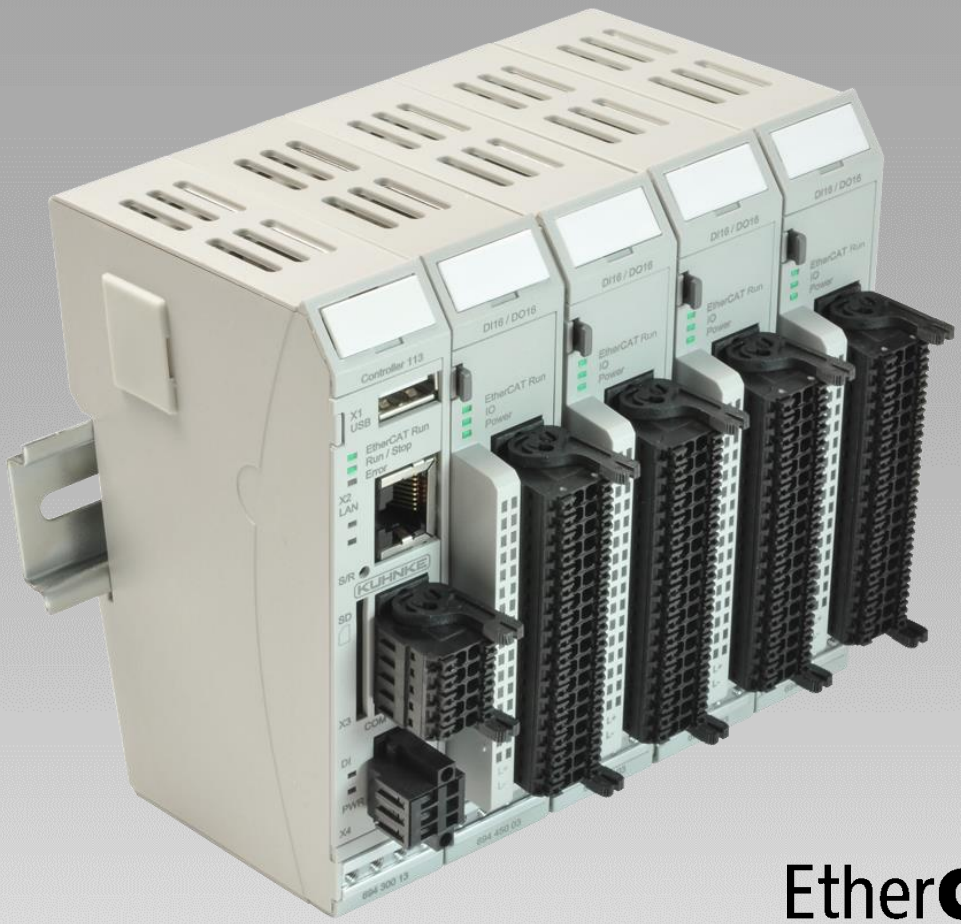
KENDRION



EtherCAT®

CANopen®

Instruction Manual

Kuhnke FIO - analogue IO Modules

IP20 EtherCAT I/O Modules

E 747GB-V2 17.05.2021

PRECISION. SAFETY. MOTION.

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Modification history

Date	Comments / modifications
25 Aug 2017	Source version after separation of the instructions into categories and translation
31 Aug 2017	Inserting a note for the AI-U modules
14 Jan 2019	Mounting instructions for the potential distributor added
18 Dec 2019	Design change
21 Jan 2020	Analog module Kuhnke FIO AI4 12Bit / AO4 16Bit CoE added
04 Feb 2021	Minor corrections in the document

1 Preface

1.1 Imprint

Contact Details

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1.2 About this Manual

This technical information is primarily directed to system designers, project engineers and device developers. It does not contain any availability information. We reserve the rights for errors, omissions and modifications. Pictures are similar.

Limitation of Liability

Specifications are for description only and are not to be understood as guaranteed product properties in a legal sense. Exact properties and characteristics shall be agreed in the specific contract. Claims for damages against us - on whatever grounds - are excluded, except in instances of deliberate intent or gross negligence on our part.

Terms of Delivery

The general conditions of sales and service of Kendrion Kuhnke Automation GmbH shall apply.

Copyright

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CODESYS V3© is a product of 3S-Smart Software GmbH.

Warranty

Warranty is subject to the provisions of the conditions of sale of Kendrion Kuhnke Automation GmbH or any contractual agreements between the parties.

Manual Objective and Organisation

This manual describes the EtherCAT slave IO modules of Kuhnke FIO. These modules provide the EtherCAT master with the sensor details and operate the actuators. Other modules control the communication with other systems.

The EtherCAT master control unit decides how to configure the network and create the control program.

This manual aims to introduce you to using the modules.

The examples are preferably based on CODESYS version 3 which has an EtherCAT master and an EtherCAT configuration utility. The procedures may change if you are using other tools.

For in-depth knowledge of IEC 611131-3 programming, please refer to the CODESYS online help engine and the references listed below.

CODESYS beginners may benefit from the comprehensive training offerings of 3S-Smart Software Solutions GmbH.

2 Reliability, Safety

2.1 Intended Use

For reasons of personal safety and to avoid material damages when working with or handling this Kuhnke product, you are advised to take heed of the notes and information contained in this instruction manual.

2.2 Target Group of the Instruction Manual

This instruction manual contains all information necessary for the use of the described product (control device, control terminal, software, etc.) according to instructions. It is written for qualified design, project planning, servicing and commissioning experts. For proper understanding and error-free application of technical descriptions, instructions for use and particularly of notes of danger and warning, extensive knowledge of automation technology is compulsory.

2.3 Intended Use

Kuhnke's products are designed, developed and manufactured for standard industrial use. They must not be used for any other purposes than the ones specified in the catalogue or the associated technical documentation. Proper and safe operation depends on the products being transported, stored, lined up, mounted, installed, put into service, operated, and serviced correctly. Ambient conditions must be within the admissible limits. Notes and information in the associated documentation apply at all times.

2.4 Transport and Storage

At times of transport and storage, protect Kuhnke FIO Module against inadmissible exposure such as mechanical stress, temperature, humidity and/or aggressive atmospheres. Transport and store Kuhnke FIO Modules only in its original packaging if possible.

Verify that the contacts are neither soiled nor damaged when consigning the unit to stock or re-packaging it. Keep and transport Kuhnke FIO Modules in a container/packaging ensuring electrostatic discharge (ESD) compliance. Some parts of the units are sensitive to ESD and may be damaged if handled inappropriately. Thus, best transport practice is to place open assemblies in statically shielded transport bags with a metal coating which avoid contamination by amines, amides or silicone. When putting Kuhnke FIO Modules into service and performing any maintenance, you should also take the appropriate precautions against electrostatic discharge.



CAUTION

Electrostatic discharge

Destruction of or damage to the unit.

- ⇨ Transport and store FIO Safety I/O in its original packaging.
- ⇨ Ensure that the ambient conditions are as specified at all times during transport and storage.
- ⇨ Handle FIO Safety I/O in a well-earthed environment (persons, place of work, packaging).
- ⇨ Do not touch electrically conductive parts such as data contacts. Some of the electronic components may be destroyed if exposed to electrostatic discharge.



DANGER

Only use devices that are in perfect condition, ie that they do not show any transport damage, fluid effects or other damage

2.5 Reliability

Reliability of Kuhnke products is brought to the highest possible standards by extensive and cost-effective means in their design and manufacture.

These include:

- selecting high-quality components,
- quality agreements with our suppliers,
- actions to avoid static charges when handling MOS circuits,
- worst case planning and design of all circuits,
- visual inspections at various stages of fabrication,
- computer-aided tests of all assemblies and their interaction in the circuit,
- statistical assessment of the quality of fabrication and of all returned goods for the immediate taking of appropriate corrective actions.

2.6 Hazard and other Warnings

Despite the actions described in section 2.4, the occurrence of faults or errors in electronic control units - even if most highly improbable - must be taken into consideration.

Please pay particular attention to the additional notices which we have marked by symbols throughout this instruction manual. While some of these notices make you aware of possible dangers, others are intended as a means of orientation. They are described further down below in descending order of importance.

Every alert and hazard warning is made up as follows:

Type and source of risk

Potential consequences of non-observance

⇨ Preventive measures

	***DANGER***
	A DANGER warning makes you aware of an immediately hazardous situation which WILL cause a serious or fatal accident if not observed.

	***WARNING***
	A WARNING makes you aware of a potentially hazardous situation which MAY cause a serious or fatal accident or damage to this or other devices if not observed.

	***CAUTION***
	A CAUTION alert makes you aware of a potentially hazardous situation which MAY cause an accident or damage to this or other devices if not observed.

	***NOTE***
	A NOTE makes you aware of a potentially hazardous situation which MAY cause damage to this or other devices if not observed.

Other Notices

	***Information***
	This symbol draws your attention to additional information concerning the use of the described product. This may include cross references to information found elsewhere (e.g. in other manuals).

2.7 Safety

Our products normally become part of larger systems or installations. The information below is intended to help you integrate the product into its environment without dangers to humans or material/equipment.



DANGER

Non-observance of the instruction manual

Measures for the prevention of dangerous faults or errors may be rendered ineffective or new hazard sources created.

- Thoroughly read the instruction manual
- Take particular heed of the hazard warnings



Information

To achieve a high degree of conceptual safety in planning and installing an electronic controller, it is essential to exactly follow the instructions given in the manual because wrong handling could lead to rendering measures against dangers ineffective or to creating additional dangers.

Project Planning

- Recommendation for 24V DC supply: Generate as electrically safely separated low voltage. Suitable devices include split-winding transformers built in compliance with European Standard EN 60742 (corresponds to VDE 0551).
- Power breakdowns or power fades: the program structure is to ensure that a defined state at restart excludes all dangerous states.
- Emergency-off installations must comply with EN 60204/IEC 204 (VDE 0113). They must be operative at any time.
- Safety and precautions regulations for qualified applications have to be complied with.
- Please pay particular attention to the notices of warning which, at relevant places, will make you aware of possible sources of dangerous mistakes or faults.
- Relevant standards and VDE regulations are to be complied with in every case.
- Control elements are to be installed in such a way as to exclude unintended operation.
- Lay control cables such that interference (inductive or capacitive) is excluded if this interference could influence controller operation or its functionality.

Maintenance and Servicing

- Precautions regulation VBG 4.0 to be observed when measuring or checking a controller after power-up. This applies to section 8 (Admissible deviations when working on parts) in particular.
- Repairs must be carried out by specially trained Kuhnke staff only (usually in the main factory in Malente). Warranty expires in every other case.
- Only use parts approved of by Kuhnke. Only genuine Kuhnke modules must be used in modular controllers.
- Modular systems: always plug or unplug modules in a power-down state. You may otherwise damage the modules or (possibly not immediately recognisably!) inhibit their functionality.
- Always dispose of (rechargeable) batteries as hazardous waste.

Disposal

- When disposing of the FIO modules, ensure that the modules are disposed of in accordance with the applicable environmental regulations.
- Treat the packaging as recyclable paper and cardboard.

2.8 Electromagnetic Compatibility

Definition

Electromagnetic compatibility is the ability of a device to function satisfactorily in its electromagnetic environment without itself causing any electromagnetic interference that would be intolerable to other devices in this environment.

Of all known phenomena of electromagnetic noise, only a certain range occurs at the location of a given device. These kinds of noise are specified in the applicable product standards.

The design and immunity to interference of programmable logic controllers are internationally governed by standard

IEC 61131-2 which, in Europe, has been the basis for European Standard
EN 61131-2.

	Information
	Refer to IEC 61131-4, User's Guideline, for general installation instructions to be complied with to ensure that hardware interface factors and the ensuing noise voltages are limited to tolerable levels.

Interference Emission

Interfering emission of electromagnetic fields, HF compliant to EN 55011, limiting value class A, Group 1

	Information
	If the controller is designed for use in residential areas, high-frequency emissions must comply with limiting value class B as described in EN 55011.Fitting the controller into earthed metal cabinets and installing filters in the supply lines may produce a shielding compliant to the above standard.

General Notes on Installation

As component parts of machines, facilities and systems, electronic control systems must comply with valid rules and regulations, depending on their field of application.

General requirements concerning the electrical equipment of machines and aiming at the safety of these machines are contained in Part 1 of European Standard EN 60204 (corresponds to VDE 0113).

Electrical Immission Safeguard

To eliminate electromagnetic interference, connect the control system to the protective earth conductor. Practice best cable routing.

Cable Routing and Wiring

Keep power circuits separate from control circuits:

- DC voltages 60 V ... 400 V
- AC voltages 25 V ... 400 V

Joint laying of control circuits is allowed for:

- shielded data signals
- shielded analogue signals
- unshielded digital I/O lines
- unshielded DC voltages < 60 V
- unshielded AC voltages < 25 V

Location of Installation

Ensure that temperatures, contaminations, impact, vibration or electromagnetic interference are no impediment to the installation.

Temperature

Consider heat sources such as general heating of rooms, sunlight, heat accumulation in assembly rooms or control cabinets.

Contamination

Use appropriate enclosures / cabinets to ensure operation of the FIO modules in a suitable environment. It is designed to prevent possible adverse effects of moisture, corrosive gases, liquids and conductive dust.

Operation of an impermissibly dirty module is not permitted. Cleaning the device is also prohibited.

Impact and Vibration

Consider possible influences caused by motors, compressors, transfer lines, presses, ramming machines and vehicles.

Electromagnetic Interference

Consider electromagnetic interference from various local sources: motors, switching devices, switching thyristors, radio-controlled devices, welding equipment, arcing, switched-mode power supplies, converters / inverters.

Particular Sources of Interference

Inductive Actuators

Switching off inductances (such as from relays, contactors, solenoids or switching magnets) produces surge voltages. It is necessary to reduce these extra voltages to a minimum.
Throttling elements could be diodes, Z-diodes, varistors or RC elements. Their rating should conform to the specifications provided by the manufacturer or supplier of the actuators.

3 Introduction

3.1 EtherCAT®[1] — Ethernet Control Automation Technology

EtherCAT is the most powerful Ethernet-based fieldbus system currently available on the market. EtherCAT puts up the top speed mark, and its flexible topology and simple configuration make it the perfect means of controlling extremely fast processes. To give you a clue: 1000 I/Os can be addressed in 30 µs.

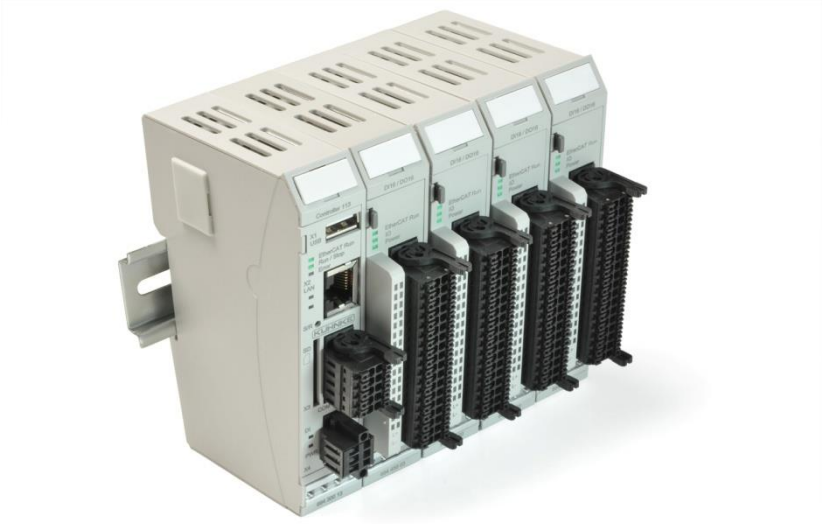
Because of its high performance, the simple wiring and its open protocol support, EtherCAT is often used as a fast motion control and I/O bus driven by an industrial PC or in conjunction with control technology on a smaller scale. EtherCAT moves beyond the limits of conventional fieldbus systems. Its interconnections between the controller at one end and both the I/O modules and drives at the other are as fast as those of a backplane bus. EtherCAT controllers thus nearly act like centralised control systems, overcoming the issue of bus transfer times that conventional fieldbus systems are burdened with.

3.2 Kuhnke FIO (Fast Input / Output)

Kuhnke FIO is a system of modules interconnecting via the backplane bus to make up a so-called EtherCAT network able to transfer process signals. For example, a Kuhnke FIO system may comprise a Kuhnke FIO controller or bus coupler plus any number of Kuhnke FIO I/O modules.

The head module (controller or bus coupler) converts the physical transfer technology (twisted pair) to LVDS (E-bus) and generates the system voltages required by the LVDS modules. The standard 100 Base Tx lines used for office network communications connect to the one side, the Kuhnke FIO I/O modules for the process signals connect to the other. This is how the Ethernet EtherCAT protocol is retained right through to the last I/O module. At the end of the modular device, the connection between the forward and return lines is automatically closed, the effect being that another 100 Base Tx line can be plugged in to connect the next EtherCAT unit to the second bus coupler port.

If the bus coupler is the last EtherCAT network station, i.e. if its RJ45 "Out" socket remains unplugged, the connection between the forward and return lines is automatically closed.



Kuhnke FIO Controller 113 and several Kuhnke FIO I/O modules

[1]EtherCAT® is a registered trademark and patented technology, licenced by Beckhoff Automation GmbH, Germany.

3.3 Kuhnke FIO — Ventura FIO

Regular product update cycles include successive revisions of the Ventura FIO modules since 2014. Revisions focused on improving the ESD properties and ensuring conformity with the guidelines of ETG (power engineering association of VDE). The revised modules are therefore referred to Kuhnke FIO or FIO V2.

Kuhnke FIO and Ventura FIO are compatible if they share the same order number. If so they are interchangeable without having to modify the control programs.

Ventura FIO modules are controlled by a wide process model map.

Kuhnke FIO modules equipped with a controller such as the analogue modules are available as variants compatible with the process map control methodology of the Ventura FIO modules or as object-controlled variants (CoE - CAN over EtherCAT).

The module descriptions in this manual will make readers aware of exceptions such as the signal range of the AO4 module.

The table below lists the visible differences between Ventura FIO and Kuhnke FIO.

Feature	Ventura FIO	Kuhnke FIO
Production date		2014, successively
Design	green dot	no dot
Module lock	green	grey
Unlock button (connector)	green	black
LED label	EtherCAT	EtherCAT Run
EtherCAT LED	green/red	green/off
LED label (RJ45)	In, Out	In L/A, Out L/A
Module control	process image	process image
		CoE
Process signal plug	extra	included
	green unlock button (including 2-pole)	black unlock button (2-pole: screw-type)
	Spring return (36-pole)	Push-in (36-pole)

4 System Description

4.1 General Service Conditions

This section describes the general requirements of installing, wiring and troubleshooting the Kuhnke FIO modules.

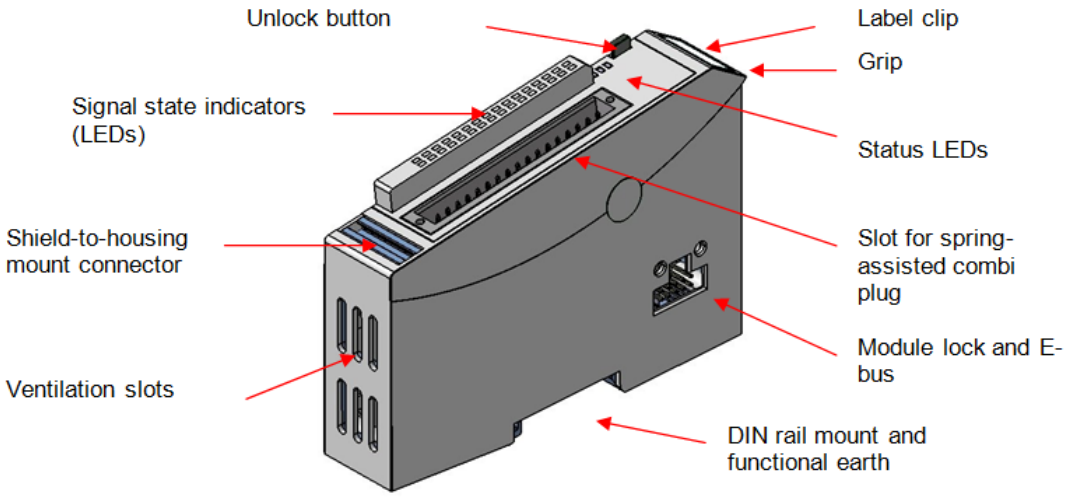
For a list of System Properties of Kuhnke FIO refer to chapter 0, page 182.

Subsequent chapters explain the specific properties of each of the modules.

4.2 Mechanical Design

The picture below shows the basic layout of the Kuhnke FIO modules.

The bus coupler and the I/O modules differ in their connectors and indicators, however.



Mechanical Design

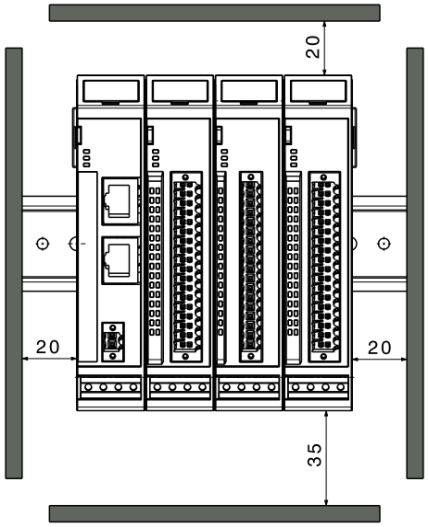
The housing mount consists of an aluminium profile with an integral snap-on device used to snap the module to a 35mm DIN rail. The housing trough including the optical fibres for the status indicators, the side face and the front is made of plastic and contains the module. The optical fibres for the signal state indicators (LEDs) are located next to the spring-assisted combi plug. They slightly protrude from the housing and allow a clear diagnosis at a glance.

Installation

Kuhnke FIO I/Os mount on 35 mm x 7.5 mm rails to DIN EN 50022.

Position

Mount with rail horizontally with the modules' multiple socket connectors pointing away from the wall. To ensure that enough air gets in through the ventilation slots, leave at least 20 mm to the top and 35 mm to adjacent devices or cabinet surfaces. Leave at least 20 mm of lateral distance to third-party units and cabinet surfaces.



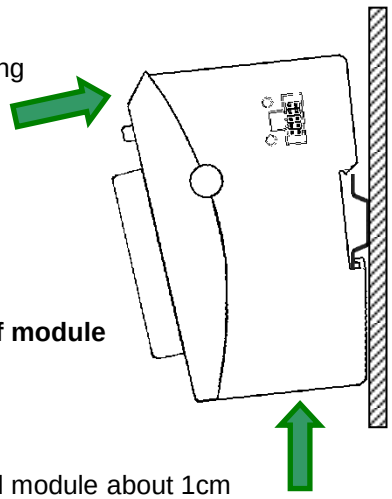
Order of Modules in Multi-FIO Systems

	NOTE
	In order to ensure that the entire FIO system works properly, arrange the FIO modules by their specific E-bus load, placing the modules with the highest E-bus load immediately next to the head module (bus coupler or controller). Take account of the head module's maximum bus load. *If possible, place the Kuhnke FIO Safety I/O modules immediately next to the head module.*

To Snap on a Single Module

- Push up the module against the mounting rail from below, allowing the metal spring to snap in between mounting rail and mounting area as illustrated.

Push the top of the module against the mounting wall until it snaps in.



Rail mounting of module

To Interconnect Two Modules

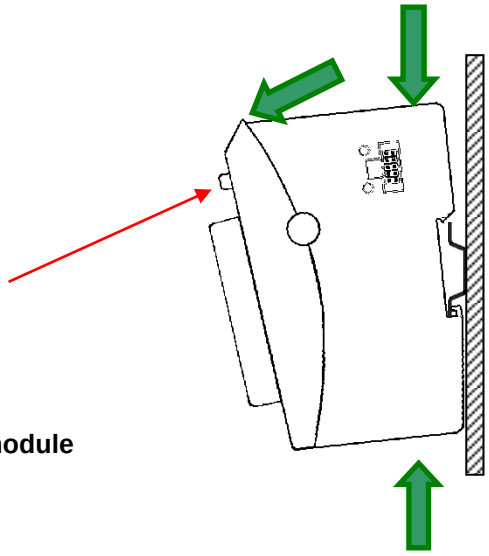
- After snapping on the first module to the rail, snap on the second module about 1cm away towards the right of the first module.
- Push the second module along the rail towards the first module until you hear the locking device snap in.

To Disconnect Two Modules

- Push down the unlock button of the module that you wish to disconnect from the module to the left of it.
- With the button still pressed, push both modules away from one another until they are about 1 cm apart.

To Take Down a Single Module

- Push the module up and against the metal spring located on the underside of the rail guide.
- Tip the module away from the rail
- as shown in the illustration.
- Pull the module down and out of the mounting rail.



Uninstalling a module

4.3 System Power Supply

General Instructions

Multi-connector plugs provide many connections in a tight space.

- Unlock buttons make it easier to unplug larger connectors where there is little space.
- Screw fittings reliably hold small connectors in place.

	Note
	The connectors must not be subjected to any inadmissible tension / pressure in order to avoid excessive force transmission to the board or contact problems. *Avoid e.g. too strong pull due to too short wiring.*

Spring-assisted multiple socket connectors support quick and easy wiring.

Single row

Tool: Screwdriver, 0.4 x 2.5 x 75 [mm] blade (DIN 5264-A)

Wires: 320 V / 10 A / 0.2 - 1.5 mm² (IEC)

Nominal current: 300 V / 10 A / 28 - 14 AWG (UL)

Supported wires with connector sleeves:

	Wire cross section [mm²]						
Connector sleeve type	0.13	0.25	0.34	0.50	0.75	1	1.5
Connector sleeve w/ collar to DIN 46 228/4	8 / 10	8 / 10	8 / 10	8 / 10	10 / 12	10 / 12	
Connector sleeve w/o collar to DIN 46 228/1	8 / 10	8 / 10	8 / 10	8 / 10	8 / 10	8 / 10	8 / 10
	Stripped end [mm] / sleeve length [mm]						

The spring-assisted PUSH-IN connector allows you to quickly attach the wires by direct insertion without any tools. Just insert the connector sleeve end of the stripped solid or fine wire in the correct opening.

Two rows:

Wires: 320V / 13.4 A / 0.14 - 1.5 mm² (IEC)

Nominal current: 300 V / 9.5 A / 26 - 16 AWG (UL)

Supported wires with connector sleeves:

	Wire cross section [mm²]						
Connector sleeve type	0.14	0.25	0.34	0.50	0.75	1	1.5
Connector sleeve w/ collar to DIN 46 228/4	8 / 10	8 / 10	8 / 10	10 / 12	12 / 14	12 / 15	
Connector sleeve w/o collar to DIN 46 228/1	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10	10 / 10
	Stripped end [mm] / sleeve length [mm]						

	NOTE
	Do not connect the power supply lines through from one Kuhnke FIO to the next. To ensure that there is as little interference as possible, install a central power supply point and establish a star topology of as short wires as possible between the central point and Kuhnke FIO.

System Power Supply

A system connector supplies the Kuhnke FIO Safety I/O system with system power from an upstream bus coupler or a compact controller. This system power supply is used for the analysis circuitry and for bus communication only.

	***Information***
	Please also note the connection printing on the device before the electrical installation.

	***WARNING***
	Potentially hazardous failures due to wrong voltages supplied *Supplying the wrong voltages may damage or destroy the unit and may provoke potentially hazardous failures.* *Preventive measures:* ⇨ We recommend to use PELV/SELV-ready power supply units to EN50178 or EN60950-1 to supply 24 VDC to bus couplers or compact PLCs. ⇨ Only use the GND terminal to connect the power supply unit to earth (PELV system). Do not use earthing variants that connect earth to +24V. ⇨ Remember that, even in case of a fault, a maximum voltage of U max. < 33 V maybe supplied to these assemblies. If you cannot rule out this risk, external protection of the power supply is mandatory. ⇨ To ensure that there is as little interference as possible, install a central power supply point and establish a star topology of as short wires as possible between the central point and the block of FIO modules.

Earth

Connect the Kuhnke FIO modules to earth by attaching the metal housing to functional earth.

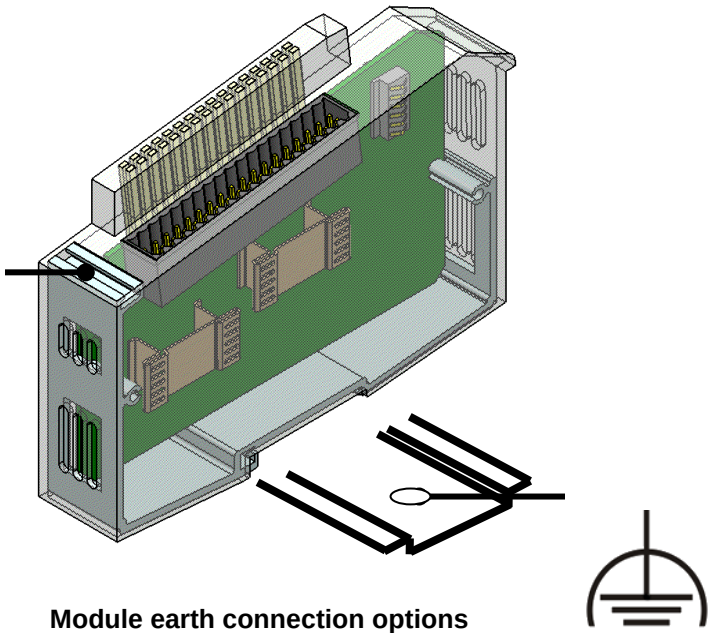
Since the functional earth connector dissipates HF currents, it is of utmost importance for the module's noise immunity.

HF interference is dissipated from the electronics board to the metal housing. The metal housing therefore needs to be suitably connected to a functional earth connector.

You will normally have to ensure that

- the connection between module housing and DIN rail conducts well,
- the connection between DIN rail and switching cabinet conducts well,
- the switching cabinet is safely connected to earth.

In special cases you may attach the earth wire straight to the module.



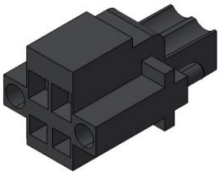
Module earth connection options

	Information
	Earth wires should be short and have a large surface (copper mesh). Refer to http://de.wikipedia.org/wiki/ground_(electronics) for further details

Bus Coupler

The system power supply connects to the bus coupler through a 2-pole plug-type terminal block with a bolt flange. Since the bus coupler supplies power to both the E-bus and the logic circuits of the I/O modules, its power consumption depends on the number of I/O modules connected.

Power to the I/O module outputs is supplied separately.

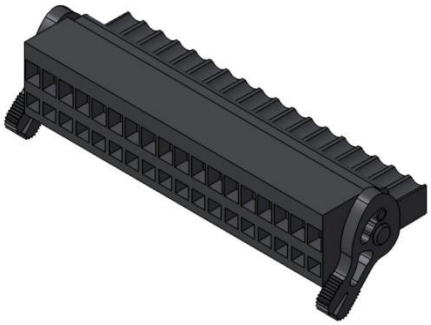


Spring-assisted plug with bolt flange for bus coupler connection

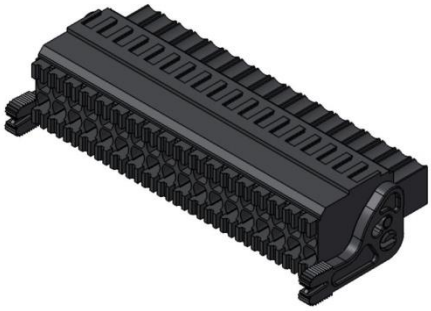
I/O Modules

The I/O supply connects to the I/O module using plug-type terminal blocks with different numbers of poles.

