Kollmorgen Automation Suite

AKT2G I/O Manual

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1 About This Manual

This manual provides installation and operating instructions for Kollmorgen AKT2G I/O slice devices, including Safety devices.

1.1 Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

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

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

1.2 Origin of the document

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

Safety content derived from the following original files:

- EL1904.pdf, v2.2.0, 2020-07-17
- EL2904.pdf, v2.2.0, 2020-07-17

1.3 Currentness

Please check whether you are using the current and valid version of this document. The current version of the PDF can be downloaded from Kollmorgen's support website at https://www.kollmorgen.com/en-us/developer-network/downloads/. In case of doubt, please contact Technical Support.

An alternative resource is to use the KAS online help. The online help will always have the latest information in electronic form. See http://webhelp.kollmorgen.com/kas/

1.4 Product features

Only the product features specified in the current user documentation are valid.

1.5 Disclaimer

The documentation has been prepared with care. The products described are subject to cyclical revision. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics. We reserve the right to revise and change the documentation at any time and without prior announcement. 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.

1.6 Safety Instructions

1.6.1 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 Kollmorgen.

1.6.2 Operator's obligation to exercise diligence

The operator must ensure that

- the safety products are only used as intended (see chapter Product description);
- the safety products are only operated in sound condition and in working order.
- the safety 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 safety products are used.
- none of the safety and warning notes attached to the safety products are removed, and all notes remain legible.

1.6.3 Description of safety symbols

In these operating instructions the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

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

1.7 Interference-Free EtherCAT Terminals

Use of interference-free EtherCAT Terminals in safety applications

If an EtherCAT Terminal is described as interference-free, this means that the consecutive terminal behaves passively in a safety application (e.g. in the case of the all-pole switch-off of a po- tential group).

In this case the terminals do not represent an active part of the safety controller and do not affect the Safety Integrity Level (SIL) or Performance Level (PL) attained in the safety application.

2 Mounting and Wiring of I/O Terminals

2.1 Instructions for ESD Protection

NOTE

Desctruction of the devices by electrostatic discharge possible!

The devices contain components at risk from electrostatic discharge caused by improper handling.

- Please ensure you are electrostatically discharged and avoid touching the contacts of the device directly.
- Avoid contact with highly insulating materials (synthetic fibers, plastic film, etc.).
- Surroundings (working place, packaging, and personnel) should be grounded properly when handling the devices.
- Each assembly must be terminated at the right hand end with an AKT2G-EM-000-000 bus end cap to ensure the protection class and ESD protection.

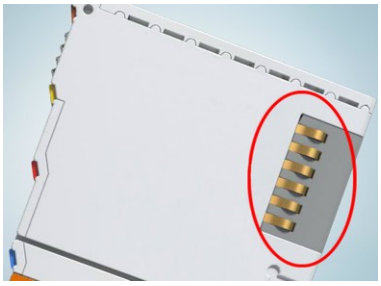


Figure 3-1: Spring contacts of the I/O components.

2.2 Installation on mounting rails

⚠WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

2.2.1 Assembly

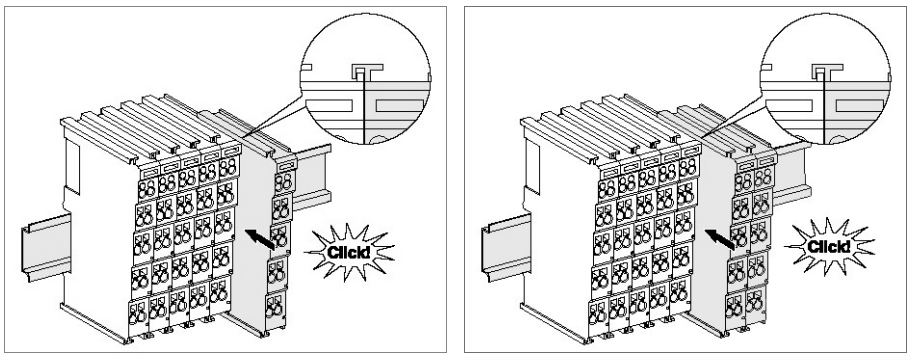


Figure 3-2: Attaching on mounting rail

The bus coupler and bus terminals are attached to commercially available 35 mm mounting rails (DIN 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 tongue and groove 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 tongue and groove, the connection will not be operational! When correctly assembled, no significant gap should be visible between the housings.

TIP

Fixing of mounting rails

The locking mechanism of the terminals and couplers extends to the profile of the mounting rail. At the installation, the locking mechanism of the components must not come into conflict with the fixing bolts of the mounting rail. To mount the mounting rails with a height of 7.5 mm under the terminals and couplers, you should use flat mounting connections (e.g. countersunk screws or blind rivets).

2.2.2 Disassembly

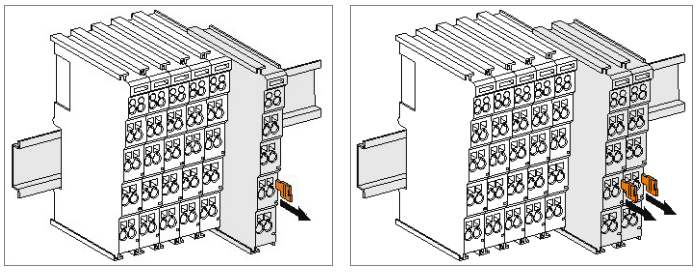


Figure 3-3: Disassembling of terminal

Each terminal is secured by a lock on the mounting rail, which must be released for disassembly:

1. Pull the terminal by its orange-colored lugs approximately 1 cm away from the mounting rail. In doing so for this terminal the mounting rail lock is released automatically and you can pull the terminal out of the bus terminal block easily 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 out of the bus terminal block.

2.2.3 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 E-Bus/K-Bus deal with the transfer of the data and the supply of the Bus Terminal electronics.
- 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 (up to 24 V) or for higher voltages via power feed terminals.

NOTE

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 (AKT2G-PSF-024-000) interrupt the power contacts and thus represent the start of a new supply rail.

2.2.4 PE power contact

The power contact labeled 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.

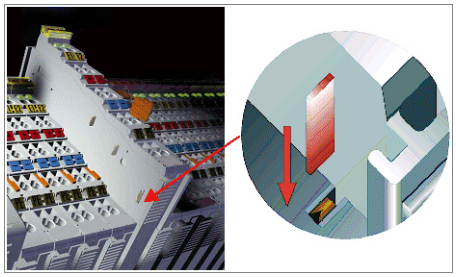


Figure 3-4: Power contact on left side

NOTE

Possible damage of the device

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.

⚠WARNING

Risk of electric shock!

The PE power contact must not be used for other potentials!

2.3 Installation instructions for enhanced mechanical load capacity

⚠WARNING

Risk of injury through electric shock and damage to the device!

Bring the Bus Terminal system into a safe, de-energized state before starting mounting, disassembly or wiring of the Bus Terminals!

2.3.1 Additional checks

The terminals have undergone the following additional tests:

Verification	Explanation
Vibration	10 frequency runs in 3 axes
	6 Hz < f < 60 Hz displacement 0.35 mm, constant amplitude
	60.1 Hz < f < 500 Hz acceleration 5 g, constant amplitude
Shocks	1000 shocks in each direction, in 3 axes
	25 g, 6 ms

2.3.2 Additional installation instructions

For terminals with enhanced mechanical load capacity, the following additional installation instructions apply:

- The enhanced mechanical load capacity is valid for all permissible installation positions
- Use a mounting rail according to EN 60715 TH35-15
- Fix the terminal segment on both sides of the mounting rail with a mechanical fixture, e.g. an earth terminal or reinforced end clamp
- The maximum total extension of the terminal segment (without coupler) is:
  64 terminals (12 mm mounting with) or 32 terminals (24 mm mounting with)
- Avoid deformation, twisting, crushing and bending of the mounting rail during edging and installation of the rail
- The mounting points of the mounting rail must be set at 5 cm intervals
- Use countersunk head screws to fasten the mounting rail
- The free length between the strain relief and the wire connection should be kept as short as possible. A distance of approx. 10 cm should be maintained to the cable duct.

2.4 Connection

2.4.1 Connection system

⚠WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

2.4.1.1 Overview

The Bus Terminal system offers different connection options for optimum adaptation to the respective application:

- The terminals of AKT2G and AKT series with standard wiring include electronics and connection level in a single enclosure.

2.4.1.2 Standard wiring (AKT2G/AKT-xx)

Figure 3-5: Standard wiring

The terminals of AKT2G and AKT series have been tried and tested for years.

They feature integrated screwless spring force technology for fast and simple assembly.

2.4.2 Wiring

⚠WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the Bus Terminals!

2.4.2.1 Terminals for standard wiring AKT2G-xx/AKT-xx

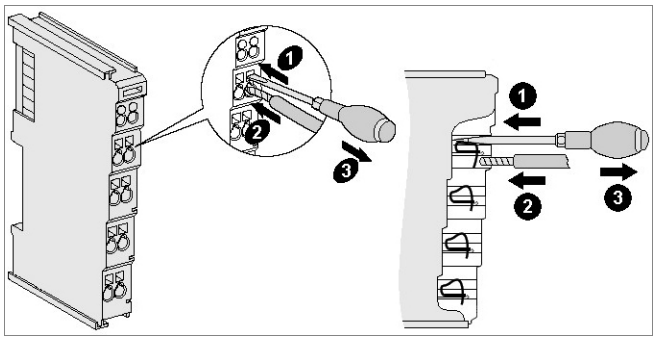


Figure 3-6: Connecting a cable on a terminal point

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

1. Open a terminal point by pushing a screwdriver straight against the stop into the square opening above the terminal point. Do not turn the screwdriver or move it alternately (don't toggle).
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal point closes automatically when the pressure is released, holding the wire securely and permanently.

   See the following table for the suitable wire size width.

Terminal Housing	AKT2G-xx, AKT-xx
Wire size width (single core wires)	0.08 ... 2.5 mm^2
Wire size width (fine-wire conductors)	0.08 ... 2.5 mm^2
Wire size width (conductors with a wire end sleeve)	0.14 ... 1.5 mm^2
Wire stripping length	8 ... 9 mm

2.4.3 Shielding

NOTE

Shielding

Encoder, analog sensors and actors should always be connected with shielded, twisted paired wires.

⚠WARNING

Observe the special conditions for the intended use of Kollmorgen fieldbus components with extended temperature range (ET) in potentially explosive areas (directive 2014/34/EU)!

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-15! The environmental conditions during use are thereby to be taken into account!
- For dust (only the fieldbus components of certificate no. KEMA 10ATEX0075 X Issue 9): The equipment shall be installed in a suitable enclosure providing a degree of protection of IP54 according to EN 60079-0 for group IIIA or IIIB and IP6X for group IIC, taking into account the environmental conditions under which the equipment is used.
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of -25 to 60°C for the use of Kollmorgen fieldbus components with extended temperature range (ET) in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the AKT2G-PSF-024-000 power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

2.5 Installation positions

NOTE

Constraints regarding installation position and operating temperature range

Please refer to the technical data for a terminal to ascertain whether any restrictions regarding the installation position and/or the operating temperature range have been specified. When installing high power dissipation terminals ensure that an adequate spacing is maintained between other components above and below the terminal in order to guarantee adequate ventilation!

2.5.1 Optimum installation position (standard)

The optimum installation position requires the mounting rail to be installed horizontally and the connection surfaces of the AKT2G terminals to face forward (see Figure 3-7: Recommended distances for standard installation position). The terminals are ventilated from below, which enables optimum cooling of the electronics through convection. “From below” is relative to the acceleration of gravity.

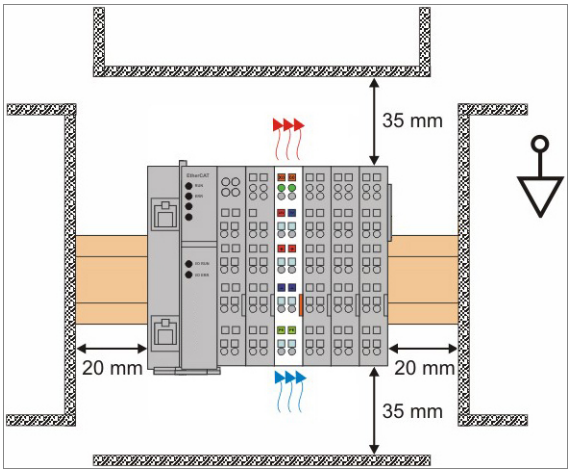


Figure 3-7: Recommended distances for standard installation position

Compliance with the distances shown in Fig. Recommended distances for standard installation position is recommended.

2.5.2 Other installation positions

All other installation positions are characterized by different spatial arrangement of the mounting rail - see Figure 3-8: Other installation positions.

The minimum distances to ambient specified above also apply to these installation positions.

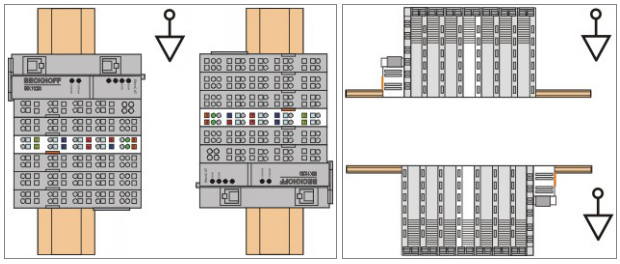


Figure 3-8: Other installation positions

2.6 Positioning of passive Terminals

TIP

Hint for positioning of passive terminals in the bus terminal block
EtherCAT Terminals (AKT2G-xx), which do not take an active part in data transfer within the bus terminal block are so called passive terminals. The passive terminals have no current consumption out of the E-Bus.
To ensure an optimal data transfer, you must not directly string together more than two passive terminals!

2.6.1 Examples for positioning of passive terminals (highlighted)

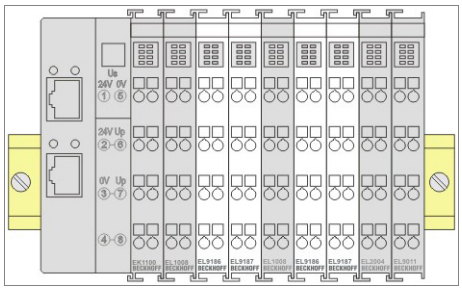


Figure 3-9: Correct positioning

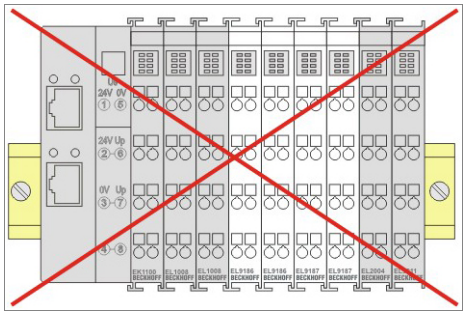


Figure 3-10: Incorrect positioning

2.7 UL Notice

Application

Kollmorgen EtherCAT modules are intended for use with Kollmorgen's UL Listed EtherCAT System only.

Examination

For cULus examination, the Kollmorgen I/O System has only been investigated for risk of fire and electrical shock (in accordance with UL508 and CSA C22.2 No. 142).

For devices with Ethernet connectors

Not for connection to telecommunication circuits.

2.7.1 Basic principles

UL certification according to UL508. Devices with this kind of certification are marked by this sign:

2.8 Continuative documentation about explosion protection

NOTE

Explosion protection for terminal systems

Pay also attention to the continuative documentation

3 Safety I/O Information

3.1 Safety Operation

3.1.1 Environmental Conditions

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

⚠WARNING

Risk of injury!

The safety components must not be used under the following operating conditions.

- under the influence of ionizing radiation (that exceeds the level of the natural environmental radiation)
- in corrosive environments
- in an environment that leads to unacceptable soiling of the safety component

NOTICE

Electromagnetic compatibility

The safety components comply with the current standards on electromagnetic compatibility with regard to spurious radiation and immunity to interference in particular.

However, in cases where devices such as mobile phones, radio equipment, transmitters or high-frequency systems that exceed the interference emissions limits specified in the standards are operated near safety components, the function of the safety components may be impaired.

3.1.2 Safety Instructions

Before installing and commissioning the safety components please read the Safety Instructions in this documentation.

⚠WARNING

Commissioning Test

Before the AKT2G-SDI-004-000/AKT2G-SDO-004-000 can be used for the safety task, the user must carry out a commissioning test so that sensor and actuator wiring errors can be ruled out.

3.1.3 Transport / Storage

Use the original packaging in which the components were delivered for transporting and storing the safety components.

⚠CAUTION

Note the specified environmental conditions

Please ensure that the digital safety components are only transported and stored under the specified environmental conditions (see technical data).

3.1.4 Mechanical Installation

DANGER

Risk of injury!

Bring the bus system into a safe, de-energized state before starting installation, disassembly or wiring of the devices!

CAUTION

Use ferrules with plastic collars

When using fine-wire cables for signal connections, use ferrules with plastic collars. This leads to a higher system availability when test pulses for the corresponding channels are switched off.

3.1.4.1 Control cabinet / terminal box

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

3.1.4.2 Installation position and minimum distances

For the prescribed installation position the mounting rail is installed horizontally and the mating surfaces of the terminals point toward the front (see illustration below). The terminals are ventilated from below, which enables optimum cooling of the electronics through convection. The direction indication “down” corresponds to the direction of positive acceleration due to gravity.

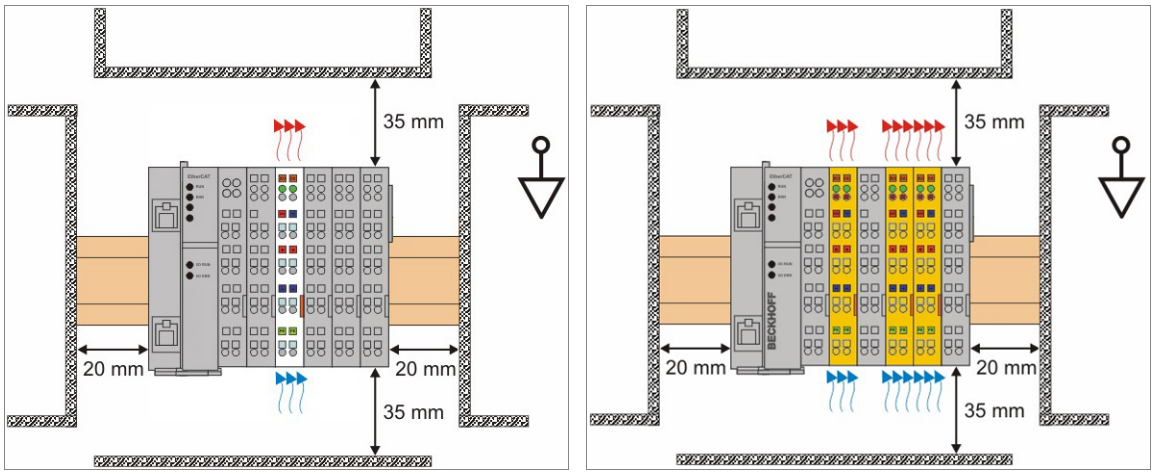


Figure 4-1: Installation position and minimum distances

In order to ensure optimum convection cooling, the distances to neighboring devices and to control cabinet walls must not be smaller than those shown in the diagram.

NOTE

External heat sources / radiant heat / impaired convection

The maximum permissible ambient temperature of 55°C was checked with the above example configuration. Impaired convection, an unfavorable location near heat sources or an unfavorable configuration of the EtherCAT Terminals may result in overheating of the terminals.

The key parameter is always the maximum permitted internally measured temperature of 95°C, above which the safety terminals switch to safe state and report an error. The internal temperature can be read from the safety components via CoE.

3.2 Safety Terminal Reaction Times

The safety terminals form a modular safety system that exchanges safety-oriented data via the Safety-over-EtherCAT protocol. This topic is intended to help you determine the system's reaction time from the change of signal at the sensor to the reaction at the actuator.

3.2.1 Typical Reaction Time

The typical reaction time is the time that is required to transmit information from the sensor to the actuator, if the overall system is working without error in normal operation.

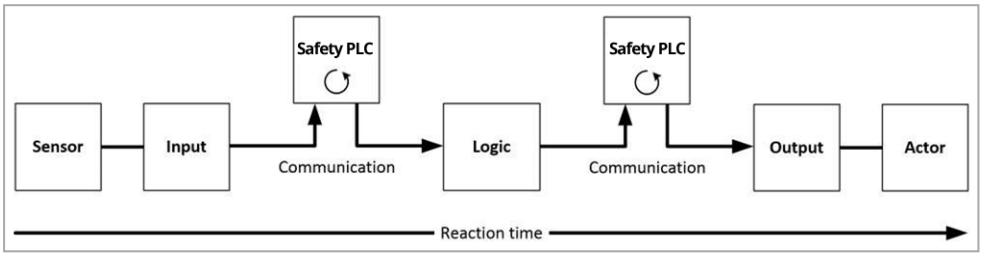


Figure 4-2: Typical reaction time

Definition	Description
RTSensor	Reaction time of the sensor until the signal is provided at the interface. Typically supplied by the sensor manufacturer.
RTInput	Reaction time of the safe input, such as AKT2G-SDI-004. This time can be found in the technical data. In the case of the AKT2G-SDI-004 it is 4 ms.
RTComm	Reaction time of the communication This is typically 3x the EtherCAT cycle time, because new data can only be sent in a new Safety-over-EtherCAT telegram. These times depend directly on the higher-level standard controller (cycle time of the PLC).
RTLogic	Reaction time of the logic terminal. This is the cycle time of the safety PLC, depending on the size of the safety project.
RTOutput	Reaction time of the output terminal. This typically lies within the range of 2 to 3 ms.
RTActor	Reaction time of the actuator. This information is typically supplied by the actuator manufacturer
WDComm	Watchdog time of the communication

This results in the following equation for the typical reaction time:

$$ReactionTime_{typ} = RT_{Sensor} + RT_{Input} + 3 * RT_{Comm} + RT_{Logic} + 3 * RT_{Comm} + RT_{output} + RT_{Actor}$$

with, for example

$$ReactionTime_{typ} = 5ms + 4ms + 3 * 1ms + 10ms + 3 * 1ms + 3ms + 20ms = 48ms$$

3.2.2 Worst-Case Reaction Time

The worst case reaction time is the maximum time required to switch off the actuator in the case of an error.

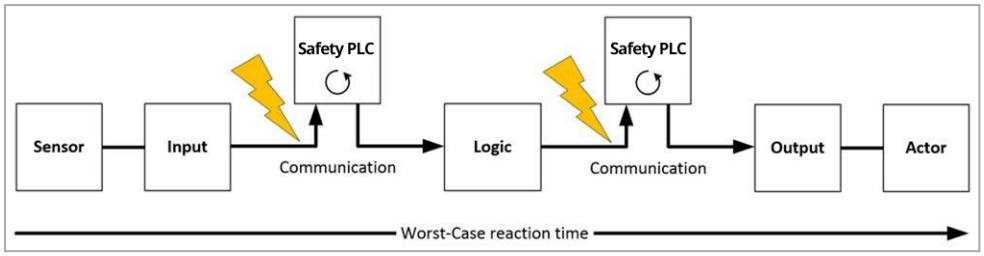


Figure 4-3: Worst-case reaction time

This assumes that a signal change occurs at the sensor and is transmitted to the input. A communication error occurs at precisely the moment when the signal is to be transferred to the communication interface. This is detected by the logic following the watchdog time of the communication link. This information should then be transferred to the output, but a further communication error occurs here. This error is detected at the output following the expiry of the watchdog time and leads to the switch-off.

This results in the following equation for the worst-case reaction:

$$ReactionTime_{max} = WD_{Comm} + WD_{Comm} + RT_{Actor}$$

with, for example

$$ReactionTime_{max} = 2 * 15ms + 20ms = 50ms$$

3.3 Safety I/O Maintenance

Maintenance

The safety components are maintenance-free!

Environmental conditions

⚠WARNING

Observe the specified environmental conditions!

Please ensure that the safety components are only stored and operated under the specified conditions (see technical data).

If the safety component is operated outside the permitted temperature range it will switch to **Global Shutdown** state.

Cleaning

Protect the safety component from unacceptable soling during operation and storage!

If the safety component was subjected to unacceptable soiling it may no longer be operated!

⚠WARNING

Have soiled terminals checked!

Cleaning of the safety component by the user is not permitted!

Please send soiled terminals to the manufacturer for inspection and cleaning!

4 Remote Input/Output Terminals

KAS remote I/Os provide a complete spectrum of bus couplers, digital and analog inputs, digital and analog outputs, stepper, counter, and thermocouple modules.

Related Documents

Please find in the table below the list of each I/O component available.

