



TRICOR[®]

Coriolis Mass Flow Meter with transmitter TCE 6000





Manual-Version

TCM_E60_CLASSIC_M_EN_190215_E011

SW-Version

This manual is valid for

Main SW: Mv3.40 and higher

Display SW: Dv3.40 and higher

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1. General Information

1.1. Features

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

- Economically-priced, non-calibrated but with excellent repeatability
- Optional custom-calibrated meters with high performance specifications
- No moving parts
- Simultaneous measuring of mass flow, density and temperature
- Calculation of volume flow as well as mass and volume total
- Flushable

The TRICOR CLASSIC Mass Flow Meters with TCE 6000 transmitter are for applications where due to cost or place restrictions no local display can be used.

TRICOR CLASSIC Mass Flow Meters with TCE 6000 transmitter are available as standard version as well as Ex certified for hazardous locations zone 2. For applications in zone 1 refer to the TCE 8000 transmitter.

TCE 6000 variants provide, depending on the selected configuration, various input and output options:

- One freely programmable 4 ... 20 mA outputs
- One freely programmable frequency output
- One to two control inputs (second control input is optional) and one control output (option)
- RS485 interface
- Optical input/output (option)
- USB interface (option)

The optional TRD 8001 remote display provides the following features:

- A graphic display
- Menu driven control with soft keys for easy operation (with manual)



Fig. 1: TCM 0325 with TCE 6000 and remote display TRD 8001



1.2. TCE 6000 Interface

1.2.1. TCE 6000 Endowment

Standard version (TCM ****_**_****-FSDS)	I/O-connector 5-pin and RS485
Expanded version (TCM ****_**_****-FFDB)	I/O-connector 5-pin, I/O-connector 8-pin, RS485 and USB (M12)
Expanded version (optical I/O) (TCM ****_**_****-FSDC)	Power 24 V DC, CTL in, F _{out} , RS485

1.2.2. Remote Control

SPS with both versions	Line 3-pin (supply by I/O-connector 5-pin) or 5-pin (supply via this line) with connector M12, 5-pin, B-coded.
PC with FSDS	KAB.RS485.TCE with connector M12, 5-pin, B-coded to RS485. Additionally the TCE 6000 must be supplied with 24 V via the I/O-connector.
PC with FFDB	KAB.RS485.TCE with connector M12, 5-pin, B-coded to RS485. Additionally the TCE 6000 must be supplied with 24 V via the I/O-connector. or KAB.USB.TCE connected to USB. This version is protected in compliance to IP 65 on the TCE 6000. Additionally the TCE 6000 must be supplied with 24 V via the I/O-connector. or Standard cable USB-A to Mini-USB-B connected to USB. This version is protected in compliance to IP 65 on the TCE 6000. Continuous operation in industrial environment and is not recommended. Additionally the TCE 6000 must be supplied with 24 V via the I/O-connector.



1.2.3. Combinations

FSDS			
FSDS/RS485	Connector B-coded (Phoenix 1432680) cable 5-pin	Communication + supply	SPS
FSDS/RS485	Connector B-coded (Phoenix 1432680) KAB.RS485.TCE	Communication	PC
	Connector A-coded to I/O5	Supply	Power supply 24 V
FFDB			
FFDB/RS485	Connector B-coded (Phoenix 1432680) Kabel 5-pin	Communication + supply	SPS
FFDB/RS485	Connector B-coded (Phoenix 1432680) KAB.RS485.TCE	Communication	PC
	Connector A-coded to I/O5 or I/O8	Supply	Power supply 24 V
FSDC			
FSDC/USB	KAB.RS485.TCE	Communication	PC
	Connector A-coded to power	Supply	Power supply 24 V

The following combinations are parametrizable via an interface cable in conjunction with a PC/Laptop with USB interface and with the TRICOR Configurator Software. The latest TRICOR Configurator Software version is available on our website in the download area.

- FSDS with KAB.RS485.TCE cable
- FFDB with KAB.RS485.TCE or KAB.USB.TCE cable
- FSDC with KAB.RS485.TCE cable

NOTE:

The cable must be ordered.



1.3. Safety

1.3.1. General Safety

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

The specification for Ingress Protection (IPxx) will only apply when all connectors are capped 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.

To guarantee the degree of Ingress Protection, ensure that cable entries are properly sealed. Thread seal or cable glands with gasket should be used.

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

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

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

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

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

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

1.3.2. Special Requirements for Ex Installations

Before installing and using TRICOR CLASSIC Mass Flow Meters in hazardous locations it is absolutely needed to read and to observe this Installation Manual and "Control drawing for hazardous areas".

In hazardous locations the covers of the TCE 6000 must not be opened under any circumstances if the supply voltage is alive.

The connector to the TCE 6000 must not be connected or disconnected with any I/O signal or the power supply alive.

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 8.3. must be observed at any time.

WARNING!

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

WARNING!

Potential risk of sparking from aluminum alloy enclosure due to impact and friction. This shall be considered during installation.



WARNING!

The installer shall ensure that the maximum ambient temperature of the equipment when installed is not exceeded.

WARNING!

Process temperature range is determined by temperature class for remote version TRICOR transmitter (see chapter 3.4).

1.3.3. Rupture Disc Handling

All TRICOR CLASSIC flow meters are fitted with a rupture disc installed on the case. A rupture disc, also known a “burst disc,” is a pressure relief device to protect systems from over-pressurization. In a Coriolis flow meter, the rupture disc prevents pressure from building up inside the welded case. In the event of an extreme failure where the internal flow tubes leak, the rupture disc element will open up once the internal case pressure exceeds approximately 4 bar [58 psi].

To avoid personal injury or property damage, connect a pipe or hose to the rupture disc housing in order to direct the relieved liquid and/or gas from the meter’s case through the rupture disc to a safe location, away from operators in the area. It is the user’s sole responsibility for the design of adequate venting and installation of adequate vent piping or directional flow after rupture occurs with the rupture disc as intended.

Particles may discharge when the rupture disc ruptures. These particles may be part of the rupture disc itself, or other environmental matter in the system. It is the user’s sole responsibility to ensure that the particles are directed to a safe location to prevent personal injury or property damage.

WARNING!

Take care not to puncture the rupture disc when installing a pipe or fitting to the rupture disc housing, which could cause premature failure of the rupture disc.

The flow meter case is filled with a dry inert gas to prevent moisture from building up. Any puncture or other physical damage to the rupture disc would allow moisture into the meter case, compromising the integrity of the meter and potentially resulting in inaccurate measurement results or total meter failure over time.

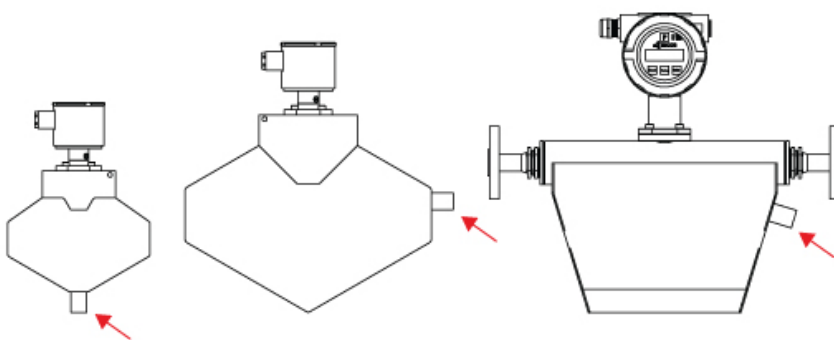


Fig. 2: Rupture disc locations vary by the meter size and style



Fig. 3: Warning sticker found near the rupture disc on all meters



1.3.4. 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.



1.4. Ordering Codes and Accessories

1.4.1. Ordering Code

TCM	XXXX	-	XX	-	X	X	X	X	-	X	X	X	X	-	Ex
Process connections¹⁾			XX												
See TCM datasheet			XX												
Mechanical options															
Medium Temperature range:															
-40 °C...+100 °C [-40 °F...+212 °F]															S
Pressure range															
With rupture disc max. 4 bar (58 psi)															G
Mechanical Design															
Standard															S
Face to face length															
Standard (other length on request)															S
Electronics options															
Electronics type															
Meter mount electronics TCE 6000															F
Interface															
RS485 (Modbus RTU)															S
RS485 (Modbus RTU) + USB (only TCE 6000)															F
Supply voltage															
24 V DC															D
Options															
8-pin I/O connector (TCE 6000 only)															B
Optical I/O (TCE 6000 only)															C
No option															S
EX-protection²⁾															
ATEX (Zone 2)															Exn

¹⁾ For connections not indicated with installation length, please contact manufacturer.

²⁾ Ex-protection only available in the option Exn.
Only if powered by an SELV supply.



