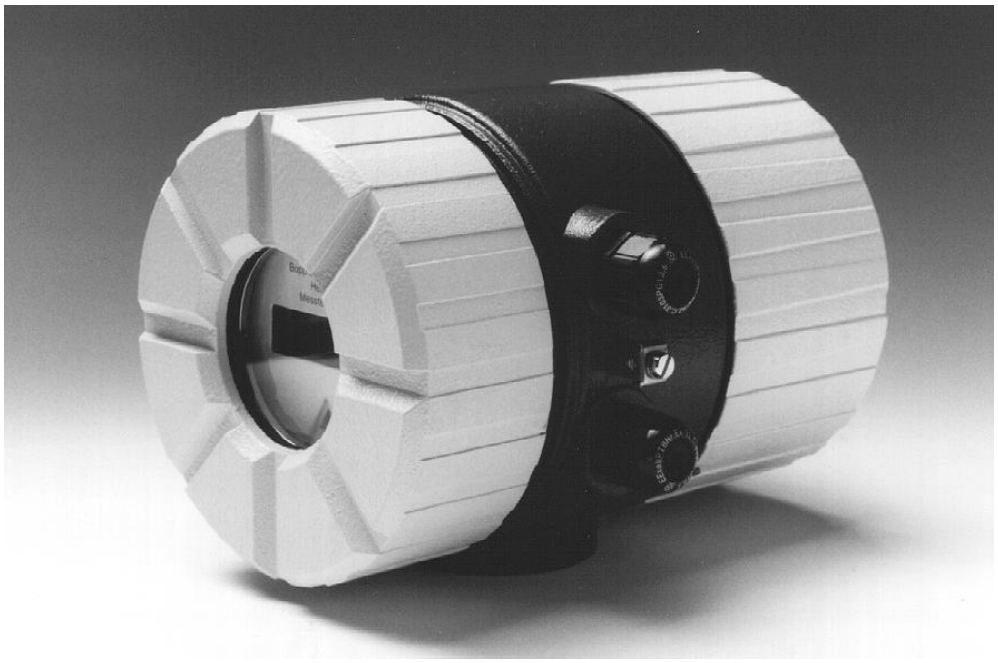
Heinrichs

Transmitter for Coriolis Mass Flowmeter

Additional Operating Instructions

Transmitter UMC3 with Profibus-PA- Interface

UMC3



Read these Operating Instructions thoroughly and keep them available for reference

Subject to modifications of the dimensions, weights, and other technical data
Printed in Germany

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1 Identification

1.1 Manufacturer

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1.2 Product type

Transmitter UMC3-PA, suitable for Coriolis mass flow meters with PROFIBUS-PA-interface.

1.3 Issue date

12.12.2007

1.4 Version No. / file

3.0
File: UMC3-PA_BA_03_Eng.Doc

2 Introduction

The Profibus PA interface of the UMC3 offers the possibility of reading measured values, reading and changing of parameters if required. The interface fulfils the requirements of the IEC 1158-2 or IEC61158. It is intrinsically safe according to the FISCO model.

As a digital field bus instrument the communication via Profibus PA substitutes all analogous process outputs (current outputs and pulse outputs) of the UMC3 standard design. No analogous outputs described in the operator's manual of the standard design are available at a field bus device.

The Profibus PA interface is designed as a pluggable module. It has a mounted memory chip. There all profile specific parameters are stored. If the PA module is exchanged by another one, the memory chip must be put into the new module to keep these parameters.

3 Installation of Profibus

3.1 Shielding

The shield must be connected on both sides (figure 1). Equipotential bonding in accordance with the explosion protection guidelines must be ensured in this case. The shield is connected in the special EMC cable gland (figure 2).

	**Warning:** Additional cable glands: They are not contained in the scope of supply. The operator is responsible for the fact that according to the enclosure and ignition enclosure certified cable glands are used. The kind of the thread is stamped on the rating plate.

3.2 Installation procedure

1. De-energize the device.
2. Unscrew the cover and remove the control unit BE2.
3. Connect the outer shield to the metalized cable glands.
4. The signal lines have to be connected to the terminals 39 and 40. Polarity need not be observed.
5. Reinstall Control unit BE2 and close the cover.
6. Switch on device.

