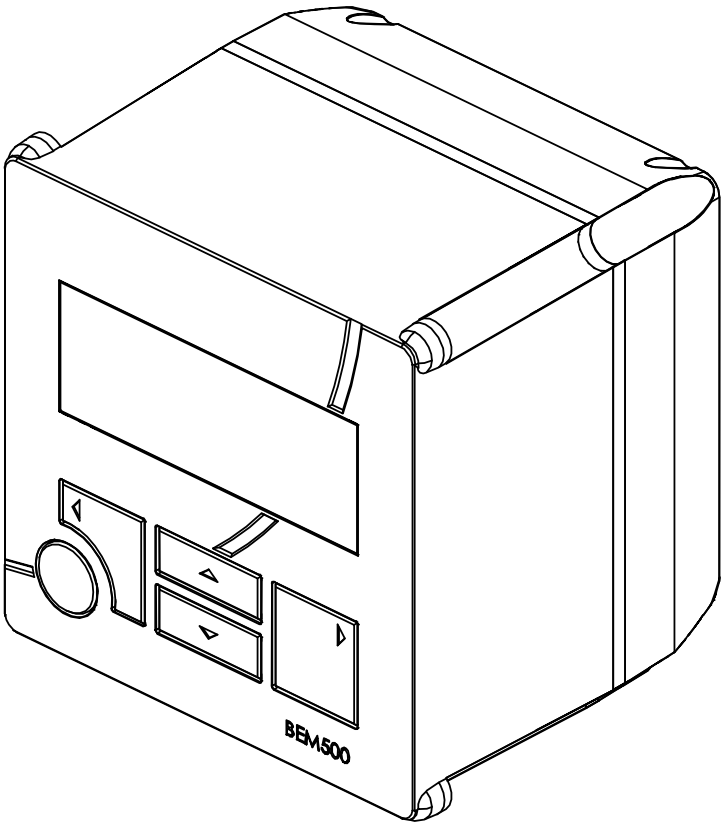
Operation instructions



KRAL display and processing unit

BEM 500

SW 3.004

OIE 12en-GB
Edition 2020-03
Original instructions

Table of contents

1 About this document

1.1 General information

These instructions form part of the product and must be kept for future reference. Furthermore please observe the associated documents.

Notice In these operating instructions the designation "Electronic unit" is used for the "Display and processing unit".

1.2 Target groups

The instructions are intended for the following persons:

- ☐ Persons who work with the product
- ☐ Operator-owners who are responsible for the use of the product

Persons who work with the product must be qualified. The qualification ensures that possible dangers and damage to property that are connected to the activity are detected and avoided. These persons are qualified personnel who carry out the work properly due to their training, knowledge and experience and on the basis of the relevant provisions.

Information on the qualification of the personnel is provided separately at the beginning of the individual chapters in these instructions. The following table provides an overview.

Target group	Activity	Qualification
Fitter	Mounting, connection	Qualified personnel for mounting
Electrician	Electrical connection	Qualified personnel for electric installation
Trained personnel	Delegated task	Personnel trained by the operator-owner who know the task delegated to them and the possible dangers arising through improper behaviour.

Tab. 1: Target groups

1.3 Associated documents

- ☐ Declaration of conformity according to EU Directive 2014/30/EU
- ☐ Corresponding operating instructions of the flowmeter
- ☐ Corresponding operating instructions of the sensor
- ☐ Calibration certificate
- ☐ Work sheet
- ☐ Wiring diagram

1.4 Symbols

1.4.1 Danger levels

	Signal word	Danger level	Consequences of non-observance
	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
	ATTENTION	Potentially dangerous situation	Material damage

1.4.2 Danger signs

	Meaning	Source and possible consequences of non-observance
	Electrical voltage	Electrical voltage causes serious physical injury or death.

1.4.3 Symbols in this document

	Meaning
	Warning personal injury
	Safety instruction
	Request for action
1.  2. 3.	Multi-step instructions for actions
⇨	Action result
	Cross-reference

2 Safety

2.1 Proper use

- ☐ The electronic unit is provided for usage with a KRAL flowmeter.
- ☐ Use the electronic unit only within the operating limits specified in the "Technical data" chapter.

2.2 Foreseeable misuse

- ☐ Any use that extends beyond the proper use or any other use is misuse.

2.3 Fundamental safety instructions

The following safety instructions must be observed:

- ☐ Read the operating instructions carefully and observe them.
- ☐ Have work only carried out by qualified personnel/trained personnel.
- ☐ Wear personal protective equipment and work carefully.
- ☐ Observe the operating instructions of the flowmeter and of the sensors.

3 Technical data

3.1 Dimensional drawing

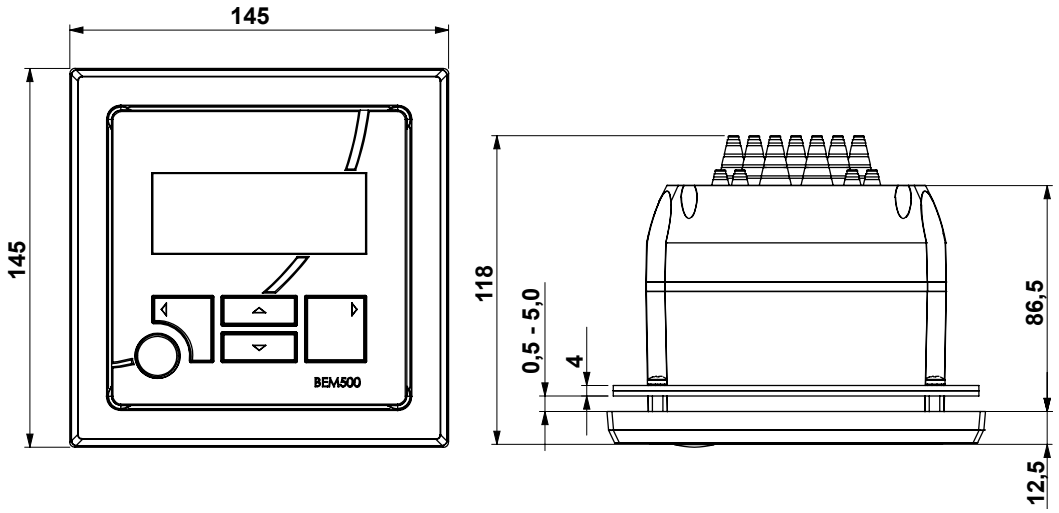


Fig. 1: Dimensional drawing

Parameter	Unit	Value
H x W x D	[mm]	145 x 145 x 118

Tab. 2: Dimensions

3.2 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

Tab. 3: Display

3.3 Connection data

3.3.1 Power supply

Parameter	Unit	Value
Power supply	[V DC]	24 ± 20 %
Max. current consumption	[mA]	0.5
Insulation voltage	[V]	<500

3.3.2 Tension spring terminals

Cable type	Unit	Terminating range
Strand	[mm²]	0.08 – 2.5
Litz wires	[mm²]	0.08 – 2.5
Wire end ferrule	[mm²]	0.25 – 1.5

3.3.3 Pulse input and temperature input

Input	Designation		Unit	Value
Pulse input	Limit frequency min. - max.		[Hz]	0.3 – 20000
	Power supply	NPN/PNP	[V DC]	24
		Namur	[V]	8.2
	Input impedance	NPN/PNP	[kΩ]	3.2
		Namur	[kΩ]	1
	Switching threshold/ hysteresis	NPN/PNP	[V]	4.5/0.2
		Namur	[V]	1.65/0.2
	Can be configured for counter mode or encoder mode			
	Chronological phase shift min. for direction detection in Encoder mode		[µs]	0.2
Temperature input	Three-wire Pt100			
	Range min. – max.		[°C]	-40 ... +200
	Resolution		[°C]	0.1

3.3.4 Analog output, pulse output and relay output

Output	Designation	Unit	Value
Analog output 4 – 20 mA	Active current source		
	Short-circuit proof		
	Scalable		
	Load	[Ω]	<500
	Electrical isolation	[V_{eff}]	500
	Resolution	[µA]	1
	Temperature drift	[%]	± 0.1
	Calibration tolerance	[%]	± 0.1
	Reaction time until Averaging 8: 20 ms x smoothing value		
	Reaction time as of Averaging 9: 0.15 s x smoothing value		
Analog output 0 – 10 V	Active voltage source		
	Short-circuit proof		
	Scalable		
	Load	[Ω]	> 500
	Resolution	[mV]	1
	Temperature drift	[%]	± 0.1
	Calibration tolerance	[%]	± 0.1
	Reaction time until Averaging 8: 20 ms x smoothing value		
	Reaction time as of Averaging 9: 0.15 s x smoothing value		

Output	Designation		Unit	Value
Pulse output	Active pulse source (PNP transistor switches power supply)			
	Short-circuit proof			
	Scalable			
	Output current max.		[mA]	20
	Load		[kΩ]	> 1
	Signal level at 24 V DC power supply	High	[V DC]	> 20
		Low	[V DC]	<1
	Pulse width can be set	High	[ms]	2 – 200
	Max. output frequency at pulse width 2 ms	***Independent***	[Hz]	250
		Encoder	[Hz]	125
	Flow direction detection in the Encoder mode possible			
Relay output	Potential-free change-over contact			
	Fuse protection by customer required			
	Nominal load voltage		[V AC]	250
			[V DC]	30
	Switching current, ohmic		[A AC/DC]	6
	Switching current, inductive		[A AC/DC]	2
	Switching time max.		[ms]	8
	Switching cycles min.			30000

