Instruction handbook

be in motion   be in motion

BAUMÜLLER

b maXX® Systems

E-Bus Terminals

E	5.17019.01

Read the instruction handbook before starting work!

Table of Contents

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

GENERAL INFORMATION

This Instruction handbook is an important component of your b maXX system; this means that you must thoroughly read this document, not least to ensure your own safety.

Additionally, the valid accident prevention regulations and general safety regulations applicable to the scope of application the device must be complied with.

In this chapter, we will describe the first steps.

1.1 First Steps

The Bus Terminal System

Currently, the input/output signals are wired locally at fieldbus devices and centrally at programmable control devices. The manufacturer-specific fieldbus devices with fixed input/output configuration and design that are currently available often make it necessary to install an entire group of devices with similar functionality.

This costly method of signal acquisition gives rise to high material, installation, planning and documentation costs as well as high costs for subsequent modification or expansion. Inventory management and service staff are put under unnecessary strain.

Flexible and stable

The Baumueller E-Bus Terminal is a flexible periphery concept consisting of electronic terminal blocks. The head of an electronic terminal block is the Bus Coupler with the EtherCAT interface.

1.2 Legend

Warnings

Warnings are marked by symbols in this instruction handbook. The warnings are introduced by signal words, which express the extent of the hazard.

Comply with the warnings under all circumstances and act with caution in order to avoid accidents, personal injury and property damage.

	DANGER!
⚠	....notifies of an imminent dangerous situation, which will lead to death or serious injuries if not avoided.

	WARNING!
⚠	....notifies of a potentially dangerous situation, which can lead to death or serious injuries if not avoided.

	CAUTION!
⚠	....notifies of a potentially dangerous situation, which can lead to minor or slight injuries if not avoided.

	NOTICE!
①	....notifies of a potentially dangerous situation, which can lead to property damage if not avoided.

**Recommenda-
tions**

	NOTE!
ⓘ	....draws attention to useful tips and recommendations as well as information for efficient and trouble-free operation.

1.3 Limitation of liability

All statements and instructions in this instruction handbook have been compiled in compliance with the applicable standards and legislation while taking the current level of technology and our long-term experience and findings into account.

The manufacturer assumes no liability for damages resulting from:

- failure to follow the application manual
- application for purposes other than those intended
- untrained personnel

The actual scope of materials delivered can vary from the explanations and illustrations described here in the event of custom designs, the use of additional ordering options or due to the most recent changes in technology.

The user assumes the responsibility of conducting maintenance and commissioning in accordance with the safety regulations of the applicable standards and all other relevant national or regional legislation relating to conductor dimensioning and protection, grounding, circuit breakers, overvoltage protection, etc.

The person who conducted the assembly or installation shall be accountable for damages occurring during assembly or connection.

1.4 Preliminary information

NOTICE!

The following shall apply if the document you are reading is designated as preliminary information:

This version pertains to preliminary technical information, which the user of the described devices and functions should receive ahead of time, in order to be able to adjust to potential changes and/or all expansions. This information is to be seen as preliminary, since it has not yet been subjected to the Baumüller internal review process. In particular, this information is still subject to changes, meaning that this preliminary information cannot be construed as legally binding. Baumüller assumes no liability for damages resulting from this potentially incorrect or incomplete version. Should you detect or suspect content-related and/or serious formal errors in this preliminary information, please contact the contact person at Baumüller assigned to you and inform us of your findings and comments, so that they can be taken into account and potentially incorporated during the transition from the preliminary information to the final (reviewed by Baumüller) information.

1.5 Copyright

Treat the instruction handbook as confidential. It is intended exclusively for those working with the device. It is not permissible to transfer the application manual to third parties without the written approval of the manufacturer.

> **NOTE!**
>
> The content-related statements, texts, diagrams, images and other illustrations are copyright protected and subject to industrial property rights. Any improper use is liable to prosecution.

b maXX®   is a registered trademark of Baumüller Nürnberg GmbH

EtherCAT® is a registered trademark of Beckhoff Automation GmbH,
33415 Verl, Deutschland

> **NOTE!**
>
> Please note, that Baumüller is not responsible to examine whether any (industrial property) rights of third parties are infringed by the application-specific use of the Baumüller products/components or the execution.

1.6 Further applicable documents from other manufacturers

Components from other manufacturers are built into the device. Hazard evaluations for these bought-in parts have been conducted by the applicable manufacturers. The conformity of the designs with the applicable European and national legislation has been declared by the respective component manufacturers.

1.7 Spare parts

> **WARNING!**
>
> Improper or defective spare parts can lead to damage, malfunctions or total failure as well as jeopardize safety.
>
> Therefore:
> - Only use original spare parts from the manufacturer

Procure replacement parts from authorized dealers or directly at the manufacturer.

1.8 Disposal

If no return or disposal agreement has been made, dismantled components can be taken for recycling after proper disassembly.

1.9 Warranty provisions

The warranty provisions are found as a separate document in the sales documents.

The operation of the devices described here in accordance with the specified methods/ procedures/requirements is permitted. Everything else, even the operation of devices in installation positions not depicted here, for instance, is not permissible and must be clarified with the factor on a case-by-case base. The warranty will be rendered null and void if the devices are operated differently than described here.

1.10 Customer service

Our customer service is available for technical support.

Information on the competent contact person can be found at any time via telephone, fax, E-mail or over the internet.

1.11 Terms Used

In this documentation, we will also refer to Baumüller's "**E-Bus Terminals**" product as „Terminal", or "plug-in module".

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

SAFETY

This section provides an overview of all of the important safety aspects for optimum protection of personnel as well as for the safe and problem-free operation.

2.1 Contents of the application manual

Each person who is tasked with performing work on or with the device must have read and understood the application manual before working with the device. This also applies if the person involved with this kind of device or a similar one, or has been trained by the manufacturer.

2.2 Changes and modifications to the device

In order to prevent hazards and to ensure optimum performance, no changes, additions or modifications may be undertaken on the device that have not been explicitly approved by the manufacturer.

2.3 Usage for the intended purpose

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

You must always use the module appropriately. Some important information is listed below. The information below should give you an idea of what is meant by appropriate use of the module. The information below has no claim to being complete; always observe all the information that is given in these operating instructions.

- Configure the application such that the module is always operating within its specifications.
- Ensure that only qualified personnel works with this module.
- Install the module as specified in this documentation.
- Ensure that connections always comply with the stipulated specifications.
- Operate the module only when it is in technically perfect condition.
- Always operate the module in an environment that is specified in the technical data.
- Always operate the module in a standard condition. For safety reasons, you must not make any changes to the module.
- Observe all the information on this topic if you intend to store the module.

You will be using the module in an appropriate way if you observe all the comments and information in these operating instructions.

	WARNING!
⚠️	**Power supply from SELV/PELV power supply unit!**
	The terminal components must be supplied with 24 V_{DC} by an SELV/PELV power supply unit with an output voltage limit U_{max} of 36 V_{DC}. Failure to observe this can result in a loss of safety.

	WARNING!
⚠️	**Danger due to use other than intended!**
	Any use of the device different from and/or exceeding beyond the scope of the intended use can lead to dangerous situations.
	Therefore:
	• Only use the device as intended.
	• Follow all specifications of this Operation Manual.
	• Ensure that exclusively qualified personnel work on or with this device.
	• Take care in project planning to see that the device is always used within its specifications.
	• The device and/or mounting rail is mounted on a wall which is sufficiently sturdy.
	• Ensure that the power supply meets the required specifications.
	• Only operate the device if it is in technically faultless condition.
	• Only use the device in combination with components approved by Baumüller Nürnberg GmbH.

2.4 Responsibility of the operator

The device will be used in commercial areas. Thus, the proprietor of the device is subject to the legal work safety regulations.

Along with the notes on work safety in this operating manual, the safety, accident prevention and environmental protection regulations valid for the area of application of this device must be complied with. Whereby:

- The proprietor must inform himself about the applicable work health and safety regulations and ascertain, in a hazard assessment, any additional hazards that could arise from the special working conditions in the use area of the device. These must then be implemented in the form of operating instruction for operation of the device.
- This application manual must be kept accessible to personnel working with the device at all times in the immediate vicinity of the device.
- The specifications of the instruction handbook must be adhered to completely and without exception.
- The device may only be operated in a technically faultless and operationally safe condition.

2.5 Protective devices

Protection rating	
.	IP 20

All devices must be installed in an appropriate control cabinet to meet the protection ratings required in IEC 60529 (IP54).

	DANGER!
	Risk of fatal injury from electrical current!
	There is an immediate risk of fatal injury if live electrical parts are contacted.
	Therefore:
	• Operate the device in an electrical cabinet which provides protection from direct contact with the devices and meets at least the protective categories (IP54) of EN 60529.

2.6   Training of the personnel

> ⚠️ **WARNING!**
>
> Risk of injury due to insufficient qualifications!
>
> Improper handling can lead to significant personal injury and material damage.
>
> Therefore:
>
> - Certain activities can only be performed by the persons stated in the respective chapters of this application manual.

In this application manual, the following qualifications are stipulated for various areas of activity:

- Operating personnel
  - The drive system may only be operated by persons who have been specially trained, familiarized and authorized.
  - Troubleshooting, maintenance, cleaning, maintenance and replacement may only be performed by trained or familiarized personnel. These persons must be familiar with the application manual and act accordingly.
  - Initial operation and familiarization may only be performed by qualified personnel.
- Qualified personnel
  - Electrical engineers authorized by Baumüller Nürnberg GmbH, and qualified electricians of the customer or a third party who have learned to install and maintain Baumüller drive systems and are authorized to ground and identify electrical power circuits and devices in accordance with the safety engineering standards of the company.
  - Qualified personnel have had occupational training or instruction in accordance with the respective locally applicable safety engineering standards for the upkeep and use of appropriate safety equipment.

2.7 Personal protective equipment

The wearing of personal protective equipment is required when working in order to minimize health and safety risks.

- The protective equipment necessary for each respective type of work shall always be worn during work.
- The personal safety signs present in each working area must be observed.

Protective work clothing

should be snug-fitting work clothes, with low tearing resistance, narrow sleeves and with no extending parts.

No rings or chains may be worn.

Hard hat

protection against falling and flying objects.

Safety shoes

protection against heavy falling objects.

Protective gloves

to protect hands against friction, abrasion, puncturing or more severe injuries, as well as the contact with hot objects.

Wear for special tasks

Protective glasses

protection of the eyes against objects, which are flying around and against splashing liquids.

2.8   Special hazards

In the following section the residual risks are specified, which result from the hazard analysis.

Observe the safety notes listed here and the warning notes in the further chapters of this manual to reduce health risks and dangerous situations.

Electricity

DANGER!

Risk of fatal injury from electricity!

There is an immediate risk of fatal injury if live electrical parts are contacted. Damage to the insulation or individual components can be life-threatening.

Therefore:
- Switch off the electrical power immediately in case of damage to the power supply insulation.
- Only allow work on the electrical system to be performed by qualified personnel.
- Switch off the current when any kind of work is being performed on the electrical system and secure it against being started again.

Danger from residual energy

DANGER!

Risk of fatal injury from electrical current!

After separation of the device from the mains parts under voltage as e. g. power connections may only be touched if the capacitors in the device have been discharged.

Therefore:
- Do not touch before taking the discharge time of the capacitors and the electrically live parts into account.
- Pay attention to corresponding notes on the equipment.
- If additional capacitors are connected to the intermediate circuit, the DC-link discharge can take much longer. In this case, the necessary waiting period must be determined itself or a measurement made as to whether the equipment is de-energized.

Moving components

	WARNING!
⚠	Risk of injury from moving components!
	Rotating components and/or those moving linearly can result in severe injury.
	Therefore:
	• Do not in intervene in moving components during operation.
	• Do not open any covering during operation.
	• The amount of residual mechanical energy depends on the application. Powered components still turn/move for a certain length of time even after the power supply has been switched off. Ensure that adequate safety measures are taken.

2.9 Fire fighting

	DANGER
⚠	Risk of fatal injury from electrical current!
	There is a risk of electric shock if an electrically-conductive, fire-extinguishing agent is used.
	Therefore:
	• Use the following fire-extinguishing agent:
	🧯 Firefighting equipment

2.10 Electrical safety

The option module is laid out for degree of pollution 2 accordant to EN 50178. This means, that only non-conductive pollutions may occur during operating time. Short-term conductivity by condensation is permitted only, if the module is out of operation.

	WARNING!
⚠️	Risk of injury due to conductive pollutions!
	No conductive pollutions may occur during operating time.
	Therefore:
	● If necessary, assure with additional measures that the degree of pollution 2 is not exceeded before installing the system.

2.10.1 Notes according to the power supply

	WARNING!
⚠️	Risk of injury from electrical current!
	Only those devices may be connected to the module, which ensure a reliable electrical isolation to the 230 V system.
	The power-supply unit for that generates the 24 volt-supply must be in accordance with the requirements for PELV referring to EN 50178.

2.11 Safety equipment

	WARNING!
⚠️	Risk of fatal injury due to non-functional safety equipment!
	Safety equipment provides for the highest level of safety in a facility. Even if safety equipment makes work processes more awkward, under no circumstances may they be circumvented. Safety can only be ensured by intact safety equipment.
	Therefore:
	● Before starting to work, check whether the safety equipment in good working order and properly installed.

2.12 Rules of conduct in case of danger or accidents

Preventive measures
- Always be prepared for accidents or fire!
- Keep first-aid equipment (e.g. first-aid kits, blankets, etc.) and fire extinguishers readily accessible.
- Familiarize personnel with accident alarm, first aid and rescue equipment.

And if something does happen: respond properly
- Stop operation of the device immediately with an EMERGENCY Stop.
- Initiate first aid measures.
- Evacuate persons from the danger zone.
- Notify the responsible persons at the scene of operations.
- Alarm medical personnel and/or the fire department.
- Keep access routes clear for rescue vehicles.

2.13 Signs and labels

The following symbols and information signs are located in the working area. They refer to the immediate vicinity in which they are affixed.

WARNING!

Risk of injury due to illegible symbols!

Over the course of time, stickers and symbols on the device can become dirty or otherwise unrecognizable.

Therefore:

● Maintain all safety, warning and operating labels on the device in easily readable condition

Electrical voltage

The working area, which is marked with this sign, is authorized for qualified personnel to work in it, only

Unauthorized persons may not touch the marked work equipment.

DANGER!

Risk of fatal injury from electrical current!

Discharge time > 1 minute

Stored electrical current!

Therefore:

● Do not touch before taking into account the discharge time of the capacitors and electrically live parts.

● Heed corresponding notes on the equipment.

● If additional capacitors are connected to the intermediate circuit, the intermediate circuit discharge can take a much longer time. In this case, the necessary waiting period must itself be determined or a measurement made as to whether the equipment is de-energized. This discharge time must be posted, together with an IEC 60417-5036 (2002-10) warning symbol, on a clearly visible location of the control cabinet.

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

3

DESCRIPTION OF THE TERMINALS

In this chapter, we will describe the terminals and explain the type code on the I/O terminals.

3.1 General

The device line of the terminals consists of the following types:

- DI200E   2-channel digital input terminal
- DI400E   4-channel digital input terminal
- DI800E   8-channel digital input terminal
- DI160E   16-channel digital input terminal
- DO200E   2-channel digital output terminal
- DO400E   4-channel digital output terminal
- DO800E   8-channel digital output terminal
- DO160E   16-channel digital output terminal
- AI401E   4-channel analog input terminal 0 ... 10 V
- AI442E   4-channel analog input terminal 4 - 20 mA
- AO201E   2-channel analog output terminal 0...10 V
- AO401E   4-channel analog output terminal 0...10 V
- AO442E   4-channel analog output terminal 4 - 20 mA
- EK000E   Bus end terminal
- ES000E   Feed terminal 24 V DC
- ES001E   Power supply terminal 24 V DC
- EA000E   E-bus terminal to ECT (RJ45)
- AI2PTE   2-channel input terminal PT100 (RTD)
                for 2- or 3-wire connection
- AI2TEE   2-channel thermocouple input terminal
                with open-circuit recognition
- AI4TEE   4-channel thermocouple input terminal
                with open-circuit recognition
- ZK000E   Incremental encoder interface

3.2 Short description and top view

3.2.1 DI200E 2-channel digital input terminal 24 V$_{DC}$, T$_{ON}$/T$_{OFF}$< 1 µs
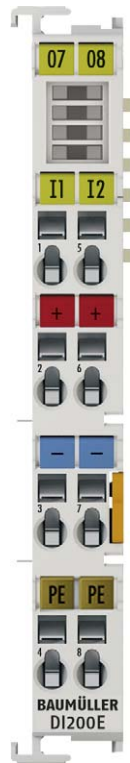
Figure 1:   Top view terminal DI200E

The DI200E digital input terminal acquires the binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation unit. It is suitable for particularly fast signals due to its very low input delay. For this variant, Distributed Clocks are activated, i.e. the input data can be monitored synchronous with other data that are also linked to distributed clock terminals. Therefore, the accuracy across the system is <<1 µs. The DI200E contains two channels, the signal state of which is indicated via LEDs.

3.2.2 DI400E 4-channel digital input terminal 24 V_{DC} with sensor supply

The DI400E digital input terminal acquires the binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation unit. The EtherCAT Terminal contains four channels that indicate their signal state by means of light emitting diodes
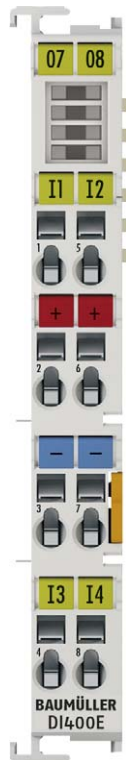
Figure 2:   Top view terminal DI400E

3.2.3 DI800E 8-channel digital input terminal 24 V_{DC}, 3 ms input filter
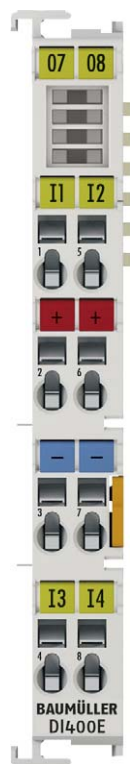
Figure 3:   Top view terminal DI800E

The DI800E digital input terminal acquires the binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation unit. The digital input terminal DI800E features an input filter (3 ms). The EtherCAT Terminals indicate their state via an LED.

3.2.4 DI160E 16 digital input channels, 24 V$_{DC}$.
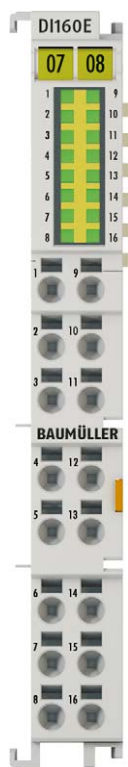
Figure 4: Top view terminal DI160E

The DI160E digital input terminal acquires the binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation device. The EtherCAT Terminal contains 16 channels, whose signal states are displayed by LEDs. The terminal is particularly suitable for space-saving use in control cabinets. By using the single-conductor connection technique, a multi-channel sensor can be connected in the smallest space with a minimum amount of wiring. The power contacts are looped through.

For the DI160E, the reference ground for all inputs is the 0 V power contact. The conductors can be connected without tools in the case of solid wires using a direct plug-in technique.

The HD EtherCAT Terminals (High Density) with increased packing density feature 16 connection points in the housing of a 12 mm terminal block.

3.2.5 DO200E 2 channel digital output terminal, 24 V_{DC}, T_{ON}/T_{OFF} < 1 µs, push-pull outputs with tristate
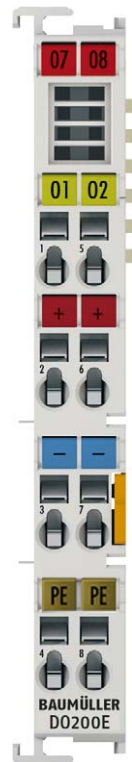
Figure 5:   Top view terminal DO200E

The DO200E digital output terminal connects the binary control signals from the automation unit on to the actuators at the process level with electrical isolation. This terminal benefits from very small output delay and is therefore suitable for signals requiring particularly fast output. The EtherCAT Terminal supports distributed clocks, i.e. output data can be monitored synchronously with other data from terminals with distributed clock support, if the user switches to terminal version DO200E-0100. The DC accuracy across the system is << 1 µs. The EtherCAT Terminal has a push-pull output that enables the output to be connected actively to 24 V, 0 V or high-resistance. The DO200E contains two channels, whose signal state per channel is indicated via LEDs.

3.2.6 DO400E 4 channel digital output terminal, 24 V_{DC}, 0.5 A

The DO400E digital output terminal connects the binary control signals from the automation unit on to the actuators at the process level with electrical isolation. The EtherCAT Terminal indicates its signal state via an LED.
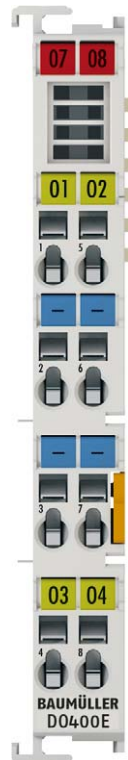
Figure 6:   Top view terminal DO400E

3.2.7 DO8000 8 channel digital output terminal, 24 V$_{DC}$, 0.5 A
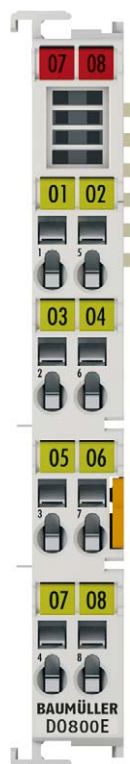
Figure 7:   Top view terminal DO800E

The DO800E digital output terminal connects the binary control signals from the automation unit on to the actuators at the process level with electrical isolation. The EtherCAT Terminal indicates its signal state via an LED.

3.2.8 DO1600 HD EtherCAT Terminal 16 channel digital output, 24 V$_{DC}$, 0.5 A

Figure 8: Top view terminal DO160E

The DO160E digital output terminal connects the binary control signals from the automation device on to the actuators at the process level with electrical isolation. The DO160E is protected against polarity reversal and processes load currents with outputs protected against overload and short-circuit. The EtherCAT Terminal contains 16 channels, whose signal states are displayed by LEDs. The terminal is particularly suitable for space-saving use in control cabinets. The connection technology is particularly suitable for single-ended inputs. All components have to use the same reference point as the DO160E. The power contacts are looped through.

The outputs are fed via the 24 V power contact in the DO160E. The conductors can be connected without tools in the case of solid wires using a direct plug-in technique.

The HD EtherCAT Terminals (High Density) with increased packing density feature 16 connection points in the housing of a 12 mm terminal block.

3.2.9   AI401E 4 channel analog input terminal, 12 bits, 0 ... +10 V
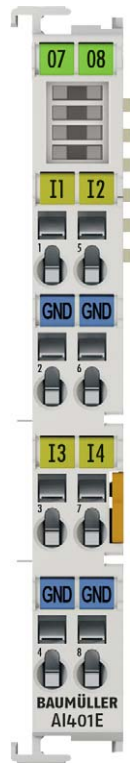
Figure 9:   Top view terminal AI401E

The AI401E analog input terminal processes signals in the range between 0 and 10 V. The voltage is digitized with a resolution of 12 bits and is transmitted (electrically isolated) to the higher-level automation device.

The AI401E EtherCAT Terminal features 2-wire conductors for the four single-ended inputs with a common internal ground potential. The power contacts are connected through. The signal state of the EtherCAT Terminal is indicated by light emitting diodes.

3.2.10 AI442E 4 channel analog input terminal, 12 bits, 4 - 20 mA
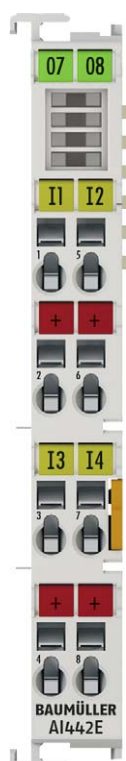
Figure 10:   Top view terminal AI442E

The AI442E analog input terminal processes signals in the range between 4 and 20 mA. The current is digitized to a resolution of 12 bits and is transmitted (electrically isolated) to the higher-level automation device.

The input electronics are independent of the supply voltage of the power contacts. In the AI442E with four inputs, the 24 V power contact is connected to the terminal in order to enable connection of 2-wire sensors without external supply. The power contacts are connected through. The signal state of the EtherCAT Terminal is indicated by light emitting diodes. The error LEDs indicate an overload condition and a broken wire.

3.2.11 AO201E 2-channel analog output terminal -10V...+10 V

The AO201E analog output terminal generates signals in the range between -10 V and +10 V. The voltage is supplied to the process level with a resolution of 16 bits and is electrically isolated. The output channels have a common ground potential. The outputs are oversampled with an adjustable, integer multiple (oversampling factor: n) of the bus cycle time (n microcycles per bus cycle). For each microcycle, the EtherCAT Terminal receives a process data block that is output consecutively. The time base of the terminal can be synchronized precisely with other EtherCAT devices via distributed clocks. This procedure enables the temporal resolution of the analog output signals to be increased to n times the bus cycle time.

The AO201E device can output a maximum of 100,000 values (100 ksamples/s) per channel and second.

Figure 11:   Top view terminal AO201E

3.2.12 AO401E 4-channel analog output terminal 0...10 V, 12 bits
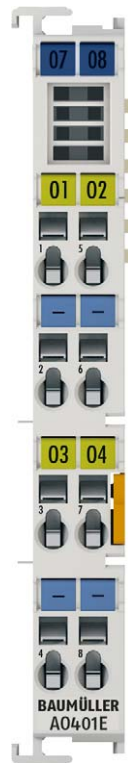
Figure 12:   Top view terminal AO401E

The AO4010 analog output terminal generate signals in the range between 0 V and 10 V. The voltage is supplied to the process level with a resolution of 12 bits and is electrically isolated. The output channels of the EtherCAT Terminal have a common ground potential. The AO4010 has four channels. The output stages are powered by the 24 V supply. The signal state of the EtherCAT Terminal is indicated by light emitting diodes.

3.2.13 AO442E 4 channel analog output terminal 4 - 20 mA, 12 bits

Figure 13:   Top view terminal AO442E

The AO442E analog output terminal generates signals in the range between 4 mA and 20 mA. The power is supplied to the process level with a resolution of 12 bits and is electrically isolated. Ground potential for the output channels of the EtherCAT Terminal is common with the 24 V_{DC} supply. The output stages are powered by the 24 V supply. The AO442E has four channels. The signal state of the EtherCAT Terminal is indicated by light emitting diodes.

3.2.14 EK000E bus end terminal

Each assembly must be terminated at the right hand end with an EK000E bus end cap.

3.2.15 ES000E - Potential supply terminal 24 V$_{DC}$.

The ES000E power feed terminal makes it possible to set up various potential groups with the standard voltage of 24 V$_{DC}$.

Figure 14:   Top view terminal ES000E
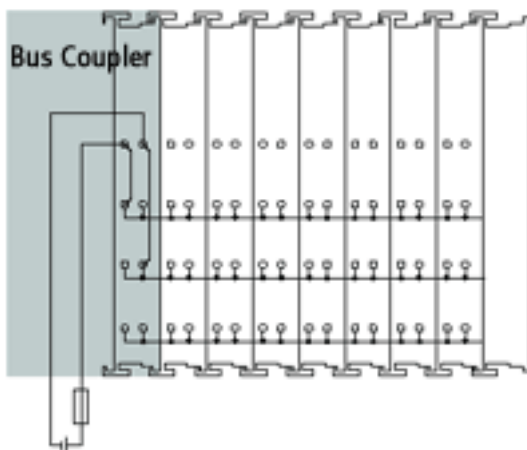
Figure 15:   Infeed via Bus Coupler only,
one potential group
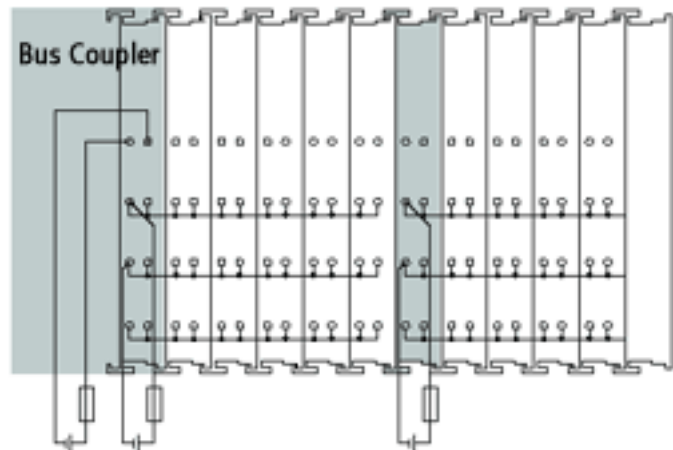
Figure 16:   Infeed via Bus Coupler and incoming feeder terminal,
three potential groups

3.2.16 ES001E - Power supply terminal 24 V$_{DC}$.

Figure 17:   Top view terminal ES001E

The ES001E power supply terminal is used to refresh the E-bus.

Data is exchanged between the coupler and the EtherCAT Terminal over the E-bus. Each terminal draws a certain amount of current from the E-bus (see "current consumption E-bus" in the technical data). This current is fed into the E-bus by the relevant coupler's power supply unit. In configurations with a large number of terminals it is possible to use the ES001E in order to supply an extra 2 A to the E-bus. The ES001E has diagnostic function which is displayed by LED and on the process image. At the same time the E0001E can be positioned for establishing a further potential group or for supplying the terminals following on the right (via power contacts).

3.2.17 EA000E EtherCAT extension

Like the E-bus end terminal, the EA000E EtherCAT extension is connected to the end of the EtherCAT Terminal block. The terminal offers the option of connecting an Ethernet cable with RJ45 connector, thereby extending the EtherCAT strand electrically isolated by up to 100 m. In the EA000E terminal, the E-bus signals are converted on the fly to 100BASE-TX Ethernet signal representation. Power supply to the EA000E electronics is via the E-bus. No parameterization or configuration tasks are required.
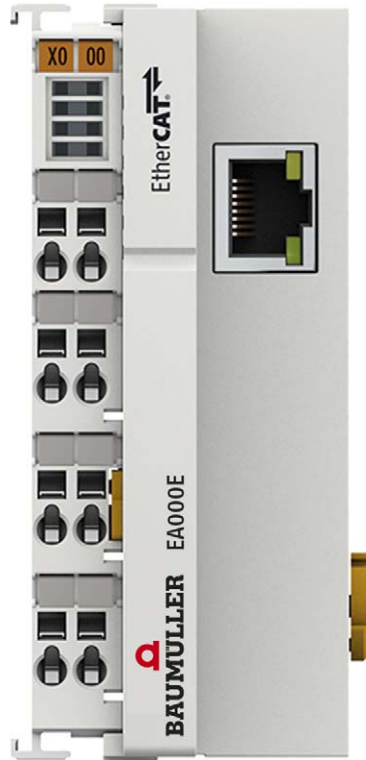
Figure 18:   Top view terminal EA000E

3.2.18 AI2PTE 2-channel input terminal PT100 (RTD) for 2- or 3-wire connection

The AI2PTE analog input terminal allows resistance sensors to be connected directly. The EtherCAT Terminal circuitry can operate 2- and 3-wire sensors. A microprocessor handles linearization across the whole temperature range, which is freely selectable. The EtherCAT Terminal's standard settings are: resolution 0.1°C in the temperature range of PT100 sensors in 3-wire connection. The EtherCAT Terminals indicate their signal state by means of light emitting diodes. Sensor malfunctions such as broken wires are indicated by error LEDs.

Figure 19:   Top view terminal AI2PTE

3.2.19 AI2TEE 2-channel thermocouple input terminal with open-circuit recognition
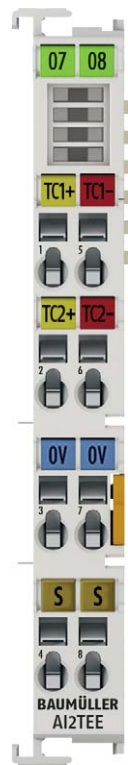
Figure 20:   Top view terminal AI2TEE

The AI2TEE analog input terminal allows thermocouples to be connected directly. The EtherCAT Terminal's circuit can operate thermocouple sensors using the 2-wire technique. Linearization over the full temperature range is realized with the aid of a microprocessor. The temperature range can be selected freely. The error LEDs indicate a broken wire. Compensation for the cold junction is made through an internal temperature measurement at the terminal. The AI2TEE can also be used for mV measurement.

