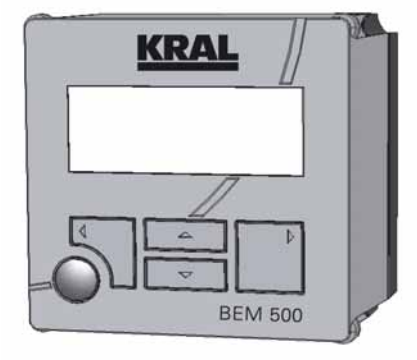
KRAL Electronics – Series BEM 500.

Operating Instructions



OIE 12en
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Symbols used

Symbol	Meaning
	Warning
	Action steps at installation and removal
	Action steps at 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

Safety instructions

The following general safety instructions must be observed:

- ☐ No liability is accepted for damage arising through non-observance of the operating instructions.
  - Installation, removal and installation work may only be carried out by specialist personnel.
  - Read the operating instructions carefully and observe them.
- ☐ 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.
- ☐ Implement all the supply lines without faults.

Standards and guidelines

Electromagnetic compatibility

The electronic unit fulfills the following standard applying to interference emission and interference susceptibility.

- ☐ EN 61326

Ambient conditions

The electronic unit fulfills the following standards applying to the ambient conditions.

- ☐ EN 60068-2-47
- ☐ EN 60068-2-64
- ☐ EN 61373

Further standards and guidelines

KRAL Volumeter® is a registered trademark of KRAL AG.
All the electrical components fulfil the CE standard.

General

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: pulses/liter) and is listed in the enclosed calibration report.

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

- ☐ PNP
- ☐ Namur
- ☐ NPN
- ☐ Push/pull

In addition the devices can also be equipped with temperature sensors and further sensors for flow direction detection. Delivery of the electronic unit is effected with settings according to customer requirement.

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 flow 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 flow measurement

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

The K-factor of a volumeter shows slightly different values at different flow rates. These are documented in the enclosed calibration report. 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 across up to seven interpolation values of the frequency in accordance with the flow quantity in a table. The K-factor relevant for the flow rate being measured is then determined by means of linear interpolation between the two nearest interpolation values.

Linearization is used for fluids of low viscosity. For viscosities higher than 20 mm^2/s it is recommended to use the resulting K-Factor. The resulting K-Factor is determined as the average value of the five upper flow values.

Temperature compensation

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

- With the "Volume measurement at X°" option 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 "Volume measurement at TA" option calculates the volume back to the inlet temperature TA. This option allows the comparison with a reservoir fill level.
- Measuring errors are also reduced at the "Mass measurement" option because the device can now use the actual density and not only a stored mean value during the mass conversion. Two different density tables can be entered and selected in the case of operation with different media.

Differential measurement

The KRAL electronic unit can process the signals of two volumeters and determine and display the resultant possible interconnections.

- The "Differential measurement A-B" option allows the subtraction of the values of the two channels, e.g. inlet and outlet of a consumer supplied by a circular pipeline and thus allows the direct display of the consumption of this device.
- The "Sum A+B" option allows the addition of the two measured values and thus, for example, the display of the total consumption if two devices.

Circulation state

The ratio A/B is also called the "circulation state". Due to the regularity of error propagation a strongly rising error in the displayed differential value A-B results at at the values A/B => 1 when the "Differential measurement " option is used, so that the value A/B can be used to judge the reliability of a differential measurement. For the case A/B = 1, for example when a consumer is switched off but a circulation pump continues to be operated, a threshold value can be entered for A-B below which the measured values are no longer used for the sum generation.

Averaging

A strongly fluctuating flow rate causes a jumping display or as a result a fluctuating analo output. The averaging function reduces this effect by generating a mean value across several measured values. The number of measured values for averaging can be set, see "2.14 Setting Average Analog output", page 34, and see "2.26 Setting Average display Rate", page 37.

Limit value

The limit value is used to activate an optional bypass valve at differential measurement. The bypass valve is controlled via the relay output 1. After the limit is exceeded by both volumeters, the proper function is recognized. The bypass valve is activated when the measured flow rate drops below the limit value while the second volumeter remains above this limit value in case a volumeter is blocked. If both volumeters drop below the limit value within 30 seconds, no error is shown.

Pressure pulse compensation

In extreme cases the flow direction can change through pulsations, meaning through liquid waves in the piping system. 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.

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 medium specifications
- ☐ Adaptation of the density tables if the analysis of the medium requires other settings
- ☐ Linearization table with up to 7 preset K-Factors per volumeter
- ☐ Information message at faults or invalid inputs
- ☐ 2 scaleable and assignable analog outputs 0 - 10V / 4 - 20 mA
- ☐ 2 scaleable and assignable pulse outputs
- ☐ 2 adjustable relay outputs

Bus connection

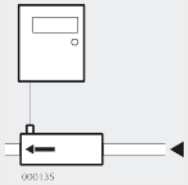
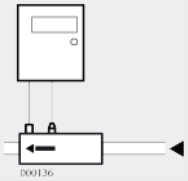
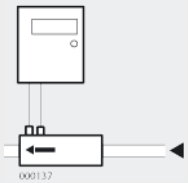
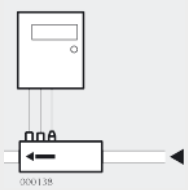
The electronic unit can be connected to the plant by means of a Modbus interface and can thus be integrated optimally into existing systems. This ensures that simple, reliable and rapid data exchange can be implemented.

Applications of the KRAL electronic unit

General

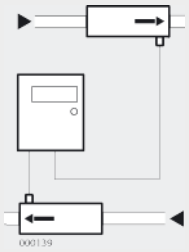
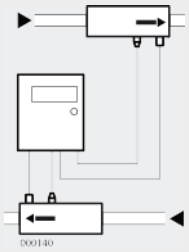
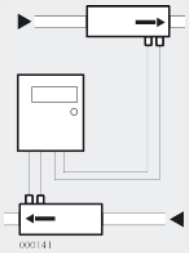
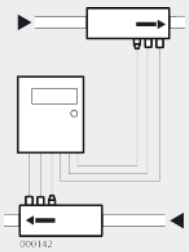
Different extension stages of the electronic unit are presented on the basis of the following examples. This allows the required functional scope to be selected in accordance with the requirements.

Single-line measurement

Extension stage	Components	Functions
Fig. 1 Basic: 	☐ 1 volumeter ☐ 1 flow sensor ☐ 1 BEM 300 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Relay outputs ☐ Analog outputs
Fig. 2 Basic + temperature compensation: 	☐ 1 volumeter ☐ 1 flow sensor ☐ 1 temperature sensor ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Temperature compensation ☐ Mass flow measurement ☐ Normalized volume measurement ☐ Relay outputs ☐ Analog outputs
Fig. 3 Basic + pressure pulse compensation: 	☐ 1 volumeter ☐ 1 flow sensor ☐ 1 flow direction sensor ☐ 1 BEM 300 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Pressure pulse compensation ☐ Relay outputs ☐ Analog outputs
Fig. 4 Basic + pressure pulse compensation + temperature compensation: 	☐ 1 volumeter ☐ 1 flow sensor ☐ 1 flow direction sensor ☐ 1 temperature sensor ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Pressure pulse compensation ☐ Temperature compensation ☐ Mass flow measurement ☐ Normalized volume measurement ☐ Relay outputs ☐ Analog outputs

Tab. 1 Extension stages single-line measurement

Differential measurement

Extension stage	Components	Functions
Fig. 5 Basic: 	☐ 2 volumeters ☐ 1 flow sensor each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Relay outputs ☐ Analog outputs
Fig. 6 Basic + temperature compensation: 	☐ 2 volumeters ☐ 1 flow sensor each ☐ 1 temperature sensor each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Temperature compensation ☐ Mass flow measurement ☐ Normalized volume measurement ☐ Relay outputs ☐ Analog outputs
Fig. 7 Basic + pressure pulse compensation: 	☐ 2 volumeters ☐ 1 flow sensor each ☐ 1 flow direction sensor each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Pressure pulse compensation ☐ Relay outputs ☐ Analog outputs
Fig. 8 Basic + pressure pulse compensation + temperature compensation: 	☐ 2 volumeters ☐ 1 flow sensor each ☐ 1 flow direction sensor each ☐ 1 temperature sensor each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Pressure pulse compensation ☐ Temperature compensation ☐ Mass flow measurement ☐ Normalized volume measurement ☐ Relay outputs ☐ Analog outputs

Tab. 2 Extension stages differential measurement

Transport

Use the original packaging for the transportation of the electronic unit and observe the ambient conditions, see "Ambient conditions", page 18.

Storage

Use the original packaging for the storage of the electronic unit and observe the ambient conditions, see "Ambient conditions", page 18.

Disposal

Safety information 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.

