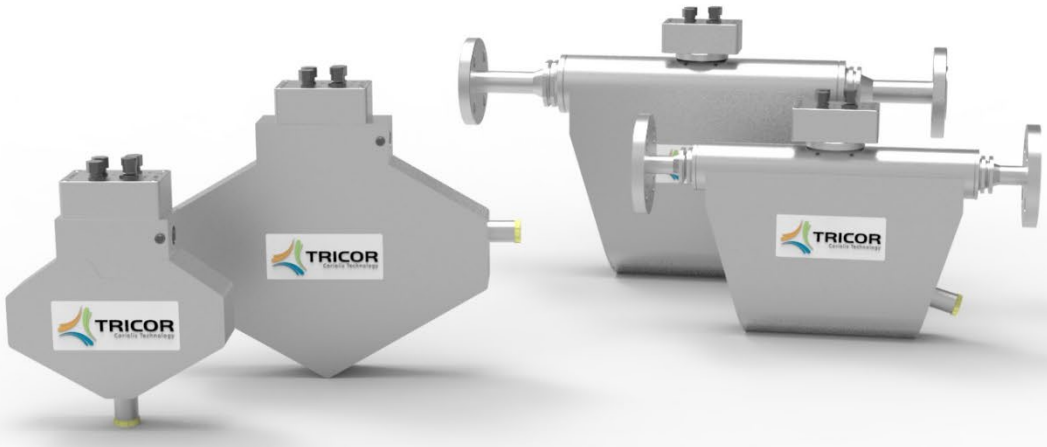
TRICOR®

Coriolis Mass Flow Meter with TCE 6000 transmitter



TRICOR Coriolis Technology

Manual-Version

TCM_E60_CLASSIC_M_EN_190215_E012

SW-Version

This manual is valid for

Main SW: Mv3.40 and higher

Display SW: Dv3.40 and higher

Index

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:

- Cost-effective, not calibrated, but with excellent repeatability
- Higher accuracy possible with customer-specific calibration
- No moving parts
- Simultaneous measurement of mass flow, density and temperature
- Calculation of volume flow, total mass and total volume
- Flushable

The TRICOR CLASSIC Mass Flow Meters with the TCE 6000 transmitter are intended for applications without a local display for cost or space reasons.

The TRICOR CLASSIC Mass Flow Meters with TCE 6000 are available in the standard version or with a manufacturer's declaration for areas exposed to explosion hazards in zone 2. Please use TCE 8000 series transmitters for applications in zone 1.

TCE 6000 versions have different input/output options depending on the chosen configuration:

- One freely programmable 4 … 20 mA output (active)
- One freely programmable frequency output
- One or two control inputs (second control input is optional) and one control output (option)
- RS485 interface
- USB interface (option)

1.2. Safety

1.2.1. Warnings

NOTE:

Notices provide important information for the correct use of the device. Non-compliance may lead to malfunctions.

WARNING!

Warnings provide very important information for the correct use of the device. Non-compliance poses a risk to the device and the life and limb of the user.

1.2.2. General Safety

All information in these operating instructions regarding safety and technical data applies only when the device is installed and operated correctly according to the operating instructions.

The information about the protection class (IPxx) applies only if plug connectors of the same or a higher protection class are connected to all jacks.

The housing must be properly closed during operation.

Shielded cables must be used for all load and electricity supply connections. The device has to be electrically grounded.

To protect against fires, the supply requires fusing with a value that is no higher than the allowable current for the cable.

The compatibility of all media contact components with the medium to be measured has to be assured.

National and international installation regulations have to be observed.

Only authorized, sufficiently qualified personnel are permitted to install and operate the device.

WARNING!

There is a risk of parts being ejected if the bursting disc ruptures; sufficient protection such as covers must be provided. Take the device out of operation and contact KEM Küppers Elektromechanik GmbH.

WARNING!

Make sure that the bursting disc is not damaged when mounting a tube or connecting elements on the housing. Damage can cause premature failure of the bursting disc.

WARNING!

Read the installation information in Section 3 carefully before installing the device!

WARNING!

The maximum permissible pressure must not be exceeded due to pressure surges.
Risk of injury or poisoning.
The maximum permissible operating pressure depends on the device version, pressure limit and temperature range. The device may be damaged if the operating pressure is exceeded. Hot, toxic and corrosive process media may be released.

Make sure that the permissible operating pressure is not exceeded. Observe the information on the sensor type plate and/or in the technical data (Section 7.3).

WARNING!

Hot and cold surfaces due to hot process media.
Risk of burns due to surface temperatures.
Wear suitable protective equipment.
Implement appropriate measures such as contact protection.

Make sure that the ambient temperature does not exceed or fall below the permissible limits due to the safety measures. Observe the information in the technical data (Section 7.3).

WARNING!

Wetting of components that are not compatible with the process medium.
Risk of injury or damage to the device.
Hot, cold, caustic, toxic and corrosive media may be released if components that are not compatible with the process medium are wetted. Media may be discharged under high pressure.

Make sure that the material of components wetted by the process medium is compatible. Observe the information in the technical data (Section 7.3).

WARNING!

Unsuitable process connections.
Risk of injury or poisoning.
Risk of the ejection of components and the discharge of medium under high pressure.

Hot, cold, caustic, toxic or corrosive process media may be discharged at the connections in case of improper installation. Make sure that the process connections (flange seals and screws, for example) are suitable for the application and the process media being used.

WARNING!

Exceeding the maximum permissible operating pressure.
Risk of injury or poisoning.
The maximum permissible operating pressure depends on the device version, pressure limit and temperature range. The device may be damaged if the operating pressure is exceeded. Hot, cold, caustic, toxic and corrosive process media may be released.

Make sure that the operating pressure does not exceed or fall below the permissible range, even in case of a fault. Observe the information on the sensor type plate and/or in the technical data (Section 7.3). Implement appropriate safety measures and/or devices.

WARNING!

External stresses and loads
Damage to the device due to severe external stresses and loads (thermal expansion or pipe strain, for example). The process medium may be released. Risk of the ejection of components and the discharge of medium under high pressure.

Avoid exposing the device to external stresses and loads.

WARNING!

Only switch the supply voltage on after all lines are properly connected and secured.

WARNING!

Risk of electric shock.
Avoid working on the device while it is connected to electrical voltage.
If working on a device under electrical voltage is unavoidable, make sure that the environment is dry.
Take care that moisture does not get into the device during cleaning and maintenance work.

WARNING!

Hot and cold components in the device
Temperatures that cause burns on unprotected skin may be present for some time after the device is switched off.
Observe appropriate wait times before starting maintenance work or use suitable personal protective equipment.

WARNING!

Hot, cold, corrosive or toxic process media
Risk of injury during maintenance work.
Hot, cold, corrosive or toxic process media may be released during work on process connections.

Do not loosen any process connections or remove any components that are under pressure while the device is pressurised. Before opening or removing the device, make sure that process media cannot be released. Flush the line.

1.2.3. Special Requirements for Ex Installation

The installation information in Section 3.4 must be observed for the installation and operation of the TRICOR CLASSIC Mass Flow Meter in areas exposed to explosion hazards (ATEX zone 2).

WARNING!

Loss of explosion protection.

Risk of explosion in areas exposed to explosion hazards if the device is opened and/or not connected as directed in the operating instructions.

WARNING!

Use in areas exposed to explosion hazards
There is a risk of explosion in areas exposed to explosion hazards.

Special requirements apply here with regard to the device location and installation. See “Electrical installation” (Sections 3.3 and 3.4).

WARNING!

Explosion hazard. Make sure that the ambient temperature and process temperature of the device does not exceed or fall below the permissible range. See the information on the type plate.

WARNING!

Explosion hazard. Disconnecting or connecting the plug connectors under voltage is not permitted in areas exposed to explosion hazards. Opening the housing under voltage is prohibited. Making repairs or technical alterations is prohibited.