3.2.20 AI4TEE 2-channel thermocouple input terminal with open-circuit recognition
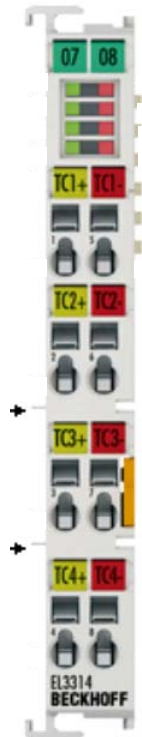
Figure 21: Top view terminal AI4TEE

4 channel analog thermocouple input terminals with open-circuit recognition

The AI4TEE analog input terminals allow thermocouples to be connected directly. The EtherCAT Terminals circuit can operate thermocouple sensors using the 2-wire technique. Linearization over the full temperature range is realized with the aid of a microprocessor. The temperature range can be selected freely. The error LEDs indicate a broken wire. Compensation for the cold junction is made through an internal temperature measurement at the terminals. The AI4TEE can also be used for mV measurement.

3.2.21 ZK000E Incremental encoder interface
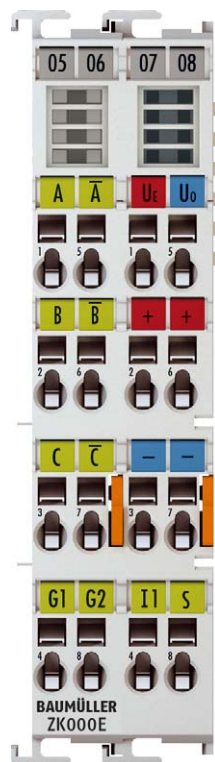
Figure 22:   Top view terminal ZK000E

The ZK000E EtherCAT Terminal is an interface for the direct connection of incremental encoders with differential inputs (RS422). A 32/16 bit counter with a quadrature decoder and a 32/16 bit latch for the zero pulse can be read, set or enabled. Incremental encoders with alarm outputs can be connected at the interface's status input. Interval measurement with a resolution of up to 100 ns is possible. The gate input allows the counter to be halted. The counter state is taken over with a rising edge at the latch input.

Due to the optional interpolating microincrement function, the ZK000E can supply even more precise axis positions for dynamic axes. In addition, it supports the synchronous reading of the encoder value together with other input data in the EtherCAT system via high-precision EtherCAT distributed clocks (DC).

3.3 Labeling of the terminals - type code

On the front panel, you will find the type code of the terminals.

NOTE

This type code applies only to Baumüller E bus terminals.

<u>xx</u>yyyz	Terminal type
	DI: Digital input
	DO: Digital output
	AI: Analog input
	AO: Analog output
	EK: Bus end terminal
	ES: Feed terminal
	KV: Terminal bus extension
	ZK Counter terminal
xx<u>yyy</u>z	Type designation
xxyyy<u>z</u>	E: E bus

This type code is located on the respective terminal. The type code contains the terminal's basic data. For a list of all technical data, refer to ▷Appendix D - Technical Data◁ from page 209 onward.

3.4 Production lot/batch number/serial number/date code/D number

The serial number for Baumüller EtherCAT slave is usually the 8-digit number printed on the device or on a sticker. The serial number indicates the configuration in delivery state and therefore refers to a whole production batch, without distinguishing the individual modules of a batch.

Structure of the serial number: **KK YY FF HH**

KK - week of production (CW, calendar week)
YY - year of production
FF - firmware version
HH - hardware version

Example with Ser. no.: 12063A02:

12 - production week 12
06 - production year 2006
3A - firmware version 3A
02 - hardware version 02

ASSEMBLY AND INSTALLATION

4.1   Instructions for ESD protection

⚠	**CAUTION!**
	Destruction of the devices by electrostatic discharge possible!
	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 by grounded probably, when handling with the devices.
	• Each assembly must be terminated at the right hand end with an EK000E bus end cap, to ensure the protection class and ESD protection.

Figure 23:   Spring contacts of the I/O components

4.2 Installation of Bus Terminals on C 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!

Dimension drawing of a Bus Terminal:
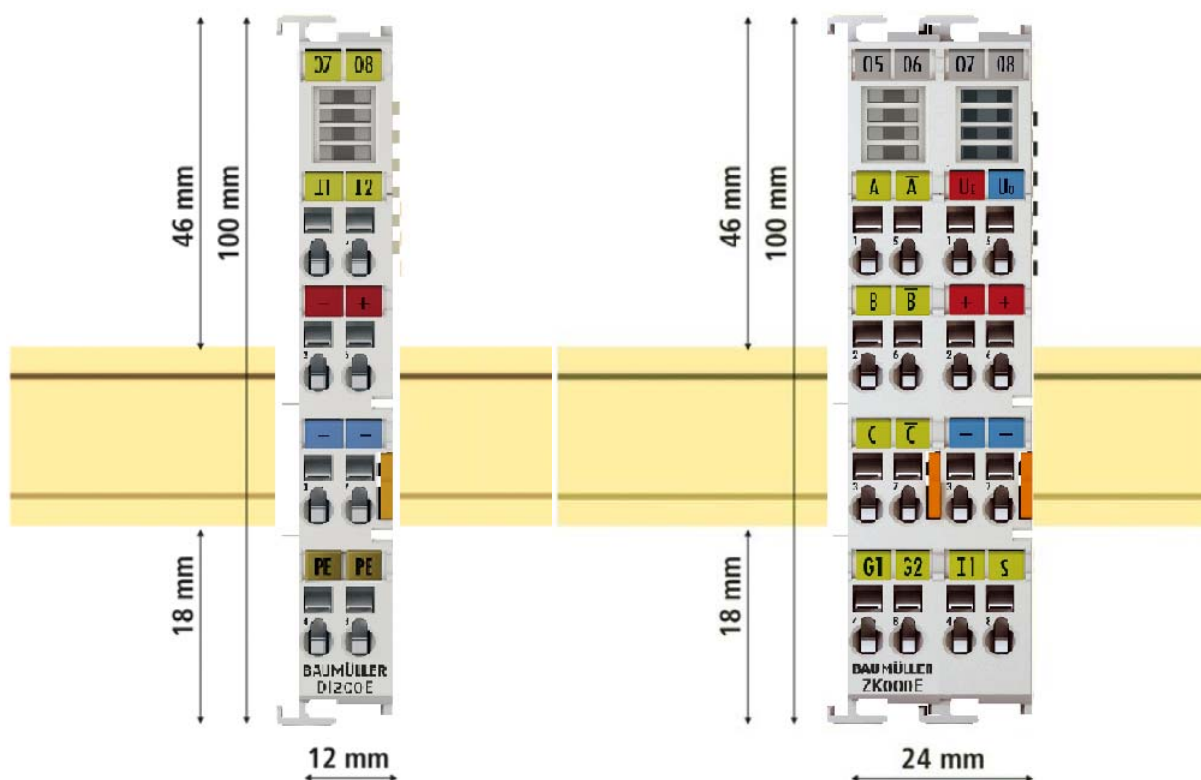
Figure24:   Dimension drawing of a Bus Terminal

4.3 Assembly

	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!
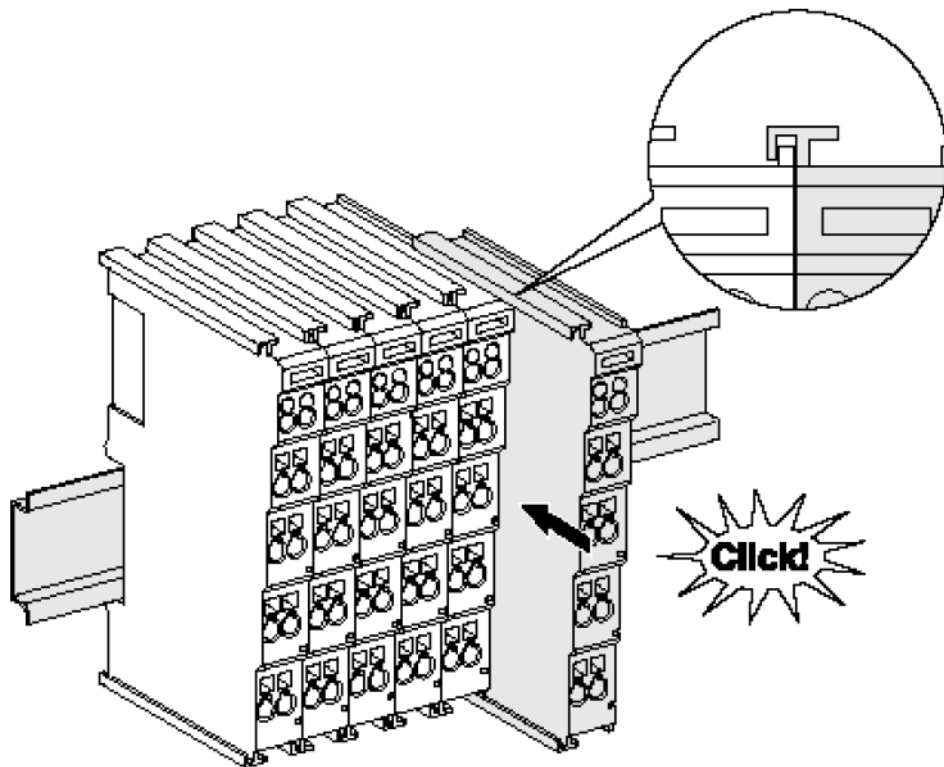
Figure 25: Attaching on mounting rail

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.

NOTE!

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).

4.4   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 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 (ES000E) interrupt the power contacts and thus represent the start of a new supply rail.

4.5   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.

CAUTION!

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).

Therefore:

- 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.

NOTICE!

Risk of electric shock!

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

4.6   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!
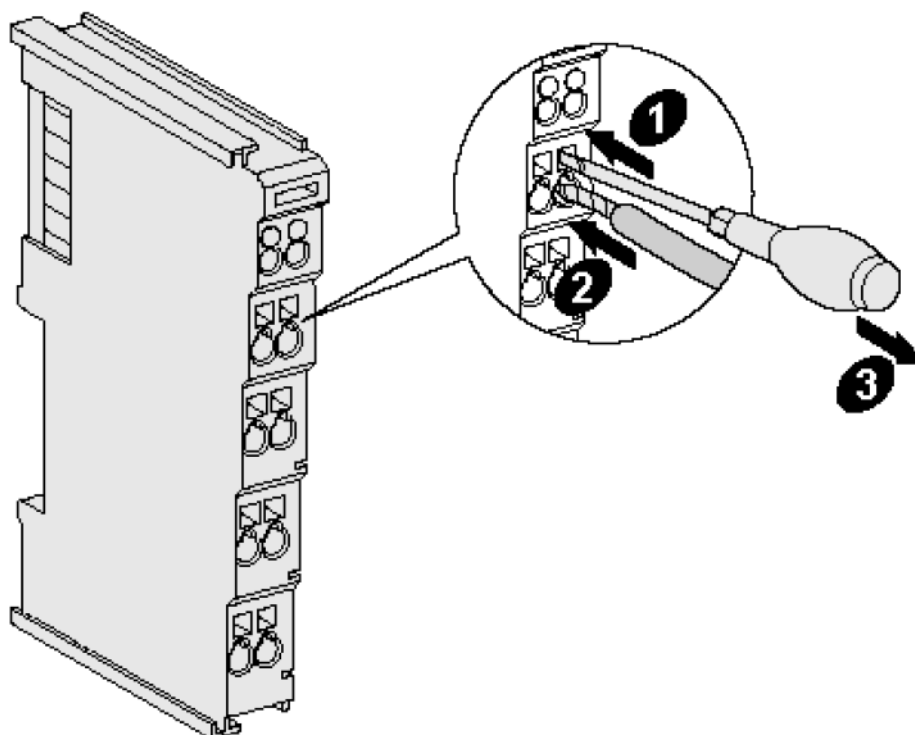
Figure 26:   Connecting a cable on a terminal point

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	
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

High Density Terminals (HD Terminals) with 16 terminal points
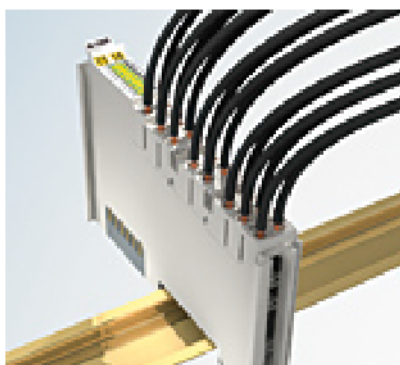
Figure 27:   High Density Terminals

The Bus Terminals from these series with 16 terminal points are distinguished by a particularly compact design, as the packaging density is twice as large as that of the standard 12 mm Bus Terminals. Massive conductors and conductors with a wire end sleeve can be inserted directly into the spring loaded terminal point without tools.

The conductors of the HD Terminals are connected without tools for single-wire conductors using the direct plug-in technique, i.e. after stripping the wire is simply plugged into the terminal point. The cables are released, as usual, using the contact release with the aid of a screwdriver. See the following table for the suitable wire size width.

Terminal housing	High Density Housing
Wire size width (single core wires)	0.08 ... 1.5 mm^2
Wire size width (fine-wire conductors)	0.25 ... 1.5 mm^2
Wire size width (conductors with a wire end sleeve)	0.14 ... 0.75 mm^2
Wire size width (ultrasonically "bonded" conductors)	only 1.5 mm^2
Wire stripping length	8 ... 9 mm

4.7 Positioning of passive Terminals

> **NOTE!**
>
> **Hint for positioning of passive terminals in the bus terminal block**
>
> EtherCAT Terminals, 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 2 passive terminals!

Examples for mounting passive terminals (highlighted)
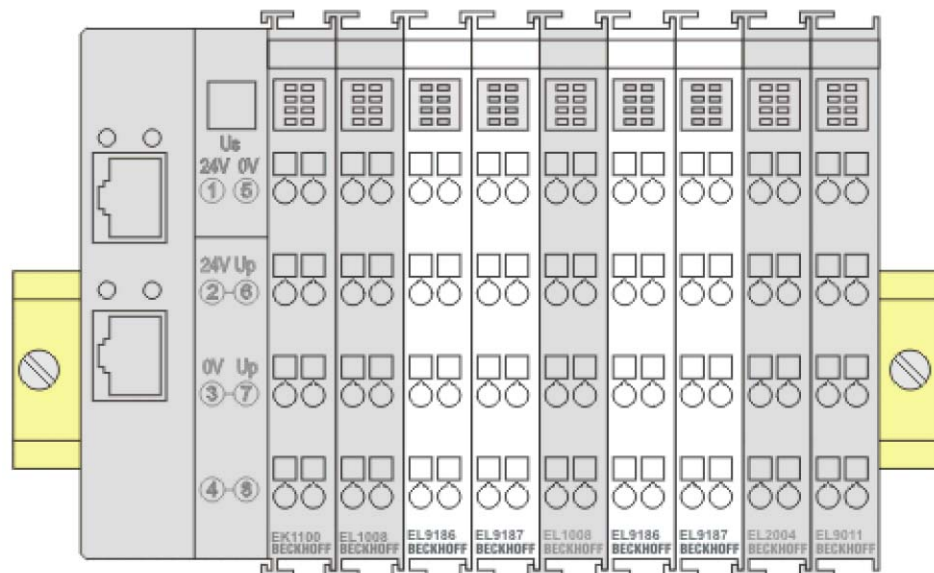
Figure 28:   Correct configuration

Figure 29:   Incorrect configuration

4.8   Installation positions

> **NOTICE!**
>
> **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!

Optimum installation position (standard)

The optimum installation position requires the mounting rail to be installed horizontally and the connection surfaces of the terminals to face forward (see Fig. "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.
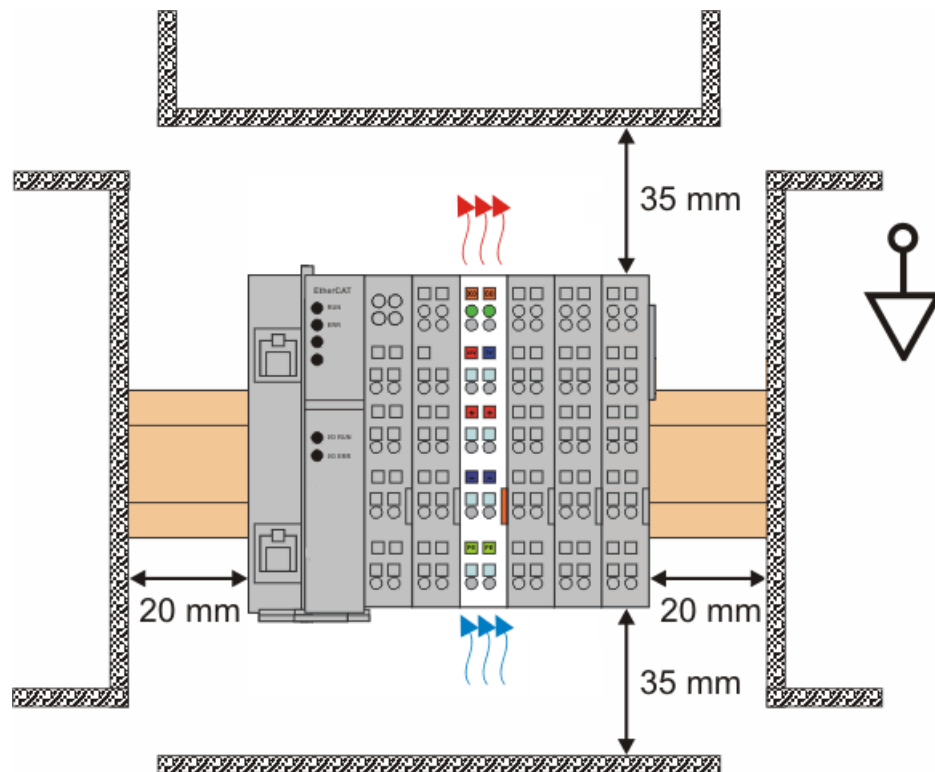
Figure 30:   Recommended distances for standard installation position

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

Other installation positions

All other installation positions are characterized by different spatial arrangement of the mounting rail.

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

4.9   UL notice

Application

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

Examination

For cULus examination, the Beckhoff 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.

Basic principles

Two UL certificates are met in the Beckhoff EtherCAT product range, depending upon the components:

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

2. UL certification according to UL508 with limited power consumption. The current consumed by the device is limited to a max. possible current consumption of 4 A. Devices with this kind of certification are marked by this sign:
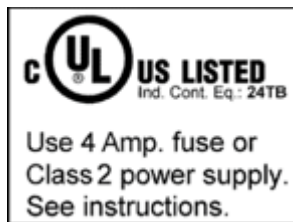
Almost all current EtherCAT products are UL certified without restrictions.

Application

If terminals certified with restrictions are used, then the current consumption at 24 V_{DC} must be limited accordingly by means of supply

- from an isolated source protected by a fuse of max. 4 A (according to UL248) or
- from a voltage supply complying with NEC class 2. A voltage source complying with NEC class 2 may not be connected in series or parallel with another NEC class 2 compliant voltage supply!

These requirements apply to the supply of all EtherCAT bus couplers, power adaptor terminals, Bus Terminals and their power contacts.

4.10 Connection of analog RTD signal lines

The RTD input terminals of the AI2xxE series measure the analog resistance of the sensor. The voltage drop at the sensor (including the line resistances, depending on the connection technology) is equivalent to the sensor resistance and therefore a measure for the sensor temperature, if the characteristic sensor curve is known. The following procedure serves for connecting analog signal cables in order to ensure error-free measurement of the analog signals.

Measures

- Sensor cable to be used
    - ○ Tightly twisted
    - ○ Shielded copper braid
    - ○ Use low-impedance cable, particularly for 2-wire connection
- Keep the sensor and sensor cables free from external potential. On no account should the GND connections (3/7 for AI2PTE) be connected with other potentials.
- The resistor for the RTD sensor (e.g. 100 or 1000 Ohm nominal) should be chosen based on the ratio between sensor resistance and line resistance, taking account of the connection type (2/3/4-wire).

Shielding measures

	NOTE!
	Shielding measures
	Due to the complexity in the "EMC" area, there is no generally applicable guideline, but only technical measures in accordance with the state of the art, which can sometimes contradict each other. These must be checked for feasibility and effectiveness, taking into account the plant specifications, and applied by the plant installer following assessment.
	The following notes on shielding are to be understood as technical suggestions that have proven themselves from time to time in practical use. It must be checked in each case which measures can be applied, depending on the installation and plant. The effectiveness of each measure must be checked individually. The formal transferability of measures to other types of plant is in general not possible.
	Priority is to be given to typical national or general normative specifications.

A shielding approach is described below that in many cases improves the measurement quality. The suggested measures must be checked for feasibility and effectiveness in the actual plant.

- Apply the shield with a low resistance and enveloping the cable by 360°
- at the entry point into the control cabinet, the shield should be earthed conductively
- the shield should be earthed again at the terminal
    - ○ at the terminal connection point, if present

- if no terminal connection point is available, earth the shield as close to the terminal as possible.
- to avoid ground loops the shield can be undone after entry into the control cabinet. A capacitive connection to the terminal shield contact is possible.
- avoid unshielded cable lengths of > 50 cm!

Figure31:   Example of AI2PTE shield connection with shield contact, in the case of potential interference sources inside the control cabinet

Figure32:   Example of AI2PTE shield connection with shield contact, in the case of potential interference sources inside and outside the control cabinet

DI200E - 2 CHANNEL DIGITAL INPUT TERMINAL

5.1   Introduction DI200E

Figure 33:   DI200E

The DI200E digital input terminal acquires the binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation unit. It is suitable for particularly fast signals due to its very low input delay. For the DI200E-0100 variant, Distributed Clocks are activated, i.e. the input data can be monitored synchronous with other data that are also linked to distributed clock terminals. Therefore, the accuracy across the system is <<1 µs. The DI200E contains two channels, the signal state of which is indicated via LEDs.

5.1.1 LEDs

LED	Color	Meaning	
INPUT 1 INPUT 2	green	off	There is no input signal at the respective input
		on	+24 V input signal at the respective input

5.1.2 Pin assignment

Terminal point		
Name	**No.**	**Description**
Input 1	1	Input 1
+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)
PE	4	PE contact
Input 2	5	Input 2
+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)
PE	8	PE contact

5.2   Switching characteristics
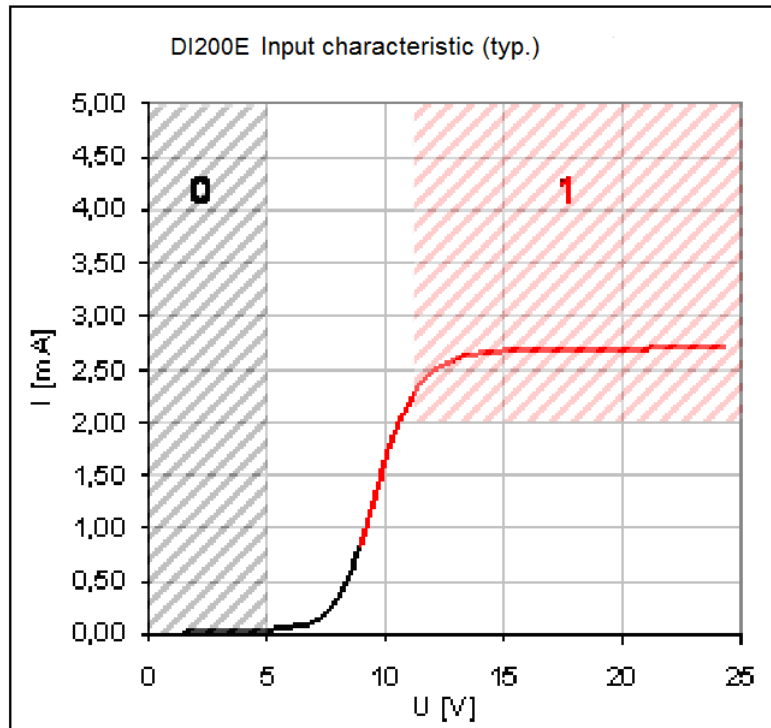
Figure 34:   Input curve on basis of EN 61131-2, type 3; typical measurement

The input circuit of the DI200E is optimized for fast signal changes and for the fastest possible signal acquisition. The duration required by a signal change (a rising or falling edge) to propagate from the clamping point at the front of the terminal through to the logic of the central evaluation unit (ESC) is specified for the DI200E series as T_{ON}/T_{OFF} < 1 µs, for both rising (T_{ON}) and falling edges (T_{OFF}). The low absolute magnitude of this propagation time means that the temperature drift of the propagation time is also very small.

It should be borne in mind that the input circuit does not include any filtering. It has been optimized for the fastest possible signal transmission from the input to the evaluation unit. Fast level changes or pulses in the µs range therefore reach the evaluation unit unfiltered or unattenuated. It may be necessary to use screened cables in order to eliminate interference from the surroundings.

The sensor/signal transducer must be able to generate sufficiently steep signal edges. The power supply unit used should have sufficient buffer reserves to ensure that the signal reaches the terminal with a sufficiently steep edge in spite of capacitive or inductive cable losses.

5.3   Distributed Clock

The distributed clock represents a local clock in the EtherCAT slave controller (ESC) with the following characteristics:

- Unit 1 ns
- Zero point 1.1.2000 00:00
- Size 64 bit (sufficient for the next 584 years; however, some EtherCAT slaves only offer 32-bit support, i.e. the variable overflows after approx. 4.2 seconds)
- The EtherCAT master automatically synchronizes the local clock with the master clock in the EtherCAT bus with a precision of < 100 ns.

DI400E - FOUR-CHANNEL DIGITAL INPUT TERMINAL

6.1   Introduction DI400E

Figure 35:   DI400E

The DI400E digital input terminal acquires the binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation unit. The DI400E version has input filters of different speeds. The EtherCAT Terminals contain four channels that indicate their signal state by means of light emitting diodes.

6.1.1 LEDs

LED	Color	Meaning	
INPUT 1 - 4	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

6.1.2 Pin assignment

Terminal point		
Name	No.	Description
Input 1	1	Input 1
+24 V	2	Sensor supply +24 V (internally connected to terminal point 6 and positive power contact)
0 V	3	Sensor supply 0 V (internally connected to terminal point 7 and negative power contact)
Input 3	4	Input 3
Input 2	5	Input 2
+24 V	6	Sensor supply +24 V (internally connected to terminal point 2 and positive power contact)
0 V	7	Sensor supply 0 V (internally connected to terminal point 3 and negative power contact)
Input 4	8	Input 4

DI800E - Eight-channel digital input terminal

7.1   Introduction DI800E

Figure 36:   DI800E

The DI800E digital input terminal acquires binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation device. The digital input terminal features an input filter (3 ms) and indicates its signal state through an LED for each channel.

7.1.1 LEDs

LED	Color	Meaning	
INPUT 1 - 8	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

7.1.2 Pin assignment

Terminal point		Description
Name	**No.**	
Input 1	1	Input 1
Input 3	2	Input 3
Input 5	3	Input 5
Input 7	4	Input 7
Input 2	5	Input 2
Input 4	6	Input 4
Input 6	7	Input 6
Input 8	8	Input 8

DI160E - 16 CHANNEL DIGITAL INPUT TERMINAL

8.1   Introduction DI160E

Figure 37:   DI160E

The DI160E digital input terminal acquires the binary control signals from the process level and transmits them, in an electrically isolated form, to the higher-level automation device. The EtherCAT Terminals contain 16 channels whose signal state is indicated by LEDs. They are particularly suitable for space-saving use in control cabinets. By using the single-conductor connection technique a multi-channel sensor can be connected in the smallest space with a minimum amount of wiring. The power contacts are connected through.

In the EtherCAT Terminal DI160E, the reference ground for all inputs is the 0 V power contact. The conductors can be connected without tools in the case of single-wire conductors using a direct plug-in technique.

The HD EtherCAT Terminals (High Density) with increased packing density are equipped with 16 connection points in the housing of a 12-mm terminal block.

8.1.1   LEDs

LED	Color	Meaning	
INPUT 1 bis 16	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

8.1.2   Pin assignment

Terminal point		
Name	**No.**	**Description**
Input 1	1	Input 1
Input 2	2	Input 2
Input 3	3	Input 3
Input 4	4	Input 4
Input 5	5	Input 5
Input 6	6	Input 6
Input 7	7	Input 7
Input 8	8	Input 8
Input 9	9	Input 9
Input 10	10	Input 10
Input 11	11	Input 11
Input 12	12	Input 12
Input 13	13	Input 13
Input 14	14	Input 14
Input 15	15	Input 15
Input 16	16	Input 16

DO200E - 2 CHANNEL DIGITAL OUTPUT TERMINAL

9.1   Introduction DO200E
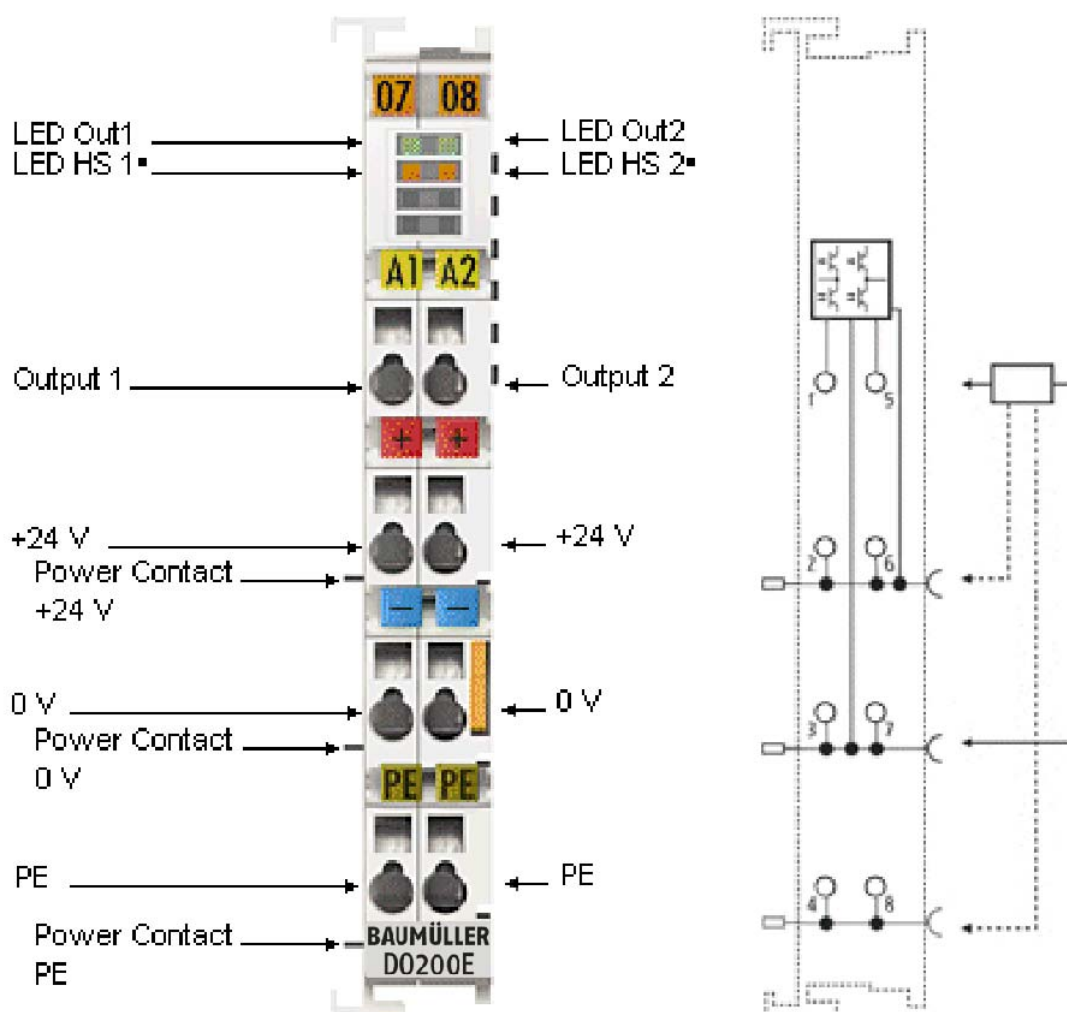
Figure 38:   DO200E

The DO200E digital output terminal connects the binary control signals from the automation device on to the actuators at the process level with electrical isolation. This terminal benefits from very small output delay and is therefore suitable for signals requiring particularly fast output. The EtherCAT terminal supports distributed clocks, i.e. the output data can be monitored synchronous with other data from terminals with distributed clock support. The accuracy across the system is <<1 µs. The EtherCAT terminal has a push-pull output that enables the output to be connected actively to 24 V, 0 V or high-resistance. The DO200E contains 2 channels, the signal state of which is indicated via LEDs. The state "high-resistance" (tristate) is indicated through a further LED for each channel.