3.3.5 Modbus interface

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

3.4 Connection field

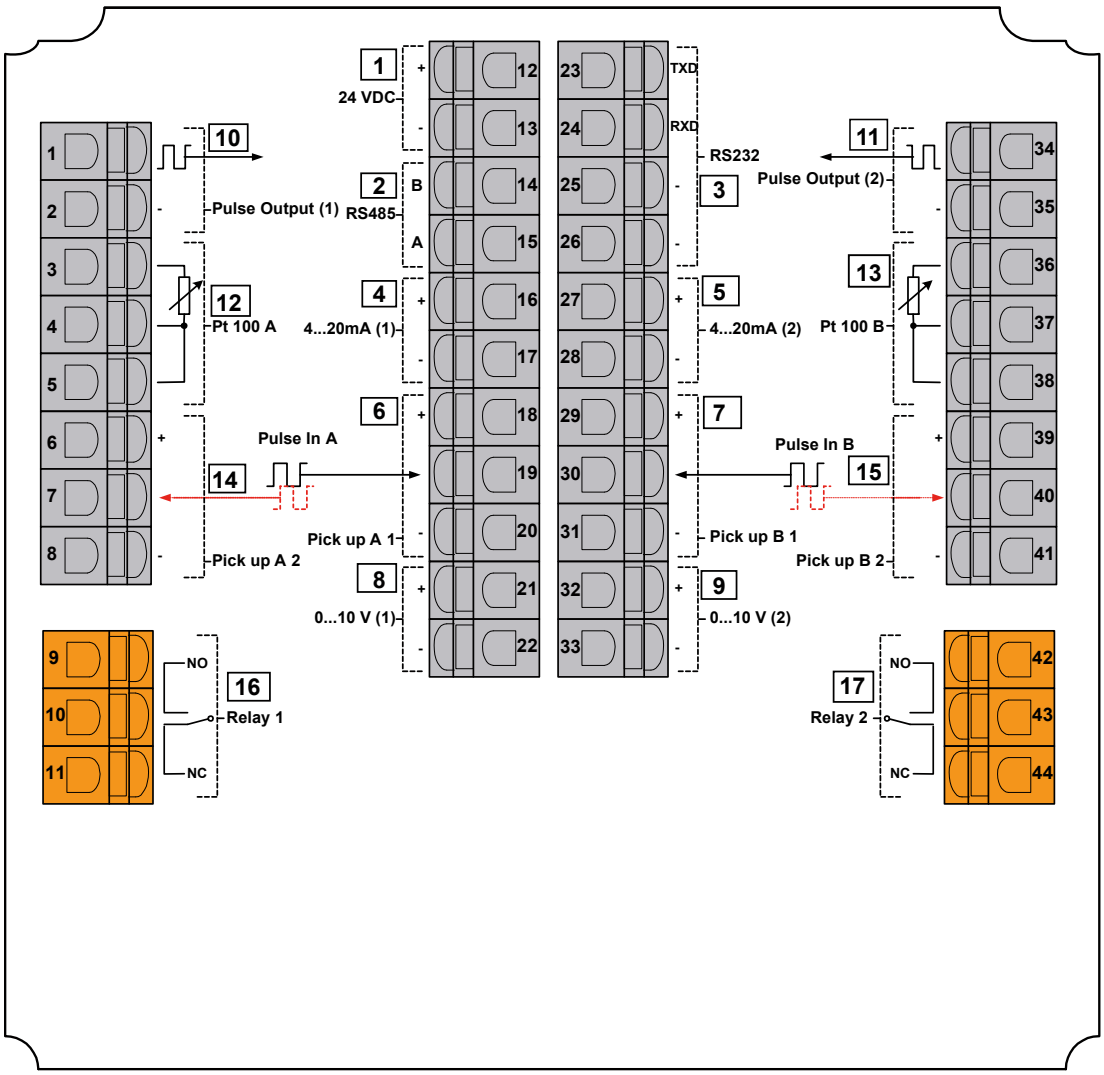


Fig. 2: Termination panel electronic unit

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

The Modbus connection takes place 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 Setting Modbus address***.

3.5 Pin assignment

Component	Connection/function			Terminal	
Pick up		**NPN/PNP Push-pull**	**Namur**	**Flowmeter A**	**Flowmeter B**
	Pick up A1 or B1	U+24 V DC	U+8.2 V DC	18	29
		Signal	Signal	19	30
		Gnd	–	20	31
	Pick up A2 or B2 (+90°)	U+24 V DC	U+8.2 V DC	6	39
		Signal	Signal	7	40
		Gnd	–	8	41
Analog output				**4 – 20 mA**	**0 – 10 V**
	Analog output 1	Signal		16	21
		Gnd		17	22
	Analog output 2	Signal		27	32
		Gnd		28	33
Pulse output	Pulse output 1	Signal		1	
		Gnd		2	
	Pulse output 2	Signal		34	
		Gnd		35	
Relay output	Relay output 1 bypass valve/filling valve	NO contact		9	
		Switching contact		10	
		NC contact		11	
	Relay output 2 group error message	NO contact		42	
		Switching contact		43	
		NC contact		44	
Temperature sensor				**Flowmeter A**	**Flowmeter B**
	Temperature sensor	Signal		3	36
		Common		4	37
		Common		5	38
Serial interface	RS 485	B		14	
		A		15	
	RS 232	TxD		23	
		RxD		24	
		Gnd		25	
		Gnd		26	
Power supply	Different power supply units are available as accessories ↳ Accessories, Page 42.				
	+24 V DC			12	
	Gnd			13	

Tab. 4: Pin assignment

3.6 Ambient conditions

Parameter	Unit	Data/value
Storage temperature min. – max.	[°C]	-20 ... +80
Operating temperature min. – max.	[°C]	-20 ... +70
Humidity (relative humidity, non-condensing)	[%]	97
EMC emitted interference/immunity to interference		EN 61326
Vibration		☐ EN 60068–2–47 ☐ EN 60068–2–64
Shock		EN 61373
Isolation min.	[V]	500
Degree of protection		IP 65

Tab. 5: Ambient conditions

3.7 Accessories

Notice The technical data of the accessories are specified separately ↳ Accessories, Page 42.

4 Function description

4.1 Functional principle

4.1.1 Usage

The electronic unit is provided for usage with a KRAL flowmeter.

Flowmeters 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 specified on the calibration certificate.

The pulse signals of up to two flowmeters can be evaluated. Pulse inputs for pick ups with the following functions is available:

- ☐ NPN
- ☐ PNP
- ☐ Namur

Either NPN or PNP can be selected for push-pull pick ups. In addition the flowmeters 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 operating data.

4.1.2 Volume measurement

Each positive edge of the pulse signal starts a period measurement and at the same time stops the previous measurement. The flow rate is then calculated via the frequency (= inverse of the period duration) and the K-factor. The inverse of the K-factor is the pulse value in l/P. This is retroactively added to the total sums for each positive edge of the signal.

4.1.3 Mass calculation

The volume can be converted into mass via a configurable fixed density value (menu 4).

4.1.4 Linearization

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

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

4.1.5 Temperature compensation

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

- With the option ***Volume at X°*** a normalized volume measurement is then possible at which the displayed values are converted to a reference temperature 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 flowmeter A. This option allows the comparison with a reservoir level.
- Measurement errors are also reduced for the ***Mass calculation*** option since the electronic unit now processes the actual density and not a stored mean value during the mass calculation. For the case of operation with diesel and heavy fuel oil the density calculation should be used since the density for heavy fuel oil is automatically calculated as of a liquid temperature of 70 °C. Below 70 °C the density calculation takes place for diesel. The changeover temperature of 70 °C was selected since the flash point of diesel lies at 60 °C.

4.1.6 Differential measurement

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

- The option ***A-B*** allows the subtraction of the values of both channels, e.g. supply and return line of a consumer supplied with a ring line. This allows differential measurement and the direct display of the consumption.
- The option ***A+B*** allows an addition of the values of both channels and with that, for example, the display of the total consumption of two consumers.

4.1.7 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 results at differential measurement with the option ***A-B*** for 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.

4.1.8 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 Setting Averaging Analog Average*** and see ***2.16 Setting Averaging Display Rate Average***.

4.1.9 Limit value bypass

The Limit value bypass function allows the automatic activation of a bypass valve when a flowmeter blocks. The bypass valve is actuated via Relay output 1. See ***3.13 Setting Function Relay 1***.

4.1.10 Group error message

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

4.1.11 Flow direction detection

In extreme cases the flow direction can change through pulsations, meaning through liquid waves in the pipe system. Through the use of two pick ups that supply signals out of phase by 90° (square wave 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 flowmeter. This means that the flow direction can be determined without additional components and taken into account in the calculation at any time.

4.1.12 Filling

A simple filling function can be implemented with the KRAL electronic unit, see ***1.07 Filling volume***. 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 Setting Function Relay 1***. The filling process can also be interrupted or aborted.

4.1.13 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 Modbus 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 liquid specifications
- ☐ Adaptation of the density tables if the analysis of the liquid requires other settings
- ☐ density calculation
- ☐ Linearization table with up to 7 preset K-factors per flowmeter
- ☐ 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

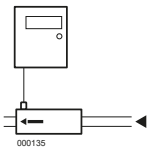
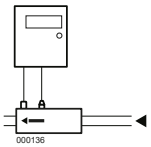
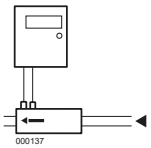
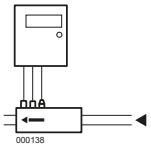
4.1.14 Modbus connection

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

4.1.15 Applications

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.

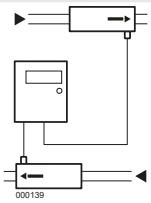
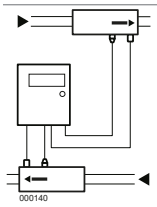
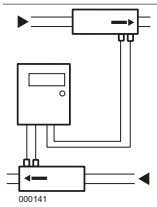
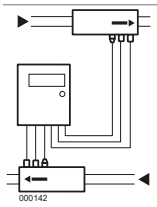
Single-line measurement

Extension stage	Components	Functions
 Basic	☐ 1 flowmeter ☐ 1 pick up ☐ 1 BEM 300 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ 1 analog output ☐ 1 pulse output
 Basic + temperature compensation	☐ 1 flowmeter ☐ 1 pick up ☐ 1 temperature sensor Pt100 ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Mass flow measurement ☐ Temperature compensation ☐ 2 relay outputs ☐ 2 analog outputs ☐ 2 pulse outputs ☐ Filling
 Basic + flow direction detection	☐ 1 flowmeter ☐ 2 pick ups ☐ 1 BEM 300 electronic unit	☐ Electronic evaluation ☐ Volume measurement ☐ Flow direction detection ☐ 1 analog output ☐ 1 pulse output
 Basic + flow direction detection + temperature compensation	☐ 1 flowmeter ☐ 2 pick ups ☐ 1 temperature sensor Pt100 ☐ 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 ☐ Filling

Tab. 6: Extension stages single-line measurement

Notice The BEM 500 electronic unit can also be used for two separate single-line measurements.

