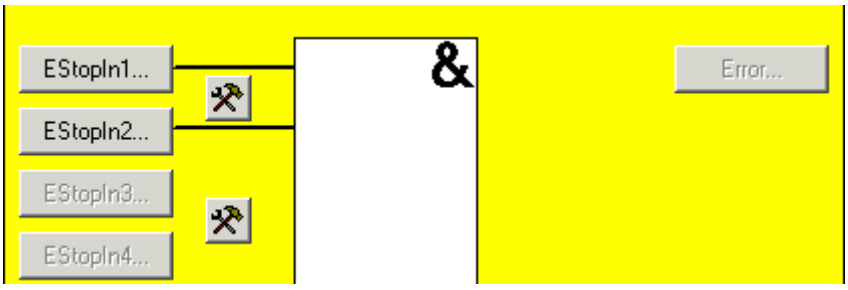
4.2.8.1 Activating and configuring the block inputs



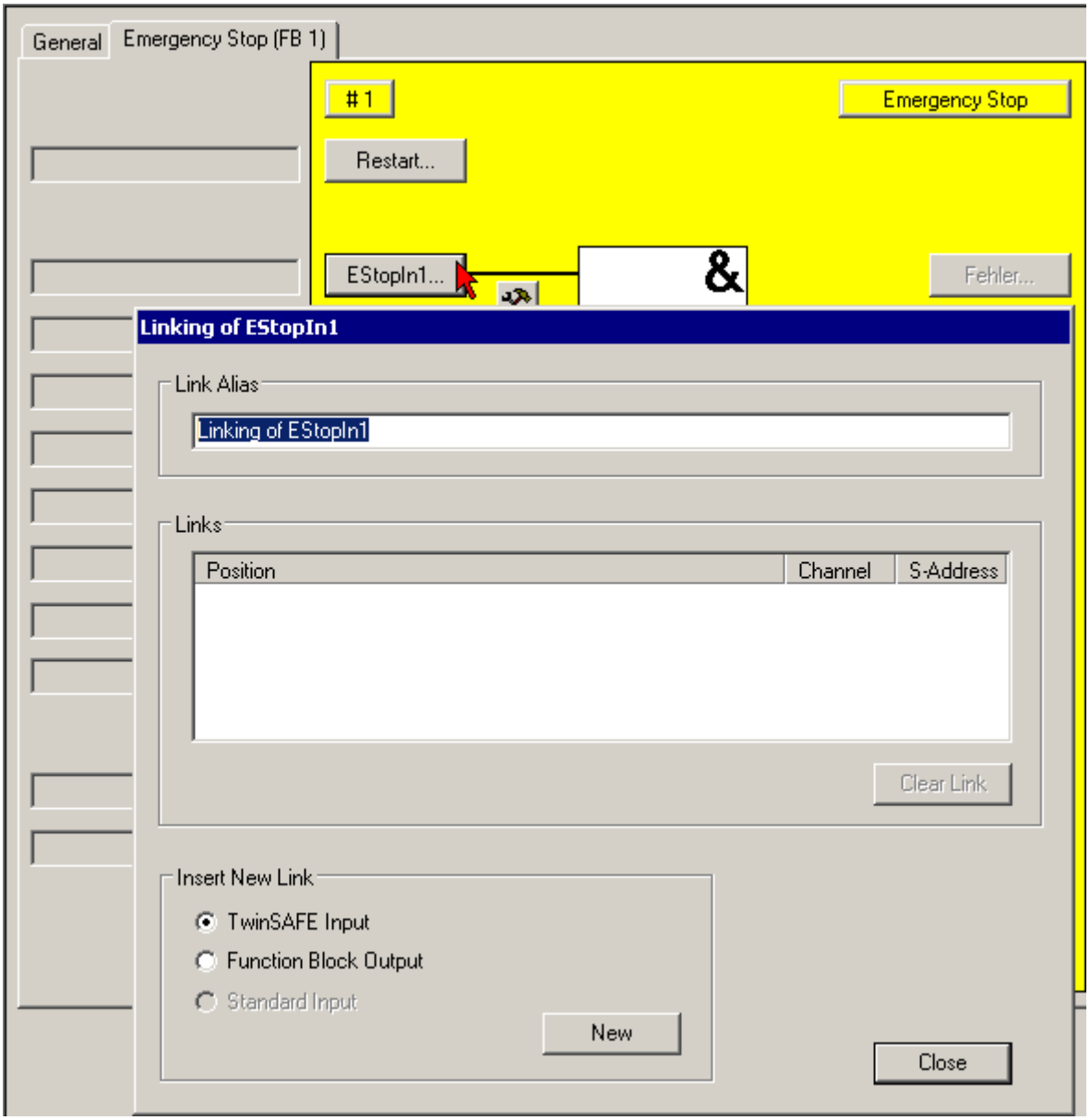
The following parameters can be set:

Deactivated:	The input is not used
Single-channel:	The inputs are linked independent of each other
Two-channel:	The inputs are monitored for equality or inequality, depending on the contact type setting. A *Discrepancy Time* can be set for monitoring the two inputs for simultaneous switching.
Make Contact:	Contact type setting
Break Contact	Contact type setting

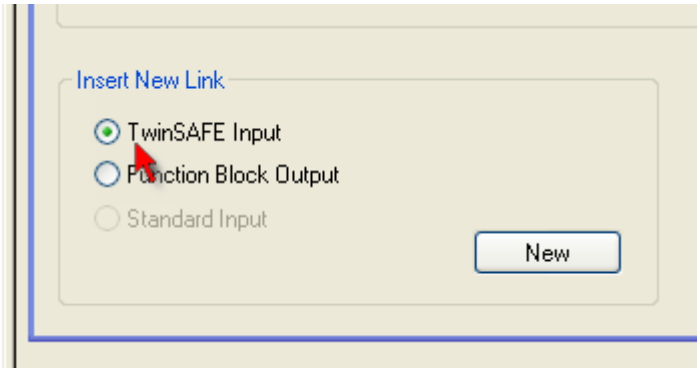
The inputs are now activated.



