Manual

TRICOR

Coriolis Mass Flow Meter

Manual-Version

File number: en_Tricor_Ex_BA

Manual-Revision: See last page

SW-Version

This Manual is valid for

Main SW: V2.3x and higher

Display SW : V2.3x and higher

1 General Information

1.1 Features

The Tricor Mass Flow Meters, based on the Coriolis principle, show many advantages compared to other flow meter principles:

- No moving parts
- High accuracy
- Simultaneous measuring of mass flow, density and temperature
- Calculation of volume flow as well as mass and volume total
- Flushable

The Tricor Mass Flow Meters are available as compact version with onsite display and as meter with remote display for wall or panel mount.

All versions are available as standard version as well as Ex certified for hazardous locations.

The meters provide the following features:

- A graphic display
- Menu driven control with soft keys for easy operation also without manual
- 2 freely programmable 4-20 mA outputs
- 1 freely programmable frequency output
- 1 control input and 1 control output
- RS485 interface

As an option are available

- HART interface
- Foundation Fieldbus interface
- A 4-20mA input for pressure measurement
- A pressure compensation

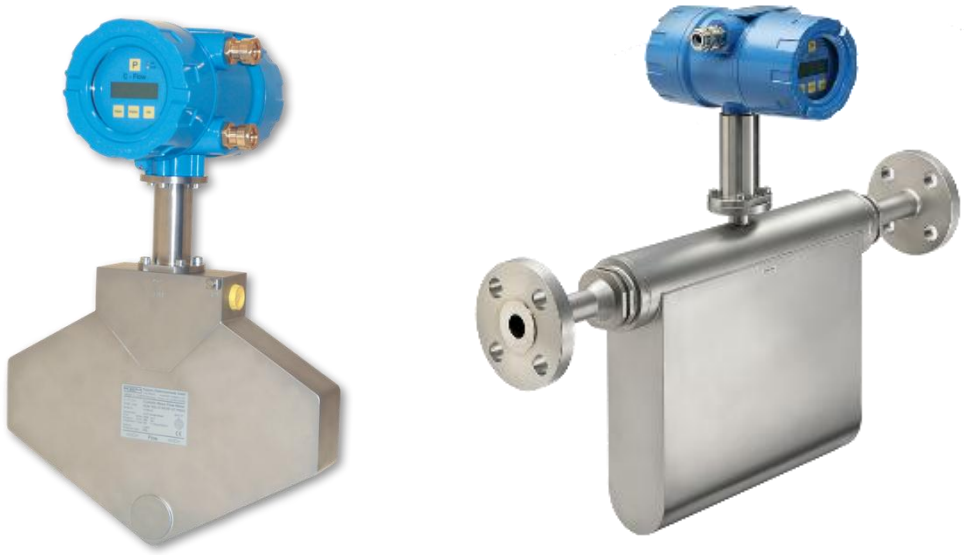


Fig. 1: Compact version

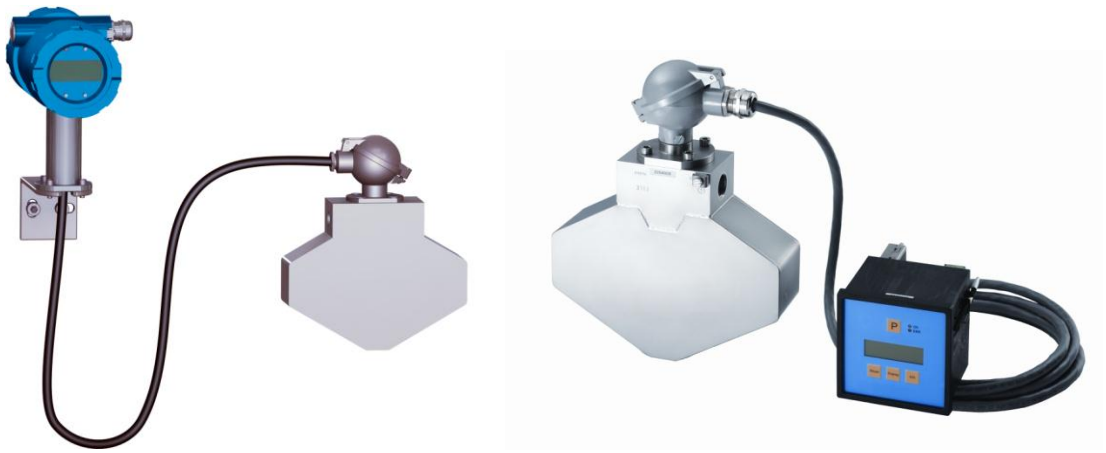


Fig. 2: Separate versions, wall mount (left) and panel mount (right)

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 unit is operated correctly in accordance with this manual.

The data for Ingress Protection 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 noted in this manual.

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

In hazardous locations the covers of the electronics of the compact or wall mount version must not be opened under any circumstances if the supply voltage is alive. For operating the keys the magnet must be used.

The analogue and digital I/O signals are not specified for driving Ex i circuits.

When using long cables make sure that the maximum inductances and capacitances for the respective voltage or gas group are not exceeded.

The maximum values specified in chapter **7.3.4** must be observed at any time.

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

1.3 Ordering Codes and Accessories

1.3.1 Ordering Code

	code (4 digits)		
TCE	8001	Low Power Electronics	for TCM 0325 to TCM 7900
	8011	High Power Electronics	for TCM 28K to TCM 65K

code	housing (1 digit)
W	wall-mounted housing with fixed cable to TCM
S	panel-mounted housing (separate cable required)
E	big wall-mounted housing with fixed cable to TCM or with junction box
L	wide panel-mounted housing (separate cable required) (Ex)

code	Options (4 digits)
X000	Interface S = RS 485 only A = Hart + RS 485 B = Foundation Fieldbus + RS485 C = HART + Foundation Fieldbus + RS485 D = Foundation Fieldbus only E = Hart + Foundation Fieldbus Z = not used
0X00	Power Supply B = 24V DC + 90-264V AC (Housing S only) D = 24V DC M = mains (90 - 264V AC)
00X0	options (S=none) A = Pressure compensation and 4-20mA input
000X	Cable length Housing "E": S=3m, for other lengths contact KEM/AWL A= junction box, separate cable required Housing "L": N = no cable included

code	Ex-protection
Ex	ATEX + IECEx
Ex1	cCSAus
empty	no Ex-protection

TCE		-		-		-	

Example:

TCE	8011	-	E	-	BDSS	-	Ex

code (4 digit)

TCM 028k Maximum Flow in kg/h

code process connections (2 digits)

Ax	ANSI flange	x = size of flange, contact KEM/AWL for code
Dx	DIN flange	x = size of flange, contact KEM/AWL for code
Fx	female thread	x = size of thread, contact KEM/AWL for code

code Mechanical options (4 digits)

X000	Temperature range S = -20 to 100°C H = -20 to 150°C
0X00	Pressure range G = 100bar with rupture disc For other ranges contact KEM/AWL
00X0	accuracy (S = standard)
000X	Flange to flange length, contact KEM/AWL for code

code Electronics / terminal (4 digits)

X000	Electronics A = junction box C = On site electronics E = Big on site electronics (Ex)
CX00	Interface S = RS 485 only A = Hart + RS 485 B = Foundation Fieldbus and RS 485 C = HART and Foundation Fieldbus and RS 485 D = Foundation Fieldbus only E = Hart and Foundation Fieldbus Z = not used
C0X0	Supply voltage D = 24V DC M = 90 - 264V AC Z=not used
C00X	options (S=none) A = Pressure compensation and 4-20mA input

code Ex-protection

Ex	ATEX + IECEx
Ex1	cCSAus
empty	no Ex-protection

Example:

TCM 028k - DC - SGSS . EADS - Ex

Please ask KEM/AWL or your nearest dealer for the possible combinations and the best solution for your application.

1.3.2 Accessories

Ordering Code	Description
(Contact KEM/AWL)	Connecting Cable TCM ⇔ TCE80xx-L-* or TCE80xx-S-*
TRD8001	Additional remote display for the compact version
HSA96	DIN Rail Adaptor for TCE80**-L-* or TCE80xx-S-*
IPS9-9	Protective front cover IP65 for TCE80**-S -*
IPS9-14	Protective front cover IP65 for TCE80**-L-*

1.4 Measuring Principle TCM

Two parallel flow tubes inside the TCM low meter are vibrating at their resonant 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 delay between both ends of the tube. This time delay is measured and used to calculate the mass flow through the tubes.

By measuring the resonant frequency of the tubes the mass of the medium and - given a constant volume inside the tubes - the specific gravity of the medium can be calculated.

As both effects are temperature dependent, the temperature is measured via a precise sensor for correcting the temperature effects of flow and density measurement.

As a consequence 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.

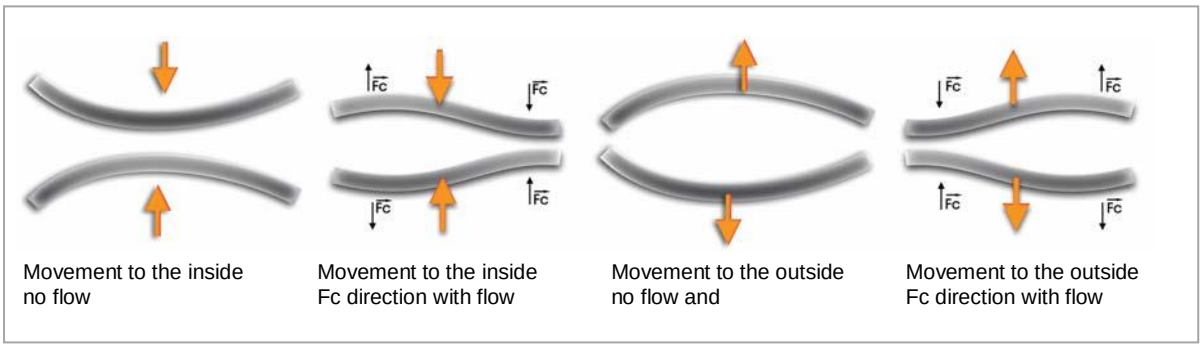


Fig. 3: Flections of the tubes with and without flow

2 Getting started

2.1 Unpacking

Verify that you have received the following items:

When you ordered a compact version:

- TCMxxxx… with mounted electronics
- User's manual

When you ordered a remote version

- TCMxxxx…(without electronics)
- TCE80xx…
- Connecting cable (with TCE80xx-E just fixed to the TCE)
- User's manual

2.2 Operating Elements

2.2.1 TCE80xx-E, TCE80xx-W and compact version

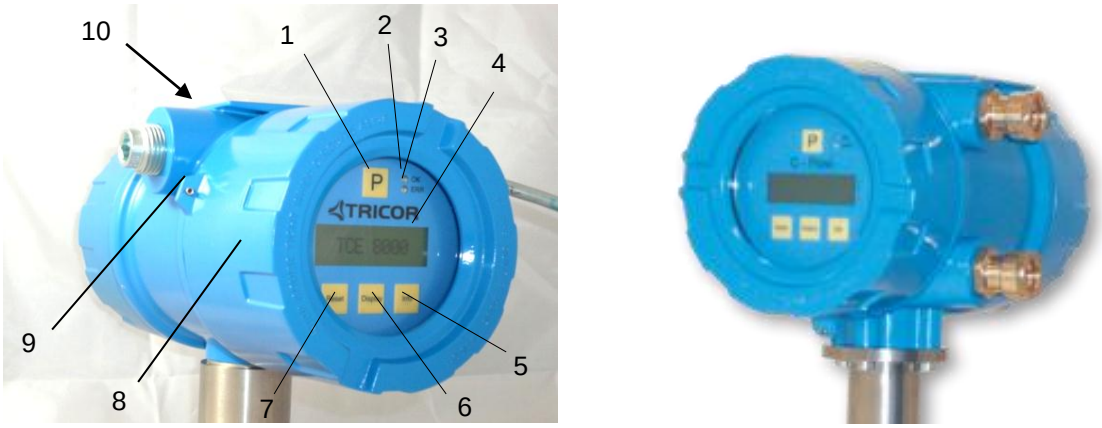


Fig. 4: Operating Elements of TCE80xx-E (right), TCE80xx-W (left) and compact version

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: softkey

6 = Pushbutton “Display”, normal: toggles the display, SETUP: softkey

7 = Pushbutton “Reset”, normal: resets the batch counter, SETUP: softkey

8 = Front cover

9 = Set screw for front cover (varying position)

10 = Screw for protective ground

Wall mount version only (not shown on the pictures):

Cable to the meter TCMnnnn, length as ordered (standard 3m) or junction box
Wall mounting bracket

For the rear view see chapter 2.3

2.2.2 TCE80xx-S and TCE80xx-L

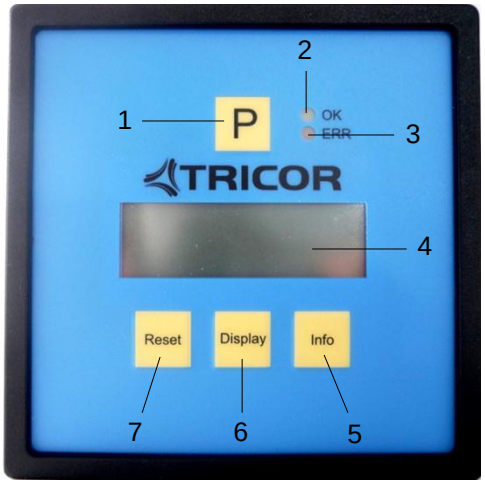


Fig. 5: Operating Elements of TCE80xx-S

Fig. 6: Operating Elements of TCE80xx-L-*-Ex

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 status menu, SETUP: softkey

6 = Pushbutton “Display”, normal: toggles the display, SETUP: softkey

7 = Pushbutton “Reset”, normal: resets the batch counter, SETUP: softkey

For the rear view see chapter 2.3

2.2.3 TCMxxxx-… (remote version)

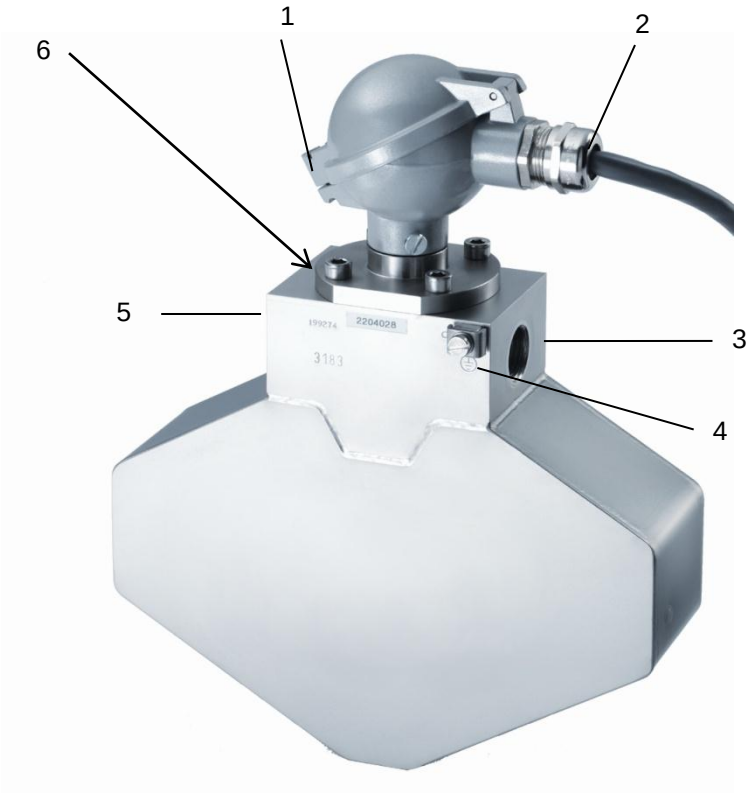


Fig. 7: Operating Elements TCM

1 = Locking screw for screw type terminals

2 = Cable gland for cable to the TCE

3 = Fluid output, flange / thread as ordered

4 = Screw for protective ground (TCM0325 through 3100 only)

5 = Fluid input, flange / thread as ordered

6 = M6 mounting threads (back side, option, TCM0300 through 3000 only)

2.3 Pin Assignments

2.3.1 TCE80xx-W and compact version (standard housing, non Ex)

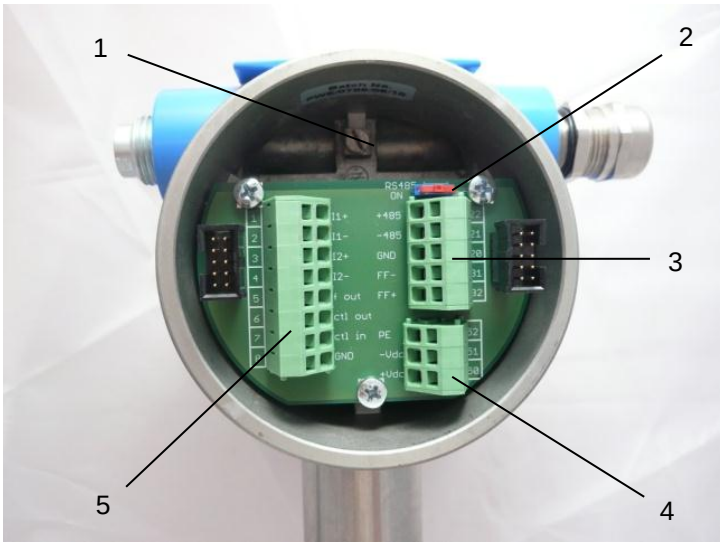


Fig. 8: Electrical terminals TCE80xx-W and compact version

1 = Terminal screw for protective ground

2 = Switch for terminating resistor for the RS485 interface

3 = Terminal block for interface (RS485 and / or FF)

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	F out	Frequency / pulse output
6	CTL OUT	Control output
7	CTL IN	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
31	FF-	Foundation fieldbus, negative rail
32	FF+	Foundation fieldbus, positive rail

24V DC Supply

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

100 – 240V AC Supply

90	L	Life (AC voltage)
91	N	Neutral
52	PE	Protective Ground

NOTE:

For the pinning of units with 1 floating analog output, 1 ground referred analog output and 1 ground referred analog input refer to the attached description and to the labeling on the unit.

2.3.2 TCE80xx-W and compact version (standard housing, cCSAus Ex)

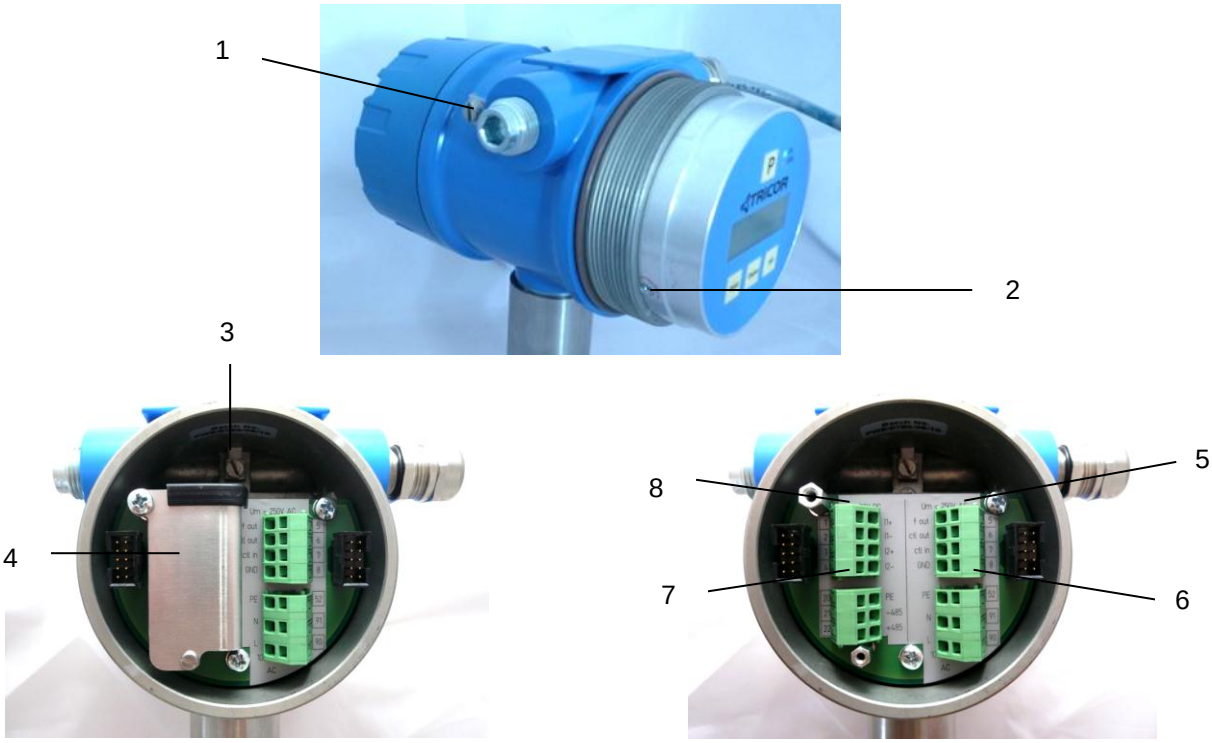


Fig. 9: Electrical terminals KCE80xx-WG-*-Ex and compact version

1 = Terminal screw for protective ground

2 = Display fixing screw (option)

3 = Terminal screw for protective ground

4 = Protective cover

5 = Terminal block for digital I/O signals (U_M = 250V DC)

6 = Terminal block power supply (U_M = 250V DC)

7 = Terminal block for Interface (U_M = 30V DC)

8 = Terminal block for analog I/O signals (U_M = 30V DC)

KCE Terminal connections

Terminals with U_M = 30V 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	COMMON	Common (for pins 21 and 22)
21	- RS485	RS485 negative line
22	+RS485	RS485 positive line

With option FF

31	FF-	Foundation fieldbus, negative rail
32	FF+	Foundation fieldbus, positive rail

Terminals with U_M = 250V 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)

24V DC Supply

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

100 – 240V AC Supply

90	L	Life (AC voltage)
91	N	Neutral
52	PE	Protective Ground

NOTE:

For the pinning of units with 1 floating analog output, 1 ground referred analog output and 1 ground referred analog input refer to the attached description and to the labeling on the unit.