WARNING!

Explosion hazard. A protective conductor connection is mandatory for operation in areas exposed to explosion hazards. The cross-section of the protective conductor has to be at least equal to the cross-section of the supply line or 1 mm².

WARNING!

Explosion hazard. Consider the possible risk of sparking due to impacts and friction on the aluminium alloy housing during installation and operation.

WARNING!

Explosion hazard. When long connecting lines are used, make sure that the maximum permissible capacitances and inductances for the corresponding voltages and group of gases are not exceeded. Complying with the limit values specified in the technical data is mandatory (see Section 7.3).

WARNING!

Repairing explosion-protected devices is prohibited.
Explosion hazard.

Repair work may only be carried out by personnel authorised by the manufacturer.

WARNING!

Working in areas exposed to explosion hazards during operation
There is a risk of an explosion when work is performed on the device in areas exposed to explosion hazards.
Disconnect the device from the mains network
and
ensure that the atmosphere does not pose an explosion hazard (permit for hot work).

1.2.4. Handling of the Bursting Disc

All TRICOR CLASSIC flowmeters have a bursting disc integrated into the housing. The bursting disc on a Coriolis flowmeter prevents the build-up of pressure in the welded housing. If liquids or gases are discharged from the measurement tubes and the internal housing pressure exceeds 2 bar [29 psi], the bursting disc ruptures.

Connect a tube or hose to the bursting disc housing to discharge the flow of liquid or gas from the housing of the measuring device through the ruptured bursting disc to a safe place. Parts may be ejected when the bursting disc ruptures. These ejected parts may come from the bursting disc itself or surrounding materials and can cause personal injury or damage to property.

The operating company is responsible for the layout of appropriate venting and the installation of appropriate venting lines.

WARNING!

There is a risk of parts being ejected if the bursting disc ruptures; sufficient protection such as covers must be provided. Take the device out of operation and contact KEM Küppers Elektromechanik GmbH.

WARNING!

Make sure that the bursting disc is not damaged when mounting a tube or connecting elements on the housing. Damage can cause premature failure of the bursting disc.

NOTE:

The housing of the flowmeter is filled with a dry gas to prevent the accumulation of moisture. If the bursting disc is damaged, moisture may enter the measuring device and impair its function or lead to failure of the measuring device.

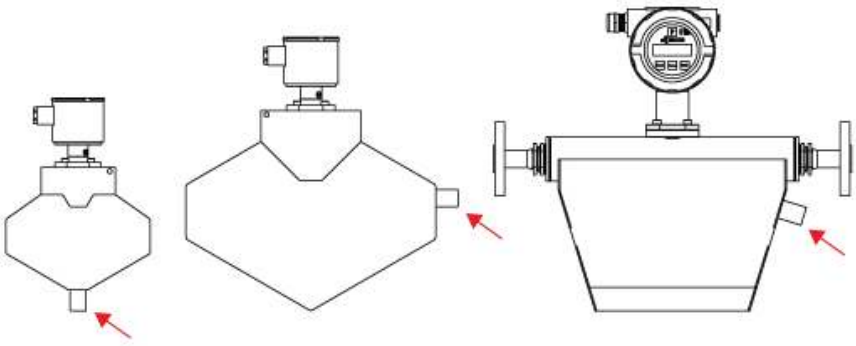


Fig. 1: The position of the bursting disc varies depending on the size and style of the measuring device

Fig. 2: Warning label near the bursting disc

1.3. Model Key and Accessories

1.3.1. Model Key

TCM	XXXX	-	X X	-	X	X	X	X	-	X	X	X	X	-	Ex

Process connections[1]															
See TCM datasheet	X X														
Mechanical options															
Medium Temperature range:															
-40 °C...+100 °C [-40 °F...+212 °F[			S												
Pressure range															
Standard pressure					G										
Mechanical Design															
Standard							S								
Face to face length															
Standard (other lengths on request)								S							
Electronic options															
Execution															
Compact version TCE 6000										F					
Interface															
RS485 (Modbus RTU)											S				
RS485 (Modbus RTU) + USB (TCE 6000 only)											F				
Supply voltage															
24V DC												D			
Options															
8-pin I/O plug connector (TCE 6000 only)													B		
No option													S		
Ex-protection[2]															
ATEX (zone 2)															Exn

[1] Please contact the manufacturer for connections without specification of the installation lengths.
[2] Explosion protection is only available with the Exn option.
Only applies for operation with SELV (safety extra low voltage).

1.3.2. Accessories

1.3.2.1. Additional Accessories

Accessories for the TCE 6000 transmitter	Designation
USB cable, USB to mini USB M12, 2 m	KAB-USB-TCE
Connection cable USB to RS485, 3 m for TCE 6000 versions “FSDS” and “FFDB”	KAB-RS485-TCE-ISO
TRICOR ESTA package for TCE 6000	TRICOR ESTA package M12
TRICOR ESTA package for TCE 8000	TRICOR ESTA package
Service and calibration	
Accredited (ILAC) according to DIN EN ISO/IEC 17025:2005	Accredited calibration
Test certificate 3.1 according to DIN 50 049/EN 10204	3.WKZ-0100
Type plate 1.4404 [AISI 316L]	TCM tag plate 1.4404

1.4. TCM Measuring Principle

Two parallel tubes inside the TCM vibrate at their resonant frequency in opposite directions. 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 the movements. The time delay is measured and used to calculate the mass flow through the tubes.

The density of the medium in the tubes can be calculated from the resonant frequency of the tubes.

Since the effect is slightly dependent on temperature, the temperature of the medium is measured with a precise temperature sensor to compensate for this temperature dependency.

Thus the mass flow, density and temperature of the medium can be measured directly with a Coriolis Mass Flow Meter. The volume flow can also be calculated from the mass flow and density.

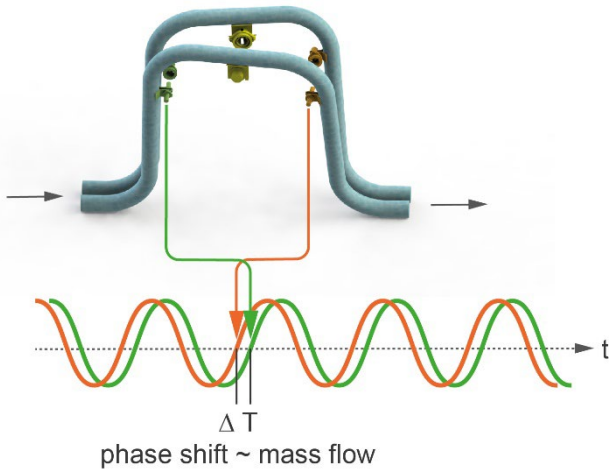


Fig. 3: Active Principle of the Coriolis Mass Flow Meter

2. Getting started

2.1. Unpacking

Confirm that you have received the following components:

- TCM **** with installed transmitter
- Operating instructions (printed version or www.kem-kueppers.com/downloads/bedienungsanleitungen)

Inspect the device to make sure it is undamaged. Contact KEM Küppers Elektromechanik GmbH in case of damage.