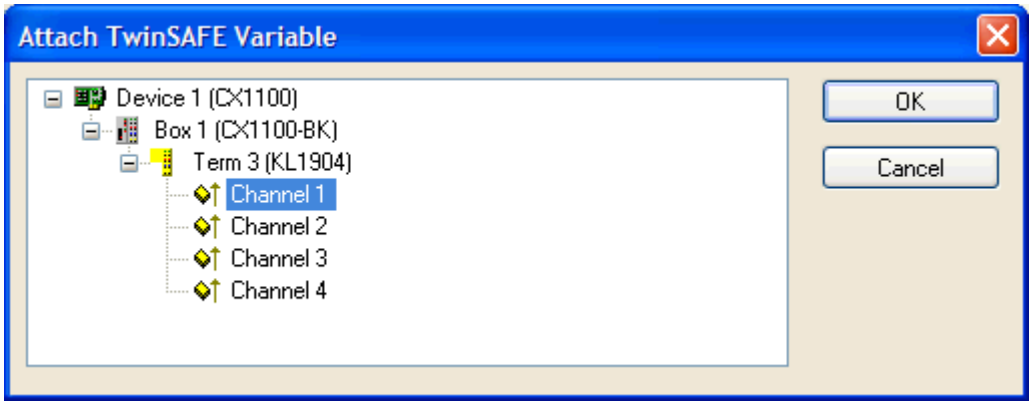
The inputs can now be linked.



Select the variable type:

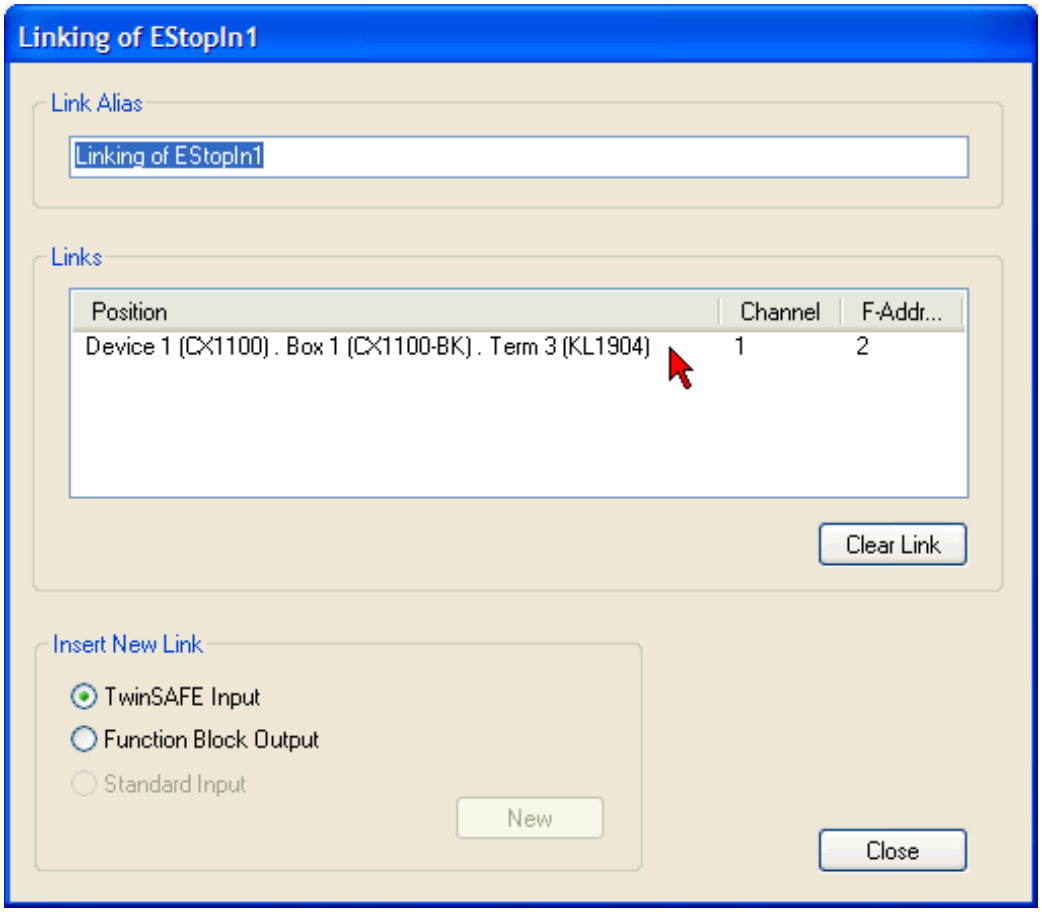


Clicking on the *New* button opens the following dialog:

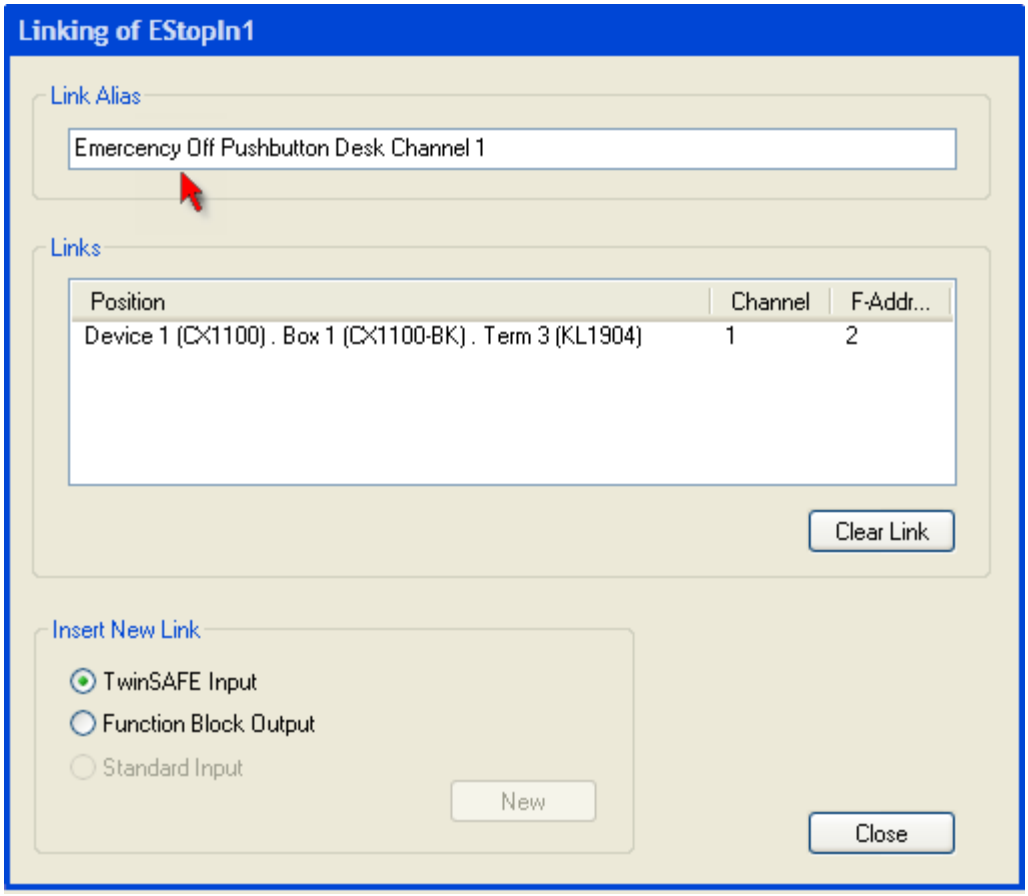


All available channels are displayed as selected.