Installation

Dimensions of electronic unit

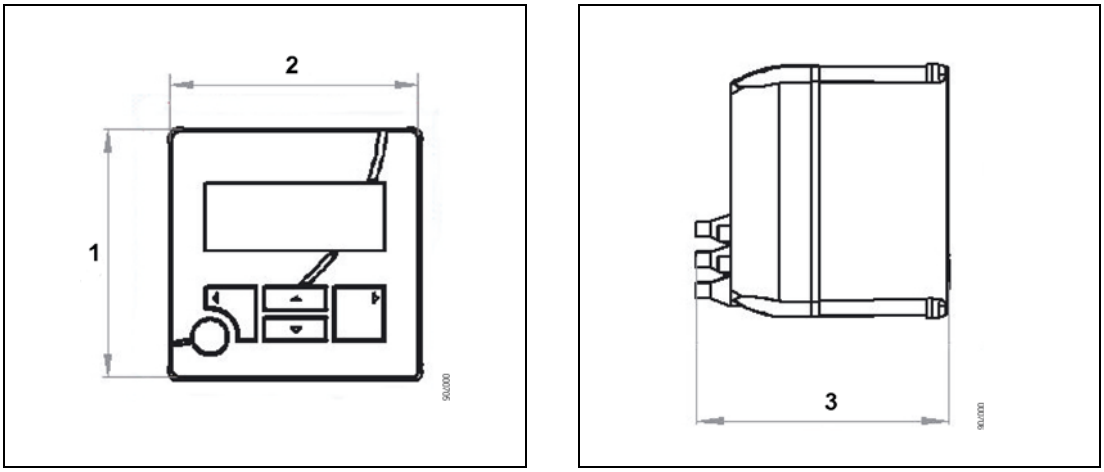


Fig. 1 BEM 500 electronic unit

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

Scope of delivery

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

- ☐ Operating Instructions
- ☐ Password
- ☐ Mounting frame
- ☐ Terminating tool
- ☐ KRAL tool set, consisting of:
  - Screwdriver for recessed-head screws
  - Hexagon socket screw key 3mm
  - Hexagon socket screw key 5mm
  - Open-end wrench 13mm

Safety instructions for installation

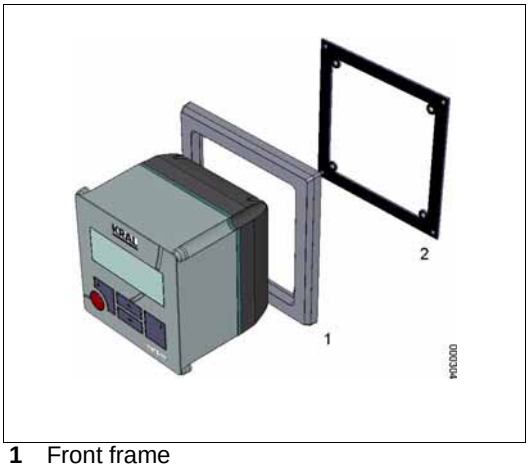
The following safety instructions must be observed during installation:
☐ Installation work may only be carried out by qualified personnel. ▪ Read the operating instructions and observe the relevant instructions.
☐ The electronic unit is a precision instrument. ▪ Ensure cleanliness and take care during installation and removal. ▪ Do not take apart the electronic unit.

Installation into control cabinet

By using the supplied mounting frame the electronic unit can be installed into control cabinets with a sheet metal width of 0,5 – 5 mm.
For installation a mounting depth of 80 mm is necessary.

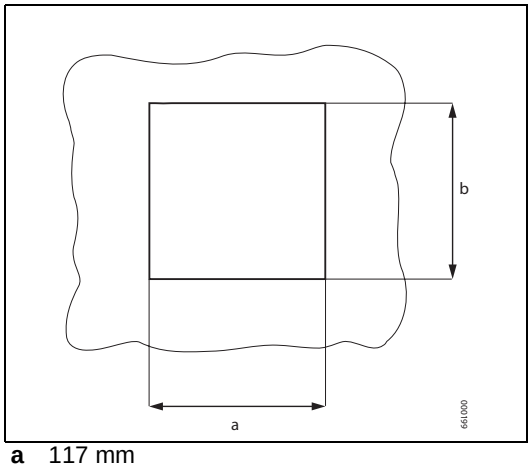
Dimensions Front frame:

- ☐ Height: 145 mm
- ☐ Width: 145 mm
- ☐ Depth: 12 mm



1 Front frame
2 Sealing frame

Fig. 2 Mounting frame BEM 500



a 117 mm
b 117 mm

Fig. 3 Control panel section

Requirement:

- ☐ Control panel section prepared, see Fig. 3

Resources:

- ☐ KRAL tool set

DANGER!
Life danger because of electric shock.

- ➤ Ensure that the power supply is de-energized.
- ➤ The electronic unit may be connected by authorized electrical personnel only.

1. Slide the front frame **1** from behind onto the electronic unit.
2. Place the electronic unit with front frame from the front into the control panel section, see Fig. 3.
3. Slide the sealing frame **2** from behind onto the electronic unit, whereby the sealing surface has to point to the front.
4. Fasten the front frame and the sealing frame by using the supplied screws and lock washers.

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

Wall mounting

For wall mounting an universal mount is available as accessory, see "Accessories", page 46.

1 Electronic unit
2 Universal mount

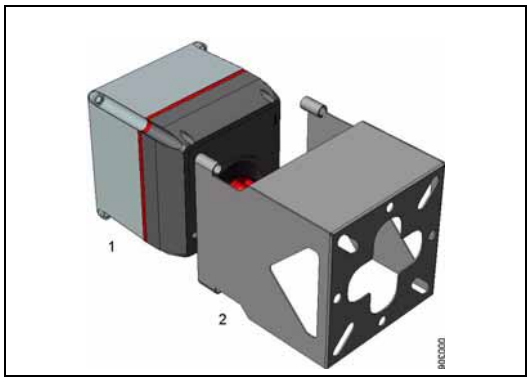


Fig. 4 Universal mount for wall mounting

Requirement:
- ☐ Universal mount is mounted to the wall
- ☐ All cables are cut to suitable length and connected

Resources
- ☐ KRAL tool set

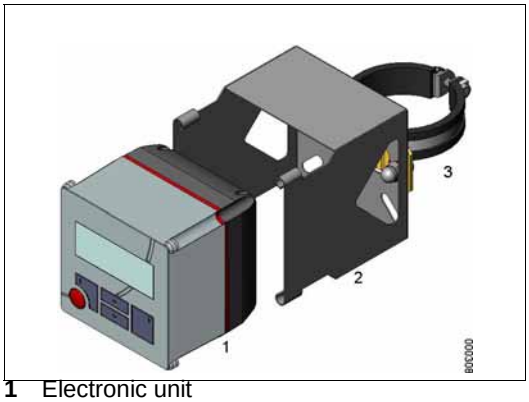
DANGER!
Life danger because of electric shock.

- ➤ Ensure that the power supply is de-energized.
- ➤ The electronic unit may be connected by authorized electrical personnel only

1. Slide the electronic unit **1** into the universal mount **2**.
2. Fasten the electronic unit by means of the 4 supplied screws, shims and wedge lock washers. The electronic unit is ready for operation after the operating voltage has been switched on.

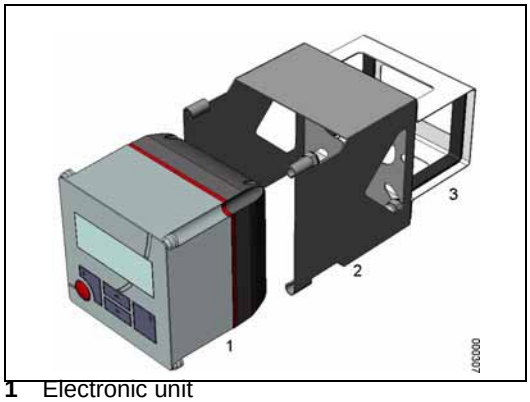
Pipe mounting / Mounting on Volumeter

The electronic unit can be mounted to a pipe or on a Volumeter by using the universal mount and an appropriate fixing device. The required fixing device is available as accessory, see "Accessories", page 46.



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

Fig. 5 Fixing device for pipe mounting / KRAL Volumeter Series OMG



1 Electronic unit
2 Universal mount
3 Fixing device OME

Fig. 6 Fixing device for KRAL Volumeter Series OME

Removal

Requirement:
- ☐ All cables are cut to suitable length and connected

Resources
- ☐ KRAL tool set

DANGER!
Life danger because of electric shock.

- ➤ Ensure that the power supply is de-energized.
- ➤ The electronic unit may be connected by authorized electrical personnel only.

1. Attach universal mount **2** to fixing device **3**.
2. Slide electronic unit into universal mount.
3. Mount fixing device including universal mount on pipe/Volumeter.
4. Fasten electronic unit by means of the supplied screws, shims and wedge lock washers.
   The electronic unit is ready for operation after the operating voltage has been switched on.

Removal

General

Requirement:
- ☐ Operating voltage switched off

Resources:
- ☐ KRAL tool set
- ☐ Terminating tool

DANGER!
Life Danger because of electric shock.

- ➤ Ensure that the power supply is de-energized.
- ➤ The electronic unit may be separated from the power supply by authorized electrical personnel only.

Removing the electronic unit from the control cabinet

1. Disconnect all the wires
2. Unscrew the connecting screws between front and sealing frames.
3. Pull off 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 of electronic unit and universal mount.
2. Pull the electronic unit out of the universal mount.

