Power Meter

# AD-LU 650 GA

Manual



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Subject to technical changes and printing errors.

# Contents


**1 About this instruction manual** **4**
1.1 Structure of the instructions . . . . . 4

**2 Safety** **5**
2.1 Intended use . . . . . 5
2.2 Predictable misuse . . . . . 5
2.3 Safe Handling . . . . . 6
2.4 Qualification of personnel . . . . . 6
2.5 Modifications to the product . . . . . 6
2.6 Use of spare parts and accessories . . . . . 6
2.7 Liability notice . . . . . 6

**3 Product description** **7**
3.1 Scope of delivery . . . . . 7
3.2 features . . . . . 7
3.3 Order keys . . . . . 8
3.4 Block diagram . . . . . 8
3.5 Update rates and program cycle time . . . . . 9
3.6 Behavior of the device in case of error . . . . . 9
3.7 Display and control elements . . . . . 9

**4 Technical data** **10**
4.1 Current inputs . . . . . 10
4.2 Voltage inputs . . . . . 10
4.3 Current inputs . . . . . 10
4.4 Analogue outputs . . . . . 10
4.5 Current outputs . . . . . 10
4.6 Voltage outputs . . . . . 11
4.7 Contact outputs . . . . . 11
4.8 Optocoupler outputs . . . . . 11
4.9 Accuracy . . . . . 11
4.10 Communication interface . . . . . 11
4.11 Supply . . . . . 11
4.12 Housing . . . . . 12
4.13 Environmental conditions . . . . . 12
4.14 Electromagnetic compatibility . . . . . 12
4.15 Electrical safety requirements . . . . . 12

**5 Assembly and commissioning** **13**
5.1 Electrical connection . . . . . 13
5.2 Commissioning the unit . . . . . 13




Subject to technical changes and printing errors.

**6 Configuration** **14**
6.1 Symbols . . . 14
6.2 Parameter . . . 14
6.2.1 Inputs . . . 15
6.2.2 Device functions . . . 17
6.2.3 Analogue outputs . . . 18
6.2.4 Relay outputs . . . 19
6.2.5 Relay function [n] = 'Trend' . . . 20
6.2.6 Relay function [n] = 'Monitor P' or 'Monitor U' . . . 21
6.3 Signals . . . 22
6.3.1 input signals . . . 22
6.3.2 Analogue output signals . . . 22
6.3.3 Relay output signals . . . 23
6.3.4 Counters . . . 23

**7 Modbus** **24**
7.1 Change slave address . . . 24
7.2 Change Baud Rate and Parity . . . 24
7.3 Communication with default settings with changed baud rate and parity 24
7.4 Data format . . . 25
7.5 data types . . . 25
7.6 Supported functions . . . 25
7.6.1 Read Holding Registers . . . 25
7.6.2 Write Multiple Registers . . . 26
7.7 Exception Codes . . . 26
7.8 Data list . . . 27

**8 Connection diagrams** **29**
8.1 Voltage and current inputs . . . 29
8.1.1 3 phases, 3 conductors same load . . . 29
8.1.2 3 phases, 3 conductors unequal load . . . 30
8.1.3 3 phases, 4 conductors equal load . . . 30
8.1.4 3 phases, 4 conductors unequal load . . . 31
8.2 Analogue outputs . . . 31
8.3 RS-485 . . . 32

**9 Appendix** **33**
9.1 Maintenance . . . 33
9.2 Faults . . . 33
9.3 Revisions . . . 34
9.4 Addresses . . . 34


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# 1 About this instruction manual

This instruction manual is part of the product.

- Be sure to read the operating instructions before using the product.
- Keep the operating instructions for the entire service life of the product and have them available for reference.
- Pass the operating instructions on to any subsequent owner or user of the product.

## 1.1 Structure of the instructions

**INFO**



**General note**

Highlight special notes and information necessary to operate the product

.

**WARNING**



**Warning notice**

Possible damage to the device or risk of injury if the instructions are not followed.

**DANGER**



**Danger notice**

Possible damage to the device, risk of injury or danger to life if the instructions are not followed.

# 2 Safety

## 2.1 Intended use

**WARNING**



**property damage**
The operating, maintenance and servicing conditions prescribed in these operating and maintenance conditions must be strictly observed.

The AD-LU 650 GA is suitable exclusively for measuring electrical quantities in the three-phase network and their conversion into analog signals, limit values and energy pulses.

The AD-LU 650 GA is designed for installation in control cabinets. The installation position is arbitrary.

The AD-LU 650 GA has its own connection for the supply voltage and can be supplied with AC voltage up to 250V AC or 24V DC. The current measurement inputs of the AD-LU 650 GA are supplied via external current transformers with secondary currents of 1A or 5A.

The AD-LU 650 GA is not suitable for measurement in medium and high voltage networks.

Any other use is not in accordance with the intended purpose! Unauthorized modifications and changes to the product lead to considerable safety risks and are forbidden for safety reasons! prohibited for safety reasons! Adamczewski Elektronische Messtechnik GmbH is not liable for any damage resulting from this or for damage from improper use Adamczewski Elektronische Messtechnik GmbH is not liable.

Malfunctions which may impair safety must be eliminated immediately! eliminated immediately! The installer must make the operating instructions available to the operator. accessible to the operator. The installer and the operator must have read and understood the operating and understood the operating instructions before starting their work.

## 2.2 Predictable misuse

In particular, this product must not be used in the following cases:

- In potentially explosive atmospheres. When operating in potentially explosive areas, sparking may cause deflagration, fire or explosion.

- Use on humans and animals.

## 2.3 Safe Handling

This product complies with the state of the art and the recognized technical safety regulations. Each device is tested for function and safety and safety before delivery.

This product may only be operated if it is in perfect working order and in compliance with the operating instructions, the usual regulations and guidelines, and the applicable safety regulations and accident prevention rules.

Extreme ambient conditions will impair the function of the product.

- Protect product from shocks.
- Use product indoors only.
- Protect product from moisture

## 2.4 Qualification of personnel

Installation, commissioning, operation, maintenance, decommissioning and disposal may only be carried out by technically qualified personnel. Work on electrical parts may only be carried out by a trained in accordance with the applicable regulations and directives. regulations and guidelines.

## 2.5 Modifications to the product

Unauthorized modifications to the product may result in malfunctions and are prohibited for safety reasons.

