

AMKmotion First steps Connecting AMKmotion drives to third-party controllers - TwinCAT 2 - TwinSAFE PLC terminal EL6900

Version: 2023/26 Part no.: 204665 Translation of the "Original Dokumentation"



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Imprint				
Name:	PDK_204665_	IB_KEKW_Fremdsteuerung		
Version:	Version: 2023/26			
	Change		Letter symbol	
	AMKmotion D	lesign	LeS	
Previous version:	2017/37			
Product version:	Product	Firmware version (Part no.)	Hardware version (Part no.)	
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Reservation:	We reserve the right to modify the content of the documentation as well as the delivery options for the product.			
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	Registration court: AG Stuttgart, HRA 230681, Kirchheim unter Teck, Tax Id no.: DE 145 912 804			
	Complementar	y: AMKmotion Verwaltungsgesellschaft mbH, HRB 774646	6	
	 For fast and reliable troubleshooting, you can help us by informing our Customer Service about the following: Type plate data for each unit Software version Device configuration and application Type of fault/problem and suspected cause 			
	• Diagnos	stic messages (error messages)		
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1 About this documentation

1.1 Structure of this document

Content	Title	Chapter no.
Validity, usage and purpose of this document	Imprint	-
	About this documentation	<u>1</u>
Safety	For Your safety	<u>1</u>
Practical information for carrying out (step by step instructions)	AMK drive with third-party controller	<u>3</u>
General about third-party controllersTwinCAT PLC	Beckhoff TwinCAT PLC	<u>4</u>
 TwinSAFE with FSoE master terminal EL6900 	Functional safety via FSoE with Beckhoff TwinSAFE PLC	5
Abbreviations and definitions	Glossary	-

1.2 Keeping this document

This document must permanently be available and readable at the place where the product is in use. If the product is used at another place or changed the owner, the document must be passed on.

1.3 Target group

Any person that is qualified and intends to work with this product must read, understand and follow this document:

- Parameterization
- Startup

1.4 Purpose

The document describes the connection of third-party controllers to the AMK drive system either with a TwinCAT 2 controller or / and functional safety.

- Compact power supply KE (EtherCAT field bus)
- Compact inverter with controller card (KW-R06 resp. KW-R07 is shown in the examples)
- Beckhoff TwinCAT PLC
- Beckhoff TwinSAFE-PLC EL6900



KW-R07 / -R17 / -R27 and iC / iX / iDT5 (with functional safety)

The startup of the functional safety is not part of this document.

Any information about functional safety (e.g. properties, parametrization, diagnostic messages) can be found in the Software description Safety manual; functional safety (Part no. 203446).

This document is addressed to any person who handles the product. It gives information about the following topics:

- Safety messages which are absolutely necessary to take care of during handling the product
- Startup and operation

Display	Meaning
	This symbol points to parts of the text to which particular attention should be paid.
'Text'	Parameter names, e.g. ID2 'SERCOS cycle time'
	Diagnostic message, e.g. 1042 'Mains phase fault'
	Name, e.g. Call up the function 'Delete PLC programme'
0x	0x followed by a hexadecimal number, e.g. 0x500A

1.5 Display conventions

Display	Meaning
•	The red hand symbol indicates the button or menu item to click on. The red hand symbol indicates the option to be selected.
ни кака кака кака кака кака кака кака ка	Click the right mouse button

1.6 Appendant documents

Device descriptions

Part no.	Title
28932	Servo drives KE/KW
202744	Controller cards KW-R06 / -R16 / -R07 / -R17
204918	Controller cards KW-R24(-R) / -R25 / -R26 / -R27
203445	Decentralized drive technology iC / iX / iDT5

Functional descriptions

Part no.	Title
204979	Software description AIPEX PRO V3
	(PC software for startup and parameterization)
203446	Safety manual; functional safety
203704	Parameter description KW-R06 / -R16 / -R07 / -R17, KW-R24(-R) / -R25 / -R26 / -R27, iC / iX /
	iDT5, KE (CAN / Ethernet)
204019	Basic knowledge AMK PLC programming in structured text
204072	AIPEX PRO add in gateway for TwinCAT
204364	Functional safety, application examples
204539	Initial startup KE/KW
204737	Initial startup of decentralized drives

Third-party descriptions

Producer	Title
Beckhoff	Documentation EL6900
Beckhoff	Documentation EL1904
Beckhoff	Documentation EL2904

Further files

Part no.	Title
nnnnn	AMK device description file AMK_ECsoe_vvv_nnnnnn.xml
	(vvv - version; nnnnnn - Part no.)
	You can get the device description file
	 from the AMK homepage
	http://www.amk-antriebe.de/download.aspx -> Configuration files
	(therefore, a registration is necessary)

2 For your safety

2.1 Basic notes for your safety

- At electrical drive systems, hazards are present in principle that can result in death or fatal injuries:
 - Electrical hazard (e. g. electric shock due to touch on electrical connections)
 - Mechanical hazard (e. g. crush, retract due to the rotation of the motor shaft)
 - Thermal hazard (e.g. burns due to touch on hot surfaces)
- These hazards are present while starting up and operating the unit, and also during servicing or maintenance work.
- Safety instructions in the documentation and on the product warn about the hazards.
- Personnel must have read and understood the safety instructions before installing and operating the product. In the documentation about the product the usage warnings pertain to direct hazards and must therefore be followed directly when operating or handling the product by the operator.
- AMKmotion products must be kept in their original order, that means it is not allowed to do a significant constructional change on hardware side and software is not allowed to be decompiled and change the source code.
- Damaged or faulty products are not allowed to be integrated or put into operation.
- Do not start the system in which the AMKmotion products are installed (begin of intended use) until you can determine that all relevant standards, laws, and directives have been complied with, e. g. low voltage directive, EMC directive, and the machinery directive, and possible further product standards. The plant manufacturer is responsible for the compliance with the laws, directives, and standards.
- The devices must be installed, electrically connected and operated as shown in the device description documentation. The technical data and the required environmental conditions must be observed at all times.

2.2 Safety rules for handling electrical systems

In particular on drive systems, the instructions pertaining to safety and the following five safety rules have to be kept in the specified sequence:

- 1. Switch off electrical circuits (also electronic and auxiliary circuits).
- 2. Secure against being switched on again.
- 3. Determine that there is no voltage.
- 4. Ground and short circuit.
- 5. Cover or close off neighboring parts that are under voltage.

Reverse the measures taken in reverse order after completing the work.

2.3 Presenting safety messages

Any safety information is configured as follows:

▲ SIGNAL WORD	
	Type and source of risk
\wedge	Consequence(s) of non-observance
Symbol	Steps to prevent:
	•

2.4 Class of hazard

Safety and warning messages are graduated into classes of hazard (according to ANSI Z535). The class of hazard defines the potential risk of harm and is described by a single word, if the safety information is ignored. The signal word is followed by a safety alert symbol (ISO 3864, DIN EN ISO 7010). In accordance with ANSI Z535, the following signal words are used to define the class of hazard.

Safety alert symbol and signal word	Class of hazard and its meaning
A DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury
	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury
	CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE	NOTICE is used to address preventions to avoid material damage, but not related to personal injury.

2.5 Used safety alert symbols

Safety symbol	Meaning
	Generic warning!
	Warning against dangerous electrical voltage!

2.6 Requirements for the personnel and their qualification

Only authorized and qualified personnel may work on and with the AMK motion drive systems.

Specialised personnel must:

- · Perform mechanical and electrical work that is described in this documentation, such as mounting and connecting
- Observe all information in the documentation accompanying the product in order to work with the product safely and in an error-free manner
- Understand and know hazards that occur when handling the product
- · Know connections and functions of the system
- Be familiar with the control concept in order to operate the drive system
- Be authorized to switch circuits and devices on and off, ground and label them
- · Observe local specific safety requirements

2.7 Warranty

- All information in the documents accompanying the product must be complied with for a safe and trouble-free operation.
- The assertion of warranty claims is excluded if the information in the documents is not observed completely.
- Hardware and firmware may not be modified except by personnel authorized by AMKmotion and after consultation with AMKmotion.
- The company AMKmotion GmbH + Co KG is not liable for damages from unintended use, incorrect installation or operation, exceeding rated values and non-observance with the environmental conditions.

2.8 Always to observe!

A DANGER

Danger to life!

The controller cards KW-R07 / KW-R17 / KW-R27 are safety modules according to the Machinery directive MRL 2006/42/EG. Before the cards are put into operation, the executing person must have read and understood the device description and the safety manual. During the startup, all information in these documentation must be taken into account.