The bus coupler supplies power to the logic circuits of I/O modules without their own micro-controller. Modules equipped with a micro-controller may feature a power supply unit that power is supplied to through the IO connector.



Spring-assisted connector with I/O module unlock button



Two-row push-In connector with unlock button

	NOTE
	Externally turning off the I/O power supply (L+) can be used to trip all outputs. *In that case, LED Power indicates that no voltage is being supplied.* *Mind, though, that not all modules have a voltage watchdog to indicate the state to the control unit.* *To have your control program check whether power is supplied to the IOs, connect L+ to a digital input and poll that input as an indirect indicator of the IO power supply.*

Remember the following if you choose to do so:

	NOTE
	Avoid any reverse feeding of outputs while the power supply to the outputs is turned off.

This applies if the system is still supplied with power.

Outputs enabled by the user program may be supplied power via the protective diode of a reversely fed output, thus overriding the switch-off function of these outputs. Moreover, the protective diode of the feeding outputs may yield under high loads and be destroyed.

4.4 Status LEDs

LED "EtherCAT Run"

An LED labelled "EtherCAT Run" is located on both the bus coupler and the I/O modules. It indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "In L/A", LED "Out L/A"

The "In L/A" and "Out L/A" LEDs are located on the bus coupler. They indicate the physical state of the Ethernet.

State	LED flash code	Explanation
Not connected	Off	No Ethernet connection
Connected	Green, on	Connected to Ethernet
Traffic	Green, flashing	Exchanging telegrams

LED "IO"

Every I/O module has an LED labelled "IO". It indicates the state of the module's I/Os. Refer to the I/O module sections in this manual to know which states of a module are monitored and indicated.

LED "Power"

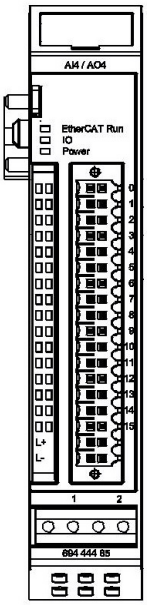
An LED labelled "Power" is located on every module that has a power supply connector (e.g. for digital outputs). It indicates the state of the I/O module's I/O power supply.

State	LED flash code	Explanation
On	Green, on	24 VDC supply ok
Off	Off	24 VDC supply not ok

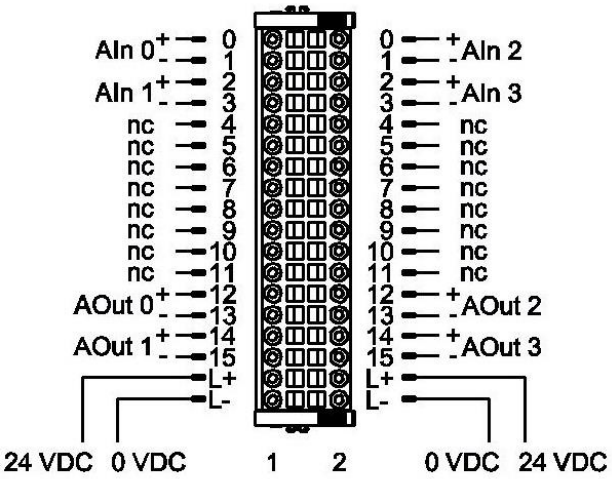
5 Kuhnke FIO Modules

5.1 Analogue FIO Modules

5.1.1 AI4 12Bit / AO4 16Bit CoE



Front view of I/O AI4/AO4 modul



I/O connection

Terminals
Power supply to module I/Os
L+ 24 VDC
L- 0 V

Funktionserde / Schirm der Analogleitungen → Abschnitt Earth

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 1x	Short circuit
	Red, 2x	Low voltage
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

LED "Power"

The LED labelled "Power" indicates the state of the I/O module's I/O power supply.

State	LED flash code	Explanation
On	Green, on	24 VDC supply ok
Off	Off	24 VDC supply not ok

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red, 1x	Short circuit
	Red, 3x	Wire failure
	Red, 5x	Excessive temp. of output drivers

Functions

The module AI4 12Bit / AO4 16Bit has 4 analog inputs and 4 analog outputs. All channels can be parameterized almost independently of each other, giving the module a high degree of flexibility.

Input and output values can be easily scaled according to their use so that, for example, the measured value of a sensor can be read directly in the desired unit.

Configuration examples

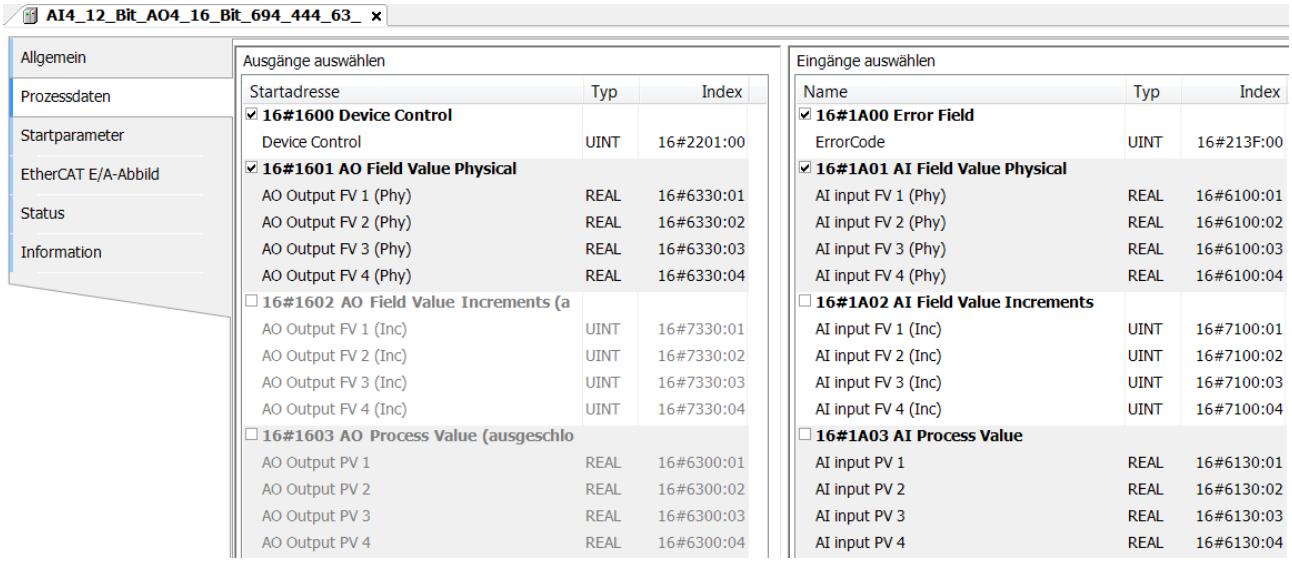
Input mapping

Depending on the configuration of the analog inputs, various predefined mappings are available.

A basic distinction is made between the following display formats:

- Field Value Physical: Input value in [V] or [mA] as REAL
  Mapping $1A01_h$ active
- Field Value Increments: Input value in digits as UINT
  Mapping $1A02_h$ active
- Process Value: Scaled input value (Process value) as REAL
  Mapping $1A03_h$ active

View of the mapped process data in CODESYS V3:



Using the analog inputs

The analog inputs are parameterized as voltage input 0...10 V at delivery. Depending on the connected sensor, these can be parameterised via the following object:

Object	Explanation
AI Sensor Type 6110_h	**42 = 0…10 V (Default)** 52 = 0…20 mA 51 = 4…20 mA

Input scaling

Input values can be scaled channel by channel by specifying two set points or by specifying factor and offset.
The scaled input values are output as process values (PV).
These are output in a separately map able object.

Objekt	Beschreibung
AI Input PV 6130$_h$	Mapable object of the scaled analog input values The predefined mapping object 1A03h can be selected for this purpose.
AI Channel Control 2001$_h$	Bit 1 = 0: Scaling by factor and offset Bit 1 = 1: Scaling by set points
AI Input Scaling 1 FV 6120$_h$	Set point 1 Field value [V] or [mA]
AI Input Scaling 1 PV 6121$_h$	Set point 1 Process value
AI Input Scaling 2 FV 6122$_h$	Set point 2 Field value [V] or [mA]
AI Input Scaling 2 PV 6123$_h$	Set point 2 Process value
AI Scaling Factor 6126$_h$	Scaling factor [Process value / Field value]
AI Scaling Offset 6127$_h$	Scaling offset [Process value]

Ausgangsmapping

Depending on the configuration of the analog outputs, various predefined mappings are available.

A basic distinction is made between the following display formats:

- Field Value Physical: Output value in [V] or [mA] as REAL
  Mapping 1601_h active
- Field Value Increments: Output value in digits as UINT
  Mapping 1602_h active
- Process Value: Scaled output value (Process value) as REAL
  Mapping 1603_h active

The above mappings are exclusive of each other, so only one of the 3 mappings can be activated.

Using the Analog Outputs

The analog outputs are not active on delivery. To use an analog output, it must be activated. The analog outputs are activated by configuring the output type of the respective output.

Objekt	Beschreibung
AO Output Type 6310_h	**0 = Disabled (Default)** 10 = 0…10 V 11 = +/- 10 V 20 = 0…20 mA 21 = 4…20 mA

Output scaling

Output values can be scaled channel by channel by specifying two set points.

The scaled output values are output as a process value (PV).

These are output in a separately mapable object.

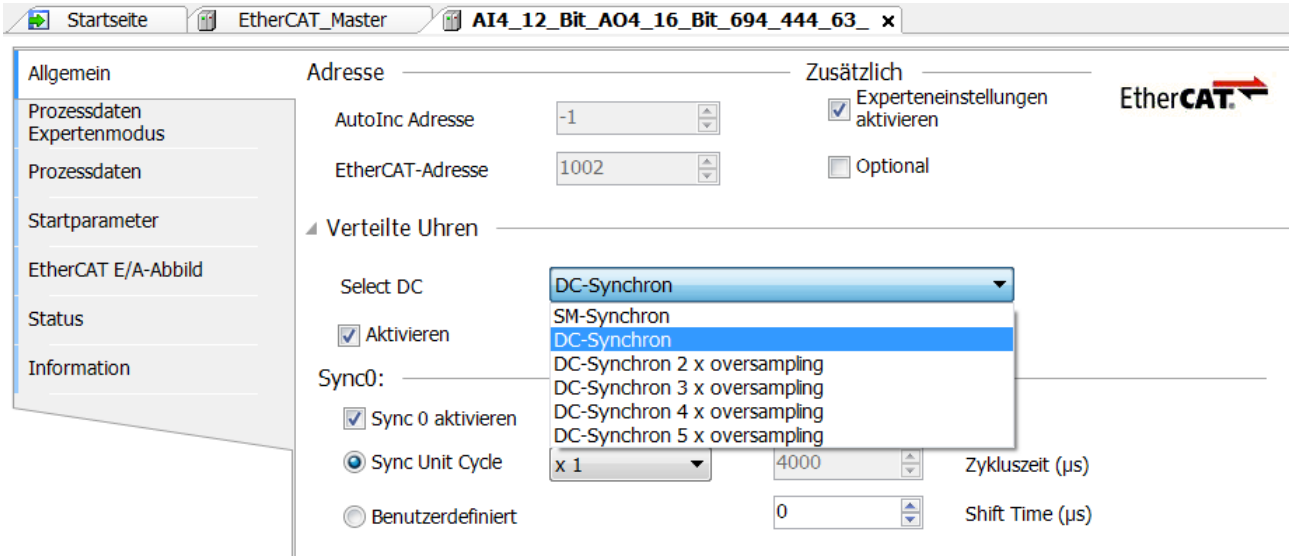
Objekt	Beschreibung
AO Output PV 6300_h	Mapable object contains the process value (PV) of the corresponding analog output. The predefined mapping object 1603h can be selected for this, other possibly selected mapping objects 1601h or 1602h must be deselected.
AO Output Scaling 1 FV 6320_h	Set point 1 Field value [V] or [mA]
AO Output Scaling 1 PV 6321_h	Set point 1 Process value
AO Output Scaling 2 FV 6322_h	Set point 2 Field value [V] or [mA]
AO Output Scaling 2 PV 6323_h	Set point 2 Process value

Distributed Clocks Operation

In order to acquire or output data in an EtherCAT network at a certain time on all participants simultaneously, all participants must work synchronously. For this purpose there is a local clock in the EtherCAT slave controllers, which is automatically synchronised by the EtherCAT master with the master clock in the EtherCAT network with an accuracy of less than 100ns.

The EtherCAT slave controllers in the EtherCAT network generate interrupts synchronously. This interrupt collects input data or processes output data simultaneously.

Several DC modes are available on the AI4 / AO4:



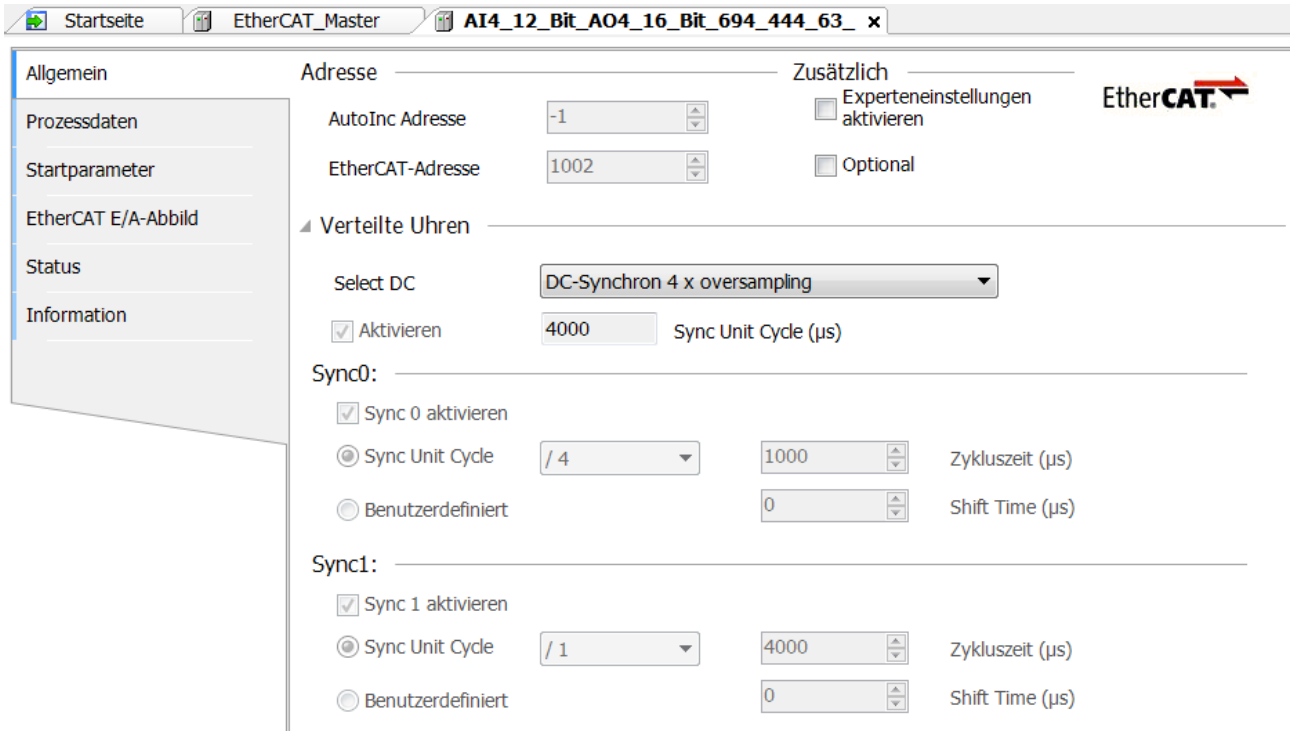
DC synchronous oversampling operation

In oversampling mode, it is possible to acquire up to 5 measured values in one bus cycle, enabling the acquisition of rapidly changing measured values.

For n-times oversampling, one of the DC synchronous operating modes with the desired factor n is selected in the EtherCAT slave setting.

Example:

- DC- Cycle time 4000µs
- 4-times oversampling



Every 1000µs the Sync 0 interrupt is triggered on the module, in which the input values are read.

These are available in the following objects:

Field Value (Real)	Process Value (Real)
AI1 Oversample Data FV 2101h	AI1 Oversample Data PV 2131h
AI2 Oversample Data FV 2102h	AI2 Oversample Data PV 2132h
AI3 Oversample Data FV 2103h	AI3 Oversample Data PV 2133h
AI4 Oversample Data FV 2104h	AI4 Oversample Data PV 2134h

Furthermore, every 4000µs the Sync 1 interrupt is triggered, with which the output values are written and the average value of the sampled input values is calculated.

Object dictionary

Device Type 1000h

Name	Device Type
Index	1000_h
Object Code	VARIABLE
No. of Elements	-
Data Type	UNSIGNED32

Access	read only
PDO Mapping	No
Value Range	Fix
Default Value	$800A\ 0192_h$

Additional Information [16] Bit 31…16

Bit 16 = Digital Input FB	o
Bit 17 = Analog Input FB	✓
Bit 18 = Digital Output FB	o
Bit 19 = Analog Output FB	✓
Bit 20 = Controller FB	o
Bit 21 = Alarm FB	o
Bit 22 = Device FB	✓
Bit 23 bis 26 = Specific Function	o
Bit 27 bis 29 = Reserved	o
Bit 30 = Reserved	o
Bit 31 = Maufacturer-specific PDO mapping	✓

Device Profile number [16] Bit 15..0

$0194_h = 404_d$ = 404 Device Profile Nummer

Error Register 1001h

Name	Error Register
Index	1001h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED8

Access	read only
PDO Mapping	Yes, TX-PDO
Value Range	
Default Value	00h

In the event of an error, the corresponding error bit is set. If the error no longer exists, it is automatically resetted.

7	6	5	4	3	2	1	0
MAN	RES	PROF	COM	TEMP	VOL	CUR	GEN

GEN: General error
CUR: Current
VOL: Voltage
TEMP: Temperature
COM: Communication
PROF: Device profile
RES: reserved, always „0“
MAN: Manufacturer specific

Manufacturer Device Name 1008h

Name	Manufacturer Device Name
Index	1008h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	No
Units	-
Value Range	Fix
Default Value	FIO AI4AO4

Subindex 0 of this object contains the length of the character string. As of subindex 1, the individual characters are contained. The character string is not terminated by null characters.

Manufacturer Hardware Version 1009h

Name	Manufacturer Hardware Version
Index	1009h
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	No
Units	-
Value Range	Fix
Default Value	1.00

Subindex 0 of this object contains the length of the character string. As of subindex 1, the individual characters are contained. The character string is not terminated by null characters.

Manufacturer Software Version 100Ah

Name	Manufacturer Software Version
Index	100Ah
Object Code	VARIABLE
No. of Elements	0
Data Type	VISIBLE_STRING

Access	read only
PDO Mapping	No
Value Range	Fix
Default Value	1.00

Identity Object 1018h

Name	Identity object
Index	1018_h
Object Code	RECORD
No. of Elements	0
Data Type	IDENTITY

Name	Highest sub index supported
Subindex	00_h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	04_h

Name	Vendor-ID
Subindex	01_h
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	$0048554B_h$

Name	Product Code
Subindex	02_h
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	$0002EF68_h$

Name	Revision number
Subindex	03_h
Data type	UNSIGNED32
Access	Read only
PDO Mapping	No
Default Value	

Name	Serial number
Subindex	04_h
Data type	UNSIGNED32
Access	Read only
PDO Mapping	No
Default Value	

The object contains information about the manufacturer, the product code and the revision and serial number.

Error Settings 10F1h

Name	Error Settings
Index	10F1h
Object Code	RECORD
No. of Elements	3
Data Type	

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	02h

Name	Local Error Reaction
Subindex	01h
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	00000001h

Name	Sync Error Counter Limit
Subindex	02h
Data type	UNSIGNED16
Access	read only
PDO Mapping	No
Default Value	0004h

Unused

Mapping 1600h (Device Control)

Name	Drive Control
Index	1600h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read write
PDO Mapping	No
Default Value	01h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2201 00 10h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	60600008h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1601h (AO Field Value Physical)

Name	AO Field Value Physical
Index	1601h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING
Exclude	1602h, 1603h

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	04h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6330 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6330 02 20h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6330 03 20h

Name	4th Object to be mapped
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6330 04 20_h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1602h (AO Field Value Increments)

Name	AO Field Value Increments
Index	1602h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING
Exclude	1601h, 1603h

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	04h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7330 01 10h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7330 02 10h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7330 03 10h

Name	4th Object to be mapped
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7330 04 10_h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1603h (AO Process Value)

Name	AO Process Value
Index	1603h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING
Exclude	1601h, 1602h

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	04

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6300 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6300 02 20h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6300 03 20h

Name	4th Object to be mapped
Subindex	04_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6300 04 20_h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A00h (Error Field)

Name	Error Field
Index	1A00h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	01h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	213F 00 10h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A01h (AI Field Value Pysical)

Name	AI Field Value Pysical
Index	1A01h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	04h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6100 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6100 02 20h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6100 03 20h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6100 04 20h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A02h (AI Field Value Increments)

Name	AI Field Value Increments
Index	1A02h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	04h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7100 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7100 02 20h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7100 03 20h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	7100 04 20h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A03h (AI Process Value)

Name	AI Process Value
Index	1A03h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	04h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6130 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6130 02 20

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6130 03 20h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	6130 04 20h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A04h (Oversample FV AI1)

Name	Oversample FV AI1
Index	1A04h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2101 01 10h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2101 02 10

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2101 03 10h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2101 04 10h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	$2101\ 05\ 10_h$

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A05h (Oversample FV AI2)

Name	Oversample FV AI2
Index	1A05h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2102 01 10h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2102 02 10

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2102 03 10h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2102 04 10h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2102 05 10_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A06h (Oversample FV AI3)

Name	Oversample FV AI3
Index	1A06h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2103 01 10h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2103 02 10

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2103 03 10h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2103 04 10h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2103 05 10_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A07h (Oversample FV AI4)

Name	Oversample FV AI4
Index	1A07h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2104 01 10h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2104 02 10

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2104 03 10h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2104 04 10h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2104 05 10_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A08h (Oversample PV AI1)

Name	Oversample PV AI1
Index	1A08h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2131 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2131 02 20

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2101 03 10h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2131 04 20h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2131 05 20_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A09h (Oversample PV AI2)

Name	Oversample PV AI2
Index	1A09h
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2132 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2132 02 20h

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2132 03 20h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2132 04 20h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	$2132\ 05\ 20_h$

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A0Ah (Oversample PV AI3)

Name	Oversample PV AI3
Index	1A0Ah
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00h
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05h

Name	1st Object to be mapped
Subindex	01h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2133 01 20h

Name	2nd Object to be mapped
Subindex	02h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2133 02 20

Name	3rd Object to be mapped
Subindex	03h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2133 03 20h

Name	4th Object to be mapped
Subindex	04h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2133 04 20h

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2133 05 20_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

Mapping 1A0B$_h$ (Oversample PV AI4)

Name	Oversample PV AI4
Index	1A0B$_h$
Object Code	RECORD
No. of Elements	9
Data Type	PDO_MAPPING

Name	Highest sub index supported
Subindex	00$_h$
Data type	UNSIGNED8
Access	read only
PDO Mapping	No
Default Value	05$_h$

Name	1st Object to be mapped
Subindex	01$_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2134 01 20$_h$

Name	2nd Object to be mapped
Subindex	02$_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2134 02 20

Name	3rd Object to be mapped
Subindex	03$_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2134 03 20$_h$

Name	4th Object to be mapped
Subindex	04$_h$
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2134 04 20$_h$

Name	5th Object to be mapped
Subindex	05_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	2134 05 20_h

Name	6th Object to be mapped
Subindex	06_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	7th Object to be mapped
Subindex	07_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	8th Object to be mapped
Subindex	08_h
Data type	UNSIGNED32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Each subindex (1-8) describes one mapped object. A mapping entry consists of four bytes which are composed as follows:

Index[16]	Bit 31..16	Index of the object to be mapped
SubIndex[8]	Bit 15..8	Subindex of the object to be mapped
Length[8]	Bit 7..0	Length of the object to be mapped

AI Channel Control 2001h

Name	AI Channel Control
Index	2001h
Object Code	ARRAY
No. of Elements	5
Data Type	UINT8

Name	Highest sub index supported
Subindex	00h
Data type	UINT8
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Channel Control 1
Subindex	01h
Data type	UINT8
Access	read write
PDO Mapping	Yes, RX-PDO
Default Value	00000000h

Name	AI Channel Control 2
Subindex	02h
Data type	UINT8
Access	read write
PDO Mapping	Yes, RX-PDO
Default Value	00000000h

Name	AI Channel Control 3
Subindex	03h
Data type	UINT8
Access	read write
PDO Mapping	Yes, RX-PDO
Default Value	00000000h

Name	AI Channel Control 4
Subindex	04h
Data type	UINT8
Access	read write
PDO Mapping	Yes, RX-PDO
Default Value	00000000h

7	6	5	4	3	2	1	0
					COMP	SCAL	ACT

ACT:

0 = Input inactive

1 = Input active (Default)

SCAL:

0 = Input values scaled by factor and offset (Default)

1 = Input values scaled by set points

COMP:

0 = Comparator inactive (Default)

1= Comparator active

AI Channel Status 2002h

Name	AI Channel State
Index	2002h
Object Code	ARRAY
No. of Elements	5
Data Type	UINT8

Name	Highest sub index supported
Subindex	00h
Data type	UINT8
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Channel Status 1
Subindex	01h
Data type	UINT8
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Channel Status 2
Subindex	02h
Data type	UINT8
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Channel Status 3
Subindex	03_h
Data type	UINT8
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Name	AI Channel Status 4
Subindex	04_h
Data type	UINT8
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Kanalzustand:

7	6	5	4	3	2	1	0
						UpLim	LoLim

LoLim (Lower Limit) / UpLim (Upper Limit)

0 = Limit not exceeded

1 = Limit exceeded

Error Log 2003h

Name	Error Log
Index	2003h
Object Code	RECORD
No. of Elements	9
Data Type	UNSIGNED32

Name	Number of errors
Subindex	00h
Data type	UNSIGNED8
Access	read write
PDO Mapping	No
Default Value	00h

Name	Standard error field
Subindex	01h .. 08h
Data type	UNSIGNED32
Access	read only
PDO Mapping	No
Default Value	00000000h

If a new error occurs, it is written to subindex 1. The existing entries in subindexes 1 to 7 are moved one position backwards. The error on subindex 7 is removed.

The number of errors that have already occurred can be read from the object with the subindex 0. If a "0" is written in this object, the counting starts again.

The object contains the error numbers from the object Error Code 213Fh

Sample Count 2100h

Name	Sample Count
Index	2100h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED32

Access	read only
PDO Mapping	Yes, TX-PDO
Value Range	
Default Value	00h

Number of samples since reset / restart

AI1 Oversample Data FV 2101h

Name	AI1 Oversample Data FV
Index	2101h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	INT16
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI1 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI1

AI2 Oversample Data FV 2102h

Name	AI2 Oversample Data FV
Index	2102h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	INT16
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI2 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI2

AI3 Oversample Data FV 2103h

Name	AI3 Oversample Data FV
Index	2103h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	INT16
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI3 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI3

AI4 Oversample Data FV 2104h

Name	AI4 Oversample Data FV
Index	2104h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	INT16
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI4 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI4

AI Input Calibration Gain 2125h

Name	AI Input Calibration Gain
Index	2125h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input Calibration Gain 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	1.0

Name	AI Input Calibration Gain 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	1.0

Name	AI Input Calibration Gain 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	1.0

Name	AI Input Calibration Gain 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	1.0

Channel dependent calibration factor for correction of gain error

AI1 Oversample Data PV 2131h

Name	AI1 Oversample Data PV
Index	2101h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI1 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI1

AI2 Oversample Data PV 2132h

Name	AI2 Oversample Data PV
Index	2102h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI2 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI2

AI3 Oversample Data PV 2133h

Name	AI3 Oversample Data PV
Index	2103h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI3 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI3

AI4 Oversample Data PV 2134h

Name	AI4 Oversample Data PV
Index	2104h
Object Code	ARRAY
No. of Elements	6

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	NO
Default Value	05h

Name	AI4 Sample N+0 .. N+4
Subindex	01h .. 05h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Oversampling input values AI4

Error Code 213F$_h$

Name	Error Code
Index	213F$_h$
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read only
PDO Mapping	Yes, TX-PDO
Value Range	
Default Value	00$_h$

2320$_h$ AO0 Temperature to high
2321$_h$ AO1 Temperature to high
2322$_h$ AO2 Temperature to high
2323$_h$ AO3 Temperature to high

2330$_h$ AI0 Overvoltage or wire break
2331$_h$ AI1 Overvoltage or wire break
2332$_h$ AI2 Overvoltage or wire break
2333$_h$ AI3 Overvoltage or wire break

3120$_h$ Module undervoltage

5100$_h$ AI0 Input value outside the parameterized limits
5101$_h$ AI1 Input value outside the parameterized limits
5102$_h$ AI2 Input value outside the parameterized limits
5103$_h$ AI3 Input value outside the parameterized limits

5300$_h$ AI0 sensor fault (Current less than 4mA)
5301$_h$ AI1 sensor fault (Current less than 4mA)
5302$_h$ AI2 sensor fault (Current less than 4mA)
5303$_h$ AI3 sensor fault (Current less than 4mA)

6010$_h$ Watchdog

8000$_h$ Communication error

Device Control 2201h

Name	Device Control
Index	2201h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read write
PDO Mapping	Yes, RX-PDO
Value Range	
Default Value	00h

7	6	5	4	3	2	1	0
							RES

RES:

0 = keine Aktion

1 = Reset Device durchführen

Device Status 2202h

Name	Device Status
Index	2202h
Object Code	VARIABLE
No. of Elements	0
Data Type	UNSIGNED16

Access	read only
PDO Mapping	Yes, TX-PDO
Value Range	
Default Value	00h

Unused

AI Input FV 6100h

Name	AI Input FV
Index	6100h
Object Code	ARRAY
No. of Elements	5
Data Type	REAL32

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input FV 1
Subindex	01h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input FV 2
Subindex	02h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input FV 3
Subindex	03h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input FV 4
Subindex	04h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Analog input values as real measured variable. When oversampling is active, the average value of the sampled process input values is displayed

AI Sensor Type 6110h

Name	AI Sensor Type
Index	6110h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	UINT16
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Sensor Type 1
Subindex	01h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Sensor Type 2
Subindex	02h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Sensor Type 3
Subindex	03h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Sensor Type 4
Subindex	04_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Channel-dependent setting of the connected sensor:
42 = 0…10 V (Default)
52 = 0…20 mA
51 = 4…20 mA

AI Input Scaling 1 FV 6120h

Name	AI Input Scaling 1 FV
Index	6120h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input Scaling 1 FV 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 1 FV 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 1 FV 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 1 FV 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

AI Input Scaling 1 PV 6121h

Name	AI Input Scaling 1 PV
Index	6121h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input Scaling 1 PV 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 1 PV 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 1 PV 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 1 PV 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

AI Input Scaling 2 FV 6122h

Name	AI Input Scaling 2 FV
Index	6122h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input Scaling 2 FV 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 2 FV 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 2 FV 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 2 FV 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

AI Input Scaling 2 PV 6123h

Name	AI Input Scaling 2 PV
Index	6123h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input Scaling 2 PV 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 2 PV 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 2 PV 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Scaling 2 PV 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

AI Input Offset 6124h

Name	AI Input Offset
Index	6124h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input Offset 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Offset 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Offset 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Input Offset 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Channel-dependent offset in [V] or [mA].