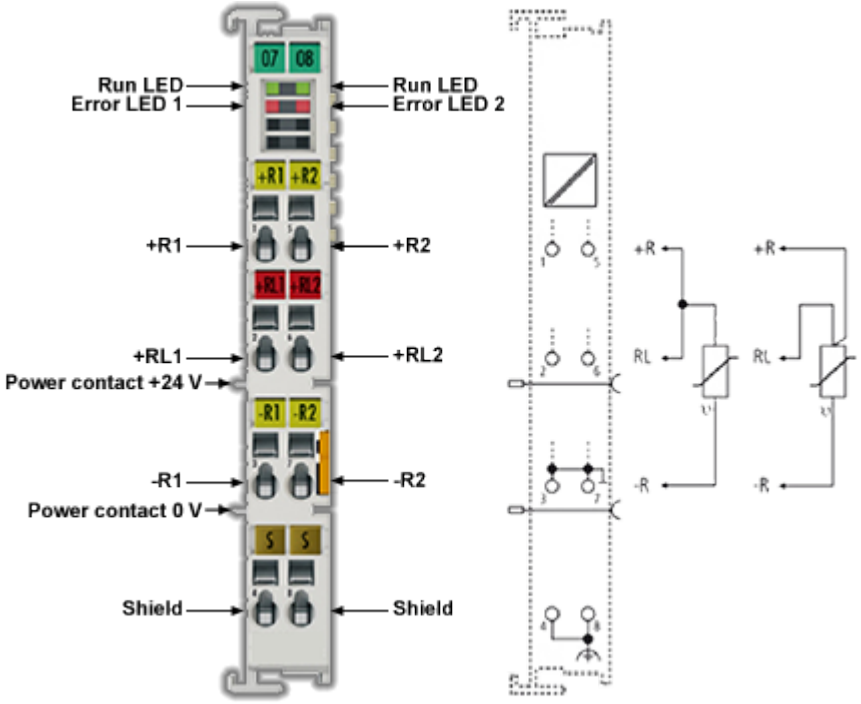
AKT2G (EtherCAT) Terminals

I/O Terminal Part Number	I/O Terminal Description
AKT2G-AN-240-000	2-channel input terminal PT100 (RTD) for resistance sensors, 16 bit, 2-, 3-wire system
AKT2G-AN-400-000	4-channel thermocouple input terminal, preset to type K, with wire breakage detection, 16 bit
AKT2G-AN-430-000	4-channel analog input, parameterisable, -10/0...+10 V, -20/0/+4...+20 mA, 16 bit
AKT2G-AT-410-000	4-channel analog output terminal 0...10 V, 12 bit, 1-wire system
AKT2G-AT-425-000	4-channel analog output terminal -10 V...+10 V, 12 bit, 4 x 2-wire system
AKT2G-DN-002-000	Up/down counter 24 V DC, 100 kHz, 32 bit counter depth
AKT2G-DN-008-000	8-channel digital input terminal 24 V DC, filter 3.0 ms, 1-wire system
AKT2G-DNH-008-000	8-channel digital input terminal 24 V DC, filter 10 µs, 1-wire system
AKT2G-DT-008-000	8-channel digital output terminal 24 V DC, 0.5 A, 1-wire system
AKT2G-ECT-000-000	EtherCAT Coupler for E-bus terminals
AKT2G-EM-000-000	Bus end cover for E-bus terminals, cover for power and E-bus contacts, grey
AKT2G-ENC-180-000	1-channel incremental encoder interface, 32 bit
AKT2G-ENC-190-000	Incremental encoder interface with differential input, 16/32 bit
AKT2G-PSF-024-000	Power supply terminal with fuse, 24 V DC
AKT2G-SDI-004-000	4-channel digital input terminal, Safety, 24 V DC
AKT2G-SDO-004-000	4-channel digital output terminal, Safety, 24 V DC, 0.5 A

Table 5-1: List of KAS I/O Terminals

4.1 AKT2G-AN-240-000

2-channel input terminal PT100 (RTD) for resistance sensors, 16 bit, 2-, 3-wire system

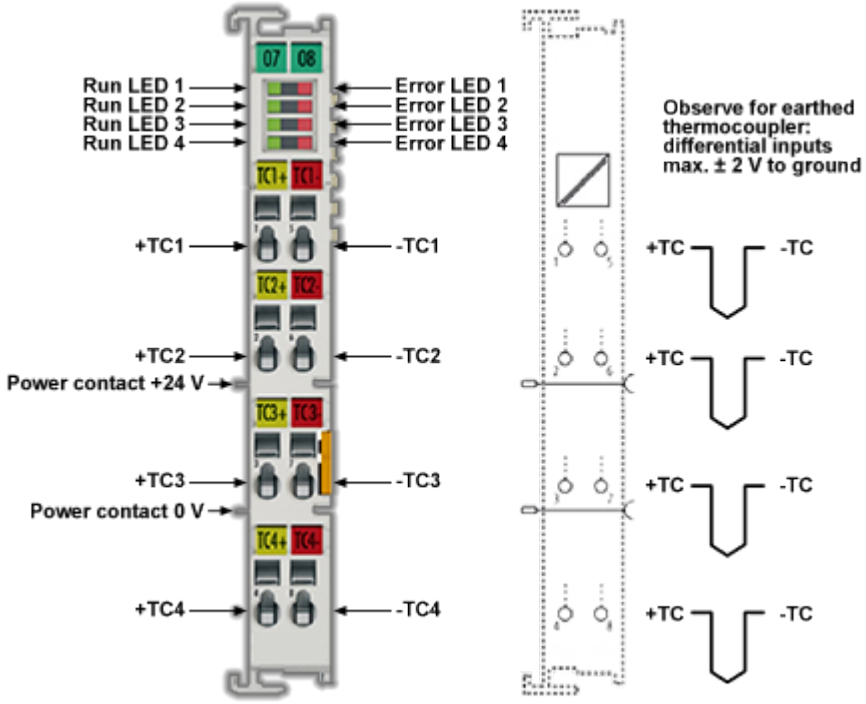


Technical Data	AKT2G-AN-240-000
Number of inputs	2
Sensor types	Pt100, Pt200, Pt500, Pt1000, Ni100, Ni120, Ni1000 KT/KTY from firmware 06 Resistance measurement 10 Ω to 1 kΩ or 10 Ω to 4 kΩ (e.g. for potentiometer connection)
Connection method	2-, 3-wire (Preset: 3-wire)
Temperature range	Range-dependent: -200…+850°C (Pt sensors); -60…+250°C (Ni sensors)
Resolution (default)	0.1°C per digit
Conversion time	approx. 800 ms - 2 ms (configurable), depending on configuration and filter setting approx. 85 ms, preset
Measuring current (depending on the sensor element and temperature)	typ. < 0.5 mA
Measuring error	for Pt sensors: < ±0.5 °C at ambient temperature 0°C ... +55°C < ±1.5 °C in the extended temperature range
Width in the process image	max. 8-byte input
Power supply for electronics	via the E-Bus
Current consumption from the Ebus	typ. 190 mA
Electrical isolation	500 V (E-bus/field voltage)
Weight	approx. 60 g

Technical Data	AKT2G-AN-240-000
Permissible ambient temperature range during operation	-25°C to +60°C (extended temperature range)
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (connected width: 12 mm)
Installation	on 35 mm mounting rail according to EN 60715
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, see also Installation instructions for enhanced mechanical load capacity.
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE ATEX cULus

4.2 AKT2G-AN-400-000

4-channel thermocouple input terminal, preset to type K, with wire breakage detection, 16 bit

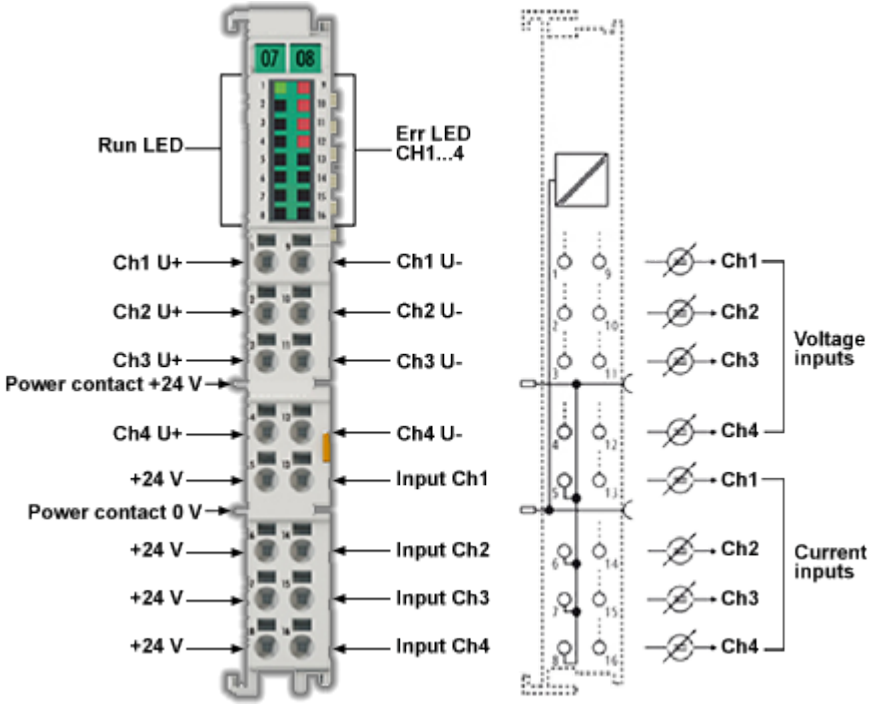


Technical Data	AKT2G-AN-400-000
Number of inputs	4
Thermocouple sensor types	Types J, K, L, B, E, N, R, S, T, U, C (default setting type K), mV measurement
Input filter limit frequency	1 kHz typ.; depending on sensor length, conversion time, sensor type
Connection technology	2-wire
Maximum cable length to the thermocouple	30 m
Measuring range, FSV	in the range defined in each case for the sensor (default setting: type K; -200 … +1370°C) Voltage: ± 30 mV (1 µV resolution) up to ± 75 mV (4 µV resolution)
Resolution	Internal: 16 bit Temperature representation: 0.1/0.01 °C per digit, default 0.1°C Note: 16 bit is used for FSV calculation; so, value leaps >0.01°C will occur at resolution 0.01°C depending of which thermocouple is set; e.g. type K: approx. 0.04°C
Supports NoCoeStorage function	yes, from firmware 01
Wiring fail indication	yes
Conversion time	approx. 2.5 s to 20 ms, depending on configuration and fil ter setting, default: approx. 250 ms

Technical Data	AKT2G-AN-400-000
Measuring error	< ±0.3 % (relative to full scale value)
Voltage supply for electronics	via the E-bus
Distributed Clocks	-
Current consumption via E-bus	typ. 200 mA
Bit width in the process data image	max. 16 byte input, max. 8 byte output
Max. potential ±TC against ground	2 V, important e.g. when operating with grounded thermocouples
Max. differential voltage between the ±TC inputs	±15 V permanent
Electrical isolation	500 V (E-bus/field voltage)
Configuration	via TwinCAT System Manager
Weight	approx. 60 g
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range), from firmware 06
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, see also installation instructions for terminals with increased mechanical load capacity
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE, ATEX, cULus, IECEx

4.3 AKT2G-AN-430-000

4-channel analog input, parameterisable, -10/0...+10 V, -20/0/+4...+20 mA, 16 bit



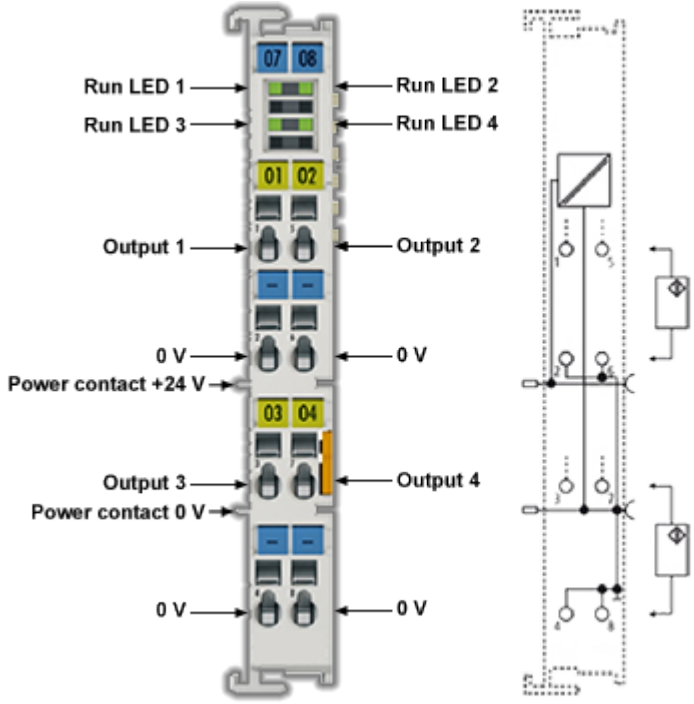
Technical Data		AKT2G-AN-430-000
Analog inputs		4 (U differential, I single-ended)
Conversion type		simultaneous
ADC type		SAR
Signal voltage		-10/0…+10 V
Signal current		-20/0/+4…+20 mA
Measuring range, nominal (Full Scale Value)	Voltage measurement range	-10/0…+10 V
	Current measurement range	-20/0/+4…+20 mA
Measuring range, technical	Voltage measurement range	-10.73…+10.73 V
	Current measurement range	-21.47…+21.47 mA
Measuring error (full measuring range)		< ±0.3 % (relative to full scale value)
Distributed Clocks		yes

Technical Data		AKT2G-AN-430-000
Distributed Clocks precision		<< 1 µs
Support NoCoeStorage		yes
Resolution		16 bit (incl. sign)
Internal resistance		Voltage measurement: > 200 kΩ | Current measurement: 85 Ω typ.
Input filter limit frequency		5 kHz
Common-mode voltage UCM		35 V max. (voltage measurement)
Minimal EtherCAT cycle time		200 µs
Overcurrent protection		50 mA typ.
Bit width of the process image		Inputs: 16 Byte
Configuration		no address or configuration settings required
MTBF (+55°C)		-
Special features		U/I parameterisable, Extended Range, standard and compact process image, activatable FIR/IIR filters
Supply voltage for electronic		via the E-bus
Current consumption via E-bus		typ. 170 mA
Electrical isolation		500 V (E bus/ fieldbus voltage)
Recommended operating voltage range (ground related to GND/ 0V power contact)	Voltage measurement range	UCM 35 V max.
	Current measurement range	single ended, dielectric strength max. 30 V
Recommended signal range	Voltage measurement range	Extended Range (107%), differential
	Current measurement range	Extended Range (107%), single ended
Destruction limit (ground related to GND/ 0V power contact)	Voltage measurement range	50 V
	Current measurement range	30 V

Technical Data		AKT2G-AN-430-000
Destruction limit (differential)	Voltage measurement range	50 V
	Current measurement range	n.a.
Weight		approx. 65 g
Permissible ambient temperature range during operation		-25…+60 °C
Permissible ambient temperature range during storage		-40…+85 °C
Permissible relative humidity		95 %, no condensation
Design		HD (High Density) housing with signal LED
Dimensions (W x H x D)		approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting		on 35 mm mounting rail conforms to EN 60715
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
Protection class		IP20
Installation position		variable
Approval		CE, cULus

4.4 AKT2G-AT-410-000

4-channel analog output terminal 0...10 V, 12 bit, 1-wire system

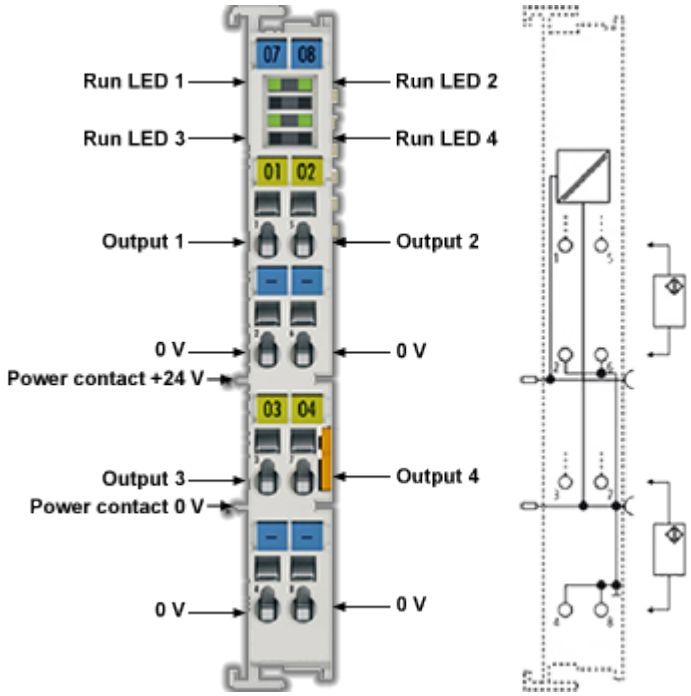


Technical Data	AKT2G-AT-410-000
Number of outputs	4
Power supply	24 V DC via the power contacts
Signal voltage	0..10 V
Load	> 5 kΩ (short-circuit-proof)
Measuring error	< ± 0.1% (at 0 °C ... +55 °C, relative to the full scale value) < ± 0.2% (when the extended temperature range is used)
Resolution	12 bit
Conversion time	~ 250 µs
Power supply for electronics	via the E-bus
Distributed Clocks	yes
Current consumption via Ebus	typ. 140 mA
Electrical isolation	500 V (E-bus/field voltage)
Bit width in process image	4 x 16-bit AO output
Configuration	via TwinCAT System Manager
Weight	approx. 60 g
Permissible ambient temperature range during operation	-25 °C ... +60 °C (extended temperature range)

Technical Data	AKT2G-AT-410-000
Permissible ambient temperature range during storage	-40 °C ... +85 °C
Permissible relative humid- ity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, see also installation instructions for enhanced mechanical load capacity
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE, ATEX, cULus

4.5 AKT2G-AT-425-000

4-channel analog output terminal -10 V...+10 V, 12 bit, 4 x 2-wire system

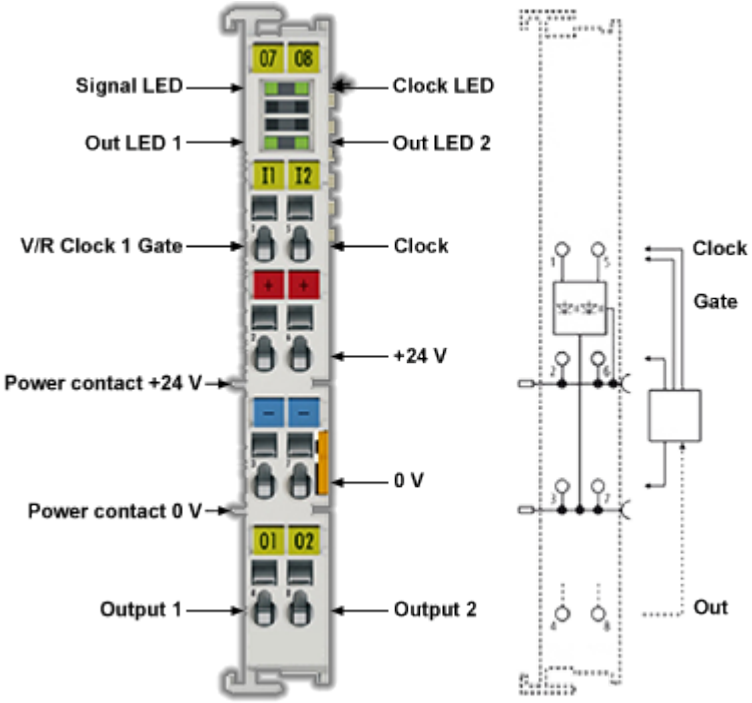


Technical Data	AKT2G-AT-425-000
Number of outputs	4
Power supply	24 V DC via the power contacts
Signal voltage	-10 ..+10 V
Load	> 5 kΩ (short-circuit-proof)
Measuring error	< ± 0.1% (at 0 °C ... +55 °C, relative to the full scale value) < ± 0.2% (when the extended temperature range is used)
Resolution	12 bit
Conversion time	~ 250 µs
Power supply for electronics	via the E-bus
Distributed Clocks	yes
Current consumption via Ebus	typ. 140 mA
Electrical isolation	500 V (E-bus/field voltage)
Bit width in process image	4 x 16-bit AO output
Configuration	via TwinCAT System Manager
Weight	approx. 60 g
Permissible ambient temperature range during operation	-25 °C ... +60 °C (extended temperature range)

Technical Data	AKT2G-AT-425-000
Permissible ambient temperature range during storage	-40 °C ... +85 °C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, see also installation instructions for enhanced mechanical load capacity
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE, ATEX, cULus

4.6 AKT2G-DN-002-000

4.6.1 Up/down counter 24 V_{DC}, 100 kHz, 32 bit counter depth



The up/down counter counts binary pulses, and transmits the counter state, in an electrically isolated form, to the higher-level automation device.

The AKT2G-DN-002 EtherCAT Terminal can alternatively be operated as:

- a single-channel counter (32 bit) that can be toggled between counting up and down via the U/D input (delivery state)
- a single-channel counter (32 bit) that is controlled via the gate connection
- two separate logic counters (32 bit) that can count in one direction only with the Clock 1 and Clock 2 inputs

The signal state of the inputs and outputs is indicated by light emitting diodes.

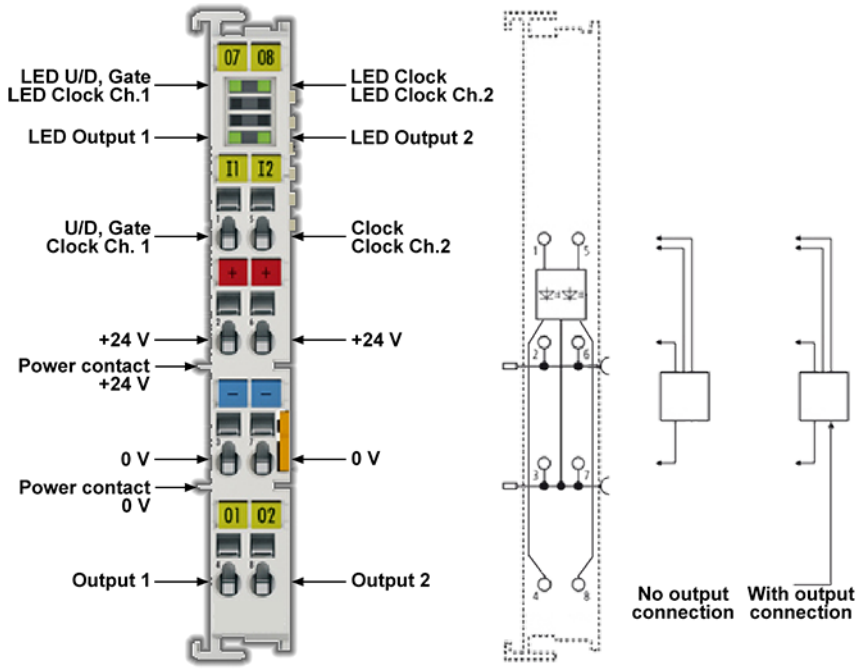
The two outputs (Output 1 and Output 2) are switched in relation to the counter value and can thus be used as fast control signals for field devices.

The AKT2G-DN-002 supports distributed clocks, i.e. the input data can be monitored synchronously with other data that are also linked to distributed clock terminals. The accuracy across the system is < 100 ns.

4.6.2 Technical Data

Technical Data	AKT2G-DN-002-000
Number of counters	1 or 2
Rated voltage	24 VDC (-15%/+20%)
Signal voltage “0”	-3 V ... 5 V (EN 61131-2, type 1)
Signal voltage “1”	15 V ... 30 V (EN 61131-2, type 1)
Counting frequency	100 kHz
Counter depth	32 bit
Input current	typ. 5 mA (EN 61131-2, type 1)
Output current (per channel)	max. 0.5 A (short-circuit-proof)
Distributed Clocks (DC)	yes
Current consumption power contacts	typ. 14 mA + load
Current consumption via E-bus	typ. 130 mA
Electrical isolation	500 V (E-bus/field voltage)
Supports NoCoeStorage function	yes
Weight	approx. 50 g
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, see also Installation instructions for enhanced mechanical load capacity
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE ATEX, cULus

4.6.3 LEDs and Connection



LEDs

LED	Color	Meaning
UP/DOWN, GATE CLOCK CH.1	green	Signal at U/D, Gate input (operating mode 32 bit up/down counter, 32 bit gated counter) Signal at the Clock input, channel 1 (operating mode 2 x 32 bit counter) see "Operating Mode Selection" on page 35
CLOCK CLOCK CH.2	green	Signal at Clock input (operating mode 32 bit up/down counter, 32 bit gated counter) Signal at the Clock input, channel 2 (operating mode 2 x 32 bit counter see "Operating Mode Selection" on page 35
OUTPUT1 OUTPUT2	green	Signal at the corresponding output

Connection

Terminal Point		Description
Name	No.	
U/D, Gate Clock Ch.1	1	Up/down input (operating mode 32 bit up/down counter), Gate input (operating mode 32 bit counter with gate function) Clock 1 input (operating mode 2 x 32 bit counter) see "Operating Mode Selection" on page 35
+24 V	2	+24 V (internally connected to terminal point 6 and positive power contact)
0 V	3	0 V (internally connected to terminal point 7 and negative power contact)

Terminal Point		Description
Name	No.	
Output 1	4	Output 1
Clock Clock Ch.2	5	Clock input (operating mode 32 bit up/down counter) and (operating mode 32 bit counter with gate function) Clock 2 input (operating mode 2 x 32 bit counter) see "Operating Mode Selection" on page 35
+24 V	6	+24 V (internally connected to terminal point 2 and positive power contact)
0 V	7	0 V (internally connected to terminal point 3 and negative power contact)
Output 2	8	Output 2

4.6.4 Basic Function Principles

The AKT2G-DN-002 input terminals count binary pulses and transfer the current value to the higher-level controller.

In addition to the 32 bit up/down counter, further available operating modes are a 32 bit gated counter or two 32 bit counters. In gated counter mode, a low or high level at the Gate input inhibits the counting function of the terminal.

If two 32 bit counters are active, the U/D input (terminal point 1) is configured as the input for the first counter and the Clock 2 input (terminal point 5) as the input for the second counter.

Beyond that, two digital outputs can be set.

The maximum input frequency is limited to 100 kHz for the AKT2G-DN-002; the counters react to the rising edge of the input signal.

4.6.5 Operating Mode Selection

The following operation modes are possible.

Operation mode	Predefined PDO Assignment	Setting of the counting direction via CoE directory	Switchable outputs

1 (default)	**1Ch. +/- Counter:**
	0x1A02 – CNT Inputs
	+
	0x1602 – CNT Outputs
		Index 0x8020:05:
		0: Enable UD counter
		• UD input (terminal point 1): sets the counting direction:
		  • High level: up;
		  • Low level: Down
		• Clock input (terminal point 5): indicates the individual pulses.
			Output 1

Operation mode	Predefined PDO Assignment	Setting of the counting direction via CoE directory	Switchable outputs
2	**1Ch. +/- Counter:** 0x1A02 – CNT Inputs + 0x1602 – CNT Outputs	**Index 0x8020:05:** 1: Enable pos. gate • Gate is inhibited by a positive level on the gate input (terminal point 1) • Clock input (terminal point 5): indicates the individual pulses. + **Index 0x8020:04:** 0: up counter 1: down counter	Output 1
3	**1Ch. +/- Counter:** 0x1A02 – CNT Inputs + 0x1602 – CNT Outputs	**Index 0x8020:05:** 2: Enable neg. gate • Gate is inhibited by a negative level on the gate input (terminal point 1) • Clock input (terminal point 5): indicates the individual pulses. + **Index 0x8020:04:** 0: up counter 1: down counter	Output 1
4	**2Ch. Counter:** 0x1A00 – CNT Inputs Channel 1 0x1A01 – CNT Inputs Channel 2 + 0x1600 – CNT Outputs Channel 1 0x1601 – CNT Outputs Channel 2	**Index 0x8000:04 (Channel1) and Index 0x8010:04 (Channel2)** 0:up counter 1:down counter	Counter 1 → Output 1 Counter 2 → Output 2

In addition, the distributed clock function may be activated for the AKT2G-DN-002.