Differential measurement

Extension stage	Components	Functions
 Basic	☐ 2 flowmeters ☐ 1 pick up each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ 2 relay outputs ☐ 2 analog outputs ☐ 2 pulse outputs
 Basic + temperature compensation	☐ 2 flowmeters ☐ 1 pick up each ☐ 1 temperature sensor Pt100 each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Mass flow measurement ☐ Temperature compensation ☐ 2 relay outputs ☐ 2 analog outputs ☐ 2 pulse outputs
 Basic + flow direction detection	☐ 2 flowmeters ☐ 2 pick up each ☐ 1 BEM 500 electronic unit	☐ Electronic evaluation ☐ Differential measurement ☐ Flow direction detection ☐ 2 relay outputs ☐ 2 analog outputs ☐ 2 pulse outputs
 Basic + flow direction detection + temperature compensation	☐ 2 flowmeters ☐ 2 pick up each ☐ 1 temperature sensor Pt100 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. 7: Extension stages differential measurement

4.2 Modbus interface

Menu item	Variable designation	Data address (HEX)	No. of words	Raw data (decimal)	Decimal places	Explanation of data value	Data reading command to BEM (HEX)
1.01	Consumption rate Q	4000	2	+/-2 147 483 647	1 ... 3	Unit rate	0103 4000 0002 D1CB
1.02	Total 1	4002	2	+/-2 000 000 000	1 ... 3	Unit total	0103 4002 0002 700B
	Total 2	4004	2	+/-2 000 000 000	1 ... 3	Unit total	0103 4004 0002 900A
1.03	Volumeter A rate QA	4006	2	+/-2 147 483 647	1 ... 3	Unit rate	0103 4006 0002 31CA
	Volumeter A temp. tA	4008	2	-400 ... +3920	1	Unit temp.	0103 4008 0002 5009
1.04	Volumeter A total TA1	4100	2	+/-2 000 000 000	1 ... 3	Unit total	0103 4100 0002 D037
	Volumeter A total TA2	4102	2	+/-2 000 000 000	1 ... 3	Unit total	0103 4102 0002 71F7
1.05	Volumeter B rate QB	400C	2	+/-2 147 483 647	1 ... 3	Unit rate	0103 400C 0002 11C8
	Volumeter B temp. tB	400E	2	-400 ... +3920	1	Unit temp.	0103 400E 0002 B008
1.06	Volumeter B total TB1	4104	2	+/-2 000 000 000	1 ... 3	Unit total	0103 4104 0002 91F6
	Volumeter B total TB2	4106	2	+/-2 000 000 000	1 ... 3	Unit total	0103 4106 0002 3036
2.05	Unit rate	4016	1	1 ... 23	0	See Data value unit rate	0103 4016 0001 700E
2.06	Unit total	4015	1	1 ... 9	0	See Data value unit total	0103 4015 0001 800E
2.07	Unit temperature	4017	1	1 ... 2	0	See Data value unit temperature	0103 4017 0001 21CE
2.10	No. of decimal places	4186	1	1 ... 3	0	See Data value number of decimal places	0103 4186 0001 71DF

Tab. 8: Variables Modbus

Notice The display values in menu items 1.01 to 1.06 are signed 32 bit integer values. With double words, the higher-value word is always sent first.

Data value	Value	Meaning	Value	Meaning	Value	Meaning
Unit rate	1	l/sec	9	lb/sec	17	galUK/h
	2	l/min	10	lb/min	18	m^3/min
	3	l/h	11	lb/h	19	m^3/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		
Unit total	1	l	4	lb	7	m^3
	2	kg	5	galUS	8	g
	3	t	6	galUK	9	ml
Unit temperature	1	°C	2	°F		
No. of decimal places	1	1 decimal place, this means all values with 1 ... 3 decimal places must be divided by 10 (10^1) to get the actual value.				
	2	2 decimal places, this means all values with 1 ... 3 decimal places must be divided by 100 (10^2) to get the actual value.				
	3	3 decimal places, this means all values with 1 ... 3 decimal places must be divided by 1000 (10^3) to get the actual value.				

Tab. 9: Data values

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 bite 0 * 2^{28} + 0 * 2^{24} =	0
	00 **01**60 9E	2. Data bite 0 * 2^{20} + 1 * 2^{16} =	65536
	00 01**60** 9E	3. Data bite 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 sum			90270

If the value of a data query for data address is 4186 = 2 (see tab. Data values number of decimal places), the Modbus value bust be divided by 100. The result is then 902.7.

If the value of a data query for data address is 4015 = 5 (see tab. Data values unit total) The unit is total galUS.

The end result for Total TA1 is therefore 902.7 galUS.

Notice The numbering of the register addresses starts at 1, the data addressing at 0. This is how e.g. when reading register 1 the data address 0 is used.

Notice All units and the number of decimal places should be read out at least during initialization of the electronic unit, i.e. during switch-on, because these values can be modified manually.

Notice For parameter settings of the electronic unit via Modbus function 10 (hex) = write holding registers (preset multiple registers) can be used. Data exchange via the Modbus connection is not password-protected – avoid unintended overwriting of the total values or parameter addresses!

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

Reset 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

5 Transportation, storage

5.1 Scope of delivery

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

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

5.2 Unpacking and checking the state of delivery

Personnel qualification:	☐ Trained personnel

1. ▶ Upon delivery check the product 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.

6 Installation, removal

6.1 Dangers during installation, removal

The following safety instructions must be strictly observed:

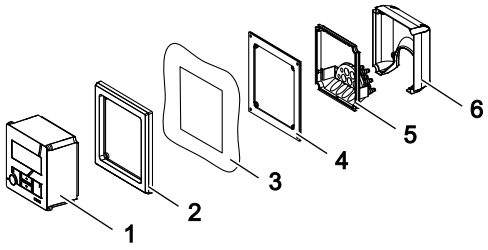
- ☐ Have all work only carried out by electricians.
- ☐ Do not take apart the electronic unit.

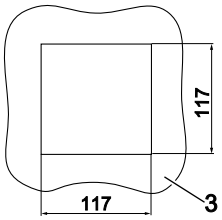
6.2 Installing the electronic unit in the control cabinet

Personnel qualification:	☐ Electrician
Personal protective equipment:	☐ Work clothing
Aids:	☐ KRAL tool set

Notice When the space is limited, mounting is also possible without a housing cover and without a seal with cable entries.

Notice An adapter set is available for converting BEM 4U to the electronic unit BEM 500 ↳ Accessories, Page 42.





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

Requirement:
✓ Control cabinet with plate thickness 0.5 - 5.0 mm
✓ Mounting depth min. 80 mm

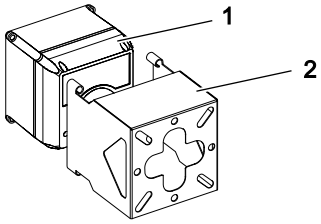
1. Create a control cabinet section.
2. If the space is limited, remove the housing cover **6** and seal with cable entries **5**.
3. Slide the front frame **2** from behind onto the electronic unit **1**.
4. Place the electronic unit with the front frame from the front into the control cabinet section.
5. Slide the sealing frame **4** from behind onto the electronic unit. In the process the sealing surface must point to the front.
6. Fasten the front frame **2** and sealing frame **4** using the 4 supplied screws and wedge lock washers. Carefully tighten with 1 Nm torque.

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

6.3 Mounting the electronic unit to the wall

Personnel qualification:	☐ Electrician
Personal protective equipment:	☐ Work clothing
Aids:	☐ KRAL tool set

For wall mounting a universal mount is available as an accessory ↳ Accessories, Page 42.



1 Electronic unit
2 Universal mount

Requirement:
✓ Universal mount mounted to the wall
✓ All cables have been shortened and connected

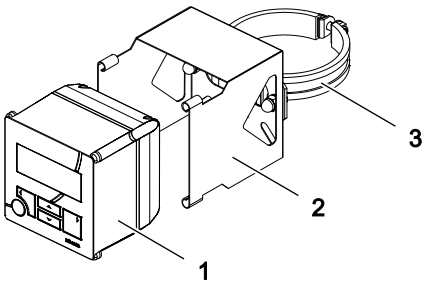
1. ▶ Slide the electronic unit **1** into the universal mount **2**.
2. ▶ Fasten the electronic unit using the supplied screws, washers and wedge lock washers.

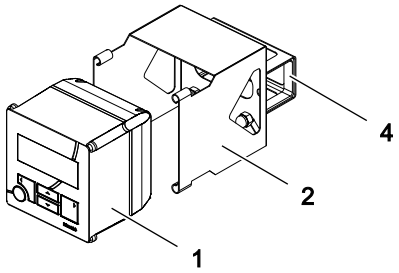
⇨ The electronic unit is ready to operate after the power supply has been switched on.

6.4 Mounting the electronic unit at the pipe/flowmeter

Personnel qualification:	☐ Electrician
Personal protective equipment:	☐ Work clothing
Aids:	☐ KRAL tool set

The electronic unit can be mounted to the pipe or on the flowmeter by means of the universal mount and the corresponding fixing kit. The required fixing kit is available as an accessory. ↳ Accessories, Page 42





1 Electronic unit
2 Universal mount
3 Fixing kit for mounting at pipe (for flowmeter OMG)
4 Fixing kit for flowmeter (for flowmeter OME)

Requirement:
✓ All cables have been shortened and connected

1. ▶ Mount the universal mount **2** on the fixing kit **3** or **4**.
2. ▶ Mount the fixing kit including universal mount to the pipe or flowmeter.
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.

7 Connection

7.1 Dangers during connection work

The following safety instructions must be strictly observed:

- ☐ Have all work only carried out by electricians.
- ☐ The connecting lines of the sensor connections are to be shielded and laid separately from the supply and measuring lines.
- ☐ Ensure that the power supply is correct (24 V DC).

7.2 Connecting cables to the tension spring terminals

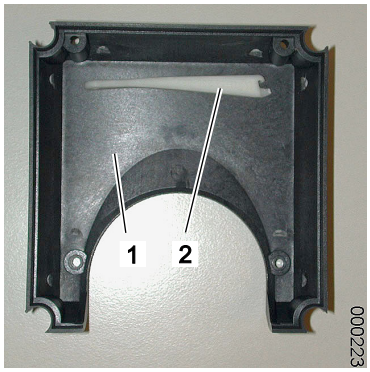
Personnel qualification:	☐ Electrician
Personal protective equipment:	☐ Work clothing
Aids:	☐ KRAL tool set ☐ Diagonal cutter

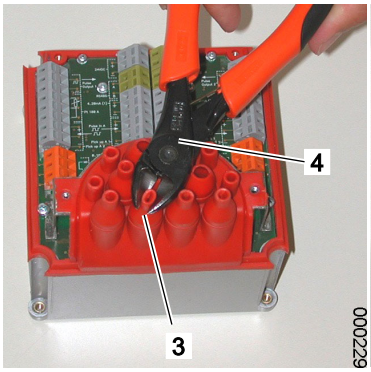
⚠ DANGER

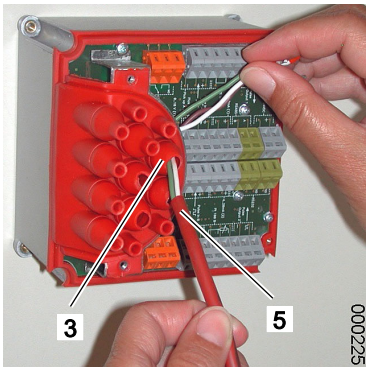
Risk of death resulting from electric shock if the connection of hazardous potentials (>48 V) to the potential-free relay outputs (orange terminals 9 - 11 and/or 42 - 44) is required.