## 2.6 Use of spare parts and accessories

The use of unsuitable spare parts and accessories may damage the product. be damaged. Please use only original spare parts and accessories from the manufacturer.

## 2.7 Liability notice

The manufacturer shall not be liable for any damage or consequential damage and recommendations, the manufacturer accepts no liability or warranty for damage or no liability or warranty. The manufacturer and the distributor shall not be liable for any costs or damages incurred by the user or third parties as a result of the use of this device, especially in case of improper use of the device, misuse or malfunction of the connection, malfunction of the device or the connected devices. Neither the manufacturer nor the distributor is liable for improper use. neither the manufacturer nor the distributor.

# 3 Product description

The AD-LU 650 GA is a programmable measuring transducer for the acquisition of all measured variables such as power, voltage, current, frequency, etc. in the single-phase or three-phase AC network.
Any measured variable can be assigned to each analogue output. The measuring ranges are configurable in wide ranges. Individually configurable filters supplement the adaptation possibilities to the measuring task. Each switching output can be assigned its own function such as limit value or pulse output for energy counting.
All parameters such as measuring ranges, output ranges, switching thresholds, etc. can be configured via the standard Modbus interface.
All measured variables, output variables and switching states can be read out via the standard Modbus interface.

## 3.1 Scope of delivery

1. AD-LU 650 GA
2. This manual

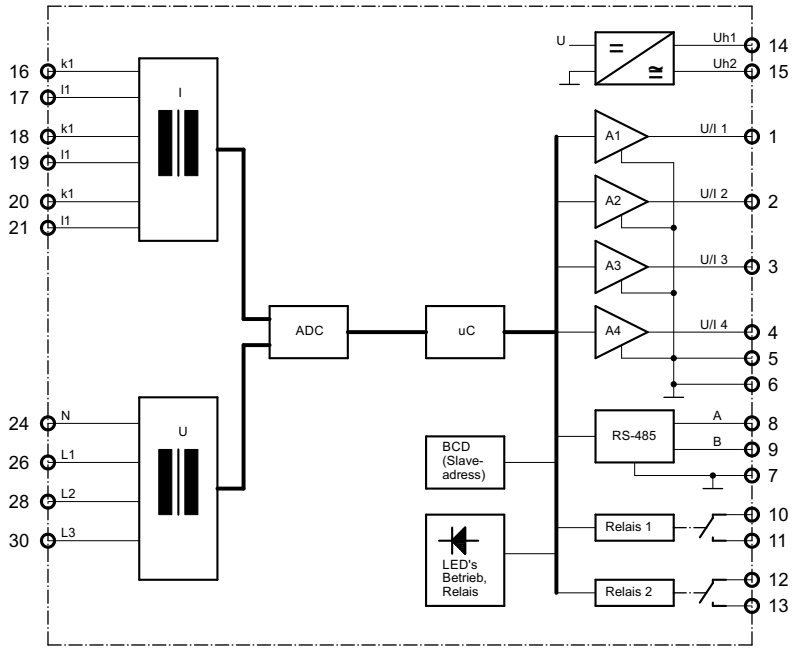
## 3.2 features

- phases: 1N, 3, 3N. Equal or unequal load
- Measured quantities: P1, P2, P3, Ptot, Q1, Q2, Q3, Qtot, S1, S2, S3, Stot, I1, I2, I3, U1, U2, U3, F, PF1, PF2, PF3, PFtot.
- counter for active energy drawn and fed back per phase and total.
- Counter for inductive and capacitive reactive power per phase and total.
- freely configurable bipolar current or voltage outputs.
- Two switching outputs as relay or optocoupler. Function configurable.
- Functions: Limit, window, trend, S0, monitor or counter.
- All measured variables can be read out via Modbus RTU.
- All parameters configurable via Configuration program AD-Studio .
- RS-485 interface configurable via Configuration program AD-Studio .
- address quickly adjustable and visible via BCD switch.
- for operation and switching outputs.

## 3.3 Order keys

- AD-LU 650 GA Standard version with relay outputs.
- Optional with open-collector optocoupler outputs instead of relay outputs.

## 3.4 Block diagram




Each current signal and each voltage signal is first safely isolated from the AC mains via a dedicated converter.

The analogue-to-digital converter (ADC) measures the currents and voltages, frequency and energy in all phases at specific time intervals.

The measured quantities are scaled in the microcontroller. Each of the analogue outputs A1 ... A4 can output one of the scaled measured quantities as a current or voltage signal.

If a limit value function is configured, the relay outputs are updated. If a relay is configured with a counter function, a pulse is output when the pulse value is reached. The RS-485 interface provides access to all measured values, counters, output values and relay states via the Modbus protocol.
The slave address can be set with two BCD switches. The operating voltage and the relay states are indicated by LEDs.

**INFO**

**Ground of RS-485 interface**

The RS-485 interface and the analogue signal outputs have a common ground

.

## 3.5 Update rates and program cycle time

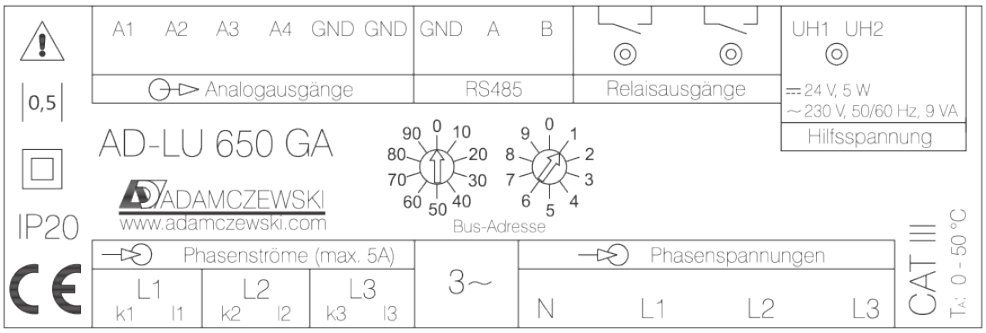
All input voltages, input currents, and frequency are determined at each zero crossing of U1 is determined. At a mains frequency of 50 Hz, this results in an update rate for U1, U2, U3, I1, I2, I3 and F of 10 ms.
All energy values are determined after 180 mains half cycles of U1. With a mains frequency of 50 Hz, this results in an update rate for P1, P2, P3, Q1, Q2, Q3, S1, S2 and S3 of 1.8 s.
The program cycle time, in which the measured values are filtered and all program functions are executed, is constant and is are executed, is constant and amounts to 10 ms.

