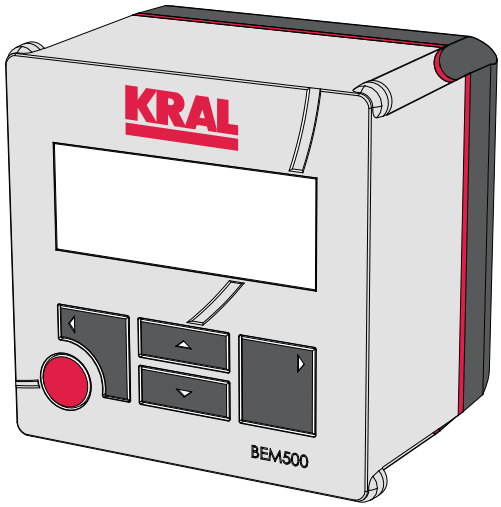
Operating Instructions



KRAL Electronics.

Series BEM 500

OIE 12en
Edition 2019-02 HW 3.003/SW 3.003

Table of content

Table of content

Target groups

The operating instructions form part of the BEM 500 electronic unit and must be kept for future reference. Furthermore please observe the associated documents.

Target groups

Target group	Tasks
Operator-owner	☐ Keep these instructions available at the installation site for future reference. ☐ Ensure that employees read and observe these instructions and the associated documents, in particular the safety instructions and warnings. ☐ Observe additional system-specific directives and regulations.
Specialist personnel, fitters	☐ Read, observe and follow these instructions and the associated documents, in particular the safety instructions and warnings.

Symbols

Symbol	Meaning
	Warning
	Note
	Action steps installation and removal
	Action steps electrical installation
	Check or fault table
	Operating steps for electronic unit
	Faults in the electronic unit
	Faults in the KRAL Volumeter
	Faults in the plant
	Input errors
▶	Request for action

Danger levels

Danger levels

	Warning	Danger level	Consequences of non-observances
⚠	**Danger**	Immediate threat of danger	Serious personal injury, death
⚠	**Warning**	Possible threat of danger	Serious personal injury, invalidity
⚠	**Caution**	Potentially dangerous situation	Slight personal injury
	Caution	Potentially dangerous situation	Material damage

Associated documents

Declaration of conformity as per EU Directive 2014/30/EU and 2014/35/EU
Corresponding operating instructions for the Volumeter
Corresponding operating instructions for the sensor
Calibration certificate
Work sheet

General safety instructions

The following safety instructions must be observed:
☐ No liability is accepted for damage arising through non-observance of the operating instructions. ▪ Read the operating instructions carefully and observe them. ▪ The operator-owner is responsible for the observance of the operating instructions. ▪ Installation, removal and installation work may only be carried out by specialist personnel. ☐ Implement all the supply lines without faults. ☐ Observe the general regulations for the prevention of accidents as well as the local safety and operating instructions. ☐ Observe the valid national and international standards and specifications of the installation location.

Volume measurement

With its functional scope the KRAL electronic unit covers a wide range of functions. The electronic unit is optimized for use together with KRAL Volumeters. KRAL Volumeters generate a specific number of pulses per flow volume unit - depending on the size and working point. This device-specific characteristic is called the K-factor (unit: Pulse/Liter) and can be found on the enclosed calibration certificate.

The pulse signals of up to two volumeters can be evaluated. The following signals are available:

- ☐ PNP
- ☐ Namur
- ☐ NPN

Either PNP or NPN can be selected for push-pull pick ups.
In addition the devices can also be equipped with temperature sensors and further pick ups for flow direction detection. The electronic unit is supplied with settings in accordance with the customer requirements.

Together with diverse options for signal transfer with analog, pulse and bus outputs this means that an extensive scope of performance is available that offers the following main possibilities:

Volume measurement

The instantaneous value of the volume flow (volume per time unit) is calculated from the measured value of the incoming pulses per time unit and the stored mean K-factor and is displayed. Furthermore the total number of measured pulses can be used to display the total flow (volume) as a total value since the device was last reset. Rate values represent the current instantaneous values, total values correspond to the sums since the last resetting.

Mass calculation

The instantaneous value of the mass flow (mass per time unit) is calculated from the measured value of the incoming pulses per time unit and the stored values of mean K-factor and mean density and is displayed. Furthermore the total number of measured pulses can be used to display the total flow (mass) as a total value since the device was last reset.
Rate values represent the current instantaneous values, total values correspond to the sums since the last resetting.

Linearization

However, the K-factor of a volumeter shows slightly different values at different flow rates. These are documented in the enclosed calibration certificate. In order to improve the measuring precision, especially at strongly varying flow rates, these different values can be taken into consideration by means of a "Linearization". To this purpose the K-factors are stored in a table across up to seven interpolation values in accordance with the flow rate. The K-factor relevant for the flow rate being measured is then determined by means of linear interpolation between the two nearest interpolation values.

The linearization is used when the fluid lies in the low-viscosity range. At viscosities exceeding 20 mm^2/s the use of the resulting K-factor is recommended. The resulting K-factor is determined as the average value of the calibration points at the five higher flow rate values.

Temperature compensation

If the KRAL volumeter is additionally equipped with a temperature sensor, the current density of the flowing fluid can be calculated from this measured value by means of a stored density table.

- ☐ At the option "Volume at X°", a normalized volume measurement is then possible at which the displayed values are converted to a reference temperature X° that can be selected freely. This ensures that measuring errors caused by changes in the density due to temperature variations are avoided.
- ☐ The option "Volume at TempA" calculates the volume back to the temperature volumeter A. This option allows the comparison with a reservoir level.
- ☐ Measuring errors are also reduced at the "Mass calculation" option, since the device can now process the actual density and not only a stored mean value at the mass conversion. For the case of operation with different fluids two different density tables can be entered and selected.

Differential measurement

The KRAL electronic unit can process the signals of two volumeters and determine and display the links possible with it.

- ☐ The option differential measurement "A-B" allows the subtraction of the values of the two channels, e.g. feed and return of a consumer supplied with a closed circular pipeline and thus allows the direct display of the consumer of this device.
- ☐ The option sum "A+B" allows the addition of the two measured values and thus, for example, the display of the total of two devices.

Circulation ratio and threshold value

The ratio A/(A-B) is called the "Circulation ratio". On the basis of the laws of error propagation, a strongly rising error of the displayed differential value A-B results for the option "Differential measurement" at values A/(A-B) >> 1, so that the value A/(A-B) can also be used to judge the reliability of a differential measurement. For the case A/(A-B) >> 1, for example in the case of a deactivated consumer but with a circulation pump that continues to be operated, a threshold value can be specified for A-B below which the measured values are not taken into consideration for the sum calculation.

Averaging

A strongly fluctuating flow rate causes a jumping display or as a result a fluctuating analog output. The averaging function reduces this effect by generating a averaging across several measured values. The number of measured values for averaging can be set, see "3.06 Averaging analog output", Page 41, and see "2.16 Averaging display rate", Page 39.

Limit value

The "Limit value bypass" function allows the automatic activation of a bypass valve when a volumeter blocks. The bypass valve is actuated via Relay output 1, see "3.13 Function relay 1", Page 42.

Collective error message

When an error message occurs, Relay output 2 is switched for the collective error.

Flow direction detection

In extreme cases the flow direction can change through pulsations, meaning through liquid waves in the piping system. Through the use of two pick ups that supply signals out of phase by 90° (quadrature encoder signals), a reversal in the flow direction is recognized by means of the flow direction sensor and taken into account when calculating the total value.
The electronic unit offers incremental encoding inputs for each volumeter. This means that the flow direction can be determined without additional components and taken into account in the calculation at any time.

Batching

A simple filling function can be implemented with the KRAL electronic unit, see "1.07 Batch quantity", Page 35. After the filling function has been started, Relay output 1 is activated when the specified quantity is reached in order, for example, to close a valve that interrupts the filling process, see "3.13 Function relay 1", Page 42. The filling process can also be interrupted or aborted.

Electronic evaluation

The electronic unit receives signals from the sensors and calculates the measured values which are indicated in the display unit and which can be called up at the analog output or at the bus interface.

Possibilities of the electronic unit:
- ☐ Language selection
- ☐ Display of the measured values in different units (volumes, masses and temperatures)
- ☐ Averaged display values
- ☐ Up to 2 density tables with 10 value pairs each that correspond to the fluid specifications
- ☐ Adaptation of the density tables if the analysis of the fluid requires other settings
- ☐ Density calculation
- ☐ Linearization table with up to 7 preset K-factors per volumeter
- ☐ Information message at faults or invalid inputs
- ☐ 2 scalable and assignable analog outputs 0 - 10 V or 4 - 20 mA
- ☐ 2 scalable and assignable pulse outputs 24 V
- ☐ 2 adjustable relay outputs

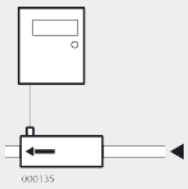
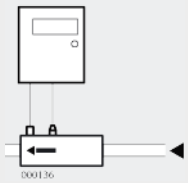
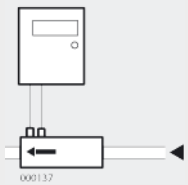
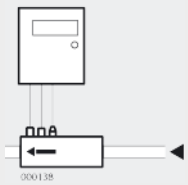
Bus connection

The electronic unit can be connected to the plant by means of a Modbus interface and can thus be integrated optimally into existing systems. This ensures that simple, reliable and rapid data exchange can be implemented.

Applications of the KRAL electronic unit

Different extension stages of the electronic unit are presented on the basis of the following examples. This allows the required functional scope to be selected in accordance with the requirements.

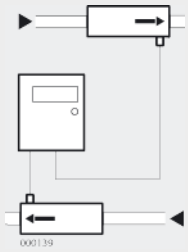
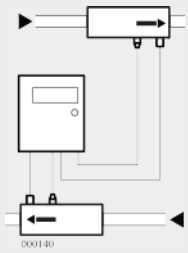
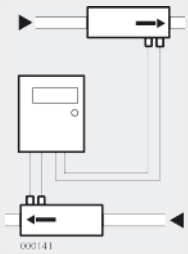
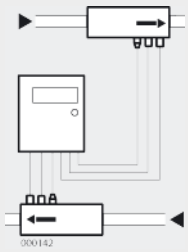
Single-line measurement

Extension stage	Components	Functions
 Fig. 1 Basic	☐ 1 Volumeter ☐ 1 Pick up ☐ 1 BEM 300 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ 1 Analog output ☐ 1 Pulse output
 Fig. 2 Basic + Temperature compensation	☐ 1 Volumeter ☐ 1 Pick up ☐ 1 Temperature sensor Pt 100 ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Mass flow measurement ☐ Temperature compensation ☐ 2 Relay outputs ☐ 2 Analog outputs ☐ 2 Pulse outputs ☐ Batching
 Fig. 3 Basic + Flow direction detection	☐ 1 Volumeter ☐ 2 Pick ups ☐ 1 BEM 300 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Flow direction detection ☐ 1 Analog output ☐ 1 Pulse output
 Fig. 4 Basic + Flow direction detection + Temperature compensation	☐ 1 Volumeter ☐ 2 Pick ups ☐ 1 Temperature sensor Pt 100 ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Flow direction detection ☐ Mass flow measurement ☐ Temperature compensation ☐ 2 Relay outputs ☐ 2 Analog outputs ☐ 2 Pulse outputs ☐ Batching

Tab. 1 Extension stages single-line measurement

Applications of the KRAL electronic unit

Differential measurement

Extension stage	Components	Functions
 Fig. 5 Basic	☐ 2 Volumeters ☐ 1 Pick up each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ 2 Relay outputs ☐ 2 Analog outputs ☐ 2 Pulse outputs
 Fig. 6 Basic + Temperature compensation	☐ 2 Volumeters ☐ 1 Pick up each ☐ 1 Temperature sensor Pt 100 each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Mass flow measurement ☐ Temperature compensation ☐ 2 Relay outputs ☐ 2 Analog outputs ☐ 2 Pulse outputs
 Fig. 7 Basic + Flow direction detection	☐ 2 Volumeters ☐ 2 Pick ups each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Flow direction detection ☐ 2 Relay outputs ☐ 2 Analog outputs ☐ 2 Pulse outputs
 Fig. 8 Basic + Flow direction detection + Temperature compensation	☐ 2 Volumeters ☐ 2 Pick ups each ☐ 1 Temperature sensor Pt 100 each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Flow direction detection ☐ Mass flow measurement ☐ Temperature compensation ☐ 2 Relay outputs ☐ 2 Analog outputs ☐ 2 Pulse outputs

Tab. 2 Extension stages differential measurement

Unpacking and checking the state of delivery

1. On delivery unpack the electronic unit and check for damage during transportation.
2. Report damage during transportation immediately to the manufacturer.
3. Dispose of packing material in accordance with the locally applicable regulations.

Transportation

► If possible, transport the electronic unit in the original packaging, while observing the ambient conditions, see "Ambient conditions", Page 21.

Storage

► If possible, store the electronic unit in original packaging in a cool and dry place, while observing the ambient conditions, see "Ambient conditions", Page 21.

Disposal

Safety instruction for disposal

The following safety instruction must be observed during disposal:
► Observe the local regulations on disposal.

Disposing of the electronic unit

► As electronic waste the electronic unit has to be disposed of properly.

Maintenance

The electronic unit is maintenance-free.

Cleaning

In order to clean the electronic unit wipe the housing with a soft cloth. In case of stronger soiling moisten the cloth with water that has a common detergent added. Only wipe the surface off lightly with a moist cloth. Under no circumstances may water penetrate the inside of the electronic unit!

Safety instructions on installation, removal and connection

The following safety instructions must be observed:

- ☐ All installation and removal work may only be carried out by qualified personnel.
  - Read the operating instructions and observe the relevant instructions.
- ☐ The electronic unit is a precision measuring device.
  - Ensure cleanliness and take care during installation and removal.
  - Do not take apart the electronic unit.
- ☐ The following qualifications are required for the electrical connection:
  - Practical electrotechnical training
  - Knowledge of the safety guidelines at the workplace
  - Knowledge of the electrotechnical safety guidelines

Installation

Dimensions

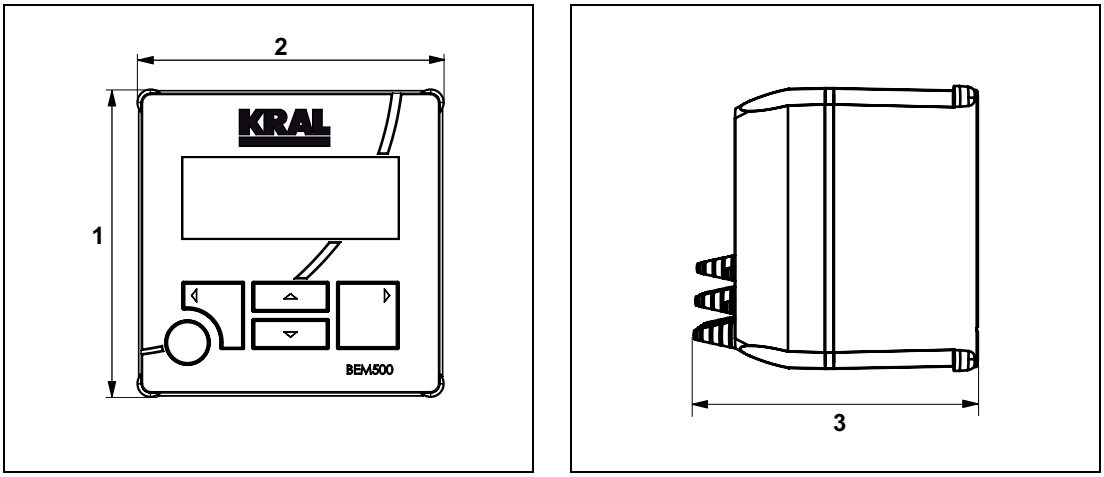


Fig. 1 Dimensions of BEM 500 electronic unit

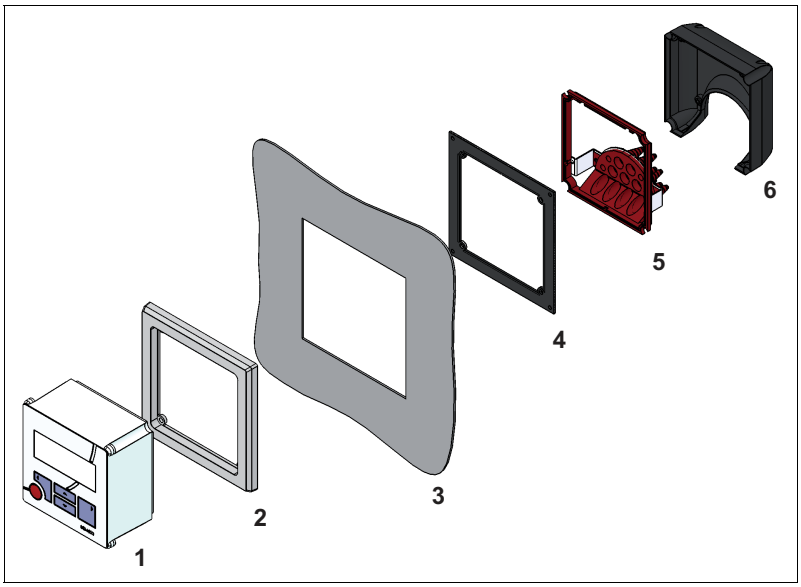
1 Height: 116 mm
2 Width: 116 mm
3 Depth: 118 mm

Scope of delivery

The following components belong to the scope of delivery of the electronic unit:

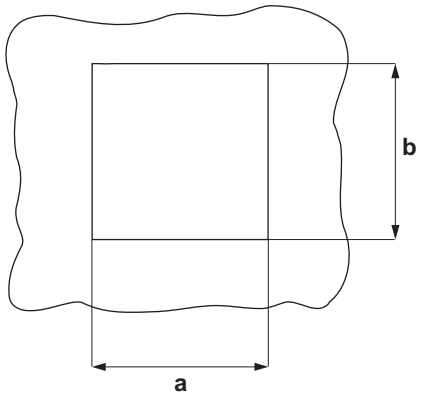
- ☐ Operating instructions
- ☐ Password
- ☐ Work sheet
- ☐ Mounting frame incl. screws and lock washers
- ☐ Terminal tool
- ☐ KRAL tool set

Installation in the control cabinet



1 Electronic unit
2 Front frame
3 Control cabinet
4 Sealing frame
5 Seal with cable entries
6 Housing cover

Fig. 2 BEM 500 control cabinet installation



a 117 mm
b 117 mm

Fig. 3 Control cabinet section

The electronic unit can be mounted in control cabinets having a sheet thickness of 0.5 – 5 mm by using the supplied mounting frame. The mounting frame consists of a front frame **2** and a sealing frame **4**, see Fig. 2, page 13.
When the space is limited, mounting is also possible without a housing cover **6** and seal with cable entries **5**, see Fig. 2, page 13.
An adapter set is available for converting BEM 4U to the electronic unit BEM 500, see "Adapter set for conversion of BEM 4U to BEM 300/500", page 55.
Required minimum mounting depth: 80 mm

Dimensions of front frame:
☐ Height: 145 mm
☐ Width: 145 mm
☐ Depth: 12 mm

Aids:
☐ KRAL tool set

Installation

DANGER
Risk of death resulting from electric shock.