9.1.1 LEDs

LED	Color	Meaning	
OUT 1 OUT 2	green	off	No output signal is present at the respective output
		on	+24 V output signal at the corresponding output
HS 1+ HS 2+	orange	off	Output switched according to LED OUT1 or LED OUT2
		on	Output 1 or 2 switched to high-resistance

9.1.2 Pin assignment

Terminal point		Description
Name	No.	
Output 1	1	Output 1
+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)
PE	4	PE contact
Output 2	5	Output 2
+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)
PE	8	PE contact

9.2 Switching characteristics

The output circuit of the DO200E is optimized for fast signal output, even at higher currents. To this end the DO200E features a push/pull output stage that actively switches to 24 V and 0 V. The push stage is overcurrent- and short circuit-protected, the pull stage (switching to 0 V) is not. This may have to be taken into account when inductive loads are switched off. The time required by a signal change as a rising/falling edge from the central controller (ESC, EtherCAT slave controller) to the connection at the front of the terminal is specified as $T_{ON}/T_{OFF} < 1$ µs for the DO200E range, both for a rising (T_{ON}) and a falling edge (T_{OFF}). Due to this short absolute signal cycle time the temperature drift during the cycle time is also very low.

The edge steepness of the output drivers is < 1 µs/24 V. The power supply of the DO200E should be dimensioned according to the power requirements of the connected actuators. The power supply lines, power supply unit and actuator lines should be suitably short or generous respectively.

NOTE!

Measurement of time delay

While optimized electronic components make the delay between the physically real edge at the ESC output and the edge at the terminal point very short (< 1 µs), it is not negligible. If the user has a particular need for precision, calibration must be carried out, and the precise time delay measured in accordance with the environmental conditions.

9.3 Tristate mode (high-resistance outputs)

In Tristate mode each channel can be switched to high-resistance. This state ensures that the respective output behaves as if it was not connected, so that it does not influence the outputs of other outputs/devices connected in parallel. The associated output takes on the same output voltage as the other active devices.

9.4 Distributed Clock

The distributed clock represents a local clock in the EtherCAT slave controller (ESC) with the following characteristics:

- Unit 1 ns
- Zero point 1.1.2000 00:00
- Size 64 bit (sufficient for the next 584 years; however, some EtherCAT slaves only offer 32-bit support, i.e. the variable overflows after approx. 4.2 seconds)
- The EtherCAT master automatically synchronizes the local clock with the master clock in the EtherCAT bus with a precision of < 100 ns.

DO400E - FOUR-CHANNEL DIGITAL OUTPUT TERMINAL

10.1 Introduction DO400E

Signal LED1 — 07 08 — Signal LED2

Signal LED3 — 01 02 — Signal LED4

Output 1 — Output 2

0 V
Power contact +24 V

0 V
Power contact 0 V

03 04

Output 3 — Output 4

BAUMÜLLER
DO400E

Figure 39:   DO400E

The DO400E digital output terminals relay binary control signals of the automation device in an electrically isolated manner to the actuators of the process level. They are protected against reverse polarity at the power contacts. The digital output terminals indicate their signal state through an LED for each channel.

10.1.1 LEDs

LED	Color	Meaning	
OUTPUT 1 - 4	green	off	No output signal
		on	24 V_{DC} output signal at the respective output

10.1.2 Pin assignment

Terminal point			
Name	No.	Description	
Output 1	1	Output 1	
0 V	2	Ground for output 1 (internally connected to terminal point 3, 6, 7 and negative power contact)	
0 V	3	Ground for output 3 (internally connected to terminal point 2, 6, 7 and negative power contact)	
Output 3	4	Output 3	
Output 2	5	Output 2	
0 V	6	Ground for output 2 (internally connected to terminal point 2, 3, 7 and negative power contact)	
0 V	7	Ground for output 4 (internally connected to terminal point 2, 3, 6 and negative power contact)	
Output 4	8	Output 4	

DO800E - Eight-channel DIGITAL OUTPUT TERMINAL

11.1 Introduction DO800E

Signal LED1 → 07 08 ← Signal LED2
Signal LED3 → ← Signal LED4
Signal LED5 → ← Signal LED6
Signal LED7 → ← Signal LED8

01 02

Output 1 → ← Output 2

03 04

Output 3 → ← Output 4
Power contact +24 V →

05 06

Output 5 → ← Output 6
Power contact 0 V →

07 08

Output 7 → ← Output 8

BAUMÜLLER
DO800E
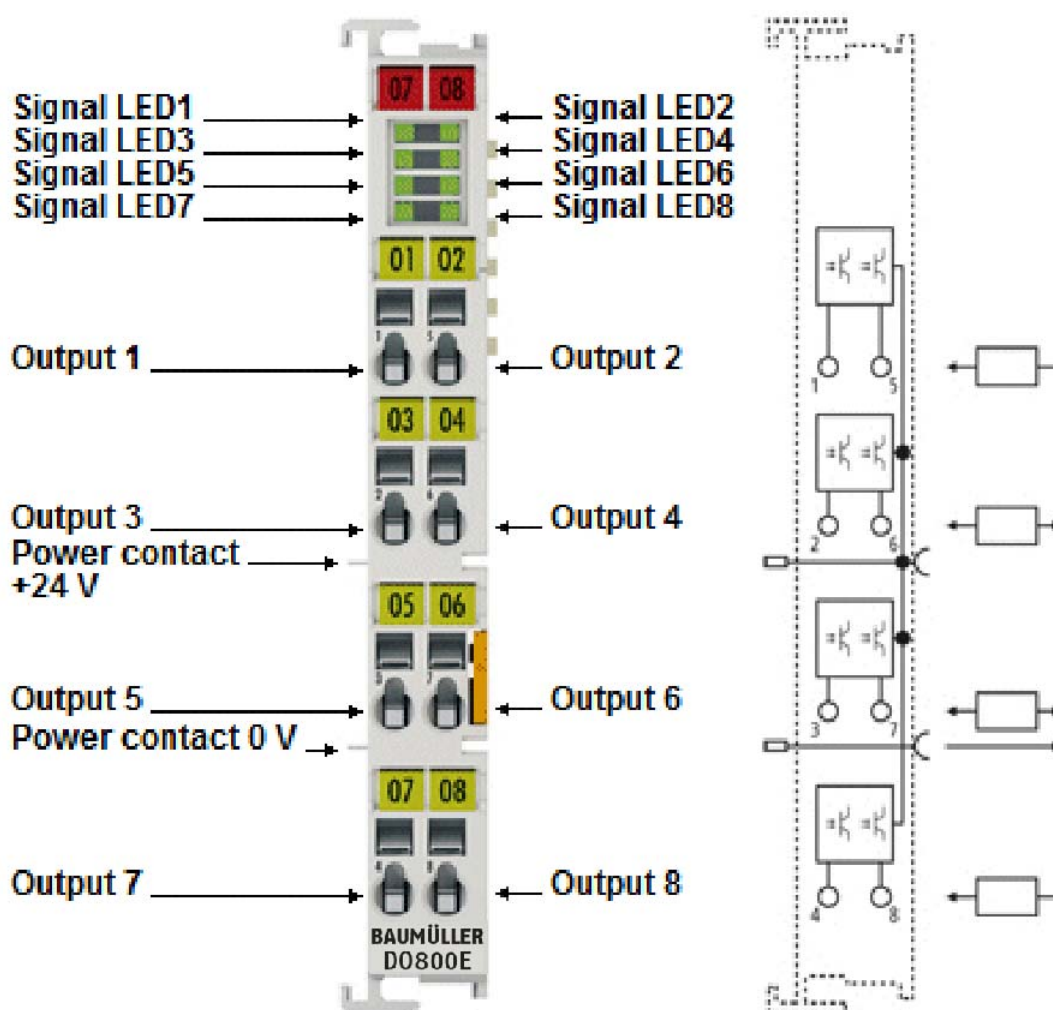
Figure 40:   DO800E

11.1 Introduction DO800E

The DO800E digital output terminals relay binary control signals of the automation device in an electrically isolated manner to the actuators of the process level. They are protected against reverse polarity at the power contacts. The digital output terminals indicate their signal state through an LED for each channel.

11.1.1 LEDs

LED	Color	Meaning	
OUTPUT 1 - 8	green	off	No output signal
		on	24 V_{DC} output signal at the respective output

11.1.2 Pin assignment

Terminal point		
Name	No.	Description
Output 1	1	Output 1
Output 3	2	Output 3
Output 5	3	Output 5
Output 7	4	Output 7
Output 2	5	Output 2
Output 4	6	Output 4
Output 6	7	Output 6
Output 8	8	Output 8

DO160E - 16 CHANNEL DIGITAL OUTPUT TERMINAL

12.1 Introduction DO160E

Figure 41:   DO160E

The DO160E digital output terminal connects the binary control signals from the automation device on to the actuators at the process level with electrical isolation. The DO160E is protected against polarity reversal and processes load currents with outputs protected against overload and short-circuit. The EtherCAT Terminal contains 16 channels whose signal state is indicated by LEDs. The power contacts are connected through.

The outputs of the DO160E are fed via the 24 V power contact. The conductors can be connected without tools in the case of single-wire conductors using a direct plug-in technique.

The HD EtherCAT Terminals (High Density) with increased packing density are equipped with 16 connection points in the housing of a 12 mm terminal block. They are particularly suitable for space-saving use in control cabinets.

12.1.1 LEDs

LED	Color	Meaning	
OUTPUT 1 - 16	green	off	No output signal
		on	24 V_{DC} output signal at the respective output

12.1.2 Pin assignment

Terminal point		
Name	No.	Description
Output 1	1	Output 1
Output 2	2	Output 2
Output 3	3	Output 3
Output 4	4	Output 4
Output 5	5	Output 5
Output 6	6	Output 6
Output 7	7	Output 7
Output 8	8	Output 8
Output 9	9	Output 9
Output 10	10	Output 10
Output 11	11	Output 11
Output 12	12	Output 12
Output 13	13	Output 13
Output 14	14	Output 14
Output 15	15	Output 15
Output 16	16	Output 16

AI401E - FOUR CHANNEL ANALOG INPUT TERMINAL

13.1 Introduction AI401E
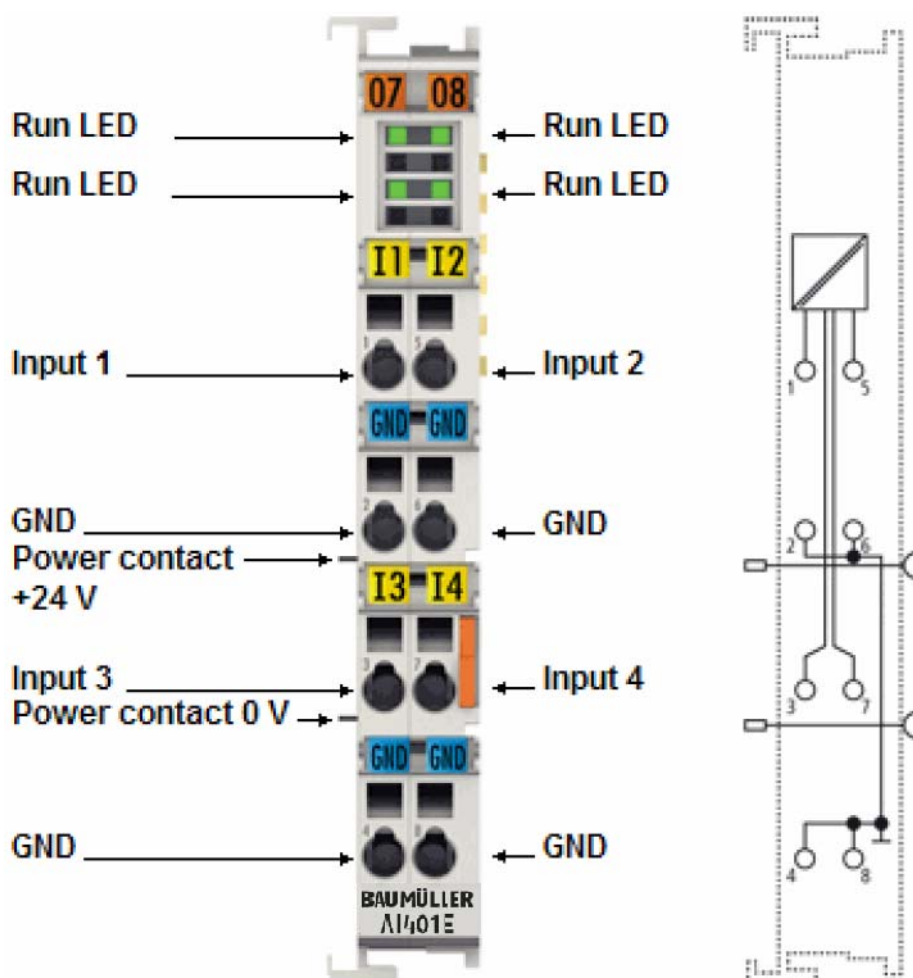
Figure 42:   AI401E

Analog Input Terminal; 4 channel, 12 bit, 0 V ... +10 V, single-ended inputs

The AI401E analog input terminal processes signals in the range between 0 and 10 V. The voltage is digitized to a resolution of 12 bits, and is transmitted, electrically isolated, to the higher-level automation device. The power contacts are connected through.

In the AI401E EtherCAT Terminal the four single-ended inputs are configured as 2-wire versions and have a common internal ground potential, which is not connected to the power contacts.

13.1.1 LEDs

LED	Color	Meaning	
RUN [1]	green	These LEDs indicate 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

[1] If several RUN LEDs are present, all of them have the same function.

13.1.2 Pin assignment

Terminal point		Description
Name	**No.**	
Input 1	1	Input 1
GND	2	Signal ground (internally connected to terminal point 4, 6, 8)
Input 3	3	Input 3
GND	4	Signal ground (internally connected to terminal point 2, 6, 8)
Input 2	5	Input 2
GND	6	Signal ground (internally connected to terminal point 2, 4, 8)
Input 4	7	Input 4
GND	8	Signal ground (internally connected to terminal point 2, 4, 6)

13.2 Object description and parameterization

13.2.1 Restore object

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore default parameters	UINT8	RO	0x01 (1_{dec})
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 (0_{dec})

13.2.2 Configuration data

Index 80n0 AI settings for $0 \leq n \leq 7$ (Ch. 1 - 8)

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	AI settings	Maximum subindex	UINT8	RO	0x18 (24_{dec})
80n0:01	Enable user scale	User scale is active.	BOOLEAN	RW	0x00 (0_{dec})
80n0:02	Presentation	0: Signed presentation 1: Absolute value with MSB as sign Signed amount representation	BIT3	RW	0x00 (0_{dec})
80n0:05	Siemens bits	The S5 bits are displayed in the three low-order bits	BOOLEAN	RW	0x00 (0_{dec})
80n0:06	Enable filter	Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary	BOOLEAN	RW	0x00 (0_{dec})
80n0:07	Enable limit 1	Limit 1 enabled	BOOLEAN	RW	0x00 (0_{dec})
80n0:08	Enable limit 2	Limit 2 enabled	BOOLEAN	RW	0x00 (0_{dec})
80n0:0A	Enable user calibration	Enabling of the user calibration	BOOLEAN	RW	0x00 (0_{dec})
80n0:0B	Enable vendor calibration	Enabling of the vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
80n0:0E	Swap limit bits	Swap limit bits	BOOLEAN	RW	0x00 (0_{dec})
80n0:11	User scale offset	User scaling offset	INT16	RW	0x0000 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:12	User scale gain	User scaling gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} (0x00010000hex) and is limited to +/- 0x7FFFF.	INT32	RW	0x00010000 (65536_{dec})
80n0:13	Limit 1	First limit value for setting the status bits	INT16	RW	0x0000 (0_{dec})
80n0:14	Limit 2	Second limit value for setting the status bits	INT16	RW	0x0000 (0_{dec})
80n0:15	Filter settings	This object determines the digital filter settings, if it is active via Enable filter (index 0x80n0:06). The possible settings are sequentially numbered. 0: 50 Hz FIR 6: IIR 5 1: 60 Hz FIR 7: IIR 6 2: IIR 1 8: IIR 7 3: IIR 2 9: IIR 8 4: IIR 3 5: IIR 4	INT16	RW	0x0000 (0_{dec})
80n0:17	User calibration offset	User offset compensation	INT16	RW	0x0000 (0_{dec})
80n0:18	User calibration gain	User calibration gain	UINT16	RW	0xFFFF (65535_{dec})

Filter

The filters of the AIxxxE are activated or deactivated via the CoE index 0x8000:15

> **NOTE!**
>
> **The filter characteristics are set via index 0x8000:15**
>
> The filter frequencies are set for all channels of the AIxxxE terminals centrally via index 0x8000:15 (channel 1). All other corresponding indices 0x80n0:15 have no parameterization function! The latest firmware version returns an EtherCAT-compliant error message, if the filter characteristics of other channels (index 0x80n0:06, 0x80n0:15) are set.

13.2.3 Objects for regular operation

The AI401E has no such objects.

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

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

13.2.4.1 Input data

Index 60n0 AI Inputs (for $0 \le n \le 7$)

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:0	AI Inputs	Maximum subindex	UINT8	RO	0x11 (17_{dec})
60n0:01	Underrange	Value below measuring range.	BOOLEAN	RO	0x00 (0_{dec})
60n0:02	Overrange	Measuring range exceeded.	BOOLEAN	RO	0x00 (0_{dec})
60n0:03	Limit 1	Limit value monitoring Limit 1 0: not active 1: Value is smaller than Limit Value 1 2: Value is larger than Limit Value 1 3: Value is equal to Limit Value 1	BIT2	RO	0x00 (0_{dec})
60n0:05	Limit 2	Limit value monitoring Limit 2 0: not active 1: Value is smaller than Limit Value 2 2: Value is larger than Limit Value 2 3: Value is equal to Limit Value 2	BIT2	RO	0x00 (0_{dec})
60n0:07	Error	The error bit is set if the data is invalid (over-range, under-range)	BOOLEAN	RO	0x00 (0_{dec})
60n0:0F	TxPDO State	Validity of the data of the associated TxPDO (0 = valid, 1 = invalid).	BOOLEAN	RO	0x00 (0_{dec})
60n0:10	TxPDO Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated.	BOOLEAN	RO	0x00 (0_{dec})
60n0:11	Value	Analog input date	INT16	RO	0x0000 (0_{dec})

13.2.4.2 Configuration data (vendor-specific)

Index 80nF AI Vendor data (for $0 \le n \le 7$)

Index (hex)	Name	Meaning	Data type	Flags	Default
80nF:0	AI Vendor data	Maximum subindex	UINT8	RO	0x02 (2_{dec})
80nF:01	Calibration offset	Offset (vendor calibration)	INT16	RW	0x0000 (0_{dec})
80nF:02	Calibration gain	Gain (vendor calibration)	UINT16	RW	0x4000 (16384_{dec})

13.2.4.3 Information and diagnostic data

Index 80nE AI Internal data (for $0 \le n \le 7$)

Index (hex)	Name	Meaning	Data type	Flags	Default
80nE:0	RTD Internal data	Maximum subindex	UINT8	RO	0x01 (1_{dec})
80nE:01	ADC raw value	ADC raw value	INT32	RO	0x00000000 (0_{dec})

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 (2_{dec})
F000:01	Module index distance	Index spacing of the objects of the individual channels	UINT16	RO	0x0010 (16_{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0008 (8_{dec})

Index F008 Code word

Index (hex)	Name	Meaning	Data type	Flags	Default
F008:0	Code word	Reserved	UINT32	RW	0x00000000 (0_{dec})

Index F010 Module list

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:0	Module list	Maximum subindex	UINT	RO	0x08 (8_{dec})
F010:01	SubIndex 001	Analog input profile (300)	INT32	RO	0x0000012C (300_{dec})
F010:02	SubIndex 002	Analog input profile (300)	INT32	RO	0x0000012C (300_{dec})
F010:03	SubIndex 003	Analog input profile (300)	INT32	RO	0x0000012C (300_{dec})
F010:04	SubIndex 004	Analog input profile (300)	INT32	RO	0x0000012C (300_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:05	SubIndex 005	Analog input profile (300)	INT32	RO	0x0000012C (300$_{dec}$)
F010:06	SubIndex 006	Analog input profile (300)	INT32	RO	0x0000012C (300$_{dec}$)
F010:07	SubIndex 007	Analog input profile (300)	INT32	RO	0x0000012C (300$_{dec}$)
F010:08	SubIndex 008	Analog input profile (300)	INT32	RO	0x0000012C (300$_{dec}$)

13.2.5 Standard objects

Standard objects (0x1000-0x1FFF)

The standard objects have the same meaning for all EtherCAT slaves.

Index 1000 Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: the Lo-Word contains the CoE profile used (5001). The Hi-Word contains the module profile according to the modular device profile.	UINT32	RO	0x012C1389 (19665801$_{dec}$)

Index 1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	AIxxxE

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	00

Index 100A Software version

Index (hex)	Name	Meaning	Data type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	01

Index 1018 Identity

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	0x04 (4_{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	0x00000002 (2_{dec})
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	0x0BC03052
1018:03	Revision	Revision number of the EtherCAT slave; the low word (bit 0-15) indicates the special terminal number, the high word (bit 16-31) refers to the device description	UINT32	RO	0x00110000
1018:04	Serial number	Serial number of the EtherCAT slave; the low byte (bit 0-7) of the low word contains the year of production, the high byte (bit 8-15) of the low word contains the week of production, the high word (bit 16-31) is 0	UINT32	RO	0x00000000

Index 10F0 Backup parameter handling

Index (hex)	Name	Meaning	Data type	Flags	Default
10F0:0	Backup parameter handling	Information for standardized loading and saving of backup entries	UINT8	RO	0x01 (1_{dec})
10F0:01	Checksum	Checksum across all backup entries of the EtherCAT slave	UINT32	RO	0x00000000 (0_{dec})

Index 1800 AI TxPDO-Par Standard Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1800:0	AI TxPDO-Par Standard Ch.1	PDO parameter TxPDO 1	UINT8	RO	0x09 (9_{dec})
1800:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 1	OCTET-STRING[2]	RO	01 1A
1800:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
1800:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 1801 AI TxPDO-Par Compact Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1801:0	AI TxPDO-Par Compact Ch.1	PDO parameter TxPDO 2	UINT8	RO	0x09 (9_{dec})
1801:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 2	OCTET-STRING[2]	RO	01 1A

Index 1802 AI TxPDO-Par Standard Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1802:0	AI TxPDO-Par Standard Ch.2	PDO parameter TxPDO 3	UINT8	RO	0x09 (9_{dec})
1802:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 3	OCTET-STRING[2]	RO	01 1A
1802:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
1802:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 1803 AI TxPDO-Par Compact Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1803:0	AI TxPDO-Par Compact Ch.2	PDO parameter TxPDO 4	UINT8	RO	0x09 (9_{dec})
1803:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 4	OCTET-STRING[2]	RO	01 1A

Index 1804 AI TxPDO-Par Standard Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
1804:0	AI TxPDO-Par Standard Ch.3	PDO parameter TxPDO 5	UINT8	RO	0x09 (9_{dec})
1804:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 5	OCTET-STRING[2]	RO	01 1A
1804:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
1804:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 1805 AI TxPDO-Par Compact Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
1805:0	AI TxPDO-Par Compact Ch.3	PDO parameter TxPDO 6	UINT8	RO	0x09 (9_{dec})
1805:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 6	OCTET-STRING[2]	RO	01 1A

Index 1806 AI TxPDO-Par Standard Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
1806:0	AI TxPDO-Par Standard Ch.4	PDO parameter TxPDO 7	UINT8	RO	0x09 (9_{dec})
1806:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 7	OCTET-STRING[2]	RO	01 1A
1806:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
1806:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 1807 AI TxPDO-Par Compact Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
1807:0	AI TxPDO-Par Compact Ch.4	PDO parameter TxPDO 8	UINT8	RO	0x09 (9_{dec})
1807:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 8	OCTET-STRING[2]	RO	01 1A

Index 1808 AI TxPDO-Par Standard Ch.5

Index (hex)	Name	Meaning	Data type	Flags	Default
1808:0	AI TxPDO-Par Standard Ch.5	PDO parameter TxPDO 9	UINT8	RO	0x09 (9_{dec})
1808:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 9	OCTET-STRING[2]	RO	01 1A
1808:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
1808:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 1809 AI TxPDO-Par Compact Ch.5

Index (hex)	Name	Meaning	Data type	Flags	Default
1809:0	AI TxPDO-Par Compact Ch.5	PDO parameter TxPDO 10	UINT8	RO	0x09 (9_{dec})
1809:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 10	OCTET-STRING[2]	RO	01 1A

Index 180A AI TxPDO-Par Standard Ch.6

Index (hex)	Name	Meaning	Data type	Flags	Default
180A:0	AI TxPDO-Par Standard Ch.6	PDO parameter TxPDO 11	UINT8	RO	0x09 (9_{dec})
180A:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 11	OCTET-STRING[2]	RO	01 1A
180A:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
180A:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 180B AI TxPDO-Par Compact Ch.6

Index (hex)	Name	Meaning	Data type	Flags	Default
180B:0	AI TxPDO-Par Compact Ch.6	PDO parameter TxPDO 12	UINT8	RO	0x09 (9_{dec})
180B:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 12	OCTET-STRING[2]	RO	01 1A

Index 180C AI TxPDO-Par Standard Ch.7

Index (hex)	Name	Meaning	Data type	Flags	Default
180C:0	AI TxPDO-Par Standard Ch.7	PDO parameter TxPDO 13	UINT8	RO	0x09 (9_{dec})
180C:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 13	OCTET-STRING[2]	RO	01 1A
180C:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
180C:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 180D AI TxPDO-Par Compact Ch.7

Index (hex)	Name	Meaning	Data type	Flags	Default
180D:0	AI TxPDO-Par Compact Ch.7	PDO parameter TxPDO 14	UINT8	RO	0x09 (9_{dec})
180D:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 14	OCTET-STRING[2]	RO	01 1A

Index 180E AI TxPDO-Par Standard Ch.8

Index (hex)	Name	Meaning	Data type	Flags	Default
180E:0	AI TxPDO-Par Standard Ch.8	PDO parameter TxPDO 15	UINT8	RO	0x09 (9_{dec})
180E:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 15	OCTET-STRING[2]	RO	01 1A
180E:07	TxPDO State	The TxPDO state is set if it was not possible to correctly read in the associated input data	BOOLEAN	RO	0x00 (0_{dec})
180E:09	TxPDO Toggle	The TxPDO toggle is toggled with each update the corresponding input data	BOOLEAN	RO	0x00 (0_{dec})

Index 180F AI TxPDO-Par Compact Ch.8

Index (hex)	Name	Meaning	Data type	Flags	Default
180F:0	AI TxPDO-Par Compact Ch.8	PDO parameter TxPDO 16	UINT8	RO	0x09 (9$_{dec}$)
180F:06	Exclude TxPDOs	Specifies the TxPDOs (index of TxPDO mapping objects) that must not be transferred together with Tx-PDO 16	OCTET-STRING[2]	RO	01 1A

Index 1A00 AI TxPDO-Map Standard Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A00:0	AI TxPDO-Map Standard Ch.1	PDO Mapping TxPDO 1	UINT8	RO	0x09 (9$_{dec}$)
1A00:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6000:01, 1
1A00:02	SubIndex 002	2. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6000:02, 1
1A00:03	SubIndex 003	3. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6000:03, 2
1A00:04	SubIndex 004	4. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6000:05, 2
1A00:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A00:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A00:07	SubIndex 007	7. PDO Mapping entry (object 0x1800 (AI TxPDO-Par Standard Ch.1), entry 0x07 (TxPDO State))	UINT32	RO	0x1800:07, 1
1A00:08	SubIndex 008	8. PDO Mapping entry (object 0x1800 (AI TxPDO-Par Standard Ch.1), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x1800:09, 1
1A00:09	SubIndex 009	9. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6000:11, 16

Index 1A01 AI TxPDO-Map Compact Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A01:0	AI TxPDO-Map Standard Ch.1	PDO Mapping TxPDO 2	UINT8	RO	0x01 (1_{dec})
1A01:01	SubIndex 001	1. PDO Mapping entry (object 0x6000 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6000:11, 16

Index 1A02 AI TxPDO-Map Standard Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1A02:0	AI TxPDO-Map Standard Ch.2	PDO Mapping TxPDO 3	UINT8	RO	0x09 (9_{dec})
1A02:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6010:01, 1
1A02:02	SubIndex 002	2. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6010:02, 1
1A02:03	SubIndex 003	3. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6010:03, 2
1A02:04	SubIndex 004	4. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6010:05, 2
1A02:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A02:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A02:07	SubIndex 007	7. PDO Mapping entry (object 0x1802 (AI TxPDO-Par Standard Ch.2), entry 0x07 (TxPDO State))	UINT32	RO	0x1802:07, 1
1A02:08	SubIndex 008	8. PDO Mapping entry (object 0x1802 (AI TxPDO-Par Standard Ch.2), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x1802:09, 1
1A02:09	SubIndex 009	9. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6010:11, 16

Index 1A03 AI TxPDO-Map Compact Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1A03:0	AI TxPDO-Map Standard Ch.2	PDO Mapping TxPDO 4	UINT8	RO	0x01 (1_{dec})
1A03:01	SubIndex 001	1. PDO Mapping entry (object 0x6010 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6010:11, 16

Index 1A04 AI TxPDO-Map Standard Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
1A04:0	AI TxPDO-Map Standard Ch.3	PDO Mapping TxPDO 5	UINT8	RO	0x09 (9$_{dec}$)
1A04:01	SubIndex 001	1. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6020:01, 1
1A04:02	SubIndex 002	2. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6020:02, 1
1A04:03	SubIndex 003	3. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6020:03, 2
1A04:04	SubIndex 004	4. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6020:05, 2
1A04:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A04:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A04:07	SubIndex 007	7. PDO Mapping entry (object 0x1804 (AI TxPDO-Par Standard Ch.3), entry 0x07 (TxPDO State))	UINT32	RO	0x1804:07, 1
1A04:08	SubIndex 008	8. PDO Mapping entry (object 0x1804 (AI TxPDO-Par Standard Ch.3), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x1804:09, 1
1A04:09	SubIndex 009	9. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6020:11, 16

Index 1A05 AI TxPDO-Map Compact Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
1A05:0	AI TxPDO-Map Standard Ch.3	PDO Mapping TxPDO 6	UINT8	RO	0x01 (1$_{dec}$)
1A05:01	SubIndex 001	1. PDO Mapping entry (object 0x6020 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6020:11, 16

Index 1A06 AI TxPDO-Map Standard Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
1A06:0	AI TxPDO-Map Standard Ch.4	PDO Mapping TxPDO 7	UINT8	RO	0x09 (9$_{dec}$)
1A06:01	SubIndex 001	1. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6030:01, 1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A06:02	SubIndex 002	2. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6030:02, 1
1A06:03	SubIndex 003	3. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6030:03, 2
1A06:04	SubIndex 004	4. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6030:05, 2
1A06:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A06:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A06:07	SubIndex 007	7. PDO Mapping entry (object 0x1806 (AI TxPDO-Par Standard Ch.4), entry 0x07 (TxPDO State))	UINT32	RO	0x1806:07, 1
1A06:08	SubIndex 008	8. PDO Mapping entry (object 0x1806 (AI TxPDO-Par Standard Ch.4), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x1806:09, 1
1A06:09	SubIndex 009	9. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6030:11, 16

Index 1A07 AI TxPDO-Map Compact Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
1A07:0	AI TxPDO-Map Standard Ch.4	PDO Mapping TxPDO 8	UINT8	RO	0x01 (1_{dec})
1A07:01	SubIndex 001	1. PDO Mapping entry (object 0x6030 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6030:11, 16

Index 1A08 AI TxPDO-Map Standard Ch.5

Index (hex)	Name	Meaning	Data type	Flags	Default
1A08:0	AI TxPDO-Map Standard Ch.5	PDO Mapping TxPDO 9	UINT8	RO	0x09 (9_{dec})
1A08:01	SubIndex 001	1. PDO Mapping entry (object 0x6040 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6040:01, 1
1A08:02	SubIndex 002	2. PDO Mapping entry (object 0x6040 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6040:02, 1
1A08:03	SubIndex 003	3. PDO Mapping entry (object 0x6040 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6040:03, 2
1A08:04	SubIndex 004	4. PDO Mapping entry (object 0x6040 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6040:05, 2

BAUMÜLLER

Index (hex)	Name	Meaning	Data type	Flags	Default
1A08:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A08:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A08:07	SubIndex 007	7. PDO Mapping entry (object 0x1808 (AI TxPDO-Par Standard Ch.5), entry 0x07 (TxPDO State))	UINT32	RO	0x1808:07, 1
1A08:08	SubIndex 008	8. PDO Mapping entry (object 0x1808 (AI TxPDO-Par Standard Ch.5), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x1808:09, 1
1A08:09	SubIndex 009	9. PDO Mapping entry (object 0x6040 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6040:11, 16

Index 1A09 AI TxPDO-Map Compact Ch.5

Index (hex)	Name	Meaning	Data type	Flags	Default
1A09:0	AI TxPDO-Map Standard Ch.5	PDO Mapping TxPDO 10	UINT8	RO	0x01 (1_{dec})
1A09:01	SubIndex 001	1. PDO Mapping entry (object 0x6040 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6040:11, 16

