TRICOR® TCM 0450/TCMH 0450
Coriolis Mass Flow Meter for High-Pressure Hydrogen
**Manual-Version**
TCM_0450_E80_M_EN_150209_E008

**SW-Version**
This manual is valid for
Main SW: Mv3.45 and higher
Display SW: Dv3.45 and higher
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1. General Information

1.1. Features

The TRICOR Mass Flow Meter TCM 0450/TCMH 0450, based on the Coriolis principle, is designed and usable for high-pressure Hydrogen applications up to 1,050 bar (15,200 psi).

For this TRICOR Mass Flow Meter TCM 0450/TCMH 0450 the transmitter electronics TCE 8000 as a remote wall mount type is available. It provides following features:

- A graphic display
- Menu driven control with soft keys for easy operation (also without manual)
- Magnet hall switches for Ex areas
- Two freely programmable 4...20 mA outputs
- One freely programmable frequency output
- One control input and one control output
- RS485 interface

Available options are:

- HART® interface
- One 4...20 mA input for pressure measurement
- Pressure compensation
- Foundation Fieldbus® communications
Fig. 1: Transducer TCM 0450/TCMH 0450 with wall-mountable transmitter electronics TCE 8001-W
1.2. Safety

1.2.1. General Safety

All statements regarding safety of operation and technical data in this manual will only apply when the TRICOR Coriolis Mass Flow Meter is operated correctly in accordance with this manual.

The data for Ingress Protection (IPxx) will only apply when all connectors are caped properly with the corresponding counterpart with the same or better IP rating. Cable glands must be populated with cables with the specified diameter and closed properly. The display cover must be closed.

During operation all openings of the housing must be closed unless otherwise is noted in this manual.

All electrical connections to the load and to the supply must be made with shielded cables unless otherwise is noted in this manual. This TCM must be grounded.

As a protection against fire in the positive supply, a fuse with a current rating not higher than the current carrying capacity of the cable used is required.

Before installing the flow meter and transmitter, the user is responsible to ensure that all wetted parts are compatible with the fluid or gas to be measured.

The user has to adhere to the instructions for installing electrical devices and corresponding instructions.

The devices described in this manual may only be connected and operated by authorized and qualified personnel.

1.2.2. Special Requirements for Ex Installations

Before installing and using TRICOR Mass Flow Meters in hazardous locations it is absolutely needed to read and to observe the “Installation Manual for Hazardous Areas”.

Document No.: TCM_E80_E_EN_160520_E004

In hazardous locations the cover of the wall mount electronics is not allowed to open under any circumstances if the supply voltage is applied. It is possible to operate the electronics with the magnet keys.

The analog and digital I/O signals are not specified for driving Ex ia circuits.

When using long cables make sure that the inductances and capacitances for the respective voltage or gas group are compliant to the Ex certification.

**WARNING!**

All specified limiting values and parameters stated in "Installation Manual for Hazardous Areas" must be adhered to at all times. Failure to do so can cause equipment failure and can lead to serious injury or death.
1.2.3. Warnings in this Manual

**NOTE:**
Notes provide important information for the correct usage of the equipment. If the notes are not observed, a malfunction of the equipment is possible.

**WARNING!**
Warnings provide very important information for the correct usage of the equipment. Not observing the warnings may lead to danger for the equipment and to danger for health and life of the user.
### General Information

#### 1.3. Ordering Codes and Accessories

#### 1.3.1. Ordering Code

<table>
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Without cable, for Ex3 version  
(order corresponding cable separately at TCC06-**)

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<td>cCSAus: Class 1, Division 1: Group A, B, C, D, T2…T4</td>
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<tr>
<td>ATEX+IECEx, Zone 1: Group IIC, T2…T4 + cCSAus: Class 1, Div. 1: Group A, B, C, D, T2…T4</td>
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</table>

**Customer Options (01…99)**

Push-Pull connector for TCM  
(only for versions Exn, Ex, Ex1)
### General Information

**Process connections**

- Autoclave 3/8" MP

**Mechanical options**

- Medium Temperature Range: 
  - -40 °F … +212 °F (-40 °C … +100 °C)

**Pressure Range**

- 1050 bar process pressure

**Accuracy**

- 1 % of reading

**Mechanical Design**

- Standard

**Electronics Options**

**Electronics Type**

- Remote electronics, Push-Pull connector

**Interface**

- Not used

**Supply Voltage**

- Not used

**Options**

- Pressure compensation and 4 - 20 mA input, MID MI002/OIML R137 compliant
- No options

**EX-Protection**

- ATEX + IECEx Zone 1: Group IIC, T2 ... T4
- ATEX Zone 2: II 3G Ex nA IIC T2 ... T4 Gc
- cCSAus: Class 1, Div. 1: Group A, B, C, D, T2 ... T4
- ATEX + IECEx, Zone 1: Group IIC, T2 ... T4 and cCSAus:Class1, Div. 1: Group A, B, C, D, T2 ... T4

### Obligatory accessories for Ex3 Version

**Connection Cable**

- Connector M23 (TCE) with push pull (TCM) for EX3-Version

<table>
<thead>
<tr>
<th>Length (ft) (m)</th>
<th>Standard</th>
<th>0</th>
<th>3</th>
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<tbody>
<tr>
<td>10 ft. (3 m)</td>
<td>0</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 ft. (6 m)</td>
<td>0</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33 ft. (10 m)</td>
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<td>66 ft. (20 m)</td>
<td>2</td>
<td>0</td>
<td></td>
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</tbody>
</table>

### 1.3.2. Accessories

There are currently no accessories available for the TCM 0450/TCMH 0450.
1.4. Measuring Principle TCM

Two parallel flow tubes inside the TCM Flow Meter are vibrating at their natural frequency in opposite direction. Any mass flow passing through the tubes will delay the vibration at the incoming side and accelerate the vibration at the outgoing side. This causes a small time shift between both ends of the tube. This time shift is measured and used to calculate the mass flow through the tubes.

By measuring the natural frequency of the tubes the density of the medium can be calculated. As both effects are temperature dependent, the temperature is measured by means of an accurate temperature sensor for correcting the temperature effects on flow and density measurement.

As a result a Coriolis Mass Flow Meter measures directly mass flow, density and temperature of the medium. Knowing the mass flow and the density, also the volume flow can be calculated.

1.5. Custody Transfer

When the “Custody Transfer” option is selected, the following restrictions apply:

- Due to an additional Modbus command filter (additional electronic component), only a few parameters that are not critical for measuring can be written via Modbus (see the document: “Modbus (RTU) Manual”: chapter 3.5). Read access to all values that can be read via Modbus remains unchanged from the standard version.
- The speed of the Modbus interface is fixed at 57600 baud and cannot be changed by the user.
- As soon as critical events (error messages) are written to the log, this is indicated by alternate flashing of the red and green LEDs until the user performs a manual reset (see chapter 4.3.5).
- The P button on the display cannot be operated with the magnet any more when the front cover is closed. This means no more device settings can be changed when the housing is closed and sealed.
- The two housing covers as well as the plug-in connections of the connecting cable must be secured with suitable seals to prevent unauthorized opening or unplugging.
- In case of a critical error state, all measured flow rate values are accumulated in a failure total counter (FAIL. TOTAL) instead of the totalizer (GRAND TOTAL) as long as the error state remains active.
- The standard displays have the following fixed two-line configuration:
  - Standard display: 1st line: “Current mass flow” + 2nd line: “Totalizer”
  - Alternative display: 1st line: “Temperature” + 2nd line “Failure Total Counter”
- Remote control is possible exclusively via RS485/Modbus RTU (HART® or Foundation Fieldbus® are permanently inactive)
- The control input (CTRL IN) is permanently inactive (=OFF)
2. Getting Started

2.1. Unpacking

Verify that you have received the following items:
- TCM 0450/TCMH 0450
- TCE 8001-W
- Instruction manual

2.2. Operating Elements

2.2.1. TCE 8***-wall mounted and compact version

![Operating Elements of TCE 80xx-W](image)

1 = Pushbutton “P”, activates/selects the different menus and confirms the settings
2 = LED "OK", flashes green when there is no error
3 = LED "ERR", flashes red when an error occurs
4 = Display
5 = Pushbutton "Info", normal: selects the error menu, setup mode: softkey
6 = Pushbutton "Display", normal: toggles the display, setup mode: softkey
7 = Pushbutton "Reset", normal: resets the BATCH TOTAL counter, setup mode: softkey
8 = Front cover
9 = Set screw for front cover (varying position)
10 = Screw for protective ground

Additionally (not shown on the pictures):
- Cable to the meter TCM 0450/TCMH 0450, length as ordered (standard: 10 ft./3 m)
- Wall mounting bracket
2.2.2. TCM 0450/TCMH 0450

Fig. 4: Operating Elements TCM 0450/TCMH 0450

1 = Locking screw for rupture disc
2 = Socket for cable to the TCE
3 = Fluid output, Autoclave
4 = Fluid input, Autoclave
5 = Mounting holes (4 x)
2.3. Pin Assignments TCE

2.3.1. TCE 8***-wall mounted and compact version, non-Ex

Fig. 5: Electrical terminals TCE 8***-W and compact version

1 = Terminal screw for protective ground
2 = Switch for terminating resistor for the RS485 interface
3 = Terminal block for interface
4 = Terminal block power supply
5 = Terminal block for I/O signals
TCE Terminal Connections

1  +I1  Current loop 1 positive terminal
2  -I1  Current loop 1 negative terminal
3  +I2  Current loop 2 positive terminal
4  -I2  Current loop 2 negative terminal
5  FOUT  Frequency/pulse output
6  CTLOUT  Control output
7  CTLIN  Control input
8  GND  Ground (for pins 5 through 7)

20  COMMON  Common (for pins 21 and 22)
21  -RS485  RS485 negative line
22  +RS485  RS485 positive line
30  COMMON  Common (for pins 31 and 32)
31  FF-  Foundation Fieldbus® negative line
32  FF+  Foundation Fieldbus® positive line

24 V DC Supply
50  +V DC  Positive supply voltage (24 V DC)
51  -V DC  Supply ground
52  PE  Protective Ground

100…240 V AC Supply
90  L  Phase (AC voltage)
91  N  Neutral
52  PE  Protective Ground

NOTE:

An active pressure compensation is not needed with the TCM 0450/TCMH 0450 Coriolis meter because of its extremely low drifts with pressure changes.

Nevertheless, if the option "PRESSURE COMPENSATION" is used the current loop 1 (Terminal 1 and 2) works as an input.
2.3.2. TCE 8***-wall mounted and compact version, Ex certified

Fig. 6: Electrical terminals TCE 8***-W-*-Ex

1  = Terminal screw for protective ground
2  = Terminal screw for protective ground
3  = Protective cover
4  = Terminal block for digital I/O signals (UM = 250 V DC)
5  = Terminal block power supply (UM = 250 V DC)
6  = Terminal block for interface (UM = 30 V DC)
7  = Terminal block for analog I/O signals (UM = 30 V DC)
**TCE Terminal Connections**

**Terminals with U_M = 30 V DC**

1. **I1**  
   Current loop 1 positive terminal
2. **-I1**  
   Current loop 1 negative terminal
3. **I2**  
   Current loop 2 positive terminal
4. **-I2**  
   Current loop 2 negative terminal

20. **GND**  
   Common (for pins 21 and 22)
21. **-RS485**  
   RS485 negative line
22. **+RS485**  
   RS485 positive line
30. **GND**  
   Common (for pins 31 and 32)
31. **FF-**  
   Foundation Fieldbus® negative line
32. **FF+**  
   Foundation Fieldbus® positive line

**Terminals with U_M = 250 V DC**

5. **F_OUT**  
   Frequency/pulse output
6. **CTL_OUT**  
   Control output
7. **CTL_IN**  
   Control input
8. **GND**  
   Ground (for pins 5 through 7)

**24 V DC Supply**

50. **+V DC**  
   Positive supply voltage (24 V DC)
51. **-V DC**  
   Supply ground
52. **PE**  
   Protective Ground

**100…240 V AC Supply**

90. **L**  
   Phase (AC voltage)
91. **N**  
   Neutral
52. **PE**  
   Protective Ground

---

**NOTE:**

An active pressure compensation is not needed with the TCM 0450/TCMH 0450 Coriolis meter because of its extremely low drifts with pressure changes.

Nevertheless, if the option "PRESSURE COMPENSATION" is used the current loop 1 (Terminal 1 and 2) works as an input.
2.4. Quick Start

**WARNING!**
As for safety and accuracy reasons many precautions must be taken, read chapter 3 carefully before installing the TCM!

In case the TCM has only to be operated without flow for testing or learning purpose, at least the following connections have to be made (see chapter 3.2):

- Connect the TCE to the TCM
- Connect the supply voltage
- The various inputs and outputs as well as the interface may be connected as well, if those features are required.

**WARNING!**
If the TRICOR Coriolis Mass Flow Meter is connected to a bigger system, for your personal safety connect the protective ground as well!

**WARNING!**
In hazardous areas it is not allowed to operate the TRICOR Coriolis Mass Flow Meter without proper wiring in accordance with chapter 3.2.5 and with the housing not properly closed!

2.4.1. First Operation

Make sure that all mechanical and electrical connections are made properly.

Switch on the power supply. The LED “OK” will flash green.

After the power up sequence the display shows the preselected values (ex factory: “Flow” and “Batch”)

Switch on the flow. The value indicated in the display should be positive.

In case of an error the LED “ERR” will flash red.

As soon as the TCM has reached the operating temperature, make the zero point calibration (see chapter 4.2.1 for detailed information):

- Switch off the flow
- Wait until the flow is zero
- Start the zero offset calibration in the ZERO OFFSET menu
- Wait until the offset procedure is finished
- Switch on the flow again

The display can be altered by pressing the pushbutton “Display”.

The internal device status can be viewed by pressing the pushbutton “Info”.