2.2. Operating Elements

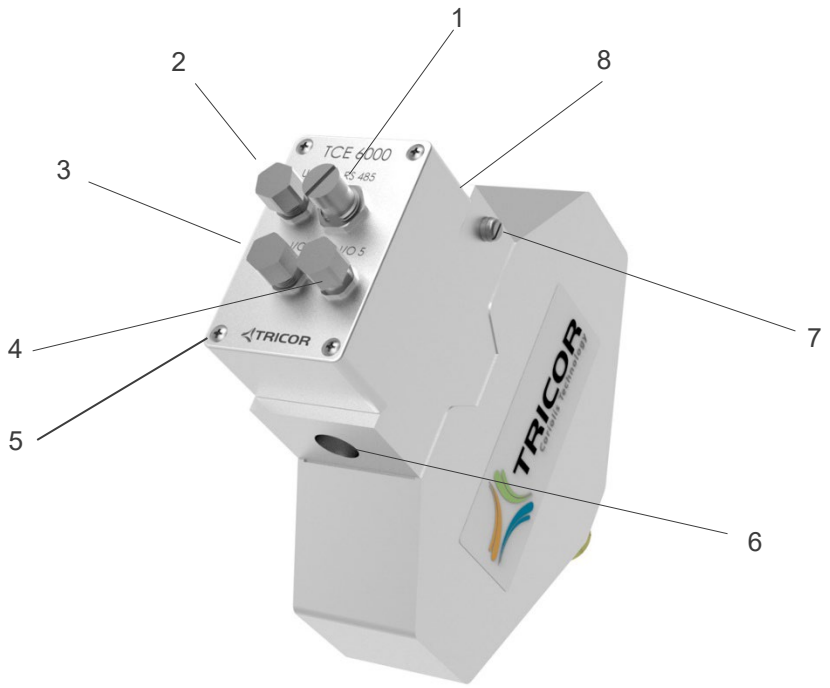


Fig. 4: Operating Elements

1 = RS485 connection, M12, B-coded, internal thread

2 = USB connection

3 = Input/output, M12, A-coded, external thread

4 = Input/output, M12, A-coded, external thread

5 = M6 installation thread (rear, option, TCM 0325 through 3100 only)

6 = Medium inlet, connection as ordered

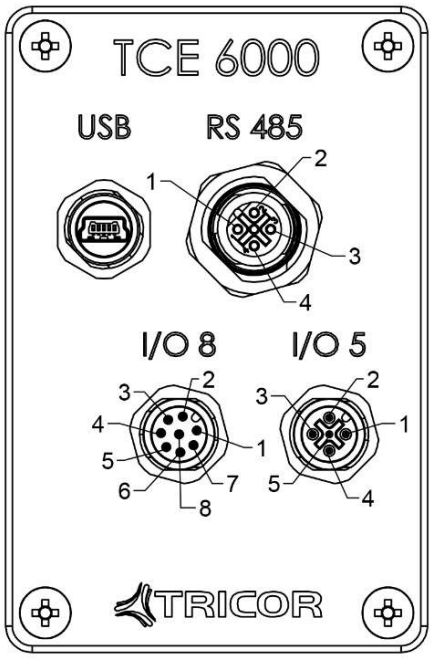
7 = Protective conductor connection (TCM 0325 through TCM 3100 only)

8 = Medium outlet, connection as ordered

2.3. Pin Assignments

I/O 5-pin (standard version “FSDS”)

1	+24V DC	Positive supply voltage (24 V DC)
2	I_{out}	Output current 4 … 20 mA, in reference to GND
3	GND	Ground
4	F_{out}	Frequency/pulse output
5	CTL IN 1	Control input 1



I/O 8-pin (extended version “FFDB”)

1	+24V DC	Positive supply voltage (24 V DC)
2	I_{out}	Output current 4 … 20 mA, in reference 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-pin (standard version “FSDS”)

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

Software-Fernsteuerung mittels RS485 (Modbus RTU)[3)]

Standard version “FSDS”	5-pin connector M12 (B-coded), RS485 connection Cable designation: KAB.RS485.TCE
Extended version “FFDB”	5-pin connector M12 (B-coded), connection designation: RS485 • Cable designation: KAB.RS485.TCE-ISO or • M12 – mini-USB (IP65), connection designation: USB Cable designation: KAB.USB.TCE • Conventional cable, USB-A to mini-USB-B on USB connection (IP20). Continuous operation not recommended

NOTE:

Cables are not included in the scope of delivery and must be ordered separately.

[3)] The Coriolis Mass Flow Meter must be supplied with 24 V via the I/O connector.

2.4. Trial run

WARNING!

Read the installation information in Section 3 carefully before installing the device!

When the device is only operated briefly with no flow for testing or familiarisation, establishing the following connections as a minimum is sufficient (see Section 3.3):

- Connect the supply voltage.
- The various inputs and outputs may also be connected when the functions are needed for testing.

NOTE:

Measuring inaccuracies are possible without a protective conductor. When the device is connected in a system, the protective conductor must be connected as well.

2.5. Commissioning

Unless otherwise specified in the order, the default factory settings are as follows:

- I_{out}: flow, 20 mA = specified range of the TCM (according to data sheet)
- F_{out}: flow, 10,000 Hz = measuring range of the TCM (according to data sheet)
- CTL OUT: Error (I/O8 only)
- CTL IN 1: Set zero point
- CTL IN 2: Reset subtotal (I/O8 only)

Verify the proper mechanical and electrical installation of the device.

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

Switch on the flow. Corresponding measured values are output via the current output and frequency output.

A zero point adjustment should be performed as soon as the working temperature is reached (Section 4.2.2).

3. Installation

3.1. Important Installation Guidelines

Coriolis Mass Flow Meters measure the flow by accelerating the medium transverse to the flow direction and measuring the effect of the inertial force. For optimum results, the device has to be decoupled from external vibrations and the medium must be homogeneous.

Installing a valve respectively before and after the flowmeter is recommended. Both valves must be closed for the zero point adjustment.

3.1.1. External Vibrations

Fixed mounting of the device on a vibration-free wall is required in case of (possible) external vibrations. If this is not possible, vibration dampers have to be used.

Flexible pipe sections are recommended in case of vibrations on the installation pipes.

Piston pumps and other pumps that produce a highly pulsating flow should be decoupled using longer, possibly flexible pipes or other measures.

Pressure surges with very high load changes at short intervals over extended periods of time have to be avoided. Please consult our technical customer service in case of applications with such requirements.

WARNING!

The maximum permissible pressure must not be exceeded due to pressure surges.
Risk of injury or poisoning.
The maximum permissible operating pressure depends on the device version, pressure limit and temperature range. The device may be damaged if the operating pressure is exceeded. Hot, toxic and corrosive process media may be released.

Make sure that the permissible operating pressure is not exceeded. Observe the information on the sensor type plate and/or in the technical data (Section 7.3).

3.1.2. Inhomogeneous Media

If the liquid contains gas bubbles or solids, suitable steps must be taken in the installation to ensure that bubbles or solids do not accumulate in the measuring cell (see Sections 3.2.3 – 3.2.6).

Measuring 2-phase mixtures with gas (foam) or solids (paint, sludge) is unproblematic if the bubbles or solids are small compared to the tube diameter and evenly distributed. If the gas fraction in the liquid measured medium or conversely the liquid fraction in the mainly gaseous measured medium becomes too large, the flow and density measurements may be significantly disrupted. Disruptions can be readily detected based on the measured driver current.

3.2. Mechanical installation

Based on the information in this section, select the installation method that is most suitable for your application. Install the TRICOR CLASSIC Mass flow Meter on a solid surface and minimise system vibrations for maximum accuracy and repeatability.

Installation instructions:

- Install the sensor between well supported pipes that bear the weight of the flowmeter. Alternatively, the TCM0325 through TCM3100 devices may be installed on the mounting bores.
- For permanent installation, the device should not be supported on the sensor housing.
- Axially centre the connecting lines for stress-free installation. Do not use the flowmeter to align the pipes. Make sure they are properly aligned before installing the flowmeter.
- Do not lift the flowmeter by the electronics, but by the sensor housing or process connections. Use suitable hoisting devices.

3.2.1. Basic Safety Instructions

WARNING!

Hot and cold surfaces due to hot process media.
Risk of burns due to surface temperatures.
Wear suitable protective equipment.
Implement appropriate measures such as contact protection.

Make sure that the ambient temperature does not exceed or fall below the permissible limits due to the safety measures. Observe the information in the technical data (Section 7.3).

WARNING!