1.4.2. Accessories

1.4.2.1. TRICOR Connection Cable (TCC) for panel-mounted housing

				TCC		X X		-		X X	
Cable Specifications/Connections											
Cable	Connector TCE	Connector TCM	Devices								
Standard cable	SUB-D, 9-pin	cable end sleeves (8pol.)	TCE 8**1-S-	0	2						
Standard cable	SUB-D, 9-pin/ Din-Rail mounting	cable end sleeves (8pol.)	TCE 8**1-S-	0	4						
High temperature cable	SUB-D, 9-pin	cable end sleeves (8pol.)	TCE 8**1-S-	0	9						
High temperature cable	SUB-D, 9-pin/ Din-Rail mounting	cable end sleeves (8pol.)	TCE 8**1-S-	1	0						
Length											
3 meter (Standard)	(≈ 10 ft.)							0	3		
6 meter	(≈ 20 ft.)							0	6		
10 meter	(≈ 33 ft.)							1	0		
15 meter	(≈ 49 ft.)							1	5		
20 meter	(≈ 66 ft.)							2	0		

1.4.2.2. Additional Accessories

Accessories for TCE 6000 transmitter	Ordering Code
Remote display for TCE 6000	TRD 8001
Connection cable TRD 8001 to TCE 6000, 2 m	TRD-TCE-6-2
Connection cable TRD 8001 to TCE 6000, 5 m	TRD-TCE-6-5
USB Cable, USB to mini USB M12, 2 m	KAB-USB-TCE
RS485 to USB connector cable 3 m for TCE 6000; versions FSDS;FFDB, FSDC	KAB-RS485-TCE-ISO
Pneumatic Power Gen. Plug M8, 3-pin, 2.5 m cable for TCE 6000 Version FSDC; 7.5 W, 24 V DC	TCE 6000-FSDC-SET-PPG
Light pulse emitter and receiver, DIN-rail for TCE 6000 Version FSDC ³⁾	OPTV-02/XO
Fiber optic cable for TCE 6000 Version FSDC for FOP 50/60, 10 m (5.5 mm)	LW-LA-10
Service and calibration	Ordering Code
DAkKS-Calibration (ILAC) according to DIN EN ISO/IEC 17025:2005	DAkKS-Calibration
Oxygen cleaning TCM	Oxygen cleaning TCM
Inspection certificate 3.1 according to DIN 50 049/EN 10204	3.WKZ-0100
TAG Plate (1.4404/316L)	TCM-Tag-Plate-1.4404

³⁾ See chapter 6 (ESTA).



1.5. Measuring Principle TCM

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

By measuring the natural frequency of the tubes the density of the medium can be calculated.

As both effects are temperature dependent, the temperature is measured by means of an accurate temperature sensor for correcting the temperature effects on flow and density measurement.

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

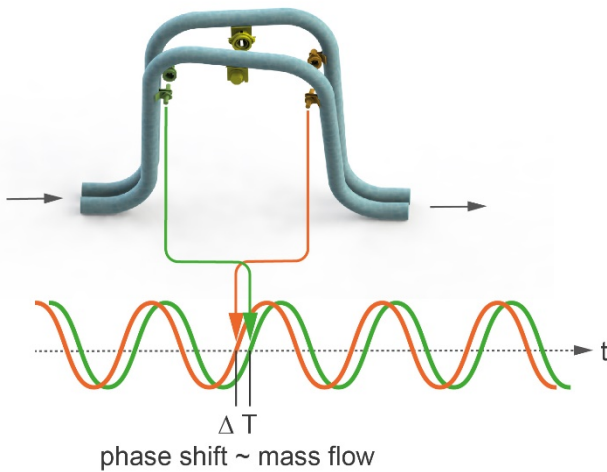


Fig. 4: Principle of operation Coriolis Mass Flow Meter



2. Getting Started

2.1. Unpacking

Verify that you have received the following items:

- TCM **** with mounted transmitter
- Instruction manual (printed booklet or www.tricorflow.com/manuals/)

2.2. Operating Elements

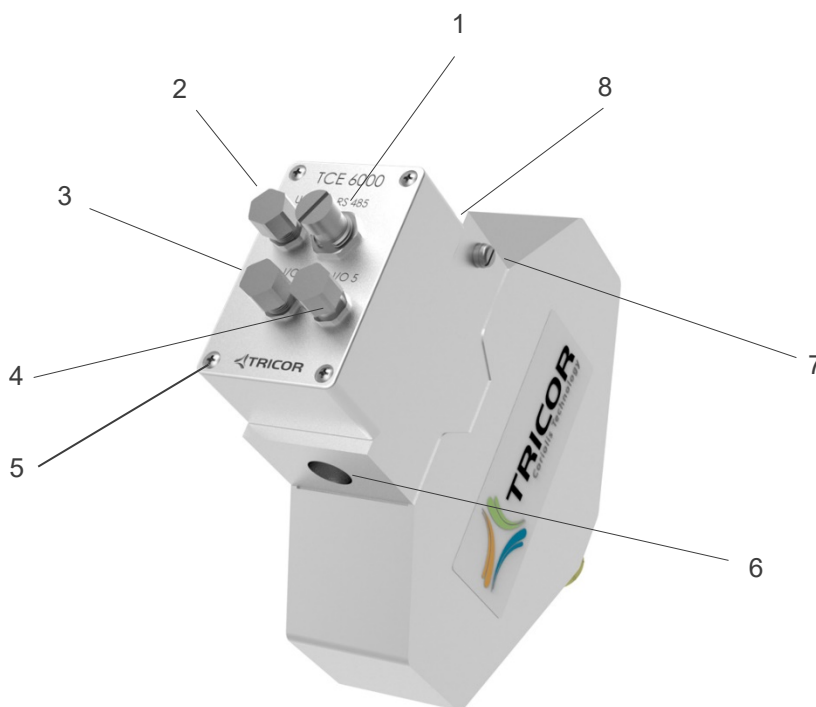


Fig. 5: Operating Elements

- 1 = Connector RS485, M12, B-coded, female
- 2 = Connector USB, M12 Optical output (option)
- 3 = Connector I/O, M12, A-coded, male, 8-pin optical input (Option)
- 4 = Connector I/O, M12, A-coded, male
- 5 = M6 mounting threads (back side, option, TCM 0325 through 3100 only)
- 6 = Fluid input, flange/thread as ordered
- 7 = Screw for protective ground (TCM 0325 through 3100 only)
- 8 = Fluid output, flange/thread as ordered



2.3. Pin Assignments

I/O 5-pinning

1	+24 V DC	Positive supply voltage (24 V DC)
2	I _{out}	Current output 4...20mA, referred to GND
3	GND	Ground
4	F _{out}	Frequency/pulse output
5	CTL IN 1	Control input 1

I/O 8-pinning

1	+24 V DC	Positive supply voltage (24 V DC)
2	I _{out}	Current output 4 ..20 mA, referred to GND
3	GND	Ground
4	F _{out}	Frequency/pulse output
5	CTL IN 1	Control input 1
6	CTL IN 2	Control input 2
7	CTL OUT	Control output
8	n.c.	Not connected

RS485-pinning

1	+24 V DC	Positive supply voltage (24 V DC)
2	-RS485	RS485 negative line
3	GND	Ground
4	+RS485	RS485 positive line
5	n.c.	Not connected

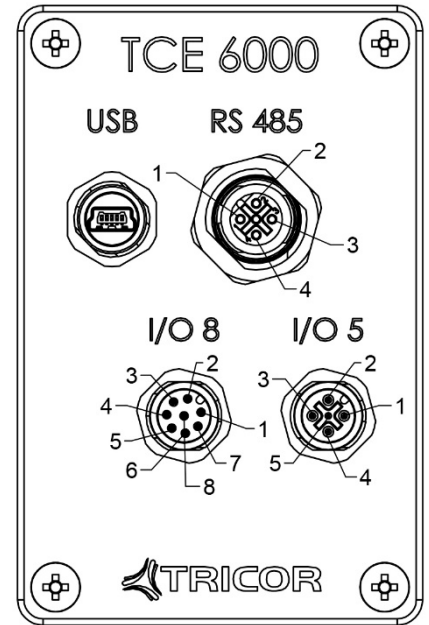
Version FSDC

I/O-pinning

1	+24 V DC	Positive supply voltage (24 V DC)
2	n.c.	Not connected
3	GND	Ground
4	n.c.	Not connected
5	n.c.	Not connected

RS485-pinning

1	+24 V DC	Positive supply voltage (24 V DC)
2	-RS485	RS485 negative line
3	GND	Ground
4	+RS485	RS485 positive line
5	n.c.	Not connected





2.4. Quick Start

WARNING!

Read installation instructions in chapter 3 carefully before installing the TCM!

In case the TCM has only to be operated without flow for testing or learning purpose, at least the following connections have to be made (see chapter 3.3):

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

WARNING!

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

WARNING!

In hazardous areas it is not allowed to operate the TRICOR CLASSIC Coriolis Mass Flow Meter without proper wiring in accordance with chapter 3.3. and with the housing not properly closed!