If the function is activated, the BATCH reading can be reset to zero by pressing the pushbutton “Reset”.

To open the control menu press button “P” for three seconds.
2.4.2. CONTROL Menu

In the CONTROL menu all configurations can be made. This includes configuration of the analog and digital outputs, customizing the display and other settings.

The menu itself is self-explaining; the function of the softkeys is indicated in the display above the pushbuttons.

To enter the CONTROL menu press the pushbutton “P” for three seconds.

If a global access code is set, the CONTROL Menu is completely locked (see chapter 6.6). With no global access code the submenu “DISPLAY” can be entered without a password as any changes in this submenu will not affect the operation of the TCM.

The submenus “ZERO OFFSET”, “SETUP”, “I/O-TEST” and “SERVICE” are password protected for avoiding unintentional changes of the operating parameters.

For “ZERO OFFSET”, “SETUP” and “I/O-TEST” the password is “2207”, for “SERVICE” refer to chapter 6.

Change the indicated number “2206” with the softkey “UP” to “2207” and confirm with “P”.

Select the desired submenu with the softkeys and confirm with “P”.

Every setting must be confirmed with “P” for storing the setting or with “EXIT” for exiting without storing.

For leaving the “SETUP” menu press “EXIT” in the main level.

NOTE:

With the “Custody Transfer” option, no settings can be configured when the front cover is closed since the P button is deactivated.

2.4.3. Using the magnet

The explosion-proof variants with the Ex d housings provide a magnet to be able to operate the pushbuttons without opening the display cover.

In hazardous, wet and dusty areas the display cover must not be opened to operate the pushbuttons.

Beside every pushbutton there is a hall sensor which can be operated via the magnet attached to the housing.

For operating the pushbuttons hold the magnet to the glass.

The best positions for operating the keys are:

<table>
<thead>
<tr>
<th>Pushbutton</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>left upper edge of the yellow area</td>
</tr>
<tr>
<td>Reset</td>
<td>lower edge of the yellow area</td>
</tr>
<tr>
<td>Display</td>
<td>lower edge of the yellow area</td>
</tr>
<tr>
<td>Info</td>
<td>lower edge of the yellow area</td>
</tr>
</tbody>
</table>

NOTE:

The P button cannot be operated with the magnet with the “Custody Transfer” option!
3. Installation

3.1. Mechanical Installation

In accordance with this manual the user should select the installation position which fits the application best. To ensure the highest degree of accuracy and repeatability, care should be taken to affix the TRICOR products in a stable process site and minimize the amount of vibration in the installation environment.

3.1.1. Installation Guidelines

Coriolis Mass Flow Meters measure the flow of a gas by vibrating the medium perpendicular to the flow direction and measuring the effect of the inertial force of the medium. Consequently, for best performance the meter must be decoupled from external vibrations and the medium must be homogenous.

External vibration:
In case of (possible) external vibrations connect the meter mechanically rigidly to a non-vibrating point or – if this is not possible – connect it by means of vibration dampers.

The TCM 0450/TCMH 0450 has to be mounted using the mounting holes, and must not be fixed directly to the external tubing.

Piston pumps and other pumps producing a strongly pulsating flow should be decoupled hydraulically via longer pipes, flexible tubes or other measures.

Inhomogeneous media:
In case the medium contains liquid droplets or solid particles make sure that those droplets or particles do not accumulate inside the meter. For this, the meter has to be mounted with tubes coming from the bottom side.

3.1.2. Horizontal Installation

The horizontal installation is the recommended installation.

The TCM 0450/TCMH 0450 has to be mounted using the four mounting holes. Fix the meter to a solid, non-vibrating surface as close to the meter as possible.

If no non-vibrating surface is available, vibration dampers might be recommended.

![Fig. 7: Recommended Horizontal Installation](image-url)
3.1.3. Vertical Installation

Mounting the meter vertically is not allowed.

Fig. 8: Vertical Installation

3.1.4. Installation of Multiple Meters (in Series)

It should be avoided to mount multiple meters directly next to each other (in series). Meters of the same type run at similar frequencies. Therefore it’s possible for meters of the same type to cross talk and disturb the measurement. To avoid these problems the following recommendations should be followed:

- Increase the distance from meter to meter to ≥ 1m
- Use independent, vibration-free and solid grounds to mount the meters

Fig. 9: Installation recommendation for multiple meters in series
3.1.5. Mechanical Installation of the Electronics

The wall mount TCE is to be mounted on the wall with 2 screws with 5 mm diameter, about 40 mm apart. For exact dimensions refer to chapter 7.3.4.

**WARNING!**
For mounting the TCM in hazardous areas refer to the “Installation Manual for Hazardous Areas”.

3.1.6. Seals of the electronics housing and the connector

The custody transfer devices must be protected against unauthorized manipulation. In order to seal the covers of the electronics housing, holes are provided in the housing body as well as in the safety bolts.

![Seals of the electronics housing and the connector](image)

**Fig. 10: Seals of the electronics housing and the connector**

The connectors on both ends of the connection cable between the TCM sensor and the TCE electronics are equipped with suitable clamps in order to be able to pull a sealing wire through these as well as through bores in the area of the plug socket on the sensor or the electronics and to secure the plug connections against unauthorized unplugging.

3.2. Electrical Installation

Make sure that the TCM is properly mounted and the process input and output are connected before making the electrical connections.

The TCM must be grounded.

The TCE requires a regulated DC power supply of 24 V ±20% or a mains voltage of 100 to 240 V AC, depending on the version.

**WARNING!**
Never connect a 24 V version to the mains supply or vice versa!

The digital inputs and outputs are referred to GND and to the ground potential of the DC supply (= negative pole). The AC supply terminals are electrically isolated from all inputs and outputs.

The ground potential GND is connected to protective ground via a 1 kΩ resistor.
The resistor will thermally withstand a potential difference of up to 30 V between PE and GND but for proper operation this difference should be limited to 5 V.

To connect the TCE, shielded cables must be used. The shield should be connected to the case. If the TCM is installed in bigger systems, the shield must not present a DC connection for avoiding high ground loop currents, make the ground connection of the shield via a capacitor of e.g. 100 nF.

**WARNING!**

Improper grounding and shielding may lead to bad EMC behavior or danger to your health!

**NOTE:**

Make sure that all cable and wires are connected and fixed properly before applying power to the TCE.

**WARNING!**

Always switch off the voltage supply before you wire the analog or digital in- and outputs or communication interface. The display module must not be removed if the voltage supply on Coriolis mass meter is on. Otherwise all totals can be reset.

### 3.2.1. Connecting TCE and TCM

TCM and TCE have to be electrically connected properly. Otherwise, the TCE electronics will show an error message.

Typically, the connecting cable is part of the TCE electronics and unchangeably fixed to it.

With the variant usable in hazardous areas (Ex3 version), an additional connecting cable is provided which is equipped with plug connectors at both ends.

The M23 plug connectors is meant to be plugged into the corresponding socket at the TCE and needs to be locked or unlocked by a quarter turn of its union nut.

The electrical connection to the TCM 0450/TCMH 0450 is done by means of a push-pull plug connector that is automatically locked to the socket.

Just push the plug into the socket until it is notable engaged.

For disconnecting just pull the plug housing. The locking is released automatically.
3.2.2. Electrical Installation of the Wall Mount Electronics Version

Connect the TCM to the TCE (see chapter 3.2.1)
Open the safety screw at the display cover of the TCE with the provided Allen key.
Remove the display cover of the TCE by turning it counter clockwise.
Pull out the display.
Prepare the cable for installation:
- Separate the single wires for about 4 ¾ inches (12 cm)
- Strip the end and cover it with a cable end sleeve
- Connect an about 2 ¾ inches (7 cm) long stranded wire to the shield

Feed the cable through the cable gland.
Connect the shield to the PE screw.

NOTE:
In bigger installations a separate PE connection with a high cross section (> 1.5 mm²) is recommended for avoiding high equalizing currents in the shield.

Connect the individual conductors to the cage clamp terminals as required.
Push a small screwdriver into the upper (smaller) opening of the terminal, feed the cable into the bigger opening and pull out the screwdriver.
For the right connections refer to chapter 2.3.
Adjust the position of the cable in the cable gland in that way that the single conductors remain short but free of tension and fix the cable in the cable gland.
Put in the display again. The display can be positioned in four different orientations, separated by 90°.
Perform – if necessary – a function test and make the necessary settings (see chapter 4.5).
Close the display cover.
Fasten the safety screw if necessary.

3.2.3. Power Supply and Grounding

3.2.3.1. 24 V DC Power Supply

The TCE requires a regulated DC power supply of 24 V ±20%.
The power supply input of the TCE is protected by a fuse. As a protection against fire in case of a short in the supply cable, the output of the power supply must be equipped with a fuse with a rating not higher than the current carrying capacity of the cable used.
For connecting the TCE use shielded cables. If several cables are used, each cable should be shielded properly.
Connect the ground of your power supply to terminal 51 and the 24 V to terminal 50. (see Fig. 11)
**Installation**

**Fig. 11: Wiring diagram for power connections, DC operation**

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Positive supply voltage, 24 V ±20%, referred to pin 51</td>
</tr>
<tr>
<td>51</td>
<td>Ground potential for supply voltage</td>
</tr>
<tr>
<td>52</td>
<td>Protective ground</td>
</tr>
</tbody>
</table>

The ground terminals 8 and 51 are internally connected together.

Ground and protective ground are internally connected via a 1 kΩ resistor. The resistor will thermally withstand a potential difference of up to 30 V between PE and GND but for proper operation this difference should be limited to 5 V.

**3.2.3.2. 100...240V AC Mains Supply**

The AC version of the TCE requires a nominal power supply of 100...240 V AC and operates over a range of 90...264 V AC.

The power supply input of the TCE is protected by a 1 A slow blow fuse. As a protection against fire in case of a short in the supply cable, the output of the power supply must be equipped with a fuse with a rating not higher than the current carrying capacity of the cable used.

For the mains powered TCE a good connection of PE is mandatory. The cross section of the PE cable should be at least equivalent to the cross section of the supply cable or to 1 mm², whichever is higher.

Connect the supply to terminal 91 (neutral) and 90 (life). (see Fig. 12)
Fig. 12: Wiring diagram for power connections, AC operation

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>Mains phase, referred to pin 91</td>
</tr>
<tr>
<td>91</td>
<td>Mains neutral</td>
</tr>
<tr>
<td>52</td>
<td>Protective ground</td>
</tr>
</tbody>
</table>

The ground terminal 8 is not connected to terminal 91.

3.2.4. Connecting the Control Inputs and Outputs

Fig. 13: Wiring diagram for digital I/O connections
The frequency and control outputs are active push-pull outputs with an output resistance of 220 Ω. They can be loaded to the positive supply or to ground. For a high output swing the load resistors $R_{load}$ should not be lower than 1 kΩ.

In case of a load resistor to ground the output voltages are:

$$V_{\text{high}} = V_{\text{supply}} \cdot R_{load} / (220 \, \Omega + R_{load})$$
$$V_{\text{low}} < 1 \, \text{V}$$

In case of a load resistor to the positive supply the output voltages are:

$$V_{\text{high}} > V_{\text{supply}} - 1 \, \text{V}$$
$$V_{\text{low}} = V_{\text{supply}} - V_{\text{supply}} \cdot R_{load} / (220 \, \Omega + R_{load})$$

The control input requires a high voltage of minimum 6.5 V and a minimum input current of 0.1 mA.

The ground terminals 8 and 51 are internally connected together.

Ground and protective ground are internally connected via a 1 kΩ resistor. The resistor will thermally withstand a potential difference of up to 30 V between PE and GND but for proper operation this difference should be limited to 5 V.

3.2.5. Connecting the Analog Outputs

The TCE 8000 provides two independent passive 4…20 mA current loops CURRENT 1 and CURRENT 2.

The current loops are isolated from each other and from the power supply.

For operation an external supply of 8…30 V (nominal 24 V DC) is required.

The minimum voltage between terminal 1 and 2 or 3 and 4 respectively is 8 V.

The minimum load resistance is 0 Ω, the maximum is determined by the supply voltage.

At a given supply voltage the maximum load resistance can be calculated as:

$$R_{\text{load (max)}} = (V_{\text{supply}} - 8 \, \text{V}) / 22 \, \text{mA}$$

For +24 V minus 10% supply this gives a maximum value of 620 Ω.

With a given load resistance, the minimum supply voltage can be calculated as:

$$V_{\text{supply (min)}} = 8 \, \text{V} + R_{\text{load}} \cdot 22 \, \text{mA}$$
Fig. 14: Wiring diagram for 4…20 mA current loop

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Positive terminal of the passive 4…20 mA loop 1</td>
</tr>
<tr>
<td>2</td>
<td>Negative terminal of the passive 4…20 mA loop 1</td>
</tr>
<tr>
<td>3</td>
<td>Positive terminal of the passive 4…20 mA loop 2</td>
</tr>
<tr>
<td>4</td>
<td>Negative terminal of the passive 4…20 mA loop 2</td>
</tr>
</tbody>
</table>

As the terminals are floating, the load resistor and the current meter can be placed in the positive or in the negative supply rail.

Connect the shield of the cables to protective ground (terminal 52).

### 3.2.6. Connecting the Analog Input

The TCE 8000 with “PRESSURE COMPENSATION” option provides one passive 4…20 mA output CURRENT 2 and one active 4…20 mA current input CURRENT 1.

The current input is designed to drive a 2-wire passive pressure sensor. It provides a minimum driving voltage of 16 V.

The negative terminal (2) is internally connected to GND (non Ex version) or to PE (Ex version).

Fig. 15: Wiring diagram for 4…20 mA current input
### Terminal Description

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Positive terminal for a passive 4…20 mA pressure sensor</td>
</tr>
<tr>
<td>2</td>
<td>Negative terminal for a passive 4…20 mA pressure sensor</td>
</tr>
</tbody>
</table>

Connect the shield of the cables to protective ground (terminal 52).