	Danger to life from touching electrical connections!			
	Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact.			
	Steps to prevent:			
	 Prior to any work on the device: Observe the 5 safety rules. 			
7	 Measure the terminal voltages. There may be no voltage present. 			
	 Plug and pull connections only when there is no voltage. 			
	 For devices that are connected to a DC bus, or generate it yourself, you need to consider the discharge times of the dc bus capacitors mentioned in the converter documentation 			
	• Before commencing work, the connections must be isolated from the voltage supply at both ends! (both ends mean: AC and DC bus supply side)			

	Danger to life due to unexpected movements!
	The drive will be torque-free in the status 'Safe torque off (STO)', in case of mains failure or in case of faulty drive controller. External application of force on the drive axis may result in life-threatening movements (e.g. hanging axes can fall down).
~··	Steps to prevent:
	 Install an external, mechanical brake that prevents a movement.
	 Install a counterweight in order to maintain the axis in balance.

Motor shaft movement (rotating parts)!
Hair, body parts and clothes can be captured and wrapped by rotating parts and people result suffer fatal injuries.
Hazardous motor movement occurs when the motor shaft moves in an uncontrolled or unintentional manner.
Even the intended drive movement may be hazardous, if persons remain inside the range of movement.
Uncontrolled motor shaft movement occurs when the motor is no longer controllable. may have lethal consequences. Possible causes include the following:
Faulty wiring, e.g., faulty phase sequence while connecting motor
Faulty components
Faulty motor parameters
Software error
Unintended motor shaft movement is caused by errors in the motor control. may have lethal consequences. Possible causes include the following:
Operator errors
Controller or application program faults
Faulty setpoint specification and scaling
Improper operating mode
The monitoring devices in the drive system are capable of detecting various fault states. However, the monitoring devices by themselves are not sufficient to completely and reliably prevent uncontrolled movement. Uncontrolled movement cannot be prevented completely, even if it occurs only for a brief period of time before a monitoring device trips and shuts down the drive or switch off power supply.
Steps to prevent:
Always ensure that the is fully de-energized before commencing work on the .
 Check the limit values for torque, speed, and position, as well as the acceleration and deceleration ramps.
 Specify the maximum permissible process speed and set ID113 accordingly.

	D	Δ	N	G	F	R
<u> </u>		<u>~`</u>		U		

	Danger to life from touching electrical connections!
	The permanent magnets of the rotor induce dangerous voltage at the motor connections when the axis rotates, even when the motor is not electrically connected. If the motor is connected to an inverter, the induced DC voltage is linked to the .
<u>_</u>	Steps to prevent:
	Make sure that the motor shaft does not rotate.
	Make sure that shock-hazard protection is installed at the motor connections.
	Make sure that the terminals are free of voltage.



Risk of injury from hanging axes

The optional motor brake is a holding brake and does NOT provide sufficient protection for persons.

Hanging axes can fall and lead to severe injury.

Steps to prevent:

- All hanging axes must be mechanically secured against falling with a fall arrester or a supplementary external brake, for instance.
- People must not stand under hanging loads

Risk of burns when touching hot surfaces!
The casing temperature can be more than 70 °C during and even after operation. Contact causes burns.
Steps to prevent:
Make sure that the surfaces have cooled down before you touch.
Wear protective clothing such as gloves if hot parts need to be touched.
Fit a warning sign with warning hot surface.
Do not mount any flammable objects near the device.

3 AMK drive with third-party controller

3.1 Prerequisites



The third-party controller is connected to the AMK drives via EtherCAT. The data exchange takes place by SoE protocol (servodrive profile over EtherCAT) acc. to IEC61800-7.



Before connecting the controller, the drive must be started up.

- Initial startup KE/KW (Part no. 204539)
- Initial startup of decentralized drives (Part no. 204737).

3.2 General procedure

In order to realise the communication between controller and AMK drive, the PLC variables must be linked to the drive parameters. The device description file describes the AMK EtherCAT slave devices. By means of these information, an EtherCAT configurator (e.g. with AIPEX PRO, TwinCAT) generates the fieldbus configuration.

AMK_ECsoe_vvv_nnnnnn (vvv - version; nnnnnn - Part no.)

See documents

When configuring the controller, the device description file is included. On the other hand, the controller configuration is acquainted to the drives.

Parameter	Name	Term in the device description file
ID24	'Configuration list MDT'	MDT
ID134	'Master control word'	Master control word
ID47	'Position command value'	Position command value
ID36	'Velocity command value'	Velocity command value
Parameter	Name	Term in the device description file
Parameter ID16	Name 'Configuration list AT'	Term in the device description file AT
Parameter ID16 ID135	Name 'Configuration list AT' 'Drive status word'	Term in the device description file AT Drive status word
Parameter ID16 ID135 ID51	Name 'Configuration list AT' 'Drive status word' 'Position feedback value'	Term in the device description file AT Drive status word Position feedback value 1

Freely configurable parameters

The ID16 'Configuration list AT' defines what parameters are cyclically transferred into the drive telegram (AT) if the ID15 'Telegram types parameter' 'configured telegram' is selected. The configurable parameters are listed in ID187 'List of data AT'.

The ID24 'Configuration list MDT' defines what parameters are cyclically transferred into the master data telegram (MDT) if 'Telegram type parameters' 'configured telegram' is selected in ID15 'Telegram types parameter'. The configurable parameters are listed in ID188 'List of data MDT'.

The configurable parameters will be dynamically read from the EtherCAT salves (ID187 and ID188).

4 Beckhoff TwinCAT PLC

The following chapters will give you a step-by-step description about which configuration is necessary to run AMK drives as EtherCAT slaves with a Beckhoff TwinCAT PLC (EtherCAT master).

4.1 KE(N, S) control signal 'Power ON' (AMK UE - DC bus ON)



Only if you use power supply modules type KE / KEN / KES (exception: KEN 05-xx).

The devices from type AMKASMART iC and AMKASYN KEN 05-xx charge the DC bus automatically. The DC bus is needed to supply the inverters.

The compact power supplies KE / KEN / KES supply the inverters via the DC bus (power supply).

After activating the control signal ID134 'Master control word' bit 14 ($0 \rightarrow 1$) (AMK control signal UE), the DC bus is charged. ID135 'Drive status word' bit 15/14 = 10 (AMK status signal QUE) shows that the DC bus voltage meets the admitted range.

4.1.1 Variant 1: Compact power supply KE(N, S) with EtherCAT interface

The compact power supply is integrated within the EtherCAT bus. The EtherCAT master can directly control it.

Parametrisation:

KE(N,S): ID32795 'Source UE' = 5



4.1.2 Variant 2: Compact power supply KE(N, S) with ACC bus interface

The compact power supply KE(N, S) is connected to an EtherCAT controller card (e.g. KW-R06) via the ACC bus. Control signals UE are sent to the controller card in the KW(D) inverter via EtherCAT. The controller card will forward it automatically to the KE(N, S) via ACC bus.

Parametrisation:

KW(D): ID32795 'Source UE' = 5 KE(N, S): ID32795 'Source UE' = 9



4.2 KW(D,Z), iC / iX / iDT5 command signal 'Drive ON' (AMK RF - controller enable)

The inverters power supply the servo motors.

After setting the control signal ID134 'Master control word' bit 15 (0 \rightarrow 1) (AMK control signal RF), the motor control is activated. ID135 'Drive status word' bit 15/14 = 11 (AMK status signal QRF) shows that the motor is under control. Position, speed or torque setpoint can be preset depending on the selected operation mode.

Parametrisation:

ID32796 'Source RF' = Code 5

4.3 Switch-on and -off flow chart KE/KW





	· · · · · · · · · · · · · · · · · · ·
*1	Close emergency OFF circuit (if existent).
*2	The module specific 'System ready' messages (SBM = 1) from the KE and KW modules signal the error-free states. The monitoring of these messages takes place in the higher-ranking controller. Time to SBM > 2 s.
*3	If present, the required external main contactor is actuated by the KE. The delay time until the contactor is actuated via terminal X20 (EH1/EH2) depends on the DC bus capacities connected to the KE.
*4	Only devices with EF logic:
	Hardware signal EF/EF2 must be applied at the latest at that time.
*5	Delay time until QRF is set depends on the connected motor resp. whether the data set must be newly calculated because of a modification of drive specific parameters.
*6	Only devices with EF logic:
	Reset hardware signal EF/EF2 if the motor has to be in a safe torque-free state afterwards.

*7	RF will be disabled via BE. BE is linked with PLC signal, see ID32796 'Source RF'.
*8	Motor is braked to a standstill after the ramp ID32782 'Deceleration ramp RF inactive'.
*9	Pulse ≥ 1 ms.
*10	Each inverter generated a DC bus error.

4.4 Switch-on and -off flow chart iC



•



	-
*1	Hint limitations!
	After power on the internal 24 VDC supply is available after < 3 s.
*2	The module specific 'System ready' messages (SBM = 1) from the modules signal the error-free states. The monitoring of these messages takes place in the higher-ranking controller. Time to SBM > 2 s.
*3	24 VDC supply must be applied at the latest at that time. Open / close motor holding brake will be automatically controlled trough the RF signal.
*4	Delay time until QRF is set depends on the connected motor resp. whether the data set must be newly calculated because of a modification of drive specific parameters.
*5	RF will be disabled via BE. BE is linked with PLC signal, see ID32796 'Source RF'.
*6	Motor is braked to a standstill after the ramp ID32782 'Deceleration ramp RF inactive'.
*7	Pulse ≥ 1 ms.
*8	(iC) Charging time after power on < 50 ms
*10	Maximum 1 power on circuit per minute.