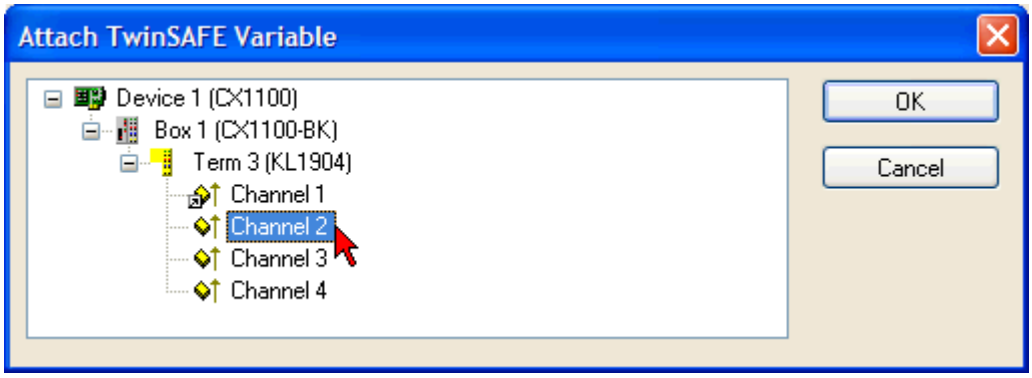
The required channel is selected and highlighted in blue with the mouse. The selection is confirmed via the OK button.



The name of the variables should now be entered in the *Link Alias* field.

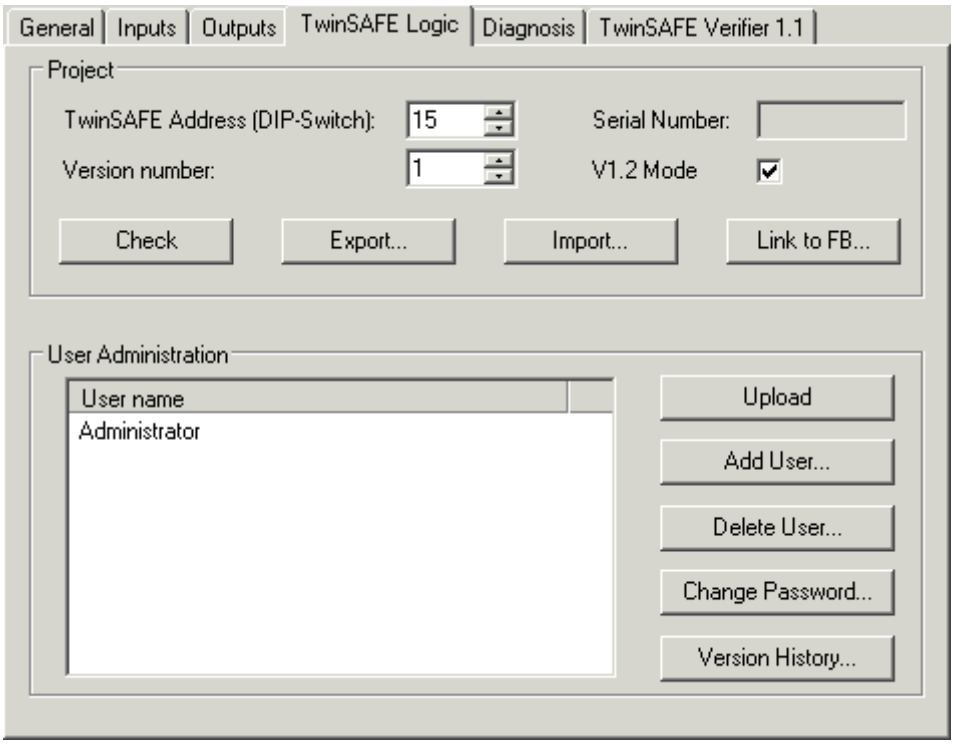


Repeat the process for the other inputs. Inputs that are already in use are identified with an arrow.



4.2.9 KL6904 user and version administration

The KL6904 has a user administration function. The administrator can create further users and issue associated passwords.



Clicking on the *Version History* button will bring up the version history for the KL6904 (which cannot be deleted) that indicates who activated what version of a project on the KL6904, and when.