---

**WARNING!**

The analog input is not short-circuit proof. Load currents above 35 mA (permanent load) or above 50 mA (short-time load) can cause damages.

---

### 3.3. Ex Installation

**WARNING!**

In hazardous locations all installations must only be carried out by qualified personnel!
Switch off all power supplies before installing or uninstalling the TRICOR Coriolis Mass Flow Meter in hazardous locations!
Never connect a remote meter TCM to anything else than the specified electronics TCE 8***!
It is absolutely needed to read and to observe the “Installation guide for hazardous locations”!
4. Manual Operation

4.1. Power On Sequence and Principles of Manual Control

The power up sequence gives the following information, each for about two seconds:

- **CORIOLIS TRICOR**
- **TCE 8000**
- **SENSOR TYPE TCM 0450**
- **SW MAIN Rev.: V3.45**

This indicates the SW version of the main processor.

- **SW DISPLAY Rev.: V3.45**

This indicates the SW version of the display processor.

If changes to the settings were made before the last power down and not saved to the backup EEPROM, the following message appears:
If no pushbutton is pressed the warning will disappear automatically after 10 seconds.

The absence of valid backup data has no influence on the reliability of operation of the meter. Making frequently a backup of the device settings helps just to restore a previous stage in case of a faulty configuration.

For further information refer to chapter 4.5.9.

Now the TCE 8000 switches to the measuring mode, displaying the default screen:

The green LED “OK” flashes with a one second period. In case of an error the red LED “ERR” flashes.

If the “Custody Transfer” option is selected and critical error messages have been recorded in the log file but there is currently no error state, the red and green LEDs flash alternately until all critical ERR messages in the log file have been reset (see chapter 4.3.5).

In manual control the TCE is menu driven and provides two operational modes, the “Measuring Mode” and the “Control Mode”.

In the measuring mode the display shows the preselected measured values and all four pushbuttons have the function printed on them. The switch between the different display views can be made at any time, by pressing the “Display” button, without influencing neither the measurement nor the digital or analog outputs.

In the control mode the three pushbuttons below the display have varying functions. The actual function is indicated in the display, just above the pushbutton.

In the control menu all necessary settings can be made, if the “Custody Transfer” option was not selected.

The control menu contains the submenus “ZERO OFFSET”, “DISPLAY”, “SETUP”, “I/O-TEST”, “SERVICE” and “FACTORY”.

For protecting the TRICOR Coriolis Mass Flow Meter against unintentional changes by unauthorized personnel, the menus “ZERO OFFSET”, “SETUP” and “I/O-TEST” are protected by a user password, the menu “SERVICE” by a service password and the menu “FACTORY” by a factory password.

Additionally, a global access code can be set that locks the TRICOR Coriolis Mass Flow Meter completely.

For the description of the control menu see chapter 4.5.
4.1.1. Using the Magnet

The explosion-proof variants with the blue Ex d housings provide a magnet to be able to operate the pushbuttons without opening the display cover.

In hazardous, wet and dusty areas the display cover must not be opened to operate the pushbuttons.

Beside every pushbutton there is a hall sensor which can be operated via the magnet attached to the housing.

For operating the pushbuttons hold the magnet to the glass.

The best positions for operating the keys are:

<table>
<thead>
<tr>
<th>Pushbutton</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>left upper edge of the yellow area</td>
</tr>
<tr>
<td>Reset</td>
<td>lower edge of the yellow area</td>
</tr>
<tr>
<td>Display</td>
<td>lower edge of the yellow area</td>
</tr>
<tr>
<td>Info</td>
<td>lower edge of the yellow area</td>
</tr>
</tbody>
</table>

**NOTE:**
The P button cannot be operated with the magnet with the “Custody Transfer” option!

4.2. Setup Guidelines

Ex factory the TRICOR Mass Flow Meters come with a setup optimized for normal applications. In more than 90% of the applications no further optimization except a regular offset adjustment is required.

The different possibilities for optimizing the settings are described below.

4.2.1. Offset Adjustment

In contrast to a positive displacement meter, a Coriolis Mass Flow Meter does not have a “natural” zero. At no flow the measured time shift is nearly zero, but not exactly. The offset adjustment determines this offset and corrects the measured value correspondingly.

As the offset depends slightly upon the temperature, the density of the medium and the operating pressure, it is strongly recommended to make the offset procedure under working conditions, i.e. with the medium to be measured and at operating pressure and temperature.

To execute an offset adjustment, please refer to chapter 4.4 and 4.5.3.

4.2.2. Flow Filter

The raw data of a mass flow meter is relatively noisy. To get a stable reading a filtering of the calculated flow is required.

The filters in the TCE 8000 are set by means of the time constant \( t \). The time constant is the time the output needs, after a jump from a value \( x \) to 0, to go to \( x/e = x/2.72 \). A higher time constant means more stable reading, but also a slower reaction to changing flows.

A rough relation between the time and the filtered flow value after a jump is:
A linear filter as it is realized in the TCE 8000 electronics just delays the flow reading and consequently the TOTAL value. Independent of the slope (fast or slow) of the rising and falling flow, the error of the internally calculated TOTAL and at the frequency output are canceled out, if the flow rises from zero (or any other value) and later goes back to the starting value. For getting a correct TOTAL via the display or the frequency output, it is just necessary to wait long enough after the flow is switched off.

For best results the TCE 8000 electronics provides two filters.

The FLOW FILTER filters the mass flow before calculating the TOTAL or the frequency and current outputs. For normal applications a moderate filtering with $t = 1\, \text{s}$ is recommended.

The DISPLAY FILTER filters the flow display additionally to the FLOW FILTER. It does not affect any other parameter or any of the outputs. The default setting is $t = 1\, \text{s}$.

If the flow is changing fast or sometimes makes a jump and the outputs have to react as fast as possible, set FLOW FILTER to $t < 1\, \text{s}$. If nevertheless the flow display has to be stable for better readability, the DISPLAY FILTER can be increased.

For setting up the FLOW FILTER refer to chapter 4.5.7.1, for the DISPLAY FILTER to chapter 4.5.4.2.

### 4.2.3. CUT OFF

As mentioned above, a mass flow meter has no natural zero and the raw data is noisy. Consequently, with now flow, a meter would indicate and give out continuously a small fluctuating flow.

The parameter CUT OFF is used to provide a clear zero. If the calculated and filtered flow is below CUT OFF, the meter indicates zero, the TOTAL values remain unchanged and the outputs show zero flow as well.

The value for CUT OFF must be above the noise floor in the given application and well below the minimum flow to be measured. As a good compromise the default value for CUT OFF is 0.3% of the full scale range of the meter.

For setting CUT OFF please refer to chapter 4.5.6.1.

### 4.2.4. Interaction of the Parameters

As each of the two parameters affects the calculation of the flow in a different way, a bad combination of different parameters can lead to systematical errors.

**FLOW FILTER and CUT OFF**

If the filter constant is set to a high value, the calculated flow is delayed compared to the actual flow. In ON-OFF operation this leads to the fact that it takes a long time until the calculated flow settles to the ON or OFF value. The TOTAL value remains correct if the TCM measures long enough after the flow got switched off. If CUT OFF is set to a high value, the meters stops measuring too early and consequently the calculated TOTAL is too low. Also the number of pulses at the frequency output is too low. The error is systematic.

---

**NOTE:**

In ON-OFF operation high values for the flow filter combined with high values for CUT OFF must be avoided! Jumps of the flow not going down to zero are not affected by CUT OFF.
4.3. Measuring Mode

4.3.1. Function of the Pushbuttons

In the measuring mode all pushbuttons have a fixed function:

- **P**: Opens the Control Menu if pressed for about three seconds
- **Reset**: Resets the batch counter to zero, if the function “KEY RESET” is enabled
- **Display**: Toggles the display between the preselected settings.
- **Info**: Opens the info menu

4.3.2. Display Selection

The TCE provides two presentable display views. Ex works view 1 shows the flow and the TOTAL value, view 2 shows density and temperature.

In the “fixed mode” the display view selected by the user remains active until the other view is selected.

For changing from one view to the other just press the pushbutton “Display”.

In the “alternate mode” the TCM toggles between display view 1 and 2 every seven seconds. In this mode the pushbutton “Display” is without function.

For changing the content of the display views, please refer to chapter 4.5.4.

4.3.3. Display Resolution

The measured values can be displayed with 8 digits, including decimal point and sign. The most positive value is “9999999.” (7 digits), the most negative value is “-999999.” (6 digits).

If the decimal point setting is set to show decimal places, the decimal point is automatically shifted to the right as soon as the displayed value exceeds the display range of the display.

Example:

<table>
<thead>
<tr>
<th>Decimal point setting:</th>
<th>x.xxx</th>
<th>x.xxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured value:</td>
<td>12345.6789</td>
<td>-12345.6789</td>
</tr>
<tr>
<td>DP setting changed to:</td>
<td>xx.xx</td>
<td>xxx.x</td>
</tr>
<tr>
<td>Displayed value:</td>
<td>12345.67</td>
<td>-12345.6</td>
</tr>
</tbody>
</table>

The new setting for the decimal point will remain, also if the measured value decreases again. It can only be reset to the original settings in the DISPLAY menu.

If the decimal point is at the most right position and the value to be displayed is still too big, the display shows “DISPLAY OVERFLOW”. As soon as the value to be displayed returns into the displayable range, the error message disappears and the display shows the value.

If the display shows the message “DISPLAY OVERFLOW”, it is advisable to adjust the unit of measure for the display accordingly. If this message appears on a TOTAL display, it is also possible to reset the corresponding TOTAL value (see chapter 4.3.4 or 4.5.10).

4.3.4. Resetting the Batch (TOTAL-) Value

For easy batching in local operation the TCE provides the possibility to reset the Batch value by pressing the pushbutton “Reset”.

For protecting the TRICOR Coriolis Mass Flow Meter against unintentional resetting, this function can be disabled.

Ex work the function is disabled.

For changing the setting, please refer to chapter 4.5.6.2.
4.3.5. Event Logging

Starting with software version Mv3.40 and Dv3.40, all TRICOR Coriolis mass flow meters include event logging that records events occurring at runtime with a timestamp and a unique code. These events can either be shown on the display or read/reset (erased) via Modbus. The use of event logging is explained below using the display as an example. For a description of access via Modbus, see the Modbus (RTU) Manual: chapter 3.6.

There are three event classes:
- INFO: Information that a permissible event has occurred (successful initialisation for example).
- WARN: Warning that a generally permissible but possibly problematic event has occurred
- ERR:ON or ERR:OFF: Indicates that an error state has occurred (ERR:ON) or is no longer active (ERR:OFF)

4.3.5.1. Event codes

All events codes are listed below and their meanings are explained.

<table>
<thead>
<tr>
<th>Event Code</th>
<th>Message on display</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERR:ON 0</td>
<td>INITIALIZATION FAILED</td>
<td>Device initialisation could not be completed successfully.</td>
</tr>
<tr>
<td>ERR:ON 1</td>
<td>AMP. SENSOR A</td>
<td>The voltage amplitude induced on Sensor A is too high or too low.</td>
</tr>
<tr>
<td>ERR:ON 2</td>
<td>AMP. SENSOR B</td>
<td>The voltage amplitude induced on Sensor B is too high or too low.</td>
</tr>
<tr>
<td>ERR:ON 3</td>
<td>MEAS. DELAY OVER 250</td>
<td>The measured time delay is above the specified allowable limit value</td>
</tr>
<tr>
<td>ERR:OFF 5</td>
<td>UNST. DRIVER CURRENT</td>
<td>Driver current is too unstable</td>
</tr>
<tr>
<td>ERR:OFF 6</td>
<td>PT1000 OUT OF RANGE</td>
<td>The value of the temperature sensor is too high or too low (often indicates a line break or short circuit)</td>
</tr>
<tr>
<td>ERR:OFF 7</td>
<td>TUBE FREQ. TOO LOW</td>
<td>The frequency of the oscillating tube is below the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 8</td>
<td>TUBE FREQ. TOO HIGH</td>
<td>The frequency of the oscillating tube is above the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 9</td>
<td>DRIVER CURRENT LOW</td>
<td>The driver current is below the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 10</td>
<td>DRIVER CURRENT HIGH</td>
<td>The driver current is above the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 17</td>
<td>MASS FLOW TOO HIGH</td>
<td>The mass flow is above the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 18</td>
<td>MASS FLOW TOO LOW</td>
<td>The mass flow is below the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 19</td>
<td>TEMPERATURE TOO HIGH</td>
<td>The temperature is above the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 20</td>
<td>TEMPERATURE TOO LOW</td>
<td>The temperature is below the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 21</td>
<td>DENSITY TOO HIGH</td>
<td>The density is above the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 22</td>
<td>DENSITY TOO LOW</td>
<td>The density is below the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 23</td>
<td>PRESSURE TOO HIGH</td>
<td>The pressure is above the specified limit value</td>
</tr>
<tr>
<td>ERR:OFF 24</td>
<td>PRESSURE TOO LOW</td>
<td>The pressure is below the specified limit value</td>
</tr>
</tbody>
</table>

Tab. 1: List of errors (ERR Codes)
### Warnings (WARN Codes)