Wetting of components that are not compatible with the process medium.
Risk of injury or damage to the device.
Hot, cold, caustic, toxic and corrosive media may be released if components that are not compatible with the process medium are wetted. Media may be discharged under high pressure.

Make sure that the material of components wetted by the process medium is compatible. Observe the information in the technical data (Section 7.3).

NOTE:

Material compatibility.

The manufacturer can assist you with the selection of sensor components that are wetted by the process medium. The operating company is responsible for selecting the components. KEM Küppers Elektromechanik GmbH assumes no liability for faults or failures due to incompatible materials.

WARNING!

Unsuitable process connections.
Risk of injury or poisoning.
Risk of the ejection of components and the discharge of medium under high pressure.

Hot, cold, caustic, toxic or corrosive process media may be discharged at the connections in case of improper installation. Make sure that the process connections (flange seals and screws, for example) are suitable for the application and the process media being used.

WARNING!

Exceeding the maximum permissible operating pressure.
Risk of injury or poisoning.
The maximum permissible operating pressure depends on the device version, pressure limit and temperature range. The device may be damaged if the operating pressure is exceeded. Hot, cold, caustic, toxic and corrosive process media may be released.

Make sure that the operating pressure does not exceed or fall below the permissible range, even in case of a fault. Observe the information on the sensor type plate and/or in the technical data (Section 7.3). Implement appropriate safety measures and/or devices.

WARNING!

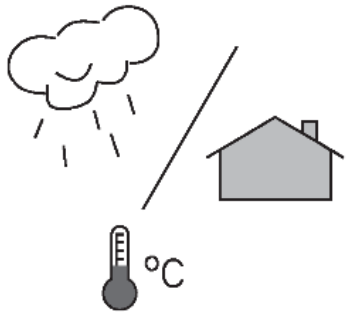
Loss of explosion protection.

Risk of explosion in areas exposed to explosion hazards if the device is opened and/or not connected as directed in the operating instructions.

WARNING!

External stresses and loads.
Damage to the device due to severe external stresses and loads (thermal expansion or pipe strain, for example). The process medium may be released. Risk of the ejection of components and the discharge of medium under high pressure.

Avoid exposing the device to external stresses and loads.



3.2.2. Requirements for the Installation Location

TRICOR Classic series flowmeters have the protection class IP65 as standard. The devices are not suitable for outdoor installation.

Process pressure and media temperature

Make sure that the process pressure (PS), media temperature (TS) and ambient temperature do not exceed or fall below the value ranges specified on the type plate/device label.

Aggressive atmospheres

Make sure the device is suitable for the application and that the installation site is not exposed to hazards due to aggressive vapours and liquids.

Direct sunlight

Protect the device from direct sunlight to prevent overheating or materials getting brittle due to UV exposure. Make sure that the ambient temperature does not exceed or fall below the permissible limits. Observe the information in the technical data (see Section 7.3).

WARNING!

Use in areas exposed to explosion hazards.
There is a risk of explosion in areas exposed to explosion hazards.

Special requirements apply here with regard to the device location and installation. See “Electrical installation” (Sections 3.3 and 3.4).

NOTE:

Measuring inaccuracies are possible without a protective conductor. When the device is connected in a system, the protective conductor must be connected as well.

3.2.3. Horizontal installation

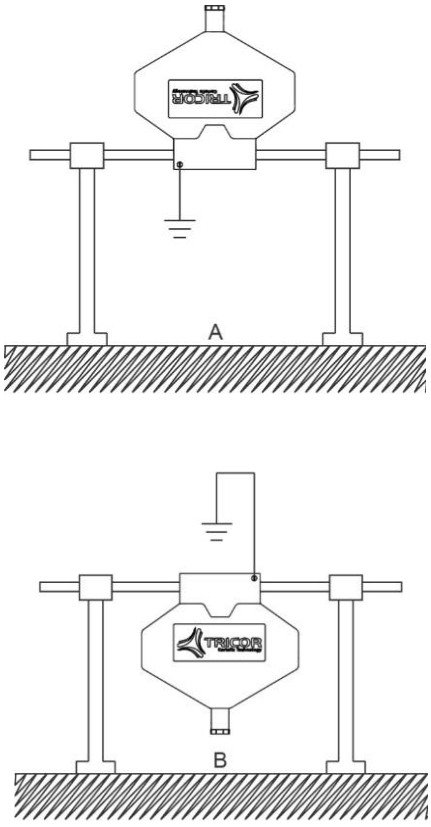


Fig. 5: Recommended Horizontal Installation

The recommended installation position is horizontal.

Choose installation position “A” if the medium contains solids, “B” in all other cases.

Mount the measuring cells on a vibration-free, solid installation surface. The mounting threads may be used for versions TCM 0325 through TCM 3100.

Vibration dampers must be used if no vibration-free installation surface is available.

3.2.4. Vertical installation

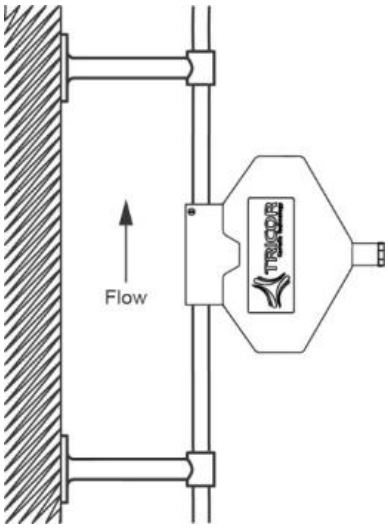


Fig. 6: Vertical installation

The TCM 0325 through TCM 3100 should not be installed vertically due to the lozenge shape of the tubes – unless you are certain that the medium contains neither gas bubbles nor solids.

All other sensors (TCM 5500 – 230K) can be installed vertically. This is the recommended installation position if the medium contains gas bubbles and/or solids.

The sensor should be installed in a riser so it does not run dry during operation.

Mount the measuring cells on a vibration-free, solid installation surface.

Vibration dampers must be used if no vibration-free installation surface is available.

3.2.5. Installation in a Drop Line

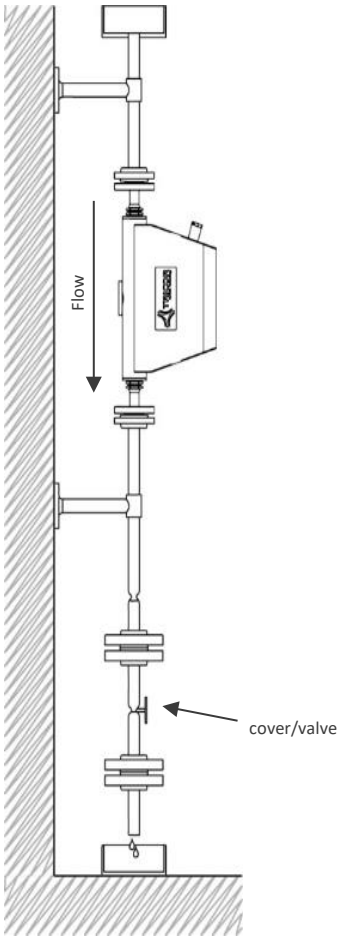


Fig. 7: Installation in a Drop Line

The TCM 0325 through TCM 3100 should not be installed vertically due to the lozenge shape of the tubes – unless you are certain that the medium contains neither gas bubbles nor solids.

All other sensors (TCM 5500 – 230K) can be installed vertically. However, installation in an (open) drop line is only permitted if a gate or valve after the sensor prevents dry running during operation or after closing the valve.

Vibration dampers must be used if no vibration-free installation surface is available.

3.2.6. Critical installations

If gas bubbles are expected in the measured medium, the measuring device must not be installed at the highest point of the pipe system. Otherwise, accumulations of gas and therefore faulty measurements must be expected regardless of the installation position of the measuring device itself (A).

If solids are expected in the measured medium, the measuring device must not be installed at the lowest point of the pipe system. Otherwise, accumulations of solids and therefore faulty measurements must be expected regardless of the installation position of the measuring device itself (B).