Removing the electronic unit from the pipe/volumeter

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

Termination panel of the electronic unit

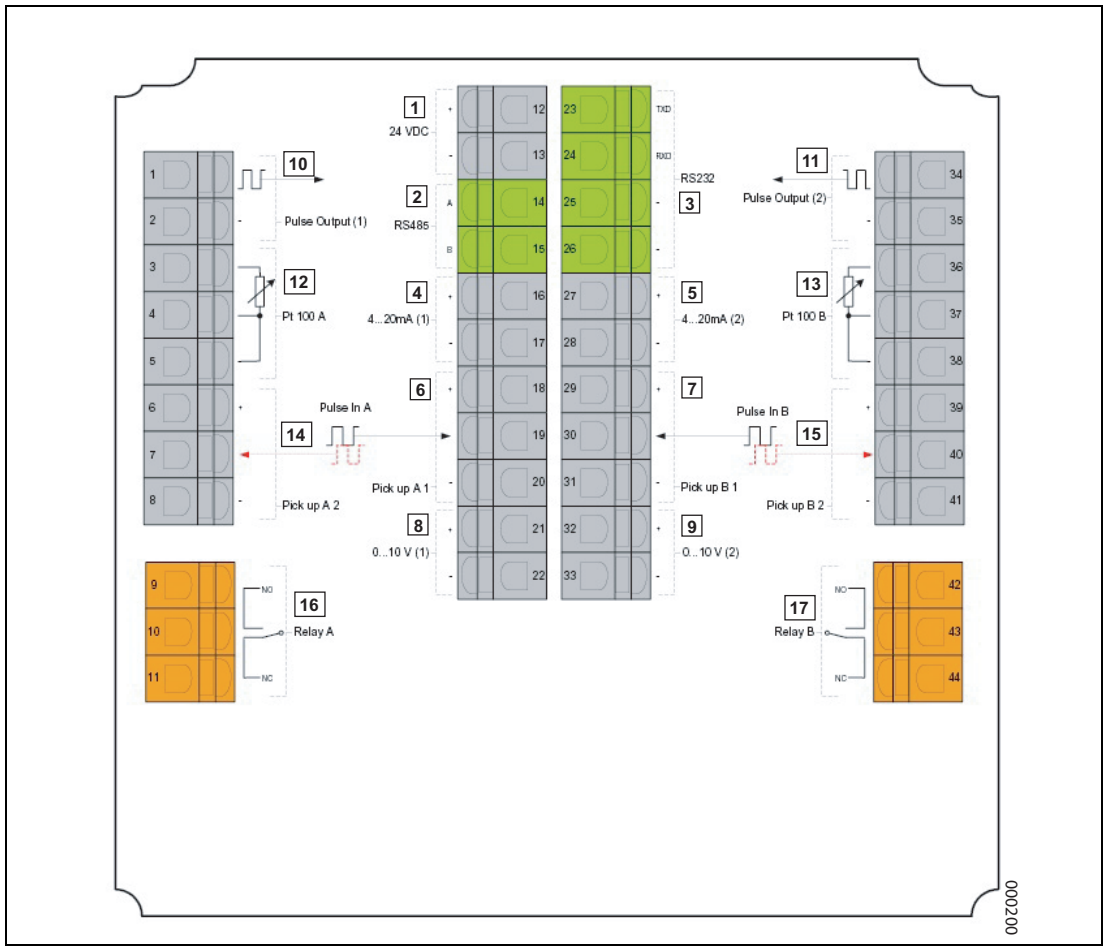


Fig. 1 Terminal panel of the BEM 500 electronic unit

1Power supply 24 V DC
2Bus interface RS485
3Serial interface RS232
4Analog output 1 4...20 mA
5Analog output 2 4...20 mA
6Pulse input A
7Pulse input B
8Analog output 1 0...10 V
9Analog output 2 0...10 V
10Pulse output 1
11Pulse output 2
12Temperature input A Pt 100
13Temperature input B Pt 100
14Flow direction sensor A
15Flow direction sensor B
16Relay output bypass valve
17Relay output centralized fault indication

The bus is connected via terminals. The assignment of the terminals is shown in the terminal diagram. The bus interface address can be selected per software, see "2.22 Setting Address Modbus", page 36.

Technical data of connections

Power supply

Designation	Data
Operating voltage	☐ Range 24 V DC ± 20%

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	☐ 0.08 – 1.5 mm^2

Pulse and temperature inputs

Component	Data
Pulse inputs	☐ Min. limit frequency 0 Hz ☐ Max. limit frequency 20 kHz ☐ Powers supply 24 V DC or Namur 8.2 V
Temperature inputs	☐ Three-wire Pt 100 ☐ Range -40° – +200°C ☐ Resolution: 12 bits correspond to 0.06°C (theoretically)

Analog, pulse and relay outputs

Component	Data
Analog outputs 4 - 20 mA	☐ Load: 500 Ohm (short-circuit proof) ☐ Electrical isolation: 500 V_{eff} ☐ Resolution 16 bits ☐ Scalable ☐ Temperature-compensated ☐ Calibrated
Analog outputs 0 - 10 V	☐ Resolution 16 bits ☐ Scalable ☐ Temperature-compensated ☐ Calibrated ☐ Adjusting time: 30 ms
Pulse outputs	☐ Scalable ☐ Max. output frequency 250 Hz ☐ Optional with flow direction detection
Relay outputs	☐ Output: NC/NO contact ☐ Nominal load voltage: 250 V AC/30 V DC ☐ Switching current, resistive: 6 A AC/DC ☐ Switching current, inductive: 2 A AC/DC

Display

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

Modbus Interface

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

The following variables are available at the Modbus:

Variable	Address HEX	Length	Term	Size	Command
Serial number	0x4012	DW	DOPPELWORD	32 bit	–
Software	0x4020	W	WORD	16 bit	–
Hardware	0x410A	W	WORD	16 bit	–
Display consumption Q	0x4000	DW	DOPPELWORD	32 bit	010340000002D1CB
Display Total T1	0x4002	DW	DOPPELWORD	32 bit	010340020002700B
Display Total T2	0x4004	DW	DOPPELWORD	32 bit	010340040002900A
Display Volumeter A QA	0x4006	DW	DOPPELWORD	32 bit	01034006000231CA
Display Volumeter A T	0x4008	DW	DOPPELWORD	32 bit	0103400800025009
Display Volumeter A Total TA1	0x4100	DW	DOPPELWORD	32 bit	010341000002D037
Display Volumeter A Total TA2	0x4102	DW	DOPPELWORD	32 bit	01034102000271F7
Display Volumeter B QB	0x400C	DW	DOPPELWORD	32 bit	0103400C000211C8
Display Volumeter B T	0x400E	DW	DOPPELWORD	32 bit	0103400E0002B008
Display Volumeter B Total TB1	0x4104	DW	DOPPELWORD	32 bit	01034104000291F6
Display Volumeter B Total TB2	0x4106	DW	DOPPELWORD	32 bit	0103410600023036

Tab. 1 Variables at the Modbus

Example for Total TA1:
Sending command: 010341000002D037
Result: 0103410001609E025B
The Doubleword begins with the 4th byte (=00) and ends with the 7th byte (=9E).
Calculation of the value: 1*2^16+6*2^12+9*2^4+14*2^0=90270

Connection assignments

Note: A change of decimal places in the electronic unit has to be considered when evaluating the data via the Modbus!
The values of the variables are transmitted without the decimal point. The calculation must be performed after receiving the data.
The setting of the Modbus address is effected in the Menu 2.22, see "2.22 Setting Address Modbus", page 36.

Attention: Data exchange via the bus connection is not protected by the password!
Writing deletes the existing values. Therefore we recommend only reading of the data.

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

Flow and flow direction sensor Volumeter A

Connection	Function	Terminal
Flow sensor 1	U+24 V DC	18
Flow sensor 1	Signal	19
Flow sensor 1	Gnd	20
Flow direction sensor 1	U+24 V DC	6
Flow direction sensor 1	Signal	7
Flow direction sensor 1	Gnd	8

Flow and flow direction sensor Volumeter B

Connection	Function	Terminal
Flow sensor 2	U+24 V DC	29
Flow sensor 2	Signal	30
Flow sensor 2	Gnd	31
Flow direction sensor 2	U+24 V DC	39
Flow direction sensor 2	Signal	40
Flow direction sensor 2	Gnd	41

Connection assignments

Analog outputs

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

The data logger can be connected to the analog outputs 4–20 mA, see "Accessories data acquisition", page 50.

Pulse outputs

Connection	Terminal
Signal output 1	1
Grounding output 1	2
Signal output 2	34
Grounding output 2	35

The data logger can be connected to these connections, see "Accessories data acquisition", page 50.

Relay outputs

Connection		Function	Terminal
Relay bypass	NO contact	NO	9
	Switching contact		10
	NC contact	NC	11
Centralized fault indication	NO contact	NO	42
	Switching contact		43
	NC contact	NC	44

Temperature sensors Volumeter A

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

Temperature sensors Volumeter B

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

Connecting cables

Power supply 24 V DC

Connection	Terminal
+24 V DC	12
Grounding	13

Different power supply units are available as accessories, see "Accessories electrical connection", page 47. These are connected here.

Serial interface

Interface	Function	Terminal
RS 485	A	14
RS 485	B	15
RS 232	TXD	23
RS 232	RXD	24
RS 232	GND	25
RS 232	GND	26

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).

Connecting cables to the tension spring terminals

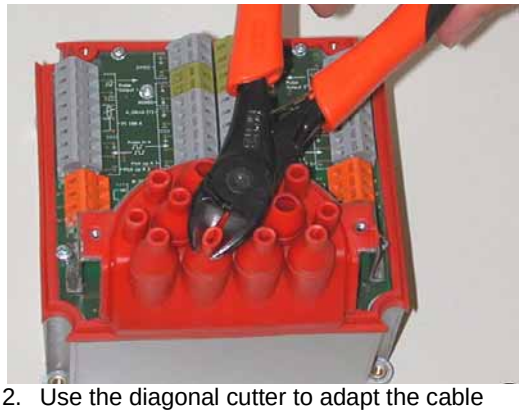
Prerequisite:

- ☐ Cable cut to suitable length
- ☐ All wires stripped to approx. 5 mm

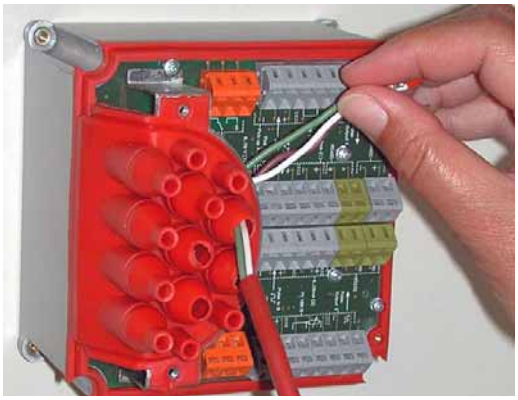
Aids:

- ☐ KRAL tool set
- ☐ Diagonal cutter

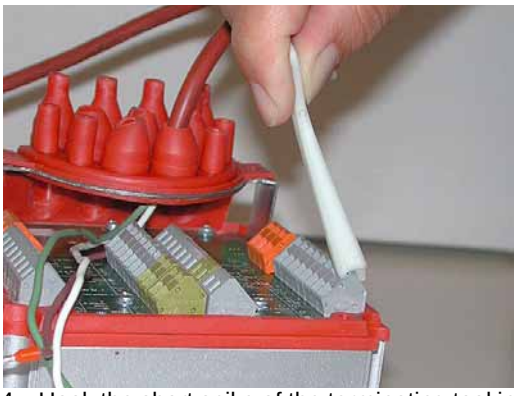
1. Remove the rear device cover and take out the terminating tool.