2.4.1. First Operation

If not ordered otherwise, the standard settings ex factory are as follows:

- I_{out} : flow, 20 mA = specified TCM range
- F_{out} : flow, 5,000 Hz = specified TCM range
- CTL OUT: fault (I/O8 only)
- CTL IN 1: make zero
- CTL IN 2: Reset batch (I/O 8 only)

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

Switch on the power supply. The TCM should slightly vibrate.

If a TRD 8001 is connected, it will show the power up sequence (see manual TRD 8001).

Switch on the flow. The output should show the corresponding values.

As soon as the TCM has reached the operating temperature, make the zero point calibration (see chapter 4.2.2.):

- Switch off the flow
- Ensure that the pipe is completely filled.
- Wait until the flow through the TCM is zero
- Start the zero point calibration by applying a low to CTL IN 1
- Wait until the offset procedure is finished (about 10 seconds)
- Switch on the flow again

2.4.2. Manual Control

For manual control a remote display TRD 8001 is required.

See the manual TRD 8001 for a description of the manual control (www.tricorflow.com/manuals/).



3. Installation

3.1. Important 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.

It is recommended to install a valve before and after the meter. For the zero calibration both valves should be closed.

3.1.1. External Vibrations

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

The TCMH 0450 sensor is mounted via mounting holes.

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.

The high pressure changes in short intervals over long time period should be avoided! If it is though an application requirement, please contact our internal sales for technical support!

3.1.2. 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 tubes down. This assures that gas bubbles will not accumulate in the measuring tubes. Meters with U-shaped tubes (TCM 5500 and bigger) can also be mounted vertically.

If a liquid might contain solid particles, the meter should be installed horizontally with the meter tubes up. This assures that the solid particles will not accumulate in the measuring tubes. Meters with U- shaped tubes (TCM 5500 and bigger) can also be mounted vertically.

The TCM 0325 through TCM 3100 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.

Two 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, must be observed.

If the amount of gas in the measured fluid or vice versa the amount of fluid in the measured gas goes to high, the flow and density readings get significantly disturbed. The disturbances can be properly detected by means of the measured drive current.



3.2. Mechanical Installation

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

3.2.1. Basic Safety Notes

CAUTION!

Hot surfaces resulting from hot process media

Risk of burns resulting from surface temperatures above 70 °C [155 °F].

Take appropriate protective measures, for example contact protection.

Make sure that protective measures do not cause the maximum permissible ambient temperature to be exceeded. Refer to the information in “Technical Data” (see chapter 8.3).

NOTE:

Hot surface is only an issue for media or ambient temperature above 50 °C [122 °F].

WARNING!

Wetted parts unsuitable for the process media

Risk of injury or damage to device.

Hot, toxic and corrosive media could be released if the process medium is unsuitable for the wetted parts.

Ensure that the material of the device parts wetted by the process medium is suitable for the medium.

Refer to the information in “Technical Data” (see chapter 8.3).

NOTE:

Material compatibility

The manufacturer can provide you with support concerning selection of sensor components wetted by process media. However, you are responsible for the selection of components. The manufacturer accepts no liability for faults or failures resulting from incompatible materials.

WARNING!

Unsuitable process connections

Risk of injury or poisoning.

In case of improper mounting hot, toxic and corrosive process media could be released at the connections.

Ensure that process connections (such as flange gaskets and bolts) are suitable for connection and process media.

WARNING!

Exceeded maximum permissible operating pressure

Risk of injury or poisoning.

The maximum permissible operating pressure depends on the device version, pressure limit and temperature rating. The device can be damaged if the operating pressure is exceeded. Hot, toxic and corrosive process media could be released.

Ensure that maximum permissible operating pressure of the device is not exceeded. Refer to the information on the sensor nameplate and/or in “Technical Data” (see chapter 8.3).



WARNING!

Unprotected cable ends

Risk of explosion through unprotected cable ends in hazardous areas.

Protect unused cable ends in accordance with IEC/EN 60079-14.

WARNING!

Loss of explosion protection

Risk of explosion in hazardous areas if the device is open or not properly closed.

Close the device as described in “Electrical Installation” (see chapter 3.3).

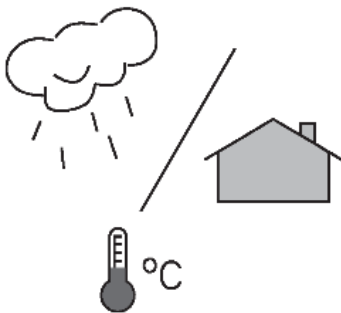
CAUTION!

External stresses and loads

Damage to device by severe external stresses and loads (e.g. thermal expansion or pipe tension). Process media can be released.

Prevent severe external stresses and loads from acting on the device.

3.2.2. Installation Location Requirements



TRICOR TCMP Series Flow Meters has IP65 rating by default. With the optional IP67/NEMA 4X enclosure rating the meters are suitable for indoor and outdoor installations.

Process pressure and medium temperature

If applicable, make sure that specifications for rated process pressure (PS) and medium temperature (TS) plus ambient temperature that are indicated on the device nameplate/label will not be exceeded.

Aggressive atmospheres

Ensure that the device is suitable for the application and that it is installed where there is no risk of penetration of aggressive vapors.

Direct sunlight

Prevent the device from overheating or materials becoming brittle due to UV exposure by protecting it from direct sunlight. Make sure that the maximum permissible ambient temperature is not exceeded. Refer to the information in “Technical Data” (see chapter 8.3).

WARNING!

Equipment used in hazardous areas

Risk of explosion in hazardous areas.

Special requirements apply to the location and installation of the device. See “Electrical Installation” (chapter 3.3).

**WARNING!****Strong vibrations**

Risk of explosion in hazardous areas.

In plants with strong vibrations, mount the transmitter in a low vibration environment.

CAUTION!**Strong vibrations**

Damage to device

In plants with strong vibrations, mount the transmitter in a low vibration environment away from the sensor.

3.2.3. Horizontal Installation

The horizontal installation is the recommended installation.

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

Install the meter to a solid, non-vibrating surface as close to the meter as possible. With the TCM 0325 through TCM 3100 this could be done via the optional mounting threads.

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

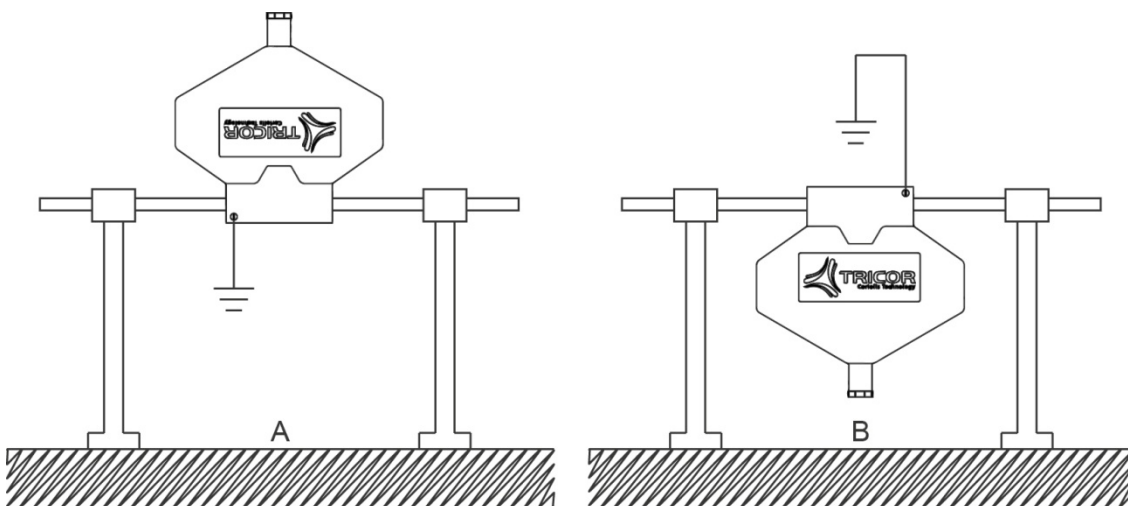


Fig. 6: Recommended horizontal Installation

3.2.4. Vertical Installation

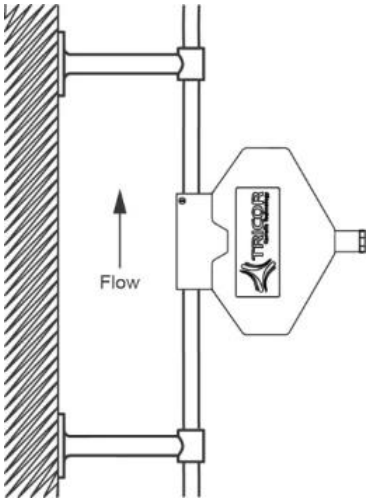


Fig. 7: Vertical Installation

TCMH Mass Flow Meters for high pressure applications (>400 bar [5,800 psi]) should not be mounted in vertical position.

The diamond shaped TCM 0325 through TCM 3100 should not be mounted vertically except you are sure that the medium contains neither gas bubbles nor solid particles.

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.