Installation at the open end of a drop line (C) is also prohibited since the sensor may occasionally run dry in this case.

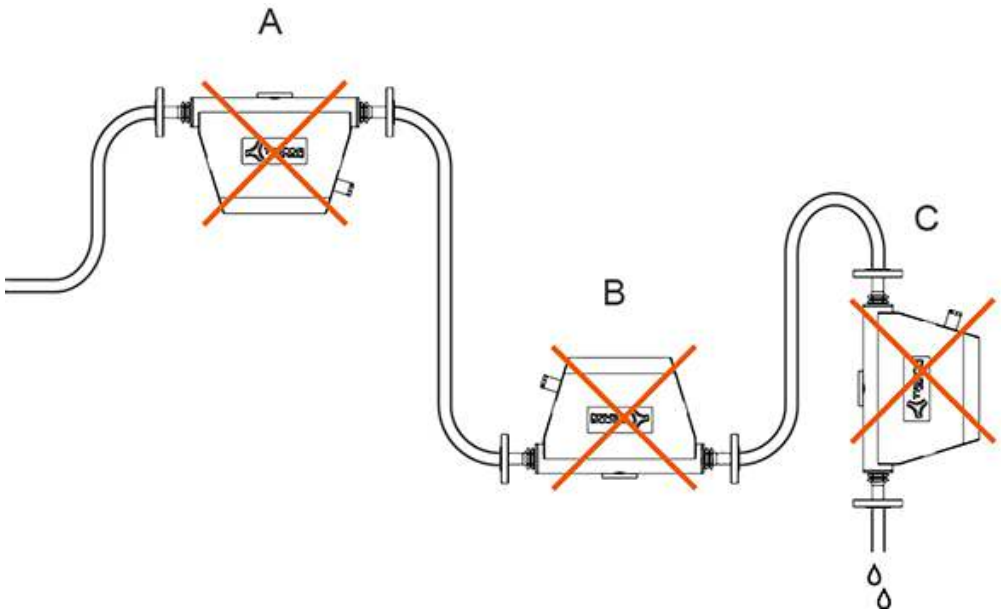


Fig. 8: Critical Installations

3.3. Electrical installation

Make sure that the TCM is properly installed and that the pipes are connected before establishing the electrical connections.

The device has to be earthed and requires a regulated power supply of 24 V DC.

Reverse polarity protected M12 plug connectors are used for all electrical connections.

The digital inputs and outputs refer to GND and the negative connection of a DC supply.

Shielded cables must be used to connect the TCE.

NOTE:

Improper earthing and shielding can cause EMC problems and danger to life!

WARNING!

Only switch the supply voltage on after all lines are properly connected and secured.

NOTE:

A separate protective conductor connection with a cross-section larger than 1 mm² is recommended in larger systems to avoid stray electric currents in the cable shield.

Wiring diagram

1	+24V DC	Positive supply voltage (24 V DC)
2	I_{out}	Output current 4 … 20 mA, in reference 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

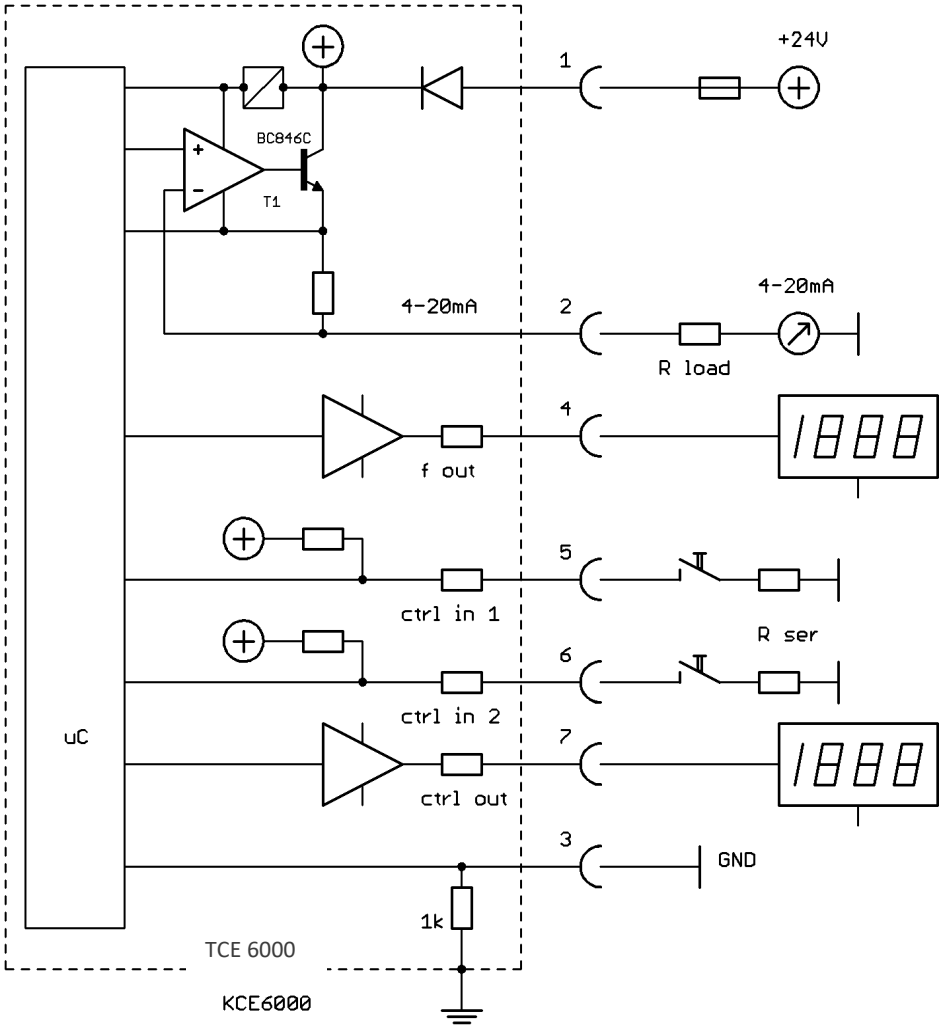


Fig. 9: TCE 6000 Connection Diagram

3.3.1. Power Supply and Grounding

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

The supply input of the TCE is protected by an internal fuse. To protect against fire due to a short-circuit in the supply cable, the power supply output must be protected by a fuse with a tripping current that does not exceed the current carrying capacity of the cable.

Use shielded cables to connect the TCE 6000.

A good protective conductor connection is mandatory for operation in areas exposed to explosion hazards. The cross-section of the protective conductor has to be at least equal to the cross-section of the supply line or 1 mm².

The earth connections of the connectors I/O5, I/O8 and RS485 are internally interconnected.

The power supply of the connectors I/O5, I/O8 and RS485 is internally interconnected. Ferrite inductors suppress electromagnetic interference.

Each of the TCE 6000's three connectors can be used for the power supply.

Earth (GND) and the protective conductor (PE) are internally interconnected by a 1 kΩ resistor. The resistor is heat-resistant up to a potential difference of 30 V. For proper operation, the difference should be limited to 5 V.

NOTE:

The USB connection cannot be used for the power supply of the TCE 6000.

3.3.2. Digital Inputs and Outputs

The frequency and control outputs are active push-pull outputs with an internal resistance of 220 Ω. The load can be connected against +24 V and against earth. For good output levels, the load resistor R_{load} should not be smaller than 1 kΩ.

The digital outputs can drive any conventional input including PLC inputs. With a load resistor against earth, the output voltage is calculated as:

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

$$V_{low} < 1\ V$$

With a load resistor against the positive supply voltage, the output voltage is calculated as:

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

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

The inputs are low-active with safety stages according to IEC946. Due to the internal pull-up resistor, they can be controlled by a push-pull output, an NPN open collector output or an earthing switch.