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

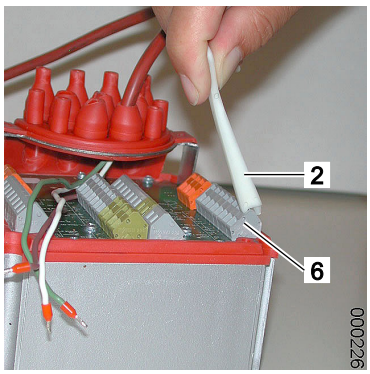
Requirement:
✓ Cable shortened to correct length
✓ All wires stripped to approx. 5 mm

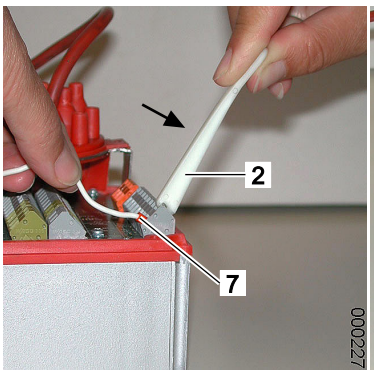


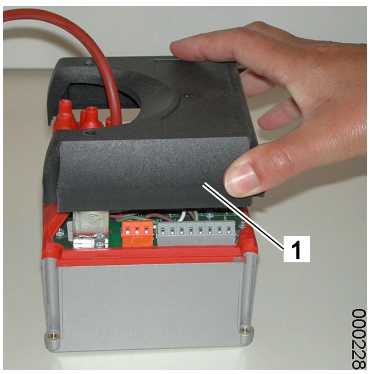




1. ▶ Remove the rear device cover **1** and remove the terminal tool **2**.
2. ▶ Use the diagonal cutter **4** to adapt the cable entry **3** to the cable diameter.
3. ▶ Pull the cable **5** through the cable entry **3**.







4. ▶ Hook the short arbour of the terminal tool **2** into the tension spring terminal **6** and press away from the cable opening so that the cable opening opens.
5. ▶ Insert the wire **7** into the cable opening and remove the terminal tool **2**.
6. ▶ Repeat Steps 4 and 5 for all the wires.
7. ▶ Replace the rear device cover **1**.

7.3 Connect the pick ups and temperature sensors

Personnel qualification:	☐ Electrician
Personal protective equipment:	☐ Work clothing
Aids:	☐ KRAL tool set ☐ Diagonal cutter ☐ Wiring diagram

ATTENTION

Device damage through incorrect connection

- ► Observe pin assignment and connection data of the electronic unit ↳ Technical data, Page 5.
- ► Before connecting the electronic unit to the power supply, ensure that all consumers (sensors) are connected correctly. See the wiring plan.

Requirement:
- ✓ Pick ups for both flowmeters installed
- ✓ Temperature sensors for both flowmeters installed

1. ► Remove the rear device cover.
2. ► Use the diagonal cutter to adapt the cable entry to the cable diameter.
3. ► Pull the cables of the sensors through the cable entries.
4. ► Connect the cables for pick ups of flowmeter A and B in accordance with the wiring diagram on the electronic unit.
5. ► Connect the cables for temperature sensors in accordance with the wiring plan at flowmeter A and B.
6. ► Check the resistance values at cables for temperature sensors on the side of the electronic unit, see the table below and remarks in the wiring plan.
7. ► Connect the cables for temperature sensors in accordance with the wiring plan at the electronic unit.
8. ► 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. 10: Resistance values at temperature sensors

7.4 Connecting analog outputs, relay outputs and pulse outputs

Personnel qualification:	☐ Electrician
Personal protective equipment:	☐ Work clothing
Aids:	☐ KRAL tool set ☐ Diagonal cutter ☐ Wiring diagram

⚠ 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.

ATTENTION

Device damage through incorrect connection.

- ► Observe pin assignment and connection data of the electronic unit Technical data, Page 5.
- ► Do not supply voltage to the analog outputs or pulse outputs (active outputs!).

1. Remove the rear device cover.
2. Use the diagonal cutter to adapt the cable entry to the cable diameter.
3. Pull the cables for the analog outputs, relay outputs or pulse outputs individually through the cable entries and connect in accordance with wiring plan.
4. Route the cables for analog outputs, relay outputs or pulse outputs to the consumer and connect the consumer.
5. Replace the rear device cover.

7.5 Connecting the power supply

Personnel qualification:	☐ Electrician
Personal protective equipment:	☐ Work clothing
Aids:	☐ KRAL tool set ☐ Diagonal cutter ☐ Wiring diagram

ATTENTION

Device damage through incorrect connection

- ► Observe pin assignment and connection data of the electronic unit Technical data, Page 5.
- ► Before connecting the electronic unit to the power supply, ensure that all consumers (sensors) are connected correctly. See the wiring plan.

Requirement:

✓ All sensors correctly connected

✓ System in a deenergized state and secured against being switched on

1. Remove the rear device cover.
2. Use the diagonal cutter to adapt the cable entry to the cable diameter.
3. Pull the supply cable (24 V DC) through the cable entry and connect.
4. Replace the rear device cover.
5. Connect the supply cable (24 V DC) to the power supply of the system.

⇨ The electronic unit is ready to operate.

8 Commissioning

8.1 Checking the electronic unit

Some basic checks must be performed before commissioning the electronic unit.

Test	Procedure
Installation	1. ▶ Check that the electronic unit is seated firmly. 2. ▶ During wall mounting/ pipe mounting or assembly on flowmeter: ensure that the rear device cover and cable entries seal properly.
Electrical installation	1. ▶ Ensure that the system is deenergized. 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 connections of the sensors, see wiring diagram.
Function test	Temperature sensor: 1. ▶ Disconnect the cables at Connections 3, 4 and 5 or 36, 37 and 38 of the electronic unit. 2. ▶ Check the resistance of the Connection, Page 18 and observe the remarks in the wiring plan.
	Electronic unit: 1. ▶ Switch on the power supply. ⇨ The start message is displayed on the display unit. ⇨ The following is displayed at the latest after 3 seconds ***1.01 Consumption Display***. 2. ▶ Write down any alarm messages and acknowledge with key SET. 3. ▶ Check the values in the menus 1.01 – 1.06 for plausibility.

9 Decommissioning

9.1 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 power supply 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 recommissioning, instantaneous values (***Q***, ***Temp.***) can be recalculated.

10 Operation

10.1 Abbreviations, units and signals

10.1.1 Abbreviations

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

10.1.2 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.

Abbreviation	Meaning
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

10.1.3 Pulse signals

Pulse inputs for pick ups with the following functions is available:

- ☐ NPN
- ☐ PNP
- ☐ Namur

Either NPN or PNP can be selected for push-pull pick ups, see ***2.12 Setting Function Pick up***.

10.2 Key assignment

The electronic unit is operated by means of five keys.

Button	Function
SET	☐ Confirmation of the entry ☐ Reset of total values ☐ Confirmation of the selection
▲	☐ Switching to the following menu item ☐ Select the previous unit ☐ Increase the digit
▼	☐ Switching to the previous menu item ☐ Select the next unit ☐ Decrease the digit
→	Navigate one menu higher
←	Navigate one menu lower

Menu items can be called up via key combinations.

Key combination	Function
← + →	***1.31 Help on operation***
SET + →	***1.13 Setting Select Language***
SET + ←	***Menu 8: Alarms***
▲ + ▼	***1.01 Consumption display***
SET + ▲	Increase brightness of the display
SET + ▼	Reduce brightness of the display

10.3 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
Enter the password, see ***2.01 Setting Enable Password***	Press **Deactivate password protection** 1. SET . ⇨ ***1.30 Enter password setting*** is displayed. ⇨ Flashing cursor indicates the active input field. 2. With ← or → Change the position within the number input. 3. With ▲ or ▼ Increase or decrease the digit. 4. Repeat Steps 2 and 3 for all the digits. 5. SET Press. ⇨ Password protection is deactivated: It is displayed ***No*** In the display. Change of settings possible. Password protection is reactivated automatically after approx. 30 minutes. Press **Activate password protection** 1. SET Press. 2. With ▲ or ▼ ***Yes*** select. 3. SET Press.

Aim	Operating steps
Change the password, see ***2.02 Setting Change password***	1. SET Press. ⇨ Flashing cursor indicates the active input field. 2. With ▲ or ▼ ***Yes*** select. 3. SET Press. ⇨ ***1.30 Enter password setting*** is displayed. ⇨ Flashing cursor indicates the active input field. 4. With ◀ or ▶ Change the position within the number input. 5. With ▲ or ▼ Increase or decrease the digit. 6. Repeat Steps 4 and 5 for all the digits. 7. SET Press. ⇨ New password is accepted.
Changing the value	Requirement: ***2.01 Setting Enable Password*** Set to ***No*** . 1. SET Press. ⇨ Flashing cursor indicates the active input field. 2. With ◀ or ▶ Change the position within the number input. 3. With ▲ or ▼ Increase or decrease the digit. 4. Repeat Steps 2 and 3 for all the digits. 5. SET Press. ⇨ Value is accepted.
Enter a minus sign	1. With ◀ Select first position left of the first number. 2. ▼ Select until the minus sign is displayed. 3. SET Press. ⇨ Minus sign is accepted.
Change the unit	Requirement: ***2.01 Setting Enable Password*** Set to ***No*** . 1. SET Press. ⇨ Flashing cursor indicates the active input field. 2. With ▲ or ▼ Select unit. 3. SET Press.

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 display***	**Call up menu item** → ▲ + ▼ Press simultaneously.
Reset sum, see ***1.02 Display total***, see ***1.04 Display Volumeter A Total***, see ***1.06 Display Volumeter B Total***	**Reset of total values** 1. → SET Press. ⇨ Total value 1 is selected. 2. → SET Press for three seconds. ⇨ Total value 1 is reset. 3. → SET Press. ⇨ Total value 2 is selected. 4. → SET Press for three seconds. ⇨ Entry of password required. 5. → Enter password and SET Press. ⇨ Total value 2 is reset.
Select the language, see ***1.13 Setting Select Language***	**Call up menu item** → SET + ▶ Press simultaneously. **Select the language** 1. → SET Press. ⇨ Flashing cursor indicates the active input field. 2. → With ▲ or ▼ Select the language. 3. → SET Press. ⇨ The selected language is applied after a different menu item has been called up.
Calling up help, see ***1.31 Help on operation***	**Call up menu item** → ◀ + ▶ Press simultaneously. **Navigate** 1. → With ▲ or ▼ browse. 2. → SET Press to leave the help.
Check selection of the density determination, see ***2.09 Select setting density determination***	1. → With ◀ or ▶ select menu. 2. → With ▲ or ▼ select menu item.
Check values of the density determination, see ***Menu 6: Density table 1/ density calculation***, see ***Menu 7: Density table 2***	1. → With ◀ or ▶ select menu. 2. → With ▲ or ▼ Select menu item.

Aim	Operating steps
Check the values for the K-factors, see ***Menu 5: K-factors flow-meter B***	1. With ◀ or ▶ select menu. 2. With ▲ or ▼ select menu item.
Call up alarms, see ***Menu 8: Alarms***	1. With SET and. ◀ Select menu. 2. With ▲ or ▼ Call up existing alarms.