4.2.10 Loading the project into the KL6904

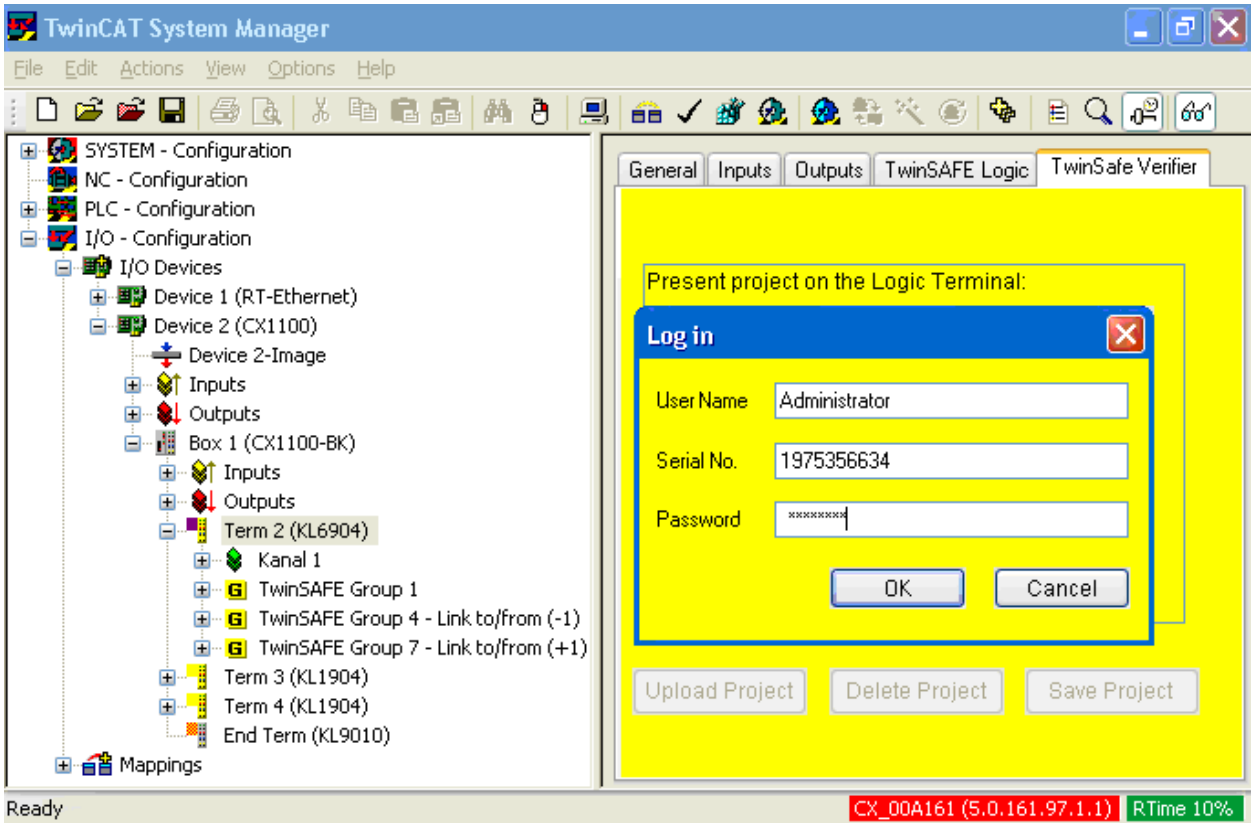
The project is loaded into the KL6904 via the fieldbus.

CAUTION	**Use only qualified tools** Only use a qualified tool for loading, verifying and enabling the project on the KL6904!

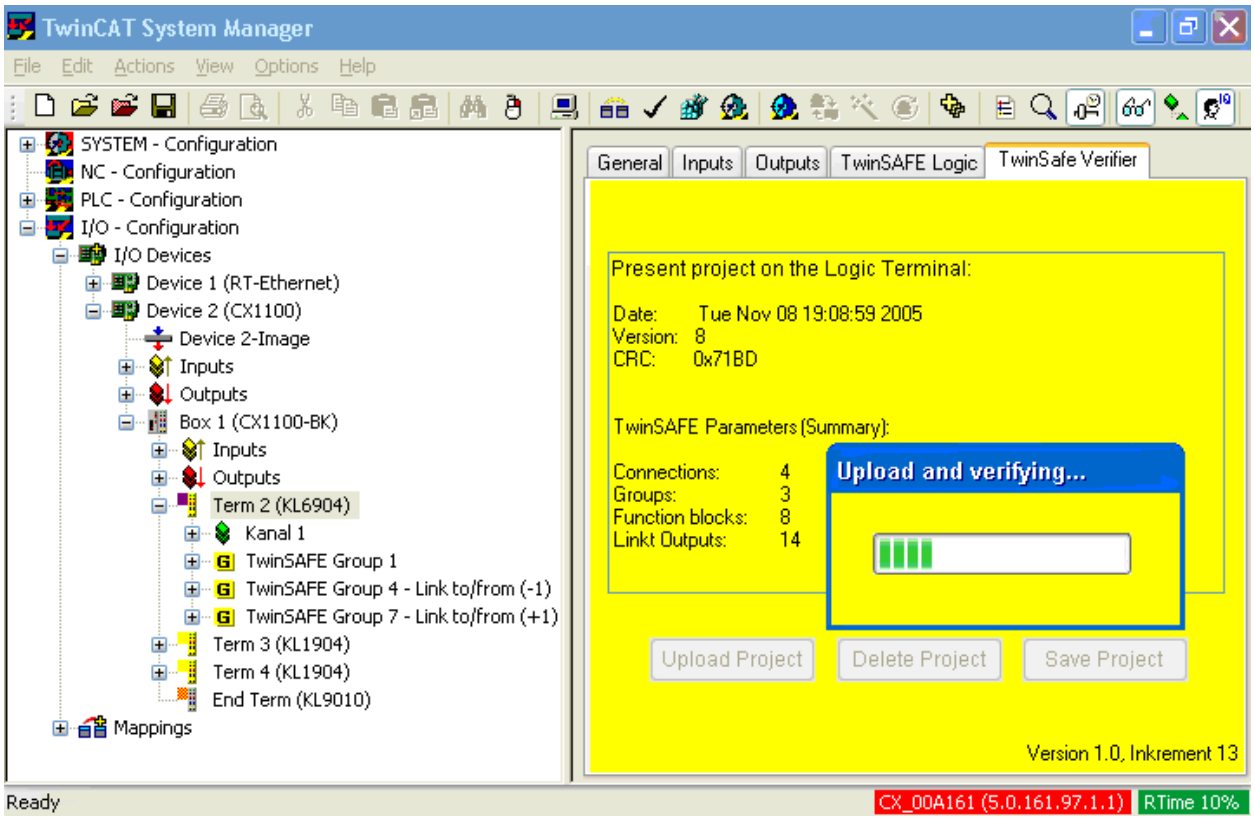
Click the *Download* button on the *TwinSAFE Verifier* tab for loading the project.

The user must enter
- his user name (default: Administrator),
- the terminal serial number (printed on the outside, e.g. 197535), and
- his password (default: TwinSAFE).

Note	**Case-sensitive** Pay attention to upper/lower case characters for the user name and password. User name and password are case-sensitive!



The project is then displayed in text mode, and the user has to confirm consistency between the information displayed and the currently projected application by re-entering the password.



The project is then started on the KL6904.

4.2.10.1 KL6904 project design limits

TwinSAFE connections	max. 7 or 15 (see *Inserting a KL6904*)
TwinSAFE blocks	48 max.
TwinSAFE groups	8 max.
Standard PLC inputs	max. 24 bit
Standard PLC outputs	max. 24 bit

Note	**TwinSAFE connection** Only one TwinSAFE connection between two TwinSAFE terminals is possible.

4.2.11 Communication between TwinCAT controllers

The MASTER_MESSAGE and SLAVE_MESSAGE data types are used for communication between two or more TwinCAT controllers via network variables.