If a R_{ser} series resistor is needed for any reason, the size should be limited to a maximum of 1 kΩ for proper operation.

The earth connection GND is connected to the protective conductor (PE) via 1 kΩ. While the resistor withstands voltages of up to 30 V between GND and PE, more than 5 V should be avoided.

See Fig. 9. TCE 6000 connection diagram for the correct connection of the power supply.

3.3.3. Analogue Outputs

The TCE 6000 has one active 4 … 20mA output (earthed).

The maximum load resistor depends on the supply voltage.

For a certain supply voltage, the maximum load resistor is calculated as:

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

Example:

At +24 V ±10%, the maximum load resistor is 620 Ω.

See Fig. 9. TCE 6000 connection diagram for the correct connection of the power supply.

3.4. Ex Installation

The TCM***-**-****-F*** -Exn is approved for operation in zone 2 (3G) T4, provided it is operated with safety extra low voltage (SELV). Exceeding or falling below the operating temperature range is not permitted.

WARNING!

Explosion hazard. Make sure that the ambient temperature and process temperature of the device does not exceed or fall below the permissible range. See the information on the type plate.

WARNING!

Explosion hazard. Disconnecting or connecting the plug connectors under voltage is not permitted in areas exposed to explosion hazards. Opening the housing under voltage is prohibited. Making repairs or technical alterations is prohibited.

WARNING!

Explosion hazard. A protective conductor connection is mandatory for operation in areas exposed to explosion hazards. The cross-section of the protective conductor has to be at least equal to the cross-section of the supply line or 1 mm².

WARNING!

Explosion hazard. Consider the possible risk of sparking due to impacts and friction on the aluminium alloy housing during installation and operation.

WARNING!

Explosion hazard. When long connecting lines are used, make sure that the maximum permissible capacitances and inductances for the corresponding voltages and group of gases are not exceeded. Complying with the limit values specified in the technical data is mandatory (see Section 7.3).

4. Manual Operation

4.1. Manual Control

The TCE 6000 has no control elements or displays. Operation and configuration is exclusively via software remote control.

4.2. Setup Guidelines

The TCM Mass Flow Meters are configured for normal applications at the factory. Aside from regular zero point adjustment as needed, no further optimisations are required for most applications.

The possible optimisations are described below. An interface cable for software remote control is required to change the settings.

4.2.1. Meter Mode

A Coriolis Mass Flow Meter measures the mass flow and density and calculates the volume flow.

To avoid difficult to understand behaviour when switching the dimensions, the TCE 6000 can be configured as a Mass Flow Meter or volumetric flowmeter. Only mass units can be configured when Mass Flow Meter is selected, only volume units when volumetric flowmeter is selected.

4.2.2. Zero Point Adjustment

In contrast to volume counters, Coriolis Mass Flow Meters have no “natural” zero point. Without a flow, the measured time delay is only approximately 0. The zero point adjustment measures this deviation, which is then taken into account in the flow calculation.

Since the offset is slightly dependent on temperature, medium density and pressure, performing the zero point adjustment with the medium being measured under operating conditions is recommended, i.e. with the medium being measured, at the operating pressure and operating temperature.

Execution:

Operate the device for a few minutes under normal conditions so the process temperature can stabilise at the sensor.

Turn off the flow, if possible with a valve respectively in front of and behind the sensor. If the valves are far away from the sensor or there is only one valve, wait long enough that the flow is definitely zero.

NOTE:

If the flow through the sensor is not zero or the sensor is shocked during the zero point adjustment, an incorrect correction value will be determined.

Start the zero point adjustment by applying a low level to CTL IN 1 (if CTL IN 1 is configured as “start offset”) or via the RS485 interface.

The offset procedure takes about 25 - 30 seconds. Open the valves again after the process is completed.

4.2.3. Flow filter

The raw data of a Mass Flow Meter are noisy. Therefore, the calculated flow rate values have to be filtered for a stable indication.

The filter in the TCE 6000 is adjusted via a time constant. The time constant is the time *t* needed by the filter to drop to $x/e = x/2{,}72$ at the output after a jump at the input from a value *x* to 0. A longer time results in a more stable indication but a slower response to flow changes.

The relationship between the time and the filtered value after a jump can be approximated as follows:

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

A linear filter, as in the TCE 6000, only delays the flow indication and the “TOTAL value”. Independently of the flow rate curve, all errors compensate each other when the flow returns to the initial value. Therefore, the values for “TOTAL” and the number of pulses on the frequency output will be correct in ON/OFF operation when one waits several time constants after shutting off the flow.

The TCE 6000 has two filters for optimal operation.

The “FLOW FILTER” filters the mass flow before the “TOTAL”, output frequency and current are calculated.

t = 1 s is recommended for normal applications.

The “DISPLAY FILTER” only filters the flow indication, in addition to the “FLOW FILTER”. It has no influence on other values or the outputs. The default value is *t* = 1 s.

To make the outputs respond more quickly with a highly fluctuating flow, set “FLOW FILTER” to *t* < 1 s. Set “DISPLAY FILTER” to a higher value to reduce the fluctuation of the flow indication for better readability.

4.2.4. CUT OFF

Since a Coriolis Mass Flow Meter has no natural zero point, it would constantly indicate small fluctuating values when there is no flow.

“CUT OFF” establishes a clear zero point: If the calculated and filtered flow is less than “CUT OFF”, “0” is indicated and output for the flow and the “TOTAL” value does not change.

The “CUT OFF” value must be significantly above the inherent noise and significantly below the smallest flow to be measured. 0.5% of the final value as the default value is a good compromise.

4.2.5. STEP RESPONSE

Sometimes a fast response to rapid flow changes is required while the indication has to be as stable as possible. This is not possible with a linear filter.

The “STEP RESPONSE” parameter enables a response to rapid flow changes with a long filter time.

If the difference between the currently measured and the filtered value for the flow is greater than “STEP RESPONSE”, the filter is erased and overwritten with the new value. Nothing is changed as long as the difference is smaller.

When the flow is constant or changes gradually, “STEP RESPONSE” should be deactivated with the setting 99% (default value). If “STEP RESPONSE” is needed, the best setting must be determined experimentally. The best value for ON/OFF operation is about 50% of the ON value.

If the value chosen for “STEP RESPONSE” is too small, minor flow changes or even the inherent noise will be sufficient to activate the function. This leads to fluctuating indications and output signals.

4.2.6. Mutual Influences of Configuration Parameters

Each of the two parameters influences the flow calculation in a different way. An unfavourable combination of the settings can result in systematic errors.

FLOW FILTER and CUT OFF

When the filter is set to a high value, the calculated flow is significantly delayed. It then takes a long time to reach a stable final value in ON/OFF operation. Nevertheless, the “TOTAL” values are correct if one waits long enough after shutting off the flow. However, if the value for the “CUT OFF” parameter setting is too high, part of this lag is disregarded and the calculated “TOTAL” value is too small. This is a systematic error.

NOTE:

Combinations of a long filter time and high “CUT OFF’ must be avoided in ON/OFF operation.

There is no influence in case of jumps that do not go to zero.

FLOW FILTER und STEP RESPONSE

As just explained, linear filters delay the flow indication but do not cause a “TOTAL” error.

When “STEP RESPONSE” is activated, a non-linear term is added to the filter. The indicated flow better follows the actual flow, but the remaining deviation depends on the “STEP RESPONSE” setting, the filter and the course of the flow.

If the flow only changes gradually or the jump is smaller than “STEP RESPONSE”, the function is not activated. The filter remains linear and only causes the normal delay.

In case of fast changes by more than “STEP RESPONSE”, the filter is made faster. The indicated value follows the actual value more closely and the delay is reduced.

A positive error for “TOTAL” results during ON/OFF operation with a fast increase and slow decrease, a negative error with a slow increase and fast decrease.

NOTE:

When “STEP RESPONSE” is used, for example, to effectively detect fast changes, the resulting measuring accuracy has to be checked for the application!