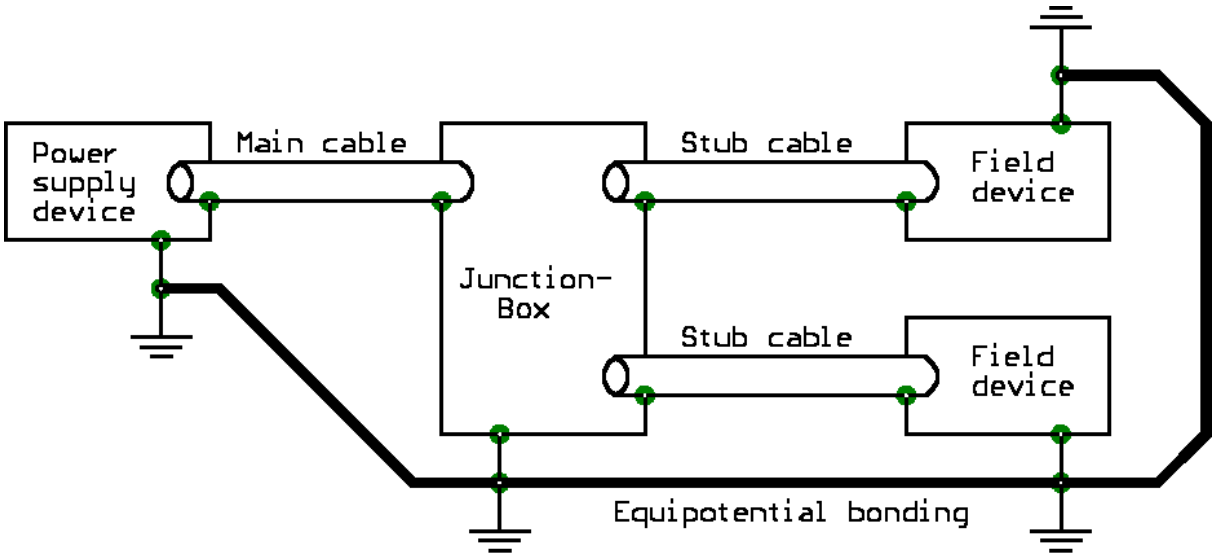

Figure 1: Combination of shielding and grounding
(Source: PNO Profibus PA User and Installation Guideline Version 1.1 / 9.1996)