## 3.6 Behavior of the device in case of error

The AD-LU 650 GA checks whether the signal voltage is present on phase L1. If this is not the case, the AD-LU 650 GA goes into error state.

- All analogue outputs are set to 0V or 0mA, depending on the configuration.
- All relay outputs are switched off.

## 3.7 Display and control elements




The AD-LU 650 GA has a green LED to indicate the supply voltage and two other LEDs to indicate the relay states. The Modbus slave address can be set via two BCD switches in the range 1...99.

# 4 Technical data

## 4.1 Current inputs

The AD-LU 650 GA has a current transformer with one primary winding per input. The data apply to all current inputs.

| Description | Value | Unit |
|---|---|---|
| Rated current range | 0 ... 1/5 | A AC |
| Surge overload capacity | 100 | A AC / 1s |
| Input resistance | 20 | mΩ |
| Overvoltage category | 300 V CAT III | |

## 4.2 Voltage inputs

| Name | Value |
|---|---|
| U1N, U2N, U3N Nominal | 230 V AC |
| U1N, U2N, U3N Max | 300 V AC |
| Current consumption per phase | 0,5 mA AC |
| Peak load | 600 V AC, 1s |

## 4.3 Current inputs

| Name | Value |
|---|---|
| Rated current I1, I2, I3 | 0 ... 1 A AC, 0 ... 5 A AC |
| Peak load | 100 A AC, 1s |
| Continuous load | 6 A AC |
| Input resistance per phase | ~20 mOhm |

## 4.4 Analogue outputs

| Name | Value |
|---|---|
| Number | 4 |
| Configurable | Each output as Current or Voltage |

## 4.5 Current outputs

| Name | Value |
|---|---|
| Max. residual ripple | 40 $\mu$Ass |
| Max. burden | 400 Ohm |
| Maximum output range | -21 ... 21 mA |

## 4.6 Voltage outputs

| Name | Value |
|---|---|
| Max. residual ripple | 20 mVss |
| Min. burden | 10 kOhm |
| Maximum output range | -10,5 ... 10,5 V |

## 4.7 Contact outputs

| Name | Value |
|---|---|
| Closer | 2 |
| Switching capacity AC | 250 V AC, 2A, 50Hz |
| Switching capacity DC | 50 V DC, 2A |

## 4.8 Optocoupler outputs

| Name | Value |
|---|---|
| Switching capacity DC | 30 V DC, 50 mA DC |

## 4.9 Accuracy

| Name | Value |
|---|---|
| Accuracy class | 0,5% |
| Temperature influence | ¡ 200 ppm/K |
| Frequency influence | ~0,2 %, 40 ... 60 Hz |
| Influence of phase angle | ~0,2 %, 40 ... 60 Hz |
| Response time | ~500 ms, 10 ... 90 % |

## 4.10 Communication interface

| Name | Value |
|---|---|
| Physical | RS-485 |
| Parameter | 19200, 8, 1 , even |
| Protocol | Modbus RTU |

## 4.11 Supply

| Name | Value |
|---|---|
| DC | 20 ... 253 V DC, 5 W |
| AC | 50 ... 253 V AC, 9 VA |

## 4.12 Housing

| Name | Value |
|---|---|
| Type of protection | IP 20 |
| Connection method | screw clamp |
| Cross section fine wire | 2,5 mm2 |
| Cross section one wire | 4 mm2 |
| Mounting | DIN rail mounting |
| Weight | ~450 g |

## 4.13 Environmental conditions

| Name | Value |
|---|---|
| Operating temperature | 0 ... 50 °C |
| Storage, transport | -25 ... 80 °C |

## 4.14 Electromagnetic compatibility

| Name | Value |
|---|---|
| Product family standard | EN 61326 |
| Emission | EN 55011, CISPR 11 Cl. B |
| During an interference effect slight signal deviations are possible. | |

## 4.15 Electrical safety requirements

| Name | Value |
|---|---|
| Product family standard | EN 60688 |
| Overvoltage category | III |
| Pollution degree | 2 |
| Isolation-voltage | 500 V AC |
| Test voltage input/output | 5 kV RMS, 1 Min. |
| Test voltage output/supply | 4 kV RMS, 1 Min. |

# 5 Assembly and commissioning

## 5.1 Electrical connection

**DANGER**



**Danger of death by electric shock**

The terminals of the voltage inputs are dangerous to touch.

- Disconnect the mains voltage and secure against reconnection.
- Ensure that the terminals are protected against accidental contact.
- Provide power supply and measuring inputs with overvoltage protection.
- Protect all connections against electrostatic discharge.

## 5.2 Commissioning the unit

- Switch off the power supply.
- Check that there is no voltage.
- Mount the unit on a top-hat rail.
- Connect supply, inputs and RS-485.
- Switch on the voltage.
- Configure the unit.
- Check the function.
- Switch off the power supply.
- Connect analogue outputs and relays or open-collector outputs.
- Switch on the power supply again.

Only connect output signals and relay outputs after the function test. to avoid unintentional switching of connected devices (pumps, valves...). These are only connected after the configuration has been completed.

# 6 Configuration

The information in this chapter relates to the configuration of parameters and the parameters and the display of measured values of the AD-LU 650 GA with the Configuration program AD-Studio .

**INFO**



**Configuration**
When configuring the AD-LU 650 GA via the RS-485 interface from a PC or laptop, no other Modbus master must be active on the bus.

## 6.1 Symbols

The following symbols are used.

**P1 ... P3** Active powers in phases L1 ... L3 in kW.

**Q1 ... Q3** Reactive powers in phases L1 ... L3 in kvar.

**S1 ... S3** Apparent powers in phases L1 ... L3 kVA.

**Ptot** Sum of active powers in phases L1 ... L3 in kW.

**Qtot** Sum of the reactive powers in phases L1 ... L3 in kvar.

**Stot** Sum of the apparent powers in the phases L1 ... L3 kVA.

**I1 ... I3** Currents in phases L1 ... L3 in A.

**U1 ... U3** Voltages in phases L1 ... L3 in V.

**F** Frequency in phase L1 in Hz.

**PF1 ... PF3** Power factors in phases L1 ... L3. L3. $PFn = |Pn|/Sn.$

**PFtot** Power factor of the whole network. $PFtot = |Ptot|/Stot..$

## 6.2 Parameter

The following is a reference of the parameters that can be changed with the Configuration program AD-Studio . The table columns have the following meaning.

