auma®

# Actuator controls

## AUMA MATIC
## AM 01.1/ AM 02.1
## AMExB 01.1/ AMExC 01.1
## Modbus

ISO 14001
TÜV SÜD
ISO 9001
Certificate Registration No.
12 100/104 4269

Operation instructions

**Scope of these instructions:** These instructions are valid for multi-turn actuators of type ranges SA(R) 07.1 – SA(R) 16.1 and SA(R)ExC 07.1 – SA(R)ExC 16.1 and for part-turn actuators of type ranges SG(R) 05.1 – SG(R) 12.1 and SGExC 05.1 – SGExC 12.1 with the controls AUMA MATIC AM 01.1/ AM 02.1 or AMExB 01.1 and AMExC 01.1 and Modbus interface.

## Table of contents

# 1. Safety instructions

## 1.1 Range of application

AUMA actuators are designed for the operation of industrial valves, e.g. globe valves, gate valves, butterfly valves and ball valves.
For other applications, please consult us. The manufacturer is not liable for any possible damage resulting from use in other than the designated applications. Such risk lies entirely with the user.
Observance of these operation instructions is considered as part of the controls' designated use.

## 1.2 Commissioning (electrical connection)

During electrical operation, certain parts inevitably carry lethal voltages. Work on the electrical system or equipment must only be carried out by a skilled electrician himself or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.

## 1.3 Maintenance

The maintenance instructions must be strictly observed, otherwise a safe operation of the multi-turn actuator/ the controls is no longer guaranteed.

## 1.4 Warnings and notes

Non-observance of the warnings and notes may lead to serious injuries or damage. Qualified personnel must be thoroughly familiar with all warnings and notes in these operation instructions.
Correct transport, proper storage, mounting and installation, as well as careful commissioning are essential to ensure a trouble-free and safe operation.
The following references draw special attention to safety-relevant procedures in these operation instructions. Each is marked by the appropriate pictograph.

**This pictograph means: Note!**
"Note" marks activities or procedures which have major influence on the correct operation. Non-observance of these notes may lead to consequential damage.

**This pictograph means: Electrostatically endangered parts!**
If this pictograph is attached to a printed circuit board, it contains parts which may be damaged or destroyed by electrostatic discharges. If the boards need to be touched during setting, measurement, or for exchange, it must be assured that immediately before a discharge through contact with an earthed metallic surface (e.g. the housing) has taken place.

**This pictograph means: Warning!**
"Warning" marks activities or procedures which, if not carried out correctly, can affect the safety of persons or material.

# 2. Short description

AUMA actuators have a modular design. Motor and gearing are mounted in a common housing.
The actuators are driven by an electric motor and controlled with the electronic controls AUMA MATIC Modbus. The electronic controls are included in the scope of delivery.

## 3. Transport and storage

- Transport to place of installation in sturdy packing.
- Do not attach ropes or hooks to the handwheel for the purpose of lifting by hoist.
- Store in well-ventilated, dry room.
- Protect against floor dampness by storage on a shelf or on a wooden pallet.
- Cover to protect against dust and dirt.
- Apply suitable corrosion protection agent to bright surfaces.

## 4. General information about Modbus

For the exchange of information among automation systems and between automation systems and the connected decentral field devices, serial fieldbuses are mainly used today as the communication system. Thousands of applications have proved impressively that cost savings of up to 40 % in wiring, commissioning, and maintenance are achieved by using fieldbus technology. Just two wires are needed to transmit all relevant information for the field devices, such as input and output signals, parameters, and diagnostics data. While in the past the fieldbuses used were often manufacturer specific and incompatible with other bus systems, the systems employed today are almost exclusively open and standardized. This means that the user is independent of individual suppliers and can choose the best product at the most competitive price.
Modbus is an open international fieldbus system which is also used successfully throughout the world. The application range includes automation in the areas of manufacturing, processing, and building.
These operation instructions cannot provide a general introduction into Modbus. For this, please refer to the literature references in appendix C (page 57).

### 4.1 Basic characteristics

Modbus defines the functional features of a serial fieldbus system with which distributed digital automation devices can be interconnected. Modbus distinguishes between master and slave devices.

**Master devices** control the data traffic on the Bus. A master is allowed to send messages without an external request.

**Slave devices** such as AUMA Modbus actuators are peripheral devices. Typical slave devices are input/ output devices, valves, actuators, and measuring transmitters. They do not have bus access, i.e. they may only ,at the request of a master, transmit messages to that master.

## 4.2 Modbus Basic functions

Modbus uses a master-slave technique in which only the master can initiate a transaction. The slaves respond by supplying the requested data in a reply or by executing the action requested in the query.

The Modbus telegram from the master contains the slave address, a function code defining the requested action, a data field, and a CRC field. The Modbus slaves' response message contains fields confirming the requested action and possibly the requested data and also a CRC field.
If an error occurs during reception of the telegram or the slave is unable to perform the requested action, the slave will generate an error telegram and send it as response to the master.

## 4.3 Transfer mode

- RS-485 twisted pair cable or fibre optic cable.
- AUMA actuators support baud rates up to 38.4 kBit/s

## 4.4 Bus access

- Master-slave technique.
- Mono-master system.
- Master and slave devices: max. 127 devices at one bus (the AUMA MATIC supports slave addresses from 1 to 127), without repeater max. 32 devices.

## 4.5 Communication

- Master-slave data exchange via query-response cycle (Polling procedure).
- Modbus RTU protocol.

## 4.6 Protection functions

- Parity check for each telegram byte
- CRC check for each telegram
- Watchdog for AUMA actuators with adjustable failure behaviour.
- Query-response cycle monitoring with configurable timer interval at the master.

## 4.7 Modbus RTU mode

Data format for a byte.

Coding system:
- 8 bit binary, hexadecimal 0-9, A-F
- 2 hexadecimal characters contained in each 8 bit field of the telegram

Bits per byte:
- 1 start bit
- 8 data bits; least significant bit sent first
- 1 bit for even/ odd parity, no bit for no parity
- 1 stop bit if parity is used, 2 stop bits if no parity is used.

# 5. Technical data

***Table 1: Modbus interface for actuator controls AM/ AMExB/ AMExC***

**Features and functions**

**Power supply**

Standard voltages:

| **3-phase AC** voltages/ frequencies | | | | | | | | | | | **1-phase AC**[1] voltages/ frequencies | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Volt | 220 | 230 | 240 | 380 | 400 | 415 | 440 | 460 | 480 | 500 | Volt | 110,115,120 | 220,230,240 |
| Hz | 50 | 50 | 50 | 50 | 50 | 50 | 60 | 60 | 60 | 50 | Hz | 50/60 | 50/60 |

Special voltages:

| **3-phase AC** voltages/ frequencies | | | | | **1-phase AC**[1] voltages/ frequencies |
|---|---|---|---|---|---|
| Volt | 525 | 575 | 660 | 690 | 208 |
| Hz | 50 | 50 | 50 | 50 | 60 |

**External supply of the electronics (option)**

24 V DC + 20 % / – 15 %,
Current consumption: Basic version approx. 200 mA, with options up to 500 mA

**Switchgear**

Standard: Reversing contactors[2] (mechanically and electrically interlocked) for motor power up to 1.5 kW

Options: Reversing contactors[2] (mechanically and electrically interlocked) for motor power up to 7.5 kW

Thyristor unit[3] (recommended for modulating actuators) for motor power up to 1.5 kW, 500 V AC, with internal fuses for motor power up to 5.5 kW, 500 V AC, external fuses required

**Control and output signals**

via Modbus interface

**Modbus interface with additional inputs (option)**

Modbus interface with 4 free 24 V DC inputs and 2 free 0/4 – 20 mA inputs. Signal transmission vial fieldbus interface.

**Local controls**

Standard: Selector switch LOCAL – OFF – REMOTE (lockable in all three positions)

Push buttons OPEN – STOP – CLOSE

3 indication light:
End position CLOSED (yellow), collective fault signal (red),
End position OPEN (green)

Option: Protection cover, lockable

**Functions**

Standard
Switch-off mode, adjustable
Limit or torque seating for end position CLOSED

Overload protection against excessive torque over the whole travel

Phase failure monitoring with automatic phase correction

Push-to-run operation or self-retaining in LOCAL

Positioner[4]:
Nominal position value via Modbus interface
Adjustable behaviour on loss of signal
Adjustable sensitivity (dead band) and pause time

**Motor protection evaluation**

Standard: For AM: Monitoring of motor temperature in combination with thermoswitches in actuator motor

For AMExB/ AMExC: Monitoring of the motor temperature with PTC tripping device in combination with PTC thermistors in the actuator motor

Optionen: Additional thermal overload relay in the controls in combination with thermoswitches within the actuator

PTC tripping device in combination with PTC thermistors in the actuator motor

**Electrical connection**

Standard: For AM: AUMA plug/ socket connector with screw type connection

For AMExB/ AMExC: Ex-plug/ socket connector with terminal board

For further options and threads for cable entries, please refer to separate technical data sheets

Special threads, other than standard mentioned above, possible

Control plug gold plated[3] (sockets and pins)

Parking frame for wall mounting of the disconnected plug

Protection cover for plug compartment (when plug is removed)

**Overvoltage protection[3] (option)**

Protection of the actuator and controls electronics against overvoltages on the fildbus cables of up to 4 kV

**Wiring diagram (basic version)**

MSP 1B1-00-7-F18E1 KMS TP102/001

1) AC current only with AM 01.1/ AM 02.1 and AMExC 01.1 in combination with actuator SGExC
2) The lifetime guaranteed by the manufacturer amounts to min. 2 million cycles. If a higher number of switching cycles is to be expected, thyristor units with virtually unlimited lifetime should be used
3) only in combination with AM 01.1 and AM 02.1
4) Requires position transmitter (potentiometer or RWG) in actuator

<table>
<tr><th colspan="2">Settings/ programming of the Modbus interface</th></tr>
<tr><td>Setting of the Modbus interface</td><td>The setting of baud rate, parity, and Modbus address is realised via the AUMA MATIC Modbus assembly</td></tr>
<tr><th colspan="2">Commands and signals of the Modbus interface</th></tr>
<tr><td>Oricess representation output (command signals)</td><td>OPEN, STOP CLOSE, nominal position value [4]</td></tr>
<tr><td>Process representation input (feedback signals)</td><td>End position OPEN, CLOSED<br>Actual position value [4]<br>Selector switch in position LOCAL/ REMOTE<br>Running indication [4] (directional)<br>Torque switch OPEN, CLOSED<br>Limit switch OPEN, CLOSED<br>Manual operation by handwheel [4] or local controls</td></tr>
<tr><td>Process representation input (fault signals)</td><td>Motor protection tripped<br>Torque switch tripped in mid-travel<br>One phase missing</td></tr>
<tr><td>Behaviour on loss of communication</td><td>The behaviour of the actuator is programmable:<br>- operation to end position OPEN or CLOSED<br>- operation to any intermediate position [4]</td></tr>
<tr><th colspan="2">General Modbus data</th></tr>
<tr><td>Communication protocol</td><td>Modbus RTU</td></tr>
<tr><td>Network topology</td><td>Linear (BUS) structure. Active bus termination on both sides.<br>Coupling and uncoupling of devices during operation without affecting other devices is possible.</td></tr>
<tr><td>Transmission medium</td><td>Twisted, shielded copper cable according to EN 50 170</td></tr>
<tr><td>Modbus interface</td><td>EIA-485 (RS485)</td></tr>
<tr><td>Transmission speed/ cable length</td><td>
<table>
<tr><th>Baud rate (kbit/s)</th><th>Max. cable length (segment length) without repeater</th><th>Possible cable length with repeater (total network cable length)</th></tr>
<tr><td>300</td><td>1,200 m</td><td>approx. 10 km</td></tr>
<tr><td>600</td><td>1,200 m</td><td>approx. 10 km</td></tr>
<tr><td>1,200</td><td>1,200 m</td><td>approx. 10 km</td></tr>
<tr><td>2,400</td><td>1,200 m</td><td>approx. 10 km</td></tr>
<tr><td>4,800</td><td>1,200 m</td><td>approx. 10 km</td></tr>
<tr><td>9,600</td><td>1,200 m</td><td>approx. 10 km</td></tr>
<tr><td>19,200</td><td>1,200 m</td><td>approx. 10 km</td></tr>
<tr><td>38,400</td><td>1,200 m</td><td>approx. 10 km</td></tr>
</table>
</td></tr>
<tr><td>Device types</td><td>Modbus slave, e.g. devices with digital and/ or analogue inputs and outputs, such as actuators, sensors</td></tr>
<tr><td>Number of devices</td><td>32 devices within each segment without repeater, with repeater expandable up to 127 [5]</td></tr>
<tr><td>Bus access</td><td>Polling between master and slaves (query-response)</td></tr>
<tr><td>Supported Modbus functions (services)</td><td>01 Read Coil Status<br>02 Read Input Status<br>03 Read Holding Registers<br>04 Read Input Registers<br>05 Force Single Coil<br>15 (0FHex) Force Multiple Coils<br>06 Preset Single Register<br>16 (10Hex) Preset Multiple Registers<br>07 Read Exception Status<br>17 (11Hex) Report Slave ID<br>08 Diagnostics:<br>00 00 Loopback<br>00 10 (0AHex) Clear Counters and Diagnostic Register<br>00 11 (0BHex) Return Bus Message Count<br>00 12 (0CHex) Return Bus Communication Error Count<br>00 13 (0DHex) Return Bus Exception Error Count<br>00 14 (0EHex) Return Slave Message Count<br>00 15 (0FHex) Return Slave No Response Count</td></tr>
</table>

4) Requires position transmitter (potentiometer or RWG) in actuator
5) The highest Modbus address which can be set at the AUMA MATIC is 127

| | | | |
|---|---|---|---|
| **Service conditions** | | | |
| Enclosure protection according to EN 60 529 | Standard: | IP 67 (when mounted) | |
| | Options: | IP 68[6)] | |
| | | DS[3)] Terminal compartment additionally sealed against interior (double sealed) | |
| Corrosion protection | Standard: | KN | Suitable for installation in industrial units, in water or power plants with a low pollutant concentration |
| | Optionen: | KS | Suitable for installation in occasionally or permanently aggressive atmosphere with a moderate pollutant concentration (e.g. wastewater treatment plants, chemical industry) |
| | | KX | Suitable for installation in extremely aggressive atmosphere with high humidity and high pollutant concentration |
| | | KX-G | Same as KX, however aluminium-free version (outer parts) |
| Finish coating | Standard: | Two-component iron-mica combination | |
| | Option: | Special primer/special finish coat (customer's choice) | |
| Colour | Standard: | Silver-grey (DB 701, similar to RAL 9007) | |
| | Option: | Other colours than standard colour are possible on request | |
| Ambient temperature | AM 01.1/ AM 02.1:<br>Standard:<br>Options: | – 25 °C to + 70 °C<br>– 40 °C to + 70 °C, low temperature version<br>– 50 °C to + 70 °C, extreme low temperature version, incl. heating system<br>– 60 °C to + 70 °C, extreme low temperature version, incl. heating system | |
| | AMExB<br>Standard: | – 20 °C to + 40 °C | |
| | AMExC:<br>Standard:<br>Options: | – 20 °C to + 40 °C<br>– 40 °C to + 40 °C, low temperature version<br>– 50 °C to + 40 °C, extreme low temperature version, incl. heating system | |
| Vibration resistance [7)] according to IEC 60 068-2-6 | 1 g, for 10 to 200 Hz<br>(only for actuator with controls. Not valid in combination with gearboxes) | | |
| Weight | approx. 7 kg (with AUMA plug/ socket connector)<br>approx. 12 kg (with Ex-plug/ socket connector with terminal board) | | |
| **Accessories** | | | |
| Wall bracket [8)] | AUMA MATIC mounted separately from the actuator, including plug/ socket connector. Connecting cables on request..<br>Recommended for high ambient temperatures, difficult access, or in case of heavy vibrations during service. | | |
| **Other information** | | | |
| EU Directives | Electromagnetic Compatibility (EMC): (89/336/EEC)<br>Low Voltage Directive: (73/23/EEC)<br>Machinery Directive: (98/37/EC) | | |
| Reference documents | Product description "Actuator controls AUMA MATIC"<br>Dimension sheets "Multi-turn actuators/ part-turn actuators with integral controls AUMA MATIC" | | |

3) Only in combination with AM 01.1 and AM 02.1

6) For version in enclosure protection IP 68, a higher corrosion protection KS or KX is strongly recommended

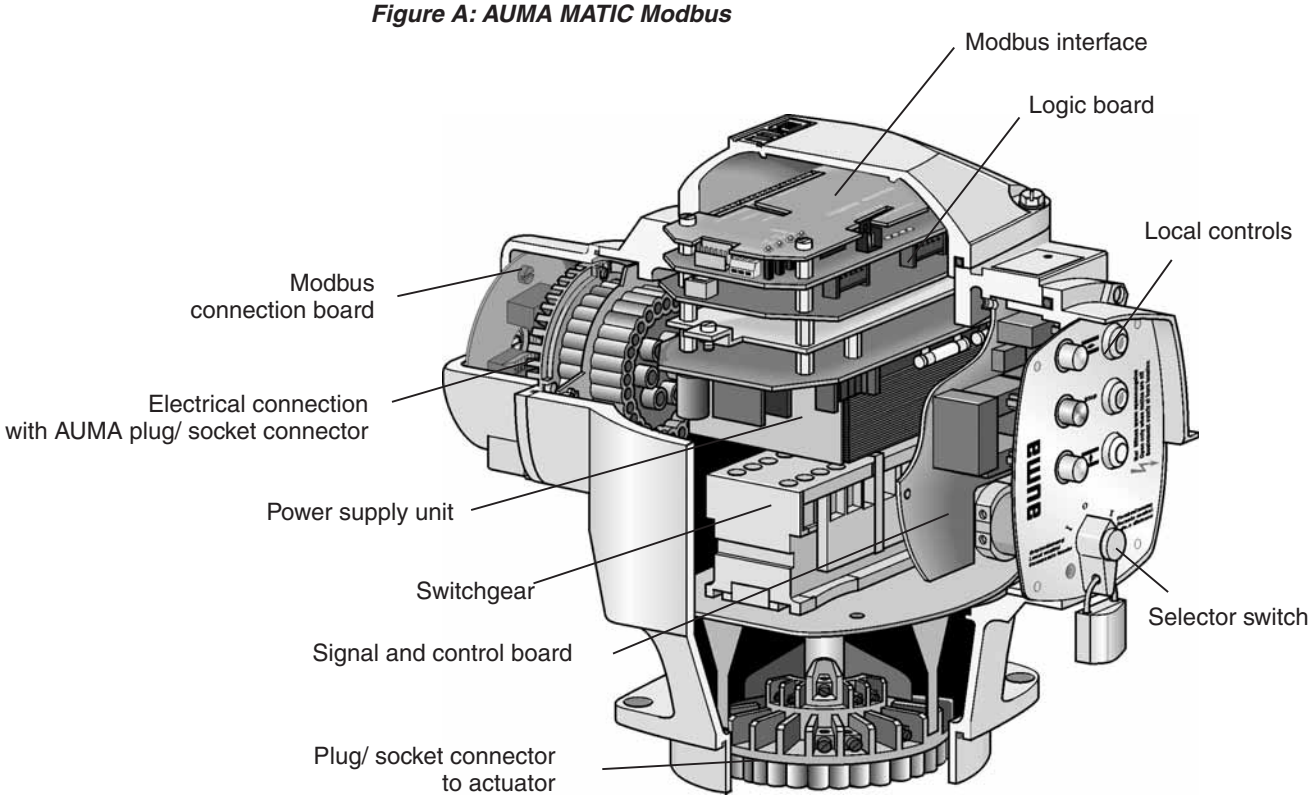
7) Resistant to vibrations during start-up or for failures of the plant. However, a fatigue strength may not be derived from this

8) Cable length between actuator and AUMA MATIC max. 100 m. Not suitable for version with potentiometer in the actuator. Instead of the potentiometer, an RWG has to be used in the actuator.