<table>
<thead>
<tr>
<th>Event code</th>
<th>Message on display</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>192</td>
<td>FACT. BACKUP MISSING</td>
<td>A factory backup has not been prepared yet</td>
</tr>
<tr>
<td>193</td>
<td>BACKUP NOT UP TO DATE</td>
<td>Settings have been changed but not yet saved in the backup</td>
</tr>
<tr>
<td>194</td>
<td>OFFSET IN PROGRESS</td>
<td>Zero point adjustment is currently in progress</td>
</tr>
<tr>
<td>195</td>
<td>GRAND TOTAL VOL OVFL</td>
<td>Overflow of the Grand Total on the display in modus: volume measurement. After this overflow the representation of the total in the display will automatically switch to scientific (exponential) notation</td>
</tr>
<tr>
<td>196</td>
<td>GRAND TOTAL MASS OVFL</td>
<td>Overflow of the Grand Total on the display in modus: mass measurement. After this overflow the representation of the total in the display will automatically switch to scientific (exponential) notation</td>
</tr>
<tr>
<td>197</td>
<td>BATCH TOTAL VOL OVFL</td>
<td>Overflow of the Batch Total on the display in modus: volume measurement. After this overflow the representation of the total in the display will automatically switch to scientific (exponential) notation</td>
</tr>
<tr>
<td>198</td>
<td>BATCH TOTAL MASS OVFL</td>
<td>Overflow of the Batch Total on the display in modus: mass measurement. After this overflow the representation of the total in the display will automatically switch to scientific (exponential) notation</td>
</tr>
<tr>
<td>199</td>
<td>FAIL. TOTAL VOL OVFL</td>
<td>Overflow of the Failure Total on the display in modus: volume measurement. After this overflow the representation of the total in the display will automatically switch to scientific (exponential) notation</td>
</tr>
<tr>
<td>200</td>
<td>FAIL. TOTAL MASS OVFL</td>
<td>Overflow of the Failure Total on the display in modus: mass measurement. After this overflow the representation of the total in the display will automatically switch to scientific (exponential) notation</td>
</tr>
</tbody>
</table>

*Tab. 2: List of warnings (WARN Codes)*

### Information (INFO Codes)

<table>
<thead>
<tr>
<th>Event code</th>
<th>Message on display</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>224</td>
<td>FACT. BACKUP OK</td>
<td>A factory backup has been prepared</td>
</tr>
<tr>
<td>225</td>
<td>BACKUP IS UP TO DATE</td>
<td>All new settings have been saved in the backup</td>
</tr>
<tr>
<td>226</td>
<td>POWER ON SEQUENCE</td>
<td>The device has been powered up</td>
</tr>
<tr>
<td>227</td>
<td>INITIALIZATION PASSED</td>
<td>Device initialisation was completed successfully</td>
</tr>
</tbody>
</table>

*Tab. 3: List of information (INFO Codes)*
4.3.5.2. Info and event log menu

The TCE display has an info and event log menu for straightforward troubleshooting. The contents of this menu are not of interest for normal operation. It only contains information for trained personnel.

To open the menu, press the “Info” button for about three seconds. Then the event log menu (“LOG DISPLAY”) is displayed first. All recorded log entries are shown and can be reset (erased) here.

Display of log entries

“NO LOGS” is displayed if no events have been recorded or they have all been reset:

```
** LOG DISPLAY **
NO LOGS
```

If events have been recorded, the most recent entry is always displayed first (the logged events are displayed in the order in which they occurred).

This is illustrated here with two log entries as an example:

```
** LOG DISPLAY **
LOG#: 2/2 INFO
TIMESTAMP: 4,800s
INITIALIZATION PASSED
```

Here the most recently recorded (most current) is an INFO event that is the second of a total of two existing log entries. It was recorded approximately 4.8 seconds after powering up the TCE and provides the information that initialisation of the TCE was completed successfully at that time (“INITIALIZATION PASSED”).

Resetting (erasing) event logs

Press the “Reset” button to reset (erase) the current log entry.

Provided the displayed event does not represent an active error state (“ERR:ON”), the following dialogue is displayed where you can confirm resetting the log entry by pressing the “Display” button or cancel by pressing the “Reset” button (attention: log entries cannot be restored once they have been reset):

```
** LOG DISPLAY **
LOG#: 2/2 INFO
CLEAR THIS LOG ENTRY?
YES  NO
```

If the displayed log entry is of the type “ERR:ON”, it cannot be reset as long as the corresponding error state remains active. In this case the following warning is shown on the display when the “Reset” button is pressed:

```
** LOG DISPLAY **
LOG#: 3/4 ERR:ON
LOG CANNOT BE CLEARED
ERROR IS STILL ACTIVE
```

If you want to reset all log entries at once, you can do so in the setup menu under the menu item “CLEAR LOGS” (see chapter 4.5.11).
Navigating between log entries

Press the “Display” button to show the previous event (log entry) in chronological order:

** LOG DISPLAY **
LOG#: 1/2 INFO
TIMESTAMP: 0,005s
POWER ON SEQUENCE

Press the “Info” button to navigate to the previous log entry. You can repeat this until you get to the last log entry.

Info menu

When the last log entry is displayed (for instance LOG#: 5/5 INFO), pressing the “Info” button again opens the Info menu that lists the following 7 internal device parameters:

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>Sensor voltage A in mV</td>
</tr>
<tr>
<td>SB</td>
<td>Sensor voltage B in mV</td>
</tr>
<tr>
<td>DR</td>
<td>Drive current in mA</td>
</tr>
<tr>
<td>PT</td>
<td>Resistance value of the temperature sensor in Ω</td>
</tr>
<tr>
<td>FRE</td>
<td>Oscillating frequency in Hz</td>
</tr>
<tr>
<td>ZP</td>
<td>Zero point offset in µs</td>
</tr>
<tr>
<td>TSF</td>
<td>Filtered time shift in µs</td>
</tr>
</tbody>
</table>

Tab. 4: List of service parameters

Press “Info” again to get general information about the TCM:

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE:</td>
<td>Sensor type (TCM*)</td>
</tr>
<tr>
<td>SER.:</td>
<td>Serial number</td>
</tr>
<tr>
<td>SW1:</td>
<td>SW version main board</td>
</tr>
<tr>
<td>SW2:</td>
<td>SW version display</td>
</tr>
<tr>
<td>COMM:</td>
<td>Active interface:</td>
</tr>
<tr>
<td></td>
<td>Modbus/baud rate/address</td>
</tr>
<tr>
<td></td>
<td>HART®/address</td>
</tr>
<tr>
<td></td>
<td>FF/address</td>
</tr>
<tr>
<td>CODE:</td>
<td>SW option code</td>
</tr>
</tbody>
</table>

Tab. 5: List of TCM device info

By pressing “Info” you can toggle between those info views. To return to the normal operation screen, press “DISPLAY”.
4.3.6. Totalizer

On the display the following three totalizer can be shown:

- Batch Total
- Grand Total
- Failure Total

The maximum number of places that can be shown on the display is limited to 7 („1234567“).

If a totalizer exceeds this limit, the representation of the total on the display will automatically switch to scientific (exponential) notation.

For example, if a totalizer has the value „9999999“ kg and then get incremented by another one kilogram, the totalizer will now display: „1.0000E7“ kg.

Thus ensures that no totalizer can be resetted by an overflow in the lifecycle of the device.

4.4. Offset Adjustment

For best accuracy the TRICOR Coriolis Mass Flow Meter needs an in situ offset adjustment. This calibration zeroes out the ambient effects and increases the measuring accuracy at low flow.

The offset adjustment must be carried out with the medium to be measured and at a temperature and pressure as close to the normal operation as possible.

Proceed as follows:

Operate the TCM for a while under normal operating conditions to make sure that the actual temperature of the TRICOR Coriolis Mass Flow Meter equals the normal operating temperature.

Switch off the flow. For best results use a valve in front and one behind the TCM. If the valves are not close to the TCM and/or only one valve is used, wait long enough to be sure that there is no more flow through the TCM.

NOTE:

If there is a residual flow through the TCM or it is exposed to mechanical shocks during the offset adjustment procedure, the resulting value will be wrong.

Start the offset procedure as follows (see also chapter 4.5.3):

- Press “P” for about three seconds
- The display shows “ZERO OFFSET”
- Press “P”
- Change the indicated number with “UP” to “2207” and confirm with “P”
- Press “SLOW” (recommended) or “FAST”
- The display shows “MAKE ZERO” for 10 to 30 seconds and counts down to “0”
- Confirm with “Info”

The offset procedure takes about 10…20 seconds (FAST) or 10…60 seconds (SLOW). During this procedure the red LED will flash.

For an automatic offset adjustment initiated by the central control unit, the control input can be configured as “Initiate offset”. In that case the TCE starts an offset procedure each time a high level is applied to the input.

To configure the input, please refer to chapter 4.5.8.4.
4.5. Control Mode

In the control mode the TCE 8000 can be adapted to the individual application. As unintentional changes of the settings might cause problems, some submenus are password protected. Additionally, using the “SERVICE” menu, a global access code can be set that locks the TRICOR Coriolis Mass Flow Meter completely.

To enter the control mode proceed as follows:
Press “P” for about three seconds
If a global access code is set the display shows

ENTER P-ACCESS CODE
0000
LEFT       UP      EXIT

Change the indicated number with “LEFT” and “UP” to the defined code and confirm with “P”.
If a wrong code is entered, the display shows “ERROR” for about two seconds and then returns to the measurement mode.
When the correct code is entered the display shows

MAIN MENU
ZERO OFFSET
UP      DOWN    EXIT

With the keys “UP” and “DOWN” you can scroll through the main list.
Select the desired submenu and confirm with “P”.

NOTE:
With the “Custody Transfer” option, no settings can be configured when the housing is closed since the P button is deactivated.

4.5.1. Function of the Pushbuttons

In the setup menu some pushbuttons have changing functions, indicated in the display above the pushbutton:
P       Confirms the selection in a list or any kind of inputs
Reset       Performs the indicated function
Display       Performs the indicated function.
Info (Exit)       Performs the indicated function.
In most cases exits the current menu point without altering the original value
4.5.2. Submenus in the Main Menu

In the Main Menu the following submenus are addressable:

**ZERO OFFSET:**
Performing the automatic offset adjustment procedure. This submenu is password protected.

**DISPLAY:**
Presetting the display. Changes made in this submenu have no influence on the general function as well on the accuracy of the TCM.

**SETUP:**
Adjusting the TCE 8000 and configuring the inputs and outputs. This submenu is password protected.

**I/O-TEST:**
Setting the outputs to defined values and displaying the actual status of the control inputs for testing the electrical connections. This submenu is password protected.

**SERVICE:**
Calibrating the TCE 8000 with connected TCM 0450/TCMH 0450. This submenu is password protected.

**FACTORY:**
Service settings for TCE 8000 with connected TCM. This submenu is password protected.

4.5.3. ZERO OFFSET Menu

Select in the main menu

![Main Menu](image)

Press “P”. The display shows

![Enter Menu Code](image)

Change the indicated number with “LEFT” and “UP” to “2207” and confirm with “P”.

If a wrong code is entered, the display shows “ERROR” for about two seconds and then asks for a new input.

When the correct code is entered the display shows

![Start Offset Procedure](image)

Press “SLOW” or “FAST”. The display shows
The time counter counts down to zero. The display shows e.g.

```
MAKE ZERO (s):  0.0
OLD ZERO:      0.000 µs
NEW ZERO:     0.123 µs
```

Press “EXIT” to return to the measuring mode.

4.5.4. DISPLAY Menu

Select in the main menu

```
MAIN MENU
DISPLAY
UP      DOWN    EXIT
```

Press “P”. The display shows

```
DISPLAY MENU
MASS TOTAL
UP      DOWN    EXIT
```

The following submenus are available:

- **MASS TOTAL**: Setting the TOTAL and Batch units and the TOTAL and Batch decimal point.
- **MASS FLOW**: Setting the flow units, the flow decimal point and a flow filter for the display.
- **TEMPERATURE**: Setting the temperature units and the temperature decimal point.
- **PRESS DISP**: Setting the pressure units (only available with option “PRESSURE COMPENSATION”).
- **DISP MODE**: Setting the content of the two display views and the display mode (static or alternating).

4.5.4.1. MASS TOTAL Menu

In the submenu MASS TOTAL the flow dimensions and the flow decimal point can be set.
Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

The following submenus are available:

**TOTAL UNITS:**
Setting the TOTAL units.

**TOTAL DP:**
Setting the TOTAL decimal point.

### TOTAL UNITS

<table>
<thead>
<tr>
<th>Mass-Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRAM</td>
<td>gram</td>
</tr>
<tr>
<td>KG</td>
<td>kilogram</td>
</tr>
<tr>
<td>POUNDS</td>
<td>pound</td>
</tr>
<tr>
<td>OUNCES</td>
<td>dry ounce</td>
</tr>
<tr>
<td>TONS</td>
<td>metric ton</td>
</tr>
<tr>
<td>STONES</td>
<td>stone</td>
</tr>
<tr>
<td>MT</td>
<td>metric ton</td>
</tr>
</tbody>
</table>

The following units can be selected:

Use the keys “UP” and “DOWN” to select the engineering unit and confirm with “P” or skip with “EXIT”.

### TOTAL DP

Use the key “LEFT” to select the desired decimal point position and confirm with “P” or skip with “EXIT”.

#### 4.5.4.2. MASS FLOW Menu

In the submenu MASS FLOW the mass flow unit, the flow decimal point and the flow filter for the display can be set.

Use the keys “UP” and “DOWN” to select the submenu and confirm with “P” or skip with “EXIT”.

---

Version: TCM_0450_E80_M_EN_150209_E008
The following submenus are available:

**FLOW UNITS:**
Setting the flow units.

**FLOW DP:**
Setting the flow decimal point.

**DISP FILTER:**
Setting the display filter.

### FLOW UNITS

<table>
<thead>
<tr>
<th>Description</th>
<th>Engineering Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-Unit</td>
<td>Mass-Unit</td>
</tr>
<tr>
<td>S</td>
<td>second</td>
</tr>
<tr>
<td>MIN</td>
<td>minute</td>
</tr>
<tr>
<td>H</td>
<td>hour</td>
</tr>
<tr>
<td>D</td>
<td>day</td>
</tr>
<tr>
<td>G</td>
<td>gram</td>
</tr>
<tr>
<td>KG</td>
<td>kilogram</td>
</tr>
<tr>
<td>LB</td>
<td>pound</td>
</tr>
<tr>
<td>OZ</td>
<td>dry ounce</td>
</tr>
<tr>
<td>T</td>
<td>metric ton</td>
</tr>
<tr>
<td>ST</td>
<td>stone</td>
</tr>
<tr>
<td>MT</td>
<td>metric ton</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the engineering unit and confirm with “P” or skip with “EXIT”.