4.3. Operating Modes of the Inputs and Outputs

The inputs and outputs can be configured for different applications. Software remote control via an interface cable is required to change the settings.

4.3.1. Frequency Output

The frequency output has two possible operating modes:

FREQUENCY (default value):
A frequency proportional to the flow is output. To also output a negative flow, the switching output can be used as the leading sign. Frequencies between 2 Hz and 10 kHz can be generated in this mode.

TOTAL COUNT:
A pulse is generated every time TOTAL increases by the increment value. For a duty factor of 50%, the output changes its state respectively after half an increment. If the flow is negative in the meantime, no pulses are generated until the subsequent positive flow has compensated the interim negative flow. This avoids double counting of the medium. The maximum frequency that can be generated in this mode is about 100 Hz.

4.3.2. Control Output

The switching output has seven possible operating modes:

FAULT:
The output enters the active state when an error occurs.

FLOW DIREC:
The output is active when the flow is positive and inactive when the flow is negative.

BATCH:
In batch mode, the TCE 6000 operates as a “BATCH” counter. The output enters the active state when the “BATCH” value is exceeded. An active signal on the control input is used to reset the batch counter to zero. The control input has to be configured as “RESET BATCH” for this operating mode.

FLOW LIMIT:
When the measured flow exceeds the configured “FLOW LIMIT“ value plus the hysteresis, the output enters the active state. When the flow becomes less than “FLOW LIMIT” minus the hysteresis, the output enters the inactive state. The output does not change in between the two thresholds.

OFF (default):
The output is always in the inactive state.

FREQUENCY:
See Section 4.3.1.

PHASE SHIFT:
Both digital outputs operate in the “TOTAL COUNT” operating mode (see Section 4.3.1) and output signals of the same frequency. The signals are phase shifted by 90°.

4.3.3. Analogue Output

The analogue output can indicate one of the following parameters:

FLOW (default):
The current is proportional to the actual flow.

DENSITY:
The current is proportional to the actual density.

TEMPERATURE:
The current is proportional to the actual temperature.

BATCH COUNT:
The current is proportional to the actual “BATCH” value.
This operating mode is only available if the control input is configured as “RESET BATCH”.

The reference values for 4 mA and 20 mA can be freely selected. A range can therefore be defined (for example, temperatures from 20 °C to 30 °C [68 °F to 86 °F]) and negative values can be used as well (for example, flow from -10 kg/min to +20 kg/min).

4.3.4. Control Input

The switching input has four possible operating modes:

EXTERNAL ZERO:
An active level starts the zero point adjustment.

RESET BATCH:
An active level resets the BATCH value to zero. This operating mode has to be selected when the control output is used as the “BATCH” output and/or an analogue output is used as the “BATCH” output.

OFF (default):
The input is deactivated. Level changes do not cause any response.

HOLD:
All flowmeters stop when an active level is applied to the input.

4.4. Data Configuration

The TCE 6000 can save the settings to a backup memory. Software remote control via an interface cable is required to save and load the settings.

4.5. I/O-Test

All inputs and outputs can be read and/or controlled directly to check the electrical installation. The following tests are available:

FREQ OUT	Generates a freely configurable frequency on the frequency output
CTRL OUT	Setting of the output level
ANALOG OUT	Setting of a user-defined output current
CTRL IN	Indication of the actual level on the control input

Software remote control via an interface cable is required to conduct the tests.

5. Remote Control

The TCE 6000 is provided with an RS485 interface as standard equipment. A USB interface is available as an option.

5.1. Serial RS485 Interface

Connect the RS485A or RS485+ signal (both designations are used in the literature) to pin 2 and RS485/RS485B to pin 4. Terminal 3 is the reference mass for the interface.

The TCE 6000 can be supplied with current via the +24 V and GND pins of each of the connections. When the TCE 6000 is operated via the RS485 interface and no other input/output signal is used, it can also be supplied with current via pins 1 and 3 of the RS485 connector.

NOTE:

The permissible voltage levels on the data lines (pins 2 and 4) are -7 V to +12 V in reference to GND (pin 3). Voltages outside this range may destroy the TCE 6000.

See the Modbus RTU Manual for the TCE 8000 regarding the use of the RS485 interface. (see Modbus RTU Manual)

5.2. USB Interface

You can use the free Windows-based “TRICOR Configurator” software to use the USB interface with a PC. All settings can be configured using the software. Measurements can also be taken automatically and the measuring data and settings can be saved.

Power cannot be supplied to the TCE 6000 via the USB interface. A separate 24 V supply is required.

A standard USB A to MINI USB cable can be used to temporarily connect the USB interface.

NOTE:

The USB A to USB M12 cable from KEM Küppers Elektromechanik GmbH is required for a stationary connection in an automated system in order to guarantee the specified IP protection class.

6. Service and Maintenance

6.1. Troubleshooting

If the TRICOR Mass Flow Meter is not working properly, please check the following points:

Does not operate

All cables properly connected?

➔ Connect missing cables

Power supply on?

➔ Turn on the power supply

Output frequency too high or unstable

Most likely EMC problems

Cable shielding and protective earth properly connected?

➔ Properly connect the shielding. Try various earthing methods if applicable.

Fluctuating flow indication with (theoretically) stable flow

Gas bubbles or solids in the medium?

➔ Install the device in the optimum position

Pronounced external vibrations?

➔ Decouple the device from the source of the vibrations

No frequency output, indication is correct

Frequency output properly connected?

➔ Correct the wiring (see Section 2.3)

Output correctly configured?

➔ Correct the configuration

Incorrect flow direction (flow indication on the display negative)?

➔ Change the flow direction

7. Service and Maintenance

The TRICOR CLASSIC Mass Flow Meters and the TCE 6000 transmitter do not require regular maintenance.

An inspection and recalibration every 5 years is recommended for optimum measurement results. When abrasive or fouling process media are used, the inspection intervals should be considerably shorter in order to monitor the measurement results and, where applicable, the pressure resistance of the measuring device.

Where regular inspection or calibration is prescribed for a special application, please adhere to the corresponding national standards and laws.

WARNING!

Repairing explosion-protected devices is prohibited.
Explosion hazard.
Repair work may only be carried out by personnel authorised by the manufacturer.

WARNING!

Working in areas exposed to explosion hazards during operation.
There is a risk of an explosion when work is performed on the device in areas exposed to explosion hazards.
Disconnect the device from the mains network
and
ensure that the atmosphere does not pose an explosion hazard (permit for hot work).

WARNING!

Risk of electric shock.
Avoid working on the device while it is connected to electrical voltage.
If working on a device under electrical voltage is unavoidable, make sure that the environment is dry.
Take care that moisture does not get into the device during cleaning and maintenance work.

WARNING!

Hot and cold components in the device.
Temperatures that cause burns on unprotected skin may be present for some time after the device is switched off.
Observe appropriate wait times before starting maintenance work or use suitable personal protective equipment.

WARNING!

Hot, cold, corrosive or toxic process media.
Risk of injury during maintenance work.
Hot, cold, corrosive or toxic process media may be released during work on process connections.

Do not loosen any process connections or remove any components that are under pressure while the device is pressurised. Before opening or removing the device, make sure that process media cannot be released. Flush the line.

NOTE:

Servicing and repairs may only be carried out by personnel authorised by the manufacturer.

Parameters for the maintenance information

The basic parameters for the maintenance information are:

- Current date and time
- Total operating time
- Operating time
- Configuration counter
- Hardware revision of the transmitter
- Hardware revision of the HMI
- Hardware revision of the sensor

7.1. Calibration

A connection via an interface (for example, “TRICOR Configurator” via RS485/USB) is required to calibrate the flow, density and temperature measurement of the TCE 6000.