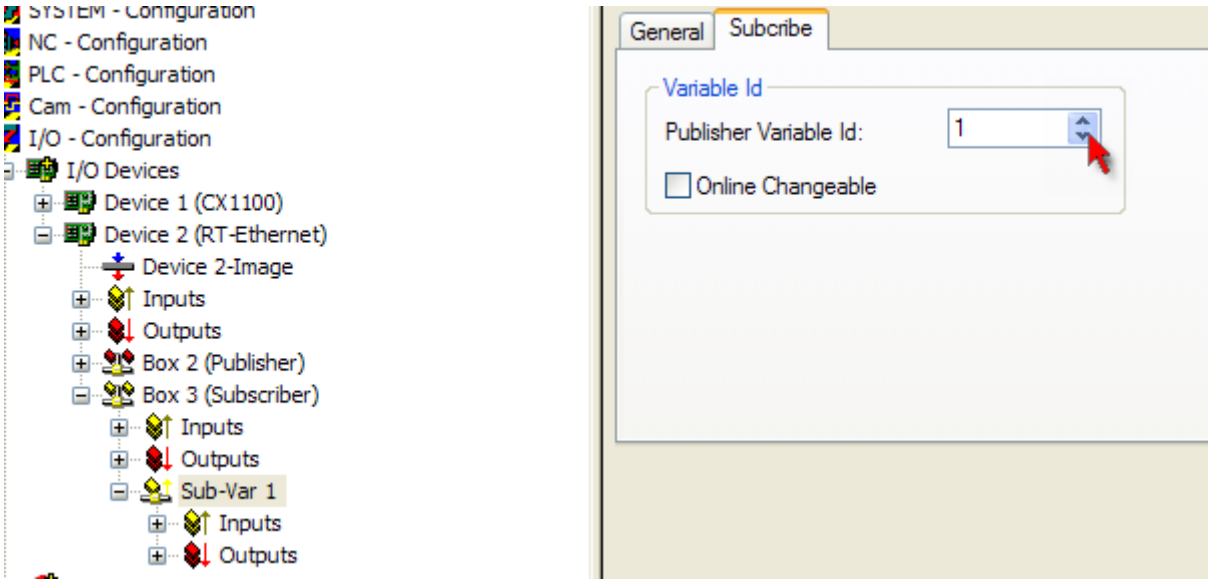
Associated variables have to be created under Publisher and Subscriber on the communicating controllers.

During TwinSAFE communication one side acts as the master, the other one as the slave.

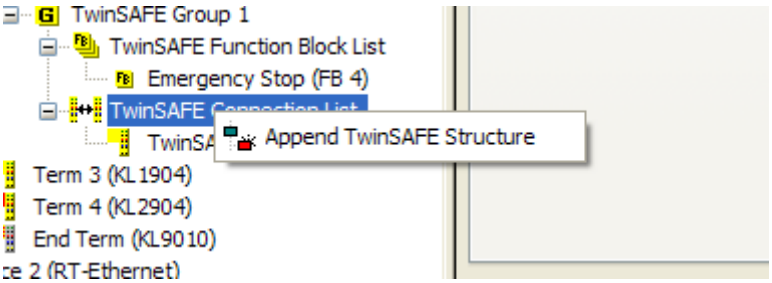
This results in the following data types:

TwinSAFE Master Publisher	MASTER_MESSAGE
TwinSAFE Master Subscriber	SLAVE_MESSAGE
TwinSAFE Slave Publisher	SLAVE_MESSAGE
TwinSAFE Slave Subscriber	MASTER_MESSAGE

The link with the via TwinSAFE logic terminal KL6904 is established with the following dialog:

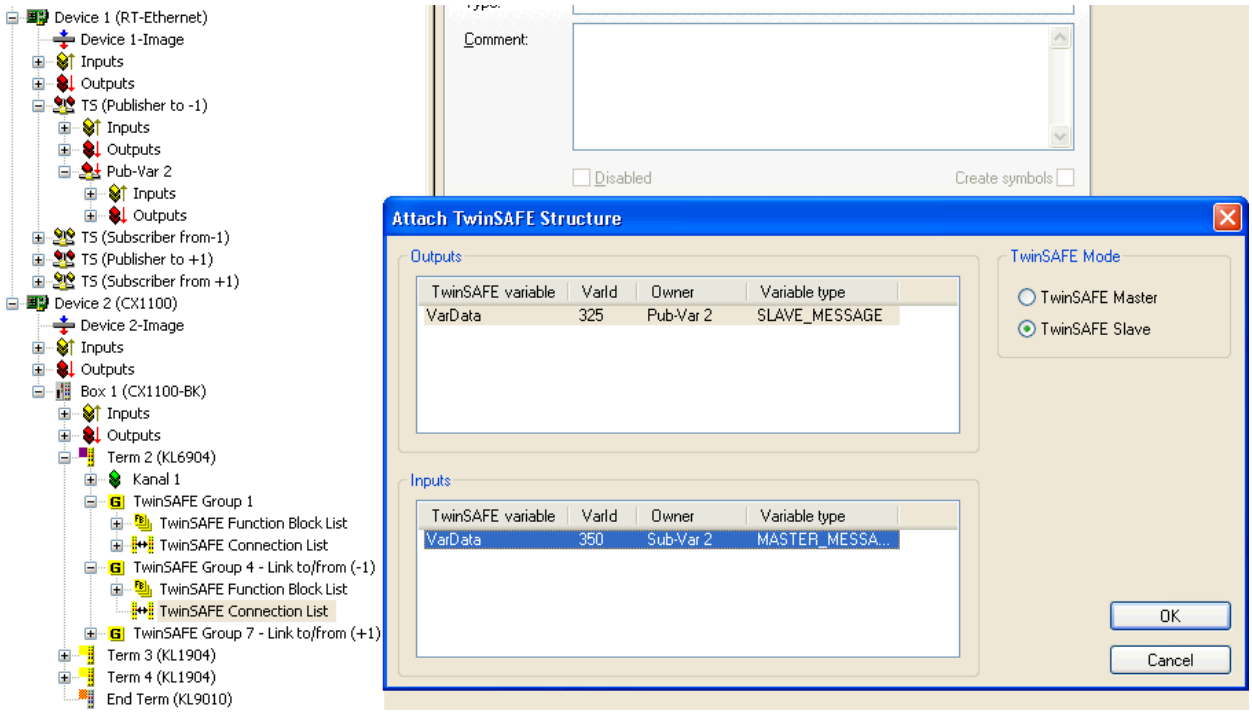


The connection created must now be made known to the TwinSAFE logic terminal. This is done by marking the TwinSAFE connection list and pressing the right mouse button.