4.5 Switch-on and -off flow chart iX / iDT5

•



	-
*1	Hint limitations!
	After power on the internal 24 VDC supply is available after < 3 s.
*2	The module specific 'System ready' messages (SBM = 1) from the modules signal the error-free states. The monitoring of these messages takes place in the higher-ranking controller. Time to SBM > 2 s.
*3	24 VDC supply must be applied at the latest at that time. Open / close motor holding brake will be automatically controlled trough the RF signal.
*4	Delay time until QRF is set depends on the connected motor resp. whether the data set must be newly calculated because of a modification of drive specific parameters.
*5	RF will be disabled via BE. BE is linked with PLC signal, see ID32796 'Source RF'.
*6	Motor is braked to a standstill after the ramp ID32782 'Deceleration ramp RF inactive'.
*7	Pulse ≥ 1 ms.
*8	(iC) Charging time after power on < 50 ms
*10	Maximum 1 power on circuit per minute.

4.6 Integrating the AMK device description file into TwinCAT

Die Gerätebeschreibungsdatei beschreibt die AMK EtherCAT Slave Geräte. Mit Hilfe dieser Informatinen erstellt ein EtherCAT-Konfigurator, z.B. unter AIPEX PRO bzw. TwinCAT, die Buskonfiguration.

Copy the up-to-date AMK device description file AMK_ECsoe_vvv_nnnnnn.xml (vvv - version, nnnnnn - Part no.) to the windows folder C:\TwinCAT\lo\EtherCAT.

The present configuration file is available from the download window of the AMK homepage (http://www.amk-antriebe.de) or from the AMK Documentation CD (Part no. 47153).

4.7 Creating a TwinCAT project

4.7.1 Create an offline TwinCAT project with AMK drive

- Start the 'TwinCAT System Manager'
- Open a new project
- Append an EtherCAT bus to the 'I/O Devices'



Insert Devi	ce and a second seco	×
Туре:	 H/O Beckhoff Lightbus Profibus DP Profinet CANopen DeviceNet EtherNet/IP SERCOS interface EtherCAT Ethe	Ok Cancel Target Type PC only C CX only C X only C All
Name:	Device 1	

To the EtherCAT bus, you can add EtherCAT slave devices (boxes). Repeat the following steps until your project is completely emulated.

🗾 Unbenannt - TwinCAT System Manager		
File Edit Actions View Options Help		
] D 📂 📽 🖬 🗇 🖪 X 🖻 🖬 🞜 🛤 🤚 🔜 📾 🗸 🏙	🏙 🤷 🛠 👯 🔨 🚳 🖹 🔍 🖓 🚳 🖉 🥙 🦉	
SYSTEM - Configuration PLC - Configuration I/O - Configuration J/O Devices	General Adapter EtherCAT Online CoE - Online Name: Device 1 (EtherCAT) Id: 1	
⊕ Device 1 (EtherCAT Append Box	Type: EtherCAT	
	Comment:	
RMB Image: Reset Image: Online Reload (Config Mode only) Online Delete (Config Mode only)		
😭 Export Device	Disabled Create symbol	ols
😭* Import Box		
📉 Scan Boxes		
	I	•
	Local (172.16.6.225.1.1) Config Mo	de //.

To execute the following step, the AMK EtherCAT configuration file must be integrated within TwinCAT. Siehe 'Integrating the AMK device description file into TwinCAT ' auf Seite 21.

Below 'AMK Arnold Mueller GmbH & Co. KG', the AMK EtherCAT slave device types are listed. Numbers is brackets show the EtherCAT revision.

You will find the device type printed on the front plate of the controller card (e.g. KW-R06)

Insert EtherCAT Device			
Search: Name: Drive 1 <u>M</u> ultiple: 1	ОК		
Type: Arnold Mueller GmbH & Co. KG	Cancel		
i in a Drives			
	Port		
₩₩ KWZ EtherCAT Drive (SoE, 2 Ch.)	0.4		
W Compact inverter module -R05 (SoE)			
KWD compact inverter module -HU5 (SoE)	l on		
WW compact inverter module -RU6 (SoE)			
	B (Ethernet)		
KW compact inverter module -RU7 (SOE, FSOE)			
	00		
WV compact inverter module -R16 (SoE)			
W/ compact inverter module -R17 (SoE)			
₩ KW/D compact inverter module -B17 (SoE FSoE)			
MCE motor controller electronic -B05 (SoE)			
MCE motor controller electronic -B06 (SoE)	MCE motor controller electronic -R06 (SoE)		
iDT5 integrated servo drive (SoE)			
→ → ↓ X servo inverter (SoE)			
iC servo converter (SoE)			
→ → ↓ iDT5 integrated servo drive (SoE,FSoE)			
→ → ↓ X servo inverter (SoE,FSoE)			
iC servo converter (SoE,FSoE)			
🕀 📲 Controls			
	_		
Extended Information Show Hidden Devices	Show Sub Groups		
	cherroub aroupo		

4.7.2 Activating the EtherCAT network

Activate the TwinCAT adaptor in your PC system

📴 Unbenannt - TwinCAT System Manager			
File Edit Actions View Options Help			
D 🖆 📽 🖬 🍜 🖪 X 🖪 🖻 📾 🖓 👌 🔜 📫 🗸 🐲 j	🙊 🔗 😤 🔨 🎯	🏘 🖹 🔍 🔐 🚳 🍢	🕵 🧶 🗊 🖇
SYSTEM - Configuration	General Adapter Et	herCAT Online CoE - Online	1 –
E I/O - Configuration		~	
	** Network Adapt		C DPBAM
	D 11		
	Description:	LAN-Verbindung 2 (TwinCA)	-Intel PCI Ethernet Adapter (Gigabit)
inputs	Device Name:	\DEVICE\{AD783852-5376-	41AB-B320-EC445C3CB246}
H···· ♥↓ Outputs	PCI Bus/Slot:		Search
Drive 1 (KW (-R06)) Device Found At		×	Compatible Devices 2
Mappings			
[none] LAN-Verbindung 2 (TwinCAT-Intel PCI Et/	nernet Adapter (Gigabit) - F		
		Cancel use v	with Netmon/Wireshark only)
4		C II I I	
			<u> </u>
		Help	
	-		
lk	<u>'</u>		
		Loc	al (172.16.6.225.1.1) Config Mode 🏑

📴 Unbenannt - TwinCAT System Manager				
File Edit Actions View Options Help				
D 🗳 📽 🖬 🍜 🔄 X 🖿 🖬 🞜 M 👌 🖳 🖴 🗸 🌋	🙆 🤮 🎨 🔨	🎯 🍫 🖹 🔍 🔐	ଟେ 🔦 🕵 🗧	🤌 🗓 💡
SYSTEM - Configuration PLC - Configuration I/O - Configuration Devices Device 1 (EtherCAT) Device 1-Image Device 1-Image	General Adapter	EtherCAT Online Col vdapter © OS (NDIS) [LAN-Verbindung 2 VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD783) VDEVICE\(AD7	E - Online C PCI (TwinCAT-Intel PI 852-5376-41AB-B:	C DPRAM CI Ethernet Adapter (Gigabit) 320-EC445C3CB246} Search Compatible Devices
			Local (172 :	16.6.225.1.1) Copfig Mode
			Local (1727	roioizzoitity coning mode

4.8 Reading AMK drives with TwinCAT online

At first, integrate the AMK EtherCAT configuration file.

Siehe 'Integrating the AMK device description file into TwinCAT ' auf Seite 21.

- Establish a physically EtherCAT connection between EtherCAT master and slaves
- Connect the EtherCAT master and slaves to the 24 VDC power supply
- Start 'TwinCAT System Manager'. Open a new project
- Start 'TwinCAT Config Mode'



Start 'Scan Devices...'



Select the TwinCAT adaptor to which the EtherCAT slaves are connected

1	new I/O devices found	×
	Device 1 (RT-Ethernet) [LAN-Verbindung 2 (TwinCAT-Intel PCI Ethernet Adapte]	OK Cancel
		Select All Unselect All

Start 'Scan for boxes' (box = EtherCAT slave)



In this example, two EtherCAT slaves are read (drive 1 + drive 2)



Integrate the PLC project.

Siehe 'Integrating the PLC project' auf Seite 27.

4.9 PLC project

Start 'TwinCAT PLC Control'. Open a new project



On no account, you may rename the program block MAIN (PRG).