2.3.3 TCE80xx-E and compact version (big housing, ATEX, IECEx)

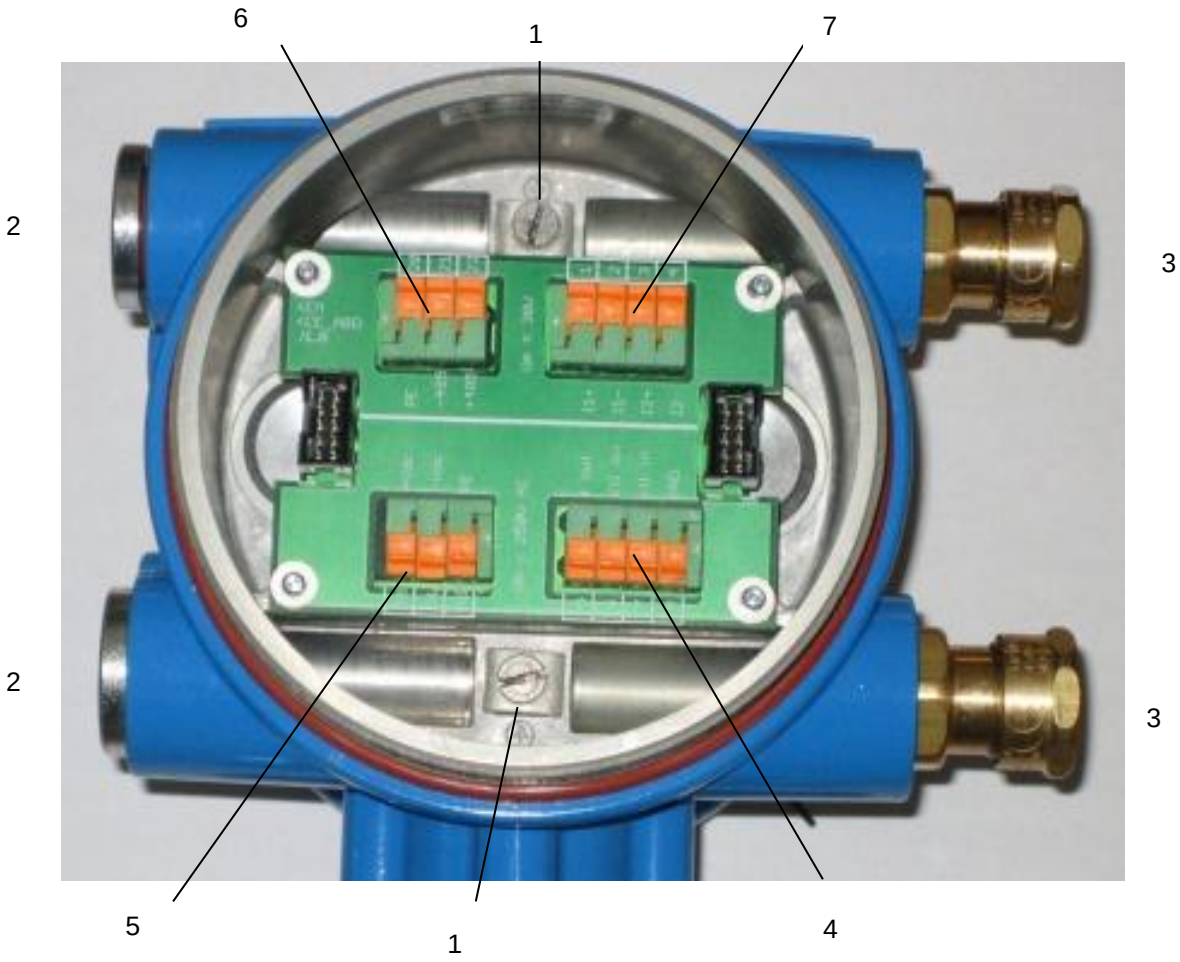


Fig. 10: Electrical terminals TCE80xx-E-*-Ex and compact version

1 = Terminal screw for protective ground

2 = Blind cover for cable opening (various numbers and positions)

3 = Cable gland (various numbers and positions)

4 = Terminal block for digital I/O signals (U_M = 250V DC)

5 = Terminal block power supply (U_M = 250V DC)

6 = Terminal block for Interface (U_M = 30V DC)

7 = Terminal block for analog I/O signals (U_M = 30V DC)

TCE Terminal connections

Terminals with U_M = 30V 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	PE / COM	Common (for pins 21 and 22), connected to PE
21	- RS485	RS485 negative line
22	+RS485	RS485 positive line

With option FF

31	FF-	Foundation fieldbus, negative rail
32	FF+	Foundation fieldbus, positive rail

Terminals with U_M = 250V 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)

24V DC Supply

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

100 – 240V AC Supply

90	L	Life (AC voltage)
91	N	Neutral
52	PE	Protective Ground

NOTE:

For the pinning of units with 1 floating analog output, 1 ground referred analog output and 1 ground referred analog input refer to the attached description and to the labeling on the unit.

2.3.4 Panel mount version TCE80xx-S (non Ex)

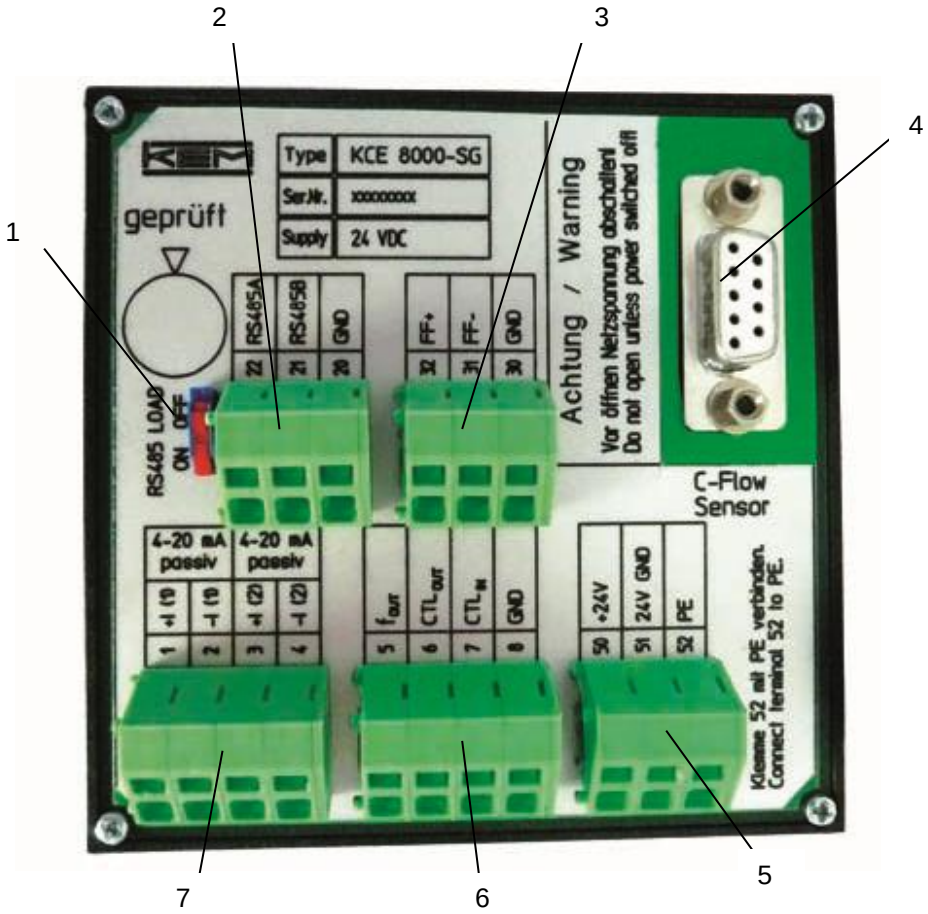


Fig. 11: Electrical terminals TCE80xx-S

1 = Sliding switch for activating the 120Ω terminal resistance for RS-485

2 = Cage clamp terminals for interface RS-485

3 = Cage clamp terminals for interface foundation field bus (option)
or relay terminals (option)

4 = Connector to the meter, D-Sub 9, female

5 = Cage clamp terminals for power supply

6 = Cage clamp terminals for digital I/O signals

7 = Cage clamp terminals for analog 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	F out	Frequency / pulse output
6	CTL OUT	Control output
7	CTL IN	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 rail
32	FF+	Foundation fieldbus, positive rail
50	+ 24 VDC	Positive supply voltage (24 VDC)
51	- 24 VDC	Supply ground
52	PE	Protective Ground
90	L	Life (AC voltage)
91	N	Neutral

Without Foundation Fieldbus interface there are no terminals 30 – 32.

With option “Relay Out” there are the relay terminals:

40	REL NO	Relay normally open contact
41	REL COM	Relay common
42	REL NC	Relay normally closed contact

NOTE:

For the pinning of units with 1 floating analog output, 1 ground referred analog output and 1 ground referred analog input refer to the attached description and to the labeling on the unit.

2.3.5 Panel mount version TCE80xx-L-*-Ex

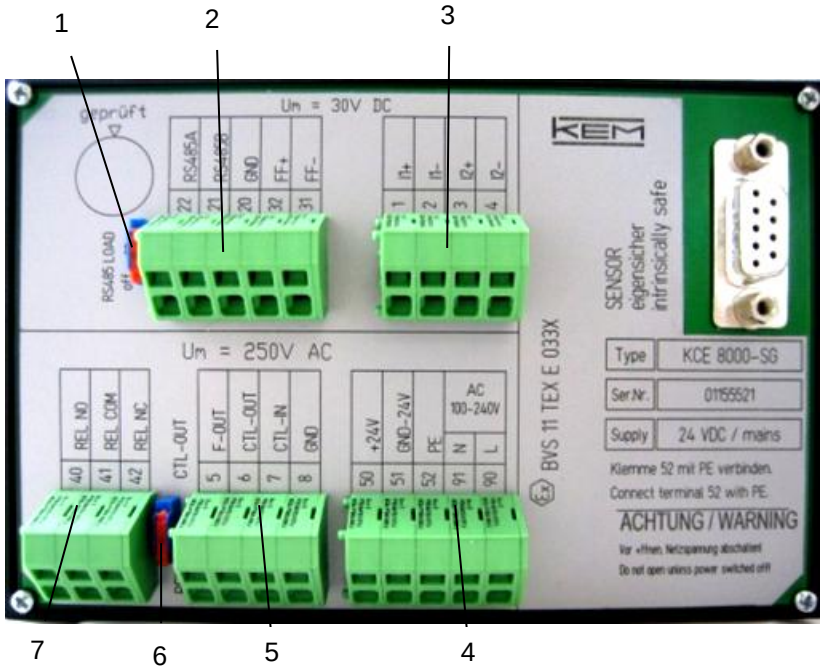


Fig. 12: Electrical terminals TCE80xx-L-*-Ex

1 = Sliding switch for activating the 120Ω terminal resistance for RS-485

2 = Terminal blocks for interface (U_M = 30V DC)

3= Terminal blocks for analog I/O signals (U_M = 30V DC)

4 = Terminal block for power supply (U_M = 250V DC)

5 = Terminal block for digital I/O signals (U_M = 250V DC)

6 = Sliding switch for activating the relay output (Option)

7 = Terminal block for relay (U_M = 250V DC)

TCE Terminal connections

Terminals with U_M = 30V 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) connected to PE
21	- RS485	RS485 negative line
22	+RS485	RS485 positive line
31	FF-	Foundation Fieldbus negative line
32	FF+	Foundation Fieldbus positive line

Terminals with U_M = 250V DC

5	F out	Frequency / pulse output
6	STAT OUT	Status output
7	CTL IN	Control input
8	GND	Ground (for pins 5 through 7)
40	REL NO	Relay normally open contact
41	REL COM	Relay common
42	REL NC	Relay normally closed contact
50	+ 24 VDC	Positive supply voltage (24 VDC)
51	- 24 VDC	Supply ground
52	PE	Protective Ground
90	L	Life (AC voltage)
91	N	Neutral

NOTE:

For the pinning of units with 1 floating analog output, 1 ground referred analog output and 1 ground referred analog input refer to the attached description and to the labeling on the unit.

2.4 Quick start

WARNING!

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

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

- Connect the supply voltage
- Connect the TCE to the TCM (only required with the remote version)
- The frequency and analogue outputs as well as the interface may be connected as well, if those features are required

WARNING!

If the unit 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 unit without proper wiring according to chapter 3.2.7 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 normally 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 unit has reached the operating temperature, make the zero point calibration (see chapter 4.4):

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

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

The error code, the device status and information like serial number, SW version a.s.o. can be viewed by pressing the key “Info” for 3 seconds.

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

For entering the CONTROL menu press “P” for 3 seconds.

2.4.3 CONTROL Menu

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

The menu itself is self-explaining, the function of the softkeys (5, 6, 7) is indicated in the display above the pushbutton.

For entering the CONTROL menu press the pushbutton “P” (4) for 3 seconds.

The submenu DISPLAY can be entered without a password as any changes in this submenu will not affect the operation of the unit.

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

For SETUP and I/O-TEST the password is “2207”, for SERVICE refer to chapter **6.4**.

Change the indicated number “2206” with the softkey “up” (6) to “2207” and confirm with “P” (4).

Select the desired submenu with the softkeys and confirm with “P” (4).

Every setting must be confirmed with “P” (4) for storing the setting or with “E” for exiting without storing.

For leaving the SETUP menu press “E” (7) in the main level.

2.4.4 Using the magnet

The Ex versions with the blue Ex d housing come with a magnet for operating the pushbuttons through the closed window 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 keys hold the magnet to the glass.

The best positions for operating the keys are:

Key	position
P	right edge of the yellow area
Reset	left edge of the yellow area
Display	lower edge of the yellow area
Info	right edge of the yellow area

3 Installation

3.1 Mechanical

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 liquid or 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 via vibration dampers.

The small meters (TCM0325 through TCM3100) can be mounted via optional mounting threads on the back side, all other meters must not be fixed directly, but via holders connected to the external tubing, as close as possible to the flanges of the meter.

In case of vibrating tubes a decoupling via flexible hoses might be recommended.

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

Inhomogeneous media:
If a liquid might contain gas bubbles or solid particles, care must be taken that the gas bubbles or the solid particles will not remain in the meter.

If a pure liquid or a liquid with possible gas bubbles is to be measured, the meter should be installed horizontally with the meter showing downwards. This assures that gas bubbles will not accumulate in the measuring tubes. Meters with U- shaped tubes (TCM5500 and greater) can also be mounted vertically.

If a liquid might contain solid particles, the meter should be installed horizontally with the meter showing upwards. This assures that the solid particles will not accumulate in the measuring tubes. Meters with U- shaped tubes (TCM5500 and greater) can also be mounted vertically

The TCM0325 through TCM3100 must not be mounted vertically, as according to the diamond shaped tube geometry gas bubbles as well as solid particles would accumulate in the meter.

2 phase media with gas bubbles (like foam) or solid particles (like paints or slurry) can be measured without any problems, if the gas bubbles or solid particles are small compared to the tube diameter and evenly distributed. The mounting guidelines, nevertheless, must be observed.

3.1.2 Horizontal Installation

The horizontal installation is the recommended installation.

If the medium might contain solid particles, mount the meter as in position “A”, in all other cases as in position “B”.

Fix the meter to a solid, non-vibrating surface as close to the meter as possible. With the TCM0325 through TCM3100 this could be done via the optional mounting threads.

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

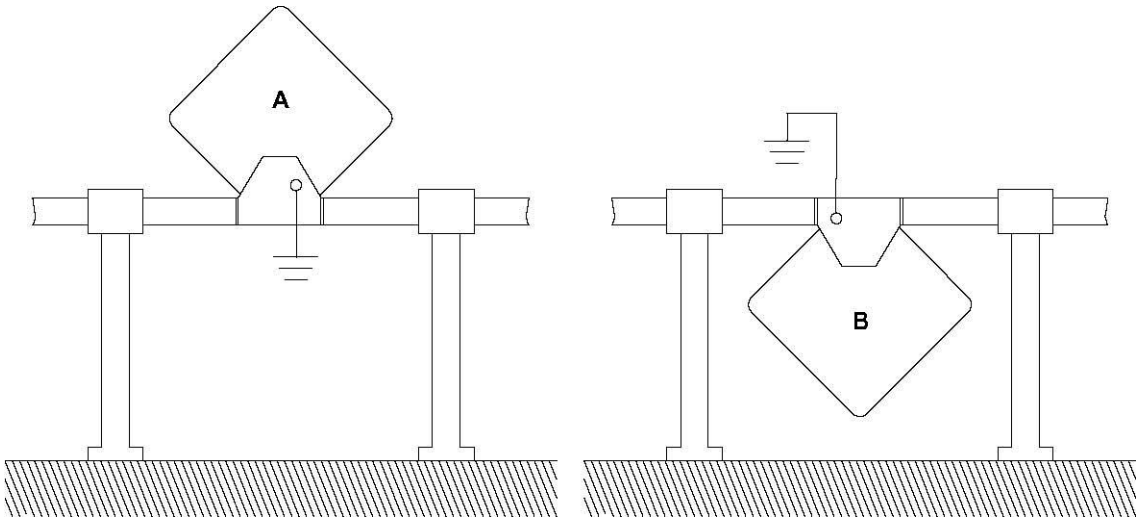


Fig. 13: Recommended Horizontal Installation

3.1.3 Vertical Installation

The diamond shaped TCM0325 through TCM3100 should not be mounted vertically at all.

All other meters can be mounted vertically. This would be the recommended position, if the medium might contain gas bubbles and solid particles.

It is recommended to mount the meter in an upstream position for avoiding that it runs empty during operation.

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.

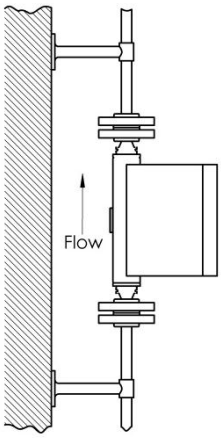


Fig. 14: Vertical Installation

3.1.4 Installation in a Drop Line

The diamond shaped TCM0325 through TCM3100 should not be mounted vertically at all.

All other meters can be mounted vertically, but mounting in a drop line is only allowed, if an orifice and the closing valve are located below the meter for making sure, that neither during operation nor after closing the valve the meter will run empty.

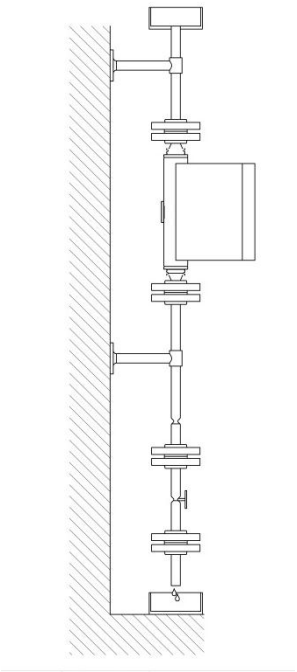


Fig. 15: Installation in a Drop Line

3.1.5 Critical Installations

The meters must not be mounted at the highest point of the tubing, if gas bubbles are to be expected (A), or at the lowest point, if solid particles are to be expected (B), as in both cases also the right orientation might not help.

Also the meters must not be mounted in a drop line near the open end (C), as in that case the meter might run empty.

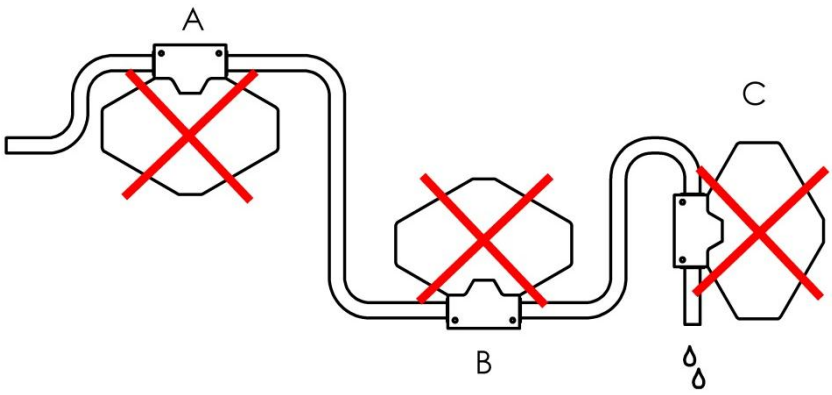


Fig. 16: Critical Installations

3.1.6 Mechanical Installation of the electronics (remote versions)

TCE80xx-W

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

TCE80xx-E

The wall mount unit is to be mounted on the wall with 2 to 4 screws with 5mm diameter, 45mm apart. For exact dimensions refer to chapter **7.3.4**

If the mounting point should be located behind the TCE80xx instead beside, unscrew the 4 screws fixing the bracket to the housing, fix the bracket to the wall and reaffix the housing to the bracket.

TCE80xx-L, TCE800-S

The housing requires an opening in the panel of 92mm x 92mm (TCE80xx-S) or138mm x 92mm (TCE80xx-L) at a maximum panel thickness of 2mm.

Push the TCE80xx into the opening. The springs will fix the unit automatically.

For removing the TCE80xx press the springs towards the housing via a screwdriver.

WARNING!

For mounting the unit in hazardous areas refer to chapter 3.2.7

3.2 Electrical installation

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

This unit must be grounded.

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

WARNING!

Never connect a 24V only 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 1kΩ.

For connecting the TCE, shielded cables must be used. The shield should be connected to the case. If 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. 100nF.

Make sure that the flow meter is grounded.