3.2.5. Installation in a Drop line

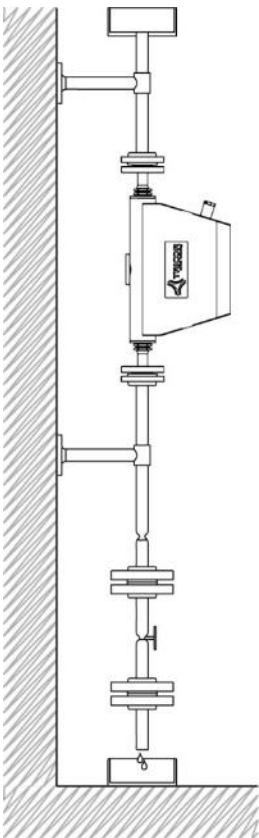


Fig. 8: Installation in a Drop Line

The diamond shaped TCM 0325 through TCM 3100 should not be mounted vertically except you are sure that the medium contains neither gas bubbles nor solid particles.

TCMH Mass Flow Meters for high pressure applications (>400 bar [5,800 psi]) should not be mounted in vertical position.

All other meters can be mounted vertically, but flow going down is only allowed as long as there is significant backpressure on the meter to prevent any type of waterfall effect and to assure the meter remains constantly full of the liquid.



3.2.6. Critical Installations

The meters must not be mounted at the highest point of the tubing (a), if gas bubbles are to be expected, or at the lowest point (B), if solid particles are to be expected, 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.

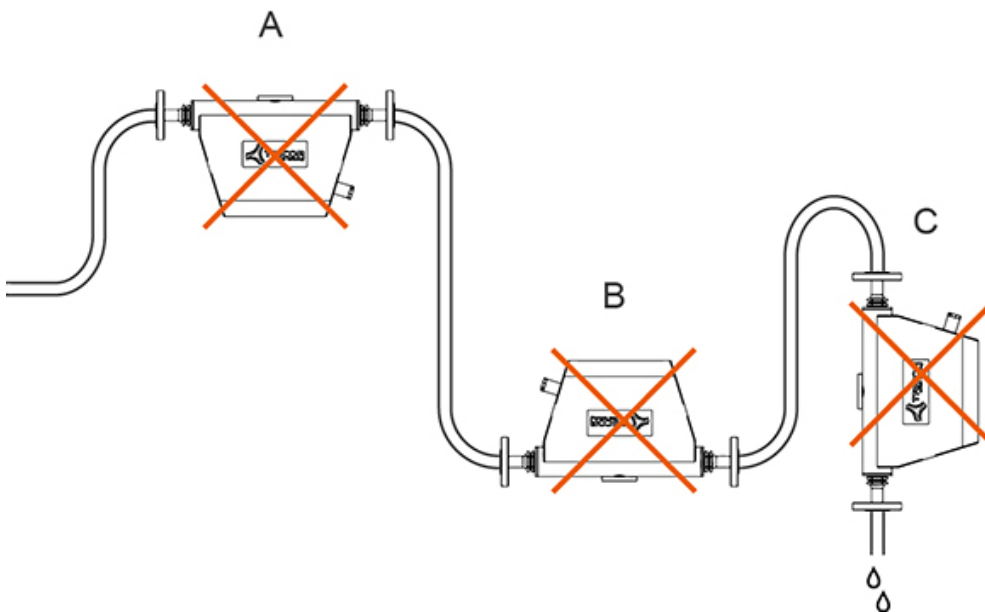


Fig. 9: Critical Installations

3.3. 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 TCM with TCE 6000 transmitter requires a regulated DC power supply of 24 V.

The digital inputs and outputs are referred to GND and to the ground potential of the DC supply (= negative pole).

The ground potential GND is connected to protective ground via a 1 k Ω .

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

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.

All electrical connections (except option FSDC) have to be done via the M12 connectors.

Connect the shields to PE.

NOTE:

In bigger installations a separate PE connection with a high cross section ($> 1.5 \text{ mm}^2$) is recommended for avoiding high equalizing currents in the shield.

Wiring diagram (does not apply for ESTA configuration)

1	+24 V DC	Positive supply voltage (24 V DC)
2	I_{out}	Current output 4 ... 20 mA, referred to GND
3	GND	Ground
4	F_{out}	Frequency/pulse output
5	CTL IN 1	Control input 1
6	CTL IN 2	Control input 2 (I/O8 only)
7	CTL OUT	Control output (I/O8 only)
8	n.c.	Not connected

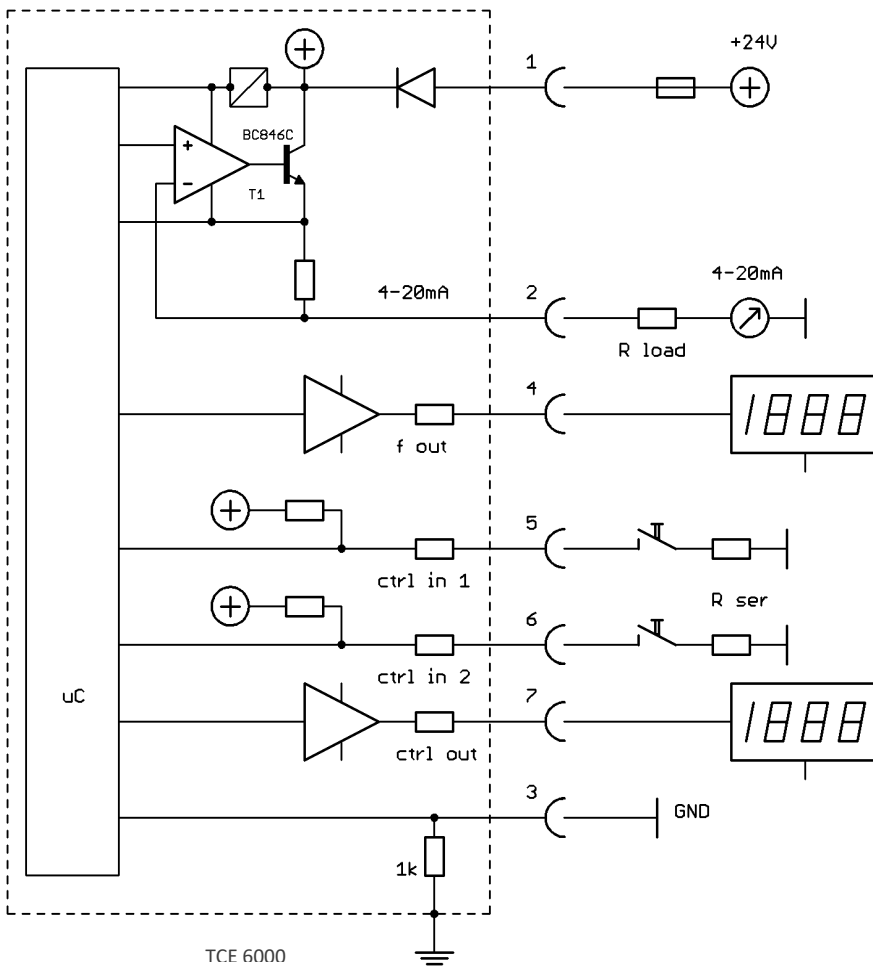


Fig. 10: Wiring diagram TCE 6000



3.3.1. Power Supply and Grounding

3.3.1.1. 24 V DC Power Supply

The TCE 6000 requires a regulated DC power supply of 24 V.

The power supply input of the TCE is protected by a 315 mA 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 6000 use shielded cables. If several cables are used, each cable should be shielded properly.

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 ground pins of connector I/O5, I/O8 and RS485 are internally connected together.

The supply pins of connector I/O5, I/O8 and RS485 are internally connected together via ferrite inductances for EMI suppression.

For operating the TCE 6000, the power supply can be applied to any of the 3 connectors.

NOTE:

The USB interface cannot be used to power the TCE 6000.

If a remote display TRD 8001 is connected, the display will be fed via the RS485 connector. In that case use the connector I/O5 or I/O8 for powering the whole system.

See Fig. 10 for connecting the power supply.

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

3.3.2. Connecting the control inputs and outputs

The frequency and control outputs are active push-pull outputs with an output resistance of 220 Ω. They can be loaded to the positive supply or to ground. For a high output swing the load resistors R_{load} should not be lower than 1 kΩ.

The digital outputs can drive any normally used input, including PLC inputs.

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

$$V_{high} = V_{supply} * \frac{R_{load}}{220 \Omega + R_{load}}$$

$$V_{low} < 1 V$$

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

$$V_{high} > V_{supply} - 1 V$$

$$V_{low} = V_{supply} - V_{supply} * \frac{R_{load}}{220 \Omega + R_{load}}$$

The inputs are active low with levels according to IEC946. Due to the internal pull up resistor they can be driven by a push pull output, an npn open collector output or a switch to ground.



If for any reason a series resistor R_{ser} is required, the value should be limited to a maximum of 1 k Ω for proper operation.