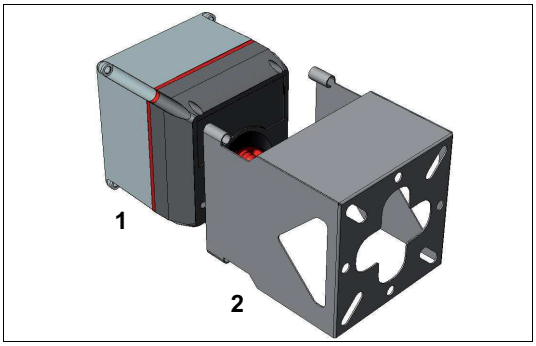
- ► Ensure that the power supply is disconnected.
- ► The electronic unit may only be connected by an authorized electrician.

1. Create a control cabinet section, see Fig. 3, page 13.
2. When the space is limited, remove the housing cover **6** and seal with cable entries **5**.
3. Slide the front frame **2** from behind onto the electronic unit **1**.
4. Place the electronic unit with the front frame from the front into the control cabinet section, see Fig. 3.
5. Slide the sealing frame **4** from behind onto the electronic unit, whereby the sealing surface has to point to the front.
6. Fasten the front frame and sealing frame using the 4 supplied screws and lock washers. Tighten the screws carefully.
   Tightening torque: 1 Nm

The electronic unit is ready for the connection of the cables.

Wall mounting

For wall mounting a universal mount is available as an accessory, see "Accessories mounting", page 54.



1 Electronic unit
2 Universal mount

Fig. 4 Universal mount for wall mounting

Prerequisite:
☐ Universal mount is mounted to the wall
☐ All cables have been cut to length and connected

Aids
☐ KRAL tool set

1. Slide the electronic unit **1** into the universal mount **2**.
2. Fasten the electronic unit using the supplied screws, washers and wedge lock washers.
   The electronic unit is ready to operate after the power supply has been switched on.

Pipe mounting/mounting on volumeter

The electronic unit can be mounted to the pipe or on the volumeter by means of the universal mount and the corresponding fixing kit. The required fixing kit is available as an accessory, see "Accessories mounting", page 54.

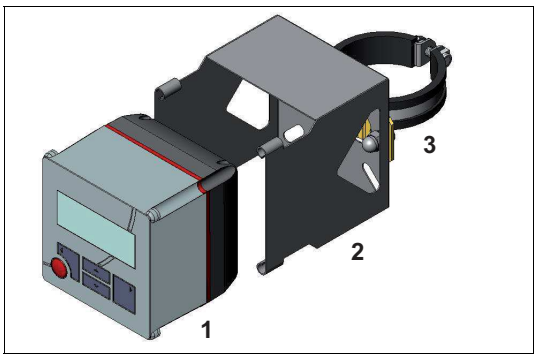


Fig. 5 Fixing kit for pipe mounting / KRAL Volumeter OMG series

1 Electronic unit
2 Universal mount
3 Fixing kit pipe mounting/OMG

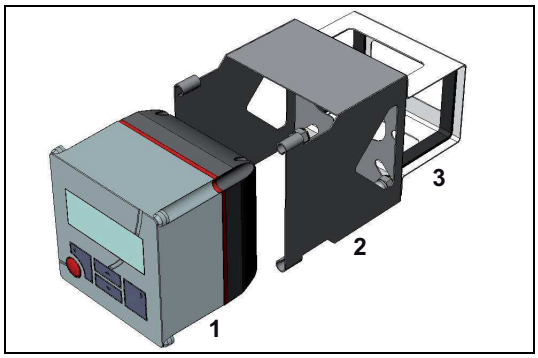


Fig. 6 Fixing kit for KRAL Volumeter OME series

1 Electronic unit
2 Universal mount
3 Fixing kit OME

Prerequisite:
☐ All cables have been cut to length and connected

Aids
☐ KRAL tool set

1. Mount the universal mount **2** on the fixing kit **3**.
2. Mount the fixing kit including universal mount to the pipe/volumeter.
3. Slide the electronic unit into the universal mount.
4. Fasten the electronic unit using the supplied screws, washers and wedge lock washers.

The electronic unit is ready to operate after the power supply has been switched on.

Removal

Prerequisite:
☐ Power supply switched off

Aids:
☐ KRAL tool set
☐ Terminal tool

Removing the electronic unit from the control cabinet

1. Disconnect all the wires.
2. Unscrew the connecting screws between the front and sealing frames.
3. Pull of the sealing frame to the rear.
4. Pull the electronic unit with front frame from the front out of the control cabinet.
5. Press the front frame to the rear and pull it off the electronic unit.

Removing the electronic unit from the wall

1. Unscrew the connecting screws between the electronic unit and the universal mount.
2. Slide the electronic unit out of the universal mount.

Removing the electronic unit from the pipe/volumeter

1. Unscrew the connecting screws between the electronic unit and the universal mount.
2. Slide the electronic unit out of the universal mount.

Termination panel of the electronic unit

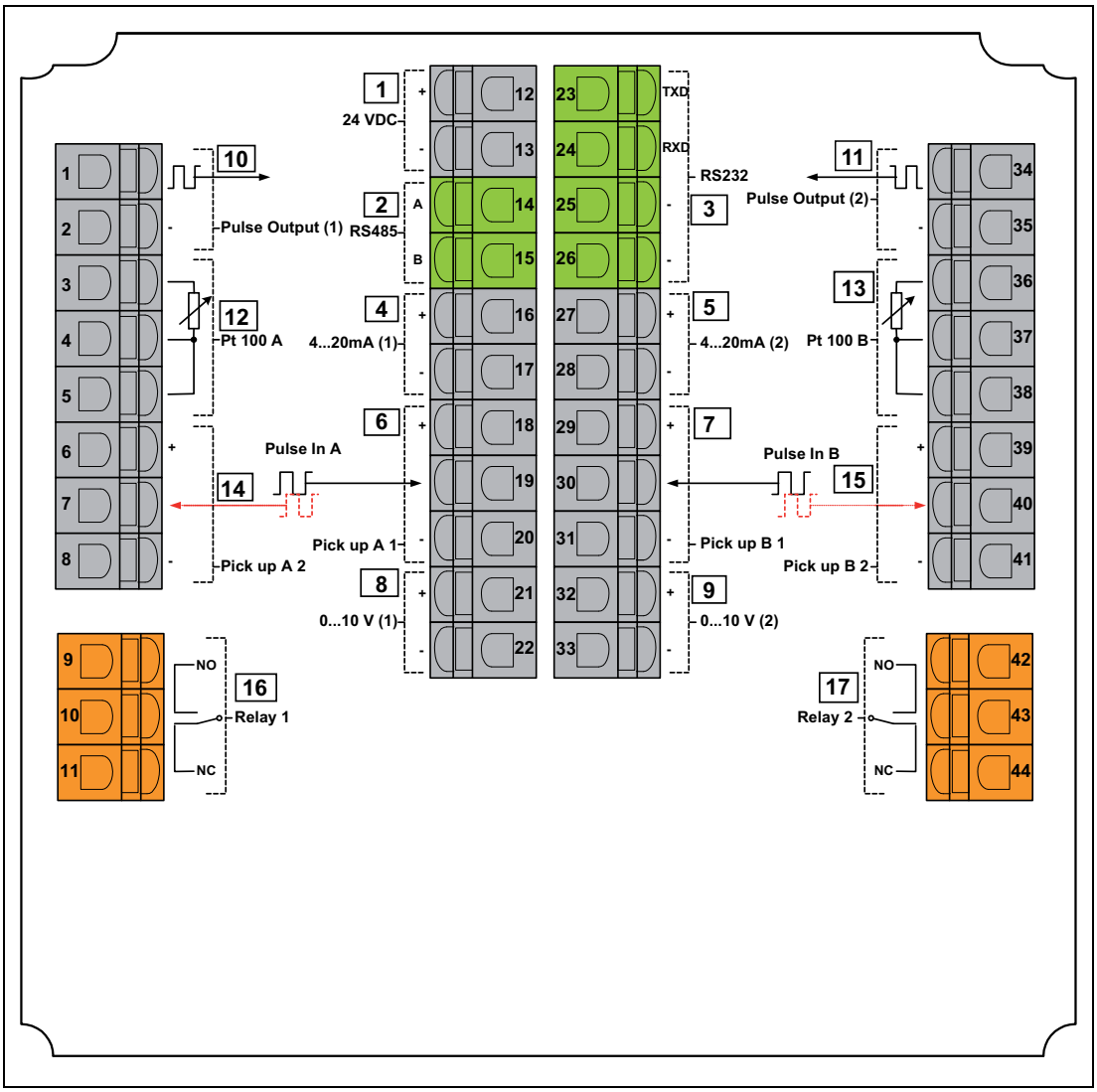


Fig. 1 Termination panel of the BEM 500 electronic unit

1 Power supply 24 V DC
2 Bus interface RS 485
3 Serial interface RS 232
4 Analog output 1 4–20 mA
5 Analog output 2 4–20 mA
6 Pick up A1
7 Pick up B1
8 Analog output 1 0–10 V
9 Analog output 2 0–10 V
10 Pulse output 1 24 V
11 Pulse output 2 24 V
12 Temperature input A Pt100
13 Temperature input B Pt100
14 Pick up A2
15 Pick up B2
16 Relay output 1 bypass valve or filling valve
17 Relay output 2 collective error message

The bus is connected via terminals. The assignment of the terminals is shown in the wiring diagram. The address of the electronic unit at the Modbus can be selected per software, see "3.19 Address Modbus", page 44.

Technical data of connections

Power supply

Designation	Data
Power supply	☐ Range 24 V DC ± 20%
Max. current consumption	☐ 0.5 A
Insulation voltage	☐ < 500 V

Tension spring terminals

Cable type	Terminating range
Strand	☐ 0.08 – 2.5 mm^2
Litz wires	☐ 0.08 – 2.5 mm^2
Wire end ferrule	☐ 0.25 – 1.5 mm^2

Pulse and temperature inputs

Component	Data
Pulse inputs	☐ Minimum limit frequency 0.3 Hz ☐ Maximum limit frequency 20 kHz ☐ Power supply for pick up 24 V DC or Namur 8.2 V ☐ Input impedance ▪ Namur: 1 kΩ ▪ 24 V DC: 3.2 kΩ ☐ Switching threshold/hysteresis ▪ Namur: 1.65 V/0.2 V ▪ PNP or NPN: 4.5 V/0.2 V ☐ Can be configured for counter or encoder mode ☐ Minimum chronological phase shift for direction detection in encoder mode: 0.2 µs
Temperature inputs	☐ Three-wire Pt100 ☐ Range -40 °C...+200 °C ☐ Resolution: 0.1 °C

Analog, pulse and relay outputs

Component	Data
Analog outputs 4–20 mA	☐ Active current sources ☐ Short-circuit proof ☐ Load < 500 Ω ☐ Electrical isolation: 500 V_{eff} ☐ Resolution: 1 µA ☐ Scalable ☐ Temperature drift: ± 0.1% ☐ Calibration tolerance: ± 0.1% ☐ Reaction time: 20 ms x smoothing value

Technical data of connections

Component	Data
Analog outputs 0–10 V	☐ Active voltage sources ☐ Short-circuit proof ☐ Load > 500 Ω ☐ Resolution: 1 mV ☐ Scalable ☐ Temperature drift: ± 0.1% ☐ Calibration tolerance: ± 0.1% ☐ Reaction time: 20 ms x smoothing value
Pulse outputs	☐ Active pulse sources (PNP transistor switches power supply) ☐ Maximum output current: 20 mA ☐ Short-circuit proof ☐ Load > 1 kΩ ☐ Scalable ☐ Signal level at 24 V DC power supply: ▪ High > 20 V DC ▪ Low < 1 V DC ☐ Flow direction detection in the "Encoder" mode possible ☐ Pulse width (high) adjustable from 2–200 ms ☐ Max. output frequency at pulse width 2 ms: ▪ Mode "Independent": 250 Hz ▪ Mode "Encoder": 125 Hz
Relay outputs	☐ Potential-free change-over contact ☐ Nominal load voltage: 250 V AC/30 V DC ☐ Switching current, ohmic: 6 A AC/DC ☐ Switching current, inductive: 2 A AC/DC ☐ Fuse protection by customer required ☐ Switching time: max. 8 ms ☐ Switching cycles: min. 30000

Display

Designation	Data
Text display	☐ 4 lines/20 characters
Updating rate	☐ 100 ms
Background illumination	☐ 10 levels, can be adjusted via software
Contrast	☐ 10 levels, can be adjusted via software
Language selection	☐ German ☐ English ☐ French ☐ Spanish

Modbus interface

Designation	Data
Interface type	☐ RS 232 (SLAVE) ☐ RS 485 (SLAVE)
Baud rate	☐ 9600 bauds
Data format	☐ 8N1 (8 data bit, no parity, 1 stop bit)
Protocol	☐ Modbus RTU
Processor cycle time	☐ 20 ms

Technical data of connections

The following variables are available at the Modbus:

Menu no.	Variable designation	Data address in HEX	No. of words	Decimal places	Data value range	Explanation of data value	Data reading command to BEM in HEX
1.01	Consumption rate Q	4000	2	1...3	+/- 2147483647	Unit rate	0103 4000 0002 D1CB
1.02	Total 1	4002	2	1...3	+/- 2000000000	Unit total	0103 4002 0002 700B
	Total 2	4004	2	1...3	+/- 2000000000	Unit total	0103 4004 0002 900A
1.03	Volumeter A rate QA	4006	2	1...3	+/- 2147483647	Unit rate	0103 4006 0002 31CA
	Volumeter A temp. tA	4008	2	1	-400...3920	Unit temp.	0103 4008 0002 5009
1.04	Volumeter A total TA1	4100	2	1...3	+/- 2000000000	Unit total	0103 4100 0002 D037
	Volumeter A total TA2	4102	2	1...3	+/- 2000000000	Unit total	0103 4102 0002 71F7
1.05	Volumeter B rate QB	400C	2	1...3	+/- 2147483647	Unit rate	0103 400C 0002 11C8
	Volumeter B temp. tB	400E	2	1	-400...3920	Unit temp.	0103 400E 0002 B008
1.06	Volumeter B total TB1	4104	2	1...3	+/- 2000000000	Unit total	0103 4104 0002 91F6
	Volumeter B total TB2	4106	2	1...3	+/- 2000000000	Unit total	0103 4106 0002 3036
2.05	Unit rate	4016	1	0	1...23	see Tab. 2, page 19	0103 4016 0001 700E
2.06	Unit total	4015	1	0	1...9	see Tab. 3, page 19	0103 4015 0001 800E
2.07	Unit temperature	4017	1	0	1...2	see Tab. 4, page 20	0103 4017 0001 21CE
2.10	No. of decimal places	4186	1	0	1...3	see Tab. 5, page 20	0103 4186 0001 71DF

Tab. 1 Variables at the Modbus

Notice: The display values in menus 1.01 to 1.06 are signed 32 bit integer values. With double words, the most significant word is always sent first.