11 Menu description

11.1 Menu structure

No.	Menu	Information
1	Display	☐ ***1.00 Information*** ☐ ***1.01 Consumption display*** ☐ ***1.02 Display total*** ☐ ***1.03 Display Volumeter A*** ☐ ***1.04 Display Volumeter A Total*** ☐ ***1.05 Display Volumeter B*** ☐ ***1.06 Display Volumeter B Total*** ☐ ***1.07 Filling amount*** ☐ ***1.08 Display direction change Volumeter A*** ☐ ***1.09 Display direction change Volumeter B*** ☐ ***1.10 Display reset bypass and group error message*** ☐ ***1.11 Setting Display brightness*** ☐ ***1.12 Setting Display contrast*** ☐ ***1.13 Setting Select language*** ☐ ***1.30 Setting Enter password*** ☐ ***1.31 Help on operation***
2	General settings	☐ ***2.01 Setting Enable password*** ☐ ***2.02 Setting Change password*** ☐ ***2.03 Setting Select mode*** ☐ ***2.04 Setting Select temperature X*** ☐ ***2.05 Setting Select unit rate*** ☐ ***2.06 Setting Select unit total*** ☐ ***2.07 Setting Select unit temperature*** ☐ ***2.08 Setting Select unit density*** ☐ ***2.09 Setting Select density determination*** ☐ ***2.10 Setting Number of decimal places*** ☐ ***2.11 Setting Display start message*** ☐ ***2.12 Setting Function pick up*** ☐ ***2.13 Setting Function pulse Inputs*** ☐ ***2.14 Setting Link channel*** ☐ ***2.15 Setting Threshold value A-B*** ☐ ***2.16 Setting Averaging display rate average*** ☐ ***2.17 Setting Deactivate alarm messages*** ☐ ***2.18 Setting Maximum flow rate error message*** ☐ ***2.19 Setting Minimum temperature volumeter*** ☐ ***2.20 Setting Maximum temperature volumeter*** ☐ ***2.21 Setting Reset to factory setting***

No.	Menu	Information
3	Output settings	☐ ***3.01 Setting Function analog output*** ☐ ***3.02 Setting Allocation analog output 1*** ☐ ***3.03 Setting Scale max. analog output 1*** ☐ ***3.04 Setting Allocation analog output 2*** ☐ ***3.05 Setting Scale analog max. output 2*** ☐ ***3.06 Setting Averaging analog average*** ☐ ***3.07 Setting Function pulse output*** ☐ ***3.08 Setting Allocation pulse output 1*** ☐ ***3.09 Setting Scale pulse output 1*** ☐ ***3.10 Setting Allocation pulse output 2*** ☐ ***3.11 Setting Scale pulse output 2*** ☐ ***3.12 Setting Pulse output pulse width setting*** ☐ ***3.13 Setting Function relay 1*** ☐ ***3.14 Setting Limit value bypass*** ☐ ***3.15 Setting Delay bypass*** ☐ ***3.16 Setting Waiting period repeat bypass*** ☐ ***3.17 Setting Switch Relay 1*** ☐ ***3.18 Setting Switch Relay 2*** ☐ ***3.19 Setting Modbus address***
4	K-factors flow-meter A	☐ ***4.01 K-factor Volumeter A Point 1*** ☐ ... ☐ ***4.07 K-factor Volumeter A Point 7***
5	K-factors flow-meter B	☐ ***5.01 K-factor Volumeter B Point 1*** ☐ ... ☐ ***5.07 K-factor Volumeter B Point 7***
6*	Density table 1/ density calculation	☐ ***6.01 Density table 1 Point 1*** ☐ ... ☐ ***6.10 Density table 1 Point 10*** ☐ ***6.20 Density calculation***
7*	Density table 2	☐ ***7.01 Density table 2 Point 2*** ☐ ... ☐ ***7.10 Density table 2 Point 10***
8	Alarms	☐ ***8.00 No alarm. The electronic unit is working without problems.*** ☐ ***8.01 Alarm Password invalid.*** ☐ ... ☐ ***8.21 Alarm Max. Flow B exceeded. Check pick up!***

* Representation depends on density determination selection, see ***2.09 Select setting density determination***.

11.2 Start

Menu item	Description
1.00 Information	= Start message with display of the serial number as well as version of the software and hardware. After switching on the start message shows for three seconds that the electronic unit is ready to operate. After that the following is displayed ***1.01 Consumption display*** **Note:** Activate or deactivate start message, see ***2.11 Setting Display start message***

11.3 Menu 1: Display

- ☐ Display of measured values
- ☐ Resetting the sum
- ☐ Setting contrast and background illumination
- ☐ ↳ Operation, Page 22

Menu item	Description
1.00 Information	Shows the serial number as well as the version of software and hardware.
1.01 Consumption display	Displays the current consumption in the preset unit. **Note**: When the direction of rotation changes, the displayed rate value can vary strongly. Increase the smoothing value, see ***2.16 Setting Averaging display***.
1.02 Display total	Shows the total values ***T1*** and ***T2*** Shows the consumption since the last reset. **Note** Total value stops at the following minimum value or maximum value: ☐ With three decimal places: +/-1 999 999.999 ☐ With a decimal place: +/-199 999 999,9 Decrease decimal places or change the unit ↳ Troubleshooting, Page 38.
1.03 Display Volumeter A	Shows flow ***QA*** and temperature ***TempA*** . If the temperature lies outside the permissible range or if a temperature sensor is not connected, ***"---,-"*** is displayed. **Note:** When the direction of rotation changes, the displayed rate value can vary strongly. Increase the smoothing value, see ***2.16 Setting Averaging display***.
1.04 Display Volumeter A Total	Shows the total values ***TA1*** and ***TA2*** of the flowmeter A since the last reset.
1.05 Display Volumeter B	Shows flow ***QB*** and temperature ***TempB*** . If the temperature lies outside the permissible range or if a temperature sensor is not connected, ***"---,-"*** is displayed. **Note**: When the direction of rotation changes, the displayed rate value can vary strongly. Increase the smoothing value, see ***2.16 Setting Averaging display***.
1.06 Display Volumeter B Total	Shows the total values ***TB1*** and ***TB2*** of the flowmeter B since the last reset.
1.07 Filling amount	***Act.*** Current dispatch amount ***Nom.*** Desired filling amount ***Function*** ☐ ***Start*** Beginning of filling. When the set filling amount is reached, filling is stopped automatically. After three seconds waiting period a further start is possible. ☐ ***Stop*** Interruption of dispatching before the set dispatch amount has been reached. ☐ ***Proceed*** Dispatching is continued. ☐ ***Cancel*** Dispatching is aborted. ***Start*** is displayed and a new dispatching process can be started. **Requirement:** ***3.13 Setting function relay 1*** Set to ***Filling*** .
1.08 Display direction change Volumeter A	Shows the number of the flow direction changes of the flowmeter A since the last reset. **Requirement:** ***2.13 Setting Function pulse inputs*** Set to ***Encoder*** . **Note:** The counter can be increased in case of a power failure even without change of direction. Recommendation: Reset the counter before starting the measurement.

Menu item	Description
1.09 Display direction change Volumeter B	Shows the number of the flow direction changes of the flowmeter B since the last reset. **Requirement**: ***2.13 Setting Function pulse inputs*** Set to ***Encoder*** . **Note**: The counter can be increased in case of a power failure even without change of direction. Recommendation: Reset the counter before starting the measurement.
1.10 Display reset bypass and group error message	Reset the group error message after eliminating the cause for the activation of the collective error message and bypass valve.
1.11 Setting Display brightness	Adjust the brightness of the display
1.12 Setting Display contrast	Adjust the contrast of the display
1.13 Setting Select language	Selection of the language
1.30 Setting Enter password	Allows password entry, can only be reached via ***2.01 Setting Enable password*** or ***2.02 Setting Change password***.
1.31 Help on operation	Shows the brief instruction.

11.4 Menu 2: General settings

- ☐ Changing general settings in accordance with the requirements of the measuring task
- ☐ Changes only possible with password
- ☐ ↳ Operation, Page 22

Menu item	Description
2.01 Setting Enable Password	Factory settings: ☐ Password: ***1000*** ☐ Password protection: ***Yes*** ***Yes*** ☐ Password protection is active - no changes is possible ***No*** ☐ Password protection is not active - changes are possible
2.02 Setting Change password	Change the password
2.03 Setting Select mode	Selection of the mode is adjusted to the measuring task. ***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 a conversion takes place with the ***Volume at X°*** density table. ***Volume at TempA*** Calculates the consumption at the temperature flowmeter A. This temperature usually corresponds to the temperature of the liquid in the reservoir. When a mass unit is selected, the system changes automatically to the mass calculation mode. **Note**: Reference temperature ***X°*** Is freely selectable, see ***2.04 Setting select temperature X***
2.04 Setting select temperature X	Setting the reference temperature **Requirement:** ***2.03 Setting Select mode*** set to **Volumes for X**.
2.05 Setting Select unit rate	Set values unit rate
2.06 Setting Select unit total	Set values unit total

Menu item	Description
2.07 Setting Select unit temperature	Set values unit temperature
2.08 Setting Select unit density	Set values unit density
2.09 Select setting density determination	Twp density tables are available for determining the density of two different liquids. Alternatively density calculation for fuel oils can be carried out. ***Table 1*** Density table 1, see description Menu 6 ***Table 2*** Density table 2, see description Menu 7 ***Fuel oils calculation*** Density calculation for fuel oils, see ***6.20 Density calculation***
2.10 Setting Number of decimal places	Select number of decimal places. 1 - 3 decimal values are available. Display without decimal place is not possible.
2.11 Setting Display start message	Activate or deactivate the start message.
2.12 Setting Function pick up	The pulse inputs have to be adjusted to the pick ups used. The following are available: ☐ ***NPN*** ☐ ***PNP*** ☐ ***Namur*** For push-pull pick ups you can either use ***NPN*** or ***PNP*** . **Note:** With this setting you can also switch the supply voltage for the pick up ↳ Technical data, Page 5.
2.13 Setting Function pulse inputs	***Counter*** Flowmeter with pick up is used. ***Encoder*** Flowmeter with two pick ups is used (flow direction detection option).
2.14 Setting Link channel	Selection of the link when using two flowmeters ***A-B*** Differentiation calculation for consumption measurement ***A+B*** Sum calculation for combination of two measuring sections
2.15 Setting 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 is used to suppress small amounts resulting from measuring errors. The threshold should be selected clearly lower than the lowest possible consumption. **Threshold = 0** Function is deactivated. **Threshold > Consumption Q** ☐ Display in ***1.01 Consumption display*** = 0 ☐ Totaling of ***T1*** and ***T2*** in ***1.02 Display total*** is stopped. All other values are not influenced!