**Name** Parameter name as found in the configuration programme.

**Default value** The parameter has this value in the delivery state and after the factory settings have been set.

**Range** Limits for smallest and largest input value. For lists, a enumeration of all elements is displayed here.

**Unit** Physical unit of the value.

**Remark** Remarks, comments or explanations.

### 6.2.1 Inputs

The connection technique significantly determines the calculation of the performances. The selected connection method must correspond to the wiring of the unit in chapter 8.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Connection method | 3N asym | 1 phase,<br>3 sym,<br>3 asym,<br>3N sym,<br>3N asm | |

#### External current transformers

The data applies to all external current transformers. If no transformers are present, the secondary current must be equal to the primary current.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Primary current | 5 | 1 ... 10000 | A |
| Secondary current | 5 | 0.001 ... 10000 | A |

#### External voltage transformers

The data applies to all external voltage transformers. If no transformers are present, the secondary voltage must be equal to the primary voltage.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Primary voltage | 230 | 1 ... 500000 | V |
| Secondary voltage | 230 | 1 ... 500000 | V |

### Filter of the inputs

Each measured value can be assigned its own filter. This makes it possible, for example to attenuate a single phase current or a phase voltage very strongly without influencing the other measured values. The larger the filter, the higher the effect of the damping. Each measured value is filtered according to the following relationship.

$$M_t = M_{t-1} + \frac{M_t - M_{t-1}}{filter}$$

with

- $M_t$ measured value at time t.
- $M_{t-1}$ measured value at time t-1.
- $Filter$ Value of the filter for this input.

A filter of 0 is not allowed. A filter of 1 returns the current measured value unfiltered. A filter of 2 returns the arithmetic mean between the current and the last measured value. the current and the last measured value.
Since the measured values are filtered cyclically, the damping function depends essentially on this cycle time. on this cycle time. The timing is explained in chapter 3.5 is explained.
The relationship between the settling time, the cycle time and the filter is

$$t_{90} = filter * 2.26 * t_z$$

with

- $t_{90}$ Settling time of the filtered measured value to 90% with a signal jump in the input from 0 to 100 %.
- $t_z$ Cycle time in seconds.

Example: Settling time of the voltages. With an update rate of 10ms for the currents and voltages and the default value of the filter of 2, a settling time of

$$t_{90(U,I)} = 2 * 2.26 * 10ms = 45.2ms$$

For the analogue outputs, the low-pass filter of the outputs must still be taken into account.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Filter P1 | 1 | 1 ... 1000 | |
| Filter P2 | 1 | 1 ... 1000 | |
| Filter P3 | 1 | 1 ... 1000 | |
| Filter Q1 | 1 | 1 ... 1000 | |
| Filter Q2 | 1 | 1 ... 1000 | |
| Filter Q3 | 1 | 1 ... 1000 | |
| Filter S1 | | 1 ... 1000 | |

| Name | Default value | Range | Unit |
|---|---|---|---|
| Filter S2 | 1 | 1 ... 1000 | |
| Filter S3 | 1 | 1 ... 1000 | |
| Filter I1 | 1 | 1 ... 1000 | |
| Filter I2 | 1 | 1 ... 1000 | |
| Filter I3 | 1 | 1 ... 1000 | |
| Filter U1 | 2 | 1 ... 1000 | |
| Filter U2 | 2 | 1 ... 1000 | |
| Filter U3 | 2 | 1 ... 1000 | |
| Filter | 2 | 1 ... 1000 | |

### 6.2.2 Device functions

**Trend function n**

The AD-LU 650 GA has two trend functions, n = 1 ... 2.

Each trend function is determined by an associated measurement signal, a signal difference and a time interval. Thus, a rising, falling or constant trend can be determined. The trend of a measurement signal is always determined and can be read out via the Modbus.

Optionally, the trend can also be displayed by the assigned relay. In this case, trend function 1 is assigned to relay 1, trend function 2 to relay 2.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Assigned measuring signal n | Ptot | P1, P2, P3, Q1, Q2, Q3, S1, S2, S3, I1, I2, I3, U1, U2, U3, F, Ptot, Qtot, Stot, PF1, PF2, PF3, PFtot | |
| Trend Delta n | 1 | 0.001 ... 1000 | kW [1] |
| Trend interval n | 10 | 3 ... 1000 | s |

[1] The unit of the delta depends on the assigned measurement signal

### 6.2.3 Analogue outputs

#### Analogue output n

The AD-LU 650 GA has four analogue outputs, n = 1 ... 4.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Assigned measuring signal [n] | Ptot | P1, P2, P3, Q1, Q2, Q3, S1, S2, S3, I1, I2, I3, U1, U2, U3, F, Ptot, Qtot, Stot, PF1, PF2, PF3, PFtot | |
| Assigned measuring range [n] | 0 ... 3,45 | -1E6 ... 1E6 | kW |
| Signal type [n] | voltage | current, voltage | |
| Voltage output [n] | 0 ... 10 [1] | -10,5 ... 10,5 | V [2] |
| Current output [n] | 0 ... 20 [1] | -21 ... 21 | mA [3] |

When using the AD-LU 650 GA as a transmitter, any measured variable can be output on any analogue output. The relationship is linear. Of course, it is also possible to assign the same input signal to several analogue outputs, e.g. for signal multiplication or with different measuring or output ranges.

$$A = (M - M_0) * \frac{A_1 - A_0}{M_1 - M_0} + A_0$$

with $A$ Output value of an analogue output in mA or V.
$A_0$ Output range start of an analogue output in mA or V.
$A_1$ Output range end of an analogue output in mA or V.
$M$ Measured value in kW, V, A, etc.
$M_0$ Measuring range start in kW, V, A etc.
$M_1$ Measuring range end in kW, V, A etc.