The variables of type MASTER_MESSAGE and SLAVE_MESSAGE are now displayed, and both (In/Out) have to be selected.

The selection is confirmed via the OK button.

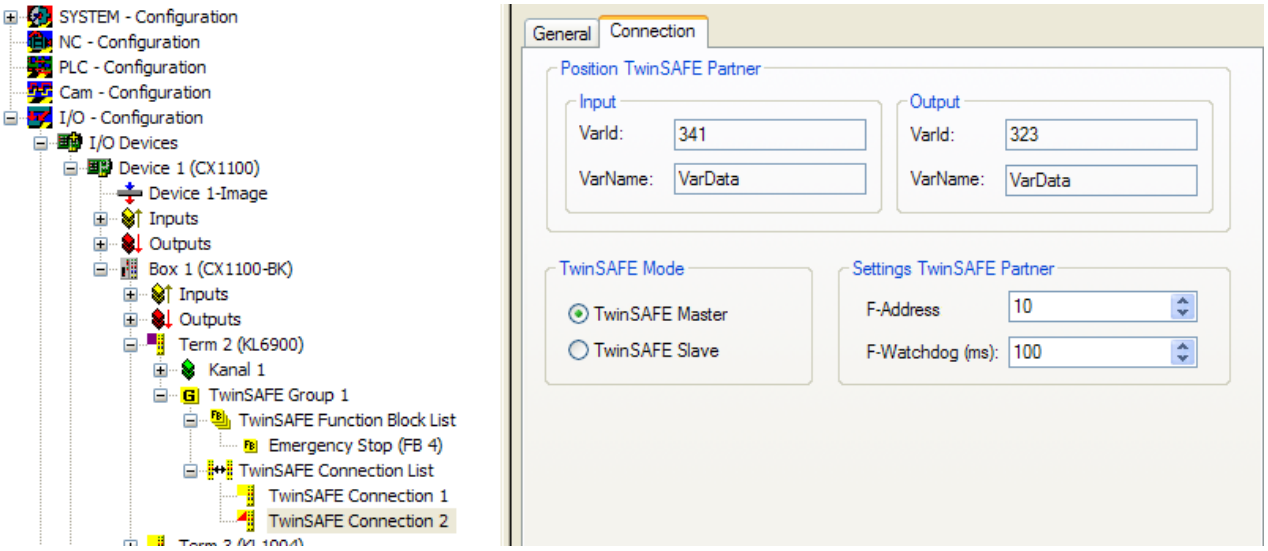


A new connection will appear in the list of TwinSAFE connections.

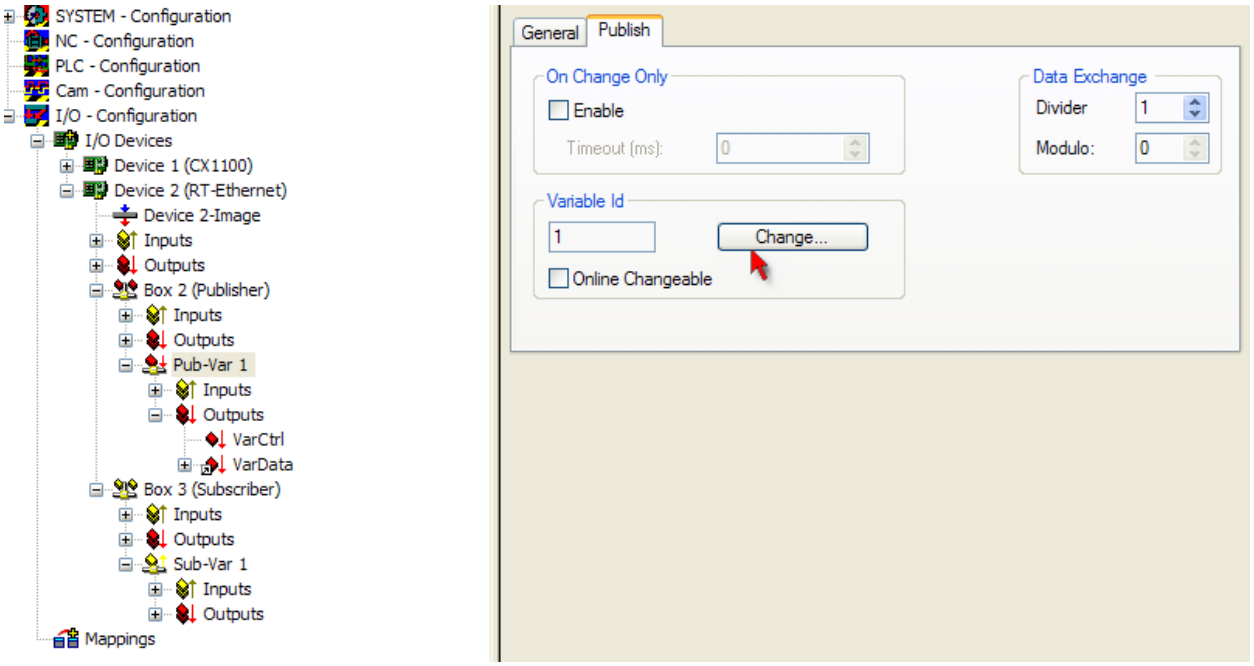
The connection has to be set on the associated tab.

One side must be a TwinSAFE master, the other one a TwinSAFE slave.

The F address of the partner device must also be set. Please not the DIP switch on the left-hand side of the KL6904.