### FLOW DP

Use the key “LEFT” to select the desired decimal point position and confirm with “P” or skip with “EXIT”.

### DISP FILTER

Use the keys “UP” and “DOWN” to select the display filter and confirm with “P” or skip with “EXIT”.
The time constant $t$ is the time the displayed value needs after a jump from a value $x$ to $0$ to go to $x/e = x/2.72$.

**NOTE:**
The display filter only filters the value in the display to provide a more stable reading. It has no influence on the outputs. It is only valid for the mass flow display view! As the display filter is additional to the global filter, the display can never react faster than the outputs.

### 4.5.4.3. TEMPERATURE Menu

In the submenu TEMPERATURE the temperature unit and the temperature decimal point for the display can be set.

Use the keys “UP” and “DOWN” to select the submenu and confirm with “P” or skip with “EXIT”.

The following submenus are available:

- **TEMP UNITS**: Setting the temperature units.
- **TEMP DP**: Setting the temperature decimal point.

#### TEMP UNITS

The following units can be selected:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>Centigrade</td>
</tr>
<tr>
<td>°F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>KELVIN</td>
<td>Kelvin</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the engineering unit and confirm with “P” or skip with “EXIT”.

---

**Display Menu**

**Temperature**

- SET TEMP DISPLAY
  - TEMP UNITS
    - °C
      - UP DOWN EXIT
4.5.4.4. PRESSURE Menu

In the submenu PRESS DISPLAY the pressure engineering unit and the decimal point can be set.

NOTE:
This menu is only visible with the option “PRESSURE COMPENSATION”.

Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

The following submenus are available:

PRESS. UNITS:
Setting the pressure units.

PRESSURE DP:
Setting the pressure decimal point.

PRESS. UNITS

The following units can be selected:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPA</td>
<td>kilopascal</td>
</tr>
<tr>
<td>MPA</td>
<td>megapascal or N/mm²</td>
</tr>
<tr>
<td>PSI</td>
<td>pound per square inch</td>
</tr>
<tr>
<td>BAR</td>
<td>bar</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the engineering unit and confirm with “P” or skip with “EXIT”.

Use the key “LEFT” to select the desired decimal point position and confirm with “P” or skip with “EXIT”.

Manual Operation

TEMP DP

SET TEMP DISPLAY
TEMP DP
UP  DOWN  EXIT

SELECT TEMP DP
000.0 °C
LEFT  EXIT

Use the key “LEFT” to select the desired decimal point position and confirm with “P” or skip with “EXIT”.

The key “P” confirms the selection or initiates the change.

The key “EXIT” skips the selection and returns to the previous menu.

PRESS DISPLAY

PRESS. UNITS

The following units can be selected:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPA</td>
<td>kilopascal</td>
</tr>
<tr>
<td>MPA</td>
<td>megapascal or N/mm²</td>
</tr>
<tr>
<td>PSI</td>
<td>pound per square inch</td>
</tr>
<tr>
<td>BAR</td>
<td>bar</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the engineering unit and confirm with “P” or skip with “EXIT”.

The key “P” confirms the selection or initiates the change.

The key “EXIT” skips the selection and returns to the previous menu.

PRESS DISPLAY

PRESS. UNITS

The following units can be selected:

<table>
<thead>
<tr>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPA</td>
<td>kilopascal</td>
</tr>
<tr>
<td>MPA</td>
<td>megapascal or N/mm²</td>
</tr>
<tr>
<td>PSI</td>
<td>pound per square inch</td>
</tr>
<tr>
<td>BAR</td>
<td>bar</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the engineering unit and confirm with “P” or skip with “EXIT”.

The key “P” confirms the selection or initiates the change.

The key “EXIT” skips the selection and returns to the previous menu.
4.5.4.5. DISP MODE Menu

In the submenu DISP MODE the display mode can be set.

Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

The following submenus are available:

DISPLAY 1:
Setting the content of display view 1.

DISPLAY 2:
Setting the content of display view 2.

BACKLIGHT:
Switching on and off the backlight.

TIME MODE:
Setting fixed or alternating display.

DISPLAY 1

Use the keys “UP” and “DOWN” to select dual line or single line and confirm with “P” or skip with “EXIT”.

The display shows
The following values can be selected:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATE</td>
<td>Actual flow</td>
</tr>
<tr>
<td>BATCH TOTAL</td>
<td>Batch count</td>
</tr>
<tr>
<td>TEMPERATURE</td>
<td>Temperature</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>TOTAL count</td>
</tr>
<tr>
<td>FAIL. TOTAL</td>
<td>Failure total count</td>
</tr>
<tr>
<td>F-OUT</td>
<td>Actual frequency at the frequency output</td>
</tr>
<tr>
<td>mA-OUT I1</td>
<td>Actual current at the analog output 1</td>
</tr>
<tr>
<td>mA-OUT I2</td>
<td>Actual current at the analog output 2</td>
</tr>
<tr>
<td>mA-IN</td>
<td>Actual current at the analog input (optional)</td>
</tr>
<tr>
<td>PRESS ext.</td>
<td>Pressure value measured from the actual analog input current (optional)</td>
</tr>
<tr>
<td>comp PRESS</td>
<td>Pressure value used for compensation (optional)</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”.

If “DUAL LINE” was selected, the display shows

**SELECT LINE2 VALUE**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BATCH TOTAL</td>
<td>Batch count</td>
</tr>
<tr>
<td>UP</td>
<td></td>
</tr>
<tr>
<td>DOWN</td>
<td></td>
</tr>
<tr>
<td>EXIT</td>
<td></td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”.

The TCM returns to the display mode menu.

**DISPLAY 2**
See DISPLAY 1

**BACKLIGHT**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET DISPLAY MODE BACKLIGTH</td>
<td>P ⇒</td>
</tr>
<tr>
<td>UP</td>
<td></td>
</tr>
<tr>
<td>DOWN</td>
<td></td>
</tr>
<tr>
<td>EXIT</td>
<td></td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to switch on or off the backlight and confirm with “P” or skip with “EXIT”.

**TIME MODE**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET DISPLAY MODE TIME MODUS</td>
<td>P ⇒</td>
</tr>
<tr>
<td>UP</td>
<td></td>
</tr>
<tr>
<td>DOWN</td>
<td></td>
</tr>
<tr>
<td>EXIT</td>
<td></td>
</tr>
</tbody>
</table>

In the “FIXED” mode the display shows constantly the defined display view 1 or 2. With the pushbutton “Display” it is possible to switch over between display view 1 or 2.

In the “ALTERNATE” mode the display switches over every 7 seconds between display view 1 and 2. The pushbutton “Display” is deactivated.

Use the keys “UP” and “DOWN” to select the desired mode and confirm with “P” or skip with “EXIT”.
4.5.5. SETUP Menu

In the SETUP menu all settings can be made to adapt the meter to the individual requirements.

Select in the main menu

```
MAIN MENU
SETUP
UP  DOWN  EXIT
```

Press “P”. The display shows

```
ENTER CODE
2206
LEFT  UP  EXIT
```

Change the indicated number with “LEFT” and “UP” to “2207” and confirm with “P”.

If a wrong code is entered, the display shows “ERROR” for about two seconds and then asks for a new input.

When the correct code is entered the display shows

```
SETUP MENU
PARAMETER
UP  DOWN  EXIT
```

The following submenus are available:

**PARAMETER:**
- CUT OFF: Setting the flow CUT OFF value
- RESET KEY: Enable/disable the key “Reset”
- FLOW-DIREC: Setting up the TCM for reverse flow
- K-FACTOR: Factor for fine scaling the metric variable of the meter
- FAULT TIME: Setting the error response time
- PRESS. COMP.: Enable/disable the pressure compensation (option)
- TOTAL COUNT: Setting up the mode of operation “TOTAL counter”
- LANGUAGE: Selecting the display language

**FILTER:**
- FLOW FILTER: Setting the flow filter time constant

**IN/OUTPUTS:**
- FREQ OUT: Configuring the frequency output
- CTRL OUT: Configuring the control output
- mA OUT: Configuring the analog output (4…20 mA)
- CTRL IN: Configuring the control input
- ANALOG IN: Configuring the analog input (option)
- INTERFACE: Configuring the interface

**DATA CONFIG:**
- SAVE DATA: Saving the actual settings as backup
- RECALL DATA: recalling the last settings from the backup

**RESET TOTAL:**
- RESET TOTAL: Resets the TOTAL and the FAIL. TOTAL count to zero.

**CLEAR LOGS:**
- CLEAR LOGS: Acknowledge (delete) all logged events in the Log memory.

Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.
4.5.6. SETUP PARAMETER Menu

In the submenu SETUP/PARAMETER all user settable internal parameter can be set for adjusting the TCM for a given application.

Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

4.5.6.1. CUT OFF Menu

In the submenu CUT OFF the CUT OFF value in percent of the full scale flow range can be set.

If the absolute value of the measured and filtered flow is below the CUT OFF value, the calculated flow is zero and consequently all outputs show zero flow and the TOTAL and batch value remain unchanged.

Typical values for CUT OFF are in the range 0.3…1%. With CUT OFF values set too low noise or any external interference might be misinterpreted as real flow. Using too high CUT OFF values, low flows might not be correctly registered anymore.

The preset CUT OFF should always be significantly smaller than the lowest flow to be measured.

Select the submenu FLOW and confirm with “P” or skip with “EXIT”.

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the CUT OFF menu.

Density CUT OFF for Gas

In case there is no presetting ex factory, make sure to change DENSITY CUT OFF to 0.0 [units].

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the CUT OFF menu.
4.5.6.2. **RESET KEY Menu**

In the submenu KEY-RESET the pushbutton “Reset” can be enabled or disabled. If the pushbutton “Reset” is active, it can be used to reset the batch counter.

Use the keys “UP” and “DOWN” to enable or disable the key and confirm with “P” or skip with “EXIT”. The display returns to the SETUP PARAMETER menu.

4.5.6.3. **FLOW DIRECTION Menu**

In the submenu FLOW-DIREC the positive direction of the flow can be set. If the flow direction is set to “FORWARD” (default setting), a flow through the meter in direction of the arrow, indicated on the type label of the meter, will be displayed positive and the opposite flow negative. If for technical reasons the meter must be mounted in that way, that the normal flow is against the direction of the arrow, the sign of the flow can be inverted by setting flow direction to “REVERSE”.

Use the keys “UP” and “DOWN” to select the positive flow direction and confirm with “P” or skip with “EXIT”. The display returns to the SETUP PARAMETER menu.

4.5.6.4. **K-FACTOR Menu**

In the submenu K-FACTOR the $k$-factor for the fine tuning of the flow calculation can be set. Ex work the TRICOR Coriolis Mass Flow Meter is calibrated with a $k$-factor $k = 1.0000$. If for any reasons the flow measured by the mass flow meter differs slightly from a flow measured with other means, the value calculated by the TCM can be adjusted by changing the $k$-factor without the need to perform a new flow calibration.

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”. The display returns to the SETUP PARAMETER menu.
4.5.6.5. FAULT TIME Menu

In the submenu FAULT TIME the reaction time of the TCE 8000 in case of an error can be defined.

The fault on delay time is the time an error must be present, before the red LED lights up and the error output signal is activated.

The fault off delay time is the time an error signal persists on the red LED and on the control output, after the error disappeared.

PARAMETER MENU

FAULT TIME

UP      DOWN    EXIT

P ➔

FAULT ON DELAY TIME

2.7000 SECONDS

RIGHT     UP     EXIT

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

The display shows

FAULT OFF DELAY TIME

2.7000 SECONDS

RIGHT     UP     EXIT

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the SETUP PARAMETER menu.

4.5.6.6. PRESS COMP Menu

In the submenu PRESS. COMP. the operational mode of the pressure compensation (option) can be set.

NOTE:

This menu is only visible with the option "PRESSURE COMPENSATION".

The following modes are possible:

**OFF:**
No pressure compensation.

**mA-IN I1:**
The pressure measured via the analog 4…20 mA input is used for the compensation.

**MANUAL:**
The pressure set via the interface is used for the compensation.

PARAMETER MENU

PRESS. COMP.

UP      DOWN    EXIT

P ➔

SELECT P COMP MODUS

OFF

UP      DOWN    EXIT

Use the keys “UP” and “DOWN” to select the desired mode and confirm with “P” or skip with “EXIT”. 
Is “mA-IN I1” selected but the status of the analog input is “OFF”, the display shows

```
CHANGE mA-IN I2
TO PRESSURE
TO PROCEED
OK
```

Confirm with "OK" and configure the analog input correspondingly, if required.

If “MANUAL” is selected, the display shows

```
MANUAL PRESSURE RATE
0.000 BAR
RIGHT UP EXIT
```

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”. The display returns to the PRESS. COMP. menu.

### 4.5.6.7. TOTAL COUNT Menu

In the submenu TOTAL COUNT the TOTAL counter can be configured.

The following operating modes are available:

**DEFAULT:**
The TOTAL count includes flow in positive as well as in negative direction. With positive flow the TOTAL value increases, with negative flow it decreases.

**FORWARD:**
The TOTAL count includes only flow in positive direction. With negative flow the TOTAL value does not change.

**BACKWARD:**
The TOTAL count includes only flow in negative direction. With positive flow the TOTAL value does not change.

Use the keys “UP” and “DOWN” to select the mode and confirm with “P” or skip with “EXIT”. The display returns to the SETUP PARAMETER menu.