No extrapolation is performed. If the measured value falls below the beginning of the measuring range, the output value is set to the beginning of the output range. If the measured value exceeds the end of the measuring range, the output value is set to the end of the output range. end of the output range.

$$M < M_0 : A = A_0$$

[2] Depends on Signal type
[3] Depends on Signal type

$$M > M_1 : A = A_1$$

Example:
$A_0 = 4mA; A_1 = 20mA;$
$M_0 = 10kW; M_1 = 30kW \quad M = 15kW \quad A = (15kW - 10kW) * \frac{20mA-4mA}{30kW-10kW} + 4mA;$
$A = 8mA \quad M > 30kW : A = 20mA \quad M < 10kW : A = 4mA$

### 6.2.4 Relay outputs

The AD-LU 650 GA has two relay outputs or two open-collector outputs, depending on the version. The following general parameters apply equally to relay outputs and open-collector outputs.

#### Relay output [n]

n = 1 ... 2.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Relay function [n] | off | Off,<br>Limit value,<br>Window,<br>Trend,<br>S0,<br>Monitor P,<br>Monitor U | |
| Mode of action [n] | Working current | Working current,<br>Quiescent current | |
| Switch on delay [n] | 0 | 0 ... 3600 | s |
| Switch off delay [n] | 0 | 0 ... 3600 | s |

The 'Relay function [n]' parameter determines the basic function of the relay. By default, the relay function is disabled.

#### Relay function [n] = 'Limit' or 'Window'

The following parameters are relevant for the relay function 'Limit' or 'Window'.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Assigned measurement signal [n] | Ptot | P1, P2, P3, Q1, Q2, Q3, S1, S2, S3, I1, I2, I3, U1, U2, U3, F, Ptot, Qtot, Stot, PF1, PF2, PF3, PFtot | |
| Switching points [n] | 0.1 ... 0.2 | kW | |

### 6.2.5 Relay function [n] = 'Trend'

The following parameter is relevant for the relay function 'trend'. The determination of the trend is carried out according to the parameters in chapter ??.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Trend function [n] | increasing | rising, falling, constant | |

#### Relay function [n] = 'S0'

The following parameters are relevant for the relay function 'S0'. With this function, energy pulses are output via the relay or the open collector output. The parameters 'Mode of action', 'Switch-on delay' and 'Switch-off delay' are not taken into account here.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Pulse valency [n] | 1 | 0.001 ... 1000 | Imp/kWh, Imp/kvarh [4] |

[4] The unit of impulse value depends on which type of energy has been selected: Imp/kWh or Imp/kvarh

| Name | Default value | Range | Unit |
|---|---|---|---|
| Energy type [n] | reference Ptot | Reference P1,<br>Reference P2,<br>Reference P3,<br>Regenerative P1,<br>Regenerate P2,<br>Regenerative P3,<br>Inductive Q1,<br>Inductive Q2,<br>Inductive Q3,<br>Capacitive Q1,<br>Capacitive Q2,<br>Capacitive Q3,<br>Reference Ptot,<br>Regenerative Ptot,<br>Inductive Qtot,<br>Capacitive Qtot | |
| Pulse length [n] | 0.25 | 0.1 ... 10 | s |

### 6.2.6 Relay function [n] = 'Monitor P' or 'Monitor U'

The following parameters are relevant for the relay function 'Monitor P' and 'Monitor U'. With the 'Monitor P' function, the regeneration into the mains is monitored. With the 'Monitor U' function, the mains voltage is monitored.

| Name | Default value | Range | Unit |
|---|---|---|---|
| Monitor phases [n] | L3, L2, L1 | L1<br>L2<br>L2, L1<br>L3,<br>L3, L1<br>L3, L2<br>L3, L2, L1 | |
| Monitor logic [n] | AND | AND<br>OR | |

The 'Monitor phases [n]' parameter determines the phases to be monitored. The 'Monitor logic [n]' parameter determines the evaluation of the monitor function. With the value 'AND', all monitored phases must fulfil the monitor condition. With the value 'OR' only one of the monitored phases must fulfil the monitor condition.

## 6.3 Signals

If the AD-LU 650 GA is in operation and connected to a PC or laptop, the current signals can be viewed with the Configuration program AD-Studio . This can be very helpful, especially during commissioning.

The data types are explained in chapter ??.

### 6.3.1 input signals

| Signalname | Data Type | Unit |
|---|---|---|
| P1 | single | kW [5]. |
| P2 | single | kW |
| P3 | single | kW |
| Q1 | single | kvar [6] |
| Q2 | single | kvar |
| Q3 | single | kvar |
| S1 | single | kVA |
| S2 | single | kVA |
| S3 | single | kVA |
| I1 | single | A |
| I2 | single | A |
| I3 | single | A |
| U1 | single | A |
| U2 | single | A |
| U3 | single | A |
| Ptot | single | kW |
| Qtot | single | kvar |
| Stot | single | kVA |
| PF1 | single | |
| PF2 | single | |
| PF3 | single | |
| PFtot | single | |

### 6.3.2 Analogue output signals

| Signalname | Data Type | Unit |
|---|---|---|
| voltage output 1 | single | V |
| Voltage output 2 | single | V |
| Voltage output 3 | single | V |
| Voltage output 4 | single | V |
| Current output 1 | single | mA |
| Current output 2 | single | mA |
| Current output 3 | single | mA |
| Current output 4 | single | mA |

**INFO**



**Reading of current or voltage outputs**
The output as a current or voltage signal depends on whether the output is configured as a current or voltage output under 6.2.3. The set values can be read. Whether a current actually flows or not cannot be displayed here.

### 6.3.3 Relay output signals

The value '1' indicates that the relay coil is energised and '0' that it is de-energised. The red indicator LED should also light up in this case.

| Signalname | Data Type | Unit |
|---|---|---|
| Relay output 1 | bool | |
| Relay output 2 | bool | |

### 6.3.4 Counters

The counters show the energy accumulated since the unit was first started. The values are stored in the EEPROM of the AD-LU 650 GA at a time interval of 1 h.

| Signalname | Data Type | Unit |
|---|---|---|
| Active consumed energy P1 | u32 | kWh |
| Active consumed energy P2 | u32 | kWh |
| Active consumed energy P3 | u32 | kWh |
| Active consumed energy Ptot | u32 | kWh |
| Active fed back energy P1 | u32 | kWh |
| Active fed back energy P2 | u32 | kWh |
| Active fed back energy P3 | u32 | kWh |
| Active fed back energy Ptot | u32 | kWh |
| Reactive energy inductive Q1 | u32 | kvarh |
| Reactive energy inductive Q2 | u32 | kvarh |
| Reactive energy inductive Q3 | u32 | kvarh |
| Reactive energy inductive Qtot | u32 | kvarh |
| Reactive energy capacitive Q1 | u32 | kvarh |
| Reactive energy capacitive Q2 | u32 | kvarh |
| Reactive energy capacitive Q3 | u32 | kvarh |
| Reactive energy capacitive Qtot | u32 | kvarh |

# 7 Modbus

The AD-LU 650 GA has an RS-485 interface as standard.
The data is transmitted via the Modbus-RTU protocol (RTU = Remote Terminal Unit), the AD-LU 650 GA is a Modbus slave. Communication takes place according to the master-slave procedure and starts with a request from the master, e.g. a PLC or a PC.
Each slave has a unique address. If a slave recognises that its address has been addressed by the master, the slave always sends a response.
The slaves never communicate with each other. They are also not able to start a communication with the master. The Modbus master can read the individual registers via the addresses.