Value	Meaning	Value	Meaning	Value	Meaning
1	l/sec	9	lb/sec	17	galUK/h
2	l/min	10	lb/min	18	m³/min
3	l/h	11	lb/h	19	m³/h
4	kg/sec	12	galUS/sec	20	g/sec
5	kg/min	13	galUS/min	21	g/min
6	kg/h	14	galUS/h	22	ml/sec
7	t/min	15	galUK/sec	23	ml/min
8	t/h	16	galUK/min		

Tab. 2 Data values unit rate

Value	Meaning	Value	Meaning	Value	Meaning
1	l	4	lb	7	m³
2	kg	5	galUS	8	g
3	t	6	galUK	9	ml

Tab. 3 Data values unit total

Technical data of connections

Value	Meaning	Value	Meaning	Value	Meaning
1	°C	2	°F		

Tab. 4 Data values unit temperature

Value	Meaning
1	1 decimal place, meaning all values with 1...3 decimal places must be divided by 10 (10^1) to get the actual value.
2	2 decimal places, meaning all values with 1...3 decimal places must be divided by 100 (10^2) to get the actual value.
3	3 decimal places, meaning all values with 1...3 decimal places must be divided by 1000 (10^3) to get the actual value.

Tab. 5 Data values number of decimal places

Example for Total TA1:
Data reading command to BEM (query): 0103 4100 0002 D037
Response from BEM: 0103 0400 0160 9E02 5B

Value	Meaning
0103 0400 0160 9E...	01 = Modbus address 1
01**03** 0400 0160 9E...	03 = Read holding registers function
0103 **04**00 0160 9E...	04 = Response of BEM consists of 4 bytes: **00** 0160 9E 1. Data byte 0 * 2^{28} + 0 * 2^{24} = 0 00 **01**60 9E 2. Data byte 0 * 2^{20} + 1 * 2^{14} = 65536 00 01**60** 9E 3. Data byte 6 * 2^{12} + 0 * 2^{8} = 24576 00 0160 **9E** 4. Data bite 9 * 2^{4} + 14 * 2^{0} = 158 => The Modbus value therefore corresponds to the total 90270

Tab. 6 Example for Total TA1

If the value of a data query for data address 4186 = 2 (see Tab. 5, page 20), the Modbus value must be divided by 100. The result is then 902.7.
If the value of a data query for data address 4015 = 5 (see Tab. 3, page 19), the unit is total galUS. The end result for Total TA1 is therefore 902.7 galUS.

Notice: Because data addresses begin with 0 and register addresses with 1, when determining the register address the value 1 must always be added, e.g. data address 4000 = register address 4001.

Notice: All units and the number of decimal places (menu no. 2.05 to 2.10, see Tab. 1, page 19) should be read out at least during initialization of the evaluation device, i.e. during switch-on, because these values can also be manually modified.

Notice: For parameter settings of the BEM with the Modbus, Modbus function 10 can be used: 10 (hex) = write holding register (preset multiple register).
Data exchange via the bus connection is not password-protected. Avoid unintended overwriting of the total or parameter addresses!

Notice: All data can be read out or written in packages of up to 64 words.

Resetting of the total values via the Modbus:
Command reset Total consumption T1: 0110 4002 0002 0400 0000 0043 B5
Command reset Total consumption T2: 0110 4004 0002 0400 0000 00C3 9F

Ambient conditions

Criterion	Data
Storage temperature	☐ Range -20...+80 °C
Operating temperature	☐ Range -20...+70 °C
Humidity	☐ 97% relative humidity, non-condensing
EMC emitted interference and immunity to interference	☐ EN 61326
Vibration	☐ EN 60068–2–47 ☐ EN 60068–2–64
Shock	☐ EN 61373
Isolation	☐ > 500 V
Degree of protection	☐ IP 65

Connection assignments

Pick up Volumeter A

Connection	PNP/NPN	Namur	Terminal
Pick up A1	U+24 V DC	U+8.2 V DC	18
	Signal	Signal	19
	Gnd	—	20
Pick up A2 (+ 90°)	U+24 V DC	U+8.2 V DC	6
	Signal	Signal	7
	Gnd	—	8

Pick up Volumeter B

Connection	PNP/NPN	Namur	Terminal
Pick up B1	U+24 V DC	U+8.2 V DC	29
	Signal	Signal	30
	Gnd	—	31
Pick up B2 (+ 90°)	U+24 V DC	U+8.2 V DC	39
	Signal	Signal	40
	Gnd	—	41

Analog outputs

Connection	Function	Terminal
Analog output 1 4–20 mA	Signal	16
	Gnd	17
Analog output 2 4–20 mA	Signal	27
	Gnd	28
Analog output 1 0–10 V	Signal	21
	Gnd	22
Analog output 2 0–10 V	Signal	32
	Gnd	33

The data logger can be connected to the analog outputs, see "Data acquisition accessories", page 59. Either the analog outputs 4–20 mA or 0–10 V can be controlled.

Connection assignments

Pulse outputs

Connection	Function	Terminal
Pulse output 1	Signal	1
	Gnd	2
Pulse output 2	Signal	34
	Gnd	35

The data logger can be connected to these connections, see "Data acquisition accessories", page 59.

Relay outputs

Connection	Function		Terminal
Relay output 1: Bypass valve or filling valve	NO contact	NO	9
	Switching contact		10
	NC contact	NC	11
Relay output 2: Collective error message	NO contact	NO	42
	Switching contact		43
	NC contact	NC	44

Temperature sensor Volumeter A

Connection	Function	Terminal
Temperature sensor Volumeter A	Signal	3
	Common	4
	Common	5

Temperature sensor Volumeter B

Connection	Function	Terminal
Temperature sensor Volumeter B	Signal	36
	Common	37
	Common	38

24 V DC connection

Different power supply units are available as accessories, see "Accessories electrical connection", page 56. These are connected here.

Connection	Terminal
+24 V DC	12
Gnd	13

Serial interface

Interface	Function	Terminal
RS 485	A	14
	B	15
RS 232	TxD	23
	RxD	24
	Gnd	25

Safety instructions for commissioning

The following safety instructions must be observed during commissioning:
☐ The following qualifications are required for commissioning: ▪ Practical electrotechnical training ▪ Knowledge of the safety guidelines at the workplace ▪ Knowledge of the electrotechnical safety guidelines

Connecting cables

Safety instructions for electrical installation

The following safety instructions must be observed during the electrical installation:
☐ The following qualifications are required for the electrical connection: ▪ Practical electrotechnical training ▪ Knowledge of the safety guidelines at the workplace ▪ Knowledge of the electrotechnical safety guidelines ☐ The connecting lines of the sensor connections are to be shielded and laid separately from the supply and measuring lines. ☐ Ensure that the supply voltage is correct (24 V DC).

DANGER
Risk of death resulting from electric shock if the connection of hazardous potentials (> 48 V) to the potential-free relay outputs (orange terminals 9–11 and/or 42–44) is required.

► Before wiring these potential-free relay switch contacts, ensure that all wires for this purpose are potential-free.

► Connect the consumer and power supply in the electronic unit,
see "Connect the pick ups and temperature sensors", page 25 and
see "Connecting the analog, relay and pulse outputs", page 25 and
see "Connecting the power supply", page 26.

Connecting cables

Connecting cables to the tension spring terminals

Prerequisite:

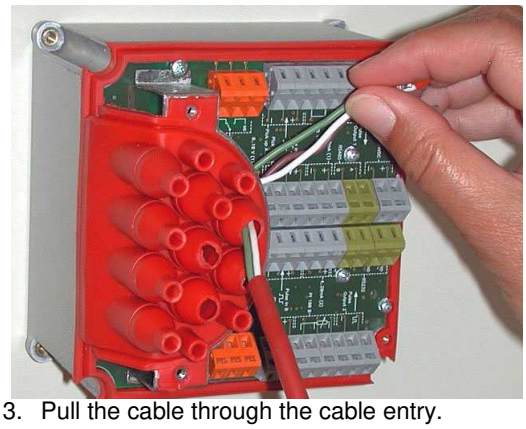
- ☐ Cable shortened to correct length
- ☐ All wires stripped to approx. 5 mm

Aids

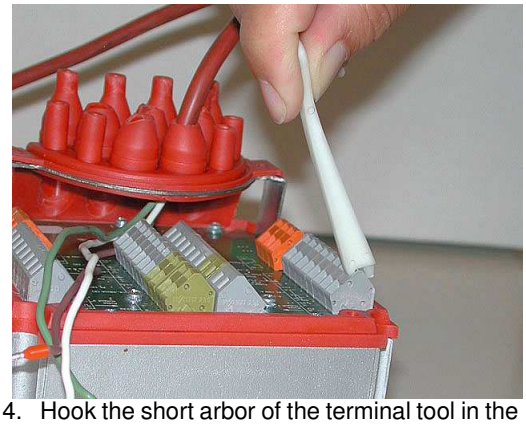
- ☐ KRAL tool set
- ☐ Diagonal cutter

1. Remove the rear device cover and remove the terminal tool.

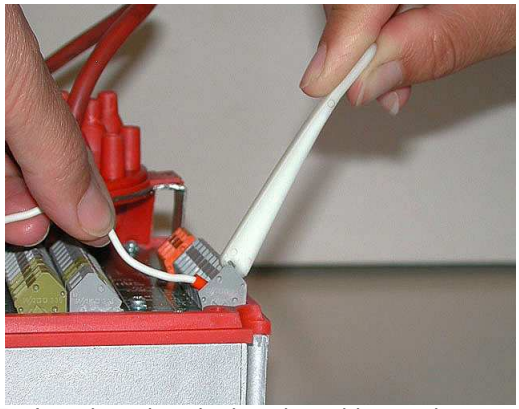
2. Use the diagonal cutter to adapt the cable entry to the cable diameter.



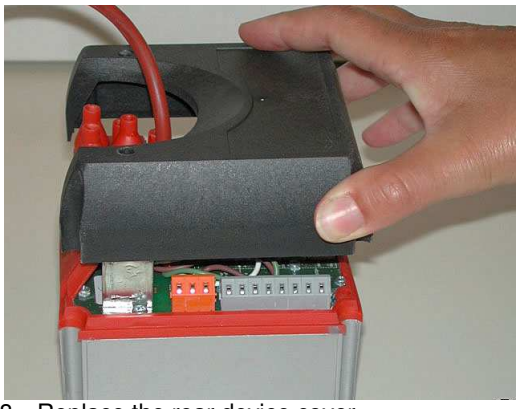
3. Pull the cable through the cable entry.



4. Hook the short arbor of the terminal tool in the tension spring terminal. Press the terminal tool from the cable opening.
   The tension spring terminal is released.



5. Introduce the wire into the cable opening.
6. Remove the terminal tool.
7. Repeat Steps 4 to 6 for all the wires.



8. Replace the rear device cover.

Connect the pick ups and temperature sensors

Prerequisites:
- ☐ Pick ups for both volumeters are mounted
- ☐ Temperature sensors for both volumeters are mounted

Aids:
- ☐ KRAL tool set
- ☐ Diagonal cutter

CAUTION
Damage to equipment through incorrect connection of temperature inputs (terminals 3–5 and/or 36–38).

► Before connecting the electronic unit to the power supply, ensure that all consumers (temperature sensors, pick ups) are connected correctly, see wiring diagram.

1. Remove the rear device cover.
2. Adapt the cable entry to the cable diameter and cut it to length, see "Connecting cables to the tension spring terminals", page 24.
3. Pull the cables of the sensors through the cable entries.
4. Connect the cables for pick ups of Volumeter A in accordance with the wiring diagram on the electronic unit, see "Pick up Volumeter A", page 21.
5. Connect the cables for pick ups of Volumeter B in accordance with the wiring diagram on the electronic unit, see "Pick up Volumeter B", page 21.
6. Connect the cables for temperature sensor(s) on Volumeter A or Volumeter B.
7. Check the resistance values on the cable for temperature sensor(s) on the side of the electronic unit, see Tab. 1, page 25, and see "Notes" in the supplied wiring diagram.
8. Connect the cables for temperature sensor(s) in accordance with the wiring diagram on the electronic unit, see "Temperature sensor Volumeter A", page 22, and see "Temperature sensor Volumeter B", page 22.
9. Replace the rear device cover.

Check between	Resistance
Compensation cables	< 1 Ω
Measuring lines Pt100	Depending on temperature: 100 Ω (0 °C) – 150 Ω (130 °C)

Tab. 1 Resistance values on temperature sensor(s)

Connecting the analog, relay and pulse outputs

Aids:
- ☐ KRAL tool set
- ☐ Diagonal cutter

DANGER
Risk of death resulting from electric shock if the connection of hazardous potentials (> 48 V) to the potential-free relay outputs (orange terminals 9–11 and/or 42–44) is required.

► Before wiring these potential-free relay switch contacts, ensure that all wires for this purpose are potential-free.

Connecting cables

CAUTION
Damage to equipment through incorrect wiring of analog or pulse outputs.

► Do not supply the analog or pulse outputs with voltage (active outputs!).

1. Remove the rear device cover.
2. Adapt the cable entry to the cable diameter and cut it to length, see "Connecting cables to the tension spring terminals", page 24.
3. Pull the cables for the analog, relay and pulse outputs individually through the cable entries.
4. Connect the cables for the analog, relay and pulse outputs according to the wiring diagram, see "Connection assignments", page 21.
5. Lay the cables for the analog, relay or pulse outputs to the consumer.
6. Connect the consumer.
7. Replace the rear device cover.

Connecting the power supply

Prerequisites:
☐ All sensors are correctly connected

Aids:
☐ KRAL tool set
☐ Diagonal cutter

CAUTION
Damage to equipment through incorrect wiring of consumer inputs.

► Before connecting the electronic unit to the power supply, ensure that all consumers (temperature sensors, pick ups) are connected correctly, see wiring diagram.

1. Remove the rear device cover.
2. Adapt the cable entry to the cable diameter and cut it to length, see "Connecting cables to the tension spring terminals", page 24.
3. Ensure that the system is de-energized.
4. Pull the supply cable (24 V DC) through the cable entry.
5. Connect the supply cable (24 V DC).
6. Connect the supply cable (24 V DC) to the power supply of the system.
7. Replace the rear device cover.
   The electronic unit is ready to operate.

Checking the electronic unit

Test	Procedure
Installation	► Check that the electronic unit is seated firmly. ► For wall and pipe mounting as well as mounting on volumeter: ensure that the rear device cover and cable entries seal properly.
Electrical installation	1. Ensure that the system is de-energized. 2. Remove the rear device cover. 3. Check that the wiring of the power supply at the termination panel is firm. 4. Check the connection of the power supply to the system. 5. Check the numbering of the pick ups. 6. Check the assignment of the sensors. 7. Check the sensor connections, see supplied wiring diagram.
Function test	Temperature sensor: 1. Disconnect the cables to connections 3, 4 and 5 or 36, 37 and 38 of the electronic unit. 2. Check the resistance, see Tab. 1, page 25 and consult "Notes" in the supplied wiring diagram.
	Electronic unit: ► Switch on the power supply. The start message is displayed on the display unit. At the latest after 3 seconds the "1.01 Display consumption" page is displayed.

Taking the electronic unit out of operation

DANGER
Risk of death resulting from electric shock.

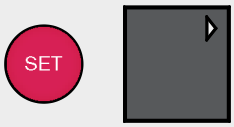
► The electronic unit may only be separated from the power supply by an authorized electrician.

► Switch off the supply voltage of the system.

Notice: All the settings and total values are retained when the electronic unit is switched off or the power supply fails. After operation is resumed, instantaneous values (Q, Temp) are recalculated.

Key assignment

The electronic unit is operated by means of five keys.

Key/combination	Designation	Function
	SET	☐ Confirmation of the entry ☐ Resetting of total values ☐ Confirmation of the selection
	ARROW UP	☐ Change to the following page of the menu ☐ Select the previous unit ☐ Increase the digit
	ARROW DOWN	☐ Change to the previous page of the menu ☐ Select the next unit ☐ Decrease the digit
	ARROW RIGHT	Navigate one menu higher
	ARROW LEFT	Navigate one menu lower
	ARROW LEFT + ARROW RIGHT	Help on operation
	SET + ARROW RIGHT	Selecting the language
	SET + ARROW LEFT	Call up alarms
	ARROW UP + ARROW DOWN	Changes to page "1.01 Consumption display"
	SET + ARROW UP	Increases the brightness of the display
	SET + ARROW DOWN	Decreases the brightness of the display

Tab. 1 Key functions

Operation at a glance

Operation at a glance

General operating steps

The following table describes the input and modification of the password as well as general operating steps, such as the changing of values and units. The password is included in the scope of delivery and consists of four digits.

