ECKELMANN
Industrieautomation

# E•FBM

## Analog Input and Output Modules AIO22U, AIO22I

## Technical Manual


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Release:

## Modification protocol

| Channel | Date | Person in charge | Modification | Release Date / Initial. |
|---|---|---|---|---|
| All | 01/15/01 | E. Baun | First edition | |
| All | 10/26/04 | W. Niebling | Complete editorial revision | |
| 2.13, 2.14 | 03/14/05 | WN | Fault corrected of Life-LED in diagram | |
| 1.4 , 9 | 12/05 | WN | New chapter standards, CE declaration deleted | |
| 2.10, 3 | 10/07 | JP | Changes in analog filter specifications | |
| | 10/2011 | WN | V2.3: Humidity chnanged | |

# Table of contents

# 1 Introduction

Together with the technical data, this documentation includes general information and instructions regarding the intended use of the analog input and output module AIO22 of the E•FBM series.

## 1.1 System manual E•FBM

The system manual includes general information about the field bus modules of series E•FBM.

Moreover, this manual includes the respective instructions regarding the intended use of the field bus modules.

## 1.2 Intended use

The components are supplied ex works with a fixed hardware and software configuration setting suited to meet the respective field of application. Modifications shall be permitted only within the framework of the options documented in the manuals. All other modifications to the hardware and software as well as the not intended use of the components shall exclude any liability of the ECKELMANN AG.

## 1.3 Use of the product and documentation

The use of the product described in this manual is intended to be made exclusively by technically qualified and especially trained staff with a training in PLC programming, by skilled persons or by persons trained by skilled persons who are in addition familiar with the valid standards.

Knowledge, correct interpretation and technically perfect implementation of the included provisions and instructions are the prerequisite for a safe installation, commissioning and operation of the described components. Reference to additional documentation is made, if necessary. This documentation is to be used within the same meaning.

ECKELMANN AG shall assume no liability for misaction and damage to Eckelmann products or products of third supplies caused by the non-observance of the information included in this manual.


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## 1.4 Standards and approvals

The product complies with the following directives

| | | |
|---|---|---|
| 89/336/EEC | Electromagnetic compatibility | EMC directive |
| 73/23/EEC | Electrical Equipment designed for use within certain voltage limits | Low voltage directive LVD |

The CE-conformation declaration is available from ECKELMANN AG.

# 2 Characteristic features of the modules

## 2.1 General

Module AIO22 of series E•FBM is a mixed analog input and output module with two inputs and outputs each. The module is available in two variants, i.e. as voltage variant AIO22U and as current variant AIO22I.

## 2.2 Module variants, options

This manual is valid for the following module variants.

### 2.2.1 Variants of the AIO22U

| | **Order number** | **2 analog inputs/outputs for 0..10V or -10..10V, 12 bit resolution Autobaud recognition at the CAN bus** |
|---|---|---|
| AIO22U | FBMAIO22U1 | With screw-type terminal connection |
| AIO22U | FBMAIO22U5 | With COMBICON connection plug |

### 2.2.2 Variants of the AIO22I

| | **Order number** | **2 analog inputs/outputs for 0..20mA, 12 bit resolution Autobaud recognition at the CAN bus** |
|---|---|---|
| AIO22I | FBMAIO22I1 | With screw-type terminal connection |
| AIO22I | FBMAIO22I5 | With COMBICON connection plug0 |


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## 2.2.3 Accessories

| Order number | Accessories for | |
|---|---|---|
| FBMSTS404 | FBMAIO22U5<br>FBMAIO22I5 | Set of matching plugs for COMBICON connection, 4 plugs<br>screw-type terminal (Phoenix Contact MSTB 2.5/ 4-ST KMGY, no. 1946312) |
| FBMSTF404 | FBMAIO22U5<br>FBMAIO22I5 | Set of matching plugs for COMBICON connection, 4 plugs<br>spring-force terminal (Phoenix Contact FKCT 2.5/ 4-ST KMGY, no. 1921900) |
| KLZCP0001 | FBMAIO22U5<br>FBMAIO22I5 | Coding section (Phoenix Contact CP-MSTB, no. 1734634) for COMBICON terminal (packing unit=100)<br>Coding element (Phoenix Contact CR-MSTB, no. 1734401) for COMBICON housing (packing unit=100) |

## 2.3 Characteristic features of the AIO22U, AIO22I

- Analog input/output module for 2 analog input/output signals each

  AIO22U: 0..10V (switchable to -10V .. 10V), AIO22I: 0 - 20 mA
- 12 bit resolution
- Sensor supply: AIO22U: 10V, AIO22I: 24V
- Parameterizable digital recursive 2nd order filter for the inputs
- Parameterizable threshold monitoring of the inputs
- Parameterizable signal generator
- Parameterizable PID controller
- Integrated sensor supply
- Indicator LED for life check
- Module address settable on the front by means of rotary switch
- 16 modules per node that can be addressed at the CAN bus
- Autobaud recognition at the CAN bus
- Screw-type terminal connection, variant with plugable terminals available
- Width of module housing 22.5 mm

The electrical characteristics of the module with COMBICON connection are the same as those of the module with screw-type terminal connection.


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## 2.4 Additional functions

### Digital 2nd order filter of the inputs

The two module inputs can be filtered via a parameterizable 2nd order low-pass filter each with a parameterizable cut-off frequency of 33 .. 5 Hz.

### Behavior of the outputs in case of malfunction

The behavior of the outputs in case of malfunction can be parameterized.

### Threshold value monitoring

The two module inputs can be monitored on the basis of a parameterizable threshold value each. Upon enabling of the threshold value monitoring by the controller, the exceeding of the preset threshold value by the input value is signaled to the controller.

### Suppression of minor input changes

The transmission conditions of the event-controlled transmission of an analog input can be parameterized by means of a „minimum change amount“. The transmission of the respective TxPDO is again enabled when the absolute change of the analog input has exceeded the change amount after the last transmission.

### Signal generator

The signal generation in the analog output module makes an autonomous generation of a preprogrammed voltage curve at the outputs of the module possible.

The advantage is the time-synchronous output of the voltage curve, an unloading of the superordinate controller and a reduction of the data transfer on the CAN bus. This function supports the output of quick, cyclic curves, e.g. during valve control where a subordinate oscillation or repeated defined lift characteristics are required.

### PID controller

The controller function is an additional function of the analog input and output modules. This function makes an independent control of the analog voltage at the module output possible. The controlling variable is determined on the basis of the setpoint received from the controller, of the actual value read at the input and of the configured controller parameters and is output at the analog output.

## 2.5 Supply voltage field level

The module does not need an external voltage supply but is supplied exclusively by the internal ME bus.

## 2.6 Sensor supply

### 2.6.1 AIO22U

The module has a sensor supply each for the input channels and makes a controlled voltage of 10 V at the terminals available.

### 2.6.2 AIO22I

The module has a sensor supply each for the input channels and makes a controlled voltage of 24 V at the terminals available.

Please observe that the masses of the 24V system voltage and the analog mass of the two input channels are connected.

## 2.7 Monitoring of the supply voltage

The module includes a monitoring unit of the 24V ME bus system voltage. The voltage is used for the generation of the sensor supply and the supply voltage of the internal analog components. In the case of an error, an emergency message is sent to the superordinate controller.

Please check the system manual for further information about the emergency messages.

## 2.8 Life LED indicating the operating state of the module

The life LED (“life light”) is positioned in the upper part of the module and indicates the operating state of the module. Both the single operating states of the module and the life LED are described in the chapter Start-up. The function of the life LED can be parameterized via the CAN bus by means of object 2000H.


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## 2.9 Inputs and outputs

Depending on the variant, the module can make available either current or voltage inputs and outputs.

### 2.9.1 AIO22U

The input and output ranges are 0 to 10 V or –10 V to +10 V.

### 2.9.2 AIO22I

The input and output range is 0 to 20 mA.

### 2.9.3 Electrical isolation

The input part with the microcontroller and the CAN bus are electrically isolated from each other. The supply voltage of the module electronics is decoupled by means of a DC/DC converter.

## 2.10 Adapting of the hardware to the analog inputs

### 2.10.1 AIO22U

The module has analog converters that make operating ranges of 0 to 10 V or ±10 V possible for inputs and outputs.

Inputs not used are to be connected directly at the module with the mass in order to minimize interferences. An analog low pass with attenuation of 20db / octave up to 650 Hz and 40db / octave above 650 Hz and the cut-off frequency of 30 Hz follows after a balancing of the input voltage or the input load impedance. A 12 bit A/D converter follows the analog filter.

### 2.10.2 AIO22I

The current inputs have an active limiting that starts at approx. 35 mA and does not permit a higher input current. The internal load impedance is protected in this way.

Inputs not used are to be connected directly at the module with the mass in order to minimize interferences. An analog low pass with attenuation of 20db / octave up to 650 Hz and 40db / octave above 650 Hz and the cut-off frequency of 30 Hz follows after a balancing of the input voltage or the input load impedance. A 12 bit A/D converter follows the analog filter.

## 2.11 Preprocessing of the signals by means of the software

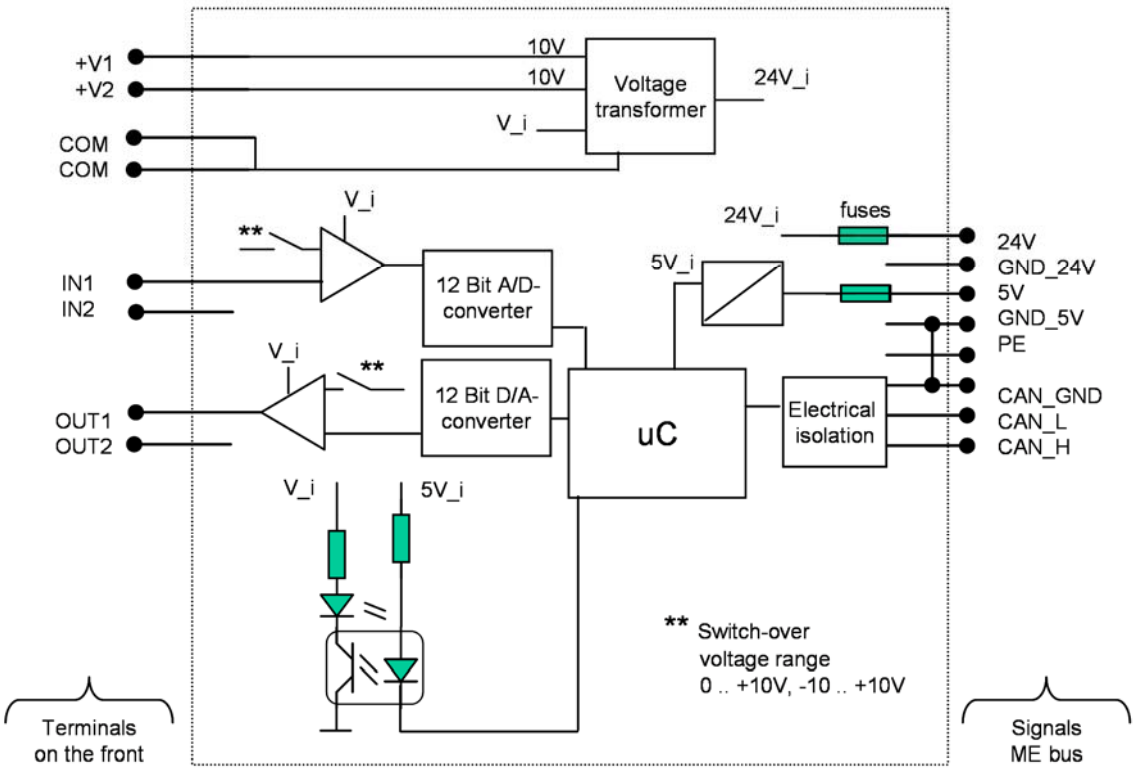
The voltage made available by the hardware is sampled at 205 Hz. The digitized values are corrected in the controller in compliance with the balancing values and are passed to the digital recursive 2nd order filter.