### 4.5.6.8. LANGUAGE Menu

In the submenu LANGUAGE the language used in the display can be selected.

For the time being, English and Russian can be selected.

Use the keys “UP” and “DOWN” to select the language and confirm with “P” or skip with “EXIT”. The display returns to the SETUP PARAMETER menu.
4.5.7. SETUP FILTER Menu

In the submenu SETUP/FILTER the filters of TCE can be configured.

Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

4.5.7.1. FLOW-FILTER Menu

In the submenu FLOW-FILTER the time constant for the flow filter can be set.

The time constant is the time the output needs after a jump from x to 0 to go to x/e = x/2.72.

A rough relation between the time and the filtered flow value after a jump is:

<table>
<thead>
<tr>
<th>Elapsed time</th>
<th>Remaining error (% of the step)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 * t</td>
<td>30</td>
</tr>
<tr>
<td>2 * t</td>
<td>10</td>
</tr>
<tr>
<td>3 * t</td>
<td>3</td>
</tr>
<tr>
<td>4 * t</td>
<td>1</td>
</tr>
</tbody>
</table>

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the SETUP FILTER menu.
4.5.8. SETUP IN/OUTPUTS Menu

In the submenu SETUP/IN/OUTPUTS the input and output ports can be configured.

Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

4.5.8.1. FREQ OUT Menu

In the submenu FREQ OUT the frequency output can be configured.

The frequency output has two operating modes:

FREQUENCY:
A frequency proportional to the actual flow is generated. If a negative flow must be given out as well, the control output can be used as sign. Frequencies between 5 Hz and 10 kHz can be generated in this mode.

TOTAL COUNT:
Each time the TOTAL increments by the selected TOTAL increment step, the output produces a pulse. For having a 50 % duty cycle, the output changes its state each time after half the increment step. If the flow is negative in between, no pulses are generated until the following positive flow compensates for the negative flow in between. Thus the medium will not be counted twice, if in between a flow backwards occurs. The maximum output frequency which can be generated in this mode is about 100 Hz.

Use the keys “UP” and “DOWN” to select the desired mode and confirm with “P” or skip with “EXIT”.

FREQUENCY

Use the keys “RIGHT” and “UP” to select the desired full scale value and confirm with “P” or skip with “EXIT”. The display shows

Use the keys “RIGHT” and “UP” to select the desired frequency and confirm with “P” or skip with “EXIT”.

Version: TCM_0450_E80_M_EN_150209_E008
The display shows

<table>
<thead>
<tr>
<th>OUTPUT NEGATIVE VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
</tr>
</tbody>
</table>

If “YES” is selected and the control output is not configured as FLOW DIREC, the display shows

<table>
<thead>
<tr>
<th>CHANGE CONTROL OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO FLOW DIRECTION</td>
</tr>
<tr>
<td>TO PROCEED</td>
</tr>
<tr>
<td>OK</td>
</tr>
</tbody>
</table>

Confirm with “OK” and configure the control output correspondingly, if required.

**TOTAL COUNT**

<table>
<thead>
<tr>
<th>FREQ OUT MENU</th>
<th>TOTAL COUNT</th>
<th>SELECT VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up</td>
<td>Down</td>
</tr>
</tbody>
</table>

Use the keys “RIGHT” and “UP” to select the desired step value and confirm with “P” or skip with “EXIT”.

4.5.8.2. CONTROL OUT Menu

In the submenu CTRL OUT the control output can be configured.

The control output has four operating modes:

**FAULT:**
In case of an error the control output goes to high. ACTIVE HIGH means the output is low in normal operation, high in case of a fault. For setting the on and off delay time, please refer to chapter 4.5.6.5.

**FLOW DIR:**
The flow direction is indicated. ACTIVE HIGH means the output is high if a positive flow is measured.

**BATCH:**
In the batch mode the TCE 8000 operates as a batch counter. If the preset batch value is reached, the control output goes to the active state. With an active signal at the control input the batch counter can be reset to zero. For this mode the control input must be configured as “RESET BATCH”. ACTIVE HIGH means the output goes to high when the preset batch value is reached.

**FLOW LIMIT:**
If the actual flow becomes more positive than the flow limit plus hysteresis, the output goes to the active state. If the actual flow becomes more negative than the flow limit minus hysteresis, the output goes to the inactive state. Between flow limit minus hysteresis and flow limit plus hysteresis, the output state does not change.

**NOTE:**
For negative flow limits the relation is: -99 is greater than -100. ACTIVE HIGH means the output goes to high when the preset limit value is reached.

**OFF:**
The output is deactivated. ACTIVE HIGH means the output is permanently at high.
**FREQUENCY:**
A frequency proportional to the current flow rate is generated. Frequencies between 0.5 Hz and 10 kHz can be generated in this mode.

**PHASE SHIFT:**
Prerequisite: the FREQ-OUT has been programmed for TOTAL COUNT. As soon as “TOTAL” has increased by the chosen amount, another pulse is generated on FREQ OUT. To have a frequency ratio of 50% on the output, the state of the output changes respectively after half the amount. A pulse offset by 90° is also generated on CTRL OUT after each pulse on FREQ-OUT.
The maximum output frequency in this operating mode is about 50 Hz.

**FAULT**

- **CTRL OUT MENU**
  - **FAULT**
    - **P →**
  - **SELECT ACTIVE STATE**
    - **ACTIVE HIGH**
      - **UP**
      - **DOWN**
      - **EXIT**

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”. The display returns to the SETUP IN/OUTPUTS menu.

**FLOW DIR**

- **CTRL OUT MENU**
  - **FLOW DIR**
    - **P →**
  - **SELECT ACTIVE STATE**
    - **ACTIVE HIGH**
      - **UP**
      - **DOWN**
      - **EXIT**

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”. The display returns to the SETUP IN/OUTPUTS menu.

**BATCH**

- **CTRL OUT MENU**
  - **BATCH**
    - **P →**
  - **SELECT ACTIVE STATE**
    - **BATCH VALUE**
      - **0.50000 KG**
      - **RIGHT**
      - **UP**
      - **EXIT**

Use the keys “RIGHT” and “UP” to select the desired step value and confirm with “P” or skip with “EXIT”. The display shows

- **SELECT ACTIVE STATE**
  - **ACTIVE HIGH**
    - **UP**
    - **DOWN**
    - **EXIT**

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”. The display returns to the SETUP IN/OUTPUTS menu.
**FLOW LIMIT**

Use the keys “RIGHT” and “UP” to select the desired step value and confirm with “P” or skip with “EXIT”.

The display shows

<table>
<thead>
<tr>
<th>HYSTERESIS IN %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00000</td>
</tr>
</tbody>
</table>

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

The display shows

<table>
<thead>
<tr>
<th>SELECT ACTIVE STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVE HIGH</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the SETUP IN/OUTPUTS menu.

**OFF**

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”.

**FREQUENCY**

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”.

The display shows

<table>
<thead>
<tr>
<th>FULL SCALE FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000.0 Hz</td>
</tr>
</tbody>
</table>

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the SETUP IN/OUTPUTS menu.
4.5.8.3. mA-OUT Menu

In the submenu mA-OUT the 4…20 mA outputs can be configured. Each analog output can show one of the following three parameters:

FLOW:
The output current is proportional to the actual flow.

TEMP:
The output current is proportional to the actual temperature.

BATCH COUNT:
The output current is proportional to the actual batch value.
This mode is only possible, if the control input is configured as “RESET BATCH”

The value for 4 mA as well as the value for 20 mA can be freely selected. Thus it is possible to zoom in (e.g. temperatures from 20 °C to 30 °C) or to show negative values as well (e.g. flow from -10 kg/min to +20 kg/min).

Use the keys “UP” and “DOWN” to select the desired output channel and confirm with “P” or skip with “EXIT”.

The standard TCE electronics provides two analog 4…20 mA outputs, I1 and I2. If the option “Pressure compensation” is installed, only the output I2 is available.

The display shows

Use the keys “UP” and “DOWN” to select the desired output value and confirm with “P” or skip with “EXIT”.

The indicated engineering unit depends on the selected output value and the display setup.

To input a negative sign (e.g. for “-20 °C”), move the cursor to the first digit. When the figures are incremented by pushing “UP” the “9” is followed by the minus sign “-“, before the “0” appears.

Use the keys “RIGHT” and “UP” to select the desired value for 4 mA and confirm with “P” or skip with “EXIT”.

The display shows

Use the keys “RIGHT” and “UP” to select the desired value for 20 mA and confirm with “P” or skip with “EXIT”.

The display returns to the SETUP IN/OUTPUTS menu.
4.5.8.4. CONTROL IN Menu

In the submenu “CTRL IN” the control input can be configured. The control input has three operating modes:

**EXT. ZERO:**
If an ACTIVE level is applied to the input, the TCE 8000 starts the zero offset adjustment procedure.

**RESET BATCH:**
If an ACTIVE level is applied to the input, the batch counter is reset to 0. This mode must be selected, if the control output is to be used as a “Batch limit” and/or if one of the analog outputs is to be used as batch output.

**OFF:**
The input is deactivated. Changes of the level applied to the input have no effect. This is the default. The ACTIVE level is freely selectable. Since the standard version of TCE has an internal pull-down resistor built in, the default is ACTIVE HIGH.

**HOLD:**
When an “ACTIVE” level is applied to the input, the flow meters (BATCH and GRAND TOTALS) are stopped.

**IN/OUTPUTS MENU**

<table>
<thead>
<tr>
<th>CTRL IN</th>
<th>UP</th>
<th>DOWN</th>
<th>EXIT</th>
</tr>
</thead>
</table>

**CONTROL IN MENU**

<table>
<thead>
<tr>
<th>EXT. ZERO</th>
<th>UP</th>
<th>DOWN</th>
<th>EXIT</th>
</tr>
</thead>
</table>

Use the keys “UP” and “DOWN” to select the desired mode and confirm with “P” or skip with “EXIT”.

If EXT. ZERO is selected and one of the outputs is set to batch output, the display shows

**CHANGE CTRL OUT MODE TO SELECT THIS**

Confirm with “OK” and configure the output correspondingly if required.

The display shows

**SELECT ACTIVE STATE**

<table>
<thead>
<tr>
<th>ACTIVE HIGH</th>
<th>UP</th>
<th>DOWN</th>
<th>EXIT</th>
</tr>
</thead>
</table>

Use the keys “UP” and “DOWN” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the SETUP IN/OUTPUTS menu.

4.5.8.5. mA-IN I1 Menu

In the submenu mA-IN I1 the 4…20 mA input can be configured. This menu is only visible with the option “PRESSURE COMPENSATION”.

The value for 4 mA as well as the value for 20 mA can be freely selected to adapt the input to any passive 4…20 mA pressure sensor.
Use the keys “UP” and “DOWN” to select “OFF” or “PRESSURE” and confirm with “P” or skip with “EXIT”.
If OFF is selected, neither a pressure value is shown nor a pressure compensation using a measured pressure value is possible.
If PRESSURE was selected the display shows:

VALUE AT 4mA
0.00 MPA
RIGHT UP EXIT

The indicated engineering unit depends on the selected output value and the display setup.
Use the keys “RIGHT” and “UP” to select the desired value for 4 mA and confirm with “P” or skip with “EXIT”.
The display shows:

VALUE AT 20mA
10.00 MPA
RIGHT UP EXIT

Use the keys “RIGHT” and “UP” to select the desired value for 20 mA and confirm with “P” or skip with “EXIT”.
The display returns to the SETUP IN/OUTPUTS menu.

4.5.8.6. INTERFACE Menu

In the submenu INTERFACE the interface can be configured.
Depending on the configuration one or more of the following interfaces can be selected:
RS485
HART®
Foundation Fieldbus®
Manual Operation

**RS485**

Data transmission is carried out via RS485 interface with the „Modbus RTU“ protocol.

- **SET INTERFACE MODUS**
  - RS485
  - **UP**
  - **DOWN**
  - **EXIT**

- **SELECT BAUD RATE**
  - 57600
  - **MODBUS**
  - **UP**
  - **DOWN**
  - **EXIT**

Use the keys “RIGHT” and “UP” to select the baud rate and confirm with “P” or skip with “EXIT”.

The display shows

- **SELECT BYTE ORDER**
  - 3-2-1-0
  - **UP**
  - **DOWN**
  - **EXIT**

Use the keys “UP” and “DOWN” to select the byte order of floating point numbers as it is valid with your system and confirm with “P” or skip with “EXIT”.

The display shows

- **ADDITIONAL TIME DELAY**
  - 00800. µs
  - **RIGHT**
  - **UP**
  - **EXIT**

If the device is installed within bigger bus and controlling systems, it might be helpful to slow down additionally the response of the TCE 8000 in order to avoid any communication errors.

Use the keys “RIGHT” and “UP” to select the additional time delay and confirm with “P” or skip with “EXIT”.

The display shows

- **SET UNIT ADDRESS**
  - 001
  - **RIGHT**
  - **UP**
  - **EXIT**

The following addresses cannot be set:

<table>
<thead>
<tr>
<th>Address</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>reserved for broadband communication (messages to all connected units)</td>
</tr>
<tr>
<td>248-255</td>
<td>reserved for special Modbus purpose</td>
</tr>
</tbody>
</table>

Use the keys “RIGHT” and “UP” to select the desired unit address and confirm with “P” or skip with “EXIT”.

The display returns to the SETUP IN/OUTPUTS menu.
4.5.9. SETUP DATA CONFIGURATION Menu

In the submenu SETUP/DATA CONFIG the current settings can be stored to the backup memory and the stored settings can be recalled.

SETUP MENU
DATA CONFIG
UP DOWN EXIT

Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

4.5.9.1. SAVE DATA Menu

In the submenu SAVE DATA the current settings can be stored in the backup memory.