Single-channel up/down counter, gated counter (operating mode 1-3)

1. Selection of the PDOs for "1Ch.+/-Counter"
2. CoE Init-command to configure index 0x8020:05:
   - "Enable UD counter" – single-channel up/down counter (operating mode 1)
     If a high signal level is encountered at the up/down input of the terminal (terminal point 1), the counter counts up in the event of positive edges at the clock input (terminal point 5), with a low signal level it counts down.
   - "Enable pos. gate" – single-channel gated counter closes in the case of a high level (operating mode 2)
     The counter is inhibited if a high level is encountered at the gate input of the terminal (terminal point 1).

The counting direction is set by index 0x8020:04 (0: up, 1: down). The clock input (terminal point 5) indicates the individual pulses.

- "Enable neg. gate" – single-channel gated counter closes in the case of a low level (operating mode 3)
  The counter is inhibited if a low level is encountered at the gate input of the terminal (terminal point 1).The counting direction is set by index 0x8020:04 (0: up, 1: down). The clock input (terminal point 5) indicates the individual pulses.

Two-channel up/down counter (operating mode 4)

1. Selection of the PDOs for "2Ch. Counter"
   The terminal points 1 or 5 serve as clock input for 32 bit counter 1 or 2.
2. CoE Init-commands to configure the indices 0x8000:04 for channel 1 and 0x8010:04 for channel. Two options are available per channel:
   - 0: up counter
   - 1: down counter

4.6.6 Objects for Commissioning

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore default parameters	UINT8	RO	0x01 (1dec)
1011:01	SubIndex 001	If this object is set to “0x64616F6C” in the set value dialog, all backup objects are reset to their delivery state.	UINT32	RW	0x00000000 (0dec)

Index 8000 CNT Settings Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
8000:0	CNT Settings Ch.1	Maximum subindex	UINT8	RO	0x13 (19dec)
8000:01	Enable function to set output	Activates the function for setting Output 1	BOOLEAN	RW	0x00 (0dec)
8000:02	Enable function to reset output	Activates the function for resetting Output 1	BOOLEAN	RW	0x00 (0dec)
8000:03	Enable reload	The counter counts to the value in index 0x8000:13	BOOLEAN	RW	0x00 (0dec)
8000:04	Count down	Counting direction: • 0: Up • 1: Down	BOOLEAN	RW	0x00 (0dec)
8000:11	Switch on threshold value	Switch-on threshold value for Output 1	UINT32	RW	0x00000000 (0dec)
8000:12	Switch off threshold value	Switch-off threshold value for Output 1	UINT32	RW	0x00000000 (0dec)
8000:13	Counter reload value	The limit that can be activated via "Enable reload" (index 0x8000:03). The counter counts to this limit and, on exceeding it, begins again at zero.	UINT32	RW	0x00000001 (1dec)

Index 8010 CNT Settings Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:0	CNT Settings Ch.2	Maximum subindex	UINT8	RO	0x13 (19dec)
8010:01	Enable function to set output	Activates the function for setting Output 2	BOOLEAN	RW	0x00 (0dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:02	Enable function to reset output	Activates the function for resetting Output 2	BOOLEAN	RW	0x00 (0dec)
8010:03	Enable reload	The counter counts to the value in index 0x8010:13	BOOLEAN	RW	0x00 (0dec)
8010:04	Count down	Counting direction • 0: Up • 1: Down	BOOLEAN	RW	0x00 (0dec)
8010:11	Switch on threshold value	Switch-on threshold value for Output 2	UINT32	RW	0x00000000 (0dec)
8010:12	Switch off threshold value	Switch-off threshold value for Output 2	UINT32	RW	0x00000000 (0dec)
8010:13	Counter reload value	The limit that can be activated via "Enable reload" (index 0x8010:03). The counter counts to this limit and, on exceeding it, begins again at zero.	UINT32	RW	0x00000001 (1dec)

Index 8020 CNT Settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8020:0	CNT Settings	Maximum subindex	UINT8	RO	0x13 (19dec)
8020:01	Enable function to set output	Activates the function for setting Output 1	BOOLEAN	RW	0x00 (0dec)
8020:02	Enable function to reset output	Activates the function for resetting Output 1	BOOLEAN	RW	0x00 (0dec)
8020:03	Enable reload	The counter counts to the value in index 0x8020:13	BOOLEAN	RW	0x00 (0dec)
8020:04	Count down	Counting direction • 0: Up • 1: Down	BOOLEAN	RW	0x00 (0dec)
8020:05	Operating mode	Operating mode • 0: Enable UD counter U/D input (terminal point 1) specifies the counting direction: High level: up, low level: down • 1: Enable pos. gate (gate inhibits with positive level) • 2: Enable neg. gate (gate inhibits with negative level)	BIT2	RW	0x00 (0dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
8020:11	Switch on threshold value	Switch-on threshold value for Output 1	UINT32	RW	0x00000000 (0dec)
8020:12	Switch off threshold value	Switch-off threshold value for Output 1	UINT32	RW	0x00000000 (0dec)
8020:13	Counter reload value	The limit that can be activated via "Enable reload" (index 0x8020:03). The counter counts to this limit and, on exceeding it, begins again at zero.	UINT32	RW	0x00000001 (1dec)

4.6.7 Profile-specific objects (0x6000-0xFFFF)

The profile-specific objects have the same meaning for all EtherCAT slaves that support the profile 5001.

Index 6000 CNT Inputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
6000:0	CNT Inputs Ch.1	Maximum subindex	UINT8	RO	0x11 (17dec)
6000:01	Output functions enabled	This bit indicates that the internal functions for the output have been enabled	BOOLEAN	RO	0x00 (0dec)
6000:02	Status of output	Status of the output	BOOLEAN	RO	0x00 (0dec)
6000:03	Set counter done	The counter was set	BOOLEAN	RO	0x00 (0dec)
6000:04	Counter inhibited	The counter is stopped for as long as this bit is set	BOOLEAN	RO	0x00 (0dec)
6000:06	Status of input clock	State of the Clock input (high level applied)	BOOLEAN	RO	0x00 (0dec)
6000:0E	Sync Error	Synchronization error	BOOLEAN	RO	0x00 (0dec)
6000:10	TxPDO Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated	BOOLEAN	RO	0x00 (0dec)
6000:11	Counter value	Counter value	UINT32	RO	0x00000000 (0dec)

Index 6010 CNT Inputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
6010:0	CNT Inputs Ch.2	Maximum subindex	UINT8	RO	0x11 (17dec)
6010:01	Output functions enabled	This bit indicates that the internal functions for the output have been enabled	BOOLEAN	RO	0x00 (0dec)
6010:02	Status of output	Status of the output	BOOLEAN	RO	0x00 (0dec)
6010:03	Set counter done	The counter was set	BOOLEAN	RO	0x00 (0dec)
6010:04	Counter inhibited	The counter is stopped for as long as this bit is set	BOOLEAN	RO	0x00 (0dec)
6010:06	Status of input clock	State of the Clock input (high level applied)	BOOLEAN	RO	0x00 (0dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
6010:0E	Sync Error	Synchronization error	BOOLEAN	RO	0x00 (0dec)
6010:10	TxPDO Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated	BOOLEAN	RO	0x00 (0dec)
6010:11	Counter value	Counter value	UINT32	RO	0x00000000 (0dec)

Index 6020 CNT Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6020:0	CNT Inputs	Maximum subindex	UINT8	RO	0x11 (17dec)
6020:01	Output functions enabled	This bit indicates that the internal functions for the output have been enabled	BOOLEAN	RO	0x00 (0dec)
6020:02	Status of output	Status of the output	BOOLEAN	RO	0x00 (0dec)
6020:03	Set counter done	The counter was set.	BOOLEAN	RO	0x00 (0dec)
6020:04	Counter inhibited	The counter is stopped for as long as this bit is set	BOOLEAN	RO	0x00 (0dec)
6020:05	Status of input UD	State of the Up/Down input (high level applied)	BOOLEAN	RO	0x00 (0dec)
6020:06	Status of input clock	State of the Clock input (high level applied)	BOOLEAN	RO	0x00 (0dec)
6020:0E	Sync Error	Synchronization error	BOOLEAN	RO	0x00 (0dec)
6020:10	TxPDO Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated	BOOLEAN	RO	0x00 (0dec)
6020:11	Counter value	Counter value	UINT32	RO	0x00000000 (0dec)

Index 7000 CNT Outputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
7000:0	CNT Outputs Ch.1	Maximum subindex	UINT8	RO	0x11 (17dec)
7000:01	Enable output functions	The internal functions for the output are enabled via this bit	BOOLEAN	RO	0x00 (0dec)
7000:02	Set output	Set output	BOOLEAN	RO	0x00 (0dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
7000:03	Set counter	Set counter	BOOLEAN	RO	0x00 (0dec)
7000:04	Inhibit counter	The counter is stopped as long as this bit is active. The previous counter state is retained.	BOOLEAN	RO	0x00 (0dec)
7000:11	Set counter value	This is the counter value to be set via “Set counter” (index 0x7000:03).	UINT32	RO	0x00000000 (0dec)

Index 7010 CNT Outputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
7010:0	CNT Outputs Ch.2	Maximum subindex	UINT8	RO	0x11 (17dec)
7010:01	Enable output functions	The internal functions for the output are enabled via this bit	BOOLEAN	RO	0x00 (0dec)
7010:02	Set output	Set output	BOOLEAN	RO	0x00 (0dec)
7010:03	Set counter	Set counter	BOOLEAN	RO	0x00 (0dec)
7010:04	Inhibit counter	The counter is stopped as long as this bit is active. The previous counter state is retained.	BOOLEAN	RO	0x00 (0dec)
7010:11	Set counter value	This is the counter value to be set via “Set counter” (index 0x7010:03).	UINT32	RO	0x00000000 (0dec)

Index 7020 CNT Outputs

Index (hex)	Name	Meaning	Data type	Flags	Default
7020:0	CNT Outputs	Maximum subindex	UINT8	RO	0x11 (17dec)
7020:01	Enable output functions	The internal functions for the output are enabled via this bit	BOOLEAN	RO	0x00 (0dec)
7020:02	Set output	Set output	BOOLEAN	RO	0x00 (0dec)
7020:03	Set counter	Set counter	BOOLEAN	RO	0x00 (0dec)
7020:04	Inhibit counter	The counter is stopped as long as this bit is active. The previous counter state is retained.	BOOLEAN	RO	0x00 (0dec)
7020:11	Set counter value	This is the counter value to be set via “Set counter” (index 0x7020:03).	UINT32	RO	0x00000000 (0dec)

Index F000 Modular device profile

Index (hex)	Name	Meaning	Data type	Flags	Default
F000:0	Modular device profile	General information for the modular device profile	UINT8	RO	0x02 (2dec)
F000:01	Module index distance	Index spacing of the objects of the individual channels	UINT16	RO	0x0010 (16dec)
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0003 (3dec)

Index F008 Code word

Index (hex)	Name	Meaning	Data type	Flags	Default
F008:0*	Code word	NoCoeStorage function: The input code of the code word 0x12345678 activates the NoCoeStorage function: Changes to the CoE directory are not saved if the function is active. The function is deactivated by: 1.) changing the code word or 2.) restarting the terminal.	UINT32	RW	0x00000000 (0dec)

* Function NoCoeStorage from Firmware 03

NOTE

Code word

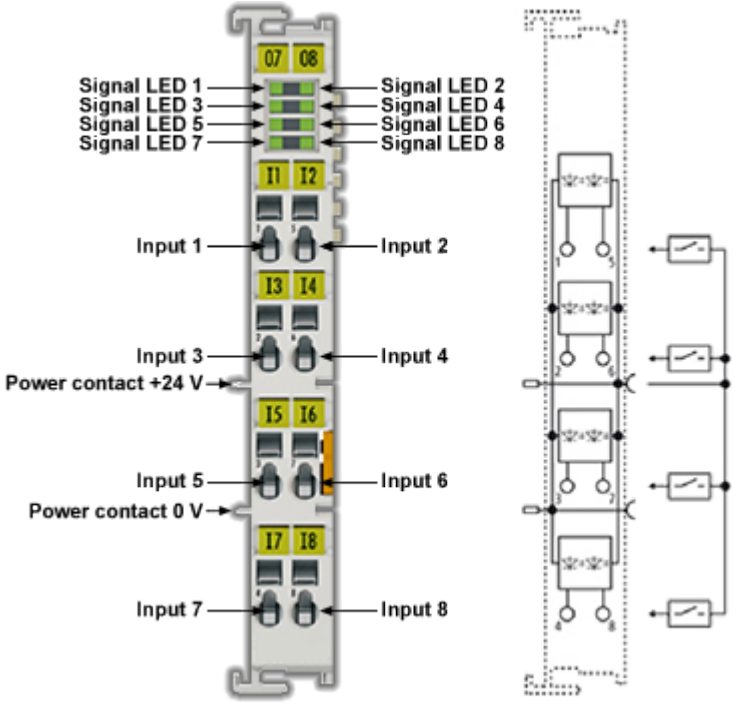
The vendor reserves the authority for the basic calibration of the terminals. The code word is therefore at present reserved.

Index F010 Module list

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:0	Module list	Maximum subindex	UINT8	RO	0x03 (3dec)
F010:01	SubIndex 001	reserved	UINT16	RO	0x0096 (150dec)
F010:02	SubIndex 002	reserved	UINT16	RO	0x0096 (150dec)
F010:03	SubIndex 003	reserved	UINT16	RO	0x0096 (150dec)

4.7 AKT2G-DN-008-000

8-channel digital input terminal 24 V DC, filter 3.0 ms, 1-wire system

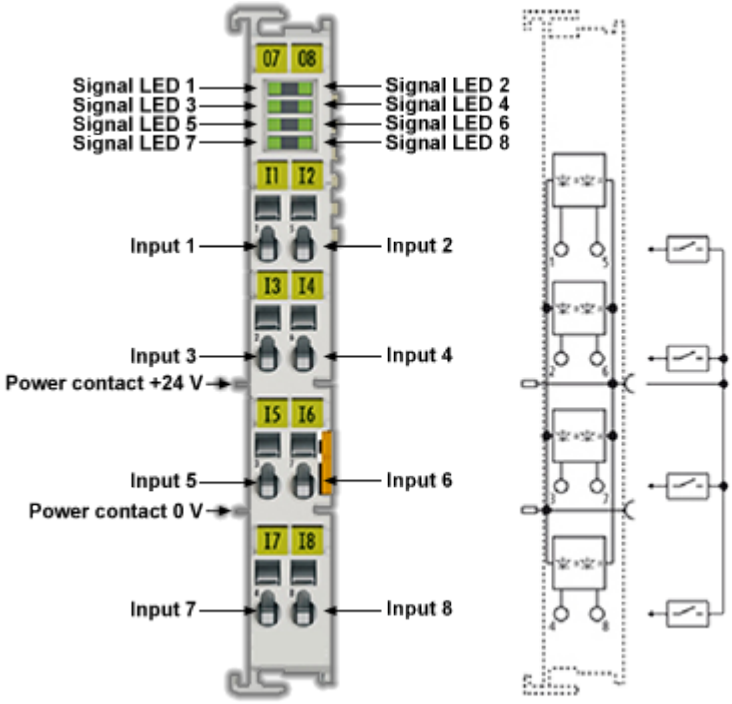


Technical Data	AKT2G-DN-008-000
Number of inputs	8
Number of simultaneously controllable in- puts, depending on the ambient temperature	8 (-25°C ... +55°C) 4 (> +55°C) (aligned in horizontal installation position)
Nominal voltage of the inputs	24 VDC (-15% / +20%)
Signal voltage "0"	-3 V ... 5 V (EN 61131-2, type 1/3)
Signal voltage "1"	11 V ... 30 V (EN 61131-2, type 1/3)
Input filter	3 ms
Input current	typically 3 mA (EN 61131-2, type 1/3)
Current consumption power contacts	typ. 2 mA + load
Current consumption via E-bus	typ. 90 mA
Electrical isolation	500 V (E-bus/field voltage)
Bit width in the process image	8 input bits
Configuration	no address setting, configuration via TwinCAT System Manager
Weight	approx. 55 g
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range, aligned in horizontal installation position) -25°C ... +45°C (all other installation positions)

Technical Data	AKT2G-DN-008-000
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27, see also Installation instructions for terminals with increased mechanical load capacity
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	see note Constraints regarding installation position and operating temperature range
Approval	CE, cULus, ATEX, IECEx

4.8 AKT2G-DNH-008-000

8-channel digital input terminal 24 V DC, filter 10 µs, 1-wire system

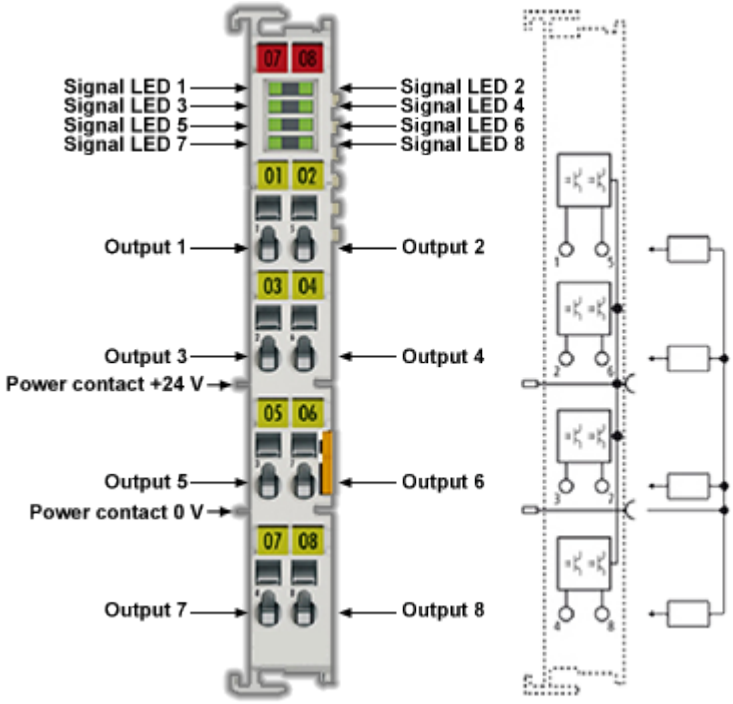


Technical Data	AKT2G-DNH-008-000
Number of imputs	8
Number of simultaneously controllable inputs, depending on the ambient temperature	8 (-25°C ... +55°C) 4 (> +55°C) (aligned in horizontal installation position)
Nominal voltage of the inputs	24 VDC (-15% / +20%)
Signal voltage "0"	-3 V ...5 V (EN 61131-2, type 1/3)
Signal voltage "1"	11 V ... 30 V (EN 61131-2, type 1/3)
Input filter	10 µs typ. (10...50 µs)
Input current	typically 3 mA (EN 61131-2, type 1/3)
Current consumption power contacts	typ. 2 mA + load
Current consumption via E-bus	typ. 90 mA
Electrical isolation	500 V (E-bus/field voltage)
Bit width in the process image	8 input bits
Configuration	no address setting, configuration via TwinCAT System Manager
Weight	approx. 55 g

Technical Data	AKT2G-DNH-008-000
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range, aligned in horizontal installa tion position) -25°C ... +45°C (all other installation positions)
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27, see also Installation instructions for terminals with increased mechanical load capacity
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	see note Constraints regarding installation position and operating temperature range
Approval	CE, cULus, ATEX

4.9 AKT2G-DT-008-000

8-channel digital output terminal 24 V DC, 0.5 A, 1-wire system

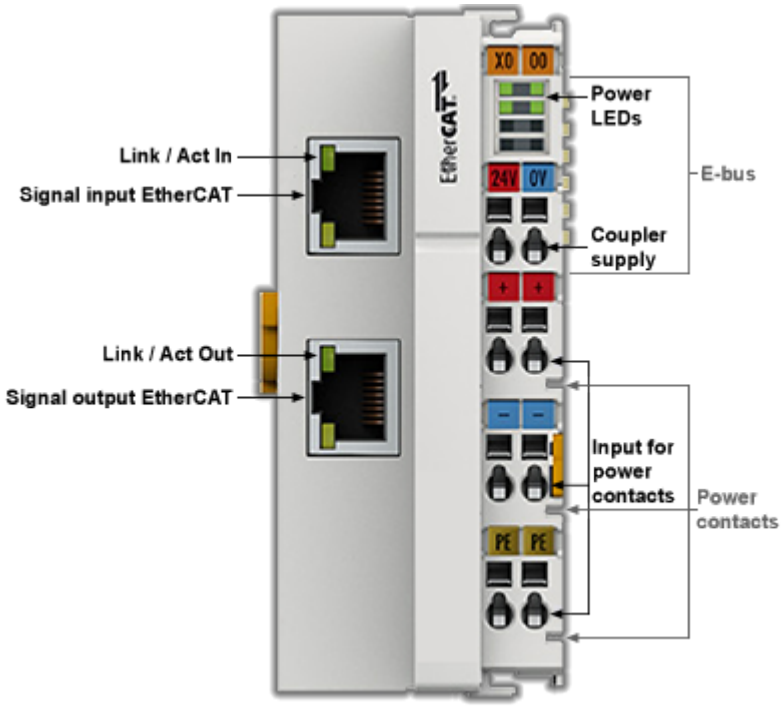


Technical Data	AKT2G-DT-008-000
Number of outputs	8
Non-reactive outputs	yes (see Interference-Free EtherCAT Terminals)
Load type	ohmic, inductive, lamp load
Nominal output voltage	24 VDC (-15% / +20%)
Switching times	TON: 60 µs typ.; TOFF: 300 µs typ.
Output current per channel	maximum 0.5 A (short-circuit proof)
Switch-off energy (inductive)	max. 150 mJ/channel
Current consumption from load voltage (power contacts)	typ. 15 mA
Supply voltage for electronic	via the E-Bus
Current consumption via E-bus	typ. 110 mA
Electrical isolation	500 V (E-bus/field voltage)
Bit width in the process image	8 output bits
Configuration	no address setting, configuration via TwinCAT System Manager
Weight	approx. 55 g

Technical Data	AKT2G-DT-008-000
Permissible ambient temperature range during operation	Aligned in horizontal installation position: -25°C ... +60°C (extended temperature range) All other installation positions: -25°C ... +45°C
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27, see also Installation instructions for terminals with increased mechanical load capacity
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	see note Constraints regarding installation position and operating temperature range
Approval	CE, cULus, ATEX

4.10 AKT2G-ECT-000-000

EtherCAT Coupler for E-bus terminals



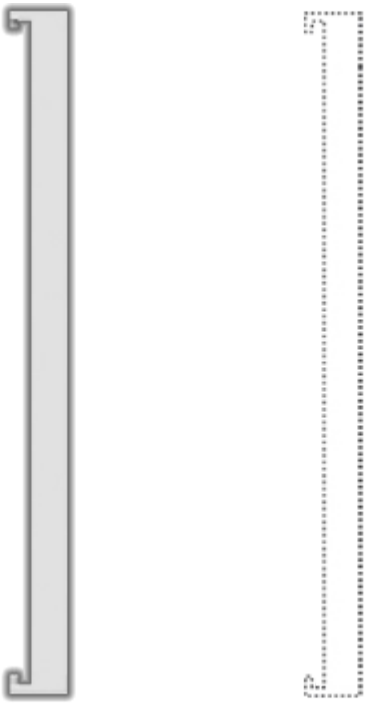
Characteristic	AKT2G-ECT-000-000
Protection class	IP20
Higher level network technology	100 MBit FastEthernet (100BASE-TX)
Higher level network - max. connection length	100 m
Higher level network connection technology	RJ45
higher-level network protocol	EtherCAT Device Protocol
supports HotConnect with address setting on the device	yes, Fast-Hot-Connect

Technical Data	AKT2G-ECT-000-000
Task in the EtherCAT system	Coupling of EtherCAT Terminals (ECT-xxx) to 100BASE-TX EtherCAT networks
Number of EtherCAT Terminals	up to 65535 in the overall system
Number of peripheral signals	max. 4.2 GB addressable IO points
Data transfer medium	Ethernet 100BASE-TX (at least Ethernet CAT5 cable)
Cable length between 2 Bus Couplers	max. 100 m (100BASE-TX)
Protocol / Baud rate	EtherCAT Device Protocol / 100 MBaud
HotConnect	no
Delay	1 µs typ.

Technical Data	AKT2G-ECT-000-000
Bus connection	2 x RJ45
Power supply	24 VDC (-15%/+20%)
Current consumption	70 mA + (∑ E-bus current/4)
E-bus power supply (5 V)	max. 2 A (-25 °C ... +55 °C)
	max. 1 A (> +55 °C)
Power contacts	max. 24 VDC, max. 10 A
Electrical isolation	500 V (power contact/supply voltage/EtherCAT)
Dimensions (W x H x D)	approx. 44 mm x 100 mm x 68 mm
Weight	approx. 105 g
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)
Permissible ambient temperature range during storage	-40°C ... + 85°C
Permissible relative air humidity	95%, no condensation
Mounting	on 35 mm mounting rail according to EN 60715
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, see also Installation instructions] for enhanced mechanical load capacity
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE, ATEX, cULus, IECEx

4.11 AKT2G-EM-000-000

Bus end cover for E-bus terminals, cover for power and E-bus contacts, grey

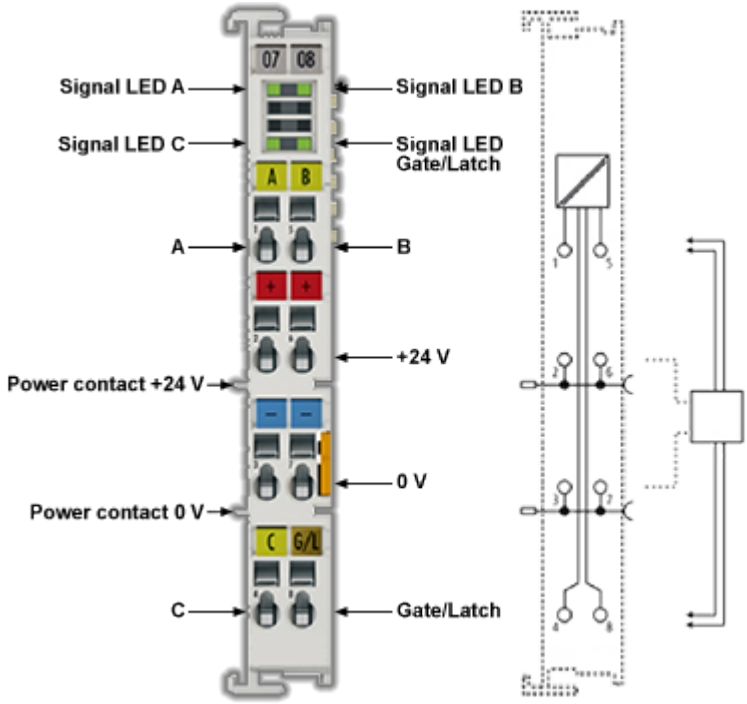


Each EtherCAT terminal block must be terminated at the right hand end with a AKT2G-EM-000-000 bus end cap due to mechanical and electrical protection.