AI Scaling Factor 6126h

Name	AI Scaling Factor
Index	6126h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Scaling Factor 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Scaling Factor 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Scaling Factor 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Scaling Factor 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Scaling factor [Process value / Field value]

AI Scaling Offset 6127h

Name	AI Scaling Offset
Index	6127h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Scaling Offset 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Scaling Offset 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Scaling Offset 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Scaling Offset 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Scaling offset [Process value]

AI Input PV 6130h

Name	AI Input PV
Index	6130h
Object Code	ARRAY
No. of Elements	5
Data Type	REAL32

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input PV 1
Subindex	01h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input PV 2
Subindex	02h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input PV 3
Subindex	03h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input PV 4
Subindex	04h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Analog process input values as real measured variables, determined by the scaling values.

When oversampling is active, the average value of the sampled process input values is displayed.

AI Filter Type 61A0h

Name	AI Filter Type
Index	61A0h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	UINT8
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Filter Type 1
Subindex	01h
Data type	ENUM
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Filter Type 2
Subindex	02h
Data type	ENUM
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Filter Type 3
Subindex	03h
Data type	ENUM
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AI Filter Type 4
Subindex	04_h
Data type	ENUM
Access	read write
PDO Mapping	No
Default Value	00000000_h

Object for activating the input filter.
0 = No Filter active
1 = PT1 Filter

AI Filter Constant $61A1_h$

Name	AI Filter Constant
Index	$61A1_h$
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00_h
Data type	UINT8
Access	read only
PDO Mapping	No
Default Value	04_h

Name	AI Filter Constant 1
Subindex	01_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AI Filter Constant 2
Subindex	02_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AI Filter Constant 3
Subindex	03_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AI Filter Constant 4
Subindex	04_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

PT1 Filter time in [ms]

AO Output PV 6300_h

Name	AO Output PV
Index	6300_h
Object Code	ARRAY
No. of Elements	5
Data Type	REAL32

Name	Highest sub index supported
Subindex	00_h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04_h

Name	AO Output PV 1
Subindex	01_h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Name	AO Output PV 2
Subindex	02_h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Name	AO Output PV 3
Subindex	03_h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Name	AO Output PV 4
Subindex	04_h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

AO Output Type 6310_h

Name	AO Sensor Type
Index	6310_h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00_h
Data type	UINT16
Access	read only
PDO Mapping	No
Default Value	04_h

Name	AO Sensor Type 1
Subindex	01_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Sensor Type 2
Subindex	02_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Sensor Type 3
Subindex	03_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Sensor Type 4
Subindex	04_h
Data type	UINT16
Access	read write
PDO Mapping	No
Default Value	00000000_h

Channel-dependent setting of the output variable:

0 = Disabled (Default)

10 = 0…10 V

11 = +/- 10 V

20 = 0…20 mA

21 = 4…20 mA

AO Output Scaling 1 FV 6320_h

Name	AO Output Scaling 1 FV
Index	6320_h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00_h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04_h

Name	AO Output Scaling 1 FV 1
Subindex	01_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 1 FV 2
Subindex	02_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 1 FV 3
Subindex	03_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 1 FV 4
Subindex	04_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

AO Output Scaling 1 PV 6321_h

Name	AO Output Scaling 1 PV
Index	6321_h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00_h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04_h

Name	AO Output Scaling 1 PV 1
Subindex	01_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 1 PV 2
Subindex	02_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 1 PV 3
Subindex	03_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 1 PV 4
Subindex	04_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

AO Output Scaling 2 FV 6322_h

Name	AO Output Scaling 2 FV
Index	6322_h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00_h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04_h

Name	AO Output Scaling 2 FV 1
Subindex	01_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 2 FV 2
Subindex	02_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 2 FV 3
Subindex	03_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

Name	AO Output Scaling 2 FV 4
Subindex	04_h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000_h

AO Output Scaling 2 PV 6323h

Name	AO Output Scaling 2 PV
Index	6323h
Object Code	RECORD
No. of Elements	5

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AO Output Scaling 2 PV 1
Subindex	01h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AO Output Scaling 2 PV 2
Subindex	02h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AO Output Scaling 2 PV 3
Subindex	03h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

Name	AO Output Scaling 2 PV 4
Subindex	04h
Data type	REAL32
Access	read write
PDO Mapping	No
Default Value	00000000h

AO Output FV 6330h

Name	AO Output FV
Index	6330h
Object Code	ARRAY
No. of Elements	5
Data Type	REAL32

Name	Highest sub index supported
Subindex	00h
Data type	REAL32
Access	read only
PDO Mapping	No
Default Value	04h

Name	AO Output FV 1
Subindex	01h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AO Output FV 2
Subindex	02h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AO Output FV 3
Subindex	03h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AO Output FV 4
Subindex	04h
Data type	REAL32
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Analoge Eingangswerte als Real Messgröße

AI Input FV 7100h

Name	AI Input FV
Index	7100h
Object Code	ARRAY
No. of Elements	5
Data Type	INT16

Name	Highest sub index supported
Subindex	00h
Data type	INT16
Access	read only
PDO Mapping	No
Default Value	04h

Name	AI Input FV 1
Subindex	01h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input FV 2
Subindex	02h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input FV 3
Subindex	03h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AI Input FV 4
Subindex	04h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Analog input values as integer measured variable. When oversampling is active, the average value of the sampled process input values is displayed.

AO Output FV 7330h

Name	AO Output FV
Index	7330h
Object Code	ARRAY
No. of Elements	5
Data Type	INT16

Name	Highest sub index supported
Subindex	00h
Data type	INT16
Access	read only
PDO Mapping	No
Default Value	04h

Name	AO Output FV 1
Subindex	01h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AO Output FV 2
Subindex	02h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AO Output FV 3
Subindex	03h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AO Output FV 4
Subindex	04h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000h

Name	AO Output FV 2
Subindex	02_h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Name	AO Output FV 3
Subindex	03_h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Name	AO Output FV 4
Subindex	04_h
Data type	INT16
Access	read only
PDO Mapping	Yes, TX-PDO
Default Value	00000000_h

Analog output values as integer values

Technical data

Analog inputs

Analoge Eingänge 4
Resolution ..... 12 Bit
Start AD-Wandlung ..... DC-synchronous, SM-synchronous
Oversampling ..... 2..5
Intrinsic error ..... ±0,2%
Temperature error ..... ±0,005%/K
Internal resistance ..... < 300Ω
Cut-off frequency of input filter ..... < 100kHz

Spannung:
Measurement range ..... 0 … 10V
Settling time ..... 0→10V: ≤22µs at 2kΩ/<200pF
Measurement error ..... < ±0,5%, typical < ±0,4% of final value
Conversion time ..... 235µs (when all channels are active)

Strom:
Measurement range ..... 0…20mA, 4…20mA
Settling time ..... 0→16V: ≤25µs at 300Ω/<1mH
Measurement error ..... < ±0,5%, typical < ±0,4% of final value
Conversion time ..... 200µs (when all channels are active)

Analog Outputs

Analog Outputs 4
Resolution ..... 16 Bit
Output rate ..... SM-/DC-synchronous,
Intrinsic error ..... ±0,2%
Temperature error ..... ±0,005%/K
Destruction limit
against external stresses 15V

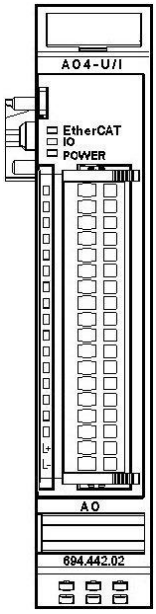
Voltage:
Output range ..... 0 … 10V, ± 10V
Short circuit protection ..... Ja
Short circuit current ..... max. 30mA
Load resistance ..... min. 1kΩ
Settling time ..... 0→10V: ≤22µs bei 2kΩ/<200pF

Current:
Output range ..... 0…20mA, 4…20mA, 0…24mA
Load resistance ..... max. 500Ω, max. 1mH (induktive)
Settling time ..... 0→16V: ≤25µs at 300Ω/<1mH

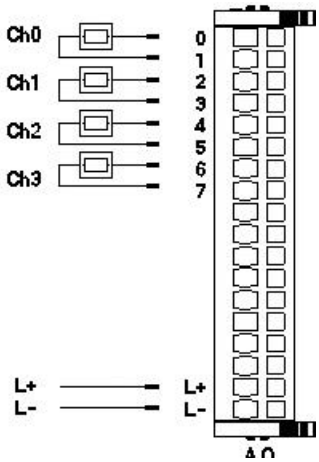
General information

Baud rate	100 Mbit/s
Controller	ASIC ET1200
E-bus connector	10-pole system plug in side wall
Terminating module	not required
IO/power connection	36-pin plug
Power supply	24 VDC -20% +25%
E-bus load	150 mA
Order-No.	694.444.65
Approvals:	c UL us LISTED 59DM E202287, EtherCAT Conformance tested

5.1.2 AO4-U/I - 12-Bit



Front view of AO4 I/O module



I/O connection

	+	-
Channel0	0	1
Channel1	2	3
Channel2	4	5
Kanal3	6	7

Terminals

Power supply to module I/Os

L+ 24 VDC

L- 0 V

	Information
	Module 694 442 02 Kuhnke FIO AO4 12-Bit is the successor module (see below for exception) compatible with module 694 442 02 Ventura FIO AO4 12-Bit. That is to say, the modules are interchangeable within the same FIO block without having to modify the device description in the EtherCAT master's control program.

Please note the following differences if you have a program including the old variant:

Ventura FIO AO4 12-Bit (old)	Kuhnke FIO AO4 12-Bit (new)
Current: 0…±20mA	Current: 0…+20mA To be able to use the current outputs, verify that variable "Channel_n_n+1_Unipolar" of these outputs is set to True. Refer to section Module Options
Short-circuit detectable	Short-circuit not detectable but outputs are short circuit-protected
Data type of output: UINT	Data type of output: INT Run the development environment and convert the data type from UINT to INT.

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 1x	Short circuit
	Red, 2x	Low voltage
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

LED "Power"

The LED labelled "Power" indicates the state of the I/O module's I/O power supply.

State	LED flash code	Explanation
On	Green, on	24 VDC supply ok
Off	Off	24 VDC supply not ok

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red, 1x	Short circuit
	Red, 3x	Wire failure
	Red, 5x	Excessive temp. of output drivers

Function

The AO4 module has 4 analogue outputs. Every channel can be separately set to the unipolar or bipolar output of voltages or currents.

Table "Analogue voltage/current values"

Measured value			Variable value				
±10	0 .. 10	0 .. 20	Bipolar [INT]		Unipolar *Data type conversion required		
V	V	mA	Decimal	Hexadecimal	Decimal [INT]	Decimal [UINT*]	Hexadecimal
-10			-32768	16#8000			
-9			-29492	16#8CCC			
-8			-26215	16#9999			
-7			-22938	16#A666			
-6			-19661	16#B333			
-5			-16384	16#C000			
-4			-13108	16#CCCC			
-3			-9831	16#D999			
-2			-6554	16#E666			
-1			-3292	16#F324			
0			0	0	0	0	0
1	1	2	3276	16#0CCC	6553	6553	16#1999
2	2	4	6553	16#1999	13107	13107	16#3332
3	3	6	9830	16#2666	19660	19660	16#4CCC
4	4	8	13106	16#3332	26214	26214	16#6665
5	5	10	16383	16#3FFF	32767	32767	16#7FFF
6	6	12	19660	16#4CCC	-26216	39320	16#9998
7	7	14	22936	16#5998	-19662	45874	16#B332
8	8	16	26213	16#6665	-13109	52427	16#CCCB
9	9	18	29490	16#7332	-6555	58981	16#E665
10	10	20	32767	16#7FFF	-2	65534	16#FFFE

Analogue Outputs

Write the output values into the following variables:

Variable	Data type	Explanation
Channel_n	INT	Output value of channel n (n=0…3).

Module Control

The module provides you with various operational options.

To set up the module choose the options as appropriate and accept by setting control bit "SetOptions" to a rising edge.

The module will confirm by returning "OptionsSet".

There are various "module error" bits that the module uses to indicate errors. The states of the error bits are retained and also used for error indication by the "IO" LED.

To reset the error bits set control bit "ResetError" to a rising edge.

Variable	Data type	Explanation
SetOptions	BOOL	Rising edge → accepts module options
ResetError	BOOL	Rising edge → acknowledges error

Module Options

The following options are available for module AO4:

Variable	Data type	Explanation	
Channel_n_On	BOOL	Enables channel n. (set to high impedance to disable)	
Channel_n_Current	BOOL	Sets channel n to current output mode	
Channel_n_n+1_Unipolar	BOOL	Channels 0 & 1 or 2 & 3 in unipolar mode	
Outputs_Active_Shortcut	BOOL	Leave outputs unchanged after short circuit	
Outputs_Active_Undervoltage	BOOL	Leave outputs unchanged after low voltage	
Outputs_Active_Specific_Error	BOOL	Leave outputs unchanged after module-specific error (see 0)	
Outputs_Active_EtherCAT_Error	BOOL	Leave outputs unchanged after short circuit	
n		0 … 3	Channel number

To set and accept options, see section Module Control.

Module State

The following module states are indicated:

Variable	Data type	Explanation
Shortcut	BOOL	Short circuit (not used)
Undervoltage	BOOL	Low voltage (supplied power < 19.2V)
Watchdog	BOOL	Internal watchdog of module
EtherCAT_Error	BOOL	Configuration error or watchdog control
Specific_Error	BOOL	Module-specific fault
OptionsSet	BOOL	Sent by module to acknowledge SetOptions

To reset the messages, see section Module Control.

Module-specific Messages

Apart from the module state, there is a set of messages containing details about the current state of the module:

Variable	Data type	Explanation
Channel_n_Overtemp	BOOL	Short circuit in output driver of channel n, i.e. the temperature is > 140 °C (automatic switch-off) (see Module Options, Outputs_Active_Shortcut)
Undervoltage_24	BOOL	Less than 19.2 V supplied to the module (see Module Options, Outputs_Active_Undervoltage)
Channel_n_Open	BOOL	Current mode: channel n load is gt 500Ω Specific_Error=TRUE
Channel_n_Shortcut	BOOL	Voltage mode: channel n load is lt 600Ω Specific_Error=TRUE

These messages are automatically reset when the state concerned has returned to normal.
Messages Channel_n_Open and Channel_n_Shortcut are combined into a single "Specific_Error" state of the module and output to the IO LED as "module-specific error".

Conversion Time

The AO4 module's cycle time (time from importing the output values till starting the DA converters) is 320 µs, irrespective of the number of active channels.

Technical Data

Analogue outputs	4
Resolution	12 bit
Output frequency	Free run
Intrinsic error	±0.2%
Temperature error	±0.005%/K
Destruction limit (external voltages)	15V

Voltage:

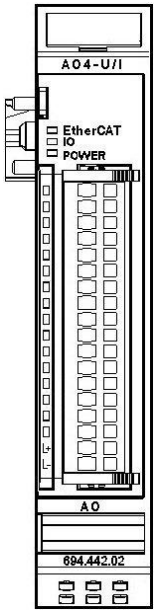
Measuring range	0 … 10V, ± 10V
Short circuit protection	Yes
Short circuit current	max. 30mA
Load resistance	min. 1kΩ
Settling time	0→10V: ≤22µs at 2kΩ/<200pF

Current:

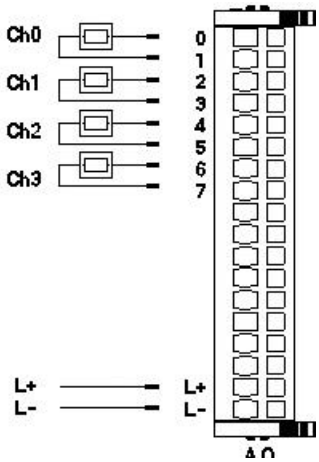
Measuring range	0…20mA
Load resistance	max. 500Ω, max. 1mH (inductive)
Settling time	0→16V: ≤25µs at 300Ω/<1mH

Baud rate	100 Mbit/s
Controller	ASIC ET1200
E-bus connector	10-pole system plug in side wall
Terminating module	not required
IO/power connection	18-pin plug
Power supply	24 VDC -20% +25%
E-bus load	150 mA
Part no.	694.442.02 12-bit
Approval:	c UL us LISTED 59DM E202287, EtherCAT Conformance tested

5.1.3 AO4-U/I - 16-Bit CoE



Front view of AO4 I/O module



I/O connection

	+	-
Channel0	0	1
Channel1	2	3
Channel2	4	5
Channel3	6	7

Terminals

Power supply to module I/Os

L+ 24 VDC

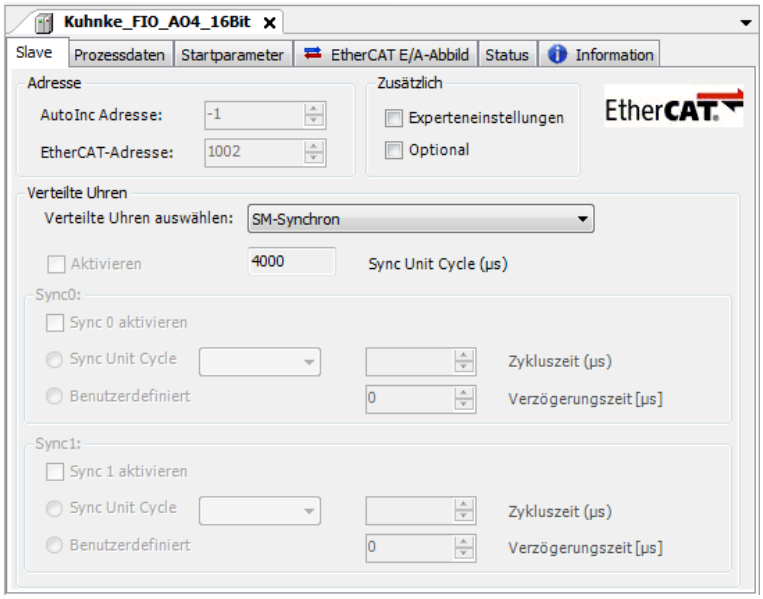
L- 0 V

	Information
	Module 694 442 52 Kuhnke FIO AO4 16-Bit is the successor module NOT compatible with module 694 442 02 Ventura FIO AO4 12-Bit. *The module complies with ETG guidelines.* *Before replacing a Ventura/Kuhnke FIO AO4 12-Bit module (694 442 02) with a Kuhnke FIO AO4 16-Bit module (694 442 52), you must modify the EtherCAT master's control program.*

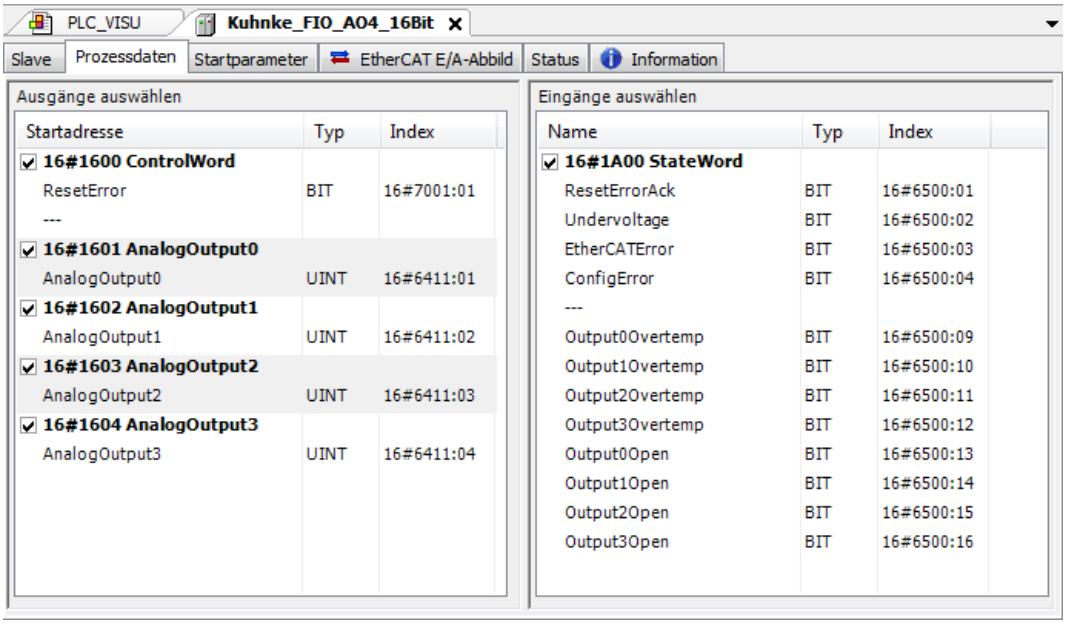
Please note the following differences:

Ventura FIO AO4 12-Bit (old)	Kuhnke FIO AO4 16-Bit (new)
Current: 0…±20mA	Current: 0…+20mA
Short-circuit detectable	Short-circuit not detectable but outputs are short circuit-protected
Output not synchronised with EtherCAT	Output synchronised with SM or DC

Output of the analogue values can be synchronised with DC (Distributed Clocks) or SM (Sync Manager).



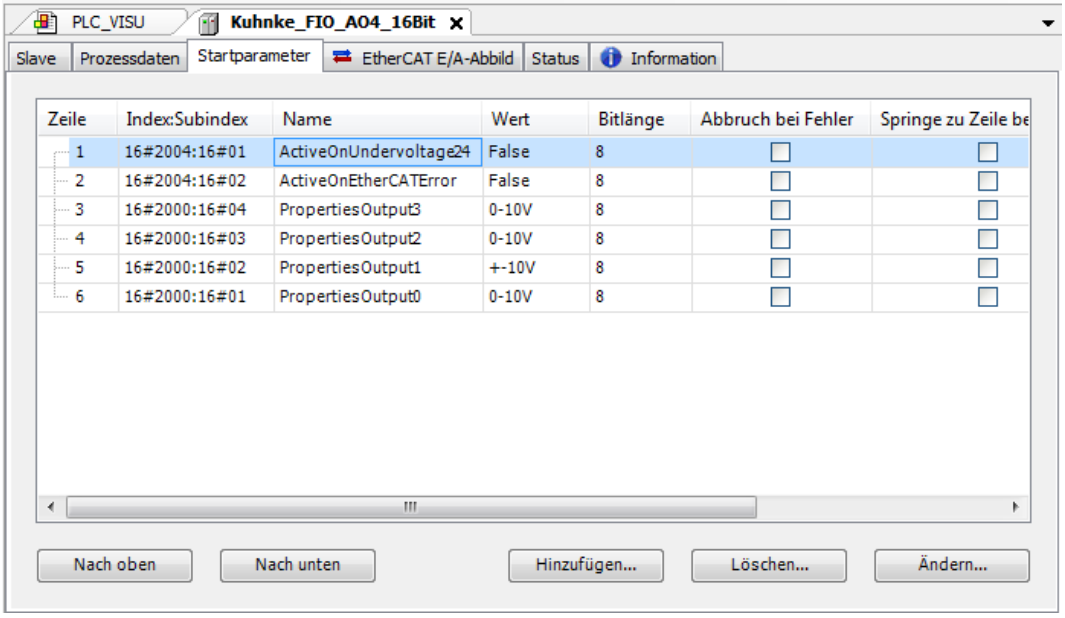
The process data objects stored as variables in the EtherCAT master's control program are used to access the output values and the module state.



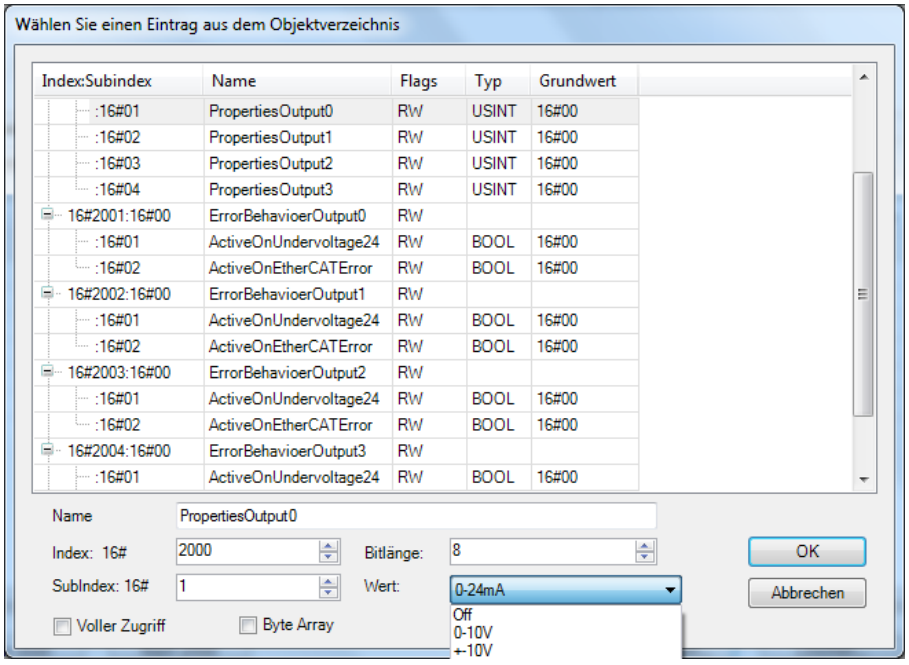
Service data objects (SDO) are available for details and settings.

You may run the configuration tool offline to change some settings of module AO4 16-Bit (such as the properties of each of the outputs). The EtherCAT master will apply the settings when starting up the module.

You can also use the SDO transfer components available for the EtherCAT master to change settings at runtime.



Click/tap on "Add…", choose an object, and set the appropriate value.



Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 1x	Short circuit
	Red, 2x	Low voltage
	Red, 4x	EtherCAT watchdog control
	Red, 6x	Module-specific fault
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

LED "Power"

The LED labelled "Power" indicates the state of the I/O module's I/O power supply.

State	LED flash code	Explanation
On	Green, on	24 VDC supply ok
Off	Off	24 VDC supply not ok

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red, 1x	Short circuit
	Red, 3x	Wire failure
	Red, 5x	Excessive temp. of output drivers

Function

The AO4 module has 4 analogue outputs. Every channel can be separately set to the unipolar or bipolar output of voltages or currents.

To output voltage or current readings (measured values) to the analogue outputs, verify that the associated output variables contain these values in the 2-byte two's complement format. The letter 'n' in the tables below represents the channel number (n=0…3).

Table "Analogue voltage/current values"

Measured value				Variable value (@ 16 bits)			
±10 / 10	0..20	4..20	0..24	Bipolar [UINT]		Unipolar [UINT]	
Volt	mA	mA	mA	Decimal	Hexadecimal	Decimal	Hexadecimal
-10				32768	16#8000		
-9				36044	16#8CCC		
-8				39321	16#9999		
-7				42598	16#A666		
-6				45875	16#B333		
-5				49152	16#C000		
-4				52428	16#CCCC		
-3				55705	16#D999		
-2				58982	16#E666		
-1				62244	16#F324		
0	0	4	0	0	0	0	0
1	2	5.6	2.4	3276	16#0CCC	6553	16#1999
2	4	7.2	4.8	6553	16#1999	13107	16#3332
3	6	8.8	7.2	9830	16#2666	19660	16#4CCC
4	8	10.4	9.6	13106	16#3332	26214	16#6665
5	10	12.0	12.0	16383	16#3FFF	32767	16#7FFF
6	12	13.6	14.4	19660	16#4CCC	39320	16#9998
7	14	15.2	16.8	22936	16#5998	45874	16#B332
8	16	16.8	19.2	26213	16#6665	52427	16#CCCB
9	18	18.4	21.6	29490	16#7332	58981	16#E665
10	20	20.0	24.0	32767	16#7FFF	65534	16#FFFE

StateWord

The state word is indicative of the module state:

Bit	Name	Explanation
0	ResetErrorAck	Acknowledges "Reset Error" in Module Control
1	Undervoltage24	24V supply low
2	EtherCATError	Sync Manager Watchdog
3	ConfigError	Mismatch of Sync Manager's quantity structure
4	-	
5	-	
6	-	
7	-	
8	Output 0 Overtemp	Over-temperature detected by output driver (automatic switch-off)
9	Output 1 Overtemp	Over-temperature detected by output driver (automatic switch-off)
10	Output 2 Overtemp	Over-temperature detected by output driver (automatic switch-off)
11	Output 3 Overtemp	Over-temperature detected by output driver (automatic switch-off)
12	Output 0 Open	If there is no current in Current mode
13	Output 1 Open	If there is no current in Current mode

Bit	Name	Explanation
14	Output 2 Open	If there is no current in Current mode
15	Output 3 Open	If there is no current in Current mode

Analogue Outputs

Write the output values into the following variables:

Variable	Data type	Explanation
AnalogOutputn	UINT	Output value of channel n (n=0…3).

ControlWord

The control word contains a bit for acknowledging errors.