At each power on the TCE 8000 compares the content of the setup memory and the backup memory. If the data in those two memories are different, the TCE 8000 gives out a warning. To avoid this warning, it is recommended to make a backup as soon as the new settings are proven to be okay.

DATA CONFIG MENU
SAVE DATA
UP DOWN EXIT

Start the backup process with “START” or skip with “EXIT”.

If START is pressed, the display shows for some seconds

MEMORY ACCESS

After that for about two seconds

READY

The display returns to the DATA CONFIG menu.
### 4.5.9.2. RECALL DATA Menu

In the submenu RECALL DATA the old settings are reloaded from the backup memory. reloading the old settings is recommended, if after bigger changes in the setup the TCM does not work properly any more.

**NOTE:**
Backup data overwritten with SAVE DATA cannot be restored!

Start the recall process with "START" or skip with “EXIT”. If START is pressed, the display shows for some seconds:

- MEMORY ACCESS
- READY

The display returns to the DATA CONFIG menu.

### 4.5.10. SETUP RESET TOTAL Menu

In the submenu SETUP/RESET TOTAL the TOTAL counter can be reset to zero.

Reset the TOTAL with "START" or skip with “EXIT”.

**NOTE:**
All TOTAL values ("GRAND TOTAL", "BATCH TOTAL" and "FAIL. TOTAL") are reset!

The display returns to the RESET TOTAL menu.
4.5.11. SETUP CLEAR LOGS Menu

In the submenu SETUP CLEAR LOGS all logged events can be acknowledged (deleted).

![Setup Menu]

Acknowledge all logged events with „START“ or skip with „EXIT“ ab.

**HINWEIS:**
Acknowledged Log entries cannot be recovered.

Das Display kehrt zum Menü CLEAR LOGS zurück.

4.5.12. I/O-TEST Menu

In the I/O-TEST menu all inputs and outputs can be tested.

Select in the main menu

![Main Menu]

Press “P”. The display shows

![Enter Code]

Change the indicated number with “LEFT” and “UP” to “2207“ and confirm with “P”.
If a wrong code is entered, the display shows “ERROR” for about two seconds and then asks for a new input.
When the correct code is entered the display shows
The following submenus are available:

- **FREQ OUT**: A freely settable frequency can be applied to the output.
- **CTRL OUT**: The output level can be set.
- **mA-OUT**: A freely settable current can be applied to the output.
- **CTRL IN**: The level currently applied to the input is indicated.
- **mA-IN**: The actual electric input current is indicated.

*(Only with option “PRESSURE COMPENSATION”)*

When the I/O-TEST menu is left, all outputs return to normal operation.

### 4.5.12.1. FREQ OUT menu

In the submenu FREQ OUT a freely settable frequency, between 1 Hz and 9,999 Hz, can be applied to the output.

![I/O-TEST MENU](image)

**FREQ OUT**

![ENTER FREQUENCY (Hz)](image)

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

If “P” was pressed the frequency is applied to the output and the display shows:

**CHANGE VALUE?**

![YES EXIT](image)

Press “YES” to enter a new value or “EXIT” to leave the menu.

If “EXIT” is pressed, the display returns to the I/O-TEST menu.

### 4.5.12.2. CTRL OUT Menu

In the submenu CTRL OUT a low or high level can be applied to the output.

![I/O-TEST MENU](image)

**CTRL OUT**

![SELECT OUTPUT LEVEL!](image)

Use the keys “HIGH” and “LOW” to set the output value or leave the menu with “EXIT”.

If “EXIT” is pressed, the display returns to the I/O-TEST menu.

### 4.5.12.3. mA-OUT Menu

In the submenu mA-OUT a freely settable current, between 2 mA and 22 mA, can be applied to the output.

![I/O-TEST MENU](image)

**mA-OUT**

![ANALOG OUT TEST](image)

Use the keys “UP” and “DOWN” to select the desired output and confirm with “P” or skip with “EXIT”.
**Manual Operation**

The display shows

```
ENTER CURRENT 1 (mA)
00.0
RIGHT   UP   EXIT
```

Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

If “P” was pressed the current is applied to the output and the display shows

```
CHANGE VALUE?
YES   EXIT
```

Press “YES” to enter a new value or “EXIT” to leave the menu.

If “EXIT” is pressed, the display returns to the I/O-TEST menu.

**4.5.12.4. CTRL IN Menu**

In the submenu CTRL IN the display shows the level currently applied to the control input.

The display shows the actual level at the input. It is automatically updated when the level at the input has changed.

After evaluating the input, press “EXIT” to return to the I/O-TEST menu.

**4.5.12.5. mA-IN Menu (optional)**

The submenu mA-IN is only selectable with the option “PRESSURE COMPENSATION”.

Here the display shows the current applied to the analog input.

After evaluating the input, press “EXIT” to return to the I/O-TEST menu.

**4.5.13. SERVICE Menu**

The SERVICE menu is used to calibrate the meter, to set a user password and to recall the original factory settings.

For a description of the menu, please refer to chapter 6.
5. Remote Operation

As a standard the TCE 8000 is equipped with a RS-485 interface. Optionally also a HART® interface is available.

Please read chapter 4 before installing a remote control, for getting a description of the functionality.

5.1. Serial RS485 Interface

5.1.1. Electrical Connection of RS485 Interface

Prepare the TCE 8000 and the cable as described in chapter 3.2.

Connect the signal RS-485A or RS-485+ (both names are used in the literature) to terminal 22 and RS-485- or RS-485B to terminal 21. Terminal 20 is the ground reference pin for the interface and is connected to GND (terminal 8) with the non-Ex versions and connected to PE (terminal 52) with the Ex versions.

NOTE:
The operating range of the data terminals (21 and 22) is -7 V to +12 V referred to the reference pin (20). Voltages outside that range could damage the TCE 8000.

5.1.2. Usage of the TRICOR Configurator

The control software TRICOR Configurator as well as the corresponding manual is provided for download at the “Download” area of the TRICOR webpage (www.tricorflow.com).

Using the TRICOR Configurator a remote operation with TRICOR meters is possible, without the need of knowledge about the Modbus protocol.

The usage of the converter CON.USB.RS-ISO is recommended for the connection between the TCE electronics and a personal computer (via USB interface).

5.1.3. RS485-Interface-Protocol

For communication via RS485 the Modbus RTU protocol is used.

A detailed description of the Modbus frame structure and the implemented registers and addresses can be found at the “Download” area of the TRICOR webpage (www.tricorflow.com).
5.2. HART®

5.2.1. Electrical Connection for HART®

For the HART® communication the current output CURRENT 2 is used. Connect the analog output CURRENT 2 as described in chapter 3.2.5 and connect a HART® communicator or a HART® Handheld Terminal in series to the analog output of the TCE. Refer to the manual of your HART® communicator, respectively of the HART® Handheld Terminal, for the proper connection.

5.2.2. Device Description File for HART® Interface Protocol

For getting the newest DD file for the HART® Interface, please contact KEM.

5.3. Foundation Fieldbus®

5.3.1. Electrical Connection for Foundation Fieldbus®

Prepare the TCE 8000 and the cable as described in chapter 3.2.2. Connect the signal FF+ (positive rail of the bus) to terminal 32 and FF- (negative rail of the bus) to terminal 31.

5.3.2. Device Description File for Foundation Fieldbus® Interface Protocol

For getting the newest DD file for the Foundation Fieldbus® Interface, please contact TRICOR representative.
6. Service and Maintenance

6.1. Maintenance

The TRICOR Mass Flow Meters do not require regular maintenance.

In case of abrasive or sedimenting media however, it is recommended to return the measuring system to the manufacturer KEM after 8,000 hours of operation for re-calibration and pressure test. This interval may be shorter when the medium is extremely abrasive or sedimenting. For best performance we recommend checking the calibration every 5 years, in harsh environments even more frequently.

If for the specific application an obligatory calibration is required, refer to the corresponding national regulations for the necessary calibration intervals.

6.2. Trouble Shooting

In case the TRICOR Mass Flow Meter does not work properly, first check the following items:

**No display, no LED lighting**
All cables properly connected?
- Connect the missing cables
Power supply switched on?
- Switch on the power supply
Display positioned properly (compact and wall mount only)?
- Remove the display and reset it properly
Internal fuse of the TCE blown?
- For checking and changing the fuses refer to chapter 6.3.

**Output frequency too high or unstable**
Most probably EMC problems
Shield and ground properly connected?
- Connect shield properly. If necessary, try additional means of grounding and shielding

**Unstable flow reading with (theoretically) stable flow**
Strong external vibrations?
- Decouple the meter from the vibration source
Flow or pressure slugs in the medium?
- Decouple the meter hydraulically

**No frequency or current output with operating display**
Output correctly wired?
- Correct the wiring (see chapter 2.3)
Output correctly configured?
- Correct the configuration (see chapter 4.5.8.1)
Wrong flow direction (Flow in the display is negative)?
- Change flow direction (see chapter 4.5.6.3)

**Pressure display shows “PRESS ERROR”**
Input correctly wired?
- Correct the wiring (see chapter 2.3)
Sensor working normally?
- Check with external digital Ampere meter. If required, replace the sensor

**No pressure compensation**
Compensation enabled?
- Enable compensation (see chapter 4.5.6.6)
Sensor working normally?
- Check with external digital Ampere meter. If required, replace the sensor
6.3. Changing the Fuses

With the Ex versions the fuses are part of the safety barriers and must only be exchanged by KEM/AWL or by personnel authorized by KEM/AWL.

In case one of the fuses has blown, contact KEM/AWL or your nearest dealer.

**WARNING!**

The Ex versions of the TCE 8000 series contain several internal fuses for protecting the intrinsically safe TCM against too high voltage and power. Those fuses are critical parts and must not be exchanged except by KEM or by service personnel authorized by KEM. If the fuses are replaced by third persons, the Ex certification for the TCM will be void!

6.4. Calibration

In the calibration menu all measurements of the TCE 8000 can be calibrated.

Press “P” for about three seconds

The display shows

```
MAIN MENU
ZERO OFFSET
UP    DOWN    EXIT
```

Use the key “UP” or “DOWN” to select

```
MAIN MENU
SERVICE
UP    DOWN    EXIT
```

Press “P”. The display shows

```
ENTER CODE
2206
LEFT    UP    EXIT
```

Change the indicated number with “LEFT” and “UP” to “2208” and confirm with “P”.

If a wrong code is entered, the display shows “ERROR” for about two seconds and then asks for a new input.
When the correct code is entered the display shows

![Service Menu]

Press “P”. The display shows

![Calibration Menu]

The following submenus are available:

- TEMP CALIB.  Calibrating the temperature measurement
- METER VAR.  Calibrating the flow measurement

### 6.4.1. Temperature Calibration

For calibrating the temperature reading of the TCE 8000, the medium temperature must be well known.

Before starting the calibration make sure that the temperature reading has been stable for several minutes, to make sure that the medium temperature and the temperature of the temperature sensor are the same.

![Temperature Calibration Menu]

Use the keys “RIGHT” and “UP” to set the actual medium temperature and confirm with “P” or skip with “EXIT”.

The display returns to the CALIBRATION menu.

### 6.4.2. Flow Calibration

Mount the TCM in the test stand or mount a reference meter in series to the TRICOR Mass Flow Meter to be calibrated. The accuracy of the test stand or reference meter must be better than 0.1% of reading over the calibration range.

For best results with the zero offset calibration, a valve each in front and behind the TRICOR Mass Flow Meter is recommended.

---

**NOTE:**

All mounting guidelines (see chapter 3.1) must be observed!

Any erroneous reading due to bad mounting will lead to a wrong calibration!

Operate the meter for at least 15 minutes for making sure that it has reached the final operating temperature. If the medium temperature differs much from the initial meter or ambient temperature, a longer warm up period might be recommended.

Close the valves and make the zero offset adjustment (see chapter 4.5.3).
If the calibration of the TRICOR Mass Flow Meter shall be checked without adjusting the reading, just compare the TCM reading with the reading of the reference meter at the desired flow rates.

If the TRICOR shall be adjusted according to the test results, make a test run (or better several tests runs) at about 50% of the TCM full scale flow.

Read the current TCM meter variable:

![CALIBRATION MENU](image)

**P ➔**

**SET METER VAR**

196.0

**RIGHT** **UP** **EXIT**

Calculate the new meter variable as:

\[
\text{METER\_VAR}_{\text{new}} = \frac{\text{METER\_VAR}_{\text{old}} \times \text{Reference\_reading}}{\text{TCE\_8000\_reading}}
\]

If you made several test runs, use the average meter variable.

Use the keys “RIGHT” and “UP” to set the calculated meter variable and confirm with “P” or skip with “EXIT”.

The display returns to the CALIBRATION menu.

### 6.5. Service

Apart from the fuses the TCE 8000 does not contain any user serviceable parts.

In case of malfunction, please contact your nearest dealer or directly KEM Küppers Elektromechanik GmbH.

For the addresses see chapter 8.

### 6.6. Global Device Password

In order to protect the TRICOR Mass Flow Meter from unauthorized access, a user-specific password can be set. It protects the access to all configuration menus. The password can be set either through the local display as described below or through the Modbus interface (see TCM\_COMO\_S\_EN\_150408\_E004, TRICOR Modbus RTU manual).

**NOTE:**

If the global access code gets lost, the meter must be returned to KEM/AWL for resetting it. Resetting the code onsite is not possible!