Create your PLC program

TwinCAT PLC Control - Doku_IB_TwinCAT.pro -	MAIN (PRG-ST)]
🌠 File Edit Project Insert Extras Online Wind	w Help _ 문 ×
12 	
Bausteine 0001 PROGF MAIN (PRG) 0003 0004 wD 0005 wD 0006 0007 END_V	AM MAIN rive_1_StatusWord AT%I*:WORD; rive_1_ControlWord AT%Q*:WORD; AR
	Target: Local (172.16.6.225.1.1), Laufzeit: 1 TwinCAT Config Mo

For example, in- out variables from type WORD are generated. Following this variables will be linked with each 'DriveStatus' and 'ControlWord' inside the TwinCAT System Manager.

Variables with designation 'AT' exist only within a project and cannot be linked to the Hardware. The addresses are extended by 'l' for inputs (AT%I) or 'Q' for outputs (AT%Q).

The variables can be addressed automatically by using the extension '*' or fixed by declaring the variable type (X = bool, W = word or D = double word).

Example:

diVelocityFeedback AT%I* : DINT; (automatic addressing) OR bolnput1 AT%IX0.0 : BOOL; (fixed addressing)

4.9.1 Create the PLC configuration

When compiling the project, a XML-type file with extension *.tpy is generated automatically. This file contains the defined variables as well as common project information. After an error-free compilation, the PLC project must be saved.

Subsequently, the XML file (*.tpy) must be read with the 'TwinCAT System Manager'. Siehe 'Integrating the PLC project' auf Seite 27.





Before you log on to the PLC hardware, the 'run mode' of the 'TwinCAT System Manager' must be started.

4.9.2 Integrating the PLC project

The following describes how to append an existing PLC project.

Compile and save the CoDeSys PLC project before appending it



Select the PLC configuration file *.tpy.

Insert IEC1131	Project	? ×
<u>S</u> uchen in:	: 🗀 Drive_On_Off 📃 🕓 🦻 🖽 -	
Zuletzt verwendete D	Maschine.tpy	
Desktop Eigene Dateien		
Arbeitsplatz		
Netzwerkumge bung	Dateiname: Doku_IB_TwinCAT Dateityp: IEC1131 Project Info (*.tpy) Abbr	nen schen 2

4.9.3 Linking PLC variables

The following describes how to link a TwinCAT variable to a PLC variable.

 $\label{eq:constraint} \text{Double-click to a TwinCAT variable to open the 'Attach Variable' window}$

🖐 Unbenannt - TwinCAT System Manager		×
<u>File Edit Actions View Options H</u> elp		
D 😅 📽 🔒 🍜 🖪, X 🖿 🖻 🚑 🗛 🁌 🖳 🖴 🗸 🌋	谢 👧 👧 🗞 🌂 🚳 🖹 🔍 🖓 🔞 🖉 🚳 🧏	
SYSTEM - Configuration PLC - Configuration I/O - Configuration Device 2 (EtherCAT) Device 2 (EtherCAT) Device 2 -Image Device 2-Image Device 2-Image Device 2-Image Device 2-Image Device 3-Inputs Device 3-Inputs Device 3-Inputs Device 4 (KW (-R06)) D	Variable Flags Online Name: Drive status word Type: UINT Group: AT Address: 93 (0x5D) User ID: 0 Linked to Comment: Image: Comment:	
Server (Port) Timestamo Messane		
eady Local (172.16.6.225.1.1) Config Mode		

Double-click to the respective PLC variable to link it to the TwinCAT variable



4.9.4 Extending the data exchange

The following describes how to extend the drive telegram (AT) resp. the master data telegram (MDT).

Freely configurable parameters

The ID16 'Configuration list AT' defines what parameters are cyclically transferred into the drive telegram (AT) if the ID15 'Telegram types parameter' 'configured telegram' is selected. The configurable parameters are listed in ID187 'List of data AT'.

The ID24 'Configuration list MDT' defines what parameters are cyclically transferred into the master data telegram (MDT) if 'Telegram type parameters' 'configured telegram' is selected in ID15 'Telegram types parameter'. The configurable parameters are listed in ID188 'List of data MDT'.

The configurable parameters will be dynamically read from the EtherCAT salves (ID187 and ID188).

The example shows how to exchange the drive telegram (AT) with the ID182 'Diagnosis manufacturer status'.



Select the parameter

Edit Pdo Entr y		×
Name:	Herstellerstatus	ОК
Index (hex):	JB6 J182	Cance
Sub Index:	0	
Data Type:	WORD 🔽	
Bit Lentgh:	16 👱	
From Dictionar	y:	
P-0-1306 - Re P-0-1307 - ak P-0-1308 - Re P-0-1309 - ak S-0-0011 - Zu S-0-0012 - Zu S-0-0013 - Zu S-0-0144 - Sta S-0-0182 - He P-0-1332 - Bir P-0-0462 - FS P-0-0463 - Sia P-0-0465 - Sia P-0-0466 - FS	eferenzzaehler1 tueller Zaehler 1 eferenzzaehler2 tueller Zaehler 2 istandsklasse1-Fehler istandsklasse3-Meldung atuswort erstellerstatus naer Eingane Tuc Soer Slave CMD cherheitsdaten S isoE Slave CRC 0 cherheitsdaten Slave 1 isoE Slave CRC 1	

4.9.5 Generating a configuration and starting the run mode

- 1. Generate mappings Generates the mapping between two process images
- 2. Check configuration Checks the present configuration for plausibility
- 3. Activate configuration Saves and activates the present configuration

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SYSTEM - Configuration 1 2 3 PLC - Configuration 1 2 3 If Doku_IB_TwinCAT I/O configuration If O configuration I/O configuration If D covices Device 2 (EtherCAT) Device 2 - Image Device 2-Image-Info If Dobuts InfoData If Drive status word If Herstellerstatus If Drive status word If Herstellerstatus If Dobuts InfoData If Drive status word If Herstellerstatus If Drive status If Drive status word If Drive status If Drive status If Drive status If Drive status If Drive status If Drive status </th <th>Variable Flags Online Name: Drive status word Type: UINT Group: AT Address: 93 (0x5D) Linked to MAIN.wDrive_1_StatusWord . Inputs . Standard . Doku_IB_TwinCAT Comment: </th> <th></th>	Variable Flags Online Name: Drive status word Type: UINT Group: AT Address: 93 (0x5D) Linked to MAIN.wDrive_1_StatusWord . Inputs . Standard . Doku_IB_TwinCAT Comment:	
Ready	Local (172.16.6.225.1.1)	rig Mode 🛛 🏑



4.10 Information about error sources

4.10.1 Revision of the device description file

By default, the check of the revision number of the connected devices is de-activated in the TwinCAT EtherCAT master. The following check can be activated:

• RevisionNo≥>min. Rev-No.<

By means of this setting, an EtherCAT device with a higher revision can run within a configuration defined with a lower version.

Example: KW-R07

```
<Type ProductCode="#x01000603" RevisionNo="#x01030105" UseLrdLwr="1">KW (-R07) (FSoE)</Type>
```

RevisionNo= 0x 0103 0105

 I
 I

 Software version KW-R06 AER5-6_105_1032_203194

 Revision xml
 AMK_ECsoe_103_202967.xml

4.10.2 TwinCAT with standard PC

values.



The drive generates the diagnostic message 2561 'System diagnostics: Failure of the master' Possible cause of error: In state 'operational', the EtherCAT master does not send any or just sporadic frames of setpoints and actual

Without full system utilisation, standard PCs will reduce their processor cycle. Because of this reduction, the real time does not run constantly and generates an error.

Start the auxiliary program 'LowPrioProc.exe' - repeatedly if necessary - until the PC reaches 100 % system utilisation. By means of the auxiliary program, the system utilisation is increased artificially and a constantly running real time is achieved. You will find the auxiliary program under C:\TwinCAT\LowPrioProc.exe.

5 Functional safety via FSoE with Beckhoff TwinSAFE PLC

Following variations are described:

Variant 1: AMK controller and TwinSAFE PLC



5.1 General overview AMK controller and TwinSAFE PLC

The overview diagram shows a FSoE configuration. The following components are used:

- AMKAMAC A5 controller
- Controller card KW-R07 / -R17 / -R27 with functional safety (KW-R07 is used with this example)
- SafePLC EL6900 with safe input and output terminals



5.2 General overview TwinCAT PLC and TwinSAFE PLC

The overview diagram shows a FSoE configuration. The following components are used:

- TwinCAT PLC
- Controller card KW-R07 / -R17 / -R27 with functional safety (KW-R07 is used with this example)
- SafePLC EL6900 with safe input and output terminals



5.3 Procedure (overview)



*1 Not applicable at TwinCAT PLC and TwinSAFE PLC combination.

Step 2: TwinSAFE configuration



*1 Not applicable at TwinCAT PLC and TwinSAFE PLC combination.

Step 3: AIPEX PRO configuration (*1)

*1 Not applicable at TwinCAT PLC and TwinSAFE PLC combination.