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

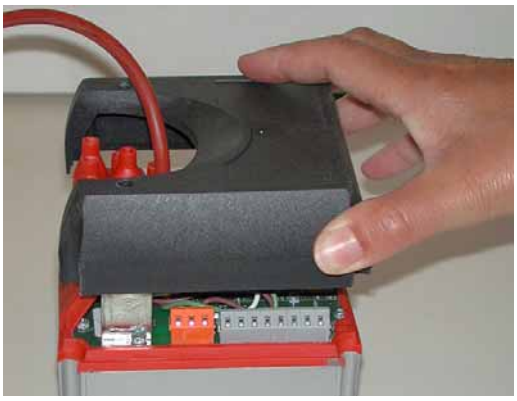


3. Pull the cable through the cable gland.



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

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



8. Replace the rear device cover.

Connecting cables

Connecting the sensors

Prerequisites:
- ☐ Temperature sensors for both volumeters are mounted
- ☐ The flow and flow direction sensors for both volumeters are mounted

Aids:
- ☐ KRAL tool set
- ☐ Diagonal cutter

1. Remove the rear device cover.
2. Adapt the cable gland to the cable diameter and cut it to length, see "Connecting cables to the tension spring terminals", page 21.
3. Pull the cables of the sensors through the cable glands.
4. Connect the cables for the flow sensor of Volumeter A in accordance with the terminal diagram, see "Flow and flow direction sensor Volumeter A", page 18.
5. Connect the cables for the flow sensor of Volumeter B in accordance with the terminal diagram, see "Flow and flow direction sensor Volumeter B", page 18.
6. Connect the cables for the temperature sensor(s) in accordance with the terminal diagram, see "Temperature sensors Volumeter A", page 19 and see "Temperature sensors Volumeter B", page 19
7. Replace the rear device cover.

Connecting analog, relay and pulse outputs

Aids:
- ☐ KRAL tool set
- ☐ Diagonal cutter

1. Remove the rear device cover.
2. Adapt the cable gland to the cable diameter and cut it to length, see "Connecting cables to the tension spring terminals", page 21.
3. Pull the cables for the analog, relay and pulse outputs individually through the cable glands.
4. Connect the cables for the analog, relay and pulse outputs in accordance with the terminal diagram, see "Connection assignments", page 18.
5. Lay the cables for the analog, relay and pulse outputs to the computer.
6. Connect the loads.
7. Replace the rear device cover.

Connecting the power supply

Prerequisites:
- ☐ All the sensors are connected

Aids:
- ☐ KRAL tool set
- ☐ Diagonal cutter

1. Remove the rear device cover.
2. Adapt the cable gland to the cable diameter and cut it to length, see "Connecting cables to the tension spring terminals", page 21.
3. Pull the power cable through the cable glands.
4. Connect the cable to the terminals.
5. Ensure that the plant is de-energized.
6. Connect the power cable to the power supply of the plant.
7. Replace the rear device cover.
   The electronic unit is ready to operate.

Safety instructions for commissioning

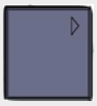
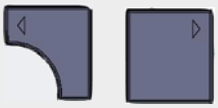
The following safety instructions must be observed during commissioning:
☐ The following qualifications are required for commissioning: ▪ Practical electrotechnical training ▪ Knowledge of the safety guidelines at the workplace ▪ Knowledge of the electrotechnical safety guidelines

Checking the electronic unit

Check	Procedure
Installation	➤ Check that the electronic unit is seated firmly. ➤ Ensure that the rear device cover and cable glands seal properly.
Electrical installation	➤ Check the numbering of the flow sensors. ➤ Check the assignment of the sensors. ➤ Check the connections of the sensors.
Power supply	1. Ensure that the plant is de-energized. 2. Remove the 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 plant.
Function test	➤ Switch on the power supply. The start message is displayed on the display unit. After 3 seconds "1.01 Display Consumption" page is displayed.

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 by pressing for 3 seconds ☐ Confirmation of the selection
	ARROW UP	☐ Change to the following page of the menu ☐ Select the previous unit ☐ Increase the number
	ARROW DOWN	☐ Change to the previous page of the menu ☐ Select the next unit ☐ Decrease the number
	ARROW RIGHT	Navigate one menu higher
	ARROW LEFT	Navigate one menu lower
	ARROW LEFT + ARROW RIGHT	Help on operation
	SET + ARROW RIGHT	Select language
	SET + ARROW LEFT	Call up alarms
	ARROW UP + ARROW DOWN	Changes to the page "1.01 Display Consumption"

Menu structure

The windows of the software are combined into menus. The menus group the pages thematically and facilitate navigation. This allows rapid access to the information of a page irrespective of the respective starting point.

Menu	Page (information)
001Display	☐ 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 "Reset bypass and centralized fault indication" ☐ 1.08 "Information" ☐ 1.09 "Setting Display Brightness" ☐ 1.10 "Setting Display Contrast" ☐ 1.11 "Setting Select Language" ☐ 1.12 "Help operation" ☐ 1.13 "Enter Password"
002Settings	☐ 2.01 "Enable Password" ☐ 2.02 "Select Mode" ☐ 2.03 "Select Temperature X" ☐ 2.04 "Select Unit Rate" ☐ 2.05 "Select Unit Total" ☐ 2.06 "Select Unit Temperature" ☐ 2.07 "Select Unit Density" ☐ 2.08 "Select Density table" ☐ 2.09 "Function Analog output" ☐ 2.10 "Allocation Analog output 1" ☐ 2.11 "Scale Analog output 1" ☐ 2.12 "Allocation Analog output 2" ☐ 2.13 "Scale Analog output 2" ☐ 2.14 "Average Analog output" ☐ 2.15 "Function Pulse output" ☐ 2.16 "Allocation Pulse output 1" ☐ 2.17 "Scale Pulse output 1" ☐ 2.18 "Allocation Pulse output 2" ☐ 2.19 "Scale Pulse output 2" ☐ 2.20 "Limit value Relay 1" ☐ 2.21 "Start message" ☐ 2.22 "Address Modbus" ☐ 2.23 "Function Sensor" ☐ 2.24 "Link Channel A B" ☐ 2.25 "Threshold value A-B" ☐ 2.26 "Average display Rate" ☐ 2.27 "Function Pulse inputs" ☐ 2.28 "Reset to factory setting" ☐ 2.29 "Decimal places"
003K-factors Volumeter A	☐ 3.01 "Volumeter A Point 1" ☐ ... ☐ 3.07 "Volumeter A Point 7"

Menu	Page (information)
004K-factors Volumeter B	☐ 4.01 "Volumeter B Point 1" ☐ ... ☐ 4.07 "Volumeter B Point 7"
005Density table 1	☐ 5.01 "Point 1" ☐ ... ☐ 5.10 "Point 10"
006Density table 2	☐ 6.01 "Point 1" ☐ ... ☐ 6.10 "Point 10"
007Alarms	☐ 7.01 "No alarm" ☐ 7.02 "Alarm 1" ☐ 7.03 "Alarm 2" ☐ ... ☐ 7.19 "Alarm 18"

Tab. 1 Menu structure

Operation at a glance

General operating steps

The following table describes the password entry 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 Setting Enable Password", page 32	1. Select Page 2.01. 2. Press SET. 3. Press the ARROW UPor ARROW DOWNkey. The password prompt is displayed. The flashing cursor indicates the active input field. 4. Use the ARROW RIGHT / ARROW LEFT key to change the position within the number input. 5. Use the ARROW UP / ARROW DOWNkey to increase or decrease keys. 6. Repeat Steps 3 and 4 for all the numbers. 7. Press SET. The password is deactivated. Entries are possible. 8. Repeat Steps 1–3 to activate the password.
Changing the 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 the ARROW RIGHT / ARROW LEFT key to change the position within the number input. 5. Use the ARROW UP / ARROW DOWNkey to increase or decrease keys. 6. Repeat Steps 3 and 4 for all the numbers. 7. Press SET. The value is changed.

Aim	Operating steps
Changing 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 the ARROW UP / ARROW DOWN keys to change the unit. 5. Press SET. The unit is changed.

Tab. 2 General operating steps

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 Display Consumption", page 30	➤ Press theARROW UP and ARROW DOWN keys simultaneously. "Consumption" is displayed.
Resetting totals see "1.02 Display Total with resetting", page 30, see "1.04 Display Volumeter A Total with resetting", page 30 or see "1.06 Display Volumeter B Total with resetting", page 31	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. Total 2 is reset.
Select the language see "1.11 Select Language", page 29	1. Press SET and ARROW RIGHT simultaneously. "Select Language" 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 "1.12 Help operation", page 29	1. Press the ARROW RIGHT and ARROW LEFT keys 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 "2.08 Setting Select Density table", page 33	1. Press ARROW LEFT / ARROW RIGHT in order to access Menu 2. 2. Use the ARROW UP / ARROW DOWNkey to scroll to Page 2.08. The selected density table is displayed.