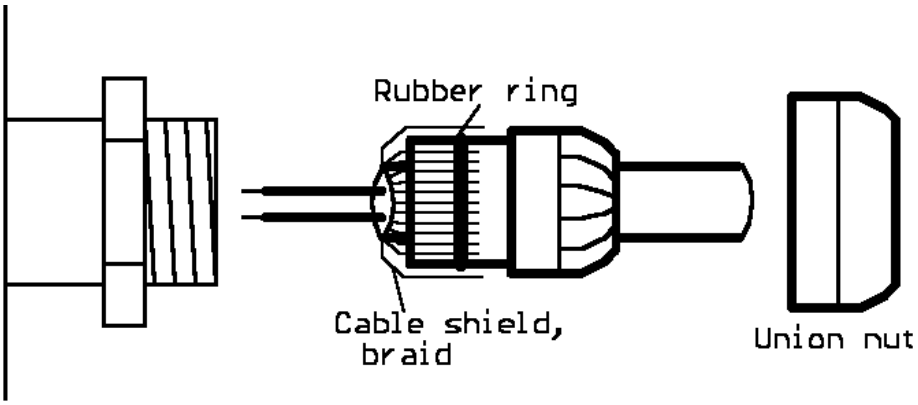

Figure 2: Connecting the cable shield in the cable gland

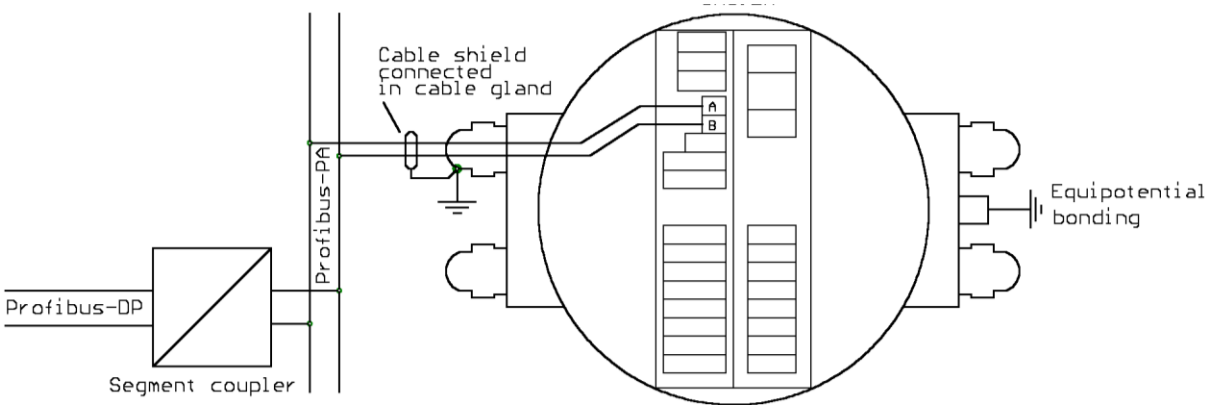

Figure 3: Connecting the UMC3 to the Profibus PA

4 Profibus PA Interface

PROFIBUS PA divides the parameters that are important for configuring the device in the system into function blocks. These parameters can only be accessed acyclically. The function and assignment of these blocks was defined by the PROFIBUS User Organization (PNO) in the “Profile for process control devices Rev. 3.0, Class B.”

The UMC3 uses profile 3.01 for Coriolis flow meters.

The *physical block* includes information about the device (e.g. type, profile or manufacturer) and diagnostics.

The “*transducer block*” contains transmitter-specific parameters (e.g. calibration factor, zero point or nominal size) and all measured values (flow rate, density, temperature, volume flow rate).

The UMC3 has an *Analog Input Function block* for the **mass flow rate** (class B), **density** (class A) and **temperature** (class A). These function blocks contain the parameters for forming the output value (e.g. limit values, measuring range or time constant). The output value of this block (*OUT*) can also be accessed cyclically.

With software releases 1.02 or later the transmitter UMC3-PA contains a „Totalizer Function Block“. The totalizer accumulates the flow. The totalizer can be read cyclically and acyclically. It can be reset cyclically and acyclically.