## 6. Design AUMA MATIC Modbus

The AUMA MATIC Modbus by AUMA represents the ideal controls for connecting multi-turn actuators of the SA range and part-turn actuators of the SG range to Modbus.

***Figure A: AUMA MATIC Modbus***




The integral controls AUMA MATIC Modbus consist of the following modules:

- Modbus interface. The interface links the Modbus data with the internal electronics.
- The logic board links the signals of the actuator with the local controls and the Modbus interface and controls the reversing contactors or the thyristors.
- Local controls with selector switch, push buttons, and indication lights. The selector switch is used to select the control devices for the local control **LOCAL – 0 – REMOTE** for remote control. The push buttons (OPEN) – **Stop** – (CLOSE) are used for the electric operation of the actuator on site.
- Plug/ socket connectors for easy mounting of the AUMA MATIC Modbus on the actuators.
- Signal and control board with primary fuses, relays for conversion of the local control commands into electrical signals, and indication lights as an option.
- Switchgear: Reversing contactors or thyristors for motor controls.
- Modbus connection board with terminals for the Modbus cable and the termination resistor for bus termination.

Actuators which have already been installed can be retrofitted for Modbus by exchanging the controls AUMA MATIC for controls AUMA MATIC Modbus.

# 7. Electrical connection

- **Work on the electrical system or equipment must only be carried out by a skilled electrician himself or by specially instructed personnel under the control and supervision of such an electrician and in accordance with the applicable electrical engineering rules.**
- **Installation regulations for Modbus must be observed for the wiring.**
  **(For literature references, please refer to appendix C)**

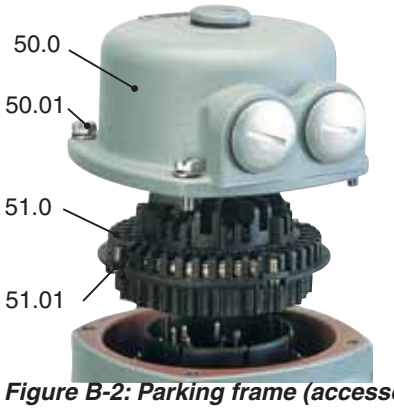
Make sure to respect electromagnetic compatibility (EMC) when installing cables:
Signal and bus cables are susceptible to interference.
Electric power cables are interference sources.

- Lay cables being susceptible to inferference or sources of interference at the highest possible distance from each other.
- The interference immunity of signal and bus cables increases if the cables are laid close to the ground potential.
- Avoid long cables, if possible, or make sure that they are laid in locations with low susceptibility to interference.
- Avoid long parallel paths with cables being either interference sources or susceptible to interference.

## 7.1 Power supply (standard)

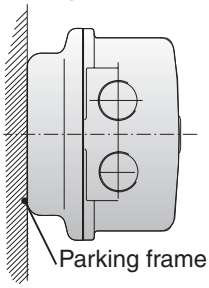
For explosion-proof version (type designation: AMExB/ AMExC), please refer to page 15 or page 17.

***Figure B-1: Connection***




- Check whether type of current, supply voltage, and frequency comply with motor data (refer to name plate at motor).
- Loosen bolts (50.01) (figure B-1) and remove connection housing.
- Loosen screws (51.01) and remove socket carrier (51.0) from plug cover (50.0).
- Insert cable glands suitable for connecting cables.
  (The enclosure protection stated on the name plate is only ensured if suitable cable glands are used).
- Seal cable entries which are not used with suitable plugs.
- Connect cables according to order-related wiring diagram.
  The wiring diagram applicable to the actuator is attached to the handwheel in a weather-proof bag, together with the operation instructions. In case the wiring diagram is not available, it can be obtained from AUMA (state commission no., refer to name plate) or downloaded directly from the Internet (www.auma.com).

***Figure B-2: Parking frame (accessory)***




A special parking frame (figure B-2) for protection against touching the bare contacts and against environmental influences, in case the electrical connection has been removed, is available.

***Table 2: Technical data AUMA plug/ socket connector for bus connection***

| Technical data | Motor power connections[1)] | Protective earth | Control terminals |
|---|---|---|---|
| No. of contacts max. | 6 (3 are used) | 1 (leading contact) | 50 pins / sockets |
| Marking | U1, V1, W1, U2, V2, W2 | ⏚ | 1 to 50 |
| Connecting voltage max. | 750 V | – | 250 V |
| Nominal current max. | 25 A | – | 16 A |
| Type of customer connection | Screws | Screw for ring lug | Screws |
| Cross section max. | 6 mm² | 6 mm² | 2.5 mm² |
| Material: Pin/ socket carrier | Polyamide | Polyamide | Polyamide |
| Contacts | Brass (Ms) | Brass (Ms) | Brass, tin plated or gold plated (option) |
| 1)Suitable for copper wires. For aluminium wires, please contact AUMA | | | |

## 7.2 Bus connection (standard)

For explosion-proof version (type designation: AMExB/ AMExC), please refer to page 15 or page 17.
For version with FO (fibre optics), refer to separate operation instructions “AUMA MATIC AM 01.1/ AM 02.1 FO connection”.

• Connect bus cable. Refer to figures C-1 and C-4.

The termination resistors for channel 1 and channel 2 are switched in via switches (S1) and (S2). Both switches are supplied in position ‘OFF’.

**Only switch on the termination resistors (position ‘ON’) if the actuator is the final device in the Modbus segment.**

***Table 3: Switch positions of S1 and S2***

| | | |
|---|---|---|
| S1 | ON | Bus termination channel 1 ON |
| | OFF | Bus termination channel 1 OFF |
| S2 | ON | Bus termination channel 2 ON (option) |
| | OFF | Bus termination channel 2 OFF (option) |

***Figure C-1: Connection board (standard)***

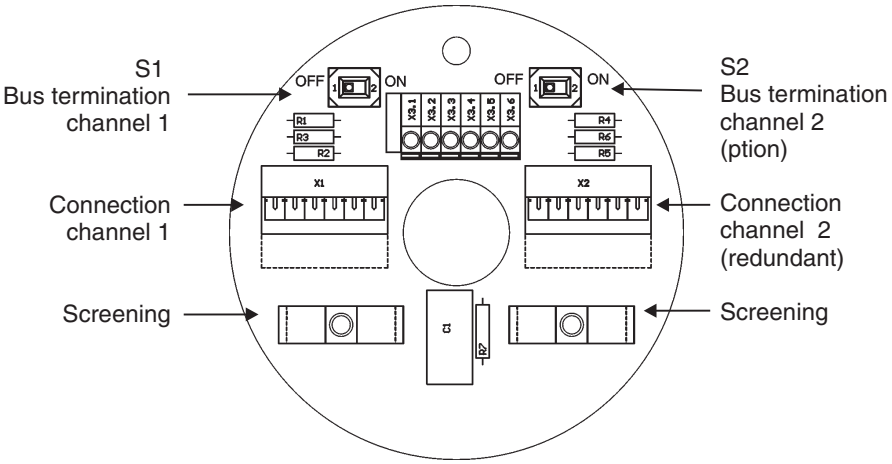



***Figure C-2: Connection (standard)***

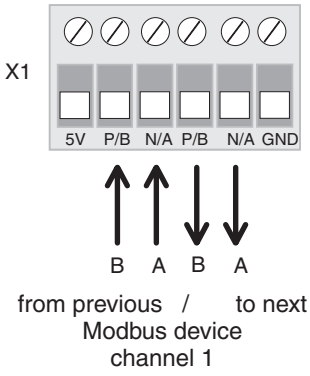


*Figure C-3: Connection board (for overvoltage protection)*

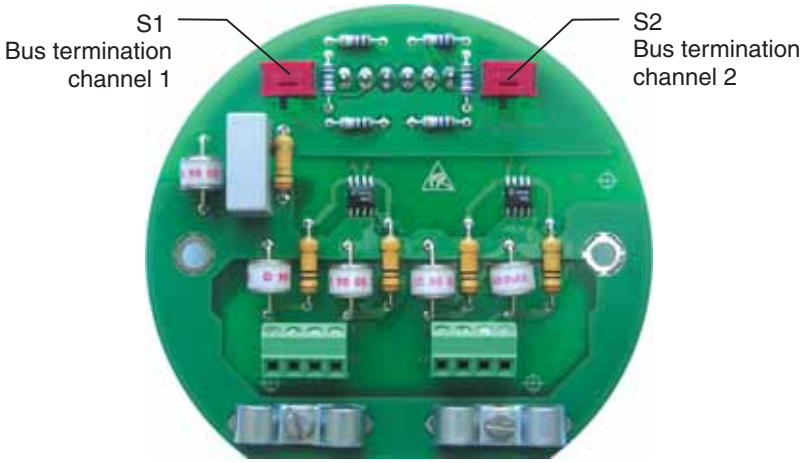



*Figure C-4: Connection for overvoltage protection*

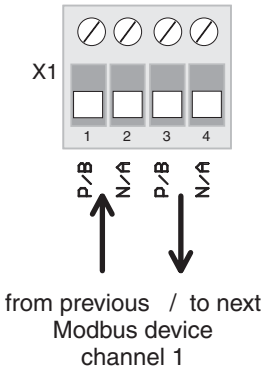



*Table 4: Assignment of Modbus cable*

| Modbus cable | AUMA labelling at the connection |
|---|---|
| A | N/A |
| B | P/B |

## 7.3 Fitting the cover

**After connection:**

- Insert the socket carrier (51.0) into the plug cover (50.0) and fasten it with screws (51.01).
- Clean sealing faces at the plug cover and the housing.
- Check whether O-ring is in good condition.
- Apply a thin film of non-acidic grease (e.g. Vaseline) to the sealing faces.
- Replace plug cover (50.0) and fasten bolts (50.01) evenly crosswise.
- Fasten cable glands with the specified torque to ensure the required enclosure protection.

## 7.4 Remote position transmitter

For the connection of remote position transmitters (potentiometer, RWG) screened cables must be used.

## 7.5 AUMA MATIC on wall bracket

The AUMA MATIC can also be mounted separately from the actuator on a wall bracket.

- For the connection of actuator and AUMA MATIC on wall bracket, use suitable flexible and screened connecting cables.
  (Preconfectioned cables can be obtained from AUMA on request)
- Permissible cable distance between actuator and AUMA MATIC amounts to a max. of 100 m.
- Versions with potentiometer in the actuator are not suitable. Instead of the potentiometer, an RWG has to be used in the actuator.
- Connect the wires in correct phase sequence.
  Check direction of rotation before switching on.

*Figure C-5: AM on wall bracket*

Connecting cable to actuator

The plug connection on the wall bracket is made as crimp version.
Use a suitable four indent crimp tool for crimping.

Cross sections for flexible wires:
Control cables: max. 0.75 to 1.5 mm²
Power supply: max. 2.5 to 4 mm²

The connector at the actuator is equipped with screw type connections.
Wire end sleeves have to be used.

## 7.6 Test run

Perform test run. Please refer to the operation instructions pertaining to the actuator (multi-turn actuator SA(R) ... / part-turn actuator SG ...).

**Check limit and torque switching:**
Check limit and torque switching, electronic position transmitter RWG or potentiometer (option) and re-set where appropriate.
The settings are described in the operation instructions pertaining to the actuator (multi-turn actuator SA(R) ... part-turn actuator SG ... ).

For actuators with feedback signal (RWG, potentiometer), a reference operation has to be performed after having changed the setting.

**Perform reference operation:**

- Operate actuator electrically (via the push buttons OPEN and CLOSE of the local controls) once to the end position OPEN and once to the end position CLOSED.
- If no reference operation is performed after changing the limit switching, the feedback signal via the bus is not correct. The bus signals the missing reference operation as warning (see page 28).

## 7.7 Mains and bus connection for Ex-version with plug/ socket connector / terminal board (KP)

**When working in potentially explosive areas, observe the European Standards EN 60079-14 “Electrical installations in hazardous areas” and EN 60079-17 “Inspection and maintenance of electrical installations in hazardous areas”.**

*Figure D-1: Connection*


*Figure D-2: Disconnection from the mains*


For the Ex-plug/ socket connector (figure D-1), the electrical mains connection is made after removing the plug cover (50.0) at the EEx e terminals of the terminal board (51.0). The flameproof compartment (type of protection EEx d) remains hereby closed.

- Check whether type of current, supply voltage, and frequency correspond to motor data (refer to name plate at motor).
- Loosen bolts (50.01) (figure D-1) and remove plug cover.

- **Insert cable glands with “EEx e” approval and of size suitable for connecting cables. For the recommended cable glands refer to appendix D, page 57.**
  **(The enclosure protection stated on the name plate is only ensured if suitable cable glands are used).**
- **Seal cable entries which are not used with suitable plugs.**
- **No more than max. 2 wires with the same cross section may be connected to one terminal.**

- Remove cable sheathing in a length of 120 – 140 mm.
  Strip wires: Controls max. 8 mm, motor max. 12 mm.
  For stranded wires use end-sleeves according to DIN 46228.
- Connect bus cable. Refer to figure (D-3).
  The termination resistor for channel 1 is connected through linking the terminals 1 – 4 and 3 – 2 (standard).
- Only connect the termination resistor if the actuator is the final device in the Modbus segment.
- Connect screen largely to the cable glands. For the recommended cable glands refer to appendix D, page 57.

If the actuator must be taken from the valve, e.g. for service purposes, it can be separated from the mains without having to remove the wiring (figure D-2). For this purpose, the screws (51.02) are removed and the plug/ socket connector is pulled off. Plug cover (50.0) and terminal board (51.0) remain together.

**Flameproof enclosure! Before opening, ensure that no explosive gas and no voltage is present.**

A special parking frame (figure D-2) for protection against touching the bare contacts and against environmental influences is available.

*Figure D-3: Bus connection for channel 1 (standard)*

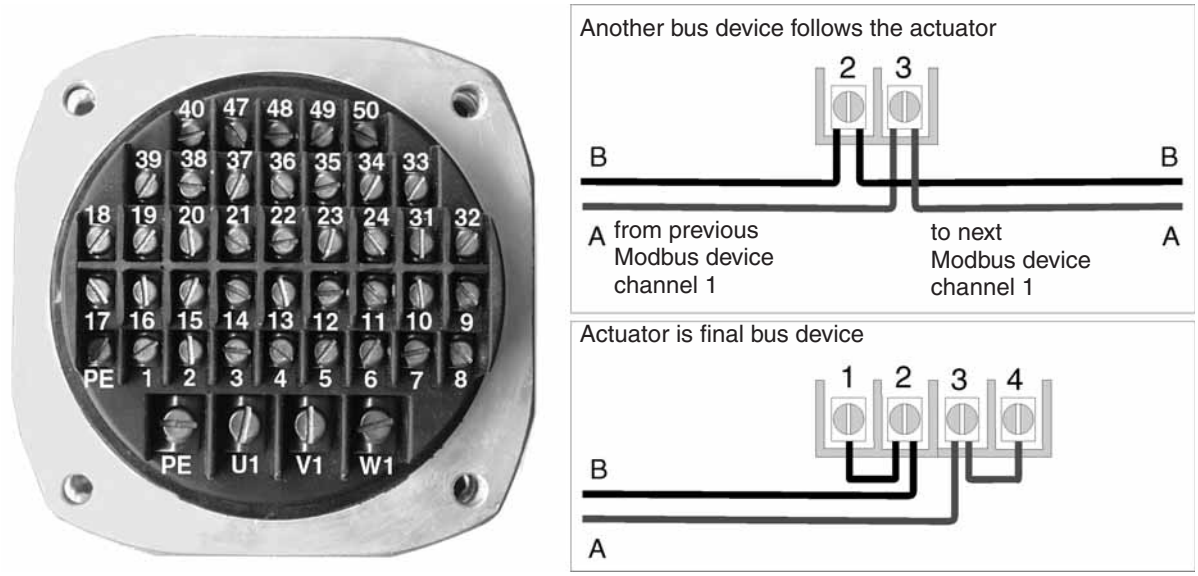


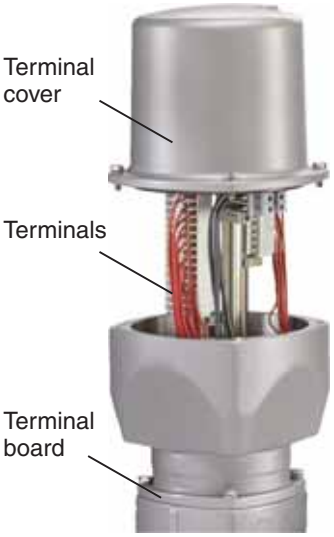

*Table 5: Technical data Ex plug/ socket connector with terminal board for explosion-proof actuators*

| Technical data | Motor power connections[1)] | Protective earth | Control terminals |
|---|---|---|---|
| No. of contacts max. | 3 | 1 (leading contact) | 38 pins/ sockets |
| Marking | U1, V1, W1 | ⏚ | 1 to 24, 31 to 50 |
| Connecting voltage max. | 550 V | – | 250 V |
| Nominal current max. | 25 A | – | 10 A |
| Type of customer connection | Screws | Screws | Screws |
| Cross section max. | 6 mm² | 6 mm² | 1.5 mm² |
| Material: Pin/ socket carrier | Araldite/ Polyamide | Araldite/ Polyamide | Araldite/ Polyamide |
| Contacts | Brass (Ms) | Brass (Ms) | Brass (Ms) tin-plated |
| 1)Suitable for copper wires. For aluminium wires, please contact AUMA | | | |

## 7.8 Mains and bus connection for Ex-version with plug-in terminal connection (KES)

**When working in potentially explosive areas, observe the European Standards EN 60079-14 “Electrical installations in hazardous areas” and EN 60079-17 “Inspection and maintenance of electrical installations in hazardous areas”.**

*Figure E-1: Plug-in terminal connection*




The bus connection is realised via terminals (figure E-1) The terminal compartment is designed for explosion protection “EEx e” (increased safety). The controls AUMA MATIC (type of protection EEx d) remain closed.