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.

3.2.1 Connecting TCE and TCM

With the remote version the TCE and TCM must be connected before making the other electrical installations. If no TCM is connected to the TCE, the TCE will only show an error message after power on.

For connecting TCE and TCM, only the supplied special cable must be used. For best accuracy the maximum cable length is limited to 20m.

NOTE

Using different cables or any kind of extension will lead to a degradation of accuracy and stability.

Connecting the cable to the TCM

Open the junction box of the TCM.

Feed the cable from the TCE into the cable gland of the TCM and connect the single wires as described in Tab. 1.

Adjust the position of the cable in the cable glands and close the cable gland.

Terminal	Signal	Color
1	Driver +	Grey
2	Driver -	Pink
3	Sensor A +	Blue
4	Sensor A -	Red
5	Sensor B +	White
6	Sensor B -	Brown
7	Pt1000 +	Green
8	Pt1000 -	Yellow
PE	Protective ground	Yellow / green

Tab. 1: Connections TCMxxxx

Close the top cover of the junction box and fix it with the screw.

Connecting the cable to the TCE80-L-* or TCE80**-S-***

Put the D-Sub connector of the cable to the connector “sensor” on the back side of the housing.

Connecting the cable to the TCE80-E-***A-Ex**

With the TCE80**-E-***A-Ex the cable is not fixed to the TCE and must be connected separately.

Open the junction box of the TCE.

Feed the cable from the TCM into the cable gland of the TCE junction box.

Push the cable end sleeves into the terminals according to tab. Tab. 1. There is no tool required to connect the cables.

If cables without end sleeves are to be connected or if cables have to be removed, open the terminal by pressing a small screwdriver into the orange operator of the terminal.

Adjust the position of the cable in the cable glands and close the cable gland.

Close the top cover of the junction box and fix it with the screw.

3.2.2 Electrical Installation of Wall Mount and Compact Version

Connect the TCM to the TCE (see chapter 3.2.1, remote version only)

Open the safety screw at the display cover of the unit 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 12 cm
- Strip the end and cover it with a cable end sleeve
- Connect a 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 (> 1.5mm²) is recommended for avoiding high equalizing currents in the shield.

Connect the individual cables to the cage clamp terminals as required.

The Ex versions have self-opening terminals. Push the cable end sleeves into the terminals. There is no tool required to connect the cables.

If cables without end sleeves are to be connected or if cables have to be removed, open the terminal by pressing a small screwdriver into the orange operator of the terminal.

The non-Ex versions have standard cage clamp terminals. 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 3.2.4 to 3.2.6.

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 put in at 4 orientations separated by 90°.

Perform – if necessary – a function test and make the necessary settings (see chapter 4).

Close the display cover.

Fasten the safety screw if necessary.

3.2.3 Electrical Installation of Panel Mount Version

Connect the TCM to the TCE (see chapter 3.2.1)

Prepare the cable for installation:

- Separate the single conductors as required
- Strip the end and cover it with a cable end sleeve
- Connect a stranded wire to the shield

Connect the shield to the PE terminal.

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

Connect the individual cables 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 3.2.4 to 3.2.6.

Perform – if necessary – a function test and make the necessary settings (see chapter 4).

3.2.4 Power Supply and Grounding

3.2.4.1 24V DC Power Supply

The DC powered TCE requires a regulated DC power supply of 24V ±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 8000 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 +24V to terminal 50. (See Fig. 17)

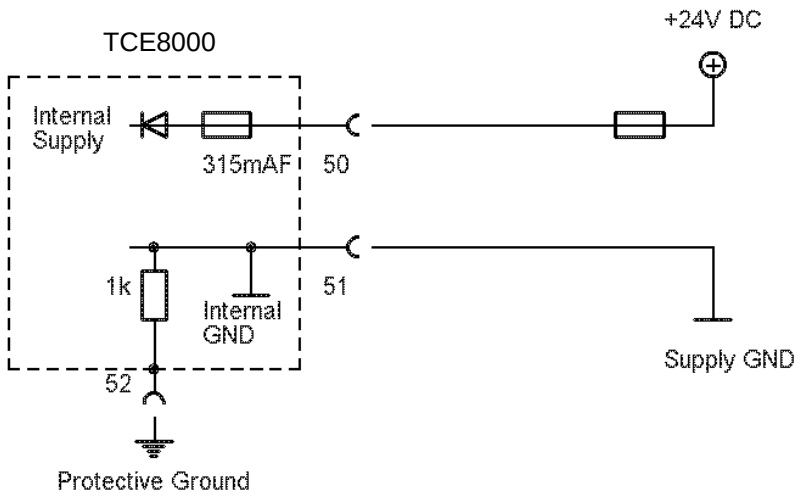


Fig. 17: Wiring diagram for power connections, DC operation

Terminal	Description
50	Positive supply Voltage, 24V ±20%, referred to pin 51
51	Ground potential for supply voltage
52	Protective ground

The ground terminals 8 and 51 are internally connected together.

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

3.2.4.2 100 to 240V AC Mains Supply

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

The power supply input of the TCE is protected by a 1A 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 units a good connection of PE is mandatory. The cross section of the PE cable should be at least the cross section of the supply cable or 1mm², whichever is higher.

Connect the supply to terminal 91 (neutral) and 90 (life). (See Fig. 18)

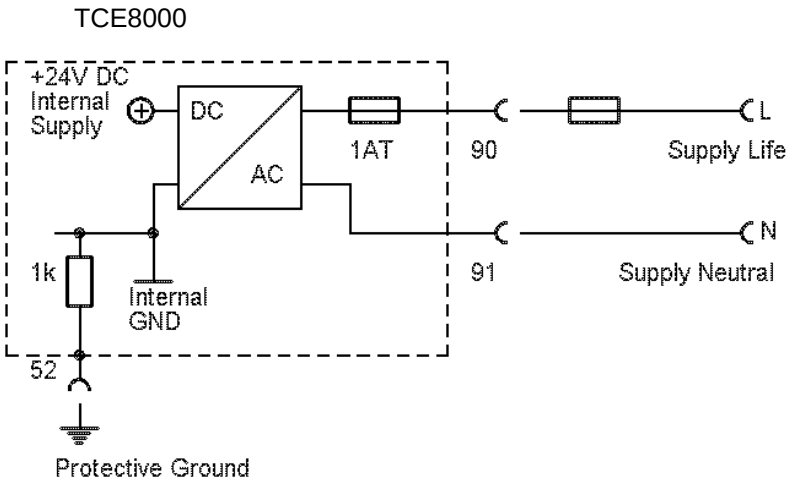


Fig. 18: Wiring diagram for power connections, AC operation

Terminal	Description
90	Mains life, referred to pin 51
91	Mains neutral
52	Protective ground

The ground terminal 8 is not connected to terminal 91.

3.2.4.3 DC and AC supply

The TCE80xx-S-xBxx or TCE80xx-L-xBxx can be connected to a 24V DC and a mains supply simultaneously. The unit will operate properly as long as one of the 2 supplies is present.

3.2.5 Connecting the control inputs and outputs

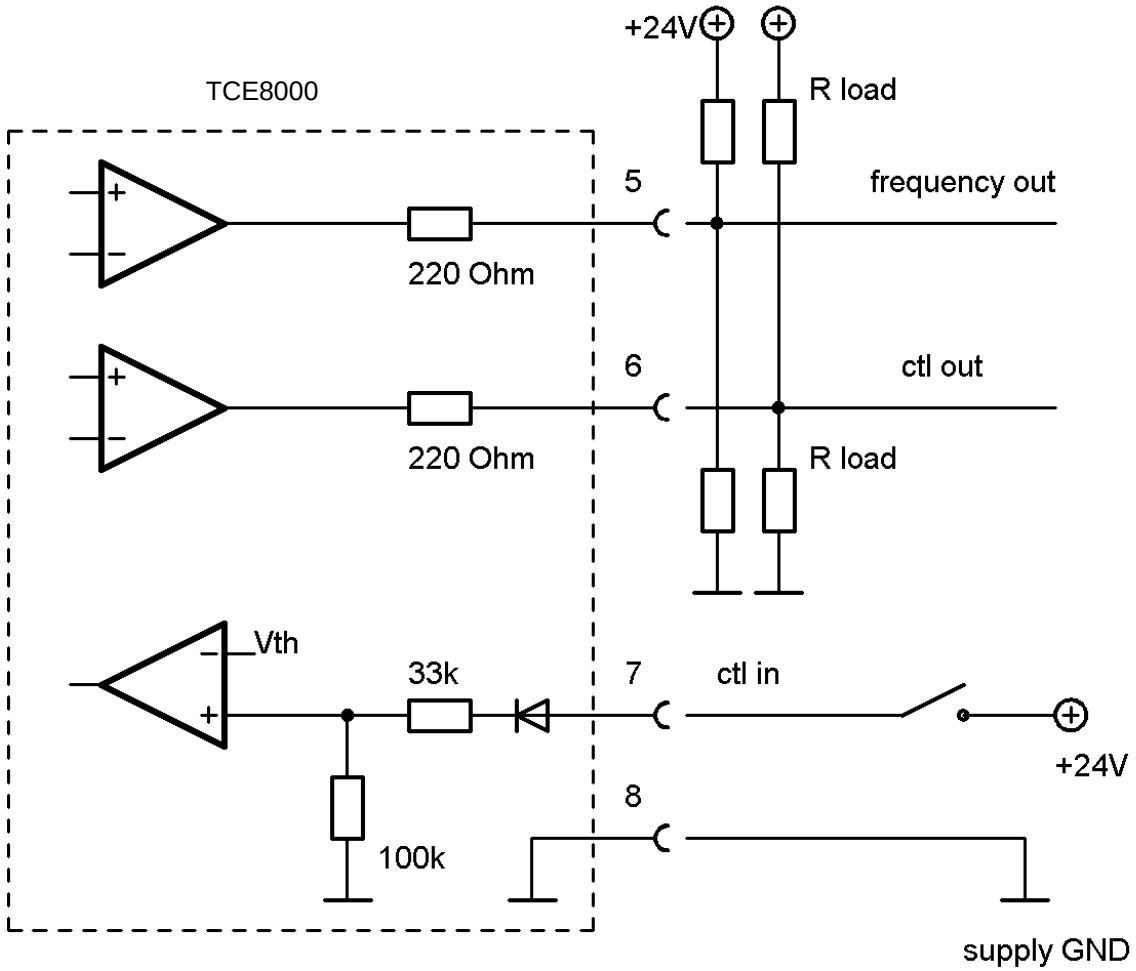


Fig. 19: Wiring diagram for digital I/O connections

Terminal	Description
5	Frequency output, active, referred to pin 8
6	Status output, active, referred to pin 8
7	Control input, active high, referred to pin 8
8	Ground potential for digital I/O- pins.

The frequency and control outputs are active push-pull outputs with an output resistance of 220Ω. 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 1kΩ.

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

$V_{high} = V_{supply} * R_{load} / (220Ω + R_{load})$
$V_{low} < 1V$

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

$V_{high} > V_{supply} – 1V$
$V_{low} = V_{supply} - V_{supply} * R_{load} / (220Ω + R_{load})$

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

The ground terminals 8 and 51 are internally connected together.

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

3.2.6 Connecting the analog outputs

The TCE8000 provides 2 independent passive 4-20mA 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 to 30V (nominal 24V) is required.

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

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

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

$R_{load}(max) = (V_{supply} – 8V) / 22mA$

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

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

$V_{supply}(min) = 8V + R_{load} * 22mA$

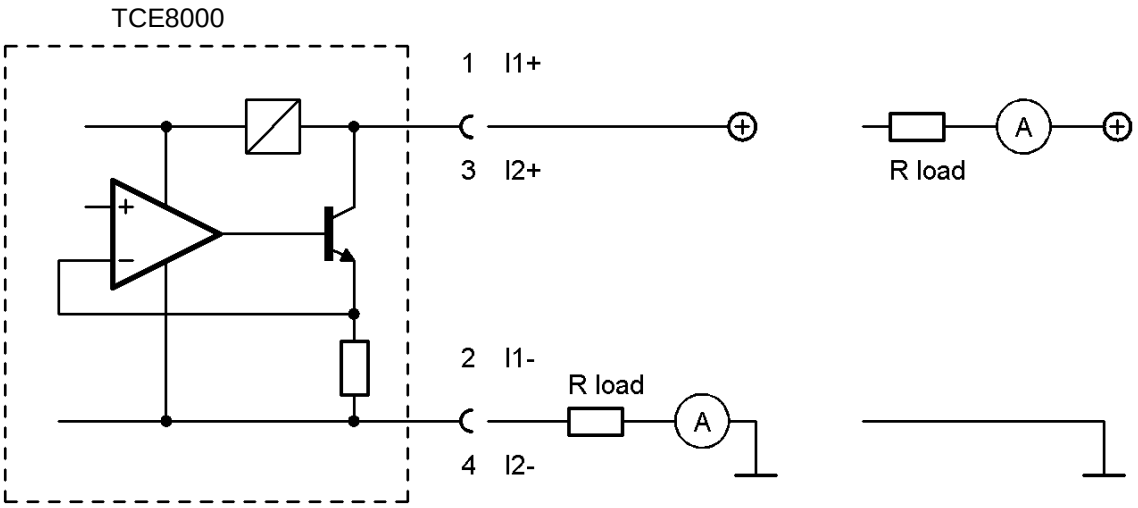


Fig. 20: Wiring diagram for 4-20mA current loop

Terminal	Description
1	Positive terminal of the passive 4-20mA loop 1
2	Negative terminal of the passive 4-20mA loop 1
3	Positive terminal of the passive 4-20mA loop 2
4	Negative terminal of the passive 4-20mA loop 2

As the terminals are floating, the load resistor and the current meter can be placed in the positive or in the negative supply rail (see Fig. 20, right or left circuit).

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

3.2.7 Connecting the analog input

The TCE8000 with option “pressure compensation” provides 1 passive 4-20mA output CURRENT 2 and 1 active 4-20mA current input CURRENT 1.

The current input is designed to drive a 2-wire passive pressure sensor. It provides a maximum drive voltage of 20V.

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

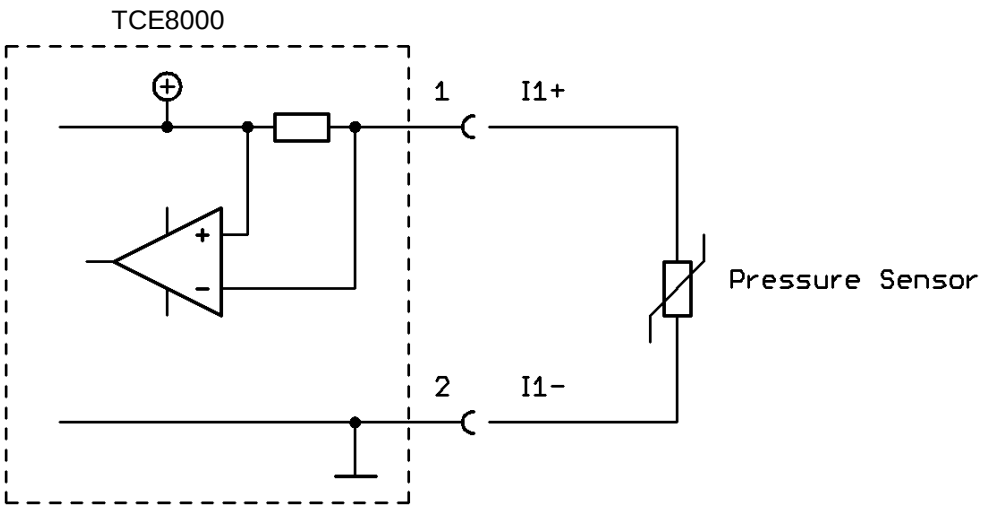


Fig. 21: Wiring diagram for 4-20mA current input

Terminal	Description
1	Positive terminal for a passive 4-20mA pressure sensor
2	Negative terminal for a passive 4-20mA pressure sensor

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

3.2.8 Connecting the relay

Optionally the panel mount versions of the TCE8000 series can be equipped with a relay output. The relay is a SPDT type with an nc (normally closed) and an no (normally open) contact.

Terminal	Description
40	Relay normally open contact
41	Relay common
42	Relay normally closed contact

The relay is specified for 125V AC maximum.

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 unit in hazardous locations!
Never connect a remote meter TCM* to anything else than the specified electronics TCE80**

3.3.1 Locating the Compact Version

The TCM***-**-****-E(or C)*** -Ex is explosion proof with EX d for the electronics and Ex i for the meter.

The inputs and outputs are not power limited and must not be used to drive intrinsically save circuits

WARNING!

Never open any cover of the electronics in hazardous locations with any supply or I/O circuits alive!

3.3.2 Locating the Remote Version with TCE80**-E-****-Ex or TCE80**-W-****-Ex

NOTE

For use in hazardous locations the TCM as well as the TCE must be Ex versions!

The TCM***-**-****-****-Ex is intrinsically safe when driven by the corresponding TCE80xx-Ex.

The TCE80**-E(or W)-****-Ex is explosion proof “EX d”. It contains the safety barriers for the TCM.

The inputs and outputs of the TCE are not power limited and must not be used to drive intrinsically save circuits

The TCE80**-E(or W)-****-Ex can be located inside and outside the hazardous area.

WARNING!

Never open any cover of the electronics in hazardous locations with any supply or I/O circuits alive!

3.3.3 Locating the Remote Version with TCE80**-L-****-Ex

NOTE

For use in hazardous locations the TCM as well as the TCE must be Ex versions!

The TCM***-**-****-****-Ex is intrinsically safe when driven by the corresponding TCE80xx-Ex.

The TCE80**-L-****-Ex is not explosion proof and only provides the intrinsically safe connections to the TCM.

The inputs and outputs of the TCE are not power limited and must not be used to drive intrinsically save circuits

The TCE80**-L-****-Ex must be located outside the hazardous area.

3.3.4 Electrical connections

For connecting TCE to TCM only the supplied special cable must be used!

Compact and Wall Mount Version, ATEC an IECEx

The supply terminals and the digital I/O terminals are rated for U_M = 250V whereas the analog input and output and the interface terminals are rated for U_M = 30V DC.

For making the required connections proceed as follows:

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

Connect the cable as described in chapter 3.2.2 ff. and in chapter 3.3.5 to 3.3.7.

Close the cable glands properly before applying power to the TCE80**!

WARNING!

The Ex d protection of the housing is void, if any of the cable glands is not closed properly!

Compact and Wall Mount Version, cCSAus Ex

The supply terminals and the digital I/O terminals are rated for U_M = 250V whereas the analog input and output and the interface terminals are rated for U_M = 30V DC.

For making the required connections proceed as follows:

Replace the cable gland for the supply and I/O cables by a CSA or UL certified seal fitting within 18” from the housing.

Prepare the cable and the TCE as described in chapter 3.2, but separate the single wires for a distance long enough that the wires are just separated in the seal fitting.

Connect the cable as described in chapter 3.2.2 ff. and in chapter 3.3.5 to 3.3.7.

Seal the cable in the seal fitting according to the national standards.

WARNING!

The Ex d protection of the housing is void, if the cables are not sealed properly!

Panel Mount Version

The supply terminals and the digital I/O terminals are rated for U_M = 250V whereas the analog output and interface terminals are rated for U_M = 30V DC.

Connect the unit as described in chapter 3.2.3 ff. and chapter 3.3.5 to 3.3.7.

3.3.5 Power Supply and Grounding

For operation in hazardous areas a good connection of PE is mandatory. The cross section of the PE cable must be at least the cross section of the supply cable or 1mm², whichever is higher.

The supply terminals (50, 51 for 24V DC or 90, 91 for mains operation) are designed for a rated voltage of 250V AC.

WARNING!

Applying 250V AC to the DC supply terminals (50, 51) will not affect the Ex safety of the TCE or TCM, but will damage the supply circuit of the TCE!

The TCE80**-L-*B**-Ex can be connected to a 24V DC and a mains supply simultaneously. The unit will operate properly as long as one of the 2 supplies is present.

For the circuit diagrams and the general description refer to chapter 3.2.4.

3.3.6 Digital Control Inputs and Outputs

The digital I/O terminals are designed for a rated voltage of 250V AC.

WARNING!

Applying 250V AC to the digital I/O terminals (5, 6, 7, 8) will not affect the Ex safety of the TCE or TCM, but will damage the I/O board of the TCE!

For the circuit diagrams and the general description refer to chapter 3.2.5.

3.3.7 Analog Inputs and Outputs

The analogue current input and output terminals are designed for a rated voltage of 30V AC.

The outputs are protected against wrong polarity. Voltages below 30V will not damage the outputs nor affect the Ex safety.

The input provides 24V for the sensor and is protected against externally applied Voltages up to 30V.

The input cannot drive Ex i certified Sensors. If the sensor is located in the hazardous area, an Ex d sensor must be used.

WARNING!

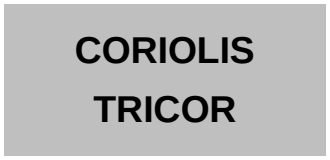
Applying more than 30V DC to any of the inputs or outputs will damage the TCE and destroy the protection of the TCM!
If more than 30V have been applied to any of the analog output pins, the unit must be returned to KEM/AWL for repair as the safety barrier might be destroyed!

For the circuit diagrams and the general description refer to chapter 3.2.6.

4 Manual Operation

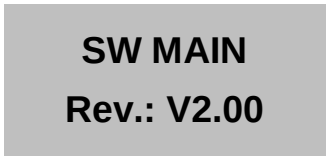
4.1 Power On Sequence and Principles of Manual Control

The power up sequence gives the following information, each for about 2 second:



This gives the type of electronics. At the time being the types TCE8001 (low power) and TCE8011 (high power) are available.