## 7.1 Change slave address

The slave address of the AD-LU 650 GA can be changed with the two BCD switches on the front panel. on the front panel. All addresses from 1 ... 99 are valid.

**INFO**



**Changing the slave address**
The slave address is always taken over from the BCD switches by the AD-LU 650 GA . The change of the slave address is therefore immediately valid.

## 7.2 Change Baud Rate and Parity

If the baud rate or the parity must be changed in order to insert the AD-LU 650 GA into an existing bus configuration, these parameters can be changed via the Configuration program AD-Studio . For this see chapter ??

**INFO**



**Change baud rate and parity**

The new baud rate and parity are only adopted after a restart of the AD-LU 650 GA .

## 7.3 Communication with default settings with changed baud rate and parity

The AD-LU 650 GA is no longer accessible through the Configuration program AD-Studio after changing the baud rate and parity. If you want to change or control

parameters, set the slave address of the AD-LU 650 GA to 0. With this setting, the AD-LU 650 GA uses slave address 1 and the default settings of the interface.

## 7.4 Data format

All data larger than one byte is sent in 'big-endian' format according to Modbus specification.
An exception is the checksum. It is sent in 'little-endian' format.
Example: The number 4660 (0x1234) is transmitted as follows:

| Byte1 | Byte0 |
|---|---|
| 0x12 | 0x34 |

## 7.5 data types

The following data types are used.

| Typ | Größe | area |
|---|---|---|
| bool | 1 byte | 0 ... 1 |
| u16 | 2 byte | 0 ... $2^{16} - 1$ |
| u32 | 4 byte | 0 ... $2^{32} - 1$ |
| single | 4 byte | IEEE 754 |

## 7.6 Supported functions

The following read and write functions are supported.

**3 (0x03)** Read Holding Registers.

**16 (0x10)** Write Multiple Registers.

### 7.6.1 Read Holding Registers

This function is used to read one or more registers of the AD-LU 650 GA .
Example: Read the active power P1 of a AD-LU 650 GA with slave address 1, see data list in ??.
The master first sends a request with the start address (40801 = 0x9F61) and the number of registers to be read (2 = 0x0002) to the AD-LU 650 GA :

| Slave | Function | Start address1 | Start address0 | Number Register1 | Number Register0 | CRC0 | CRC1 |
|---|---|---|---|---|---|---|---|
| 1 | 0x03 | 0x9F | 0x61 | 0x00 | 0x02 | 0xBB | 0xC1 |

The request is checked. If all data are in order, the AD-LU 650 GA responds with the number of bytes and the requested registers:

| Slave | Function | Number bytes | Register1 | Register0 | CRC0 | CRC1 |
|---|---|---|---|---|---|---|
| 1 | 0x03 | 4 | 0x00 | 0x00 | 0xFA | 0x33 |

If an error occurs, the AD-LU 650 GA responds with an error message:

| Slave | Error code | Exception | CRC0 | CRC1 |
|---|---|---|---|---|
| 1 | 0x83 | see 7.7 | | |

### 7.6.2 Write Multiple Registers

This function is used to write one or more registers of the AD-LU 650 GA .
The master first sends a request to the AD-LU 650 GA with the start address, the number of registers and the registers to be written. registers to be written to the AD-LU 650 GA :

| Slave | funct. | Start adr.1 | Start-adr.0 | Quantity Reg.1 | Number Reg.0 | Number of bytes | Value Reg.1 | Value Reg.0 | CRC0 | CRC1 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0x10 | | | | | | | | | |

The request is checked. If all data are in order, the AD-LU 650 GA responds with the start address and the number of written registers:

| Slave | Funct. | Start adr.1 | Start-adr.0 | Quantity Reg.1 | Number Reg.0 | CRC0 | CRC1 |
|---|---|---|---|---|---|---|---|
| 1 | 0x10 | | | | | | |

If an error occurs, the AD-LU 650 GA responds with an error message:

| Slave | Error code | Exception | CRC0 | CRC1 |
|---|---|---|---|---|
| 1 | 0x90 | see 7.7 | | |

## 7.7 Exception Codes

In the case of an error request, the AD-LU 650 GA responds with an error telegram and one of the following error telegram and one of the following exception codes. As error code, the function code is returned with 0x80.

**1 (0x01)** The Modbus function is not supported.

**2 (0x02)** The register address does not exist.

**3 (0x03)** The data is invalid.

## 7.8 Data list

The data list contains all Modbus registers supported by the AD-LU 650 GA .