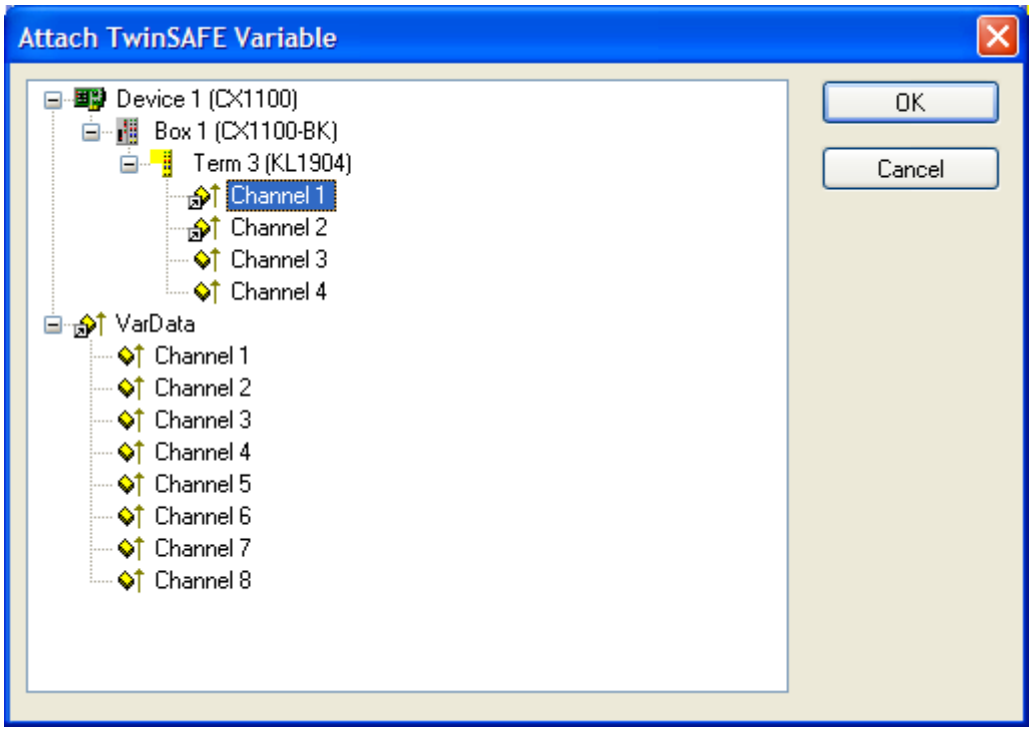


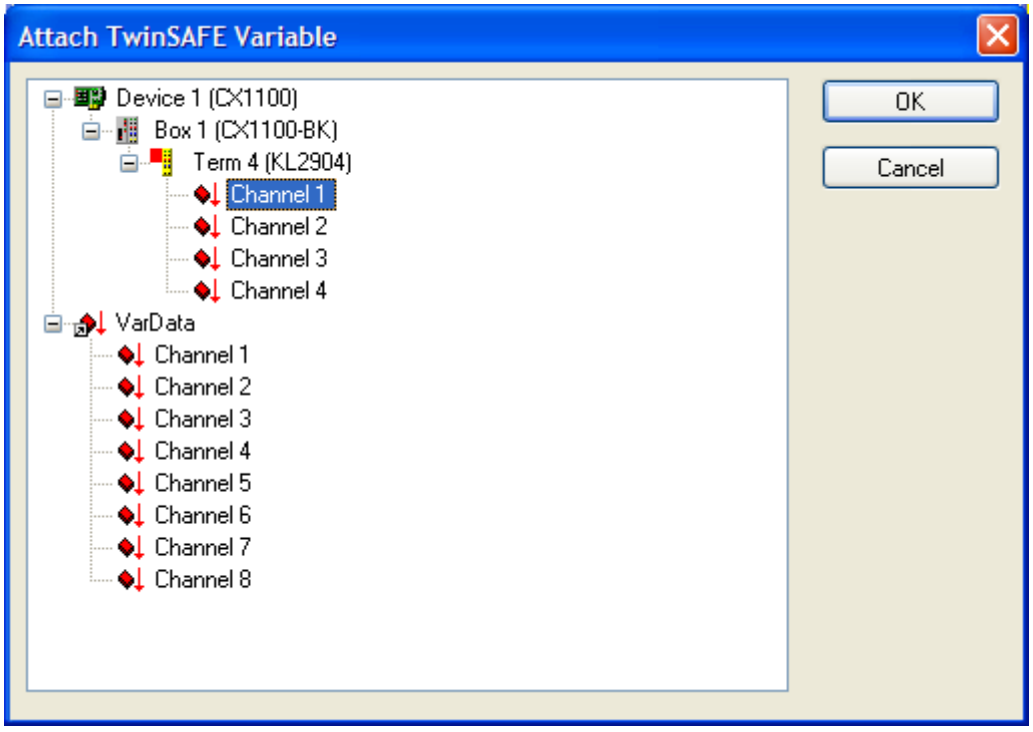
If several connections are to be established, a unique ID must be set for each Publisher variable.



This ID must also be set on the partner device, i.e. the Subscriber.

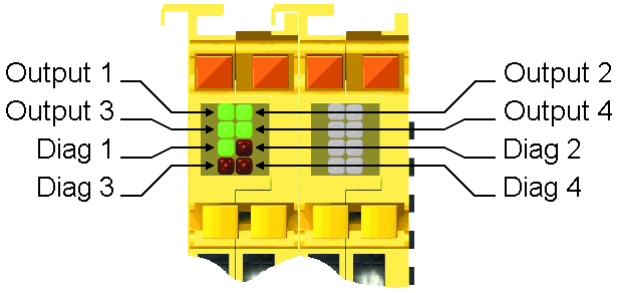
The network variables can now be used in the project. The inputs are shown under TwinSAFE Input, the outputs under TwinSAFE Output.





4.3 Diagnostics

4.3.1 Diagnostic LEDs



4.3.1.1 Diag 1 (green)

The *Diag 1* LED indicates the state of the TwinSAFE interface.

Flashing Code	Meaning
LED illuminated continuously	normal operation: TwinSAFE communication OK
rapid flickering, alternating with 1 flash pulse	Communication error: at least one connection is not in *Run* state.
rapid flickering, alternating with 2 flash pulses	Error in the function block
rapid flickering, alternating with 3 flash pulses	Error in the function block and communication error: at least one connection is not in *Run* state.

These errors can be rest through a falling edge at the ERR_ACK input of the TwinSAFE group.

4.3.1.2 Diag 2 (red)

The *Diag 2* LED indicates the state of the digital outputs.

Flashing Code	Meaning
rapid flickering, alternating with 1 flash pulse	Output 1: Open load or current below minimum value of 20 mA or current above maximum value of 500 mA
rapid flickering, alternating with 2 flash pulses	Output 2: Open load or current below minimum value of 20 mA or current above maximum value of 500 mA
rapid flickering, alternating with 3 flash pulses	Output 3: Open load or current below minimum value of 20 mA or current above maximum value of 500 mA
rapid flickering, alternating with 4 flash pulses	Output 4: Open load or current below minimum value of 20 mA or current above maximum value of 500 mA
rapid flickering, alternating with 5 flash pulses	Field voltage too low
rapid flickering, alternating with 6 flash pulses	Field voltage too high
rapid flickering, alternating with 7 flash pulses	Terminal temperature too low
rapid flickering, alternating with 8 flash pulses	Terminal temperature too high
rapid flickering, alternating with 9 flash pulses	Temperature difference error
rapid flickering, alternating with 10 flash pulses	error in output circuit through Open Load, external supply or cross-circuit

These errors can only be reset by switching the power supply for the TwinSAFE terminal off and back on again.