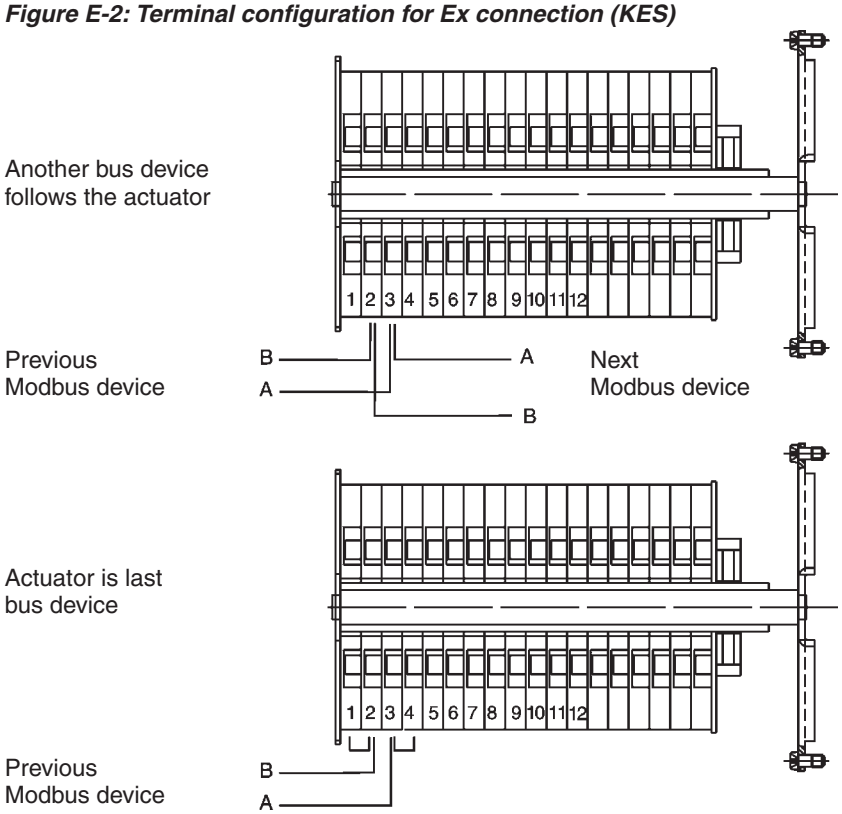
- Loosen bolts (1) (figure E-1) and remove terminal cover.

- **Insert cable glands with “EEx e” approval and of size suitable for connecting cables. For the recommended cable glands refer to appendix D, page 57. (The enclosure protection stated on the name plate is only ensured if suitable cable glands are used).**
- **Seal cable entries which are not used with suitable plugs.**

**Cross sections for connection:**
Control cables: max. 2.5 mm²
Motor connection: max. 10 mm²,
Suitable bus cables, see page 19.

- Connect bus cable to channel 1 according to configuration of the terminals (figure E-2).
  The termination resistor for channel 1 is connected through linking the terminals 1 – 2 and 3 – 4.
- Only connect the termination resistors if the actuator is the final device in the Modbus segment.

*Figure E-2: Terminal configuration for Ex connection (KES)*



## 7.9 Redundant bus connection

AUMA Modbus devices can be connected with a second (redundant) Modbus cable. If the bus on channel 1 fails, e. g. through cable break, the slave automatically switches to channel 2 after a waiting time.
Thus, the change-over is realised with a time delay (see parameter 5 “Time for channel changing in 0.1s”, page 35).
Additionally, the communication cannot be carried out on both channels simultaneously.
If the redundancy is activated (see parameter 4 “Redundancy”, page 34), the AUMA MATIC transmits its data using both channels but receives the data only using the active channel.

**This cable redundancy may only be applied after previous integration test using the desired process control system!**

- **For versions with AUMA plug/ socket connector (subclause 7.2):**
  Connect redundant bus cable to channel 2 in the same way as channel 1 (figure C-2).
- **For Ex-version with plug/ socket connector / terminal board (KP) (subclause 7.7):**
  Connect cable B to terminal 6, cable A to terminal 7.
  The termination resistor for channel 2 is connected through linking the terminals 5 – 6 and 7 – 8.
- **For Ex-version with plug-in terminal connection (KES) (subclause 7.8):**
  Connect cable B to terminal 6, cable A to terminal 7 (figure E-2).
  The termination resistor for channel 2 is connected through linking the terminals 5 – 6 and 7 – 8.

The setting of the redundant bus connection is realised via the parameters 4 and 5 (refert to pages 34, 35).

## 7.10 Bus cables

Only cables according to the recommendations of EIA 485 standard may be used for Modbus wiring.

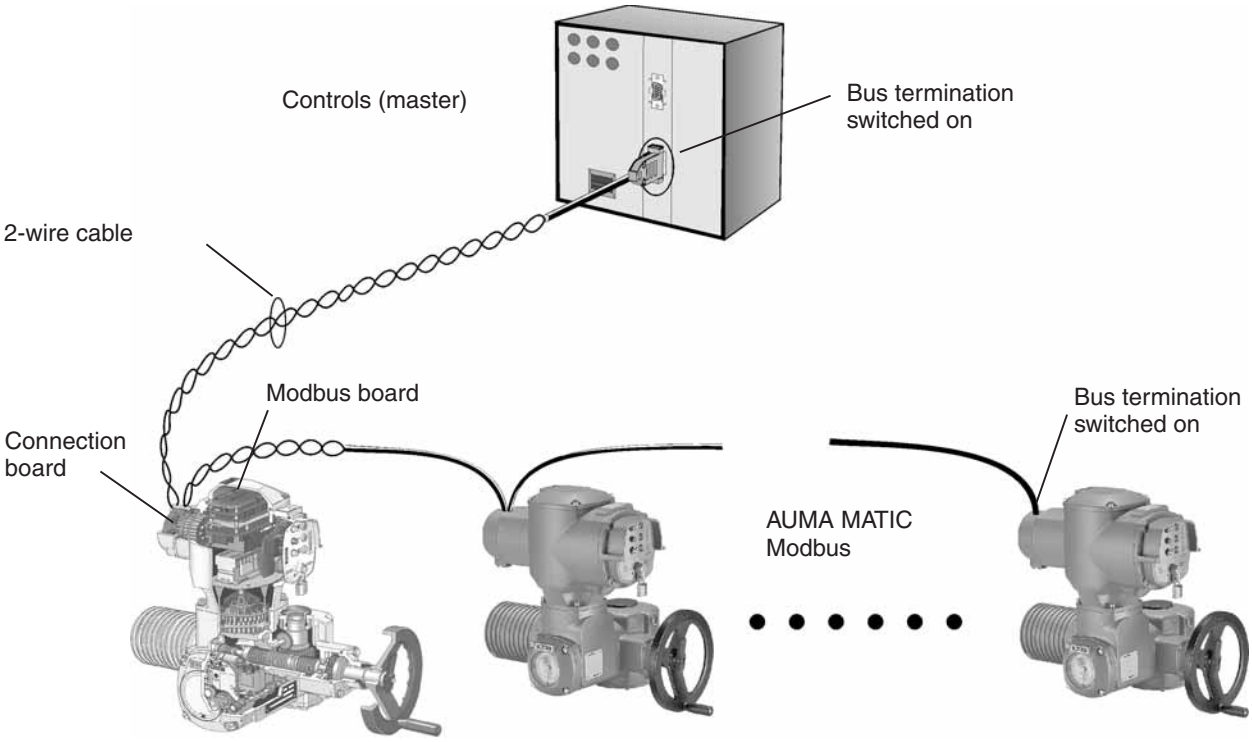
A maximum of up to 32 Modbus devices may be connected in one segment. If more stations are to be connected to one Modbus network, several segments must be connected with repeaters.
The bus cable must be laid at a distance of at least 20 cm from other cables. It should be laid in a separate, conductive, and earthed cable trunking.
It must be ensured that there are no potential differences between the individual devices on the Modbus (perform a potential compensation).

The max. cable length without repeater amounts to 1,200 m (independent of the baud rate).

**Cable recommendation for Modbus**

| | |
|---|---|
| Characteristic impedance: | 35 to 165 Ohm, at a measurement frequency of 3 to 20 MHz. |
| Cable capacity: | < 30 pF per metre |
| Core diameter | > 0.64 mm |
| Core cross section: | > 0.34 mm², corresponds to AWG 22 |
| Loop resistance: | < 110 Ohm per km |
| Screening: | copper shielding braid or shielding braid and shielding foil |

***Figure F: Example: Modbus with one secment***



## 7.11 Setting the Modbus interface

**A correct communication is only possible if the settings of the baud rate, the parity, and the stop bits agree with the master settings.**

The settings are realised on the Modbus interface board.

- Loosen screws and remove cover (figure G-1)

***Figure G-1***

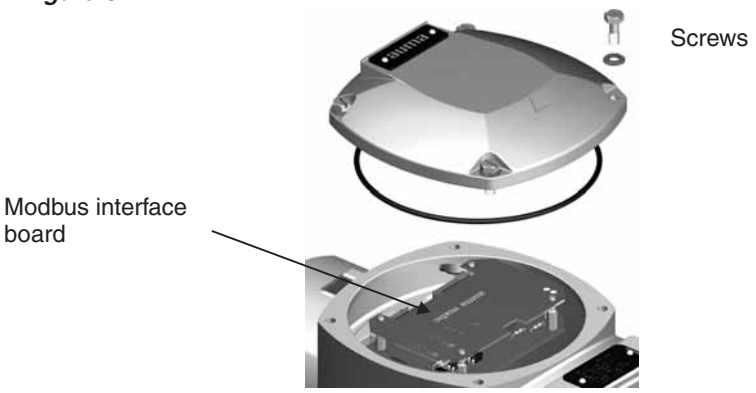
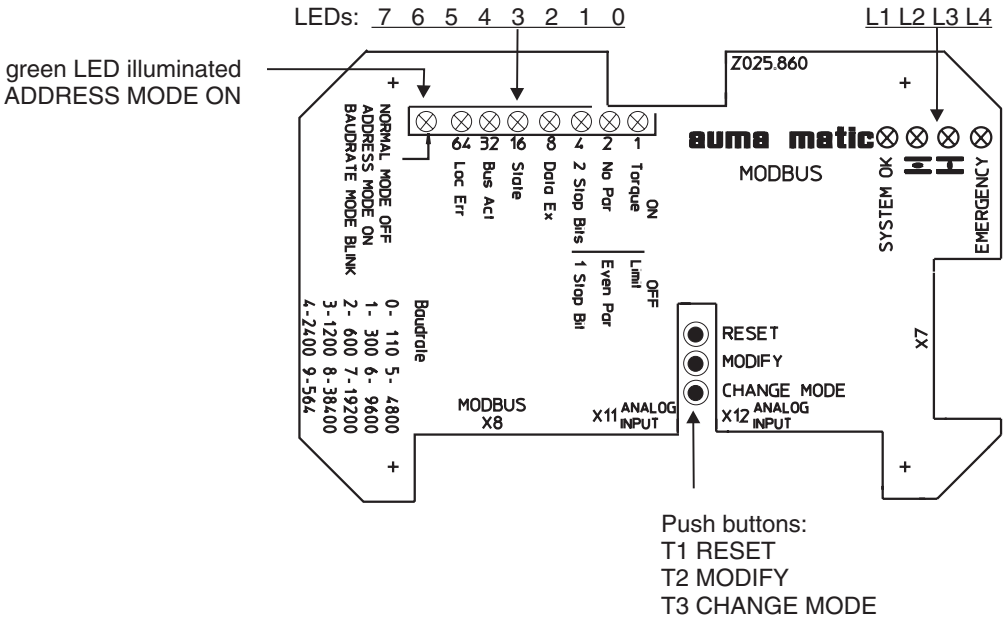



***Figure G-2: Modbus interface board***



## 7.12 Setting the communication parameters

**Push buttons:**
T1 **RESET**
T2 **MODIFY**
T3 **CHANGE MODE:**
**DEFAULT MODE:** for status indication and basic programming,
**ADDRESS MODE** for address setting
**BAUD RATE MODE** for baud rate selection

Push button 3 (CHANGE MODE) is used to switch between the following modes:

1) **DEFAULT MODE** is characterised by LED 7 (green) being switched off. Display and modification of type of seating in end position CLOSED, parity bits and stop bits as well as display of DataExchange, status, BusActivity, and LocalError.
2) **ADDRESS MODE** is characterised by LED 7 (green) being illuminated. The address is adjustable.
3) **BAUD RATE MODE**
is characterised by the blinking of LED 7 (green). The baud rate is adjustable. If no push buttons are pressed for 30 seconds, the display will revert to **DEFAULT MODE**.

The push button **MODIFY** allows incrementation of the figure shown in the LED row. The new value is immediately accepted in the **DEFAULT MODE**. For **ADDRESS MODE** and **BAUD RATE MODE**, the value is only accepted when leaving these modes.

## 7.13 Setting parameter seating mode in end position CLOSED, parity bits and number of stop bits

When not pressing push button **CHANGE MODE**, you are in the **DEFAULT MODE** (LED 7 is not illuminated). LED 0, LED 1, and LED 2 show the value of the three mentioned parameters:

| | | | |
|---|---|---|---|
| **LED** | **Parameter** | **LED on** | **LED off** |
| 0 | seating mode in end position CLOSED | torque seating | limit seating |
| 1 | Parity setting | No Parity | Even Parity |
| 2 | Number of stop bits | 2 stop bits | 1 stop bit |

Push button S3 "**MODIFY**" is used to set these parameters. If, for example, type of seating in end position CLOSED = torque seating, parity setting = even parity, and number of stop bits = 1 stop bit is to be selected, the combination 001 must be illuminated for the first 3 LEDs. The push button "**MODIFY**" is operated until this combination appears. The parameter values become immediately valid.

## 7.14 Setting the Modbus address

The Modbus address is set using push buttons T2 and T3. This is done according to the following sequence:

(a) Press push button T1 **CHANGE MODE** (hold down for 1 to 2 seconds):
The green LED 7 **ADRESS MODE** is illuminated (not blinking);
it indicates the programming mode for the Modbus address.
The actually set Modbus address is displayed as binary coding by LEDs 6 to 0 (1 to 127).
(b) Set desired bus address using push button T2 **MODIFY**:
(Factory setting: slave address 2)
(c) Each pressing of the push button increments the address value by one. Address 1 will follow after address 127. If push button T2 **MODIFY** is held down (approx. 1/3 s), the incrementation is done automatically.

(d) After setting the required Modbus address, quit the programming mode by pressing key T3 **CHANGE MODE**. The newly set address now becomes valid.
Pressing the key T3 results in changing to **BAUD RATE MODE**; renewed pressing of key 3 results in reverting to **DEFAULT MODE**.
(e) Alternatively to clause d), pressing the push button T3 may be ommitted. After 30 s the status address mode is automatically quit and the **DEFAULT MODE** is indicated. The set address is thus accepted.

## 7.15 Setting the baud rate

The baud rate is selected with the push buttons T2 and T3. This is done according to the following sequence:

(a) Press push button T3 **CHANGE MODE** (hold down for 1 to 2 seconds): The green LED 7 is illuminated (not blinking): the **ADDRESS MODE** is active.
(b) Press push button T3 **CHANGE MODE** again (hold down for 1 to 2 seconds): The green LED 7 is blinking: now, the **BAUD RATE MODE** is active.
(c) Select the desired Modbus baud rate pressing push button T2 **MODIFY**.
(d) The baud rate setting changes each time, push button T2 is pressed. After the setting 56,400 bit/s (1001), the setting 110 Bit/s (0000) follows again. If push button T2 **MODIFY** is held down (approx. 1/3 s), the incrementation is done automatically. Only the first 4 LEDs count as only 10 baud rate settings are possible.

| Setting | LED 3 | LED 2 | LED 1 | LED 0 | Baud rate bit/s | Notes |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 110 | |
| 1 | 0 | 0 | 0 | 1 | 300 | |
| 2 | 0 | 0 | 1 | 0 | 600 | |
| 3 | 0 | 0 | 1 | 1 | 1200 | |
| 4 | 0 | 1 | 0 | 0 | 2400 | |
| 5 | 0 | 1 | 0 | 1 | 4800 | |
| 6 | 0 | 1 | 1 | 0 | 9600 | Default setting |
| 7 | 0 | 1 | 1 | 1 | 19200 | |
| 8 | 1 | 0 | 0 | 0 | 38400 | Baud rate deviation – 2.5 % ! |
| 9 | 1 | 0 | 0 | 1 | 56400 | Baud rate deviation – 5 % (**not recommended**) |

(e) After setting the required Modbus baud rate, close the programming mode by pressing push button T3. The newly set baud rate becomes valid and the interface is in **DEFAULT MODE**.
(f) Alternatively to clause e), pressing the push button T3 **CHANGE MODE** may be omitted. After 30 s, the **BAUD RATE MODE** status is automatically quit and the **DEFAULT MODE** is indicated. The set baud rate is thus accepted.