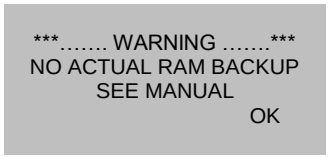
This gives the sensor size. At the time being Sensors from TCM0325 (300kg/h max.) to TCM65k (65,000kg/h max.) are available



This indicates the SW version of the main processor.

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 key is pressed the warning will disappear automatically after 10 seconds.
For further information refer to chapter 4.5.9.

Now the TCE8000 switches to the measuring mode, displaying the default screen:

The green LED “OK” flashes with a 1 second period. In case of an error the red LED “ERR” flashes.

In manual control the TCE is menu driven and provides 2 operational modes, the “Measuring Mode” and the “Control Mode”.

In the measuring mode the display shows the preselected measured values and all 4 pushbuttons have the function printed on them. The switch over between the different measuring displays and the error display can be made at any time without interrupting the measurements.

In the control mode the 3 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.

The control menu contains the 5 submenus “ZERO OFFSET”, “DISPLAY”, “SETUP”, “I/O-TEST” and “SERVICE”.

For protecting the unit against unintentional changes by unauthorized personnel, the menus “ZERO OFFSET”, “SETUP” and “I/O-TEST” are protected by a user password and the menu “SERVICE” by a service password.

For the description of the control menu see chapter 4.5.

4.1.1 Using the magnet

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 keys hold the magnet to the glass.

The best positions for operating the keys are:

Key	position
P	right edge of the yellow area
Reset	left edge of the yellow area
Display	lower edge of the yellow area
Info	right edge of the yellow area

4.2 Setup guidelines

Ex factory the Tricor mass flow meter 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 Meter Mode

A coriolis mass flow meter measures the mass flow and the density and can calculate the volume flow.

For avoiding strange effects with the total values when changing the dimensions, the TCE8000 can be set up as a mass flow OR a volume flow meter.

When set up as mass flow meter, only mass and mass flow engineering units can be selected, when set up as volume flow meter, only volume and volume flow engineering units can be selected.

For changing the meter mode refer to chapter 4.5.6.1.

4.2.2 Offset Calibration

In contrast to a PD meter, a coriolis mass flow meter has no “natural” zero. At no flow the measured time shift is nearly zero, but not exactly. The offset calibration 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.

For making the offset calibration refer to chapter 4.4 and 4.5.3.

4.2.3 Flow filter

The rough data of a mass flow meter are relative noisy. For having a stable reading a filtering of the calculated flow is required.

The filters in the TCE8000 are set via the time constant t. 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 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

Elapsed time	Remaining error (% of the step)
1 * t	30
2 * t	10
3 * t	3
4 * t	1

A linear filter as it is realized in the TCE8000 electronics just delays the flow reading and consequently the total. 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 cancel 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 TCE8000 electronics provide 2 filters.

The FLOW FILTER filters the mass flow before calculating other parameters like volume flow, total or the frequency and current outputs. For normal applications a moderate filtering with t = 1s 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 = 1s.

If the flow is fast changing or sometimes makes a jump and the outputs have to react as fast as possible, set FLOW FILTER to t < 1s. 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 **Fehler! Verweisquelle konnte nicht gefunden werden.**, for the DISPLAY FILTER to chapter 4.5.4.1.

4.2.4 Cutoff

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

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

The value for CUTOFF 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 CUTOFF is 0.5% of the full scale range of the meter.

For setting CUTOFF refer to chapter 4.5.6.2.

4.2.5 Step response

Sometimes it is necessary to react fast to a fast changing flow, but also to have a stable output, if the flow is (mostly) constant. This cannot be achieved by adjusting the flow filter.

The parameter STEP RESPONSE provides a fast reaction at fast changing flow, also the filter constant is high.

If the difference between the measured flow and the filtered flow is smaller than the step response value, the flow filter remains active. If the difference is higher than step response, the filter is cleared and filled with the new value.

The recommended value for constant or slowly changing flow is 99% (the default value ex works). If the unit has to react to fast changing flow, the optimum value depends on the individual situation. For ON / OFF operation a value of half the ON flow is recommended.

If STEP RESPONSE is set too low, even small changes in flow or even the internal noise will activate the step response function and partially or all the time deactivate the filter, leading to noisy readings and noisy output signals.

For setting STEP RESPONSE refer to chapter 4.5.6.3.

4.2.6 Interaction of the parameters

As each of the 3 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 CUTOFF

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 unit measures long enough after the flow got switched off. If cutoff 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 cutoff must be avoided!
>
> Jumps of the flow not going down to zero are not affected by cutoff.

FLOW FILTER and STEP RESPONSE

As described above, a linear filter just delays the flow reading and consequently the total but does not alter the final total.

If the step response is activated, a nonlinear term is added to the filter. The indicated flow will follow more closely the total flow, but the remaining deviation depends on the values for the filter and for step response, but also on the slope of the flow change and on the size of a step.

If the flow changes slowly or a jump is smaller than step response, the step response function will not be activated and remains linear all the time, producing the normal delay.

If the flow changes fast and the step is higher than step response, the filter will be made faster, the indicated flow follows more closely the actual flow and the delay will be smaller.

In ON-OFF operation with a fast rising and slowly falling flow a systematic positive error is to be expected. If the rising is slow and the falling fast, the error will be negative.

WARNING!

If step response is used (e.g. for good reaction to fast changing flow), checking the accuracy for the given application is strongly recommended!

4.3 Measuring mode

4.3.1 Function of the keys

In the measuring mode all pushbuttons have a fixed function:

P	Opens the Control Menu if pressed for about 3 seconds
Reset	Resets the batch counter to zero, if the function “KEY RESET” is enabled
Display	Toggles the display between the 2 preselected settings.
Info	Opens the info menu

4.3.2 Display selection

The TCE provides 2 presettable 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 unit toggles between display view 1 and 2 every 7 seconds. In this mode the pushbutton “Display” is without function.

For changing the content of the 2 display views refer to chapter 4.5.4.

4.3.3 Resetting the batch 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 unit against unintentional resetting of the batch value, this function can be disabled.

Ex work the function is disabled.

For changing the setting refer to chapter 4.5.6.5.

4.3.4 Error Menu

For easy debugging in case of a malfunction of the system, the TCE provides an info and error menu.

The content of the info and error menu is not of interest for normal operation and some information is only readable for trained personnel.

For entering the menu press the pushbutton “Info” for about 3 seconds.

The display shows “NO ERROR” or one or more of the following error messages:

Code	Error
1	Amplitude sensor A is out of range (too high or too low)
2	Amplitude sensor B is out of range (too high or too low)
3	Measured time delay is too high
4	Offset adjust procedure is in progress
5	Driver current is not stable
6	Temperature sensor is out of range. Typically indicated if the line is broken or has a short
7	Oscillating frequency too low
8	Oscillating frequency too high
9	Driver current too low

Tab. 2: Error Codes

Press “Info” a second time for getting 8 internal operating parameters:

Code	Value
SA	Sensor voltage A in mV
SB	Sensor voltage B in mV
DR	Driver current in mA
PT	Measured Temperature in °C
FRE	Oscillating frequency in Hz
TOT	Totalizer value in the selected units
ZP	Zero point offset in µs
RS485	RS485 address

Tab. 3: List of service parameters

Press “Info” again for getting general information about the unit:

Code	Value
TYPE:	Sensor type (TCM*)
SER.:	Serial number
SW1:	SW version main board
SW2:	SW version display

Tab. 4: List of unit info

By pressing “Info” you can toggle between those 3 lists, for returning to the normal operation press “Display”.

4.4 Offset calibration

For best accuracy the Tricor needs an in situ offset calibration. This calibration zeroes out the ambient effects and increases the measuring accuracy at low flow.

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

Proceed as follows:

Operate the unit for a while under normal operating conditions for making sure that the actual temperature of the unit 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 for being sure that there is no more flow through the TCM.

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

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

- Press “P” for about 3 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 s and counts down to “0”
- Confirm with “Info”

The offset procedure takes about 10 s (fast) or 25 – 30 s (slow). During the procedure the red LED will flash.

For an automatic offset calibration 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.

For configuring the input refer to chapter 4.5.8.4.

4.5 Control Mode

In the control mode the TCE8000 can be adapted to the individual application. As unintentional changes of the settings might cause problems, some submenus are password protected.

To enter the control mode proceed as follows:

Press “P” for about 3 seconds

The display shows:

With the keys “UP” and “DOWN” you can scroll through the main list.

Select the desired submenu and confirm with “P”.

4.5.1 Function of the keys

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	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 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 unit.

SETUP:
Adjusting the TCE8000 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 TCE8000.
This submenu is password protected.

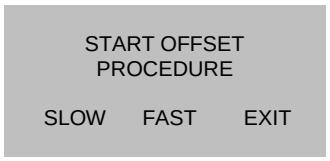
4.5.3 ZERO OFFSET Menu

Select in the main menu

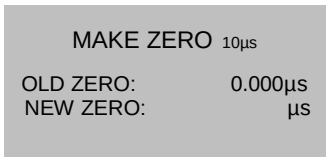
Press “P”. The display shows

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 2s and then asks for a new input.

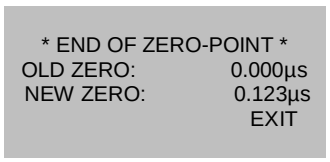
When the correct code is entered the display shows:



Press “SLOW” or “FAST”. The display shows



The time counter counts down to zero. The display shows:



Press “EXIT” to return to the measuring mode.

4.5.4 DISPLAY Menu

Select in the main menu

Press “P”. The display shows

The following submenus are available:

FLOW DISPLAY:
Setting the flow units, the flow decimal point and a flow filter for the display.

TOTAL DISP:
Setting the total and batch units and the total and batch decimal point.

DENS DISP:
Setting the density units.

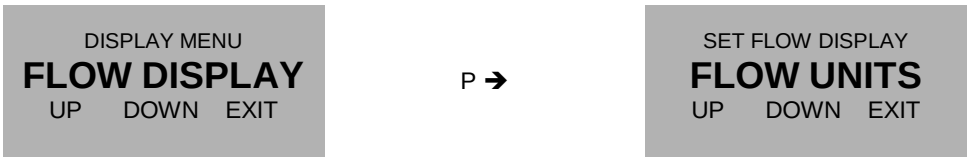
TEMP DISP:
Setting the temperature units.

PRESS DISP:
Setting the pressure units (only option pressure compensation).

DISP MODE:
Setting the content of the 2 display views, the mode (static or alternating) and the backlight.

4.5.4.1 FLOW DISPLAY menu

In the submenu “FLOW DISPLAY” the flow dimensions, the flow decimal point and the flow filter for the display can be set.



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

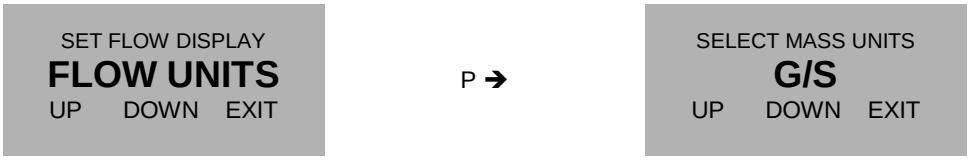
The following submenus are available:

FLOW UNITS:
Setting the flow units.

FLOW DP:
Setting the flow decimal point.

DISP FILTER:
Setting the display filter.

FLOW UNITS



Depending on the selected meter mode (mass flow meter or volume flow meter) the display indicates “SELECT MASS UNITS” or “SELECT VOLUME UNITS” and provides correspondingly only mass or volume units.

The meter mode can only be changed in the SETUP menu (see chapter 4.5.6.1)

The following units (volume or mass per time) can be selected:

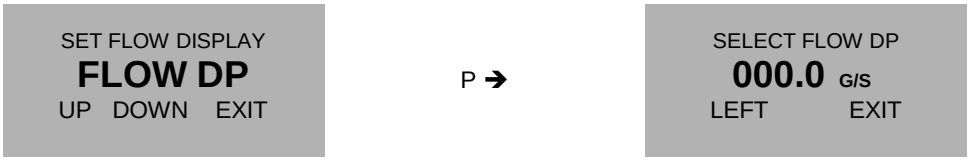
time-Unit	Description
S	second
MIN	minute
H	hour
D	day

Mass-Unit	Description
G	gram
KG	kilogram
LB	pound
OZ	dry ounce
T	metric ton
ST	stone

Volume-Unit	Description
CC	cubic centimeter
L	liter
m3	cubic meter
UGAL	US gallon
LOZ	fluid ounce
EGAL	English gallon
BBL	English barrel

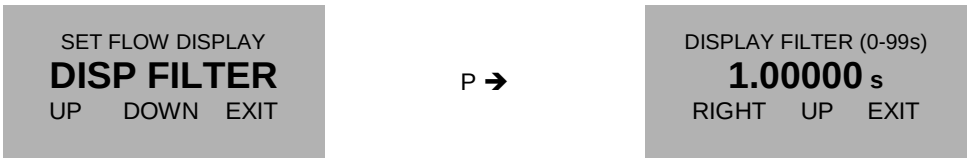
Use the keys “UP” and “DOWN” to select the engineering unit and confirm with “P” or skip with “EXIT”.

FLOW DP



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

DISP FILTER



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

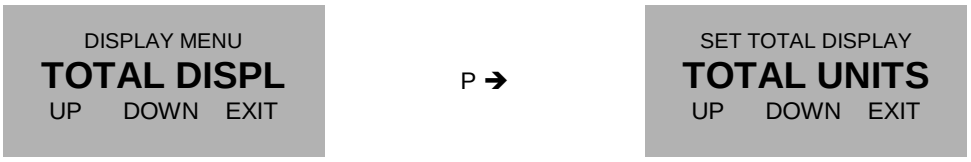
NOTE:

The display filter only filters the value in the display for providing a more stable reading. It has no influence on the outputs.
As the display filter is additional to the global filter, the display can never react faster than the outputs.

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

4.5.4.2 TOTAL DISP menu

In the submenu “TOTAL DISPL” the total and batch dimensions and decimal point can be set.



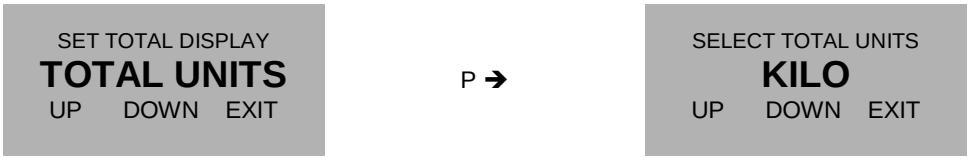
Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

The following submenus are available:

TOTAL UNITS:
Setting the total units.

TOTAL DP:
Setting the total decimal point.

TOTAL UNITS



Depending on the selected meter mode (mass flow meter or volume flow meter) only mass or volume units can be selected.

The meter mode can only be changed in the SETUP menu (see chapter 4.5.6.1)

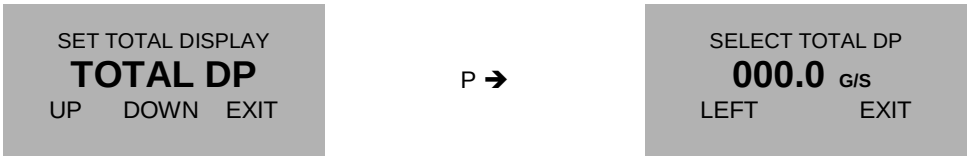
The following units can be selected:

Mass-Unit	Description
G	gram
KG	kilogram
LB	pound
OZ	dry ounce
T	metric ton
ST	stone

Volume-Unit	Description
CC	cubic centimeter
L	liter
m3	cubic meter
UGAL	US gallon
LOZ	fluid ounce
EGAL	English gallon
BBL	English barrel

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

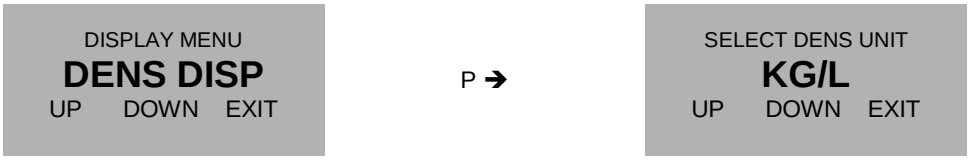
TOTAL DP



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

4.5.4.3 DENS DISPLAY menu

In the submenu “DENS DISPLAY” the density dimension can be set.



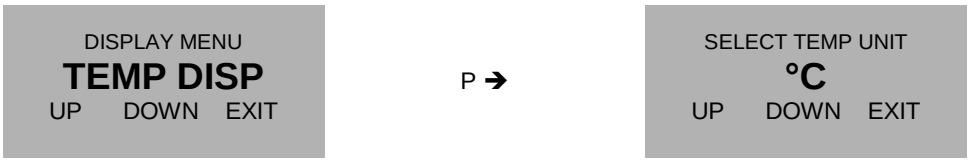
The following units (mass per volume) can be selected:

Unit	Description
G/CC	gram per cubic centimeter
G/L	gram per liter
KG/L	kilogram per liter
LB/FT3	pound per cubic feet
LB/GAL	pound per US gallon
KG/M3	kilogram per cubic meter
BRIX	Brix

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

4.5.4.4 TEMP DISP menu

In the submenu “TEMP DISP” the temperature engineering unit can be set.



The following units can be selected:

Unit	Description
°C	Centigrade
°F	Fahrenheit
KELVIN	Kelvin

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

4.5.4.5 PRESS DISP menu

In the submenu “PRESS DISP” the pressure engineering unit and the decimal point can be set.

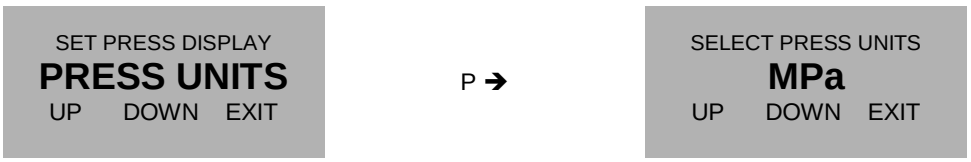
Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “EXIT”.

The following submenus are available:

PRESS UNITS:
Setting the pressure units.

PRESS DP:
Setting the pressure decimal point.

PRESS UNITS

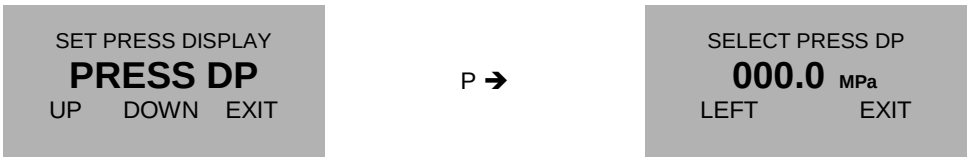


The following units can be selected:

Unit	**Description**
Pa	Pascal
MPa	Megapascal or N/mm²
bar	bar

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

PRESS DP



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

4.5.4.6 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:

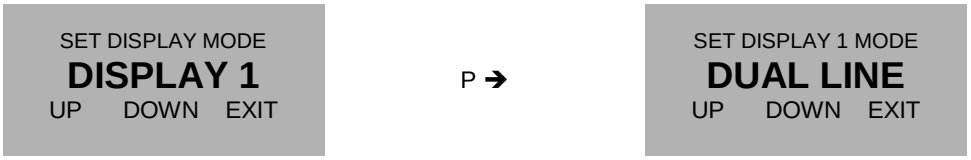
DISPLAY 1:
Setting the content of display view 1.

DISPLAY 2:
Setting the content of display view 2.

BACKLIGHT:
Switching on and off the backlight.

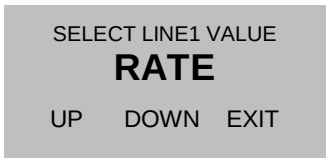
TIME MODE:
Setting fixed or alternating display.

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:

Value	Description
RATE	Actual flow
BATCH	Batch count
DENS:	Density
TEMP.	Temperature
TOTAL	Total count
F-OUT	Actual frequency at the frequency output
CURR-1	Actual currant at the analog output 1
CURR-2	Actual currant at the analog output 2
mA-IN	Actual analog input current (option)
PRESS	Pressure (option)

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

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

The unit returns to the display mode menu.

DISPLAY 2
See DISPLAY 1

BACKLIGHT

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

TIME MODE

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.

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

Press “P”. The display shows

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 2s and then asks for a new input.

When the correct code is entered the display shows:

The following submenus are available:

PARAMETER:

METER MODE	Selecting mass or volume meter mode
FLOW CUT OFF	Setting the flow cutoff value
DENS CUT OFF	Setting the density cutoff value
STEP RESP:	Adjusting the settings for fast changing flow
RESET KEY	Enable / disable the key “Reset”
FLOW-DIREC	Setting up the unit for reverse flow
K-FACTOR	Fine scaling the meter
FAULT TIME	Setting the error response time
PRESS COMP	Enable / disable the pressure compensation (option)
LANGUAGE	Selecting the display language

FILTER:

FLOW FILTER	Setting the flow filter time constant
DENS FILTER	Setting the density filter time constant

IN/OUTPUTS:

FREQ OUT	Configuring the frequency output
CTRL OUT	Configuring the control output
ANALOG OUT	Configuring the analog output
CTRL IN	Configuring the control input
ANALOG IN	Configuring the analog output
INTERFACE	Configuring the interface

DATA CONFIG:

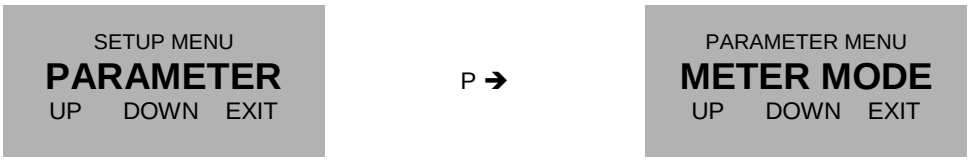
SAVE DATA	Saving the actual settings as backup
RECALL DATA	recalling the last settings from the backup

RESET TOTAL:
Resets the total count to zero.