4.3.1.3 Diag 3 (red) and Diag 4 (red)

The *Diag 3* and *Diag 4* LEDs indicate internal terminal errors.

Note	**Returning the terminal** These errors lead to shutdown of the terminal. The terminal must be checked by Beckhoff Automation GmbH & Co. KG.

Diag 3 LED (red)	Diag 4 LED (red)	Source of error
lit	flashing	µC1
lit	off	µC2

In the event of a fault the *Diag 4* LED indicates the type of error through flashing codes. The flashing codes are structured as follows:

Flashing sequence	Meaning
Rapid flickering	Start of flashing code
First slow sequence	Error code
Second slow sequence	Error code argument

Start Error code Error code argument

Count the number of flash pulses after the rapid flickering sequence
- during the first slow sequence in order to ascertain the error code
- during the second slow sequence in order to ascertain the error argument

The flashing code is repeated after the second slow sequence, followed by rapid flickering.

4.4 Maintenance

The TwinSAFE terminals are maintenance-free!

WARNING	**Observe the specified environmental conditions!** Please ensure that the TwinSAFE terminals are only stored and operated under the specified conditions (see technical data).

If the terminal is operated outside the permitted temperature range it will switch to *Global Fault* state.

4.4.1 Cleaning

Protect the TwinSAFE terminals from unacceptable soling during operation and storage!

If the TwinSAFE terminals were subjected to unacceptable soiling it may no longer be operated!

WARNING	**Have soiled terminals checked!** Cleaning of the TwinSAFE terminals by the user is not permitted! Please send soiled terminals to the manufacturer for inspection and cleaning!

4.5 Service life

The TwinSAFE terminals are designed for a service life of 20 years.

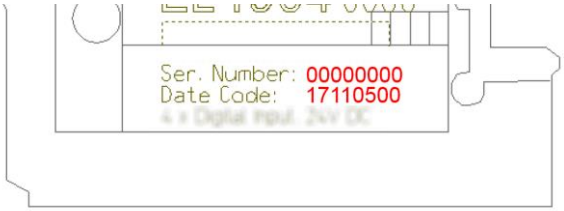
Due to the high diagnostic coverage within the lifecycle no special proof tests are required.

The TwinSAFE terminals bear a date code, which is composed as follows:

Date Code: CW YY SW HW

Legend:		Example: Date Code	17 11 05 00
CW:	Calendar week of manufacture	Calendar week:	17
YY:	Year of manufacture	Year:	2011
SW:	Software version	Software version:	05
HW:	Hardware version	Hardware version:	00

In addition the TwinSAFE terminals bear a unique serial number.



4.6 Decommissioning

 **DANGER**	**Serious risk of injury!** Bring the bus system into a safe, de-energized state before starting disassembly of the Bus Terminals!

4.6.1 Disposal

In order to dispose of the device, it must be removed and fully dismantled.

- Housing components (polycarbonate, polyamide (PA6.6)) are suitable for plastic recycling.
- Metal parts can be sent for metal recycling.
- Electronic parts such as disk drives and circuit boards must be disposed of in accordance with national electronics scrap regulations.

5 Appendix

5.1 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.

5.1.1 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.

5.1.2 Beckhoff company headquarters

Beckhoff Automation GmbH & Co.KG
Huelshorstweg 20
33415 Verl
Germany

Phone: + 49 (0) 5246/963-0
Fax: + 49 (0) 5246/963-198
E-mail: info@beckhoff.com
Web: www.beckhoff.com

Beckhoff Support
Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- world-wide support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline: + 49 (0) 5246/963-157
Fax: + 49 (0) 5246/963-9157
E-mail: support@beckhoff.com

Beckhoff Service
The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

Hotline: + 49 (0) 5246/963-460
Fax: + 49 (0) 5246/963-479
E-mail: service@beckhoff.com

5.2 Certificates

Reliability of KL6904

Test and Certification body

TÜV SÜD Rail GmbH
Rail Automation - IQSE
Barthstraße 16
D-80339 Munich

Manufacturer

Beckhoff Automation GmbH & Co. KG
Huelshorstweg 20
D-33415 Verl

Safety parameters KL6904

Key figures	KL6904
Lifetime [a]	20
Prooftest Intervall [a]	not required [1]
PFH_D	1.73E-09
%SIL3	1.73%
PFD	1.42E-04
%SIL3	14.2%
$MTTF_d$	High
B10d (cycles)	-
DC	High
Performance level	PL e
Category	4
HFT	1
Element classification*	Type B

*) Classification according to IEC 61508-2:2010 (see chapters 7.4.4.1.2 and 7.4.4.1.3)

The KL6904 Bus Terminal can be used for safety-related applications within the meaning of IEC 61508:2010 up to SIL3 and EN ISO 13849-1 up to PL e (Cat4).

[1] Special proof tests for the product are not required during the lifetime of the KL6904 Bus terminal as a result of the high diagnostic coverage of the system.

Munich, 2016-03-07

Günter Greil

Digital unterschrieben von Guentar Greil
DN: c=DE, o=TUEV SUED Rail GmbH, ou=Rail & Automation, cn=Guentar Greil, email=guenter.greil@tuev-sued.de
Datum: 2016.03.07 17:52:08 +01'00'

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

CERTIFICATE

No. Z10 15 03 62386 033

Holder of Certificate: **Beckhoff Automation GmbH & Co. KG**
Hülshorstweg 20
33415 Verl
GERMANY

Factory(ies): 62386

Certification Mark:

Product: **Safety components**

Model(s): **KL 6904, EL 6900, EL 6930**

Parameters:

Supply voltage:	24VDC (-15%...+20%)
Power dissipation:	2W
Protection class:	IP20

with "TwinSAFE Verifier" OR "CODESYS Safety for EtherCAT Safety Module".
Note: "CODESYS Safety for EtherCAT Safety Module" is developed in accordance with EN 61508:2010.

Tested according to:
2006/42/EC
EN 61508-1:2010 (SIL1-3)
EN 61508-2:2010 (SIL1-3)
EN 61508-3:2010 (SIL1-3)
DIN EN ISO 13849-1:2008 (Cat 4, PL e)
DIN EN 81-1:2010
EN 13243:2004
DIN EN 61000-6-2:2006
DIN EN 61000-6-4:2007

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. See also notes overleaf.

Test report no.: BV82168T

Valid until: 2020-03-05

Date, 2015-03-06 (Günter Greil)

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