Menu item	Description
2.16 Setting Averaging display rate average	The averaging allows for a stable display with varying flow amounts. Possible values, adjusted to the requirements, are between 1 and 10000. In case of averaging the display of quick changes takes place with a time delay. Examples of reaction time for a change of 99.9 % of the actual frequency jump: ☐ Averaging ***0*** or ***1***: 0.02 s ☐ Averaging ***2***: 0.04 s ☐ Averaging ***8***: 0.16 s ☐ Averaging ***9***: 1.3 s ☐ Averaging ***500***: 75 s ☐ Averaging ***1000***: 150 s ☐ Averaging ***10000***: 1500 s No filter is active for Averaging 0 or 1. In the case of Averaging 2 – 8 a continuous average-value generation is carried out. A V_Z1 filter is active at Averaging 9 – 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 Setting Deactivate alarm messages	Deactivate the display of alarm messages and group error message Key combination SET +  (Call up alarms) becomes ineffective.
2.18 Setting Maximum flow rate error message	Setting of the percentage via Q_{nom}, for which the alarm ***Is exceeded*** is displayed. In this case Q_{nom} is always the flow rate at the highest still valid frequency of the linearization in Menu 4 and Menu 5.
2.19 Setting Minimum temperature volumeter	Set the smallest permissible operating temperature of the flowmeter. This temperature is limited mainly by the selection of the pick up. A drop below it results in a corresponding error message.
2.20 Setting Maximum temperature volumeter	Set the highest permissible operating temperature of the flowmeter. This temperature is limited mainly by the selection of the pick up. Exceeding results in a corresponding error message.
2.21 Setting Reset to factory setting	Reset of all settings to factory settings (delivery state)

11.5 Menu 3: Output settings

☐ Adaption of the outputs in accordance with the requirements of the measuring task
☐ Changes only possible with password
☐ Operation, Page 22

Menu item	Description
3.01 Setting Function analog output	The following two analog outputs are available: ☐ 2 x 4-20 mA or ☐ 2 x 0-10 V
3.02 Setting Allocation analog output 1	☐ ***Q*** Rate consumption A-B or A+B ☐ ***QA*** Rate current flow flowmeter A ☐ ***QB*** Rate current flow flowmeter B ☐ ***T1*** Total consumption A-B or A+B ☐ ***TA1*** Total flow flowmeter A ☐ ***TB1*** Total flow flowmeter B
3.03 Setting Scale max. 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 and 0 V or 4 mA respectively is output.

Menu item	Description
3.04 Setting Allocation analog output 2	☐ ***Q*** Rate consumption A-B or A+B ☐ ***QA*** Rate current flow flowmeter A ☐ ***QB*** Rate current flow flowmeter B ☐ ***T1*** Total consumption A-B or A+B ☐ ***TA1*** Total flow flowmeter A ☐ ***TB1*** Total flow flowmeter B
3.05 Setting Scale analog max. 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 1 is deactivated and 0 V or 4 mA respectively is output.
3.06 Setting averaging analog average	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 ***0*** or ***1***: 0.02 s ☐ Averaging ***2***: 0.04 s ☐ Averaging ***8***: 0.16 s ☐ Averaging ***9***: 1.3 s ☐ Averaging ***500***: 75 s ☐ Averaging ***1000***: 150 s ☐ Averaging ***10000***: 1500 s No filter is active for Averaging 0 or 1. In the case of Averaging 2 – 8 a continuous average-value generation is carried out. A V_Z1 filter is active at Averaging 9 – 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.
3.07 Setting Function pulse output	***Independent*** The two pulse outputs can be used independently of each other. ***Encoder*** Both pulse outputs deliver two 90° square wave signals out of phase. This passes on the information about the flow direction. The allocation of the second pulse output and its scale remain 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 requirements: ☐ Function pulse inputs = ***Encoder*** ☐ Function pulse outputs = ***Independent*** ☐ Occurrence of changes in the 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 ***0*** . Only then are pulses output again at the pulse output in accordance with the scale.
3.08 Setting Allocation pulse output 1	A total value can be assigned freely to the Pulse output 1. ***T*** Total consumption A-B or A+B ***TA*** Total flow flowmeter A ***TB*** Total flow flowmeter B **Note:** After the setting has been changed, the electronic unit has to be restarted.

Menu item	Description
3.09 Setting 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, the manufacturer recommends using the pulse output only for total values. Select the scale so that the limit frequency of 250/125 Hz is not exceeded. ***0*** Pulse output is switched off. No pulses are output anymore. **Note:** After the setting has been changed, the electronic unit has to be restarted.
3.10 Setting Allocation pulse output 2	A total value can be assigned freely to the Pulse output 2. ***T*** Total consumption A-B or A+B ***TA*** Total flow flowmeter A ***TB*** Total flow flowmeter B **Requirement:** ***3.07 Setting Function pulse output*** Set to ***Independent*** . **Note:** After the setting has been changed, the electronic unit has to be restarted.
3.11 Setting 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, the manufacturer recommends using the pulse output only for total values. Select the scale so that the limit frequency of 250/125 Hz is not exceeded. ***0*** Pulse output is switched off. No pulses are output anymore. **Requirement:** ***3.07 Setting Function pulse output*** Set to ***Independent*** . **Note:** After the setting has been changed, the electronic unit has to be restarted.
3.12 Setting Pulse output pulse width setting	Increasing the pulse width always involves a reduction in 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.

Menu item	Description
3.13 Setting Function relay 1	***Off*** Relay 1 is deactivated. ***Bypass 1*** Differential measurement with two flowmeters. If one of the counters with the rate values drop below the ***Limit value bypass*** and the second follows within the ***Bypass delay***, the relay goes to the basic setting and the alarm ***Bypass valve activated*** is generated. Alarm, Relay 1 and Relay 2 can be reset again in ***1.10 Display reset bypass and group error message*** . ***Bypass 2*** Single-line measurement with flowmeter A. If it falls below ***Limit value bypass*** The relay goes into the basic setting. After every expiry of the repeat attempt period, the relay is switched until the bypass time ***Bypass delay*** is expired. After that it drops again and the repeat attempt period starts again. If it is exceeded within the repeat attempt period ***Limit value bypass*** , the relay remains switched. ***Bypass 3*** Differential measurement with two flowmeters analog ***Bypass 2***. However, both flowmeters must be operated with the ***Limit value bypass*** . ***Filling*** Filling function, see ***1.07 Filling amount***, ***Bypass 4*** Differential measurement with two flowmeters. If it falls below ***Limit value bypass*** trough one of the flowmeters, the relay goes into the basic setting. No alarm message is generated because the NO contact of Relay 1 must always be switched in series with a motor on contact to ensure a correct by-pass release. **Note:** In the case of the functions Bypass 2 and Bypass 3 the valves should be switched via additional semi-conductor relays in view of the switching frequency.
3.14 Setting Limit value bypass	The function allows the automatic activation of a bypass valve when a flowmeter blocks. The limit value is selected smaller than the smallest minimum flow rate occurring during normal operation. ***0*** All bypass function are deactivated.
3.15 Setting Delay bypass	The time delay is the sensitivity of the bypass function. The condition for triggering the bypass relay must exist continuously during the set time. **Note:** The manufacturer recommends high sensitivity under high safety requirements.
3.16 Setting Waiting period repeat bypass	The repeat attempt period is important at the relay function ***Bypass_2*** or ***Bypass 3***, see ***3.13 Setting Function relay 1***If the limit value is not exceeded, the flowmeter remains in bypass operation. After expiry of the ***Waiting period repeat bypass*** relay is switched and the valve is closed. If the limit value is not exceeded within the***Bypass delay*** the relay is switched back to the initial position. The ***Waiting period repeat bypass*** starts running again.
3.17 Setting Switch Relay 1	Manual switching of the relay can be necessary in emergencies or during commissioning of the system. ***On*** Manual switching is activated. ***Off*** Manual switching is deactivated.
3.18 Setting Switch Relay 2	Manual switching of the relay can be necessary in emergencies or during commissioning of the system. ***On*** Manual switching is activated. ***Off*** Manual switching is deactivated.
3.19 Setting Modbus address	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 Modbus connection is not password-protected! Write access deletes existing values. Therefore the manufacturer only recommends reading of the data.

11.6 Menu 4: K-factors flowmeter A

- ☐ Entry of the K-factors of the flowmeter A with increasing frequency for the formation of the linearization characteristic
- ☐ K-factors, associated frequencies and resulting K-factor, see calibration certificate of the flowmeter
- ☐ Resulting K-factor, also see rating plate of the flowmeter
- ☐ Changes only possible with password
- ☐ ↳ Operation, Page 22

Menu item	Description
4.01 K-factor Volumeter A Point 1 ... ***4.07 K-factor Volumeter A Point 7***	Example without linearization: ☐ ***Point 1***: Resulting K-factor and frequency at Q_{nom} ☐ ***Point 2***: Frequency ***0*** Example linearizion with three points: ☐ ***Point 1***: Any K-factor and associated frequency ☐ ***Point 2***: K-factor and associated frequency in ascending order ☐ ***Point 3***: K-factor and frequency at Q_{nom} (highest value) ☐ ***Point 4***: Frequency ***0*** **Note:** The number of linearization points is limited by the input of the frequency 0. ***0*** . Ensure that the K-factor and frequency of Q_{nom} are entered respectively in the preceding point. The linearization is extended to 0 Hz or to ∞ Hz via the first or last two linearization points resp. and mirrored into negative values.

11.7 Menu 5: K-factors flowmeter B

- ☐ Entry of the K-factors of the flowmeter B with increasing frequency for the formation of the linearization characteristic
- ☐ K-factors, associated frequencies and resulting K-factor, see calibration certificate of the flowmeter
- ☐ Resulting K-factor, also see rating plate of the flowmeter
- ☐ Changes only possible with password
- ☐ ↳ Operation, Page 22

Menu item	Description
5.01 K-factor Volumeter B Point 1 ... ***5.07 K-factor Volumeter B Point 7***	Example without linearization: ☐ ***Point 1***: Resulting K-factor and frequency at Q_{nom} ☐ ***Point 2***: Frequency ***0*** Example linearizion with three points: ☐ ***Point 1***: Any K-factor and associated frequency ☐ ***Point 2***: K-factor and associated frequency in ascending order ☐ ***Point 3***: K-factor and frequency at Q_{nom} (highest value) ☐ ***Point 4***: Frequency ***0*** **Note:** The number of linearization points is limited by the input of the frequency 0. ***0*** . Ensure that the K-factor and frequency of Q_{nom} are entered respectively in the preceding point. The linearization is extended to ***0*** or to ∞Hz via the first or last two linearization points resp. and mirrored into negative values.

11.8 Menu 6: Density table 1/density calculation

- ☐ Entry of up to 10 temperature values and density values of a density table in ascending order
- ☐ Enables temperature compensation and mass calculation of the flow values
- ☐ The density table can be requested from the supplier of the liquid.
- ☐ Changes only possible with password
- ☐ ↳ Operation, Page 22

Menu item	Description
6.01 Density table 1 Point 1 ... ***6.10 Density table 1 Point 10***	Example with a density value: ☐ ***Point 1***: Temperature value and associated density value ☐ ***Point 2***: Density value ***0*** Example with three density values: ☐ ***Point 1***: Temperature value and associated density value ☐ ***Point 2***: Further temperature value in ascending order and associated density value ☐ ***Point 3***: Further temperature value in ascending order and associated density value ☐ ***Point 4***: 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.
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.