5.3.1 Create and transmit SafePMT parameter set

- AMK controller cards KW-R07 / KW-R17 / KW-R27: See document Safety manual; functional safety (Part no. 203446) Chapter Startup, subtopic Parameterisation
- AMK Decentralised drive technology iC / iX / iDT5: See document Safety manual; functional safety (Part no. 205016) Chapter Startup, subtopic Parameterisation and Supplement to the Safety Manual 2013/18 when using iC / iX / iDT with Functional Safety Part no. 204446 Chapter Startup, subtopic Parameterisation

5.3.2 Step 1: addressing



The EtherCAT and FSoE addresses of the different participants must stringently be set equal in the AMK drives and in TwinCAT System Manager. The addressing of the AMK drives will be done with the AMK software AIPEX PRO.

FSoE addressing

- AMK controller card KW-R07 / KW-R17 / KW-R27: See document Safety manual; functional safety (Part no. 203446) chapter Startup, subtopic FSoE addressing
- AMK Decentralised drive technology iC / iX / iDT5: See documentSafety manual; functional safety (Part no. 205016) Chapter Startup, subtopic FSoE addressing and Supplement to the Safety Manual 2013/18 when using iC / iX / iDT with Functional SafetyPart no. 204446 Chapter Startup, subtopic FSoE addressing
- SafePLC and safe input and output terminals: See manufacturer-specific descriptions

EtherCAT addressing

- AMK controller card KW-R07 / KW-R17: See document Controller cards KW-R06 / -R16 / -R07 / -R17 (Part no. 202744) chapter Startup - operation - maintenance - service, subtopic Addressing bus participants
- AMK controller card KW-R27: See documentController cards KW-R24(-R) / -R25 / -R26 / -R27 (Part no. 204918) chapter Startup - operation maintenance - service, subtopic Addressing bus participants
- AMK Decentralised drive technology iC / iX / iDT5: See document Decentralized drive technology iC / iX / iDT5 (Part no. 203445) chapter Startup - operation - maintenance service, subtopic Addressing bus participants

See document 'Software description AIPEX PRO V3' (Part no. 204979) chapter: Directmode, subtopic Function Communications

5.3.3 Step 2: TwinSAFE configuration

Hardware overview with AMK controller and TwinSAFE PLC



EC - EtherCAT connection



Hardware overview with TwinCAT PLC and TwinSAFE PLC

Step 2.1: Creating a TwinCAT project

Hardware prerequisites 'System structure with TwinCAT PC': Siehe 'Hardware overview with AMK controller and TwinSAFE PLC' auf Seite 37.

A TwinCAT project can be created offline or read online: Siehe 'Creating a TwinCAT project' auf Seite 21. Example: controller card KW-R07 with SafePLC EL6900 and safe inputs and outputs



Step 2.2: Creating a TwinCAT PLC project

For realising a standard data exchange between TwinSafe PLC and PLC controller, you have to create a TwinCAT project with variables.

AT%Q = output variables (point of view PLC controller) AT%I = input variables (point of view PLC controller) Siehe 'PLC project' auf Seite 26.

First the variables must be creating inside the TwinCAT PLC project. Further you can use them with the TwinCAT System Manger.

The variables *boSafePLC_Run_Stop* and *boSafePLC_ERR_Ack* are subsequently used to start / stop the SafePLC. The commanding is done by the PLC controller.

TwinCAT PLC Control - Doku_I	B_FSoE.pro - [MAIN (PRG-ST)]
🦉 File Edit Actions View Opti	ons Help
🖹 🗲 🖬 📲 🚳 🛷 +8 🖴	
Bausteine	0001 PROGRAM MAIN 0002 VAR 0003 boSafePLC_Run_Stop AT%Q*:BOOL; 0005 boSafePLC_ERR_Ack AT%Q*:BOOL; 0006 0007



Not applicable at TwinCAT PLC and TwinSAFE PLC combination.

For realising a standard data exchange between TwinSafe PLC and AMK controller, you can create more variables. The variables by_IN_Data_0 and by_OUT_Data_0 can used freely.



Step 2.3: TwinCAT addressing

The EtherCAT and FSoE addresses of the different participants must stringently be set equal in the AMK drives and in TwinCAT System Manager. The addressing of the AMK drives will be done with the AMK software AIPEX PRO.

Hardware addressing: Siehe 'Step 1: addressing' auf Seite 36.

EtherCAT addressing



The physical addressing of the AMK drives can be done by means of AIPEX PRO or with the DIP switch S1 on the controller card.

The EtherCAT addressing of the TwinSAFE PLC as well as the safe input and output terminals is done with the AIPEX PRO direct mode.(*1)

(*1) Not applicable at TwinCAT PLC and TwinSAFE PLC combination.

Enter the preset EtherCAT addresses of any participant.



FSoE addressing



The physical addressing of the safety board can be done by means of AIPEX PRO of with the DIP switch S1 on the controller card.

The FSoE addressing of the SafePLC as well as the save input and output terminals is done directly by DIP switch on the hardware.

Enter the preset FSoE addresses of any participant.

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Image: System - Configuration Image: Pice System	General EtherCAT DC Process Data Startup SoE - Online Safe Parameter Online FSoE Address: 15 2 3 Log-Files SRA Prm Debug Path:
Ready	Local (172.16.6.225.1.1) Config Mode //

Step 2.4: TwinSAFE Group

The TwinSAFE Group is a group of TwinSAFE clamps (inputs and outputs) witch are logically linked via EL6900.

Appending 'TwinSAFE Group'

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Image: System - Configuration Image: System - Configuration </th <th>Image: Section 1 EtherCAT Process Data Startup CoE - Online Online TwinSAFE Logic TwinSAFE Verifier Project TwinSAFE Address (DIP-Switch): Image: Section 1 Out67934 Version number: Image: Section 1 Project CRC (online): Out67934 Map Project CRC Project CRC (online): Image: Substance Out67934 Map Secial Number Check Export Import Link to FB Restore Mode User Administration User name Upload Add User Delete User Change Password Version History Version History Version History</th>	Image: Section 1 EtherCAT Process Data Startup CoE - Online Online TwinSAFE Logic TwinSAFE Verifier Project TwinSAFE Address (DIP-Switch): Image: Section 1 Out67934 Version number: Image: Section 1 Project CRC (online): Out67934 Map Project CRC Project CRC (online): Image: Substance Out67934 Map Secial Number Check Export Import Link to FB Restore Mode User Administration User name Upload Add User Delete User Change Password Version History Version History Version History
Term 8 (EL901 RMB Delete Box	
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Appending function block 'Decoupler'

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Constraints of the image o	Image: Second state Image: General Function Block List Image: TwinSAFE Function Block List Id: 2 Id: 2 Image: Second state Ima	
A Mappings		
Ready	Local (172.16.6.225.1.1) Config M	ode //

By means of the function block 'Decoupler', for example safe inputs can be linked to particular bits of the FSoE control word.



Configuration example

Used are two 'Decoupler' function blocks.

Decoupler (FB1)

- Input DecIn1: By means of the 'system ready' message of the functional safety (status word, bit 28 VALID), the safety functions except STO are set to 1 (= inactive) status word, bit 28 = 1 → control word, bit 1 - 6, 9 - 16 = 1
- Input DecIn2: SAFE Input 1 triggers 'Safe torque off (STO)'.
- Input DecIn3: SAFE Input 2 sets SAFE Output 2

Allgemein Decoupler (FB 1)				
	#1 Decoupler		Online 🗖 Map State 🗖 Map Diag 🗖	
			Fehler	
VALID	Decin1	J	DecOut1	SS1, SS2, SOS, SSR1, SDIp
SAFE Input 1	Decln2		DecOut2	,sto
SAFE Input 2	Decln3		DecOut3	SAFE Output 2
	DecIn4		DecOut4	



Not applicable at TwinCAT PLC and TwinSAFE PLC combination.

Decoupler (FB2)

This example shows the preparation for a standard data exchange between TwinSAFE PLC and AMK PLC. Therefore, the BYTE-type variable by_IN_Date_0 was defined inside the TwinCAT PLC project. The TwinSAFE PLC will send the status of wState2_Bit12 (VALID Bit) with the variable by_IN_Date_0 to the AMK controller. If you evaluate the VALID bit with the AMK controller, you can check the working state of the FSoE slave and FSoE master.

Enter a TwinSAFE status variable at the Decoupler input DecIn1.



Linking of DecIn1				
Linking of DecIn	5	e text (Safety_	_iX_VALID)	
Position			Kanal	FSoE A
				Clear Link
Insert New Link TwinSAFE Input Constant Input	utput	New 12		Close
Attach TwinSAFE Variab	le O(res.)	_		×
wState2_Bit1 wState2_Bit1 wState2_Bit1 wState2_Bit1 wState2_Bit1 wState2_Bit1 wState2_Bit1	1(res.) 2(res.) 3(S			Cancel

Link TwinSAFE status variable with standard output (by_IN_Date_0).