Bit	Name	Explanation
0	ResetError	0 -> errors are retained, 1 -> errors cleared after removing their cause
1-15	-	not used

Object Dictionary

Index	Name	Type	Default	Min Max	Access
1000	Device Type	UINT32	0xF0191		RO
1001	Error Register	UINT8			RO
1008	Device Name	String			RO
1009	Hardware Version	String	1.00		RO
100A	Software Version	String	1.00		RO
1018	Identity Object	ARRAY			
1018, 0	Number of Entries	UINT8	4		RO
1018, 1	Vendor Id	UINT32	0x0048554B		RO
1018, 2	Product Code	UINT32			RO
1018, 3	Revision Number	UINT32	2		RO
1018, 4	Serial Number	UINT32	0		RO
2000	Analogue Output Properties	Array			
2000, 0	Number of Entries	UINT8	4		RO
2000, 1	Properties Output 0	UINT8	0-10V	Off (0), 0-10V (1), +-10V (3), 0-20mA (6), 4-20mA (5), 0-24mA (7)	RW
2000, 2	Properties Output 1	UINT8	0-10V	Off, 0-10V, +-10V, 0-20mA, 4-20mA, 0-24mA	RW
2000, 3	Properties Output 2	UINT8	0-10V	Off, 0-10V, +-10V, 0-20mA, 4-20mA, 0-24mA	RW

Index	Name	Type	Default	Min Max	Access
2000, 4	Properties Output 3	UINT8	0-10V	Off, 0-10V, +-10V, 0-20mA, 4-20mA, 0-24mA	RW
2001	ErrorBehavior Output 0	Array			
2001, 0	Number of Entries	UINT8	2		RO
2001, 1	Active on Undervoltage 24	BOOL	FALSE		RW
2001, 1	Active on EtherCAT Watchdog Error	BOOL	FALSE		RW
2002	ErrorBehavior Output 1	Array			
2002, 0	Number of Entries	UINT8	2		RO
2002, 1	Active on Undervoltage 24	BOOL	FALSE		RW
2002, 1	Active on EtherCAT Watchdog Error	BOOL	FALSE		RW
2003	ErrorBehavior Output 2	Array			
2003, 0	Number of Entries	UINT8	2		RO
2003, 1	Active on Undervoltage 24	BOOL	FALSE		RW
2003, 1	Active on EtherCAT Watchdog Error	BOOL	FALSE		RW
2004	ErrorBehavior Output 3	Array			
2004, 0	Number of Entries	UINT8	2		RO
2004, 1	Active on Undervoltage 24	BOOL	FALSE		RW
2004, 1	Active on EtherCAT Watchdog Error	BOOL	FALSE		RW
6411	Analogue Outputs	Array			
6411, 0	Number of Entries	UINT8	4		RO
6411, 1	Analogue Output 0	UINT16			RW P
6411, 2	Analogue Output 1	UINT16			RW P
6411, 3	Analogue Output 2	UINT16			RW P
6411, 4	Analogue Output 3	UINT16			RW P
6500	State Word	Array			
6500, 0	Number of Entries	UINT8	16		RO
6500, 1	Reset Error Ack	BOOL			RO P
6500, 2	Undervoltage24	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
6500, 5	-	BOOL			RO P
6500, 6	-	BOOL			RO P
6500, 7	-	BOOL			RO P
6500, 8	-	BOOL			RO P
6500, 9	Output 0 Overtemp	BOOL			RO P
6500, 10	Output 1 Overtemp	BOOL			RO P
6500, 11	Output 2 Overtemp	BOOL			RO P
6500, 12	Output 3 Overtemp	BOOL			RO P
6500, 13	Output 0 Open	BOOL			RO P
6500, 14	Output 1 Open	BOOL			RO P
6500, 15	Output 2 Open	BOOL			RO P
6500, 16	Output 3 Open	BOOL			RO P
7001	Control Word	Array			

Index	Name	Type	Default	Min Max	Access
7001, 0	Number of Entries	UINT8	1		RO
7001, 1	Reset Error	BOOL			RW P

RO=read-only, RW= read/write, P=process image

Technical Data

Analogue outputs 4
Resolution ..... 16 bit
Output frequency ..... Synchronised with SM/DC
Intrinsic error ..... ±0.2%
Temperature error ..... ±0.005%/K
Destruction limit
(external voltages) 15V

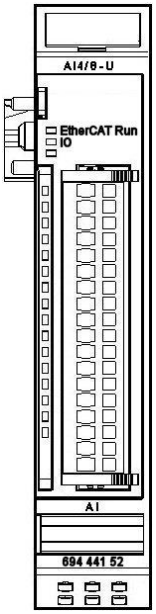
Voltage:
Measuring range ..... 0 … 10V, ± 10V
Short circuit protection ..... Yes
Short circuit current ..... max. 30mA
Load resistance ..... min. 1kΩ
Settling time ..... 0→10V: ≤22µs at 2kΩ/<200pF

Current:
Measuring range ..... 0…20mA, 4…20mA, 0…24mA
Load resistance ..... max. 500Ω, max. 1mH (inductive)
Settling time ..... 0→16V: ≤25µs at 300Ω/<1mH

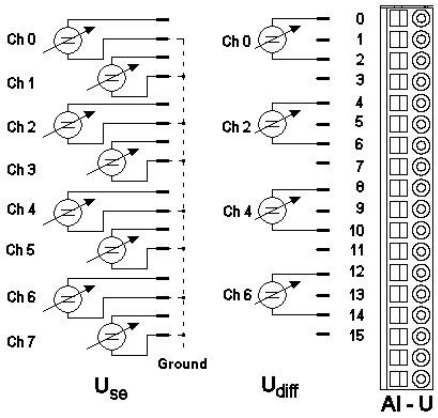
Baud rate ..... 100 Mbit/s
Controller ..... ASIC ET1200
E-bus connector ..... 10-pole system plug in side wall
Terminating module ..... not required
IO/power connection ..... 18-pin plug
Power supply ..... 24 VDC -20% +25%
E-bus load ..... 150 mA
Part no. ..... 694.442.52 16-Bit (CoE)

Approval: ..... c UL us LISTED 59DM E202287 EtherCAT Conformance tested

5.1.4 AI4/8-U



Front view of AI4/8-U I/O module



I/O connection

Terminals

The module needs no separate 24V connector. Power is supplied to the module through the E-bus connector.

Operative earth / shielding of analogue wires → section 0

	Information
	Module 694 441 52 Kuhnke FIO AI4 8-U is the successor module NOT compatible with module 694 441 02 Ventura FIO AI4 8-U. *The module complies with ETG guidelines.* *Before replacing a Ventura/Kuhnke FIO AI4 8-U module (694 441 02) with a Kuhnke FIO AI4 8-U module (694 441 52), you must modify the EtherCAT master's control program.*

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 7x	Configuration error (E-bus pre-operational), no. of

State	LED flash code	Explanation
		process data differs from that in the module
Defective	Red, on	Module defective

LED "Power"

There is no LED labelled "Power" because a separate power feed is not required.

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled

Function

The AI4/8-U module has 8 analogue inputs. If signal lines are single-ended (measured against earth, L-), 8 channels are available. To measure differential signals, you will need 2 channels for every signal, i.e. you can pick up no more than 4 differential signals. Channels can be combined as follows: 0/1, 2/3, 4/5 and 6/7.

Measured Value

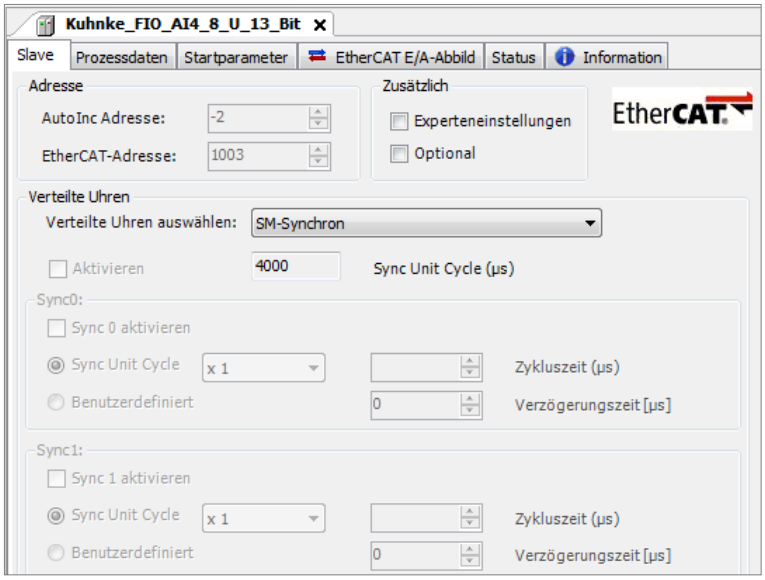
Table "Analogue voltage values"

Measured value			Variable value (@ 16 bits)			
±10 V	±5 V	±2,5 V	Bipolar		Unipolar [UINT*] *Data type conversion required	
Volt	Volt	Volt	Decimal	Hexadecimal	Decimal	Hexadecimal
-10	-5	-2.5	-32768	16#8000		
-9	-4.5	-2.25	-29492	16#8CCC		
-8	-4	-2	-26215	16#9999		
-7	-3.5	-1.75	-22938	16#A666		
-6	-3	-1.5	-19661	16#B333		
-5	-2.5	-1.25	-16384	16#C000		
-4	-2	-1	-13108	16#CCCC		
-3	-1.5	-0.75	-9831	16#D999		
-2	-1	-0.5	-6574	16#E666		
-1	-0.5	-0.25	-3292	16#F324		
0	0	0	0	0	0	0
1	0.5	0.25	3276	16#0CCC	6553	16#1999
2	1	0.5	6553	16#1999	13107	16#3332
3	1.5	0.75	9830	16#2666	19660	16#4CCC
4	2	1	13106	16#3332	26214	16#6665
5	2.5	1.25	16383	16#3FFF	32767	16#7FFF
6	3	1.5	19660	16#4CCC	39320	16#9998
7	3.5	1.75	22936	16#5998	45874	16#B332
8	4	2	26213	16#6665	52427	16#CCCB
9	4.5	2.25	29490	16#7332	58981	16#E665
10	5	2.5	32767	16#7FFF	65534	16#FFFE

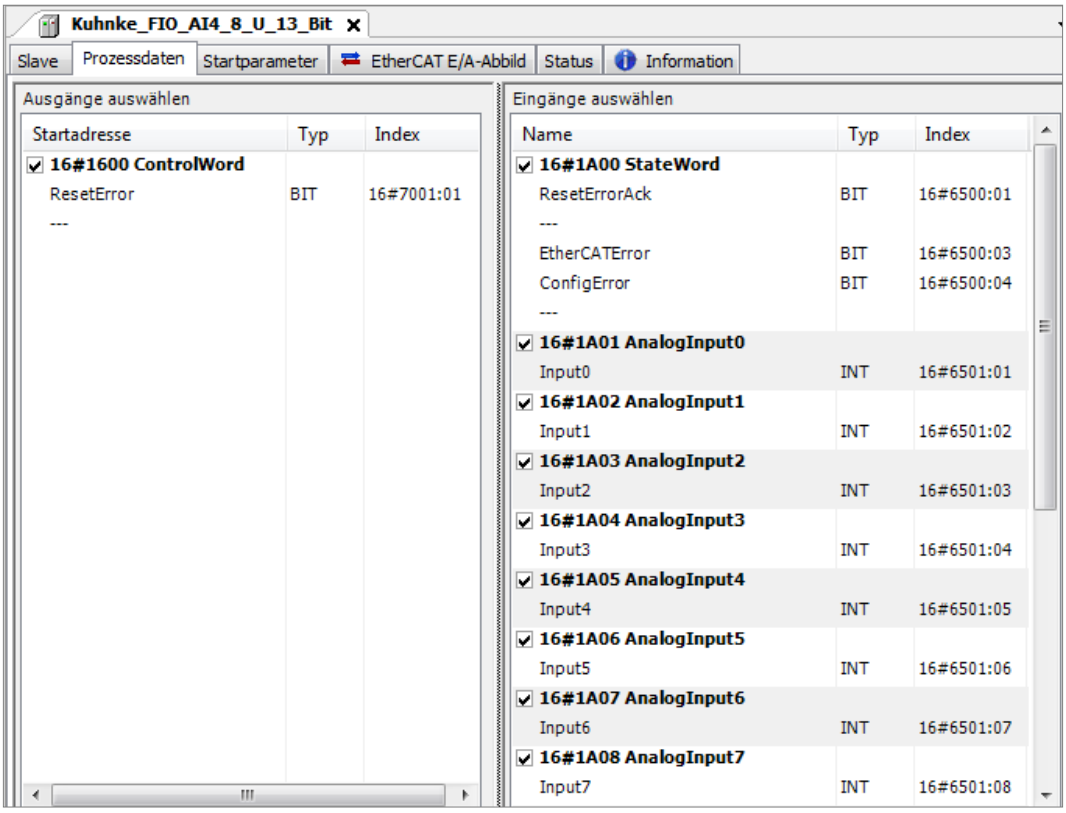
	Information
	If the inputs are not used but switched on, the measured values displayed in the I / O image are floated. To prevent this, you should deactivate the measurement channel at the start parameters or set the input to ground (short-circuit when measuring differential signals).

To Set up the Options

Conversion of the analogue values can be synchronised with DC (Distributed Clocks) or SM (Sync Manager).



The process data objects stored as variables in the EtherCAT master's control program are used to access the input values and the module state.

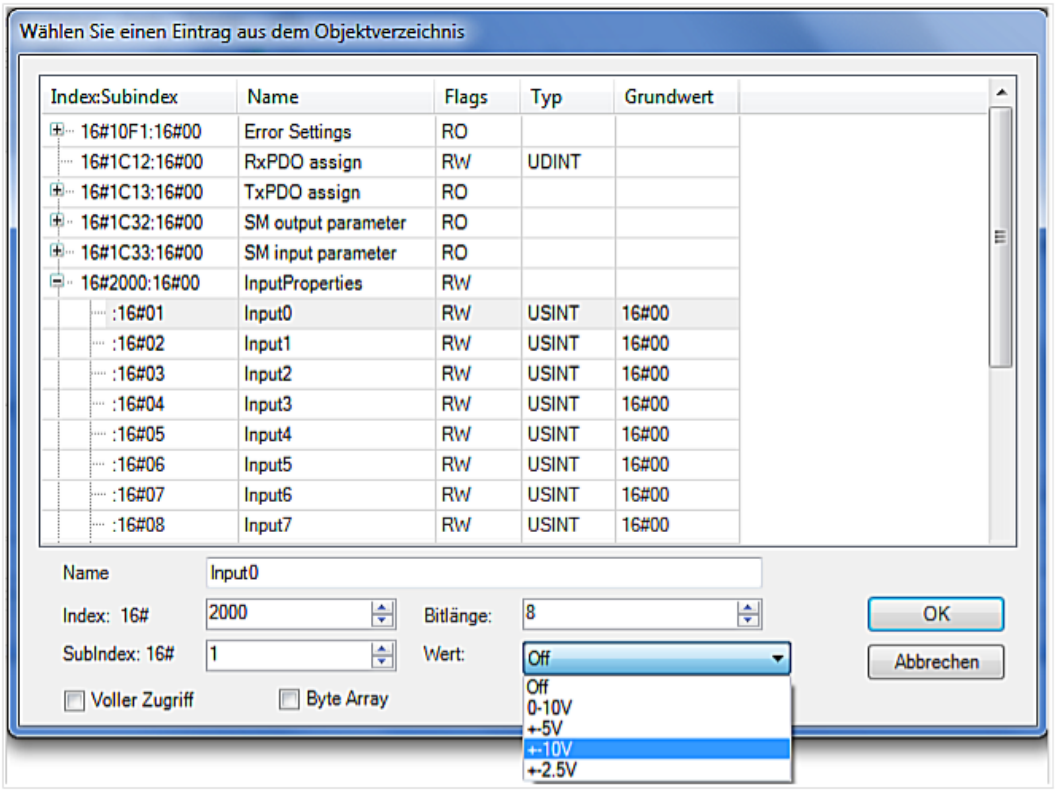


Service data objects (SDO) are available for details and settings.

You may run the configuration tool offline and choose the "Startup Parameters" to change some settings of module AI4/8U 16-Bit (such as the properties of each of the inputs). The EtherCAT master will apply the settings when starting up the module.

You can also use the SDO transfer components available for the EtherCAT master to change settings at runtime.

Click/tap on "Add…", choose an object, and set the appropriate value.



Options

You can set up the following options:

Name	Value	Explanation
InputProperties	0	Off (default)
	1	0-10V
	2	±5 V
	3	±10 V
	4	±2,5 V
InputSwitch	0	Single-Ended (default)
	1	Differential
Average	n=1..255	Inputn= average after n cycles (default=1)

StateWord

The state word is indicative of the module state:

Bit	Name	Explanation
0	ResetErrorAck	Acknowledges "Reset Error" in Module Control
1		not used
2	EtherCATError	Sync Manager Watchdog

3	ConfigError	Mismatch of Sync Manager's quantity structure
4-15		not used

Analogue Inputs

Check the following variables for the digitised input values:

Variable	Data type	Explanation
Inputn	INT	Value of channel n (n=0…7).

ControlWord

The control word contains a bit for acknowledging errors.

Bit	Name	Explanation
0	ResetError	0 -> errors are retained, 1 -> errors cleared after removing their cause
1-15	-	not used

Object Dictionary

Index	Name	Type	Default	Min Max	Access
1000	Device Type	UINT32	0x40191		RO
1001	Error Register	UINT8			RO
1008	Device Name	String	AI4/8-U 13-Bit		RO
1009	Hardware Version	String	1.00		RO
100A	Software Version	String	1.00		RO
1018	Identity Object	Array			
1018, 0	Number of Entries	UINT8	4		RO
1018, 1	Vendor Id	UINT32	0x0048554B		RO
1018, 2	Product Code	UINT32	185340		RO
1018, 3	Revision Number	UINT32	2		RO
1018, 4	Serial Number	UINT32	0		RO
2000	Analog Input Properties	Array			
2000, 0	Number of Entries	UINT8	8		RO
2000, 1	Input 0	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 2	Input 1	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 3	Input 2	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 4	Input 3	UINT8	Off	Off (0), 0-10V (1),	RW

Index	Name	Type	Default	Min Max	Access
				+-5V (2) +-10V (3) +-2.5V (4)	
2000, 5	Input 4	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 6	Input 5	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 7	Input 6	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 8	Input 7	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2001	Input Switch	Array			
2001, 0	Number of Entries	UINT8	4		RO
2001, 1	Input 0_1 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 2	Input 2_3 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 3	Input 4_5 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 4	Input 6_7 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2003	Input Filter	Array			
2003, 0	Number of Entries	UINT8	8		RO
2003, 1	Input 0 Average	UINT8	1	1..255	RW
2003, 2	Input 1 Average	UINT8	1	1..255	RW
2003, 3	Input 2 Average	UINT8	1	1..255	RW
2003, 4	Input 3 Average	UINT8	1	1..255	RW
2003, 5	Input 4 Average	UINT8	1	1..255	RW
2003, 6	Input 5 Average	UINT8	1	1..255	RW
2003, 7	Input 6 Average	UINT8	1	1..255	RW
2003, 8	Input 7 Average	UINT8	1	1..255	RW
6401	Analogue input	Array			
6401, 0	Number of Entries	UINT8	8		RO
6401, 1	Analog Input 0	UINT16			RO P
6401, 2	Analog Input 1	UINT16			RO P
6401, 3	Analog Input 2	UINT16			RO P

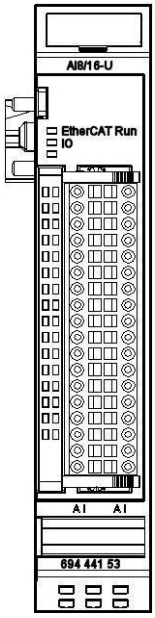
Index	Name	Type	Default	Min Max	Access
6401, 4	Analog Input 3	UINT16			RO P
6401, 5	Analog Input 4	UINT16			RO P
6401, 6	Analog Input 5	UINT16			RO P
6401, 7	Analog Input 6	UINT16			RO P
6401, 8	Analog Input 7	UINT16			RO P
6500	StateWord	Array			
6500, 0	Number of Entries	UINT8	16		RO
6500, 1	ResetErrorAck	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
7001	Module Control	Array			
7001, 0	Number of Entries	UINT8	1		RO
7001, 1	Reset Error	BOOL			RW P

RO=read-only, RW= read/write, P=process image

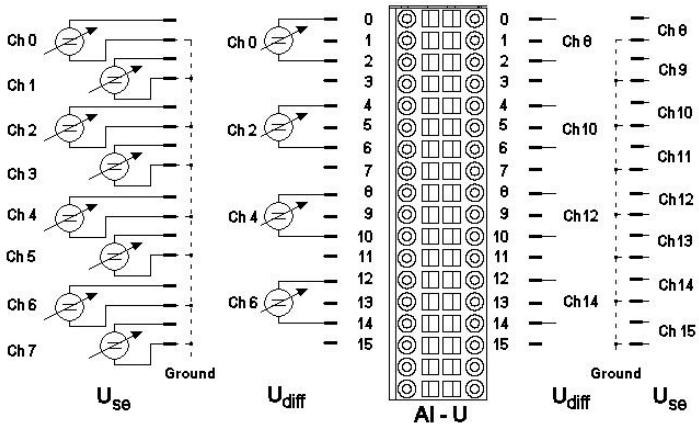
Technical Data

Analogue inputs	8 single-ended or 4 differential
Measuring range	0 …10V, ± 5V, ± 10V, ± 2,5V
Resolution	13 bit
Start AD conversion	synchronised with DC / SM
Conversion time	464 µs (if all channels are active)
Internal resistance	> 1MΩ
Input filter cutoff frequency	typ. 1kHz
Measuring error	< ±0.4%, typ. < ±0.2% of final value
Baud rate	100 Mbit/s
Controller	ASIC ET1200
E-bus connector	10-pole system plug in side wall
Terminating module	not required
IO/power connection	18-pin plug
Power supply	24 VDC -20% +25%
E-bus load	190 mA
Part no.	694.441.52 13-Bit (CoE)
Approval:	c UL us LISTED 59DM E202287, EtherCAT Conformance tested

5.1.5 AI8/16-U



Front view of AI8/16-U I/O module



I/O connection

Terminals

The module needs no separate 24V connector. Power is supplied to the module through the E-bus connector.

Operative earth / shielding of analogue wires → section 0

	Information
	Module 694 441 53 Kuhnke FIO AI8/16-U is the successor module NOT compatible with module 694 441 03 Ventura FIO AI8/16-U. *The module complies with ETG guidelines.* *Before replacing a Ventura/Kuhnke FIO AI8/16-U module (694 441 03) with a Kuhnke FIO AI8/16-U module (694 441 53), you must modify the EtherCAT master's control program.*

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off

State	LED flash code	Explanation
	Red, 4x	EtherCAT watchdog control
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

LED "Power"

There is no LED labelled "Power" because a separate power feed is not required.

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled

Function

The AI8/16-U module has 16 analogue inputs. If signal lines are single-ended (measured against earth, L-), 16 channels are available. To measure differential signals, you will need 2 channels for every signal, i.e. you can pick up no more than 8 differential signals. Channels can be combined as follows: 0/1, 2/3, 4/5, 6/7, 8/9, 10/11, 12/13 and 14/15.

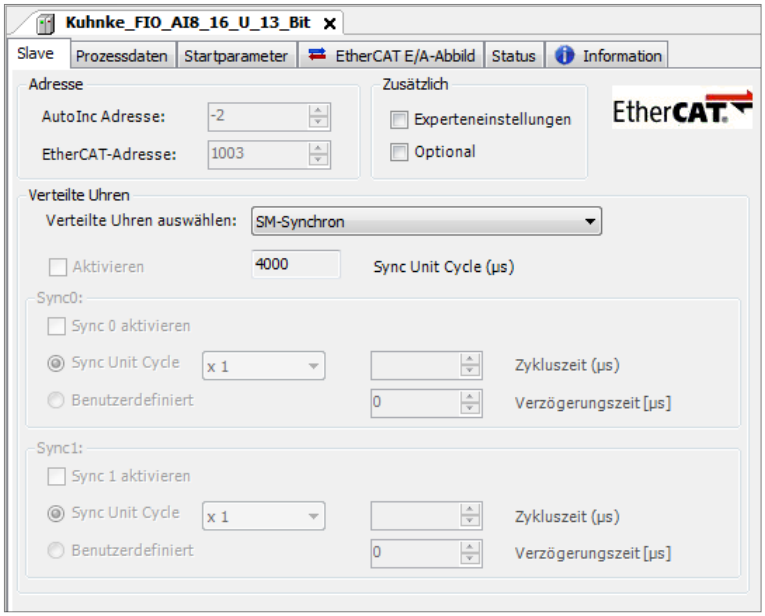
Table of measured values:

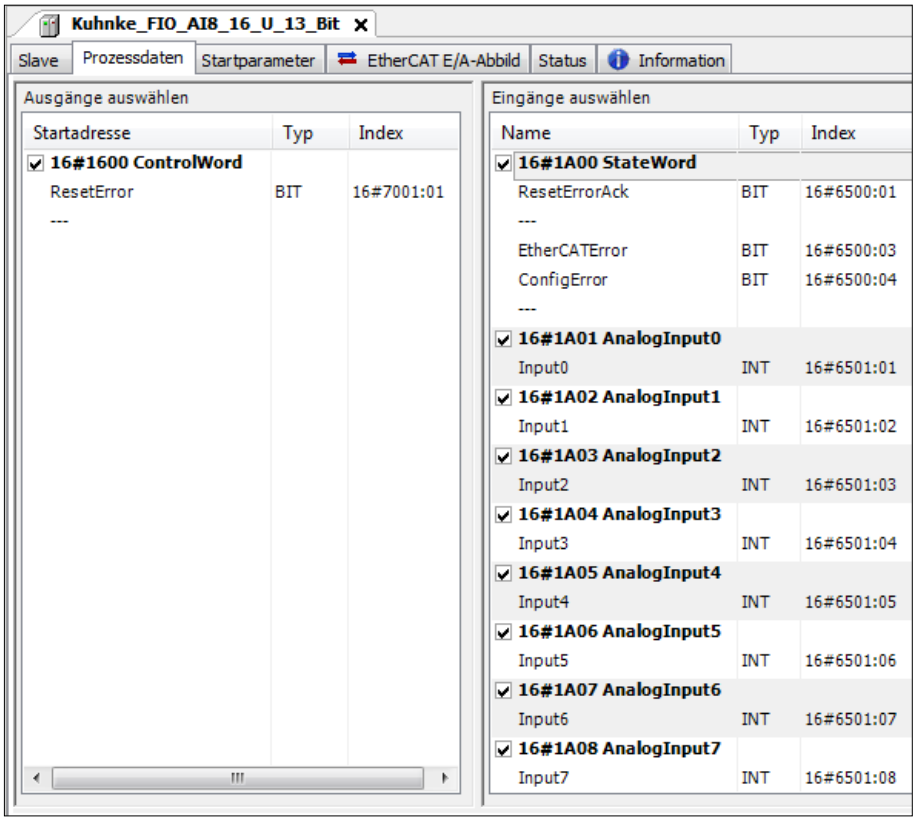
Measured value			Variable value (@ 16 bits)			
±10 V	±5 V	±2,5 V	Bipolar		Unipolar [UINT*] *Data type conversion required	
Volt	Volt	Volt	Decimal	Hexadecimal	Decimal	Hexadecimal
-10	-5	-2.5	-32768	16#8000		
-9	-4.5	-2.25	-29492	16#8CCC		
-8	-4	-2	-26215	16#9999		
-7	-3.5	-1.75	-22938	16#A666		
-6	-3	-1.5	-19661	16#B333		
-5	-2.5	-1.25	-16384	16#C000		
-4	-2	-1	-13108	16#CCCC		
-3	-1.5	-0.75	-9831	16#D999		
-2	-1	-0.5	-6574	16#E666		
-1	-0.5	-0.25	-3292	16#F324		
0	0	0	0	0	0	0
1	0.5	0.25	3276	16#0CCC	6553	16#1999
2	1	0.5	6553	16#1999	13107	16#3332
3	1.5	0.75	9830	16#2666	19660	16#4CCC
4	2	1	13106	16#3332	26214	16#6665
5	2.5	1.25	16383	16#3FFF	32767	16#7FFF
6	3	1.5	19660	16#4CCC	39320	16#9998
7	3.5	1.75	22936	16#5998	45874	16#B332
8	4	2	26213	16#6665	52427	16#CCCB
9	4.5	2.25	29490	16#7332	58981	16#E665
10	5	2.5	32767	16#7FFF	65534	16#FFFE

	Information
	If the inputs are not used but switched on, the measured values displayed in the I / O image are floated. To prevent this, you should deactivate the measurement channel at the start parameters or set the input to ground (short-circuit when measuring differential signals).

To Set up the Options

Conversion of the analogue values can be synchronised with DC (Distributed Clocks) or SM (Sync Manager).





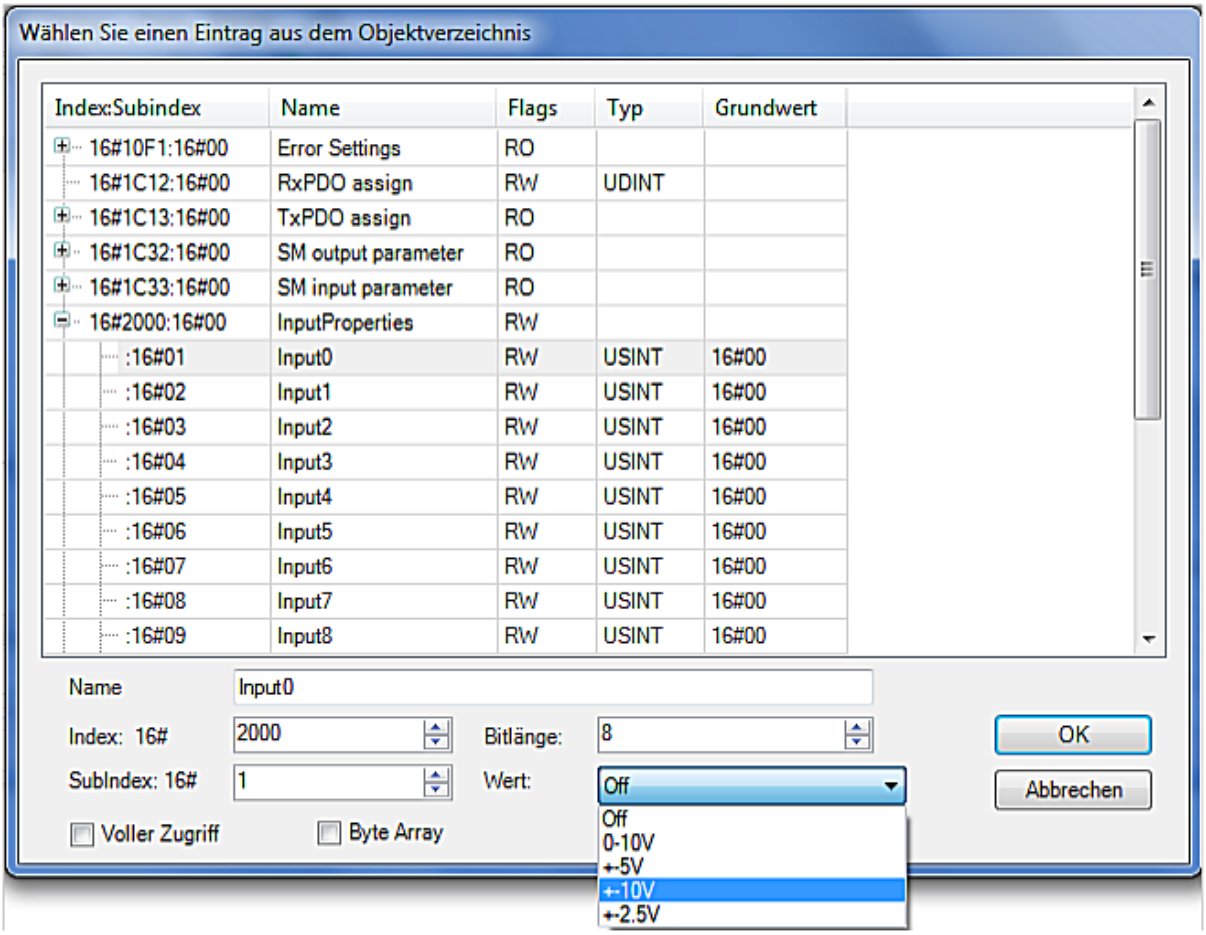
The process data objects stored as variables in the EtherCAT master's control program are used to access the input values and the module state.

Service data objects (SDO) are available for details and settings.

You may run the configuration tool offline and choose the "Startup Parameters" to change some settings of module AI4/8U 16-Bit (such as the properties of each of the inputs). The EtherCAT master will apply the settings when starting up the module.

You can also use the SDO transfer components available for the EtherCAT master to change settings at runtime.

Click/tap on "Add…", choose an object, and set the appropriate value.



Options

You can set up the following options for every channel:

Name	Value	Explanation
InputProperties	0	Off (default)
	1	0-10V
	2	±5 V
	3	±10 V
	4	±2,5 V
InputSwitch	0	Single-Ended (default)
	1	Differential
Average	n=1..255	Inputn= average after n cycles (default=1)

StateWord

The state word is indicative of the module state:

Bit	Name	Explanation
0	ResetErrorAck	Acknowledges "Reset Error" in Module Control
1		not used
2	EtherCATError	Sync Manager Watchdog
3	ConfigError	Mismatch of Sync Manager's quantity structure
4-15		not used

Analogue Inputs

Check the following variables for the digitised input values:

Variable	Data type	Explanation
Inputn	INT	Value of channel n (n=0…15).