11.9 Menu 7: Density table 2

- ☐ Entry of two density tables when using different liquids
- ☐ Enables temperature compensation and mass calculation of the flow values
- ☐ The density table can be requested from the supplier of the liquid.
- ☐ Selection of the density table used, see ***2.09 Select setting density determination***
- ☐ Changes only possible with password
- ☐ ↳ Operation, Page 22

Menu item	Description
7.01 Density table 2 Point 2 ... ***7.10 Density table 2 Point 10***	Example with a density value: ☐ ***Point 1***: Temperature value and associated density value ☐ ***Point 2***: Density value ***0*** Example with three density values: ☐ ***Point 1***: Temperature value and associated density value ☐ ***Point 2***: Further temperature value in ascending order and associated density value ☐ ***Point 3***: Further temperature value in ascending order and associated density value ☐ ***Point 4***: 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.

11.10 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.

SET	Confirming the alarm. The alarm message disappears from the display. Suitable measures for eliminating the error can be taken subsequently.
SET + 	Activated alarm displayed again

If an alarm occurs, Relay output 2 Group error message is also activated.

12 Maintenance

12.1 Required maintenance

The electronic unit is maintenance-free.

12.2 Cleaning the electronic unit

ATTENTION

Device damage through water.

► Ensure that no water enters the electronic unit.

→ Wipe the housing with a soft cloth. In the case of strong soiling wipe off the housing surface slightly moist with a common detergent.

13 Disposal

13.1 Disposing of the electronic unit

ATTENTION

Environmental damage through improper disposal.

► Dispose of all the components in an environmentally friendly manner in accordance with the applicable local regulations.

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

14 Troubleshooting

14.1 Fault table

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

Alarms

Fault message	Cause and elimination
8.00 No alarm. The electronic unit is working without problems.	There is no fault.
8.01 Alarm Password invalid.	Incorrect password input. ☐ Repeat the password entry with the correct password.
8.02 Alarm K-factors Vol. A frequencies not ascending!	Frequencies of flowmeter A have not been entered in ascending order. ☐ Enter the frequencies in ascending order, see ***Menu 4: K-factors Volumeter A***
8.03 Alarm K-factors Vol. B frequencies not ascending!	The frequencies of flowmeter B have not been entered in ascending order. ☐ Enter the frequencies in ascending order, see ***Menu 5: K-factors Volumeter B***
8.04 Alarm density table 1 temperatures not ascending!	The temperatures are not entered in ascending order. ☐ Enter the temperatures in ascending order, see ***Menu 6: Density table 1/density calculation***
8.05 Alarm density table 2 temperatures not ascending!	The temperatures are not entered in ascending order. ☐ Enter the temperatures in ascending order, see ***Menu 7: Density table 2***

Fault message	Cause and elimination
8.06 Alarm Bypass valve activated. Check volumeter!	Relay 2 for collective error message is active, Relay 1 for bypass valve has dropped. ☐ Check flowmeter for blockage. ☐ Optimize settings in the menu items ***3.13 – 3.16*** . In case of independent measurement with two flowmeters: ☐ If bypass function is not desired, ***3.14 Setting Limit value bypass*** Set to ***0*** . ☐ Reset the bypass and group error message, see ***1.10 Display reset bypass and group error message***.
8.07 Alarm Max. Flow B exceeded. Check pick up!	The maximum permissible flow rate was exceeded in flowmeter A. ☐ Limit the flow rate. ☐ Check flowmeter. ☐ Use a larger size. ☐ Check and eliminate an electromagnetic interference using an oscilloscope (e.g. terminate shield to Gnd).
8.08 Alarm Volumeter A or B outside the temperature range!	At least one of the measured temperatures of the connected flowmeter lies outside the permissible range. ☐ Adjust temperature range of the flowmeters, see ***2.19 Setting Minimum temperature volumeter*** or ***2.20 Setting Maximum temperature volumeter***. ☐ Limit the temperature in the system. ☐ Use suitable sensors. ☐ Use suitable flowmeters.
8.09 Alarm analog output 1 or 2 scaling exceeded!	The flow rate exceeds the maximum scale value of an analog output. ☐ Correct the scale, see ***3.03 Setting Scale max. analog output 1*** or ***3.05 Setting Scale analog max. output 2***.
8.10 Alarm pulse output 1 or 2 max. frequency exceeded!	The maximum output frequency of Pulse output 1 or 2 has been exceeded. ☐ Correct the scale, see ***3.09 Setting Scale pulse output 1*** or ***3.11 Setting Scale pulse output 2***. ☐ Correct the pulse width, see ***3.12 Setting Pulse output pulse width setting***. The maximum frequency of a pulse output amounts to: ☐ Mode ***Encoder:*** 1/(4 x pulse width in s) ☐ Mode ***Independent:*** 1/(2 x pulse width in s)
8.11 Alarm Change of direction A exceeded, check 30/s signals!	A pick up at flowmeter A has failed. This error message is only displayed at the setting Function pulse inputs ***Encoder***, see ***2.13 Setting Function pulse inputs*** ☐ Check pulse inputs channel A (terminal 7 + 19): a) Square wave signal at both inputs: >30 direction change/s -or- b) Square wave signal at an input: Strong vibration (in case of standstill of the flowmeter) -or- c) A pick up delivers no signal (with running flowmeter) 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.
8.12 Alarm Change of direction B exceeded, check 30/s signals!	A pick up at flowmeter B has failed. This error message is only displayed at the setting Function pulse inputs ***Encoder***, see ***2.13 Setting Function pulse inputs*** ☐ Check pulse inputs channel B (terminals 30 + 40): a) Square wave signal on both inputs: >30 direction change/s -or- b) Square wave signal at an input: Strong vibration (in case of standstill of the flowmeter) -or- c) A pick up delivers no signal (with running flowmeter) 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.
8.13 Alarm temperature sensor failure Volumeter A!	Temperature sensor A or Temperature input A is defective. ☐ Check the sensor connection. ☐ Replace the sensor. ☐ Check the temperature input.

14.1 Fault table

Fault message	Cause and elimination
8.14 Alarm temperature sensor failure Volumeter B!	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.
8.15 Alarm Electronics outside the temperature range!	The temperature range of the electronic unit has been exceeded. ☐ Check the electronic unit. ☐ Replace the electronic unit.
8.16 Alarm New unit density. Correct density values!	The unit of density has been changed. ☐ Convert the numerical values and correct the density table/density calculation.
8.17 Alarm New unit temp. Correct temperature values!	The temperature unit has been changed. ☐ Convert the numerical values and correct the density table/density calculation.
8.16 Alarm New unit rate. Correct the scale of analog output!	The unit of the rate has been changed. ☐ Check the scale of the analog outputs and correct it.
8.19 Alarm New unit total. Correct the scale of pulse output!	The unit of Total has been changed. ☐ Check the scale of the pulse outputs and correct it.
8.20 Alarm Mode changed. Check value density determination!	Mode has been changed. ☐ Correct the density table/density calculation.
8.21 Alarm Max. Flow B exceeded. Check pick up!	The maximum permissible flow rate was exceeded in flowmeter B. ☐ Limit the flow rate. ☐ Check flowmeter. ☐ Use a larger size. ☐ Check and eliminate an electromagnetic interference using an oscilloscope (e.g. terminate shield to Gnd).

Further faults

Further fault	Cause and elimination
Rate = 0, although pulse signals can be measured at the terminals of the electronic unit with the oscilloscope	One pick up each per flowmeter is connected and the function pulse input ***Encoder*** is selected. ☐ ***2.13 Setting Function pulse inputs*** Set to ***Counter*** . If a pick up fails in Encoder mode or the temperature sensor fails, a rate of 0 is displayed and the total value is no longer modified. ☐ Check the wiring, replace the pick up.
Analog output does not function	Analog output function selected incorrectly. ☐ Select the correct function, see ***3.01 Setting Function analog output*** Signal cable connected to an incorrect analog output. ☐ Correct the connection.
Negative flow	The signal wires at the respective flowmeter are connected incorrectly. ☐ Swap the signal wires.
No flow or flow rate too low	☐ Check the alarms, see ***Menu 8 Alarms*** ☐ Check the connection of the pick up. ☐ Check the pick up 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	☐ Switch the function of the pulse input of ***Set Counter*** to ***Encoder*** , see ***2.13 Setting Function pulse inputs***.

Further fault	Cause and elimination
When the electronic unit is switched on, the following alarms are displayed: ☐ ***8.07 Alarm. Max. flow A exceeded. Check pick up!*** ☐ ***8.10 Alarm. Analog output 1 or 2 scaling exceeded!*** ☐ ***8.11 Alarm. Change of direction A exceeded, check 30/s signals!*** ☐ ***8.12 Alarm. Change of direction B exceeded, check 30/s signals!*** ☐ ***8.21 Alarm. Max. flow B exceeded. Check pick up!***	☐ 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.
POWER FAIL no counting	Falls below supply voltage 17.5 V
Keyboard background illumination flashes.	There is an input error. ☐ SET + Press simultaneously. -> The existing errors are displayed. ☐ Eliminate 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 ☐ Specify another unit for total, e.g. m^3 instead of l. After the modification, the total value is still available after the overflow. ☐ Reduce the number of decimal places.

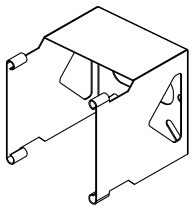
15 Accessories

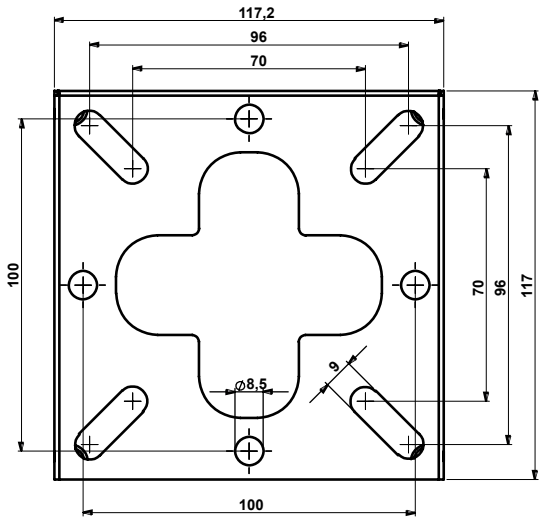
15.1 Installation

15.1.1 Fixing kits

The 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.