# 8. Commissioning with controls

## 8.1 Introduction

To commission a Modbus slave, a special configuration of the master using a configuration file is usually not required.
The Modbus RTU transmission is based on a simple protocol containing the slave address, a function code with offset address, the process data, and a checksum.

## 8.2 Overview of the Modbus functions for data transmission

| Function | Function code (decimal) | Description |
|---|---|---|
| Force Single Coil | 05 | Sets one single bit to ON or OFF within slave |
| Force Multiple Coils | 15 | Sets several subsequent bits to ON or OFF within slave |
| Read Coil Status | 01 | Reads the status of individual pieces of output bit information out of the slave. |
| Read Input Status | 02 | Reads the status of individual pieces of input bit information out of the slave |
| Preset Single Register | 06 | Writs data into one single holding register (16 bit) of slave |
| Preset Multiple Register | 16 | Writes data into subsequent holding registers |
| Read Input Register | 04 | Reads the content of input data register (16 bit) out of the slave |
| Read Holding Register | 03 | Reads the content of holding registers out of the slave |

## 8.3 Modbus function and corresponding offset addresses of the AUMA MATIC

| Action | Permissible function function code (decimal) | Permissible offset addresses (decimal) | Permissible offset addresses (hexadecimal) |
|---|---|---|---|
| Write or read process representation output data (master outputs) | Force Single Coil (05)<br>Force Multiple Coils (15)<br>Read Coil Status (01) | 0 to 2 | 0x0000 to 0x0002 |
| | Preset Single Register (06)<br>Preset Multiple Register (16)<br>Read Holding Register (03) | 4096 to 4098 | 0x1000 to 0x1002 |
| Read process representation input data (master inputs | Read Input Status (02) | 8192 to 8239 | 0x2000 to 0x202F |
| | Read Input Register (04) | 12288 to 12296 | 0x3000 to 0x3008 |
| Write or read parameters of AUMA MATIC | Preset Single Register (06)<br>Preset Multiple Register (16)<br>Read Holding Register (03) | 16384 to 16433 | 0x4000 to 0x4031 |

# 9. Input data

## 9.1 Reading the actuator signals from the actuator using register functions

Functions to be used:
Read Input Register (04)
Grey bits are collective signals. They contain the results of a disjunction (OR operation) of other information.

| Offset (hexadecimal) | Offset (decimal) | Register contents (For the description, refer to chapter 9.2) |
|---|---|---|
| 0x3000 | 12288 | Register 1: Locigal signalsMeldungen |
| 0x3001 | 12289 | Register 2: Actuator signals |
| 0x3002 | 12290 | Register 3: E2 Actual position |
| 0x3003 | 12291 | Register 4: Fault signals |
| 0x3004 | 12292 | Register 5: Warning signals |

Register 1: Locigal signalsMeldungen

| Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 |
|---|---|---|---|---|---|---|---|
| – | – | – | – | – | – | – | – |

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Fault ind. | Warning ind. | Running CLOSE | Running OPEN | – | Setpoint reached | CLOSED position | OPEN position |

Register 2: Actuator signals

| Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 |
|---|---|---|---|---|---|---|---|
| – | – | – | – | – | – | – | – |

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| TSC (DSR) | TSO (DOEL) | LSC (WSR) | LSO (WOEL) | Local sw. position | Remote sw. position | Mains failure | Thermal fault |

Register 4: Fault signals

| Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 |
|---|---|---|---|---|---|---|---|
| – | – | – | – | – | – | – | – |

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| -- | -- | TSC (DSR) fault | TSO (DOEL) fault | Mains failure | Tthermal fault | Switch not REMOTE | Wrong command |

Register 5: Warning signals

| Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 |
|---|---|---|---|---|---|---|---|
| – | – | – | – | – | – | – | – |

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| – | – | No reference operation | Hardware fault | Potentiometer fault | Loss of transm. signal | Channel 2 active | 24 V power failure |

<table>
<tr><th>Offset (hexadecimal)</th><th>Offset (decimal)</th><th>Register contents<br>(For the description, refer to chapter 9.2)</th></tr>
<tr><td>0x3005</td><td>12293</td><td>Register 6: Physical operation
<table>
<tr><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>Local CLOSE</td><td>Local OPEN</td><td>Remote CLOSE</td><td>Remote openF</td><td>Start stepping mode</td><td>Operation pause</td><td>–</td><td>Rev.prev. /dead time</td></tr>
<tr><td>Bit 15</td><td>Bit 14</td><td>Bit 13</td><td>Bit 12</td><td>Bit 11</td><td>Bit 10</td><td>Bit 9</td><td>Bit 8</td><td>Bit 7</td><td>Bit 6</td><td>Bit 5</td><td>Bit 4</td><td>Bit 3</td><td>Bit 2</td><td>Bit 1</td><td>Bit 0</td></tr>
</table></td></tr>
<tr><td>0x3006</td><td>12294</td><td>Register 7: Options
<table>
<tr><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>Analogue 3/4 loss</td><td>Analogue 2 loss</td><td>–</td><td>Dig. input 4</td><td>Dig. input 3</td><td>Dig. input 2</td><td>Dig. input 1</td></tr>
<tr><td>Bit 15</td><td>Bit 14</td><td>Bit 13</td><td>Bit 12</td><td>Bit 11</td><td>Bit 10</td><td>Bit 9</td><td>Bit 8</td><td>Bit 7</td><td>Bit 6</td><td>Bit 5</td><td>Bit 4</td><td>Bit 3</td><td>Bit 2</td><td>Bit 1</td><td>Bit 0</td></tr>
</table></td></tr>
<tr><td>0x3007</td><td>12295</td><td>Register 8: First analogue input (wiring diagram designation: analogue 2)</td></tr>
<tr><td>0x3008</td><td>12296</td><td>Register 9: Second analogue input (wiring diagram designation: analogue 3/4)</td></tr>
</table>

**To ensure that the actuator gives a correct end position signal after power failure in end position CLOSED/ OPEN, we recommend to evaluate the information LSC (WSR)/ LSO (WOEL) (bit 5/4 in register 2) for the end position signal CLOSED/ OPEN.**

## 9.2 Description of the input data

**Register 1: Logical signals**
Important signals from the actuator concerning errors, warnings, operations:

| Bit | Designation | Value | Description |
|---|---|---|---|
| 0 | **OPEN position** Limit seating in end position OPEN | 1 | Limit switch in direction OPEN operated. |
| | | 0 | other |
| 1 | **CLOSED position** Limit seating in end position CLOSED | 1 | Limit switch in direction CLOSE operated. |
| | | 0 | other |
| | **CLOSED position** Torque seating in end position CLOSED | 1 | Torque switch and limit switch in direction CLOSE operated. |
| | | 0 | other |
| 2 | **Setpoint reached** | 1 | The setpoint is within max. error variable (outer dead band). Signal occurs only if Modbus master has set the Setpoint reached bit. |
| | | 0 | other |
| 3 | — | 1 | (reserved for extensions) |
| | | 0 | |
| 4 | **Running OPEN** | 1 | Operation command (OPEN or SETPOINT) from Modbus in direction OPEN is executed. For operation in stepping mode, this signal is also active during an off-time, the dead time, and the reversing prevention. |
| | | 0 | No operation is carried out via Modbus. |
| 5 | **Running CLOSED** | 1 | Operation command (CLOSE or SETPOINT) from Modbus in direction CLOSE is executed. For operation in stepping mode, this signal is also active during an off-time, the dead time, and the reversing prevention. |
| | | 0 | No operation is carried out via Modbus. |
| 6 | **Warning ind.** | 1 | One or several warnings have occurred.<br>Collective signal: Contains the result of a disjunction (OR operation) of all bits of the register “Warning signals (page 28) |
| | | 0 | No warnings are active (all bits of the warnings cancelled). |
| 7 | **Fault ind.** | 1 | One or several faults have occurred so that the actuator can no longer be controlled via Modbus (at least one bit set in fault byte).<br>Collective signal: Contains the result of a disjunction (OR operation) of all bits of the register “Fault signals” (page 27). |
| | | 0 | No faults are active (all bits are cancelled in fault register). |

**Register 2: Actuator signals**
Basic signals originating from the logic

| Bit | Designation | Value | Description |
|---|---|---|---|
| 0 | **Thermal fault** | 1 | A thermal fault (motor protection) has occurred. |
| | | 0 | No thermal fault has occurred. |
| 1 | **Mains fault** | 1 | A mains failure has occurred, e.g. phase error. |
| | | 0 | No mains failure has occurred. |
| 2 | **Remote sw. position** | 1 | Selector switch in position REMOTE. |
| | | 0 | Selector switch not in position REMOTE. |
| 3 | **Local sw. position** | 1 | Selector switch in position LOCAL. |
| | | 0 | Selector switch not in position LOCAL. |
| 4 | **LSO (WOEL)** | 1 | Limit switch OPEN left operated. |
| | | 0 | Limit switch OPEN left not operated. |
| 5 | **LSC (WSR)** | 1 | Limit switch CLOSE right operated. |
| | | 0 | Limit switch CLOSE right not operated. |
| 6 | **TSO (DOEL)** | 1 | Torque switch OPEN left operated (storing). |
| | | 0 | Torque switch OPEN left not operated. |
| 7 | **TSC (DSR)** | 1 | Torque switch CLOSE right operated (storing). |
| | | 0 | Torque switch CLOSE right not operated. |

**Register 3: E2 Actual position**
Actual actuator position, complete value, or low register

| Condition | Value |
|---|---|
| Parameter 2 (measured data coding position transmitter) = 0 | Value range 0..100 % |
| Parameter 2 (measured data coding position transmitter) = 1 | Value range 0..1000 % |

**Register 4: Fault signals**

The actuator is not ready for remote operation. As soon as one of these signals is set, bit 7 of register 1 will also be set.

| Bit | Designation | Value | Description |
|---|---|---|---|
| 0 | **Wrong command** | 1 | Indicates the fact that several operation commands were received simultaneously via Modbus (e.g. Remote OPEN and Remote CLOSE simultaneously or Remote CLOSE/ Remote OPEN and Remote SETPOINT (nominal) simultaneously) or that the max. value for a nominal position has been exceeded (setpoint > 1000 or > 100). |
| | | 0 | Operation commands correct |
| 1 | **Selector not remote** | 1 | Selector switch: position LOCAL or OFF |
| | | 0 | Selector switch: position REMOTE |
| 2 | **Thermal fault** | 1 | Motor protection has tripped; remedy: resetting local controls via selector switch position RESET after the motor has cooled off. |
| | | 0 | other |
| 3 | **Mains failure** | 1 | Loss of one phase or incorrect phase sequence. |
| | | 0 | other |
| 4 | **TSO (DOEL) fault** | 1 | Torque fault OPEN occurred (only torque or torque before limit, according to type of seating); remedy: resetting using counter command. |
| | | 0 | other |
| 5 | **TSC (DSR) fault** | 1 | Torque fault CLOSED occurred (only torque or torque before limit, according to type of seating); remedy: resetting using counter command. |
| | | 0 | other |

| Bit | Designation | Value | Description |
|---|---|---|---|
| 6 | — | 1 | not assigned (reserved for extensions) |
| | | 0 | |
| 7 | — | 1 | not assigned (reserved for extensions) |
| | | 0 | |

**Register 5: Warning signals**
The warning signals serve only information purposes and do not interrupt or cancel an operation (as opposed to faults). As soon as one of these signals is set, bit 6 of register 1 will be set simultaneously.

| Bit | Designation | Value | Description |
|---|---|---|---|
| 0 | **Failure 24 V supply** | 1 | Failure 24 V supply voltage (internal 24 V DC supply outside the permissible range). |
| | | 0 | other |
| 1 | **Channel 2 active** | 1 | Actuator uses channel 2 for communication. |
| | | 0 | other |
| 2 | **Loss of transm. signal** | 1 | Signal interrupted at position transmitter RWG: For recognition purposes, parameter 1 must be set to value 3 (RWG 4 – 20 mA). |
| | | 0 | other |
| 3 | **Potentiometer fault** | 1 | Potentiometer fault: in end position CLOSED a value is measured being higher than the one in end position OPEN. |
| | | 0 | other |
| 4 | **Hardware-fault** | 1 | Hardware fault: If this bit is set, the Modbus board must be checked/ replaced. |
| | | 0 | other |
| 5 | **No reference operation** | 1 | No reference operation: The values of the position transmitter cannot be used as long as the reference operation (end position OPEN, en position CLOSED) has not been performed. A nominal operation is not possible. |
| | | 0 | other |
| 6 | — | 1 | not assigned (reserved for extensions) |
| | | 0 | |
| 7 | — | 1 | not assigned (reserved for extensions) |
| | | 0 | |

**Register 6: Physical operation**

| Bit | Designation | Value | Description |
|---|---|---|---|
| 0 | **Rev.prev./ dead time** | 1 | Reversing prevention/ dead time warning: The actuator does not start as long as reversing prevention or dead time is still active. The bit is set if a operation command is available which cannot be executed immediately. The bit is cancelled as soon as the actuator starts |
| | | 0 | other |
| 1 | — | 1 | not assigned (reserved for extensions) |
| | | 0 | |
| 2 | **Operation pause** | 1 | Operation pause |
| | | 0 | other |
| 3 | **Start stepping mode** | 1 | Indicates that the actuator is within the stepping range during active stepping mode. Conditions: position transmitter is provided, stepping mode is active, remote operation is being performed. |
| | | 0 | other |

| | | | |
|---|---|---|---|
| 4 | **Remote OPEN** | 1 | Remote operation via Modbus in direction OPEN (remote operation bit for logic board set and movement of potentiometer detected). Signalling of this bit requires a position transmitter. |
| | | 0 | other |
| 5 | **Remote CLOSE** | 1 | Remote operation via Modbus in direction CLOSE (remote operation bit for logic board set and movement of potentiometer detected). Signalling of this bit requires a position transmitter. |
| | | 0 | other |
| 6 | **Local OPEN** | 1 | Actuator runs locally in direction OPEN (local controls or handwheel).<br>Signalling of this bit requires a position transmitter. |
| | | 0 | other |
| 7 | **Local CLOSE** | 1 | Actuator runs locally in direction CLOSE (local controls or handwheel). Signalling of this bit requires a position transmitter. |
| | | 0 | other |

**Register 7: Options**
Digital inputs and signal loss at analogue inputs

| Bit | Designation | Value | Description |
|---|---|---|---|
| 0 | **Dig. input 1** | 1 | Digital input Nr. 1 = 1 (switch closed) |
| | | 0 | Digital input Nr. 1 = 0 (switch open) |
| 1 | **Dig. input 2** | 1 | Digital input Nr. 2 = 1 (switch closed) |
| | | 0 | Digital input Nr. 2 = 0 (switch open) |
| 2 | **Dig. input 3** | 1 | Digital input Nr. 3 = 1 (switch closed) |
| | | 0 | Digital input Nr. 3 = 0 (switch open) |
| 3 | **Dig. input 4** | 1 | Digital input Nr. 4 = 1 (switch closed) |
| | | 0 | Digital input Nr. 4 = 0 (switch open) |
| 4 | **—** | 1 | Not assigned (reserved for extensions) |
| | | 0 | |
| 5 | **Analogue 2 loss** | 1 | Signal interrupted at analogue input 2 (first free analogue input) i.e. the measured value is more than 0.2 mA lower than the set minimum value. |
| | | 0 | no signal interruption analogue input 2 detected |
| 6 | **Analogue 3/4 loss** | 1 | Signal interrupted at analogue input 3/4 (second free analogue input) i.e. the measured value is more than 0.2 mA lower than the set minimum value. |
| | | 0 | no signal interruption analogue input 3/4 detected |
| 7 | **—** | 1 | not assigned (reserved for extensions) |
| | | 0 | |

**Register 8: First analogue input (wiring diagram designation analogue 2)**

The data content depends on parameter 22 (coding analogue 2), holding register offset: 0x4015 (hexadezimal), 16405 (dezimal)

Settings:
0: 0 to 100 percent (default value)
1: 0 to 1000 per mil
2: 0 to 1023 (raw value of analogue-digital converter, not standardised)

**Register 9: Second analogue input (wiring diagram designation analogue 3/4)**

The data content depends on parameter 25 (coding analogue 3/4), holding register offset: 0x4018 (hexadecimal), 16408 (decimal)

Settings:
0: 0 to 100 percent (default value)
1: 1 to 1000 per mil
2: 0 to 1023 (raw value of analogue-digital converter, not standardised)

## 9.3 Reading the feedback signals from the actuator using status functions

Functions to be used:
Read Input Status (02)

Grey bits are collective signals. They contain the results of a disjunction (OR operation) of other information.

| **Offset (hexadecimal)** | **Offset (decimal)** | **Content** (Description in subclause 9.2) |
|---|---|---|
| 0x2000 | 8192 | OPEN position |
| 0x2001 | 8193 | CLOSED position |
| 0x2002 | 8194 | Setpoint reached |
| 0x2003 | 8195 | - - |
| 0x2004 | 8196 | Running OPEN |
| 0x2005 | 8197 | Running CLOSE |
| 0x2006 | 8198 | Warning signals (refer to page 28, register 5) |
| 0x2007 | 8199 | Error signals (refer to page 27, register 4) |
| 0x2008 | 8200 | Thermal fault |
| 0x2009 | 8201 | Mains failure (phase loss) |
| 0x200A | 8202 | Selector switch REMOTE |
| 0x200B | 8203 | Selector switch LOCAL |
| 0x200C | 8204 | LSO (WOEL) |
| 0x200D | 8205 | LSC (WSR) |
| 0x200E | 8206 | TSO (DOEL) |
| 0x200F | 8207 | TSC (DSR) |
| 0x2010 | 8208 | Wrong command |
| 0x2011 | 8209 | Selector switch not remote |
| 0x2012 | 8210 | Thermal fault |
| 0x2013 | 8211 | Mains failure (phase loss) |
| 0x2014 | 8212 | TSO (DOEL) fault |
| 0x2015 | 8213 | TSC (DSR) fault |
| 0x2016 | 8214 | - - |
| 0x2017 | 8215 | - - |
| 0x2018 | 8216 | 24 V power supply failure |
| 0x2019 | 8217 | Channel 2 active |

| **Offset (hexadecimal)** | **Offset (decimal)** | **Content** (Description in subclause 9.2) |
|---|---|---|
| 0x201A | 8218 | Signal loss position transmitter |
| 0x201B | 8219 | Potentiometer fault (wrong polarity) |
| 0x201C | 8220 | Hardware fault |
| 0x201D | 8221 | No reference operation |
| 0x201E | 8222 | - - |
| 0x201F | 8223 | - - |
| 0x2020 | 8224 | Rev.prev./ dead time |
| 0x2021 | 8225 | - - |
| 0x2022 | 8226 | Operation pause |
| 0x2023 | 8227 | Start stepping mode |
| 0x2024 | 8228 | Remote OPEN |
| 0x2025 | 8229 | Remote CLOSE |
| 0x2026 | 8230 | Local OPEN |
| 0x2027 | 8231 | Local CLOSE |
| 0x2028 | 8232 | Digital input 0 |
| 0x2029 | 8233 | Digital input 1 |
| 0x202A | 8234 | Digital input 2 |
| 0x202B | 8235 | Digital input 3 |
| 0x202C | 8236 | - - |
| 0x202D | 8237 | Singal loss customer analogue input 1 |
| 0x202E | 8238 | Signal loss customer analogue input 2 |
| 0x202F | 8239 | - - |

# 10. Process representation output

Via the process representation output, the master (controls) can control the slave (actuator).