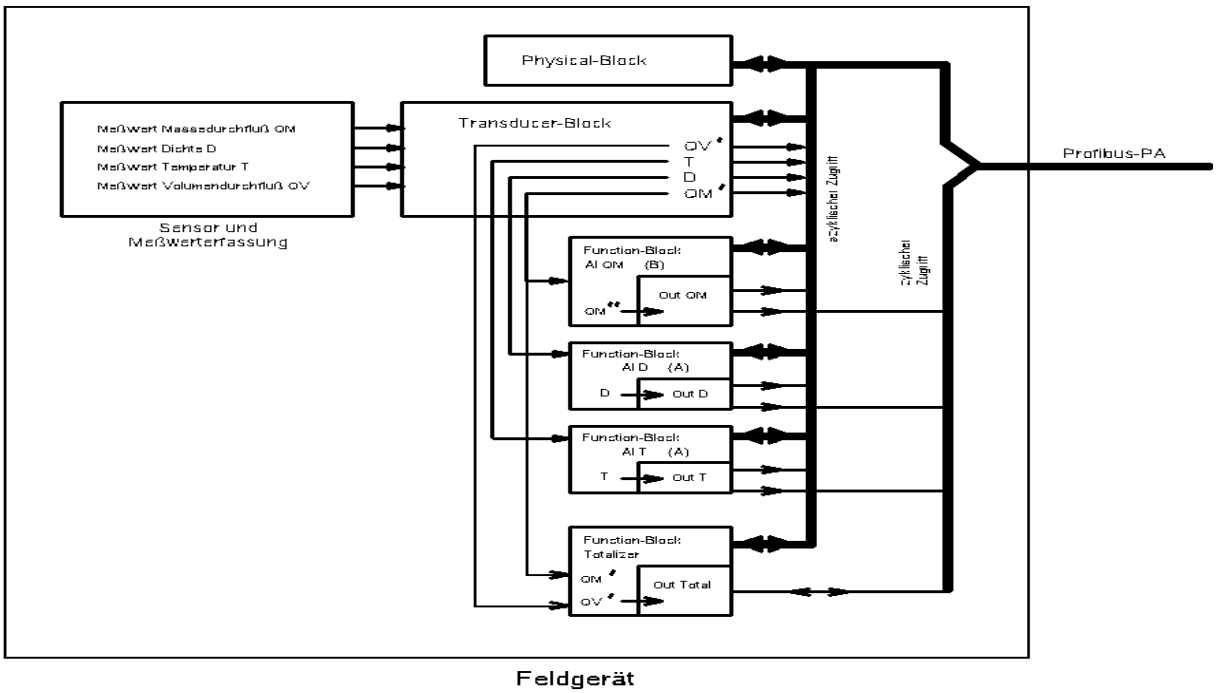

Figure 4: Block model of the UMC3 with PROFIBUS PA

4.1 GSD File

This file is shipped together with every PA device on a data carrier or can be accessed from the download area of our homepage http://www.heinrichs.eu/

It contains information for the master (e.g. baud rate or response times). This file is needed for the integration of the device into the PROFIBUS-PA network and will be copied into the subdirectory defined by the programmable controller software.

For devices with a serial number above, 258000 (delivered after 11.2007):

Name of file:
HM0B01.gsd together with the picture "**TMU.bmp**" for UMC3 with 3 *Analog Input Function Blocks* and one *Totalizer Function Block*.
This GSD-file also supports the SK2 and SK3 segment coupler from vendor Pepperl & Fuchs.

For older devices: **PA139702.gsd** has to be used!
Transmitters with 3 *Analog Input Function Blocks* without totalizer function.

4.2 Device address

The device address is used for selecting the device in the system. This address only may assign once. Note that devices with an identical address will collide during bus accesses! The device address can be set via the bus or the control unit BE2 (see UMC3 settings, device address).

When the device is shipped from the factory, the **preset address is 126**.

Before commissioning the system, every new device must be assigned a new, unused address (< 126).

5 Cyclic communication

The master can cyclically read out the "*OUT*" measured value from the UMC3 transmitter. The measured value is represented as a 32-bit floating-point number in accordance with IEEE-754; the corresponding status is represented as an 8-bit word. The UMC3 does not support “condensed status“. The unit of measured value can be selected but is not transmitted via cyclic communication.

OUT values of the three *Analog Input Function blocks can be switched on and off by service* “Check Configuration“.
Sequence of OUT values:

1. Mass flow rate (5Bytes),
2. Density(5Bytes),
3. Temperature (5Bytes),
4. Totalizer (5Bytes)

   Additionally, the totalizer can reset by cyclically writing a byte, or be set to a preset value or be stopped:
   parameter SET_TOT (first byte)

   The totalizing mode (forward only, reverse only, forward&reverse) can be selected by a further cyclically written byte:
   parameter MODE_TOT (second byte)
   See also chapter 6.5 Totalizer Function Block on page 16.

   The parameters also can be written acylically.

   Attention: cyclically writing has a higher priority than acyclically writing.
   The acyclically written value will be overwritten!

The OUT-values of the three *Analog Input Function Blocks* and the *Totalizer Function Block* can switched on and off by the check-configuration service. This service controlls the behavior of the totalizer.