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

4.5.6 SETUP PARAMETER menu

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

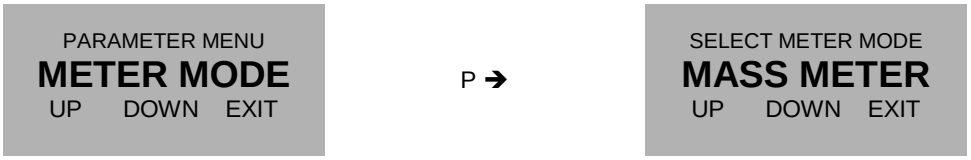


Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “E”.

4.5.6.1 METER MODE menu

In the submenu “METER MODE” can be set, if the flow meter shall be used as a mass flow meter or a volume flow meter.

If “mass flow meter” is selected, no volume units can be displayed and vice versa.



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

If the mode is changed, the display shows:

Then the following message scrolls through the display:

WARNING! CHANGING THE METER MODE WILL RESET ALL UNITS AND THE TOTAL COUNTER. DO YOU WANT TO PROCEED?

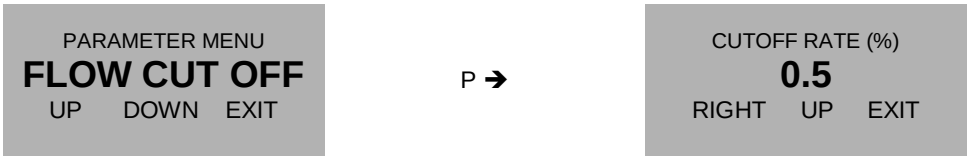
Confirm with “YES” or skip with “NO”.

The display returns to the setup parameter menu.

4.5.6.2 FLOW CUT OFF menu

In the submenu “FLOW CUT-OFF” the cutoff in percent of the full scale flow range can be set.

If the absolute value of the measured and filtered flow is below the cutoff value, the calculated flow is “0” and consequently all outputs show zero flow and the total and batch value remain unchanged.



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

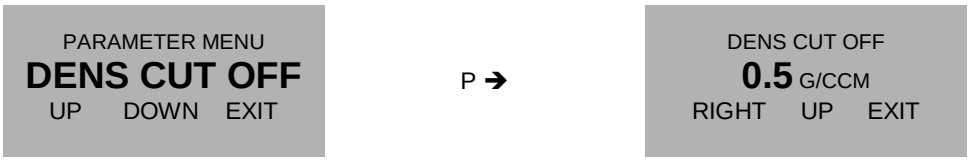
The display returns to the setup parameter menu.

4.5.6.3 DENS CUT OFF menu

In the submenu “DENS CUT-OFF” the cutoff for the density range can be set.

If the current density is below the cutoff value, the calculated flow is “0” and consequently all outputs show zero flow and the total and batch value remain unchanged.

The density cut off does not influence the density display. Also density below the cut of will be measured and displayed.



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.

4.5.6.4 RESP STEP menu

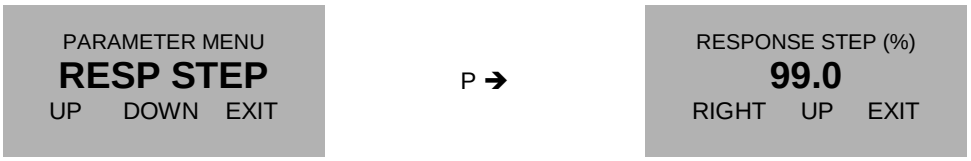
In the submenu “RESP STEP” the reaction to fast changing flows can be set.

If the difference between the measured flow and the filtered flow is smaller than the step response value, the flow filter remains active. If the difference is higher than step response, the filter is cleared and filled with the new value.

The recommended value for constant or slowly changing flow is 99% (the default value ex work). If the unit has to react to fast changing flow, the optimum value depends on the individual situation. For ON / OFF operation a value of half the ON flow is recommended.

NOTE:

A too low value will lead to noisy measurement whereas a too high value with fast changing flow (ON /OFF operation) will lead to a too slow reaction of the meter.



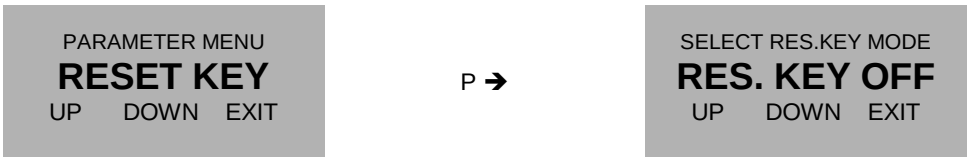
Use the keys “RIGHT” and “UP” to select the desired value and confirm with “P” or skip with “EXIT”.

The display returns to the setup parameter menu.

4.5.6.5 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 “E”.

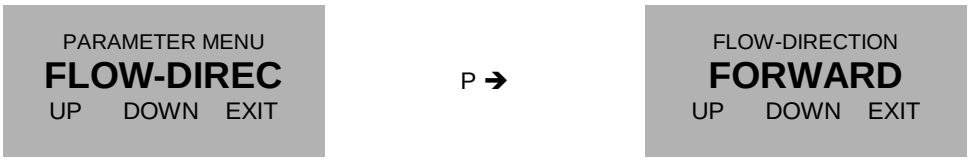
The display returns to the setup menu

4.5.6.6 FLOW DIRECTION menu

In the submenu “FLOW-DIREC” the positive direction of the flow can be set.

If flow direction is “forward” (default setting), a flow through the meter in direction of the arrow on the meter will be displayed positive, 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”.



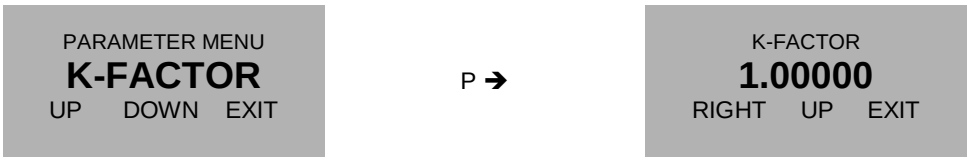
Use the keys “UP” and “DOWN” to select the positive flow direction and confirm with “P” or skip with “E”.

The display returns to the setup menu

4.5.6.7 K-FACTOR menu

In the submenu “K-FACTOR” the k- factor for fine tuning of the flow calculation can be set.

Ex work the unit is calibrated with a k- factor of “1”. 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 TCM8000 can be adjusted by changing the k- factor.



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

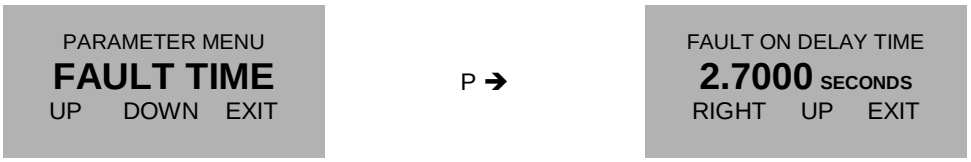
The display returns to the setup parameter menu.

4.5.6.8 FAULT TIME menu

In the submenu “FAULT TIME” the reaction time of the TCE8000 in case of an error can be defined.

The fault on delay time is the time an error must be present, until 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.



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

The display shows

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

The display returns to the setup menu.

4.5.6.9 PRESS COMP menu

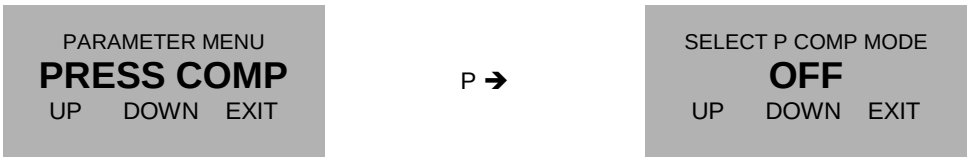
In the submenu “PRESS COMP” the operational mode of the pressure compensation (option) can be set.

The following modes are possible:

OFF:
No pressure compensation.

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

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



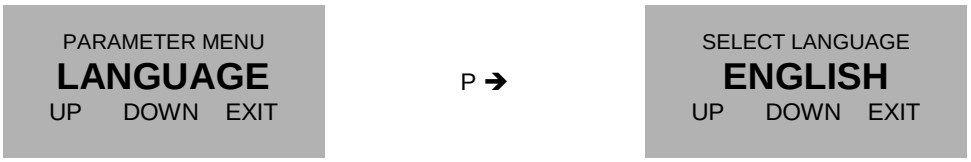
Use the keys “UP” and “DOWN” to select the desired mode and confirm with “P” or skip with “E”.

The display returns to the setup menu

4.5.6.10 LANGUAGE menu

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

At the time being English and Russian can be selected. If Russian is selected, only the main menu is in Russian language, the control menu remains in English.



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

The display returns to the setup menu

4.5.7 SETUP FILTER menu

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

Elapsed time	Remaining error (% of the step)
1 * t	30
2 * t	10
3 * t	3
4 * t	1

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.

4.5.7.2 DENS-FILTER menu

In the submenu “DENS-FILTER” the time constant for the density 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

Elapsed time	Remaining error (% of the step)
1 * t	30
2 * t	10
3 * t	3
4 * t	1

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 of the TCE8000 can be configured.

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

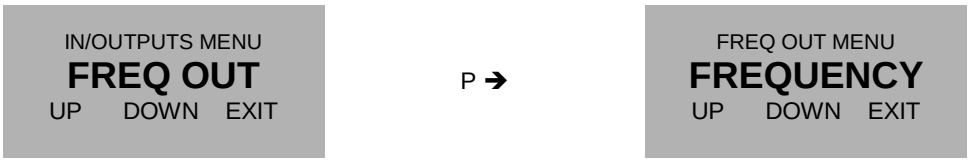
4.5.8.1 FREQ OUT menu

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

The frequency output has 2 operating modes:

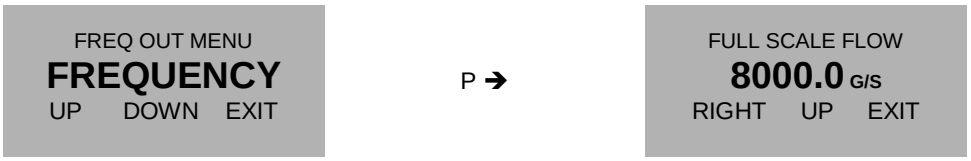
FREQUENCY:
A frequency proportional to the actual flow is generated.
If a negative flow must be given out as well, the control output can be used as sign.
Frequencies between 0.5Hz and 10kHz can be generated in this mode.

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 50Hz.



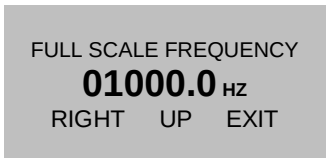
Use the keys “UP” and “DOWN” to select the desired mode and confirm with “P” or skip with “E”.

FREQUENCY



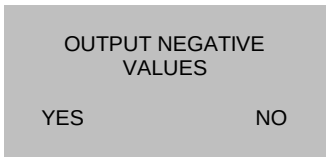
Use the keys “RIGHT” and “UP” to select the desired full scale value and confirm with “P” or skip with “EXIT”.

The display shows

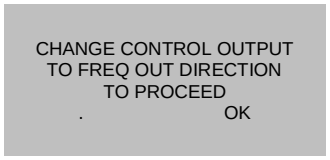


Use the keys “RIGHT” and “UP” to select the desired frequency and confirm with “P” or skip with “EXIT”.

The display shows



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



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

TOTAL COUNT

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 3 operating modes:

BATCH:
In the batch mode the TCE8000 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”.

FAULT:
In case of an error the control output goes high. For setting the on and off delay time refer to chapter 4.5.6.8.

FLOW DIREC:
The control output is low, if a positive flow is measured, and high, if a negative flow is measured.

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

If FAULT or FLOW DIREC was selected, the KCE changes the settings and returns to the IN/OUTPUT menu.

If BATCH was selected, the display shows

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

4.5.8.3 ANALOG OUT menu

In the submenu “ANALOG OUT” the 4 – 20mA outputs can be configured.

Each analog output can show one of the following 4 parameters:

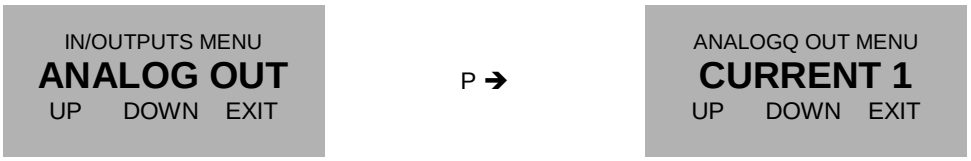
FLOW:
The output current is proportional to the actual flow.

DENSITY:
The output current is proportional to the actual density.

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

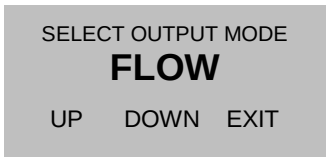
BATCH COUNT:
The output current is proportional to the actual batch value.
This mode is only possible, if the control input is configured as “RESET BATCH”

The value for 4mA as well as the value for 20mA 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 -10kg/min to +20kg/min).



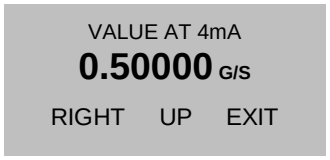
Use the keys “UP” and “DOWN” to select the desired output channel and confirm with “P” or skip with “E”.

The display shows



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

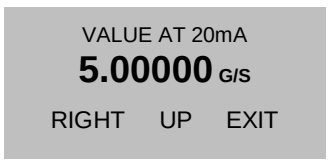
The display shows



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



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 IN/OUTPUT menu.

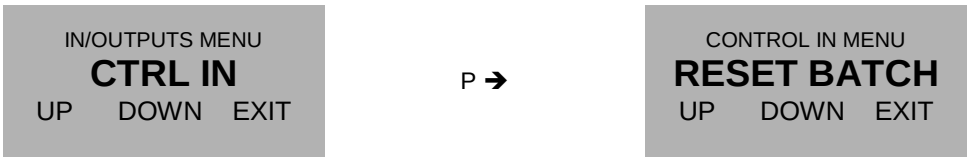
4.5.8.4 CONTROL IN menu

In the submenu “CTRL IN” the control input can be configured.

The control input has 2 operating modes:

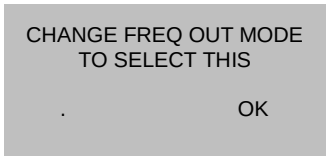
RESET BATCH:
If a high level is applied to the input, the batch counter is reset to 0.
This mode must be selected, if the control output is to be used as a batch output and / or if one of the analog outputs is to be used as batch output

EXTERNAL ZERO:
If a high level is applied to the input, the TCE8000 starts the zero offset procedure.



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

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

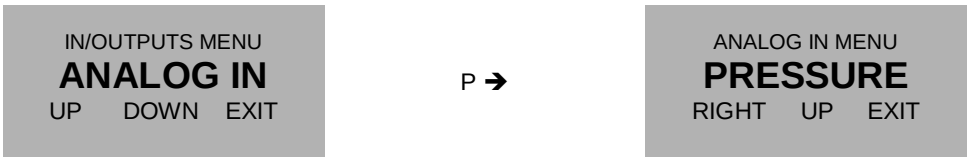


Confirm with “OK” and configure the output correspondingly if required.

4.5.8.5 ANALOG IN menu

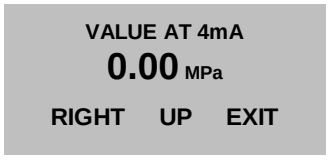
In the submenu “ANALOG IN” the 4 – 20mA input can be configured.

The value for 4mA as well as the value for 20mA can be freely selected to adapt the input to any passive 4-20mA pressure sensor.



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

If “PRESSURE” was selected the display shows



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

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 IN/OUTPUT menu.

4.5.8.6 INTERFACE menu

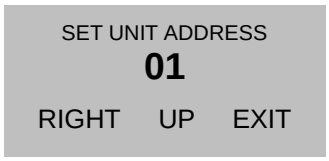
In the submenu “INTERFACE” the interface can be configured.

Depending on the configuration one or more of the following interfaces can be selected:

RS485
HART
Foundation Fieldbus

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

If “RS485” is selected, the display shows:

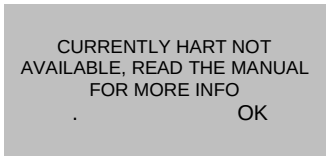


Use the keys “RIGHT” and “UP” to select the desired unit address and confirm with “P” or skip with “EXIT”.

The following addresses cannot be set:

Address	**Function**
0	reserved for broadband communication (messages to all connected units)
248-255	reserved for special Modbus purpose

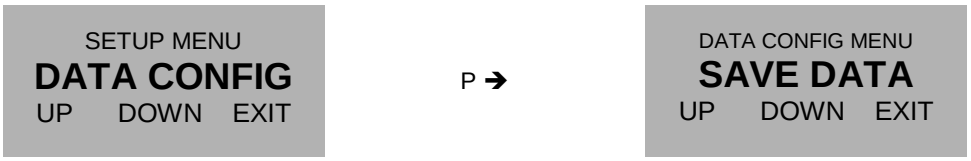
If an interface not implemented is selected, the display shows



Confirm with “OK” and select an implemented interface.

4.5.9 SETUP DATA CONFIGURATION menu

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

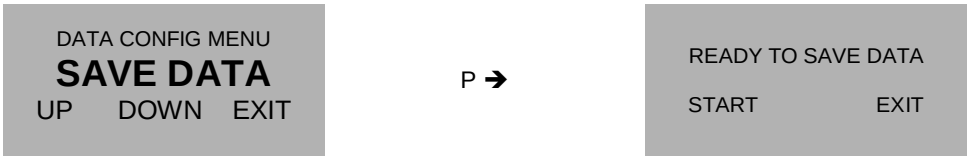


Use the keys “UP” and “DOWN” to select the desired submenu and confirm with “P” or skip with “E”.

4.5.9.1 SAVE DATA menu

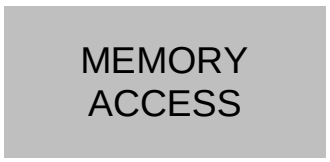
In the submenu “SAVE DATA” the current settings can be stored in the backup memory.

At each power on the TCE8000 compares the content of the setup memory and the backup memory. If the data in those 2 memories are different, the TCE8000 gives out a warning. For avoiding that warning it is recommended to make a backup as soon as the new settings are proven to be okay.



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

If “START” is pressed, the display shows for some seconds



After that for about 2 seconds

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.

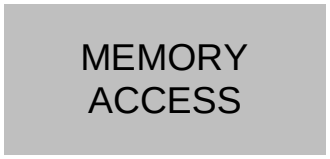
Reloading the old settings is recommended if after bigger changes in the setup the unit does not work properly any more.

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



After that for about 2 seconds

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”.

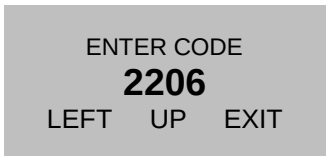
The display returns to the RESET TOTAL menu.

4.5.11 I/O-TEST Menu

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

Select in the main menu

Press “P”. The display shows



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 2s and then asks for a new input.

When the correct code is entered the display shows:

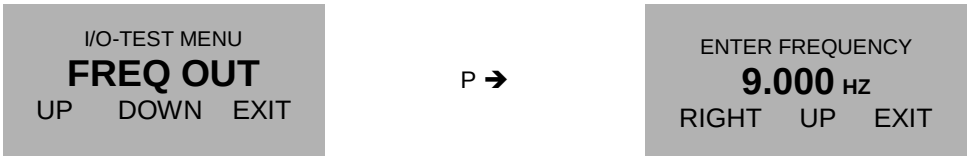
The following submenus are available:

FREQ OUT	A freely settable frequency can be applied to the output
CTRL OUT	The output level can be set
ANALOG OUT	A freely settable current can be applied to the outputs
CTRL IN	The level currently applied to the input is indicated
ANALOG IN	The current flowing in the input the input is indicated

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

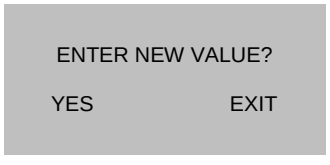
4.5.11.1 FREQ OUT menu

In the submenu “FREQ OUT” a freely settable frequency between 1Hz and 9999Hz can be applied to the output.



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

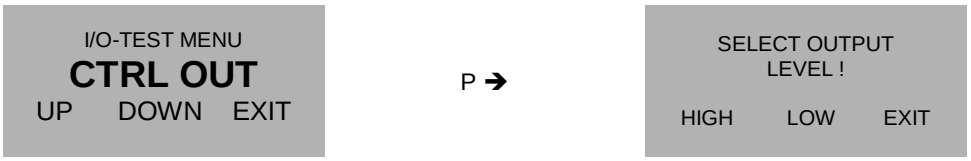


Press “YES” to enter a new value or “EXIT” to leave the menu.

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

4.5.11.2 CTRL OUT menu

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

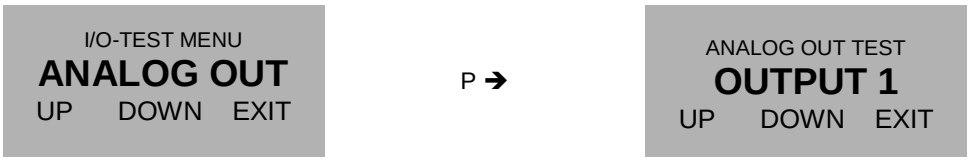


Use the keys “HIGH” and “LOW” to set the output value or leave the menu with “EXIT”.

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

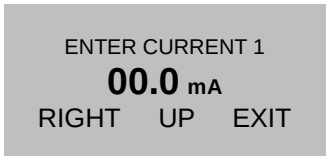
4.5.11.3 ANALOG OUT menu

In the submenu “ANALOG OUT” a freely settable current between 2mA and 21mA can be applied to the output.