Index 1A0A AI TxPDO-Map Standard Ch.6

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0A:0	AI TxPDO-Map Standard Ch.6	PDO Mapping TxPDO 11	UINT8	RO	0x09 (9_{dec})
1A0A:01	SubIndex 001	1. PDO Mapping entry (object 0x6050 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6050:01, 1
1A0A:02	SubIndex 002	2. PDO Mapping entry (object 0x6050 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6050:02, 1
1A0A:03	SubIndex 003	3. PDO Mapping entry (object 0x6050 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6050:03, 2
1A0A:04	SubIndex 004	4. PDO Mapping entry (object 0x6050 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6050:05, 2
1A0A:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A0A:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A0A:07	SubIndex 007	7. PDO Mapping entry (object 0x180A (AI TxPDO-Par Standard Ch.6), entry 0x07 (TxPDO State))	UINT32	RO	0x180A:07, 1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0A:08	SubIndex 008	8. PDO Mapping entry (object 0x180A (AI TxPDO-Par Standard Ch.6), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x180A:09, 1
1A0A:09	SubIndex 009	9. PDO Mapping entry (object 0x6050 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6050:11, 16

Index 1A0B AI TxPDO-Map Compact Ch.6

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0B:0	AI TxPDO-Map Standard Ch.6	PDO Mapping TxPDO 12	UINT8	RO	0x01 (1_{dec})
1A0B:01	SubIndex 001	1. PDO Mapping entry (object 0x6050 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6050:11, 16

Index 1A0C AI TxPDO-Map Standard Ch.7

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0C:0	AI TxPDO-Map Standard Ch.7	PDO Mapping TxPDO 13	UINT8	RO	0x09 (9_{dec})
1A0C:01	SubIndex 001	1. PDO Mapping entry (object 0x6060 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6060:01, 1
1A0C:02	SubIndex 002	2. PDO Mapping entry (object 0x6060 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6060:02, 1
1A0C:03	SubIndex 003	3. PDO Mapping entry (object 0x6060 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6060:03, 2
1A0C:04	SubIndex 004	4. PDO Mapping entry (object 0x6060 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6060:05, 2
1A0C:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A0C:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A0C:07	SubIndex 007	7. PDO Mapping entry (object 0x180C (AI TxPDO-Par Standard Ch.7), entry 0x07 (TxPDO State))	UINT32	RO	0x180C:07, 1
1A0C:08	SubIndex 008	8. PDO Mapping entry (object 0x180C (AI TxPDO-Par Standard Ch.7), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x180C:09, 1
1A0C:09	SubIndex 009	9. PDO Mapping entry (object 0x6060 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6060:11, 16

Index 1A0D AI TxPDO-Map Compact Ch.7

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0D:0	AI TxPDO-Map Standard Ch.7	PDO Mapping TxPDO 14	UINT8	RO	0x01 (1_{dec})
1A0D:01	SubIndex 001	1. PDO Mapping entry (object 0x6060 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6060:11, 16

Index 1A0E AI TxPDO-Map Standard Ch.8

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0E:0	AI TxPDO-Map Standard Ch.8	PDO Mapping TxPDO 15	UINT8	RO	0x09 (9_{dec})
1A0E:01	SubIndex 001	1. PDO Mapping entry (object 0x6070 (AI Inputs), entry 0x01 (Underrange))	UINT32	RO	0x6070:01, 1
1A0E:02	SubIndex 002	2. PDO Mapping entry (object 0x6070 (AI Inputs), entry 0x02 (Overrange))	UINT32	RO	0x6070:02, 1
1A0E:03	SubIndex 003	3. PDO Mapping entry (object 0x6070 (AI Inputs), entry 0x03 (Limit 1))	UINT32	RO	0x6070:03, 2
1A0E:04	SubIndex 004	4. PDO Mapping entry (object 0x6070 (AI Inputs), entry 0x05 (Limit 2))	UINT32	RO	0x6070:05, 2
1A0E:05	SubIndex 005	5. PDO Mapping entry (2 bits align)	UINT32	RO	0x0000:00, 2
1A0E:06	SubIndex 006	6. PDO Mapping entry (6 bits align)	UINT32	RO	0x0000:00, 6
1A0E:07	SubIndex 007	7. PDO Mapping entry (object 0x180E (AI TxPDO-Par Standard Ch.8), entry 0x07 (TxPDO State))	UINT32	RO	0x180E:07, 1
1A0E:08	SubIndex 008	8. PDO Mapping entry (object 0x180E (AI TxPDO-Par Standard Ch.8), entry 0x09 (TxPDO Toggle))	UINT32	RO	0x180E:09, 1
1A0E:09	SubIndex 009	9. PDO Mapping entry (object 0x6070 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6070:11, 16

Index 1A0F AI TxPDO-Map Compact Ch.8

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0F:0	AI TxPDO-Map Standard Ch.8	PDO Mapping TxPDO 16	UINT8	RO	0x01 (1_{dec})
1A0F:01	SubIndex 001	1. PDO Mapping entry (object 0x6070 (AI Inputs), entry 0x11 (Value))	UINT32	RO	0x6070:11, 16

Index 1C00 Sync manager type

Index (hex)	Name	Meaning	Data type	Flags	Default
1C00:0	Sync manager type	Using the sync managers	UINT8	RO	0x04 (4_{dec})
1C00:01	SubIndex 001	Sync-Manager Type Channel 1: Mailbox Write	UINT8	RO	0x01 (1_{dec})
1C00:02	SubIndex 002	Sync-Manager Type Channel 2: Mailbox Read	UINT8	RO	0x02 (2_{dec})
1C00:03	SubIndex 003	Sync-Manager Type Channel 3: Process Data Write (Outputs)	UINT8	RO	0x03 (3_{dec})
1C00:04	SubIndex 004	Sync-Manager Type Channel 4: Process Data Read (Inputs)	UINT8	RO	0x04 (4_{dec})

Index 1C12 RxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	0x00 (0_{dec})

Index 1C13 TxPDO assign

It must be ensured that the channels are entered in the PDO assignment ("TxPDO assign", object 0x1C13) successively.

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	0x08 (8_{dec})
1C13:01	SubIndex 001	1st allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A00 (6656_{dec})
1C13:02	SubIndex 002	2nd allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A02 (6658_{dec})
1C13:03	SubIndex 003	3rd allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A04 (6660_{dec})
1C13:04	SubIndex 004	4th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A06 (6662_{dec})
1C13:05	SubIndex 005	5th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A08 (6664_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:06	SubIndex 006	6th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A0A (6666_{dec})
1C13:07	SubIndex 007	7th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A0C (6668_{dec})
1C13:08	SubIndex 008	8th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A0E (6670_{dec})

Index 1C33 SM input parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:0	SM input parameter	Synchronization parameters for the inputs	UINT8	RO	0x20 (32_{dec})
1C33:01	Sync mode	Current synchronization mode: • Bit 0 = 0: Free Run • Bit 0 = 1: Synchron with SM 2 Event • Bit 15 = 0: Standard • Bit 15 = 1: FastOp mode (CoE deactivated)	UINT16	RW	0x0000 (0_{dec})
1C33:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchronous with SM 2 event: Master cycle time • DC-Mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x000F4240 (1000000_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: free run is supported • Bit 1: synchronous with SM 2 event is supported (outputs available) • Bit 1: synchronous with SM 3 event is supported (no outputs available) • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 01: input shift through local event (outputs available) • Bit 4-5 = 10: input shift with SYNC1 event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C33:08)	UINT16	RO	0xC003 (49155_{dec})
1C33:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x0000FDE8 (65000_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:06	Calc and copy time	Time between reading of the inputs and availability of the inputs for the master (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:08	Command	With this entry the real required process data provision time can be measured. • 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started The entries 0x1C33:03, 0x1C33:06, 1C33:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset.	UINT16	RW	0x0000 (0_{dec})
1C33:09	Delay time	Time between SYNC1 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C33:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

13.3 Notices on analog specifications

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

AI442E - 4 Channel Analog Input Terminal 4... 20 mA

14.1 Introduction AI442E
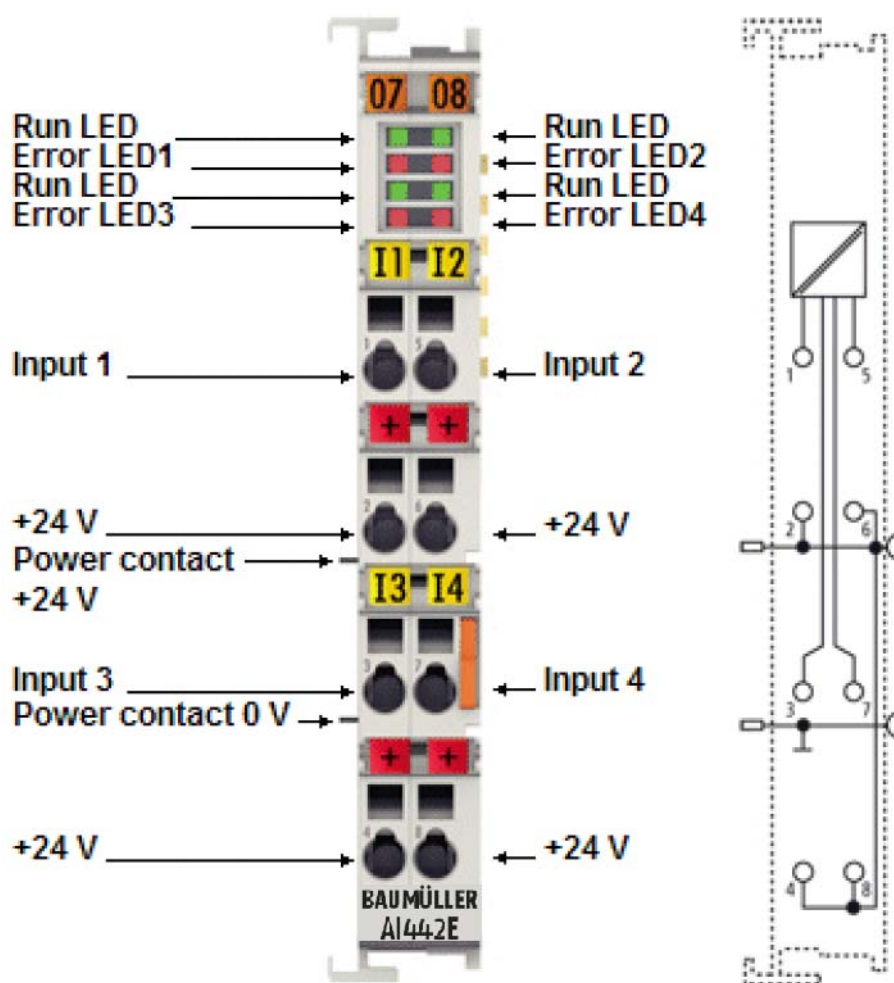
Figure 43:   AI442E

Analog Input Terminal; 4 channel, 12 bits, 4... 20 mA, single-ended inputs

The AI442E analog input terminal processes signals in the range between 4 mA and 20 mA. The current is digitized to a resolution of 12 bits, and is transmitted, in an electrically isolated form, to the higher-level automation device. The input electronics is independent of the supply voltage of the power contacts. The power contacts are connected through. The reference ground for the inputs is the 0 V power contact.

The error LEDs indicate an overload condition and a broken wire.

In the AI442E with four inputs the 24 V power contact is connected to the terminal, in order to enable connection of 2-wire sensors without external supply.

14.1.1 LEDs

LED	Color	Meaning	
RUN [1]	green	These LEDs indicate 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
ERROR [2]	red	Fault indication for broken wire and if the measuring range for the respective channel is exceeded (under- or overrun)	

[1] If several RUN LEDs are present, all of them have the same function.

[2] The error display shows the signal processing state for each channel.

14.1.2 Pin assignment

Terminal point		Description
Name	**No.**	
Input 1	1	Input 1
+24 V	2	+24 V (internally connected to terminal point 4, 6, 8 and positive power contact)
Input 3	3	Input 3
+24 V	4	+24 V (internally connected to terminal point 2, 6, 8 and positive power contact)
Input 2	5	Input 2
+24 V	6	+24 V (internally connected to terminal point 2, 4, 8 and positive power contact)
Input 4	7	Input 4
+24 V	8	+24 V (internally connected to terminal point 2, 4, 6 and positive power contact)

14.2 Object description and parameterization

See ▷Object description and parameterization ◁ from page 83 onward.

14.3 Notices on analog specifications

See ▷Notices on analog specifications ◁ from page 158 onward.

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

AO201E - TWO-CHANNEL ANALOG OUTPUT TERMINAL -10 V ... +10 V

15.1 Introduction AO201E

Run LED — Run LED

+Output 1 — +Output 2

Power contact
+24 V

GND — GND
Power contact 0 V

Shield — Shield

BAUMÜLLER
AO201E
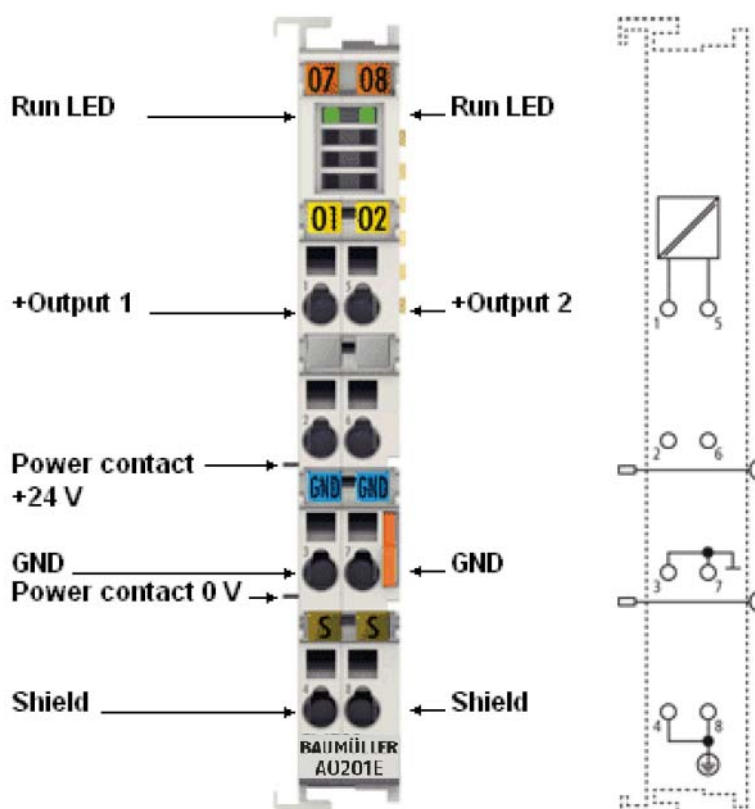
Figure 44:   AO201E

Two-channel analog output terminal with oversampling

For each microcycle, the EtherCAT Terminal receives a process data block which are output consecutively. The timebase of the terminal can be synchronized precisely with other EtherCAT devices via distributed clocks. This procedure enables the temporal resolution of the analog output signals to be increased to n times the bus cycle time.

The AO201E device can output a maximum of 100,000 values (100 ksamples/s) per channel and second.

The analog output terminal generates signals in the range -10 to +10 V. The voltage is set by the process with a resolution of 16 bit and output in electrically isolated form.

The output channels have a common ground potential. The output data are output with a configurable, integer multiple (oversampling factor: n) of the bus cycle time (n microcycles per bus cycle).

15.1.1 LEDs

LED	Color	Meaning	
RUN [1]	green	These LEDs indicate 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

[1] If several RUN LEDs are present, all of them have the same function.

15.1.2 Pin assignment

Terminal point		Description
Name	**No.**	**Description**
+ Output 1	1	+ Output 1
n.c.	2	not used
GND	3	Signal ground for output 1 (internally connected to terminal point 7)
Shield	4	Shield (internally connected to terminal point 8)
+ Output 2	5	+ Output 2
n.c.	6	not used
GND	7	Signal ground for output 2 (internally connected to terminal point 3)
Shield	8	Shield (internally connected to terminal point 4)

AO401E - 4 CHANNEL ANALOG OUTPUT TERMINAL 0 ... 10 V

16.1 Introduction AO401E
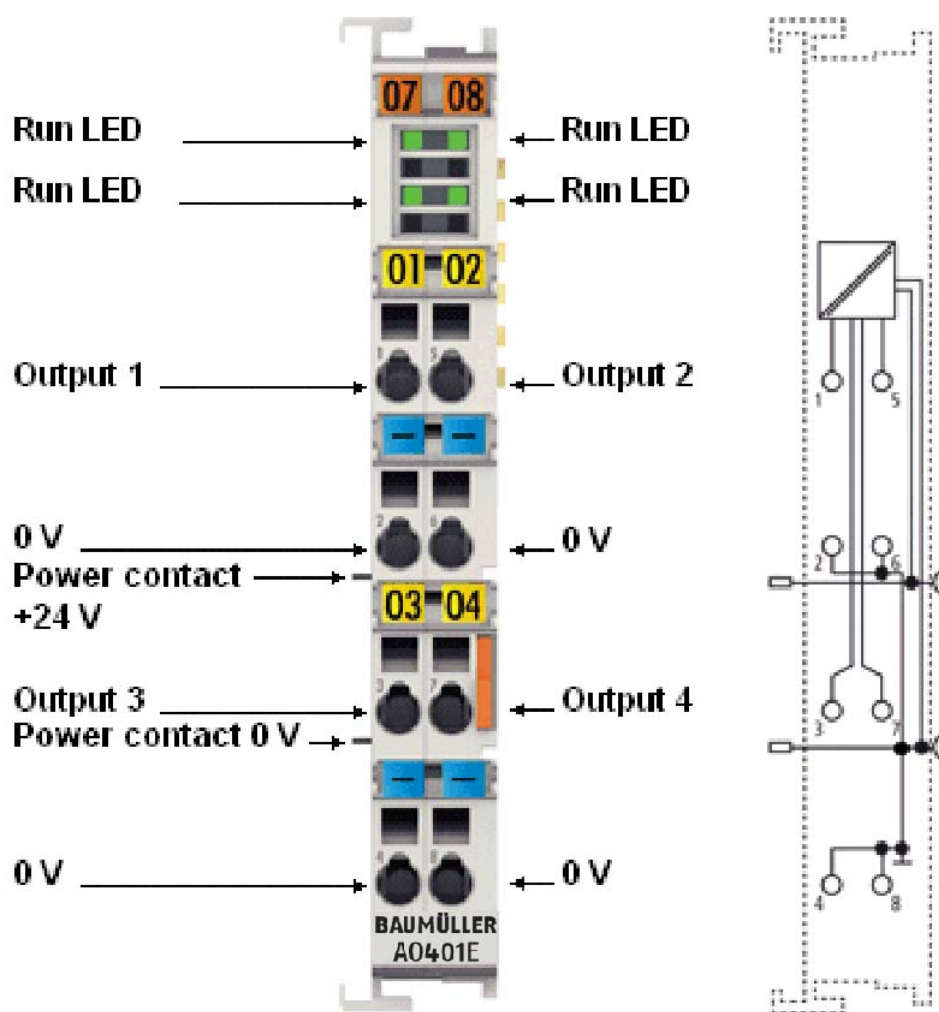
Figure 45:   AO401E

Four-channel analog output terminal, 0 ... 10 V, 12 bit

The AO401E analog output terminal generates signals in the range between 0 and 10 V. The voltage is supplied to the process level with a resolution of 12 bits, and is electrically isolated. The output channels of the EtherCAT Terminals have a common ground potential. The output stages are powered by the 24 V supply.

The signal state of the EtherCAT Terminals is indicated by light emitting diodes.

The AO401E 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.

16.1.1 LEDs

LED	Color	Meaning	
RUN [1]	green	These LEDs indicate 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

[1] If several RUN LEDs are present, all of them have the same function.

16.1.2 Pin assignment

Terminal point		
Name	**No.**	**Description**
Output 1	1	Output 1
Ground	2	0 V (internally connected to terminal points 4, 6 and 8)
Output 3	3	Output 3
Ground	4	0 V (internally connected to terminal points 2, 6 and 8)
Output 2	5	Output 2
Ground	6	0 V (internally connected to terminal points 2, 4 and 8)
Output 4	7	Output 4
Ground	8	0 V (internally connected to terminal points 2, 4 and 6)

16.2 Object description and parameterization

16.2.1 Restore object

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore default parameters	UINT8	RO	0x01 (1_{dec})
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 (0_{dec})

16.2.2 Configuration data

Index 8pp0 AO settings (Ch. 1 - 8)

Index (hex)	Name	Meaning	Data type	Flags	Default
8pp0:0	AO settings	Maximum subindex	UINT8	RO	0x16 (22_{dec})
8pp0:01	Enable user scale	User scale is active.	BOOLEAN	RW	0x00 (0_{dec})
8pp0:02	Presentation	0: Signed presentation The measured value is presented in two's complement format. Maximum representation range for 16 bits = -32768_{dec} ... $+32767_{dec}$ 1: Unsigned presentation Maximum presentation range for 16 bits = 0 .. $+65535_{dec}$ 2: Absolute value with MSB as sign The measured value is output in magnitude-sign format. Maximum representation range for 16 bits = -32768_{dec} ... $+32767_{dec}$ 3: Absolute value Negative numbers are also output as positive numbers.	BIT3	RW	0x00 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
8pp0:05	Watchdog	0: Default watchdog value The default value (8pp0:13) is active. 1: Watchdog ramp The ramp (8pp0:14) for moving to the default value is active. 2: Last output value In the event of a watchdog drop the last process data is issued.	BIT2	RW	0x00 (0_{dec})
8pp0:07	Enable user calibration	Enablement of the user calibration (see data stream flow chart	BOOLEAN	RW	0x00 (0_{dec})
8pp0:08	Enable vendor calibration	Enablement of the vendor calibration (see data stream flow chart	BOOLEAN	RW	0x01 (1_{dec})
8pp0:11	Offset	User scaling offset	INT16	RW	0x0000 (0_{dec})
8pp0:12	Gain	User scaling gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535_{dec} (0x00010000hex)	INT32	RW	0x00010000 (65536_{dec})
8pp0:13	Default output	Default output value	INT16	RW	0x0000 (0_{dec})
8pp0:14	Default output ramp	Ramp for ramping down to the default value Value in digits/ms.	INT16	RW	0xFFFF (65535_{dec})
8pp0:15	User calibration offset	User calibration offset	INT16	RW	0x0000 (0_{dec})
8pp0:16	User calibration gain	User calibration gain	UINT16	RW	0xFFFF (65535_{dec})

Index 8ppE AO internal data Ch.1-8

Index (hex)	Name	Meaning	Data type	Flags	Default
8ppE:0	AO internal data Ch.1-8	Maximum subindex	UINT8	RO	0x01 (1_{dec})
8ppE:01	DAC raw value	DAC raw value	UINT16	RO	0x0000 (0_{dec})

Index 8ppF AO vendor data Ch.1-8

Index (hex)	Name	Meaning	Data type	Flags	Default
8ppF:0	AO vendor data Ch.1-8	Maximum subindex	UINT8	RO	0x02 (2_{dec})
8ppF:01	Calibration offset	Vendor calibration offset	INT16	RW	0x0000 (0_{dec})
8ppF:02	Calibration gain	Vendor calibration gain	UINT16	RW	0x1EFA (7930_{dec})

16.2.3 Output data

Index 7pp0 AO outputs Ch.1-8

Index (hex)	Name	Meaning	Data type	Flags	Default
7pp0:0	AO outputs Ch.1-8	Maximum subindex	UINT8	RO	0x01 (1_{dec})
7pp0:01	Analog output	Analog output data	UINT16	RO	0x0000 (0_{dec})

16.2.4 Standard objects

Index 1000 Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: the Lo-Word contains the CoE profile used (5001). The Hi-Word contains the module profile according to the modular device profile.	UINT32	RO	0x01901389 (26219401_{dec})

Index 1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	AIxxxE

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	01

Index 100A Software version

Index (hex)	Name	Meaning	Data type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	01

Index 1018 Identity

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	$0x04$ (4_{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	$0x00000002$ (2_{dec})
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	0x0Fxx3052
1018:03	Revision	Revision number of the EtherCAT slave; the low word (bit 0-15) indicates the special terminal number, the high word (bit 16-31) refers to the device description	UINT32	RO	$0x00100000$ (1048576_{dec})
1018:04	Serial number	Serial number of the EtherCAT slave; the low byte (bit 0-7) of the low word contains the year of production, the high byte (bit 8-15) of the low word contains the week of production, the high word (bit 16-31) is 0	UINT32	RO	0x00000000

Index 10F0 Backup parameter handling

Index (hex)	Name	Meaning	Data type	Flags	Default
10F0:0	Backup parameter handling	Information for standardized loading and saving of backup entries	UINT8	RO	$0x01$ (1_{dec})
10F0:01	Checksum	Checksum across all backup entries of the EtherCAT slave	UINT32	RO	$0x00000000$ (0_{dec})

Index 1600 RxPDO-Map Outputs Ch.1

Index (hex)	Name	Meaning	Data type	Flags	Default
1600:0	RxPDO-Map Outputs Ch.1	PDO Mapping RxPDO 1	UINT8	RW	0x01 (1_{dec})
1600:01	SubIndex 001	1. PDO Mapping entry (object 0x7000 (AO outputs Ch.1), entry 0x01 (Analog output))	UINT32	RW	0x7000:01, 16

Index 1601 RxPDO-Map Outputs Ch.2

Index (hex)	Name	Meaning	Data type	Flags	Default
1601:0	RxPDO-Map Outputs Ch.2	PDO Mapping RxPDO 2	UINT8	RW	0x01 (1_{dec})
1601:01	SubIndex 001	1. PDO Mapping entry (object 0x7010 (AO outputs Ch.2), entry 0x01 (Analog output))	UINT32	RW	0x7010:01, 16

Index 1602 RxPDO-Map Outputs Ch.3

Index (hex)	Name	Meaning	Data type	Flags	Default
1602:0	RxPDO-Map Outputs Ch.3	PDO Mapping RxPDO 3	UINT8	RW	0x01 (1_{dec})
1602:01	SubIndex 001	1. PDO Mapping entry (object 0x7020 (AO outputs Ch.3), entry 0x01 (Analog output))	UINT32	RW	0x7020:01, 16

Index 1603 RxPDO-Map Outputs Ch.4

Index (hex)	Name	Meaning	Data type	Flags	Default
1603:0	RxPDO-Map Outputs Ch.4	PDO Mapping RxPDO 4	UINT8	RW	0x01 (1_{dec})
1603:01	SubIndex 001	1. PDO Mapping entry (object 0x7030 (AO outputs Ch.4), entry 0x01 (Analog output))	UINT32	RW	0x7030:01, 16

Index 1604 RxPDO-Map Outputs Ch.5

Index (hex)	Name	Meaning	Data type	Flags	Default
1604:0	RxPDO-Map Outputs Ch.5	PDO Mapping RxPDO 5	UINT8	RW	0x01 (1_{dec})
1604:01	SubIndex 001	1. PDO Mapping entry (object 0x7040 (AO outputs Ch.5), entry 0x01 (Analog output))	UINT32	RW	0x7040:01, 16

Index 1605 RxPDO-Map Outputs Ch.6

Index (hex)	Name	Meaning	Data type	Flags	Default
1605:0	RxPDO-Map Outputs Ch.6	PDO Mapping RxPDO 6	UINT8	RW	0x01 (1_{dec})
1605:01	SubIndex 001	1. PDO Mapping entry (object 0x7050 (AO outputs Ch.6), entry 0x01 (Analog output))	UINT32	RW	0x7050:01, 16

Index 1606 RxPDO-Map Outputs Ch.7

Index (hex)	Name	Meaning	Data type	Flags	Default
1606:0	RxPDO-Map Outputs Ch.7	PDO Mapping RxPDO 7	UINT8	RW	0x01 (1_{dec})
1606:01	SubIndex 001	1. PDO Mapping entry (object 0x7060 (AO outputs Ch.7), entry 0x01 (Analog output))	UINT32	RW	0x7060:01, 16

Index 1607 RxPDO-Map Outputs Ch.8

Index (hex)	Name	Meaning	Data type	Flags	Default
1607:0	RxPDO-Map Outputs Ch.8	PDO Mapping RxPDO 8	UINT8	RW	0x01 (1_{dec})
1607:01	SubIndex 001	1. PDO Mapping entry (object 0x7070 (AO outputs Ch.8), entry 0x01 (Analog output))	UINT32	RW	0x7070:01, 16

Index 1C00 Sync manager type

Index (hex)	Name	Meaning	Data type	Flags	Default
1C00:0	Sync manager type	Using the sync managers	UINT8	RO	0x04 (4_{dec})
1C00:01	SubIndex 001	Sync-Manager Type Channel 1: Mailbox Write	UINT8	RO	0x01 (1_{dec})
1C00:02	SubIndex 002	Sync-Manager Type Channel 2: Mailbox Read	UINT8	RO	0x02 (2_{dec})
1C00:03	SubIndex 003	Sync-Manager Type Channel 3: Process Data Write (Outputs)	UINT8	RO	0x03 (3_{dec})
1C00:04	SubIndex 004	Sync-Manager Type Channel 4: Process Data Read (Inputs)	UINT8	RO	0x04 (4_{dec})

Index 1C12 RxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	0x00 (0_{dec})
1C12:01	SubIndex 001	1st allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1600 (5632_{dec})
1C12:02	SubIndex 002	2nd allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1601 (5633_{dec})
1C12:03	SubIndex 003	3rd allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1602 (5634_{dec})
1C12:04	SubIndex 004	4th allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1603 (5635_{dec})
1C12:05	SubIndex 005	5th allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1604 (5636_{dec})
1C12:06	SubIndex 006	6th allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1605 (5637_{dec})
1C12:07	SubIndex 007	7th allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1606 (5638_{dec})
1C12:08	SubIndex 008	8th allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x1607 (5639_{dec})

Index 1C32 SM output parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0	SM output parameter	Synchronization parameters for the outputs	UINT8	RO	0x07 (7_{dec})
1C32:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchron with SM 2 Event • 2: DC-Mode - Synchron with SYNC0 Event • 3: DC-Mode - Synchron with SYNC1 Event	UINT16	RW	0x0001 (1_{dec})
1C32:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchronous with SM 2 event: Master cycle time • DC-Mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x00000000 (0_{dec})
1C32:03	Shift time	Time between SYNC0 event and output of the outputs (in ns, DC mode only)	UINT32	RW	0x00000000 (0_{dec})
1C32:04	Sync modes supported	Supported synchronization modes: • Bit 0 = 1: free run is supported • Bit 1 = 1: Synchronous with SM 2 event is supported • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 10: Output shift with SYNC1 event (only DC mode) • Bit 14 = 1: dynamic times (measurement through writing of 1C32:08)	UINT16	RO	0x8007 (32775_{dec})
1C32:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x00000000 (0_{dec})
1C32:06	Calc and copy time	Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:08	Command	• 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started The entries 1C32:03, 1C32:05, 1C32:06, 1C32:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset	UINT16	RW	0x0000 (0_{dec})
1C32:09	Delay time	Time between SYNC1 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C32:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

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 (2_{dec})
F000:01	Module index distance	Index spacing of the objects of the individual channels	UINT16	RO	0x0010 (16_{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0008 (8_{dec})

Index F008 Code word

Index (hex)	Name	Meaning	Data type	Flags	Default
F008:0	Code word	Code word (currently reserved)	UINT32	RW	0x00000000 (0_{dec})

16.3 Notices on analog specifications

See ▷Notices on analog specifications ◁ from page 158 onward.