Technical Data	AKT2G-EM-000-000
Electrical isolation	-
Bit width in the process image	0
Configuration	no address or configuration settings
Diagnosis	-
PE contact	no
Renewed infeed	-
Connection facility to additional power contact	-
Side by side mounting on Bus Terminals with power contact	yes
Side by side mounting on Bus Terminals without power contact	yes
Electrical connection to mounting rail	no
Weight	approx. 8 g
Permissible ambient temperature	-25°C ... +60°C (extended temperature range)
Permissible ambient temperature range (during storage)	-40°C ... +85°C
Permissible relative humidity	95%, no condensation

Technical Data	AKT2G-EM-000-000
Dimensions (W x H x D)	approx. 8 mm x 100 mm x 34 mm (width aligned: 5 mm)
Mounting	aligned to the last terminal in the terminal block
Vibration/shock resistance	conforms to EN 60068-2-6/EN 60068-2-27
EMC resistance burst/ESD	conforms to EN 61000-6-2/EN 61000-6-4
Protection class	IP 20
Installation position	variable
Approval	CE, ATEX, cULus

4.12 AKT2G-ENC-180-000



4.12.1 Incremental Encoder Interface AKT2G-ENC-180

The AKT2G-ENC-180 EtherCAT Terminal is an interface with 24 V inputs for the direct connection of incremental encoders. A 32 bit counter with a quadrature decoder and a 32 bit latch for the zero pulse can be read, set or enabled.

The measurement of period and frequency is possible. The gate input allows the locking of the counter, selectively with a high or low level. The latch input is similarly configurable and evaluates high or low levels.

The AKT2G-ENC-180 supports distributed clocks, i.e. the input data can be synchronously acquired with other data that are similarly connected, distributed to distributed clock terminals. The universal system accuracy is around < 100 ns.

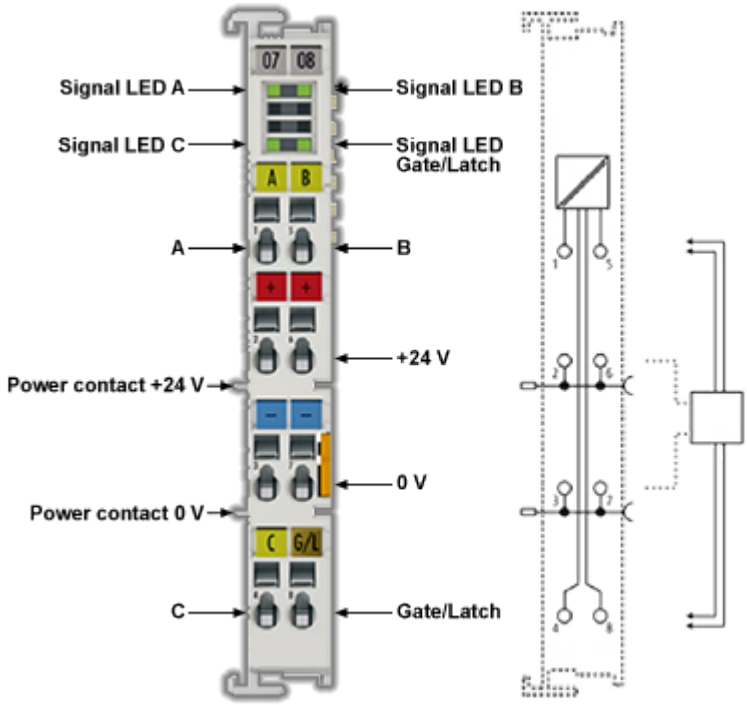
With a moving axis, the micro-increment functionality offers 256 times higher axis position resolution than physically provided by the encoder.

The AKT2G-ENC-180 can also be used as a single-channel 32/16 bit counter on channel A, in which case the signal level on channel B defines the count direction.

4.12.2 AKT2G-ENC-180 Technical Data

Technical Data	AKT2G-ENC-180-000
Sensor inputs	1
Encoder connection	A, B, C, gate/latch input, 24 V
Encoder operating voltage	24 V
Signal voltage "0" (inputs A, B, C, gate/latch)	0 V .. 5 V (EN 61131-2, type 1)
Signal voltage "1" (inputs A, B, C, gate/latch)	15 V .. 30 V (EN 61131-2, type 1)
Counter	1 x 32/16-bit binary, switchable
Limit frequency	max. 400,000 increments/s with 4-fold evaluation), corresponds to 100 kHz
Quadrature decoder	4-fold evaluation
Timestamp resolution	1 ns
Timestamp accuracy	100 ns
Commands	Read, set, latch, gate function
Power supply for electronic	via the E-Bus
Distributed Clocks	yes
Supply voltage	24 V_{DC} (-15 %/+20 %)
Current consumption from the E-bus	typ. 130 mA
Current consumption from the power contacts	0.1 A (excluding sensor load current)
Electrical isolation	500 V (E-bus/field voltage)
Supports NoCoeStorage function	yes
Weight	approx. 50 g
Permissible ambient temperature range during operation	-25 °C ... +60 °C (extended temperature range)
Permissible ambient temperature range during storage	-40 °C ... +85 °C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27, see also Installation instructions for terminals with increased mechanical load capacity
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE, ATEX, cULus

4.12.3 AKT2G-ENC-180-000 LEDs and Pin Assignment



AKT2G-ENC-180-000 LEDs

LED	Color	Meaning
A, B, C	green	flashes when pulses are present at the inputs
Gate, Latch	green	lights up when a signal is present at the gate/latch input

AKT2G-ENC-180-000 Pin Assignment

Terminal Point	No.	Comment
A	1	Encoder input A
+24 V	2	+24 V (internally connected to terminal point 6 and positive power contact)
0 V	3	0 V (internally connected to terminal point 7 and negative power contact)
C	4	Encoder input C
C	5	Encoder input B
+24 V	6	+24 V (internally connected to terminal point 2 and positive power contact)
0 V	7	0 V (internally connected to terminal point 3 and negative power contact)
Gate / Latch 24 V	8	Gate / Latch input

4.12.4 Commissioning AKT2G-ENC-180-000

4.12.4.1 Basic function principles

The terminal acquires the 90° phase-shifted digital output signal of an incremental encoder on channels A and B. The zero pulse is acquired on channel C. These signals are converted into a position value with quadruple evaluation with the aid of the quadrature encoder and the 32-bit counter. The latch and reset functions enable the exact referencing and saving of the counter value, irrespective of the speed.

Incremental encoders divide a 360° rotation of the encoder axis into individual steps (increments) and mark a full revolution by means of a special mark (zero pulse).

The phase angle between the signals on channels A and B sets the counting direction.

Up: signal on channel A leads signal on channel B by 90°

Down: signal on channel A lags signal on channel B by 90°

In case of single evaluation, the positive edges on channel A are counted.

In case of quadruple evaluation, the positive and negative edges on channel A and channel B are counted.

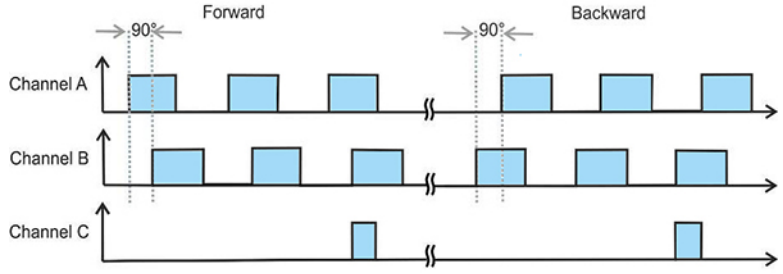


Figure 5-1: Quadrature decoder

Whereas absolute value encoders deliver an absolute and unambiguous position value over the complete travel path directly after switching on, it is necessary with incremental encoders to perform a reference run homing after switching on in order to be able to determine an unambiguous position.

Referencing can be carried out, for example, with the aid of reference cams or using the zero pulse of the encoder.

4.12.4.2 Operating modes and settings

4.12.4.2.1 General

The AKT2G-ENC-180 incremental encoder interface terminal enables connection of incremental encoders with the Bus Coupler or the PLC. A 32-bit counter with quadrature decoder as well as a 32-bit latch can be read, set or activated (switchable to 16-bit). In addition to the encoder inputs A, B and C, a gate/latch input (24 V) is also available on the AKT2G-ENC-180 for latching/saving the counter value. The gate/latch input is parameterizable via the CoE directory. no function, or disabling the counter at HIGH or LOW signal level.

The AKT2G-ENC-180 can also be used as a single-channel 32/16 bit counter on channel A, in which case the signal level on channel B defines the count direction. The changeover to this mode takes place via the CoE directory.

The Counter Value input value represents a 32-bit “position counter”. At the period input the period between two positive edges of channel A is measured with a resolution of 100 ns (default setting, decimal value x 100 ns). Depending on the setting (index 0x8000:14, index 0x8000:16), the period length may be up to 1.6 s or 3.2 s.

4.12.4.2.2 Operating modes

Permissible operating modes for the AKT2G-ENC-180

The following modes are available for the AKT2G-ENC-180. They apply both for the encoder analysis and counter terminal mode.

The combinations of DC, PDO and CoE settings listed below are permissible per mode. Other settings can lead to irregular process data and error messages in the Safety PLC System Manager Logger window.

Mode	DC	Pain PDO	Optional PDO 1	Optional PDO 2	Features CoE
1	FreeRun	Predefined PDO Assignment: Standard 32-bit (MDP 511): 0x1A00 + 0x1600 + 0x1A02			CoE combinations 0x8000:nn
		0x1A00 Inputs: 16 Bit Status, 32 Bit Counter Value, 32 Bit Latch Value + 0x1600 Outputs: 16 Bit Control, 32 Bit Set Counter Value	0x1A02 32 Bit Period or 0x1A03 32 Bit Frequency	--	
2	FreeRun	Predefined PDO Assignment: Standard 16-bit (MDP 511): 0x1A01 + 0x1601 + 0x1A02			CoE combinations 0x8000:nn
		0x1A01 Inputs: 16 Bit Status, 16 Bit Counter Value, 16 Bit Latch Value + 0x1601 Outputs: 16 Bit Control 16 Bit Set Counter Value	0x1A02 32 Bit Period or 0x1A03 32 Bit Frequency	--	
3	DC/DCi	Predefined PDO Assignment: Standard 32 Bit with 64 Bit Timestamp (MDP 511): 0x1A00 + 0x1600 + 0x1A02 + 0x1A04			CoE combinations 0x8000:nn
		0x1A00 Inputs: 16 Bit Status, 32 Bit Counter Value, 32 Bit Latch Value + 0x1600 Outputs: 16 Bit Control, 32 Bit Set Counter Value	0x1A02 32 Bit Period or 0x1A03 32 Bit Frequency	0x1A04 64 Bit Timestamp or 0x1A05 32 Bit Timestamp (compact)	

Mode	DC	Pain PDO	Optional PDO 1	Optional PDO 2	Features CoE
4	DC/DCi	Predefined PDO Assignment: Standard 16 Bit with 32 Bit Timestamp (MDP 511): 0x1A01 + 0x1601 + 0x1A02 + 0x1A05			CoE combinations 0x8000:nn
		0x1A01 Inputs: 16 Bit Status, 16 Bit Counter Value, 16 Bit Latch Value + 0x1601 Outputs: 16 Bit Control, 16 Bit Set Counter Value	0x1A02 32 Bit Period or 0x1A03 32 Bit Frequency	0x1A04 64 Bit Timestamp or 0x1A05 32 Bit Timestamp (compact)	

4.12.4.2.3 Explanatory notes for parameters and modes

4.12.4.2.3.1 Frequency

- The timeframe for the frequency calculation as well as the resolution can be parameterized in the CoE objects Frequency window (index: 0x80n0:11), Frequency scaling (index: 0x80n0:13), Frequency resolution (index: 0x80n0:15) and Frequency wait time (index: 0x80n0:17). • The positive edges of track A are counted in the specified timeframe (see Frequency modes) and the next subsequent edge including the time until it arrives is counted. The waiting time for the edge can be set in the CoE object Frequency Wait Time (index: 0x80n0:17) (unit: ms) and is set as standard to 1.6 seconds. This is also the maximum value.
- The frequency is always specified as a positive number, irrespective of the sense of rotation.
- The size of the timeframe is 10 ms (default), but at the least the basic unit Frequency window base (index: 0x80n0:0F).
- This calculation is carried out in the terminal in free-running mode without reference to the distributed clocks system. It is therefore independent of the DC mode.
- AKT2G-ENC-180: No frequency measurement is possible if the counter is blocked by the gate. In this case the period can be measured regardless.
- AKT2G-ENC-180: A C or external reset restarts the frequency measurement. The last frequency value remains unchanged until a new frequency value is determined.
- The object Frequency window base (index: 0x80n0:0F) is used for switching the basic unit for the Frequency window between 1 µs and 1 ms, in order to adjust the time window for the measurement. The following maximum measuring windows are therefore possible:

Basic unit	Max. timeframe
1 µs	65.5 ms
1 ms	65 s

- on expiry of the measuring window Frequency window (index: 0x80n0:11), the subsequent positive edge on track A is awaited, but at the longest for 1.6 s or the time from Frequency wait time (index: 0x80n0:17).
- The frequency is measured with different accuracies depending on the selected basic unit Frequency window base (index 0x80n0:0F) and the window size.

4.12.4.2.3.2 Frequency mode A

The measurement is automatically performed in frequency mode A if the window size is smaller than or equal to 600 ms.

- Basic unit 1 µs: all window sizes
- Basic unit 1 ms: up to 600 ms window size

4.12.4.2.3.3 Measurement sequence

- The measurement starts with a positive edge at track A. The current counter value and time (resolution: 100 ns) are stored.
- On expiry of the measuring window Frequency window (index: 0x80n0:11), the subsequent rising edge on track A is awaited, but at the longest for 1.6 s or the time from Frequency wait time (index: 0x80n0:17).
- The frequency is calculated from the edge difference and the actual elapsed time.

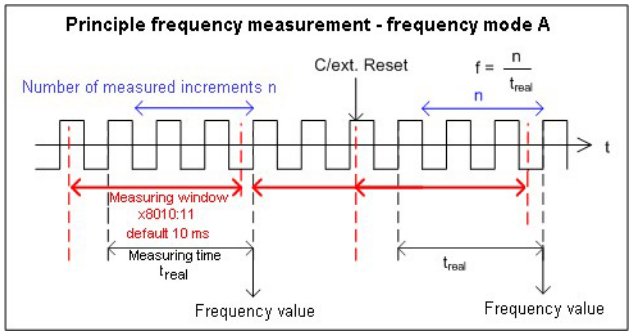


Figure 5-2: Frequency measurement principle - frequency mode A

4.12.4.2.3.4 Frequency mode B

The measurement is automatically performed in frequency mode B if the window size is greater than 600 ms.

- Basic unit 1 ms: from 601 ms window size

Measurement sequence

- At the start of the measurement the time and the current position are stored with a resolution of 100 ns, irrespective of the current signal position.
- After the measurement the current position is stored irrespective of the current signal position.
- The frequency is calculated from the number of increments and the actual elapsed time.
- The frequency measurement therefore takes place with reduced accuracy.
- The larger the measuring window in relation to the basic unit, the more precise the frequency calculation.

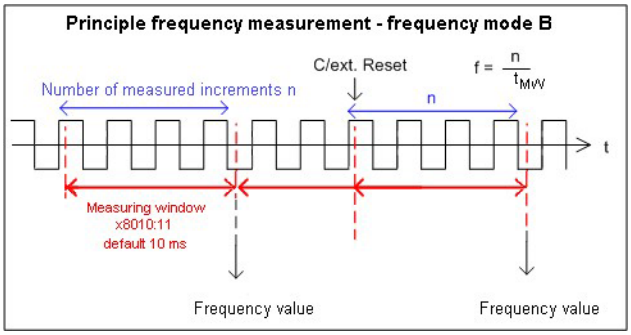


Figure 5-3: Frequency measurement principle - frequency mode B

4.12.4.2.3.5 Period calculation

- This calculation is carried out free-running in the slave without reference to the distributed clocks system. It is therefore independent of the DC mode.
- During each cycle the interval between two positive edges of input A is counted.
- Depending on the setting, periods of up to 1.6 s or 3.2 s in length are measurable.
- If no edge change occurs for approx. 1.6 s, any period specification is cancelled.

4.12.4.2.3.6 Gate function

The counter can be latched with the aid of the gate function. The Gate polarity object (index: 0x8000:04) provides three different options:

0: The gate function is inactive.

1: The counter value is latched by a HIGH level at the gate input. The counter value does not change as long as the HIGH level is applied. Signals on channels A and B have no effect on the counter value.

2: The counter value is locked by a LOW level at the gate input. The counter value does not change as long as the LOW level is applied. Signals on channels A and B have no effect on the counter value.

In the case of a simultaneous activation of the gate function (latch on HIGH level / latch on LOW level) and Enable extern reset (reset on positive edge / reset on negative edge), the counter value is first reset to zero. Latching subsequently takes place.

4.12.4.2.3.7 Latch

Activating the latch C input (“C”) and latching the counter value

- The counter value is saved in Latch value (index: 0x6000:12) upon the first latch pulse (positive edge on input “C”) after setting the bit (TRUE) in Enable latch C (index: 0x7000:01) (takes priority over Enable latch extern on positive / negative edge index: 0x7000:02 / 0x7000:04). If the bit is set, the subsequent pulses on the other inputs have no effect on the latch value in Latch value (index: 0x6000:12).
- After re-activation of Enable latch C (index: 0x7000:01), the next counter value at the latch input can be written only if the value of the Latch C valid bit (index 0x6000:01 FALSE) has been reset.

Activation of the external latch input and saving (“latching”) of the counter value (index 0x7000:02, 0x7000:04)

- The counter value at the latch input Latch value (index 0x6000:12) will be saved upon the first external latch pulse with a positive edge if the bit (TRUE) is set in Enable extern latch on positive edge (index: 0x7000: 02). The subsequent pulses have no influence on the latch value in Latch value (index: 0x6000:12).
- The counter value at the latch input Latch value (index: 0x6000:12) will be saved upon the first external latch pulse with a negative edge if the bit (TRUE) is set in Enable extern latch on negative edge (index: 0x7000: 04). The subsequent pulses have no influence on the latch value in Latch value (index: 0x6000:12).
- After re-activation, a new counter value on the latch input can be written only if the value of the Latch extern valid bit (index: 0x6000:02) has been reset.

4.12.4.2.3.8 Reset

The counter can be reset via Enable C reset (index: 0x8000:01) or via Enable extern reset (index: 0x8000:02). Extern reset polarity (index: 0x8000:10) defines whether the reset takes place on a positive or negative edge at the external latch input.

“Enable C reset” (index: 0x8000:01)

- For activation the bit in Enable C reset (index: 0x8000:01) is set to TRUE.

  The counter value is reset to zero if the zero pulse is present on channel C.

“Enable extern reset” (index: 0x8000:02),

- For activation the bit in Enable extern reset (index: 0x8000:02) is set to TRUE.
- “Extern reset polarity” (index: 0x8000:10)
  - Bit not set: the counter is set to zero with a negative edge at the external latch input.
  - Bit set: the counter is set to zero with a positive edge at the external latch input.

  The simultaneous activation of the functions Enable C reset (index: 0x8000:01) und Enable extern reset (index: 0x8000:02) is not possible.

4.12.4.2.3.9 Up/down counter

- The operating mode (encoder or up/down counter) is selected via the CoE object Enable up/down counter (index: 0x80n0:03).

  On the CoE - Online tab, click on the row of the index to be parameterized, enter the corresponding value in the SetValue dialog and confirm with OK.

  - 0: the up/down counter is not active.
  - 1: the up/down counter is active. • In the case of the AKT2G-ENC-180 the counter value can be locked via the object Gate polarity (index:

  0x8000:04) (s. Gate function).

- The counting direction (up/down) is specified via the signal level at channel B. • An additional option for reversing the direction of rotation is to set the Reversion of rotation bit (index: 0x80n0:0E).
- Connection:

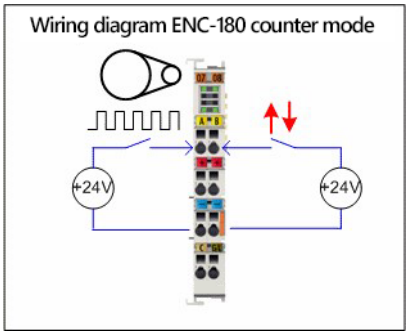


Figure 5-4: Counter connection principle

4.12.4.2.3.10 Micro-increments

- Works with and without distributed clocks, but in the AKT2G-ENC-180 this is only meaningful in conjunction with one of the DC modes
- By setting the counter value only the integer component can be modified.
- The principle:

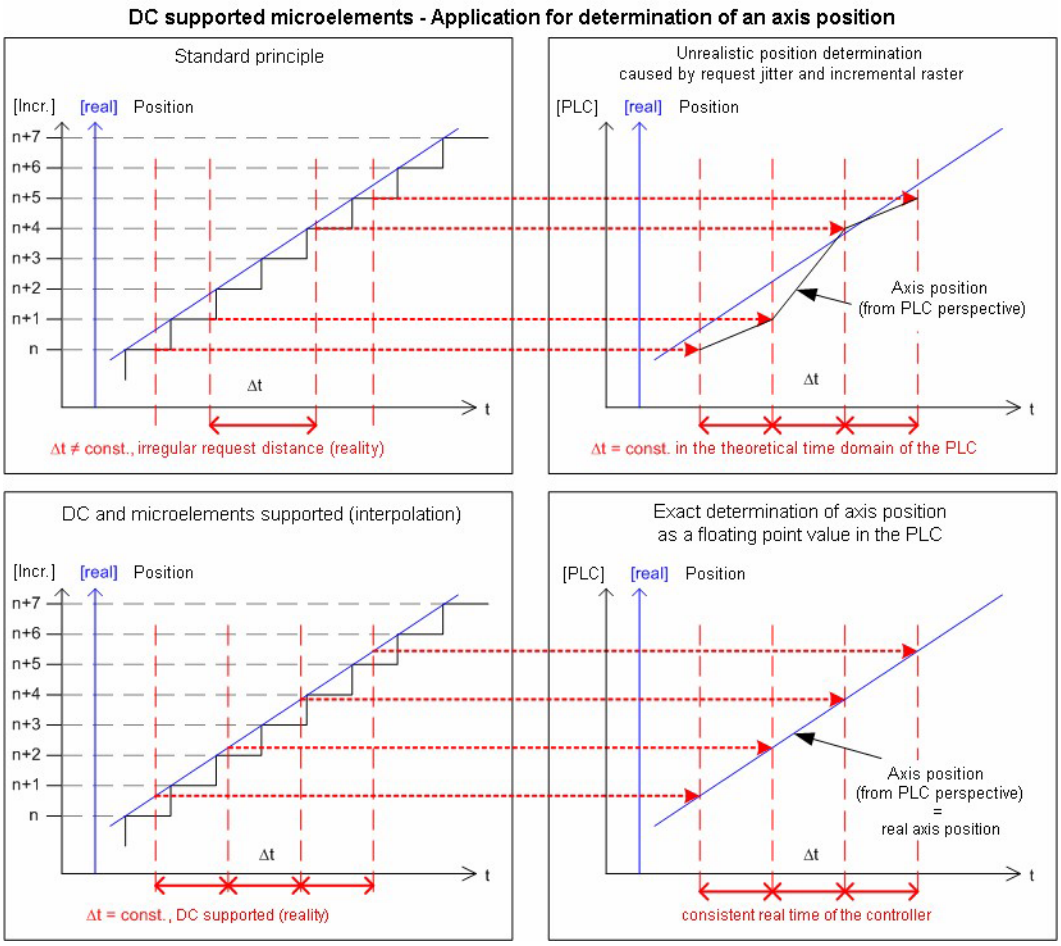


Figure 5-5: Principle of frequency measurement

The highly constant query cycles (accuracy: 100 ns) of the distributed clocks system permits the AKT2G-ENC-180 to interpolate interpolated axis positions between the counted encoder increments above a certain speed. The interpolation resolution is 8 bit, corresponding to 256 values. A standard encoder with 1,024 bars with 4-way evaluation and micro-increments thus becomes a high-resolution axis encoder with 4096 * 256 = 1,048,567 bars.

If the speed falls below the minimum speed, this is displayed by the object Extrapolation stall (index: 0x60n0:08) in the process data.

4.12.4.2.3.11 Digital filter

The AKT2G-ENC-180 has a digital filter on encoder channels A and B that can be switched off (object Disable Filter, index: 0x80n0:08). This acts as a diffuse low-pass filter at about 100 KHz (equals 400,000 increments/second with 4-fold evaluation), i.e. the permissible limit frequency.

In each application it is advisable to check whether it would be advantageous to deactivate the filter - the detection of fast axis movements may be improved as a result.