Aim	Operating steps
Checking the value of a density table see "Menu 5: Density table 1", page 38 or see "Menu 6: Density table 2", page 39	1. Press ARROW LEFT / ARROW RIGHT in order to access Menu 5 or 6. 2. Use the ARROW UP / ARROW DOWNkey to select the desired page. The density or temperature value is displayed.
Checking the values for the K-factors see "Menu 3: K-factors Volumeter A", page 37 or see "Menu 4: K-factors Volumeter B", page 38	1. Press ARROW RIGHT / ARROW LEFT in order to access Menu 3 "K-factors Volumeter A". 2. Use ARROW UP / ARROW DOWN to select the K-factors Volumeter A. 3. Check the K-factors Volumeter A. 4. Press ARROW RIGHT / ARROW LEFT in order to access Menu 4 "K-factors Volumeter B". 5. Check the K-factors Volumeter B.

Tab. 3 Basic functions

Quantities and units

Overview

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
Mass	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. 4 Quantities and units

Pulse signals

The following signals are available:

- ☐ PNP
- ☐ Namur
- ☐ NPN
- ☐ Push/pull

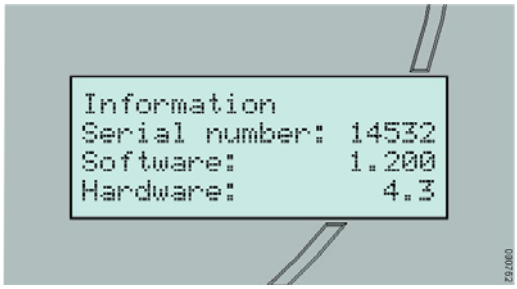
General

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 "2.21 Setting Display Start message", page 36.

Start message



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

Shortcut pages

The following pages can be called up from the various windows as required by means of key combinations, see "Key assignment", page 24.

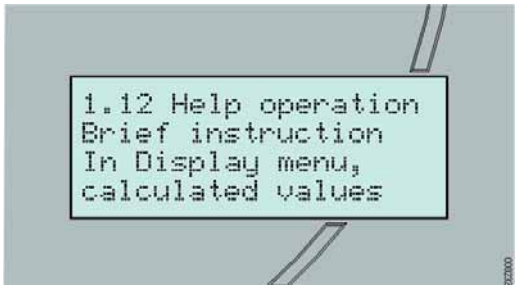
1.11 Select Language

This page is called up by pressing the SET and ARROW RIGHT keys simultaneously.

After the SET key has been pressed again, the ARROW UP or ARROW DOWN key can be used to navigate through the available languages. The languages German, English, French and Spanish are available. The language is selected by pressing the SET key and used after another page has been called up.

1.12 Help operation

This page can be called up at any time by pressing the ARROW LEFT and ARROW RIGHT keys simultaneously.



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

Menu 7: Alarms

This menu is called up by pressing the SET and ARROW LEFT keys simultaneously.

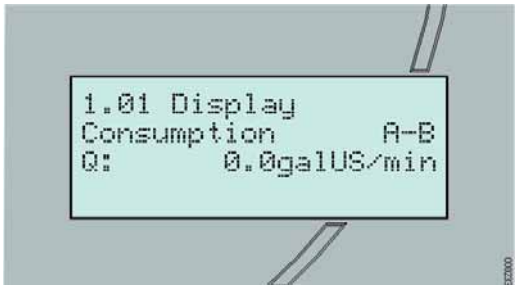
The ARROW UP and ARROW DOWN keys can be used to call up the various pages of the menu.

Menu 1: Display

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

1.01 Display Consumption

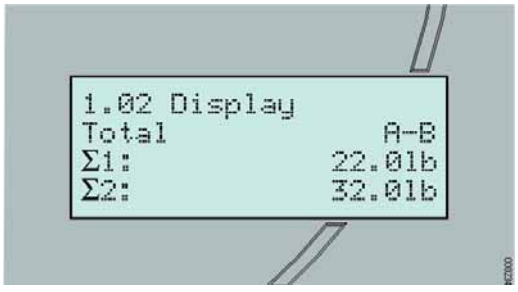
The "Consumption" page displays the most important information (consumption, total) in the preset units.
This page can be called up from any menu by simultaneously pressing the ARROW UP and ARROW DOWN keys.



By pressing the ARROW UP key, the "Total" page is displayed.

1.02 Display Total with resetting

The "Total" page displays the total value since the last resetting. Resetting is carried out via the selection of the corresponding numerical value by pressing the SET key. The total is reset by pressing the SET key once more for three seconds. In case of Total 2 a page for entering the password is displayed beforehand. Afterwards the total is reset.



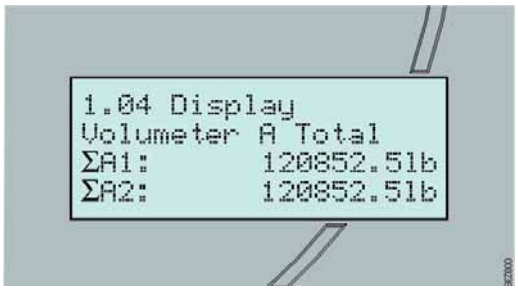
By pressing the ARROW UP key, the "Volumeter A" page is displayed.

1.03 Display Volumeter A

The flow rate and temperature in Volumeter A are displayed on the "Volumeter A" page.

If the temperature lies outside the permissible range or if no temperature sensor is connected, "---,-" is displayed.
Conclusions can be drawn on the operating state of the plant together with the information from the "Consumption" and "Volumeter A" pages.
By pressing the ARROW UP key, the "Volumeter A Total" page is displayed.

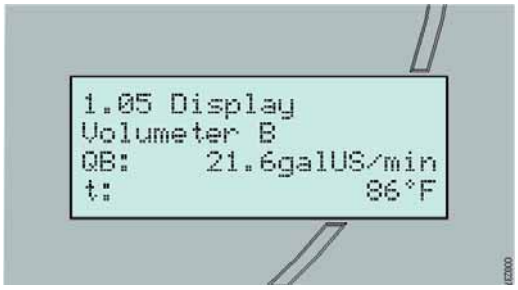
1.04 Display Volumeter A Total with resetting



Resetting functions similarly to Menu item 1.02.
By pressing the ARROW UP key, the "Volumeter B" window is displayed.

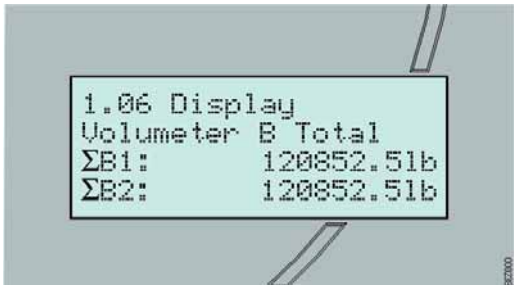
1.05 Display Volumeter B

The flow rate and temperature in Volumeter B are displayed on the "Volumeter B" page.



If the temperature lies outside the permissible range or if no temperature sensor is connected, "---,-" is displayed.
By pressing the ARROW UP key, the "Volumeter B Total" page is displayed.

1.06 Display Volumeter B Total with resetting



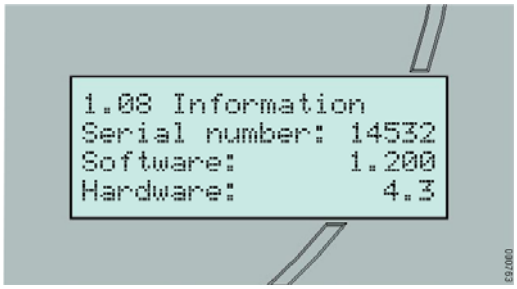
Resetting functions similarly to Menu item 1.02. By pressing the ARROW UP key, the "Reset bypass and coll. error message" page is displayed.

1.07 Display Reset bypass and coll. 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 to reset by pressing the SET and ARROW UP or ARROW DOWN keys. Pressing SET once more carries out the function.

By pressing the ARROW UP key, the "Information" page is displayed.

1.08 Display Information



By pressing the ARROW UP key, the "Setting Display Brightness" page is displayed.

1.09 Setting Display Brightness

The brightness of the display can be set here.

By pressing the ARROW UP key, the "Setting Display Contrast" page is displayed.

1.10 Setting Display Contrast

The contrast can be set on this page.

Pages 1.11 and 1.12 are described separately, see "Shortcut pages", page 29.

Menu 2: Settings

Menu 2 allows adaptation in accordance with the requirements of the measuring task. All the settings can only be changed after the password has been entered. The password is included in the scope of delivery and consists of four digits.

2.01 Setting Enable Password

The function is selected with SET.
The password is displayed when the ARROW UP or ARROW DOWN key is pressed.
Ex-works the password setting is "1000".
The password can be entered by using the arrow keys, see "General operating steps", page 26.
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.

By pressing the ARROW UP key, the "Select Mode" page is displayed.

2.02 Setting Select Mode

The selection of the mode is adapted to the measuring task.
"Volume" means the volumetric flow measurement without consideration of temperature influences.
"Volume at X°" takes the temperatures in the inlet and outlet into consideration and calculates the consumption at a reference temperature X°, see 2.03 "Setting Select Temperature X°".
"Volume measurement at TA" calculates the consumption at the inlet temperature TA. The inlet temperature usually corresponds to the temperature of the medium in the tank.

By pressing the ARROW UP key, the "Select Temperature X°" page is displayed.

2.03 Setting Select Temperature X

The reference temperature is set in this dialog box.
Since setting is only effective if "Volume at X°" was selected under 2.02.

By pressing the ARROW UP key, the "Select Unit Rate" page is displayed.

2.04 Setting Select Unit Rate

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

By pressing the ARROW UP key, the "Select Unit Total" page is displayed.

2.05 Setting Select Unit Total

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

By pressing the ARROW UP key, the "Select Unit Temperature" page is displayed.

2.06 Setting Select Unit Temperature

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

By pressing the ARROW UP key, the "Select Unit Density" page is displayed.

2.07 Setting Select Unit Density

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

By pressing the ARROW UP key, the "Select Density table" page is displayed.

2.08 Setting Select Density table

A maximum of 2 density tables are available when 2 different media are used. The density table is selected in this dialog box.