Allgemein D	Decoupler (FB-2)								
		#1						Decoup	bler
								F	ehler
Safety_X_V	ALID	Decin1						De	cOut1
	Linking of Dec	Dut1							1
	Link Alias								
	- Links								
	Position						Kanal	FSoE	A
1	Insert New Lir	nk				1			1
	C TwinSAI	FE Output							
	C Function	n Block Input							
	Standar 2	d Output		New	b 3			Clos	e

Bit addressing

Attach Variable Standard Out Var 5 (Input)	x
PLC - Configuration ☐ ∰ PLC - Configuration ☐ ∰ TwinSAFE_A5 ☐ ∰ Standard ☐ MAIN.by_IN_Data_0 > IB 0.0, BYTE [1.0] 1	Show Variables C Unused Used and unused Exclude disabled Exclude other Devices Exclude same Image Show Tooltips
Variable Size Mismatch	Show Variable Types
Linked Variable: MAIN.by_IN_Data_0 Size Offset Linked Variable: 8 Own Variable: 1 Overlapped: 1 (Size and Offset in bits) Cancel	Matching Type Matching Size All Types Array Mode Offsets Continuous Show Dialog Variable Name Hand area
	Take over
	Cancel OK

Symbolic name

inking of DecOut1			
Link Alias MAIN.by_IN_Data_0 Bit 2			
Links			
Position MAIN.by_IN_Data_0 . Eingänge . Standard	d. TwinSAFE_A5	Kanal	FSoE A
			Clear Link
┌─ Insert New Link ─────			
C TwinSAFE Output			
C Function Block Input			
Standard Output			
	New		Close

You can find the used variables in the device tree. Below the clamp 'EL6900' – 'Module 2 (FSOE). TwinCAT use standard names like 'Standard Out Var 1', 'Standard Out Var 2' Rename the standard variable names to a clear name. This variable name will further be also used for the TwinCAT 'configuration file'. This 'configuration file' will be read from AIPEX PRO to create the EtherCAT configuration file.



5.3.3.1 Step 2.5: TwinSafe PLC Start / Stop / ErrAck

The example shows how the TwinCAT variables are linked to an AMK controller. Thus the AMK controller can start the TwinSAFE PLC.

📴 TwinSafe_Schulungsdemo_5 - Twin	CAT System Manager
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1 - Konfiguration	Alloemeit Input/Dutputs 2
onfiguration	
Coreto	t #1 Online
Gerät 2 (EtherCAT)	
📥 Gerät 2-Prozessabbild	Eingänge
🛨 Gerät 2-Prozessabbild-Info	RUN/STOP g_boSafePLC_RUN_STOP_Q
· 谢 Eingänge	
🜲 Ausgänge	ERR Ack 3 LooSafePLC_ERR_Ack_Q
🔹 InfoData 💦 👔	
➡I Antrieb 1 (KW (-R06))	LINKING OF EKR ACK
➡ Klemme 2 (KW (-R07) (FSoE))	
Klemme 3 (EK1100)	
H Viewa 4 (FL 1004)	g_boSafePLC_ERR_Ack_Q
E E Klemme 4 (EL1904)	
Module 1 (ESOE)	
Module 2 (FSOE)	
🕀 📕 Module 3 (FSOE)	Pesition Kanal F
🕀 💊 WcState	🔍 g_boSafePLC_ERR_Ack_Q . Ausgänge . Standard . TwinSafe_Schulung 🌙
🕂 👷 InfoData	6
G TwinSAFE Gruppe 1	
E E TwipSAFE Funktion Block Lis	
B Decoupler (FB 1)	
B Decoupler (FB 2)	
E WINDARE Verbindungsliste	Clear Link
Klemme 4 (FI 1904)	
Klemme 6 (EL 1904)	
E	C TwinSAFE Input
🗄 📲 Klemme 8 (EL2008)	C Function Block Output
Klemme 9 (EL9011)	G Standard Input
	New 5
	Close

ERR Ack = low - high - low edge RUN/STOP = low - high edge



Not applicable at TwinCAT PLC and TwinSAFE PLC combination.

The example shows the preparation for a standard data exchange between AMK controller and TwinSafe PLC. With the variables, the TwinSAFE PLC can be controlled with the AMK controller. The TwinCAT PLC (dummy) variables (by_IN_Data_0 and by_OUT_Data_0) will be linked with the TwinSAFE PLC control and status in- and outputs. The bit numbers will be entered with an offset value.

Example:

Signal / Status	Variable
ERR Ack	by_OUT_Data_0 Offset 0 (bit 0)
RUN / STOP	by_OUT_Data_0 Offset 1 (bit 1)

Signal / Status	Variable
FB ERR	by_IN_Data_0 Offset 0 (bit 0)
COMERR	by_IN_Data_0 Offset 1 (bit 1)

General Input/Dutputs	
#1 Online 🗌	
Inputs BoRUN_STOP Attach Variable Standard Out Var 5 (Input) ERR Ac Attach Variable Standard Out Var 5 (Input) Outputs PLC - Configuration FB ERF TwinSAFE_A5 COM ER Standard	Show Variables Unused Used and unused Exclude disabled Exclude other Devices
OUT ER Info Data Map Stat Linked Variable: Main.by_IN_Data_0 Size Offset Linked Variable: 8 0wn Variable: 1 0verlapped: 1 Cancel	 Exclude same Image Show Tooltips Show Variable Types Matching Type Matching Size All Types Array Mode Offsets Continuous Show Dialog
🖢 3 chose Standard Output -> New	Variable Name Hand over Take over

You can find the used variables in the device tree. Below the clamp 'EL6900' – 'Module 2 (FSOE). TwinCAT use standard names like 'Standard Out Var 1', 'Standard Out Var 2' ... Rename the standard variable names to a clear name. This variable name will further be also used for the TwinCAT 'configuration file'. This 'configuration file' will be read from AIPEX PRO to create the EtherCAT configuration file.



Step 2.6: Activating and transferring configuration

- 1. Chose EtherCAT bus
- 2. Generate allocation
 - (Generate allocation between 2 process images)
- 3. Check configuration (Plausibility check)
- 4. Activate configuration (Save and activate current configuration)

🗾 TwinSAFE_A5 - TwinCAT System Manager						
File Edit Actions View Options Help						
] 🗅 📂 📽 🔛 🍜 R. X 🖻 🖷	1 🖻 M 8 🖳 👘 🎸 🌋 🗶 🗶	\$\$ × @ \$ \$ E Q # 60 \$				
	General Adapter 2 ier 3 T 4 Inline CoE	- Online				
E/A - Konfiguration	NetId: 172.16.6.225.3.1	Advanced Settings				
⊡ 🔫 Gerät 2 (EtherCAT), 1		Export Configuration File				
		Sync Unit Assignment				
		Topology				
庄 🛥 📕 Antrieb 1 (KW (-R06))						

Check whether the 'pre-operational' state is reached.

😴 TwinSAFE_A5 - TwinCAT System Manager					
File Edit Actions View Options Help					
D 🛎 📽 日 🍜 R. X 🖻 🖻 🖻	# 8 🖳 📾 🗸 🏙 👧 👧 🏤 🖄 🌀 🍕) E Q P 60 🔦			
SYSTEM - Konfiguration SPS - Konfiguration SPS - Konfiguration	General Adapter EtherCAT				
E/A - Konriguration	No Addr Name	tate			
Gerät 2 (EtherCAT) 1 Gerät 2 (EtherCAT) 1 Gerät 2-Prozessabbild-Info Gerät 2-Proze	■ 1 1 Antrieb 1 (KW (-R06)) ■ 2 2 Klemme 2 (KW (-R07) (FSoE)) 3 10 Klemme 3 (EK1100) ■ 4 6 Klemme 4 (EL1904) ■ 5 5 Klemme 5 (EL6900) ■ 6 7 Klemme 6 (EL2904) ■ 7 8 Klemme 7 (EL1008) ■ 9 3 Antrieb 9 (iC) ■ 10 11 Antrieb 10 (K) ■ 11 50 Klemme 11 (K (FSoE))	PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP PREOP 3			

Generate the safety configuration and transfer it to the SafePLC EL6900.

🚊 📲 Kle	🗄 📲 Klemme 3 (EK1100)				
÷ 象	InfoData				
ب	Klemme 4 (EL1904)				
⊡■	Klemme 5 (EL6900)				
(±)	🍯 Module 1 (FSO\Bigg				
(±)	Module 2 (FSOE)				
÷.	Module 3 (FSOE)				
÷.	象 WcState				
(±)	象 InfoData				
÷.	G TwinSAFE Gruppe	1			

The specific serial number is used for entering the password!

General EtherCAT Process Data Startup CoE -	Online Online MinSAFE Logic TwinSAFE Verifier
Project	
TwinSAFE Address (DIP-Switch): 🔟 🛨	Serial Number: 00312468
Version number: 1	Project CRC (offline): 0xF5CC
Map Project CRC	Project CRC (online):
🔲 Map Serial Number	
Check Export Import	Link to FB Restore Mode
User Administration	
User name	Upload
	Add User
	Delete User
	Change Password
	Version History

User name: Administrator

Serial No.: see previous image

Password: TwinSAFE

General EtherCAT Prozessdaten Startup	CoE - Online Online TwinSAFE Logik TwinSAFE Verifier
Initializing Getting adjusted language from host OK! Loading language library Failed! Determining version information OK!	1
Ready.	Login 🔀
	User Name:
	Serial No.
	Password:
T	OK Cancel
Upload Delete	Download 2
	Version 1.5, Build 1

The procedure is finished by pressing the 'Start' button.