Subsequently, the processed values are adapted to the CANopen format and are sent to the CAN master via the CAN bus, if the transmission conditions are met.

## 2.12 Serial EEPROM

The module is equipped with a serial EEPROM to make a non-volatile storage of the configuration parameters possible, such as balancing values, filter parameters etc. The storage of the configuration parameters is enabled by the write access to a determined CANopen object. The loading of the configuration parameters is made during each system initialization or also during the write access to the CANopen object made available for that.

## 2.13 Schematic diagram AIO22U





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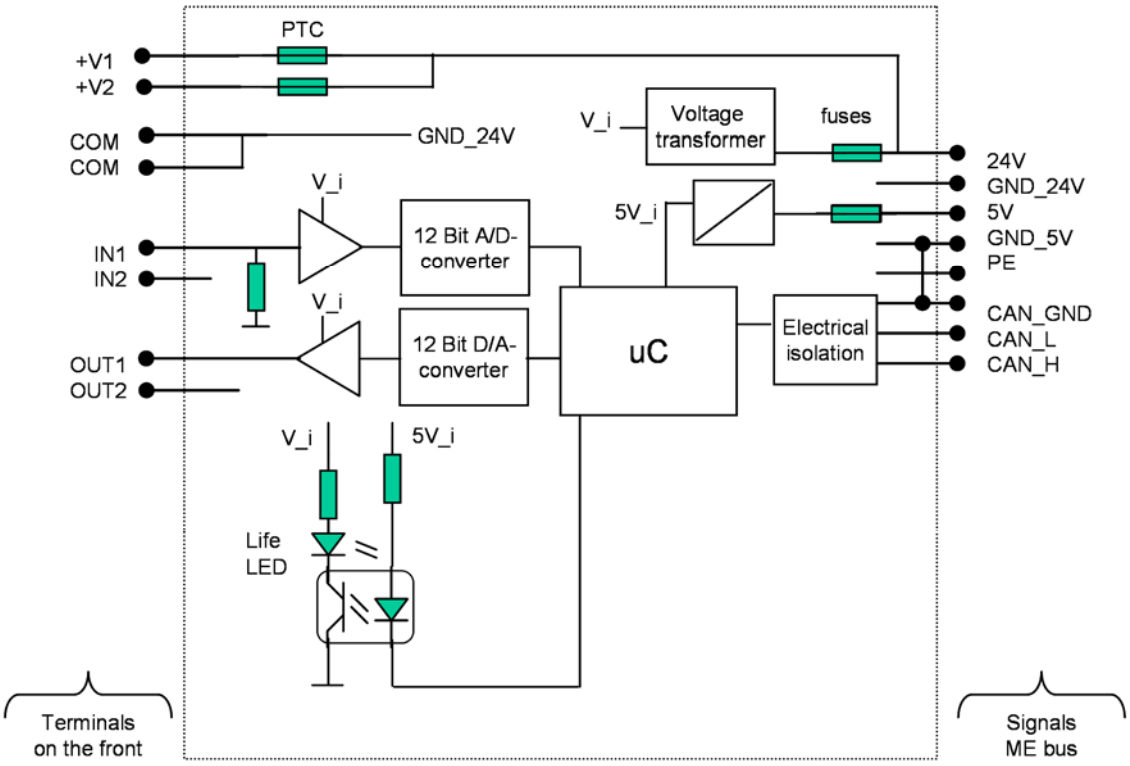
## 2.14 Schematic diagram AIO22I



# 3 Technical data

## 3.1 General

| General data | |
|---|---|
| Use<br>AIO22U<br>AIO22I | 2-channel analog input/output module<br>0 V or -10 V to +10 V<br>0 or 4 to 20 mA |
| Indication | LED indicating operating state<br>parameterizable via CANopen object 2000H |
| Module addressing | 4 bit, freely selectable in the range 30h to 3Fh |
| Connection system | Direct screw-type terminals optionally COMBICON connector system with screw-type terminals or spring-force plugs |
| Weight | 125 g |
| Installation height | min. 180mm |
| Dimensions (H x W x D) | 99 mm x 22.5 mm x 114.5 mm<br>The dimensions are valid for the screw-type terminal connection and the COMBICON connection without matching plugs |

| Supply | |
|---|---|
| Supply voltages<br>Control voltage for sensor supply<br>Logic voltage | <br>typ. 24V DC (18...32V DC) supply via ME bus<br>typ. 5.0V DC (4.75...5.25V DC) via ME bus |
| Current input | max. 160 mA via 5 V system bus<br>max. 180 mA via 24 V system bus |
| Power loss | max. 6.2 W |

| Fusing | |
|---|---|
| Fusing:<br>Sensor supply<br>Logic part<br>System voltage | <br>PTC current limiting at AIO22I<br>SMD fuse 500 mA, slow<br>SMD fuse 1500 mA, slow |
| Protection | 24 V system voltage is protected by an unambiguous connecting direction in the housing.<br>5 V bus voltage is protected by an unambiguous connecting direction in the housing.<br>The sensor supply is protected against short-circuit, overcurrent and recovery.<br>Current and voltage input (optional) are protected against voltages of up to 32 V |
| Electrical isolation:<br>Between ME bus and input/output terminals | <br>500 V DC |
| Recovery | Up to max. ±32 V is possible at an input/output terminal |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| Environment | Transportation and storage | Operation |
|---|---|---|
| Ambient temperature | -20°C to +70°C | 0°C to +50°C<br>In case of max. load, vertical mounting and sufficient convection |
| Temperature change | max. 20 K/h | max. 10 K/h |
| Relative humidity (not condensing) | 5% to 95% | 5% to 95% |
| Shock (10 ms) | max. 15 G | max. 5 G |
| Vibration (10 to 100 Hz) | max. 2 G | max. 0.5 G |
| Air pressure | 660 hPa to 1060 hPa | 860 hPa to 1060 hPa |
| Type of protection | IP20 | |

## 3.2 Technical data AIO22U

| Inputs AIO22U | |
|---|---|
| Current input: | |
| Input impedance | > 500 kOhm |
| Measuring range (switchable) | 0 to 10 V or –10 V to +10 V<br>max. 0 to 10.238 V or–10.238 V to +10.238V |
| Max. voltage at the input | 32 V |
| Resolution | 12 bit |
| Conversion method | Successive approximation |
| Value of LSB | 2.5 mV for measuring range 0 to 10 V or<br>5 mV for measuring range -10 V to +10 V |
| Inaccuracy | max. 50 mV for measuring range 0 to 10 V or<br>max. 100 mV for measuring range -10 V to +10 V |
| Sample frequency | 205 Hz |
| Filter | Analog low pass with attenuation of 20db / octave up to 650 Hz and 40db / octave above 6500 Hz and the cut-off frequency of 30 Hz.<br>Digital configurable low-pass filter |
| Admissible sensor types | Active and passive sensors |
| Sensor supply, sensor current | 10 V, controlled, max. 10 mA |
| Protection | Input protection by means of high-ohmic voltage divider, protection of the sensor supply by longitudinal diodes and active current limitation<br>ESD protection by means of transil diodes at the PE |
| Admissible connection lines | Shielded lines with connected shield in front of the module |

| **Outputs AIO22U** | |
|---|---|
| Voltage output: | |
| Output range (switchable) | 0 to 10 V or –10 to +10 V<br>max. 0 to 10.238 V or –10.238 V to +10.238 V |
| Max. output current | 2 mA |
| Min. load impedance | 5 kOhm |
| Resolution | 12 bit |
| Value of LSB | 2.5 mV or 5 mV |
| Inaccuracy | max. 50 mV or 100 mV |
| Output rate | min. 10 ms continuously, min. 5 ms continuously (digital input filter switched off) |
| Filter | Analog 1st order low pass filter with a cut-off frequency of approx. 730 Hz |
| Protection | Output protection by means of passive current limitation, longitudinal and parallel diodes, short-circuit-proof<br>ESD protection by means of transil diodes at the PE |
| Admissible connection lines | Shielded lines with connected shield in front of the module |

## 3.3 Technical data AIO22I

| **Inputs AIO22I** | |
|---|---|
| Current input: | |
| Input impedance | < 150 Ohm |
| Value of load impedance | 100 Ohm |
| Measuring range | 0 or 4 to 20 mA<br>max. 0 or 4 to 20.475 mA |
| Max. admissible permanent current through the load impedance | 50.0 mA |
| Resolution | 12 Bit |
| Conversion method | Successive approximation |
| Value of LSB | 5 µA |
| Inaccuracy | max. 140 µA |
| Sample frequency | 205 Hz |
| Filter | Analog low pass with attenuation of 20db / octave up to 650 Hz and 40db / octave above 6500 Hz and the cut-off frequency of 30 Hz.<br>Digital, configurable low-pass filter |
| Admissible sensor types | Active and passive sensors |
| Sensor supply, sensor current | 24 V, of system voltage, max. 20 mA |
| Protection | Input protection by means of bipolar active current limiting per channel, protection by passive current limiting<br>ESD protection by means of transil diodes at the PE |
| Admissible connection lines | Shielded lines with connected shield in front of the module |

| **Outputs AIO22I** | |
|---|---|
| Current output: | |
| Value of load impedance | max. 500 Ohm |
| Output range | 0 or 4 to 20 mA<br>max. 0 or 4 to 20.475 mA |
| Resolution | 12 bit |
| Value of LSB | 5 µA |
| Inaccuracy | max. 140 µA |
| Output rate | min. 10 ms continuously, min. 5 ms continuously (digital input filter switched off) |
| Filter | Analog 1st order low pass filter with a cut-off frequency of approx. 800 Hz |
| Protection | Output protection by means of passive current limitation, longitudinal and parallel diodes |
| Admissible connection lines | ESD protection by means of transil diodes at the PE<br>Shielded lines with connected shield in front of the module |

# 4 Mounting and installation

## 4.1 Module housing

All modules of series E•FBM have modular ME BUS housings. As a general rule, the housing is composed of a lower part and an upper part with the electronic system. For further details regarding the housing design please check the system manual.

## 4.2 Mounting

All modules of series E•FBM can be directly snapped on a mounting rail TS35 with a height dimension of 7.5 or 15mm as per European Standard EN 50022.

The mounting is easy and space-saving. The single modules are safely connected and positioned thanks to the 10-pole cross connection integrated in the housing bottom. Both the energy supply of the control electronics and the transmission of the bus signals are made via this cross connection.

The installation position must be vertical in order to ensure sufficient ventilation. On the top and on the bottom, a clearance of at least 80 mm should be kept for the module.

## 4.3 ESD protection

When handling the module, always take suited ESD protective measures, such as bracelets, conductive supports and suited packing material.