ControlWord

The control word contains a bit for acknowledging errors.

Bit	Name	Explanation
0	ResetError	0 -> errors are retained, 1 -> errors cleared after removing their cause
1-15	-	not used

Object Dictionary

Index	Name	Type	Default	Min Max	Access
1000	Device Type	UINT32	0x40191		RO
1001	Error Register	UINT8			RO
1008	Device Name	String	AI4/8-U 13-Bit		RO
1009	Hardware Version	String	1.00		RO
100A	Software Version	String	1.00		RO
1018	Identity Object	Array			
1018, 0	Number of Entries	UINT8	4		RO
1018, 1	Vendor Id	UINT32	0x0048554B		RO
1018, 2	Product Code	UINT32	185341		RO
1018, 3	Revision Number	UINT32	2		RO
1018, 4	Serial Number	UINT32	0		RO
2000	Analog Input Properties	Array			
2000, 0	Number of Entries	UINT8	16		RO
2000, 1	Input 0	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 2	Input 1	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 3	Input 2	UINT8	Off	Off (0), 0-10V (1),	RW

Index	Name	Type	Default	Min Max	Access
				+-5V (2) +-10V (3) +-2.5V (4)	
2000, 4	Input 3	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 5	Input 4	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 6	Input 5	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 7	Input 6	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 8	Input 7	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 9	Input 8	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 10	Input 9	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 11	Input 10	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 12	Input 11	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW

Index	Name	Type	Default	Min Max	Access
2000, 13	Input 12	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 14	Input 13	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 15	Input 14	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2000, 16	Input 15	UINT8	Off	Off (0), 0-10V (1), +-5V (2) +-10V (3) +-2.5V (4)	RW
2001	Number of Entries	UINT8	8		RO
2001, 1	Input 0_1 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 2	Input 2_3 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 3	Input 4_5 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 4	Input 6_7 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 5	Input 8_9 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 6	Input 10_11 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 7	Input 12_13 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2001, 8	Input 14_15 Switch	UINT8	Single-ended	Single-ended (0) Differential (1)	RW
2003	Input Average	Array			
2003, 0	Number of Entries	UINT8	16		RO
2003, 1	Input 0 Average	UINT8	1	1..255	RW
2003, 2	Input 1 Average	UINT8	1	1..255	RW
2003, 3	Input 2 Average	UINT8	1	1..255	RW
2003, 4	Input 3 Average	UINT8	1	1..255	RW
2003, 5	Input 4 Average	UINT8	1	1..255	RW
2003, 6	Input 5 Average	UINT8	1	1..255	RW
2003, 7	Input 6 Average	UINT8	1	1..255	RW
2003, 8	Input 7 Average	UINT8	1	1..255	RW
2003, 9	Input 8 Average	UINT8	1	1..255	RW

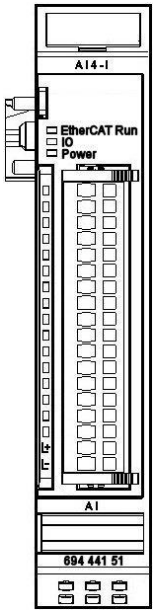
Index	Name	Type	Default	Min Max	Access
2003, 10	Input 9 Average	UINT8	1	1..255	RW
2003, 11	Input 10 Average	UINT8	1	1..255	RW
2003, 12	Input 11 Average	UINT8	1	1..255	RW
2003, 13	Input 12 Average	UINT8	1	1..255	RW
2003, 14	Input 13 Average	UINT8	1	1..255	RW
2003, 15	Input 14 Average	UINT8	1	1..255	RW
2003, 16	Input 15 Average	UINT8	1	1..255	RW
6401	Analogue input	Array			
6401, 0	Number of Entries	UINT8	16		RO
6401, 1	Analog Input 0	UINT16			RO P
6401, 2	Analog Input 1	UINT16			RO P
6401, 3	Analog Input 2	UINT16			RO P
6401, 4	Analog Input 3	UINT16			RO P
6401, 5	Analog Input 4	UINT16			RO P
6401, 6	Analog Input 5	UINT16			RO P
6401, 7	Analog Input 6	UINT16			RO P
6401, 8	Analog Input 7	UINT16			RO P
6401, 9	Analog Input 8	UINT16			RO P
6401, 10	Analog Input 9	UINT16			RO P
6401, 11	Analog Input 10	UINT16			RO P
6401, 12	Analog Input 11	UINT16			RO P
6401, 13	Analog Input 12	UINT16			RO P
6401, 14	Analog Input 13	UINT16			RO P
6401, 15	Analog Input 14	UINT16			RO P
6401, 16	Analog Input 15	UINT16			RO P
6500	StateWord	Array			
6500, 0	Number of Entries	UINT8	16		RO
6500, 1	ResetErrorAck	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
7001	Module Control	Array			
7001, 0	Number of Entries	UINT8	1		RO
7001, 1	Reset Error	BOOL			RW P

RO=read-only, RW= read/write, P=process image

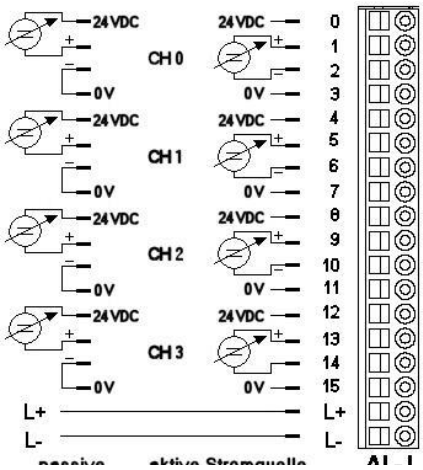
Technical Data

Analogue inputs	16 single-ended or 8 differential
Measuring range	0 …10V, ± 5V, ± 10V, ± 2,5V
Resolution	13 bit
Start AD conversion	synchronised with DC / SM
Conversion time	580 µs (if all channels are active)
Internal resistance	> 1MΩ
Input filter cutoff frequency	typ. 1kHz
Measuring error	< ±0.4%, typ. < ±0.2% of final value
Baud rate	100 Mbit/s
Controller	ASIC ET1200
E-bus connector	10-pole system plug in side wall
Terminating module	not required
IO/power connection	36-pin plug
Power supply	24 VDC -20% +25%
E-bus load	190 mA
Part no.	694.441.53 13-Bit (CoE)
Approval:	c UL us LISTED 59DM E202287, EtherCAT Conformance tested

5.1.6 AI4-I



Front view of AI4-I I/O module



I/O connection

Terminals

The 24 V connector supplies power to the sensors.

Power is supplied to the module through the E-bus connector.

Operative earth / shielding of analogue wires → section 0

	Information
	Module 694 441 51 Kuhnke FIO AI4-I 12-Bit is the successor module NOT compatible with module 694 441 01 Ventura FIO AI4-I 12-Bit. *The module complies with ETG guidelines.* *Before replacing a Ventura/Kuhnke FIO AI4-I 12-Bit module (694 441 01) with a Kuhnke FIO AI4-I 12-Bit module (694 441 51), you must modify the EtherCAT master's control program.*

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module

State	LED flash code	Explanation
Defective	Red, on	Module defective

LED "Power"

The LED labelled "Power" indicates the state of the power supplied to the I/O module's I/O sensors.

State	LED flash code	Explanation
On	Green, on	24 VDC supply ok
Off	Off	24 VDC supply not ok

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled
Added to the CoE variant (694 441 51 Kuhnke FIO AI4-I 12-Bit)		
Error	Red, 1x	Current > 20.5 mA
	Red, 2x	Current < 3.5 mA (4..20 mA mode)

Function

The AI4-I module has four analogue current signal inputs. Their measuring range can be set separately for every channel, i.e. either to 0..20mA or to 4..20mA.

Analogue Inputs

Check the following variable for the digitised input values:

Variable	Data type	Explanation
AnalogInputn	INT	Value measured on channel n (n= 0…3)

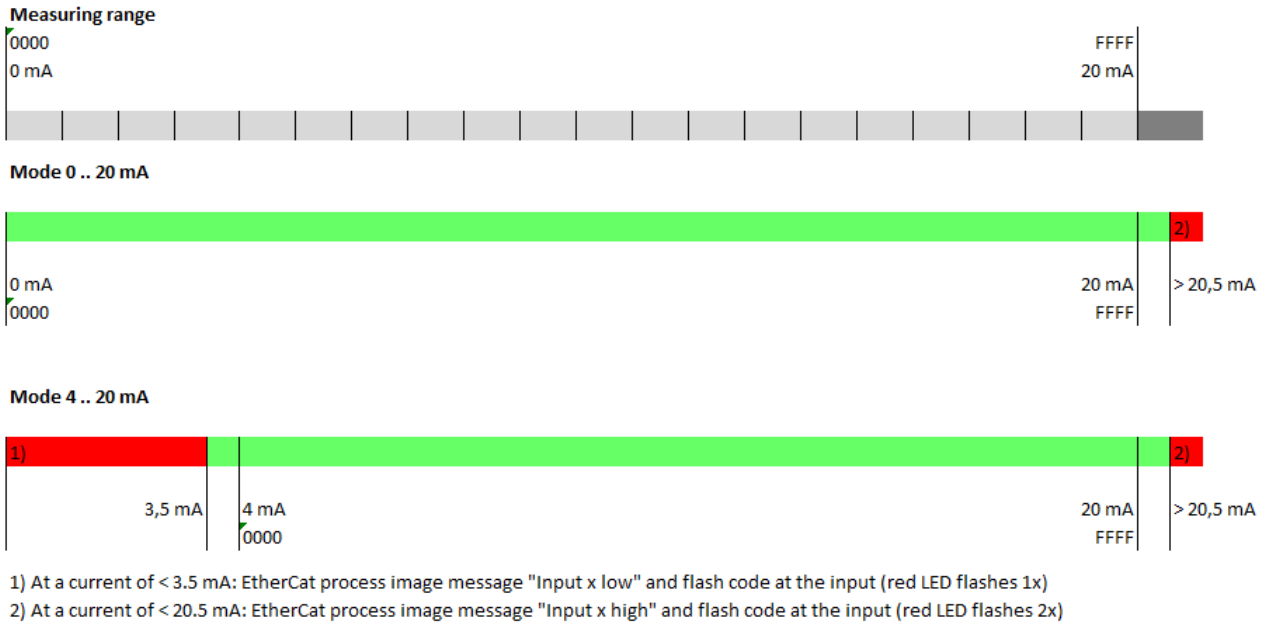
Measured value

Table "0-20 mA current mode"

Current [mA]	Value [hex]
0	0x0
10	0x7FFF
20	0xFFFF

Table "4-20 mA current mode"

Current [mA]	Value [hex]
4	0x0
12	0x7FFF
20	0xFFFF

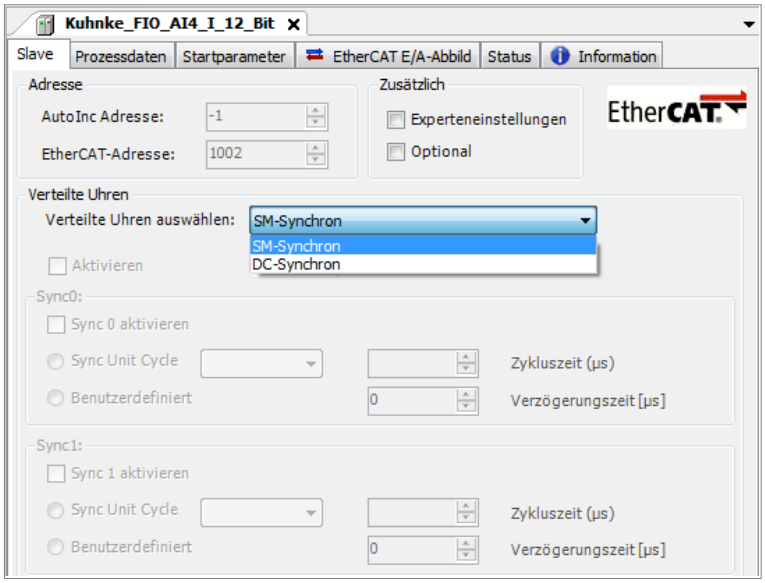


1) At a current of < 3.5 mA: EtherCat process image message "Input x low" and flash code at the input (red LED flashes 1x)
2) At a current of < 20.5 mA: EtherCat process image message "Input x high" and flash code at the input (red LED flashes 2x)

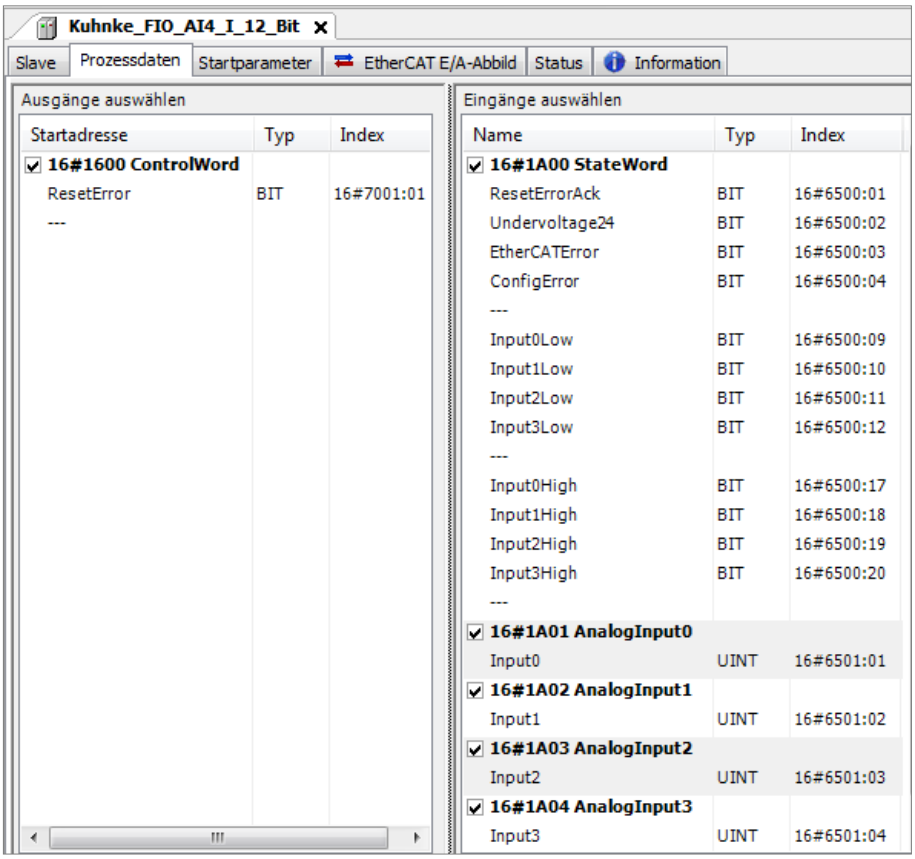
Measured & variable values and state of AI4-I CoE

To Set up the Options

Conversion of the analogue values can be synchronised with DC (Distributed Clocks) or SM (Sync Manager).



The process data objects stored as variables in the EtherCAT master's control program are used to access the input values and the module state.

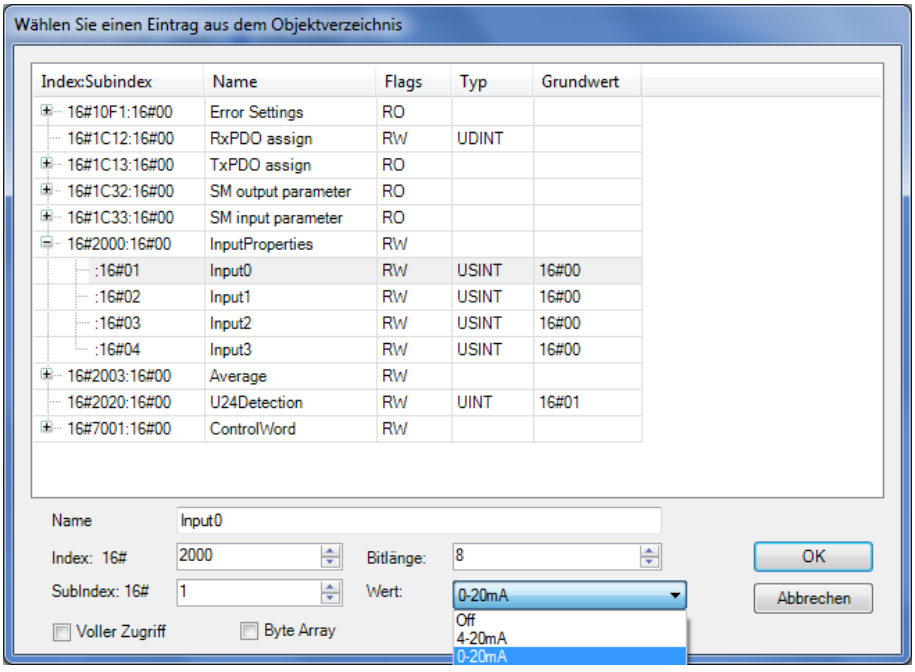


Service data objects (SDO) are available for details and settings.

You may run the configuration tool offline and choose the "Startup Parameters" to change some settings of module AI4-I 12-Bit (such as the properties of each of the inputs). The EtherCAT master will apply the settings when starting up the module.

You can also use the SDO transfer components available for the EtherCAT master to change settings at runtime.

Click/tap on "Add…", choose an object, and set the appropriate value.



Options

You can set up the following options for every channel:

Name	Value	Explanation
InputProperties	0	Off (default)
	5	4-20mA
	6	0-20mA
Average	n=1..255	Inputn= average after n cycles (default=1)

StateWord

The state word (DWORD) is indicative of the module state:

Bit	Name	Explanation
0	ResetErrorAck	Acknowledges "Reset Error" in Module Control
1	Undervoltage24	Power to passive sensors < 19 V (no error, just info)
2	EtherCATError	Sync Manager Watchdog
3	ConfigError	Mismatch of Sync Manager's quantity structure
4-7		not used
8	Input0low	Current at 4-20mA < 3.5mA
9	Input1low	Current at 4-20mA < 3.5mA
10	Input2low	Current at 4-20mA < 3.5mA
11	Input3low	Current at 4-20mA < 3.5mA
12-15		not used
16	Input0high	Current > 20.5 mA
17	Input1high	Current > 20.5 mA
18	Input2high	Current > 20.5 mA
19	Input3high	Current > 20.5 mA
20-31	-	not used

Analogue Inputs

Check the following variables for the digitised input values:

Variable	Data type	Explanation
Inputn	INT	Value of channel n (n=0…3).

ControlWord

The control word contains a bit for acknowledging errors.

Bit	Name	Explanation
0	ResetError	0 -> errors are retained, 1 -> errors cleared after removing their cause
1-15	-	not used

Object Dictionary

Index	Name	Type	Default	Min Max	Access
1000	Device Type	UINT32	0x40191		RO
1001	Error Register	UINT8			RO
1008	Device Name	String	AI4-I 12-Bit		RO
1009	Hardware Version	String	1.00		RO
100A	Software Version	String	1.00		RO
1018	Identity Object	Array			
1018, 0	Number of Entries	UINT8	4		RO

Index	Name	Type	Default	Min Max	Access
1018, 1	Vendor Id	UINT32	0x0048554B		RO
1018, 2	Product Code	UINT32	185339		RO
1018, 3	Revision Number	UINT32	1		RO
1018, 4	Serial Number	UINT32			RO
2000	Analog Input Properties	Array			
2000, 0	Number of Entries	UINT8	4		RO
2000, 1	Input 0	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 2	Input 1	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 3	Input 2	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 4	Input 3	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2003	Input Average	Array			
2003, 0	Number of Entries	UINT8	4		RO
2003, 1	Input 0 Average	UINT8	1	1..255	RW
2003, 2	Input 1 Average	UINT8	1	1..255	RW
2003, 3	Input 2 Average	UINT8	1	1..255	RW
2003, 4	Input 3 Average	UINT8	1	1..255	RW
6401	Analogue input	Array			
6401, 0	Number of Entries	UINT8	4		RO
6401, 1	Analog Input 0	UINT16			RO P
6401, 2	Analog Input 1	UINT16			RO P
6401, 3	Analog Input 2	UINT16			RO P
6401, 4	Analog Input 3	UINT16			RO P
6500	StateWord	Array			
6500, 0	Number of Entries	UINT8	32		RO
6500, 1	ResetErrorAck	BOOL			RO P
6500, 2	Undervoltage24	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
6500, 5..8	-	BOOL			RO P
6500, 9	Input 0 low	BOOL			RO P
6500, 10	Input 1 low	BOOL			RO P
6500, 11	Input 2 low	BOOL			RO P
6500, 12	Input 3 low	BOOL			RO P
6500, 13..16	-	BOOL			RO P
6500, 17	Input 0 high	BOOL			RO P
6500, 18	Input 1 high	BOOL			RO P
6500, 19	Input 2 high	BOOL			RO P
6500, 20	Input 3 high	BOOL			RO P
6500, 21..32	-	BOOL			RO P

Index	Name	Type	Default	Min Max	Access
6500, 1	ResetErrorAck	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
7001	Module Control	Array			
7001, 0	Number of Entries	UINT8	1		RO
7001, 1	Reset Error	BOOL			RW P

RO=read-only, RW= read/write, P=process image

Technical Data

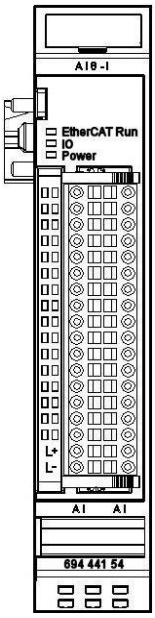
Analogue inputs 4
Measuring range ..... 0…20mA, 4…20mA (final value: 20mA)
Resolution ..... 12 bit

Start AD conversion ..... synchronised with DC / SM
Conversion time ..... 235 µs (if all channels are active)
Internal resistance ..... < 300Ω
Input filter cutoff frequency ..... 100 kHz
Measuring error ..... < ±0.5%, typ. < ±0.4% of final value
Supply of Sensors ..... 24VDC, a total of max. 200mA

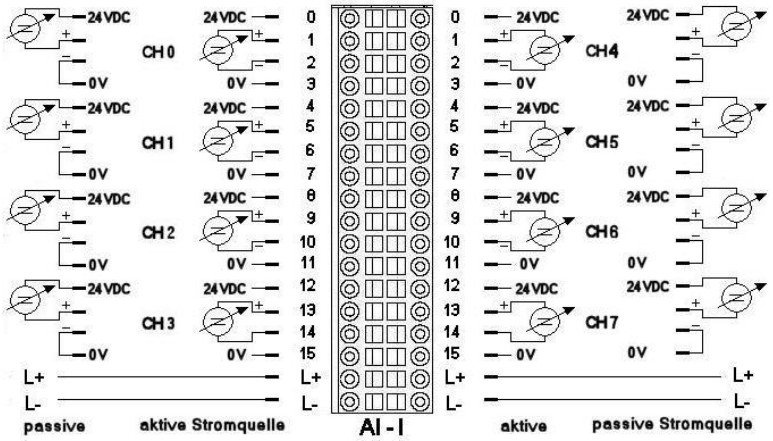
Baud rate ..... 100 Mbit/s
Controller ..... ASIC ET1200
E-bus connector ..... 10-pole system plug in side wall
Terminating module ..... not required
IO/power connection ..... 18-pin plug
Power supply ..... 24 VDC -20% +25%
E-bus load ..... 190 mA
Part no. ..... 694.441.51 (CoE)

Approval: .....

5.1.7 AI8-I



Front view of AI8-I I/O module



I/O connection

Terminals

The 24 V connector supplies power to the sensors.

Power is supplied to the module through the E-bus connector.

Operative earth / shielding of analogue wires → section 0

	Information
	Module 694 441 54 Kuhnke FIO AI8-I 12-Bit is the successor module NOT compatible with module 694 441 04 Ventura FIO AI8-I 12-Bit. *The module complies with ETG guidelines.* *Before replacing a Ventura/Kuhnke FIO AI8-I 12-Bit module (694 441 04) with a Kuhnke FIO AI8-I 12-Bit module (694 441 54), you must modify the EtherCAT master's control program.*

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On

State	LED flash code	Explanation
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

LED "Power"

The LED labelled "Power" indicates the state of the power supplied to the I/O module's I/O sensors.

State	LED flash code	Explanation
On	Green, on	24 VDC supply ok
Off	Off	24 VDC supply not ok

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled
Added to the CoE variant (694 441 51 Kuhnke FIO AI4-I 12-Bit)		
Error	red	Current > 20.5 mA
		Current < 3.5 mA (4..20 mA mode)

Function

The AI8-I module has eight analogue current signal inputs. Their measuring range can be set separately for every channel, i.e. either to 0..20mA or to 4..20mA.

Analogue Inputs

Check the following variable for the digitised input values:

Variable	Data type	Explanation
AnalogInputn	INT	Value measured on channel n (n= 0…7)

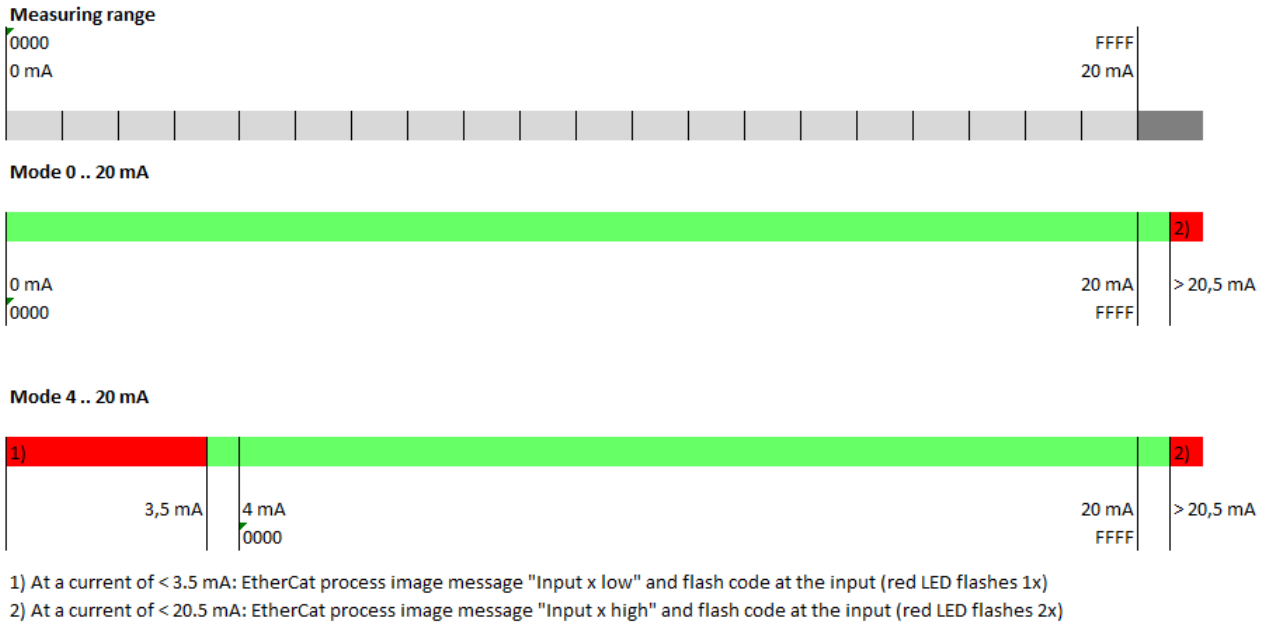
Measured value

Table "0-20 mA current mode"

Current [mA]	Value [hex]
0	0x0
10	0x7FFF
20	0xFFFF

Table "4-20 mA current mode"

Current [mA]	Value [hex]
4	0x0
12	0x7FFF
20	0xFFFF

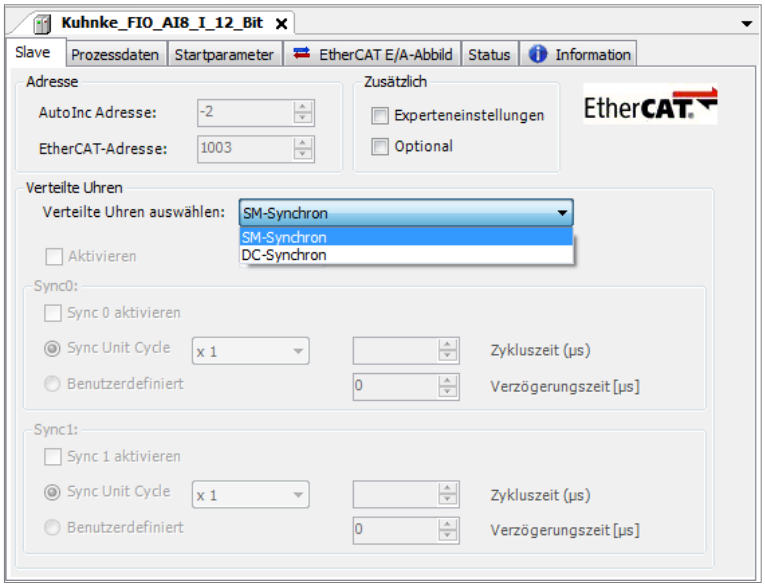


1) At a current of < 3.5 mA: EtherCat process image message "Input x low" and flash code at the input (red LED flashes 1x)
2) At a current of < 20.5 mA: EtherCat process image message "Input x high" and flash code at the input (red LED flashes 2x)

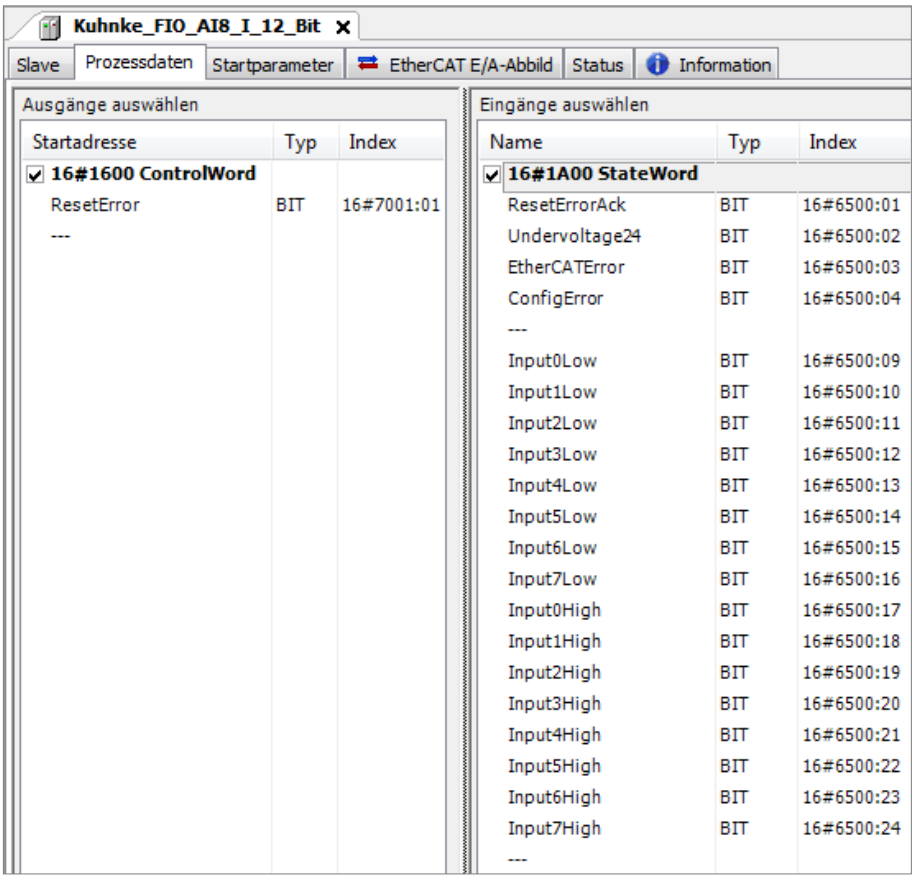
Measured & variable values and state of AI8-I CoE

To Set up the Options

Conversion of the analogue values can be synchronised with DC (Distributed Clocks) or SM (Sync Manager).