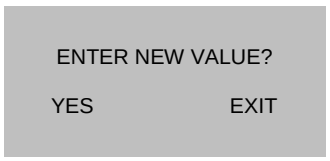
Use the keys “UP” and “DOWN” to select the desired output and confirm with “P” or skip with “E”.

The display shows



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

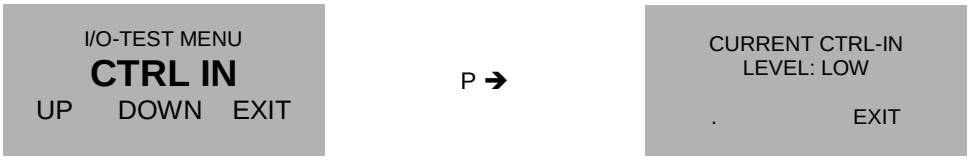


Press “YES” to enter a new value or “EXIT” to leave the menu.

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

4.5.11.4 CTRL IN menu

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



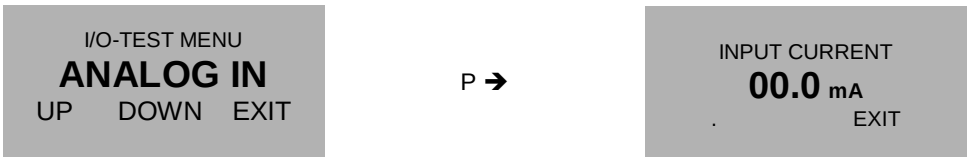
The display does not show the actual level at the input, but the level at the moment, when the CTRL IN menu was entered.

If both input levels have to be tested, leave the menu with “EXIT”, change the input level an reenter the menu.

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

4.5.11.5 ANALOG IN menu

In the submenu “ANALOG IN” the display shows the current applied to the analog input.



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

4.5.12 SERVICE Menu

The “SERVICE” menu is used to calibrate the meter and to recall the original factory settings.

For a description of the menu refer to chapter **6.4**.

5 Remote operation

As a standard the TCE8000 is equipped with an RS-485 Interface. Optionally also a HART or Foundation Fieldbus interface is available.

5.1 RS485

5.1.1 Electrical connection of RS-485

Prepare the TCE8000 and the cable as described in chapter 3.2.2 or 3.2.3.

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 -7V to +12V referred to the reference pin (20). Voltages outside that range could damage the TCE8000.

5.1.2 Ex installation of RS485

The RS-485 terminals are designed for an operating voltage of -7V to +12V and a rated voltage of 30V AC.

For connecting the interface refer to chapter 5.1.1 and 3.2.7.

WARNING!

Applying more than 30V DC to any of the RS-485 terminals will damage the TCE and destroy the protection of the TCM!

WARNING!

If more than 30V have been applied to any of the RS-485 terminals, the unit must be returned to KEM/AWL for repair as the safety barrier might have been destroyed!

5.1.3 RS485 Interface Protocol

From SW versions 2.2 on, the Tricor mass flow meters use Modbus RTU as communication protocol.

5.1.3.1 Modbus Byte Structure

The Tricor units use a Modbus data structure without parity bit. The characters are transmitted in the following structure:

1 Start Bit
8 Data Bit
No Parity Bit
1 Stop Bit

The baud rate can be set to 9600bps, 19200bps and 56000bps (see chapter 4.5.8.6).

2 characters must not be separated by more than 1.7ms at 9600 baud or by more than 0.75ms at 19200 or 56000 baud.

5.1.3.2 Modbus Frame Structure

The Modbus frame contains the following blocks:

Address	Func. Code	Data Field (command address + data)	CRC (error check)	
1 byte	1 byte	Up to 52 bytes	1 byte	1 byte

2 Frames must be separated by at least 4ms at 9600 baud or at least 1.75ms at 19200 or 56000 baud.

Address = Slave address:

The slave addresses can be set between 1 and 247 (see chapter 4.5.8.6).

Address “0” is reserved for broadcast communication and addresses 248 to 255 are reserved for special purposes. Those addresses cannot be assigned to a unit.

Function Code

The following Modbus function codes are implemented:

Code	Function	
0x01	Read coil	Read one or more single bit variables
0x03	Read holding register	Read one or more 16 bit variables
0x05	Write single coil	Write one single bit variable
0x10	Write multiple registers	Write one or more 16 bit variables

Data Field

The data field is function specific. See tables at the end of the chapter.

Error Checking Field

The content of the 2 bytes of the error-checking field are calculated according to the Modbus rules.

Frame and Data Structure

0x01 Read Coils

Request

Address	Function Code	Starting Address		Quantity of Coils		CRC	
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

Response

Address	Function Code	Byte count	Data	CRC	
1 byte	1 byte	1 byte	(up to 50 bytes)	1 byte	1 byte

As one coil is a single bit, the byte count is

Byte count = (Number of coils) / 8 (if number of coils is a multiple of 8)

Byte count = (Number of coils) / 8 + 1 (if number of coils is not a multiple of 8)

0x03 Read Holding Register

Request

Address	Function Code	Starting Address		Quantity of Registers		CRC	
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

Response

Address	Function Code	Byte count	Data	CRC	
1 byte	1 byte	1 byte	(up to 50 bytes)	1 byte	1 byte

As one register is 2 byte long, the byte count is

Byte count = (Number of registers) * 2

0x05 Write single Coil

Request

Address	Function Code	Output Address		Data		CRC	
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

Response

Address	Function Code	Output Address		Data		CRC	
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

0x10 Write multiple Register

Request

Address	Function Code	Starting Address		Quantity of Registers		Byte count	Data	CRC	
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	up to 48 bytes	1 byte	1 byte

Response

Address	Function Code	Starting Address		Quantity of Registers		CRC	
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

5.1.3.3 Modbus Exception response

In case the Tricor receives a complete frame, but with invalid addresses or data, an exception response is returned.

In the returned function code the MSB will be set to “1”. The returned function code can be calculated as:

Returned function code = received function code + 0x80

The data field will contain one of the following error codes:

Code	Name	Description
01	Illegal Function	The requested function is not existing / not implemented
02	Illegal Data Address	The address (plus length) is not existing / not allowed
03	Illegal Data Value	The transferred data are out of range
04	Slave Device Failure	Failure during command execution
05	Acknowledge	Command received, execution still pending
06	Slave device busy	Tricor not yet ready, resend message later

5.1.3.4 Modbus Data model

Modbus defines the following data:

Primary Table	Object type	Communication type	
Coil	Single bit	Read / write	
Input register	16 bit	read only	
Holding register	16 bit	Read / write	

5.1.3.5 Modbus memory structure

In the TCE8000 the address are used as follows:

Address range 1**:**

Single coils, 1 bit long

Address range 2**:**

Float values, 4 byte long

Adress range 4**:**

Integer values, 2 byte long

ReadCoil(0x01)/WriteSingleCoil(0x05)

Register		Register Description	Read / Write
10010		Write EEPROM flag	R / W
10050		Ctrl. Out Test Mode (true = test mode)	R / W
10100		Output negative frequencies	R / W
10200		AnalogOut1 test mode (true = test mode)	R / W
10201		AnalogOut2 test mode (true = test mode)	R / W

ReadRegisters(0x03)
Measuring values (float)

Register high	Register low	Register Description	Read / Write
20000	20001	Mass flow rate	R
20002	20003	Mass batch total	R
20004	20005	Density	R
20006	20007	Temperature	R
20008	20009	Volume flow rate	R
20010	20011	Volume batch total	R
20012	20013	Mass grand total	R
20014	20015	Volume grand total	R

ReadHoldingRegisters(0x03)/WriteMultipleRegisters(0x10)
General values (float)

20104	20105	CutOff in % f.s.	R / W
20106	20107	StepResponse in % f.s.	R / W
20108	20109	CutOff in current units	R / W
20110	20111	StepResponse in current units	R / W
20112	20113	Flow Filter	R / W
20114	20115	Density Filter	R / W
20200	20201	AnalogOut1 4mA FLOW	R / W
20202	20203	AnalogOut1 20mA FLOW	R / W
20204	20205	AnalogOut1 4mA DENSITY	R / W
20206	20207	AnalogOut1 20mA DENSITY	R / W
20208	20209	AnalogOut1 4mA TEMPERATURE	R / W
20210	20211	AnalogOut1 20mA TEMPERATURE	R / W
20212	20213	AnalogOut1 4mA TOTAL	R / W
20214	20215	AnalogOut1 20mA TOTAL	R / W
20216	20217	AnalogOut2 4mA FLOW	R / W
20218	20219	AnalogOut2 20mA FLOW	R / W
20220	20221	AnalogOut2 4mA DENSITY	R / W
20222	20223	AnalogOut2 20mA DENSITY	R / W
20224	20225	AnalogOut2 4mA TEMPERATURE	R / W
20226	20227	AnalogOut2 20mA TEMPERATURE	R / W
20228	20229	AnalogOut2 4mA TOTAL	R / W
20230	20231	AnalogOut2 20mA TOTAL	R / W
20250	20251	Full Scale Flow	R / W
20252	20253	Full Scale Frequency	R / W
20254	20255	Total Count	R / W
20256	20257	Batch Value	R / W

Start zero procedure (float)

20300	20301	start offset procedure [data = seconds]	W

Test mode set values (float)

20350	20351	Test Mode Freq. Out value [Hz]	W
20352	20353	Test Mode Current 1 out (mA)	W
20354	20355	Test Mode Current 2 out (mA)	W
20356	20357	Test Mode CtrlOut value [0 for LOW,1 for HIGH]	W

Current output values (float)

20360	20361	FREQ OUT value (Hz)	R
20362	20363	AnalogOut1 (mA)	R
20364	20365	AnalogOut2 (mA)	R

Holding Registers

Integer Values

40010		Meter mode 0 = Mass flow meter 1 = Volume flow meter	R / W
40100		Mass flow rate unit	R / W
40101		Density unit	R / W
40102		Temperature unit	R / W
40103		Volume flow rate unit	R / W
40104		Mass total unit	R / W
40105		Volume total unit	R / W
40150		AnalogOut1 mode 0 = flow 1 = density 2 = temperature 3 = total	R / W
40151		AnalogOut2 mode See 0150	R / W
40152		FrequencyOut mode 0 = frequency 1 = total count	R / W
40153		ControlOut mode 0 = fault 1 = frequency out sign 2 = batch	R / W
40154		ControlIn mode 0 = start offset calibration 1 = reset batch	R / W
40155		ControlOut Batch Output Level 0 = high 1 = low	R / W

For a complete description of all operations via Modbus, including examples for many applications and operations refer to the complete Modbus manual available from KEM/AWL.

5.2 HART

5.2.1 Electrical connection for HART

For the HART communication the current output CURRENT 1 is used.

Connect the analog output CURRENT 1 as described in chapter 3.2.6 and connect the HART communicator in series to the analog output of the TCE.

Refer to the manual of your HART communicator for the proper connection.

5.2.2 Ex installation for HART

The analogue current output terminals are designed for a rated voltage of 30V AC.

The outputs are protected against wrong polarity. Voltages below 30V will not damage the outputs nor affect the Ex safety.

Refer to chapter 3.3.7

WARNING!

Applying more than 30V DC to the analog output terminals will damage the TCE and destroy the protection of the TCM!

WARNING!

If more than 30V have been applied to any of the analog output terminals, the unit must be returned to KEM/AWL for repair as the safety barrier might be destroyed!

5.2.3 HART Interface Protocol

For getting the newest DD file contact KEM.

5.3 Foundation Fieldbus

5.3.1 Electrical connection of Foundation Fieldbus

Prepare the TCE8000 and the cable as described in chapter 3.2.2 or 3.2.3.

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 Ex installation of Foundation Fieldbus

The FF terminals are designed for a rated voltage of 30V AC.

For connecting the interface refer to chapter 5.3.1 and 3.2.7.

WARNING!

Applying more than 30V DC respect to PE to any of the FF terminals will damage the TCE and destroy the protection of the TCM!

WARNING!

If more than 30V have been applied to any of the FF terminals, the unit must be returned to KEM/AWL for repair as the safety barrier might be destroyed!

5.3.3 FF Interface Protocol

For getting the newest DD file contact KEM/AWL.

6 Service and Maintenance

6.1 Maintenance

The sensors of the TCM series as well as the electronics of the TCE8000 series do not require regular maintenance.

In case of abrasive or sedimenting media however it is recommended to return the measuring system to KEM/AWL 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 frequent.

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 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
Gas bubbles or solid particles in the medium?
➔ Mount the meter with the correct orientation
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
Output correctly configured?
➔ Correct the configuration
Wrong flow direction (Flow in the display is negative)?
➔ Change flow direction

Pressure display shows “PRESS ERROR”
Input correctly wired?
➔ Correct the wiring
Sensor working normally?
➔ Check with external DAM. If required, replace the sensor

No pressure compensation
Compensation enabled?
➔ Enable compensation
Sensor working normally?
➔ Check with external DAM. If required, replace the sensor

6.3 Changing the fuses

The power supply inputs of the TCE8000 contain fuses.

With the non-Ex versions the fuses can easily be replaced by qualified personnel.

6.3.1 Changing the fuse with the TCE80**-W-**** and compact version

Switch off the power supply.

Open the safety screw at the display cover of the unit with the provided Allen key.

Remove the display cover of the TCE by turning it counter clockwise.

Pull out the display

Remove the 3 screws in the PCB and pull it out carefully.

Below the ribbon cable connector you find the following fuse in the fuse holder:

Littelfuse NANO 2 375mA slow blow, ordering code 0452.375

NOTE

For your own safety replace the fuse only by the same type and rating.

Replace the fuse and reclose the unit.

6.3.2 Changing the fuse with the TCE80**-S-****

Switch off the power supply.

Remove the 4 screws in the back panel and pull out the back panel carefully.

Below the ribbon cable connector you find the following fuse in the fuse holder:

Littelfuse NANO 2 375mA slow blow, ordering code 0452.375

NOTE

For your own safety replace the fuse only by the same type and rating.

Replace the fuse and reclose the unit.

6.3.3 Changing the fuses with the Ex versions

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

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

WARNING!

The Ex versions of the TCE8000 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 unit will be void!

6.4 Calibration

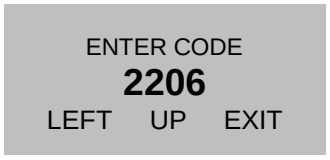
In the calibration menu the flow, density and temperature measurement of the TCE8000 can be calibrated.

Press “P” for about 3 seconds

The display shows:

Use the key “UP” or “DOWN” to select

Press “P”. The display shows

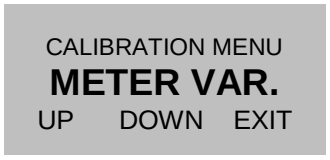


Change the indicated number with “LEFT” and “UP” to 2208 and confirm with “P”.

If a wrong code is entered, the display shows “ERROR” for about 2s and then asks for a new input.

When the correct code is entered the display shows:

Press “P”. The display shows



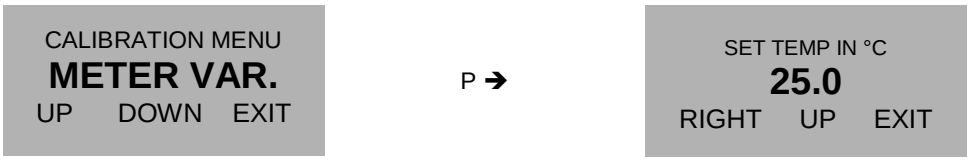
The following submenus are available:

TEMP CALIB.	Calibrating the temperature measurement
AIR CALIB.	Calibrating the density measurement at low density
WATER CALIB.	Calibrating the density measurement at high density
METER VAR.	Calibrating the flow measurement

6.4.1 Temperature Calibration

For calibrating the temperature reading of the TCE8000, the medium temperature must be well known.

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



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

The display returns to the CALIBRATION menu.

NOTE:

The flow and density measurements are temperature corrected. Changing the temperature calibration may affect the flow or density accuracy.
After a temperature calibration, a recalibration of flow and density is strongly recommended!

6.4.2 Air Density Calibration

NOTE

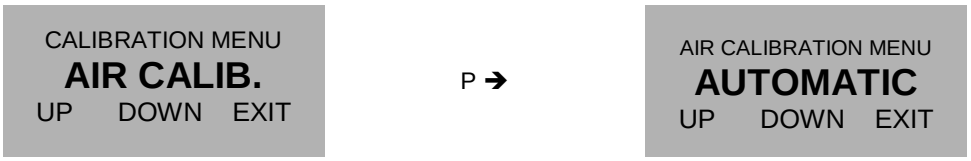
Make sure that the temperature reading is calibrated before starting the air calibration.

The low end calibration of the density measurement is normally done with empty tubes (filled with air).

In the automatic mode the unit performs an automatic calibration, assuming that the tubes are filled with normal air.

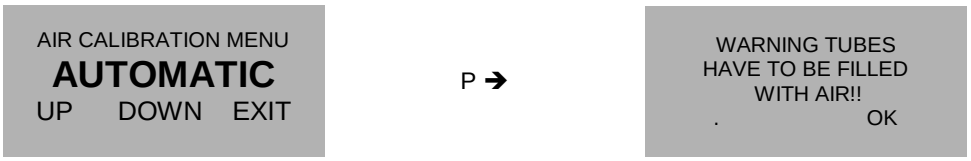
In the manual mode the three parameters temperature, tube frequency and reference density can be altered individually. This is necessary if the air calibration is performed with a gas with a density different than air. In that case make first the automatic calibration and then override in the manual calibration the density value by the density of the medium used for calibration.

Before starting an automatic calibration, make sure that the TCM is completely empty as any drop of a liquid inside will spoil the calibration result.

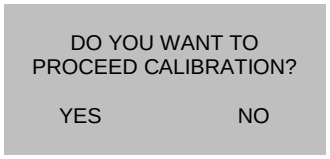


Use the keys “UP” and “DOWN” to select the mode and confirm with “P” or skip with “EXIT”.

AUTOMATIC mode

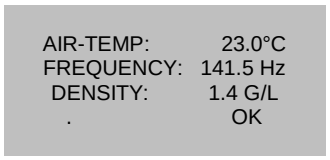


Confirm with “OK”. The display shows



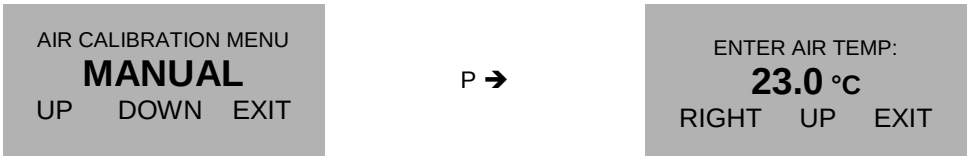
Start the calibration with “YES” or skip with “NO”.

When “YES” was pressed, the display shows

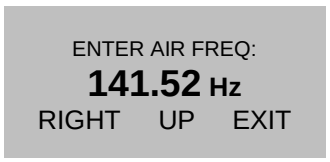


Confirm with “OK”. The display returns to the AIR CALIBRATION menu.

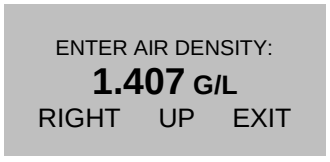
MANUAL MODE



Use the keys “RIGHT” and “UP” to set the reference temperature and confirm with “P” or skip with “EXIT”. The display shows



This value must only be entered, if you have the data from a calibration sheet of the KCM. Skip with “EXIT”. The display shows



Use the keys “RIGHT” and “UP” to set the reference density and confirm with “P” or skip with “EXIT”.

The display returns to the AIR CALIBRATION menu.

6.4.3 Water Density Calibration

NOTE

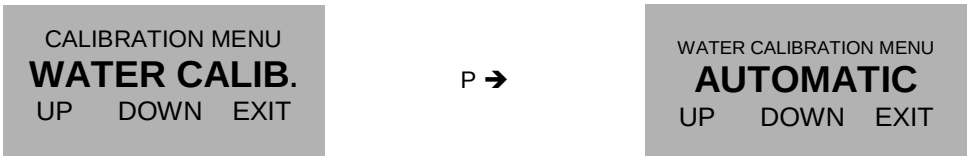
Make sure that the temperature reading is calibrated before starting the water calibration.

The high end calibration of the density measurement is normally done with tubes filled with water, but any other liquid with well-known density can be used as well.

In the automatic mode the unit performs an automatic calibration, assuming that the tubes are filled with water.

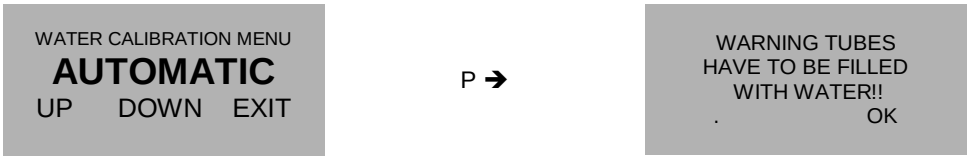
In the manual mode the three parameters temperature, tube frequency and reference density can be altered individually. This is necessary if the water calibration is performed with a liquid with a density different than water. In that case make first the automatic calibration and then override in the manual calibration the density value by the density of the medium used for calibration.

Before starting an automatic calibration, make sure that the TCM is completely filled with the test medium. Any pollution (air bubbles, solid particles or rests of other liquids) will spoil the calibration.

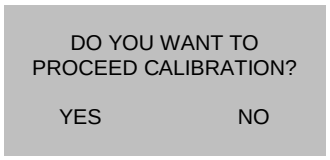


Use the keys “UP” and “DOWN” to select the mode and confirm with “P” or skip with “EXIT”.