Make the following checks:

- Checking of the entire system for correct wiring
- Checking of the set CAN address
- Checking of the correct ME bus contacting
- Checking of the correct grounding


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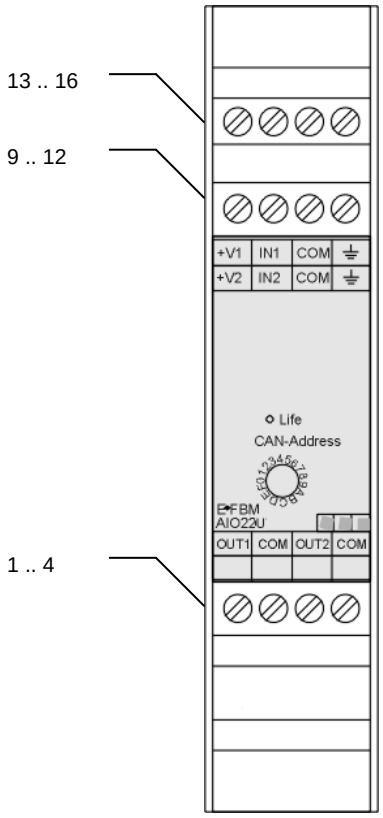
## 4.4 Terminal markings AIO22U

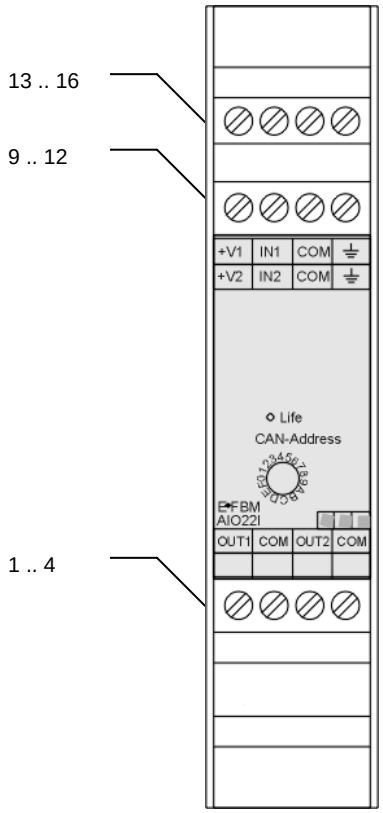
The pin assignment of the two variants AIO22U and AIO22I differs in the signal potentials. The markings are the same for the two modules.




| Terminal | Marking | Signal | Comment |
|---|---|---|---|
| 14, 10 | IN1.. IN2 | 2 analog inputs 0..10V (-10..10V) | |
| 1, 3 | OUT1, OUT2 | 2 analog outputs 0..10V (-10..10V) | |
| 13, 9 | +V1, +V2 | Sensor supply 10V | |
| 15, 11, 2, 4 | COM | Reference potential sensor supply | Terminals internally bridged |
| 16, 12 | ⏚ | Shielding | Terminals internally bridged |

## 4.5 Terminal markings AIO22I

The pin assignment of the two variants AIO22U and AIO22I differs in the signal potentials. The markings are the same for the two modules.

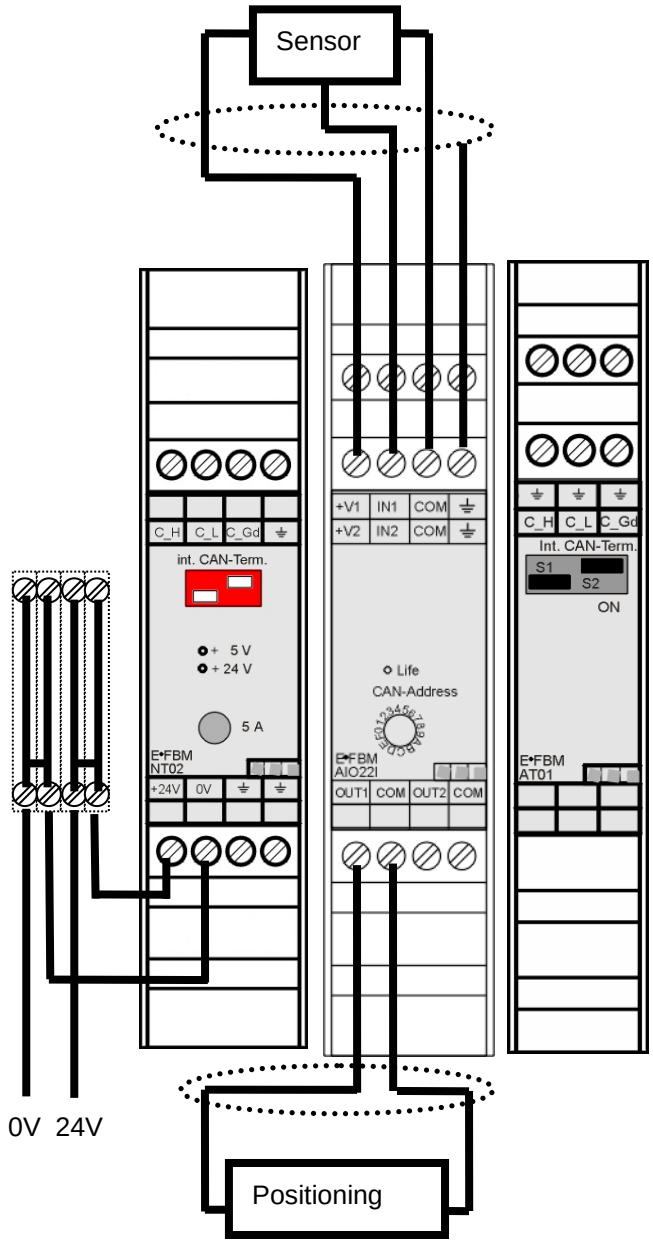



| Terminal | Marking | Signal | Comment |
|---|---|---|---|
| 14, 10 | IN1.. IN2 | 2 analog inputs 0..20 mA | |
| 1, 3 | OUT1, OUT2 | 2 analog outputs 0..20 mA | |
| 13, 9 | +V1, +V2 | Sensor supply 24V | |
| 15, 11, 2, 4 | COM | Reference potential sensor supply | Terminals internally bridged |
| 16, 12 | ⏚ | Shielding | Terminals internally bridged |

## 4.6 Example of connection AIO22I (AIO22U)

The voltage output V2 supplies a sensor with the voltage 24V. The sensor is connected at the second analog input with shielded lines.

The wiring diagram is also valid for module AIO22U. In case of this module, a voltage of 10V is output at the output V2.




**Note:**

For the connection of a sensor to an input with –10..10V, this sensor is to be equipped with an external voltage.

For an increase of the discharge capacity of the shield, the latter should be contacted on a large area in front of the module. A connection at the module is omitted.

# 5 Start-up

The start-up of the module can be made after the mechanical and the electrical installation of the field bus modules.


Supply voltage on: As soon as the supply voltage has been switched on, the module is in the state of automatic baud rate recognition. The life LED in the upper part of the module is flashing at 8 Hz. Upon recognition of the baud rate, an internal initialization of the module is made. Subsequently, the module is in the internal state „*Pre-operational*“. The module is now ready for operation and attends control signals via the CAN bus. The life LED is flashing at 0.25 Hz.

Initialization of the module: Upon successful initialization of the module via the CAN bus (e.g. by a controller) with the signal „Start-remote-node“, the module is in state „*Operational*“. The life LED is on (permanently).

All inputs are to be controlled and the specified voltage and current values are to be checked.

Module stopped: If the signal „Stop-remote-node“ is sent via the CAN bus, the module passes to the state „*Stopped*“. The module attends the respective signal to leave this state. In this state, the life LED is permanently off.

The life LED mode can be modified via the CAN bus (see chapter Parameterizing). Therefore, the statements made for the life LED are only valid for the default setting.

## 5.1 Shield

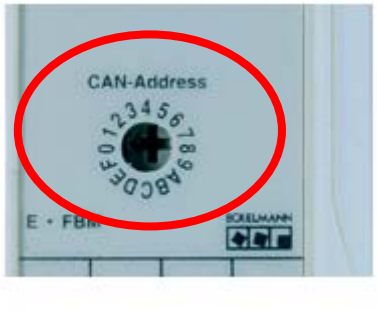
Only shielded lines are permitted for the inputs and outputs. The shield are to be connected on a large area immediately in front of the input terminals, in order to have interferences discharged already in front of the module.

The module-internal PE terminals should not be used in order to meet all specified EMC requirements.

# 6 Programming and parameterizing

## 6.1 Setting of the node address

Each E•FBM module of a line is to be set with an unambiguous node address at the CAN bus.

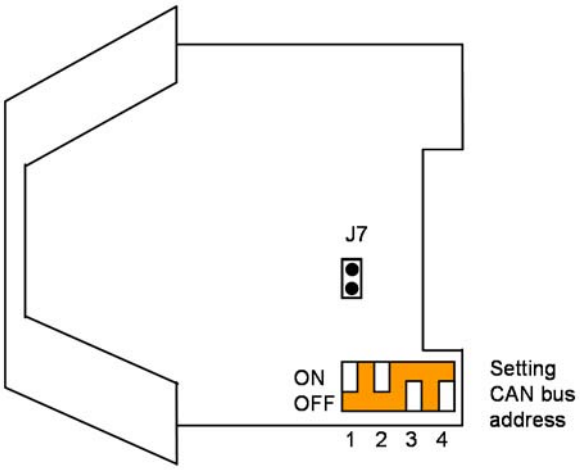



The setting of the node address is made via a hexagonal switch on the front (4 low-value address bits) and via a coding switch inside the housing (3 higher-value address bits). Therefore, max. 16 modules are possible within one module type by coding via the hexagonal switch.

| Module type | Higher-value address bits firmly set via the internal coding switch | Low-value address bits, settable on the front via the hexagon switch | Set node address (hex) | Set node address (decimal) |
|---|---|---|---|---|
| AIO22x<br>CNT02 | 30H | 0…FH | 30H…3FH | 48 .. 63 |

When setting the node address, make sure that no double assigning of modules to the same node address at the CAN bus occurs, i.e. several modules of the above table at the same CAN bus need to have differently set hexagon switches.

## 6.2 AIO22 bridges and coding switches




The basis address (higher-value address bits) of the CAN bus can be modified by means of the 4-pole DIL switch. Normally, the preset address should not be modified.

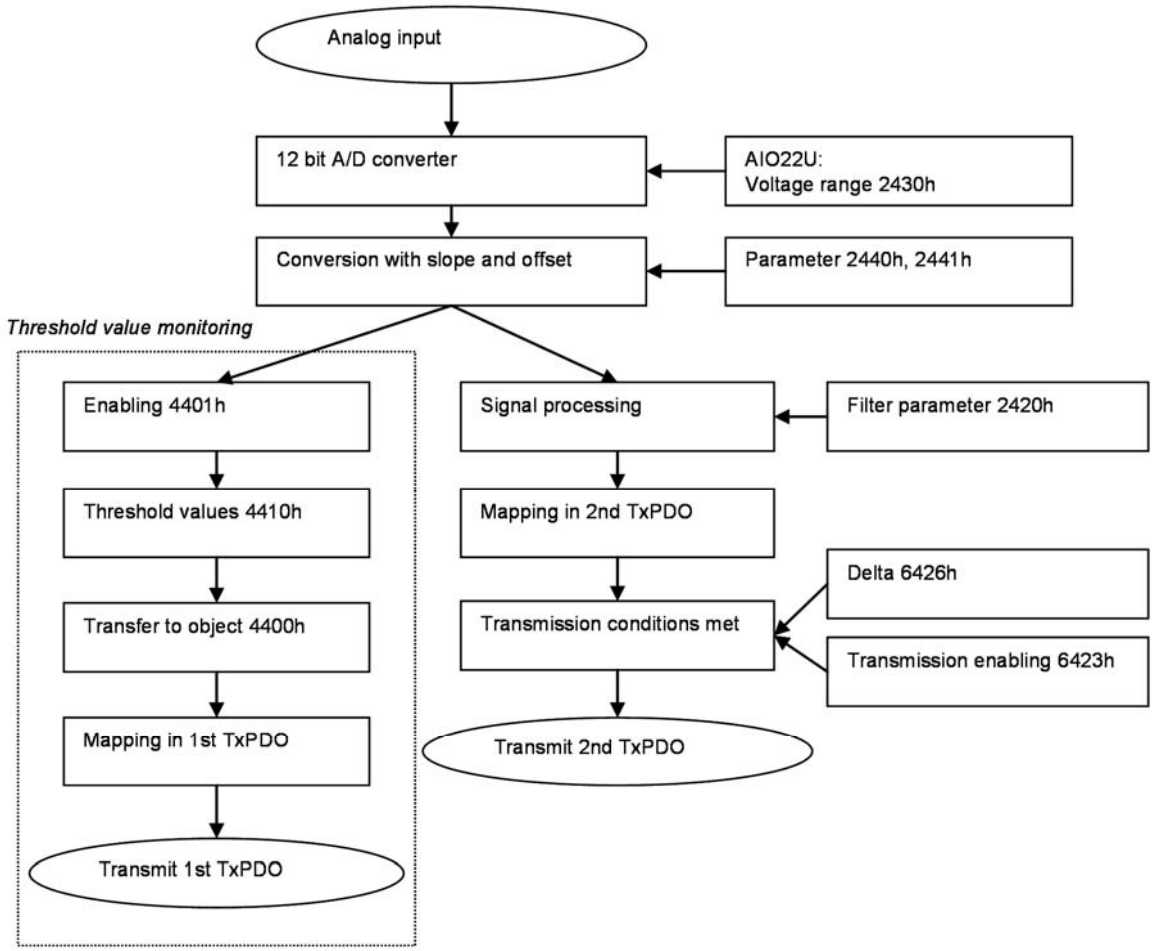
Note: The setting of the basis address is made by means of the DIL switches 1 .. 3. The setting of the DIL switches 4 (ON or OFF) has no influence on the resulting basis address

| DIL switch 1 | DIL switch 2 | DIL switch 3 | DIL switch 4 | Resulting basis address | Presetting AIO22 |
|---|---|---|---|---|---|
| OFF | OFF | OFF | OFF | 00H | |
| ON | OFF | OFF | OFF | 10H | |
| OFF | ON | OFF | OFF | 20H | |
| ON | ON | OFF | OFF | 30H | √ |
| OFF | OFF | ON | OFF | 40H | |
| ON | OFF | ON | OFF | 50H | |
| OFF | ON | ON | OFF | 60H | |
| ON | ON | ON | OFF | 70H | |