The process data objects stored as variables in the EtherCAT master's control program are used to acces the input values and the module state.

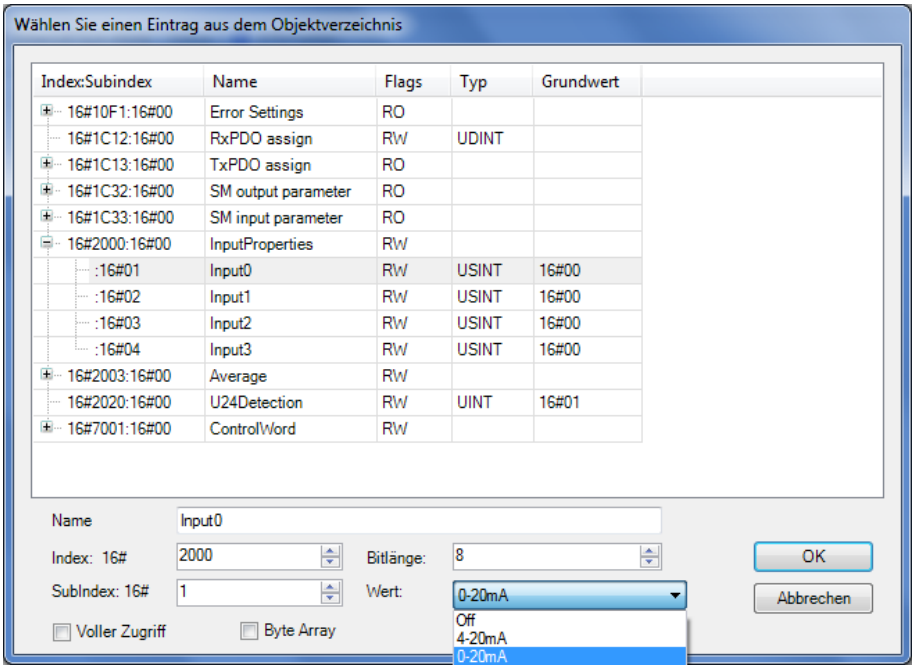


Service data objects (SDO) are available for details and settings.

You may run the configuration tool offline and choose the "Startup Parameters" to change some settings of module AI8-I 12-Bit (such as the properties of each of the inputs). The EtherCAT master will apply the settings when starting up the module.

You can also use the SDO transfer components available for the EtherCAT master to change settings at runtime.

Click/tap on "Add…", choose an object, and set the appropriate value.



Options

You can set up the following options for every channel:

Name	Value	Explanation
InputProperties	0	Off (default)
	5	4-20mA
	6	0-20mA
Average	n=1..255	Inputn= average after n cycles (default=1)

StateWord

The state word (DWORD) is indicative of the module state:

Bit	Name	Explanation
0	ResetErrorAck	Acknowledges "Reset Error" in Module Control
1	Undervoltage24	Power to passive sensors < 19 V (no error, just info)
2	EtherCATError	Sync Manager Watchdog
3	ConfigError	Mismatch of Sync Manager's quantity structure
4-7		not used
8	Input0low	Current at 4-20mA < 3.5mA
9	Input1low	Current at 4-20mA < 3.5mA
10	Input2low	Current at 4-20mA < 3.5mA
11	Input3low	Current at 4-20mA < 3.5mA
12	Input4low	Current at 4-20mA < 3.5mA
13	Input5low	Current at 4-20mA < 3.5mA
14	Input6low	Current at 4-20mA < 3.5mA
15	Input7low	Current at 4-20mA < 3.5mA
16	Input0high	Current > 20.5 mA
17	Input1high	Current > 20.5 mA
18	Input2high	Current > 20.5 mA
19	Input3high	Current > 20.5 mA
20	Input4high	Current > 20.5 mA
21	Input5high	Current > 20.5 mA
22	Input6high	Current > 20.5 mA
23	Input7high	Current > 20.5 mA
24-31	-	not used

Analogue Inputs

Check the following variables for the digitised input values:

Variable	Data type	Explanation
Inputn	INT	Value of channel n (n=0…7).

ControlWord

The control word contains a bit for acknowledging errors.

Bit	Name	Explanation
0	ResetError	0 -> errors are retained, 1 -> errors cleared after removing their cause
1-15	-	not used

Object Dictionary

Index	Name	Type	Default	Min Max	Access
1000	Device Type	UINT32	0x40191		RO
1001	Error Register	UINT8			RO
1008	Device Name	String	AI8-I 12-Bit		RO
1009	Hardware Version	String	1.00		RO
100A	Software Version	String	1.00		RO
1018	Identity Object	Array			
1018, 0	Number of Entries	UINT8	4		RO
1018, 1	Vendor Id	UINT32	0x0048554B		RO
1018, 2	Product Code	UINT32	185345		RO
1018, 3	Revision Number	UINT32	1		RO
1018, 4	Serial Number	UINT32			RO
2000	Analog Input Properties	Array			
2000, 0	Number of Entries	UINT8	8		RO
2000, 1	Input 0	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 2	Input 1	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 3	Input 2	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 4	Input 3	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 5	Input 4	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 6	Input 5	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 7	Input 6	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2000, 8	Input 7	UINT8	Off	Off (0), 4-20mA (5), 0-20mA (6)	RW
2003	Input Average	Array			
2003, 0	Number of Entries	UINT8	8		RO
2003, 1	Input 0 Average	UINT8	1	1..255	RW
2003, 2	Input 1 Average	UINT8	1	1..255	RW
2003, 3	Input 2 Average	UINT8	1	1..255	RW
2003, 4	Input 3 Average	UINT8	1	1..255	RW
2003, 5	Input 4 Average	UINT8	1	1..255	RW
2003, 6	Input 5 Average	UINT8	1	1..255	RW
2003, 7	Input 6 Average	UINT8	1	1..255	RW

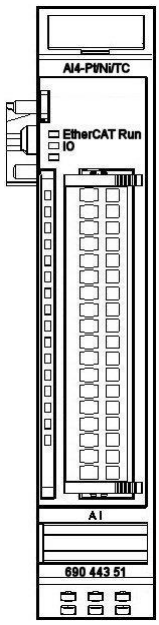
Index	Name	Type	Default	Min Max	Access
2003, 8	Input 7 Average	UINT8	1	1..255	RW
6401	Analogue input	Array			
6401, 0	Number of Entries	UINT8	8		RO
6401, 1	Analog Input 0	UINT16			RO P
6401, 2	Analog Input 1	UINT16			RO P
6401, 3	Analog Input 2	UINT16			RO P
6401, 4	Analog Input 3	UINT16			RO P
6401, 5	Analog Input 4	UINT16			RO P
6401, 6	Analog Input 5	UINT16			RO P
6401, 7	Analog Input 6	UINT16			RO P
6401, 8	Analog Input 7	UINT16			RO P
6500	StateWord	Array			
6500, 0	Number of Entries	UINT8	32		RO
6500, 1	ResetErrorAck	BOOL			RO P
6500, 2	Undervoltage24	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
6500, 5..8	-	BOOL			RO P
6500, 9	Input 0 low	BOOL			RO P
6500, 10	Input 1 low	BOOL			RO P
6500, 11	Input 2 low	BOOL			RO P
6500, 12	Input 3 low	BOOL			RO P
6500, 13	Input 4 low	BOOL			RO P
6500, 14	Input 5 low	BOOL			RO P
6500, 15	Input 6 low	BOOL			RO P
6500, 16	Input 7 low	BOOL			RO P
6500, 17	Input 0 high	BOOL			RO P
6500, 18	Input 1 high	BOOL			RO P
6500, 19	Input 2 high	BOOL			RO P
6500, 20	Input 3 high	BOOL			RO P
6500, 21	Input 4 high	BOOL			RO P
6500, 22	Input 5 high	BOOL			RO P
6500, 23	Input 6 high	BOOL			RO P
6500, 24	Input 7 high	BOOL			RO P
6500, 25..32	-	BOOL			RO P
6500, 1	ResetErrorAck	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
7001	Module Control	Array			
7001, 0	Number of Entries	UINT8	1		RO
7001, 1	Reset Error	BOOL			RW P

RO=read-only, RW= read/write, P=process image

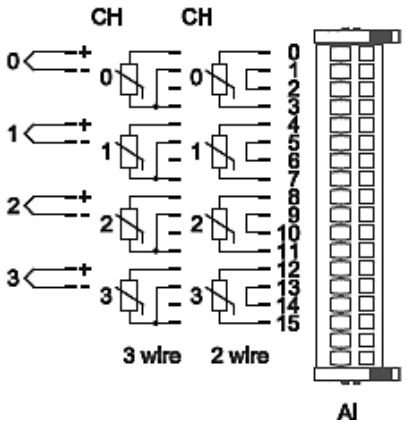
Technical Data

Analogue inputs	8
Measuring range	0…20mA, 4…20mA (final value: 20mA)
Resolution	12 bit
Start AD conversion	synchronised with DC / SM
Conversion time	290 µs (if all channels are active)
Internal resistance	< 300Ω
Input filter cutoff frequency	100 kHz
Measuring error	< ±0.5%, typ. < ±0.4% of final value
Supply of Sensors	24VDC, a total of max. 200mA
Baud rate	100 Mbit/s
Controller	ASIC ET1200
E-bus connector	10-pole system plug in side wall
Terminating module	not required
IO/power connection	36-pin plug
Power supply	24 VDC -20% +25%
E-bus load	190 mA
Part no.	694.441.54 (CoE)
Approval:	c UL us LISTED 59DM E202287 EtherCAT Conformance tested

5.1.8 AI4-Pt/Ni/TC



Front view of I/O module AI4-Pt/Ni/Tc



I/O connection

Terminals

The module needs no separate 24V connector. Power is supplied to the module through the E-bus connector.

Operative earth / shielding of analogue wires → section 0

	Information
	Module 694 443 57 Kuhnke FIO AI4-Pt/Ni/TC is the INCOMPATIBLE successor to the following modules: *694 443 01 Ventura FIO AI4-Pt/Ni100* *694 443 03 Ventura FIO AI4-Pt/Ni1000* *694 443 05 Ventura FIO AI4-TE* *The module complies with ETG guidelines.* *Before replacing a Ventura FIO AI4-Pt/Ni100 or 694 443 03 Ventura FIO AI4-Pt/Ni1000 or 694 443 05 Ventura FIO AI4-TE (694 443 01) with a Kuhnke FIO AI4-Pt/Ni/TC module (694 443 57), you must modify the EtherCAT master's control program.*

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error

State	LED flash code	Explanation
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red, 1x	Sensor low
	Red, 2x	Sensor high

Note on Pt100/NI100 mode

Error "input high" is not shown in the Pt100 and Ni100 modes, unless a temperature sensor is connected. Check that your wiring is correct (jumpered 2-wire or 3-wire connection) to ensure that all error are detected/shown properly.

Note on thermocouple mode

- Errors *input low* and *input high* are just indicative of the temperature being out of the set range.
- A short circuit (input low) is not detected in thermocouple mode (types J,K) because the thermal voltage is too small for a short circuit to be relevant to the measured result.
- Since a broken wire is not detected, the floating module values may provoke an indication of error *input high* or *input low*.

Function

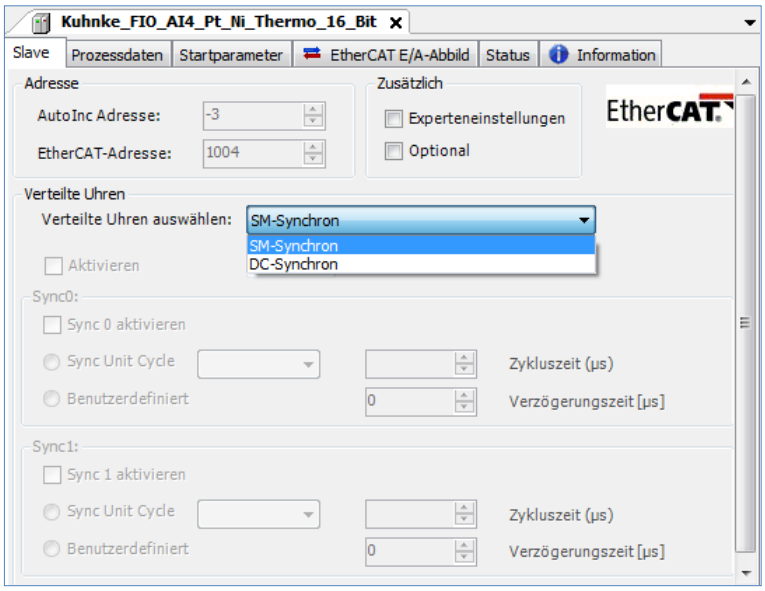
Module AI4-Pt/Ni/TC features four analogue inputs for temperature sensors. Every channel can be separately set to one of the following sensor types: millivolt, Pt100, Pt1000, Ni100, Ni1000 (DIN 43760) or thermocouple.

Measured value

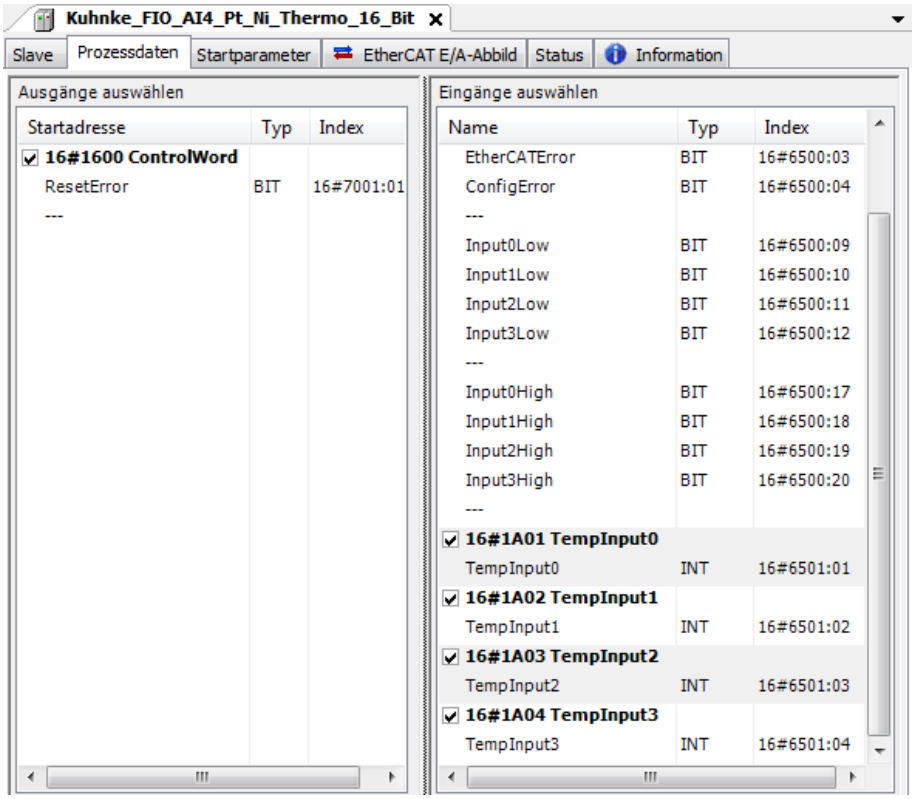
Readings are shown in 0.1 °C steps (default). Alternatively, you can choose to show them as Ohm/Volt or raw data.

To Set up the Options

Conversion of the analogue values can be synchronised with DC (Distributed Clocks) or SM (Sync Manager).



The process data objects stored as variables in the EtherCAT master's control program are used to access the input values and the module state.

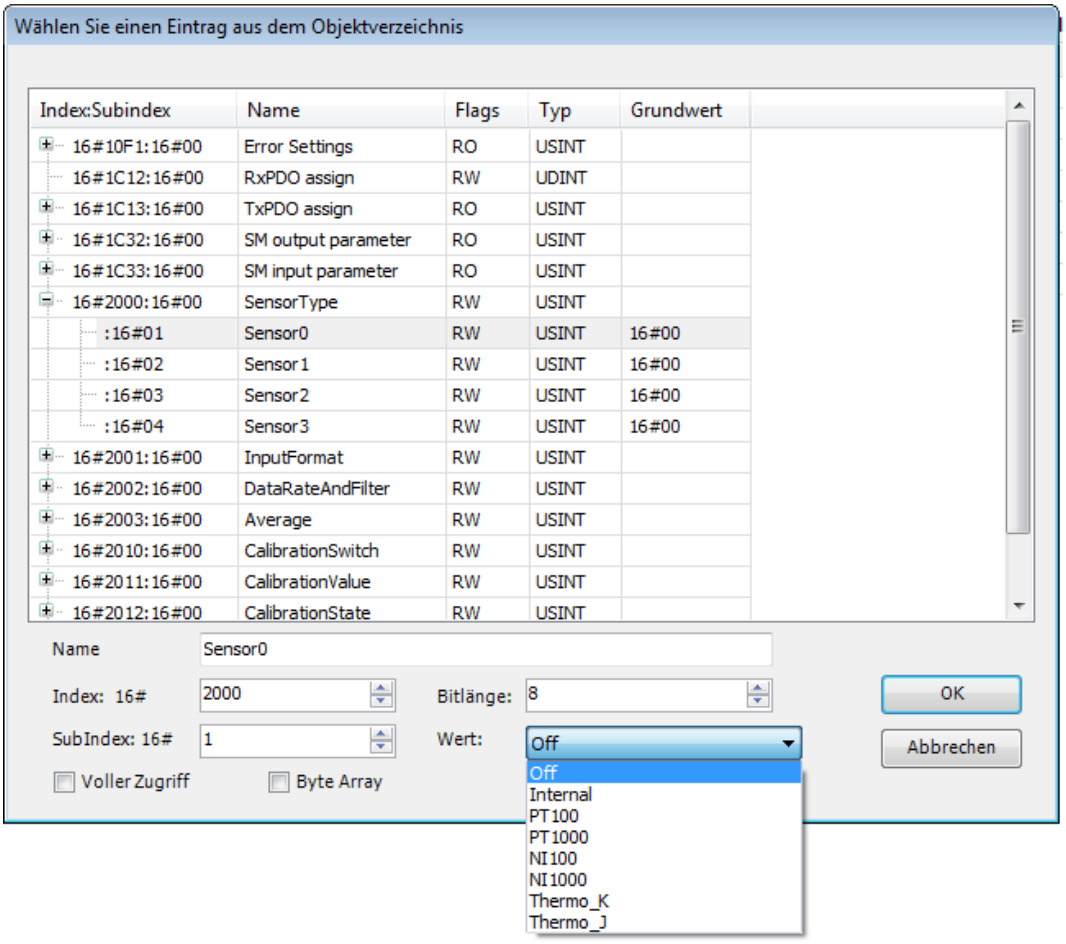


Service data objects (SDO) are available for details and settings.

You may run the configuration tool offline and choose the "Startup Parameters" to change some settings of module AI4-Pt/Ni/TC (such as the properties of each of the inputs). The EtherCAT master will apply the settings when starting up the module.

You can also use the SDO transfer components available for the EtherCAT master to change settings at runtime.

Click/tap on "Add…", choose an object, and set the appropriate value.



Options

You can set up the following options for every channel:

Name	Value	Explanation
SensorType	0	Off (default)
	1	Internal (Cold junction)
	2	Pt100
	3	Pt1000
	4	Ni100
	5	Ni1000 (DIN43760)
	6	Thermo K
	7	Thermo J
InputFormat	0	0.1°C
	1	Ω / V
	2	Raw (raw data)
Data rate and filter	0	1000 readings per second
	1	600 readings per second
	2	330 readings per second
	3	175 readings per second
	4	90 readings per second
	5	45 readings per second
	6	20 readings per second
	7	20 readings per second plus 50 & 60 Hz filter
	8	20 readings per second plus 50 Hz filter

Name	Value	Explanation
	9	20 readings per second plus +60 Hz filter
Average	n=1..255	Inputn= average after n cycles (default=1)

StateWord

The state word (DWORD) is indicative of the module state:

Bit	Name	Explanation
0	ResetErrorAck	Acknowledges "Reset Error" in Module Control
1	-	not used
2	EtherCATError	Sync Manager Watchdog
3	ConfigError	Mismatch of Sync Manager's quantity structure
4-7	-	not used
8	Input0low	Incorrect range of connected reading
9	Input1low	Incorrect range of connected reading
10	Input2low	Incorrect range of connected reading
11	Input3low	Incorrect range of connected reading
12-15	-	not used
16	Input0high	Incorrect range of connected reading
17	Input1high	Incorrect range of connected reading
18	Input2high	Incorrect range of connected reading
19	Input3high	Incorrect range of connected reading
20-31	-	not used

Analogue Inputs

Check the following variables for the digitised input values:

Variable	Data type	Explanation
TempInputn	INT	Value of channel n (n=0…3) in 0.1°C, Ω or 2µV

ControlWord

The control word contains a bit for acknowledging errors.

Bit	Name	Explanation
0	ResetError	0 -> errors are retained, 1 -> errors cleared after removing their cause
1-15	-	not used

Cold Point Compensation

Cold points are automatically compensated if thermocouples are used. Temperature readings are taken immediately at the plug near the connection

Calibration

This module need not be calibrated by the end user because it is calibrated after fabrication.

It can only be calibrated once because the calibration values are kept on memory.

The calibration objects (2010:n; 2011:n and 2012:n) in the Startup Parameters are intended for internal use only.

Object Dictionary

Index	Name	Type	Default	Min Max	Access
1000	Device Type	UINT32	0x40191		RO
1001	Error Register	UINT8			RO
1008	Device Name	String	AI4_Pt/Ni/Thermo		RO
1009	Hardware Version	String	1.00		RO
100A	Software Version	String	1.00		RO
1018	Identity Object	Array			
1018, 0	Number of Entries	UINT8	4		RO
1018, 1	Vendor Id	UINT32	0x0048554B		RO
1018, 2	Product Code	UINT32	185345		RO
1018, 3	Revision Number	UINT32	1		RO
1018, 4	Serial Number	UINT32			RO
2000	Sensor Type	Array			
2000, 0	Number of Entries	UINT8	4		RO
2000, 1	Sensor0	UINT8	Off	Off (0), Internal (1), PT100 (2), PT1000 (3), NI100 (4), NI1000 (5), Thermo_K (6), Thermo_J (7),	RW
2000, 2	Sensor1	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2000, 3	Sensor2	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2000, 4	Sensor3	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2001	Input Format	Array			
2001, 0	Number of Entries	UINT8	4		RO

Index	Name	Type	Default	Min Max	Access
2001, 1	Input0Format	UINT8	0.1°C	0.1°C (0), Ω / V (1) Raw (2)	RW
2001, 2	Input1Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2001, 3	Input2Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2001, 4	Input3Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2002	Data RateAndFilter	Array			
2002, 0	Number of Entries	UINT8	4		
2002, 1	Input0DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 2	Input1DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 3	Input2DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 4	Input3DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3)	RO

Index	Name	Type	Default	Min Max	Access
				90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	
2003	Average	Array			
2003, 0	Number of Entries	UINT8	4		RO
2003, 1	Input 0 Average	UINT8	1	1..255	RW
2003, 2	Input 1 Average	UINT8	1	1..255	RW
2003, 3	Input 2 Average	UINT8	1	1..255	RW
2003, 4	Input 3 Average	UINT8	1	1..255	RW
6401	Analogue input	Array			
6401, 0	Number of Entries	UINT8	4		RO
6401, 1	Analog Input 0	UINT16			RO P
6401, 2	Analog Input 1	UINT16			RO P
6401, 3	Analog Input 2	UINT16			RO P
6500	StateWord	Array			RO P
6500, 0	Number of Entries	UINT8	32		RO P
6500, 1	ResetErrorAck	BOOL			RO P
6500, 2	-	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
6500, 5..8	-	BOOL			RO P
6500, 9	Input 0 low	BOOL			RO P
6500, 10	Input 1 low	BOOL			RO P
6500, 11	Input 2 low	BOOL			RO P
6500, 12	Input 3 low	BOOL			RO P
6500, 13..16	-	BOOL			RO P
6500, 17	Input 0 high	BOOL			RO P
6500, 18	Input 1 high	BOOL			RO P
6500, 19	Input 2 high	BOOL			RO P
6500, 20	Input 3 high	BOOL			RO P
6500, 21..32	-	BOOL			RO P
7001	Module Control	Array			
7001, 0	Number of Entries	UINT8	1		RO
7001, 1	Reset Error	BOOL			RW P

RO=read-only, RW= read/write, P=process image

Technical Data

Analogue inputs	4
Resolution	16 bit
Input filter cutoff frequency	typ. 0.33 Hz
Conversion time	50 ms (adjustable)
Measuring error	<±0.54% (of final measuring range value)
Temperatur drift	<±50 ppm (of final measuring range value)

Thermocouple

Sensor types	J, K, Internal (Cold junction)
Cold point compensation	Yes
Measuring range Type K	-200°C…+1372°C
Measuring range Type J	-50°C…+760°C
Measuring range mV	-40 … +65 mV

Pt100 / Ni100

Measuring range Pt	-75°C…+670°C
Measuring range Ni	-60°C…+250°C
Input resistance	70…320Ω
Measuring current	1mA (typ.)

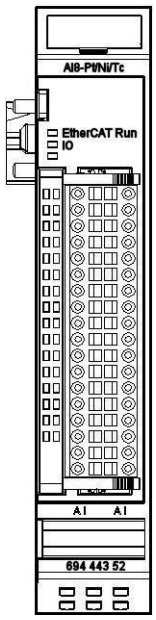
Pt1000 / Ni1000 DIN43760

Measuring range Pt	-75°C…+670°C
Measuring range Ni	-60°C…+250°C
Input resistance	700…3200Ω
Measuring current	0,1mA (typ.)

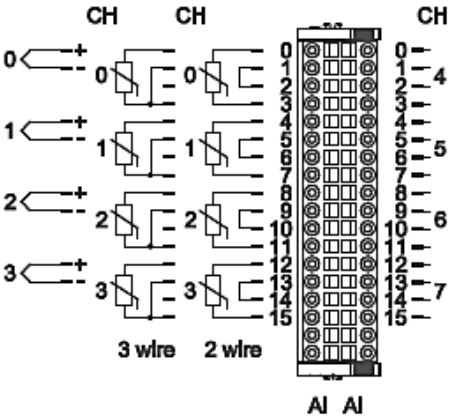
Baud rate	100 Mbit/s
Controller	ASIC ET1200
E-bus connector	10-pole system plug in side wall
Terminating module	not required
IO connection	18-pin plug
Power supply	none
E-bus load	170 mA
Part no.	694.443.57 (CoE)

Approval: c UL us LISTED 59DM E202287 EtherCAT Conformance tested

5.1.9 AI8-Pt/Ni/TC



Front view of I/O module AI8-Pt/Ni/TC



I/O connection

Terminals

The module needs no separate 24V connector. Power is supplied to the module through the E-bus connector.

Operative earth / shielding of analogue wires → section 0

	Information
	Module 694 443 58 Kuhnke FIO AI8-Pt/Ni/TC is the INCOMPATIBLE successor to the following modules: *694 443 02 Ventura FIO AI8-Pt/Ni100* *694 443 04 Ventura FIO AI8-Pt/Ni1000* *694 443 06 Ventura FIO AI8-TE* *The module complies with ETG guidelines.* *Before replacing a Ventura FIO AI8-Pt/Ni100 (694 443 02) or Ventura FIO AI8-Pt/Ni1000 (694 443 04) or Ventura FIO AI4-TE (694 443 06) with a Kuhnke FIO AI8-Pt/Ni/TC module (694 443 58), you must modify the EtherCAT master's control program.*

Status LEDs

LED "EtherCAT Run"

The LED labelled "EtherCAT Run" indicates the state of the EtherCAT ASIC.

State	LED flash code	Explanation
Init	Off	Initialising, no data exchange
Pre-Op	Off/green, 1:1	Pre-operational, no data exchange
Safe-Op	Off/green, 5:1	Safe operation, inputs readable
Op	Green, on	Operational, unrestricted data exchange

LED "IO"

The LED labelled "IO" indicates the state of the module's I/Os.

State	LED flash code	Explanation
Ok	Green, on	No error
Error	Off	Malfunction of module if E-bus LED = On
		Inoperative if E-bus LED = Off
	Red, 4x	EtherCAT watchdog control
	Red, 7x	Configuration error (E-bus pre-operational), no. of process data differs from that in the module
Defective	Red, on	Module defective

LEDs "Channel"

The "Channel" LEDs indicate the state of every channel.

State	LED flash code	Explanation
On	Green, on	Channel enabled
Off	Off	Channel disabled
Error	Red, 1x	Sensor low
	Red, 2x	Sensor high

Note on Pt100/NI100 mode

Error "input high" is not shown in the Pt100 and Ni100 modes, unless a temperature sensor is connected. Check that your wiring is correct (jumpered 2-wire or 3-wire connection) to ensure that all error are detected/shown properly.

Note on thermocouple mode

- Errors *input low* and *input high* are just indicative of the temperature being out of the set range.
- A short circuit (input low) is not detected in thermocouple mode (types J,K) because the thermal voltage is too small for a short circuit to be relevant to the measured result.
- Since a broken wire is not detected, the floating module values may provoke an indication of error *input high* or *input low*.

Function

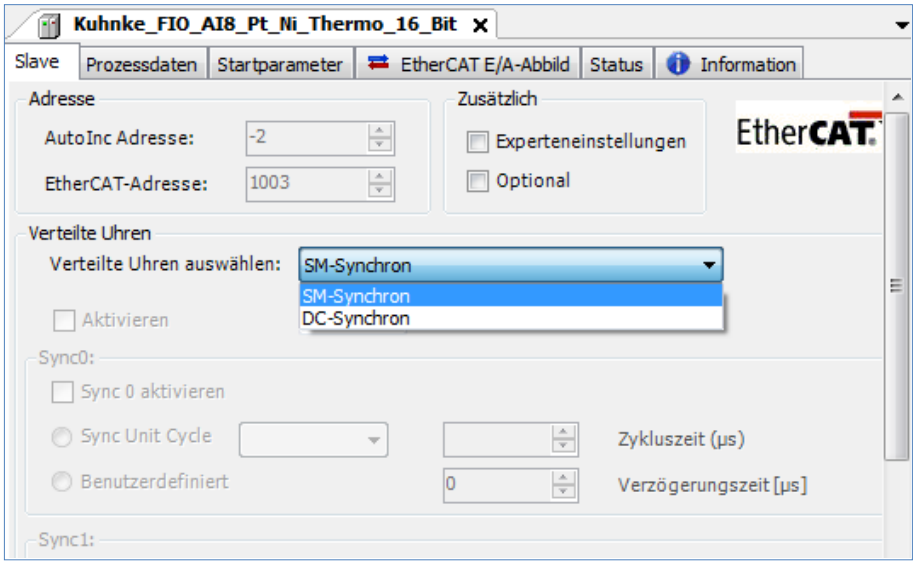
The AI8-I module has eight analogue temperature sensor inputs. Every channel can be separately set to one of the following sensor types: millivolt, Pt100, Pt1000, Ni100, Ni1000 (DIN 43760) or thermocouple.