By pressing the ARROW UP key, the "Function analog output" page is displayed.

2.09 Setting Select Function Analog output

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

By pressing the ARROW UP key, the "Allocation Analog output 1" page is displayed.

2.10 Setting Allocation Analog output 1

A rate value can be assigned freely to the analog output 1.

Available rate values:

- ☐ Q Consumption rate A-B
- ☐ QA Flow rate A
- ☐ QB Flow rate B

By pressing the ARROW UP key, the "Scale Analog output 1" page is displayed.

2.11 Setting Scale Analog output 1

Scaling of the analog output allows the maximum value to be set. The maximum value is set slightly higher than the highest possible occurring flow rate.

By pressing the ARROW UP key, the "Allocation Analog output 2" page is displayed.

2.12 Setting Allocation Analog output 2

A rate value can be assigned freely to the analog output 2.

Available rate values:

- ☐ Q Consumption rate A-B
- ☐ QA Flow rate A
- ☐ QB Flow rate B

By pressing the ARROW UP key, the "Scale Analog output 2" page is displayed.

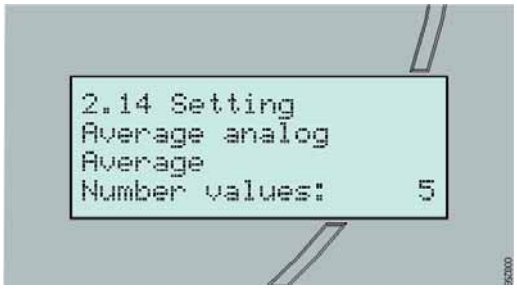
2.13 Setting Scale Analog output 2

Scaling of the analog output allows the maximum value to be set. The maximum value is set slightly higher than the highest possible occurring flow rate.

By pressing the ARROW UP key, the "Average analog output" window is displayed.

2.14 Setting Average Analog output

If the flow rate fluctuates strongly, it may be necessary for the signal transfer to be averaged. Averaging can be adapted to the requirements with values between 1 and 1000. If "1" is selected, averaging is not carried out. The analog output is controlled directly. If "1000" is selected, averaging is carried out across 150 seconds. Averaging always worsens the time response of the output signal.

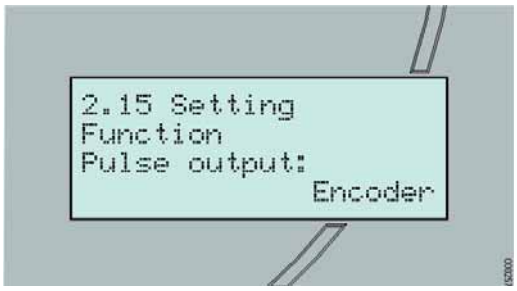


By pressing the ARROW UP key, the "Function pulse output" page is displayed.

2.15 Setting Function Pulse output

The two pulse outputs can be used independently. To this purpose the setting "Independent" is selected. If the "Encoder" setting is used, both pulse supply two 90° phase-displaced rectugular signals. This allows the information about the flow direction to be passed on. In the "Encoder" setting the allocation of the second pulse output and its scaling remain without effect.

Menu 2: Settings

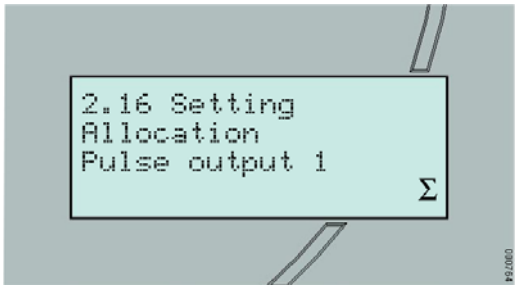


By pressing the ARROW UP key, the "Allocation Pulse output 1" page is displayed.

2.16 Setting Allocation Pulse output 1

A total value can be assigned freely to the pulse output 1.
Available total values are:

- ☐ S Consumption A-B
- ☐ SA Volumeter A
- ☐ SB Volumeter B



By pressing the ARROW UP key, the "Scale Pulse output 1" page is displayed.

2.17 Setting Scale Pulse output 1

Scaling of the pulse output allows the pulse significance to be set.

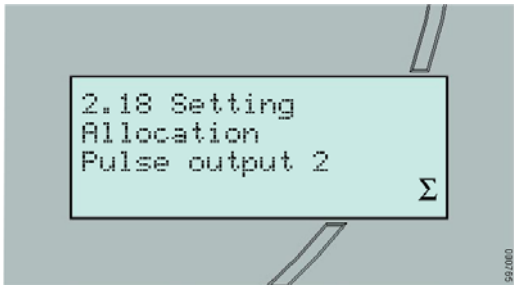
By pressing the ARROW UP key, the "Allocation Pulse output 2" page is displayed.

2.18 Setting Allocation Pulse output 2

A total value can be assigned freely to the pulse output 2.
Available total values are:

- ☐ S Consumption A-B
- ☐ SA Volumeter A
- ☐ SB Volumeter B

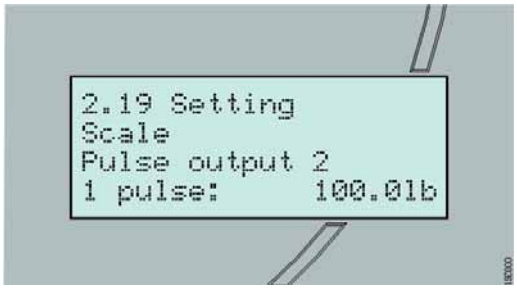
This allocation is only effective in the setting Function Pulse output "independent!



By pressing the ARROW UP key, the "Scale Pulse output 2" page is displayed.

2.19 Setting Scale Pulse output 2

Scaling of the pulse output allows the pulse significance to be set. This allocation is only effective in the setting Function Pulse output "independent!



By pressing the ARROW UP key, the "Limit value Relay 1" page is displayed.

2.20 Setting Limit value Relay 1

The function allows the automatic activation of a bypass valve when a volumeter is blocked. The limit value is selected smaller that the smallest minimum flow rate occurring in normal operation.

By pressing the ARROW UP key, the "Start message" page is displayed.

2.21 Setting Display Start message

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

By pressing the ARROW UP key, the "Address Modbus" page is displayed.

2.22 Setting Address Modbus

The transfer of data by means of the Modbus is possible via the serial interface. The address can be set here.

Attention: Data exchange via the bus connection is not protected by the password!
Writing deletes the existing values. Therefore we recommend only reading of the data.
By pressing the ARROW UP key, the "Function Sensor" page is displayed.

2.23 Setting Function Sensor

The setting of the sensor type has to be adapted to the pulse encoder used.
The following signals are available:

- ☐ PNP
- ☐ Namur
- ☐ NPN
- ☐ Push/pull

By pressing the ARROW UP key, the "Link Channel A B" page is displayed.

2.24 Setting Link Channel A B

If 2 volumeters are used, the link can be selected:

- ☐ "A-B" is used in consumption measurement.
- ☐ "A+B" is used at the combination of two measuring systems.

By pressing the ARROW UP key, the "Threshold value A B" page is displayed.

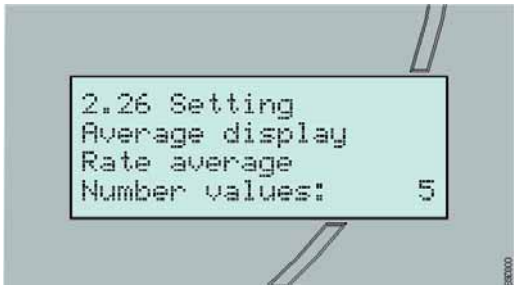
2.25 Setting Threshold value A-B

The threshold value is required in the consumption measurement application if the consumer is switched off and the circulation pump continues to be operated. The threshold value is selected clearly lower than the smallest possible consumption.

By pressing the ARROW UP key, the "Average display Rate" page is displayed.

2.26 Setting Average display Rate

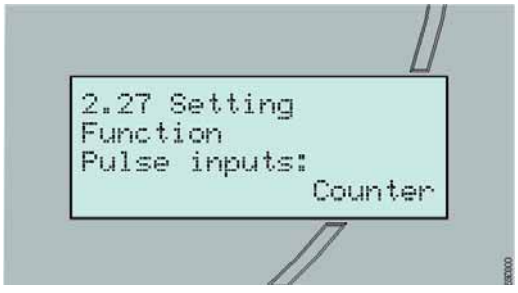
In the case of fluctuating flow rates the use of mean-value generation allows a stable display. Averaging can be adapted to the requirements with values between 1 and 1000. If "1" is selected, averaging is not carried out. The values are displayed directly. If "1000" is selected, averaging is carried out across 150 seconds. However, rapid changes are only displayed with a time delay.



By pressing the ARROW UP key, the "Function pulse input" page is displayed.

2.27 Setting Function Pulse input

If one pulse each is used per volumeter, the "Counter" function is selected.
"Encoder" is used if the volumeter is equipped with 2 pulse encoders (pressure pulse compensation option).



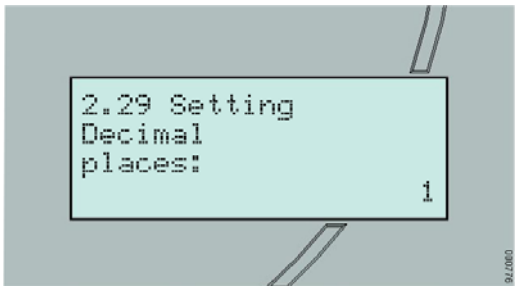
By pressing the ARROW UP key, the "Reset to factory setting" page is displayed.

2.28 Setting Reset to factory setting

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

2.29 Setting Decimal places

This page enables the selection of the number of decimal places. 1–3 decimal places are available.