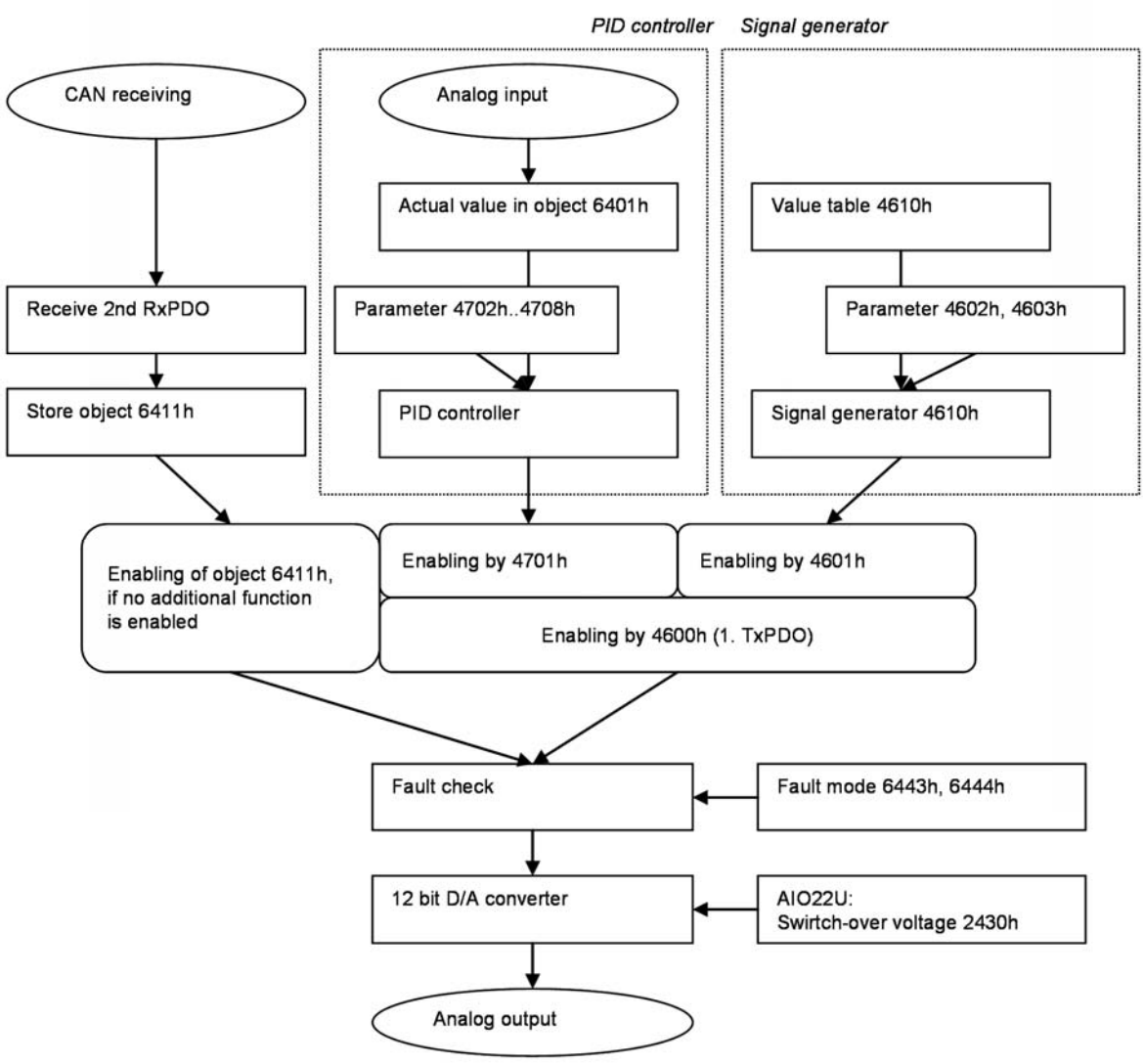
Bridge J7 is provided for an optional termination of the CAN bus. With closed bridge, a resistance of 120 Ohm is added on the ME bus between the lines CAN_L and CAN_H. In normal operation, the bridge must not be closed.

## 6.3 Signal and data flow

The configuration parameters and the data flow for a signal input are displayed in the following diagram.



The configuration parameters and the data flow for a signal output are displayed in the following diagram.





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## 6.4 Parameterizing

After power-on and the subsequent internal initialization it is possible to parameterize the following objects by means of SDO transfer:

Communication profile area:

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Guard time (ms) | 100C | 0 | unsigned 16 | 0 .. 65535 | 0 |
| Life time factor | 100D | 0 | unsigned 8 | 0 .. 255 | 0 |
| Heartbeat time (ms) | 1017 | 0 | unsigned 16 | 0 .. 65535 | 0 |
| Inhibit time for 1. TxPDO (0.1 ms) | 1800 | 3 | unsigned 16 | 0 .. 2550 | 0 |
| Inhibit time for 2. TxPDO (0.1 ms) | 1801 | 3 | unsigned 16 | 0 .. 2550 | 0 |

Standardized device profile area:

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Suppression of minor input modifications | 6426 | 1, 2 | See the following chapter | | |
| Transmission enabling for TxPDO | 6423 | 0 | unsigned 8 | 0: disabled<br>1: enabled | 1 |
| Behavior of the analog outputs in the error state | 6443, 6444 | 1, 2 | See the following chapter | | |
| NMT behavior of the module in case of severe communication errors | 67FE | 1 | unsigned 8 | 0: pre-operational<br>1: not modified<br>2: stopped | 0 |

Manufacturer-specific profile area:

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Mode of life LED | 2000 | 1 | See the following chapter | | |
| Filter parameters | 2420 | 1, 2 | See the following chapter | | |
| Value range of inputs and outputs | 2430 | 1, 2 | See the following chapter | | |
| Balancing of inputs: calculated correction slope of the analog input | 2440 | 1, 2 | See the following chapter Balancing of inputs | | |
| Balancing of inputs: calculated correction offset of the analog input | 2441 | 1, 2 | | | |
| Balancing of inputs: measured minimum value of the analog input | 2442 | 1, 2 | | | |
| Balancing of inputs: measured maximum value of the analog input | 2443 | 1, 2 | | | |
| Balancing of inputs: measured minimum value of the analog input for range -10…+10V | 2444 | 1, 2 | | | |
| Balancing of inputs: measured maximum value of the analog input for range -10…+10V | 2445 | 1, 2 | | | |

Manufacturer-specific profile area (additional functions):

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Threshold value monitoring at the inputs | 4401, 4410 | 1, 2 | See the following chapter | | |
| Enabling of signal output PID controller, signal generator | 4600 | 1, 2 | See the following chapter | | |
| Signal generator | 4601.. 4610 | 1, 2 | See the following chapter | | |
| PID controller | 4701.. 4707 | 1, 2 | See the following chapter | | |

### 6.4.1 Suppression of minor input modifications

Minor input modifications can be suppressed via a settable minimum value. The function requires the following parameters. The sub-index 1, 2 corresponds to channel 1, 2.

| Meaning | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Minimum modification amount analog input | 6426 | 1, 2 | unsigned 32 | 0 .. 65535 | 2 |

Object 6426h „Delta“ defines the transmission conditions of the event-controlled transmission of the analog inputs, in this case: „minimum modification amount“. The transmission of the respective TxPDO is again enabled if the absolute modification of the analog input has exceeded the modification amount since the last transmission.

The Delta value refers to object 6426h. A bit in object 6426h corresponds to a value of the maximum range (20, 475mA) divided by 4095.

The table includes some examples for the parameterizing of Delta.

| Entry in object 6426 (hexadecimal) | Corresponds to the minimum required input modification for the range 0...20mA of | Corresponds to the minimum required input modification for the range 0...10V of | Corresponds to the minimum required input modification for the range -10...+10V von |
|---|---|---|---|
| 0002 | 10 µA | 5 mV | 10 mV |
| 0004 | 20 µA | 10 mV | 20 mV |
| 000A | 50 µA | 25 mV | 50 mV |

## 6.4.2 Behavior of the analog outputs in case of malfunction

The function makes the presetting of a determined behavior of the analog outputs in case of malfunction possible. The function requires the following parameters. The sub-index 1, 2 corresponds to channel 1, 2.

| Meaning | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Fault mode | 6443 | 1, 2 | unsigned 8 | 0: last admissible value<br>1: predefined state | 1 |
| Fault value | 6444 | 1, 2 | integer 32 | -32768 .. 32767 | 0 |

With the parameter „Fault mode“ (object 6443h) it is defined whether in case of malfunction an output (object 6411h) is to assume a predefined value (stored in object 6444h) or the last valid value.

With the parameter „Fault value“ (object 6444h), the output voltage is defined in case of a device error with respectively set „Fault mode“.

The data format of a value in output n is defined as follows:

(Object 6444h, sub-index n) = (object 6411h, sub-index n) * 65536

The data format of object 6444h is represented in the following table:

In the range

0...+10V, 0...20mA

| Object 6444h, sub index n (hexadecimal) | Corresponds to object 6411h, sub-index n | AIO22U output [mV] | AIO22I Output [mA] |
|---|---|---|---|
| 00000000 | 0 | 0.0000 V | 0.0000 mA |
| 00080000 | 8 | 0.0025 V | 0.0050 mA |
| 7D000000 | 32000 | 10.000 V | 20.000 mA |
| 7FF80000 | 32760 | 10.238 V | 20.475 mA |

In the range

–10...10V

| Object 6444h, sub-index n (hexadecimal) | Corresponds to object 6411h, sub-index n | AIO22U output [mV] |
|---|---|---|
| 80000000 | -32768 | -10.238 V |
| 83000000 | -32000 | -10.000 V |
| FFF00000 | -16 | -0.005 V |
| 00000000 | 0 | 0.0000 V |
| 00100000 | 16 | 0.005 V |
| 7D000000 | 32000 | 10.000 V |
| 7FF00000 | 32752 | 10.238 V |


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### 6.4.3 Mode of life LED

The operating states of the FBM are visually indicated by means of the life LED. The function of the life LED can be parameterized via the CAN bus by means of object 2000h.

| Meaning | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Mode of the life LED | 2000 | 1 | unsigned 8 | 0, 1 | 0 |

Two possible indication patterns of operating states can be parameterized by means of object 2000h for FBM states.

| | (Index 2000h, sub-index1) = 0 | (Index 2000h , sub-index1) = 1 |
|---|---|---|
| FBM state after voltage on (automatic baud rate recognition) | Flashing at 8 Hz, 1:1 | |
| FBM state „Pre-operational“ | Flashing at 0.25 Hz, 1:1 | Flashing at 0.25 Hz, 1:1 |
| FBM state „Operational“ | „permanently on“ | Flashing at 1 Hz, 1:1 |
| FBM state „Stopped“ | „permanently off“ | Flashing at 0.25 Hz, 7:1 („long-time on“ and „short-time off“) |

### 6.4.4 Digital 2nd order filter for the inputs

Measured values can be smoothed by a digital 2nd order filter. The function requires the following parameters. The sub-index 1, 2 corresponds to channel 1, 2.