AUTOMATIC mode

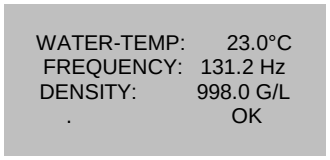


Confirm with “OK”. The display shows



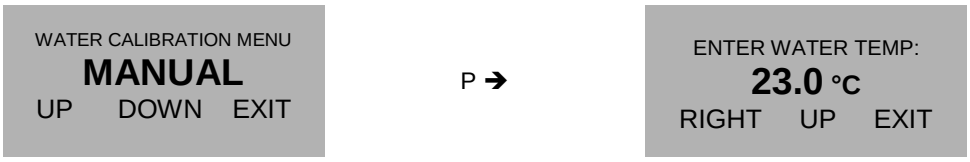
Start the calibration with “YES” or skip with “NO”

When “YES” was pressed, the display shows



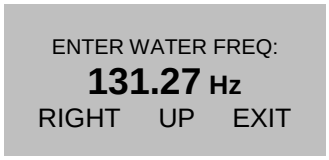
Confirm with “OK”. The display returns to the WATER CALIBRATION menu.

MANUAL MODE

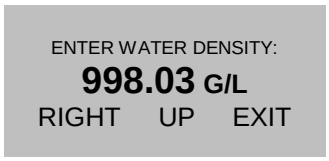


Use the keys “RIGHT” and “UP” to set the reference temperature and confirm with “P” or skip with “EXIT”.

The display shows



This value must only be entered, if you have the data from a calibration sheet of the KCM. Skip with “EXIT”. The display shows



Use the keys “RIGHT” and “UP” to set the reference density and confirm with “P” or skip with “EXIT”.

The display returns to the WATER CALIBRATION menu.

6.4.4 Flow Calibration

NOTE

Make sure that the temperature reading is calibrated before starting the flow calibration.

Mount the meter in the test stand or mount a reference meter in series to the tricor 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 calibration, a valve each in front and behind the tricor 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!

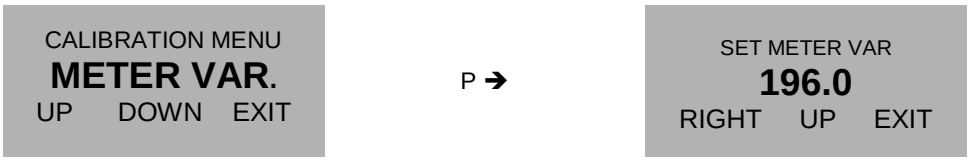
Operate the meter for at least 15 minutes for making sure that it has reached the final operating temperature. If the medium temperature differs much from the initial meter or ambient temperature, a longer warm up period might be recommended.

Close the valves and make the zero calibration (see chapter 4.2.2).

If the calibration of the tricor shall be checked without adjusting the reading, just compare the tricor 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 tricor full scale flow.

Read the current tricor meter variable:



Calculate the new meter variable as:

METER_VARnew = METER_VARold * Reference_reading / TCE8000_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

The TCE8000 does not contain any user serviceable parts.

In case of malfunction, please contact your nearest dealer or directly KEM or AWL.
For the addresses see chapter 7.7.

6.6 Reloading Factory Settings

In case the unit has been completely misadjusted for any reason, the unit can be reset to the original settings ex works.

Press “P” for about 3 seconds. The display shows:

Use the key “UP” or “DOWN” to select

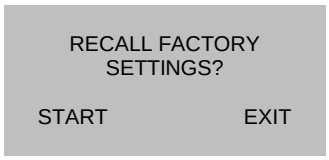
Press “P”. The display shows

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 2s and then asks for a new input.

When the correct code is entered the display shows:

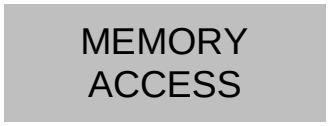
Use the key “UP” or “DOWN” to select RECALL FACT. and confirm with “P” or skip with “EXIT”.

The display shows.



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

If “START” is pressed, the display shows for some seconds



After that for about 2 seconds.

The display returns to the RECALL FACT menu.

7 Listings

7.1 Warranty

For warranty refer to the general terms and conditions of KEM or AWL, which can be found on the corresponding websites.

7.2 Certifications and compliances

Category	**Standards or description**	
EC Declaration of Conformity - EMC	Meets intent of Directive 2004 / 108 / EEC for Electromagnetic Compatibility. Compliance is given to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326 / 2006	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A radiated and Conducted Emissions[1] and Immunity[1].
	IEC 61000-4-2 /2009	Electrostatic Discharge Immunity (Performance criterion B)
	IEC 61000-4-3 / 2008	Radiated RF Electromagnetic Field Immunity (Performance criterion B)
	IEC 61000-4-4 / A1-2009	Electrical Fast Transient / Burst Immunity (Performance criterion B)
	IEC 61000-4-5 / 2007[2]	Power Line Surge Immunity (Performance criterion B)
	IEC 61000-4-6 / 2009	Conducted RF Immunity (Performance criterion B)
	IEC 61000-4-11 / 2005[2]	Voltage Dips and Interruptions Immunity (Performance criterion B)
Australia / New Zealand Declaration of Conformity-EMC	Complies with the Radiocommunications Act and demonstrated per EMC Emission standard[1]	
	AS/NZS 2064	Industrial, Scientific, and Medical Equipment: 1992
FCC EMC Compliance	Emissions comply with the Clas A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B[1.]	

[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

Category	**Standards or description**	
EC Declaration of Conformity – Low Voltage	Compliance is given to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 2006/95/EEC	
	EN 61010-1 / 2002	Safety requirements for electrical equipment for measurement control and laboratory use.
Designed to meet the following US standards	UL 61010-1 / 2004	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 / 2002	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 IECEx	II 2G Ex d [ia] IIC T4 Gb Ex d [ia] IIC T4 Gb	TCE800*-E-****-Ex TCM0325 … 7900-**-****-E***-Ex
	II 2G Ex d [ia] IIB T4 Gb Ex d [ia] IIB T4 Gb	TCE801*-E-****-Ex TCM28k … 65k-**-****-E***-Ex
	II (2)G [Ex ia Gb] IIC [Ex ia Gb] IIC	TCE800*-L-****-Ex
	II (2)G [Ex ia Gb] IIB [Ex ia Gb] IIB	TCE801*-L-****-Ex
	II 2G Ex ia IIC T4 Gb Ex ia IIC T4 Gb	TCM0325 ... 7900-**-****-A***-Ex
	II 2G Ex ia IIB T4 Gb Ex ia IIB T4 Gb	TCM28k, TCM65k-**-****-A***-Ex
cCSAus	Class I, Division 1 Group C and D, T4	TC*……..-Ex1

7.3 Technical Data

7.3.1 Technical Data TCM Transducer

	TCM0325	TCM0650	TCM1550	TCM3100	TCM5500	TCM7900	TCM28k	TCM65k
Mass flow range (kg/h)	3 to 300	6 to 600	15 to 1500	30 to 3000	55 to 5500	79 to 7900	280 to 28 000	650 to 65 000
Mass flow range (lb/min)	0.11 to 11	0.22 to 22	0.55 to 55	1.1 to 110	2.0 to 203	2.9 to 291	10 to 1030	24 to 2390
Volume flow range (l/h)	3 to 300	6 to 600	15 to 1500	30 to 3000	55 to 5500	79 to 7900	280 to 28 000	650 to 65 000
Basic Accuracy (% of flow)	0.1							
Zero Stability (% of f. s.)	0.01							
Zero Drift (% f.s. per °C)	0.001							
Repeatability (% of flow)	0.1							
Density meas. range	0 - 4500 kg/m³							
Density accuracy	±0.002 kg/l							
Temperature accuracy	±1°C ±0.5% of reading							
Process and Ambient								
Process connections	female thread 1/2" adaptors for flanges, diary and tri-clamp				flanges EN1092, ANSI B16.5, DIN2512			
Max. pressure	200 bar				350 bar	100 bar		
Max. pressure (Option)	350 bar							
Pressure Drop	Contact KEM or AWL							
Operating Density range	500 - 2500 kg/m³ (standard), 5 - 4500 kg/m³ (upon request)							
Process temperature	-40 … +100°C (standard), -100 ... +150°C (upon request)							
Ambient temperature	-40 ... +70°C							
Storage temperature	-40 ... +100°C							
El. connections remote	screw type terminals							
El. connections compact.	none (internally connected to the electronics)							
General								
Ingress Protection	IP65 (IP67 on request)							
Tube arrangement	2 serial	2 parallel	2 serial	2 parallel	2 parallel	2 parallel	2 parallel	2 parallel
Tube inner diameter	4mm	4mm	8mm	8mm	7mm	9mm	16mm	28mm
Tube material	stainless steel DIN 1.4404							
Housing material	stainless steel DIN 1.4301							
Dimensions	see drawings							

7.3.2 Ex Data TCM Transducer

	TCM0325	TCM0650	TCM1550	TCM3100	TCM5500	TCM7900	TCM28k	TCM65k
Driver coil								
Vmax (V)	35				35		35	
Imax (mA)	100				100		100	
Pmax (W)	0.5				0.75		1.4	
Ri (Ohm)	55				116		116	
L (mH)	2.77				1.85		7.0	
C (nF)	<< 1				<< 1		<< 1	
Sensor coil								
Vmax (V)	35				35		35	
Imax (mA)	100				100		100	
Pmax (W)	0.5				0.75		0.75	
Ri (Ohm)	55				116		116	
L (mH)	2.77				1.85		1.85	
C (nF)	<< 1				<< 1		<< 1	
Pt1000								
Vmax (V)	12							
Imax (mA)	60							
Pmax (W)	0.2							
Ri (Ohm)	> 900							
L (mH)	<< 0.1							
C (nF)	<< 1							
Temperature								
Medium temp. standard	≤ 70°C (T4), ≤ 100°C (T3)							
Medium temp. „high temp“	≤ 70°C (T4), ≤ 135°C (T3), ≤ 150°C (T2)							

7.3.3 Technical Data TCE 8000 Transmitter

General	
Display:	Graphic, 132 x 32 dot
Supply voltage:	24 VDC, ± 20% 100 – 230V AC, ± 10% (option)
Programming:	via front keyboard
Interface:	RS 485, option HART or Foundation Fieldbus
EMC:	according to EN 61000-6-4 and EN 61000-6-2
Power consumption:	max. 4 W
Exd housing:	
Dimensions:	see drawing
Connections:	internal cage clamp terminals via cable gland
Material:	aluminum diecast
Protection class	IP 65 (IP67 upon request)
Weight:	approx. 2 kg
Temperature:	operating:- 40 up to 70°C storage and transport: -40 up to 80°C
Panel-mounted housing:	
Dimensions:	see drawing
Connections:	rear cage clamp terminals
Material:	Noryl
Protection class:	front: IP 50, rear: IP 30
Weight:	approx. 500g
Temperature:	operation: 0 to 60°C storage and transport: -20 up to 70°C

Analog Outputs	
Two current outputs:	4-20 mA passive, two-wire, isolated (option: 1 output)
Resolution:	14 bit
Linearity:	± 0.05% of full scale
Temperature drift:	0.05% per 10K
Load:	< 620 Ω (at 24V supply)
Output value:	flow rate, job total, density or temperature
Analog Input (option)	
Input type:	4-20 mA active for two-wire passive pressure sensor
Resolution:	12 bit
Linearity:	± 0.05% of full scale
Temperature drift:	0.05% per 10K
Supply voltage:	> 20V (at 20mA sensor current)
Pulse Output	
Frequency range:	0.5 -10,000 Hz
Output signal:	active push pull output of flow rate and / or cycle output
Digital I/O	
Status output type	push pull
Low / high level	1V / 23V @ 24Vsupply, 10kΩ load
Allowed load current	20mA max.
Output signal	Programmable
Control input type	Active high
Threshold voltage	6.5V
Input current	0.1mA @ 6.5V, 0.2mA @ 24V Vin
Input signal	Programmable

7.3.4 Ex Data TCE 8000 Transmitter

Barrier output

	TCE8001	TCE8011	TCE8021
Driver coil hot side			
Vmax (V)	7	14	14
Imax (mA)	100	100	100
Pmax (W)	0.42	1.12	1.12
Driver coil cold side			
Vmax (V)	1		
Imax (mA)	100		
Pmax (W)	0.1		
Sensor coil			
Vmax (V)	1.8		
Imax (mA)	23		
Pmax (W)	0.08		
Pt1000 driver			
Vmax (V)	5		
Imax (mA)	58		
Pmax (W)	0.25 (< 0.028W @ R(Pt1000) > 900 Ohm)		

7.3.5 Dimensional Drawings (mm)

Compact versions

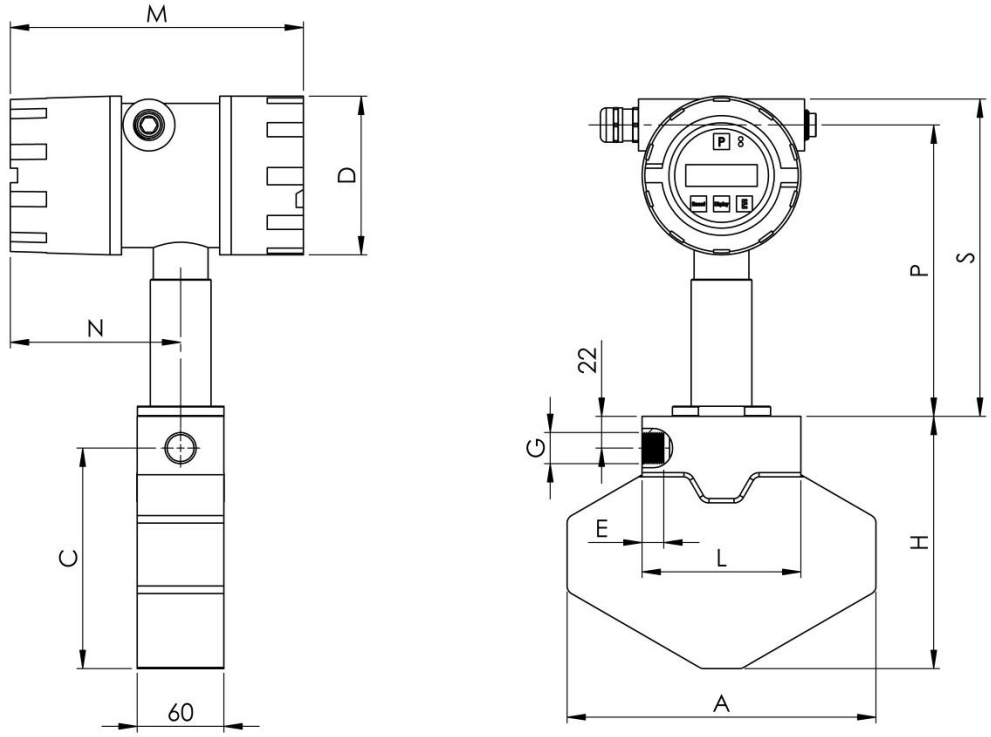


Fig. 22: Dimensions TCM0325--****-C*** through TCM3100-**-****-C***

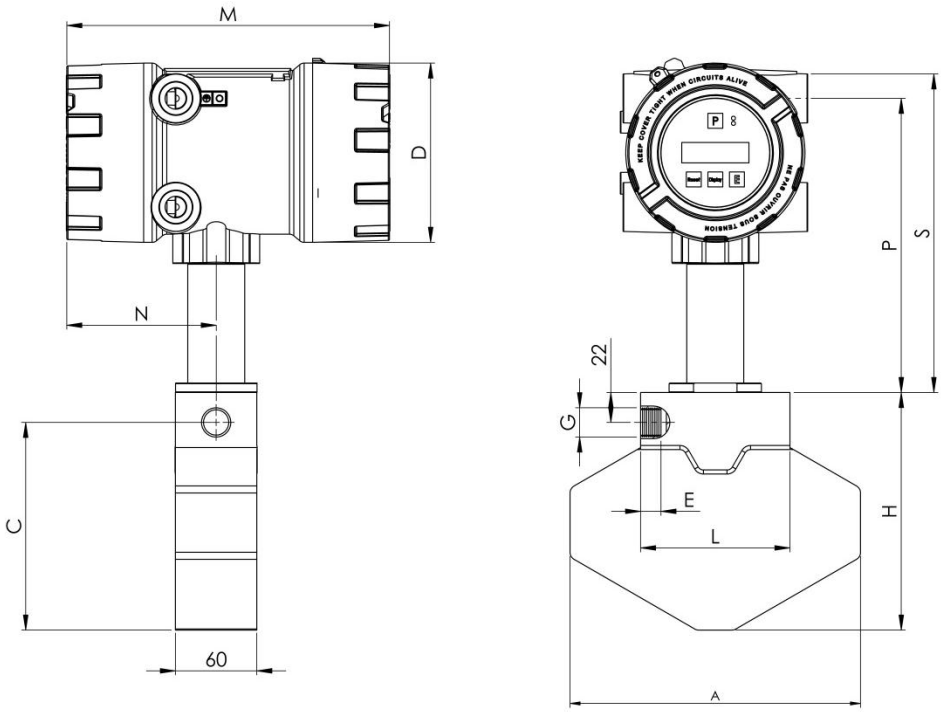


Fig. 23: Dimensions TCM0325--****-E*** through TCM3100-**-****-E***

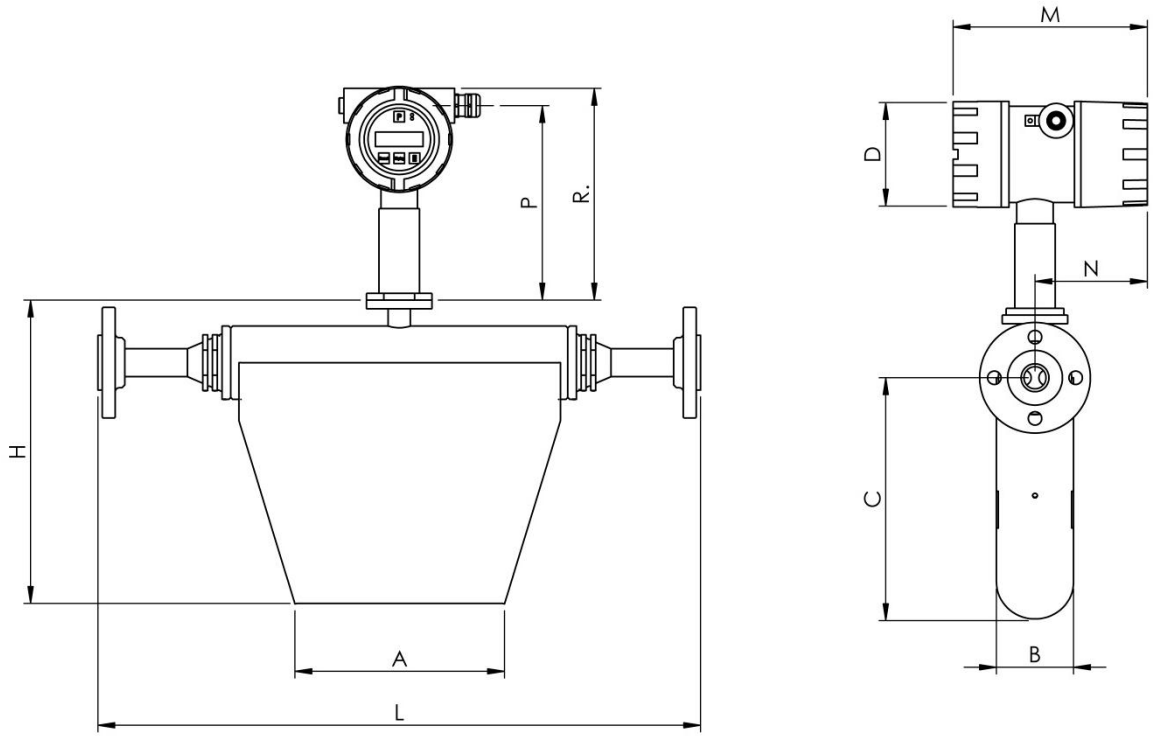


Fig. 24: Dimensions TCM5500--****-C*** through TCM65k-**-****-C***

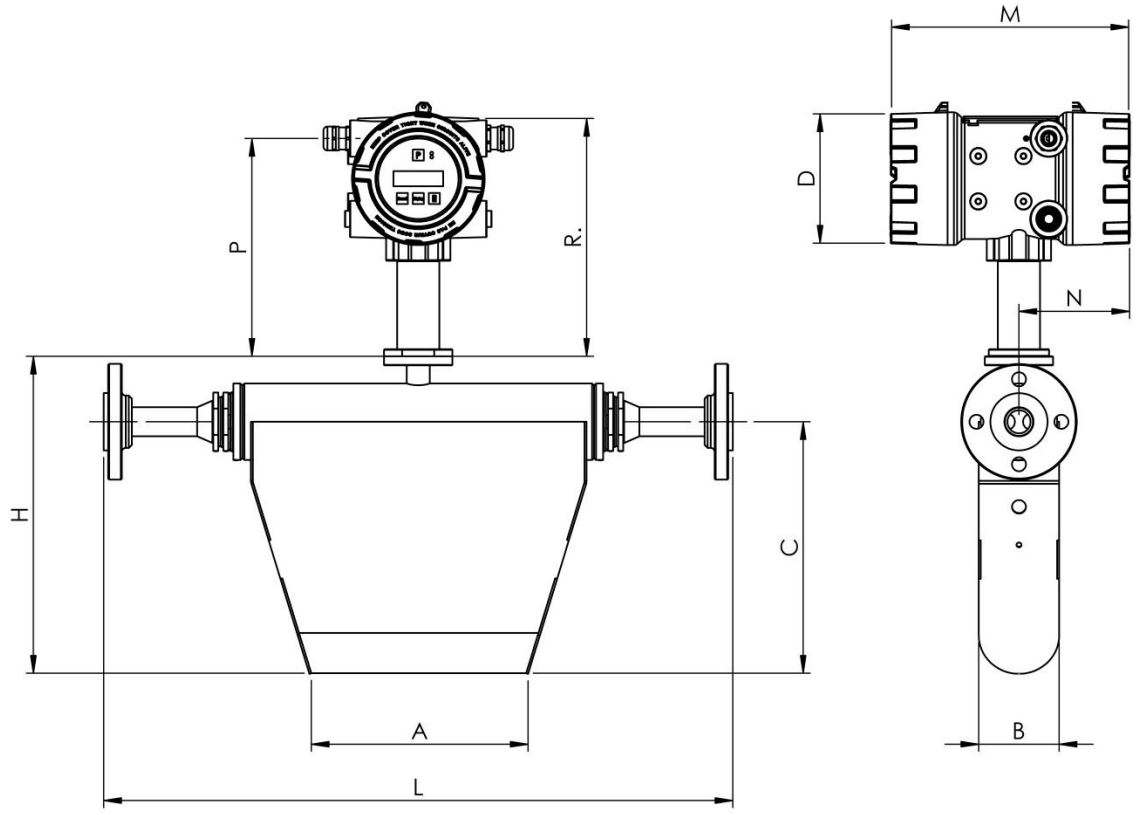


Fig. 25: Dimensions TCM5500--****-E*** through TCM65k-**-****-E***

Sensor Dimensions

Type	A	C	E	H	L	G
TCM0325	214	160	15	182	110	G ½ ”
TCM0650	214	160	15	182	87	G ½ ”
TCM1550	350	258	18	280	140	G ½ ”
TCM3100	350	258	18	280	140	G ½ ”