4.13 AKT2G-ENC-190-000

4.13.1 Interface terminal for incremental encoder

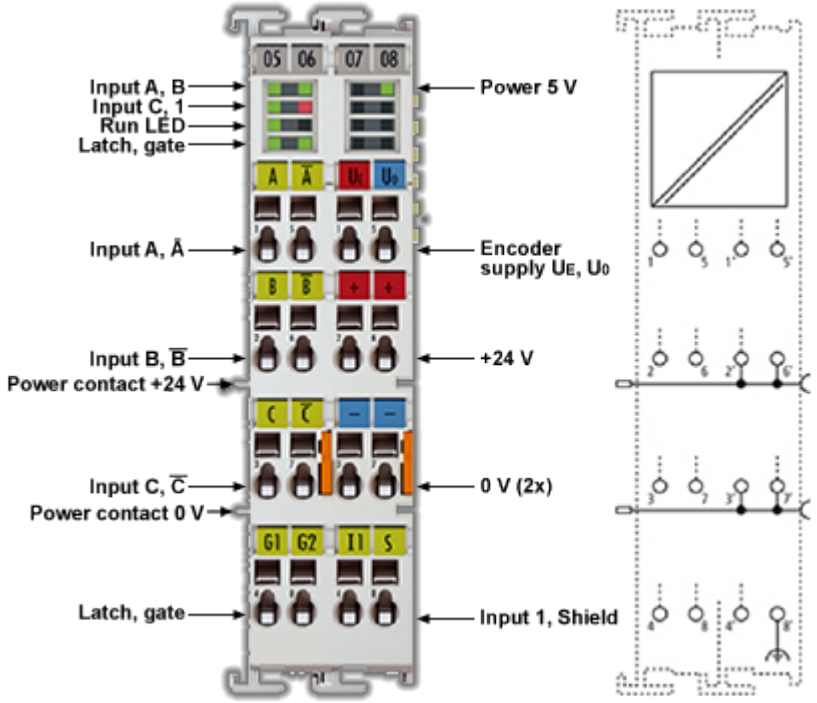


Figure 5-6: AKT2G-ENC-190-000

The AKT2G-ENC-190-000 EtherCAT Terminal is an interface for direct connection of incremental encoders with differential inputs (RS422). A 16-bit counter (in normal operating mode) or a switchable 16/32-bit counter (in enhanced operating mode) with a quadrature decoder and a 16-bit latch (in normal operating mode) or 32-bit latch (in enhanced operating mode) for the zero pulse can be read, set or enabled. Incremental encoders with alarm output can be connected at the negative switching status input of the interface. The measurement of period and frequency is possible. The gate input allows the locking of the counter, alternatively with a high or low level. The latch input is similarly configurable and evaluates high or low levels. The AKT2G-ENC-190-000 can also be used as bidirectional counter on channel A; channel B specifies the count direction.

4.13.2 Technology

The AKT2G-ENC-190-000 incremental encoder interface terminal enables connection of incremental encoders with

A/B/C track to the Bus Coupler and the PLC. A 16-bit counter (in normal operating mode) or a switchable 16/32-bit counter (in enhanced operating mode) with a quadrature decoder and a 16-bit latch (in normal operating mode) or 32-bit latch (in enhanced operating mode) can be read, set or enabled. Differential signals based on RS422 are provided as encoder connection. From hardware 09 [❝ 204] single-ended 5 V signals are possible for the AKT2G-ENC-190-000 based on pull-up resistors.

In addition to the encoder inputs A, B and C, an additional latch input G1 (24 V) and a gate input G2 (24 V) for locking the counter during operation are available.

The terminal is supplied as a 4-fold quadrature decoder with complementary analysis of the sensor signals A, B, C. If the incremental encoder has an alarm output it can be connected to the INPUT 1 status input of the AKT2G-ENC-190-000. The AKT2G-ENC-190-000 can optionally be operated as a bidirectional counter terminal on channel A.

4.13.2.1 AKT2G-ENC-190-000 input impedance

The signal source must be able to operate the input impedance of the AKT2G-ENC-190-000 (typically 220 Ω, subject to modification) with adequate voltage levels according to RS422.

4.13.2.2 Gate/latch input

For gate and latch inputs (24 V) a max. input frequency of 1 MHz is permitted. Subject to modification.

4.13.2.3 Level on interface

In differential mode the AKT2G-ENC-190-000 expects the signal levels after RS422. The data are transferred without ground reference as voltage difference between two cables (signal A and inverted signal /A). The terminal analyses signal levels in the range -200 mV < Vid < +200 mV as valid signals. The differential signal must be in the common mode range (<+13.2 V and >-10 V, with respect to GND) (cf. diagram). Signal levels outside this range can lead to destruction.

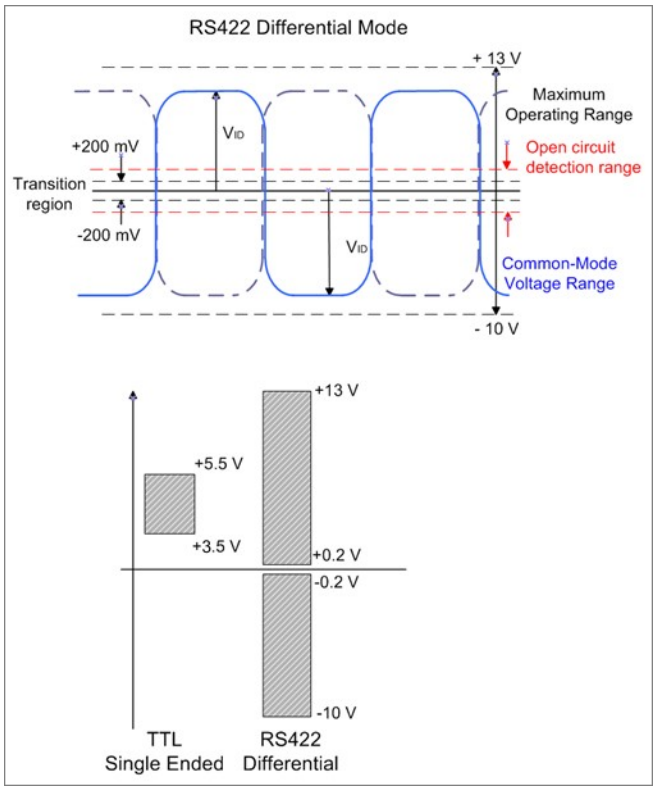


Figure 5-7: Level interface

In differential mode only the voltage difference is evaluated, so that common-mode interference on the transmission link does not lead to corruption of the wanted signal, since any interference affects both cables simultaneously.

If the AKT2G-ENC-190-000 is only operated in single-ended mode, a nominal level voltage between 3.5 V and 5.5 V is expected.

The AKT2G-ENC-190-000-0010 and AKT2G-ENC-190-000-0011 do not support single-ended mode.

4.13.3 Technical Data

Technical Data	AKT2G-ENC-190-000
Sensor connection	A, ¬A, B, ¬B, C, ¬C (RS422 differential inputs) also single-ended connection (5 V ±20%) possible
Additional inputs	gate, latch (24 VDC, both max. 1 MHz permitted), status input (max. 5 VDC, potential-free, switching to negative potential)
Encoder operating voltage / Encoder supply	5 VDC (generated from the 24 V DC power contacts)
Sensor output current	0.5 A
Counter	16 bit, 16/32 bit switchable
Zero pulse latch	16 bit, 16/32 bit switchable
Limit frequency	1 MHz (equals 4 million increments with 4-fold evaluation)
Quadrature decoder	4-fold evaluation
Distributed Clocks	in enhanced operating mode
Broken wire detection to sensor	in enhanced operating mode
Commands	read, set, enable
Cycle time	min. 100 µs
Current consumption via Ebus	typ. 130 mA
Current consumption from the power contacts	0.1 A (excluding sensor load current)
Electrical isolation	500 V (E-bus/field voltage)
Bit width in process image	up to 6 bytes outputs, 22 bytes inputs, depends on parametrization
MTBF (+55°C)	-
Weight	approx. 100 g
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)
Permissible ambient temperature range during storage	-40°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 27 mm x 10 mm x 70 mm (width aligned: 24 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, see also installation instructions for enhanced mechanical load capacity
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE ATEX cULus

4.13.4 AKT2G-ENC-190-000 LEDs and Connection

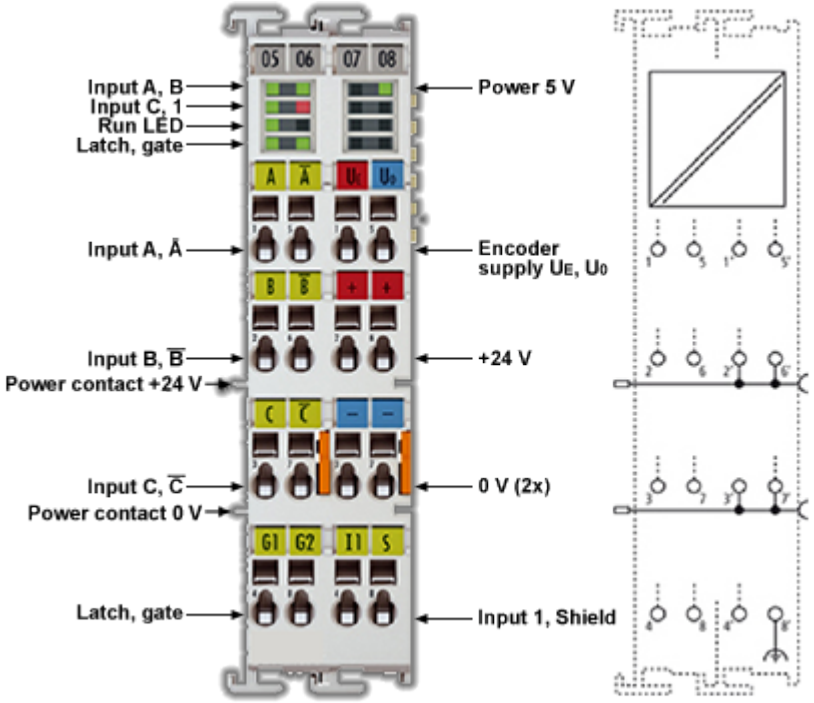


Figure 5-8: AKT2G-ENC-190-000

4.13.4.1 Connection

NOTE

Encoder supply via the terminal

The encoder supply voltage (5 V), can be taken from the terminal point 1'.

Terminal Point	No.	Comment
A	1	Encoder input A
B	2	Encoder input B
C	3	Encoder input C
Latch 24 V	4	Latch input
¬A	5	Encoder input A
¬B	6	Encoder input B
¬C	7	Encoder input C
Gate 24 V	8	Gate input
Ue = +5 V	1'	+5 V encoder supply
+24 V	2'	+24 V (internally connected to terminal point 6' and positive power contact)
0 V	3'	0 V (internally connected to terminal point 7' and negative power contact)
Input 1	4'	Status input 1 Alarm input from rotary encoder. Internally connected to 5 V via pull-up. Switching to negative potential, i.e. connection to GND leads to error bit and LED display. If externally supplied (not recommended) 5 V max. against GND is permitted.
Uo = 0 V	5'	0 V encoder supply
+24 V	6'	+24 V (internally connected to terminal point 2' and positive power contact)

Terminal Point	No.	Comment
0 V	7'	0 V (internally connected to terminal point 3' and negative power contact)
Shield	8'	Screen

4.13.4.2 LEDs

LED	Color	Meaning	
LED	Color	Meaning	
INPUT A, B, C	green	indicates TRUE level	
INPUT 1	red	is lit, if INPUT 1 is connected to GND [INPUT 1 is connected to an internal 5 V HIGH level though internal pull-up (default)]	
LATCH	green	is lit, if a signal (+24 V) is connected to the latch input	
GATE	green	is lit, if a signal (+24 V) is connected to the gate input	
RUN	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: INIT = initialization of the terminal or BOOTSTRAP = function for firmware updates of the terminal
		flashing	State of the EtherCAT State Machine: PREOP = function for mailbox communication and different standard-settings set
		single flash	State of the EtherCAT State Machine: SAFEOP = verification of the Sync Manager channels and the distributed clocks. Outputs remain in safe state
		on	State of the EtherCAT State Machine: OP = normal operating state; mailbox and process data communication is possible
POWER 5 V	green	Operating voltage display for incremental encoder power supply	

4.13.5 Commissioning AKT2G-ENC-190-000

4.13.5.1 Normal Operation Mode

4.13.5.1.1 Process data and modes - Normal Operation Mode

In AKT2G-ENC-190-000 “normal operation mode” the following modes are available:

Mode	Distributed Clock	Main PDO	Comment	Optional PDO 1	Comment	Features CoE	Comment
1	Operational	0x1A00 + 0x1600	16 bit Value/Latch Byte-Alignment	0x1A02	Frequency: 32 bit Period: 16 bit Window: 16 bit CoE object 0x8001:02	0x8000:01 + 0x8001:02	Register reload + Reload Value
2	Operational	"	"	"	"	0x8000:02	Index Reset
3	Operational	"	"	"	"	0x8000:03, :04, :05	FWD Cnt + pos/ neg Gate
4	Operational	0x1A01 + 0x1601	16 bit Value/Latch Word Alignment	0x1A02	Frequency: 32 bit Period: 16 bit Window: 16 bit CoE object 0x8001:02	0x8000:01 + 0x8001:02	Register reload + Reload Value
5	Operational	"	"	"	"	0x8000:02	Index Reset
6	Operational	"	"	"	"	0x8000:03, :04, :05	FWD Cnt + pos/ neg Gate

NOTE

Frequency

- The timeframe for the frequency calculation is set to 10 ms (see Fig. “Process data” tab); in addition a variably configurable measuring window is available (parameterization via object 0x8001:01, output frequency value in object 0x6000:06).
- Only the increment edges in the specified time window are counted.
- If no edge change occurs for approx. 1.6 s, any frequency specification is cancelled.
- This calculation is carried out in the slave without reference to the distributed clocks system. It is therefore independent of the DC mode.
- No frequency measurement is possible if the counter is blocked by the gate. In this case the period can be measured regardless.
- If an encoder signal is only present at input A/A and the frequency/period is to be measured, the terminal must be set to “Enable FWD count” in CoE 0x8000:03.
- A C or external reset restarts the frequency measurement. The last frequency value remains unchanged until a new frequency value is determined.

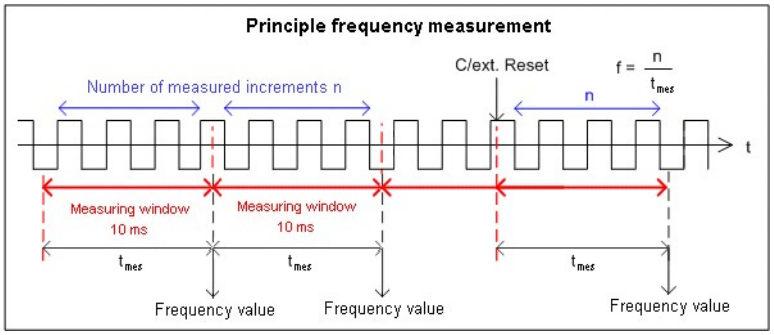


Figure 5-9: Frequency measurement principle in normal operation mode

Period calculation

- This calculation is carried out in the slave without reference to the distributed clocks system. It is therefore independent of the DC mode.
- In each cycle the interval between 2 positive edges of input A is counted with a resolution of 100 ns.
- If no edge change occurs for approx. 1.6 s, any period specification is canceled.
- **NOTE**

  Frequency and period measurement

  From the explanatory notes above it is apparent that the frequency measurement can measure the current axis status (velocity) significantly more accurately than the period measurement. Frequency measurement is therefore preferable, if possible.

Register Reload

- If Register Reload is enabled in CoE object 0x8000:01, the counter value is set to zero in the event of overflow over the value in CoE object 0x8001:02 and to the value in CoE object 0x8001:02 in the event of underflow below 0.

Index Reset

- If Index Reset is enabled in CoE object 0x8000:02, input C resets the counter to 0.

  NOTE

  "Register Reload" and "Index Reset"

  "Register Reload" and "Index Reset" cannot be operated simultaneously.

FWD Cnt

- If FwdCnt is activated in CoE object 0x8000:03, the AKT2G-ENC-190-000 operates as counter on channel A. Channel B indicates the counting direction: B=TRUE forward, B=FALSE backward. The counter can be locked via the gate input (24 V).
  - CoE object 0x8000:04 (TRUE): Locking of the counter at the gate input with positive edge (0 V -> + 24 V).
  - CoE object 0x8000:05 (TRUE): Locking of the counter at the gate input with negative edge (+ 24 V -> + 0 V).

4.13.5.1.2 Object Description and Parameterization - Normal Operation Mode

4.13.5.1.2.1 Restore object

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore the default settings	UINT8	RO	0x01 (1dec)
1011:01	SubIndex 001	If this object is set to "0x64616F6C" in the set value dialog, all backup objects are reset to their delivery state. Note: Some FW versions also accept the following input: "0x6C6F6164".	UINT32	RW	0x00000000 (0dec)

4.13.5.1.2.2 Configuration data

Index 8000 Non-Volatile Settings 0

Index (hex)	Name	Meaning	Data type	Flags	Default
8000:0	Non-Volatile Settings 0	Maximum subindex	UINT8	RO	0x05 (5dec)
8000:01	Enable register reload	The counter counts up to the "Counter reload value", or the "Counter reload value" (0x8001:02) is loaded in the event of an underflow Example 360° encoder with set bit: Moves in positive direction via Counter reload value: Reset counter value to 0. Moves in negative direction less than 0: Reset counter value to Counter reload value	BOOLEAN	RW	0x00 (0dec)
8000:02	Enable index reset	Activates input "C" for resetting the counter. Example 360° encoder with set bit: Moves in positive direction (signal at input "C"): Reset counter value to 0 Moves in negative direction (signal at input "C"): underflow with FFFF, FFFE etc.)	BOOLEAN	RW	0x00 (0dec)
8000:03	Enable FWD count	FALSE The terminal operates in quadrature decoder mode TRUE The terminal operates as counter, count direction to input B	BOOLEAN	RW	0x00 (0dec)
8000:04	Enable pos. gate	Gate input responds to positive edge and locks the counter	BOOLEAN	RW	0x01 (1dec)
8000:05	Enable neg. gate	Gate input responds to negative edge and locks the counter	BOOLEAN	RW	0x00 (0dec)

Index 8001 Non-Volatile Settings 1

Index (hex)	Name	Meaning	Data type	Flags	Default
8001:0	Non-Volatile Settings 1	Maximum subindex	UINT8	RO	0x02 (2_{dec})
8001:01	Frequency window	The value specifies the size of the time window for the “Window” variable. resolution: 16µs; e.g. default value: 16 µs x 100_{dec} = 1.6 ms	UINT16	RW	0x0064 (100_{dec})
8001:02	Counter reload value	If “Enable register reload” = TRUE, the counter counts up to this value and is loaded with this value in the event of an underflow	UINT16	RW	0xFFFF (65535_{dec})

4.13.5.1.2.3 Input data

Index 6000 Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6000:0	Inputs	Length of this object	UINT8	RO	0x06 (6_{dec})
6000:01	Status	Status byte	UINT8	RO	0x00 (0_{dec})
6000:02	Value	meter reading	UINT16	RO	0x0000 (0_{dec})
6000:03	Latch	Latch value	UINT16	RO	0x0000 (0_{dec})
6000:04	Frequency	Frequency value (resolution: 0.01 Hz / digit) [fixed 10 ms measuring window]	UINT32	RO	0x00000000 (0_{dec})
6000:05	Period	Period (resolution 500 ns / digit)	UINT16	RO	0x0000 (0_{dec})
6000:06	Window	Measured value of the variable timeframe (“Frequency window” (0x8001:01)	UINT16	RO	0x0000 (0_{dec})

4.13.5.1.2.4 Output data

Index 7000 Outputs

Index (hex)	Name	Meaning	Data type	Flags	Default
7000:0	Outputs	Length of this object	UINT8	RO	0x02 (2_{dec})
7000:01	Ctrl	Control byte	UINT8	RO	0x00 (0_{dec})
7000:02	Value	The counter value to be set via CNT_SET (CB.02).	UINT16	RO	0x0000 (0_{dec})

4.13.5.1.3 Control and status byte

4.13.5.1.4 Control byte

The control byte (CB) is located in the output process image, and is transmitted from the controller to the terminal.

Bit	CB.7	CB.6	CB.5	CB.4	CB.3	CB.2	CB.1	CB.0
Name	-	-	-	-	EN_LATCH_EXTN	CNT_SET	EN_LATCH_EXTP	EN_LATC

Legend

Bit	Name	Description	
CB.3	EN_ LATCH_ EXTN	1_{bin}	With a valid EN_LATCH_EXTN bit the counter value is stored in latch input (index 0x6000:03) when the first external latch pulse with falling edge is encountered. Subsequent pulses have no influence on the latch value. Please note: A new counter value can only be written to the latch input when the Latch Valid bit (LAT_EXT_VAL) in the status byte has a low signal level.
CB.2	CNT_ SET	rise	The counter is set with rising edge of CNT_SET to the value specified via the process data (index 0x7000:02).
CB.1	EN_ LATCH_ EXTP	1_{bin}	With a valid EN_LATCH_EXTP bit the counter value is stored in latch input (index 0x6000:03) when the first external latch pulse with rising edge is encountered. Subsequent pulses have no influence on the latch value. Please note: A new counter value can only be written to the latch input when the Latch Valid bit (LAT_EXT_VAL) in the status byte has a low signal level.
CB.0	EN_ LATC	1_{bin}	The null point latch (C input) is activated. The counter value is saved when the first external latch pulse after a valid EN_LATC bit encountered (this has priority over EN_LAT_EXTN / EN_LAT_EXTP). If the bit is set subsequent pulses have no influence on the latch value. Please note: A new counter value can only be written to the latch input when the Latch Valid bit (LATC_VAL) in the status byte has a low signal level (the LATC_VAL bit (SB.0) is only cleared by the terminal when the C pulse = LOW).

4.13.5.1.5 Status byte

The status byte (SB) is located in the input process image, and is transmitted from terminal to the controller.

Bit	SB.7	SB.6	SB.5	SB.4	SB.3	SB.2	SB.1	SB.0
Name	-	-	STATUS_ INPUT	OVERFLOW	UNDERFLOW	CNTSET_ ACC	LAT_EXT_ VAL	LATC_ VAL

4.13.5.1.6 Legend

Bit	Name	Description	
SB.5	STATUS_ INPUT	0_{bin} /1_{bin}	Indicates the status of INPUT 1
SB.4	OVERFLOW	1_{bin}	This bit is set if the 16-bit counter overflows (65535 to 0). It is reset when the counter exceeds one third of its measuring range (21845 to 21846) or immediately an underflow occurs.
SB.3	UNDERFLOW	1_{bin}	This bit is set if the 16-bit counter underflows (0 to 65535). It is reset when the counter drops below two thirds of its measuring range (43690 to 43689) or immediately an overflow occurs.

Bit	Name	Description	
SB.2	CNTSET_ACC	1_{bin}	The data for setting the counter (index 0x7000:02) is accepted from the terminal.
SB.1	LAT_EXT_VAL	1_{bin}	An external latch pulse has occurred. The data with index 0x6000:03 match the latched value when the bit is set. To reactivate the latch input EN_LAT_EXTN or EN_LATCH_EXTP (CB.3 or CB.1) has first to be cleared and then to be set once more.
SB.0	LATC_VAL	1_{bin}	A zero point latch has occurred. The data with index 0x6000:03 match the latched value when the bit is set. In order to reactivate the latch input, it is necessary for EN_LATC (CB.0) first be cleared and then to be set once more.

4.13.5.1.7 Single-Ended Connection for TTL Encoder

In addition to encoders with differential RS422 interface, single-ended encoders with TTL interface are also supported. Please note the following:

- Operating mode selection encoder "0x8000:03 Enable FWD count = FALSE".
- The differential inputs (/A, /B, /C) must remain open and must not be connected to ground

4.13.5.2 Enhanced Operation Mode

4.13.5.2.1 Process data and modes - Enhanced operation mode

In AKT2G-ENC-190-000 “enhanced operation mode” the following modes are available:

Mode	DC	Main PDO	Comment	Optional PDO 1	Comment	Optional PDO 2	Comment	Features CoE	Comment
7	FreeRun	0x1A04 + 0x1603	Count/Latch in 32 bit	0x1A05 or 0x1A06	Frequency (32 bit) or Period (32bit)	--		0x80n0:nn	CoE combinations 0x80n0:nn
8	"	0x1A03 + 0x1602	compact: Count/Latch in 16 bit	"	"	--		"	"
9	DC/DCi	0x1A04 + 0x1603	Count/Latch in 32 bit	"	"	0x1A07 or 0x1A08	Timestamp 64 bit Timestamp 32 bit (compact)	"	"
10	"	0x1A03 + 0x1602	compact: Count/Latch in 16 bit	"	"	"	"	"	"

4.13.5.2.1.1 Frequency

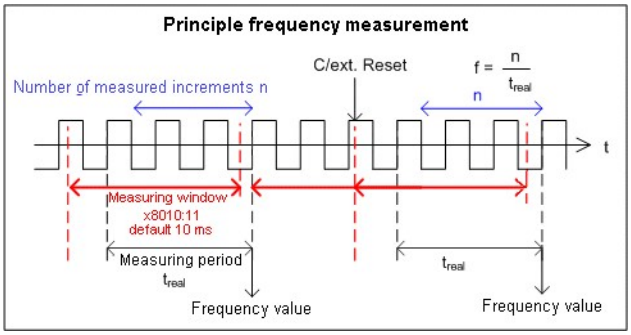
- The time window for the frequency calculation and the resolution can be parameterized in CoE objects 0x80n0:11 [❮ 141], 0x80n0:13 [❮ 141], 0x80n0:15 [❮ 141], 0x80n0:17 [❮ 141].
- The positive edges of track A are counted within the specified timeframe and the next edge including the time up to it are counted. The waiting time can be set in CoE object 0x80n0:17 “Frequency Wait Time” (unit: ms). The default value is 1.6 sec. This is also the maximum value.
- The time window is 10 ms (default), min. 1 µs. With the default setting it is possible to measure frequencies up to approx. 800 kHz. At higher frequencies a smaller value must be selected for the timeframe.
- The time is measured with a resolution of 100 ns.
- This calculation is carried out in the slave without reference to the distributed clocks system. It is therefore independent of the DC mode.
- No frequency measurement is possible if the counter is blocked by the gate. In this case the period can be measured regardless.
- If an encoder signal only is only present at input A/A and the frequency/period is to be measured, the terminal must be set to “Up/Down Counter” in CoE 0x8010:03 [❮ 141].
- A C or external reset restarts the frequency measurement. The last frequency value remains unchanged until a new frequency value is determined.

4.13.5.2.1.2 Frequency measurement

- Basic unit 1 µs: all window sizes

4.13.5.2.1.3 Measurement sequence

- The measurement starts with a positive edge at track A. The current counter value and time (resolution: 100 ns) are stored.
- After the measuring window time has elapsed (index 0x80n0:11 [❝ 141]), the system waits for the following rising edge at track A or a maximum of 1.6 sec or the time from 0x80n0:17 [❝ 141]
- The frequency is calculated from the edge difference and the actual elapsed time.