15.1.2 Universal mount fixing kit

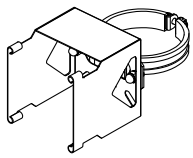
Fixing kit	Application	Article No.	Suitable for
	Wall mounting	UZA 20	BEM 300 BEM 500



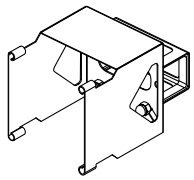
Mounting: M8

Fig. 3: Mounting dimensions of universal mount UZA 20

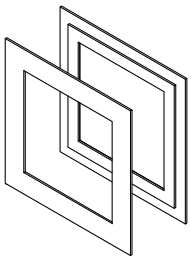
15.1.3 Fixing kit for pipe mounting/mounting on OMG

Fixing kit	Application	Article No.	Suitable for	Pipe diameter [mm] min.	Pipe diameter [mm] max.
	Pipe mounting/mounting on flowmeter OMG	UZA 28	BEM 300 / OMG-013 BEM 500 / OMG-013	85	92
		UZA 25	BEM 300 / OMG-020 BEM 500 / OMG-020	72	80
		UZA 26	BEM 300 / OMG-032 BEM 500 / OMG-032	102	110
		UZA 27	BEM 300 / OMG-052 BEM 500 / OMG-052	115	122

15.1.4 Fixing kit mounting on OME

Fixing kit	Application	Article No.	Suitable for
	Mounting on flowmeter OME	UZA 21[1.2]	BEM 300 / BEM 500 / OME-013
		UZA 22[1.2]	BEM 300 / BEM 500 / OME-020
		UZA 24[2]	BEM 300 / BEM 500 / OME-032
	[1] Not suitable for OME with DIN flanges [2] Not suitable for OME with temperature sensor connection		

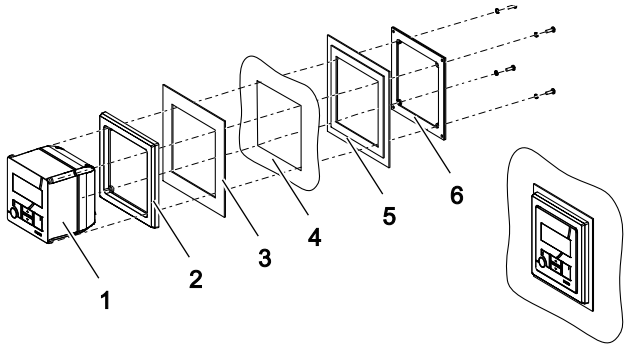
15.1.5 Adapter set for conversion of BEM 4U to BEM 300 / BEM 500

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

Change BEM 4U to BEM 500

Notice 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.

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



1	Electronic unit	**5**	Sheeting**
2	Front frame*	**6**	Sealing frame*
3	Sheeting bonded to seal**	**7**	Screws and wedge lock washers*
4	Control cabinet		
*	Included in the scope of delivery of the BEM 300/BEM 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 wedge lock washers **7**.

15.2 Electrical connection

15.2.1 Different voltage

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

15.2.2 Rack mounting power supply unit EEN 12

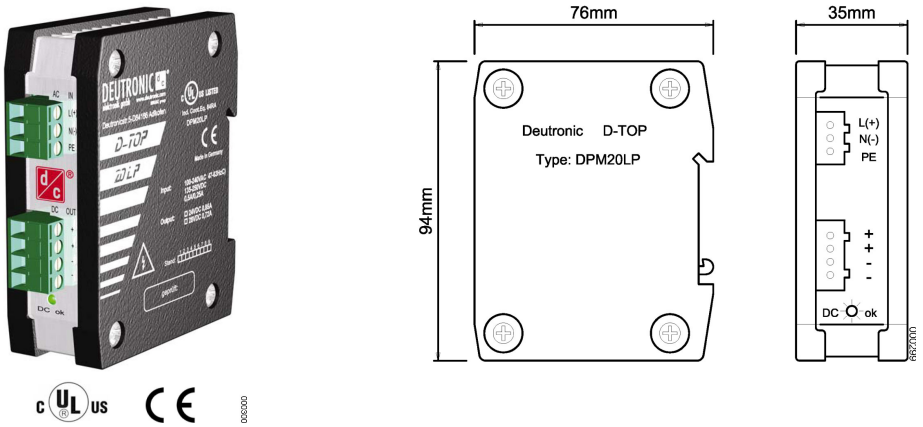


Fig. 4: Rack mounting power supply unit EEN 12

Component	Parameter	Unit	Value
Input	Input voltage	[V AC] [Hz] [V DC]	☐ 100 – 240 (tolerance: 93 – 265) ☐ 47 – 63 ☐ 135 – 370
	Starting current inrush max.	[V AC]	☐ 30 (at 230 V AC) ☐ 15 (at 115 V AC) 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	[A typ.]	☐ 0.25 (at 230 V AC) ☐ 0.5 (at 115 V AC)
Output	Output voltage	[V DC]	24
	Output current max.	[mA]	850
	Output power	[W]	20
	Function display		LED at front panel
	Current limitation		Fold-back, set to approx. 1.05 x I_{nom}
	System deviation at load change stat. 10 – 90 %	[%]	0.1
	System deviation at load change dyn. 10 – 90 %	[%]	1.0
	Adjusting time	[ms]	1
	System deviation at input change ±10 %	[%]	0.1
	Mains buffering	[ms]	> 20
	Residual ripple	[mVss]	<50
	Switching peaks	[mVss]	<100
	Overvoltage protection at the output		Suppressor diode (Transil diode)

Component	Parameter	Unit	Value
Environment	Storage temperature	[°C]	-40 ~ +85
	Operating temperature	[°C]	-25 ~ +60, 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)	[kV]	3, routine tested
	EMC emitted interference		EN 55011-B
	EMC immunity to interference		EN 61000–6–2
	Efficiency	[%]	83, depending on input voltage and output voltage
	Connections: Screw terminals, pluggable	[mm^2]	☐ Input: 0.5 – 2.5 ☐ Output Ua^+: 2 x 0.5 – 2.5 ☐ Output GND: 2 x 0.5 – 2.5
	Dimensions (WxDxH)	[mm]	36 x 76 x 94
	Weight	[g]	Approx. 250
	Model		Sheet steel, can be snapped onto a DIN rail TS35 (EN 60715) or can be screwed on

Tab. 11: Technical data EEN 12

Terminal assignment

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

15.2.3 Plug-in power supply unit EEN 13

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

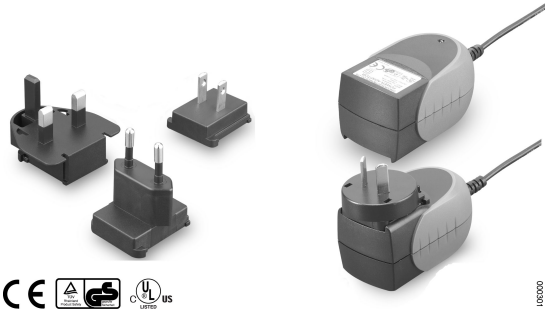


Fig. 5: Plug-in power supply unit EEN 13

Component	Parameter	Unit	Value
Input	Power consumption	[W]	20
	Input voltage	[V AC]	90 – 264
	Frequency	[Hz]	47 – 63
	Max. current consumption	[A]	0.4.
	Leak flow max.	[mA]	0.25

Component	Parameter	Unit	Value
Output	Output voltage	[V DC]	24 ± 2 %
	Output current max.	[mA]	625
	Output power	[W]	15
	Short-circuit protection		Continuous (auto recovery)
	Overvoltage protection		Yes
Environment	Operating temperature	[°C]	0 ~ +40
	Storage temperature	[°C]	-20 °C ~ +85
	Dimensions	[mm]	80.6 x 47.9 x 43.3
	Weight	[g]	130

Tab. 12: Technical data EEN 13

Cable assignment

Connection	Function	Color
Output	+ 24 V	White
	GND	Black

16 Appendix

16.1 Glossary

Designation	Meaning
Updating rate	☐ Shortest period in which a change is displayed in the display
Analog output	☐ Represents an internal digital value as an electrical value (0–10 V, 4–20 mA) ☐ Is updated with the cycle time
Analog input	☐ Converts an electrical value (0–10 V, 4–20 mA) into a digital value
Resolution	☐ Maximum number of possible subdivision steps for describing a value
Baud rate	☐ Rate of data transfer per time unit (bit/s)
Density	☐ Ratio of mass-to-volume (e.g. kg/m^3)
density calculation	☐ Describes the relationship of density-to-temperature with two values (density for reference temperature) ☐ Maps the volume coefficient of expansion ☐ Temperature <70 °C: Density calculation takes place for diesel temperature ≥70 °C: Density calculation takes place for heavy fuel oil
Density determination	☐ The current density is determined by means of the temperature measurement, either via one or two density tables (interpolation) or via density calculation.
Density table	☐ Describes the relationship of density-to-temperature ☐ Maps the volume coefficient of expansion
Differential measurement	☐ The values of two flowmeters are measured and subtracted
Flow rate	☐ Amount flowing per time unit (e.g. l/s)
Flow direction detection	☐ Detection of the flow direction through two sensors with square wave signals out of phase by 90°
Adjusting time	☐ Time span after whose expiry the output is identical with the input
Single-line measurement	☐ The values of a flowmeter are measured and evaluated
Electronic unit	☐ Display and processing unit BEM 300/BEM 500 ☐ Display and processing unit BEM 100/BEM 150
Remote display	☐ Additional display of the values of the electronic unit
Galvanic isolation	☐ Isolation of differing voltage potentials
Averaging	☐ Low-pass filter function for suppressing abrupt changes
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

Designation	Meaning
Pulse (signal)	☐ A rising edge is followed after a certain period by a falling edge ☐ Corresponds to the square wave signal
Pulse output	☐ Generates pulses with 24 V signal level conforming to the scale of an input variable
Pulse input	☐ Processes pulse signals
Pick up (A/B)1	☐ Sensor that generates one pulse per defined flow rate
Pick up (A/B)2	☐ Sensor that generates one pulse with +90° phase shift per defined flow rate ☐ Allows a flow direction recognition in combination with Pick up 1
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 flowmeter
Linearization	☐ Maps the dependence of the K-factor of a flowmeter across the flow range in an electronic unit
Linearity	☐ Dependence of the K-factor across the flow range
Mass calculation	☐ Volumetric values are converted into mass values under consideration of the temperature via the density table
Modbus connection	☐ Digital communication with connected users
Modbus interface	☐ Makes available the hardware (e.g. RS 232) and software (e.g. Modbus RTU protocol) required for digital communication
Rate	☐ Volume per time unit
Reaction time	☐ Time for a change of 99.9 % of the actual jump
Square wave signal	☐ Pulse signal with square wave form
Relay output	☐ Potential-free change-over contact
Return line	☐ Line from the consumer back to the reservoir
Group error message	☐ Message that indicates the occurrence of at least one error
Threshold value	☐ Value at which an action is triggered when it is overpassed or underpassed
Serial interface	☐ Sends or receives data in chronological sequence
Scale	☐ Assigning of a maximum input value to a maximum output value
Temperature input	☐ Processes signals of a temperature sensor
Temperature sensor	☐ Converts the physical value temperature into an electrical value (e.g. resistance)
Temperature compensation	☐ Consideration of the current temperature at the volume calculation and mass calculation in order to compensate density changes
Total	☐ Volume values that have been measured since the last reset
Total flow	☐ Quantity that has passed the flowmeter since the last reset
Total consumption	☐ Quantity that has been consumed since the last reset
Consumption	☐ Consumption Q=QA-QB
Link channel AB	☐ Q=QA-QB or Q=QA+QB
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 flowmeter is calculated from the K-factor [P/l] and the pulses of the flowmeter
Volumeter	☐ Flowmeter
Supply line	☐ Line from the reservoir to the consumer
Circulation ratio	☐ Ratio of supply rate/consumption (A/(A-B))
Reset	☐ Setting the variable to the value 0
Cycle time	☐ Time section in which all the calculations are carried out, inputs processed and outputs operated

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