AO442E - 4 CHANNEL ANALOG OUTPUT TERMINAL, 4 ... 20 MA

17.1 Introduction AO442E
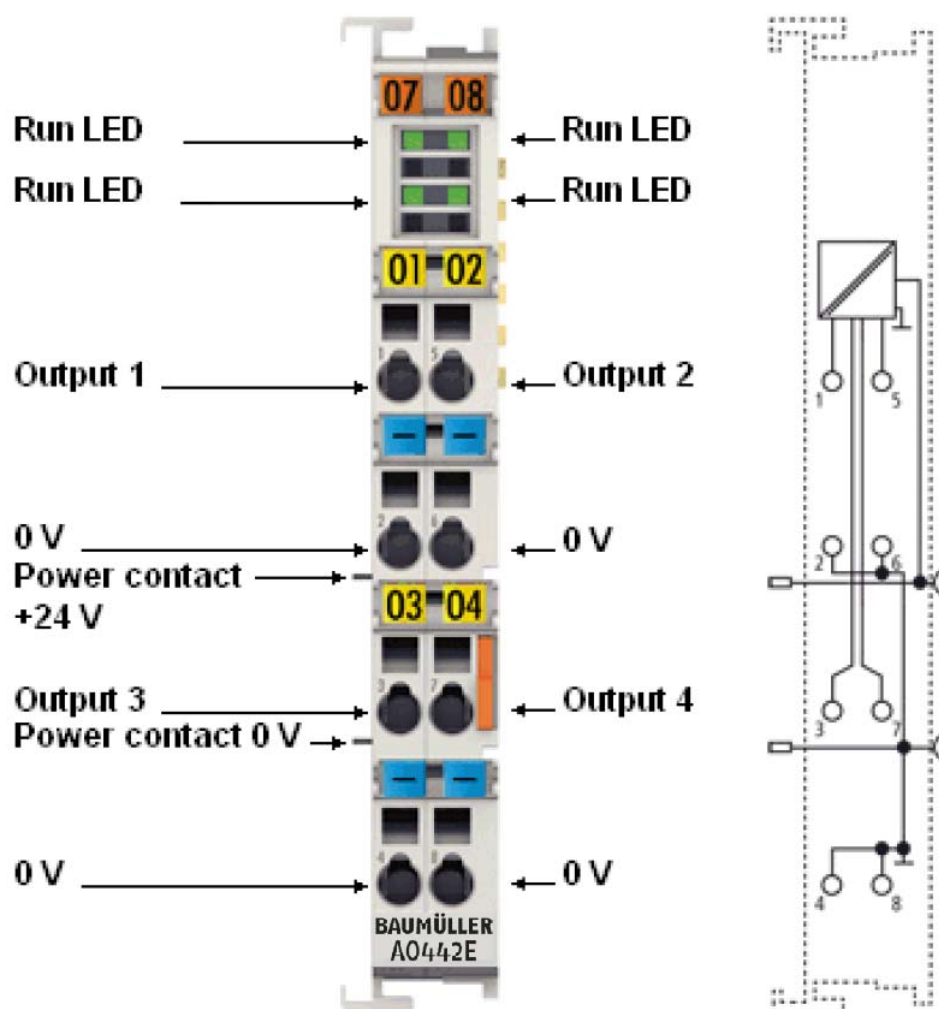
Figure 46:   AO442E

Four-channel analog output terminal, 4 ... 20 mA, 12 bit

The AO442E Analog Output Terminal generates analog output signals in the range between 4 mA and 20 mA. The power is supplied to the process level with a resolution of 12 bits, and is electrically isolated. Ground potential for the output channels of an Ether-CAT Terminal is common with the 0 V_{DC} supply. The output stages are powered by the 24 V supply. The signal state of the EtherCAT Terminals is indicated by light emitting diodes.

The AO442E support 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.

17.1.1 LEDs

LED	Color	Meaning	
RUN [1]	green	These LEDs indicate 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

[1] If several RUN LEDs are present, all of them have the same function.

17.1.2 Pin assignment

Terminal point		Description
Name	**No.**	**Description**
Output 1	1	Output 1
Ground	2	0 V (internally connected to terminal points 4, 6 and 8)
Output 3	3	Output 3
Ground	4	0 V (internally connected to terminal points 2, 6 and 8)
Output 2	5	Output 2
Ground	6	0 V (internally connected to terminal points 2, 4 and 8)
Output 4	7	Output 4
Ground	8	0 V (internally connected to terminal points 2, 4 and 6)

17.2 Object description and parameterization

See ▷Object description and parameterization ◁ from page 115 onward.

17.3 Notices on analog specifications

See ##AI2PTE Kap. 20.8#

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

ES000E - POTENTIAL SUPPLY TERMINAL 24 V$_{DC}$

18.1 Introduction ES000E
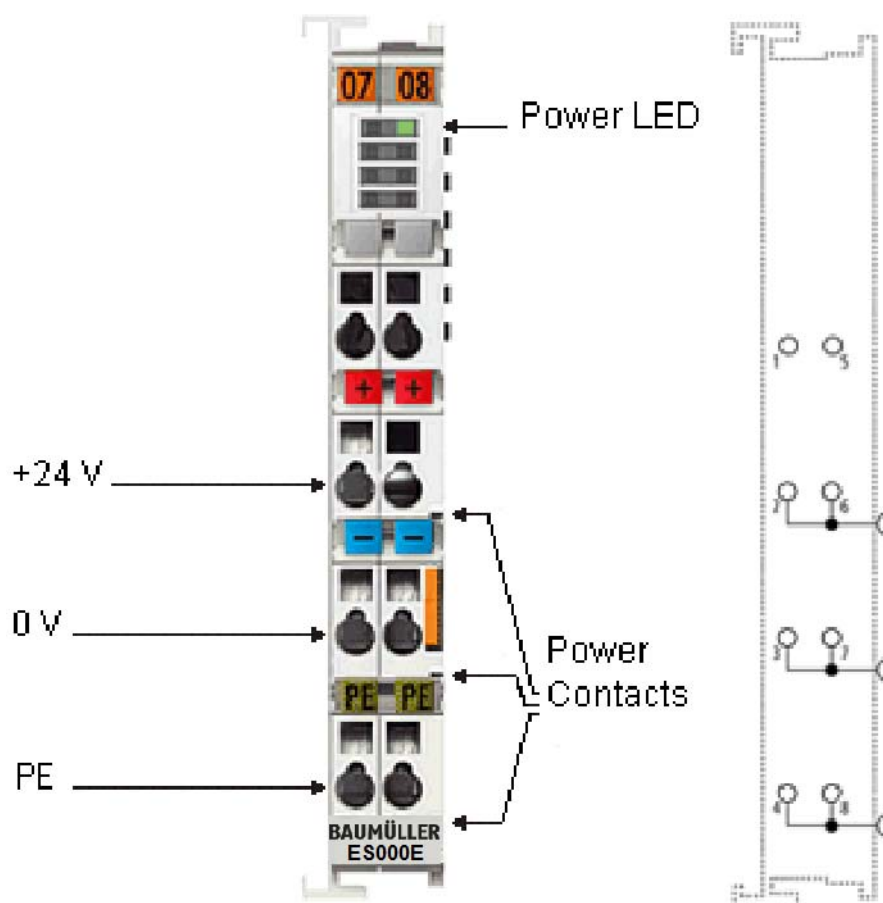
Figure 47:   ES000E

The ES000E 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.

18.1.1 LEDs

LED	Color	Meaning	
Power LED	green	off	No input voltage at supply input
		on	24 V_{DC} at supply input

18.1.2 Pin assignment

Terminal point			
Name	**No.**	**Description**	
	1	not used	
+24 V	2	Supply input + 24 V connected internally with terminal 6 and positive power contact	
0 V	3	0 V connected internally with terminal 7 and negative power contact	
PE	4	PE (connected internally with terminal 8 and PE power contact)	
	5	not used	
+24 V	6	Supply input + 24 V connected internally with terminal 2 and positive power contact	
0 V	7	0 V connected internally with terminal 3 and negative power contact	
PE	8	PE (connected internally with terminal 4 and PE power contact)	

ES001E - POWER SUPPLY TERMINAL 24 V_{DC}

19.1 Introduction ES001E
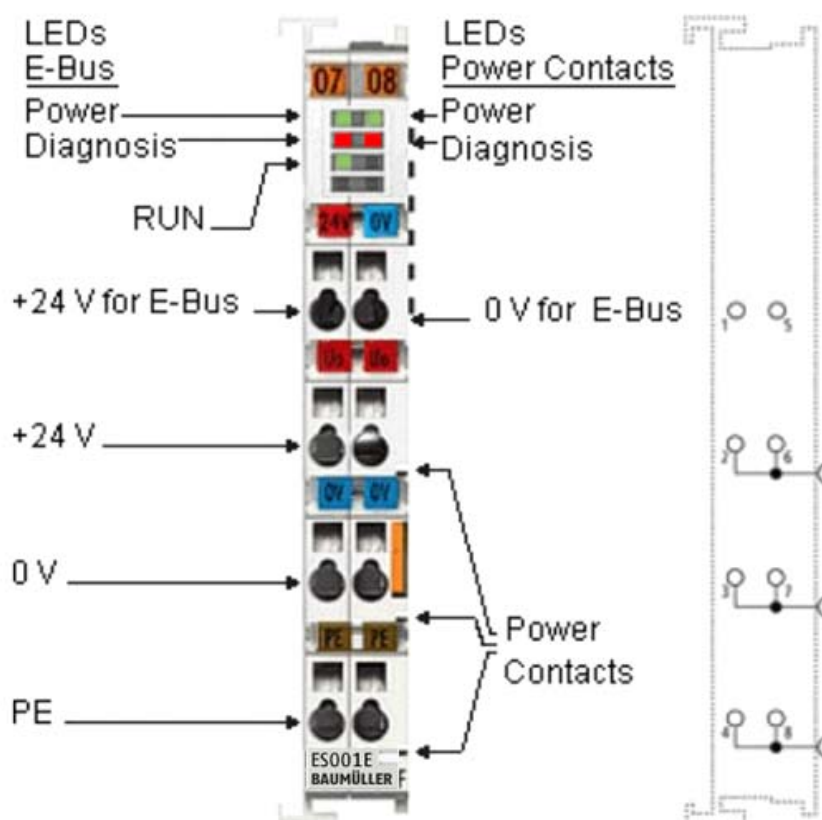
Figure 48:   ES001E

19.1.1 LEDs

LED	Color		Meaning
Power LED (E-Bus)	green	off	No input voltage at supply input for the E-Bus
		on	24 V_{DC} at supply input for the E-Bus
Power LED (Power Contacts)	green	off	No input voltage at supply input
		on	24 V_{DC} at supply input
Diagnosis LED** Us	red	off	No error
		on	Undervoltage: Us less than 17 V
Diagnosis LED** Up	red	off	No error
		on	Undervoltage: Up less than 17 V
RUN	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: **INIT** = Initialization of the terminal
		flashing (2 Hz)	State of the EtherCAT State Machine: **PREOP** = Setting for mailbox communication and variant standard settings
		flashing (1 Hz)	State of the EtherCAT State Machine: **SAFEOP** = Channel checking of the Sync Manager and the Distributed Clocks. Outputs stay in safe operation mode.
		on	State of the EtherCAT State Machine: **OP** = Normal operation mode, mailbox- and process data communication possible
		flashing (10 Hz)	State of the EtherCAT State Machine: **BOOTSTRAP** = Function for e.g. firmware updates of the terminal

19.1.2 Pin assignment

Terminal point		Description
Name	**No.**	
+24 V for E-Bus	1	Supply input + 24 V for the E-Bus
+24 V	2	Supply input + 24 V connected internally with terminal 6 and positive power contact
0 V	3	0 V connected internally with terminal 7 and negative power contact
PE	4	PE (connected internally with terminal 8)
0 V for E-Bus	5	0 V for supply input E-Bus
+24 V	6	Supply input + 24 V connected internally with terminal 2 and positive power contact
0 V	7	0 V connected internally with terminal 3 and negative power contact
PE	8	PE (connected internally with terminal 4)

Process data ES001E

The ES001E has a bit width of 2 bits (diagnosis bits for the power contacts voltage [Up] and for the E-Bus voltage [Us], „Undervoltage") and is displayed in process data as follows:

If the Up or Us voltage is below 17 V, the corresponding diagnosis bit „Undervoltage" has TRUE (1) status.

EA000E - ETHERCAT EXTENSION

20.1 Introduction EA000E
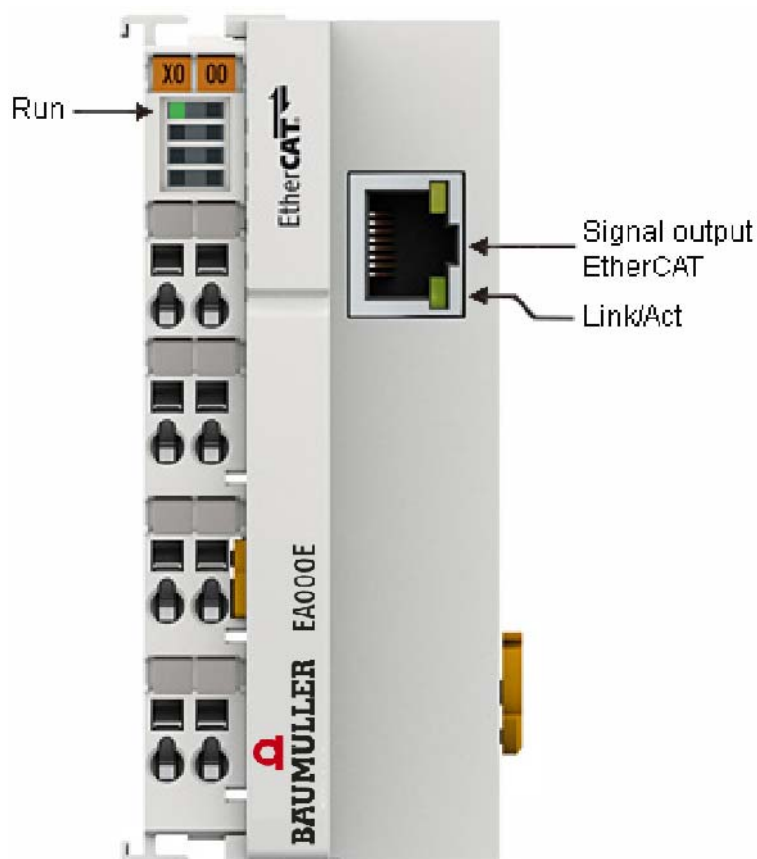
Figure 49:   EA000E

Like the E-bus end terminal, the EA000E EtherCAT extension is connected to the end of the EtherCAT Terminal Block. The terminal offers the option of connecting an Ethernet cable with RJ 45 connector, thereby extending the EtherCAT strand electrically isolated by up to 100 m. In the EA000E terminal, the E-bus signals are converted on the fly to

100BASE-TX Ethernet signal representation. Power supply to the electronics is via the E-bus. No parameterization or configuration tasks are required.

20.1.1 LEDs

LED	Color	Display	State	Description
LINK / ACT (X1)	green	off	-	no connection on the EtherCAT strand
		on	linked	EtherCAT device connected
		flashing	active	Communication with EtherCAT device

LED	Color	Meaning	
RUN	green	This LED indicates the terminal's operating state:	
		off	State of the EtherCAT State Machine: INIT = initialization of the terminal
		flashing uniformly	State of the EtherCAT State Machine: PREOP = function for mailbox communication and different standard-settings set
		flashing slowly	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
		flashing rapidly	State of the EtherCAT State Machine: BOOTSTRAP = function for terminal firmware updates

20.1.2 Pin assignment

Terminal point		
Name	**Type**	**Description**
X1	RJ45	Connection for EtherCAT networks (100BASE-TX-Ethernet signal representation)

AI2PTE - 2-CHANNEL ANALOG INPUT TERMINAL PT100 (RTD)

21.1 Introduction AI2PTE
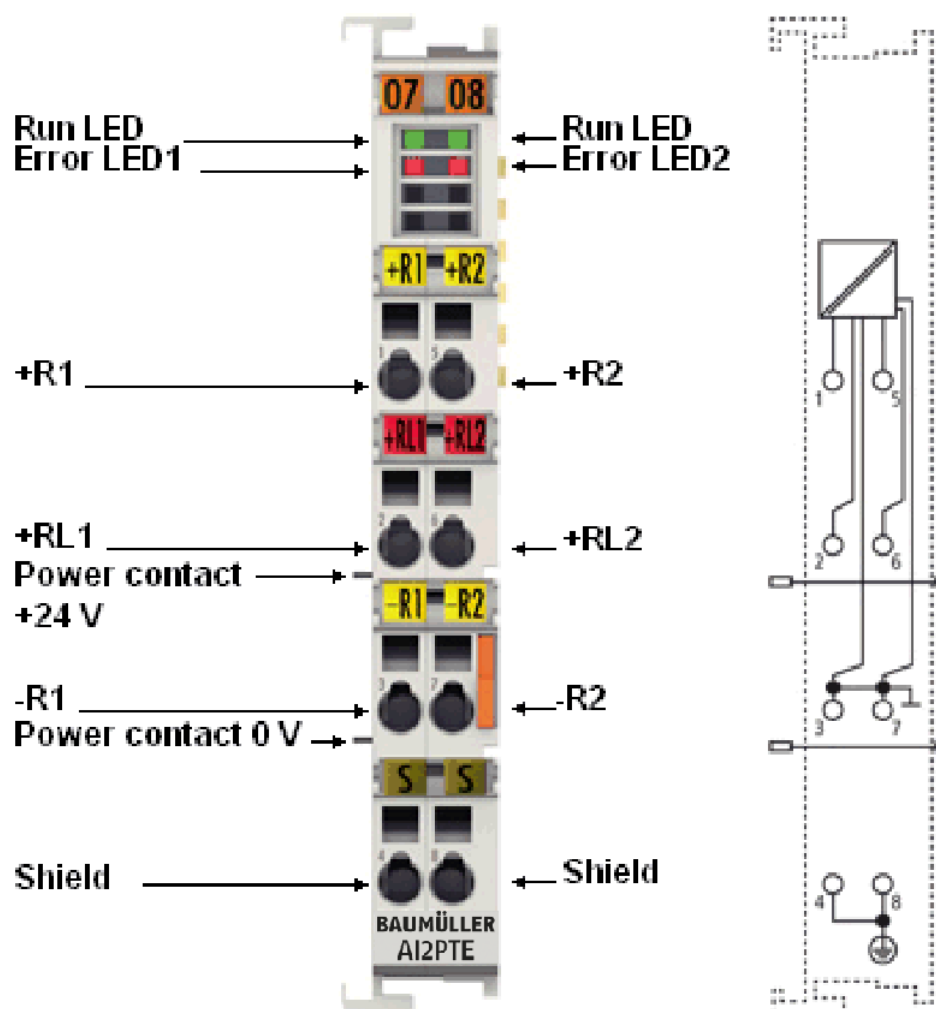
Figure 50:   AI2PTE

The AI2PTE analog input terminals allow resistance sensors to be connected directly. The AI2PTE circuitry can operate 2-wire sensors. Several characteristic sensor curves (Pt100, Pt1000, NI120, NI1000, KTY types and others) are supported.

The terminals from the AI2PTE series can measure the temperature at the measuring point or directly output the resistance values of the sensors. For temperature measurements the temperature value is calculated via the characteristic curves stored in the terminal.

The EtherCAT Terminals indicate their signal state by means of light emitting diodes. Sensor malfunctions such as broken wires are indicated by error LEDs.

21.1.1 LEDs

	NOTE!
	Two-wire connection AI2PTE
	If the AI2PTE is operated with a two-wire connection, the inputs +R and +RL must be bridged by the user.

LED	Color	Meaning	
RUN	green	These LEDs indicate 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
ERROR1 ERROR2	red	Short circuit or wire breakage. The resistance is in the invalid range of the characteristic curve	

21.1.2 Pin assignment

Terminal point		
Name	**No.**	**Description**
+R1	1	Input +R1
+RL1	2	Input +RL1
-R1	3	Input -R1
Shield	4	Shield (internally connected to terminal point 8)
+R2	5	Input +R2
+RL2	6	Input +RL2
-R2	7	Input -R2
Shield	8	Shield (internally connected to terminal point 4)

21.2 Technology RTD (Resistance Temperature Device) measuring

21.2.1 Function

The AI2PTE analog input terminal allows resistance sensors in the range 0 - 4096 Ohm.

Functions:

- Resistance measurement
  - Measuring range 0 to 1024 Ohm; Resolution 1/64 Ohm
  - Measuring range 0 to 4096 Ohm; Resolution 1/16 Ohm
  - The use of the terminal in the range from 0 to 10 Ohm is not recommended due to the relatively low measuring accuracy.
  - With the AI2PTE the external bridge must be inserted between +R and +RL in 3-wire mode

- Temperature   measurement
  The measured sensor resistance is converted directly into a temperature by the internal µC via the desired linearization characteristic curve.
  - Standard resolution 1/10°C (1 digit = 0.1!C) according to a theoretically representable temperature range [- 3276.7 to 3276.8°C]. The physically specified temperature range for the respective sensor is to be observed!
  - Various PTC sensor characteristic curves are implemented over their complete measuring range for selection in the AI2PTE series: Pt/Ni xxxx, KTY xx
  - Scaling and presentation can be changed

Additional notes:

- The resistance is determined by means of ratiometric voltage measurement.
- The error state 'broken wire' is detected as overrange, signaled as an error to the controller and indicated by the ERROR LED.

- The error state 'short-circuit' is detected as underrange if the resistance is smaller than the smallest resistance of the measuring range, signaled as an error to the controller and indicated by the ERROR LED.
- Characteristic curves for KT/KTY sensors are implemented and selectable via the CoE directory.
- In the delivery state, the measured value is displayed in increments of 1/10°C in two's complement format (integer).
- Other methods of display, e.g. high resolution with 1/100°C can be selected via CoE 0x80n0:02.
  When using the high resolution a temperature range of -320 to +320°C (-32566 to 32567) is measurable by the 2-byte PDO.
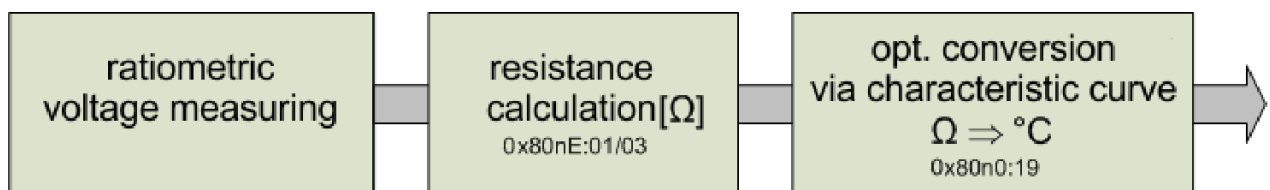
Figure51:   Display of the measurement and calculation of the resistance/temperature

21.2.2 Ratiometric voltage measurement

The AI2PTE measures resistance ratiometrically by means of voltage comparison, see ▷Figure 52 on page 141 (3-wire connection technique):

- A constant voltage of 2.5 V is applied across a highly precise known reference resistance R_{ref} (5 kOhm) and the sensor R_t connected in series.
- The sensor resistance can be determined by comparing the two voltages, V1 at reference and V2 at the sensor.
- The measuring current through the sensor thus depends on the sensor resistance; this must be considered in questions of sensor self-heating. Example: at 0°C and thus 1000 Ohm internal resistance, a Pt1000 thus causes a measuring current of 0.1 mA on an AI2PTE.

	NOTE!
🛈	**Wiring of the input channels**
	Due to this measurement principle (resistive temperature sensor), a sensor may not be connected in parallel to two or more input channels!

21.2.3 Connection techniques

The electrical connection of a resistance sensor to the AI2PTE can take place using the 2-wire or 3-wire methods. Since the measuring method is a resistance measurement, the sensor supply cables with their internal resistance can falsify the measurement. The following are available for this:
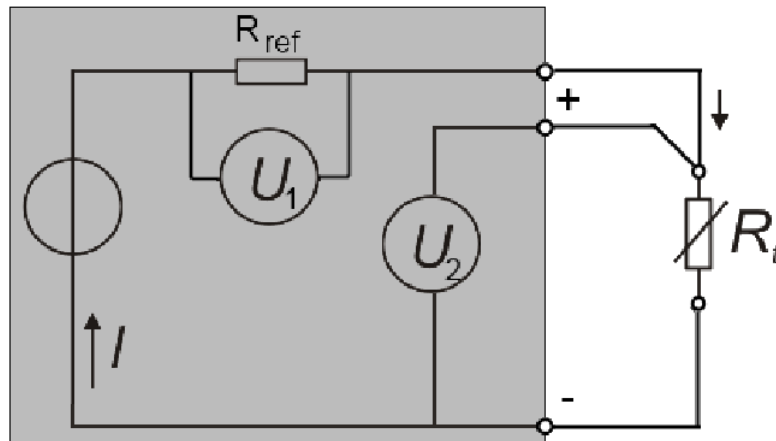
Figure 52:   3-wire connection technology

- 3-wire   sensors:
This simplified connection reduces wiring costs and compensates cable resistances to a considerable degree.
- 2-wire sensors: Very simple connection, recommended only for short supply cables
The supply line resistances can be eliminated from the calculation in 2-wire mode if they are made known to the AI2PTE in the CoE object 0x80n0:1B (unit [1/32 Ohm]). The determination of the supply line resistance is possible on the application side either by measurement or by comparison.

NOTE!

Two-wire connection

If the AI2PTE is operated with a two-wire connection, the inputs +R and +RL must be bridged by the user.

Overview of suitable resistance sensors

The following resistance sensors are suitable for temperature measurement with the AI2PTE (table) and can be selected via the object 0x80n0:19.

Type	Resistance range	Implemented temperature range
Pt100 (0,00385 Ω/Ω/°C, IEC60751 characteristic curve Pt385)	~ 18 ... ~390 Ohm	-200°C to 850°C
Ni100		-60°C to 250°C
Pt1000 (0,00385 Ω/Ω/°C, IEC60751 characteristic curve Pt385)	~180 ... ~ 3900 Ohm	-200°C to 850°C
Pt500		-200°C to 850°C

Type	Resistance range	Implemented temperature range
Pt200		-200°C to 1370°C
Ni1000		-60°C to 250°C
Ni1000 100°C: 1500 Ohm		-30 to 160°C
Ni120		-60°C to 320°C
KT100/110/130/210/230 KTY10/11/13/16/19	~500 ... ~2200 Ohm	-55 ...150°C
KTY81/82-110,120,150		
KTY81-121		
KTY81-122		
KTY81-151		
KTY81-152		
KTY81/82-210,220,250		
KTY81-221		
KTY81-222		
KTY81-251		
KTY81-252		
KTY83-110,120,150	~500 ... ~2500 Ohm	-50 ...175°C
KTY83-121		
KTY83-122		
KTY83-151		
KTY83-152		
KTY84-130,150	~350 ... ~2500 Ohm	-40 ...300°C
KTY84-151		
KTY21/23-6	~500 ... ~4000 Ohm	-50 ...150°C
KTY1x-5		
KTY1x-7		
KTY21/23-5		
KTY21/23-		

21.3 Basic principles of RTD technology

Certain materials change their electrical resistance if the temperature of the material changes. Thanks to this property they can be used as sensors for the measurement of temperature. Such an RTD element (Resistance Temperature Device) or thermistor then exhibits a well-known material-dependent property, i.e. how the resistance changes in re-

lation to the temperature – the so-called characteristic. In an initial approximation this characteristic can be taken to be a linear equation:

$$\Delta R \;=\; k \cdot \Delta T$$

The factor k can be positive or negative and must be specified by the sensor manufacturer:

- positive coefficient (PTC): resistance increases with increasing temperature, i.e. it conducts less well; the sensor is then referred to as a PTC thermistor
- negative coefficient (NTC): resistance increases with decreasing temperature, i.e. it conducts better; the sensor is then referred to as an NTC thermistor

The larger the coefficient, the higher the sensitivity of the sensor.

NOTE!

Temperature measurement

This kind of temperature measurement is to be distinguished from that using thermocouple sensors: these spontaneously generate a (small) voltage across the conductor, which is measured at the contact points.

Within a very small measuring range nearly all materials can be described by such a linear characteristic. However, it is often necessary to measure over a large measuring range, e.g. several tens or hundreds of K. Within such ranges the characteristic must be described for many materials by non-linear equations of a higher order or by using exponential components. Examples of such equations are

- Platinum/PT sensors (PTC thermistor) according to IEC 60751:
  - for the range -200°C ... 0°C:

$$R(T) \;=\; R_0(1 + AT + BT^2 + C(T - 100°\text{C})T^3)$$

  - for the range 0°C ... 850°C:

$$R(T) \;=\; R_0(1 + AT + BT^2)$$

The coefficients A, B and C are to be specified by the sensor manufacturer or taken from the standard. The parameter R_0 indicates the resistance in ohm of the platinum sensor at T = 0°C. The sensor designations are based on these characteristics, e.g. for PT100 R_0 = 100 Ohm at T = 0°C.

- Steinhart-Hart (for NTC thermistor)

$$\frac{1}{T} \;=\; a + b \cdot \ln R + c \cdot \ln^3(\text{R})$$

The coefficients a, b, c should be specified by the sensor manufacturer, or they can be determined by measuring the resistance at three known temperatures.

- B-parameter equation (for NTC thermistor)

$$R_T = R(T) = A \cdot e^{\frac{B}{T}} = R_{T0} \cdot e^{B\left(\frac{1}{T} - \frac{1}{T_0}\right)}$$

The coefficients R_{T0}, B, T_0 should be specified by the sensor manufacturer, or they can be determined by measuring the resistance at two known temperatures.

The B-parameter equation is a simplified version of the Steinhart-Hart equation. The B-parameter itself is only constant in a small range, e.g. between 25°C ... 50°C or 25°C ... 85°C, which is identified as follows: $B_{25/50}$ or $B_{25/85}$. The accuracy of the equation strongly depends on the B-parameter. The larger the measuring range, the lower the accuracy. If a larger measuring range required, it is preferable to use the Steinhart-Hart equation.

• and others

A typical characteristic is shown for each of the NTC and PTC families in following figure:
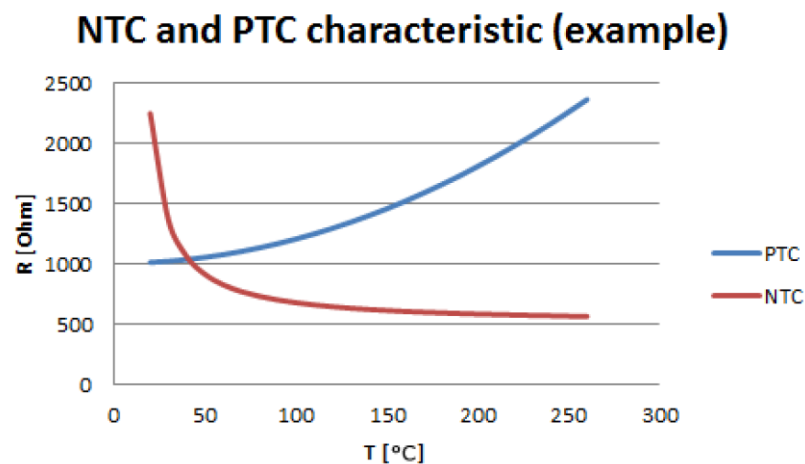
Figure 53:   Examples for temperature-dependent resistance values

Hence, there is no such thing as a general NTC or PTC sensor – in fact, they are names for sensor families with a certain behavior.

For common sensors/characteristics such as PT100, these characteristics are already permanently implemented into the measuring devices. The user must check whether a sensor that he intends to use is supported by the measuring device. The following criteria apply here:

- Temperature range: does the sensor support the intended temperature range?
- Measuring range: can the sensor resistance be measured in the intended temperature range?
- Characteristic curve: can the measured resistance be converted accordingly into temperature? (base point, gradient/coefficient)
- Velocity: how often is the resistance measured?

In a quite basic way, a sensor manufacturer can of course also publish the characteristic of its sensor as a value table.

Instruction handbook **E-Bus Terminals** .
Document No.: 5.17019.01

Baumüller Nürnberg GmbH

NOTE!

Resistance measurement

To determine the resistance it is usual to pass a measuring current in the mA range (< 5 mA) through the sensor and to measure the resulting voltage. Three effects must be taken into consideration when doing this:

- the measuring current can lead to self-heating of the sensor. However, this usually has only a minimal effect on the measuring accuracy. Special sensors tend to be used for cryogenic applications.
- the sensor supply lines also always have a resistance and add a (usually) constant additional resistance to the measurement. This can be compensated by
  - 3-wire connection of the sensor
  - manually accounting for the known wire resistance in the calculation
  - using a sensor with a higher nominal resistance – the supply line effects are then of less consequence
  - Insulation faults or thermovoltages can affect the measurement.

For classification there follows an overview of the NTC/PTC properties of various sensors:

NTC	PTC
many semiconductors	many metals
various ceramics	various ceramics
NTC20, NTC100 etc.	Pt100, Pt1000, ..
	KTY ..
	Ni100, Ni1000, ..
	FeT

NOTE!

Sensor exchange

Please note that 1:1 exchangeability is not always guaranteed, especially in the case of manufacturer-specified sensors. If necessary the new sensor must be recalibrated in the system.

21.4 Settings and application notes

Default setting

The AI2PTE can be used for direct temperature or resistance measurements.

The relationship between temperature and resistance of a Pt100/Pt1000 sensor is shown below:

Temperature	typical resistance, approx.
850°C	Pt1000: 3.9 kΩ Pt100: 390 Ω
320°C	Pt1000: 2.2 kΩ Pt100: 220 Ω
-200°C	Pt1000: 180 Ω Pt100: 18 Ω

Default/factory setting

- 2-wire connection
- Pt100 (CoE 0x80n0:19)
- Presentation signed (CoE 0x80n0:02)
- Limits disabled
- 50 Hz filter enabled
- All channels enabled

Area of application

The terminal is calibrated in the measuring range „1/16 Ω" (10 Ω to 4 kΩ) and can be used in this resistance range.