5.1 Assignment of status and diagnostic bits

The meaning of the status messages has been defined by the PROFIBUS User Organization (PNO). The device reports the following states (low priority (good) to highest priority (bad):

Hex	Meaning	Quality of measured value, state	Bits in Diagnosis
		GOOD	
0x84	update event (settled for 30 s after changing a parameter)		
0x8A	Exceeding HI-LIM	“Good, warning value exceeded”	
0x89	Falling below LO-LIM	“Good, measured value falls below warning value”	
0x8E	Exceeding HI-HI-LIM	“Good, alarm value exceeded”	
0x8D	Falling below LO-LO-LIM	“Good, measured value falls below alarm value“	
0x53	partially filled	**UNCERTAIN** “uncertain, measurement inaccurate”	DIA_MEASUREMENT + EXTENSION
		BAD	
0x12	Exceeding the upper sensor limit	“Bad, sensor failure, high limited“	
0x11	Falling below the lower sensor limit	“Bad, sensor failure, low limited“	
0x11	Empty pipe	“Bad, sensor failure, low limited“	DIA_MEASUREMENT + EXTENSION
0x0F	System error internal communication error	“Bad, device failure, high limited and low limited	DIA_HW_ELECTR + EXTENSION
0x13	self test error sensor1, sensor2, exciter, temperature sensor, does not vibrate	“Bad, sensor failure, high limited and low limited	DIA_HW_MECH + EXTENSION
0x07	EEPROM-failure	“Bad, configuration error, high limited and low limited	DIA_CONF_INVAL + EXTENSION

5.1.1 Function block mass flow: assignment of the status byte

The assignment of the status byte depends on the chosen failsafe behavior:
Setting “use substitute value“: Status=0x48
Setting “use last usable value“: Status=0x44

5.2 Assignment of the bits of the extended diagnosis

	Octet	1	2	3	4	5	6
Malfunction SENSOR1	Hex	00	00	00	00	01	00
Malfunction SENSOR2	Hex	00	00	00	00	02	00
Exciter current too small	Hex	00	00	00	00	04	00
Exciter current too large	Hex	00	00	00	00	08	00
Malfunction temperature sensor	Hex	00	00	00	00	10	00
does not vibrate	Hex	00	00	00	00	20	00
Parameters inconsistent	Hex	00	00	00	00	40	00
Partially filled?	Hex	00	00	00	00	80	00
Density measurement switched off	Hex	00	00	00	00	00	01
Empty pipe	Hex	00	00	00	00	00	02
Simulation	Hex	00	00	00	00	00	04
EEPROM-failure	Hex	00	00	00	00	00	20
Internal communication faulty	Hex	00	00	00	00	00	40
System error		lo	milo	mihi	hi	00	00

6 Acyclic communication

6.1 Transducer block Coriolis

Calculating the measured value:
Command "Set zero point!" (1 = execute, 0 = no action)
This command causes the UMC3 to calibrate the zero point.
The zero point can also be shifted manually: The "**zero point**" parameter is set in the unit of the mass flow rate QM and continuously subtracted.
After the "Set zero point!" command this parameter will be set to zero.
It takes the device approx. 30 seconds to carry out the calibration.

Calibration factor: The measured value is multiplied by the calibration factor.
The following formula is used:

QM = (uncorrected QM – zero point) x calibration factor

Flow direction: The flow can be assigned a sign (0 = +, 1 = -).
If the sign is negative, reverse flow turns into forward flow.

Low flow cut off: The unit of the low-flow cut off is identical to the unit of the mass flow rate.
If the flow falls below the low-flow cut off, the flow (forward or reverse flow) will be set to zero.
The hysteresis is the alarm hysteresis set in the function block and has a one-sided effect.

Information:
Device mode: The UMC3 measures bidirectional (forward and reverse flow).

Nominal size: This parameter can be set via the bus.
When shipping the device, the nominal size does not have a correspondence to the standard parameters of the UMC3. When shipping the device, the nominal size is set to zero.

The **upper** and the **lower sensor limit** define the range for the upper-range value. The unit is identical with the respectively unit (mass flow, density, temperature, volume flow).

The limits cannot be changed by the bus.

Measured values can be acyclically read from the transducer block.
The following units are available:

Mass flow:	kg/s, kg/min, kg/h, t/h, g/min, lb/s, lb/min, lb/h, ston/h, lton/h
Density:	kg/l, g/l, g/cm3, lb/ft3, lb/USG
Temperature:	°C, K, °F
Volume flow:	m^3/h, l/h, l/min, l/s, USG/h, USG/min, USG/s, UKG/h, UKG/min, UKG/s, USB/d, MG/d, m^3/s, ft^3/min, cm^3/s

6.2 Analog Input Function Block Mass flow

This block fulfills the conformance-class B.