## 10.1 Transmitting operation commands to or reading out from the actuator using register functions

Functions to be used:
Preset Single Register (06); Preset Multiple Register (16);
Read Holding Register (03)

| Offset (hexadecimal) | Offset (decimal) | Register contents |
|---|---|---|
| 0x1000 | 4096 | Register 1: Commands<br>Bit 15: 0 · Bit 14: 0 · Bit 13: 0 · Bit 12: 0 · Bit 11: 0 · Bit 10: 0 · Bit 9: 0 · Bit 8: 0<br>Bit 7: 0 · Bit 6: 0 · Bit 5: 0 · Bit 4: 0 · Bit 3: 0 · Bit 2: Remote SETPOINT · Bit 1: Remote CLOSED · Bit 0: Remote OPEN |
| 0x1002 | 4098 | Register 2: E1 Setpoint |
| | | |

**Holding register operation commands also change the corresponding coils for operation commands.**
**Operation commands which cannot be executed are rejected with ILLEGAL DATA VALUE (code 03). Operation commands cannot be executed if a thermal fault or mains failure have occurred, or if the local controls are not set to remote, or if commands are contradictory.**
**If a thermal fault or a mains failure occurs during remote operation, or if the remote operation is switched off via the selector switch, the actuator will cancel all pending operation commands**

## 10.2 Description of the output data

### Register 1: Commands (high byte)

With the bits 0 – 2, the operation commands are transmitted to the actuator. Only one of these bits may be set at any given time. If remote SETPOINT is set, the value of the nominal position (register 2) is used.
Bits 3 – 15 are reserved for future extensions and must remain set to 0.
As soon as these bits are written to via coil functions, the contents of the respective Holding Registers for the operation commands will also change.
If the Coil Remote SETPOINT is used, the respective setpoint has to be entered on the setpoint register.

| Bit | Designation | Value | Description |
|---|---|---|---|
| 0 | **Remote OPEN** | 1 | Running OPEN |
| | | 0 | Not running OPEN |
| 1 | **Remote CLOSED** | 1 | Running CLOSE |
| | | 0 | Not running CLOSE |
| 2 | **Remote SETPOINT** | 1 | Running to setpoint<br>Can only be set if a position transmitter e.g. potentiometer/ RWG (options) is available. |
| | | 0 | Not running to setpoint. |
| 3 | - - | 1 | Not assigned (reserved for extensions) |
| | | 0 | |
| 4 | - - | 1 | Not assigned (reserved for extensions) |
| | | 0 | |
| 5 | - - | 1 | Not assigned (reserved for extensions) |
| | | 0 | |
| 6 | - - | 1 | Not assigned (reserved for extensions) |
| | | 0 | |
| 7 | - - | 1 | Not assigned (reserved for extensions) |
| | | 0 | |

**Register 2: E1 Setpoint**

The setpoint can be transmitted either as a value between 0 – 100 (percent) or 0 – 1000 (per mil). The cange-over between 0 – 100 and 0 – 1000is realised via parameter 2 “Measured data coding position transmitter”. According to this programming, different maximum values apply. When these limits are exceeded, the actuator stops and signals a fault.

**Byte 2: Setpoint 0...100 or setpoint 0...1000**

| Condition | Value |
|---|---|
| Parameter 2 (measured data coding position transmitter) = 0 | Setpoint 0...100 % |
| Parameter 2 (measured data coding position transmitter) = 1 | Setpoint 0...1000 % |

## 10.3 Transmission of operation commands to the actuator using coil functions

Functions to be used:
Force Single Coil (05)
Force Multiple Coils (15)
Read Coil Status (01)

| Offset (hexadecimal) | Offset (decimal) | Contents (Description in page 41) |
|---|---|---|
| 0x0000 | 0 | REMOTE OPEN |
| 0x0001 | 1 | REMOTE CLOSED |
| 0x0002 | 2 | REMOTE SETPOINT |

If a Force Coil is set, the other two coils will be deleted by the actuator (the actuator executes the last command issued).
Coil operation commands also change the corresponding holding register for the operation commands.

Operation commands which cannot be executed are rejected with ILLEGAL DATA VALUE (code 03). Operation commands cannot be executed if:
- a thermal fault or a power failure have occurred.
- the remote controls is not set to REMOTE.
- an impermissible nominal value has been set (>100 or >1000).
- commands are contradictory (coil contents at Force Multiple Coils or holding registers contradictory).

If a thermal fault or a power failure occurs during remote operation or if the remote operation is switched off, the actuator will cancel the pending operation commands.

## 11. Operation parameters of the actuator

Functions to be used:

The parameters of the AUMA MATIC can be written or read using the following functions:
Preset Single Register (06),
Preset Multiple Register (16), or
Read Holding Register (03)

Parameters should only be changed as a whole parameter record in order to avoid inconsistent parameter records. The Modbus software checks the consistency of parameters and refuses inconsistent parameter records (ILLEGAL DATA VALUE, code 03).

**Parameter 1 “Position transmitter”**
Holding Register Offset: 0x4000 (hex.), 16384 (decimal)

Default value (standard setting): 1
0: The actuator is not equipped with a position transmitter.
1: The actuator is equipped with a potentiometer without RWG.
Switch S1.2 on Modbus board must be switched off!
2: Actuator is equipped with an RWG 0 – 20 mA.
For this position transmitter, the signal interruption noitoring is not active.
Switch S1.2 must be switched on!
3: Actuator is equipped with an RWG 4 – 20 mA.
For this position transmitter, the signal interruption monitoring is active.
Switch S1.2 on Modbus board must be switched on!

**Parameter 2 “Measured data coding position transmitter”**
Holding Register Offset: 0x4001 (hexadecimal), 16385 (decimal)

Default value: 0
0: Feedback signal (register 3, E2 actual position) 0 to 100 percent,
resolution is 1 %,
setpoint (register 2, E1 actual position) 0 to 100 percent.
1: Feedback signal (register 3, E2 actual position) 0 to 1000 per mil,
resolution is 0.1 %,
setpoint (register 2, E1 actual position) 0 to 1000 per mil.

**Parameter 3 “Reversing prevention in ms”**
Parameter for setting the waiting time in between a change of direction.
If necessary, adjust the value to the mechanics to prevent destruction caused by excessively fast changes of direction.
Holding Register Offset: 0x4002 (hexadecimal), 16386 (decimal)

Default value: 200
lowest value: 100 (0.1s)
maximum value: 1000 (1 s)

**Parameter 4 “Redundancy”**
Holding Register Offset: 0x4003 (hexadecimal), 16387 (decimal)

Default value 0
0: no cable redundancy (only the first channel is used for communication).
1: Cable redundancy is switched on (first and second communication channel connected).

**Parameter 5 “Time for channel changing in 0.1 s”**
Indicates the time after which the channel is changed if no process data, i.e. expiry of connection control time of 0.1 s, is received. This parameter is only effective if the cable redundancy (parameter 4) is switched on.

Holding Register Offset: 0x4004 (hexadecimal), 16388 (decimal)

Default value: 50
lowest value: 50 (5 s)
maximum value: 6000 (10 min)

**Parameter 6 “Failure behaviour”**
Failure operation on failure of connection.
The parameters set in the most recent connection also apply to the failure behaviour after interruption and restoring of the voltage supply.

Holding Register Offset: 0x4005 (hexadecimal), 16389 (decimal)

Default value: 0
0: Failure behaviour switched off (parameters 7, 8, 9 insignificant)
1: Simple failure behaviour switched on.
A failure operation will only be started if a connection to the master (process data exchange) was already available.
2: Extended failure behaviour switched on.

**If extended failure behaviour is switched on, a failure operation can be initiated immediately after the actuator has been switched on.**

**Parameter 7 “Delay time for failure operation 0.1 s”**
Delay time for failure operation in 0.1 s.
Indicates the down time of process data exchange after which a failure operation will be started. If the exchange is restored during this time, no failure operation will be performed.

Holding Register Offset: 0x4006 (hexadecimal), 16390 (decimal)

Default value: 30
lowest value: 0 (actuator reacts immediately)
maximum value: 12,000 (actuator reacts after 20 minutes)

**Parameter 8 “Failure operation”**
Holding Register Offset: 0x4007 (hexadecimal), 16391 (decimal)

Default value 0
0: The actuator stops (STOP).
1: Actuator runs CLOSE
2: Actuator runs OPEN
3: Actuator runs to failure position.
If no position transmitter is installed (parameter 1 = 0), value 3 is not permitted. In this case, the parameter record is rejected.

**Parameter 9 “Failure position in per mil”**
Actuator runs to the pre-set failure position.

This parameter is only effective if parameter 8 (failure operation) is set to value 3, and if parameter 6 (failure behaviour) is not 0.

Holding Register Offset: 0x4008 (hexadecimal), 16392 (decimal)

Default value: 0
lowest value: 0 (end position CLOSED)
maximum value: 1,000 (end position OPEN)

**Parameter 10: not used**

**For detailed descriptions of parameters 11 to 14, please refer to subclause 12.2**

**Parameter 11 “Dead time positioner in 0.1 s”**
Indicates the dead time which has to be maintained between two motor starts. In case the Modbus master issues a command before that time, the AUMA MATIC delays the actuator reaction until dead time has expired.

Holding Register Offset: 0x400A (hexadecimal), 16394 (decimal)

**The Modbus master of the controls must ensure that the maximum number of motor starts of the actuator is not exceeded.**

Default value: 0
minimum value: 0 (actuator reacts immediately)
maximum value: 600 (actuator delays reaction by 1 minute max.)

**Parameter 12 “Overrun direction OPEN in per mil”**
The motor is switched off as soon as the distance between the actuator position and the nominal position reaches this value. This is only valid for operations in direction OPEN.
This parameter must be lower than the value in parameter 14 (max. error in per mil).

Holding Register Offset: 0x400B (hexadecimal), 16395 (decimal)

Default value: 5
minimum value: 0 (no overrun in direction OPEN)
maximum value: 100 (10 % overrun in direction OPEN)

**Parameter 13 “Overrun direction CLOSE in per mil”**
The motor is switched off as soon as the distance between the actuator position and the nominal position reaches this value. This is only valid for operations in direction CLOSE.
This parameter must be smaller than the value in parameter 14 (max. error in per mil).

Holding Register Offset: 0x400C (hexadecimal), 16396 (decimal)

Default value: 5
minimum value: 0 (no overrun in direction CLOSE)
maximum value: 100 (10 % overrun in direction CLOSE)

**Parameter 14 “Max. error in per mil”**
The actuator will only be restarted if the distance between the nominal position and the actual position is higher than this value.
Corresponds to the outer dead band.
This parameter must be higher than the value in parameter 12 (overrun in direction OPEN) and parameter 13 (overrun in direction CLOSE).

**The parameter must be set sufficiently high to ensure a stable function of the positioner. If the value is set too low, the actuator moves continuously within nominal value range which will result in reducing the life time of the actuator.**

Holding Register Offset: 0x400D (hexadecimal), 16397 (decimal)

Default value: 10
minimum value: 1 (0,1 % error).
maximum value: 100 (10 % error).

**Parameters 15 to 19 are not used**

**Parameter 20 “Start analogue 2 in 0.1 mA”**
Current value at which the measuring range of analogue 2 input (option) begins. This value must be smaller than the value in parameter 21 (end analogue 2 in 0.1 mA). If a sensor with 4 – 20 mA signal is connected to the analogue 2 input, the value must be set to 40.

Holding Register Offset: 0x4013 (hexadecimal), 16403 (decimal)

Default value: 0
minimum value: 0 (value for sensor with 0 – 20 mA signal)
maximum value: 150
important value: 40 (this corresponds to the correct value for a sensor with a 4 - 20 mA signal)

**Parameter 21 “End analogue 2 in 0.1 mA”**
Current value at which the measuring range of analogue 2 input (option) ends. This value must be higher than the value in parameter 20 (start analogue 2 in 0.1 mA).

Holding Register Offset: 0x4014 (hexadecimal), 16404 (decimal)

Default value: 200
minimum value: 50
maximum value: 200 (value for sensor with 0 – 20 or 4 – 20 mA signal)

**Parameter 22 "Coding analogue 2"**
Holding Register Offset: 0x4015 (hexadecimal), 16405 (decimal)

Default value: 0
0: 0 to 100 percent
1: 0 to 1000 per mil
2: 0 to 1023 (raw value of analogue-digital converter, not standardised)

**Parameter 23 “Start analogue 3/4 in 0.1 mA”**
Current value at which the measuring range of analogue 3/4 input begins. This value must be smaller than the value in parameter 24 (end analogue 3/4).
If a sensor with a 4 – 20 mA signal is connected to analogue 3/4, the value must be set to 40.

Holding Register Offset: 0x4016 (hexadecimal), 16406 (decimal)

Default value 0
minimum value: 0 (value for sensor with 0 – 20 mA output)
maximum value: 150
important value: 40 (this corresponds to the correct value for a sensor with a 4 – 20 mA signal)

**Parameter 24 “End analogue 3/4 in 0.1 mA”**
Current value at which the measuring range of analogue 3/4 input ends. This value must be higher than the value in parameter 23 (start analogue 3/4).

Holding Register Offset: 0x4017 (hexadecimal), 16407 (decimal)

Default value: 200
minimum value: 50
maximum value: 200 (value for sensor with 0 – 20 mA or 4 – 20 mA output)

**Parameter 25 “Coding analogue 3/4”**
Holding Register Offset: 0x4018 (hexadecimal), 16408 (decimal)

Default value: 0
0: 0 to 100 percent
1: 0 to 1000 per mil
2: 0 to 1023 (raw value of analogue-digital converter, not standardised)

**The stepping mode increases the number of starts of the actuator. It must be ensured that the maximum number of starts will equally not be exceeded when operating in stepping mode.**

**Parameter 26 “Stepping direction OPEN active”**
This parameter is only effective if parameter 1 (position transmitter) is not 0. Otherwise, the parameter record will be rejected.

Holding Register Offset: 0x4019 (hexadecimal), 16409 (decimal)

Default value: 0
0: Stepping mode in direction OPEN switched off
1: Stepping mode in direction OPEN switched on

**Parameter 27 “Stepping operating time OPEN in 0.1 s”**
Stepping operating time direction OPEN in 0.1 s
This parameter is only effective if parameter 26 (stepping direction OPEN active) is not 0.

Holding Register Offset: 0x401A (hexadecimal), 16410 (decimal)

Default value: 10
minimum value: 1 (actuator runs 0.1 s per stepping period)
maximum value: 36,000 (actuator runs 1 hour per stepping period)

**Parameter 28 “Stepping pause time OPEN in 0.1 s”**
Stepping pause time direction OPEN in 0.1 s
This parameter is only effective if parameter 26 (stepping direction OPEN active) is not 0.

Holding Register Offset: 0x401B (hexadecimal), 16411 (decimal)
Default value 50
Default value: 50
minimum value: 1 (actuator stationary 0.1 s per stepping period)
maximum value: 36,000 (actuator stationary 1 hour per stepping period)

**Parameter 29 “Stepping start OPEN in per mil”**
Start stepping range in direction OPEN with indication of position in per mil. This value must be smaller than the value in parameter 30 (stepping end OPEN in per mil). Otherwise, the parameter record will be rejected.
This parameter is only effective if parameter 26 (stepping direction OPEN active) is not 0.

Holding Register Offset: 0x401C (hexadecimal), 16412 (decimal)

Default value: 0
minimum value: 0 (stepping mode in direction OPEN begins at position 0, end position CLOSED)
maximum value: 999

**Parameter 30 “Stepping end OPEN in per mil”**
End stepping range in direction OPEN with indication of position in per mil. This value must be higher than the value in parameter 29 (stepping start OPEN in per mil). Otherwise, the parameter record will be rejected. This parameter is only effective if parameter 26 (stepping direction OPEN active) is not 0.

Holding Register Offset: 0x401D (hexadecimal), 16413 (decimal)

Default value: 1000
minimum value: 1
maximum value: 1,000 (Stepping mode in direction OPEN ends at position 1,000, end position OPEN)

**Parameter 31 “Stepping direction CLOSE active”**
This parameter is only effective if parameter 1 (position transmitter) is not 0. Otherwise, the parameter record will be rejected.

Holding Register Offset: 0x401E (hexadecimal), 16414 (decimal)

Default value: 0
0: Stepping mode in direction CLOSE switched off
1: Stepping mode in direction CLOSE switched on

**Parameter 32 “Stepping operating time CLOSE in 0.1 s”**
Operating time for stepping mode in direction CLOSE. Indication in 0.1 seconds.
This parameter is only effective if parameter 31 (stepping direction CLOSE active) is not 0.

Holding Register Offset: 0x401F (hexadecimal), 16415 (decimal)

Default value: 10
minimum value: 1 (actuator runs 0.1 s per stepping period)
maximum value: 36,000 (actuator runs 1 hour per stepping period)

**Parameter 33 “Stepping pause time CLOSE in 0.1 s”**
Pause time for stepping mode in direction CLOSE. Indication in 0.1 seconds
This parameter is only effective if parameter 31 (stepping direction CLOSE active) is not 0. Otherwise, the parameter record will be rejected.