4.13.5.2.1.4 Period calculation

- This calculation is carried out in the slave without reference to the distributed clocks system. It is therefore independent of the DC mode.
- In each cycle the interval between 2 positive edges of input A is counted with a resolution of 100 ns.
- If no edge change occurs for approx. 1.6 s, any period specification is cancelled.

NOTE

Frequency and period measurement

From the explanatory notes above it is apparent that the frequency measurement can measure the current axis status (velocity) significantly more accurately than the period measurement. Frequency measurement is therefore preferable, if possible.

4.13.5.2.1.5 Latch

Activation of latch C input (“C”) and saving (“latching”) of the counter value (index 0x70n0:01 [❝ 145])

- The counter value is saved at the first external latch pulse (positive edge at input “C”) after the bit has been set (“TRUE”) in index 0x70n0:01 [❝ 145] (has priority before 0x70n0:02 [❝ 145] / 0x70n0:04 [❝ 145]). The subsequent pulses at the other inputs have no influence on the latch value in index 0x60n0:12 [❝ 144] if the bit is set.
- Note for “Latch C valid” bit: A new counter value at the latch input can only be written once the value of the “Latch C valid” bit (index 0x60n0:01 [❝ 144]) is “FALSE”.

Activation of the external latch input (“gate/latch”) and latching of the counter value (index 0x70n0:02 [❝ 145], 0x70n0:04 [❝ 145])

- The counter value at the latch input (Index 0x70n0:02 [❝ 145]) will be saved upon the first external latch pulse with a rising edge if the bit (“TRUE”) is set in index 0x60n0:12 [❝ 144]. The subsequent pulses have no influence on the latch value in index 0x60n0:12 [❝ 144].
- The counter value at the latch input (Index 0x60n0:12 [❝ 144]) will be saved upon the first external latch pulse with a falling edge if the bit (“TRUE”) is set in index 0x70n0:04 [❝ 145]. The subsequent pulses have no influence on the latch value in index 0x60n0:12 [❝ 144].
- Note for "Latch extern valid" bit: A new counter value at the latch input can only be written once the value of the “Latch extern valid” bit (index 0x60n0:02 [❝ 144]) is “FALSE”.

4.13.5.2.1.6 Reset

- Counter reset (index 0x80n0:01 [❝ 141], 0x80n0:02 [❝ 141], 0x80n0:10 [❝ 141]): For a counter reset via input C set the bit in index 0x80n0:01 [❝ 141], for a reset via the external latch input set the bit in index 0x80n0:02 [❝ 141].
- The functions "Enable C reset" (0x80n0:01 [❝ 141]) and "Enable extern reset" (0x80n0:02 [❝ 141]) cannot be activated simultaneously.
- Note for "Extern reset polarity", index 0x80n0:10 [❝ 141]: The edge for setting the counter to zero can be selected via index 0x80n0:10 [❝ 141].

  Bit not set: counter is set to zero with falling edge.

  Bit set: counter is set to zero with rising edge.

4.13.5.2.1.7 Up/down counter

- The mode (encoder or up/down counter) is set via the CoE objects (profile-specific objects, tab CoE Online, index 0x80n0:03 [❝ 141] "Enable up/down counter"). Click on the corresponding row of the index to be parameterized, enter 1 in the SetValue dialog and confirm with OK.
- Set the gate polarity accordingly via object 0x80n0:04 [❝ 141].
- An additional option for reversing the rotation direction is available by setting the bit in index 0x80n0:0E [❝ 141].

4.13.5.2.1.8 Overflow/underflow

- Overflow/underflow control is inactive in combination with an activated reset function (C/external).
- The underflow bit (0x60n0:04 [❝ 144]) is set if an underflow ...00 →...FF occurs. It is reset if 2/3 of the counter range are underrun.
- The overflow bit (0x60n0:05 [❝ 144]) is set if an overflow FF...→ 00... occurs. It is reset if 1/3 of the counter range is exceeded.

4.13.5.2.1.9 Open circuit detection

- A separate open circuit detection can be activated for each of the channels A, B and C (index 0x80n0:0B [❝ 141], 0x80n0:0C [❝ 141], 0x80n0:0D [❝ 141]).
- Open circuit detection is activated for channels A and B by default.
- A differential voltage of typically -1.5 V >Vid > +1.5 V is detected as an open circuit.
- If an open circuit is detected, it is indicated as process data open circuit = TRUE. The bit in object 0x60n0:07 [❝ 144] is set. An open circuit is indicated separately in indices 0xA0n0:01 [❝ 145] (track A), 0xA0n0:02 [❝ 145] (track B) and 0xA0n0:03 [❝ 145](track C).
- TxPDO state also becomes TRUE if an open circuit is detected, since invalid data have to be assumed.

NOTE

Open circuit detection vs. single-ended lines (TTL interface)

The open circuit detection does principally not work with single-ended lines (TTL interface).

4.13.5.2.1.10 Micro-increments

- Works with and without distributed clocks, but this is only meaningful in conjunction with one of the DC modes
- By setting the counter value only the integer component can be modified.

- The principle:

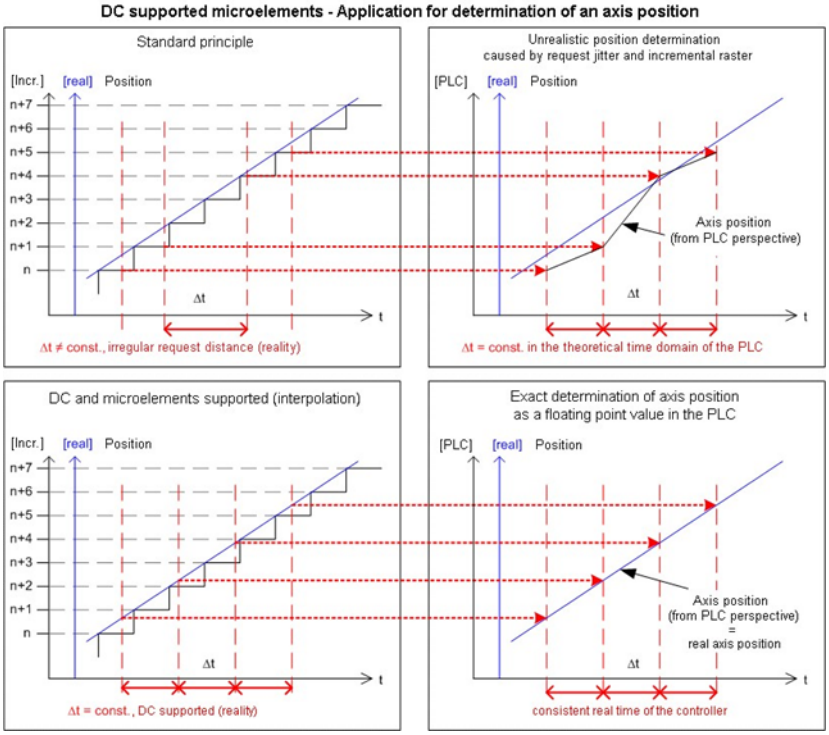


Figure 5-10: Frequency measurement principle in enhanced operation mode

The highly constant query cycles (accuracy: 100 ns) of the distributed clocks systems enable the AKT2G-ENC-190 to interpolate axis positions between the counted encoder increments from a certain speed. The interpolation resolution is 8 bit, corresponding to 256 values. A standard encoder with 1,024 bars with 4way evaluation and micro-increments thus becomes a high-resolution axis encoder with 4096 * 256 = 1,048,567 bars.

Underrunning of the minimum velocity is indicated by the object 0x60n0:08 [“ 144] (extrapolation stall) in the process data.

4.13.5.2.1.11 Configuration Data

4.13.5.2.2 Index 8010 ENC Settings

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:0	ENC Settings	Maximum subindex	UINT8	RO	0x17 (32dec)
8010:01	Enable C reset	The counter is reset via the C input.	BOOLEAN	RW	0x00 (0dec)
8010:02	Enable extern reset	A counter reset is triggered via the external latch input (24 V)	BOOLEAN	RW	0x00 (0dec)
8010:03	Enable up/down counter	Enablement of the up/down counter in place of the encoder with the bit set. Increments are counted at input A. Input B specifies the counting direction.	BOOLEAN	RW	0x00 (0dec)
8010:04	Gate polarity	0: Disable gate 1: Enable pos. gate (gate locks with “HIGH” level) 2: Enable neg. gate (gate locks with “LOW” level)	BIT2	RW	0x01 (1dec)
8010:08	Disable filter	0: Activates the input filter (inputs A, /A, B, /B, C, /C only) 1: Deactivates the input filter If a filter is activated a signal edge must be present for at least 2.4 µs in order to be counted as an increment.	BOOLEAN	RW	0x01 (1dec)
8010:0A	Enable micro increments	If DC mode is activated, the AKT2G-ENC-190 interpolates micro-increments between the integer encoder increments. The lower 8 bits of the counter value are used in each case for the display. A 32-bit counter thus becomes a 24+8-bit counter, a 16-bit counter becomes an 8+8-bit counter.	BOOLEAN	RW	0x00 (0dec)
8010:0B	Open circuit detection A	An open circuit on track A is indicated in index 0x6010:07 and as process data. Diagnosis is only possible if the corresponding input is wired differentially. A differential voltage < 3.5 V (typical, subject to change) is detected as a broken wire.	BOOLEAN	RW	0x01 (1dec)
8010:0C	Open circuit detection B	An open circuit on track B is indicated in index 0x6010:07 and as process data. Diagnosis is only possible if the corresponding input is wired differentially. A differential voltage < 3.5 V (typical, subject to change) is detected as a broken wire.	BOOLEAN	RW	0x01 (1dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:0D	Open circuit detection C	An open circuit on track C is indicated in index 0x6010:07 and as process data. Diagnosis is only possible if the corresponding input is wired differentially. A differential voltage < 3.5 V (typical, subject to change) is detected as a broken wire.	BOOLEAN	RW	0x00 (0dec)
8010:0E	Reversion of rotation	Activates reversion of rotation	BOOLEAN	RW	0x00 (0dec)
8010:10	Extern reset polarity	0: Fall (the counter is set to zero with a falling edge) 1: Rise (the counter is set to zero with a rising edge)	BIT1	RW	0x01 (1dec)
8010:11	Frequency window	This is the minimum time over which the frequency is determined. Default 10 ms [resolution: 1 µs] The number of pulses in the time window + the following is measured. The maximum waiting time is specified in the "Frequency Wait Time" parameter. The number of pulses is divided by the actual time window size. The determined frequency is output in index 0x6010:13 and as a process data. The frequency calculation is carried out locally without distributed clocks function.	UINT16	RW	0x2710 (10000dec)
8010:13	Frequency scaling	Scaling of the frequency measurement (must be divided by this value to obtain the unit in Hz): 100: “0.01 Hz”	UINT16	RW	0x0064 (100dec)
8010:14	Period scaling	Resolution of the period in the process data: 100: “100 ns” period value is a multiple of 100 ns 500: “500 ns” period value is a multiple of 500 ns	UINT16	RW	0x0064 (100dec)
8010:15	Frequency resolution	Resolution of the frequency measurement: 100: “0.01 Hz”	UINT16	RW	0x0064 (100dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
8010:16	Period resolution	Internal resolution of the period measurement: 100: “100 ns” period value is a multiple of 100 ns The period is calculated internally with a resolution of 100 ns. The max. measurable period can then be approx. 1.6 seconds. 500: “500 ns” period value is a multiple of 500 ns Internally the period is calculated with 500 ns resolution. The maximum measurable period is approx. 32.7 ms. The resolution of process data continues to be the value according to index 0x8010:14 (e.g. 100 ns [default]).	UINT16	RW	0x01F4 (500dec)
8010:17	Frequency Wait Time	Waiting time [ms] for frequency measurement Once the time specified in the frequency window has elapsed, the system waits for the next positive edge from track A. This enables the update speed for the Frequency process data to be optimized, depending on the expected frequencies. At least double the period of the minimum frequency to be measured should be entered here. t >= 2* (1 / fmin)	UINT16	RW	0x0640 (1600dec)

4.13.5.2.3 Index 6010 ENC Inputs

Index (hex)	Name	Meaning	Data type	Flags	Default
6010:0	ENC Inputs	Maximum subindex	UINT8	RO	0x16 (22dec)
6010:01	Latch C valid	The counter value was locked with the “C” input. The data with index 0x6010:12 match the latched value when the bit is set. To reactivate the latch input, index 0x7010:01 must be cancelled and then reset.	BOOLEAN	RO	0x00 (0dec)
6010:02	Latch extern valid	The counter value was locked via the external latch. The data with index 0x6010:12 match the latched value when the bit is set. To reactivate the latch input, index 0x7000:02 or object index 0x7000:04 must be cancelled and then reset.	BOOLEAN	RO	0x00 (0dec)
6010:03	Set counter done	The counter was set.	BOOLEAN	RO	0x00 (0dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
6010:04	Counter underflow	Counter underflow. Overflow/underflow control is inactive in combination with a reset function (C/external).	BOOLEAN	RO	0x00 (0dec)
6010:05	Counter overflow	Counter overflow. Overflow/underflow control is inactive in combination with a reset function (C/external).	BOOLEAN	RO	0x00 (0dec)
6010:06	Status of input status	State of the status input (alarm “input 1”)	BOOLEAN	RO	0x00 (0dec)
6010:07	Open circuit	Indicates an open circuit. Configuration via index 0x8010:0A, 0x8010:0B, 0x8010:0C	BOOLEAN	RO	0x00 (0dec)
6010:08	Extrapolation stall	The extrapolated part of the counter is invalid	BOOLEAN	RO	0x00 (0dec)
6010:09	Status of input A	Status of input A	BOOLEAN	RO	0x00 (0dec)
6010:0A	Status of input B	Status of input B	BOOLEAN	RO	0x00 (0dec)
6010:0B	Status of input C	Status of input C	BOOLEAN	RO	0x00 (0dec)
6010:0C	Status of input gate	The state of the gate input	BOOLEAN	RO	0x00 (0dec)
6010:0D	Status of extern latch	Status of the extern latch input	BOOLEAN	RO	0x00 (0dec)
6010:0E	Sync Error	The Sync error bit is only required for DC mode. It indicates whether a synchronization error has occurred during the previous cycle. This means a SYNC signal was triggered in the AKT2G-ENC-190, although no new process data were available (0=OK, 1=NOK).	BOOLEAN	RO	0x00 (0dec)
6010:0F	TxPDO State	Validity of the data of the associated TxPDO (0 = valid, 1 = invalid).	BOOLEAN	RO	0x00 (0dec)
6010:10	TxPDO Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated.	BOOLEAN	RO	0x00 (0dec)
6010:11	Counter value	Counter value	UINT32	RO	0x00000000 (0dec)
6010:12	Latch value	Latch value	UINT32	RO	0x00000000 (0dec)
6010:13	Frequency value	The frequency (setting of the scaling and resolution in index 0x8010:13 and 0x8010:15)	UINT32	RO	0x00000000 (0dec)

Index (hex)	Name	Meaning	Data type	Flags	Default
6010:14	Period value	The period (setting of the scaling and resolution in index 0x8010:14 and 0x8010:16)	UINT32	RO	0x00000000 (0dec)
6010:16	Timestamp	Timestamp of the last counter change	UINT64	RO	

4.13.5.2.4 Index 7010 ENC Outputs

Index (hex)	Name	Meaning	Data type	Flags	Default
7010:0	ENC Outputs	Maximum subindex	UINT8	RO	0x11 (17dec)
7010:01	Enable latch C	Activate latching via input “C”.	BOOLEAN	RO	0x00 (0dec)
7010:02	Enable latch extern on positive edge	Activate external latch with positive edge.	BOOLEAN	RO	0x00 (0dec)
7010:03	Set counter	Set counter	BOOLEAN	RO	0x00 (0dec)
7010:04	Enable latch extern on negative edge	Activate external latch with negative edge.	BOOLEAN	RO	0x00 (0dec)
7010:11	Set counter value	The counter value to be set via “Set counter” (index 0x7010:03).	UINT32	RO	0x00000000 (0dec)

4.13.5.2.4.1 Information / Diagnostic Data (Channel Specific)

4.13.5.2.5 Index A010 ENC Diag data

Index (hex)	Name	Meaning	Data type	Flags	Default
A010:0	ENC Diag data	Maximum subindex	UINT8	RO	0x03 (3dec)
A010:01	Open circuit A	Open circuit on track A	BOOLEAN	RO	0x00 (0dec)
A010:02	Open circuit B	Open circuit on track B	BOOLEAN	RO	0x00 (0dec)
A010:03	Open circuit C	Open circuit on track C	BOOLEAN	RO	0x00 (0dec)

4.13.5.2.6 Single-ended connection for TTL encoder

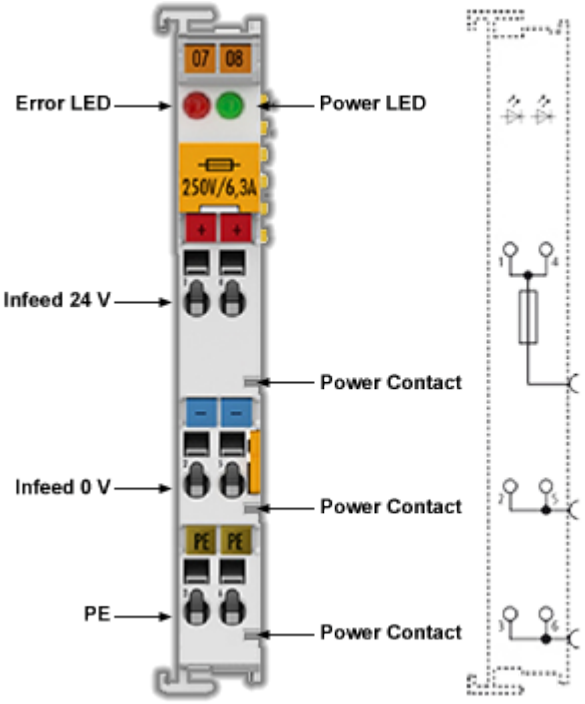
In addition to encoders with differential RS422 interface, single-ended encoders with TTL interface are also supported. Please note the following:

- Operating mode selection encoder "0x80n0:03 [❝ 141] Enable up/down counter = FALSE".
- The differential inputs (/A, /B, /C) must remain open and must not be connected to ground
- The option to reverse the direction of rotation is given by setting the bit in index 0x80n0:0E [❝ 141] "reversion of rotation =TRUE".
- The open circuit detection does not work in principle conditionally with single-ended connection

4.14 AKT2G-PSF-024-000

Power supply terminal with fuse, 24 V DC

The AKT2G-PSF-024 feed terminal can be positioned at any location between the input and output terminals for establishing a further potential group or for supplying the terminals following on the right in applications with high current load. The E-Bus is looped through.



Technical Data	AKT2G-PSF-024-000
Nominal voltage	24 VDC
Power contact current load	max. 10 A
Electrical isolation	500 V (E-bus/field potential)
Integrated fine-wire fuse	yes; 6.3 A
Current consumption from E-Bus	-
Bit width in the process image	-
Configuration	no address or configuration settings
Power LED	yes
Diagnosis (fuse)	yes, Error LED
Electrical connection to mounting rail	no
PE contact	yes
Renewed infeed	yes
Connection facility to additional power contact	1
Side by side mounting on Bus Terminals with power contact	yes

Technical Data	AKT2G-PSF-024-000
Side by side mounting on Bus Terminals without power contact	yes
Weight	approx. 55 g
Permissible ambient temperature range (during operation)	0°C ... +55°C
Permissible ambient temperature range (during storage)	-25°C ... +85°C
Permissible relative humidity	95%, no condensation
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)
Mounting	on 35 mm mounting rail conforms to EN 60715
Vibration/shock resistance	conforms to EN 60068-2-6/EN 60068-2-27
EMC resistance burst/ESD	conforms to EN 61000-6-2/EN 61000-6-4
Protection class	IP 20
Installation position	variable, see Positioning of passive Terminals
Approval	CE, ATEX, cULus

⚠CAUTION

Hazard to individuals and devices!

When designing a Bus Terminal block with different potentials on the power contacts (e.g. 230 V AC and 24 V DC), please note that it is mandatory to use potential separation terminals!
Bring the bus system into a safe, powered down state before starting installation, disassembly or wiring of the Bus Terminals!

4.14.1 Connections

Terminal Point		Description
Indication	Number	
+24 V	1	Supply input + 24 V (connected internally with terminal 4 and positive power contact)
0 V	2	0 V for supply input (connected internally with terminal 5 and negative power contact)
PE	3	PE (connected internally with terminal 6 and PE power contact)
+24 V	4	Supply input + 24 V (connected internally with terminal 1 and positive power contact)
0 V	5	0 V for supply input (connected internally with terminal 2 and negative power contact)
PE	6	PE (connected internally with terminal 3 and PE power contact)

4.14.2 LEDs

LED	Color	Meaning	
Power LED	green	off	No input voltage at supply input
		on	24 VDC at supply input
Error LED	red	off	Fuse OK
		on	Fuse error

4.15 AKT2G-SDI-004-000

4.15.1 Safety terminal with 4 digital fail-safe inputs

The AKT2G-SDI-004 is a digital input terminal with floating contacts for 24 V DC. The Bus Terminal has 4 fail-safe inputs.

With two-channel connection, the AKT2G-SDI-004 meets the requirements of IEC 61508:2010 SIL 3, DIN EN ISO 13849-1:2015 (Cat 4, PL e), UL508, UL1998 and UL991.

The safety terminal has the typical design of an EtherCAT terminal.

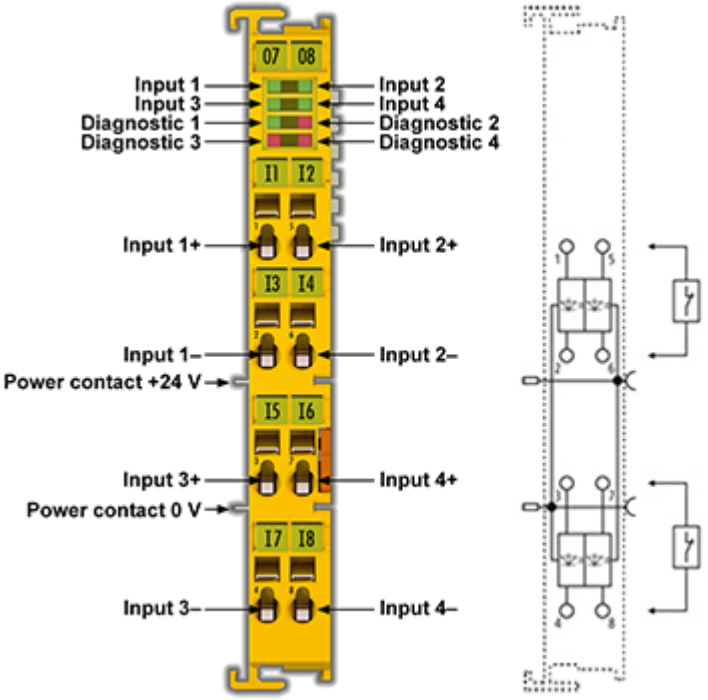


Figure 5-11: AKT2G-SDI-004 – safety terminal with 4 digital fail-safe inputs

TIP

Be sure to review

- Safety Instructions
- Safety Operation
- Safety Terminal Reaction Times
- Safety I/O Maintenance

4.15.2 Intended use

⚠WARNING

Caution - Risk of injury!

Safety components may only be used for the purposes described below!

The safety terminals expand the application range of the E-Bus terminal system with functions that enable them to be used for machine safety applications. The safety 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 safety terminals enable connection of:

- 24 VDC sensors (AKT2G-SDI-004) such as emergency off pushbutton switches, pull cord switches, position switches, two-hand switches, safety mats, light curtains, light barriers, laser scanner, etc.
- 24 VDC actuators (AKT2G-SDO-004) such as contactors, protection door switches with tumbler, signal lamps, servo drives, etc.

NOTE

Test pulses

When selecting actuators please ensure that the AKT2G-SDO-004 test pulses do not lead to actuator switching or diagnostic message from the AKT2G-SDO-004.

The following safety components have been developed for these tasks:

- The AKT2G-SDI-004 is an EtherCAT Terminal with 4 digital fail-safe inputs.
- The AKT2G-SDO-004 is an EtherCAT Terminal with 4 digital fail-safe outputs.

These safety components are suitable for operation on the

- Kollmorgen AKT2G-ECT-000-000 series Bus Couplers

⚠WARNING

Power supply from SELV/PELV power supply unit!

The safety components must be supplied with 24 VDC by an SELV/PELV power supply unit with an output voltage limit Umax of 36 VDC. Failure to observe this can result in a loss of safety.

⚠CAUTION

Follow the machinery directive!

The safety components may only be used in machines as defined in the machinery directive.

⚠CAUTION

Ensure traceability!

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

4.15.3 Technical Data

Product designation	AKT2G-SDI-004
Number of inputs	4
Status display	4 (one green LED per input)
Reaction time (read input/write to E-bus)	typically: 4 ms, maximum: see error reaction time
Error reaction time	≤ watchdog time
Cable length between sensor and terminal	unshielded max. 100 m (0.75 or 1 mm²) shielded max. 100 m (0.75 or 1 mm²)
Output current of the clock outputs	typically 10 mA, max. 15 mA
Input process image	6 bytes
Output process image	6 bytes
AKT2G-SDI-004 supply voltage (PELV)	24 VDC (–15% / +20%)
Signal voltage "0" inputs	-3 V to 5 V (EN 61131-2, type 3) see section Characteristic curve of the inputs
Signal voltage "1" inputs	11 V to 30 V (EN 61131-2, type 3) see section Characteristic curve of the inputs
Current consumption of the modular electronics at 24 V (without current consumption of sensors)	4 channels occupied: typically 12 mA 0 channels occupied: typically 1.4 mA
Current consumption via E-bus	4 channels occupied: approx. 200 mA
Power dissipation of the terminal	typically 1 W
Electrical isolation (between the channels)	no
Electrical isolation (between the channels and the E-bus)	yes
Insulation voltage (between the channels and the E-bus, under common operating conditions)	insulation tested with 500 VDC
Dimensions (W x H x D)	12mm x 100mm x 68mm
Weight	approx. 50 g
Permissible ambient temperature (operation) up to SW 05	0 °C to +55 °C (see note in Installation position and minimum distances)
Permissible ambient temperature (operation) from SW 06 (week 02/2014)	-25°C to +55 °C (see note in Installation position and minimum distances)
Permissible ambient temperature (transport/storage)	-40°C to +70°C

Product designation	AKT2G-SDI-004
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 (the deviation from 3K3 is possible only with optimal environmental conditions and also applies only to the technical data which are specified differently in this documentation)
Permissible level of contamination according to EN 60664-1	level of contamination 2 (comply with the section Safety I/O Maintenance
Impermissible operating conditions	Safety terminals must not be used under the following operating conditions: • under the influence of ionizing radiation (that exceeds the level of the natural environmental radiation) • in corrosive environments • in an environment that leads to unacceptable soiling of the Bus Terminal
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
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	see section Installation position and minimum distances
Approvals	CE, cULus

4.15.4 Safety Parameters

Key Figures	AKT2G-SDI-004
Lifetime [a]	20
Prooftest Interval [a]	not required [1]
PFHD	1.11E-09
%SIL3	1.11%
PFD	8.29E-05
%SIL3	8.29 %
MTTFd	high
DC	high
Performance level	PL e
Category	4
HFT	1
Element classification [2]	Type B

1. Special proof tests are not required during the entire service life of the AKT2G-SDI-004 EtherCAT terminal.
2. Classification according to IEC 61508-2:2010 (chapter 7.4.4.1.2 and 7.4.4.1.3)

The AKT2G-SDI-004 EtherCAT 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).