Filter time constant:
0...59 seconds, is used for damping the measured value.
Damping is carried out during measured-value acquisition. The Profibus-PA-profile requires setting this value to zero when carrying out the “factory reset”. However the value will be reset to a reasonable value (3 seconds).

Simulation:
Instead of the measured value and the status from the transducer block, a simulated value and status can be defined.
Simulation can be switched on or off (1 = ON, 0 = OFF).
Please note: **the simulation initialized by field bus must be switched off. It will not be finished automatically when switching off the device and restarting it.**
The OUT Status and the OUT value are not necessarily identical with the preset simulation value (depending on the simulation status).
Warning: OUT value does not indicate whether it is a measured or simulated value!

Mapping of the measured value:
Based on the measured value for the flow rate (see transducer block), the relative flow is calculated first.

PV Scale parameter (consisting of 100 % = URV, 0 % = LRV)).

$$Q \text{ in } \% = \frac{(Q \text{ in kg/h}) - LRV}{URV - LRV} \quad \text{(PV Scale)}$$

Based on the relative flow rate, the value for the output (OUT) is counted back:
Parameter OUT Scale [(consisting of 100 % = URV, 0 % = LRV, unit of output (OUT Scale)]
Output value, URV and LRV in the unit of the output (e.g./min).

OUT in unit = (Q in %) *(URV-LRV) + LRV

It seems practical to use the same URV, LRV for PV scale and OUT scale.

The OUT value can be retrieved using the cyclic services.

The units that can be set for OUT scale are listed under Transducer block/ mass flow units

Monitoring the measured value:
upper warning limit **HI-LIM**: if the limit is exceeded a warning will be issued
upper alarm limit **HI-HI-LIM**: if the limit is exceeded an alarm will be issued
lower warning limit **LO-LIM**: if the measured value falls below this limit, a warning will be issued.
lower alarm limit **LO-LO-LIM**: if the measured value falls below this limit, a an alarm will be issued.

The **Hysteresis** of the limit values has a one-sided effect.

The unit of these parameters is the unit of OUT scale (see above).

The monitoring results can be found under the corresponding output values
HI-ALM, HI-HI-ALM, LO-ALM, LO-LO-ALM

Measured value OUT, failsafe behavior
The measured value "**OUT**" can be read acyclically. In the target mode „manual" OUT can be set by the user.
In case of a malfunction OUT is invalid and the value of OUT can be substituted by following values:
Parameter **Failsafe Type:**

0: OUT will be substituted by the **„Failsafe Value**". In this case the status byte will show "uncertain, substitute value" (Hex 0x48)

1: OUT will keep the last usable value before occurring of the malfunction. In this case the status byte will show "uncertain, substitute value" (Hex 0x44).

2: OUT = 0.0; In this case the status byte will reflect the status byte from the transducer block.

The factory setting of fail safe type is 1.

6.3 Analog Input Function Block Density

This block fulfills conformance-class A.

Filter time constant:
The **filter time constant** for the density measurement is fixed to 9 seconds.
The Profibus-PA-profile requires setting this value to zero when carrying out the “factory reset”. However the value will be reset to its fixed value.

Mapping of the measured value OUT:
Since this AI block fulfills the conformance class A it is not possible to map the measured value.

The OUT value reflects the measured value for the density from the transducer block.

The OUT value can be retrieved using the cyclic services.

The unit is the same like selected in the transducer block /density unit.

The OUT value neither can be simulated nor be written in target mode “manual”

Monitoring the measured value:

upper warning limit **HI-LIM**: if the limit is exceeded a warning will be issued
upper alarm limit **HI-HI-LIM**: if the limit is exceeded an alarm will be issued
lower warning limit **LO-LIM**: if the measured value falls below this limit, a warning will be issued.
lower alarm limit **LO-LO-LIM**: if the measured value falls below this limit, a an alarm will be issued.
The **Hysteresis** of the limit values has a one-sided effect.