Menu 3: K-factors Volumeter A

The K-factors of Volumeter A are entered with ascending frequency in Menu 3 "K-factors Volumeter A". This function shows the linearization characteristic of Volumeter A.
In case no linearization is required it is sufficient to enter the resulting K-Factor on page 3.01 and a K-Factor of "0" on page 3.02. The purpose of entering the maximal frequency on page 3.07 is the indication of the fault message "Maximum flow rate exceeded".

3.01 K-factor Volumeter A Point 1

By pressing the ARROW UP key, the "Volumeter A Point 2" page is displayed.

3.02 K-factor Volumeter A Point 2

If the ARROW UP key is pressed repeatedly, the pages of the K-factors Volumeter A, Point 3 to 7 are displayed consecutively.

3.07 K-factor Volumeter A Point 7

The frequency value of Point 7 is used to calculate the maximum flow rate of Volumeter A. If the maximum flow rate is exceeded an alarm message can be displayed, see "Alarms", page 40.

Menu 4: K-factors Volumeter B

The K-factors of Volumeter B are entered with ascending frequency in Menu 4 "K-factors Volumeter B". This function shows the linearization characteristic of Volumeter B.
In case no linearization is required it is sufficient to enter the resulting K-Factor on page 4.01 and a K-Factor of "0" on page 4.02. The purpose of entering the maximal frequency on page 4.07 is the indication of the fault message "Maximum flow rate exceeded".

4.01 K-factor Volumeter B Point 1

If the ARROW UP key is pressed repeatedly, the pages of the K-factors Volumeter B, Point 2 to 7 are displayed consecutively.
According to Menu 3 "K-factors Volumeter A" the frequency value of Point 7 is used to calculate the maximum flow rate of Volumeter B.

Menu 5: Density table 1

Menu 5 "Density table 1" allows a temperature compensation and the mass conversion of the flow rate values.
The density table is entered in accordance with the medium used. If only the first value of the density table is entered, a display with a mass unit is possible without the connection of a temperature sensor.
The density table can be requested from the supplier of the medium.
If no density value is entered, the temperature inputs are inactive. If a density value is entered, the temperature inputs are also inactive. However a conversion to mass units is possible. Prerequisite is that the process temperature is constant and is known and that the density at this temperature has been entered.

5.01 Density table 1 Point 1

The values of the densitya table are entered. The temperature values have to be entered in ascending order

By pressing the ARROW UP key, the "Density table 1 Point 2" page is displayed.

5.02 Density table 1 Point 2

If the ARROW UP key is pressed repeatedly, the pages of the Density table 1, Point 3 to 10 are displayed consecutively.

5.10 Density table 1 Point 10

A density table consists of 10 value pairs. This generally allows a high-quality mapping of the volume-to-mass relationship to be formed.

Menu 6: Density table 2

If different media are used, it is possible to enter two density tables. The density table used is selected in Menu 2 "Settings", see "2.08 Setting Select Density table", page 33.
The values of the density table are entered similarly to Menu 5. The temperature values have to be entered in ascending order. If only the first value of the density table is entered, a display with a mass unit is possible without the connection of a temperature sensor.

6.01 Density table 2 Point 1

If the Arrow Up key is pressed repeatedly, the pages of the Density table 2, Points 2 to 10 are displayed consecutively.

Menu 7: Alarms

The electronic unit evaluates different measured values during operation and analyzes the operating state. If appropriate, the self-diagnostic function displays an alarm message. This provides information used to eliminate the error.
When an alarm occurs, this is shown on the display. The alarm can be confirmed by pressing the SET key. After confirmation active alarms can be displayed with SET and ARROW LEFT.
The individual pages of the menu are described in the fault table, see "Alarms", page 40.

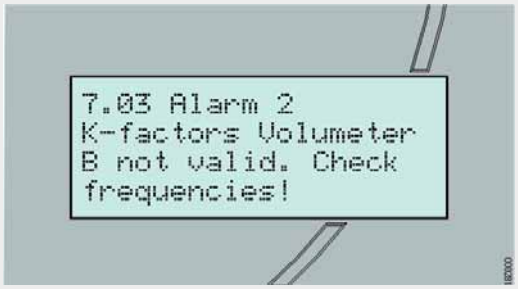
Information on faults

Faults can have different causes. In the following tables on troubleshooting the causes are classified and are identified by the following symbols:

Symbol	Cause
	Faults in the electronic unit
	Faults in the KRAL Volumeter®
	Faults in the plant
	Input errors

Thanks to the high quality standard faults in the system 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.

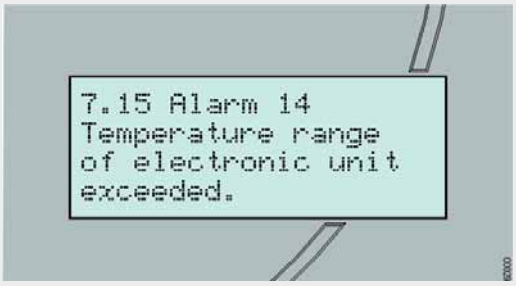
Alarms

Fault display	Cause and remedy	Checked
	There is no fault. ➤ No operating steps necessary.	
	The frequencies of Volumeter A are not entered in ascending order. ➤ Enter the frequencies in ascending order, see "Menu 3: K-factors Volumeter A", page 37.	☐
	The frequencies of Volumeter B are not entered in ascending order. ➤ Enter the frequencies in ascending order, see "Menu 4: K-factors Volumeter B", page 38.	☐

Fault display	Cause and remedy	Checked
	The temperatures are not entered in ascending order. ➤ Enter the temperatures in ascending order, see "Menu 5: Density table 1", page 38.	☐
	The temperatures are not entered in ascending order. ➤ Enter the temperatures in ascending order, see "Menu 6: Density table 2", page 39.	☐
	Relay 2 and the connected bypass valve have been activated. ➤ Check the volumeter for blocking. ➤ Set the limit at proper functioning.	☐ ☐
	The maximum permissible flow rate was exceeded in a volumeter. ➤ Limit the flow rate. ➤ Check the volumeter. ➤ Use a larger size.	☐ ☐ ☐
	The maximum permissible temperature of the volumeter has been exceeded. ➤ Limit the temperature in the plant. ➤ Use suitable sensors. ➤ Use suitable volumeters.	☐ ☐ ☐

Alarms

Fault display	Cause and remedy	Checked
	The flow rate exceeds the maximum scale value of an analog output. ➤ Correct the scale, see "2.11 Setting Scale Analog output 1", page 34 and see "2.13 Setting Scale Analog output 2", page 34.	☐
	The flow rate exceeds the maximum scale value of a pulse output. ➤ Correct the scale, see "2.17 Setting Scale Pulse output 1", page 35 and see "2.19 Setting Scale Pulse output 2", page 35. The maximum frequency of the pulse output amounts to 250 Hz.	☐
	A pulse encoder at Volumeter A has failed. This error message is only displayed at the setting Function pulse inputs "Encoder", see "2.27 Setting Function Pulse input", page 37. ➤ Check the connections of the pulse encoder. ➤ Check the position of the pulse encoder in the dry bush. ➤ Replace the pulse encoder.	☐ ☐ ☐
	A pulse encoder at Volumeter B has failed. This error message is only displayed at the setting Function pulse inputs "Encoder", see "2.27 Setting Function Pulse input", page 37. ➤ Check the connections of the pulse encoder. ➤ Check the position of the pulse encoder in the dry bush. ➤ Replace the pulse encoder.	☐ ☐ ☐
	Temperature sensor A is defective. ➤ Check the connection. ➤ Replace the sensor. This function in only active at temperature compensation or mass measurement with at least two density/temperature value pairs.	☐ ☐

Fault display	Cause and remedy	Checked
	Temperature sensor B is defective. ➤ Check the connection. ➤ Replace the sensor. This function in only active at temperature compensation or mass measurement with at least two density/temperature value pairs.	☐ ☐
	The temperature range of the electronic unit has been exceeded. ➤ Check the electronic unit. ➤ Replace the electronic unit.	☐ ☐
	The unit of density has been changed. ➤ Convert the numerical values and correct the density table.	☐
	The temperature unit has been changed. ➤ Convert the numerical values and correct the density table.	☐
	The unit of the rate has been changed. ➤ Check the analog output scale and correct it.	☐

Further faults

Fault display	Cause and remedy	Checked
	The unit of Total has been changed. ➤ Check the pulse output scale and correct it.	☐

Tab. 1 Alarms

Further faults

Further faults	Cause and remedy	Checked
Rate = 0, although pulse signals can be measured at the terminals of the electronic unit with the oscilloscope.	One pulse encoder each is connected and the function pulse input "Encoder" is selected. ➤ Select the "Counter" function, see "2.27 Setting Function Pulse input", page 37.	☐
Analog output does not function.	Analog output function selected incorrectly. ➤ Select the correct function, see "2.09 Setting Select Function Analog output", page 33.	☐
	Signal cable connected to an incorrect analog output. ➤ Correct the connection.	☐

Tab. 2 Further faults

Maintaining the electronic unit

The electronic unit is maintenance-free.

Cleaning the electronic unit

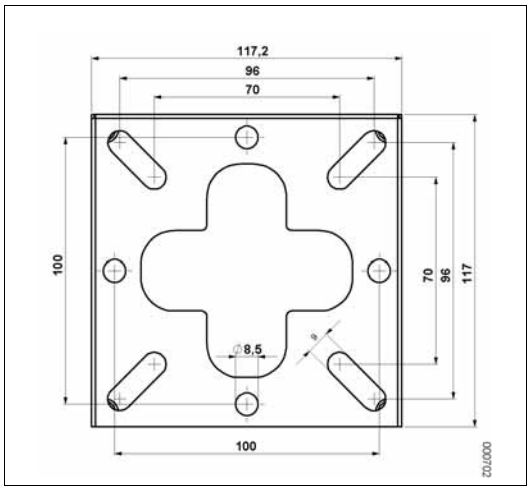
In order to clean the electronic unit wipe the enclosure with a soft cloth. In case of stronger soiling moisten the cloth with water that has a common detergent added. Only wipe the surface off lightly with a moist cloth. Under no circumstances may water penetrate the inside of the electronic unit!