Aim	Operating steps
Entering the password see "2.01 Enable password", Page 36	1. Select Page 2.01. 2. Press SET. The "1.30 Enter Password" page is displayed. 3. The flashing cursor indicates the active input field. Use ARROW RIGHT/ARROW LEFT to change the position within the digit input. 4. Use ARROW UP/ARROW DOWN to increase or decrease digits. 5. Repeat Steps 3 and 4 for all the digits. 6. Press SET. The password is deactivated. Entries are possible. 7. Repeat Steps 1–3 to activate the password.
Change the password see "2.02 Change password", Page 37	1. Enter the password, see above. 2. Use ARROW UP to change to the page "2.02 Setting Change Password". 3. Press SET. 4. Use ARROW UP to change the input to "Yes". 5. Press SET. 6. Enter a new password. 7. Press SET. The new password is accepted.
Enter a value	1. Enter the password, see above. 2. Change to the desired page. 3. Press SET. The flashing cursor indicates the active input field. 4. Use ARROW RIGHT/ARROW LEFT to change the position within the digit input. 5. Use ARROW UP/ARROW DOWN to increase or decrease digits. 6. Repeat Steps 3 and 4 for all the digits. 7. Press SET. The value is entered.
Enter a minus sign	1. Use ARROW LEFT to select the first position to the left of the first digit. 2. Press ARROW DOWN until the minus sign is displayed. 3. Press SET. The minus sign is accepted.
Change the unit	1. Enter the password, see above. 2. Change to the desired page. 3. Press SET. The active input field is marked. 4. Use ARROW UP/ARROW DOWN to change the unit. 5. Press SET. The unit is changed.

Tab. 2 General operating steps

Operation at a glance

Operating the basic functions

The following table describes the basic operating steps. They can be carried out in part without a password having to be entered.

Aim	Operating steps
Reading the consumption see "1.01 Consumption", Page 34	► Press ARROW UP and ARROW DOWN simultaneously. "Consumption " is displayed.
Resetting totals see "1.02 Total with reset", Page 34, see "1.04 Volumeter A Total with reset", Page 35 or see "1.06 Volumeter B Total with reset", Page 35	1. Select menu 1.02, 1.04 or 1.06. 2. Press SET. Total 1 flashes. 3. Press SET for 3 seconds. Total 1 is set to 0. 4. Press SET. Total 2 flashes. 5. Press SET for 3 seconds. The password prompt is displayed. 6. Enter the password and press SET. Total 2 is reset.
Select the language see "1.13 Setting select language", Page 34	1. Press SET and ARROW RIGHT simultaneously. "Language selection" is displayed. 2. Press SET. 3. Press ARROW DOWN/ARROW UP to select the language. 4. Press SET. The language is selected. After you have navigated to a different page, the language is used in the display.
Calling up help see "1.31 Help operation", Page 34	1. Press ARROW RIGHT and ARROW LEFT simultaneously. Information about the operation is displayed. 2. Scroll using ARROW UP/ARROW DOWN. 3. Use SET to exit the page.
Checking the selection of the density table see "2.09 Select density determination", Page 38	1. Press ARROW LEFT/ARROW RIGHT to access menu 2. 2. Use ARROW UP/ARROW DOWN to scroll to Page 2.08. The selected density table is displayed.
Checking the values of a density table see "Menu 6: Density table 1/ Density determination", Page 44 or see "Menu 7: Density table 2", Page 45	1. Press ARROW LEFT/ARROW RIGHT to access menu 6 or 7. 2. Use ARROW UP/ARROW DOWN to select the desired page of the density table. The density or temperature value is displayed.
Checking the values for the K-factors see "Menu 4: K-factors Volumeter A", Page 44 or see "Menu 5: K-factors Volumeter B", Page 44	1. Press ARROW RIGHT/ARROW LEFT in order to access menu 4 "K-factors Volumeter A". 2. Use ARROW UP/ARROW DOWN to select the pages of the individual K-factors Volumeter A. 3. Check the K-factors Volumeter A. 4. Press ARROW RIGHT/ARROW LEFT in order to access menu 5 "K-factors Volumeter B". 5. Check the K-factors Volumeter B.

Tab. 3 Operating the basic functions

Abbreviations, quantities and units

Abbreviations used

Abbreviation	Meaning
Q	Current consumption QA-QB
Q_{rated}	Nominal flow rate
T1	Total consumption since last reset, without password protection
T2	Total consumption since last reset, with password protection
QA	Current flow Volumeter A (supply line)
QB	Current flow Volumeter B (return line)
Temp.	Temperature
TA1	Total flow Volumeter A since last reset, without password protection
TA2	Total flow Volumeter A since last reset, with password protection
TB1	Total flow Volumeter B since last reset, without password protection
TB2	Total flow Volumeter B since last reset, with password protection
G1	Limit value Relay 1
Rho	Density
f	Frequency
K	K-factor

Tab. 4 Overview of the used abbreviations

Quantities and units

In order to make extensive conversions by the user superfluous, various country-specific units and quantities of a unit are available for the display.

Quantity	Units
Volume	ml, l, galUS, galUK, m^3
Masses	g, kg, t, lb
Flow, volumetric	ml/s, ml/min, l/s, l/min, l/h, galUS/s, galUS/min, galUS/h, galUK/s, galUK/min, galUK/h, m^3/min, m^3/h
Flow, mass-specific	g/s, g/min, kg/s, kg/min, kg/h, t/min, t/h, lb/s, lb/min, lb/h
Temperature	°C, °F
Density	kg/m^3, lb/galUS, lb/galUK
Frequency	Hz
K-factor	P/l

Tab. 5 Overview of the quantities and units

Pulse signals

The following signals are available:

- ☐ PNP
- ☐ Namur
- ☐ NPN

Either PNP or NPN can be selected for push-pull pick ups, see "2.12 Function pick up", Page 38.

Menu structure

	Menu	Page (information)
1	Display	☐ 1.00 Information ☐ 1.01 Consumption ☐ 1.02 Total ☐ 1.03 Volumeter A ☐ 1.04 Volumeter A Total ☐ 1.05 Volumeter B ☐ 1.06 Volumeter B Total ☐ 1.07 Batch quantity ☐ 1.08 Flow direction change Volumeter A ☐ 1.09 Flow direction change Volumeter B ☐ 1.10 Reset bypass and collective error message ☐ 1.11 Setting display brightness ☐ 1.12 Setting display contrast ☐ 1.13 Setting select language
2	General settings	☐ 2.01 Enable password ☐ 2.02 Change password ☐ 2.03 Select mode ☐ 2.04 Select temperature X ☐ 2.05 Select unit rate ☐ 2.06 Select unit total ☐ 2.07 Select unit temperature ☐ 2.08 Select unit density ☐ 2.09 Select density determination ☐ 2.10 Number of decimal places ☐ 2.11 Display start message ☐ 2.12 Function pick up ☐ 2.13 Function pulse inputs ☐ 2.14 Link channel ☐ 2.15 Threshold value A-B ☐ 2.16 Averaging display rate ☐ 2.17 Deactivate alarm messages ☐ 2.18 Maximum flow rate error message ☐ 2.19 Minimum temperature Volumeter ☐ 2.20 Maximum temperature Volumeter ☐ 2.21 Reset to factory settings
3	Output settings	☐ 3.01 Function analog output ☐ 3.02 Allocation analog output 1 ☐ 3.03 Scale analog output 1 ☐ 3.04 Allocation analog output 2 ☐ 3.05 Scale analog output 2 ☐ 3.06 Averaging analog output ☐ 3.07 Function pulse output ☐ 3.08 Allocation pulse output 1 ☐ 3.09 Scale pulse output 1 ☐ 3.10 Allocation pulse output 2 ☐ 3.11 Scale pulse output 2 ☐ 3.12 Pulse output pulse width ☐ 3.13 Function relay 1

	Menu	Page (information)
		☐ 3.14 Limit value bypass ☐ 3.15 Time delay bypass ☐ 3.16 Waiting period repeat bypass ☐ 3.17 Relay 1 switch ☐ 3.18 Relay 2 switch ☐ 3.19 Address Modbus
4	K-factors Volumeter A	☐ 4.01 Volumeter A Point 1 ☐ ... ☐ 4.07 Volumeter A Point 7
5	K-factors Volumeter B	☐ 5.01 Volumeter B Point 1 ☐ ... ☐ 5.07 Volumeter B Point 7
6*	Density table 1/Density calculation	☐ 6.01 Point 1 ☐ ... ☐ 6.10 Point 10 ☐ 6.20 Density calculation
7*	Density table 2	☐ 7.01 Point 1 ☐ ... ☐ 7.10 Point 10
8	Alarms	☐ 8.00 No alarm ☐ 8.01 Alarm ☐ 8.02 Alarm ☐ ... ☐ 8.21 Alarm

Tab. 1 Menu structure

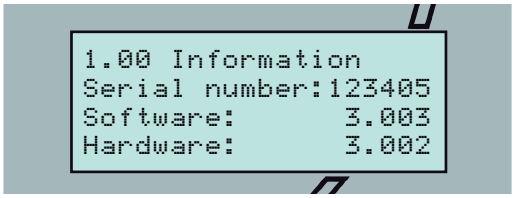
* Display depends on selection of density determination, see "2.09 Select density determination", page 38.

Note: The displayed numerical values and settings can deviate from the actual values and are only used as representative values here.

Start

After the power supply has been switched on, a start message indicates that the electronic unit is ready to operate. The display of the start message can be activated or deactivated, see "2.11 Display start message", page 38.

Start message



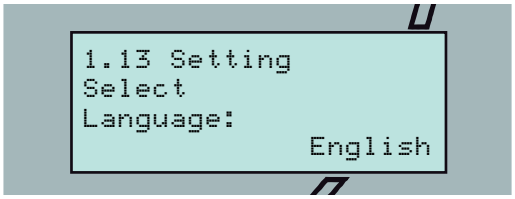
If the display of the start message is activated, it is displayed for three seconds. This is followed directly by the page "Consumption".

Shortcut pages

The following pages can be called up from the various windows as required by means of key combinations, see "Key assignment", page 28.

1.13 Setting select language

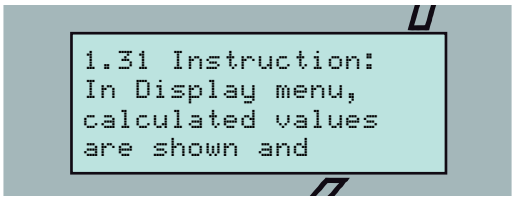
Shortcut: Press SET and ARROW RIGHT simultaneously.



1. Press SET.
2. Use ARROW UP or ARROW DOWN to select the desired language.
3. Press SET.
   The selected language is applied after a different page has been called up.

1.31 Help operation

Shortcut: Press ARROW LEFT and ARROW RIGHT simultaneously.



This page displays brief instructions for operating. Press ARROW UPor ARROW DOWNto navigate in the text. Use SET to exit the help.

Menu 8: Alarms

Shortcut: Press SET and ARROW LEFT simultaneously.

Use ARROW UPor ARROW DOWNto call up the existing alarms.

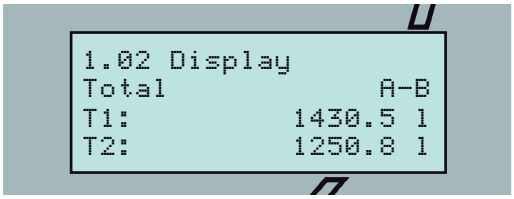
Menu 1: Display

Menu 1 "Display" displays the measured values. Totals can be reset here; the contrast and background illumination of the display can be set.

1.01 Consumption

The "Consumption" page displays the current consumption in the preset unit.
This page can be called up from any menu by simultaneously pressing the keys ARROW UP and ARROW DOWN.
When the direction of rotation changes, the displayed rate value can vary strongly. In this case the smoothing value of the display has to be increased, see "2.16 Averaging display rate", page 39.

1.02 Total with reset



The "Total" page displays the total consumption value since the last resetting.

Note: Depending on the number of decimal places the total value stops at the following minimum or maximum values:

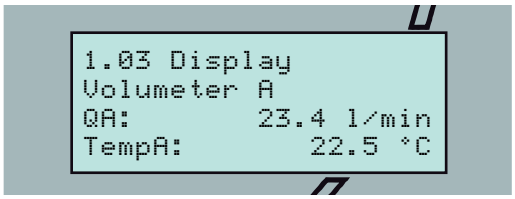
Number of decimal places	Minimum value	Maximum value
3	-1 999 999.999	1 999 999.999
1	-199 999 999.9	199 999 999.9

In order to avoid this a different unit can be selected or the number of decimal places reduced, see "Further faults", page 52.

Resetting the total values:

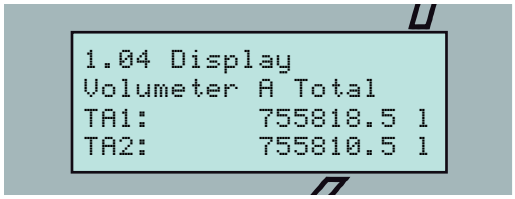
1. Press SET.
   T1 is selected.
2. Press SET for three seconds.
   The total value T1 is reset.
3. Press SET.
   T2 is selected.
4. Press SET for three seconds.
   The page for entering the password is displayed.
5. Enter the password and press SET.
   The total value T2 is reset.

1.03 Volumeter A



The flow rate and temperature in Volumeter A is displayed on the "Volumeter A" page.
If the temperature lies outside the permissible range or if a temperature sensor is not connected, "---,-" is displayed.
When the direction of rotation changes, the displayed rate value can vary strongly. In this case the smoothing value of the display has to be increased, see "2.16 Averaging display rate", page 39.

1.04 Volumeter A Total with reset



The "Volumeter A Total" page displays the total value of Volumeter A since the last resetting. Resetting of the value functions analog to menu item 1.02.

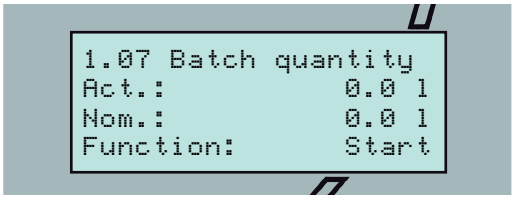
1.05 Volumeter B

Description analogous to menu item 1.03.

1.06 Volumeter B Total with reset

Description analogous to menu item 1.04.

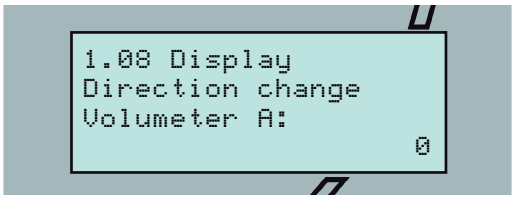
1.07 Batch quantity



This page is only displayed if the function "Relay 1" in menu 3.13 is set to "Batching", see "3.13 Function relay 1", page 42.

Line	Description
Act.	Current batch quantity
Nom.	The desired batch quantity can be set. 1. Press SET. 2. Use ARROW UP and ARROW DOWN to set the desired value. 3. Press SET. The cursor changes to the "Function" display.
Function	Press ARROW UP or ARROW DOWN to select the following options: ☐ "Start": Beginning of batching. When the set batch quantity is reached, batching is stopped automatically. After 3 seconds waiting period a further start is possible. ☐ "Stop": Interruption of batching before the set batch quantity has been reached. ☐ "Continue": Batching is continued. ☐ "Cancel": Batching is aborted. "Start" is displayed and a new batch process can be started. ► Press SET. The function is executed.

1.08 Flow direction change Volumeter A



On this page the number of flow direction changes of Volumeter A since the last reset is displayed.
Prerequisite: In menu 2.13 the pulse inputs function is set to "Encoder", see "2.13 Function pulse inputs", page 38. Resetting of the value functions analog to menu item 1.02.
Note: The counter can be increased in case of a voltage breakdown. We therefore recommend resetting the counter before beginning measuring.

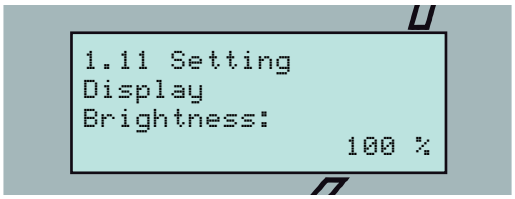
1.09 Flow direction change Volumeter B

Description analog to menu item 1.08.

1.10 Reset bypass and collective error message

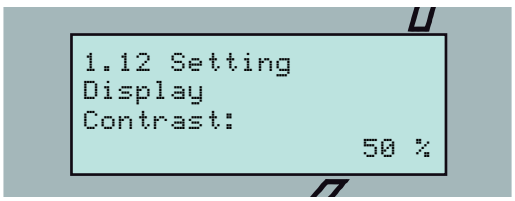
After the cause for the activation of the collective error message and of the bypass valve has been eliminated, this function is used for resetting.

1.11 Setting display brightness



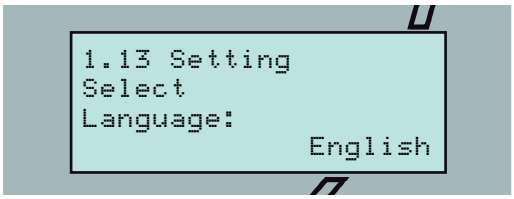
The brightness of the display is adjusted on this page.

1.12 Setting display contrast



The contrast of the display is adjusted on this page.

1.13 Setting select language

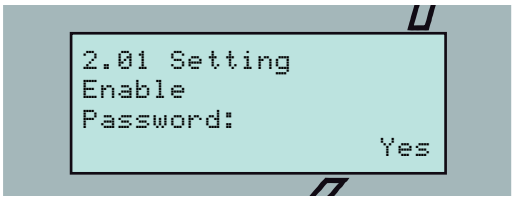


The language is selected on this page. The page can be called up via the shortcut, see "1.13 Setting select language", page 34.