Measured value

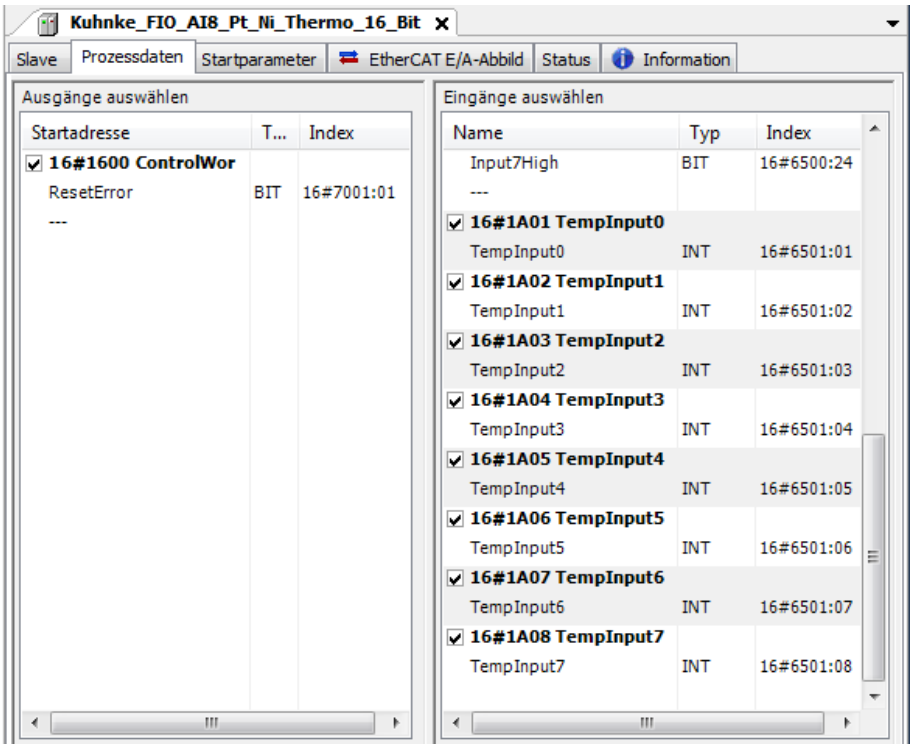
Readings are shown in 0.1 °C steps (default). Alternatively, you can choose to show them as Ohm/Volt or raw data.

To Set up the Options

Conversion of the analogue values can be synchronised with DC (Distributed Clocks) or SM (Sync Manager).



The process data objects stored as variables in the EtherCAT master's control program are used to access the input values and the module state.

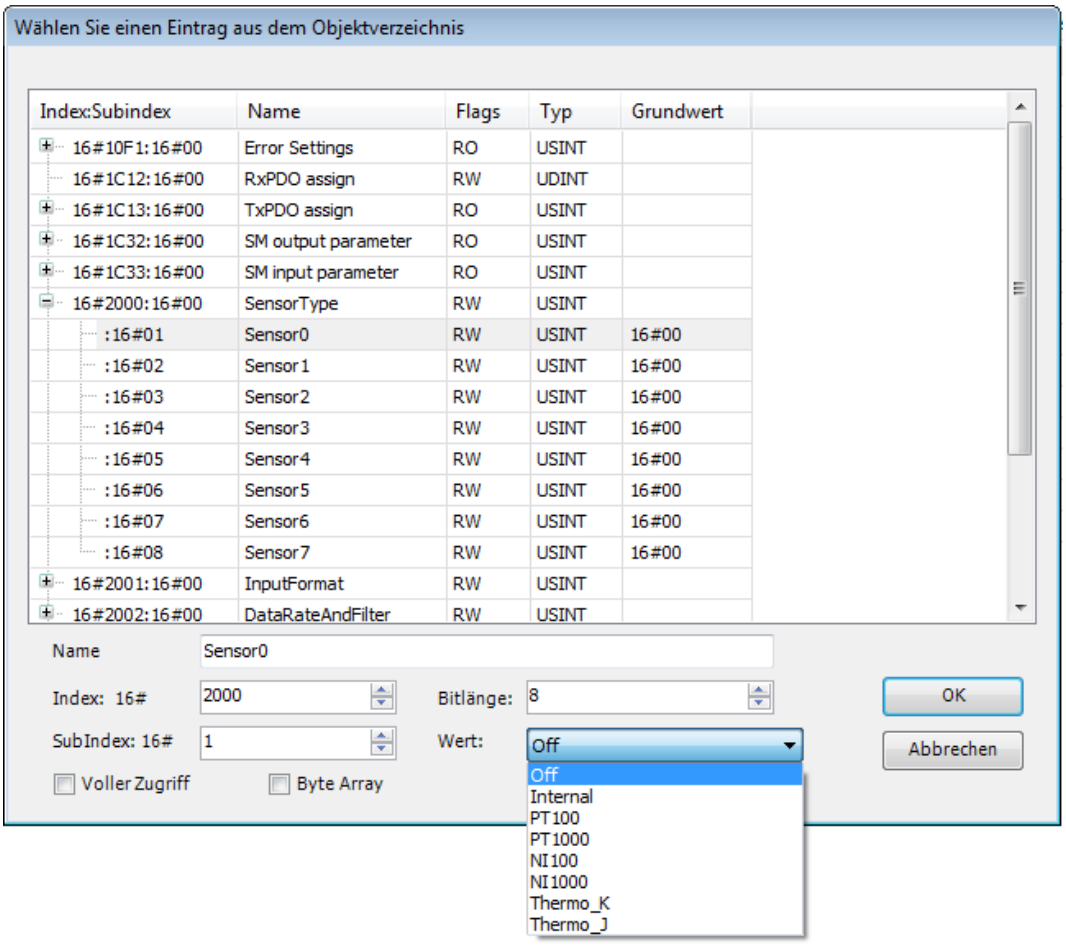


Service data objects (SDO) are available for details and settings.

You may run the configuration tool offline and choose the "Startup Parameters" to change some settings of module AI8-Pt/Ni/TC (such as the properties of each of the inputs). The EtherCAT master will apply the settings when starting up the module.

You can also use the SDO transfer components available for the EtherCAT master to change settings at runtime.

Click/tap on "Add…", choose an object, and set the appropriate value.



Options

You can set up the following options for every channel:

Name	Value	Explanation
SensorType	0	Off (default)
	1	Internal (Cold junction)
	2	Pt100
	3	Pt1000
	4	Ni100
	5	Ni1000 (DIN43760)
	6	Thermo K
	7	Thermo J
InputFormat	0	0.1°C
Data rate and filter	1	Ω / V
	2	Raw (raw data)
	0	1000 readings per second
Average	1	600 readings per second
	2	330 readings per second
	3	175 readings per second
	4	90 readings per second
	5	45 readings per second
	6	20 readings per second
	7	20 readings per second plus 50 & 60 Hz filter
	8	20 readings per second plus 50 Hz filter

Name	Value	Explanation
	9	20 readings per second plus +60 Hz filter
	n=1..255	Inputn= average after n cycles (default=1)

StateWord

The state word (DWORD) is indicative of the module state:

Bit	Name	Explanation
0	ResetErrorAck	Acknowledges "Reset Error" in Module Control
1	-	not used
2	EtherCATError	Sync Manager Watchdog
3	ConfigError	Mismatch of Sync Manager's quantity structure
4-7	-	not used
8	Input0low	Incorrect range of connected reading
9	Input1low	Incorrect range of connected reading
10	Input2low	Incorrect range of connected reading
11	Input3low	Incorrect range of connected reading
12	Input4low	Incorrect range of connected reading
13	Input5low	Incorrect range of connected reading
14	Input6low	Incorrect range of connected reading
15	Input7low	Incorrect range of connected reading
16	Input0high	Incorrect range of connected reading
17	Input1high	Incorrect range of connected reading
18	Input2high	Incorrect range of connected reading
19	Input3high	Incorrect range of connected reading
20	Input4high	Incorrect range of connected reading
21	Input5high	Incorrect range of connected reading
22	Input6high	Incorrect range of connected reading
23	Input7high	Incorrect range of connected reading
24-31	-	not used

Analogue Inputs

Check the following variables for the digitised input values:

Variable	Data type	Explanation
TempInputn	INT	Value of channel n (n=0…7) in 0.1°C, Ω or 2µV

ControlWord

The control word contains a bit for acknowledging errors.

Bit	Name	Explanation
0	ResetError	0 -> errors are retained, 1 -> errors cleared after removing their cause
1-15	-	not used

Cold Point Compensation

Cold points are automatically compensated if thermocouples are used. Temperature readings are taken immediately at the plug near the connection

Calibration

This module need not be calibrated by the end user because it is calibrated after fabrication.

It can only be calibrated once because the calibration values are kept on memory.

The calibration objects (2010:n; 2011:n and 2012:n) in the Startup Parameters are intended for internal use only.

Object Dictionary

Index	Name	Type	Default	Min Max	Access
1000	Device Type	UINT32	0x40191		RO
1001	Error Register	UINT8			RO
1008	Device Name	String	AI8_Pt/Ni/Thermo		RO
1009	Hardware Version	String	1.00		RO
100A	Software Version	String	1.00		RO
1018	Identity Object	Array			
1018, 0	Number of Entries	UINT8	4		RO
1018, 1	Vendor Id	UINT32	0x0048554B		RO
1018, 2	Product Code	UINT32	185346		RO
1018, 3	Revision Number	UINT32	1		RO
1018, 4	Serial Number	UINT32			RO
2000	Sensor Type	Array			
2000, 0	Number of Entries	UINT8	8		RO
2000, 1	Sensor0	UINT8	Off	Off (0), Internal (1), PT100 (2), PT1000 (3), NI100 (4), NI1000 (5), Thermo_K (6), Thermo_J (7),	RW
2000, 2	Sensor1	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2000, 3	Sensor2	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2000, 4	Sensor3	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000,	RW

Index	Name	Type	Default	Min Max	Access
				Thermo_K, Thermo_J,	
2000, 5	Sensor4	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2000, 6	Sensor5	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2000, 7	Sensor6	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2000, 8	Sensor7	UINT8	Off	Off, Internal, PT100, PT1000, NI100, NI1000, Thermo_K, Thermo_J,	RW
2001	Input Format	Array			
2001, 0	Number of Entries	UINT8	8		RO
2001, 1	Input0Format	UINT8	0.1°C	0.1°C (0), Ω / V (1) Raw (2)	RW
2001, 2	Input1Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2001, 3	Input2Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2001, 4	Input3Format	UINT8	0.1°C	0.1°C, Ω / V	RW

Index	Name	Type	Default	Min Max	Access
				Raw	
2001, 5	Input4Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2001, 6	Input5Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2001, 7	Input6Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2001, 8	Input Format	UINT8	0.1°C	0.1°C, Ω / V Raw	RW
2002	Data RateAndFilter	Array			
2002, 0	Number of Entries	UINT8	8		
2002, 1	Input0DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 2	Input1DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 3	Input2DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 4	Input3DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1)	RO

Index	Name	Type	Default	Min Max	Access
				330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	
2002, 5	Input4DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 6	Input5DataRateAnd Filter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 7	Input6DataRateAndFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8) 20 + 60Hz (9)	RO
2002, 8	Input7DataRateandFilter [readings per second]	UINT8	20	1000 (0) 600 (1) 330 (2) 175 (3) 90 (4) 45 (5) 20 (6) 20+50&60Hz (7) 20 + 50Hz (8)	RO

Index	Name	Type	Default	Min Max	Access
				20 + 60Hz (9)	
2003	Average	Array			
2003, 0	Number of Entries	UINT8	8		RO
2003, 1	Input 0 Average	UINT8	1	1..255	RW
2003, 2	Input 1 Average	UINT8	1	1..255	RW
2003, 3	Input 2 Average	UINT8	1	1..255	RW
2003, 4	Input 3 Average	UINT8	1	1..255	RW
2003, 5	Input 4 Average	UINT8	1	1..255	RW
2003, 6	Input 5 Average	UINT8	1	1..255	RW
2003, 7	Input 6 Average	UINT8	1	1..255	RW
2003, 8	Input 7 Average	UINT8	1	1..255	RW
6401	Analogue input	Array			
6401, 0	Number of Entries	UINT8	8		RO
6401, 1	Analog Input 0	UINT16			RO P
6401, 2	Analog Input 1	UINT16			RO P
6401, 3	Analog Input 2	UINT16			RO P
6401, 4	Analog Input 3	UINT16			RO P
6401, 5	Analog Input 4	UINT16			RO P
6401, 6	Analog Input 5	UINT16			RO P
6401, 7	Analog Input 6	UINT16			RO P
6401, 8	Analog Input 7	UINT16			RO P
6500	StateWord	Array			
6500, 0	Number of Entries	UINT8	32		RO
6500, 1	ResetErrorAck	BOOL			RO P
6500, 2	-	BOOL			RO P
6500, 3	EtherCAT Error	BOOL			RO P
6500, 4	ConfigError	BOOL			RO P
6500, 5...8	-	BOOL			RO P
6500, 9	Input 0 low	BOOL			RO P
6500, 10	Input 1 low	BOOL			RO P
6500, 11	Input 2 low	BOOL			RO P
6500, 12	Input 3 low	BOOL			RO P
6500, 13	Input 4 low	BOOL			RO P
6500, 14	Input 5 low	BOOL			RO P
6500, 15	Input 6 low	BOOL			RO P
6500, 16	Input 7 low	BOOL			RO P
6500, 17	Input 0 high	BOOL			RO P
6500, 18	Input 1 high	BOOL			RO P
6500, 19	Input 2 high	BOOL			RO P
6500, 20	Input 3 high	BOOL			RO P
6500, 21	Input 4 high	BOOL			RO P
6500, 22	Input 5 high	BOOL			RO P
6500, 23	Input 6 high	BOOL			RO P
6500, 24	Input 7 high	BOOL			RO P
6500, 25..32	ResetErrorAck	BOOL			RO P
6500, 1	EtherCAT Error	BOOL			RO P

Index	Name	Type	Default	Min Max	Access
6500, 3	ConfigError	BOOL			RO P
6500, 4	Module Control	Array			
7001	Number of Entries	UINT8	1		RO
7001, 0	Reset Error	BOOL			RW P
7001, 1					

RO=read-only, RW= read/write, P=process image

Technical Data

Analogue inputs	8
Resolution	16 bit
Input filter cutoff frequency	typ. 0.33 Hz
Conversion time	50 ms (adjustable)
Measuring error	<±0.54% (of final measuring range value)
Temperatur drift	<±50 ppm (of final measuring range value)

Thermocouple

Sensor types	J, K, Internal (Cold junction)
Cold point compensation	Yes
Measuring range Type K	-200°C…+1372°C
Measuring range Type J	-50°C…+760°C
Measuring range mV	-40 … +65 mV

Pt100 / Ni100

Measuring range Pt	-75°C…+670°C
Measuring range Ni	-60°C…+250°C
Input resistance	70…320Ω
Measuring current	1mA (typ.)

Pt1000 / Ni1000 DIN43760

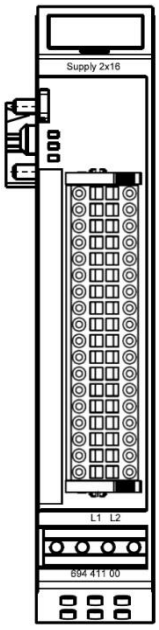
Measuring range Pt	-75°C…+670°C
Measuring range Ni	-60°C…+250°C
Input resistance	700…3200Ω
Measuring current	0.1mA (typ.)

Baud rate	100 Mbit/s
Controller	ASIC ET1200
E-bus connector	10-pole system plug in side wall
Terminating module	not required
IO connection	36-pin plug
Power supply	none
E-bus load	170 mA
Part no.	694.443.58 (CoE)

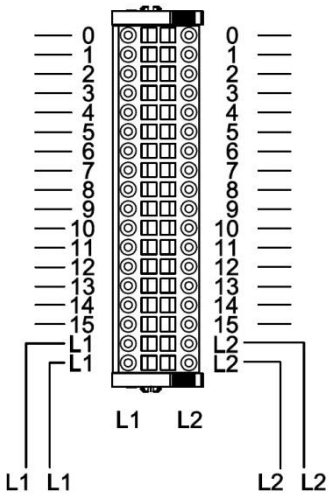
Approval: c UL us LISTED 59DM E202287 EtherCAT Conformance tested

6 Accessories

6.1 Power Distributor 2 x 16



Front view of power distributor



Power connectors

Terminals

The power distribution module 2 x 16 has two separate power lines.

It picks up the potential fed to connections L1 and L2 (0 VDC or 24 VDC, to the operator's discretion) and distributes its among the connections 0 to 15 along the same line.

The E-bus is fed through from the upstream to the downstream module.

Status LEDs

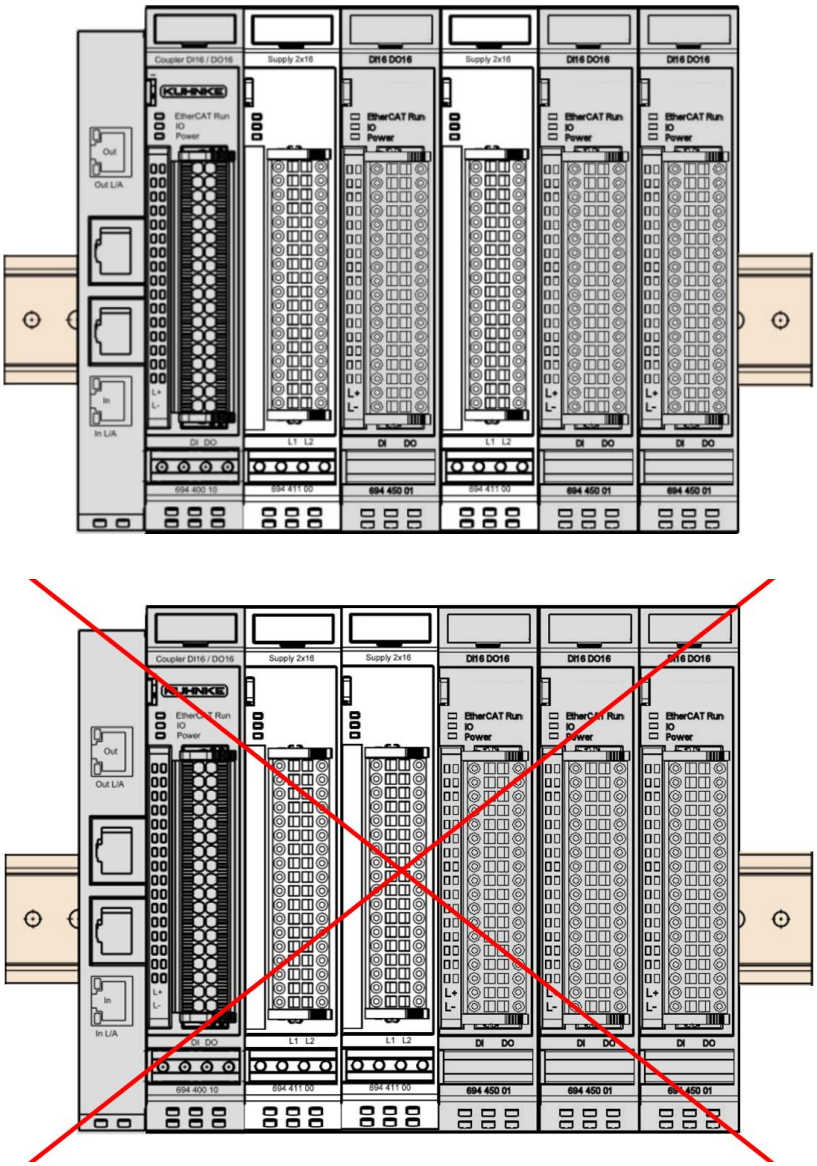
None.

Function

2-wire or 3-wire connection of digital IO modules.

Mounting

When mounting, you should make sure that you do not mount several potential distributors next to each other to prevent possible EMC problems. Please note the following connection example:



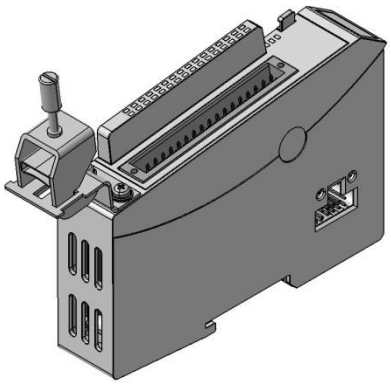
Technical Data

Power Distributor 2 x 16

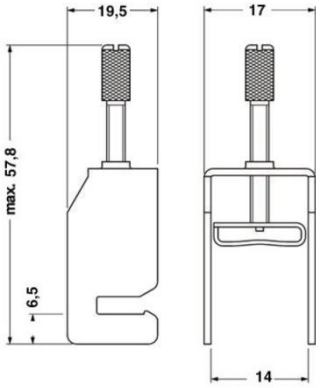
Power connection ..... 36-pin male
E-bus connector ..... 10-pole system plug in side wall
E-bus load..... none
Part no. 694.411.00

Approval:.....

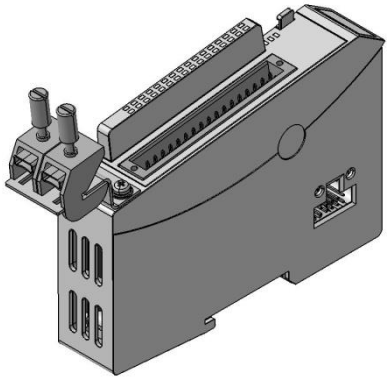
6.2 Shield Terminal



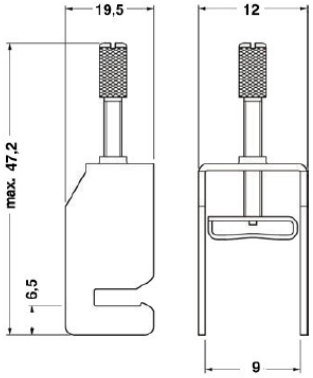
Shield terminal 1x14mm



Dimensions

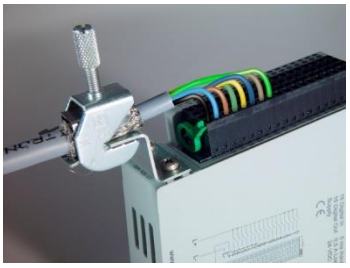


Shield terminal 2x8mm



Dimensions

Terminals



The shield terminal assembly consists of the actual shield terminal, the terminal bracket, tweo M3x5 screws, 2 washers, and 2 spring washers.

Use the 2 screws, washers and spring washers to mount the terminal bracket on the housing mount of the Kuhnke FIO module.

Screw the screws into the 2 holes tapped into the bottom of the front side.

Function

The shield terminal makes it easier for you to connect the cable shield. The terminal deflects the cable shield power to the DIN rails that the Kuhnke FIO module is snapped on to.

	NOTE
	Verify that the DIN rail is properly earthed.

	NOTE
	Do not use the shield terminals as a strain relief.

Technical Data

Shield Terminal 2x8mm

Shield terminals, 8mm. ..... 2 pcs:
Part no. 694.412.01

Shield Terminal 14mm

Shield terminals, 14mm. ..... 1 pcs:
Part no. 694.412.02

7 Configuration

The EtherCAT master needs to be configured to drive the EtherCAT network.

One major part of the configuration is to specify the EtherCAT slave stations.

There are two ways of documenting the properties of an EtherCAT slave.

1. The basic properties are stored in an EEPROM of the slave, whereas a XML device file (ESI file) describes the others.
2. All of the properties are stored in an EEPROM of the slave. (This method is not supported by every OEM supplier.)

The XML device files provide EtherCAT administrators with convenient options.

EtherCAT allows both, a configuration offline and the scanning of station data via an Ethernet line (online configuration).

The examples below are based around the standard ETG configuration tool (EtherCAT configuration tool supplied by Beckhoff Automation GmbH) which accesses the XML device files for both offline and online configuration.

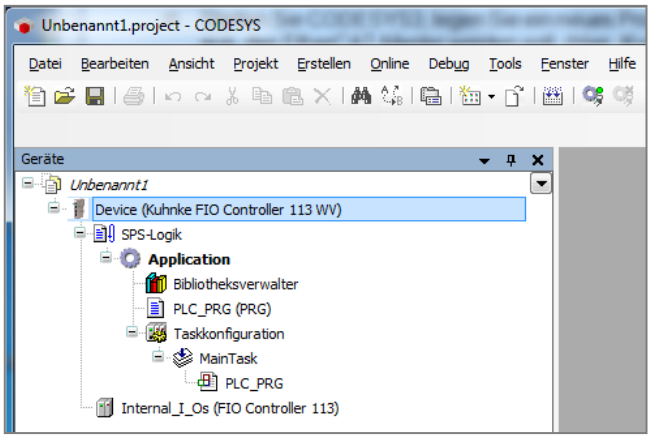
The file to use for Kuhnke FIO is called "KuhnkeEtherCATModulesAll.xml".

Copy file "KuhnkeEtherCATModulesAll.xml" to folder C:\Programs\EtherCAT Configurator\EtherCAT or, if you are using another tool, to the folder set for that tool.

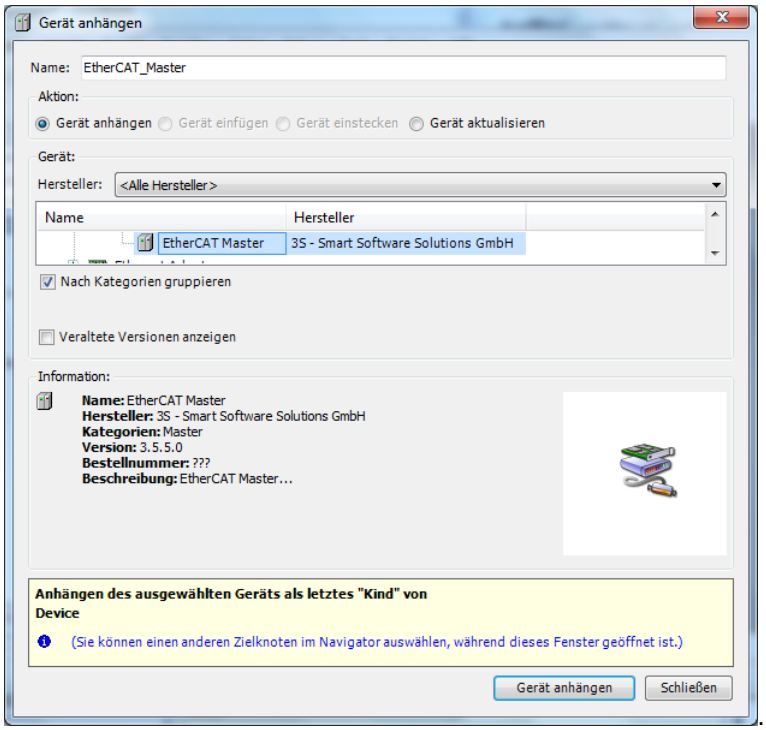
7.1 CODESYS V3 (CODESYS Configurator)

Offline Configuration

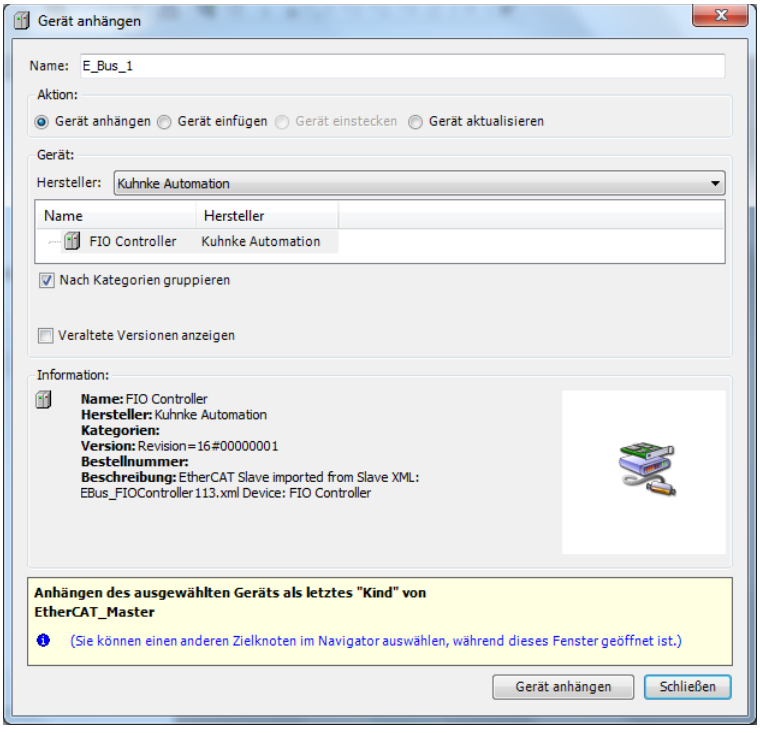
- Run CODESYS3, create a new project (default project), and select the device to become the EtherCAT master (here: "Kuhnke FIO Controller 113 WV").



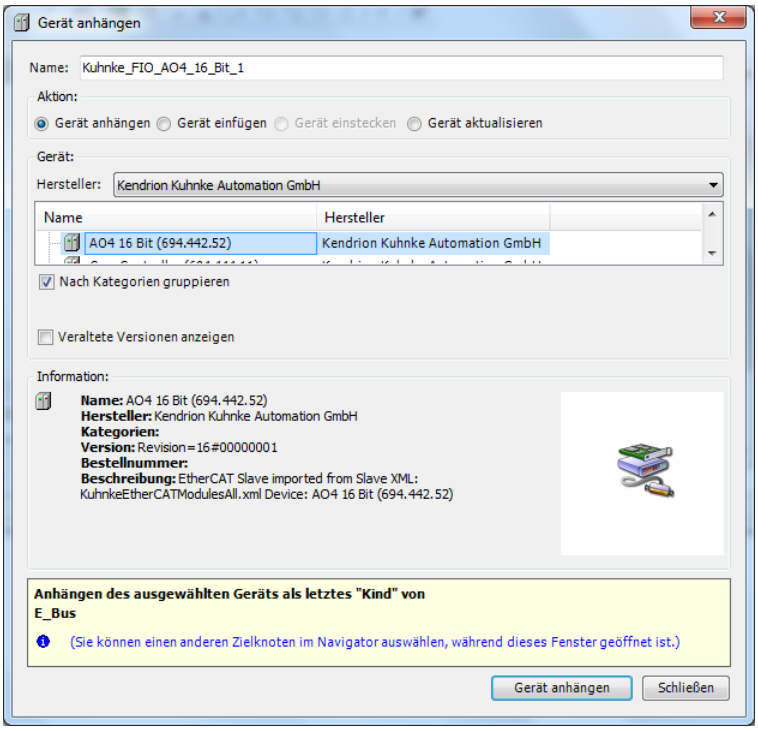
- Highlight the device and pick the 3S "EtherCAT Master" from the right-click menu.