Ground and protective ground are internally connected via a 1 k Ω resistor. The resistor will thermally withstand a potential difference of up to 30 V between PE and GND but for proper operation this difference should be limited to 5 V. See Fig. 10 for connecting the power supply.

3.3.3. Connecting the analog outputs

The TCE 6000 provides 1 active 4 ... 20mA current output referred to GND.

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

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

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

For 24 V $\pm 10\%$ supply this gives a maximum value of 620 Ω .

See Fig. 10 for connecting the power supply.

3.4. 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 or disconnect any connector in hazardous locations with any supply or I/O circuits alive!

The TCM***.**-***-F*** -Exn is specified for operation in zone 2 (3G), if powered by an SELV supply.

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.

WARNING!

Make sure that the maximum values are not exceeded.



4. Manual Operation

4.1. Manual Control

The TCE 6000 does not provide any manual control. If a manual control is required, a remote display TRD 8001 must be used. For the description of the manual control refer to the TRD 8001 manual:

www.tricorflow.com/manuals/

An additional option consists in the parameterization of the TCE 6000 via an interface cable (see chapter 1.2.3.)

4.2. Setup Guidelines

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

The different possibilities for optimizing the settings are described below.

For changing the settings, the TRD 8001 or a remote control is required.

An additional option consists in the parameterization of the TCE 6000 via an interface cable (see chapter 1.2.3.)

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 TCE 6000 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.

4.2.2. Offset Calibration

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

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

4.2.3. Flow filter

The raw data of a Mass Flow Meter is relatively noisy. To get a stable reading a filtering of the calculated flow is required.

The filters in the TCE 6000 are set by means of the time constant t . The time constant is the time the output needs, after a jump from a value x to 0, to go to $x/e = x/2.72$. A higher time constant means more stable reading, but also a slower reaction to changing flows.



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

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 TCE 6000 electronics just delays the flow reading and consequently the "TOTAL" value. Independent of the slope (fast or slow) of the rising and falling flow, the error of the internally calculated TOTAL and at the frequency output are canceled out, if the flow rises from zero (or any other value) and later goes back to the starting value. For getting a correct "TOTAL" via the display or the frequency output, it is just necessary to wait long enough after the flow is switched off.

For best results the TCE 6000 electronics provides two filters.

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

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

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

4.2.4. CUT OFF

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

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

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

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). 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.

4.2.6. Interaction of the Parameters

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

FLOW FILTER and CUT OFF

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

NOTE:

In ON-OFF operation high values for the flow filter combined with high values for “CUT OFF” must be avoided!

Jumps of the flow not going down to zero are not affected by “CUT OFF”.

FLOW FILTER and STEP RESPONSE

As just described, 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 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. Offset calibration

For best accuracy the TRICOR CLASSIC Mass Flow Meter 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 by applying a low level to CTL IN 1 (if CTL IN 1 is configured as “make offset”), via the TRD 8001 or via the interface.

The offset procedure takes about 10 s (fast) or 25 - 30 s (slow).

After the offset procedure reopen the valves and restart the flow.

4.4. I/O Settings

The inputs and outputs of the TCE 6000 can be used for different purposes. The following chapters give an overview over the possible settings. For changing the settings the TRD 8001 or a remote control is required.

4.4.1. Frequency Output

The frequency output has two operating modes:

FREQUENCY (Default):

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 2 Hz and 10 kHz can be generated in this mode.

TOTAL COUNT:

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

4.4.2. Control Output

The control output has seven operating modes:

FAULT:

In case of an error the control output goes high.

FLOW DIREC:

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

BATCH:

In the batch mode the TCE 6000 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”.

**FLOW LIMIT:**

If the flow rate is greater than the value set for "FLOW LIMIT" plus hysteresis, the control output goes high. If the flow rate is lower than "FLOW LIMIT" minus hysteresis, the control output goes low. The output status don't changes between the two thresholds.

OFF (Default):

The output is always low.

FREQUENCY:

See chapter 4.4.1.

PHASE SHIFT:

Both outputs operate in the „TOTAL COUNT“ mode (see chapter 4.4.1.) and provide signals with the same frequency. The signals are 90° displaced from each other.

4.4.3. Analog Output

The analog output can show one of the following four parameters:

FLOW (Default):

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

4.4.4. Control Input

The control inputs have four operating modes:

EXTERNAL ZERO:

If a high level is applied to the input, the TCE 6000 starts the zero offset procedure.

RESET BATCH:

If a low 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

OFF (Default):

The input is deactivated. Level changes lead to no reaction

HOLD:

If a low level is applied to the input, all flow meters stop.



4.5. Data Configuration

The TCE 6000 can store the settings in a backup memory.

For storing or reloading the settings the TRD 8001 or a remote control is required.

4.6. I/O Test

For testing the electrical connections, all inputs and outputs can be controlled or read out directly.

The following tests 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 actual level at the input is indicated

For making the tests the TRD 8001 or a remote control is required.



5. Remote operation

As a standard the TCE 6000 is equipped with an RS485 Interface. Optionally an USB interface is available.

5.1. Serial RS485 Interface

5.1.1. Electrical Connection of RS485 Interface

Connect the signal RS485A or RS485+ (both names are used in the literature) to pin 2 and RS485- or RS485B to pin 4 of the connector "RS485". Terminal 3 is the ground reference pin for the interface.

The TCE 6000 can be powered via the +24 V and GND pins of any of the connectors. If the TCE 6000 is used via the RS485 and no other I/O signal is used, it can be powered also via pin 1 and 3 of the RS485 connector.

NOTE:

The operating range of the data pins (2 and 4) is -7 V to +12 V referred to ground (3). Voltages outside that range could damage the TCE 6000.

5.1.2. RS485 Interface Protocol

The RS485 interface uses a KEM proprietary protocol for communicating with the remote display TRD 8001.

For using the RS485 interface for remote communication, the TCE 6000 can be delivered with a special firmware. In that case a Modbus protocol is used.

NOTE:

Units with Modbus protocol cannot be used with the TRD 8001.

For getting Modbus protocol, please contact KEM/AWL.

5.2. USB Interface

For using the USB interface with a PC, the remote control SW "TRICOR Configurator" for Microsoft Windows is available free of charge.

With the TRICOR Configurator all settings can be made. Additionally automatic measurements as well as the storage of the measured data and the settings are possible.

5.2.1. Electrical connection for USB

The TCE 6000 cannot be powered via the USB interface. Therefore a separate 24 V supply is required.

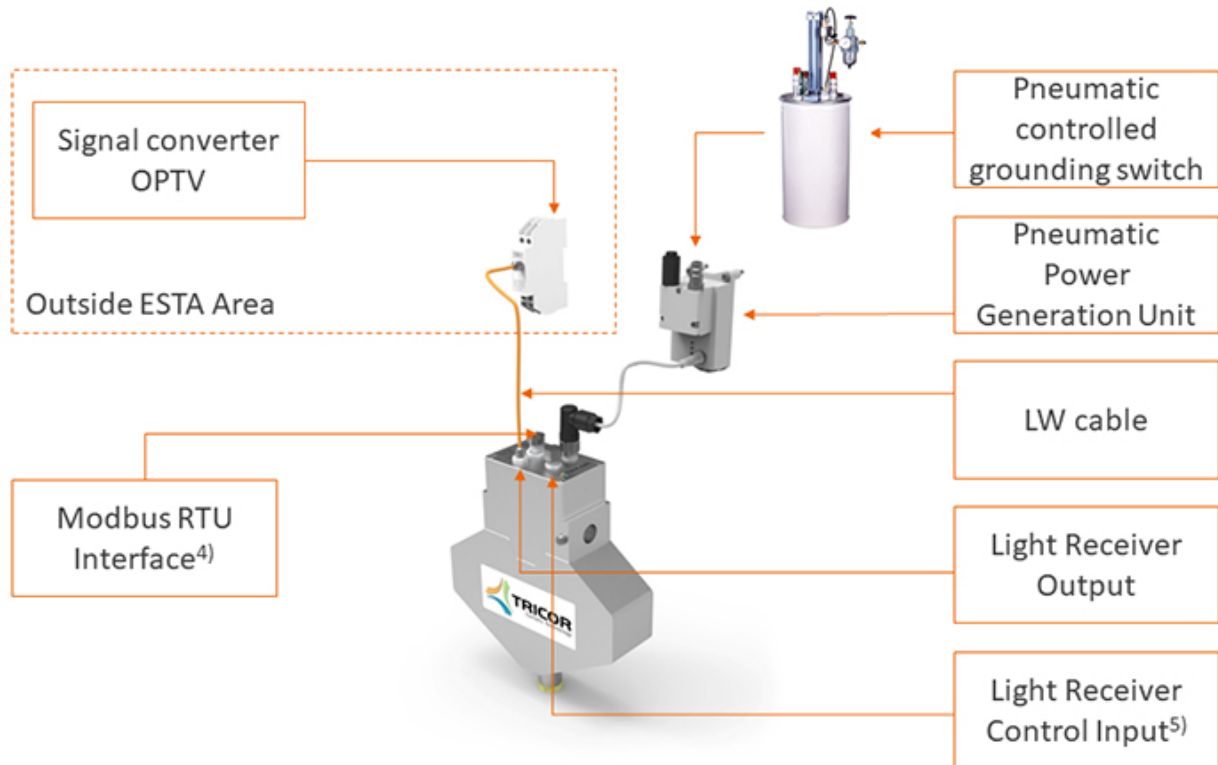
For temporary connection of the USB interface a normal USB A to MINI USB cable can be used.