Menu 2: General settings

Menu 2 allows general adjustments in accordance with the requirements of the measuring task. All the settings can only be changed after the password has been entered.

2.01 Enable password



Factory settings:
- ☐ Password: "1000"
- ☐ Password protection active (setting "Yes")

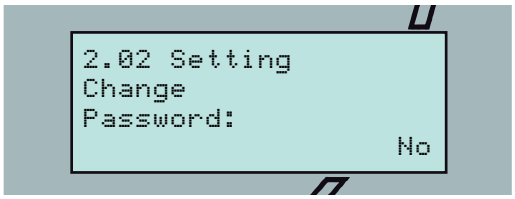
Setting	Meaning
Yes	☐ Password protection is active ☐ No changes possible
No	☐ Password protection is not active ☐ Changes are possible

Deactivate password protection:
1. Press SET.
   The password prompt is displayed.
2. Enter the password using the arrow keys, see "General operating steps", page 29.
3. Press SET.
   The password protection is deactivated: It is possible to change the setting.
   The password protection is reactivated automatically after approx. 30 minutes.

If the password is not active, "No" is shown in the display. The password can be activated at any time again by pressing the SET and ARROW UP or ARROW DOWN keys. This prevents unwanted changes by third parties.

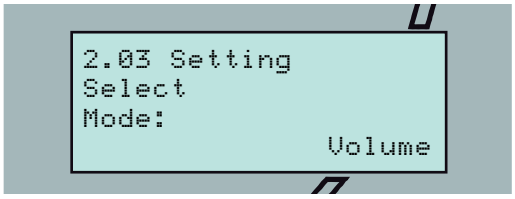
Menu 2: General settings

2.02 Change password



After the valid password has been entered, the password can be changed on this page.

2.03 Select mode

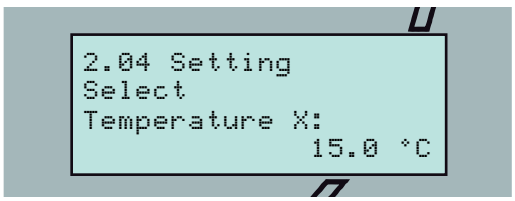


Selection of the mode is adjusted to the measuring task.

Setting	Meaning
Volume	Volumetric flow rate measurement without consideration of temperature influences.
Volume at X°	Q, QA or QB are converted with temperature and density table to mass. Then the density table is used to convert to Volume at X° that is also displayed in this form. The reference temperature X° can be selected freely, see "2.04 Select temperature X", page 37.
Volume at TempA	Calculates the consumption at the temperature Volumeter A. This temperature usually corresponds to the temperature of the fluid in the reservoir.

When a mass unit is selected, the system changes automatically to the mass calculation mode.

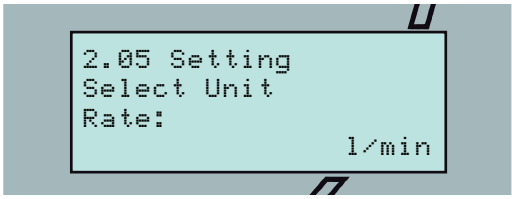
2.04 Select temperature X



The reference temperature is set in this dialog.

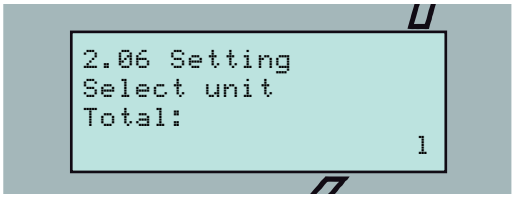
This setting is only effective if "Volume at X°" has been selected under "2.03 Select mode".

2.05 Select unit rate



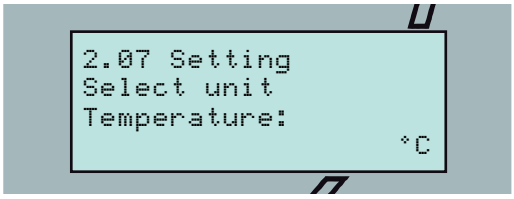
The unit of the rate can be selected in accordance with the requirements from a list.

2.06 Select unit total



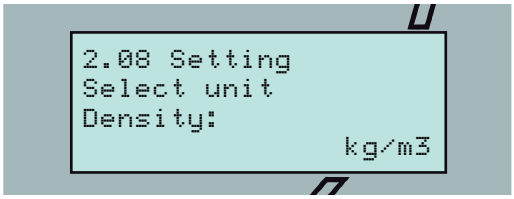
The unit of the total can be selected in accordance with the requirements.

2.07 Select unit temperature



The unit of the temperature can be selected in accordance with the requirements.

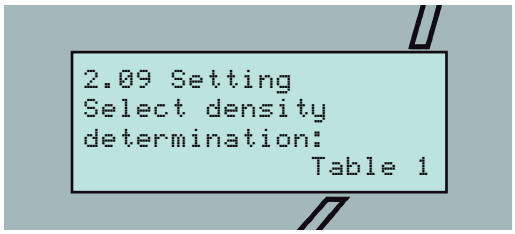
2.08 Select unit density



The unit of the density can be selected in accordance with the requirements.

Menu 2: General settings

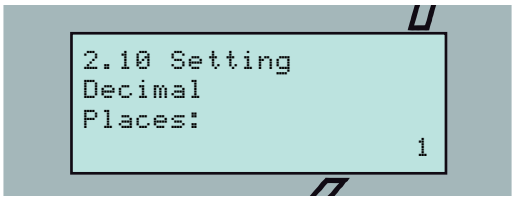
2.09 Select density determination



Setting	Description
Table 1	Select density table 1, see "6.01 Density table 1 Point 1", page 45
Table 2	Select density table 2, see "7.02 Point 1", page 46
Fuel oils calculation	Select density calculation for fuel oils, see "6.20 Density calculation", page 45

2 density tables are available for determining the density of 2 different liquids. Alternatively a density calculation for fuel oils can be carried out. If density calculation is selected, only menu item 6.20 is available.

2.10 Number of decimal places

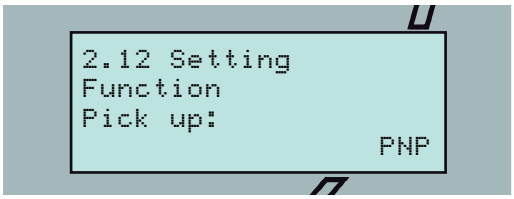


The number of decimal places can be selected on this page. 1 – 3 decimal places can be selected. Display without decimal place is not possible.

2.11 Display start message

The display of the start message can be activated or deactivated.

2.12 Function pick up



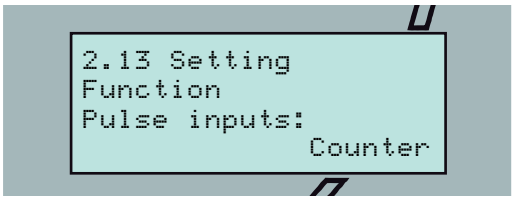
The setting of the pick up type has to be adapted to the pick up used.

Available signals:

- ☐ PNP
- ☐ Namur
- ☐ NPN

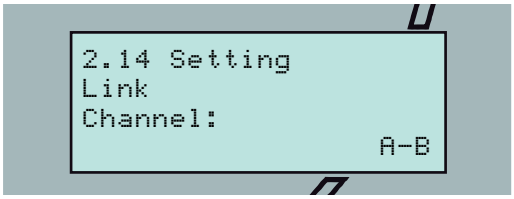
Either PNP or NPN can be selected for push-pull pick ups.

2.13 Function pulse inputs



If one pick up each is used per volumeter, the "Counter" function is selected. "Encoder" is used if the volumeter is equipped with 2 pick ups (flow direction detection option).

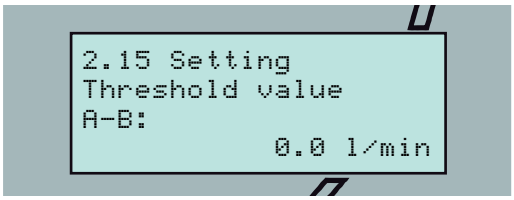
2.14 Link channel



The link can be selected when 2 volumeters are used:

- ☐ "A-B" is used for difference calculation (consumption measurement).
- ☐ "A+B" is used for sum calculation (combination of two measuring sections).

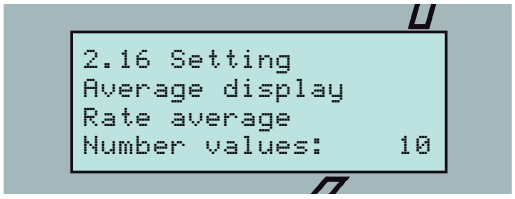
2.15 Threshold value A-B



The threshold value is required for consumption measurement when the consumer is switched off and the circulation pump continues to run. The threshold function is used to suppress small amounts resulting from measuring errors.
The threshold value should be selected clearly lower than the lowest possible consumption.

Setting Threshold value	Result
Threshold value = 0	Function is deactivated
Threshold > Consumption Q	☐ Display in menu 1.01 = 0 ☐ Totaling of T1 and T2 in menu 1.02 is stopped. All other values are not influenced!

2.16 Averaging display rate



In the case of fluctuating flow rates the use of averaging allows a stable display. Averaging can be adapted to the requirements with values between 1 and 10000. However, rapid changes are only displayed with a time delay.

Examples of reaction time for a change of 99.9% of the actual frequency jump:

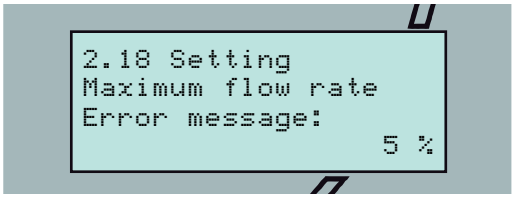
Averaging	Reaction time
0 or 1	0.02 s
2	0.04 s
9	0.18 s
10	1.5 s
500	75 s
1000	150 s
10000	1500 s

No filter is active for Averaging 0 and 1. In the case of Averaging 2–9 a continuous average-value generation is carried out. A V_Z1 filter is active at Averaging 10–10000. In the process the old measured value is weighted higher by the averaging value than the new measured value. Averaging of the display is also active on the Modbus.

2.17 Deactivate alarm messages

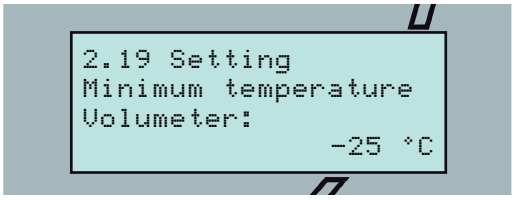
The display of alarm messages can be suppressed on this page.
Note: The collective error message is then also deactivated. The key combination SET and ARROW LEFT (Call up alarms) also becomes ineffective.

2.18 Maximum flow rate error message



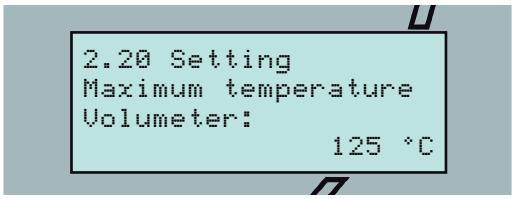
In this menu the percentage across Q_{rated} is entered, at which the alarm message "Maximum flow rate exceeded" is displayed. In this case Q_{rated} is always the flow rate at the highest still valid frequency of the linearization in enu 4 + 5.

2.19 Minimum temperature Volumeter



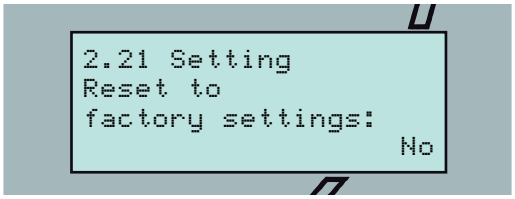
The lowest permissible operating temperature of the volumeter is specified in this menu. This temperature is limited mainly by the selection of the pick up. A drop below it results in a corresponding error message.

2.20 Maximum temperature Volumeter



The highest permissible operating temperature of the volumeter is specified in this menu. This temperature is limited mainly by the selection of the pick up. Exceeding results in a corresponding error message.

2.21 Reset to factory settings

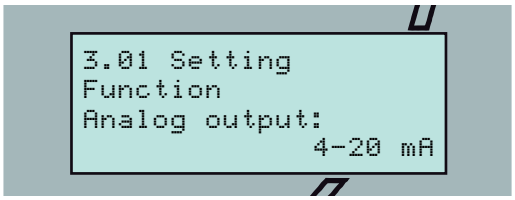


This function resets all the settings to the state of delivery.

Menu 3: Output settings

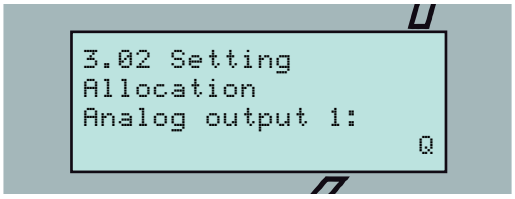
Menu 3 allows adjustment of the outputs in accordance with the requirements of the measuring task. All the settings can only be changed after the password has been entered.

3.01 Function analog output



The function of the analog output can be specified here. Either 2 units 4-20 mA or 2 units 0-10 V analog outputs are available.

3.02 Allocation analog output 1

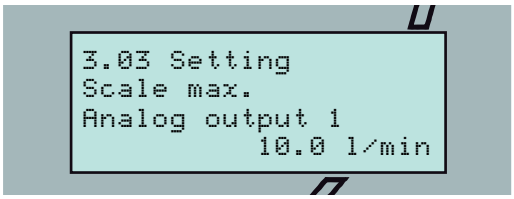


A total or rate value can be assigned freely to the Analog output 1.

Available values:

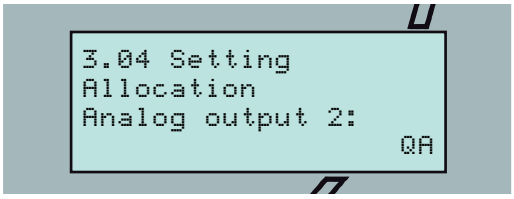
- ☐ Q Rate consumption A-B or A+B
- ☐ QA Rate current flow Volumeter A
- ☐ QB Rate current flow Volumeter B
- ☐ T1 Total consumption A-B or A+B
- ☐ TA1 Total flow Volumeter A
- ☐ TB1 Total flow Volumeter B

3.03 Scale analog output 1



The scale of the analog output is used to set the maximum value. The maximum value is set slightly higher than the highest possible occurring flow rate. If the value "0" is entered here, Analog output 1 is deactivated, so that 0 V or 4 mA respectively is output.

3.04 Allocation analog output 2



A total or rate value can be assigned freely to the Analog output 2.

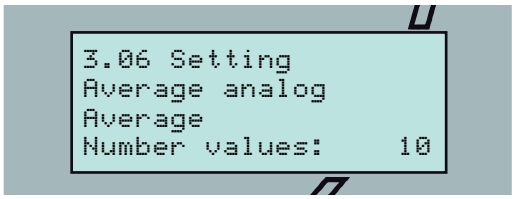
Available values:

- ☐ Q Rate consumption A-B or A+B
- ☐ QA Rate current flow Volumeter A
- ☐ QB Rate current flow Volumeter B
- ☐ T1 Total consumption A-B or A+B
- ☐ TA1 Total flow Volumeter A
- ☐ TB1 Total flow Volumeter B

3.05 Scale analog output 2

The scale of the analog output is used to set the maximum value. The maximum value is set slightly higher than the highest possible occurring flow rate. If the value "0" is entered here, Analog output 2 is deactivated, so that 0 V or 4 mA respectively is output.

3.06 Averaging analog output



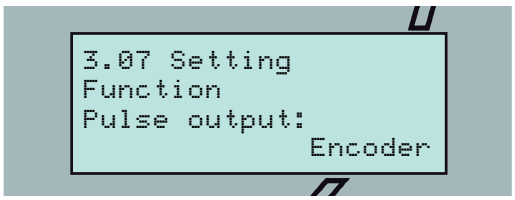
In the case of fluctuating flow rates the averaging allows a stable value at the analog output. Averaging can be adapted to the requirements with values between 1 and 10000. However, rapid changes are only displayed with a time delay.

Examples of reaction time for a change of 99.9 % of the actual frequency jump:

Averaging	Reaction time
0 or 1	0.02 s
2	0.04 s
9	0.18 s
10	1.5 s
500	75 s
1000	150 s
10000	1500 s

No filter is active for Averaging 0 and 1. In the case of Averaging 2–9 a continuous average-value generation is carried out. A V_Z1 filter is active at Averaging 10–10000. In the process the old measured value is weighted higher by the averaging value than the new measured value.

3.07 Function pulse output



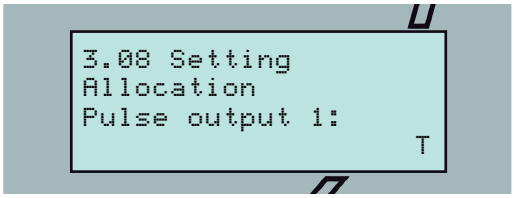
The two pulse outputs can be used independently of each other. To this purpose the setting "Independent" is selected. At the "Encoder" setting both pulse outputs supply two square wave signals out of phase by 90°. This passes on the information about the flow direction. At the "Encoder" setting the allocation of the second pulse output and its scale remains ineffective.
Note: After the setting has been changed, the electronic unit has to be restarted.