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Cut-off frequency of filter | 2420 | 1, 2 | unsigned 8 | 0 .. 6 | 0 |

Object 2420h, sub-index1 and sub-index2 define the cut-off frequency of the digital recursive 2nd order filter for each analog input.

| Object 2420h Sub-Index1 Sub-Index2 | Cut-off frequency, Hz |
|---|---|
| 0 | No filter |
| 1 | 33,33 |
| 2 | 25 |
| 3 | 20 |
| 4 | 14,3 |
| 5 | 10 |
| 6 | 5 |

The resulting signal attenuation of the respective input results from the attenuation of the analog filter and the attenuation damping of the digital filter.

The filter is not active if the value 0 is indicated in the object.

## 6.4.5 Value ranges of inputs and outputs

Object 2430h defines the value range of inputs and outputs of the respective channel. The following ranges can be set. The sub-index 1, 2 corresponds to channel 1, 2.

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Value range of inputs and outputs AIO22U | 2430 | 1, 2 | unsigned 16 | 1: 0.. 10V<br>2: -10.. 10V | 1 |
| Value range of inputs and outputs AIO22I | 2430 | 1, 2 | unsigned 16 | 32: 0 .. 20 mA | 32 |

| Contents object 2430h (hex) | AIO22U<br>Voltage inputs and outputs | AIO22I<br>Current inputs and outputs |
|---|---|---|
| 0001 | 0...10V | -- |
| 0002 | -10...+10V | -- |
| 0020 | -- | 0...20 mA |

## 6.4.6 Threshold value monitoring at the inputs (starting with SW-V1.07)

This function makes a monitoring of the input voltage possible.

The respective bits of the virtual digital input are set as soon as the limit values are exceeded. The virtual inputs are sent in 1.TxPDO (object 4400h) of the analog input module. In this way, this analog input module is treated as a module with mixed inputs (analog and digital). The function requires the following parameters. The sub-index 1, 2 corresponds to channel 1, 2.

| Meaning | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Enabling of the virtual digital input | 4401 | 1, 2 | unsigned 8 | 0: disabled<br>>0: enabled | 0 |
| Threshold values, eight for each channel | 4410 | 1, 2 | See description | | |

Parameterizing of the threshold values (object 4410, sub-index 1..2):

During parameterizing of the 8 threshold values of each input, a box with 16 bytes (2 bytes each for a threshold value) is transmitted for each input to the AIO22. Each threshold is composed of a 16 bit word SXXXXXXXXXXXX000 with S: sign (two's complement), X: data (12 bit). When exceeding the threshold, the respective bits of the virtual logic input are set.


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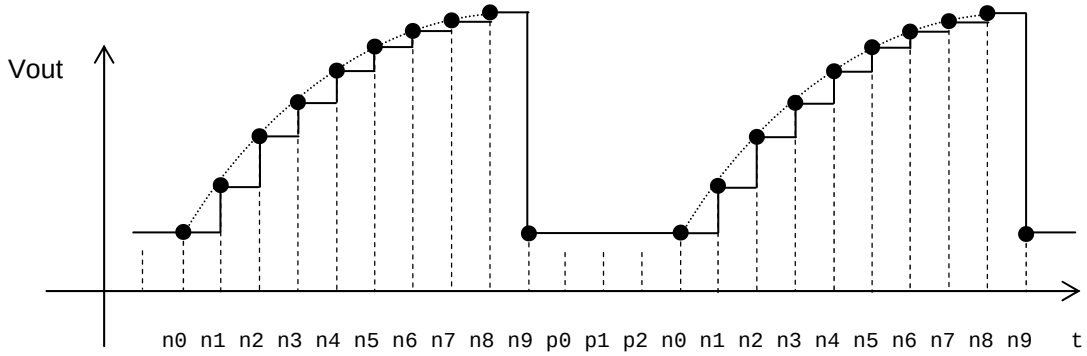
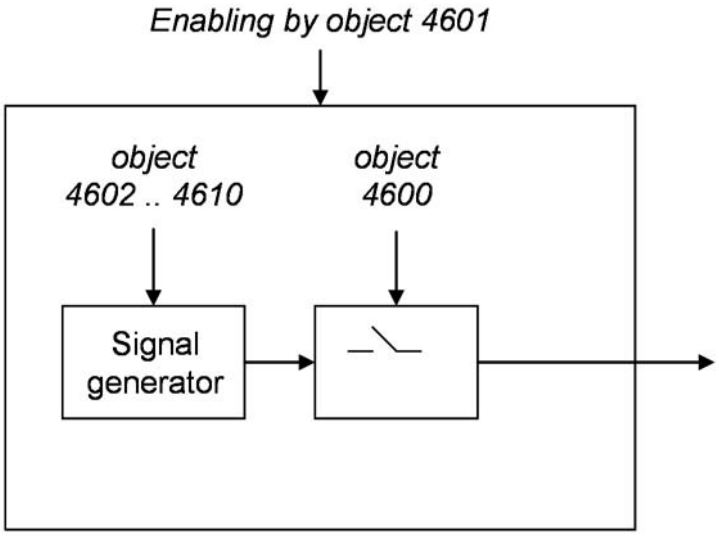
### 6.4.7 Signal generator

The module software includes a signal generator.

For the realization of this function, a table is reserved in the module storage for each output with max. 32 values (2 bytes each). The values are read and output in a parameterized interval $\Delta t$ from the table for the generation of the analog voltage at the module output. The length of the period results from the total of $n_x$ output values and $p_x$ interval values in the interval $\Delta t$.




The signal generation is configured with the following parameters. The sub-index 1, 2 corresponds to channel 1, 2.



| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Enabling of the signal output PID controller, signal generator | 4600 | 1, 2 | unsigned 8 | 0: disabled<br>>0: enabled<br>*See note 4* | 0 |
| Enabling of the signal generator | 4601 | 1, 2 | unsigned 8 | 0: disabled<br>>0: enabled<br>*See note 1* | 0 |
| ∆t: Interval between the output of the single values | 4602 | 1, 2 | unsigned 8 | 1...100 ms | 0 |
| nx: Number of output values per period | 4603 | 1, 2 | unsigned 16 | 0...32<br>*See note 2* | 32 |
| px: Number of intervals after the output of nx values, while the analog output value remains constant with the last output value of nx | | | | 0...32<br>*See note 2* | 32 |
| Vout: Analog output values max. 32 per channel | 4610 | 1, 2 | See description | *See note 3* | 0 |

**Note 1:** Upon each enabling of the signal generator by object 4601h, its parameters are set to default values. Upon enabling, the additional objects of the signal generator are available for writing or reading.

**Note 2:** The first byte (low byte) includes the number of output values nx. The second byte (high byte) includes the number of intervals after the output px, where the last output value remains unchanged.

**Note 3:** During parameterizing of the output values, a domain of the size 64 byte (2 byte each for an output value) is transmitted to the AIO22 for each channel. Each output value is composed of a 16 bit word SXXXXXXXXXXX000 with S: sign (two's complement), X: data (12 bit)

**Note 4:** The signal output is enabled only if the respective object 4600h is set by the controller. This object can be addressed as virtual digital output by the controller via the 1. RxPDO. Upon enabling, the signal generator starts the output of value n0.

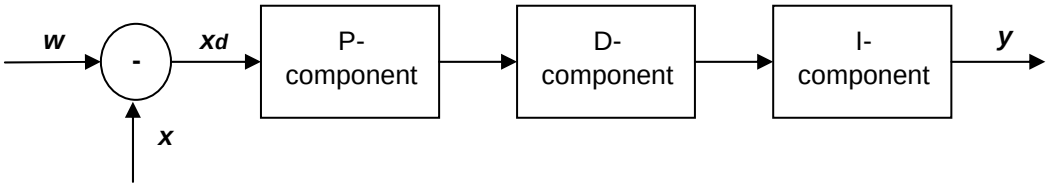
If this virtual output is not set, an analog value previously transmitted by the controller is output at the analog output.

Since the signal output is an autonomous activity of the output modules, the analog values change without presetting by the controller, provided a respective configuration had been made.

## 6.4.8 PID controller

The software of the module includes a PID controller. For an implementation of this function, the module AIO22 requires the controller parameters and the enabling of the controller functions.

### 6.4.8.1 Signal flow diagram of the PID controller




| Parameter | Meaning |
|---|---|
| *w* | Setpoint (preset analog output value in object 6411h) |
| *x* | Actual value |
| *y* | Correcting variable |
| *xd* | Control difference *w – x* |

### 6.4.8.2 PID algorithm

The PID algorithm is realized as follows (source: Edgar Dittmar „ Mikrocomputer-Einsatz in der Automatisierung“, Vogel Verlag, 1st edition 1979, ISBN 3-8023-0574-4):

$$y_i = K_{PM} * \left( x_{di} + \frac{T_S}{T_N} * \sum_{i=0}^{i=n} x_{di} + \frac{T_V}{T_S} * \left( x_{di} - x_{di\,-\,1} \right) \right)$$

with the constants

Gain of the algorithm $$K_{PM} = \left( 1 + \frac{T_v}{T_n} \right) * K_P$$

Integer constant of the algorithm $$\frac{T_S}{T_N} = \frac{T_S}{T_n + T_v}$$

Differential constant of the algorithm $\frac{T_V}{T_S} = \frac{T_v}{\left(1 + \frac{T_v}{T_n}\right) * Ts}$

The algorithm constants are configured with the following parameters:

Gain of the algorithm K_PM $K_{PM} = \left(1 + \frac{T_v}{T_n}\right) * K_P$

Integrator time of the algorithm T_N $T_N = T_n + T_v$

Derivative time of the algorithm T_V $T_V = \frac{T_n * T_v}{T_n + T_v}$

Scanning time of algorithm T_S $Ts$

The parameters of the algorithm constants are deviated from the parameters of the PID controller function in the time range

$$y = \left(1 + \frac{T_v}{T_n}\right) * K_P * x_d + K_P * \left(\frac{1}{T_n} * \int_{-\infty}^{t} (x_d * dt) + T_v * \frac{d}{dt} x_d\right)$$

that have the following meaning

Controller gain of the PID controller $K_p$

Integrator time of the PID controller $T_n$

Derivative time of the PID controller $T_v$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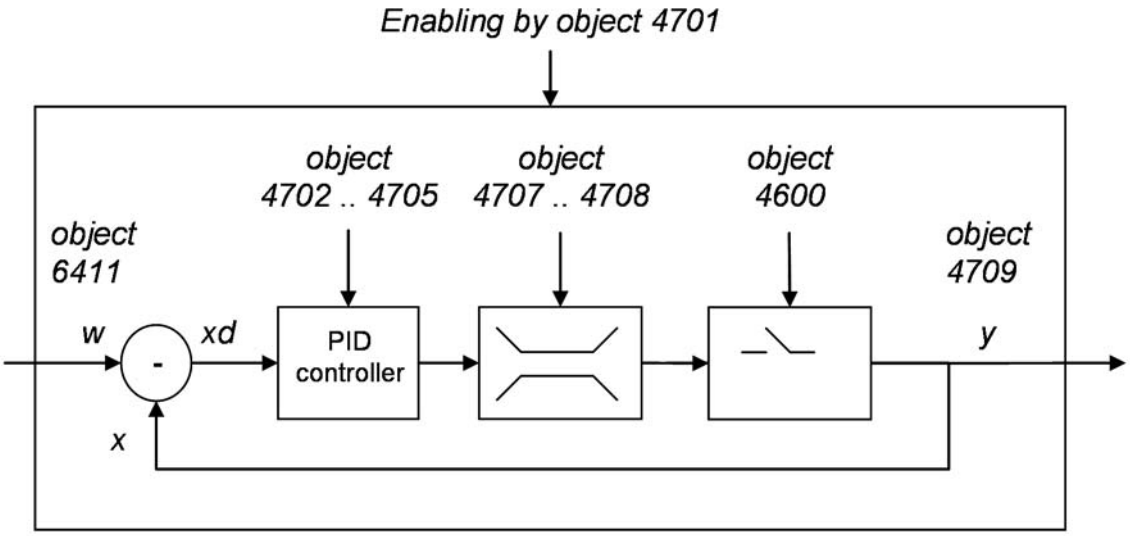
On the basis of the a.m. mentioned relations, the single controller types can be represented as follows:

| | | | | | |
|---|---|---|---|---|---|
| PI algorithm | $T_v = 0$ | | $K_{PM} = K_P$ | $\frac{T_S}{T_N} = \frac{T_S}{T_n}$ | $\frac{T_V}{T_S} = 0$ |
| PD algorithm | $T_n = \infty$ | | $K_{PM} = K_P$ | $\frac{T_S}{T_N} = 0$ | $\frac{T_V}{T_S} = \frac{T_v}{Ts}$ |
| P algorithm | $T_v = 0$ | $T_n = \infty$ | $K_{PM} = K_P$ | $\frac{T_S}{T_N} = 0$ | $\frac{T_V}{T_S} = 0$ |

The function requires the following parameters. The sub-index 1, 2 corresponds to channel 1, 2.



| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Enabling of the signal output PID controller, signal generator | 4600 | 1, 2 | unsigned 32 | 0: disabled<br>>0: enabled<br>*See note 3* | 0 |
| Enabling of the PID controller | 4701 | 1, 2 | unsigned 32 | 0: disabled<br>>0: enabled<br>*See note 1* | 0 |
| K_PM: Controller gain of the algorithm | 4702 | 1, 2 | unsigned 32 | *See note 2* | 1000 |
| T_N: Integrator time of the algorithm | 4703 | 1, 2 | unsigned 32 | 5...50000 ms | 32 |
| T_V: Derivative time of the algorithm | 4704 | 1, 2 | unsigned 32 | 0...1000 ms | 0 |
| T_S: Scanning time of the algorithm | 4705 | 1, 2 | unsigned 32 | 5...1000 ms | 10 |
| Yi_max: Maximum correcting variable at the output | 4707 | 1, 2 | unsigned 32 | -32768...32767<br>*See note 4* | 32767 |
| Yi_min: Minimum correcting value at the output | 4708 | 1, 2 | unsigned 32 | -32768...32767<br>*See note 4* | 0 |
| Output of the output values | 4709 | 1, 2 | | | |

**Note 1:** Upon each enabling of the PID controller by object 4701h, its parameters are set to default values and internal values are initialized. The integral component is set to 0. Upon enabling, the additional objects of the PID controller are available for writing or reading.

**Note 2:** The controller gain K_PM is a „short“ value with 3 positions after the decimal point that is entered in object 4702h as K_PM*1000 (example: The value *1123* is entered in the object 4702h for a determined controller gain of *1.1234*).

**Note 3:** The output of the correcting variable of the PID controller is enabled only if the respective object 4600h is set by the controller. This object can be addressed as virtual digital output by the controller via the 1. RxPDO.

If this virtual output is not set, an analog value previously transmitted by the controller is output at the analog output. In this case, the PID controller is not active. At a new setting of the virtual output, the current value of the PID controller is output.

Since the PID controller is an autonomous activity of the output modules, the analog values change without presetting by the controller, provided a respective configuration had been made.

**Note 4:** Upon exceeding of the minimum and maximum controlling variables of the output, the summation of the I-component of the PID controller is stopped. The I-component is only summed again if the controlling variable exceeds the maximum value or if it exceeds the minimum value.

## 6.5 Balancing of the inputs

By means of a balancing procedure, the inputs can be adapted in their characteristic curve. Balancing is made to compensate internal inaccuracies of the analog part of the input (operational amplifier etc.).

Prior to the supply, this function is carried out in the in-company system test. Normally, the user does not need to carry out this function again.

The function requires the following parameters. The sub-index 1, 2 corresponds to channel 1, 2.

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Minimum value | 2442, 2444 | 1, 2 | integer 16 | See description | |
| Maximum value | 2443, 2445 | 1, 2 | integer 16 | See description | |

During balancing, the input values are measured in the following two reference points and are stored. The admissible ranges for the min./max. values are shown in the table.

| | Setpoint applied to the input | Admissible range at the output of the 10 bit A/D converter for the balancing | Balancing is made during overwriting of the object |
|---|---|---|---|
| Minimum value for 0..20mA | 0 mA | 0...0.16 mA | 2442 |
| Maximum value for 0..20mA | 20.000 mA | 19.68...20.32 mA | 2443 |
| | | | |
| Minimum value for 0..10V | 0 V | 0...80 mV | 2442 |
| Maximum value for 0..10V | 10V | 9.84...10.16 V | 2443 |
| | | | |
| Minimum value for -10..10V | -10 V | -10.16... –9.84 V | 2444 |
| Maximum value for -10..10V | 10V | 9.68...10.32 V | 2445 |

The measuring is made during the overwriting of the objects with an optional value. The measured values can be checked at any time by means of read access.

Prior to the calculation, it is checked whether the reference points are in the admissible range. In case of error, an error message is sent to the superordinate controller.

### 6.5.1 Calculation of slope and offset (range 0..10V, 0..20mA)

The correction values of slope (object 2440h) and offset (object 2441h) are calculated during each initialization of the system or during a balancing procedure on the basis of the reference points stored in object 2442h and 2443h. In case of error, an error message is sent to the superordinate controller.

After a conversion, the slope is stored as real number of a channel n on the basis of the following formula:

(Object 2440h, sub-index n) = 65536 * (setpoint_max - setpoint_min) /

[(Object 2443h, sub-index n) - (object 2442h, sub-index n)]

with the parameters in compliance with object 2430h.

| Object 2430 (hexadecimal) | Corresponds to range | Setpoint_min used in the formula | Setpoint_max used in the formula |
|---|---|---|---|
| 0001 | 0..10V | 0 | 32000 |
| 0001 | -10..10V | -32000 | 32000 |
| 0020 | 0..20 mA | 0 | 32000 |

The offset is stored as real number in a 16 bit value for a channel n on the basis of the following formula:

(Object 2441h, sub-index n) = setpoint_min -

(Object 2442h, sub-index n) * (setpoint_max - setpoint_min) /

[(Object 2443h, sub-index n) - (object 2442h, sub-index n)]

Balancing is completed with the storing of the parameters in the non-volatile storage.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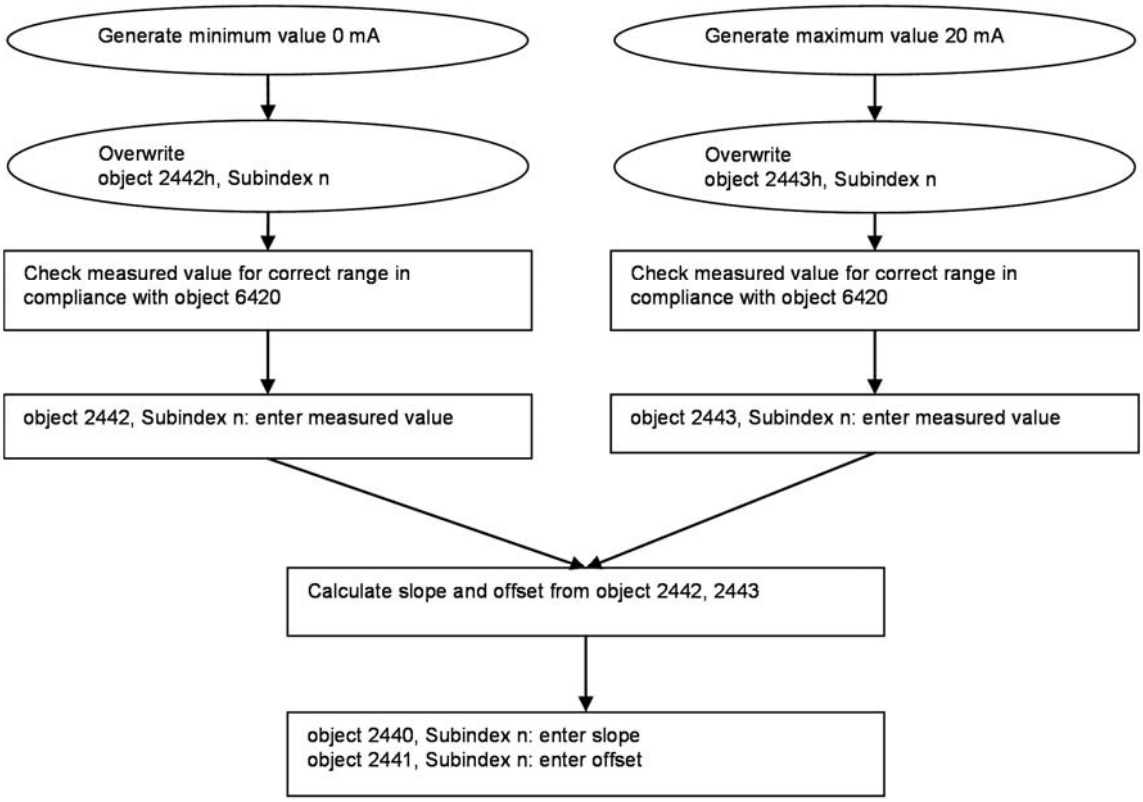


### 6.5.2 Correction of slope and offset (range -10..10V)

The correction values of slope (object 2440h) and offset (object 2441h) are calculated during each initialization of the system or during a balancing procedure on the basis of the reference points stored in object 2444h and 2445h.

Otherwise, the procedure is the same as for the range 0..10V.

### 6.5.3 Correction of the measured values with slope and offset

The signals applied to the other inputs are corrected as follows for a channel n:

Measured value (object 6401h, sub-index n) =

Unconditioned input value* slope (object 2440h, sub-index n) +

Offset (object 2441h, sub-index n)

## 6.6 Storing of parameters in the non-volatile storage

The described parameters are stored in the RAM and during initialization of the module they are automatically overwritten by the previously stored parameters of the non-volatile storage. The following two objects make the storing and loading of parameters in the non-volatile storage possible.

### 6.6.1 Store Parameter (object 1010)

The object Store Parameter (object 1010) makes the parameter storage in the non-volatile storage possible.

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Store Parameter communication profile area | 1010 | 2 | Unsigned 32 | Read: 65766173h<br>Write: 00000001 | 00000001 |
| Store Parameter of the standardized and the manufacturer-specific profile area | 1010 | 3 | Unsigned 32 | Read: 65766173h<br>Write: 00000001 | 00000001 |

The storing of the parameters of the communication profile is enabled by the writing of a determined value on the corresponding sub-index 2 of the object.

The storing of the parameters of the standardized and the manufacturer-specific profile area is enabled by the writing of a determined value on the corresponding sub-index 3 of the object. The parameters of the additional functions of the manufacturer-specific profile area are not stored.