For the calculation or estimation of the MTTFd value from the PFHD value, further information can be found in ISO 13849-1:2015 Table K.1.

4.15.5 Characteristic curve of the inputs

The characteristic curve of the inputs is similar to type 3 according to EN 61131-2.

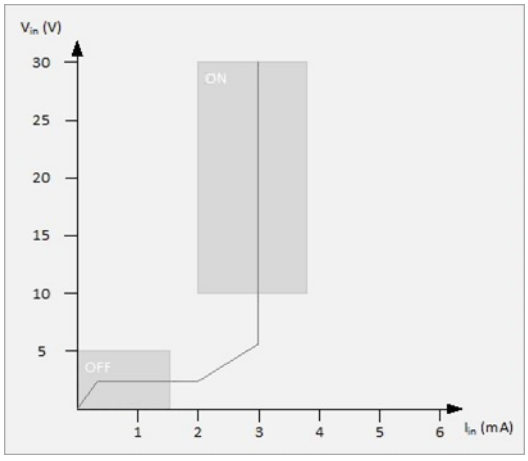
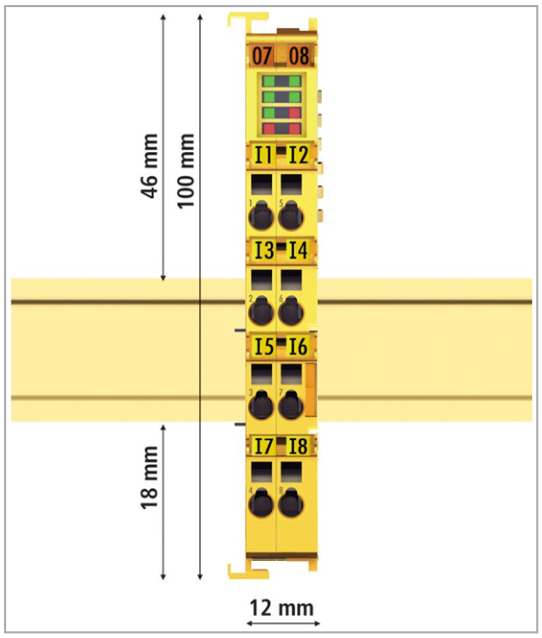


Figure 5-12: Characteristic curve of the inputs

4.15.6 Dimensions



Width	12 mm (side-by-side installation)
Height	100 mm
Depth	68 mm

Figure 5-13: Dimensions of the AKT2G-SDI-004.

4.15.7 Block Diagram of the AKT2G-SDI-004

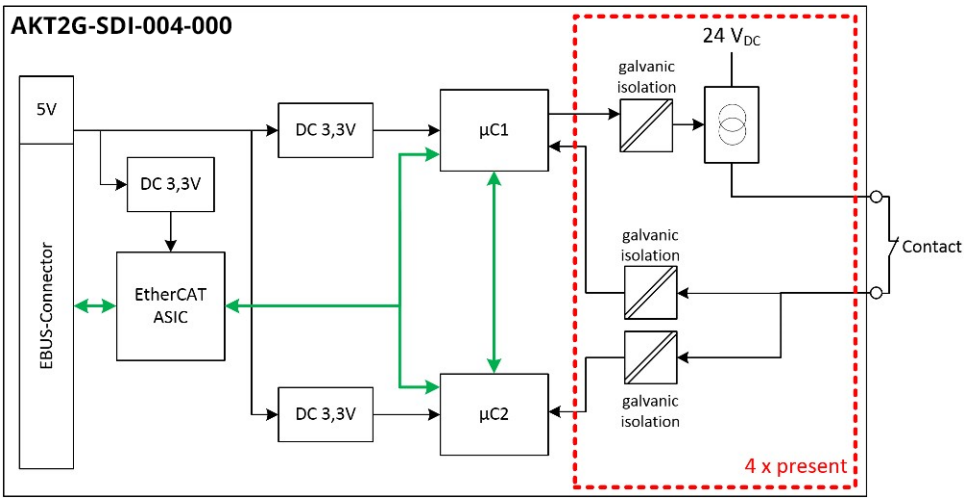


Figure 5-14: Block diagram of the AKT2G-SDI-004

The block diagram shows the basic configuration of a channel in the AKT2G-SDI-004. The part with a red border is present four times in the terminal.

4.15.8 AKT2G-SDI-004 Pin Assignment

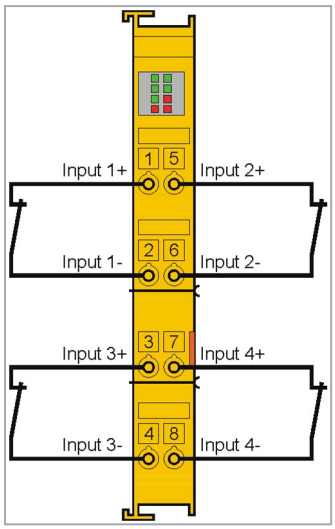


Figure 5-15: AKT2G-SDI-004 pin assignment

Terminal point	Input	Signal
1	1	Input 1+
2		Input 1-
3	3	Input 3+
4		Input 3-
5	2	Input 2+
6		Input 2-
7	4	Input 4+
8		Input 4-

NOTE

Configurable inputs

The inputs 1 to 4 can be occupied as you want with normally closed contacts or normally open contacts. The corresponding analysis is carried out in the safety PLC.

4.15.9 Signal Cables

4.15.9.1 Permitted cable length

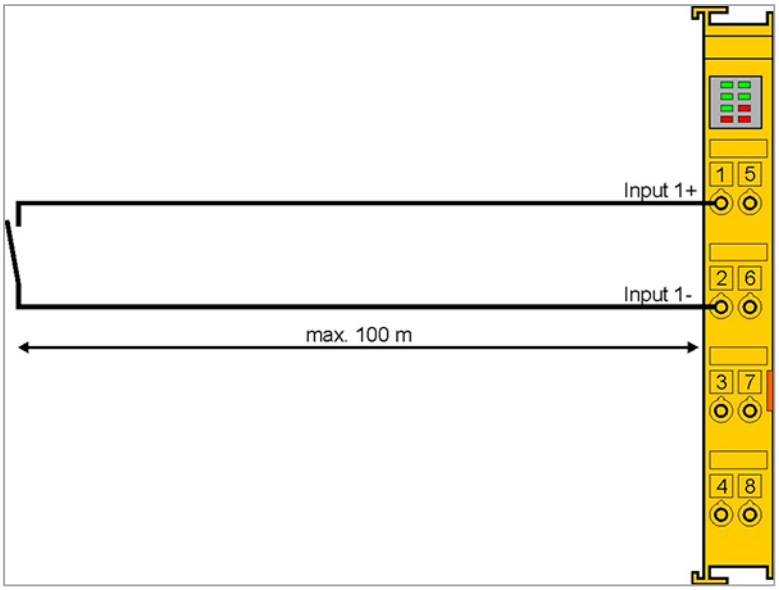


Figure 5-16: Permitted cable length

When connecting a single switching contact via its own continuous cabling (or via a non-metallic sheathed cable), the maximum permitted cable length is 100 m.

The use of contact points, connectors or additional switching contacts in the cabling reduces the maximum propagation.

4.15.9.2 Cable routing

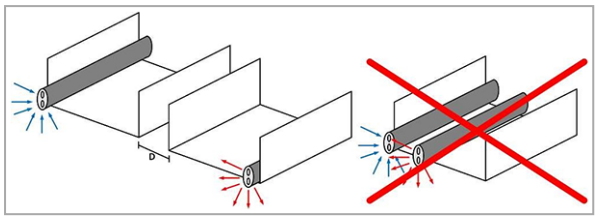


Figure 5-17: Cable routing

NOTICE

Route the signal cable separately

The signal cable must be routed separately from potential sources of interference, such as motor supply cables, 230 VAC power cables etc.!

Interference caused by cables routed in parallel can influence the signal form of the test pulses and thus cause diagnostic messages (e.g. sensor errors or OpenLoad errors).

- D: Distance between the cable ducts should be as large as possible
- blue arrows: signal line
- red arrows: potential source of interference

The common routing of signals together with other clocked signals in a common cable also reduces the maximum propagation, since crosstalk of the signals can occur over long cable lengths and cause diagnostic messages.

The test pulses can be switched off (sensor test parameter) if the connection of a common cable is unavoidable. However, this then leads to a reduction in the degree of diagnostic cover when calculating the performance level.

4.15.9.3 Test pulses

The typical length of a test pulse (switching from 24 V to 0 V and back to 24 V) is 350 µs and takes place approx. 250 times per second.

The test pulses at the outputs Input 1+ to Input 4+ are generated separately for each channel in order to be able to detect cross-circuits between the individual channels of a terminal and also between channels of different terminals. In order to generate test pulses as shown in the diagram, the sensor test active safety parameter must be set to true for the respective channels. The test cycle for all four channels is typically 4 ms. The times between the test pulses of different channels vary, thus allowing better diagnostic detection.

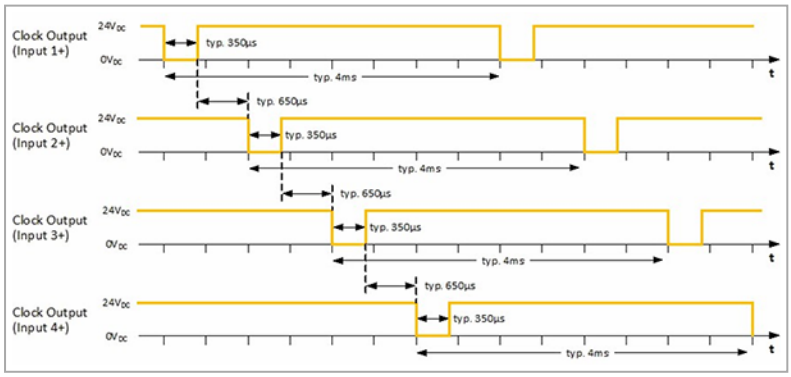


Figure 5-18: Typical course of test pulses of the inputs

If self-testing sensors are to be used on the safe inputs, please refer to chapter Configuration for light barriers, light grids, light curtains etc.

4.15.10 Address Settings on Safety Terminals with 65535 Possible Addresses

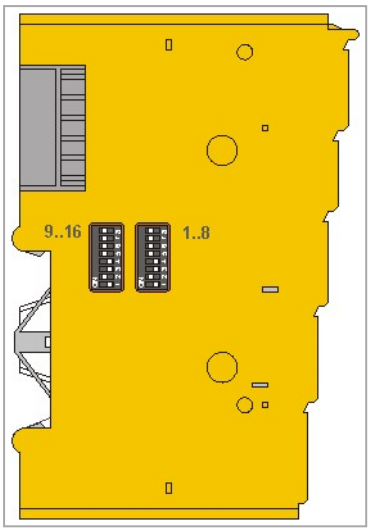


Figure 5-19: Address settings on safety terminals with 65535 possible addresses

Set the safety address for the terminal using the two dip switches (with 8 setting options) on the lefthand side of the AKT2G-SDI-004 safety terminal. Safety addresses between 1 and 65535 are available.

DIP switches																Address
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**1**
OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**2**
ON	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**3**
OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**4**
ON	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**5**
OFF	**ON**	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**6**
ON	**ON**	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**7**
OFF	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	**8**
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	**…**
ON	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	**65535**

⚠WARNING

Safety address

Each safety address may only be used once within a network!
The address 0 is not a valid safety address!

4.15.11 Safety Terminal Address and Parameters

PrmName	Meaning	Values
FSoE_Address	DIP switch address	1 to 65535
Operating Mode	Digital / standstill monitoring 1 and 2	Digital / standstill 1 and 2
Sensor test channel 1 active	The clock signal for connection Input1+ is checked at connection Input1-.	true / false
Sensor test channel 2 active	The clock signal for connection Input2+ is checked at connection Input2-.	true / false
Sensor test channel 3 active	The clock signal for connection Input3+ is checked at connection Input3-.	true / false
Sensor test channel 4 active	The clock signal for connection Input4+ is checked at connection Input4-.	true / false
Logic channel 1 and 2	Logic of channels 1 and 2	• single logic • asynchronous repetition OSSD (sensor test must be switched off) • any pulse repetition OSSD (sensor test must be switched off) • short cut is no module fault
Logic channel 3 and 4	Logic of channels 3 and 4	• single logic • asynchronous repetition OSSD (sensor test must be switched off) • any pulse repetition OSSD (sensor test must be switched off) • short cut is no module fault
Store Code	This parameter is required for the safety Restore Mode	0x0000
Project CRC	This parameter is required for the safety Restore Mode	0x0000

NOTE

Test pulses

If the parameters **Current Measurement active** or **Testing of outputs active** are set to TRUE, the terminal generates test pulses at the outputs. To avoid generating test pulses at the channel outputs, testing of outputs active and Current measurement active must be set to FALSE.

Please note that deactivating **Current measurement active** and/or **Testing of outputs active** may reduce the achievable performance level. A calculation example for the performance level can be found in the safety PLC application manual.

There are no known applications for which it would make sense to set **Testing of outputs active** to FALSE, while **Current measurement active** is set to TRUE.

4.15.11.1 AKT2G-SDI-004 configuration for light barriers, light grids, light curtains etc.

The AKT2G-SDI-004 also supports direct connection of contact-free protective devices with two self-testing outputs such as light barriers, light grids, light curtains, laser scanners, etc.

⚠CAUTION

Sensors with self-testing outputs!

Only sensors with self-testing outputs and a maximum sensor self-test duration of 350 µs may be connected to the AKT2G-SDI-004 (see illustration below).

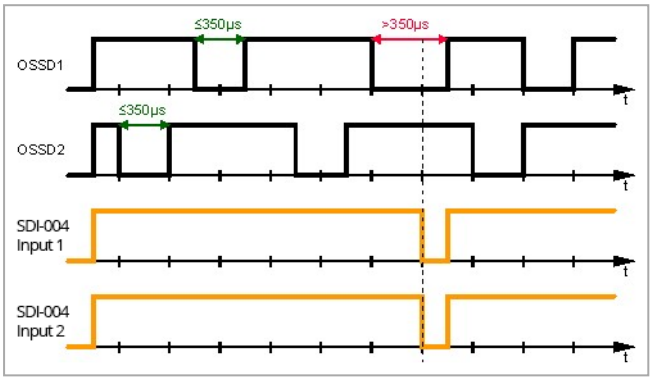


Figure 5-20: Maximum permissible sensor self-test duration of 350 µs

Parameter

To connect these sensors please set the following parameters for the AKT2G-SDI-004 in the safety PLC software:

Connect the two sensor signals either to channels 1 and 2 or channels 3 and 4 and *activate asynchronous repetition OSSD* or *any pulse repetition* for the two inputs used under parameter *Logic for channel x and y*. The difference between these settings is that with *any pulse repetition* simultaneous tests of the OSSD signals up to 350 µs are allowed.

For the two inputs used set the sensor test for the AKT2G-SDI-004 to **False**.

4.15.11.2 Configuration of the AKT2G-SDI-004 for safety switching mats

The AKT2G-SDI-004 also supports direct connection of safety switching mats.

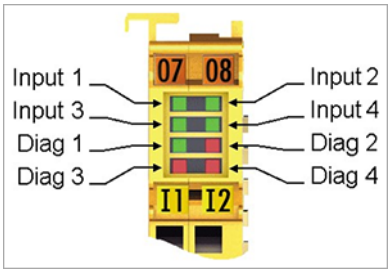
Parameter

To connect these switching mats please set the following parameters for the AKT2G-SDI-004 in the safety PLC software:

Connect the two sensor signals either to channels 1 and 2 or channels 3 and 4 and activate *short cut channel x/y is no module fault* for the two inputs used under parameter *Logic for channel x and y*.

4.15.12 AKT2G-SDI-004 Diagostic LEDs

The LEDs Diag 1 to Diag 4 display diagnostic information for the AKT2G-SDI-004.



4.15.12.1 Diag 1 (green)

The **Diag 1** LED indicates the state of the safety network.

Flashing Code	Meaning
LED illuminated continuously	normal operation: Safety communication OK
rapid flickering, alternating with 1 flash pulse	Error in S parameter (safety parameter)
rapid flickering, alternating with 2 flash pulses	Error in I parameter (Individual parameter)
rapid flickering, alternating with 3 flash pulses	Waiting for S and I parameter
rapid flickering, alternating with 4 flash pulses	S- and I-parameter correct: waiting for first host message
rapid flickering, alternating with 5 flash pulses	Watchdog error
rapid flickering, alternating with 6 flash pulses	CRC error
rapid flickering, alternating with 7 flash pulses	Sequence number error
rapid flickering, alternating with 8 flash pulses	Communication error in the safety protocol

4.15.12.2 Diag 2 (red)

The **Diag 2** LED illuminates red if the terminal detects an external supply or cross-circuit. The LED extinguishes once the error is rectified.

4.15.12.3 Diag 3 (red) and Diag 4 (red)

If the **Diag 3** LED is lit, the **Diag 4** LED indicates internal terminal errors.

4.15.12.3.1 Flashing Codes

In the case of such an error, the **Diag 4** LED on the AKT2G-SDI-004 displays flashing codes that describe the error in more detail.

A flashing code consists of four sequences, which are interrupted in each case by a short break. After the four sequences there is a long break, following which the flashing code is displayed again.

Count the individual sequences of the flashing code.

The errors indicated by the following flashing codes are reversible. After successful troubleshooting the terminal can be restarted.

Diag 3 LED	Diag 4 LED	Meaning	Remedy
	Flashing Code	Meaning	Remedy
lit	6-1-1-1	max. internal temperature exceeded	Ensure that the permissible ambient temperature is adhered to.
	7-1-1-1	internal temperature below min. value	
	2-1-2-1	max. supply voltage µC1 exceeded	Check the supply voltage.
	3-1-2-1	max. supply voltage µC2 exceeded	
	4-1-2-1	voltage fell below min. supply voltage µC1	
	5-1-2-1	voltage fell below min. supply voltage µC2	
	8-1-1-1	Temperature difference between the measuring points exceeded	Check the installation position and the ambient temperature.

If another flashing code is displayed, this means that there is an internal terminal error that has stopped the terminal. In this case the terminal must be checked by Kollmorgen.

NOTE

Note the flashing codes and return the terminal

Note the flashing code displayed and include this information with the terminal when you return it.

4.15.13 AKT2G-SDI-004 Diagostic Objects

⚠CAUTION

Do not change CoE objects!

Do not make any modifications to the CoE objects in the safety components! Any modifications of the CoE objects will permanently set the safety components to the Fail-Stop state.

Index $FA80_{hex}$: Internal temperature values

The CoE object $FA80_{hex}$ indicates the current internal temperature values of the AKT2G-SDI-004.

Index	Name	Meaning	Flags	Default
FA80:01	Temperature 1	Temperature measurement 1	RO	0_{bin}
FA80:02	Temperature 2	Temperature measurement 2	RO	0_{bin}

Index $800E_{hex}$: diagnostic information

The CoE object $800E_{hex}$ displays further diagnostic information.

Index	Name	Meaning			Flags	Default
800E:0	Diag	The following sub-indices contain detailed diagnostic information.			RO	
800E:0A	Sensor test error	Bit	Error during the sensor test		RO	
		0	1_{bin}	Error at input 1		0_{bin}
		1	1_{bin}	Error at input 2		0_{bin}
		2	1_{bin}	Error at input 3		0_{bin}
		3	1_{bin}	Error at input 4		0_{bin}
800E:0B	Error during two channel evaluation	Bit	Error during the contiguous evaluation of two channels, i.e. the two channels contradict each other.		RO	
		0	1_{bin}	Error in the first input pair		0_{bin}
		1	1_{bin}	Error in the second input pair		0_{bin}
800E:0C	Error in the safety mat operation mode: input pair disagree	Bits	Error in the input pair		RO	
		1, 0	11_{bin}	Error in the first input pair		00_{bin}
		3, 2	11_{bin}	Error in the second input pair		00_{bin}

Index	Name	Meaning			Flags	Default
800E:0D	Error in the safety mat operation mode: external supply	Bit	Error in the test pulses in the safety mat operating mode; i.e. the terminal has detected an external supply.		RO	
		0	1_{bin}	Error at input 1		0_{bin}
		1	1_{bin}	Error at input 2		0_{bin}
		2	1_{bin}	Error at input 3		0_{bin}
		3	1_{bin}	Error at input 4		0_{bin}

NOTE

Differing diagnostic messages possible

Due to the variable order or execution of the test series, diagnostic messages differing from those given in the table above are possible.

4.15.14 Certificates

The AKT2G-SDI-004-000 has been tested to the following directives and standards.

- 2006/42/EC
- EN 61508-1:2010 (up to SIL 3)
- EN 61508-2:2010 (up to SIL 3)
- EN 61508-3:2010 (up to SIL 3)
- EN 62061:2005/A2:2015 (up to SILCL 3)
- EN ISO 13849-1:2015 (Cat. 4, PL e)
- EN 81-20:2014
- EN 81-22:2014
- EN 81-50:2014
- EN 13243:2015

⚠CAUTION

Note on approval accroding to EN 81-20, EN 81-22, and EN 81-50

- The Safety components may only be used in machines that have been designed and installed in accordance with the requirements of the EN 60204-1 standard.
- Provide a surge filter for the supply voltage of the Safety components against overvoltages. (Reduction to overvoltage category II)
- EN 81 requires that in the case of devices with internal temperature monitoring, a stop must be reached in the event of an overtemperature. In this case, passengers must be able to disembark (see EN 81-20 chapter 5.10.4.3, for example). To ensure this, application measures are necessary. The internal terminal temperature of the Safety components can be read out by the user. There is a direct switch-off at the maximum permissible temperature of the respective Safety component (see Installation position and minimum distances).
- The user must select a temperature threshold below the maximum temperature such that a stop can be reached in all cases before the maximum temperature is reached. Information on the optimum terminal configuration can be found under Notes on the arrangement of Safety components and under Example configuration for temperature measurement.
- For the use of the Safety components according to EN 81-22 and EN 81-50, the conditions described in the manuals for achieving category 4 according to EN ISO 13849-1:2015 must be observed.
- The use of Safety components is limited to indoor applications.

- Basic protection against direct contact must be provided, either by fulfilling protection class IP2X or by installing the Safety components in a control cabinet which corresponds at least to protection class IP54 according to EN 60529.
- The ambient conditions regarding temperature, humidity, heat dissipation, EMC and vibrations, as specified in the operating instructions under technical data, must be observed.
- The operating conditions in potentially explosive atmospheres (ATEX) are specified in the operating instructions.
- The safe state (triggering) of the application must be the de-energized state. The safe state of the Safety components is always the de-energized, switched-off state, and this cannot be changed.
- The service life specified in the operating instructions must be observed.
- If the Safety component is operated outside the permissible temperature range, it changes to "Global Shutdown" state.
- The Safety components must be installed in a control cabinet with protection class IP54 according to EN 60529, so that the requirement for contamination level 3 according to EN 60664-1 can be reduced to level 2.
- The Safety components must be supplied by a SELV/PELV power supply unit with a maximum voltage of Umax ≤ 36 VDC.

4.16 AKT2G-SDO-004-000

4.16.1 Safety terminal with 4 digital fail-safe outputs

The AKT2G-SDO-004 is a safe output terminal with digital outputs for connecting actuators (contactors, relays, etc.) with a maximum current 0.5 A (24 VDC). The Bus Terminal has 4 fail-safe outputs.

The AKT2G-SDO-004 meets the requirements of IEC 61508:2010 SIL 3, DIN EN ISO 13849-1:2015 (Cat 4, PL e), UL508, UL1998 and UL991.

The safety terminal has the typical design of an EtherCAT terminal.