Holding Register Offset: 0x4020 (hexadecimal), 16416 (decimal)

Default value: 50
minimum value: 1 (actuator stationary 0.1 s per stepping period)
maximum value: 36,000 (actuator stationary 1 hour per stepping period)

**Parameter 34 “Stepping start CLOSE in per mil”**
Start stepping range in direction CLOSE with indication of position in per mil.
This value must be higher than the value in parameter 35 (stepping end CLOSE in per mil). Otherwise, the parameter record will be rejected.
This parameter is only effective if parameter 31 (stepping direction CLOSE active) is not 0.

Holding Register Offset: 0x4021 (hexadecimal), 16417 (decimal)

Default value: 1000
minimum value: 1
maximum value: 1,000 (Stepping mode in direction CLOSE starts at position 1,000, end position OPEN)

**Parameter 35 “Stepping end CLOSED in per mil”**
End stepping range in direction CLOSE with indication of position in per mil. This value must be higher than the value in parameter 34 (stepping start CLOSE in per mil). This parameter is only effective if parameter 31 (stepping direction CLOSE active) is not 0. Otherwise, the total parameter record will be rejected.

Holding Register Offset: 0x4022 (hexadecimal), 16418 (decimal)

Default value: 0
minimum value: 0 (stepping mode in direction CLOSE ends at position 0, end position CLOSED)
maximum value: 999

**Parameters 36 to 50 are spare parameters**
They are reserved for extensions.

Default value: 0
Value range: 0 to 65535

# 12. Description of actuator functions

## 12.1 Operation commands for OPEN/ CLOSE operation

Operation commands are determined by the operation command bits and the nominal value (setpoint) of the Modbus process representation output. Only one command bit may be set at any given time. If several command bits are set, no operation is performed and the fault signal 'Wrong command' is given.
To avoid placing too much strain on the mechanics the actuator is equipped with a (programmable) delay when changing direction (reversing prevention).

**The following operation command bits are required for OPEN/ CLOSE operation**:
Remote OPEN
Remote CLOSE

**Remote operation OPEN / STOP**
**Remote OPEN = 1** The actuator runs in direction OPEN.
**Remote OPEN = 0** The actuator stops.
The actuator is switched off automatically if the end position OPEN (limit switch LSO [WOEL]) is reached.
Occurring faults (thermal protection, phase failure, torque failure) stop the operation.

**Remote operation CLOSE/ STOP**
**Remote CLOSED = 1** The actuator runs to position CLOSED.
**Remote CLOSED = 0** The actuator stops.
The actuator is switched off automatically if the end position CLOSED is reached (limit switch LSC [WSR] for limit seating or LSC [WSR] and TSC [DSR] for torque seating). Occurring faults (thermal failure, phase failure, torque failure) stop the operation.

**Remote operation to setpoint position/ STOP**

The positioner can only function if the actuator is equipped with a position transmitter, e.g. potentiometer/ RWG (option).

**Remote SETPOINT = 1** The actuator moves to the set nominal value.
**Remote SETPOINT = 0** The actuator stops.
The setpoint must be indicated in % or in ‰ (depending on the AUMA user parameter 2 "Measured data coding position transmitter".
Occurring faults (thermal failure, phase failure, torque failure) stop an operation via the positioner.

With a setpoint of 0 % (0 ‰), the actuator runs to the end position CLOSED. With a setpoint of 100 % (1000 ‰), the actuator runs to the end position OPEN. In case the setpoint is more than 100 % (1,000 ‰) , no operation is performed and the fault signal "Wrong command" is given.

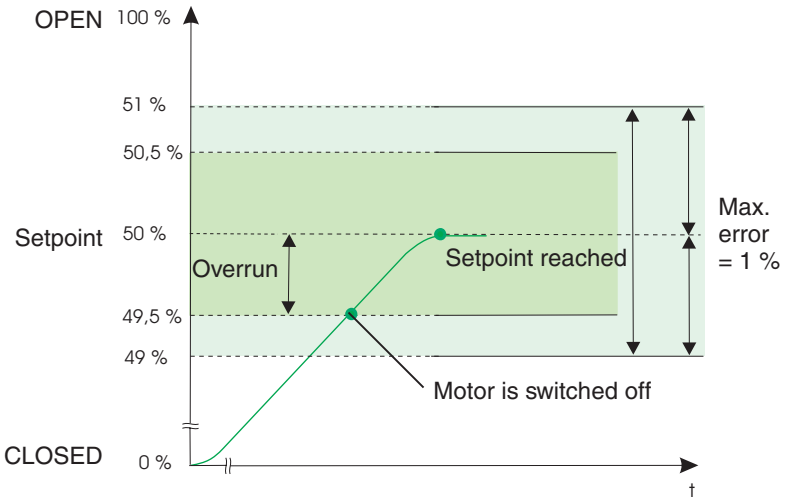
## 12.2 Positioner

The positioner is activated via the bit 'Remote SETPOINT'.
The positioner is a three-position controller. Via the setpoint E1 in the process representation output, the nominal value of the position is transmitted to the actuator as nominal variable.

The positioner integrated in the actuator controls AUMA MATIC provides the position signal for controlling the motor depending on the nominal and actual position value. The feedback signal (actual position E2) is produced internally within the actuator.

The position transmitter compares the nominal value of the position set in the controls to the locally measured actual value of the position. If the difference between nominal value and actual value is higher than the max. error (parameter 14), the positioner drives the motor, depending on the error, either in direction OPEN or direction CLOSE.

*Figure H: Modulating duty: nominal operation to 50 %*




**Overrun (inner dead band)**

The inner dead band determines the switching-off point of the actuator. The tripping point in both directions can be set via the parameters 12 and 13 (page 35), so that the actuator stops as close as possible to the nominal value.

**Max. error (outer dead band)**

The outer dead band determines the switching-on point of the actuator. If the actual position or a change in nominal value is higher than the max. permissible error set with parameter 14 (page 36), the motor is started.

**The parameter must be set sufficiently high to ensure a stable function of the positioner. If the value is set too low, the number of starts is likely to be increased. Thus, the end of the lifetime of the actuator and valve will be reached sooner.**

**Dead time**

The dead time prevents the operation to a new nominal position within a pre-defined time period. The time can be between 0 and 1 minute and is set in parameter 11.

**The controls must ensure that the maximum number of motor starts of the actuator is not exceeded. This can be achieved by setting the parameter 11 to a sufficiently high value.**

For further information on the positioner, please refer to the operation instructions pertaining to the actuator (multi-turn actuator SA(R).../ part-turn actuator SG... with AUMA MATIC AM...).

## 12.3 Stepping mode

Stepping mode requires a position transmitter (option).
The stepping mode lengthens the operating time for part of or for the whole travel.

**Setting operation and pause times as well as stepping ranges**
The operation and pause times (stepping times) in opening or closing direction are set with the parameters 27, 28 and 32, 33. An individual operation and pause time can be set for each direction.
The stepping ranges can be set separately in direction OPEN and CLOSE (parameter 29, 30 and 34, 35).
**Indication of operation in stepping mode**
The states of the operation in stepping mode are indicated by the bits 2 and 3 in register 6 of the process representation input.

## 13. Failure function

The failure function allows the start of failure operations in case of special events, e.g. when the communication between the actuator and the master is interrupted. This function is set with the parameters 6 to 9.

If the actuator is in the failure function, the set failure position is approached via a failure operation.
If the actuator is then moved to another position (e.g. by manual operation), it will try to perform the set failure action while the selector switch is in position REMOTE.

**To prevent a new approach to the failure position during manual operation, the selector switch (local controls) must be switched to position 'LOCAL' or 'OFF' before operating the handwheel.**

The following events can trigger the failure function:

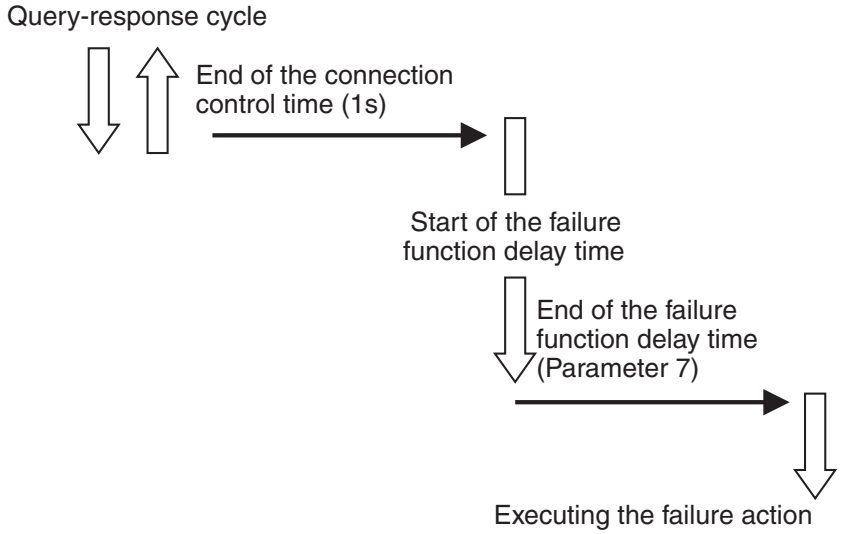
- The connection to the master is interrupted.
- The master sends no telegrams to the actuator.

As soon as the cause for triggering the failure function is eliminated (connection restored, master in Operate state), the operation commands from the master can be executed again.

**The last operation command having been transmitted to the actuator prior to the connection failure is deleted within the actuator. To ensure a defined behaviour, a valid operation command must be transmitted to the actuator upon resuming communication.**

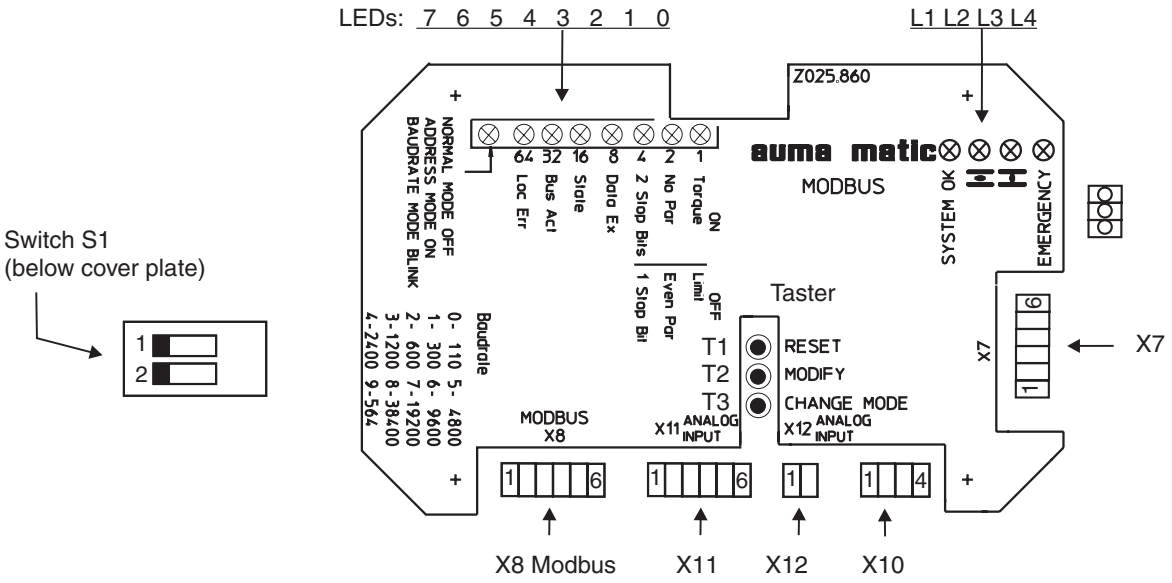
### Time behaviour of the failure function

The internal connection control time (1 s) is started with the last Modbus query-response cycle prior to communication failure.
If no valid Modbus telegram was received within this connection control time, the failure function will be initiated with the start of the delay time. At the end of the delay time, the failure action will be executed:



# 14. Description Modbus interface

***Figure J: Modbus interface board***




**S1.1** When using the external analogue input X11 AI 3/4, the switch S1.1 must be in position On.

**S1.2** Switch for setting the position feedback via position transmitter potentiometers/ RWG (option).

S1.2 = OFF: The actuator is equipped with a potentiometer.

S1.2 = ON: Switch may only be in this position if an RWG (0/4 – 20 mA) is installed in the actuator.

## 14.1 Indication during system start-up

When starting the system, the LEDs 0 to 7 will be illuminated. LEDs L1 to L4 are switched off. This signifies that the board is correctly started.
After a short time (approx. 1/4 s), the LED L1 (round red LED) will be illuminated and the LEDs 0 to LED 7 will be switched off one after the other. This means that the microcontroller is now operating. If LED L1 is switched off and the LEDs 0 to 7 are still illuminated, then the system is in the reset status (this situation can also be reproduced by constantly pressing push button T1).

### 14.1.1 Indications of operation LEDs 7 to 0

| Indications of operation | | | | |
|---|---|---|---|---|
| **LED** | **Default Mode** | | **Significance** | |
| | **LED on** | **LED is off** | **Address Mode** | **Baud rate Mode** |
| 0 (red) | torque seating | limit seating | 1 | 1 |
| 1 (red) | no parity | even parity | 2 | 2 |
| 2 (red) | 2 stop bits | 1 stop bit | 4 | 4 |
| 3 (red) | data exchange | no data exchange | 8 | 8 |
| 4 (red) | state (blinking) | | 16 | – |
| 5 (red) | bus active | no bus active | 32 | – |
| 6 (red) | local error | no local error | 64 | – |
| 7 (red) | off | | on | blinking |

LED 0 Indicates torque or limit switching in end position CLOSED (illuminated for torque switching)

LED 1 Indicates the quantity of the parity bits from the Modbus protocol (illuminated for No Parity). Only No Parity and Even Parity are supported, Odd paritiy is not supported

LED 2 Indicates the quantity of stop bits - 1 or 2 - (illuminated for 2 stop bits)
LED 3 Is blinking for each incoming telegram which is assigned to the actuator.
LED 4 Applications LED:
- is blinking in 1 s intervals for normal service (0.5 s illumination, 0.5 s pause)
- is permanently illuminated in case of initialisation failure
- is blinking twice while Fail Safe status is active.

LED 5 Is blinking for each telegram which has been recognized at the bus.
LED 6 Local actuator signal:
- blinking once: Thermal fault
- blinking twice: Power failure
- blinking 3 times: TSO (DOEL) fault
- blinking 4 times: TSC (DSR) fault
- blinking 5 times: 24 V power supply > 28.3 V or <18 V

LED 7 indicates the setting mode:
Off: **DEFAULT MODE**
On: **ADDRESS MODE**
Blinking: **BAUD RATE MODE**

### 14.1.2 System displays LEDs L1 to L4

LED L1 indicates the actuator status. If L1 is illuminated, the actuator is ready for operation.

| System indications | |
|---|---|
| L1 (red) | System is Ok (CPU working) |
| L2 (red) | Actuator runs OPEN |
| L3 (red) | Actuator runs CLOSE |
| L4 (red) | not assigned |

LEDs L2 to L4 are illuminated if the actuator has received and processed a feasible operation command via the bus. The following combinations are valid:

| Operation indications | | | |
|---|---|---|---|
| **LED 4** | **LED 3** | **LED 2** | **Signification** |
| off | off | on | no operation |
| off | off | on | operation direction OPEN |
| off | on | on | operation direction CLOSE |

## 14.2 Customer input assignment of the Modbus interface (option)

**X7 Digital inputs** This plug provides pins for 4 digital customer inputs.

*Table 6: Digital inputs (galvanically isolated)*

| Pin | Description |
|---|---|
| 1 | Digital input 1 |
| 2 | Digital input 2 |
| 3 | Digital input 3 |
| 4 | Digital input 4 |
| 5 | + 24 V DC |
| 6 | + 24 V DC |

These signals are freely available inputs which the microcontroller transmits into the process representation input (register 7, bits 0 – 3). The inputs are galvanically isolated and internally connected to 0 V via pull-down resistors. In an unconnected state, a logical zero is transmitted. To set an input to logical one, + 24 V DC must be applied (pins 5 or 6).

- **For these signals, proposed external wiring diagrams (appendix B) must be observed.**
- **The bounce time of the connected switches should not be more than 1 ms.**

**X11** **Second analogue input** (analogue 3/4)
An external 0/4 – 20mA sensor for transmitting the measured values via the Modbus can be connected to this input.

*Table 7: Analogue inputs at plug X11*

| Pin | Description |
|---|---|
| 1 | + 24 V DC |
| 2 | GND (system ground) |
| 3 | GND (system ground) |
| 4 | AN 3+: analogue signal 0 – 20 mA (plus) |
| 5 | AN 4–: analog signal 0 – 20 mA (minus) |
| 6 | GND (system ground) |

If switch S1.1 is set to position ON, then pin 5 (AN 3/4+) is connected to GND and input AN 3/4– can be used in the same way as AN 2.
If the switch is set to position OFF, a differential measurement between AN 3/4+ and AN 3/4– can be performed.

**X12** **First analogue input** (analogue 2).
An external 0/4 – 20mA sensor for transmitting the measured values via the Modbus can be connected to this input.

*Table 8: Analogue inputs at plug X12 AI 2*

| Pin | Description |
|---|---|
| 1 | AN 2: analogue signal (0 – 20 mA) |
| 2 | GND (system ground) |

- **Potential-free differential measurement is not possible due to the presence of a permanent ground (GND) connection.**
- **For these signals, proposed external wiring diagrams (appendix B) must be observed.**
- **The inputs AN2, AN3, and AN4 do not have galvanic isolation via opto-isolator. The maximum load of the 24 V DC voltage source applied by the sensors must not exceed 40 mA altogether.**

## 14.3 Modbus connection assignment

**X8 MODBUS** The bus signals and the galvanically isolated power supply for the bus termination are allocated to this plug.