> **NOTE!**
>
> **Resistance Measurement mode**
>
> In Resistance Measurement mode the measured value is always displayed unsigned, irrespective of the Presentation setting (object 0x80n0:02), as 0x0 ... 0xFFFF with the respective value.
>
> 1/16 Ω -> ~62 mΩ/Digit

21.5 CoE object description

21.5.1 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 (1_{dec})
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 (0_{dec})

Index 80n0 RTD Settings for $0 \le n \le 7$ (Ch. 1 - 8)

> **NOTE!**
>
> **The filter properties are set only via index 0x8000:15**
>
> The filter frequencies are set for all channels of the AI2PTE terminal centrally via index 0x8000:15 (channel 1).
>
> The corresponding indices 8010:15 of the AI2PTE have no parameterization function!

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	RTD Settings	Maximum subindex	UINT8	RO	0x1B (27_{dec})
80n0:01	Enable user scale	User scale is active	BOOLEAN	RW	0x00 (0_{dec})
80n0:02	Presentation	0: Signed presentation 1: Absolute value with MSB as sign Signed amount representation	BIT3	RW	0x00 (0_{dec})
80n0:05	Siemens bits	The S5 bits are superimposed on the three low-order bits (value 60n0:11) Bit 0 = 1 ("overrange" or "underrange") Bit 1 (not used) Bit 2 (not used)	BOOLEAN	RW	0x00 (0_{dec})
80n0:06	Enable filter	Enable filter, which makes PLC-cycle-synchronous data exchange unnecessary	BOOLEAN	RW	0x00 (0_{dec})
80n0:07	Enable limit 1	The status bits are set in relation to Limit 1	BOOLEAN	RW	0x00 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:08	Enable limit 2	The status bits are set in relation to Limit 2	BOOLEAN	RW	0x00 (0_{dec})
80n0:09	Enable automatic calibration	A calibration is cyclically started. (optional)	BOOLEAN	RW	0x00 (0_{dec})
80n0:0A	Enable user calibration	Enabling of the user calibration	BOOLEAN	RW	0x00 (0_{dec})
80n0:0B	Enable vendor calibration	Enabling of the vendor calibration	BOOLEAN	RW	0x01 (1_{dec})
80n0:11	User scale offset	User scaling offset	INT16	RW	0x0000 (0_{dec})
80n0:12	User scale gain	This is the user scaling gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535 (0x00010000).	INT32	RW	0x00010000 (65536_{dec})
80n0:13	Limit 1	First limit value for setting the status bits (resolution 0.1°C)	INT16	RW	0x0000 (0_{dec})
80n0:14	Limit 2	Second limit value for setting the status bits (resolution 0.1°C)	INT16	RW	0x0000 (0_{dec})
80n0:15	Filter settings	This object determines the digital filter settings, if it is active via Enable filter (index 0x80n0:06). The possible settings are sequentially numbered. 0: 50 Hz 6: 3,75 kHz 1: 60 Hz 7: 7,5 kHz 2: 100 Hz 8: 15 kHz 3: 500 Hz 9: 30 kHz 4: 1 kHz 10: 5 Hz 5: 2 kHz 11: 10 Hz	INT16	RW	0x0000 (0_{dec})
80n0:17	User calibration offset	User offset calibration	INT16	RW	0x0000 (0_{dec})
80n0:18	User calibration gain	User gain compensation	UINT16	RW	0xFFFF (65535_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:19	RTD element (see ▷Overview of suitable resistance sensors ◁ on page 141)	RTD element 0: Pt100 1: Ni100 -60°C bis 250° 2:Pt1000 -200°C bis 850°C 3: Pt500 -200°C bis 850°C 4: Pt200 -200° C bis 850°C 5: Ni1000 -60°C bis 250°C 6: Ni1000 100°C: 1500 Ohm (-30 bis 160°C) 7: Ni120 -60°C bis 320°C 8: Output in Ohm Resolution 1/16 Ohm (0 to 4096 Ohm) 9: Output in Ohm Resolution 1/64 Ohm (0 to 1024 Ohm) 10-32: KT100/110/130/210/230 KTY10/11/13/16/19 KTY81/82-110,120,150 (-50...150°C) KTY81-121 KTY81-122 KTY81-151 KTY81-152 KTY81/82-210,220,250 KTY81-221 KTY81-222 KTY81-251 KTY81-252 KTY83-110,120,150 (-50...175°C) KTY83-121 KTY83-122 KTY83-151 KTY83-152 KTY84-130,150 (-40...300°C) KTY84-151 KTY21/23-6 (-50...150°C) KTY1x-5 KTY1x-7 KTY21/23-5 KTY21/23-7	UINT16	RW	0x0000 (0_{dec})
80n0:1A	Connection technology (see ▷Connection techniques ◁ on page 140)	Connection technology 0: Two-wire connection 1: Three-wire connection	UINT16	RW	0x0000 (0_{dec})
80n0:1B	Wire calibration 1/32 Ohm	Calibration of the supply lines	INT16	RW	0x0000 (0_{dec})

21.5.2 Complete overview

Standard objects (0x1000-0x1FFF)

The standard objects have the same meaning for all EtherCAT slaves.

Index 1000 Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: the Lo-Word contains the CoE profile used (5001). The Hi-Word contains the module profile according to the modular device profile.	UINT32	RO	( )

Index 1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	(...)

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	00

Index 100A Software version

Index (hex)	Name	Meaning	Data type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	01

Index 1018 Identity

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	0x04 (4_{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	0x00000002 (2_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	(...)
1018:03	Revision	Revision number of the EtherCAT slave; the low word (bit 0-15) indicates the special terminal number, the high word (bit 16-31) refers to the device description	UINT32	RO	(...)
1018:04	Serial number	Serial number of the EtherCAT slave; the low byte (bit 0-7) of the low word contains the year of production, the high byte (bit 8-15) of the low word contains the week of production, the high word (bit 16-31) is 0	UINT32	RO	(...)

Index 10F0 Backup parameter handling

Index (hex)	Name	Meaning	Data type	Flags	Default
10F0:0	Backup parameter handling	Information for standardized loading and saving of backup entries	UINT8	RO	0x01 (1_{dec})
10F0:01	Checksum	Checksum across all backup entries of the EtherCAT slave	UINT32	RO	0x00000000 (0_{dec})

Index 1A0n TxPDO-Map for $0 \leq n \leq 1$ (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0n:0	TxPDO-Map Ch.1	PDO Mapping TxPDO 1	UINT8	RW	0x09 (9_{dec})
1A0n:01	SubIndex 001	1. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x01 (Underrange))	UINT32	RW	0x60n0:01, 1
1A0n:02	SubIndex 002	2. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x02 (Overrange))	UINT32	RW	0x60n0:02, 1
1A0n:03	SubIndex 003	3. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x03 (Limit 1))	UINT32	RW	0x60n0:03, 2
1A0n:04	SubIndex 004	4. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x05 (Limit 2))	UINT32	RW	0x60n0:05, 2
1A0n:05	SubIndex 005	5. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x07 (Error))	UINT32	RW	0x60n0:07, 1
1A0n:06	SubIndex 006	6. PDO Mapping entry (7 bits align)	UINT32	RW	0x0000:00, 7

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0n:07	SubIndex 007	7. PDO Mapping entry (object 0x180n (TxPDO-Par Ch.1), entry 0x07 (TxPDO-State))	UINT32	RW	0x180n:07, 1
1A0n:08	SubIndex 008	8. PDO Mapping entry (object 0x180n (TxPDO-Par Ch.1), entry 0x09 (TxPDO-Toggle))	UINT32	RW	0x180n:09, 1
1A0n:09	SubIndex 009	9. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x11 (Value))	UINT32	RW	0x60n0:11, 16

Index 1C00 Sync manager type

Index (hex)	Name	Meaning	Data type	Flags	Default
1C00:0	Sync manager type	Using the sync managers	UINT8	RO	$0x04 (4_{dec})$
1C00:01	SubIndex 001	Sync-Manager Type Channel 1: Mailbox Write	UINT8	RO	$0x01 (1_{dec})$
1C00:02	SubIndex 002	Sync-Manager Type Channel 2: Mailbox Read	UINT8	RO	$0x02 (2_{dec})$
1C00:03	SubIndex 003	Sync-Manager Type Channel 3: Process Data Write (Outputs)	UINT8	RO	$0x03 (3_{dec})$
1C00:04	SubIndex 004	Sync-Manager Type Channel 4: Process Data Read (Inputs)	UINT8	RO	$0x04 (4_{dec})$

Index 1C12 RxPDO assign

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	$0x00 (0_{dec})$

Index 1C13 TxPDO assign*)

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	0x08 (8_{dec})
1C13:01	SubIndex 001	1st allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A00 (6656_{dec})
1C13:02	SubIndex 002	2nd allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A01 (6657_{dec})
1C13:03	SubIndex 003	3rd allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A02 (6658_{dec})
1C13:04	SubIndex 004	4th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A03 (6659_{dec})
1C13:05	SubIndex 005	5th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A04 (6660_{dec})
1C13:06	SubIndex 006	6th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A05 (6661_{dec})
1C13:07	SubIndex 007	7th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A06 (6662_{dec})
1C13:08	SubIndex 008	8th allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A07 (6663_{dec})

*) for AI2PTE subindex x01 and x02

Index 1C33 SM input parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:0	SM input parameter	Synchronization parameters for the inputs	UINT8	RO	0x07 (7_{dec})
1C33:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchronous with SM 3 event (no outputs available) • 2: DC - Synchronous with SYNC0 Event • 3: DC - Synchronous with SYNC1 Event • 34: Synchronous with SM 2 event (outputs available)	UINT16	RW	0x0000 (0_{dec})
1C33:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchronous with SM 2 event: Master cycle time • DC-Mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x00000000 (0_{dec})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: free run is supported • Bit 1: synchronous with SM 2 event is supported (outputs available) • Bit 1: synchronous with SM 3 event is supported (no outputs available) • Bit 2-3 = 01: DC mode is supported • Bit 4-5 = 01: input shift through local event (outputs available) • Bit 4-5 = 10: input shift with SYNC1 event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C33:08)	UINT16	RO	0x8007 (32775_{dec})
1C33:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x0000FDE8 (65000_{dec})
1C33:06	Calc and copy time	Time between reading of the inputs and availability of the inputs for the master (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:08	Command	• 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started The entries 0x1C33:03, 0x1C33:06, 1C33:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset.	UINT16	RW	0x0000 (0_{dec})
1C33:09	Delay time	Time between SYNC1 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dec})
1C33:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C33:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C33:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

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

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

Index 60n0 RTD Inputs for $0 \le n \le 1$ (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:0	RTD Inputs	Maximum subindex	UINT8	RO	0x11 (17_{dec})
60n0:01	Underrange	The measuring range is undershot.	BOOLEAN	RO	0x00 (0_{dec})
60n0:02	Overrange	The measuring range is overshot. ("open circuit" detection if "error" [index 0x60n0:07) is set	BOOLEAN	RO	0x00 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:03	Limit 1	Limit value monitoring 0: not active 1: Value is larger than the limit value 2: Value is smaller than the limit value 3: Value is equal to the limit value	BIT2	RO	0x00 (0_{dec})
60n0:05	Limit 2	Limit value monitoring 0: not active 1: Value is larger than the limit value 2: Value is smaller than the limit value 3: Value is equal to the limit value	BIT2	RO	0x00 (0_{dec})
60n0:07	Error	The error bit is set if the data is invalid.	BOOLEAN	RO	0x00 (0_{dec})
60n0:0F	TxPDO State	Validity of the data of the associated TxPDO (0 = valid, 1 = invalid).	BOOLEAN	RO	0x00 (0_{dec})
60n0:10	TxPDO Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated	BOOLEAN	RO	0x00 (0_{dec})
60n0:11	Value	The analog input data	INT16	RO	0x0000 (0_{dec})

Index 80nE RTD Internal data for $0 \leq n \leq 1$ (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
80nE:0	RTD Internal data	Maximum subindex	UINT8	RO	0x04 (4_{dec})
80nE:01	ADC raw value	ADC raw value 1	INT32	RO	0x00000000 (0_{dec})
80nE:02	Resistor 1	Resistance 1 (measured value of resistance sensor, resolution: 1/32 Ohm)	UINT16	RO	0x0000 (0_{dec})
80nE:03	ADC raw value 2 (RL)	ADC raw value 2 (RL)	INT32	RO	0x00000000 (0_{dec})
80nE:04	Resistor 2 (RL)	Resistance 2 (RL) (measured value of resistance sensor, resolution 1/32 Ohm)	UINT16	RO	0x0000 (0_{dec})

Index 80nF RTD Vendor data for $0 \leq n \leq 1$ (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
80nF:0	RTD Vendor data	Maximum subindex	UINT8	RO	0x06 (6_{dec})
80nF:01	Calibration offset	Manufacturer calibration offset	INT16	RW	0x0000 (0_{dec})

156
of 210   Instruction handbook **E-Bus Terminals** .
Document No.: 5.17019.01   Baumüller Nürnberg GmbH

Index (hex)	Name	Meaning	Data type	Flags	Default
80nF:02	Calibration gain	Manufacturer calibration gain	UINT16	RW	0x9E50 (40528$_{dec}$)
80nF:03	Calibration offset RL	Manufacturer calibration offset (input RL)	INT16	RW	0x0000 (0$_{dec}$)
80nF:04	Calibration gain RL	Manufacturer calibration gain (input RL)	UINT16	RW	0x9E50 (40528$_{dec}$)
80nF:05	Calibration offset 4-wire	Manufacturer calibration offset (4-wire connection technology)	INT16	RW	0x0000 (0$_{dec}$)
80nF:06	Calibration gain 4-wire	Manufacturer calibration gain (4-wire connection technology)	UINT16	RW	0x9E50 (40528$_{dec}$)

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 (2$_{dec}$)
F000:01	Module index distance	Index spacing of the objects of the individual channels	UINT16	RO	0x0010 (16$_{dec}$)
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0004 (4$_{dec}$)

Index F008 Code word

Index (hex)	Name	Meaning	Data type	Flags	Default
F008:0	Code word	Currently reserved	UINT32	RW	0x00000000 (0$_{dec}$)

Index F010 Module list [for {n=1, n=2} (2-channel)]

Index (hex)	Name	Meaning	Data type	Flags	Default
F010:0	Module list	Maximum subindex	UINT	RO	0x02 (2$_{dec}$)
F010:0n	SubIndex 00n	Profile 320	INT32	RO	0x00000140 (320$_{dec}$)

21.6 Status word

The status information for each channel of the AI2PTE and AI2TEE is transmitted cyclically from the terminal to the EtherCAT Master as process data (PDO).

The AI2PTE or AI2TEE transmit the following process data:

- **Underrange**: Measurement is below range
- **Overrange**: Range of measurement exceeded ("Cable break" together with "Error")
- **Limit 1**: Limit value monitoring 0: ok, 1: Limit value overshot , 2: Limit value undershot
- **Limit 2**: Limit value monitoring 0: ok, 1: Limit value overshot , 2: Limit value undershot
- **Error**: The error bit is set if the process data is invalid (cable break, overrange, underrange)
- **TxPDO State**: Validity of the data of the associated TxPDO (0 = valid, 1 = invalid).
- **TxPDO Toggle**: The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated. This allows the currently required conversion time to be derived.

The limit evaluation is set in the "8000" objects in the CoE directory.

21.7 Notices on analog specifications

I/O devices with analog inputs are characterized by a number of technical characteristic data; refer to the technical data in the respective documents.

Some explanations are given below for the correct interpretation of these characteristic data.

21.7.1 Full scale value (FSV)

An I/O device with an analog input measures over a nominal measuring range that is limited by an upper and a lower limit (initial value and end value); these can usually be taken from the device designation.

The range between the two limits is called the measuring span and corresponds to the equation (end value - initial value). Analogous to pointing devices this is the measuring scale (see IEC 61131) or also the dynamic range.

For analog I/O devices the rule is that the limit with the largest value is chosen as the full scale value of the respective product (also called the reference value) and is given a positive sign. This applies to both symmetrical and asymmetrical measuring spans.
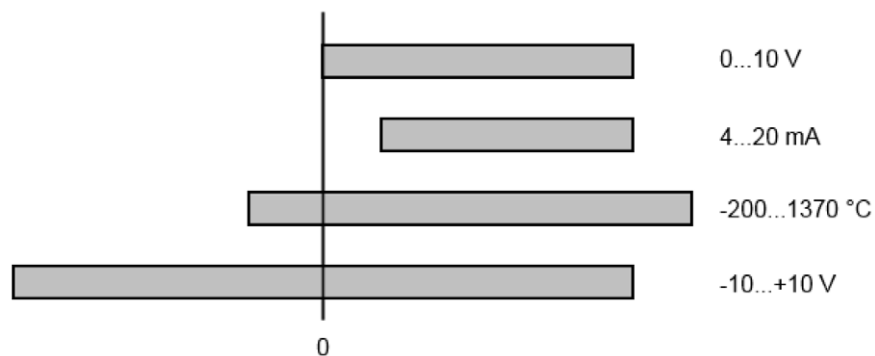
Figure 54:   Full scale value, measuring span

For the above examples this means:

- Measuring range 0 V ... +10 V: asymmetric unipolar, full scale value = 10 V, measuring span = 10 V

- Measuring range 4 mA ... 20 mA: asymmetric unipolar, full scale value = 20 mA, measuring span = 16 mA

- Measuring range -200°C ... 1370°C: asymmetric bipolar, full scale value = 1370°C, measuring span = 1570°C

- Measuring range -10 V ... +10 V: symmetric bipolar, full scale value = 10 V, measuring span = 20 V

This applies to analog output terminals/ boxes (and related Baumüller product groups).

21.7.2 Measuring error / measurement deviation

The relative measuring error (% of the full scale value) is referenced to the full scale value and is calculated as the quotient of the largest numerical deviation from the true value ('measuring error') referenced to the full scale value.

$$\text{Measuring error} \; = \; \frac{|\text{max. deviation}|}{\text{full scale value}}$$

The measuring error is generally valid for the entire permitted operating temperature range, also called the „usage error limit" and contains random and systematic portions of the referred device (i.e. „all" influences such as temperature, inherent noise, aging, etc.).

It always to be regarded as a positive/negative span with ±, even if it is specified without ± in some cases.

The maximum deviation can also be specified directly.

Example: Measuring range 0..10 V and measuring error < ± 0.3 % full scale value
$\rightarrow^{..}$ maximum deviation ± 30 mV in the permissible operating temperature range.

> **NOTE!**
>
> **Lower measuring error**
>
> Since this specification also includes the temperature drift, a significantly lower measuring error can usually be assumed in case of a constant ambient temperature of the device and thermal stabilization after a user calibration.
>
> This applies to analog output devices.

21.7.3 Temperature coefficient tK [ppm/K]

An electronic circuit is usually temperature dependent to a greater or lesser degree. In analog measurement technology this means that when a measured value is determined by means of an electronic circuit, its deviation from the "true" value is reproducibly dependent on the ambient/operating temperature.

A manufacturer can alleviate this by using components of a higher quality or by software means.

The specified temperature coefficient allows the user to calculate the expected measuring error outside the basic accuracy at 23°C.

Due to the extensive uncertainty considerations that are incorporated in the determination of the basic accuracy (at 23°C), Baumüller recommends a quadratic summation.

Example: Let the basic accuracy at 23°C be ±0.01% typ. (full scale value), tK = 20 ppm/K typ.; the accuracy A35 at 35°C is wanted, hence ΔT = 12 K.

$$G35 = \sqrt{(0{,}01\%)^2 + \left(12\text{K} \cdot 20\frac{\text{ppm}}{\text{K}}\right)^2} = 0{,}026\% \quad \text{full scale value, typ}$$

Remarks: ppm $\cong 10^{-6}$ % $\cong 10^{-2}$

21.7.4 Single-ended / differential typification

For analog inputs a basic distinction between two types is made: single-ended (SE) and differential (DIFF), referring to the difference in electrical connection with regard to the potential difference.

The diagram shows two-channel versions of an SE module and a DIFF module as examples for all multichannel versions.
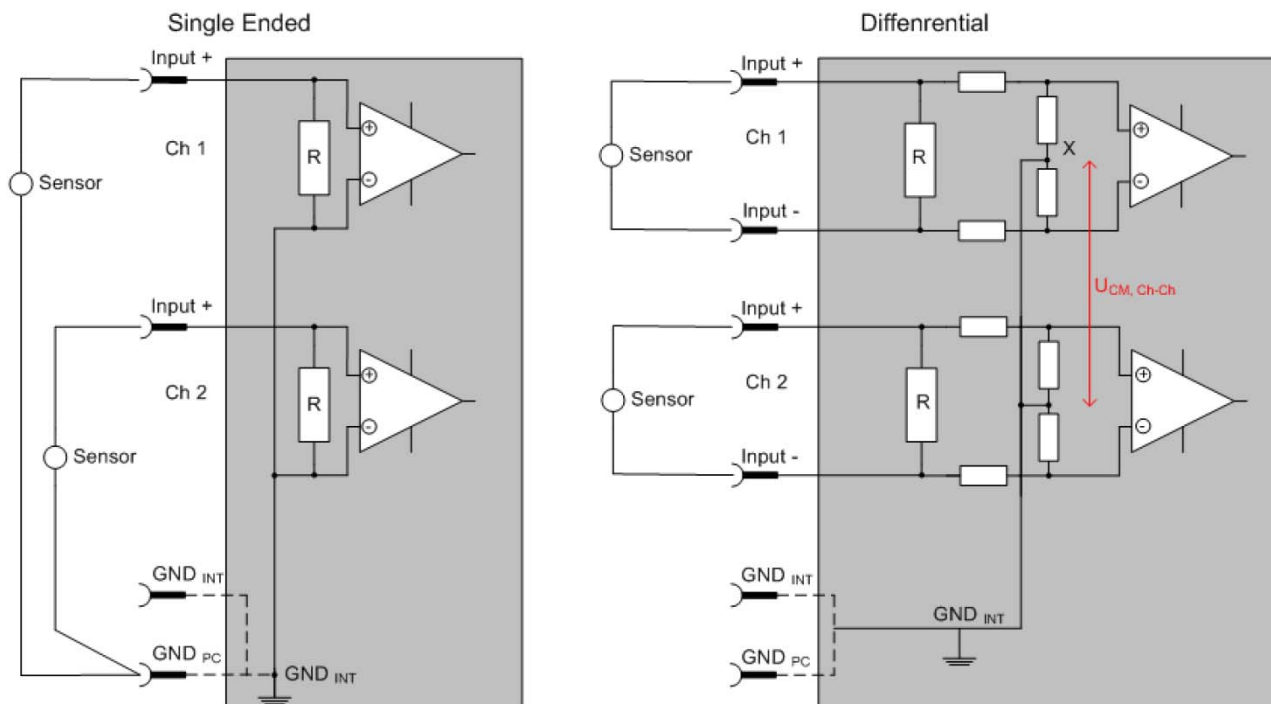
Figure 55:   SE and DIFF module as 2-channel version

NOTE!

Dashed lines indicate that the respective connection may not necessarily be present in each SE or DIFF module. Electrical isolated channels are operating as differential type in general, hence there is no direct relation (voltaic) to ground within the module established at all. Indeed, specified information to recommended and maximum voltage levels have to be taken into account.

The basic rule:

- Analog measurements always take the form of voltage measurements between two potential points. For voltage measurements a large R is used, in order to ensure a high impedance. For current measurements a small R is used as shunt. If the purpose is resistance measurement, corresponding considerations are applied.

  - Baumüller generally refers to these two points as input+/signal potential and input-/reference potential.

  - For measurements between two potential points two potentials have to be supplied.

  - Regarding the terms "single-wire connection" or "three-wire connection", please note the following for pure analog measurements: three- or four-wire connections can be used for sensor supply, but are not involved in the actual analog measurement, which always takes place between two potentials/wires. In particular this also applies to SE, even though the term suggest that only one wire is required.

- The term "electrical isolation" should be clarified in advance. IO modules feature 1..8 or more analog channels; with regard to the channel connection a distinction is made in terms of:
  - how the channels WITHIN a module relate to each other, or
  - how the channels of SEVERAL modules relate to each other.

The property of electrical isolation indicates whether the channels are directly connected to each other.

- Terminals (and related product groups) always feature electrical isolation between the field/analog side and the bus/EtherCAT side. In other words, if two analog terminals are not connected via the power contacts (cable), the modules are effectively electrically isolated.
- If channels within a module are electrically isolated, or if a single-channel module has no power contacts, the channels are effectively always differential. See also explanatory notes below. Differential channels are not necessarily electrically isolated.

- Analog measuring channels are subject to technical limits, both in terms of the recommended operating range (continuous operation) and the destruction limit. Please refer to the respective terminal documentation for further details.

Explanation

- . **differential (DIFF)**
  - Differential measurement is the most flexible concept. The user can freely choose both connection points, input+/signal potential and input-/reference potential, within the framework of the technical specification.
  - A differential channel can also be operated as SE, if the reference potential of several sensors is linked. This interconnection may take place via the system GND.
  - Since a differential channel is configured symmetrically internally (cf. ▷ Figure 55 on page 161), there will be a mid-potential (X) between the two supplied potentials that is the same as the internal ground/reference ground for this channel. If several DIFF channels are used in a module without electrical isolation, the technical property V_{CM} (common-mode voltage) indicates the degree to which the mean voltage of the channels may differ.
  - The internal reference ground may be accessible as connection point at the terminal/ box, in order to stabilize a defined GND potential in the terminal/ box. In this case it is particularly important to pay attention to the quality of this potential (noiselessness, voltage stability). At this GND point a wire may be connected to make sure that $V_{CM,max}$ is not exceeded in the differential sensor cable. If differential channels are not electrically isolated, usually only one $V_{CM,max}$ is permitted. If the channels are electrically isolated this limit should not apply, and the channels voltages may differ up to the specified separation limit.
  - Differential measurement in combination with correct sensor wiring has the special advantage that any interference affecting the sensor cable (ideally the feed and return line are arranged side by side, so that interference signals have the same effect on both wires) has very little effect on the measurement, since the potential of both lines varies jointly (hence the term common mode). In simple terms: Common-mode interference has the same effect on both wires in terms of amplitude and phasing.
  - Nevertheless, the suppression of common-mode interference within a channel or between channels is subject to technical limits, which are specified in the technical data.

- **Single Ended (SE)**
  - If the analog circuit is designed as SE, the input/reference wire is internally fixed to a certain potential that cannot be changed. This potential must be accessible from outside on at least one point for connecting the reference potential, e.g. via the power contacts (cable).
  - In other words, in situations with several channels SE offers users the option to avoid returning at least one of the two sensor cables to the terminal/ box (in contrast to DIFF). Instead, the reference wire can be consolidated at the sensors, e.g. in the system GND.
  - A disadvantage of this approach is that the separate feed and return line can result in voltage/current variations, which a SE channel may no longer be able to handle. See common-mode interference. A V_{CM} effect cannot occur, since the module channels are internally always 'hardwired' through the input/reference potential.

Typification of the 2/3/4-wire connection of current sensors

Current transducers/sensors/field devices (referred to in the following simply as 'sensor') with the industrial 0/4-20 mA interface typically have internal transformation electronics for the physical measured variable (temperature, current, etc.) at the current control output. These internal electronics must be supplied with energy (voltage, current). The type of cable for this supply thus separates the sensors into self-supplied or externally supplied sensors:

Self-supplied sensors

- The sensor draws the energy for its own operation via the sensor/signal cable + and -. So that enough energy is always available for the sensor's own operation and open-circuit detection is possible, a lower limit of 4 mA has been specified for the 4-20 mA interface; i.e. the sensor allows a minimum current of 4 mA and a maximum current of 20 mA to pass.
- 2-wire connection see ▷Figure 56 on page 163, cf. IEC60381-1
- Such current transducers generally represent a current sink and thus like to sit between + and – as a 'variable load'. Refer also to the sensor manufacturer's information
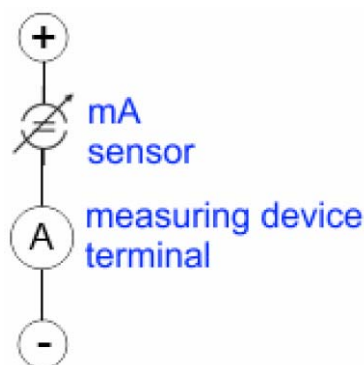
Figure 56:   2-wire connection

Therefore, they are to be connected as follows:
  - preferably to „**single-ended" inputs** if the +Supply connections of the terminal/ box are also to be used - connect to +Supply and Signal

○ they can, however, also be connected to **„differential" inputs**, if the termination to GND is then manufactured on the application side . to be connected with the right polarity to +Signal and –Signal It is important to refer to the information page Configuration of 0/4..20 mA differential inputs.

Externally supplied sensors

- 3- and 4-wire connection see ▷Figure 57 on page 164, cf. IEC60381-1
- the sensor draws the energy/operating voltage for its own operation from 2 supply cables of its own. One or two further sensor cables are used for the signal transmission of the current loop:
  ○ 1 sensor cable: according to the terminology such sensors are to be connected to „single-ended" inputs in 3 cables with +/-/Signal lines and if necessary FE/shield
  ○ 2 sensor cables: for sensors with 4-wire connection based on +supply/-supply/+signal/-signal, check whether +signal can be connected to +supply or .signal to .supply.
    - Yes: then you can connect accordingly to a „single-ended" input.
    - No: the „differential" input for +Signal and –Signal is to be selected; +Supply and –Supply are to be connected via additional cables.
    It is important to refer to the information page Configuration of 0/4..20 mA differential inputs!

Note: expert organizations such as NAMUR demand a usable measuring range <4 mA/ >20 mA for error detection and adjustment, see also NAMUR NE043.

The device documentation must be consulted in order to see whether the respective device supports such an extended signal range.

Usually there is an internal diode existing within unipolar terminals/ boxes (and related product groups), in this case the polarity/direction of current have to be observed.
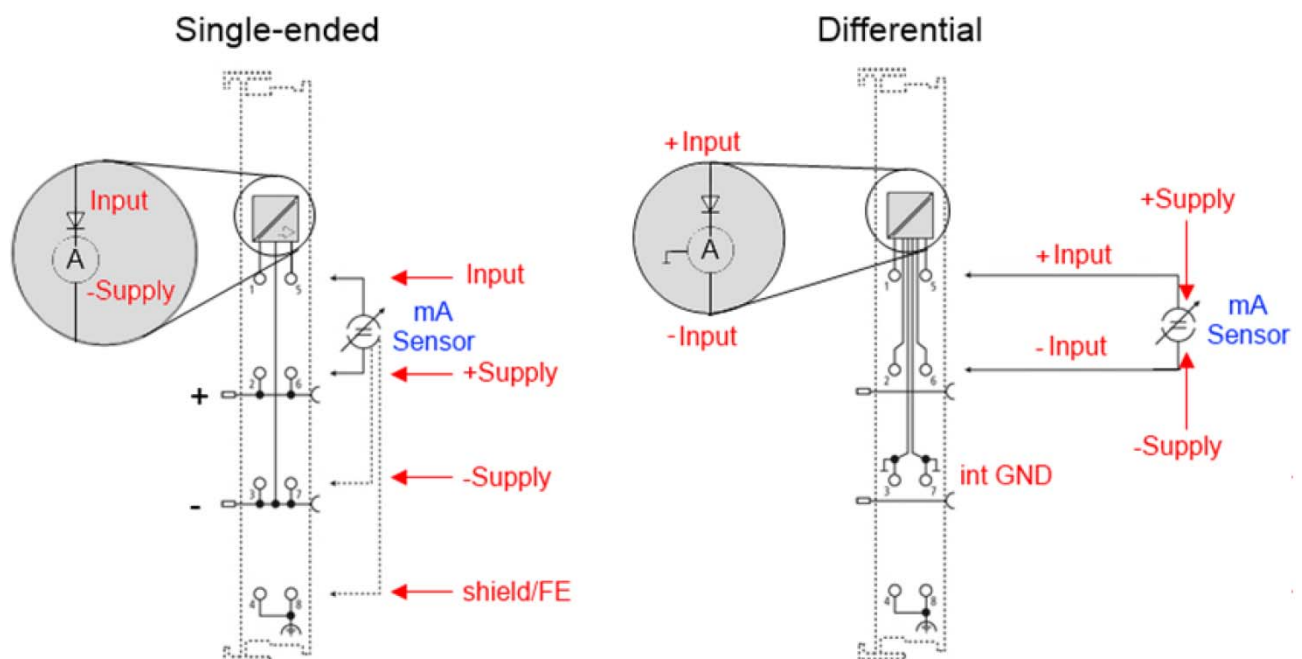
Figure 57:   Connection of externally supplied sensors

21.7.5 Common-mode voltage and reference ground (based on differential inputs)

Common-mode voltage (V_{CM}) is defined as the average value of the voltages of the individual connections/ inputs and is measured/specified against reference ground.
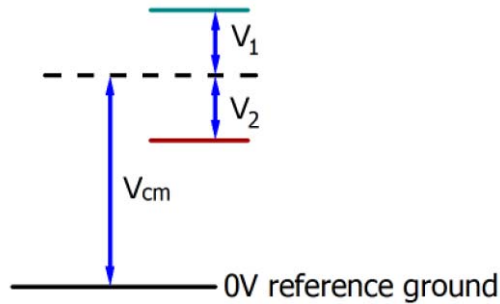
Figure 58:   Common-mode voltage (V_{CM})

The definition of the reference ground is important for the definition of the permitted common-mode voltage range and for measurement of the common-mode rejection ratio (CMRR) for differential inputs.