The BEM 500 can be used as a **Pulse selector** under the following prerequisites:

- ☐ Function pulse inputs = Encoder
- ☐ Function pulse outputs = Independent
- ☐ Occurrence of changes in direction of rotation

If reverse pulses occur at the pulse inputs, no pulses are output at the assigned pulse outputs. Instead up to 10 reverse pulses are stored in a reverse counter. As soon as forwards pulses are generated again, these are deducted from the counter level of the reverse counter until it shows "0" again. Only then are pulses output again at the pulse output in accordance with the scale.

3.08 Allocation pulse output 1



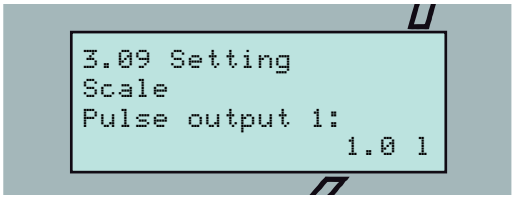
A total value can be assigned freely to the Pulse output 1.

Available total values:

- ☐ T Total consumption A-B or A+B
- ☐ TA Total flow Volumeter A
- ☐ TB Total flow Volumeter B

Note: After the setting has been changed, the electronic unit has to be restarted.

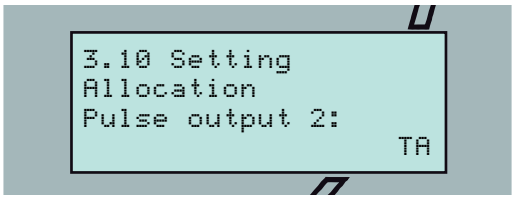
3.09 Scale pulse output 1



The scale of the pulse output is used to set the pulse significance. Since the pulse values can also be output in packets, we also recommend using the pulse output only for total values. If the value "0" is entered here, the pulse output is deactivated, so that no pulses are output.
Note: Select the scale so that the limit frequency of 250/125 Hz is not exceeded.
Note: After the setting has been changed, the electronic unit has to be restarted.

Menu 3: Output settings

3.10 Allocation pulse output 2



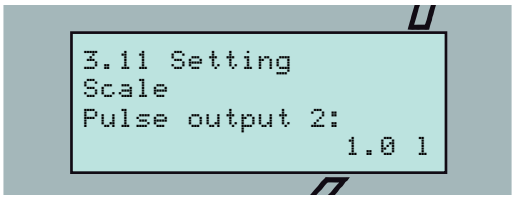
A total value can be assigned freely to the Pulse output 2.

Available total values:

- ☐ T Total consumption A-B or A+B
- ☐ TA Total flow Volumeter A
- ☐ TB Total flow Volumeter B

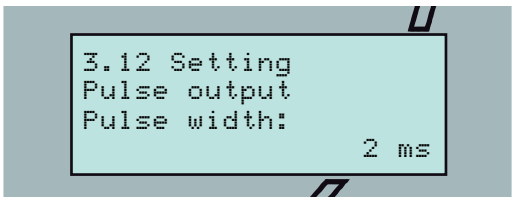
Note: This allocation is only effective with the setting Function pulse output "independent", see "3.07 Function pulse output", page 41.
Note: After the setting has been changed, the electronic unit has to be restarted.

3.11 Scale pulse output 2



The scale of the pulse output is used to set the pulse significance. Since the pulse values can also be output in packets, we also recommend using the pulse output only for total values. If the value "0" is entered here, the pulse output is deactivated, so that no pulses are output.
Note: Select the scale so that the limit frequency of 250/125 Hz is not exceeded.
Note: This allocation is only effective with the setting Function pulse output "independent", see "3.07 Function pulse output", page 41.
Note: After the setting has been changed, the electronic unit has to be restarted.

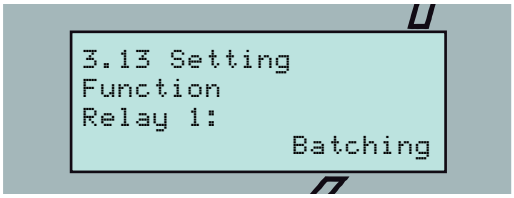
3.12 Pulse output pulse width



The pulse width of the pulse output can be set in this menu.

Note: Increasing the pulse width always involves a reduction is the maximum output frequency (e.g. pulse width 200 ms – maximum frequency 2.5 Hz).
Note: After the setting has been changed, the electronic unit has to be restarted.

3.13 Function relay 1



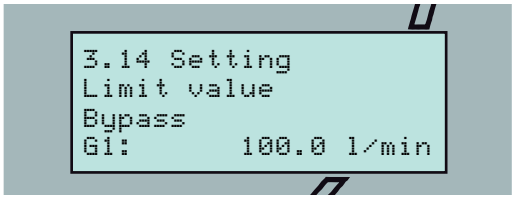
The relay function can be selected in this menu.
Note: Since the bypass function is safety-relevant, we recommend the use as an NO contact at Relay 1 (terminals 9+10) that triggers a valve open when disconnected for the functions Bypass 1–3.
Dropping of Relay 1 then corresponds to the opening of the bypass valve.

Function	Description
Off	Relay output 1 is deactivated
Bypass 1	Differential measurement with 2 volumeters. If one of the two counter does not show a rate over the "Bypass limit value " and the second one does not follow within the "Delay Bypass", the relay reverts to its initial position and the alarm "Bypass valve activated" is generated. The alarm and Relay 1 and 2 can be reset in menu 1.10.
Bypass 2	Single-line measurement Volumeter A. When the value drops below the limit, the relay reverts to its initial position. After every expiry of the repeat attempt period, the relay is switched until the bypass time delay has expired. If the limit value is exceeded within this period, the relay remains switched. Otherwise it reverts to its initial position and the repeat attempt period starts to run again.

Function	Description
Bypass 3	Differential measurement with 2 volumeters. Functions like Bypass 2, but both volumeters have to be operated above the limit value.
Batching	Batch function, see "1.07 Batch quantity", page 35.

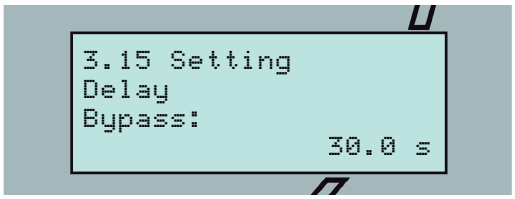
Note: In the case of the functions Bypass 2 and Bypass 3 the valves should be switched via additional semiconductor relays in view of the switching frequency

3.14 Limit value bypass



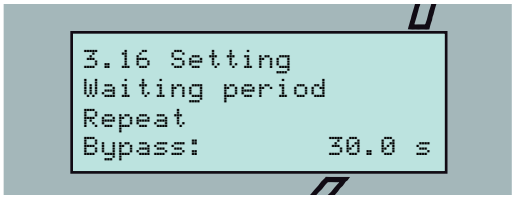
The function allows the automatic activation of a bypass valve when a volumeter blocks. The limit value is selected smaller than the smallest minimum flow rate occurring during normal operation. If G1 = 0 is set, all the bypass functions have to be deactivated.

3.15 Delay bypass



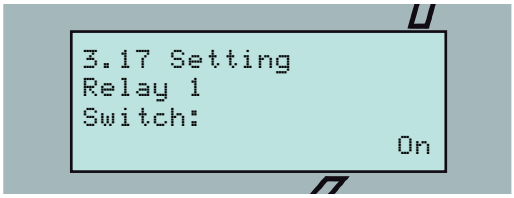
The time set here indicates the sensitivity of the bypass function. The condition for triggering the bypass relay must exist continuously during the set time.
Note: We recommend high sensitivity under high safety requirements.

3.16 Waiting period repeat bypass



The waiting period of the bypass repeat attempt can be set in this menu. The repeat attempt period is of importance when the relay function "Bypass 2" or "Bypass 3" has been selected, see "3.13 Function relay 1", page 42. If the limit value is not exceeded, the volumeter remains in bypass operation.
Therefore the relay is switched and thus the valve is closed after the "Waiting period repeat bypass" has expired: If the limit value is not exceeded within the "Delay bypass", the relay is switched back to the initial position. The Waiting period repeat bypass restarts.

3.17 Relay 1 switch

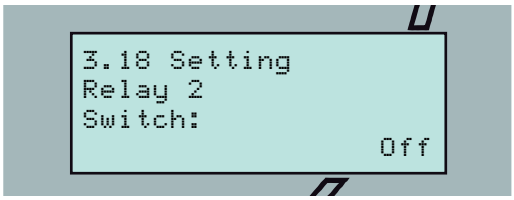


Cursor	Description
Flashes	Relay 1 can be switched manually.
Not visible	Manual switching is deactivated.

Manual switching of the relay can be necessary in emergencies or during commissioning of the plant.

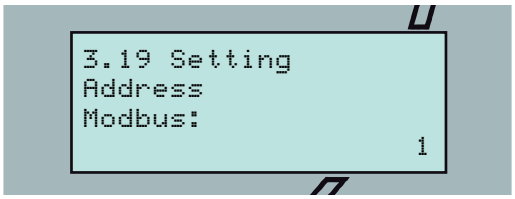
1. Deactivate the password protection, see 2.01.
2. Press SET.
   The cursor flashes.
3. Switch the relay with ARROW UP or ARROW DOWN.
4. Confirm with SET.
   The cursor disappears. Manual switching is deactivated.

3.18 Relay 2 switch



Function analog to 3.17 "Relay 1 switch".

3.19 Address Modbus



The transfer of data by means of the Modbus is possible via the serial interface. The address can be set here.
Note: Data exchange via the bus connection is not password-protected! Write access deletes existing values. Therefore we only recommend reading of the data.

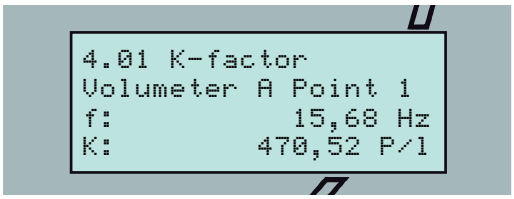
Menu 4: K-factors Volumeter A

The K-factors of Volumeter A are entered in menu 4 "K-factors Volumeter A" with rising frequency. This maps the linearization characteristic of Volumeter A.
Examples:

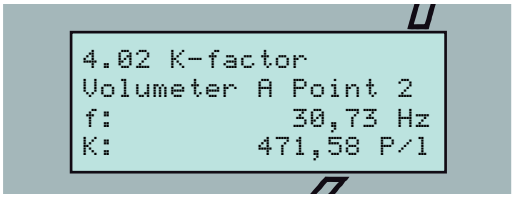
Linearization	Input
None	☐ Page 4.01: Resulting K-factor and frequency at Q_{rated} ☐ Page 4.02: Frequency "0"
Linearization with 2 points	☐ Page 4.01: Any K-factor and associated frequency ☐ Page 4.02: K-factor and frequency at Q_{rated} ☐ Page 4.03: Frequency "0"
Linearization with 3 points	☐ Page 4.01: Any K-factor and associated frequency ☐ Page 4.02: K-factor and associated frequency in ascending order ☐ Page 4.03: K-factor and frequency at Q_{rated} ☐ Page 4.04: Frequency "0"

Note: The number of linearization points is limited by the input of the frequency "0". Ensure that the K-factor and frequency of Q_{rated} are entered respectively on the preceding page.
The linearization is extended to "0" or to ∞Hz via the first or last two linearization points resp. and mirrored into negative values.
The K-factors and the corresponding frequencies are located on the calibration certificate of the volumeter. The resulting K-factor is listed additionally on the rating plate of the volumeter.

4.01 Volumeter A Point 1



4.02 Volumeter A Point 2

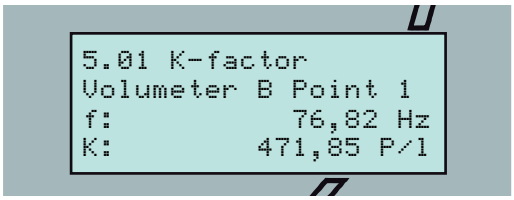


The pages of the K-factors Volumeter A, Point 3 to 7 are displayed consecutively by repeated pressing of the key ARROW UP.

Menu 5: K-factors Volumeter B

The K-factors of Volumeter B are entered in menu 5 "K-factors Volumeter B" with rising frequency. This maps the linearization characteristic of Volumeter B.
The K-factors and frequencies are entered analog to menu 4.

5.01 Volumeter B Point 1



The pages of the K-factors Volumeter B, Point 2 to 7 are displayed consecutively by repeated pressing of the key ARROW UP.

Menu 6: Density table 1/Density determination

Up to 10 temperature and density values of a density table can be entered in ascending order in menu 6 "Density table 1". This allows a temperature compensation and the mass calculation of the flow rate values. The density table can be requested from the supplier of the fluid.

Menu 7: Density table 2

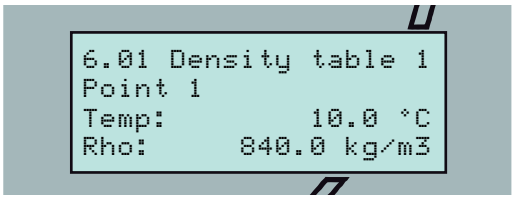
Examples:

Density table	Input
with 1 density value	☐ Page 6.01: Temperature value and associated density value ☐ Page 6.02: Density value "0"
with 2 density values	☐ Page 6.01: Temperature value and associated density value ☐ Page 6.02: Further temperature value in ascending order and associated density value ☐ Page 6.03: Density value "0"
with 3 density values	☐ Page 6.01: Temperature value and associated density value ☐ Page 6.02: Further temperature value in ascending order and associated density value ☐ Page 6.03: Further temperature value in ascending order and associated density value ☐ Page 6.04: Density value "0"

Note: The number of density table values is limited by the input of the density value "0".
A density value for the minimum and maximum temperature respectively is added automatically to the density table. The value for the minimum temperature (-40 °C) is determined internally by extending the linearizations between the first two points. The value for the maximum temperature (200 °C) is determined internally by extending the linearizations between the last two points.
If only one density value is entered, display with a mass unit without connection of a temperature sensor is also possible. Prerequisite is that the process temperature is constant and is known and that the density at this temperature has been entered.

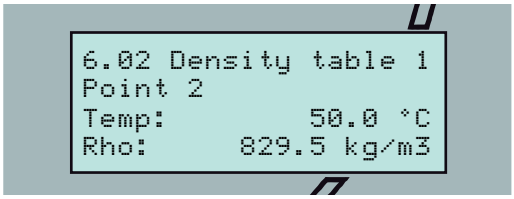
In menu 6 "Density calculation" a density calculation can be carried out. If "Density calculation" is selected, the menu items Density table 1 and Density table 2 will not be displayed, see "2.09 Select density determination", page 38.

6.01 Density table 1 Point 1



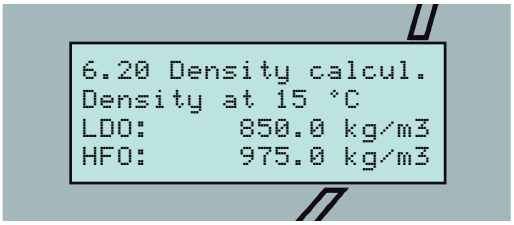
► Enter Value 1 of the density table.

6.02 Density table 1 Point 2



► Enter Value 2 of the density table.
The pages of the Density table 1, Point 3 to 10 are displayed consecutively by repeated pressing of the key ARROW UP. Enter the corresponding value of the density table respectively.

6.20 Density calculation

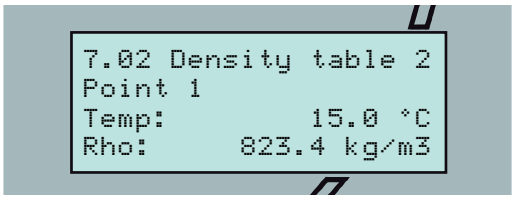


For consumption measurement of heavy fuel oil engines, the density calculation for fuel oils should always be used. The density calculation is always implemented at liquid temperatures below 70 °C for diesel, and from 70 °C for heavy fuel oil. For this purpose, density must be entered at 15 °C for both liquids. The density calculation is implemented in accordance with PTB and DIN 51757 Process B for fuel oils.

Menu 7: Density table 2

The entry of two density tables is possible if different fluids are used. Selection of the used density table is carried out in menu 2 "General settings", see "2.09 Select density determination", page 38.
The values of the density table are entered analog to menu 6.

7.02 Point 1



The pages of the Density table 2, Points 2 to 10 are displayed consecutively by repeated pressing of the key ARROW UP.