Type	A	B	C	H	L	G
TCM5500	197	61	204	260	460	*)
TCM7900	197	61	204	260	460	*)
TCM28k	218	80	253	315	625	*)
TCM65k	360	151	387	480	830	*)

*) See order code or ask KEM/AWL

Electronics Dimensions

Type	D	M	N	P	R	
Housing “C”	110	205	118	188	218	
Housing “E”	130	240	111	217	243	

Remote meter

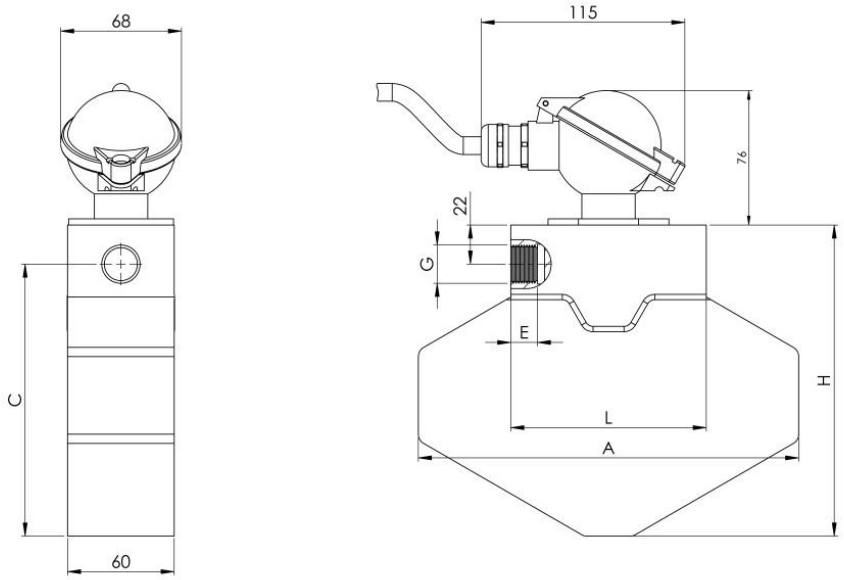


Fig. 26: Dimensions TCM*-**-****-A*****

Remote wall-mounted electronics

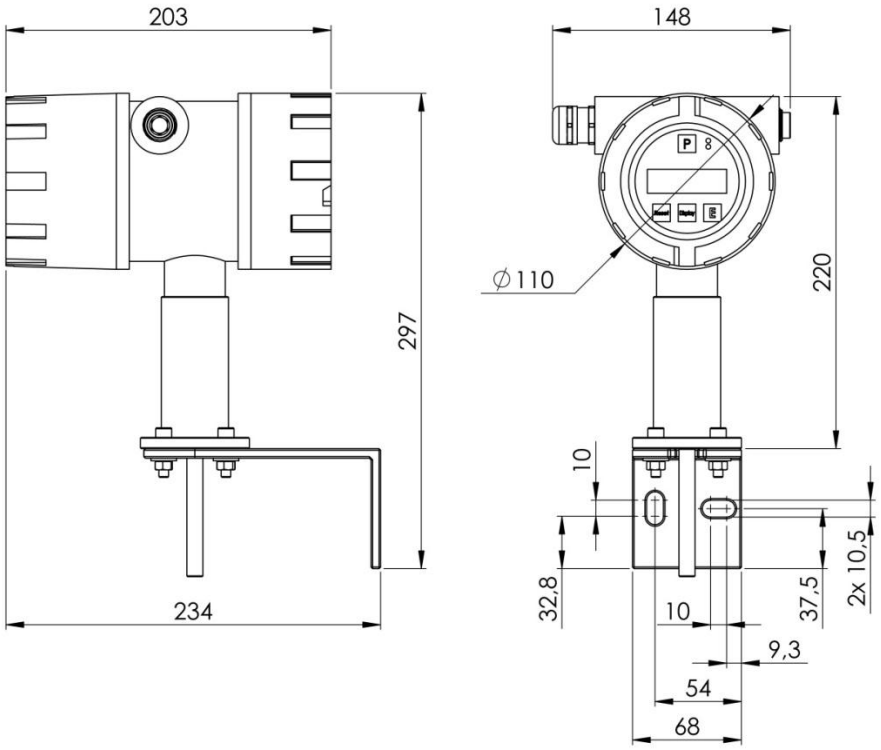


Fig. 27: Dimensions TCE8000-W-**

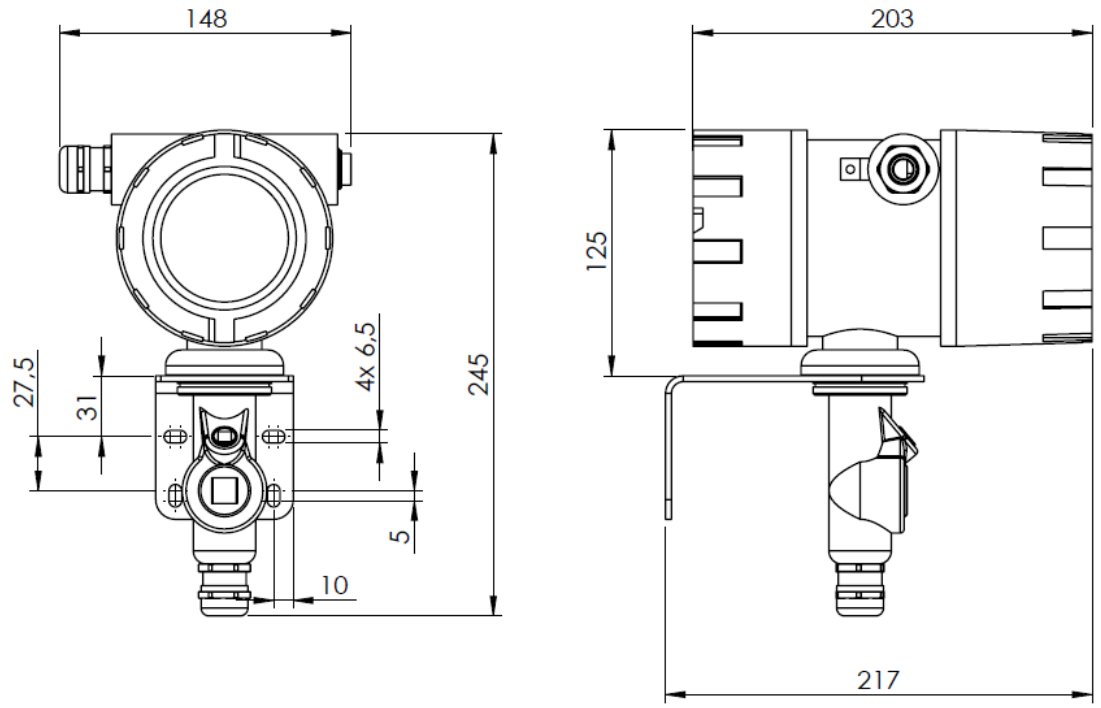


Fig. 28: Dimensions TCE8000-W-**-CEx (except ***A)**

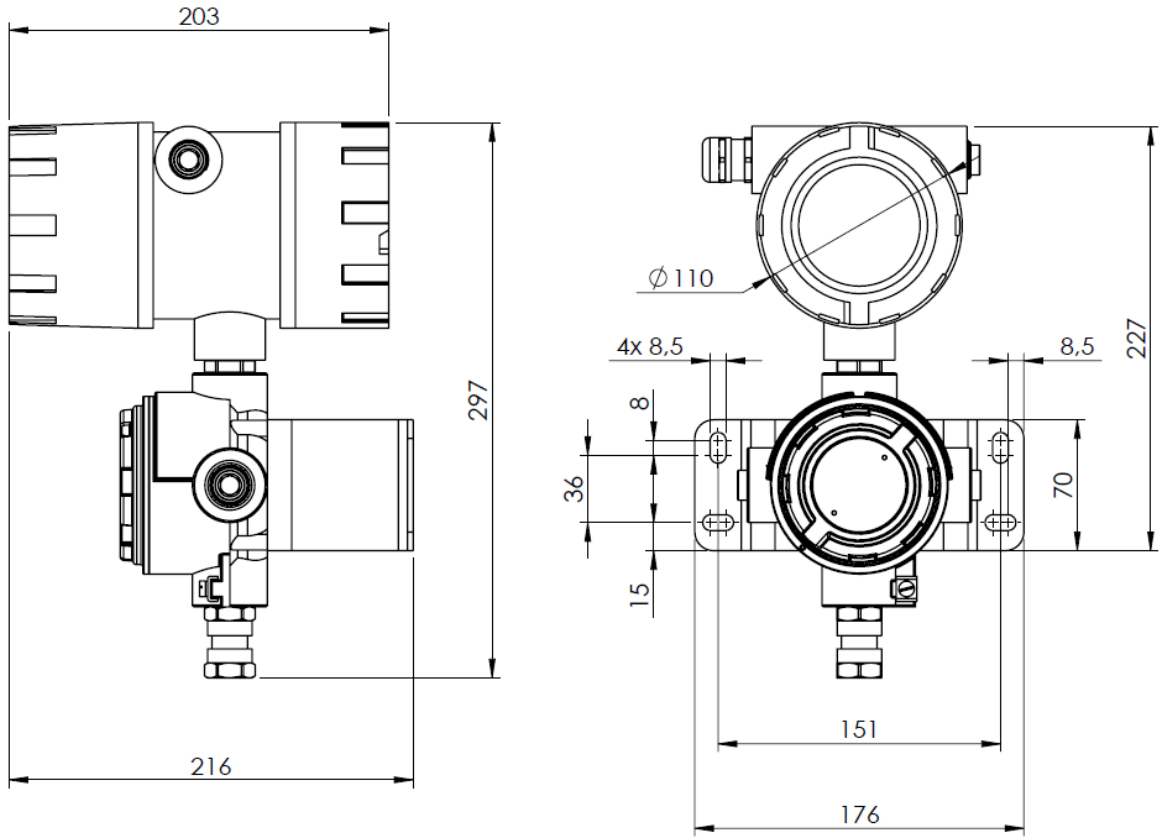


Fig. 29: Dimensions TCE8000-W-*A**

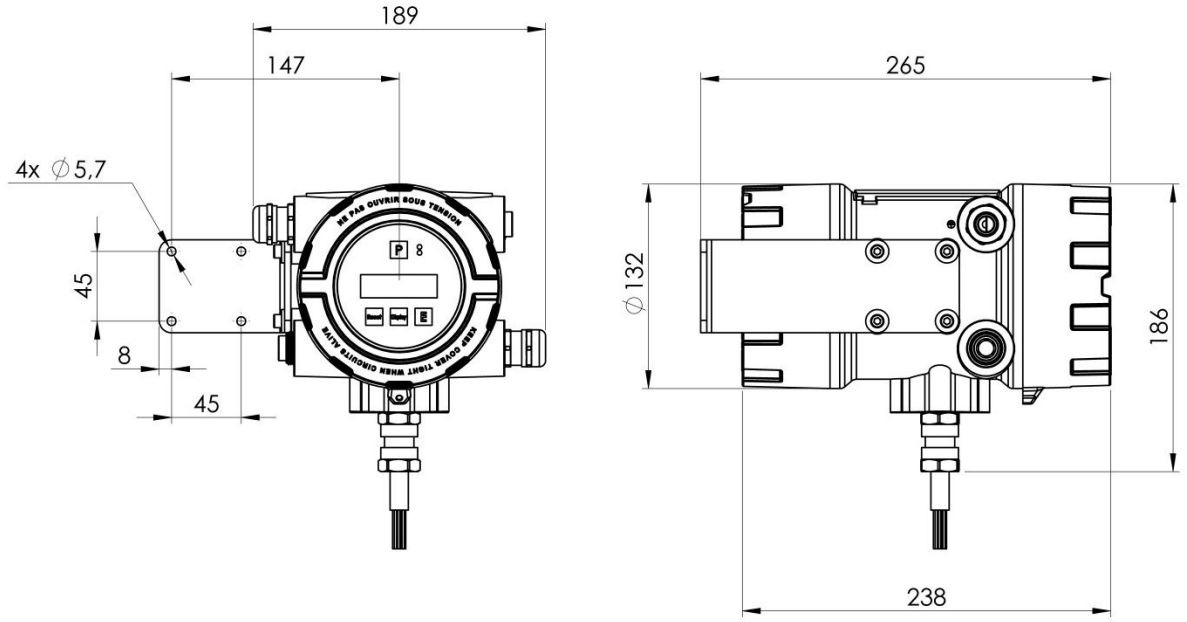


Fig. 30: Dimensions TCE8000-E-** (except ***A)**

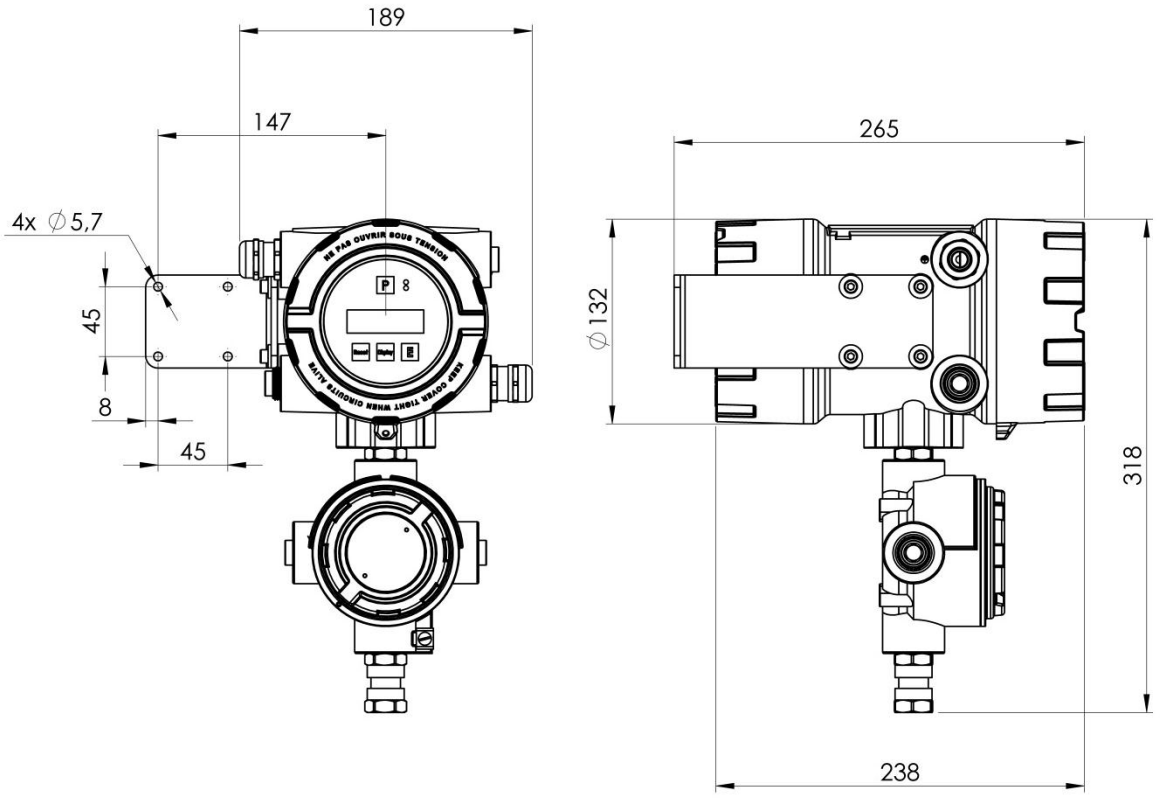


Fig. 31: Dimensions TCE8000-E-*A**

Remote panel-mounted housings

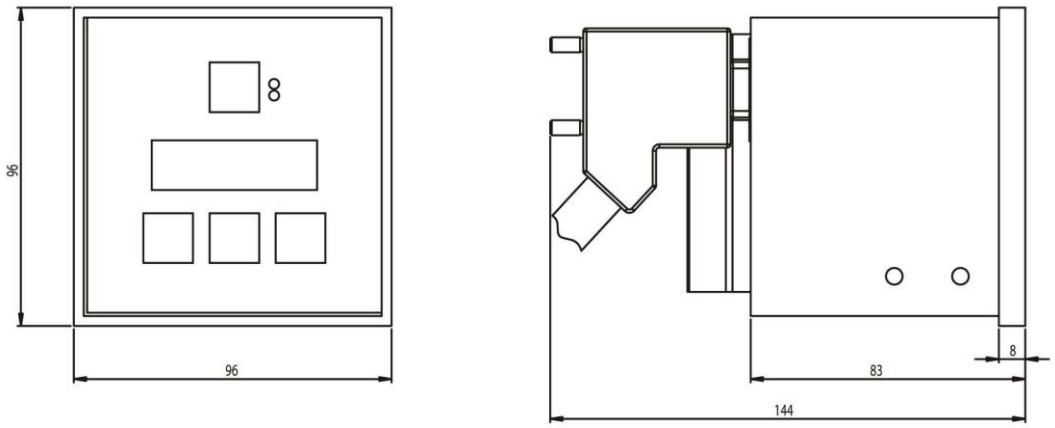


Fig. 32: Dimensions TCE8000-S-****

The required cutout for the panel is 92mm +0.8/-0mm x 92mm +0.8/-0mm.

The maximum thickness of the panel is 2mm.

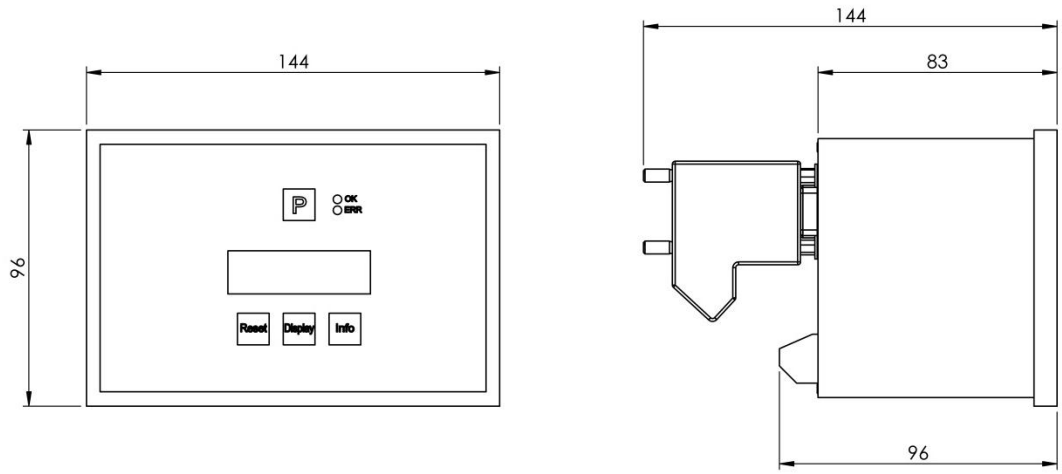


Fig. 33: Dimensions TCE8000-L-****

The required cutout for the panel is 138mm +1.0/-0mm x 92mm +0.8/-0mm.

The maximum thickness of the panel is 2mm.

7.4 WEEE and RoHS

The unit described herein is not subject to the WEEE directive and the corresponding national laws.

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

The unit described herein fully complies with the RoHS directive.

7.5 List of figures

7.6 List of tables

7.7 Addresses

Manufacturer

KEM
Küppers Elektromechanik GmbH
Liebigstraße 5
DE-85757 Karlsfeld
Germany

Tel.: +49 8131 593910
info@kem-kueppers.com
www.kem-kueppers.com

Tricor web page

www.tricorflow.com

Sales Contact

America:
AWL
TRICOR Coriolis Technology
8809 Industrial Drive
Franksville, WI 53126
USA

Tel.: +1 800-850-6110
sales@aw-lake.com
www.awgearmeters.com

Europe, Asia:
KEM
Küppers Elektromechanik GmbH
Liebigstraße 5
DE-85757 Karlsfeld
Germany

Tel.: +49 8131 593910
info@kem-kueppers.com
www.kem-kueppers.com

China:
KEM China
Rm. 430, JInYuan Building, No. 36 BeiyuanLu,
CN- Chaoyang District, Beijing 100012
P.R.CHINA

Tel.:+86 10 84929567 / +86 10 84929577
Fax:+86 10 52003739
shaw@kem-kueppers.cn
www.kem-kueppers.cn