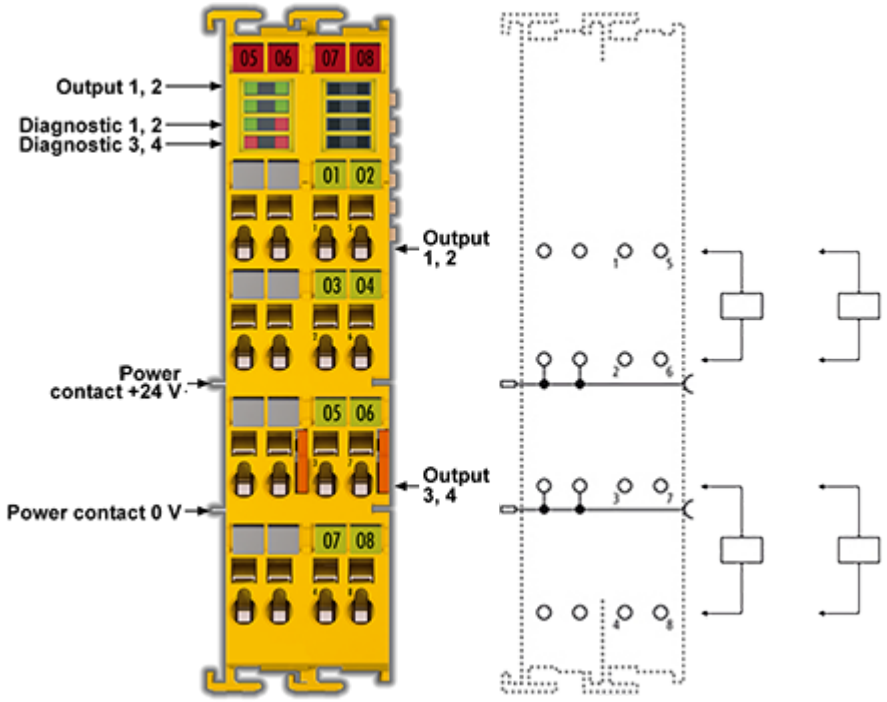


Figure 5-21: AKT2G-SDO-004-000 safety terminal with 4 digital fail-safe outputs

TIP

Be sure to review

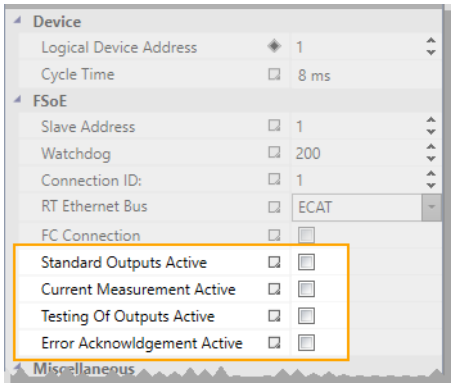
- Safety Instructions
- Safety Operation
- Safety Terminal Reaction Times
- Safety I/O Maintenance

Description of Safety Parameters

Parameter Name	Description	Values
Standard outputs	In addition the safe output can be switched off from the PLC program. The safe outputs are logically ANDed with the standard digital outputs.	True / False
Current measurement active	Current measurement for the outputs are activated	True / False
Testing of outputs active	Test pulses for the outputs are activated	True / False

Parameter Name	Description	Values
Error acknowledge active	True: Terminal errors lead to a reset of the FSoE connection (error code 14 (0x0E)). This error code is shown in the diagnostic data for the connection until it is acknowledged. False (Default): Terminal errors can only be reset by switching the power supply off and back on again.	True / False

For example, using the BBH SafePLC2 software, the parameters can be configured from the AKT2G-SDO-004-000 Properties:



4.16.2 Intended use

⚠WARNING

Caution - Risk of injury!

Safety components may only be used for the purposes described below!

The safety terminals expand the application range of the E-Bus terminal system with functions that enable them to be used for machine safety applications. The safety 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 safety terminals enable connection of:

- 24 VDC sensors (AKT2G-SDI-004) such as emergency off pushbutton switches, pull cord switches, position switches, two-hand switches, safety mats, light curtains, light barriers, laser scanner, etc.
- 24 VDC actuators (AKT2G-SDO-004 such as contactors, protection door switches with tumbler, signal lamps, servo drives, etc.

NOTE

Test pulses

When selecting actuators please ensure that the AKT2G-SDO-004 test pulses do not lead to actuator switching or diagnostic message from the AKT2G-SDO-004.

The following safety components have been developed for these tasks:

- The AKT2G-SDI-004 is an EtherCAT Terminal with 4 digital fail-safe inputs.
- The AKT2G-SDO-004 is an EtherCAT Terminal with 4 digital fail-safe outputs.

These safety components are suitable for operation on the

- Kollmorgen AKT2G-ECT-000-000 series Bus Couplers

⚠WARNING

Power supply from SELV/PELV power supply unit!

The safety components must be supplied with 24 VDC by an SELV/PELV power supply unit with an output voltage limit Umax of 36 VDC. Failure to observe this can result in a loss of safety.

⚠CAUTION

Follow the machinery directive!

The safety components may only be used in machines as defined in the machinery directive.

⚠CAUTION

Ensure traceability!

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

4.16.3 Technical Data

Product designation	AKT2G-SDO-004-000
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 with parameter **current measurement active** set
Actuators	When selecting actuators please ensure that the AKT2G-SDO-004-000 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	6 bytes
Output process image	6 bytes
AKT2G-SDO-004-000 supply voltage (PELV)	24 VDC (–15%/+20%)
Current consumption via E-bus	approx. 221 mA
Power dissipation of the terminal	typically 2 W
Electrical isolation (between the channels)	no
Electrical isolation (between the channels and the E-bus)	yes
Insulation voltage (between the channels and the E-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) up to SW 03	0°C to +55°C (see note in Installation position and minimum distances)
Permissible ambient temperature (operation) from SW 04 (week 02/2014)	-25°C to +55 °C (see note in Installation position and minimum distances)
Permissible ambient temperature (transport/storage)	-40°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)

Product designation	AKT2G-SDO-004-000
Climate category according to EN 60721-3-3	3K3 (the deviation from 3K3 is possible only with optimal environmental conditions and also applies only to the technical data which are specified differently in this documentation)
Permissible level of contamination according to EN 60664-1	level of contamination 2 (comply with the section Safety I/O Maintenance
Impermissible operating conditions	safety terminals must not be used under the following operating conditions: • under the influence of ionizing radiation (that exceeds the level of the natural environmental radiation) • in corrosive environments • in an environment that leads to unacceptable soiling of the Bus Terminal
EMC immunity/emission	conforms to EN 61000-6-2 / EN 61000-6-4
Vibration/shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
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	see section Installation position and minimum distances
Approvals	CE, cULus

4.16.4 Safety Parameters

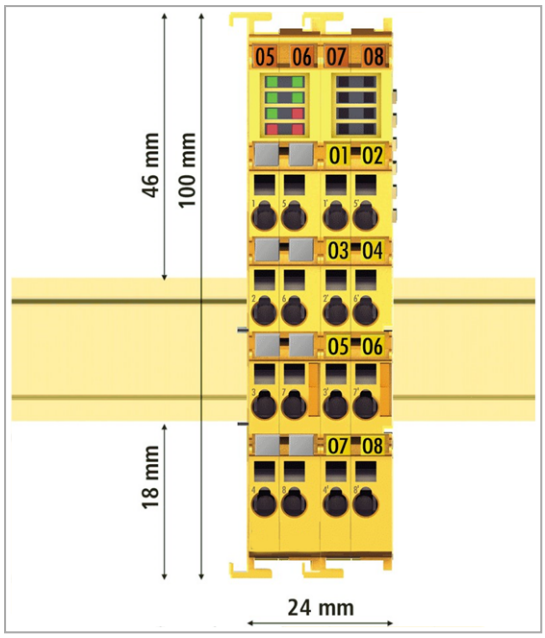
Key Figures	AKT2G-SDO-004-000
Lifetime [a]	20
Prooftest Interval [a]	not required [1]
PFH_D	1.25E-09
%SIL3	1,25 %
PFD	8.45E-05
%SIL3	8,45 %
$MTTF_d$	high
DC	high
Performance level	PL e
Category	4
HFT	1
Element classification [2]	Type B

1. Special proof tests are not required during the entire service life of the AKT2G-SDO-004 EtherCAT terminal.
2. Classification according to IEC 61508-2:2010 (chapter 7.4.4.1.2 and 7.4.4.1.3)

The AKT2G-SDO-004 EtherCAT 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).

For the calculation or estimation of the $MTTF_d$ value from the PFH_D value, further information can be found in ISO 13849-1:2015 Table K.1.

4.16.5 Dimensions



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

Figure 5-22: Dimensions of the AKT2G-SDO-004.

4.16.6 Block Diagram of the AKT2G-SDO-004

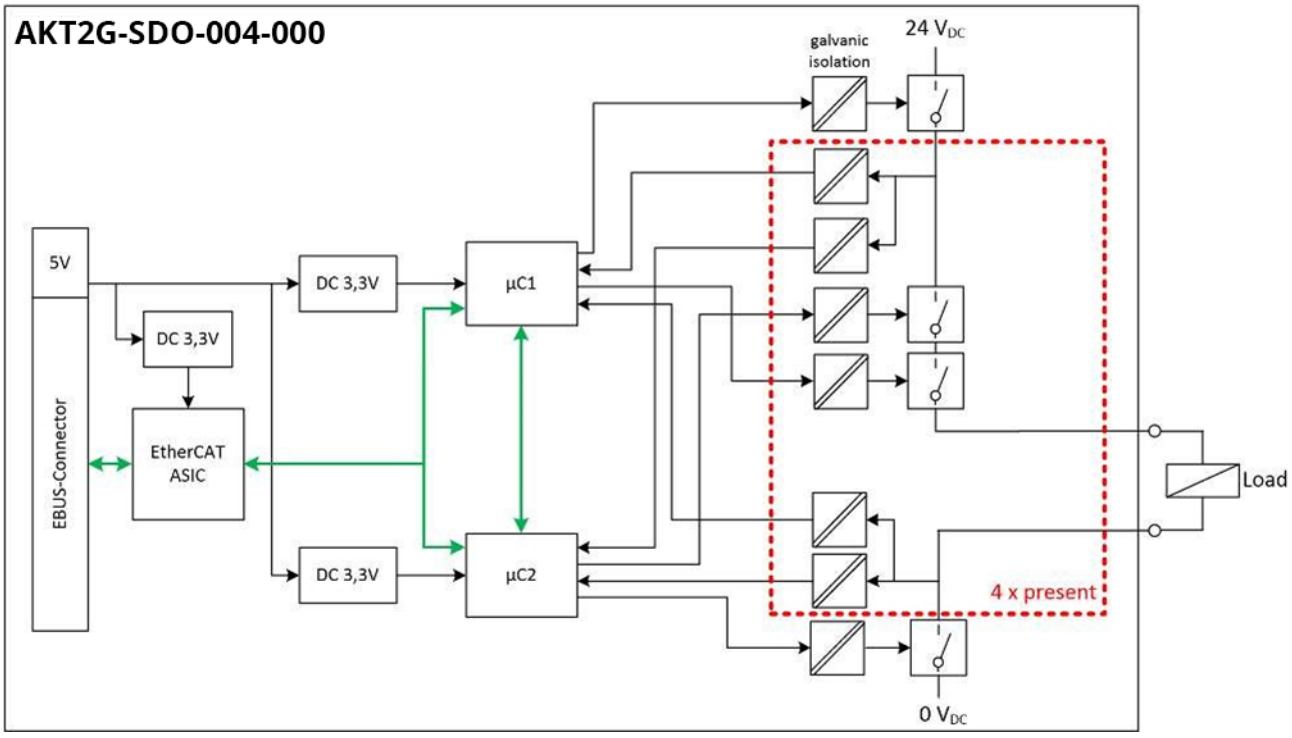


Figure 5-23: Block diagram of the AKT2G-SDO-004

The block diagram shows the basic configuration of a channel in the AKT2G-SDO-004. The part with a red border is present four times in the terminal. The high-side and low-side switches only exist once for all channels. This means that each channel has a total of four stop paths.

4.16.7 AKT2G-SDO-004 Pin Assignment

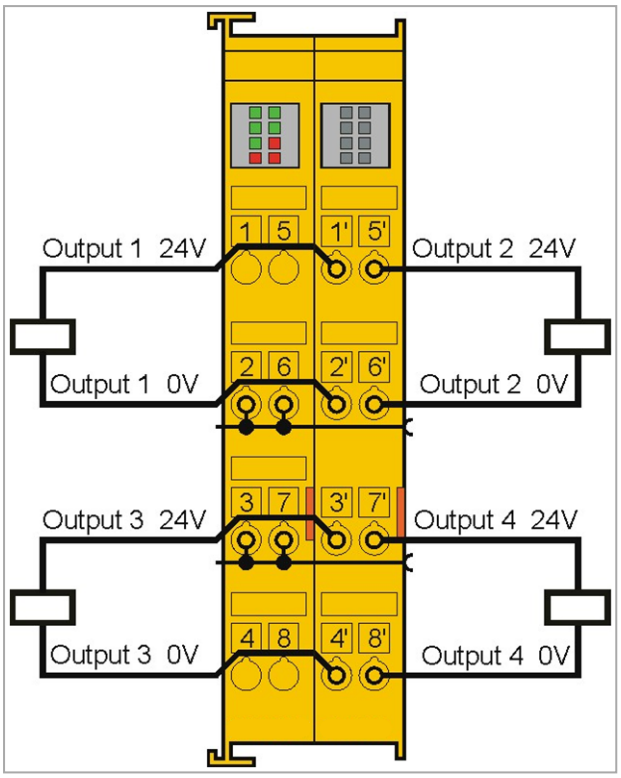


Figure 5-24: AKT2G-SDO-004 pin assignment

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 AKT2G-SDO-004 test pulses do not lead to actuator switching or diagnostic message from the AKT2G-SDO-004.

4.16.8 Signal Cables

4.16.8.1 Permitted cable length

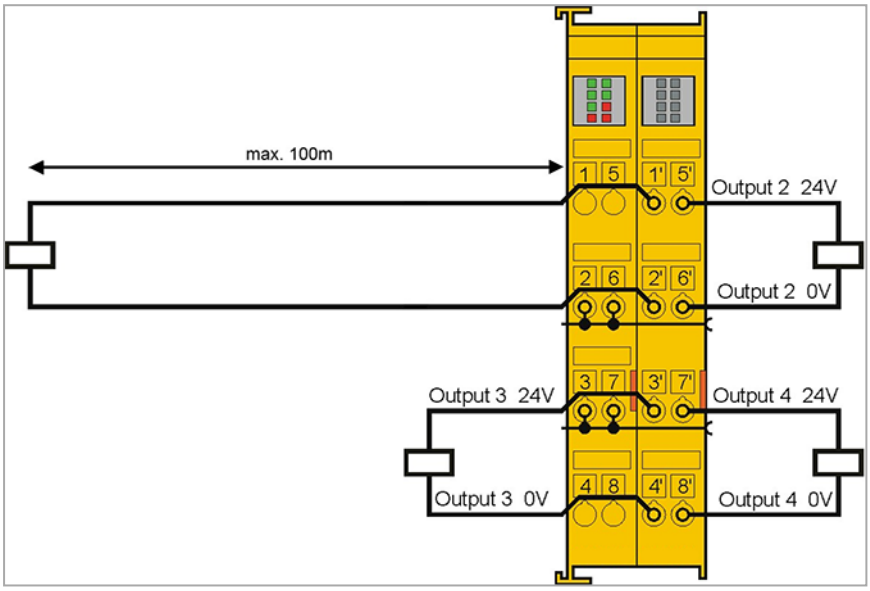


Figure 5-25: Permitted cable length

When connecting a single switching contact via its own continuous cabling (or via a non-metallic sheathed cable), the maximum permitted cable length is 100 m.

The use of contact points, connectors or additional switching contacts in the cabling reduces the maximum propagation.

4.16.8.2 Cable routing

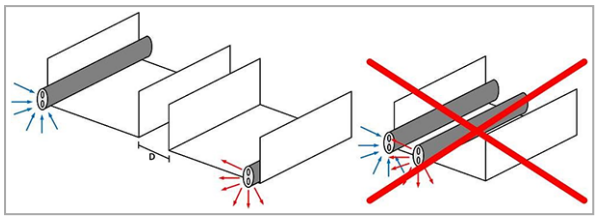


Figure 5-26: Cable routing

NOTICE

Route the signal cable separately

The signal cable must be routed separately from potential sources of interference, such as motor supply cables, 230 VAC power cables etc.!

Interference caused by cables routed in parallel can influence the signal form of the test pulses and thus cause diagnostic messages (e.g. sensor errors or OpenLoad errors).

- D: Distance between the cable ducts should be as large as possible
- blue arrows: signal line
- red arrows: potential source of interference

The common routing of signals together with other clocked signals in a common cable also reduces the maximum propagation, since crosstalk of the signals can occur over long cable lengths and cause diagnostic messages.

The test pulses can be switched off (sensor test parameter) if the connection of a common cable is unavoidable. However, this then leads to a reduction in the degree of diagnostic cover when calculating the performance level.

4.16.8.3 Test Pulses

The typical length of test pulse (switching from 24 V to 0 V and back to 24 V) is 300 µs to 800 µs. Testing usually takes place 5 to 7 times per second.

NOTE

Test pulses for the outputs

The following diagram shows a typical test pulse curve for the four outputs of an AKT2G-SDO-004. The parameters Current measurement active and Testing of outputs active are enabled.

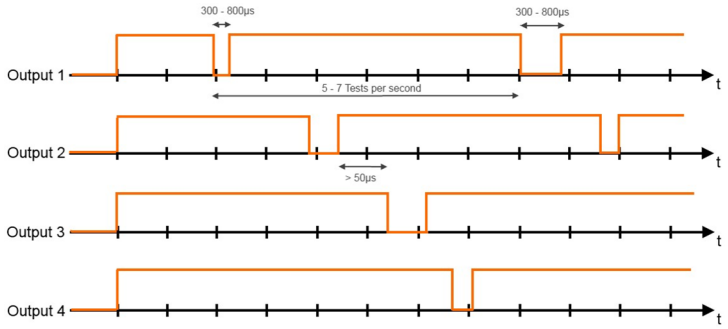


Figure 5-27: Typical course of test pulses of the outputs.

4.16.9 Address Settings on Safety Terminals with 1023 Possible Addresses

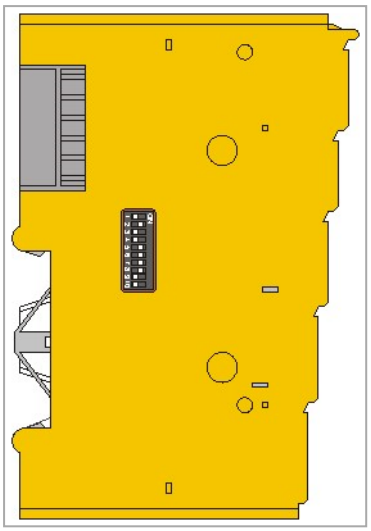


Figure 5-28: Address settings on safety terminals with 1023 possible addresses

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

DIP switch										Address
1	2	3	4	5	6	7	8	9	10	
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

Safety address

Each safety address may only be used once within a network!
The address 0 is not a valid safety address!

4.16.10 Safety Terminal Address and Parameters

PrmName	Meaning	Values
FSoE_ Address	DIP switch address	1 to 1023
Standard outputs active	In addition the output can be switched off from the standard PLC. The safe output is linked with the standard logic signal AND.	true / false
Current measurement active	Current measurement for the outputs is activated	true / false
Testing of outputs active	Test pulses for the outputs are activated	true / false
Error acknowledge active	**True:** Terminal errors lead to a reset of the safety connection (error code 14 (0x0E)). This error code is shown in the diagnostic data for the connection until the user acknowledges it via ErrAck. **False (Default):** Terminal errors can only be reset by switching the power supply off and back on again.	true / false
Store Code	This parameter is required for the safety Restore Mode	0x0000
Project CRC	This parameter is required for the safety Restore Mode	0x0000

NOTE

Test pulses

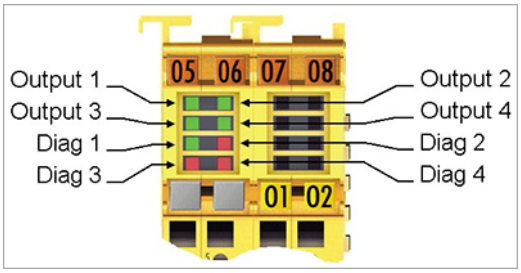
If the parameters **Current Measurement active** or **Testing of outputs active** are set to TRUE, the terminal generates test pulses at the outputs. To avoid generating test pulses at the channel outputs, testing of outputs active and Current measurement active must be set to FALSE.

Please note that deactivating **Current measurement active** and/or **Testing of outputs active** may reduce the achievable performance level. A calculation example for the performance level can be found in the safety PLC application manual.

There are no known applications for which it would make sense to set **Testing of outputs active** to FALSE, while **Current measurement active** is set to TRUE.

4.16.11 AKT2G-SDO-004 Diagostic LEDs

The LEDs Diag 1 to Diag 4 display diagnostic information for the AKT2G-SDO-004.



4.16.11.1 Diag 1 (green)

The **Diag 1** LED indicates the state of the safety network.

Flashing Code	Meaning
LED illuminated continuously	Diagnostic flashing code in preparation

4.16.11.2 Diag 2 (red)

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

Flashing Code	Meaning
rapid flickering, alternating with 1 flash pulse	Error at output 1
rapid flickering, alternating with 2 flash pulses	Error at output 2
rapid flickering, alternating with 3 flash pulses	Error at output 3
rapid flickering, alternating with 4 flash pulses	Error at output 4
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	Internal terminal temperature too low
rapid flickering, alternating with 8 flash pulses	Internal 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

4.16.11.3 Diag 3 (red) and Diag 4 (red)

If the **Diag 3** LED is lit, the **Diag 4** LED indicates internal terminal errors.

These errors lead to shutdown of the terminal. The terminal must be checked by Kollmorgen.

4.16.11.3.1 Flashing Codes

In the case of such an error, the **Diag 4** LED on the AKT2G-SDO-004 displays flashing codes that describe the error in more detail.

A flashing code consists of four sequences, which are interrupted in each case by a short break. After the four sequences there is a long break, following which the flashing code is displayed again.

Count the individual sequences of the flashing code.

NOTE

Note the flashing codes and return the terminal

Note the flashing code displayed and include this information with the terminal when you return it.

4.16.12 Possible Causes of Diagnostic Messages - AKT2G-SDO-004

Diagnostics	Possible cause	Remedial actions
Diag 2 LED Flash code 1 to 4 or 10	If parameters "Testing of outputs active" and/or "Current measurement active" are enabled:	
	Faulty test pulses. Cause: external supply or cross-circuit.	Eliminate cross-circuit or external supply.
	Faulty test pulses. Cause: parallel routed cables with high capacitive coupling and dynamized signals, possibly also in common cables	Isolate lines and lay in separate non-metallic sheathed cable. Create a distance between the non-metallic sheathed cables.
	Cause: Current is below the limit of 20 mA or above the limit of 500 mA.	Select actuator accordingly. Current > 20mA and < 500mA
	Regardless of whether the parameters "Testing of outputs active" and/or "Current measurement active" are enabled:	
	The output voltage lies below the permissible voltage range (24V - 15%/+20%). A possible cause is a short-circuit at the output or e.g. a voltage drop at the instant of switching.	Eliminate short-circuit. Design power supply accordingly. Check supply lines for voltage drop.
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal
Diag 2 LED Flash code 5	Voltage at the power contacts not switched on.	Switch on voltage at the power contacts and reset the error display through PowerOn Reset of the terminal
	Voltage at the power contacts was switched on after the terminal supply	Switch on voltage at the power contacts before or at the same time as the terminal supply and reset the error display through PowerOn Reset of the terminal
	Voltage on the power contacts too low.	Increase the voltage at the power contacts and reset the error display through PowerOn Reset of the terminal
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal

Diagnostics	Possible cause	Remedial actions
Diag 2 LED Flash code 6	Field voltage too high. Voltage on the power contacts too high.	Reduce the voltage at the power contacts and reset the error display through PowerOn Reset of the terminal
	Voltage briefly too high due to external influences, such as switching contactors off.	Use an R/C or diode-based protective circuit on the actuators
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal
Diag 2 LED Flash code 7	Terminal temperature too low	Comply with the specified temperature range
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal
Diag 2 LED Flash code 8	Terminal temperature too high	Comply with the specified temperature range
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal
Diag 2 LED Flash code 9	Terminal temperature difference too large: one of the 3 internal measuring points is faulty	Replace terminal
	Terminal temperature difference too large: An internal measuring point shows an elevated temperature due to inadequate convection.	Check the installation position of the terminal and modify it according to the specifications in section Mechanical installation, if required
	EMC faults	Take suitable EMC measures
	Internal defect	Replace terminal

4.16.13 Certificates

The AKT2G-SDO-004-000 has been tested to the following directives and standards.

- 2006/42/EC
- EN 61508-1:2010 (up to SIL 3)
- EN 61508-2:2010 (up to SIL 3)
- EN 61508-3:2010 (up to SIL 3)
- EN 62061:2005/A2:2015 (up to SILCL 3)
- EN ISO 13849-1:2015 (Cat. 4, PL e)
- EN 81-20:2014
- EN 81-22:2014
- EN 81-50:2014
- EN 13243:2015

⚠CAUTION

Note on approval accroding to EN 81-20, EN 81-22, and EN 81-50

- The Safety components may only be used in machines that have been designed and installed in accordance with the requirements of the EN 60204-1 standard.
- Provide a surge filter for the supply voltage of the Safety components against overvoltages. (Reduction to overvoltage category II)
- EN 81 requires that in the case of devices with internal temperature monitoring, a stop must be reached in the event of an overtemperature. In this case, passengers must be able to disembark (see EN 81-20 chapter 5.10.4.3, for example). To ensure this, application measures are necessary. The internal terminal temperature of the Safety components can be read out by the user. There is a direct switch-off at the maximum permissible temperature of the respective Safety component (see Installation position and minimum distances).
- The user must select a temperature threshold below the maximum temperature such that a stop can be reached in all cases before the maximum temperature is reached. Information on the optimum terminal configuration can be found under Notes on the arrangement of Safety components and under Example configuration for temperature measurement.
- For the use of the Safety components according to EN 81-22 and EN 81-50, the conditions described in the manuals for achieving category 4 according to EN ISO 13849-1:2015 must be observed.
- The use of Safety components is limited to indoor applications.
- Basic protection against direct contact must be provided, either by fulfilling protection class IP2X or by installing the Safety components in a control cabinet which corresponds at least to protection class IP54 according to EN 60529.
- The ambient conditions regarding temperature, humidity, heat dissipation, EMC and vibrations, as specified in the operating instructions under technical data, must be observed.
- The operating conditions in potentially explosive atmospheres (ATEX) are specified in the operating instructions.
- The safe state (triggering) of the application must be the de-energized state. The safe state of the Safety components is always the de-energized, switched-off state, and this cannot be changed.
- The service life specified in the operating instructions must be observed.
- If the Safety component is operated outside the permissible temperature range, it changes to "Global Shutdown" state.
- The Safety components must be installed in a control cabinet with protection class IP54 according to EN 60529, so that the requirement for contamination level 3 according to EN 60664-1 can be reduced to level 2.
- The Safety components must be supplied by a SELV/PELV power supply unit with a maximum voltage of Umax ≤ 36 VDC.

About KOLLMORGEN

Kollmorgen is a leading provider of motion systems and components for machine builders. Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions that are unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.

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