The unit of these parameters is the unit of OUT scale (see above).

The monitoring results can be found under the corresponding output values
HI-ALM, HI-HI-ALM, LO-ALM, LO-LO-ALM

6.4 Analog Input Function Block Temperature

This block fulfills conformance-class A.

Filter time constant:
The **filter time constant** for the temperature measurement is fixed to 15 seconds.
The Profibus-PA-profile requires setting this value to zero when carrying out the “factory reset”. However the value will be reset to its fixed value.

Mapping of the measured value OUT:
Since this AI block fulfills the conformance class A it is not possible to map the measured value.

The OUT value reflects the measured value for the temperature from the transducer block.

The OUT value can be retrieved using the cyclic services.

The unit is the same like selected in the transducer block / temperature unit.

The OUT value neither can be simulated nor be written in target mode “manual”

Monitoring the measured value:
upper warning limit **HI-LIM**: if the limit is exceeded a warning will be issued
upper alarm limit **HI-HI-LIM**: if the limit is exceeded an alarm will be issued
lower warning limit **LO-LIM**: if the measured value falls below this limit, a warning will be issued.
lower alarm limit **LO-LO-LIM**: if the measured value falls below this limit, a an alarm will be issued.
The **Hysteresis** of the limit values has a one-sided effect.

The unit of these parameters is the unit of OUT scale (see above).

The monitoring results can be found under the corresponding output values
HI-ALM, HI-HI-ALM, LO-ALM, LO-LO-ALM

6.5 Totalizer Function Block

The totalizer accumulates the measured flow from the transducer block.

TOTAL: accumulated flow.
Attention: since this value is only represented by a 32-bit floating point, the value will become inaccurate for large countings (>1000000). Therefore the totalizer should be reset in time.

Attention: The counter displayed by the control unit BE2 does not represent TOTAL but follows the settings done by the control unit BE2 (unit, resetting)

The totalizer unit can be selected (**UNIT_TOT**):
massflow: kg, t, g, lbs, ston, lton
volumeflow: m^3, l, USG, UKG, USB, ft^3,cm^3
From the unit results wether the massflow or the volumeflow will be accumulated. When changing the unit from mass into volume or volume into mass the totalizer content will be kept and converted with a density of 1.0 kg/l. It is recommendet to reset the totalizer when changing the unit from mass into volume or vice versa.

Parameters for controling the totalizer:
The totalizer accumulates with **SET_TOT**=0. It can be reset by SET_TOT=1 and can be preset to a value (parameter **PRESET_TOT**) by SET_TOT=2.
The totalizing mode can be selected between forward&reverse (parameter **MODE_TOT**=0), forwrad only(parameter MODE_TOT=1), reverse only (Parameter MODE_TOT=2), or stopped (parameter MODE_TOT=3).

Attention: This parameter will not be saved at power fail (as demanded by the profile) !

The parameters SET_TOT and MODE_TOT can be written cyclically also. In this case the acylically written values will be overwritten.

Failsafe behaviour: if the transmitter recognizes a serious failure so that the transmitter stops measuring the totalizer will be stopped anyway.

The totalizer's content will be stored save at power failure.

Monitoring the measured value:
upper warning limit **HI-LIM**: if the limit is exceeded a warning will be issued
upper alarm limit **HI-HI-LIM**: if the limit is exceeded an alarm will be issued
lower warning limit **LO-LIM**: if the measured value falls below this limit, a warning will be issued.
lower alarm limit **LO-LO-LIM**: if the measured value falls below this limit, a an alarm will be issued.
The **Hysteresis** of the limit values has a one-sided effect.

The unit of these parameters is the unit of TOTAL.

The monitoring results can be found under the corresponding output values
HI-ALM, HI-HI-ALM, LO-ALM, LO-LO-ALM

6.6 Physical Block

The *Physical Block* contains parameters informing about the device. However some parameters affect the device's behavior:

Enable local operations:
If this parameter is set to 1 it is possible to change parameters by the control unit BE2. When it is set to 0, parameters only can be changed if there no cylical or acyclical communication occurs for at least 30 seconds via field bus.