| Register | Count | Typ | Description | Unit | R/W |
|---|---|---|---|---|---|
| 40401 | 1 | u16 | Direction energy flow L1<br>0 = Consumption<br>1 = Feedback | | R |
| 40402 | 1 | u16 | direction energy flow L2<br>0 = Consumption<br>1 = Feedback | | R |
| 40403 | 1 | u16 | direction energy flow L3<br>0 = Consumption<br>1 = Feedback | | R |
| 40606 | 1 | u16 | Relay state 1 | | R |
| 40607 | 1 | u16 | relay state 2 | | R |
| 40801 | 2 | single | P1 | kW | R |
| 40802 | 2 | single | P2 | kW | R |
| 40803 | 2 | single | P3 | kW | R |
| 40804 | 2 | single | Q1 | kvar | R |
| 40805 | 2 | single | Q2 | kvar | R |
| 40806 | 2 | single | Q3 | kvar | R |
| 40807 | 2 | single | S1 | kVA | R |
| 40808 | 2 | single | S2 | kVA | R |
| 40809 | 2 | single | S3 | kVA | R |
| 40810 | 2 | single | I1 | A | R |
| 40811 | 2 | single | I2 | A | R |
| 40812 | 2 | single | I3 | A | R |
| 40813 | 2 | single | U1 | V | R |
| 40814 | 2 | single | U2 | V | R |
| 40815 | 2 | single | U3 | V | R |
| 40816 | 2 | single | F | Hz | R |
| 40817 | 2 | single | Ptot | kW | R |
| 40818 | 2 | single | Qtot | kVAr | R |
| 40819 | 2 | single | Stot | kVA | R |
| 40820 | 2 | single | PF1 | | R |
| 40821 | 2 | single | PF2 | | R |
| 40822 | 2 | single | PF3 | | R |
| 40823 | 2 | single | PFtot | | R |
| 40901 | 2 | single | Iout1 | mA | R [1]. |
| 40902 | 2 | single | Iout2 | mA | R |
| 40903 | 2 | single | Iout3 | mA | R |
| 40904 | 2 | single | Iout4 | mA | R |
| 40905 | 2 | single | Uout1 | V | R [2]. |
| 40906 | 2 | single | Uout2 | V | R |
| 40907 | 2 | single | Uout3 | V | R |
| 40908 | 2 | single | Uaus4 | V | R |

[1]Only if configured as current output
[2]Only if configured as voltage output

| Register | Count | Typ | Description | Unit | R/W |
|---|---|---|---|---|---|
| 47218 | 2 | u32 | Active energy consumed P1 | kWh | R/W |
| 47219 | 2 | u32 | Active energy consumed P2 | kWh | R/W |
| 47220 | 2 | u32 | Active energy consumed P3 | kWh | R/W |
| 47221 | 2 | u32 | Active energy fed back P1 | kWh | R/W |
| 47222 | 2 | u32 | Active energy fed back P2 | kWh | R/W |
| 47223 | 2 | u32 | Active energy fed back P3 | kWh | R/W |
| 47224 | 2 | u32 | Reactive energy inductive Q1 | kvarh | R/W |
| 47225 | 2 | u32 | Reactive energy inductive Q2 | kvarh | R/W |
| 47226 | 2 | u32 | Reactive energy inductive Q3 | kvarh | R/W |
| 47227 | 2 | u32 | Reactive energy capacitive Q1 | kvarh | R/W |
| 47228 | 2 | u32 | Reactive energy capacitive Q2 | kvarh | R/W |
| 47229 | 2 | u32 | Reactive energy capacitive Q3 | kvarh | R/W |
| 47230 | 2 | u32 | Active energy consumed Ptot | kWh | R/W |
| 47231 | 2 | u32 | Active energy fed back Ptot | kWh | R/W |
| 47232 | 2 | u32 | Reactive energy inductive Qtot | kvarh | R/W |
| 47233 | 2 | u32 | Reactive energy capacitive Qtot | kvarh | R/W |
| 49401 | 1 | u16 | Trend 1<br>0 = rising<br>1 = falling<br>2 = constant | | R |
| 49402 | 1 | u16 | Trend 2<br>0 = rising<br>1 = falling<br>2 = constant | | R |

**INFO**

**Writing counters**

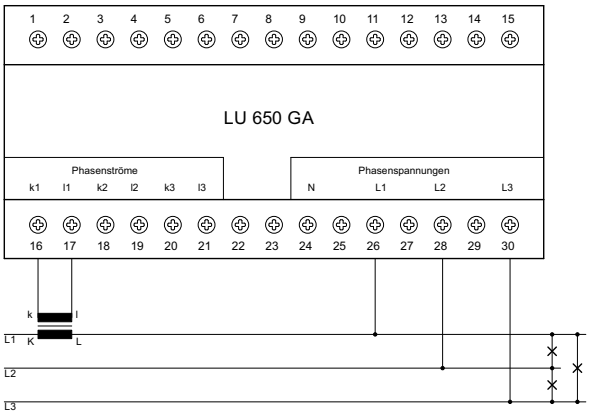
Writing a counter continues counting with the new value. This function can be used to reset the counter to 0 or to set it to a known counter value

.