Menu 8: Alarms

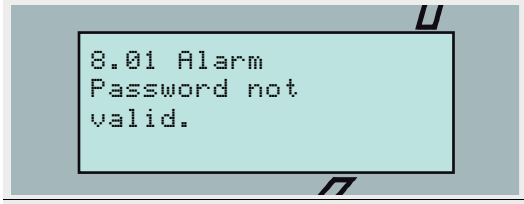
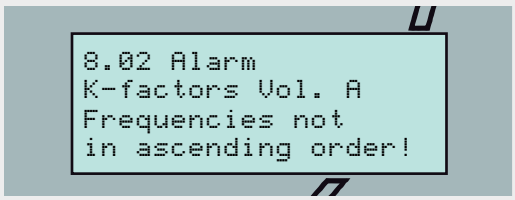
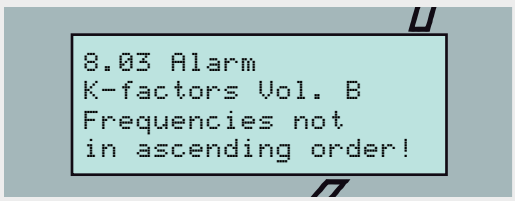
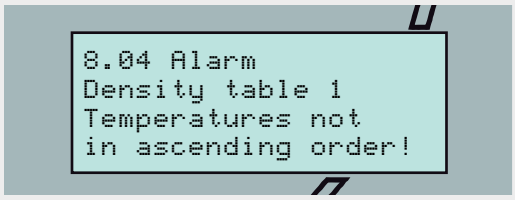
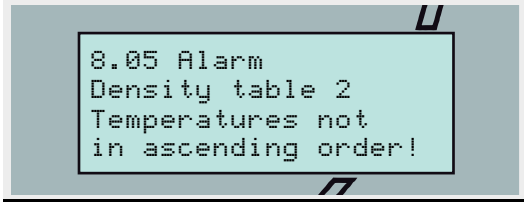
The electronic unit evaluates different measured values during operation and analyzes the operating state. If an error occurs, an alarm message is displayed. This provides information used to eliminate the error. The alarm is confirmed by pressing the SET key. The alarm message disappears from the display. Suitable measures for eliminating the error can be taken subsequently.
Active alarms can be displayed again after confirmation with SET and ARROW LEFT.

The individual pages of the menu are described in the fault table, see "Alarms", page 47. If an alarm occurs, Relay output 2 Collective error message is also activated.

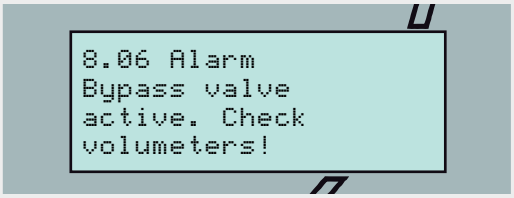
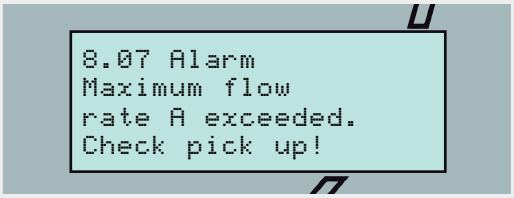
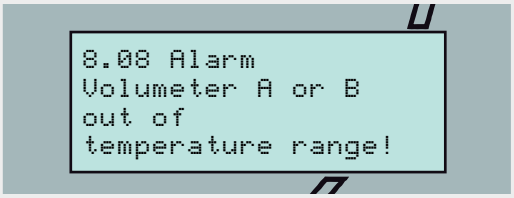
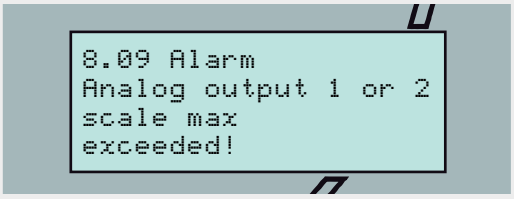
Information about faults

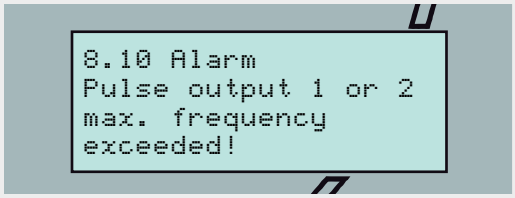
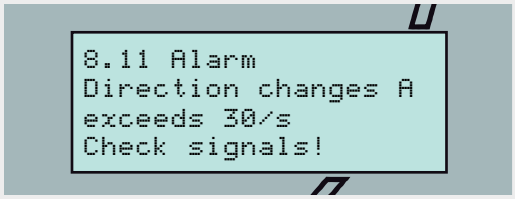
Thanks to the high quality standard faults in the electronic unit are very rare. Implausible display values therefore usually indicate faults in the plant. The following fault table lists the various fault messages as well as their cause and remedy.

Alarms

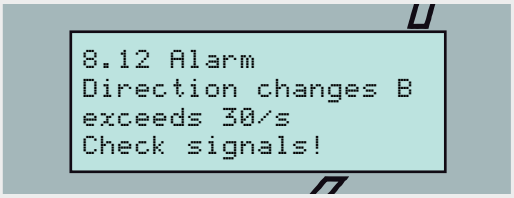
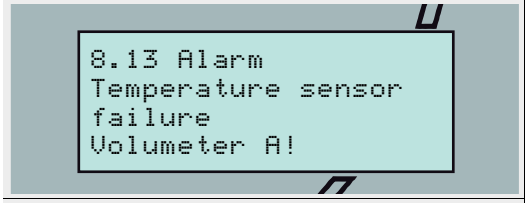
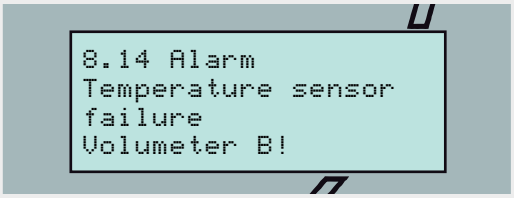
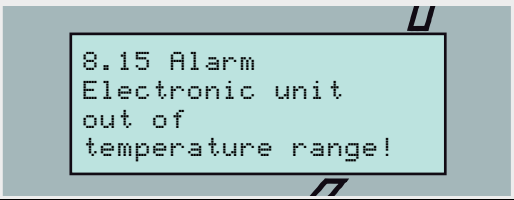
Fault display		Cause and elimination	Checked
		There is no fault. ► No operating steps necessary.	
		Incorrect password input. ► Repeat the password entry with the correct password.	
		The frequencies of Volumeter A are not entered in ascending order. ► Enter the frequencies in ascending order, see "Menu 4: K-factors Volumeter A", Page 44.	☐
		The frequencies of Volumeter B are not entered in ascending order. ► Enter the frequencies in ascending order, see "Menu 5: K-factors Volumeter B", Page 44.	☐
		The temperatures are not entered in ascending order. ► Enter the temperatures in ascending order, see "Menu 6: Density table 1/Density determination", Page 44.	☐
		The temperatures are not entered in ascending order. ► Enter the temperatures in ascending order, see "Menu 7: Density table 2", Page 45.	☐

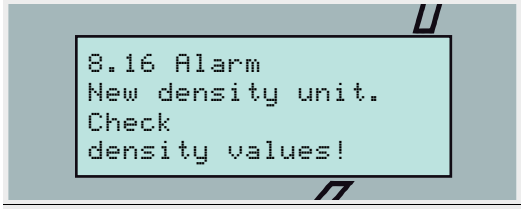
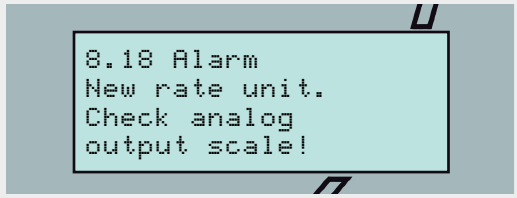
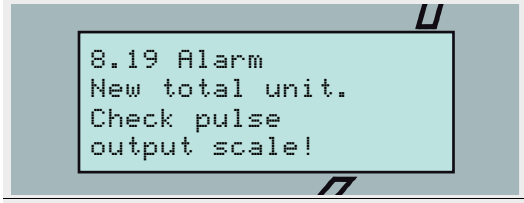
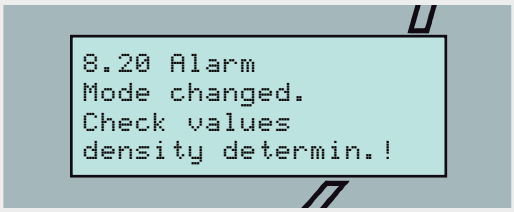
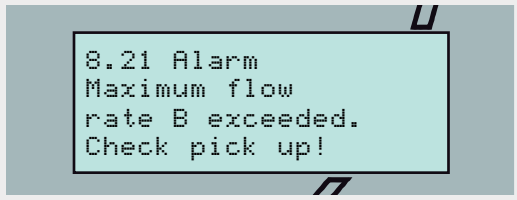
Alarms

Fault display		Cause and elimination	Checked
		Relay 2 for collective error message is active, Relay 1 for bypass valve has dropped. ► Check the volumeter for blocking. ► Optimize settings in menus 3.13 –3.16. In case of independent measurement with two volumeters: 1. If a bypass function is not desired, set the bypass limit value to "0", see "3.14 Limit value bypass", Page 43 2. Reset the bypass and collective error message, see "1.10 Reset bypass and collective error message", Page 36	☐ ☐ ☐ ☐
		The maximum permissible flow rate was exceeded in Volumeter A. ► Limit the flow rate. ► Check the volumeter. ► Use a larger size. ► Check and eliminate an electromagnetic interference using an oscilloscope (e.g. terminate shield to Gnd).	☐ ☐ ☐ ☐
		At least one of the measured temperatures of the connected volumeter lies outside the permissible range. ► Adapt the temperature of the volumeter, see "2.19 Minimum temperature Volumeter", Page 39, or see "2.20 Maximum temperature Volumeter", Page 40. ► Limit the temperature in the plant. ► Use suitable sensors. ► Use suitable volumeters.	☐ ☐ ☐ ☐
		The flow rate exceeds the maximum scale value of an analog output. ► Correct the scale, see "3.03 Scale analog output 1", Page 40 or see "3.05 Scale analog output 2", Page 40.	☐

Fault display		Cause and elimination	Checked
		The maximum output frequency of Pulse output 1 or 2 has been exceeded. ► Correct the scale, see "3.09 Scale pulse output 1", Page 41 or see "3.11 Scale pulse output 2", Page 42. ► Correct the pulse width, see "3.12 Pulse output pulse width", Page 42. The maximum frequency of a pulse output amounts to: ☐ In the mode "Encoder": 1/(4 x pulse width in s) ☐ In the mode "Independent": 1/(2 x pulse width in s)	☐ ☐
		A pick up at Volumeter A has failed. This error message is only displayed at the setting Function pulse inputs "Encoder", see "2.13 Function pulse inputs", Page 38. ► Check the pulse inputs for channel A (connections 7 + 18): a) Square wave signal on both inputs: > 30 direction changes/s - or - b) Square wave signal on one input: strong vibration (at volumeter standstill) - or - c) One of the pick ups supplies no signal (with running volumeter) With c): ► Check the connection of the corresponding pick up. ► Check the position of the corresponding pick up in the dry sleeve. ► Replace the corresponding pick up.	☐ ☐ ☐

Alarms

Fault display	Cause and elimination	Checked
	A pick up at Volumeter B has failed. This error message is only displayed at the setting Function pulse inputs "Encoder", see "2.13 Function pulse inputs", Page 38. ► Check the pulse inputs for channel B (connections 30 + 40): a) Square wave signal on both inputs: > 30 direction changes/s - or - b) Square wave signal on one input: strong vibration (at volumeter standstill) - or - c) One of the pick ups supplies no signal (with running volumeter) With c): ► Check the connection of the corresponding pick up. ► Check the position of the corresponding pick up in the dry sleeve. ► Replace the corresponding pick up.	☐ ☐ ☐ ☐
	Temperature sensor A or Temperature input A is defective. ► Check the sensor connection. ► Replace the sensor. ► Check the temperature input.	☐ ☐ ☐
	Temperature sensor B or Temperature input B is defective. ► Check the sensor connection. ► Replace the sensor. ► Check the temperature input. If single-line measurement with temperature compensation is used: ► Connect a 100 Ohm resistor between Terminal 36 and 37 with a wire jumper from 37 to 38.	☐ ☐ ☐ ☐
	The temperature range of the electronic unit has been exceeded. ► Check the electronic unit. ► Replace the electronic unit.	☐ ☐

Fault display	Cause and elimination	Checked
	The unit of density has been changed. ► Convert the numerical values and correct the density table/ density calculation.	☐
	The temperature unit has been changed. ► Convert the numerical values and correct the density table/ density calculation.	☐
	The unit of the rate has been changed. ► Check the scale of the analog outputs and correct it.	☐
	The unit of Total has been changed. ► Check and correct the scale of the pulse outputs.	☐
	Mode has been changed. ► Correct the density table/density calculation.	☐
	The maximum permissible flow rate was exceeded in Volumeter B. ► Limit the flow rate. ► Check the volumeter. ► Use a larger size. ► Check and eliminate an electromagnetic interference using an oscilloscope (e.g. terminate shield to Gnd).	☐ ☐ ☐ ☐

Tab. 1 Alarms

Further faults

Further faults		Cause and elimination	Checked
Rate = 0, although pulse signals can be measured at the terminals of the electronic unit with the oscilloscope.		One pick up each is connected per volumeter and the function pulse input "Encoder" is selected. ► Select the "Counter" function, see "2.13 Function pulse inputs", Page 38.	☐
		A rate of 0 is displayed after breakdown of pick up in the encoder mode or temperature sensor and the total value is not changing. ► Check wiring, replace pick up.	☐
Analog output does not function.		Analog output function selected incorrectly. ► Select the correct function, see "3.01 Function analog output", Page 40.	☐
		Signal cable connected to an incorrect analog output. ► Correct the connection.	☐
Negative flow rate		The signal wires at the respective volumeter are connected incorrectly. ► Swap the signal wires.	☐
No flow or flow rate too low		► Check the alarms, see "Menu 8: Alarms", Page 34.	☐
		► Check the connection of the sensor.	☐
		► Check the sensor and replace it if necessary.	☐
		► Check the connection of the temperature sensor.	☐
		► Check the temperature sensor and replace it if necessary.	☐
Double flow when the option flow direction detection is used		Change the function of the pulse input from "Counter" to "Encoder", see "2.13 Function pulse inputs", Page 38.	☐
When the electronic unit is switched on, the following alarms are displayed: ☐ 8.07 Max. flow rate A exceeded. ☐ 8.10 Analog output scale max. exceeded ☐ 8.12 Sensor failure ☐ 8.13 Sensor failure		► Use a power pack 24 V DC 15 W or insert a debounced switch between the electronic unit and power pack ► Shield the lines to the pick ups and terminate the shield to Gnd (chassis) or ground.	☐ ☐

Further faults

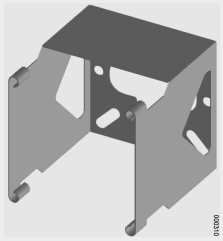
Further faults		Cause and elimination	Checked
Keyboard background illumination flashes.		There is an input error. 1. Press SET and ARROW LEFT simultaneously. The existing errors are displayed. 2. Eliminate the errors.	☐ ☐
Overflow of the total value		After an overflow of the total value the electronic unit displays the following: ☐ for 3 decimal places: +/- 1 999 999.999 ☐ for 1 decimal place: +/- 199 999 999.9 ► Select a different unit for the total, e.g. m^3 instead of l. After change the total value remains available after the overflow. ► Reduce the number of decimal places.	 ☐ ☐

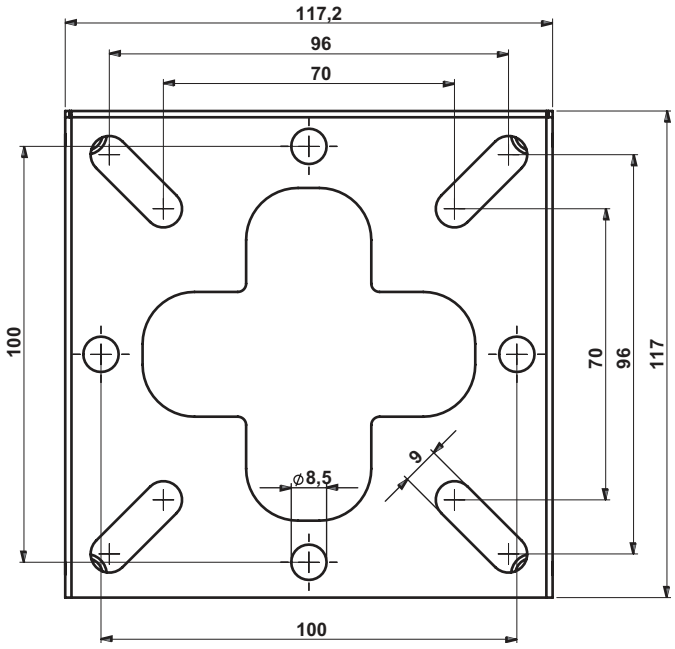
Tab. 2 Further faults

Accessories mounting

The KRAL electronic unit can be installed by various methods. In addition to the mounting frame that forms part of the scope of delivery, diverse fixing kits for mounting the electronic unit are available as accessories.