Pr	oject	
	DecIn5 is linked to TwinSAFE Connection 3 (ConnId = 3), Channel 2.	
	TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 7. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 10. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 11. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 12. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 13. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 13. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 14. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 2 (ConnId = 2), Channel 14. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 1 (ConnId = 2), Channel 15. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 1 (ConnId = 1), Channel 2. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 1 (ConnId = 1), Channel 1. TwinSAFE Function Block #1, DecOut3 is linked to TwinSAFE Connection 1 (ConnId = 1), Channel 1.	
		▶
[Save Print Cancel Star	L

Following enter password: TwinSAFE

Login	×
User Name:	Administrator
Serial No.	312468
Password:	
	OK Cancel

Restart system

Step 2.7: Exporting the TwinCAT configuration file

Not applicable at TwinCAT PLC and TwinSAFE PLC combination.

With the subsequent step, the safe configuration file is read in by the AMK controller.



5.3.4 Step 3: AIPEX PRO configuration

Hardware overview with AIPEX PRO PC



Not applicable at TwinCAT PLC and TwinSAFE PLC combination.



ETH - Ethernet connection

Step 3.1: Creating an AIPEX PRO project

Reading the project

Hardware prerequisites 'System structure with AIPEX PRO PC': Siehe 'Hardware overview with AIPEX PRO PC' auf Seite 54.

Create an AIPEX PRO project and append all present participants: See document First steps Initial startup KE/KW (Part no. 204539), chapter Creating an online project for initial motor startup.

Check addressing



The EtherCAT and FSoE addresses of the different participants must stringently be set equal in the AMK drives and in TwinCAT System Manager. The addressing of the AMK drives will be done with the AMK software AIPEX PRO.



The present addressing can be rechecked in the AIPEX PRO Directmode.

Menu 'Communication' = EtherCAT addresses

Menu 'Functional safety' = FSoE addresses

<mark>₩₩</mark> Tw	vinSafeD	emo_A5.ai	pex - AIPEX	PRO	<u>_ ×</u>		
Projec	<u>Project Online Edit View Extras Startup Configuration ?</u>						
	🗅 🚅 🖬 4 🖳 🕱 🗰 🔿 🧣 📲 👢 🐰 ங 📾 🚳 🔈 🏪 😓						
	PC Eigenschaften - PC Ansicht Serieller Ansc						
	Directm	ode					
 	ACC —			nernet	Ethernet 💽		
4	Address		- IP	Padress 172.16.4.124	□-172.16.4.124 A5D		
	Master	, í	_ s.	ubnet Mask 255 255 0 0 4 B C	- 2 IDT		
					- 1/1 KW (-R06) - 1/2 KW (-R07) (F		
-	Lonfigura	tion	G	ateway 0.0.0.0 Delete Detect	- 1/10 EK1100		
		Clear			1/6 EL1904		
ļ∟					1/5 EL6900		
Ι.		T.U					
	LtherLA	I Master	-	1			
		Actual	Fix addr.	Device type	A5D 410 1327 204607		
	1	1	1	KW (-R06) Rev1030105			
	2	2	2	KW (-R07) (FSoE) Rev103	C Parameters		
	3	10	10	EK1100 Rev110000	C Temporary parameters		
	4	6	6	EL1904 Rev100000	C Diagnostics		
	5	5	5	EL6900 Rev100000	Communication		
	7	8	/	EL2504 Rev100000	C Opecial functions		
	8	9	9	EL2008 Rev100000	C PLC		
	9	3	3	iC Rev1030100	C Cysteninio		
	10	11	11	iX Rev1030100	C Functional safety		
	11	50	50	iX (FSoE) Rev1030100	Monitor		
					Urladen		
					Systemhochlauf		
	C Set Simple Mode Set Standard Mode						
- 0	Configurat	ion			- überspielen		
1							

Reading the TwinCAT configuration file

Read in the before-exported TwinCAT safe configuration file. Siehe 'Step 2.7: Exporting the TwinCAT configuration file' auf Seite 53.



Subsequently, the unsafe data exchange must be configured manually.







Existing network configuration available

All manual created links get cancelled and must be following manual done new. All automatically configured links can be rebuild with the AIPEX PRO function menu 'Configuration' 'Create configuration'

Step 3.2: Creating an AIPEX PRO PLC project

See document Software description AFL - AMK Function Library, part 1 (Part no. 203905).

5.3.4.1 Standard data transfer between TwinSAFE PLC and AMK controller

5.3.4.1.1 AIPEX PRO network configuration

A standard data transfer between TwinSAFE PLC and AMK controller must be create manually.

Data transfer TwinSAFE PLC to AMK controller

Click in the device tree onto the TwinSAFE PLC EL6900 (at the example Safety 5, transmitter).

You will find which are defined in TwinCAT inside the group 'Standard Out Vars TxPDO'. Click onto your first variable. Return this process for all variables.



Click in the device tree onto the AMK controller (at the example Steuerung, receiver).

👷 Unbenannt - AIPEX PRO						
Project O <u>n</u> line <u>Edit</u> View Extras Startup Configuration ?						
D 😂 🖬 4 😫 💐 🦛 🌳 😭 🐇 🐜 📾 🖀 🎥 🏝 🍮						
PC	r 7	🖬 🔿 🖨 🗛				
			TRANSMIT			
E die ACC Anschluss X137	NR	DEVICE	TRANSMIT VARIABLE			
EtherCAT (CC) - Anschlu	1	2 - AntriebS2	FSOE_FSoE Sla			
EtherCAT - Anschluss X	2	2 - AntriebS2	SafetySlaveMessage.FSOE			
🖹 🔠 Antrieb1	3	2 - AntriebS2	SafetySlaveMessage.FSOE			
CIR ACC - Anschluss	4	2 - AntriebS2	SafetySlaveMessage.FSOE			
	16	2 - AntriebS2	SafetySlaveMessage.FSOE(
ONLINE	17	2 - AntriebS2	SafetySlaveMessage.FSOE_v			
🕕 K 🔒 P. 🔗 N. 👫 S 🕂 D	🤷 🗶 🗸	/erbir 🐮 Optio	Create Configuration			
			<i>h</i> .			

The standard data transfer is done inside the asynchronous task. Link your first TwinCAT variable (at the example Standard Out Vars TxPDO 1.boFB_Err.0) to a free AMK PLC variable (at the example byIn0). The following TwinCAT PLC variables will be linked automatically.

Ą	Unbenannt - AIPEX PRO						
P	roject Online Edit View Extras Startup Configuration ?						
Ī	D 😂 🖬 4 🖳 💐 🦛 🔿 🕐 📳 🐰 🍋 📾 📾 🎒 놀 🍮						
	r 1	🗉 🖙 🤜 🖓					
			TRANSMIT		RECEIVE		
	NR	DEVICE	TRANSMIT VARIABLE	DATA TYPE	255 - Steuerung		
	119	5 - Safety 5	1asterMessageFSOEFSoE Moster ConnIE	UINT		-	
	120	5 - Safety 5	Standard Out Vars TxPDO 1.boFB_ERR.0	BOOL		I 1	
	121	5 - Safety	Standard Out Vars TxPDO 1.boCOM_ERR.1	BOOL	🖃 GRUPPE byIn		
Π	122	5 - Safety	Standard Out Vars TxPDO 1.boiX_VALID.2	BOOL	byIn0		
	123	5 - Safety 5	Standard Out Vars TxPDO 1.boR07_VALID.3 BOOL byIn 2				
	124	6 - Safety 6	FSOE_FSOE Slove and USINT				
	125	6 - Safety 6	TxPDO.FSOE_InputChannel1.0 BOOL byIn3				
	* *	Connections			[Create Conf	iguration
							11.

Data transfer between AMK conroller and TwinSAFE PLC

Make now reverse order. Click at first at the device tree onto the transmitter (AMK controller).

Insert the next free byOutx transmit variable (at the example: byOut0).

As next step click onto the receiver (TwinSAFE PLC EL9600). Link your first TwinCAT variable to the byOutx (at the example: byOut0). The following TwinCAT PLC variables will be linked automatically with the byOut0.

175	255 - Steuerung	byOut0	SINT	Standard In Vars RxPDO 1.boERR_Ack.0	•
176	255 - Steuerung	byOut0	SINT	Standard In Vars RxPDO 1.boRUN_STOP.1	•

5.3.4.1.2 Read and write asynchronous data's with the AMK PLC project

Use the AMK function blocks GET_COM_VAR_ASYNC_INT to read data's and SET_COM_VAR_ASYNC_INT to write data's. The function blocks are called inside the asynchronous task (PLC_PRG).