*Table 9: Assignment for plug X8*

| Pin | Description |
|---|---|
| 1 | Channel 1: B cable Modbus |
| 2 | Channel 1: A cable Modbus |
| 3 | Channel 2: A cable Modbus (redundant channel) |
| 4 | Channel 2: B cable Modbus (redundant channel) |
| 5 | GND float (Modbus ground) |
| 6 | + 5 V float (Modbus + 5 V) |

## 14.4 Assignment positioner connections

**X10** The signals required for the position transmitter with potentiometer or with RWG are allocated to this plug.

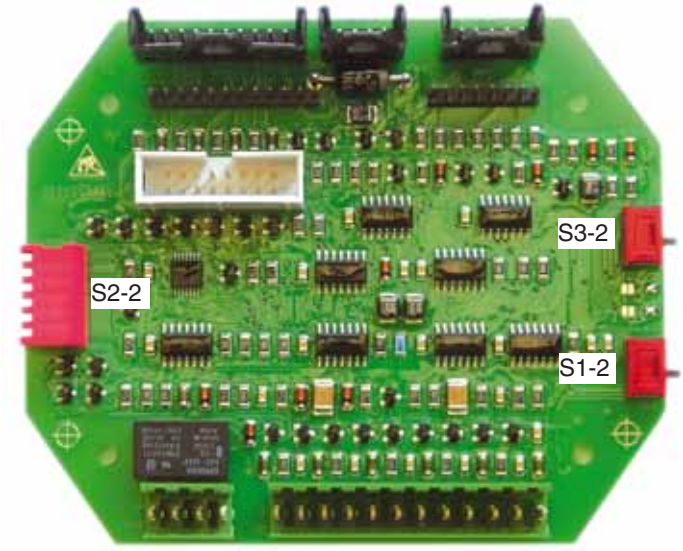
*Table 10: Assignment for plug X10 AI 1*

| Pin | Description |
|---|---|
| 1 | + 5 V for potentiometer |
| 2 | AN 1: analogue signal from position transmitter |
| 3 | GND (system ground) |
| 4 | + 24V for RWG |

## 14.5 Checking/ setting the switches on the logic board

The settings on the logic board are already made in the factory, according to the order details.
The logic board is located below the Modbus board.

***Figure K: Logic board***




S3-2 (1 2)
S3-2:
Switching-off in end position OPEN.
Switch position has no influence.
When controlling via Profibus DP, switching-off is always realised by limit seating in end position OPEN

S3-2 (1 2)

S1-2 (1 2)
Position 1:
Switching-off by limit seating in end position CLOSED

S1-2 (1 2)
Position 2:
Switching-off by torque seating in end position CLOSED

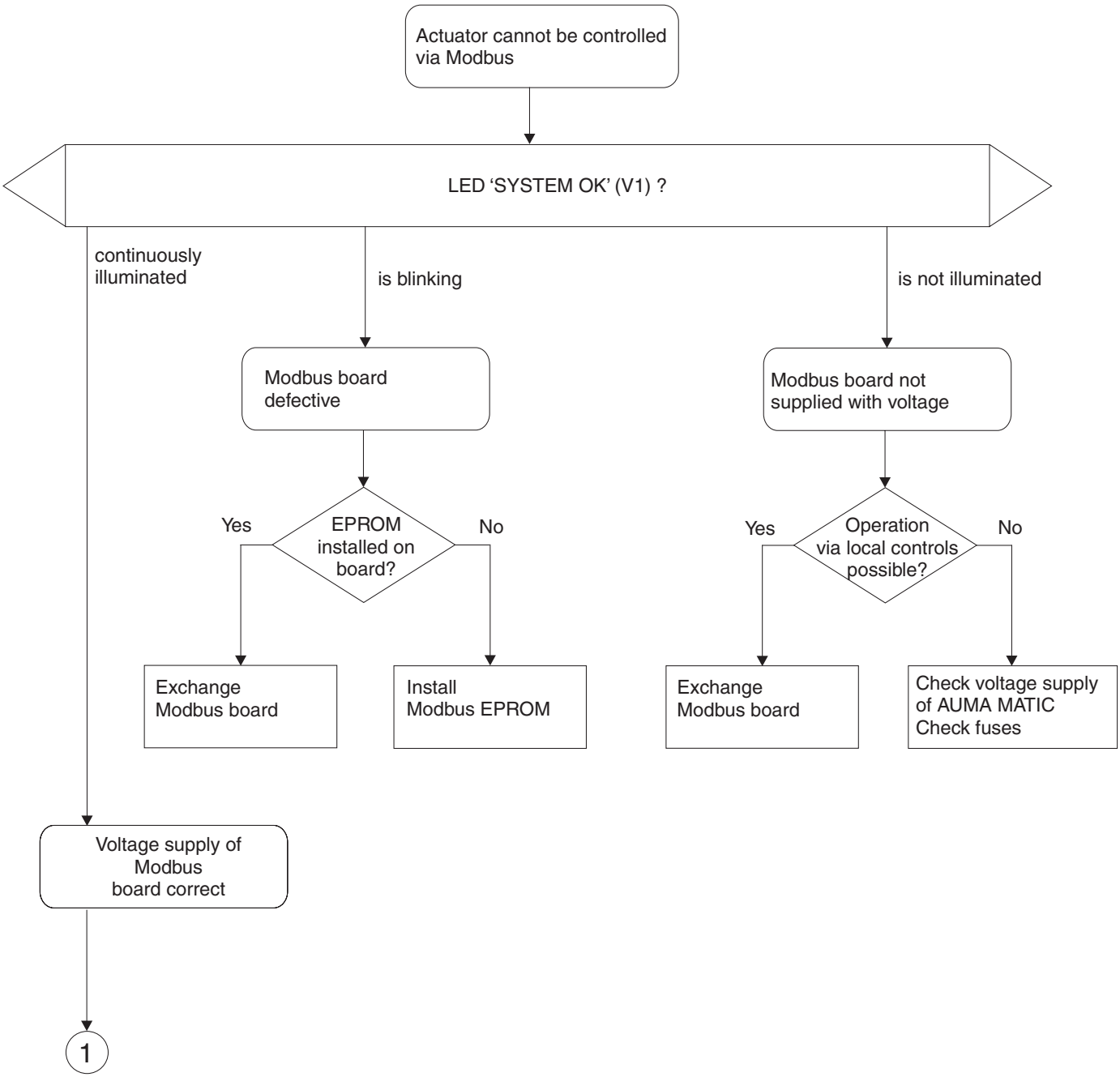
**The setting of the end position seating in end position CLOSED must be the same on the Modbus board (LED 0 in default mode, figure J, page 44) and on the logic board (switch S1-2).**

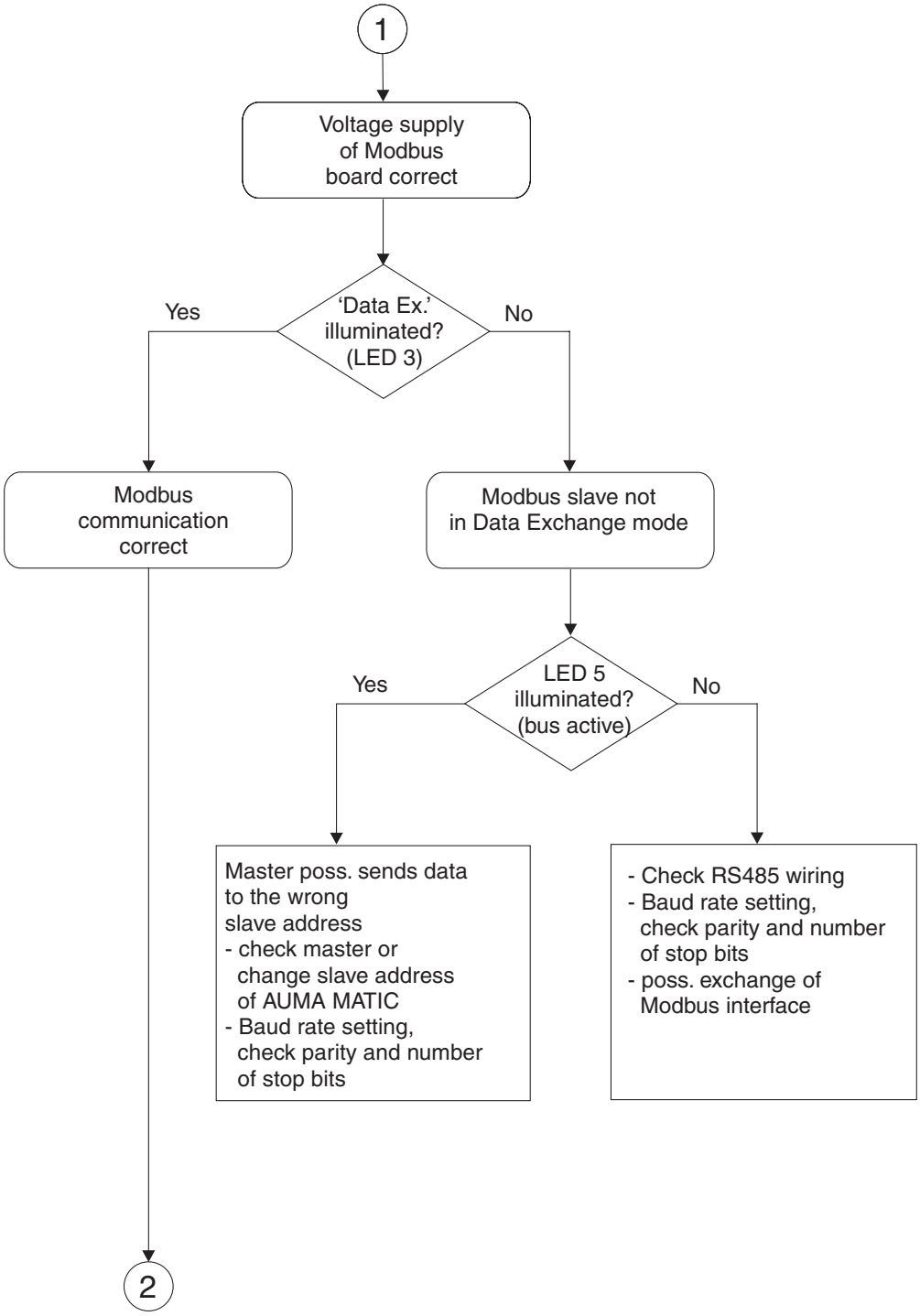
***Table 11***

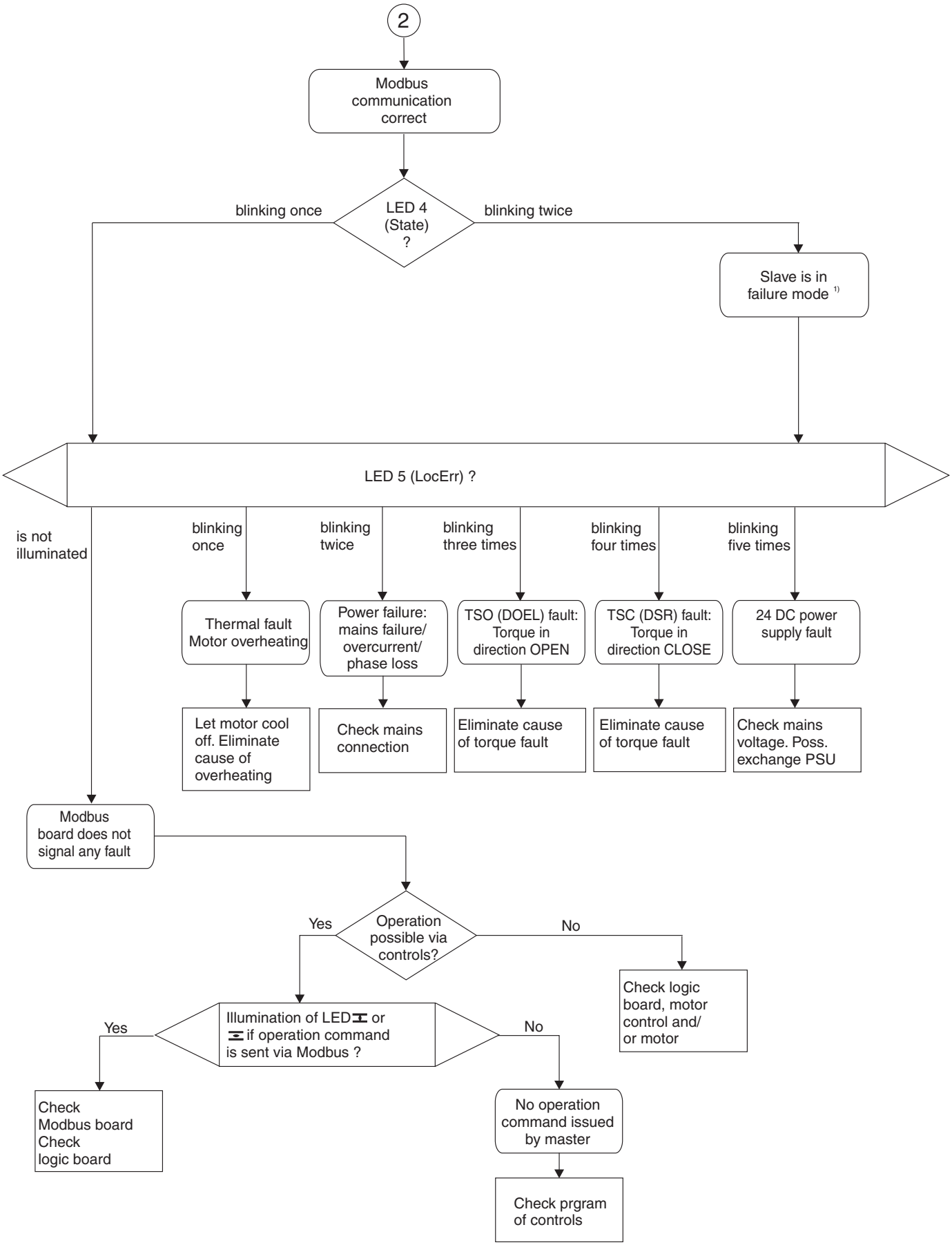
| **DIP switch S2-2** | **Programming** (ON = pressed) | |
|---|---|---|
| | Direction CLOSE | Direction OPEN |
| Self-retaining REMOTE | Self-retaining REMOTE may not be used! | |
| Push-to-run operation REMOTE | OFF ON 1 2 3 4 5 6 | OFF ON 1 2 3 4 5 6 |
| Self-retaining LOCAL | OFF ON 1 2 3 4 5 6 | OFF ON 1 2 3 4 5 6 |
| Push-to-run operation LOCAL | OFF ON 1 2 3 4 5 6 | OFF ON 1 2 3 4 5 6 |
| Blinker transmitter (option) | Blinker transmitter must be deactivated! | Blinker transm. deact. OFF ON 1 2 3 4 5 6 |
| Torque error: torque switch tripping (in mid-travel) contained in collective fault signal (insignificant for fieldbus interface) | included<br>OFF ON 1 2 3 4 5 6 | not included<br>OFF ON 1 2 3 4 5 6 |

# 15. Troubleshooting and corrective actions

## 15.1 Actuator can not be controlled via Modbus




1
Voltage supply of Modbus board correct
'Data Ex.' illuminated? (LED 3)
Yes
No
Modbus communication correct
Modbus slave not in Data Exchange mode
LED 5 illuminated? (bus active)
Yes
No
Master poss. sends data to the wrong slave address
- check master or change slave address of AUMA MATIC
- Baud rate setting, check parity and number of stop bits
- Check RS485 wiring
- Baud rate setting, check parity and number of stop bits
- poss. exchange of Modbus interface
2




1) refer to setting of application parameters 6, 7, 8, and 9

### 15.2 Position feedback does not function

- Check if the voltage at plug (X1) on the Modbus board, pin 3 (-) and pin 2 (+) is subject ot linear incrementation when running open and linear decrement when running close.
  The value for position CLOSED should be within the range of 0 to 2 V.
  The value for position OPEN should be within the range of 3 to 5 V. The voltage difference between CLOSED and OPEN should be superior to 3V.

### 15.3 Actuator is not switched off by the limit switch in direction CLOSE

The actuator is set to torque seating.
Set actuator to limit seating:

- Set switch S4 (see figure H, page 44) on the Modbus board to position 'LIMIT'.
- Adjust switch S1-2 on the logic board (see page 47) to position 1.

### 15.4 Actuator stops immediately after having started

- Set switch S2-2 (blinker transmitter) on the logic board to position 'ON'.

### 15.5 Actuator does not signal reference operation, connection failure position transmitter or signal interruption position transmitter

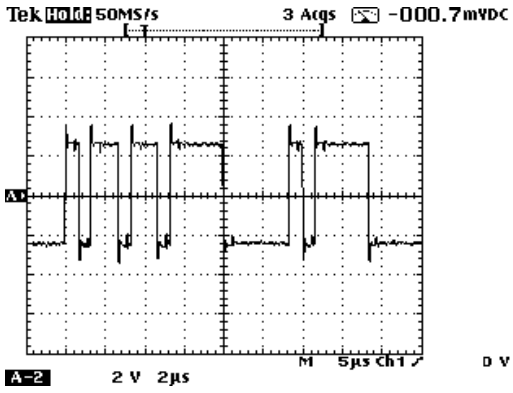
The position transmitter (potentiometer, RWG) is faulty.

- Check position transmitter wiring and connection
- Check the setting of parameter 1 "Position transmitter"
- If the actuator is not equipped with a position transmitter, parameter 1 has to be set to value 0 (no position transmitter)

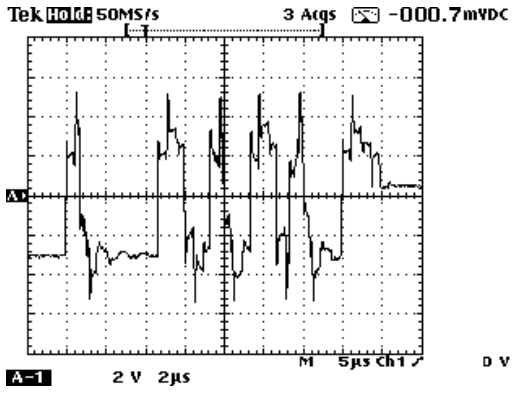
### 15.6 Measuring the Modbus signals using an oscilloscope

On the Modbus board, the signal from Modbus channel 1 on the plug (X8 Modbus, refer to page 46) pin 1 (P/B) and pin 2 (N/A) can be checked using a digital oscilloscope.
The off-load voltage between pin 1 (+) and pin 2 (-) must be positive and within the range of 0.8 V and 1.4 V.