An emergency message is transmitted to the superordinate controller in case of an error, i.e. the unsuccessful writing.

Please check the system manual for further information about the emergency messages.


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### 6.6.2 Restore Parameter (object 1011h)

The object Restore Parameter makes the loading of the parameters into the RAM possible from the non-volatile storage.

| Parameter | Object (hex) | Sub-index | Type | Admissible input | Preset value |
|---|---|---|---|---|---|
| Restore Parameter communication profile area | 1011 | 2 | Unsigned 32 | Write: 64616F6Ch<br>Read: 00000001 | 00000001 |
| Restore parameter of the standardized and manufacturer-specific profile area | 1011 | 3 | Unsigned 32 | Write: 64616F6Ch<br>Read: 00000001 | 00000001 |

The loading of the parameters of the communication profile is enabled by the writing of a determined value to the sub-index 2 of the object.

The loading of the parameters of the standardized and of the manufacturer-specific profile area is enabled by the writing of a determined value to the sub-index 3 of the object.

Upon successful loading of the parameters, the module sends a „Bootup message“.

In the case of error, i.e. the unsuccessful loading, an emergency message is sent to the superordinate controller.

Please check the system manual for further information about the emergency messages.

## 6.7 PDO mapping

### 6.7.1 Mapped objects

The term PDO mapping stands for „Mapping of application objects in PDOs“. In objects RxPDO (1600h-1601h) and TxPDO (1A00h-1A01h), this mapping of the objects is established for the receiver PDO RxPDO 1...2 and the transmission PDO TxPDO 1...2. This mapping is defined in the module and cannot be modified.

1. RxPDO: Upon enabling of the additional functions i.e. signal generator (object 4601h) or PID controller (object 4701h), the object „Enabling of additional functions “ (object 4600h) is mapped automatically in the 1.RxPDO.

2. RxPDO: The values of the two analog outputs have a size of 2 byte each (objects: 6411h, sub-ID 1 and 2) and are expected in the first 4 bytes of the 2. receiver PDO.

1st TxPDO: In case of the enabled threshold value check (object 4401h), the objects 4400h sub-index 1 and 2 (logic inputs) are mapped into the 1st TxPDO.

2nd TxPDO: The two analog inputs are transmitted with 2 byte each (object: 6401h, sub-ID 1 and 2) in the first 4 bytes of the 2nd transmission PDO. Upon enabling of the additional function PID controller (object 4701h), also the controlling variables are transmitted in the 2. TxPDO together with the actual values

| Object | Byte | Mapped object | Parameter |
|---|---|---|---|
| 1. RxPDO | 0 | 4600h, sub-ID 1 | Enabling of additional functions analog output 1 |
| | 1 | 4600h, sub-ID 2 | Enabling of additional functions analog output 2 |
| 2. RxPDO | 0, 1 | 6411h, sub-ID 1 | Analog output 1 (or setpoint for PID controller) |
| | 2, 3 | 6411h, sub-ID 2 | Analog output 2 (or setpoint for PID controller) |
| 1. TxPDO | 0 | 4400h, sub-ID 1 | Threshold value monitoring input 1 |
| | 1 | 4400h, sub-ID 2 | Threshold value monitoring input 2 |
| 2. TxPDO | 0, 1 | 6401h, sub-ID 1 | Analog input 1 |
| | 2, 3 | 6401h, sub-ID 2 | Analog input 2 |
| | 4, 5 | 4709h, sub-ID 1 | Correcting variable 1. output of PID controller (in case of enabling with 4701h) |
| | 6, 7 | 4709h, sub-ID 2 | Correcting variable 2. output of PID controller (in case of enabling with 4701h) |


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## 6.7.2 Data format of the analog inputs

The analog inputs are included in object 6401h. The data format is indicated in the following table (CiA DS 401 V2.0):

The input value read via the 12 bit A/D converter is stored in a 16 bit word, by correcting the input value with the values of slope and offset of the parameters 2440h und 2441h with the respective sub-indices.

Range

0...+10V, 0...20mA

| Contents object 6401 [decimal] | AIO22U input [mV] | AIO22I input [mA] |
|---|---|---|
| 0 | 0.0000 V | 0.000 mA |
| 8 | 0.0025 V | 0.005 mA |
| 31992 | 9.9975 V | 19.995 mA |
| 32000 | 10.000 V | 20.000 mA |
| 32760 | 10.238 V | 20.475 mA |

Range

–10...+10V

| Contents object 6401 [decimal] | AIO22U input [mV] | |
|---|---|---|
| -32768 | -10.238 V | |
| -32000 | -10.000 V | |
| -16 | - 0.005 V | |
| 0 | 0.000 V | |
| 31984 | 9.995 V | |
| 32000 | 10.000 V | |
| 32752 | 10.238 V | |

## 6.7.3 Data format of the analog outputs

The values of the analog outputs are written into the object 6411h. The data format is indicated in the following table (CiA DS 401 V2.0):

Range

0...+10V, 0...20mA

| Contents object 6411 [decimal] | AIO22U output [mV] | AIO22I output [mA] |
|---|---|---|
| 0 | 0.0000 V | 0.0000 mA |
| 8 | 0.0025 V | 0.0050 mA |
| 32000 | 10.000 V | 20.000 mA |
| 32760 | 10.238 V | 20.475 mA |

Range

–10...+10V

| Contents object 6411 [decimal] | AIO22U Output [mV] | |
|---|---|---|
| -32768 | -10.238 V | |
| -32000 | -10.000 V | |
| -16 | -0.005 V | |
| 0 | 0.0000 V | |
| 16 | 0.005 V | |
| 32000 | 10.000 V | |
| 32752 | 10.238 V | |


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# 7 Maintenance and repair

General maintenance instructions are given in the system manual.

## 7.1 Replacement of the module

In case of a defect, the module electronics are replaced completely. Remove all connected lines and switch off the voltage.

Prior to be removed, the respective module is to be separated from modules probably plugged on the left and on the right, since the single modules are connected with the internal ME bus via a connector.

Subsequently remove the respective module from the rail by means of a suited tool, after using a lever at the bracket on bottom side of the module.

For further information please check the system manual.

## 7.2 Maintenance in case of an error

| Problem | Possible cause | Action |
|---|---|---|
| Module does not operate | Contacting of the ME bus is not correct | Check the module |
| | 24V current supply at the power unit is missing | Check the 24V supply |
| | Internal module error | Replace the module |
| Life LED is off | Life LED is programmed differently | Check the parameterizing |
| Current is not recognized correctly | Incorrect parameterizing | Check parameterizing and balancing |
| | Incorrect supply of the sensor | Measure the supply voltage |
| | PTC fuse is activated | Check sensor for short-circuit |

# 8 Technical annex: parameterizing via the CAN bus

## 8.1 CANopen

The description of the implemented structures and functions of the CANopen, such as the mapping of the process data objects (PDO), the service data objects (SDO), the network management (NMT) as well as of the emergency messages is made in the system manual

## 8.2 Emergency messages

Internal errors are written in a predefined error field and can be read in the object dictionary (index 1003H). The error field includes the single errors stated in a device, described in the form of error codes, as well as a device-specific additional information in the timely order of their occurring.

The presence of a device error and its type is displayed in a register that can be read by means of the object dictionary 1001H.

The transmission of the device-internal emergency objects is made by means of standardized high-priority messages.

An emergency message is sent once, at the occurring and after the elimination of the error.

Please check the system manual for further information about the error messages.

## 8.3 Configuration

The function and the configuration parameters are indicated as far as possible in the CANopen object dictionary of the device. The object dictionary is composed of 3 areas:

- Communication profile area as per CiA DS 301
- Standardized device profile area as per CiA DS 401
- Manufacturer-specific profile area


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## 8.4 AIO22

### 8.4.1 Communication profile area (parameters corresponding to CiA DS 301)

The following table includes all general parameters that belong to the communication profile area of the CANopen object dictionary (CiA DS 301).

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 1000 | 0 | Device type | Unsigned 32 | R | Device type | 000C0191 | |
| 1001 | 0 | Error register | Unsigned 8 | R | Error register, bit-coded | | 00 |
| 1003 | | Error field | | | | | |
| | 0 | Number | Unsigned 8 | RW | Number of errors occurred 0...4 | 0..4 | 00 |
| | 1 | 1. error field | Unsigned 32 | R | Error code + Manuf.specific error field | | |
| | 2 | 2. error field | Unsigned 32 | R | Error code + Manuf.specific error field | | |
| | 3 | 3. error field | Unsigned 32 | R | Error code + Manuf.specific error field | | |
| | 4 | 4. error field | Unsigned 32 | R | Error code + Manuf.specific error field | | |
| 1004 | | Number of PDO | | | Number of PDO | | |
| | 0 | Number | Unsigned 32 | R | Total | 00010001 | |
| | 1 | Synchronous PDO | Unsigned 32 | R | Synchronous PDO | 00000000 | |
| | 2 | Asynchronous PDO | Unsigned 32 | R | Asynchronous PDO | 00010001 | |
| 1008 | 0 | Device name | Vis-String | R | Device name | "EST FBM-AIO22U " or "EST FBM-AIO22I " | |
| 1009 | 0 | Hardware version | Vis-String | R | Version HW | "Vxxh IDxx " | |
| 100A | 0 | Software version | Vis-String | R | Version SW | "V1.04 " | |
| 100B | 0 | Node-Id | Unsigned 32 | R | CAN address | 00000030 + setting hex. switch | |
| 100C | 0 | Guard time | Unsigned 16 | RW | NMT guard time (ms) 0..65535 | 0000..FFFF | 0000 |
| 100D | 0 | Life time factor | Unsigned 8 | RW | NMT life time 0..255 | 00..FF | 00 |
| 100E | 0 | Node guarding Id | Unsigned 32 | R | CobId node guard | 00000700 + Node-Id | |
| 1010 | | Store parameters | | | Storing of the configuration parameters in the non-volatile storage | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 03 | |
| | 1 | All parameters | Unsigned 32 | R | Not implemented | 00000000 | |
| | 2 | Communication parameters | Unsigned 32 | RW | Write: 65766173 (hex) Read: 00000001 | 00000001 | |
| | 3 | Application parameters | Unsigned 32 | RW | Write: 65766173 (hex) Read: 00000001 | 00000001 | |

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 1011 | | Restore parame-ters | | | Loading of the configuration parameters from the non-volatile storage | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 03 | |
| | 1 | All parameters | Unsigned 32 | R | Not implemented | 00000000 | |
| | 2 | Communication parameters | Unsigned 32 | R | Write16F6C Hex) Read000001 | 00000001 | |
| | 3 | Application pa-rameters | Unsigned 32 | RW | Write16F6C Hex) Read000001 | 00000001 | |
| 1012 | 0 | COB-ID time stamp message | Unsigned 32 | R | Time stamp Id | 80000100 | |
| 1014 | 0 | COB-ID emergency message | Unsigned 32 | R | CobId emergency | 40000080 + Node-Id | |
| 1017 | 0 | Heartbeat time | Unsigned 16 | RW | Heartbeat cycle time (ms) 0..65535 | 0000..FFFF | 0000 |
| 1200 | | SDO parameters | | | SDO parameters | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | Client->Server Id | Unsigned 32 | R | CobId ReciveSDO | 00000600+Node-Id | |
| | 2 | Server->Client Id | Unsigned 32 | R | CobId TransmitSDO | 00000580+Node-Id | |
| 1400 | | 1.RxPDO | | | Communication parameters 1.RxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 04 | |
| | 1 | ID Used By PDO | Unsigned 32 | R | CobId 1.RxPDO | 00000200+Node-Id | |
| | 2 | Transmission type | Unsigned 8 | R | | FF | |
| | 3 | Inhibit time | Unsigned 16 | R | Time in 0.1 ms (0..2550) | | 0000 |
| | 4 | CMS priority group | Unsigned 8 | R | | 03 | |
| 1401 | | 2.RxPDO | | | Communication parameters 2.RxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 04 | |
| | 1 | ID Used By PDO | Unsigned 32 | R | CobId 2.RxPDO | 00000300+Node-Id | |
| | 2 | Transmission type | Unsigned 8 | R | | FF | |
| | 3 | Inhibit time | Unsigned 16 | R | Time in 0.1 ms (0..2550) | | 0000 |
| | 4 | CMS priority group | Unsigned 8 | R | | 03 | |
| 1600 | | 1. RxPDO Mapping | | | Mapping parameters 1.RxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 00 or 02 | |
| | 1 | 1. mapped object | Unsigned 32 | R | Index+SubID+Size (in case of release by 4701h) | 46000108 | |
| | 2 | 2. mapped object | Unsigned 32 | R | Index+SubID+Size (in case of release by 4701h) | 46000208 | |
| 1601 | | 2. RxPDO mapping | | | Mapping parameters 2.RxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. mapped object | Unsigned 32 | R | Index+SubID+Size | 6411010110 | |
| | 2 | 2. mapped object | Unsigned 32 | R | Index+SubID+Size | 6411010210 | |
| 1800 | | 1.TxPDO | | | Communication parameters 1.TxPDO | | |