Write locking:
If this parameter is set to 2457 it is allowed to change parameters. If set to 0 it is disabled to change any settings. No other values are accepted.

Ident number selector:
This parameter changes the ID number of the device. If it is set to 0 (factory setting for older devices) the device must be accessed by using the profile specific ID 0x9702. If it is set to 1 (factory setting for devices with serial numbers starting from 258000) the device must be accessed by using the manufacturer specific ID **0x0B01**. This parameter decides whether the profile-GSD-file or the manufacturer specific GSD-file HM0B01.gsd must be used.

Extended diagnosis:
Extended diagnosis displays the actual error messages and status. Each bit represents a message. The assignments can be found in chapter 5.2 Assignment of the bits of the extended diagnosis on page 10.

6.6.1 Factory Reset

- Writing a “1” forces the device to reset all parameters into the state when shipped (the devices address will not be affected).
  Attention: The Profibus-PA-profile requires that the unit for the mass flow will be reset into **kg/s**. Together with the unit the displayed OUT-value for the mass flow will change. The unit can be reset by the field bus or by the control unit. Enter the parameter “FLOW” / ”mass flow QM unit” with valid customer password. Change the unit to another one, press Enter. Reenter a second time and now change the unit to the desired value. Accept by pressing the Enter-key.

- Writing 2712 resets the device address to 126

- Writing 2506 forces a reset of the device.

  Attention:
  Only the Profibus-PA module will be reset. The transmitter itself will not be affected. The communication will fail temporarily.

7 Local operating with control unit BE2

The handling and all functions are identical to the standard design of the UMC3. However, not all parameters are mapped to Profibus PA. The following table lists all parameters mapped to Profibus PA.

MEASURED VALUES	displayed are the outputs of the transducer block Attention: displayed are the measured values independent from the settings of the AI block. If a simulation is started via field bus, the display shows the actual measured values and the message “Simulation”. The via field bus simulated value is not shown in the display. Attention: The displayed counter of the local control unit is not identical to the totalizer function block! No preset and reset Prifubus PA command influence the local counter.
PASSWORD	Attention: Entering of a valid password can be prohibited depending on the physical block’s settings.
Counter	not available.
MEASUREMENT-PROCESSING	-Damping -Low flow cut off: field bus: absolute value; local control: percentage of upper range value -Zero point calibration
FLOW	- QM unit; used as mass flow dimension for transducer block’s measured value and Zero point, AI’ s OUT value, AI’s limits
DENSITY	Measurement on/off, Limit for empty pipe detection are not mapped to field bus. Density measurement is always process density. -density unit: used as dimension for transducer block and its OUT value.
TEMPERATURE	- maximum temperature is not mapped, can be read out at local display - temperature unit: use as dimension for transducer block and its OUT value
PULSE OUTPUT	not available
STATUS	not available
CURRENT OUTPUTS	not available
SIMULATION	In simulation mode “setting Q, D, T” the measured values of transducer blocks and AIs follow the simulated settings. Transducer block’s status is set to “GOOD” independent from real existing error messages.
SELF-TEST	Parameters are not mapped to field bus. Detected errors are indicated by diagnostic bits.
TRANSMITTER SETTINGS	- device address (0...126)
SENSOR SETTINGS	- Sensor constant set mass flow transducer block parameter “Calibration Factor“. Sign can be set by local control unit or by transducer block’s parameter “flow direction”

8 Characteristic values of Profibus-PA Interface

Basic current: 12 mA ± 0.5 mA (-20°C to 60°C)
< 16mA ± 0.5 mA (60°C to 80°C)

Fault current: < 20,5 mA

Baud rate: 31.25 kBaud

Safety data of Profibus-PA interface:

Terminals 39 and 40 type of protection **EEx ia IIC**
For connecting a certified Profibus-PA circuit in accordance
With the FISCO model (PTB-W-53).

The maximum values satisfying safety requirements are the following

Effective inner inductance L_i <= negligible
Effective inner capacitance C_i <= 1,2 nF