Universal mount fixing kit

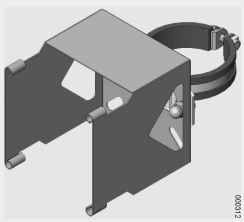
Fixing kit	Application	Article No.	suitable for
	Wall mounting	UZA 20	BEM 300 BEM 500



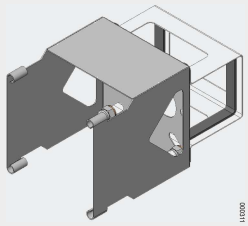
Mounting: M8

Fig. 1 Mounting dimensions of universal mount UZA 20

Fixing kit for pipe mounting / mounting on OMG

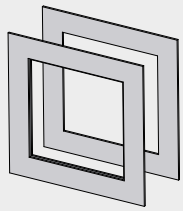
Fixing kit	Application	Article No.	suitable for	Pipe diameter [mm]	
				min.	max.
	Pipe mounting/ mounting on volumeter OMG	UZA 28	BEM 300 / OMG13 BEM 500 / OMG 13	85	92
		UZA 25	BEM 300 / OMG 20 BEM 500 / OMG 20	72	80
		UZA 26	BEM 300 / OMG 32 BEM 500 / OMG 32	102	110
		UZA 27	BEM 300 / OMG 52 BEM 500 / OMG 52	115	122

Fixing kit OME

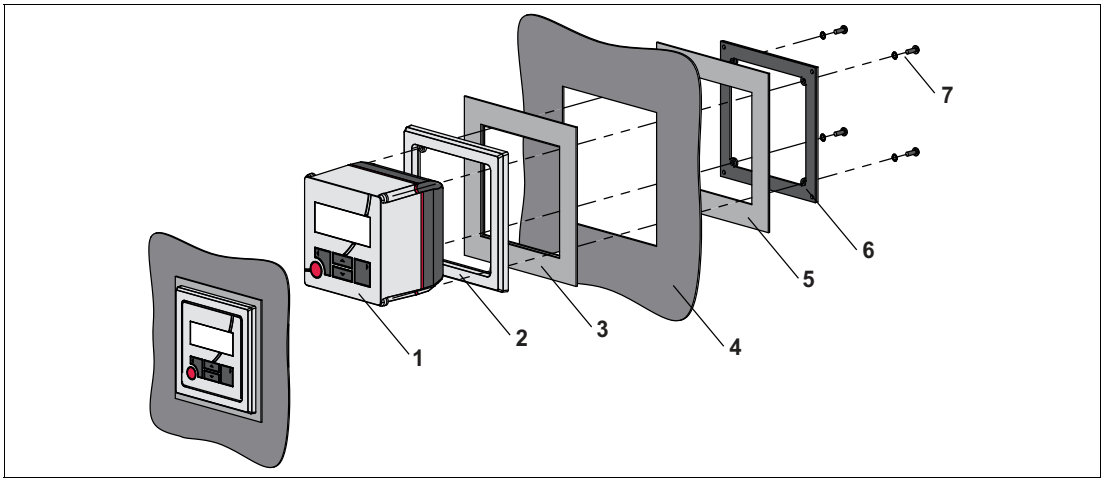
Fixing kit	Application	Article No.	suitable for
	Mount on Volumeter OME	UZA 21 [1,2)]	BEM 300/500 / OME 13
		UZA 22 [1,2)]	BEM 300/500 / OME 20
		UZA 24 [2)]	BEM 300/500 / OME 32

[1)] Not suitable for OME with DIN flanges.
[2)] Not suitable for OME with temperature sensor connection

Adapter set for conversion of BEM 4U to BEM 300/500

Adapter set	Application	Article No.	suitable for
	☐ Mounting in control cabinet ☐ Conversion of BEM 4U to BEM 300/500	EGT 23	BEM 300 BEM 500 Scope of delivery: ☐ 1 sheeting bonded to seal ☐ 1 sheeting

When changing from BEM 4U to BEM 500 please take into account:
The previously used temperature sensors have to be replaced by temperature sensors with Pt100 output. These temperature sensors are available from KRAL.
During conversion, observe setting the temperature sensor units.



1 Electronic unit
2 Front frame*
3 Sheeting bonded to seal**
4 Control cabinet
5 Sheeting**
6 Sealing frame*
7 Screws and lock washers*

* included in the scope of delivery of the BEM 300/500
** Adapter set

1. Remove the BEM 4U.
2. Slide the front frame **2** and sheeting with seal **3** from the rear onto the electronic unit **1**.
3. Position the electronic unit in the control cabinet section.
4. Slide on the sheeting **5** and sealing frame **6** and fasten using the screws and lock washers **7**.

Accessories electrical connection

Notice: Depending on the sheeting thickness of the control cabinet the supplied screws may have to be replaced by longer screws.

Accessories electrical connection

The electronic unit operates with a power supply of 24 V DC. If a different voltage is available in the system, a suitable power supply unit can be used.

Rack mounting power supply unit EEN 12

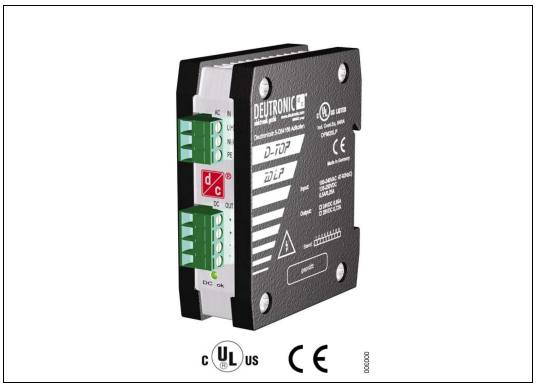


Fig. 2 Rack mounting power supply unit EEN 12

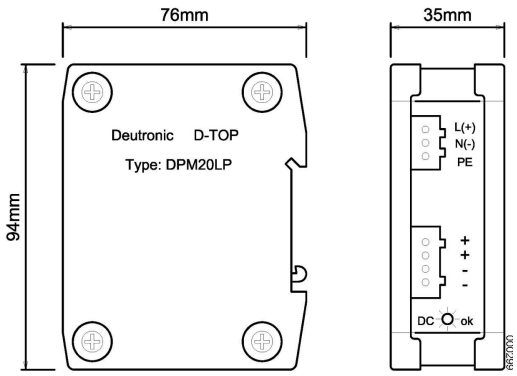


Fig. 3 Dimensions

Input	Data
Input voltage	☐ 100–240 V AC (tolerance: 93–265 V AC) 47–63 Hz 135–370 V DC
Starting current inrush	☐ 230 V AC: 30 A max. ☐ 115 V AC: 15 A max. limited by NTC, in heated state higher
Overvoltage protection at the input	☐ Varistor
Fuse	☐ Internal fuse T4A 250 V, additional external fuse not required
Current consumption	☐ 230 V AC: 0.25 A typ. ☐ 115 V AC: 0.5 A typ.

Output	Data
Output voltage	24 V DC
Output current max.	850 mA
Output power	20 W
Function display	LED at front panel
Current limitation	Fold-back, set to approx. 1.05 x Irated
System deviation at load change stat. 10–90%	0.1%
System deviation at load change dyn. 10–90%	1.0%
Adjusting time	1 ms
System deviation at input change ±10%	0.1%
Mains buffering	> 20 ms
Residual ripple	< 50 mVss

Accessories electrical connection

Output	Data
Switching peaks	< 100 mVss
Overvoltage protection at the output	Suppressor diode (Transil diode)

Environment	Data
Storage temperature	-40 °C ~ +85 °C
Operating temperature	-25 °C ~ +60 °C, above 50 °C performance reduction 1.5%/°C
Cooling	Air convection
Electrical safety	Design to EN 60950
Degree of protection	IP 20
Insulation voltage	Input/Output 3 kV routine tested
EMC emitted interference	EN 55011-B
Immunity to interference	EN 61000-6-2
Efficiency	83%, depending on input and output voltage
Connections: Screw terminals, pluggable	☐ Input: 0.5–2.5 mm^2 ☐ Output Ua^+: 2x0.5–2.5 mm^2 ☐ Output GND: 2x0.5–2.5 mm^2
Dimensions	36 x 76 x 94 mm (WxDxH)
Weight	approx. 250 g
Model	Sheet steel, can be snapped onto a DIN rail TS35 (EN 60715) or can be screwed on

Terminal assignment

Connection	Function	Terminal
Input	IN L+	1
	IN N-	2
	PE	3
Output	+Ua	4
	+Ua	5
	GND	6
	GND	7

Accessories electrical connection

Plug-in power supply unit EEN 13

The accessory set includes exchangeable connectors that can be used in most countries of the world.

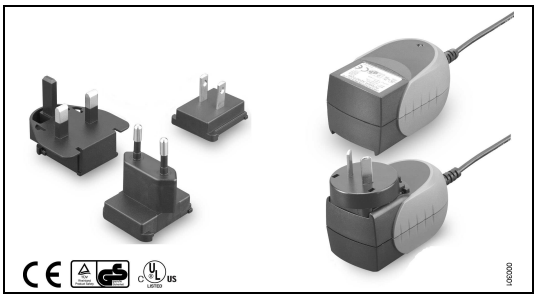


Fig. 4 Plug-in power supply unit EEN 13

Input	Data
Power consumption	20 W
Input voltage	90–264 V AC
Frequency	47–63 Hz
Current consumption	0.4 A max.
Leakage current	0.25 mA max.

Output	Data
Output voltage	24 V DC ±2%
Output current max.	625 mA
Output power	15 W
Short-circuit protection	Continuous (auto recovery)
Overvoltage protection	Yes

Environment	Data
Operating temperature	0 ~ +40 °C
Storage temperature	-20 °C ~ +85 °C
Dimensions	80.6 x 47.9 x 43.3 mm
Weight	130 g

Cable assignment

Connection	Function	Color
Output	+24 V	White
	GND	Black

Data acquisition accessories

If measured values are to be recorded regularly, this can be done using the data acquisition accessories. Measured values are stored in intervals that can be specified freely. The data can be evaluated subsequently and be exported for further processing.

Data logger BEA 80 and BEA 81

Fig. 5 Data logger BEA 81

Scope of delivery:
- ☐ Data logger BEA 80 or BEA 81
- ☐ Windows software (USB stick) for 98 / NT / 2000 / XP / VISTA / WIN7 (32/64 bit)
- ☐ USB cable, length 2 m

Input

Input	BEA 80	BEA 81
Analog input	-2...30 mA; max. 316 mA	–
Pulse input	–	☐ High: > 2.8 V; max. 30 V ☐ Low: < 0.4 V
Max. pulse frequency	–	10 kHz
Input impedance	10 Ω	60 kΩ
Precision	± 0.1% at 4...20 mA	± 2 pulses
Resolution	0.5 µA	1 pulse

Features

Features	BEA 80	BEA 81
Number of records	1 000 000	500 000
Start/stop options	Multiple	Multiple
Password protection	For configuration	For configuration
Recording interval	0.25 s...1 day	1 s...1 day
Battery	3.6 V lithium	3.6 V lithium
Battery durability	Up to 10 years	Up to 10 years
Display almost depleted battery	Red LED flashes every 10 s	Red LED flashes every 10 s
Operating temperature	-40...+80 °C	-40...+80 °C
Online recording on PC	Possible	Possible
Rapid download	Up to 115 200 bauds	Up to 115 200 bauds
Alarms	When overpassed or underpassed	–

Dimensions

Housing	BEA 80	BEA 81
Height	36 mm	36 mm
Width	56 mm	64 mm
Depth	16 mm	16 mm
Weight	24 g	24 g

Display accessories

The BEM 500 electronic unit is normally installed near the volumeter. The electronic unit can communicate with an additional display via the bus interface. This remote display can display the electronic unit display values. This means that the current consumption, the total values and the temperatures can be displayed at distances of up to 200 m.

Remote display BEA 59

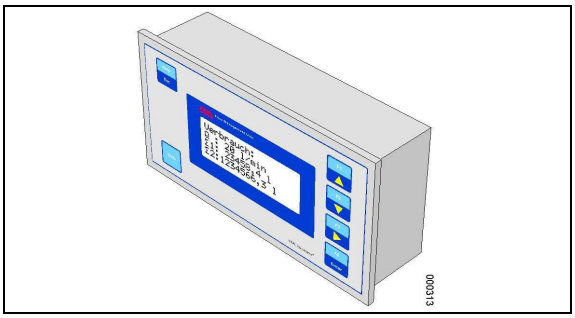


Fig. 6 Remote display BEA 59

Features	BEA 59
Text display	4 lines/20 characters
Background illumination	LED
Interface type	☐ RS 232 ☐ RS 485
Degree of protection	Front IP 65
Operating temperature	0...+50 °C
Power supply	24 V DC

Glossary

Term	Meaning
Adjusting time	☐ Time span after whose expiry the output is identical with the input
Analog input	☐ Converts an electrical value (0–10 V, 4–20 mA) into a digital value
Analog output	☐ Represents an internal digital value as an electrical value (0–10 V, 4–20 mA) ☐ Is updated with the cycle time
Averaging	☐ Low-pass filter function for suppressing abrupt changes
Baud rate	☐ Rate of data transfer per time unit (bit/s)
Bus connection	☐ Digital communication with connected users
Bus interface	☐ Makes available the hardware (e.g. RS 232) and software (e.g. Modbus RTU protocol) required for digital communication
Circulation ratio	☐ Ratio of supply rate/consumption (A/(A-B))
Collective error message	☐ Message that indicates the occurrence of at least one error
Consumption	☐ Consumption Q=QA-QB
Cycle time	☐ Time section in which all the calculations are carried out, inputs processed and outputs operated
Density	☐ Ratio of mass-to-volume (e.g. kg/m^3)
Density calculation	☐ Describes the relationship of density-to-temperature with 2 values (density at reference temperature) ☐ Maps the expansion coefficient ☐ Temperature < 70 °C: densitiy calculation for diesel Temperature ≥ 70 °C: densitiy calculation for heavy fuel oil
Density table	☐ Describes the relationship of density-to-temperature ☐ Thus maps the expansion coefficient
Differential measurement	☐ The values of two volumeters are measured and subtracted
Electronic unit	☐ Electronic unit BEM 300/500
Flow direction detection	☐ Detection of the flow direction through two sensors with square wave signals out of phase by 90°
Flow rate	☐ Amount flowing per time unit (e.g. l/s)
Galvanic isolation	☐ Isolation of differing voltage potentials
Incremental encoding input	☐ Processes two *square wave signals* out of phase by 90° ☐ Provides a counting function under consideration of the flow direction and a frequency measuring function
K-factor	☐ Number of pulses per flow volume unit ☐ Characteristic of a volumeter
Limit frequency	☐ Minimum or maximum frequency that can be used
Limit value	☐ Set value at which an action is carried out (e.g. switching of a relay) when it is reached or exceeded
Linearity	☐ Dependence of the K-factor across the flow range
Linearization	☐ Maps the dependence of the K-factor of a volumeter across the flow range in an electronic unit
Link channel AB	☐ Q=QA-QB or Q=QA+QB
Mass calculation	☐ Volumetric values are converted into mass values under consideration of the temperature via the density table
Pick up (A/B)1	☐ Sensor that generates one pulse per defined flow rate

Glossary

Term	Meaning
Pick up (A/B)2	☐ Sensor that generates one pulse with +90° phase shift per defined flow rate to pick up 1 ☐ Allows a flow direction detection in combination with Pick up 1
Pulse (signal)	☐ A rising edge is followed after a certain period by a falling edge ☐ Corresponds to the square wave signal
Pulse input	☐ Processes pulse signals
Pulse output	☐ Generates pulses with 24 V signal level conforming to the scale of an input variable
Rate	☐ Volume per time unit
Relay output	☐ Potential-free change-over contact
Remote display	☐ Additional display of the values of the electronic unit ☐ Communication via bus interface
Reset	☐ Setting the variable to the value 0
Resolution	☐ Maximum number of possible subdivision steps for describing a value
Return line	☐ Line from the consumer back to the tank
Scale	☐ Assigning of a maximum input value to a maximum output value
Serial interface	☐ Sends or receives data in chronological sequence
Single-line measurement	☐ The values of a volumeter are measured and evaluated
Square wave signal	☐ Pulse signal with square wave form
Supply line	☐ Line from the tank to the consumer
Temperature compensation	☐ Consideration of the current temperature at the volume and mass calculation in order to compensate density changes
Temperature input	☐ Processes signals of a temperature sensor
Temperature sensor	☐ Converts the physical value temperature into an electrical value (e.g. resistance)
Threshold value	☐ Value at which an action is triggered when it is overpassed or underpassed
Total	☐ Volume values that have been measured since the last reset
Total consumption	☐ Quantity that has been consumed since the last reset
Total flow	☐ Quantity that has passed the volumeter since the last reset
Updating rate	☐ Shortest period in which a change is displayed in the display
Volume calculation	☐ The volume is converted to a standard temperature by means of the density table and the temperature
Volume measurement	☐ The volume that passes the volumeter is calculated from the K-factor [P/l] and the pulses of the volumeter
Volumeter	☐ Flow rate measuring device

Tab. 1 Glossary

KRAL

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