For a stationary connection in an automatic system the USB A to USB M12 cable available from KEM is mandatory for maintaining the specified IP rating.

6. ESTA

6.1. Installation

Set-up of a TCM/TCE 6000 with optical I/O



⁴⁾ The interface may be used for parameterization of the flow meter (not allowed in active ESTA mode).

⁵⁾ On request

Fig. 11: ESTA Installation

NOTE:

For parameterization of the flow meter, the interface may be used.

WARNING:

Parameter setting is not allowed during active ESTA operation.



7. Service and Maintenance

7.1. Maintenance

The sensors of the TCM series as well as the TCE 6000 transmitter do not require regular maintenance.

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

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

7.2. Trouble Shooting

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

No operation at all

All cables properly connected?

→ Connect the missing cables

Power supply switched on?

→ Switch on the power supply

Internal fuse of the TCE blown?

→ For checking and changing the fuses refer to chapter 7.4.

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

No frequency or current output with operating display

Output correctly wired?

→ Correct the wiring (see chapter 2.3.)

Output correctly configured?

→ Correct the configuration

Wrong flow direction (Flow in the display is negative)?

→ Change flow direction



7.3. Maintenance and Repair Work

WARNING!

Impermissible repair of explosion protected devices

Risk of explosion in hazardous areas

Repair must be carried out by persons authorised by the manufacturer..

WARNING!

Maintenance during continued operation in a hazardous area

There is a risk of explosion when carrying out repairs and maintenance on the device in a hazardous area.

Isolate the device from power. - or -

Ensure that the atmosphere is explosion-free (hot work permit).

WARNING!

Impermissible accessories and spare parts

Risk of explosion in areas subject to explosion hazard.

Only use original accessories or original spare parts.

Observe all relevant installation and safety instructions described in the instructions for the device or enclosed with the accessory or spare part.

WARNING!

Humid environment

Risk of electric shock.

Avoid working on the device when it is energized.

If working on an energized device is necessary, ensure that the environment is dry.

Make sure when carrying out cleaning and maintenance work that no moisture penetrates the inside of the device.

CAUTION!

Hot parts in the device

Temperatures that can burn unprotected skin may be present for some time after the device has been switched off.

Observe the waiting time specified in "Technical Data" (see chapter 8.3) before starting with maintenance work.

WARNING!

Enclosure open

Risk of explosion in hazardous areas as a result of hot components and/or charged capacitors inside the device.

To open the device in a hazardous area:

1. Isolate the device from power.
2. Observe the wait time specified in "Technical Data" (chapter 8.3) before opening the device.
3. Visually inspect sensor inlet and outlet.

Exception: Devices exclusively having the type of protection "Intrinsic safety Ex i" may be opened in an energized state in hazardous areas.



CAUTION!**Hazardous voltage at open device**

Risk of electric shock when the enclosure is opened or enclosure parts are removed.

Before you open the enclosure or remove enclosure parts, de-energize the device.

If maintenance measures in an energized state are necessary, observe the particular precautionary measures. Have maintenance work carried out by qualified personnel.

WARNING!**Hot, toxic or corrosive process media**

Risk of injury during maintenance work.

When working on the process connection, hot, toxic or corrosive process media could be released.

As long as the device is under pressure, do not loosen process connections and do not remove any parts that are pressurized.

Before opening or removing the device ensure that process media cannot be released.

WARNING!**Improper connection after maintenance**

Risk of explosion in areas subject to explosion hazard.

Connect the device correctly after maintenance.

Close the device after maintenance work.

The device is maintenance-free. However, a periodic inspection according to pertinent directives and regulations must be carried out.

An inspection can include check of:

- Ambient conditions
 - Seal integrity of the process connections, cable entries, and cover screws
 - Reliability of power supply, lightning protection, and grounds
-

NOTE:

Repairs and service may only be carried out by persons authorised by the manufacturer.

NOTE:

The manufacturer defines flow sensors as non-repairable products.

Maintenance information parameters

The basic maintenance information parameters are:

- Current Date and Time
 - Operating Time Total
 - Operating Time
 - Configuration Counter
 - Transmitter Hardware Revision
 - HMI Hardware Revision
 - Sensor Hardware Revision
-



7.4. Changing the Fuses

The power supply inputs of the TCE 6000 contains a fuse. With the non-Ex versions the fuse can easily be replaced by qualified personnel.

Switch off the power supply.

Open the 4 screws in the top cover of the TCE 6000.

Remove the top cover carefully.

Near the lower end of the PCB in the top cover 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. Put the top cover carefully on the TCE 6000 again and fix it with the 4 screws.

NOTE:

Make sure that the top cover and the gasket in the top cover are at the right position before reaffixing the screws.

7.5. Calibration

For calibrating the flow, density and temperature measurement of the TCE 6000 the remote display TRD 8001 or a connection via interface (e. g. TRICOR Configurator via USB) is required.

7.5.1. Recalibration

KEM Küppers Elektromechanik GmbH and AW-Lake Company offers to recalibrate the sensor in Germany or the USA. The following calibration types are offered as standard according to configuration:

- Standard calibration
- Customer specified calibration
- Calibrations according DIN EN ISO/IEC 17025:2005
- Density calibration
- Witness calibration

7.6. Cleaning

Cleaning the enclosure

- Clean the outside of the enclosure with the inscriptions and the display window using a cloth moistened with water or a mild detergent.
- Do not use any aggressive cleansing agents or solvents, e.g. acetone. Plastic parts or the painted surface could be damaged. The inscriptions could become unreadable.



7.7. Service

The TCE 6000 does not contain any user serviceable parts except the fuse.

In case of malfunction, please contact your nearest dealer or directly KEM or AWL.

7.8. 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.

For reloading the original settings the TRD 8001 or an interface connection is required.

8. Listings

8.1. Warranty

For warranty refer to the general terms and conditions of KEM Küppers Elektromechanik GmbH, which can be found on the corresponding website (www.kem-kueppers.com), respectively for the Americas those of AW Lake Company (www.aw-lake.com).

8.2. Certifications and Compliances

Category	Standards or description	
EU Declaration of Conformity – EMC	Meets the Directive 2014/30/EU for Electromagnetic Compatibility. Compliance is given to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61000-6-2	Generic standards – Immunity standard for industrial environments
	EN 61000-6-4	Emission standard for industrial environments
Australia/New Zealand Declaration of Conformity-EMC	Complies with the EMC Emission standard ⁶⁾	
	AS/NZS 2064	
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B ⁶⁾ .	
EU 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/EU	
	EN 61010-1	Safety requirements for electrical equipment for measurement control and laboratory use.
Designed to meet the following US standards	UL 61010-1/2012	Standard for electrical measuring and test equipment.
Designed to meet the following Canadian standards	CAN/CSA C22.2 no. 61010-1-4/2008	Safety requirements for electrical equipment for measurement, control, and laboratory use.
International standards	IEC61010-1/2010	Safety requirements for electrical equipment for measurement, control, and laboratory use.
Equipment Type	Test and measuring	
Safety Class	Class 1 (as defined in IEC 61010-1, Annex H) – grounded product	
ATEX Zone 2	II 3G Ex nA IIC T4	(Option)

⁶⁾ Compliance demonstrated using high-quality shielded interface cables.