5.3.4.2 Read synchronous data's with the AMK PLC project

5.3.4.2.1 State Safety Inputs (EL1904)

The state of the safety inputs can be read cyclic with an AMK function block from type _FormalDeviceAccess_. Click onto the Safety Inputs Interface at the device tree. Follow exactly as represented.



Additional variable access		×
Mappable variables TxPD0.FS0EFSoE Slave CMD TxPD0.FS0E_FSoE Slave CRC_0 TxPD0.FS0E_FSoE Slave CRC_0 TxPD0.FS0E_InputChannel1 2 2 Possible Selection Read (by PLC) Write (by PLC)	Add >> Remove <<	PLC functions GET_FDEV_READ_TX_PD0_FS0E_INPUT_CHAN WAR:TxPD0.FS0E_InputChannel1 DEVICE:EL1904, 4 K. Safety Eingang 24V, Twins Add read-back function
		OK Cancel

Call an instance of the automatically generated function block.

Baus 	teine FormalDeviceAccess_ È GET_FDEV_READ TX PDO FSOE INPUT CHANNEL1 BYTE (FB) IPLC_PRG (PRG)
⊡≣ F	PLC_PRG (PRG)
0004	PROGRAM FPLC_PRG
0005	VAR
0006	fbGET_FDEV_READ_TX_PDO_FSOE_INPUT_CHANNEL1_BYTE:
0007	GET_FDEV_READ_TX_PDO_FSOE_INPUT_CHANNEL1_BYTE;
8000	END_VAR
0001	
0002	(* function read the state of the input channels *)
0003	fbGET FDEV READ TX PDO FSOE INPUT CHANNEL1 BYTE(
0004	boEnable:= TRUE,
0005	stDevice:= g stSafety6, (* EL 1904 *)
0006	boEnabAck=> ,
0007	boErr=> ,
0007	boErr=> , iErrID=> ,

5.3.4.2.2 Image of FSoE control and status data's

Image of FSoE control data's reflected to the AMK standard parameter. ID33211 'Safety data master 0' include bit 0..15 of FSoE control data's ID33213 'Safety data master 1' include bit 16..31 of FSoE control data's

Image of FSoE status data's reflected to the AMK standard parameter. ID33231 'Safety data slave 0' include bit 0..15 of FSoE status data's ID33233 'Safety data slave 1' include bit 16..31 of FSoE status data's The state of the images can be cyclic read with an AMK function block typ _FormalDeviceAccess_. Create the function block in the same way as exampled with the Safety Inputs (EL1909).

Click onto the FSoE drive Interface at the device tree. Open the dialog field [Erweiterte Variablenzugriffe...]. Generate for each standard parameter witch you want to read with the PLC a PLC function (GET_FDEV function_ ...). Repeat this process for all FSoE drives. Is a GET_FDEV function_ ... for a standard parameter available, only the DEVICE will be expanded with the FSoE drive name.

5.3.4.3 Start TwinSAFE PLC



5.4 Information about error sources



The EtherCAT and FSoE addresses of the different participants must stringently be set equal in the AMK drives and in TwinCAT System Manager. The addressing of the AMK drives will be done with the AMK software AIPEX PRO.



If you modify the TwinCAT configuration, you have to transfer it to the SafePLC (EL6900). The appending configuration file has always to be linked to the AIPEX PRO project, compiled and transferred to the AMK controller.



A new safe configuration file will completely overwrite the existing one. Manually added links will be lost.



After any modification of the configuration, a restart becomes necessary.

After any restart, the SafePLC (EL6900) must be separately restarted .



Within the SafePMT parameter set, the commanding by FSoE master must be selected (Prm7 = 0)

Diagnostic message 3606, Info1:70, Info2:6

Error messages of the FSoE handling

The FSoE watchdog has expired, i.e. no new FSoE frame was received within the watchdog time

If you get the diagnostic message 3606, Info1:70, Info2:6 you have to increase the FSoE Watchdog time (recommended 200 ms). **Cause:**

The FSoE master sends data (control word) via the EtherCAT master to the FSoE slave. The FSoE slave must be respond (status data) within the configured time FSoE Watchdog.

Factors that affect the transmission time:

- FSoE Slave, read control word
- FSoE Slave, process data
- FSoE Slave, write status word
- Overload EtherCAT bus
- Bad frames

Picture: 'Settings FSoE Salve' with TwinCAT System Manager

🗾 EL 6900.tsm - TwinCAT System Manager 📃 🗖
Eile Edit Actions View Options Help
; D 🛎 📽 🖬 🚳 🔃 🖇 🖻 📾 🛤 🤌 🔜 🖴 🗸 🏙 👧 🧶 📚 🔨 🚳 🖹 Q 🖓 🚱 👷 🔊 🥸
Image: Second Street Image: Street Image: Street
Ready Local (169.254.50.167.1.1) Contig Mode

Glossary

Α

A4 / A5 / A6 AMKAMAC controller A4 / A5 / A6

ACC

AMK CAN Communication (CAN bus interface with standard CANopen protocol DS301 and additional hardware synchronization signal)

AIPEX

AMK startup and parameterizing software (PC software): Programming, parameterization, configuration, diagnosis, oscilloscope, status information

AT

Drive telegram from slave to master

В

BA

Binary output

BE

Digital input

С

CAN

Controller Area Network

D

DI Digital input

DO Digital output

E

EMV

Electromagnetic compatibility

EMC Electromagnetic compatibility

EnDat 2.1 Motor encoder interface protocol of the company Heidenhain

EtherCAT Real-time Ethernet bus

EnDat 2.2 Motor encoder interface protocol of the company Heidenhain

F

FL

Command (Causes a new system run-up)

FSoE

Fail-Safe over EtherCAT

l

iC AMKASMART decentralized inverter with power supply

ID

iDT

Parameter identification numbers acc. to SERCOS Standard

AMKASMART Servo motors with integrated inverter

Incremental encoder, optical encoder with sine and cosine track and zero pulse

iX AMKASMART decentralized inverter

K

KWD AMKASYN compact double inverter to control two motors

KW-Rxx AMKASYN controller card for installation into compact inverter

KW AMKASYN compact inverter

KEN

AMKASYN compact power supply without recovery

KES

AMKASYN compact power supply with sinusoidal voltage and current

KWZ

AMKASYN compact two-axes inverter to control two motors

KE AMKASYN compact power supply with recovery

KE/KW

Modular AMK drive system (contains compact power supply KE, compact inverter KW with controller card and applicable option card)

Μ

MDT

Master Data Telegram from master to slave

Modulo

Modulo processing of position setpoint and actual values

Ν

NK

Cam switch

0

Operational

In state operational, data are transferred cyclically via fieldbus

Ρ

PDK_xxxxxx_abcdefgh

Product documentation; xxxxxx - AMK part no. , abcdefgh - name

Pre-operational

In pre-operational state, the controller can access the bus participants via the service channel. No cyclic data is exchanged.

PRG

Program

Q

QUE

Acknowledgment DC bus on; shows that DC bus is loaded

QBR

Acknowledgment motor holding brake

QRF

Acknowledgment controller enable; the drive is controlled in the activated operation mode

R

RF

Command 'Controller enable'; the drive is energized and will be controlled depending on the selected operation mode. Controller enable can only be set if the device is error-free (SBM = TRUE) and acknowledgement DC bus on is set (QUE = TRUE).Acknowledgement controller enable (QRF) is set.

S

SA Safe output

SafePMT

Safe parameter editor

SBM

System ready message; shows that the device is error-free In case of error. SBM will be reset

SE

Safe input

SoE

Servodrive Profile (SERCOS) over EtherCAT (Acc. to IEC 61800-7-300)

STO

Safe torque off (Safety function acc. to DIN EN 61800-5-2)

T

TwinCAT

Automation software

U

UZN

DC bus voltage pole negative

UZP

DC bus voltage pole positive

Your opinion is important!

With our documentation we want to offer you the highest quality support in handling the AMKmotion products. That is why we are now working on optimizing our documentation.

Your comments or suggestions are always of interest to us.

We would be grateful if you take a bit of time and answer our questions. Please return a copy of this page to us.



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fax no.: +49 7021/50 05-199

Thank you for your assistance. Your AMKmotion documentation team

- 1. How would you rate the layout of our AMKmotion documentation?
 - (1) very good (2) good (3) satisfactory (4) less than satisfactory (5) poor

2. Is the content structured well?

- (1) very good (2) good (3) moderate (4) hardly (5) not at all
- 3. How easy is it to understand the documentation?
 - (1) very easy (2) easy (3) moderately easy (4) difficult (5) extremely difficult
- 4. Did you miss any topics in the documentation?
 - (1) no (2) if yes, which ones:
- 5. How would you rate the overall service at AMKmotion?
 - (1) very good (2) good (3) satisfactory (4) less than satisfactory (5) poor

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