***Example for correct Modbus signal:***



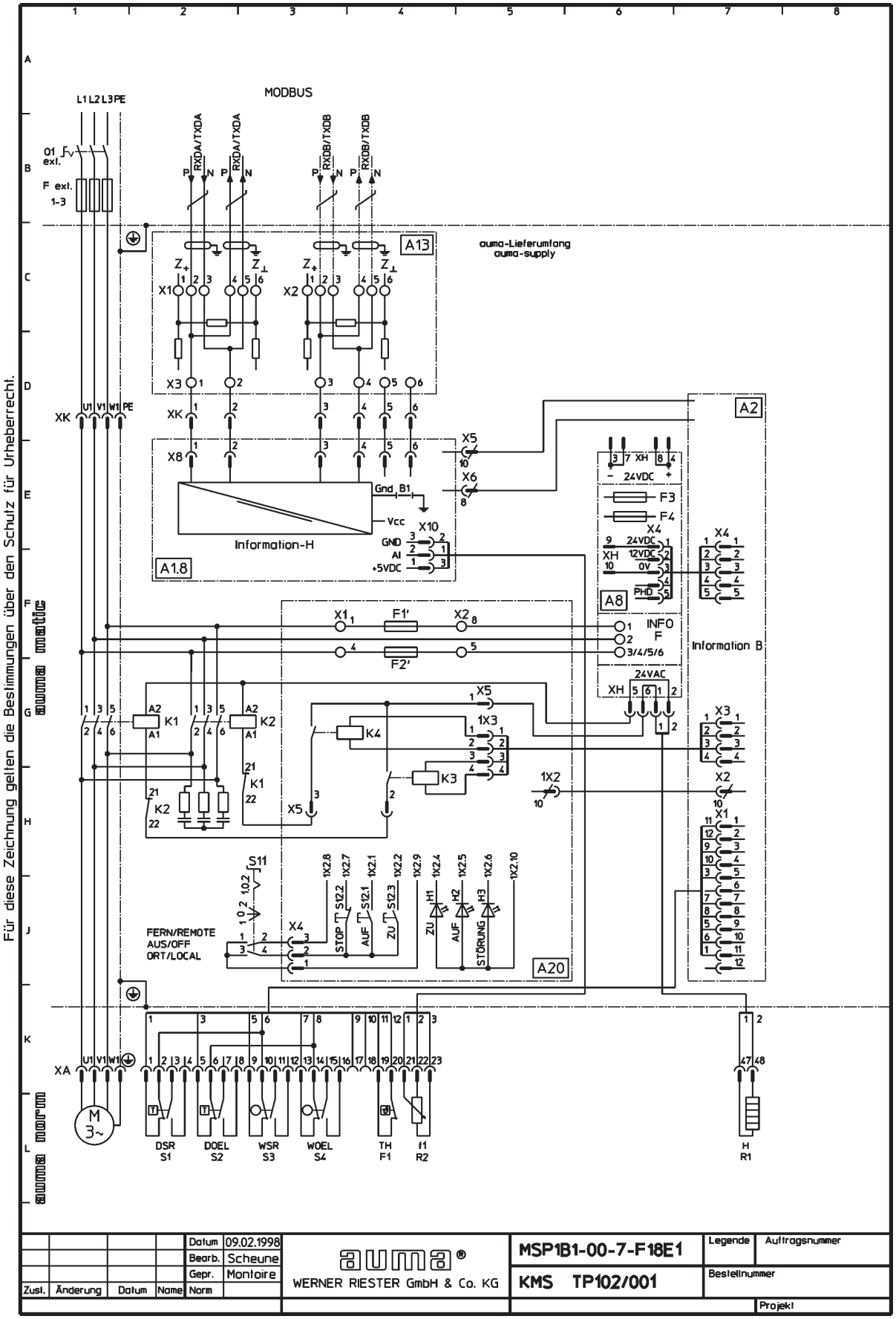

***Example for incorrect Modbus signal (Bus only terminated on one side):***



## 16. Appendix A Standard wiring diagram

Legend page 53

Original wiring diagram and legend are delivered together with the actuator.



## 16.1 Legend for standard wiring diagram

| | | |
|---|---|---|
| S 1 | TSC (DSR) | Torque switch, closing, clockwise rotation |
| S 2 | TSO (DOEL) | Torque switch, opening, counterclockwise rotation |
| S 3 | LSC (WSR) | Limit switch, closing, clockwise rotation |
| S 4 | LSO (WOEL) | Limit switch, opening, counterclockwise rotation |
| R 2 | | Potentiometer |
| F 1 | Th | Thermoswitch (motor protection) |
| R 1 | H | Heater |
| A 1.8 | | Modbus board |
| A 2 | | Logic board |
| A 8 | | Power supply board |
| A 13 | | Bus connection board |
| A 20 | | Signal and control board |
| F 1, F 2 | | Primary fuses for power supply unit |
| F 3, F 4 | | Secondary fuses |
| H 1 | | Indication light end position CLOSED |
| H 2 | | Indication light end position OPEN |
| H 3 | | Indication light FAULT |
| K 1, K 2 | | Reversing contactors |
| K 3, K4 | | Control relays for reversing contactors |
| S 11 | | Selector switch LOCAL – OFF – REMOTE |
| S 12.1<br>S 12.2<br>S 12.3 | | Push button OPEN<br>Pusbutton STOP<br>Push button CLOSE |

## 16.2 Additional information to the wiring diagram legend

**Information B:**
Local controls

**Information F:**
Power supply board

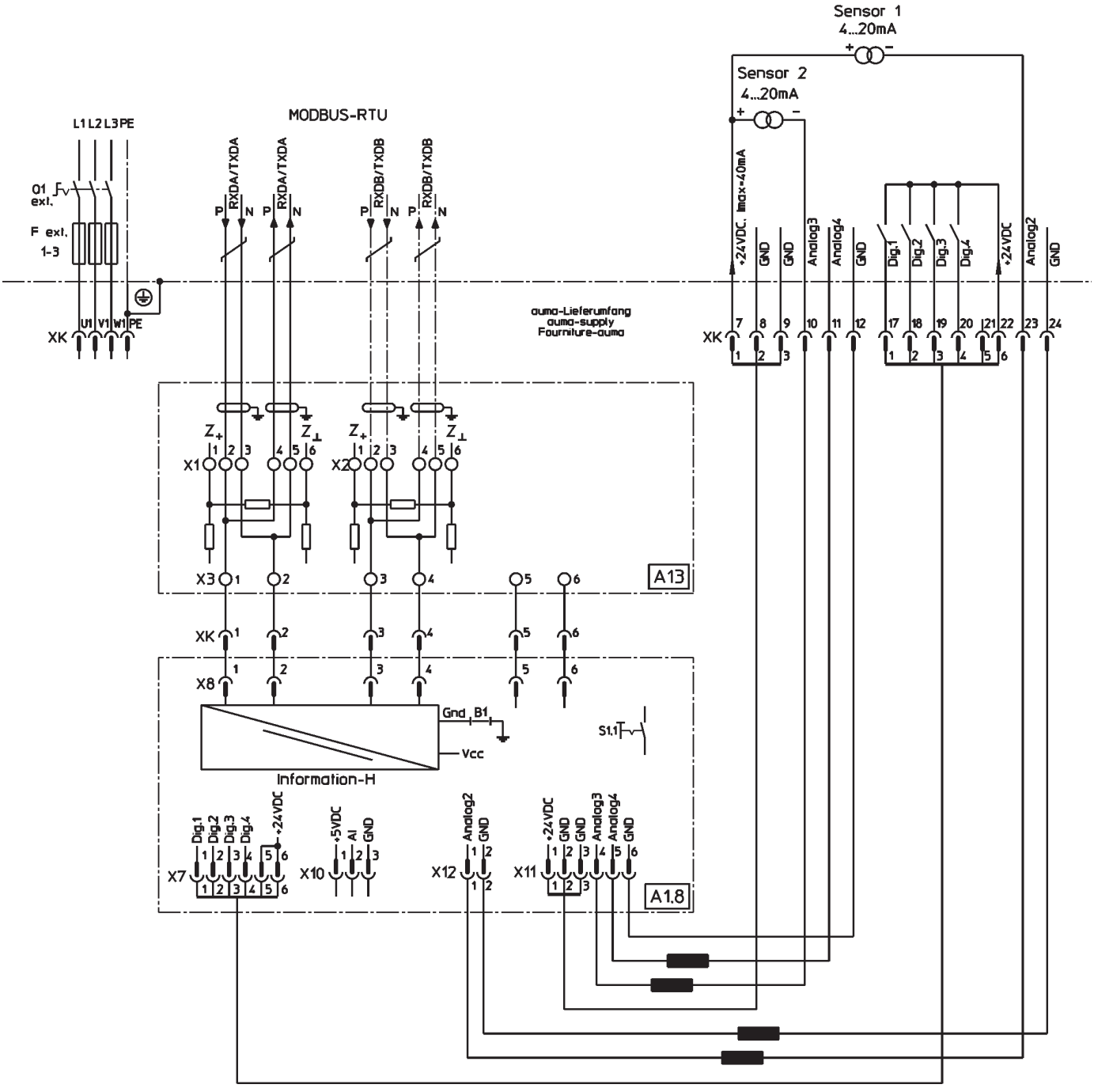
**Information H:**
Modbus board

## 17. Appendix B Proposed external wiring diagram

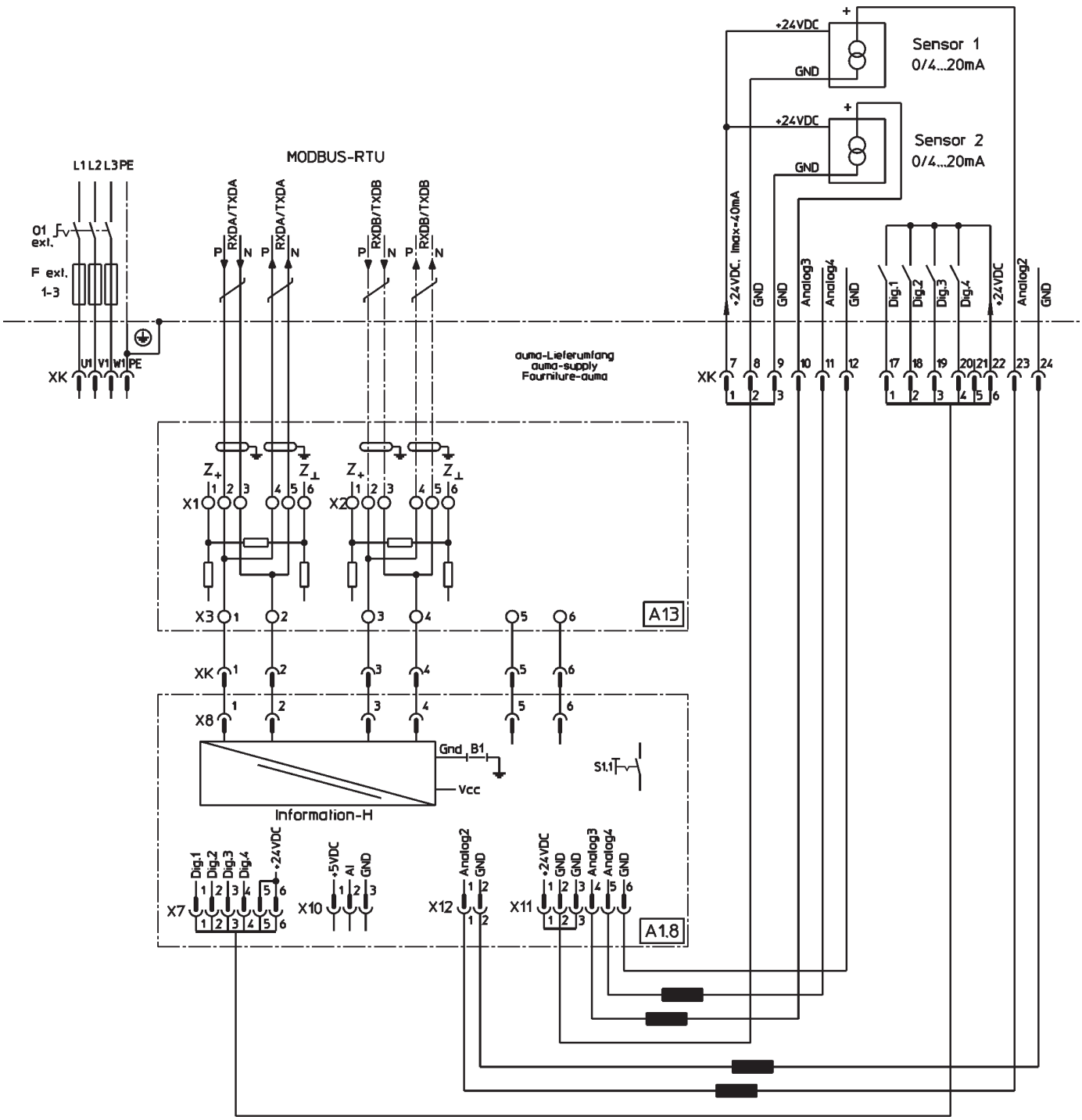
Digital and analogue inputs are optional.

The two analogue customer connections (AI 3/4 and AI 2) as well as the four digital customer inputs (Dig 1 ...4) are only provided (wired) by the factory if explicitly mentioned in the order.
The 5th digit of the MSP number (refer to name plate) indicates if analogue connections are available.
If the 5th digit is assigned to '0', no external connections are available.
If the 5th digit is assigned to 'L', the connections are provided.

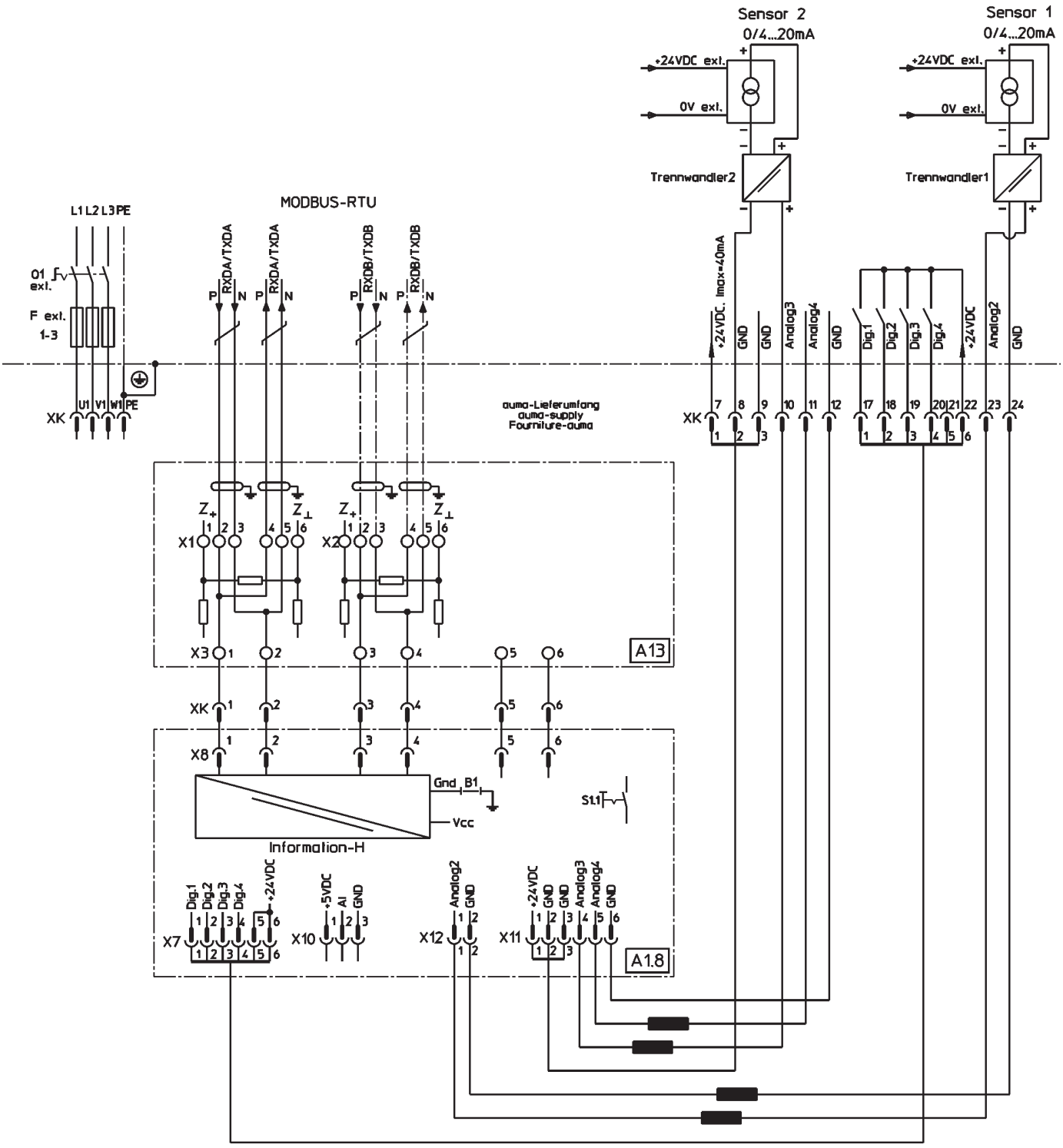
***Connection of external sensors, 2-wire technology***



***Connection of external sensors, 3-wire technology***



***Connection of external sensors, 4-wire technology***



## 18. Appendix C Literature references

1. Modicon protocol:
Reference Guide PI-MBUS-300

2. http:/ www.modbus.org
Modbus Application Protocol Specification
Modbus over serial line specification and implementation guide

## 19. Appendix D Connecting the cable shield for AUMA MATIC AMExB/ AMExC 01.1

The shield of the fieldbus cable should be largely connected with the respective threads.

Recommended threads e.g. WAZU-EMV/EX supplied by Hugro (refer to www.hugro-gmbh.de).

## Notes

## Index



**Information also available on the Internet:**

Wiring diagram, inspection records and further actuator information can be downloaded directly from the Internet by entering the order no. or COMM. no (refer to name plate).
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