8.3. Technical Data

8.3.1. TCM Transducer - Technical Data for Liquids

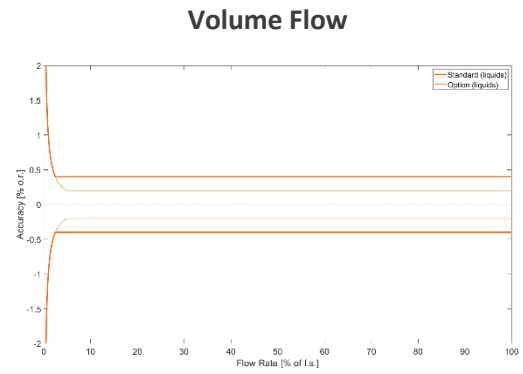
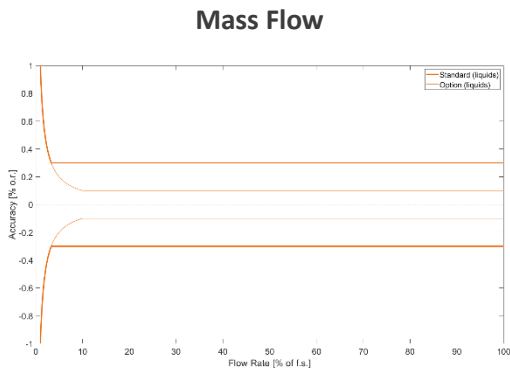
	TCM 0325	TCM 0650	TCM 1550	TCM 3100	TCM 5500	TCM 7900	TCM 028K	TCM 065K	TCM 230K ⁷⁾	
Max. Flow Rate (kg/h)	325	650	1,550	3,100	5,500	7,900	28,000	65,000	230,000	
Max. Flow Rate (lb/min)	12	24	57	114	202	290	1,029	2,388	8,450	
Basic Accuracy (Mass Flow)	±0.3 % of flow rate (option: up to 0.1 % of flow rate)								±0.3 % (±0.15 %)	
Basic Accuracy (Volume Flow)	±0.3 % of flow rate (option: up to 0.15 % of flow rate)								±0.3 % (±0.2 %)	
Repeatability	±0.05 % of flow rate									
Zero Stability	±0.01 % of full scale								±0,015 %	
Density Range	up to 2,500 kg/m ³ [2.5 g/cm ³] (higher ranges on request)									
Density Accuracy	±1.0 kg/m ³ [±0.001 g/cm ³]									
Density Repeatability	±0.5 kg/m ³ , ±0.0005 g/cm ³									
Process Temperature Range	±1 °C ±0.5 % of reading [±1.8 °F ±0.5 % of reading]									
Temperature Repeatability	±0.2 °C [±0.36 °F]									
Process and Ambient										
Process Connections	female thread ½" adaptors for flanges, dairy and tri-clamp				flanges EN1092, ANSI B16.5, DIN2512 treaded tri-clamp					
Max. Pressure Standard	200 bar [2,900 psi] option: up to 345 bar [5,000 psi] (not for ASME)					100 bar [1,450 psi]				
Pressure Drop at max. Flow	for detail information please contact us									
Process Temperature (non Ex)	-40 °C ... +100 °C [-40 °F ... +212 °F] (standard)									
Ambient Temperature	-40 °C ... +70 °C [-40 °F ... +158 °F]									
Storage Temperature	-40 °C ... +100 °C [-40 °F ... +212 °F]									
Electr. Connections Remote	screw type terminals									
Electr. Connections Meter Mount	none (internally connected to the electronics)									
Ingress Protection	IP65 (IP66/IP67 on request)									
General										
Tube Arrangement	2 serial	2 parallel	2 serial	2 parallel	2 parallel	2 parallel	2 parallel	2 parallel	2 parallel	
Tube Inner Diameter	4 mm	4 mm	8 mm	8 mm	7 mm	9 mm	16 mm	28 mm	43 mm	
Tube Material	1.4404 [AISI 316L]									
Housing Material	1.4404 [AISI 316L]									
Dimensions	see dimensional drawings chapter 8.3.6									

Calibration for Liquids and Gases: The TRICOR CLASSIC flowmeters are always factory calibrated with water.
 Calibration Conditions: Water: 20 °C ... 25 °C [68 °F ... 77 °F], ambient temperature: 20 °C ... 25 °C [68 °F ... 77 °F].
 All specifications are based on above mentioned calibration reference conditions, a flow calibration protocol is attached to each instrument.
 Stated accuracy combines the effects of repeatability, linearity and hysteresis.
 Typical flow dynamics based on max. flow rate is 100:1.

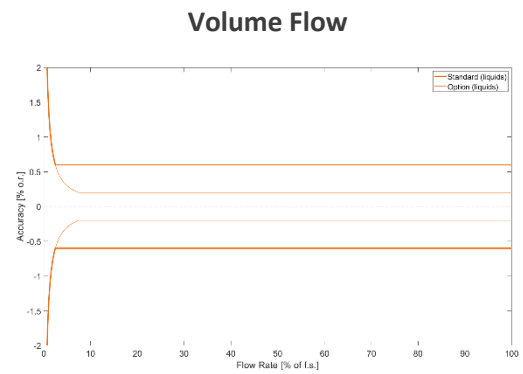
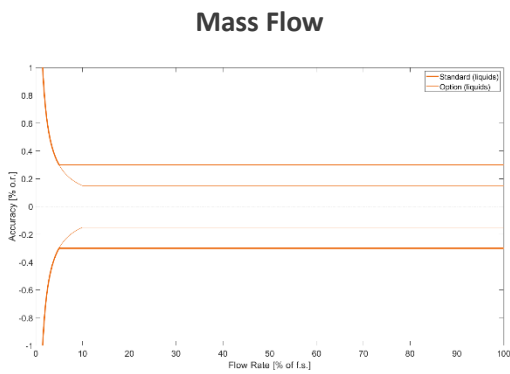
⁷⁾ TCM 230K not available in combination with TCE 6000.

8.3.2. Accuracy for Liquids

8.3.2.1. TCM 0325 to TCM 065K



8.3.2.2. TCM 230K



Flow Rate of full Scale	Accuracy
$\geq \frac{\text{Zero Point}}{\text{Basic Accuracy}} * 100$	$\pm \text{Basic Accuracy}$
$< \frac{\text{Zero Point}}{\text{Basic Accuracy}} * 100$	$\pm \frac{\text{Zero Point}}{\text{Measured Value}} * 100$

8.3.3. TCM Transducer - Technical Data for Gases

	TCM 0325	TCM 0650	TCM 1550	TCM 3100	TCM 5500	TCM 7900	TCM 028K	TCM 065K	TCM 230K ⁸⁾
Nom. Flow Rate (kg/h) ^{9) 11)}	78	177	333	740	910	1,430	5,100	15,650	48,900
Nom. Flow Rate (lb/min) ^{9) 11)}	3	7	12	27	34	53	188	575	1,797
Nom. Flow Rate (Nm ³ /h) ^{9) 10)}	109	247	464	1,031	1,268	1,993	7,109	21,813	68,157
Nom. Flow Rate (SCFM) ^{9) 10)}	64	146	273	607	747	1,173	4,184	12,838	40,115
Basic Accuracy	±1 % of flow rate (option: up to ±0.5 % of flow rate)								
Repeatability	±0,25 % of flow rate								
Zero Stability in kg/h	0.0325	0.065	0.155	0.31	0.55	0.79	2.8	6.5	23
Zero Stability in lb/min	0.0012	0.0024	0.0057	0.0114	0.020	0.029	0.103	0.239	0.845
Density Measuring Range	see comment ⁸⁾								
Density Accuracy	±1.0 kg/m ³ [±0.001 g/cm ³]								
Density Repeatability	±0.5 kg/m ³ [±0.0005 g/cm ³]								
Temperature Accuracy	±1 °C ±0.5 % of reading [±1.8 °F ±0.5 % of reading]								
Temperature Repeatability	±0.2 °C [±0.36 °F]								
Process and Ambient									
Process Connections	female thread ½“ adaptors for flanges, dairy and tri-clamp				flanges EN1092, ANSI B16.5, DIN2512 treaded tri-clamp				
Max. Pressure Standard (Option)	200 bar [2,900 psi] option: up to 345 bar [5,000 psi] (not for ASME)					100 bar [1,450 psi]			
Pressure Drop at Max. Flow	for detail information please contact us								
Process Temperature (non Ex)	-40 °C ... +100 °C [-40 °F ... +212 °F] (standard)								
Ambient Temperature	-40 °C ... +70 °C [-40 °F ... +158 °F]								
Storage Temperature	-40 °C ... +100 °C [-40 °F ... +212 °F]								
Electr. Connections Meter Mount	None (connected internally)								
Ingress Protection	IP20/IP65								
General									
Tube Arrangement	2 serial	2 parallel	2 serial	2 parallel	2 parallel	2 parallel	2 parallel	2 parallel	2 parallel
Tube Inner Diameter	4 mm	4 mm	8 mm	8 mm	7 mm	9 mm	16 mm	28 mm	43 mm
Tube Material	1.4404 [AISI 316L]								
Housing Material	1.4404 [AISI 316L]								
Dimensions	see chapter 8.3.6								

Max. allowed flow velocity (Ma 0.5).

For gas applications, flow rate and pressure drop for individual sensor sizes are dependent on operating temperature, pressure and fluid composition. Therefore, when selecting a sensor for any particular gas application, please use the TSP (TRICOR Sizing Program) or contact us.

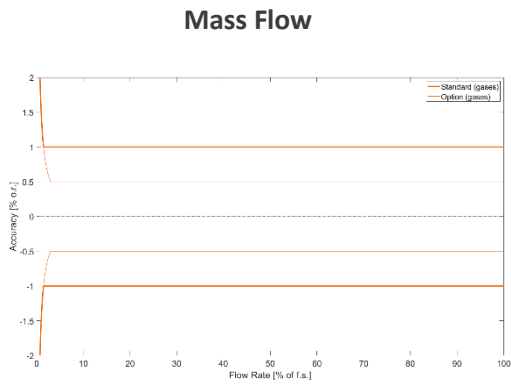
⁸⁾ TCM 230K not available in combination with TCE 6000.