# 8 Connection diagrams

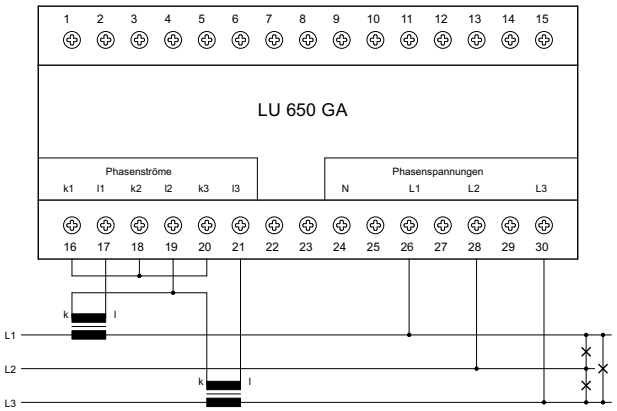
## 8.1 Voltage and current inputs

### 8.1.1 3 phases, 3 conductors same load



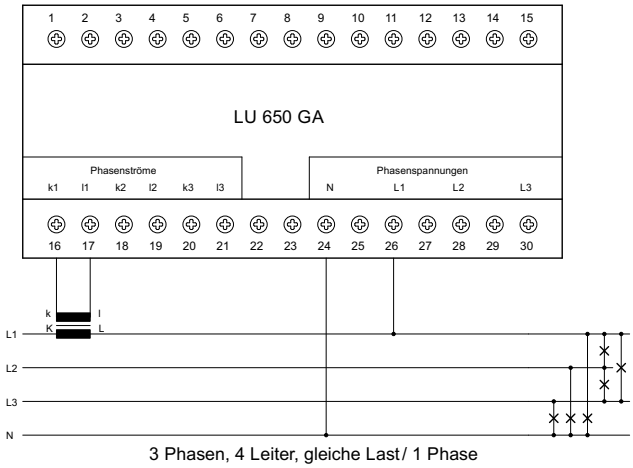

3 Phasen, 3 Leiter, gleiche Last

## 8.1.2 3 phases, 3 conductors unequal load



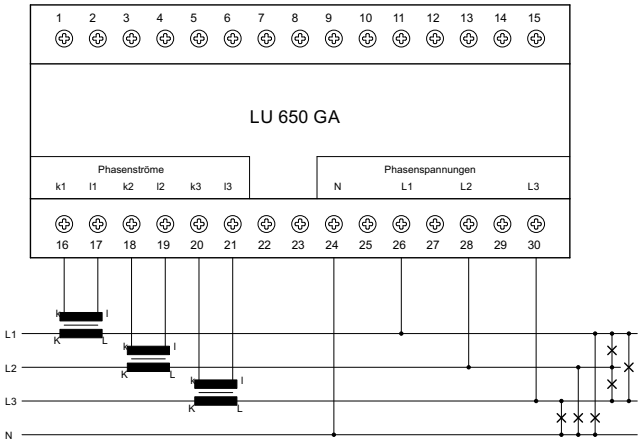

3 Phasen, 3 Leiter, ungleiche Last

## 8.1.3 3 phases, 4 conductors equal load



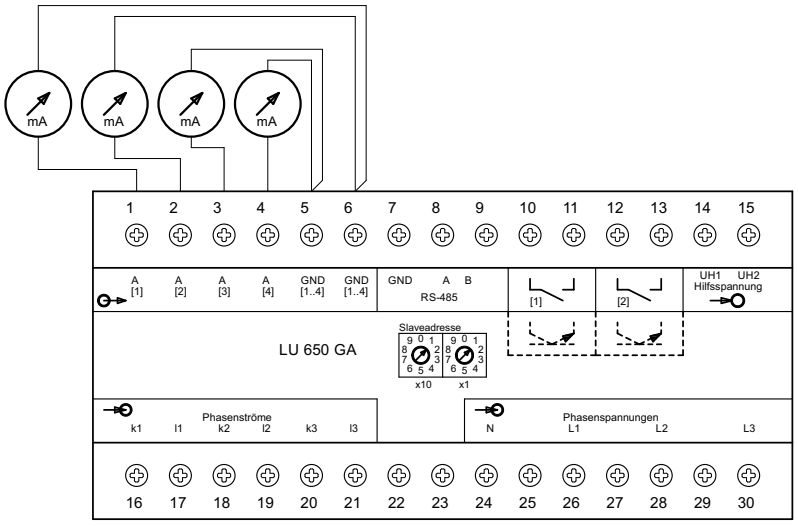

3 Phasen, 4 Leiter, gleiche Last / 1 Phase

### 8.1.4 3 phases, 4 conductors unequal load




3 Phasen, 4 Leiter, ungleiche Last

## 8.2 Analogue outputs





Subject to technical changes and printing errors.

All analogue outputs, even if configured as current outputs, have a common ground, which is divided between terminals 5 and 6. In the picture, all four current outputs are used. In this case, two ground lines must be connected to one ground terminal.

**INFO**

**Additional ground terminal**

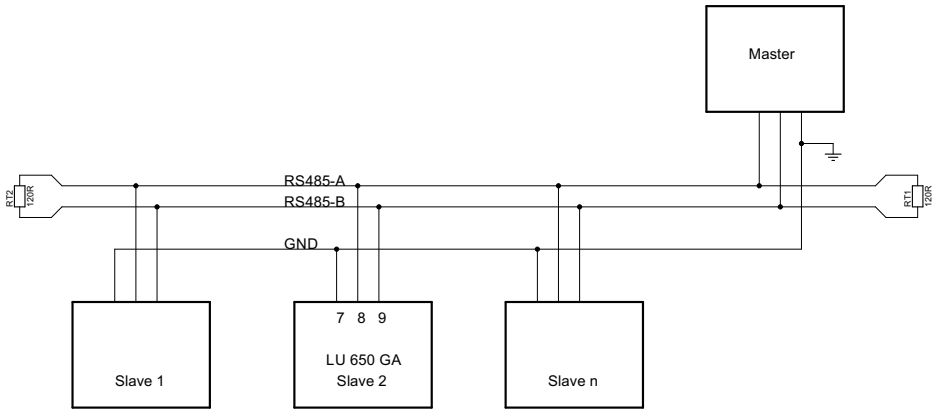
If the RS-485 interface is not used, the ground terminal of the interface (terminal 7) can also be used as signal ground

.

## 8.3 RS-485

The illustration shows the wiring of the RS-485 interface of the AD-LU 650 GA in a Modbus segment. segment is shown. According to the 'Modbus over serial line' specification

- twisted, shielded cable must be used.
- , the ground connection of all bus participants must be connected to each other and connected to protective earth at one point, if possible at the bus master.
- the bus cable must be terminated at both ends with terminating resistors of 150 ohms between between lines A and B.



# 9 Appendix

## 9.1 Maintenance

During proper operation of the AD-LU 650 GA , it is maintenance-free. maintenance-free. In the event of damage, the unit may only be repaired by the manufacturer. by the manufacturer.

## 9.2 Faults

If an error or malfunction occurs, first try to find the cause using the following table. If the error still occurs, please contact the manufacturer or dealer of the device.

| Error | Cause | Action |
|---|---|---|
| Power values are negative | Terminals k/l of the current transformer reversed or current transformer snapped on incorrectly. Backfeed into the grid e.g. by a photovoltaic system. | Check the terminals k/l of the current transformers. |
| Measured values for current, voltage or power are too large or too small. | Transmission ratio of the current or voltage transformers incorrectly configured. Connection technology of the inputs incorrectly configured. | Check the data of the current and voltage transformers and the connection technology with the Configuration program AD-Studio . and the connection technology. |
| Analogue output for voltage or current is overdriven. | Analogue output is configured for current instead of voltage or vice versa. | Check the configuration of the analogue output with the Configuration program AD-Studio . |
| No connection to the unit via the RS-485 interface | Slave address or transmission protocol set incorrectly. Data lines A and B interchanged. | Check the configuration of the interface with the Configuration program AD-Studio . Check the slave address of the unit at the two BCD switches on the front. front side. Check the correct connection of the two data lines A and B. |

## 9.3 Revisions

| Revision | Date | Remark |
|---|---|---|
| 1.0 | 2021-05-04 | Document created |

## 9.4 Addresses

If you have any further questions about the product, requests or suggestions, please contact us at the address below.

Adamczewski Elektronische Messtechnik GmbH

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