The reference ground is also the potential against which the input resistance and the input impedance for single-ended inputs or the common-mode resistance and the common-mode impedance for differential inputs is measured.

The reference ground is usually accessible at or near the terminal/ box, e.g. at the terminal contacts, power contacts (cable) or a mounting rail. Please refer to the documentation regarding positioning. The reference ground should be specified for the device under consideration.

For multi-channel terminals/ boxes with resistive (=direct, ohmic, galvanic) or capacitive connection between the channels, the reference ground should preferably be the symmetry point of all channels, taking into account the connection resistances.

21.7.6 Dielectric strength

A distinction should be made between:

- Dielectric strength (destruction limit): Exceedance can result in irreversible changes to the electronics
  - Against a specified reference ground
  - Differential
- Recommended operating voltage range: If the range is exceeded, it can no longer be assumed that the system operates as specified
  - Against a specified reference ground
  - Differential
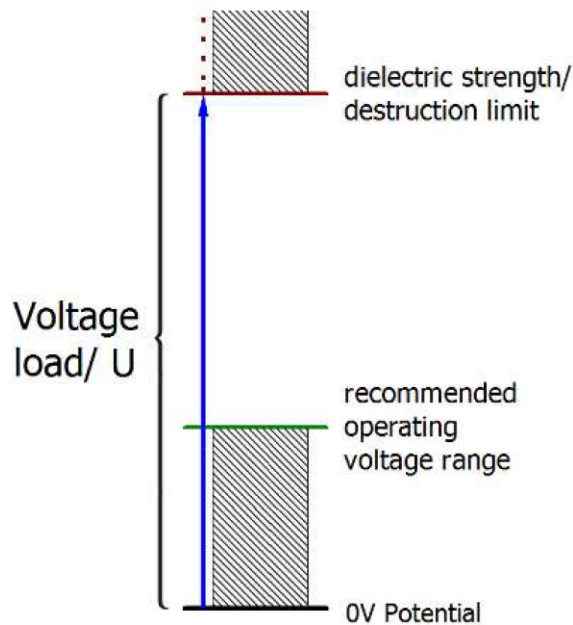
Figure 59:   Recommended operating voltage range

The device documentation may contain particular specifications and timings, taking into account:

- Self-heating
- Rated voltage
- Insulating strength
- Edge steepness of the applied voltage or holding periods
- Normative environment (e.g. PELV)

21.7.7 Temporal aspects of analog/digital conversion

The conversion of the constant electrical input signal to a value-discrete digital and machine-readable form takes place in the analog input modules with ADC (analog digital converter). Although different ADC technologies are in use, from a user perspective they all have a common characteristic: after the conversion a certain digital value is available in the controller for further processing. This digital value, the so-called analog process data, has a fixed temporal relationship with the „original parameter", i.e. the electrical input value. Therefore, corresponding temporal characteristic data can be determined and specified.

This process involves several functional components, which act more or less strongly in every AI (analog input) module:

- the electrical input circuit
- the analog/digital conversion
- the digital further processing
- the final provision of the process and diagnostic data for collection at the fieldbus (EtherCAT, I/O-bus, etc.)
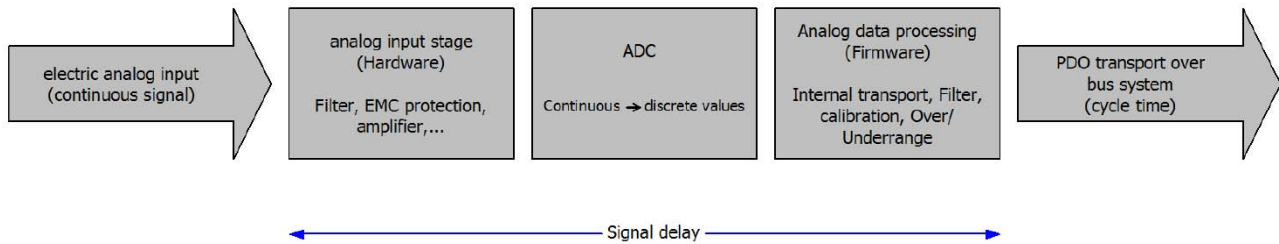
Figure 60:   Signal processing analog input

21.8 Restoring the delivery state

To restore the delivery state for backup objects in AI2xxE terminals, the CoE object Restore default parameters, SubIndex 001 can be selected.

Enter the value 1684107116 in field Dec or the value 0x64616F6C in field Hex and confirm with OK.

All backup objects are reset to the delivery state.

An incorrect entry for the restore value has no effect.

AI2TEE - 2 CHANNEL ANALOG THERMOCOUPLE INPUT TERMINAL

22.1 Introduction AI2TEE

2 channel analog thermocouple input terminals with open-circuit recognition

The AI2TEE analog input terminals allow thermocouples to be connected directly. The EtherCAT Terminals circuit can operate thermocouple sensors using the 2-wire technique. Linearization over the full temperature range is realized with the aid of a microprocessor. The temperature range can be selected freely. The error LEDs indicate a broken wire. Compensation for the cold junction is made through an internal temperature measurement at the terminals. The AI2TEE can also be used for mV measurement.

Figure 61:   AI2TEE

Instruction handbook **E-Bus Terminals** .

22.1.1 LEDs

LED	Color	Meaning		
RUN	green	These LEDs indicate the terminal's operating state:		
		off	State of the EtherCAT State Machine: INIT = initialization of the terminal	
		flash-ing uni-formly	State of the EtherCAT State Machine: PREOP = function for mailbox communication and different standard-settings set	
		flash-ing slowly	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	
		flash-ing rap-idly	State of the EtherCAT State Machine: BOOTSTRAP = function for firmware updates of the terminal	
ERROR1 ERROR2	red	Short circuit or wire breakage. The resistance is in the invalid range of the characteristic curve		

22.1.2 Pin assignment

> **NOTE!**
>
> **Earthed thermocouples**
>
> Observe for earthed thermocouples: Differential inputs max. ± 2 V to ground!

> **NOTE!**
>
> **Current carrying capacity of the input contacts**
>
> The maximum permitted current on the signal-relevant terminal points (inputs, GND) is 40 mA (if applicable).

Terminal point		
Name	**No.**	**Description**
Input +TC1	1	Input +TC1
Input +TC2	2	Input +TC2
GND	3	Ground (internally connected with terminal point 7)
Shield	4	Shield (internally connected to terminal point 8)
Input –TC1	5	Input –TC1
Input –TC2	6	Input –TC2
GND	7	Ground (internally connected with terminal point 3)
Shield	8	Shield (internally connected to terminal point 4)

22.2 TC technology basics

The thermocouple terminals can evaluate thermocouples of the types J, K, B, C, E, N, R, S, T, U and L. The characteristic curves are linearized and the reference temperature determined directly within the terminal. Temperatures are output in 1/10°C, for example (device-dependent). The terminal is fully configurable via the Bus Coupler or the control system. Different output formats may be selected or own scaling activated. In addition, linearization of the characteristic curve and determination and calculation of the reference temperature (temperature at the terminal connection contacts) can be switched off.

Measuring principle of the thermocouple

Thermocouples can be classified as active transducers. They exploit the thermo-electric effect (Seebeck, Peltier, Thomson). A voltage referred to as thermovoltage occurs over the length of a cable with different temperatures at both ends. It is an unambiguous function of the temperature and the material. In a "TC element" this effect is utilized by operating two different conductor materials in parallel (see ▷Figure 62 on page 173)
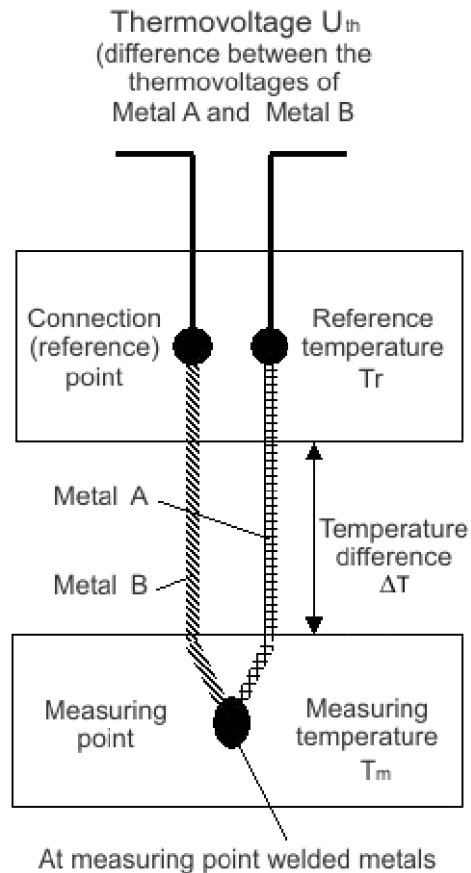
Figure 62:   Principle of the thermocouple

Example:

In the following example, the voltage U_{th} is given which is present at a type-K thermocouple at the temperature T_m.

$$U_{th} = (k_{NiCr} - k_{Ni}) \cdot \Delta T$$

with $\Delta T = T_m - T_v$

A type-K thermocouple consists of a junction of a nickel-chrome alloy and nickel, where k_{NiCr} and k_{Ni} represent the thermoelectric coefficients of nickel-chrome and nickel respectively. By adapting the equation according to T_m, the sought-after temperature can be calculated from the voltage measured across the thermocouple. Based on the difference to the cold junction temperature, the temperature at the measurement point can be determined to an accuracy of better than one tenth of a Kelvin with the aid of the above thermocouple equation.

NOTE!

Sensor circuit

A modification of the sensor circuit with additional devices such as change over switches or multiplexer decreases the measure accuracy. We strongly advise against such modifications.

Internal conversion of the thermovoltage and the reference voltage

Since the coefficients are determined at a reference temperature of 0°C, it is necessary to compensate for the effect of the reference temperature. This is done by converting the reference temperature into a reference voltage that depends on the type of thermocouple, and adding this to the measured thermovoltage.

The temperature is found from the resulting voltage and the corresponding characteristic curve.

$$U_k = U_m + U_v$$

$$T_{out} = f(U_k)$$

Overview of suitable thermocouples

The following thermocouples are suitable for temperature measurement:

Type (according to EN60584-1)	Element	Implemented temperature range	Color coding (sheath - plus pole - minus pole)
B	Pt30%Rh-Pt6Rh	600°C to 1800°C	gray - gray -white
C [1]	W5%Re-W25%Re	0°C to 2320°C	n.d.
E	NiCr-CuNi	-100°C to 1000°C	violet - violet - white
J	Fe-CuNi	-100°C to 1200°C	black - black - white
K	NiCr-Ni	-200°C to 1370°C	green - green - white
L [2]	Fe-CuNi	0°C to 900°C	blue - red - blue
N	NiCrSi-NiSi	-100°C to 1300°C	pink - pink - white
R	Pt13%Rh-Pt	0°C to 1767°C	orange - orange - white
S	Pt10%Rh-Pt	0°C to 1760°C	orange - orange - white
T	Cu-CuNi	-200°C to 400°C	brown - brown - white
U [2]	Cu-CuNi	0°C to 600°C	brown - red - brown

[1] not standardized according to EN60584-1

[2] according to DIN 43710

NOTE!

Maximum cable length to the thermocouple

Without additional protective measures, the maximum cable length from the EtherCAT Terminal to the thermocouple is 30 m. For longer cable lengths, suitable surge protection should be provided.

22.3 Process data

22.3.1 Sync Manager

PDO allocation (for channel 1 - 8, 0 $\leq$ n $\leq$ 7)

SM2, PDO assignment 0x1C12				
Index	**Index of excluded PDOs**	**Size (byte.bit)**	**Name**	**PDO content**
0x160n	-	2.0	TC Outputs Channel n	Index 0x70n0:11 - CJCompensation

SM3, PDO assignment 0x1C13				
Index	**Index of excluded PDOs**	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n (default)	-	4.0	TC Inputs Channel n	Index 0x60n0:01 - Underrange Index 0x60n0:02 - Overrange Index 0x60n0:03 - Limit 1 Index 0x60n0:05 - Limit 2 Index 0x60n0:07 - Error Index 0x60n0:0F - TxPDO Status Index 0x180n:09- TxPDO Toggle Index 0x60n0:11 - Value

22.4 Settings

22.4.1 Presentation, index 0x80n0:02

In the delivery state, the measured value is output in increments of 1/10°C in two's complement format (signed integer).

Index 0x80n0:02 offers the possibility to change the method of representation of the measured value.

Measured value	Output (hexadecimal)	Output (Signed Integer, decimal)
-200,0 °C	0xF830	-2000
-100,0 °C	0xFC18	-1000
-0,1 °C	0xFFFF	-1
0,0 °C	0x0000	0

Measured value	Output (hexadecimal)	Output (Signed Integer, decimal)
0,1 °C	0x0001	1
100,0 °C	0x03E8	1000
200,0 °C	0x07D0	2000
500,0 °C	0x1388	5000
850,0 °C	0x2134	8500
1000,0 °C	0x2170	10000

- **Signed Integer:**

  The measured value is presented in two's complement format.

  Maximum presentation range for 16 bit = -32768 ... +32767

     Example:

     $1000\ 0000\ 0000\ 0000_{bin}$ = $0x8000_{hex}$ = $- 32768_{dec}$

     $1111\ 1111\ 1111\ 1110_{bin}$ = $0nFFFE_{hex}$ = $- 2_{dec}$

     $1111\ 1111\ 1111\ 1111_{bin}$ = $0nFFFF_{hex}$ = $- 1_{dec}$

     $0000\ 0000\ 0000\ 0001_{bin}$ = $0n0001_{hex}$ = $+1_{dec}$

     $0000\ 0000\ 0000\ 0010_{bin}$ = $0n0002_{hex}$ = $+2_{dec}$

     $0111\ \ \ \ 1111\ \ \ \ 1111\ \ \ \ 1111_{bin}$ = $0x7FFF_{hex}$ = $+32767_{dec}$

- **Absolute value with MSB as sign:**

  The measured value is output in magnitude-sign format.

  Maximum presentation range for 16 bit = -32767 ... +32767

     Example:

     $1111\ 1111\ 1111\ 1111_{bin}$ = $0nFFFF_{hex}$ = $- 32767_{dec}$

     $1000\ 0000\ 0000\ 0010_{bin}$ = $0x8002_{hex}$ = $- 2_{dec}$

     $1000\ 0000\ 0000\ 0001_{bin}$ = $0x8001_{hex}$ = $- 1_{dec}$

     $0000\ 0000\ 0000\ 0001_{bin}$ = $0n0001_{hex}$ = $+1_{dec}$

     $0000\ 0000\ 0000\ 0010_{bin}$ = $0n0002_{hex}$ = $+2_{dec}$

     $0111\ \ \ \ 1111\ \ \ \ 1111\ \ \ \ 1111_{bin}$ = $0x7FFF_{hex}$ = $+32767_{dec}$

- **High resolution (1/100°C):**

  The measured value is output in 1/100°C steps.

22.4.2 Underrange, Overrange

Undershoot and overshoot of the measuring range (underrange, overrange), index 0x60n0:02, 0x60n0:03.

- $U_k > Uk_{max}$: Index 0x60n0:02 and index 0x60n0:07 (overrange and error bit) are set. The linearization of the characteristic curve is continued with the coefficients of the overrange limit up to the limit stop of the A/D converter or to the maximum value of 0x7FFF.

- $U_k < Uk_{max}$: Index 0x60n0:01 and index 0x60n0:07 (underrange and error bit) are set. The linearization of the characteristic curve is continued with the coefficients of the underrange limit up to the limit stop of the A/D converter or to the minimum value of 0x8000.

For overrange or underrange the red error LED is switched on.

22.4.3 Notch filter (conversion times)

Notch filter, index 0x80n0:06

The AI2TEE terminals are equipped with a digital filter. The filter performs a notch filter function and determines the conversion time of the terminal. It is parameterized via the indices 0x80n0:15. The higher the filter frequency, the faster the conversion time.

	NOTE!
🛈	**Index 0x80n0:06** The filter function is always active even if the bit is not set, since this is obligatory for the measurement process!

	NOTE!
🛈	**The filter characteristics are set via index Index 0x8000:15** The filter frequencies are set for all channels of the AI2TEE terminals centrally via index 0x8000:15 (channel 1). The corresponding indices 0x8010:15 of the AI2TEE have no parameterization function.

	NOTE!
🛈	**Conversion time** The conversion time is determined as follows: No. of active channels * no. of measurements * no. of filter periods + computing time = conversion time

Typical conversion times with 3 measurements (thermocouple, broken wire, cold junction):

Filter frequency	Conversion time (update time)
5 Hz	1,2 s
10 Hz	0,6 s
50 Hz	126 ms
60 Hz	106 ms
100 Hz	66 ms
500 Hz	18 ms
1000 Hz	12 ms
2000 Hz	10 ms
3750 Hz	8 ms
7500 Hz	7 ms
15000 Hz	7 ms
30000 Hz	7 ms
mV-range	6 ms

22.4.4 Limit 1 and Limit 2

A temperature range can be set that is limited by the values in the indices 0x80n0:13 and 0x80n0:14. If the limit values are overshot, the bits in indices 0x80n0:07 and 0x80n0:08 are set.

The temperature value is entered with a resolution of 0.1°C.

Example:

Limit 1= 30°C

Value index 0x80n0:13 = 300

22.5 Notices on analog specifications

Instruction handbook **E-Bus Terminals** .
Document No.: 5.17019.01

Baumüller Nürnberg GmbH

22.6 Object description and parameterization

22.6.1 Restore object

Index 1011 Restore default parameters

Index (hex)	Name	Meaning	Data type	Flags	Default
1011:0	Restore default parameters	Restore default parameters	UINT8	RO	0x01 (1_{dec})
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 (0_{dec})

22.6.2 Configuration data

Index 80n0 TC Settings for $0 \leq n \leq 7$ (Ch. 1 - 8)

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0	TC Settings	Maximum subindex	UINT8	RO	0x19 (25_{dec})
80n0:01	Enable user scale	User scale is active	BOOLEAN	RW	0x00 (0_{dec})
80n0:02	Presentation	0: Signed presentation, 0.1°C/digit 1: Absolute value with MSB as sign (signed amount representation), 0.1°C/digit 2: High resolution (0.01°C/digit)	BIT3	RW	0x00 (0_{dec})
80n0:05	Siemens bits	The S5 bits are displayed in the three low-order bits	BOOLEAN	RW	0x00 (0_{dec})
80n0:06	Enable filter	This setting generally activates the basic filters in object 0x80n0:15. In the AI2TEE these are technically realized in the ADC and can therefore not be switched off, even if they are set to "disabled" in the object.	BOOLEAN	RW	0x00 (0_{dec})
80n0:07	Enable limit 1	Limit 1 enabled	BOOLEAN	RW	0x00 (0_{dec})
80n0:08	Enable limit 2	Limit 2 enabled	BOOLEAN	RW	0x00 (0_{dec})
80n0:0A	Enable user cali-bration	Enabling of the user calibration	BOOLEAN	RW	0x00 (0_{dec})
80n0:0B	Enable vendor calibration	Enabling of the vendor calibration	BOOLEAN	RW	0x01 (1_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:0C	Cold junction compensation	0: internal 1: no Cold junction compensation is not active 2: Extern process data Cold junction compensation takes place via the process data (resolution [1/10]°C)	BIT2	RW	0x00 (0_{dec})
80n0:0E	Disable wire break detection	0: Wire break detection is active 1: Wire break detection is not active	BOOLEAN	RW	0x00 (0_{dec})
80n0:11	User scale offset	User scaling offset	INT16	RW	0x0000 (0_{dec})
80n0:12	User scale gain	This is the user scaling gain. The gain is represented in fixed-point format, with the factor 2^{-16}. The value 1 corresponds to 65535 (0x00010000).	INT32	RW	0x00010000 (65536_{dec})
80n0:13	Limit 1	First limit value for setting the status bits (resolution 0.1°C)	INT16	RW	0x0000 (0_{dec})
80n0:14	Limit 2	Second limit value for setting the status bits (resolution 0.1°C)	INT16	RW	0x0000 (0_{dec})
80n0:15	Filter settings	This object determines the basic digital filter settings. The possible settings are sequentially numbered. 0: 50 Hz 6: 3,75 kHz 1: 60 Hz 7: 7,5 kHz 2: 100 Hz 8: 15 kHz 3: 500 Hz 9: 30 kHz 4: 1 kHz 10: 5 Hz 5: 2 kHz 11: 10 Hz	UINT16	RW	0x0000 (0_{dec})
80n0:17	User calibration offset	User offset calibration	INT16	RW	0x0000 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
80n0:18	User calibration gain	User calibration gain	UINT16	RW	0xFFFF (65535$_{dec}$)
80n0:19	TC Element	Thermocouple Implemented temperature range 0: Type: K -200°C to 1370°C 1: Type: J -100°C to 1200°C 2: Type: L 0°C to 900°C 3: Type: E -100°C to 1000°C 4: Type: T -200°C to 400°C 5: Type: N -100°C to 1300°C 6: Type: U 0°C to 600°C 7: Type: B 600°C to 1800°C 8: Type: R 0°C to 1767°C 9: Type: S 0°C to 1760°C 10: Type: C 0°C to 2320°C 100: ± 30 mV (1 µV resolution) 101: ± 60 mV (2 µV resolution) 102: ± 75 mV (4 µV resolution)	UINT16	RW	0x0000 (0$_{dec}$)

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

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

22.6.4 Configuration data (vendor-specific)

Index 80nF TC Vendor data for 0 $\leq$ n $\leq$ 1 (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
80nF:0	TC Vendor data	Maximum subindex	UINT8	RO	0x04 (4$_{dec}$)
80nF:01	Calibration offset TC	Thermocouple offset (vendor calibration)	INT16	RW	0x0000 (0$_{dec}$)
80nF:02	Calibration gain TC	Thermocouple gain (vendor calibration)	UINT16	RW	0x5B9A (23450$_{dec}$)
80nF:03	Calibration offset CJ	Cold junction offset [Pt1000] (vendor calibration)	INT16	RW	0x01B8 (440$_{dec}$)
80nF:04	Calibration gain CJ	Cold junction gain [Pt1000] (vendor calibration)	UINT16	RW	0x39B2 (14770$_{dec}$)

22.6.5 Input data

Index 60n0 TC Inputs for 0 ≤ n ≤ 1 (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:0	TC Inputs	Maximum subindex	UINT8	RO	0x11 (17_{dec})
60n0:01	Underrange	Value below measuring range.	BOOLEAN	RO	0x00 (0_{dec})
60n0:02	Overrange	Measuring range exceeded. ("wire breakage" together with "error" [index 0x60n0:07])	BOOLEAN	RO	0x00 (0_{dec})
60n0:03	Limit 1	Limit value monitoring 0: not activated 1: limit range exceeded 2: limit range undershot	BIT2	RO	0x00 (0_{dec})
60n0:05	Limit 2	Limit value monitoring 0: not activated 1: limit range exceeded 2: limit range undershot	BIT2	RO	0x00 (0_{dec})
60n0:07	Error	The error bit is set if the value is invalid (wire breakage, overrange, underrange)	BOOLEAN	RO	0x00 (0_{dec})
60n0:0F	TxPDO State	Validity of the data of the associated TxPDO (0 = valid, 1 = invalid).	BOOLEAN	RO	0x00 (0_{dec})
60n0:10	TxPDO Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated	BOOLEAN	RO	0x00 (0_{dec})
60n0:11	Value	Analog input value (resolution: see Configuration data index 0x80n0:02)	INT16	RO	0x0000 (0_{dec})

22.6.6 Output data

Index 70n0 TC Outputs for 0 ≤ n ≤ 1 (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
70n0:0	TC Outputs	Maximum Subindex	UINT8	RO	0x11 (17_{dec})
70n0:01	CJCompensation	Temperature of the cold junction (resolution in 1/10°C) (index 0x80n0:0C, comparison via the process data)	INT16	RO	0x0000 (0_{dec})

22.6.7 Information and diagnostic data

Index 80nE TC Internal data for $0 \leq n \leq 1$ (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
80nE:0	TC Internal data	Maximum subindex	UINT8	RO	0x05 (5_{dec})
80nE:01	ADC raw value TC	ADC raw value thermocouple	UINT32	RO	0x00000000 (0_{dec})
80nE:02	ADC raw value PT1000	ADC raw value PT1000	UINT32	RO	0x00000000 (0_{dec})
80nE:03	CJ temperature	Cold junction temperature (resolution [1/10]°C)	INT16	RO	0x0000 (0_{dec})
80nE:04	CJ voltage	Cold junction voltage (resolution 1 µV)	INT16	RO	0x0000 (0_{dec})
80nE:05	CJ resistor	Cold junction resistance (PT1000 temperature sensor) (resolution 1/10 Ohm)	UINT16	RO	0x0000 (0_{dec})

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 (2_{dec})
F000:01	Module index distance	Index spacing of the objects of the individual channels	UINT16	RO	0x0010 (16_{dec})
F000:02	Maximum number of modules	Number of channels	UINT16	RO	0x0004 (4_{dec})

Index F008 Code word

Index (hex)	Name	Meaning	Data type	Flags	Default
F008:0	Code word	Currently reserved	UINT32	RW	0x00000000 (0_{dec})

22.6.8 Standard objects (0x1000-0x1FFF)

The standard objects have the same meaning for all EtherCAT slaves.

Index 1000 Device type

Index (hex)	Name	Meaning	Data type	Flags	Default
1000:0	Device type	Device type of the EtherCAT slave: the Lo-Word contains the CoE profile used (5001). The Hi-Word contains the module profile according to the modular device profile.	UINT32	RO	0x014A1389 (21631881_{dec})

Index 1008 Device name

Index (hex)	Name	Meaning	Data type	Flags	Default
1008:0	Device name	Device name of the EtherCAT slave	STRING	RO	(...)

Index 1009 Hardware version

Index (hex)	Name	Meaning	Data type	Flags	Default
1009:0	Hardware version	Hardware version of the EtherCAT slave	STRING	RO	00

Index 100A Software version

Index (hex)	Name	Meaning	Data type	Flags	Default
100A:0	Software version	Firmware version of the EtherCAT slave	STRING	RO	01

Index 1018 Identity

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:0	Identity	Information for identifying the slave	UINT8	RO	0x04 (4_{dec})
1018:01	Vendor ID	Vendor ID of the EtherCAT slave	UINT32	RO	0x00000002 (2_{dec})
1018:02	Product code	Product code of the EtherCAT slave	UINT32	RO	(...)

Index (hex)	Name	Meaning	Data type	Flags	Default
1018:03	Revision	Revision number of the EtherCAT slave; the low word (bit 0-15) indicates the special terminal number, the high word (bit 16-31) refers to the device description	UINT32	RO	(...)
1018:04	Serial number	Serial number of the EtherCAT slave; the low byte (bit 0-7) of the low word contains the year of production, the high byte (bit 8-15) of the low word contains the week of production, the high word (bit 16-31) is 0	UINT32	RO	0x00000000 (0_{dec})

Index 10F0 Backup parameter handling

Index (hex)	Name	Meaning	Data type	Flags	Default
10F0:0	Backup parameter handling	Information for standardized loading and saving of backup entries	UINT8	RO	0x01 (1_{dec})
10F0:01	Checksum	Checksum across all backup entries of the EtherCAT slave	UINT32	RO	0x00000000 (0_{dec})

Index 160n RxPDO-Map (for Ch. 1 - 1 ($0 \leq n \leq 1$))

Index (hex)	Name	Meaning	Data type	Flags	Default
160n:0	RxPDO-Map Ch. n+1	PDO Mapping RxPDO n+1	UINT8	RW	0x01 (1_{dec})
160n:01	SubIndex 001	n. PDO Mapping entry (object 0x70n0 (TC Outputs Ch. n+1), entry 0x11 (CJCompensation))	UINT32	RW	0x70n0:11, 16

Index 1A0n TxPDO-Map for $0 \leq n \leq 1$ (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0n:0	TxPDO-Map Ch.1	PDO Mapping TxPDO 1	UINT8	RW	0x09 (9_{dec})
1A0n:01	SubIndex 001	1. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x01 (Underrange))	UINT32	RW	0x60n0:01, 1

Index (hex)	Name	Meaning	Data type	Flags	Default
1A0n:02	SubIndex 002	2. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x02 (Over-range))	UINT32	RW	0x60n0:02, 1
1A0n:03	SubIndex 003	3. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x03 (Limit 1))	UINT32	RW	0x60n0:03, 2
1A0n:04	SubIndex 004	4. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x05 (Limit 2))	UINT32	RW	0x60n0:05, 2
1A0n:05	SubIndex 005	5. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x07 (Error))	UINT32	RW	0x60n0:07, 1
1A0n:06	SubIndex 006	6. PDO Mapping entry (7 bits align)	UINT32	RW	0x0000:00, 7
1A0n:07	SubIndex 007	7. PDO Mapping entry (object 0x60n0 (TxPDO-Par Ch.1), entry 0x0F (TxPDO-State))	UINT32	RW	0x60n0:0F, 1
1A0n:08	SubIndex 008	8. PDO Mapping entry (object 0x180n (TxPDO-Par Ch.1), entry 0x09 (TxPDO-Toggle))	UINT32	RW	0x180n:09, 1
1A0n:09	SubIndex 009	9. PDO Mapping entry (object 0x60n0 (RTD Inputs Ch.1), entry 0x11 (Value))	UINT32	RW	0x60n0:11, 16

Index 1C00 Sync manager type

Index (hex)	Name	Meaning	Data type	Flags	Default
1C00:0	Sync manager type	Using the sync managers	UINT8	RO	0x04 (4_{dec})
1C00:01	SubIndex 001	Sync-Manager Type Channel 1: Mailbox Write	UINT8	RO	0x01 (1_{dec})
1C00:02	SubIndex 002	Sync-Manager Type Channel 2: Mailbox Read	UINT8	RO	0x02 (2_{dec})
1C00:03	SubIndex 003	Sync-Manager Type Channel 3: Process Data Write (Outputs)	UINT8	RO	0x03 (3_{dec})
1C00:04	SubIndex 004	Sync-Manager Type Channel 4: Process Data Read (Inputs)	UINT8	RO	0x04 (4_{dec})

Index 1C12 RxPDO assign for 0 ≤ n ≤ 1 (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
1C12:0	RxPDO assign	PDO Assign Outputs	UINT8	RW	0x0n (n_{dec})
1C12:0n	Subindex 00n	n. allocated RxPDO (contains the index of the associated RxPDO mapping object)	UINT16	RW	0x160n

Index 1C13 TxPDO assign for 0 ≤ n ≤ 1 (Ch. 1 - 2)

Index (hex)	Name	Meaning	Data type	Flags	Default
1C13:0	TxPDO assign	PDO Assign Inputs	UINT8	RW	0x0n (n_{dec})
1C13:0n	SubIndex 00n	n. allocated TxPDO (contains the index of the associated TxPDO mapping object)	UINT16	RW	0x1A0n

Index 1C32 SM output parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:0	SM output parameter	Synchronization parameters for the outputs	UINT8	RO	0x07 (7_{dec})
1C32:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchron with SM 2 Event • 2: DC-Mode - Synchron with SYNC0 Event • 3: DC-Mode - Synchron with SYNC1 Event	UINT16	RW	0x0000 (0_{dec})
1C32:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchron with SM 2 event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x00000000 (0_{dec})
1C32:03	Shift time	Time between SYNC0 event and output of the outputs (in ns, DC mode only)	UINT32	RW	0x00000000 (0_{dec})

Index (hex)	Name	Meaning	Data type	Flags	Default
1C32:04	Sync modes supported	Supported synchronization modes: • Bit 0 = 1: free run is supported • Bit 1 = 1: Synchron with SM 2 event is supported • Bit 3:2 = 10: DC mode is supported • Bit 5:4 = 01: Output shift with SYNC1 event (only DC mode) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08)	UINT16	RO	0x8007 (32775_{dec})
1C32:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x00000000 (0_{dec})
1C32:06	Calc and copy time	Minimum time between SYNC0 and SYNC1 event (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:08	Command	• 0: Measurement of the local cycle time is stopped • 1: Measurement of the local cycle time is started The entries 0x1C32:03, 0x1C32:05, 0x1C32:06, 0x1C32:09, 0x1C33:03, 0x1C33:06, 0x1C33:09 are updated with the maximum measured values. For a subsequent measurement the measured values are reset	UINT16	RW	0x0000 (0_{dec})
1C32:09	Delay time	Time between SYNC1 event and output of the outputs (in ns, DC mode only)	UINT32	RO	0x00000000 (0_{dec})
1C32:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:0C	Cycle exceeded counter	Number of occasions the cycle time was exceeded in OPERATIONAL (cycle was not completed in time or the next cycle began too early)	UINT16	RO	0x0000 (0_{dec})
1C32:0D	Shift too short counter	Number of occasions that the interval between SYNC0 and SYNC1 event was too short (DC mode only)	UINT16	RO	0x0000 (0_{dec})
1C32:20	Sync error	The synchronization was not correct in the last cycle (outputs were output too late; DC mode only)	BOOLEAN	RO	0x00 (0_{dec})

Index 1C33 SM input parameter

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:0	SM input parameter	Synchronization parameters for the inputs	UINT8	RO	0x07 (7_{dez})
1C33:01	Sync mode	Current synchronization mode: • 0: Free Run • 1: Synchron with SM 3 event (no outputs available) • 2: DC - Synchron with SYNC0 Event • 3: DC - Synchron with SYNC1 Event • 34: Synchron with SM 2 event (outputs available)	UINT16	RW	0x0000 (0_{dez})
1C33:02	Cycle time	Cycle time (in ns): • Free Run: Cycle time of the local timer • Synchron with SM 2 event: Master cycle time • DC mode: SYNC0/SYNC1 Cycle Time	UINT32	RW	0x00000000 (0_{dez})
1C33:03	Shift time	Time between SYNC0 event and reading of the inputs (in ns, only DC mode)	UINT32	RW	0x00000000 (0_{dez})
1C33:04	Sync modes supported	Supported synchronization modes: • Bit 0: free run is supported • Bit 1: Synchron with SM 2 Event is supported (outputs available) • Bit 1: Synchron with SM 3 Event is supported (no outputs available) • Bit 3:2 = 01: DC mode is supported • Bit 5:4 = 10: input shift through local event (outputs available) • Bit 5:4 = 01: input shift with SYNC1 event (no outputs available) • Bit 14 = 1: dynamic times (measurement through writing of 0x1C32:08 or 0x1C33:08)	UINT16	RO	0x8007 (32775_{dez})
1C33:05	Minimum cycle time	Minimum cycle time (in ns)	UINT32	RO	0x00000000 (0_{dez})
1C33:06	Calc and copy time	Time between reading of the inputs and availability of the inputs for the master (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dez})
1C33:08	Command	as 0x1C32:08	UINT16	RW	0x0000 (0_{dez})
1C33:09	Delay time	Time 0x1between SYNC1 event and reading of the inputs (in ns, only DC mode)	UINT32	RO	0x00000000 (0_{dez})
1C33:0B	SM event missed counter	Number of missed SM events in OPERATIONAL (DC mode only)	UINT16	RO	0x0000 (0_{dez})

Index (hex)	Name	Meaning	Data type	Flags	Default
1C33:0C	Cycle exceeded counter	as 0x1C32:0C	UINT16	RO	0x0000 (0_{dez})
1C33:0D	Shift too short counter	as 0x1C32:0D	UINT16	RO	0x0000 (0_{dez})
1C33:20	Sync error	as 0x1C32:20	BOOLEAN	RO	0x00 (0_{dez})

22.7 Status word

See ▷ Status word ◁ on page 158.