⁹⁾ Nominal flow rates that produce approximately 3 bar [43 psi] pressure drop for natural gas at 50 bar [725 psi] operational pressure.

¹⁰⁾ Normal reference conditions (Nm³/h) are 1,013 bar und 0 °C. Standard (SCFM) reference conditions are 14.7 psi und 60 °F.

¹¹⁾ Flow rate and density range depend on the gas density and the pressure range.

8.3.4. Accuracy for Gases



Flow Rate of full Scale	Accuracy
$\geq \frac{\text{Zero Point}}{\text{Basic Accuracy}} * 100$	$\pm \text{Basic Accuracy}$
$< \frac{\text{Zero Point}}{\text{Basic Accuracy}} * 100$	$\pm \frac{\text{Zero Point}}{\text{Measured Value}} * 100$



8.3.5. Technical Data TCE 6000 Transmitter

General	
Supply Voltage	24 V DC
Programming	via TRD 8001 or via interface
Interface	RS 485, USB (option)
EMC	according to EN 61000-6-4 and EN 61000-6-2
Power Consumption	max. 4 W
Electrical Connections	M12, A-coded, male (I/O, power supply) M12, B-coded, female (RS485, power supply) M12 MINI USB
Material	aluminum diecast
Temperature	ambient: : -40 °C ... +70 °C [-40 °F ... +158 °F] storage and transport: -40 °C ... +80 °C [-40 °F ... +176 °F]
Protection Class	IP65
Analog Output	
Current Output	4 ... 20 mA active
Resolution	14 bit
Linearity	±0.05 %
Temperature Drift	0.05 % per 10 K
Load	< 800 Ω
Output Value	programmable: flow, total, density, temperature
Pulse/frequency Output	
Frequency Range	0.5 - 10,000 Hz (for ESTA (OPTV receiver) 0.5 - 5,000 Hz)
Output Signal	active push pull output for flow rate, optional: insulated optical frequency output
Status In- and Output	
Status Output	push pull programmable (option) (in TOTAL mode: 0.5 - 100 Hz)
Control Input	programmable (standard: 1 input/option: 2 inputs), optional: insulated optical control input

NOTE:

For parameterization of the flow meter, the interface may be used.

WARNING:

Parameter setting is not allowed during active ESTA operation.

8.3.6. Dimensional Drawings

Dimensional Drawing TCM 0325 to TCM 0650

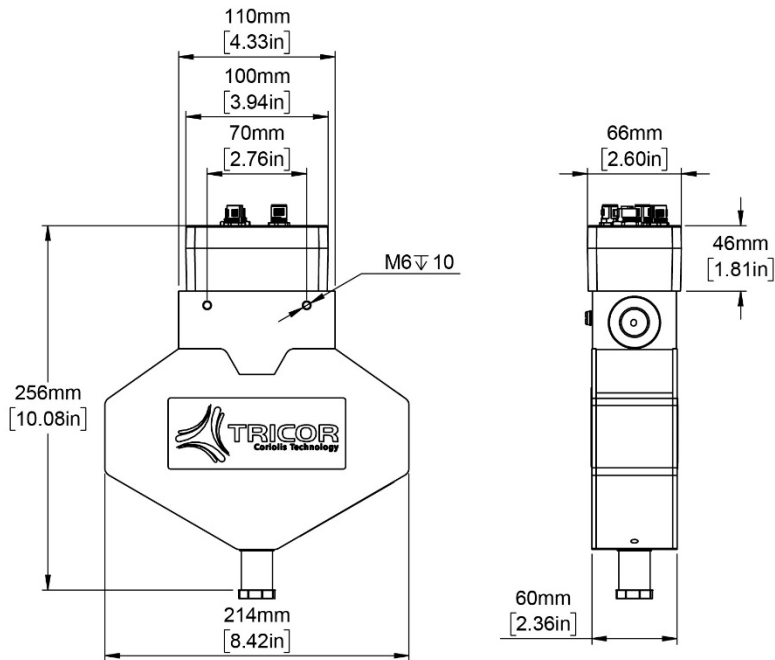


Fig. 12: Dimensions TCM 0325-**-****-**** through TCM 0650-**-****-****

Dimensional Drawing TCM 1550 to TCM 3100

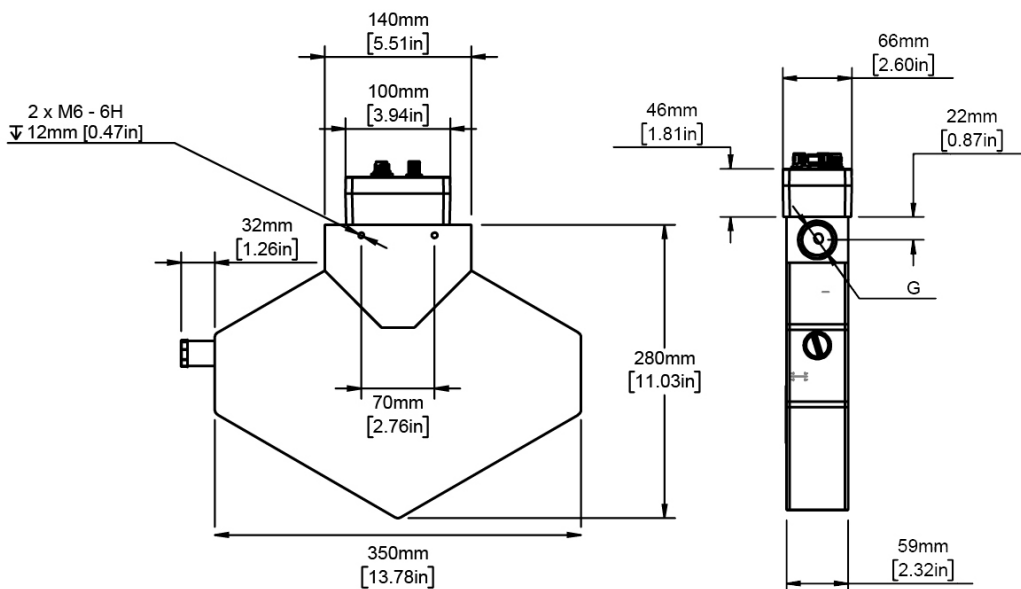


Fig. 13: Dimensions TCM 1550-**-****-**** through TCM 3100-**-****-****

Dimensional Drawing TCM 5500 to TCM 065K

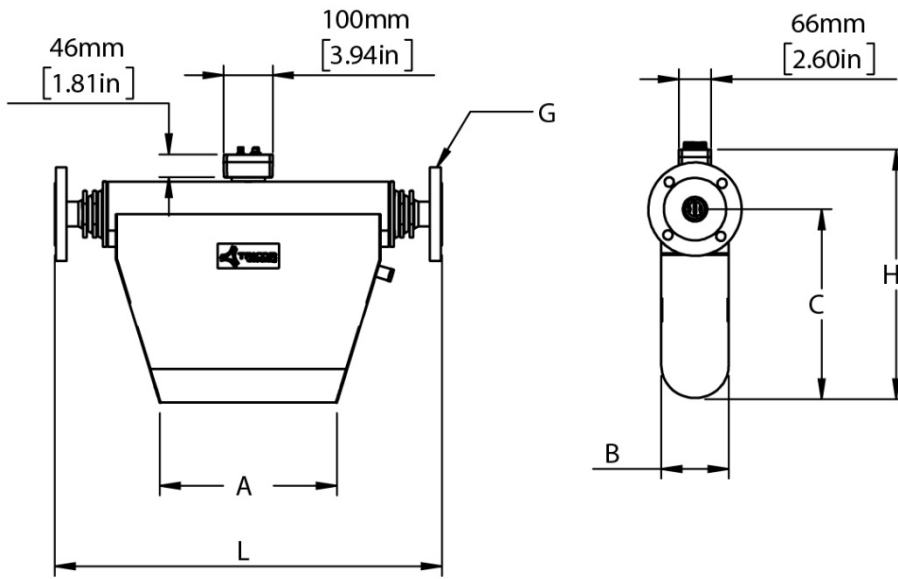


Fig. 14: Dimensions TCM 5500-**-***-**** through TCM 065K-**-***-****

Sensor Type	A	B	C	H	L ¹²⁾	Connection ¹³⁾
TCM 5500, 7900	200 mm [7.87 in]	61 mm [2.40 in]	204 mm [8.03 in]	260 mm [10.24 in]	460 mm [18.11 in]	on request
TCM 028K	217 mm [8.54 in]	80 mm [3.15 in]	253 mm [9.96 in]	315 mm [12.40 in]	625 mm [24.61 in]	on request
TCM 065K	360 mm [14.17 in]	151 mm [5.94 in]	387 mm [15.24 in]	480 mm [18.90 in]	830 mm [32.68 in]	on request

¹²⁾ other connections on request

¹³⁾ further lengths on request

8.4. WEEE and RoHS

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

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

The TCM described herein fully complies with the RoHS directive.

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