Press “P” for about three seconds. The display shows

![MAIN MENU](image)

**ZERO OFFSET**

**UP** **DOWN** **EXIT**

Use the key “UP” or “DOWN” to select

![MAIN MENU](image)

**SERVICE**

**UP** **DOWN** **EXIT**
Press “P”. The display shows

```
ENTER CODE
  2206
  LEFT  UP  EXIT
```

Change the indicated number with “LEFT” and “UP” to “2208” and confirm with “P”.
If a wrong code is entered, the display shows “ERROR” for about two seconds and then asks for a new input.
When the correct code is entered the display shows

```
SERVICE MENU
  CALIBRATION
    UP  DOWN  EXIT
```

Use the key “UP” or “DOWN” to select ACCESS CODE and confirm with “P” or skip with “EXIT”

```
SERVICE MENU
  ACCESS CODE
    P ➔
  UP  DOWN  EXIT
```

```
SET P-ACCESS CODE
  0001
  LEFT  UP  EXIT
```

Change the indicated number with “LEFT” and “UP” to the desired code number and confirm with “P”.
The display shows

```
OLD P-CODE: 0
NEW P-CODE: ****
OK                        CANCEL
```

Confirm with “OK” or skip with “CANCEL”.
The display returns to the ACCESS CODE menu.

6.7. Reloading Factory Settings

In case the TCM has been completely misadjusted for any reason, the TCM can be reset to the original settings ex works.
Press “P” for about three seconds. The display shows

```
MAIN MENU
  ZERO OFFSET
    UP  DOWN  EXIT
```

Use the key “UP” or “DOWN” to select

```
MAIN MENU
  SERVICE
    UP  DOWN  EXIT
```
Press “P”. The display shows

**ENTER CODE**

2206

LEFT UP EXIT

Change the indicated number with “LEFT” and “UP” to “2208” and confirm with “P”.
If a wrong code is entered, the display shows “ERROR” for about two seconds and then asks for a new input.

When the correct code is entered the display shows

**SERVICE MENU**

**CALIBRATION**

UP DOWN EXIT

Use the key “UP” or “DOWN” to select RECALL FACT and confirm with “P” or skip with “EXIT”.
The display shows

**RECALL FACTORY SETTINGS?**

START EXIT

Start the recall process with “START” or skip with “EXIT”.
If START is pressed, the display shows for some seconds

**MEMORY ACCESS**

After that for about two seconds

**READY**

The display returns to the RECALL FACTORY menu.
7. Listings

7.1. Warranty

For warranty refer to the general terms and conditions of KEM Küppers Elektromechanik GmbH, which can be found on the corresponding website (www.kem-kueppers.com).

7.2. Certifications and Compliances

<table>
<thead>
<tr>
<th>Category</th>
<th>Standards or description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU Declaration of Conformity - EMC</td>
<td>Meets intent of Directive 2014/30/EU for Electromagnetic Compatibility. Compliance is given to the following specifications as listed in the Official Journal of the European Union:</td>
</tr>
<tr>
<td>EN 61326/2006</td>
<td>EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A radiated and Conducted Emissions 1) and Immunity 1).</td>
</tr>
<tr>
<td>IEC 61000-4-2/2009</td>
<td>Electrostatic Discharge Immunity (Performance criterion B)</td>
</tr>
<tr>
<td>IEC 61000-4-3/2011</td>
<td>Radiated RF Electromagnetic Field Immunity (Performance criterion B)</td>
</tr>
<tr>
<td>IEC 61000-4-4/A1-2013</td>
<td>Electrical Fast Transient/Burst Immunity (Performance criterion B)</td>
</tr>
<tr>
<td>IEC 61000-4-5/2015 2)</td>
<td>Power Line Surge Immunity (Performance criterion B)</td>
</tr>
<tr>
<td>IEC 61000-4-6/2014</td>
<td>Conducted RF Immunity (Performance criterion B)</td>
</tr>
<tr>
<td>IEC 61000-4-11/2005 2)</td>
<td>Voltage Dips and Interruptions Immunity (Performance criterion B)</td>
</tr>
<tr>
<td>Australia/New Zealand Declaration of Conformity-EMC</td>
<td>Complies with the EMC Emission standard 1)</td>
</tr>
<tr>
<td>AS/NZS 2064</td>
<td></td>
</tr>
</tbody>
</table>

1) Compliance demonstrated using high-quality shielded interface cables.
2) Applies only to units with AC mains supply instead of or additional to the SELV supply.
## EU Declaration of Conformity – Low Voltage

Compliance is given to the following specification as listed in the Official Journal of the European Union: 
Low Voltage Directive 2014/35/EU

| EN 61010-1/2010 | Safety requirements for electrical equipment for measurement control and laboratory use. |
| Designed to meet the following US standards | UL 61010-1/2012 | Standard for electrical measuring and test equipment. |
| Designed to meet the following Canadian standards | CAN/CSA C22.2 no. 61010-1-4/2008 | Safety requirements for electrical equipment for measurement, control, and laboratory use. |
| International standards | IEC61010-1/2010 | Safety requirements for electrical equipment for measurement, control, and laboratory use. |

## Equipment Type

Test and measuring

## Safety Class

Class 1 (as defined in IEC 61010-1, Annex H) – grounded product

### ATEX

| II 2G Ex d [ia] IIC T2…T4 Gb Ex d [ia] IIC T2…T4 Gb | TCE 800*-W-****-Ex and TCE 800*-W-****-Ex3 |
| II 2G Ex ia IIC T2…T4 Gb Ex ia IIC T4 Gb | TCM 0450-*.*,****.-****-Ex and TCM 0450-*.*,****.-****-Ex3 |

### ATEX

| II 3G Ex nA IIC T2…T4 Gc | TCE 800*-W-****-Exn |
| II 3G Ex nA IIC T2…T4 Gc | TCM 0450-*.*,****.-****-Exn |

### cCSAus

| Class I, Division 1 Group A, B, C, D, T2…T4 | TCE 800*-W-****-Ex1 and TCE 800*-W-****-Ex3 |
| TCM 0450-*.*,****.-****-Ex1 and TCM 0450-*.*,****.-****-Ex3 |
### 7.3. Technical Data

#### 7.3.1. Technical Data TCM 0450/TCMH 0450 Transducer

<table>
<thead>
<tr>
<th><strong>Measurement Mass Flow</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass Flow Rate (max.)</td>
<td>450 kg/h, 16.53 lb/min</td>
</tr>
<tr>
<td>Accuracy</td>
<td>1 % of reading</td>
</tr>
<tr>
<td>Zero Stability</td>
<td>±0.1 % of full scale (0.45 kg/h)</td>
</tr>
<tr>
<td></td>
<td>±0.1 % of full scale (0.01653 lb/min)</td>
</tr>
<tr>
<td>Max. zero offset drift with temperature change</td>
<td>0.001 % of reading per °C</td>
</tr>
<tr>
<td>Max. zero offset drift with pressure change</td>
<td>0.001 % of reading per bar</td>
</tr>
<tr>
<td>Repeatability</td>
<td>0.5 % of reading</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Measurement Temperature</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>±1.8 °F ±0.5 % of reading</td>
</tr>
<tr>
<td></td>
<td>±1 °C ±0.5 % of reading</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Process and Environment</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection</td>
<td>3/8&quot; Autoclave (MP)</td>
</tr>
<tr>
<td>Pressure Rating</td>
<td>1,050 bar, 15,200</td>
</tr>
<tr>
<td>Process Temperature</td>
<td>Standard: -40 °F ... +212 °F (-40 °C ... +100 °C)</td>
</tr>
<tr>
<td></td>
<td>Ex-Version: -40 °F ... +158 °F (-40 °C ... +70 °C)</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>-40 °F ... +158 °F (-40 °C ... +70 °C)</td>
</tr>
<tr>
<td>Electrical Connection</td>
<td>Push-Pull connector</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>General</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingress Protection</td>
<td>IP65 (NEMA 4)</td>
</tr>
<tr>
<td>Tube Design</td>
<td>2 parallel</td>
</tr>
<tr>
<td>Tube Diameter Inside</td>
<td>2.4 mm/0.095&quot;</td>
</tr>
<tr>
<td>Tube Material</td>
<td>Sandvik Alloy HP 160</td>
</tr>
<tr>
<td>Manifold Material</td>
<td>1.4435/AISI 316L</td>
</tr>
<tr>
<td>Housing Material</td>
<td>1.4404/AISI 316L</td>
</tr>
<tr>
<td>Dimensions</td>
<td>See chapter 7.3.4</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 7.5 kg/16.5 lb</td>
</tr>
</tbody>
</table>
# 7.3.2. Technical Data TCE 8000 Transmitter

## General

<table>
<thead>
<tr>
<th>Display</th>
<th>back-lit LCD screen, 132 x 32 dot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>24 V DC, ±20 % or 90 … 264 V (version dependent)</td>
</tr>
<tr>
<td>Programming</td>
<td>via front keyboard or Windows-based TRICOR configurator program (Modbus)</td>
</tr>
<tr>
<td>Interface</td>
<td>RS 485 (Modbus RTU), Option HART®, Foundation Fieldbus® other options on request</td>
</tr>
<tr>
<td>EMC</td>
<td>According to EN 61000-6-4 and EN 61000-6-2</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>max. 6 W</td>
</tr>
<tr>
<td>Dimensions</td>
<td>see chapter 7.3.4</td>
</tr>
<tr>
<td>Electrical Connections</td>
<td>cage clamp terminals</td>
</tr>
<tr>
<td>Cable Glands</td>
<td>or 7 - 13 mm cables</td>
</tr>
<tr>
<td>Housing Material</td>
<td>Aluminum diecast (option: 1.4404/AISI 316L)</td>
</tr>
<tr>
<td>Protection class</td>
<td>IP65 (IP66/IP67 on request)</td>
</tr>
<tr>
<td>Weight:</td>
<td>with Aluminum diecast housing: 3.8 kg/8.3 lb with 3 m cable with 1.4404/AISI 316L housing: 6.15 kg/13.56 lb</td>
</tr>
<tr>
<td>Temperature</td>
<td>ambient: -40 °F ... +158 °F (-40 °C ... +70 °C) storage and transport: -40 °F ... +176 °F (-40 °C ... +80 °C)</td>
</tr>
</tbody>
</table>

## Analog Outputs

<table>
<thead>
<tr>
<th>Current Outputs (2x)</th>
<th>4 … 20 mA passive, two-wire, isolated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>14 bit</td>
</tr>
<tr>
<td>Linearity</td>
<td>±0.05 % of full scale</td>
</tr>
<tr>
<td>Temperature Drift</td>
<td>0.05 % per 10 K</td>
</tr>
<tr>
<td>Load</td>
<td>&lt; 620 Ω (at 24 V supply)</td>
</tr>
<tr>
<td>Output Value</td>
<td>programmable: flow, total, density, temperature</td>
</tr>
</tbody>
</table>

### Pulse Output

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>0.5 - 10,000 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Signal</td>
<td>active push pull output for flow rate</td>
</tr>
</tbody>
</table>

### Status In- and Output

<table>
<thead>
<tr>
<th>Status Output</th>
<th>push pull programmable (in TOTAL mode: 0.5 - 100 Hz; in FREQUENCY mode: 0.5 - 10,000 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Input</td>
<td>programmable</td>
</tr>
</tbody>
</table>

### Analog Input (option)

<table>
<thead>
<tr>
<th>Input Type</th>
<th>4-20 mA active for two-wire passive pressure sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>12 bit</td>
</tr>
<tr>
<td>Linearity</td>
<td>±0.05 % of full scale</td>
</tr>
<tr>
<td>Temperature Drift</td>
<td>0.05 % per 10 K</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>&gt; 20 V (at 20 mA sensor current)</td>
</tr>
</tbody>
</table>
7.3.3. Technical Data TCE/TCM Cable

<table>
<thead>
<tr>
<th></th>
<th>Standard cable</th>
<th>High temperature cable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer Diameter</td>
<td>8.30 mm ±0.2 mm</td>
<td>6,9 mm ±0,2 mm</td>
</tr>
<tr>
<td>Sheath</td>
<td>PUR (DIN VDE 0207 UL Style 20233)</td>
<td>FEP</td>
</tr>
<tr>
<td>Colour</td>
<td>blue (similar RAL5002 matt)</td>
<td>black</td>
</tr>
<tr>
<td>Labeling</td>
<td>UL (white)</td>
<td>-</td>
</tr>
<tr>
<td>RoHS</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Resistance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halogen-free</td>
<td>halogen-free (IEC 60754-2)</td>
<td>-</td>
</tr>
<tr>
<td>Flammability</td>
<td>flame-retardant (IEC 60332-1-2</td>
<td>flame-retardant</td>
</tr>
<tr>
<td></td>
<td>(VDE 0472 Part 804 B))</td>
<td></td>
</tr>
<tr>
<td>Hydrolysis Resistance</td>
<td>hydrolysis resistance</td>
<td>-</td>
</tr>
<tr>
<td>Oil Resistance</td>
<td>Oil resistance (DIN EN 60811-2-1)</td>
<td>Oil resistance</td>
</tr>
<tr>
<td><strong>Laying</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range of Temperatures</td>
<td>moved: -22 °F to +176 °F (UL)</td>
<td>-85 °F to +356 °F (-65 °C to +180 °C)</td>
</tr>
<tr>
<td></td>
<td>-30 °C to +80 °C (UL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fixed: -58 °F to +176 °F (UL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-50 °C to +80 °C (UL)</td>
<td></td>
</tr>
<tr>
<td>Bending Radius</td>
<td>moved: 85 mm (10xD)</td>
<td>moved: 71 mm (10xD)</td>
</tr>
<tr>
<td></td>
<td>fixed: 42.5 mm (5xD)</td>
<td>fixed: 35.5 mm (5xD)</td>
</tr>
</tbody>
</table>
7.3.4. Dimensional Drawings

Fig. 16: Meter Dimensions TCM 0450/TCMH 0450, Ex/Ex1

Fig. 17: Meter Dimensions TCM 0450/TCMH 0450, Ex3
7.4. WEEE and RoHS

The TRICOR Coriolis Mass Flow Meter described herein is not subject to the WEEE directive and the corresponding national laws.

At the end of life forward the TCM to a specialized recycling company and do not dispose it off as domestic waste.

The TCM described herein fully complies with the RoHS directive.

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