Accessories mounting

As described in section "Installation and removal" there are different ways of installing the electronic unit into a system. In addition to the mounting frame which is included in the scope of delivery, several fixing devices are available as accessories for the mounting of the electronic unit.

Fixing device universal mount

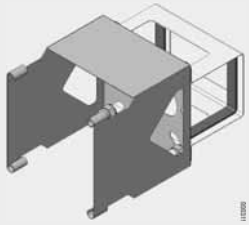
Fixing device	Application	Item no.	applicable for
 Universal mount	Wall mounting	UZA 20	BEM 300 BEM 500



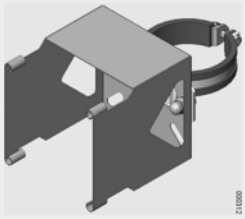
Fixing: M8

Fig. 1 Fixing dimensions Universal mount UZA 20

Fixing device OME

Fixing device	Application	Item no.	applicable for
 Fixing device OME	Mounting on Volumeter OME	UZA 21	BEM 300 / OME 13 BEM 500 / OME 13
		UZA 22	BEM 300 / OME 20 BEM 500 / OME 20
		UZA 23	BEM 300 / OME 24 BEM 500 / OME 24
		UZA 24	BEM 300 / OME 32 BEM 500 / OME 32

Fixing device Pipe mounting / mounting on Volumeter OMG

Fixing device	Application	Item no.	applicable for	Pipe diameter [mm] min.	max.
 Fixing device Pipe / OMG	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

Accessories electrical connection

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

Rack mounting power supply unit EEN 12

Fig. 2 Rack mounting supply unit EEN 12

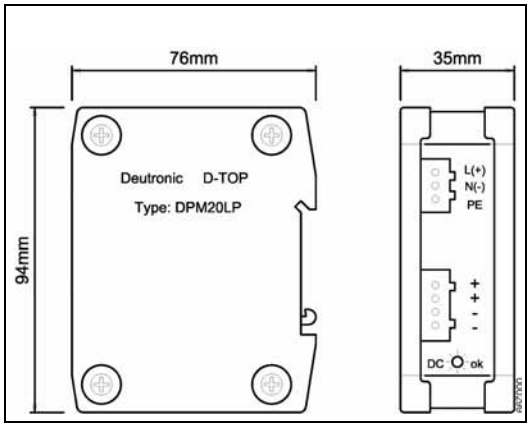


Fig. 3 Dimensions

Input	Data
Input voltage	☐ 100–240 V AC (tolerance: 93–265 V AC) 47 – 63 Hz 135–370 V DC
Inrush current	☐ 230 V AC: 30 A max. ☐ 115 V AC: 15 A max. limited by NTC, cold start values
Overvoltage protection Input	☐ Varistor
Fuse	☐ Internal fuse T4A 250 V, additional external fuse not required
Current consumption	☐ 230 V AC: 0.25A typ. ☐ 115 V AC: 0.5A typ.

Accessories electrical connection

Output	Data
Output voltage	24 V DC
Output current	850 mA
Operational indication	LED at front panel
Current limiting	Fold-back, set to approx. 1.05 x INominal
Load regulation stat. 10-90%	0.1%
Load regulation dyn. 10-90%	1.0%
Recovery time	1 ms
Line regulation ±10%	0.1%
Hold up time	> 20 ms
Ripple & noise (p-p)	< 50 mVss
Switching spikes	< 100 mVss
Overvoltage protection at output	Suppressor diode (transildiode)

Environment	Data
Storage temperature	-40 °C ~ +85 °C
Operating temperature	-25 °C ~ +60 °C, above 50 °C derate 1.5%/°C
Cooling	Natural convection
Electrical safety	Assembly acc. to EN60950
Degree of protection	IP20
Insulation voltage	Input/Output 3 kV each unit
EMC RFI emission	EN55011-B
Immunity to interference	EN61000-6-2
Efficiency	83%, depending on input and output voltage
Connections: Screw-type terminals, plug type	☐ 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
Case	Steel housing, clip fastening on DIN rail TS35 (EN60715) or with screws

Terminal assignment

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

Plug-in power supply unit EEN 13

The set contains interchangeable connections, which can be used in most countries around the world.

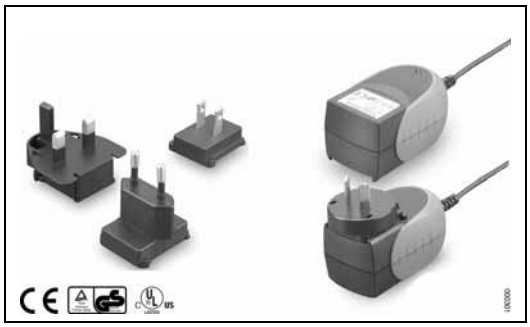
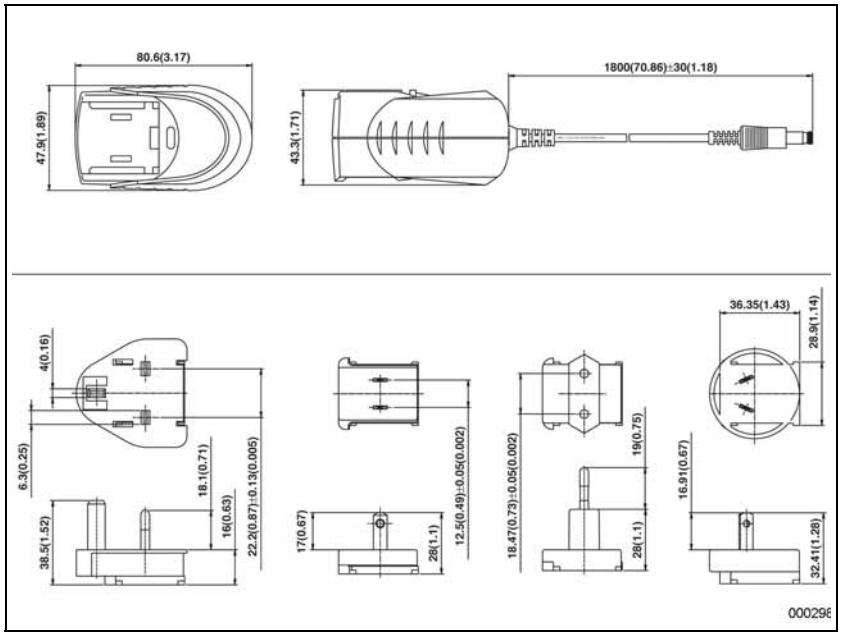


Fig. 4 Plug-in power supply unit EEN 13



Unit: mm (Inch)

Fig. 5 Dimensions 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%
Max. output current	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°~ +85 °C
Dimensions	80.6x47.9x43.3 mm
Weight	130 g

Cable assignment

Connection	Function	Colour
Output	+24 V	white
Output	GND	black

Accessories data acquisition

The electronic unit displays instantaneous values. For periodical acquisition of measurement values several accessories are available which enable storage of the values at freely defined intervals. Values can be analysed afterwards and exported for further processing.

Data logger BEA 60 and BEA 61

Scope of delivery:

- ☐ Data logger BEA 60 or BEA 61
- ☐ Software-CD
- ☐ Connection cable RS 232
- ☐ Connection cable for pulse or analog input

Fig. 6 Data logger BEA 60

Input	BEA 60	BEA 61
Analog input	4–20 mA	–
Pulse input	–	24 V
Maximum input	50 mA	50 mA
Input impedance	10 Ohm	10 Ohm
Resolution	0.08 mA	0.08 mA
Accuracy	±0.1 mA ±0,6%	±0.1 mA ±0,6%

Features	BEA 60	BEA 61
Memory Size	16 k (non-volatile)	16 k (non-volatile)
Number of readings	16000	16000
Resolution	8 bit	8 bit

Features	BEA 60	BEA 61
Stop Options	☐ when full ☐ after n readings ☐ first in first out	☐ when full ☐ after n readings ☐ first in first out
Logging interval	1 sec. to 10 days	1 sec. to 10 days
Range	–	0–255 Impulse pro Datensatz
Operating temperature	-40 °C – +85 °C	-40 °C – +85 °C
Battery life	up to 5 years	up to 5 years

Dimensions

Case	BEA 60	BEA 61
Height	34 mm	34 mm
Width	59 mm	59 mm
Depth	80 mm	80 mm
Weight	110 g	110 g
Degree of protection	IP 68	IP 68

Accessories display

Usually the electronic unit BEM 500 is mounted nearby the Volumeters. Via bus interface communication of the electronic unit is possible by using an additional display. This remote display is able to display the measurement values of the electronic unit. Thus current consumption, total values and temperatures are able to be displayed to a distance up to 200 m.

Remote display BEA 59

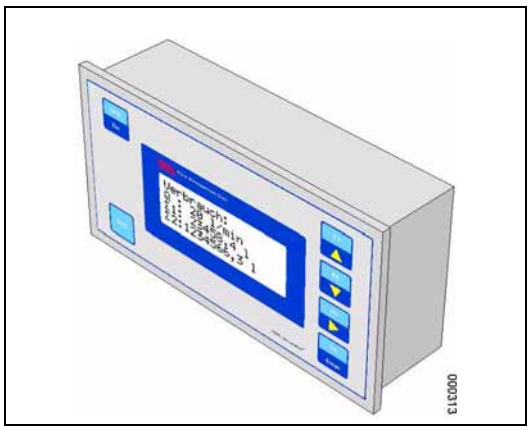


Fig. 7 Remote display BEA 59

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

KRAL

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