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| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| | 0 | Number | Unsigned 8 | R | Number of elements | 04 | |
| | 1 | ID Used By PDO | Unsigned 32 | R | CobId 1.TxPDO | 00000180+Node-Id | |
| | 2 | Transmission type | Unsigned 8 | R | | FF | |
| | 3 | Inhibit time | Unsigned 16 | RW | Time in 0.1 ms (0..2550) | 0000…09F6 | 0000 |
| | 4 | CMS priority group | Unsigned 8 | R | | 03 | |
| 1801 | | 2.TxPDO | | | Communication parameters 2.TxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 04 | |
| | 1 | ID Used By PDO | Unsigned 32 | R | CobId 2.TxPDO | 00000280+Node-Id | |
| | 2 | Transmission type | Unsigned 8 | R | | FF | |
| | 3 | Inhibit time | Unsigned 16 | RW | Time in 0.1 ms (0..2550) | 0000…09F6 | 0000 |
| | 4 | CMS priority group | Unsigned 8 | R | | 03 | |
| 1A00 | | 1. TxPDO mapping | | | Mapping parameters 1.TxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 00 or 02 | |
| | 1 | 1. mapped object | Unsigned 32 | R | Index+SubID+Size (in case of release by 4401h) | 44000108 | |
| | 2 | 2. mapped object | Unsigned 32 | R | Index+SubID+Size (in case of release by 4401h) | 44000208 | |
| 1A01 | | 2. TxPDO mapping | | | Mapping parameters 2.TxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 or 04 | |
| | 1 | 1.mapped object | Unsigned 32 | R | Index+SubID+Size | 64010110 | |
| | 2 | 2. mapped object | Unsigned 32 | R | Index+SubID+Size | 64010210 | |
| | 3 | 3. mapped object | Unsigned 32 | R | Index+SubID+Size ((in case of release by 4701h) | 47090110 | |
| | 4 | 4. mapped object | Unsigned 32 | R | Index+SubID+Size (in case of release by 4701h) | 47090210 | |

## 8.4.2 Standardized device profile area (parameters corresponding to CiA DS 401)

The following table is a summary of the parameters of the AIO22 that are part of the standardized device profile area of the CANopen object dictionary (CiA DS 401) and that describe the device function of the module.

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 6401 | | Analog inputs | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Integer 16 | R | 1. input | | 0 |
| | 2 | 2. input | Integer 16 | R | 2. input | | 0 |
| 6411 | | Analog outputs | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | R | 1. output 0..32767 | | 0 |

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| | 2 | 2. output | Integer 16 | R | 2. output 0..32767 | | 0 |
| 6421 | | Interrupt selection | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements, 2 | 02 | |
| | 1 | 1. input | Integer 16 | R | Input changed by more that delta | 04 | |
| | 2 | 2. input | Integer 16 | R | Input changed by more that delta | 04 | |
| 6423 | 0 | Global interrupt | Unsigned 8 | RW | Transmission enable for TxPDO<br>00: disabled<br>01: enabled | | 01 |
| 6426 | | Delta | | | Minimum modification amount for TxPDO | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Unsigned 32 | RW | Delta (in LSB of ADC) | 00000002 | |
| | 2 | 2. input | Unsigned 32 | RW | Delta (in LSB of ADC) | 00000002 | |
| 6443 | | Error mode | | | Error mode of analog outputs | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Unsigned 8 | R | 00: Not modified<br>01: Predefined state | | 01 |
| | 2 | 2. output | Unsigned 8 | R | 00: Not modified<br>01: Predefined state | | 01 |
| 6444 | | Error value | | | Error values for outputs | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 32 | R | Error value | | 0 |
| | 2 | 2. output | Integer 32 | R | Error value | | 0 |
| 67FE | | Error behavior | | | NMT error behavior in case of communication errors | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 01 | |
| | 1 | NMT state in case of communication errors | Unsigned 8 | RW | 00: Pre-operational<br>01: Not modified<br>02: Stopped | | 00 |

### 8.4.3 Manufacturer-specific profile area

In the following table, the additional parameters of the AIO22 are summarized that describe the manufacturer-specific device functions and that are not mentioned in the standardized device profile area of the CANopen object dictionary.

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 2000 | | Life LED | | | Mode life LED | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 01 | |
| | 1 | Life LED | Unsigned 8 | RW | 00 or 01 | | 00 |


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| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 2420 | | Filter parameters | | | Filter parameters | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Unsigned 8 | RW | Filter 0..6<br>Not activated: 0 | | 00 |
| | 2 | 2. input | Unsigned 8 | RW | Filter 0..6<br>Not activated: 0 | | 00 |
| 2430 | | Analog range | | | Value range for inputs and outputs | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Unsigned 16 | RW | AIO22U: 0…10V: 0001<br>-10..10V: 0002<br><br>AIO22I: 0…20 mA: 0020 | | 0001<br><br><br>0020 |
| | 2 | 2. output | Unsigned 16 | RW | as 1. output | | |
| 2440 | | Slope | | | Calculated slope correction | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Unsigned 32 | R | 16 bit in front of decimal point and 16 bit after the decimal point | | |
| | 2 | 2. input | Unsigned 32 | R | as 1. input | | |
| 2441 | | Offset | | | Calculated offset correction | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Integer 16 | R | In LSB des ADC | 0000 | |
| | 2 | 2. input | Integer 16 | R | as 1. input | 0000 | |
| 2442 | | Minimum values | | | Balancing reference points min. values 0..10V / 0..20 mA | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Integer 16 | RW | Left-aligned | 0000 | |
| | 2 | 2. input | Integer 16 | RW | as 1. input | 0000 | |
| 2443 | | Maximum values | | | Balancing interpolation points max. values 0..10V / 0..20 mA | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Integer 16 | RW | Left-aligned | 0000 | |
| | 2 | 2. input | Integer 16 | RW | as 1. input | 0000 | |
| 2444 | | Minimum values | | | Balancing interpolation points max. values -10..10V | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Integer 16 | RW | Left-aligned | 0000 | |
| | 2 | 2. input | Integer 16 | RW | as 1. input | 0000 | |
| 2445 | | Maximum values | | | Balancing interpolation points max. values -10..10V | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Integer 16 | RW | Left-aligned | 0000 | |
| | 2 | 2. input | Integer 16 | RW | as 1. input | 0000 | |

## 8.4.4 Additional functions of the analog outputs (starting with SW version V1.07)

### 8.4.4.1 Threshold value monitoring of the inputs (starting with SW version V1.07)

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 4400 | | Logical inputs | | | Monitoring of the limit values | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Unsigned 8 | R | 00 or 01 | YY | 00 |
| | 2 | 2. input | Unsigned 8 | R | 00 or 01 | YY | 00 |
| 4401 | | Enabling of logical inputs | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| | 2 | 2. input | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| 4410 | | Threshold values | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. input | | RW | *See chapter Parameterizing* | | 00 |
| | 2 | 2. input | | RW | as input 1 | | 00 |


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### 8.4.4.2 Signal generator

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 4600 | | Enabling of the additional functions | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| | 2 | 2. output | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| 4601 | | Enabling signal generator | | | *See note 1* | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| | 2 | 2. output | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| 4602 | | Interval | | | Time in ms between the output of the single values | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Unsigned 8 | RW | XX | | 00 |
| | 2 | 2. output | Unsigned 8 | RW | XX | | 00 |
| 4603 | | Number of values | | | Output values and intervals | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Unsigned 16 | RW | *See note 2* | XXYY | 0020 |
| | 2 | 2. output | Unsigned 16 | RW | *See note 2* | XXYY | 0020 |
| 4610 | | Output values | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | | RW | *See note 3* | | 0 |
| | 2 | 2. output | | RW | *See note 3* | | 0 |

**Note 1:** Upon each enabling of the signal generator, its parameters are set to default values.

**Note 2:** The first byte includes the number of output values. The second byte includes the number of output intervals, where the last conversion value remains unchanged.

**Note 3:** During parameterizing of the output values, a field (DOMAIN) of the size 64 byte (2 byte each for an output value) is transmitted to the AIO22 for each channel. Each output value is composed of a 16 bit word SXXXXXXXXXXX000 with S: sign (two's complement), X: data (12 bit)

## 8.4.4.3 PID controller

| Index (hex) | Sub-index | Name | Type | Attr. | Meaning | Contents (hex) | Default (hex) |
|---|---|---|---|---|---|---|---|
| 4701 | | Enabling PID controller | | | *See note 1* | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| | 2 | 2. output | Unsigned 8 | RW | 0X: enabled<br>00: disabled | | 00 |
| 4702 | | Controller gain | | | *See note 2* | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | RW | Range: -30000...30000 | XXXX | 03E8 |
| | 2 | 2. output | Integer 16 | RW | Range: -30000...30000 | XXXX | 03E8 |
| 4703 | | Integrator time | | | Time in ms between the intervals | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | RW | Range: 5...50000 ms | XXXX | 0020 |
| | 2 | 2. output | Integer 16 | RW | Range: 5...50000 ms | XXXX | 0020 |
| 4704 | | Derivative time | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | RW | Range: 0...1000 ms | XXXX | 0000 |
| | 2 | 2. output | Integer 16 | RW | Range: 0...1000 ms | XXXX | 0000 |
| 4705 | | Scanning time | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | RW | Range: 5...1000 ms | XXXX | 000A |
| | 2 | 2. output | Integer 16 | RW | Range: 5...1000 ms | XXXX | 000A |
| 4707 | | Max. correcting variable | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | RW | Range: -32768...32767 | XXXX | 7FFF |
| | 2 | 2. output | Integer 16 | RW | Range: -32768...32767 | XXXX | 7FFF |
| 4708 | | Min. correcting variable | | | | | |
| | 0 | Number | Unsigned 8 | R | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | RW | Range: -32768...32767 | XXXX | 0000 |
| | 2 | 2. output | Integer 16 | RW | Range: -32768...32767 | XXXX | 0000 |
| 4709 | | Correcting variable | | | *Note: internal object* | | |
| | 0 | Number | Unsigned 8 | -- | Number of elements | 02 | |
| | 1 | 1. output | Integer 16 | -- | Range: -32768...32767 | XXXX | |
| | 2 | 2. output | Integer 16 | -- | Range: -32768...32767 | XXXX | |

**Note 1:** Upon each enabling of the PID controller, its parameters are set to default values.

**Note 2:** The controller gain Kp is a „short“ value with 3 positions after the decimal point that is entered in object 4702h as Kp*1000 (example: The value *1123* is entered in the object 4702h for a determined controller gain of *1.1234*).


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