22.8 Notices on analog specifications

See ▷ Notices on analog specifications ◁ from page 158 onward.

22.9 Restoring the delivery state

To restore the delivery state for backup objects in AI2xxE terminals, the CoE object Restore default parameters, SubIndex 001 can be selected.

Enter the value 1684107116 in field Dec or the value 0x64616F6C in field Hex and confirm with OK.

All backup objects are reset to the delivery state.

An incorrect entry for the restore value has no effect.

AI4TEE - 4 CHANNEL ANALOG THERMOCOUPLE INPUT TERMINAL

23.1 Introduction AI4TEE

4 channel analog thermocouple input terminals with open-circuit recognition

The AI4TEE analog input terminals allow thermocouples to be connected directly. The EtherCAT Terminals circuit can operate thermocouple sensors using the 2-wire technique. Linearization over the full temperature range is realized with the aid of a microprocessor. The temperature range can be selected freely. The error LEDs indicate a broken wire. Compensation for the cold junction is made through an internal temperature measurement at the terminals. The AI4TEE can also be used for mV measurement.

Figure 63: AI4TEE

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

23.1.1 LEDs

LED	Color	Meaning	
RUN	green	These LEDs indicate the terminal's operating state:	
		off	State of the EtherCAT State Machine: INIT = initialization of the terminal
		flashing uniformly	State of the EtherCAT State Machine: PREOP = function for mailbox communication and different standard-settings set
		flashing slowly	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
		flashing rapidly	State of the EtherCAT State Machine: BOOTSTRAP = function for firmware updates of the terminal
ERROR1 ERROR2	red	Short circuit or wire breakage. The resistance is in the invalid range of the characteristic curve	

23.1.2 Pin assignment

> **NOTE!**
>
> **Earthed thermocouples**
>
> Observe for earthed thermocouples: Differential inputs max. ± 2 V to ground!

> **NOTE!**
>
> **Current carrying capacity of the input contacts**
>
> The maximum permitted current on the signal-relevant terminal points (inputs, GND) is 40 mA (if applicable).

Terminal point		
Name	**No.**	**Description**
Input +TC1	1	Input +TC1
Input +TC2	2	Input +TC2
Input +TC3	3	Input +TC3
Input +TC4	4	Input +TC4
Input -TC1	5	Input -TC1
Input -TC2	6	Input -TC2
Input -TC3	7	Input -TC3
Input -TC4	8	Input -TC4

ZK000E - INCREMENTAL ENCODER INTERFACE

24.1 Introduction ZK000E
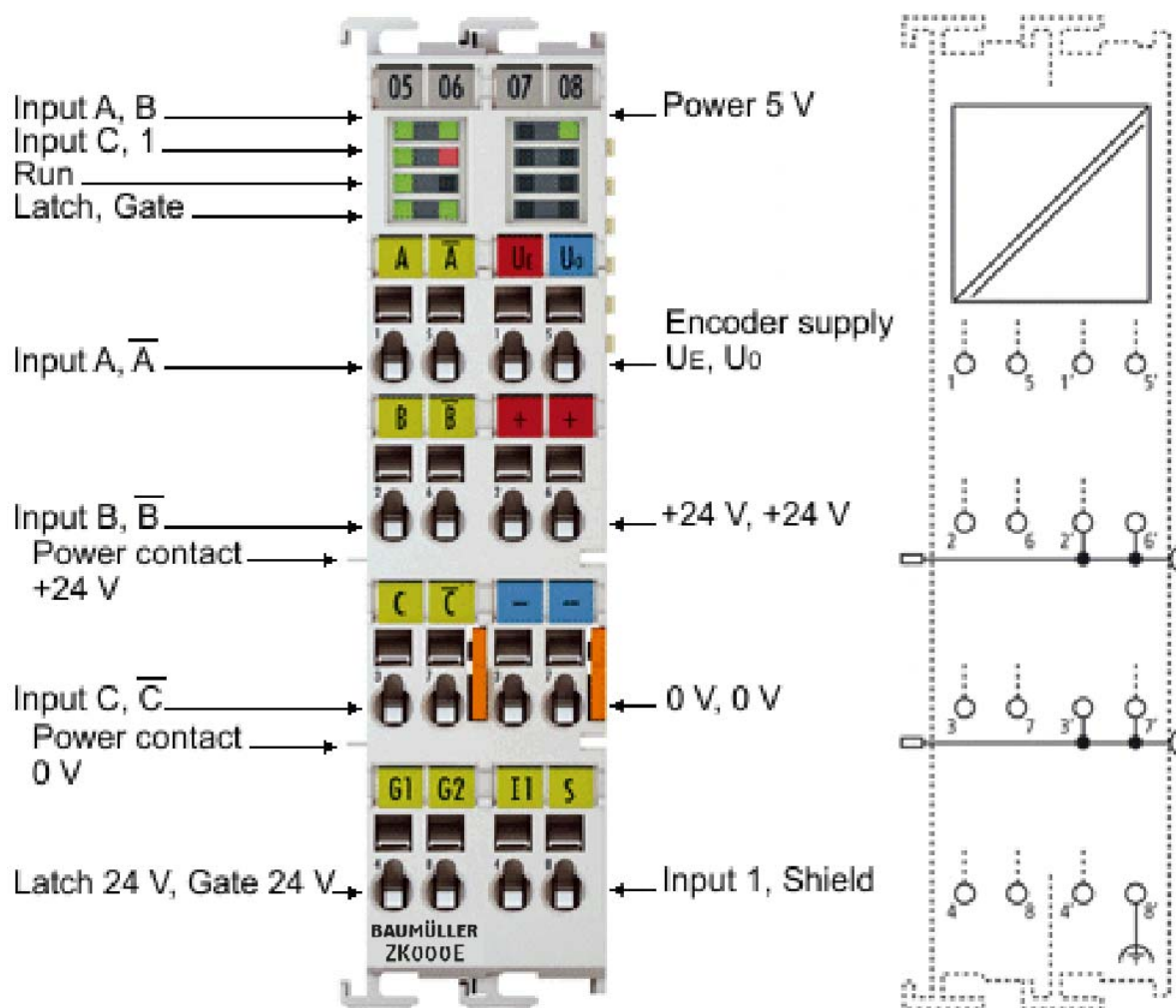
Figure 64:   ZK000E

The ZK000E 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 ZK000E can also be used as bidirectional counter on channel A; channel B specifies the count direction.

24.1.1 LEDs

| 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	

24.1.2 Pin assignment

Terminal point		Description
Name	**No.**	**Description**
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 $\overline{A}$
¬ B	6	Encoder input $\overline{B}$
¬ C	7	Encoder input $\overline{C}$
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)
0 V	7'	0 V (internally connected to terminal point 3' and negative power contact)
Shield	8'	Screen

24.2 Technology

The ZK000E 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. Single-ended 5 V signals are possible for the ZK000E 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 ZK000E. The ZK000E can optionally be operated as a bidirectional counter terminal on channel A.

Specific settings are described in the following two sections.

> **NOTE!**
>
> **Process data monitoring**
> - WcState: if $\neq$ 0 this EtherCAT device does not take part in the process data traffic
> - State: if $\neq$ 8, the EtherCAT device is not in OP (operational) status
> - TxPDO state, SyncError: if $\neq$ 0, then no valid process data are available, e.g. caused by broken wire
> - TxPDO Toggle: if this bit is toggling, a new set of process data is available

EtherCAT cycle time

For the ZK000E a minimum EtherCAT cycle time of >100 µs is recommended. If a faster cycle time is used, the toggling process record TxPDO Toggle should be used to monitor when new process data are supplied by the ZK000E.

ZK000E input impedance

The signal source must be able to operate the input impedance of the ZK000E (typically 220 Ohm, subject to modification) with adequate voltage levels according to RS485.

Gate/latch input

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

Level on interface

In differential mode the ZK000E 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 < V_{id} < +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.

RS422 Differential Mode
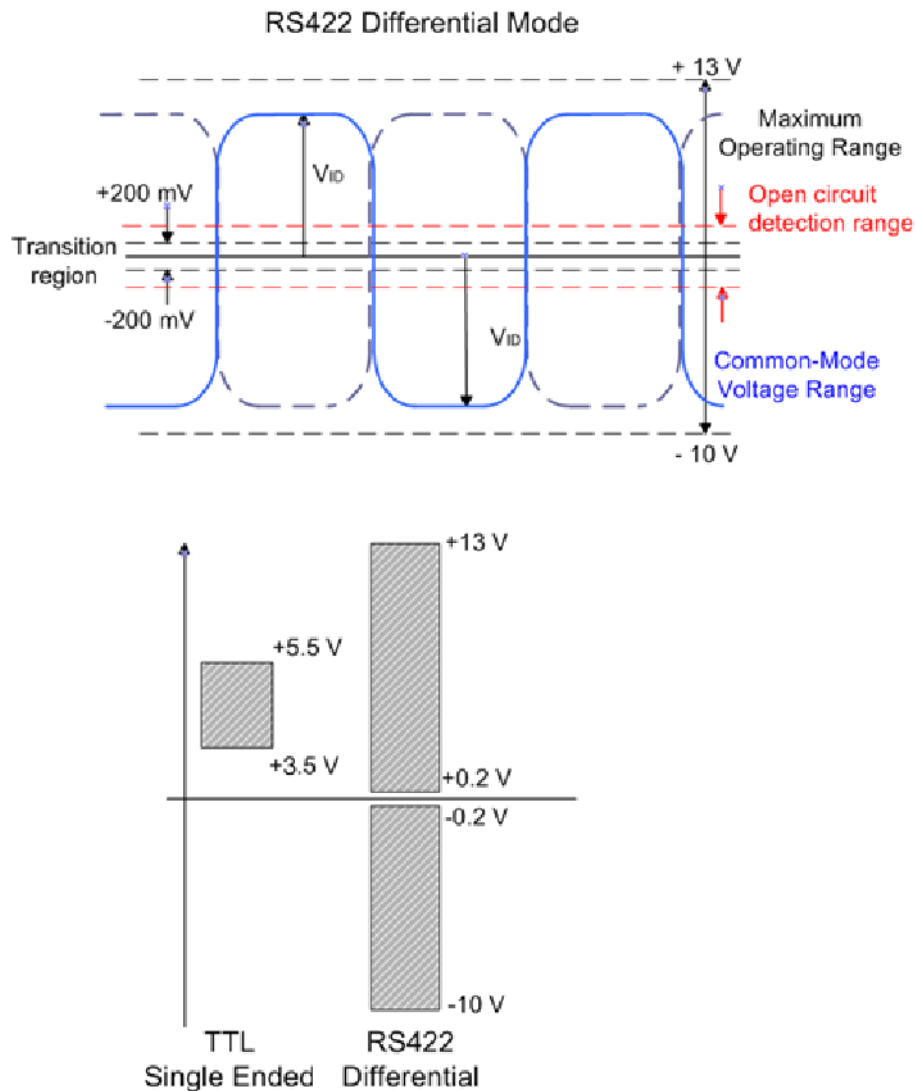
Figure 65:   Level interface

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 ZK000E is only operated in single-ended mode, a nominal level voltage between 3.5 V and 5.5 V is expected.

The open circuit detection (Index 0x80n0:0B, 0x80n0:0C, 0x80n0:0D) is typically activated in the range -1.5 V > V_{id} > +1.5 V (subject to change).

Instruction handbook **E-Bus Terminals** .

Document No.: 5.17019.01

Baumüller Nürnberg GmbH

DISMANTLING, STORAGE

In this chapter, we will describe how you decommission the terminals and store it. Observe the ▷Basic Safety Instructions ◁ from page 11 onward.

25.1 Safety regulations

Bring the bus system into a safe, powered down state before starting disassembly of the Terminals! Only specially trained personnel are allowed to dismantle the terminals. The safety regulations for commissioning apply analogously to dismantling.

25.2 Requirements of the personnel carrying out work

The personnel that carries out dismantling must have the necessary knowledge and have been trained appropriately to carry out this work. Choose these persons such that they understand and can apply the safety instructions printed on the unit and parts of it and on the connections.

25.3 Disassembly

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

1 Carefully pull the orange-colored lug approximately 1 cm out of the disassembled terminal, until it protrudes loosely. The lock with the mounting rail is now released for this terminal, and the terminal can be pulled from the mounting rail without excessive force.

2 Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal away from the mounting rail.

25.4 Storage conditions

Store the terminals in suitable packaging according to the storage conditions in ▷Appendix D - Technical Data◁ from page 209 onward.

25.5 Recommissioning

If you want to recommission the terminals, observe the information in "Storage Conditions". Then, carry out ▷Assembly and Installation ◁ from page 47 onward again.

APPENDIX A ABBREVIATIONS

ADC	Analog digital converter
CPU	Central Processing Unit
EEPROM	Electrically eraseable programmable read only memory
EMC	Electromagnetic compatibility
EN	European standard
EPROM	Erasable Programmable Read Only Memory
EXT, ext	Extern
I/O	Input/Output, Eingang und Ausgang
I/O Bus	Bus for the input and output modules (bus between b maXX controller PLC and the modules right handed of the PLC or power supply unit)
LED	Light Emitting Diode
MSB	most significant bit
OVRL	**Ov**er **r**ange **l**imit
PA	
PLC	Process loop control, Speicher programmierbare Steuerung, SPS
RAM	Random Access Memory
ROM	Read Only Memory
RTD	**R**esistance **T**emperature **D**evice
SEEROM	serial EEPROM
SW	Software
UNRL	**Un**der **r**ange **l**imit

A

APPENDIX B ACCESSORIES

In this appendix, you will find a list of all the accessories that are available for Baumüller Nürnberg GmbH's E-bus terminals.

If you have any queries about accessories or suggestions for improvements, Baumüller's Product Management will be pleased to hear from you.

B.1   List of all accessories

At the moment there are no accessories available for the E-bus terminals.

B.1 List of all accessories

APPENDIX C DECLARATION OF CONFORMITY

be in motion   be in motion   be in motion

www.baumueller.com

BAUMÜLLER

EU – Declaration of Conformity

Doc.-No.:   5.18009.01
Date: 12-Oct-2023

according to EMC Directive 2014/30/EU

The Manufacturer: Baumüller Nürnberg GmbH

                               Ostendstraße 80-90

                               90482 Nürnberg, Deutschland

declares, that the product:

Designation: E-Bus terminals and E-Bus couplers

Type: DI160E, DI800E, DI400E, DI200E, DO160E, DO800E, DO400E, DO200E,
                    AI401E, AI442E, AO401E, AO442E, AO201E, ES000E, EK000E, EA000E,
                    AI2PTE, AI2TEE, AI4TEE, ZK000E

is developed, designed and manufactured in accordance with the EMC Directive 2014/30/EU.

Applied harmonized standards:

Standard	Title
EN 61000-6-2: 2005	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
EN 61000-6-4: 2007+A1:2011	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

The products must be installed correctly, and all notes and safety notes of the referring instruction handbook must be complied with, to guarantee the compliance to the guidelines.

Subject to change of this declaration of EC conformity without notice. Actual valid edition on request.

APPENDIX D - TECHNICAL DATA

In this appendix, you will find the technical data for Baumüller Nürnberg GmbH's E-bus terminals.

D.1   Terminal housing

Mechanical data	
Design form	compact terminal housing with signal LED
Material	polyamide (PA 6.6)
Dimensions (w x h x d)	12 mm x 100 mm x 68 mm
Mounting	on 35 mm C mounting rail according to EN 50022 with lock
Side by side mount. by means of	double slot and key connection
Labelling	standard terminal block marking and plain language slides (8 mm x 47 mm)

Connection	
Wiring	Cage Clamp® spring-loaded system
Connection cross-section	0.08 mm² ... 2.5 mm², AWG 28-14, stranded wire, solid wire
Power contacts	up to 3 blade/spring contacts
Current load I_{MAX}	10 A (125 A short-circuit)

D.2   DI200E 2 channel and DI400E 4 channel digital input terminals

Technical data	DI200E	DI400E
Digital inputs	2	4
Nominal voltage of the inputs	24 V_{DC} (-15% / +20%)	
Signal voltage „0"	-3 ... +5 V (based on EN 61131-2, type 3)	
Signal voltage „1"	11 ... 30 V (based on EN 61131-2, type 3)	
Input current	3 mA typ. (based on EN 61131-2, type 3)	
Input delay T_{on} / T_{off}	< 1 µs	
Input filter		10 µs typ. (10...50 µs)
Distributed clocks	yes	
Current consumption power contacts		typ. 2 mA + load
Current consumption from the E-bus	110 mA typ.	typ. 90 mA
Electrical isolation	500 V_{eff} (E-bus / field voltage)	
Bit width in the process image	2 input bits	4 input bits
Configuration	no address or configuration settings required	
Weight	approx. 55 g	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	
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	
Installation position	variable	
Protection class	IP20	

D.3 DI800E and DI160E 8 channel and 16 channel digital input terminals

Technical data	DI8000E	DI160E
Number of inputs	8	16
Nominal voltage of the inputs	24 V_{DC} (-15% / +20%)	
Signal voltage „0"	-3 ... +5 V	
Signal voltage „1"	15 ... 30 V	
Input filter	3.0 ms	
Input current	typ. 3 mA (EN 61131-2, type 1/3)	typ. 3 mA (EN 61131-2, type 3)
Current consumption power contacts	typ. 2 mA + load	
Current consumption via E-bus	typ. 90 mA	typ. 100 mA
Electrical isolation	500 V_{eff} (E-bus / field voltage)	
Bit width in the process image	8 input bits	16 input bits
Configuration	no address setting, configuration via ProMaster	
Weight	approx. 55 g	approx. 65 g
Permissible ambient temperature range during operation	0°C ... +55°C	-25°C ... +60°C
Permissible ambient temperature range during storage	-40°C ... +85°C	-40°C ... +85°C
Permissible relative humidity	95%, no condensation	
Vibration/shock resistance	according to IEC 68-2-6 / IEC 68-2-27	
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4	
Installation position	variable	
Protection class	IP20	

D.4 DO200E 2 channel digital output terminal

Technical data	DO200E
Digital outputs	2
Rated voltage of the outputs	24 V_{DC} (-15% / +20%)
Load type	ohmic, inductive, lamp load
Output current per channel	max. 0.5 A (short-circuit-proof in push mode)
Current limitation	typ. 4 A/150 µs
Output switching time T_{ON}/T_{OFF}	< 1 µs
Output stage	Push-Pull
Supply voltage for electronic	via the E-bus
Current consumption via E-bus	typ. 130 mA
Current consumption via power voltage	typ. 30 mA + load
Electrical isolation	500 V_{eff} (E-bus / field voltage)
Distributed Clocks (DC)	yes
Accuracy Distributed Clocks	<< 1 µs
Bit width in process image	4 bit
Configuration	no address or configuration settings required
Weight	approx. 60 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
Vibration/shock resistance	conforms to IEC 68-2-6 / IEC 68-2-27
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20

D.5 DO400E and DO800E 4 channel and 8 channel digital output terminal

Technical data	DO400E	DO800E
Number of outputs	4	8
Nominal output voltage	24 V_{DC} (-15% / +20%)	
Load type	ohmic, inductive, lamp load	
Output current per channel	maximum 0.5 A (short-circuit proof)	
Switch-off energy (inductive)	maximum 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. 100 mA	typ. 110 mA
Electrical isolation	500 V_{eff} (E-bus / field voltage)	
Bit width in the process image	4 output bits	8 output bits
Configuration	no address or configuration settings required	
Weight	approx. 55 g	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	
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27	
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4	
Installation position	variable	
Protection class	IP20	

D.6   DO160E 16 channel digital output terminal

Technical data	DO160E
Digital outputs	16
Rated load voltage	24 V_{DC} (-15% / +20%)
Load type	ohmic, inductive, lamp load
Max. output current	0.5 A (short-circuit-proof) per channel
Short circuit current	0.6 ... 2.0 A
Breaking energy	< 150 mJ/channel
Reverse voltage protection	yes
Switching times	T_{ON}: 60 µs typ., T_{OFF}: 300 µs typ.
Power supply for the electronics	via the power contacts
Current consumption from the E-bus	typ. 140 mA
Current consumption of power contacts	30 mA typ. + load
Electrical isolation	500 V_{eff} (E-bus / field voltage)
Bit width in process image	16 output bits
Configuration	no address or configuration settings required
Conductor types	solid wire, stranded wire and ferrule
Conductor connection	solid wire conductors: direct plug-in technique; stranded wire conductors and ferrules: spring actuation by screwdriver
Rated cross-section	solid wire: 0.08…1.5 mm²; stranded wire: 0.25…1.5 mm²; ferrule: 0.14…0.75 mm²
Weight	approx. 65 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
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
Installation position	variable
Protection class	IP20

D.7　AI401E 4 channel analog input terminal 0...+10 V

Technical data	AI401E
analog inputs	4 (single ended)
Signal voltage	0 ... +10 V
Internal resistance	> 130 kΩ
Resolution	12 bit (16 bit presentation)
Conversion time (default setting:50 Hz filter)	typical 0.625 ms
Input filter limit frequency	1 kHz
Measuring error (full measuring range)	< ± 0.3% (relative to the full scale value)
Supply voltage for electronic	via the E-bus
Current consumption via E-bus	typ. 130 mA
Distributed Clocks support	no
Electrical isolation	500 V_{eff} (E-bus / field voltage)
Dielectric strength	max. 40 V
Bit width of the process image (default setting)	2 bytes status, 2 bytes value per channel
Configuration	no address or configuration settings required
Weight	approx. 60 g
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)
Permissible ambient temperature range during storage	-25°C ... +85°C
Permissible relative humidity	95%, no condensation
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
Installation position	variable
Protection class	IP20

D.8   AI442E 4 channel analog input terminal 4 - 20 mA

Technical data	AI442E
analog inputs	4
Signal current	4 mA ... 20 mA
Internal resistance	typ. 85 Ω
Resolution	12 bit (16 bit presentation)
Conversion time (default setting: 50 Hz filter)	typ. 0.625 ms
Input filter limit frequency	1 kHz
Measuring error (full measuring range)	< $\pm$ 0.30% (at 0°C ... +55°C, relative to the full scale value)
Supply voltage for electronic	via the E-bus
Current consumption via E-bus	typ. 130 mA
Distributed clocks support	no
Electrical isolation	500 V_{eff} (E-bus / field voltage)
Dielectric strength	max. 30 V
Bit width of the process image (default setting)	2 bytes status, 2 bytes value per channel
Configuration	no address or configuration settings required
Weight	approx. 60 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
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20

D.9 AO201E 2 channel analog output terminal -10 V...+10 V

Technical data	AO201E
Number of outputs	2
Signal voltage	-10 V ... 10 V
Oversampling factor	n = integer multiple of the EtherCAT cycle time, configurable between 1 and 100
Distributed Clocks precision	< 100 ns
Load	> 5 kΩ (short-circuit-proof)
Resolution	16 bit (including sign)
Conversion time	~ 10 µs
Output rate	max. 100 ksamples/s
Measuring error	< ± 0.1% (at 0°C ... +55°C, relative to the full scale value)
Electrical isolation	500 V_{eff} (E-bus / field voltage)
Supply voltage for electronics	via E-bus
Power supply for outputs	via E-bus
Current consumption via E-bus	typ. 180 mA
Bit width in process image	Output: n x 2 x 16 bit data, 2 x 16 bit CycleCounter, 4byte StartTimeNextOutput, if required
Configuration	via ProMaster
Weight	approx. 60 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
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
Installation position	variable
Protection class	IP20

Technical data	AO401E
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)
Resolution	12 bit
Conversion time	~ 250 µs
Power supply for electronics	via the E-bus
Distributed Clocks	yes
Current consumption via E-bus	typ. 140 mA
Electrical isolation	500 V (E-bus / field voltage)
Bit width in process image	4 x 16-bit-AO output
Configuration	via ProMaster
Weight	approx. 60 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
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20

D.11 AO442E 4 channel analog output terminal 4 - 20 mA

Technical data	AO442E
Number of outputs	4
Power supply	24 V_{DC} via the power contacts
Signal current	4 ... 20 mA
Load	< 350 Ω (short-circuit-proof)
Measuring error	< ± 0.1% (relative to full scale value)
Resolution	12 bit
Conversion time	~ 250 µs
Power supply for electronics	via the E-bus
Distributed Clocks	yes
Current consumption via E-bus	typ. 140 mA
Electrical isolation	500 V (E-bus / field voltage)
Bit width in process image	4 x 16-bit-AO output
Configuration	via ProMaster
Weight	ca. 60 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
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20

D.12 EK000E bud end cup

Technical data	EK000E
PE contact	no
Electrical connection to mounting rail	no
Weight	approx. 8 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. 7 mm x 100 mm x 34 mm (with aligned: 5 mm)
Mounting	aligned to the last terminal in the terminal block
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20

D.13   ES000E Potential supply terminal 24 V DC

Technical data	ES000E
Nominal voltage	24 V_{DC}
Power contact current load	max. 10 A
Electrical isolation	500 V (E-bus / field voltage)
Current consumption from E-bus	-
Bit width in the process image	-
Configuration	no address or configuration settings required
Power LED	yes
Diagnosis	no
Electrical connection to mounting rail	no
PE contact	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
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20

Technical Data	ES001E
Input voltage	24 V_{DC}
Output current for E-bus supply	2 A
Power contact voltage	24 V_{DC}
Power contact current load	max. 10 A
Current consumption from E-Bus	-
Electrical isolation	500 V (E-bus/field potential)
Diagnosis	yes, via LED and in the process image
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
Side by side mounting on Bus Terminals without power contact	yes
Bit width in the process image	2 bits (diagnosis)
Configuration	no address or configuration settings
Weight	approx. 65 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
Protect. class	IP 20
Installation pos.	variable
Approval	CE, cULus

D.15 AI2PTE - 2 channel input terminal PT100 (RTD) for 2- and 3-wire connection

Technical data	AI2PTE
Number of inputs	2
Sensor types	Pt100, Pt200, Pt500, Pt1000, Ni100, Ni120, Ni1000, KT/KTY Resistance measurement 10 Ohm...1 kOhm or 10 Ohm...4 kOhm (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	< ± 0.5°C for Pt sensors
Width in the process image	max. 8 bytes input
Power supply for electronics	via the E-Bus
Current consumption from the E-bus	typ. 190 mA
Electrical isolation	500 V (E-bus / field voltage)
Configuration	via ProMaster
Weight	ca. 60 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
Vibration/shock resistance	according to EN 60068-2-6 / EN 60068-2-27
EMC resistance burst/ ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Installation position	variable
Protection class	IP20

with open-circuit recognition

Technical data	AI2TEE
Number of inputs	2
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...+1.370°C) Voltage: ±30 mV (1 µV resolution) up to ±75 mV (4 µV resolution)
Resolution	0.1°C / 0.01°C pro Digit
Wiring fail indication	yes
Conversion time	approx. 1.2 s to 20 ms, depending on configuration and filter setting, default: approx. 125 ms
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. 8 bytes input, max.4 bytes output
Electrical isolation	500 V (E-bus / field voltage)
Configuration	via ProMaster
Weight	ca. 60 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
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
Installation position	variable
Protection class	IP20

D.17   AI4TEE - 4 channel analog thermocouple input terminal

with open-circuit recognition

Technical data	AI4TEE
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 type.; 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	yes, from firmware 01
Wiring fail indication	yes, from firmware 01
Conversion time	approx. 2.5 s to 20 ms, depending on configuration and filter setting, default: approx. 250 ms
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
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)

Technical data	AI4TEE
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 cULus

D.18 ZK000E Incremental Encoder Interface

Technical data	ZK000E
Sensor connection	A, A(inv), B, B(inv), C, C(inv), (RS422 differential inputs) also single-ended connection (5 V ±20%)
Additional inputs	Gate, latch (24 V_{DC}, both max. 1 MHz permitted), status input (max. 5 V_{DC}, potential free, switching to negative potential)
Sensor supply	5 V_{DC}
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
Commands	read, set, enable
Cycle time	min. 100 µs
Current consumption via 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)
Bit width in process image	up to 6 bytes outputs, 22 bytes inputs, depends on parameterization
Configuration	via ProDrive
Weight	ca. 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
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
Installation position	variable
Protection class	IP20

be in motion
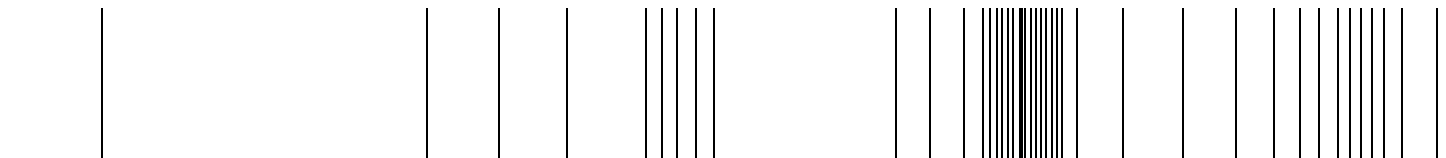
Baumüller Nürnberg GmbH   Ostendstraße 80-90   90482 Nuremberg Tel: +49(0)911-5432-0 Fax: +49(0)911-5432-130 **www.baumueller.com**