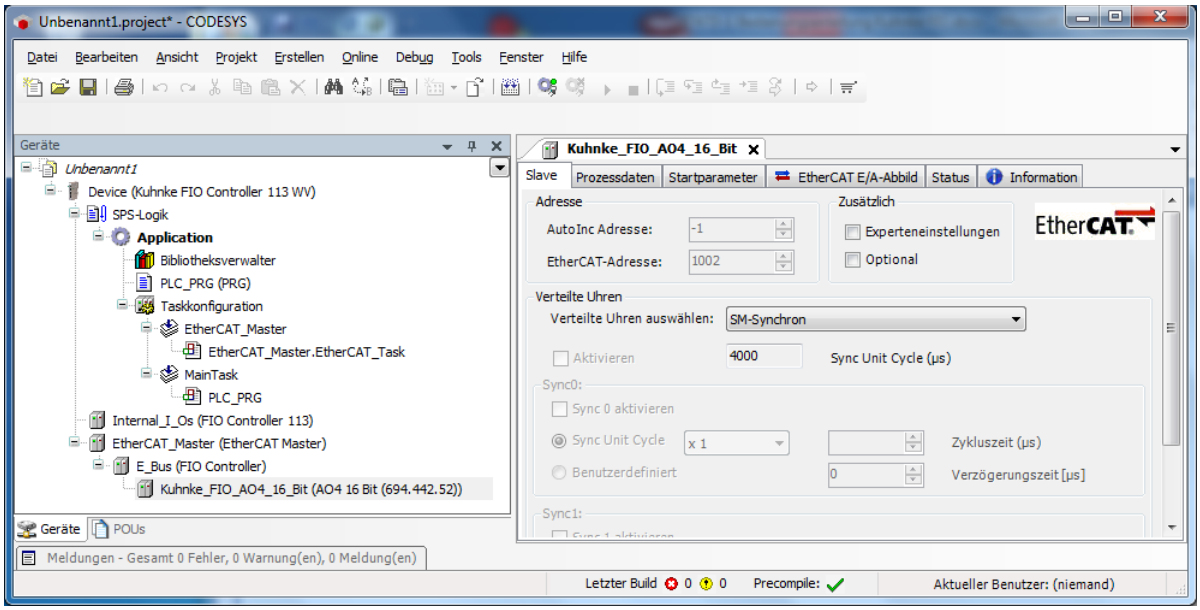
- Go down the list of devices, pick "EtherCAT_Master (EtherCAT Master)", and add Kuhnke Automation's "FIO Controller".



- Go down the list of devices, pick "E-Bus (FIO Controller)", and add Kendrion Kuhnke Automation's "AO4 16Bit".



- Now highlight "Kuhnke_FIO_AO4_16Bit" in the list of devices and make the appropriate settings on the right-hand side (see section "AO4 16Bit").



- Keep repeating the last two steps until your configuration is complete.

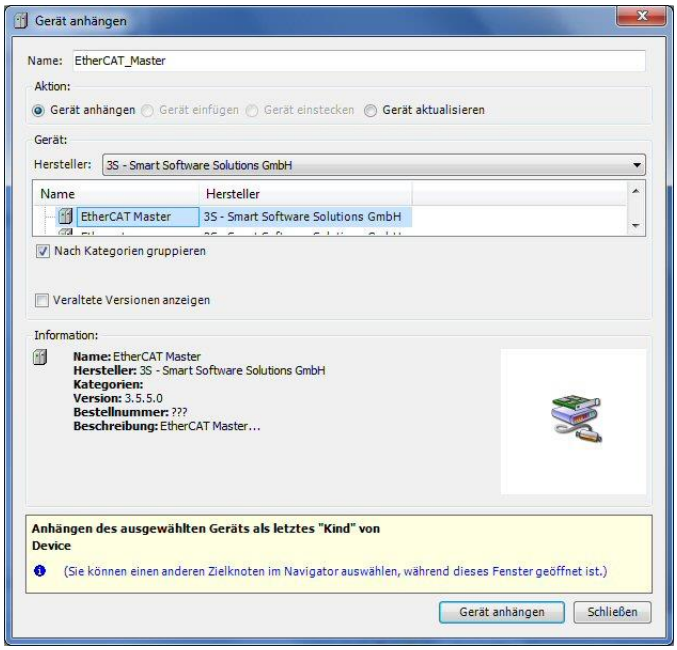
If the configuration is complete and all devices are connected to the programming PC, you can log in and run the configuration tool to test your Kuhnke FIO modules.

⚠	***DANGER***
	Set outputs only if you are sure that this will cause no harm.

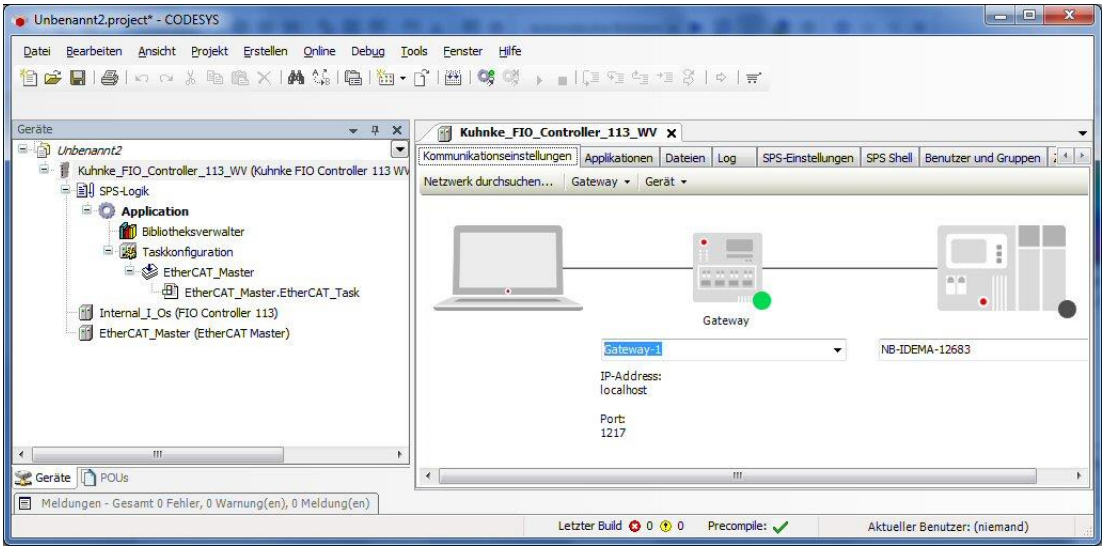
Online Configuration

EtherCAT allows you to scan the stations connected to an Ethernet line. The example below illustrates how to identify the actual configuration of an I/O unit consisting of a Kuhnke Controller 113, a Kuhnke FIO AI8-I module, and a Kuhnke FIO AI8-Pt/Ni/Tc module.

- Connect Kuhnke Controller 113 to the Kuhnke FIO AI8-I module and the Kuhnke FIO AI8-Pt/Ni/Tc module and turn on the power supply.
- Use a CAT5 cable to connect your PC's Ethernet port to your CoDeSys3 controm unit (Kuhnke Controller 113) (both a patch cable and a crossover cable will work).
- Run CoDeSys V3.
- Open a project for your CoDeSys3 control unit (Kuhnke Controller 113).
- Select "Device (…..Kuhnke FIO Controller 113)" and pick "Gerät anhängen" (add device).

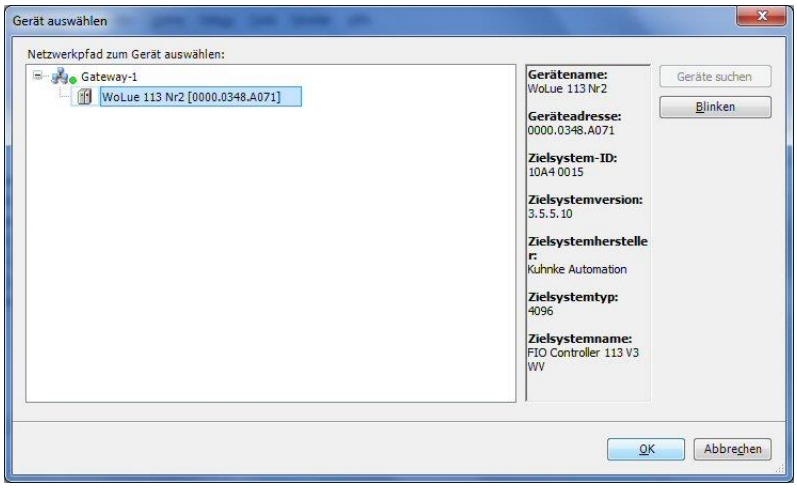


- Configure an EtherCAT master by adding an "EtherCAT Master" supplied by 3S-Smart Software Solutions GmbH to your device.

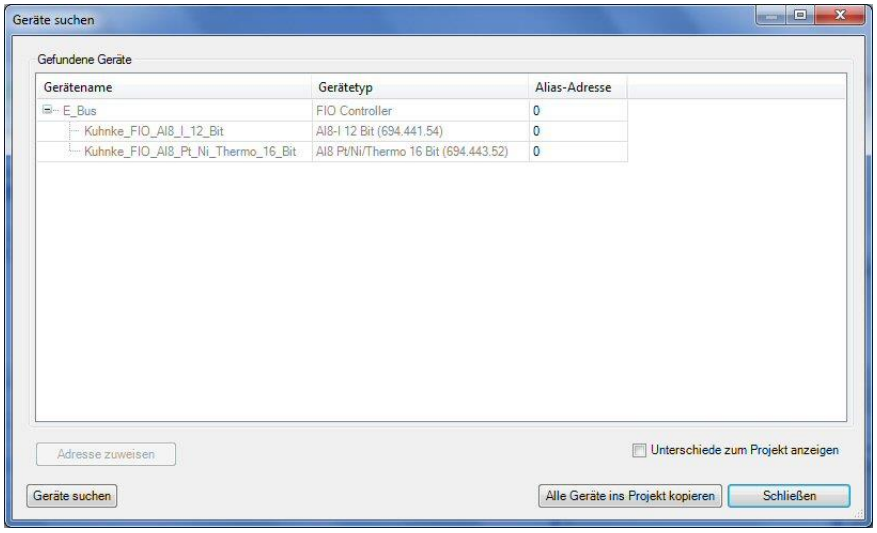


- Select "Device (…..Kuhnke FIO Controller 113)" and choose "Netzwerk durchsuchen" (search network).

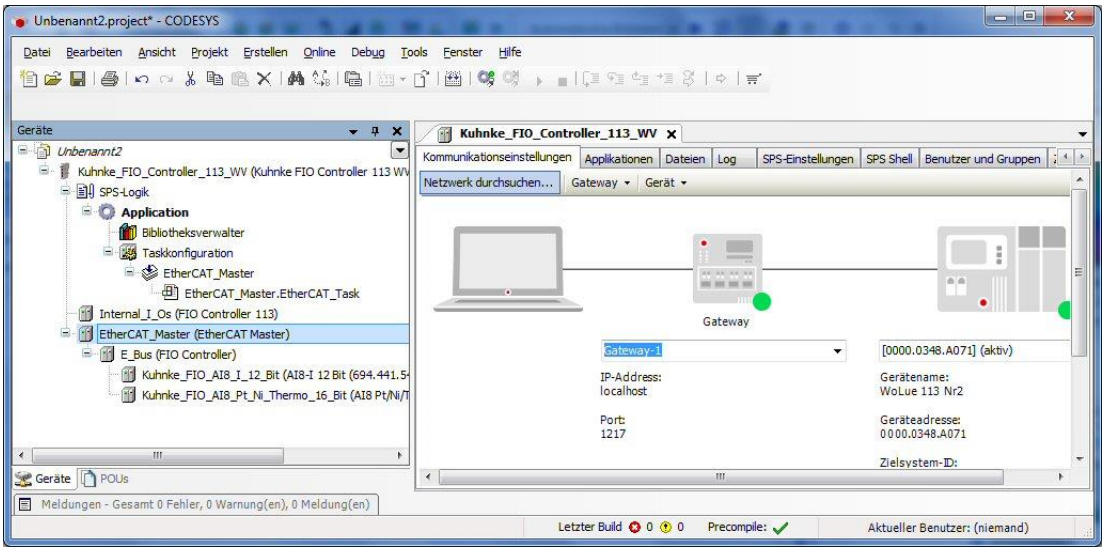
The software now scans the Ethernet network and finds the CoDeSys3 control unit connected to it.



- Now select "EtherCAT_Master" and choose "Netzwerk durchsuchen" (search network). CoDeSys scans your EtherCAT configuration.



- Click on "Alle Geräte ins Projekt kopieren" (copy all devices to the project).
  You have added your actual EtherCAT configuration to your project.



- Test the EtherCAT IOs.

⚠	***DANGER***
	Set outputs only if you are sure that this will cause no harm.

8 Appendix

8.1 Technical Data (Summarised)

System Properties of Kuhnke FIO

Fieldbus	EtherCAT 100 Mbit/s
Dimensions	25mm x 120mm x 90mm (W x H x D)
Housing mount	aluminium
Shield	connects directly to the module housing
Installation	35mm DIN rail
IO connection	spring-assisted combi plug with mechanical ejector, 4 … 36-pin
Signal indication	LED, local assignment to terminal
Diagnostics	LED: bus state, module state, broken wire/excessive current
Numer of connectors	up to 32 digital I/Os and 8 analogue channels per module
Supply voltage	24 VDC -20% / +25%
Overvoltage category	Overvoltage category 2
Numer of I/O modules	20 per bus coupler (total max. power consumption: 3A)
Electrical insulation	modules electrically insulated from one another and from the bus
Length of analogue signal lines	< 30m
Storage temperature	-25 …+ 70 [°C]
Working temperature	0…+ 55 [°C]
Rel. humidity	5...95 [%], non-condensing
Protection	IP20
Immunity to noise	Zone B to EN 61131-2, mounted on earthed DIN rail in earthed control cubicle
Permitted operating environment	Operation only permitted in an environment that at least complies with degree of protection IP54 according to IEC 60529 (eg suitable control cabinet)

Bus Coupler

Kuhnke FIO bus coupler

Part no.	694.400.00
Fieldbus	EtherCAT 100 Mbit/s 100 Base TX to IEEE802.3
Connection	2x RJ45
Controller	ASIC ET1100
Extension	connection to first Kuhnke FIO I/O module integrated in side panel of module
Diagnostics	LED: EtherCAT module state EtherCAT In/Out state

Kuhnke FIO Bus Coupler DI16/DO16

Part no.	694.400.10
Fieldbus	EtherCAT 100 Mbit/s 100 Base TX to IEEE802.3
Connection	2x RJ45
Controller	ASIC ET1100

Extension ..... connection to first Kuhnke FIO I/O module integrated in side panel of module
Diagnostics ..... LED: EtherCAT module state,
EtherCAT In/Out state
I/O state (summarised)
state of every I/O
Digital inputs ..... 16, 3 ms delay
Digital outputs ..... 16, load: 0.5 A, high-side semiconductor

Kuhnke FIO Bus Coupler DI8 DO8

Part no. 694.400.08
Fieldbus ..... EtherCAT 100 Mbit/s 100 Base TX to IEEE802.3
Connection..... 2x RJ45
Controller ..... ASIC ET1100
Extension ..... connection to first Kuhnke FIO I/O module integrated in side panel of module
Diagnostics ..... LED: EtherCAT module state,
EtherCAT In/Out state
I/O state (summarised)
state of every I/O
Digital inputs ..... 8, 3 ms delay
Digital outputs ..... 8, load: 0.5 A, high-side semiconductor

Kuhnke FIO Bus Coupler DI8 DO4

Part no. 694.400.04
Fieldbus ..... EtherCAT 100 Mbit/s 100 Base TX to IEEE802.3
Connection..... 2x RJ45
Controller ..... ASIC ET1100
Extension ..... connection to first Kuhnke FIO I/O module integrated in side panel of module
Diagnostics ..... LED: EtherCAT module state,
EtherCAT In/Out state
I/O state (summarised)
state of every I/O
Digital inputs ..... 8, 3 ms delay
Digital outputs ..... 4, load: 0.5 A, high-side semiconductor

Kuhnke FIO I/O Modules (General)

Fieldbus ..... EtherCAT 100 Mbit/s LVDS: E-bus
Controller ..... ASIC ET1200 or ET1100
Extension ..... connection to adjacent Kuhnke FIO I/O modules integrated in side panels of module
Diagnostics ..... LED: EtherCAT state
I/O states (summarised) *,
IO power supply state *
state of every I/O
(* if available)

Extender

Kuhnke FIO Extender 2 Port

Part no. 694.400.02
Ports 2x RJ45

Controller

Kuhnke FIO Controller 113

http://productfinder.kuhnke.kendrion.com

Kuhnke FIO Controller 116

http://productfinder.kuhnke.kendrion.com

Digital FIO Modules

Kuhnke FIO DI16/DO16 1ms/0.5A

Part no. 694.450.03
Digital inputs ..... 16, 1 ms delay
Digital outputs ..... 16, load: 0.5 A, high-side semiconductor

Kuhnke FIO DI16/DO16 5ms/0.5A

Part no. 694.450.01
Digital inputs ..... 16, 5 ms delay
Digital outputs ..... 16, load: 0.5 A, high-side semiconductor

Kuhnke FIO DI16/DO16 1ms/0.5A LS

Part no. 694.450.13
Digital inputs ..... 16, 1 ms delay, low/side
Digital outputs ..... 16, load: 0.5 A, low-side semiconductor

Kuhnke FIO DI16/DO8 1ms/1A

Part no. 694.450.02
Digital inputs ..... 16, 1 ms delay
Digital outputs ..... 8, load: 1 A, high-side semiconductor

Kuhnke FIO DI8/DO8 1ms/0.5A

Part no. 694.450.05
Digital inputs ..... 8, 1 ms delay
Digital outputs ..... 8, load: 0,5 A, high-side semiconductor

Kuhnke FIO DI8/DO8 5ms/0.5A

Part no. 694.450.04
Digital inputs ..... 8, 5 ms delay
Digital outputs ..... 8, load: 0,5 A, high-side semiconductor

Kuhnke FIO DI16 1ms

Part no. 694.451.03
Digital inputs ..... 16, 1 ms delay

Kuhnke FIO DI16 2-wire

Part no. 694.451.43
Digital inputs ..... 16, 1 ms delay
+16 x 24V each max. 1A

Kuhnke FIO DI32 1ms

Part no. 694.451.02
Digital inputs ..... 32, 1 ms delay

Kuhnke FIO DO8 1A

Part no. 694.452.02
Digital outputs ..... 8, load: 1 A, high-side semiconductor

Kuhnke FIO DO8 2A

Part no. 694.452.06
Digital outputs ..... 8, load: 2 A (∑ max. 10A), high-side semiconductor,

Kuhnke FIO DO16 0.5A

Part no. 694.452.01
Digital outputs ..... 16, load: 0.5 A, high-side semiconductor

Kuhnke FIO DO16 2-wire

Part no. 694.452.41
Digital outputs ..... 16, load: 1 A, high-side semiconductor
+16 Ground connections

Kuhnke FIO DO8 NO Relay 24V

Part no. 694.452.03
Digital outputs ..... 8, load: 5A (resistive) / 2A (inductive), n.o. relay
Swiching voltage ..... max. 24 VDC / VAC

Kuhnke FIO DO8 NO Relay 230 VAC

Part no. 694.452.04
Digital outputs ..... 8, load: 5A (resistive) / 2A (inductive), n.o. relay
Swiching voltage ..... max. 24 VDC/ 230 VAC

Analogue FIO Modules

Kuhnke FIO AI4, 12 Bit / AO4, 16Bit

Part no. 694.444.65
Analogue Inputs 4
Resolution ..... 12 Bit
Output signal ..... 0..10V, (0→10V: ≤22µs at 2kΩ/<200pF)
0..20mA, 4..20mA, (0→16V: ≤25µs at 300Ω/<1mH)

Output frequency ..... DC-synchron, SM-synchron
Analogue outputs..... 4
Resolution ..... 16 Bit
Output signal ..... 0..10V, +/- 10V, (0→10V: ≤22µs at 2kΩ/<200pF)
0..20mA, 4..20mA, 0..24mA, (0→16V: ≤25µs at 300Ω/<1mH)
Output frequency ..... DC-synchron, SM-synchron

Kuhnke FIO AO4, 16-Bit

Part no. 694.442.52
Analogue outputs..... 4
Resolution..... 16 bit
Output signal ..... 0..10V, +/- 10V, (at loads > 1kΩ, <1µF)
0..20mA, 4..20mA, 0..24mA, (at loads < 500Ω, <1mH)
(channels configure separately),
Output frequency ..... synchronised with DC / SM

Kuhnke FIO AO4, 12-Bit

Part no. 694.442.02
Analogue outputs..... 4
Resolution..... 12 bit
Output signal ..... 0..10V, +/- 10V, (at loads > 1kΩ, <1µF)
0..20mA, 4..20mA, 0..24mA, (at loads < 500Ω, <1mH)
(configurable),
Output frequency ..... 220 µs (constant)

Kuhnke FIO AI4/8-U 13-Bit

Part no. 694.441.52
Analogue inputs..... 4x differential signal or 8x single-ended
Resolution..... 13 bit
Measuring range ..... 0...10V, +/- 10V, +/- 5V, +/- 2.5V
Conversion time..... 464 µs (all channels)

Kuhnke FIO AI8/16-U 13-Bit

Part no. 694.441.53
Analogue inputs..... 8x differential signal or 16x single-ended
Resolution..... 13 bit
Measuring range ..... 0...10V, +/- 10V, +/- 5V, +/- 2.5V
Conversion time..... 580 µs (all channels)

Kuhnke FIO AI4-I 12-Bit

Part no. 694.441.51
Analogue inputs..... 4
Resolution..... 12 bit
Measuring range..... 0 …20mA, 4…20mA
Conversion time..... 235 µs (4 channels)

Kuhnke FIO AI8-I 12-Bit

Part no. 694.441.54

Analogue inputs 8
Resolution ..... 12 bit
Measuring range ..... 0 …20mA, 4…20mA
Conversion time ..... 290 µs (8 channels)

Kuhnke FIO AI4-Pt/Ni/TC 16-Bit

Part no. 694.443.51
Analogue inputs 4
Resolution ..... 16 bit
Measuring range ..... mV, Pt100, Pt1000, Ni100, Ni1000DIN43760, thermalcouple types K, J
Conversion time ..... 50 ms (adjustable)

Kuhnke FIO AI8-Pt/Ni/TC 16-Bit

Part no. 694.443.52
Analogue inputs 8
Resolution ..... 16 bit
Measuring range ..... mV, Pt100, Pt1000, Ni100, Ni1000DIN43760, thermalcouple types K, J
Conversion time ..... 50 ms (adjustable)

Mixed I/O Modules

Kuhnke FIO MIX 02

Part no. 694.444.62
Digital inputs ..... 4x 1ms, 1x 0.1ms, 3x 0.001 ms delay
Digital outputs 8x 0.5A, 16x 0.1A
Counters ..... 1 (clock, direction, reset)
Counting frequency ..... 500 kHz (up to 1 MHz)
Analogue inputs ..... 4x 0..+10 V, 12 bit
RS485 ..... 2.4..921.6 kBit/s, electrically insulated

Counter / Posi / Drive / CAM Modules

Counter2 5V

Part no. 694.444.01
Encoder inputs 2
Counting frequency ..... max. 200 kHz
Digital inputs ..... 8, 1 ms delay
Digital outputs ..... 2, load: 2.0 A, high-side semiconductor

Kuhnke FIO CounterPosi2 5V

Part no. 694.454.01
Encoder inputs 2
Counting frequency ..... max. 200 kHz
Digital inputs ..... 8, 1 ms delay
Digital outputs ..... 2, load: 2.0 A, high-side semiconductor

Analogue outputs..... 2, -10V..+10 V, 12 bit

Kuhnke FIO Drive Control

http://productfinder.kuhnke.kendrion.com

Kuhnke FIO CAM Control

http://productfinder.kuhnke.kendrion.com

Interface and Communication Modules

Kuhnke FIO RS485 1 Port

Part no. 694.455.02
Serial interface..... RS485, electrically insulated
Baud rate ..... 2400…115200 Bit/s
Payload data..... max. 152 bytes In/Out

Kuhnke FIO RS232 2 Port

Part no. 694.455.04
Serial interface..... 2x RS232, electrically insulated
Baud rate ..... 2400…115200 Bit/s
Payload data..... max. 152 bytes In/Out

Kuhnke FIO CAN Master/Slave

Part no. 694.455.06
Serial interface..... RS485, electrically insulated
Baud rate ..... 100,125, 250, 500 and 1000 kbit/s
Payload data..... 9 frames of max. 8 bytes In/Out per EtherCAT cycle

FIO Safety Modules

Kuhnke FIO Safety PLC

http://productfinder.kuhnke.kendrion.com

Kuhnke FIO Safety SDI4/SDO2

http://productfinder.kuhnke.kendrion.com

8.2 Order Specifications

Kuhnke FIO Modules

Link to the Product Finder	Part no.	ID no.	Power / IO connector
Controller			
Kuhnke FIO Controller 113	694.300.13	178.445	3-pin, 10-pin
Kuhnke FIO Controller 116	694.300.16	187.320	3-pin, 10-pin
Bus coupler / Extender			
Kuhnke FIO Bus Coupler	694.400.00	182.633	2-pin
Kuhnke FIO Bus Coupler DI16 DO16	694.400.10	184.111	36-pin
Kuhnke FIO Bus Coupler DI8 DO8	694.400.08	192.874	18-pin
Kuhnke FIO Bus Coupler DI8 DO4	694.400.04	193.512	18-pin
Kuhnke FIO Extender 2 Port	694.440.02	182.673	none
Digital FIO Modules			
Kuhnke FIO DI16 DO16 1ms/0.5A	694.450.03	182.642	36-pin
Kuhnke FIO DI16 DO16 5ms/0.5A	694.450.01	182.643	36-pin
Kuhnke FIO DI16 DO16 LS 1ms/0.5A	694.450.13	182.641	36-pin
Kuhnke FIO DI16 DO8 1ms/1A	694.450.02	176.617	36-pin
Kuhnke FIO DI8 DO8 5ms/0.5A	694.450.04	182.638	18-pin
Kuhnke FIO DI8 DO8 1ms/0.5A	694.450.05	182.637	18-pin
Kuhnke FIO DI16 1ms	694.451.03	182.639	18-pin
Kuhnke FIO DI16 2-wire	694.451.43	196.425	36-pin
Kuhnke FIO DI32 1ms	694.451.02	182.644	36-pin
Kuhnke FIO DO8 1A	694.452.02	176.618	18-pin
Kuhnke FIO DO8 2A	694.452.06	190.485	18-pin
Kuhnke FIO DO16 0.5A	694.452.01	182.646	18-pin
Kuhnke FIO DO16 2-wire	694.452.41	196.429	36-pin
Kuhnke FIO DO8 Relay NO 24V	694.452.03	184.720	18-pin
Kuhnke FIO DO8 Relay NO 230VAC	694.452.04	187.657	18-pin
Analogue FIO Modules			
Kuhnke FIO AI4, 12 Bit / AO4, 16Bit	694.444.65	192.357	36-pin
Kuhnke FIO AO4, 16-Bit	694.442.52	183.564	18-pin
Kuhnke FIO AO4, 12-Bit	694.442.02	182.632	18-pin
Kuhnke FIO AI4-I 12-Bit CoE	694.441.51	184.919	18-pin
Kuhnke FIO AI8-I 12-Bit CoE	694.441.54	183.279	36-pin
Kuhnke FIO AI4/8-U 13-Bit CoE	694.441.52	184.920	18-pin
Kuhnke FIO AI8/16-U 13-Bit CoE	694.441.53	184.921	36-pin
Kuhnke FIO AI4-Pt/Ni/TC	694.443.01	184.894	18-pin

Link to the Product Finder	Part no.	ID no.	Power / IO connector
Kuhnke FIO AI8-Pt/Ni/TC	694.443.02	184.895	36-pin
Counter / Posi / Drive / CAM Modules			
Counter2 5V	694.444.01	182.634	36-pin
Kuhnke FIO Counter/Posi2 5V	694.454.01	182.636	36-pin
Kuhnke FIO Drive Control Stepper / BLDC	694.454.16	178.789	36-pin
Kuhnke FIO CAM Control	694.444.11	186.682	36-pin
Mixed IO Modules			
Kuhnke FIO MIX 02 CoE	694.444.62	176.215	36-pin
Communication Modules			
Kuhnke FIO RS485 1 Port	694.455.02	187.270	18-pin
Kuhnke FIO RS232 2 Port	694.455.04	185.725	18-pin
Kuhnke FIO CAN Master/Slave	694.455.06	187.272	18-pin
Safety Modules			
Kuhnke FIO Safety PLC	694.330.00	178.779	none
Kuhnke FIO Safety SDI4 SDO2	694.430.00	186.696	18-pin
Kuhnke FIO Safety SDI8 SDO2	694.430.10	188.895	18-pin
Kuhnke FIO Safety SDI16 SDO4	694.430.20	192.405	36-pin
Kuhnke FIO Safety SDI16	694.431.00	192.406	36-pin

Kuhnke FIO Accessories

Link to the Product Finder	Part no.	ID no.	Connector
Kuhnke FIO Power Distributor			
Kuhnke FIO Power Distributor 2x16	694.411.00	155.915	36-pin
Kuhnke FIO Shield Terminal			
Kuhnke FIO Shield Terminal 2x8mm	694.412.01	154.008	-
Kuhnke FIO Shield Terminal 14mm	694.412.02	154.009	-

	Information
	The 2, 18 and 36-pin IO/Power connectors are included in the module package and part of the delivery. D-SUB connectors are not included but sold separately.

Name	Part no.	ID no.	Type
Kuhnke FIO Connector (black plug, black unlock button)			
Ventura FIO connector, 2-pin, 1x	694.102.02.01	178.638	Spring return, screw
Kuhnke FIO connector, 18-pin, 1x	694.101.18.01	178.640	Spring return, unlock button
Kuhnke FIO connector, 36-pin, 1x	694.101.36.01	178.642	Push-in, unlock button
Kuhnke FIO connector, 2-pin, 20x	694.102.02.20	178.639	Spring return, screw
Kuhnke FIO connector, 18-pin, 20x	694.101.18.20	178.641	Spring return, unlock button
Kuhnke FIO connector, 36-pin, 20x	694.101.36.20	178.643	Push-in, unlock button

Name	Part no.	ID no.	Type
Ventura FIO Connector (black plug, black unlock button)			
Ventura FIO connector, 2-pin, 1x	694.100.02.01	155.373	Spring return, unlock button
Kuhnke FIO connector, 18-pin, 1x	694.100.18.01	155.375	Spring return, unlock button
Kuhnke FIO connector, 36-pin, 1x	694.100.36.01	155.377	Spring return, unlock button
Kuhnke FIO connector, 2-pin, 20x	694.100.02.20	155.374	Spring return, unlock button
Kuhnke FIO connector, 18-pin, 20x	694.100.18.20	155.376	Spring return, unlock button
Kuhnke FIO connector, 36-pin, 20x	694.100.36.20	155.378	Spring return, unlock button

Name	Part no.	ID no.
PROFIBUS Connector		
PROFIBUS D-SUB Connector, termination resistance activates separately	645.180.00	93.288

9 Sales & Service

Please visit our Internet site to find a comprehensive overview of our sales and service network including all the relevant addresses. Feel free to also contact us at our headquarters in Malente/Germany



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