7.1.1. Recalibration

KEM Küppers Elektromechanik GmbH and AW-Lake Company will recalibrate the sensor in Germany or the USA. The following configuration types are offered as standard depending on the configuration:

- Standard calibration
- Customer-specific calibration
- Calibrations according to DIN EN ISO/IEC 17025:2005
- Density calibration (including fraction settings if required)
- Calibration in the presence of witnesses

7.2. Cleaning

Cleaning the housing

- Clean the outside of the housing with the labelling and the display window using a cloth moistened with water and a mild cleaning agent.
- Do not use aggressive cleaning agents or solvents, such as: Acetone. Plastic parts or the painted surfaces may be damaged. The labelling may become illegible.

7.3. Service

The TCE 6000 does not contain parts that can be exchanged or repaired by the user.

Please contact KEM/AWL or the nearest distributor in case of a malfunction.

7.4. Resetting to Factory Settings

If the device settings are entirely incorrect for some reason, the device can be reset to the original factory settings.

A connection via an interface is required for resetting to the factory settings.

8. Important Notices

8.1. Warranty

The terms of guarantee (general business terms and conditions) are available on the website of KEM Küppers Elektromechanik GmbH (www.kem-kueppers.com) or, for America, the website of AW Lake Company (www.aw-lake.com).

8.2. Certifications and Compliances

Category	Standards or description	
EU Declaration of Conformity – EMC	Compliant with Directive 2014/30/EU for electromagnetic compatibility. Conformity with the following standards listed in the official journal of the European Community is given:	
	EN 61326/2006	Electrical equipment for measurement, control and laboratory use – EMC requirements, class A, stray radiation[3)] and immunity[3)]
	IEC 61000-4-2/2009	Electrostatic discharge immunity (criterion B)
	IEC 61000-4-3/2011	HF radiation immunity (criterion B)
	IEC 61000-4-4/A1-2013	Immunity to transients and bursts (criterion B)
	IEC 61000-4-5/2015[4)]	Immunity to surge voltages (criterion B)
	IEC 61000-4-6/2015	Immunity to mains-borne disturbances (criterion B)
	IEC 61000-4-11/2005[4)]	Immunity to voltage drops (criterion B)
EU Declaration of Conformity – Low Voltage	Compliant with the Low Voltage Directive 2014/35/EU for electromagnetic compatibility. Conformity with the following standards listed in the official journal of the European Community is given:	
	EN 61010-1/2010	Safety provisions for electrical measuring, control and laboratory devices
Additional conformity	IEC61010-1/2010	Safety provisions for electrical measuring, control and laboratory devices
Device type	Testing and measuring devices	
Safety classification	Class 1 (as specified in IEC 61010-1, Annex H) – earthed devices	

[3)] Conformity was tested using high-quality shielded cables.
[4)] Only applies for devices with AC mains supply instead of or in addition to the SELV supply.

8.3. Technical Data

8.3.1. TCM transmitter – Technical Data for Liquids

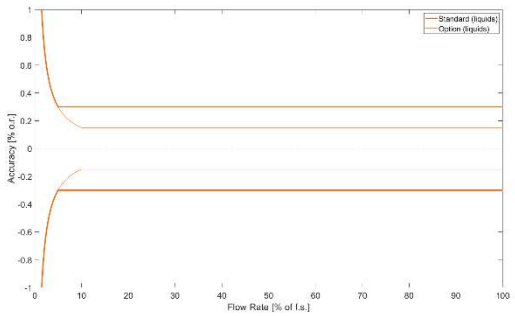
	TCM 0325	TCM 0650	TCM 1550	TCM 3100	TCM 5500	TCM 7900	TCM 028K
Max. flow (kg/h)	325	650	1,550	3,100	5,500	7,900	28,000
Max. flow (lb/min)	12	24	57	114	202	290	1,029
Basic accuracy, mass	±0.1% of the measured value						
Basic accuracy, volume	±0.15% of the measured value						
Reproducibility	±0.05% of the measured value						
Zero point stability	±0.01% of the maximum value						
Measuring range, density	Up to 2,500 kg/m³ [2.5 g/cm³] (larger measuring range on request)						
Measuring accuracy, density	±1.0 kg/m³ [±0.001 g/cm³]						
Reproducibility, density	±0.5 kg/m³ [±0.0005 g/cm³]						
Measuring accuracy, process temperature	±1 °C ±0.5% of the measured value [±1.8 °F ±0.5% of the measured value]						
Reproducibility, temperature	±0.2 °C [±0.36 °F]						
Process and environmental conditions							
Process connections	Internal thread ½" Flanges on request			Flange EN1092, ANSI B16.5			
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, max. flow	Pressure loss gradients for various media on request						
Process temperature	-40 °C ... +100 °C [-40 °F ... +212 °F] (standard) -40 °C ... +70 °C [-40 °F ... +158 °F] (explosion hazard zone 2)						
Ambient temperature	-40 °C ... +70 °C [-40 °F ... +158 °F]						
Storage temperature	-40 °C ... +80 °C [-40 °F ... +176 °F]						
Electrical connections Compact version	None (internally connected)						
Protection class	IP65						
General							
Tube arrangement	2 serial	2 parallel	2 serial	2 parallel	2 parallel	2 parallel	2 parallel
Internal tube diameter	4 mm	4 mm	8 mm	8 mm	7 mm	9 mm	16 mm
Raw material	1.4404 [AISI 316L]						
Housing material	1.4404 [AISI 316L]						
Dimensions	See dimensional drawings, Section 7.3.6						

Calibration for liquids and gases: The TRICOR CLASSIC flowmeters are calibrated at the factory using water.
Calibration conditions: Water: 20 °C ... 25 °C [68 °F ... 77 °F], ambient temperature: 20 °C ... 25 °C [68 °F ... 77 °F].
All information is based on the calibration/reference conditions described above. A calibration record is included with each device.
The specified accuracy values combine reproducibility, linearity and hysteresis.
Typical measuring range dynamics in reference to the max. flow 100:1

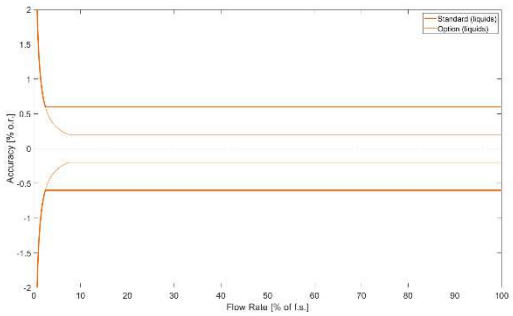
8.3.2. Accuracy for Liquids

TCM 0325 to TCM 065K

Mass Flow



Volume Flow



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

8.3.3. TCM Transmitter – Technical Data for Gases

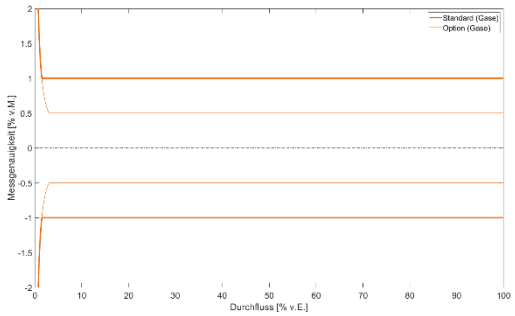
	TCM 0325	TCM 0650	TCM 1550	TCM 3100	TCM 5500	TCM 7900	TCM 028K
Nom. Flow Rate (kg/h)[5) 7)]	78	177	333	740	910	1,430	5,100
Nom. Flow Rate (lb/min)[5) 7)]	3	7	12	27	34	53	188
Nom. Flow Rate (Nm^3/h)[5) 6)]	109	247	464	1,031	1,268	1,993	7,109
Nom. Flow Rate (SCFM)[5) 6)]	64	146	273	607	747	1,173	4,184
Basic Accuracy	±0.5% of the measured value						
Repeatability	±0.25% of the measured value						
Zero Stability in kg/h	0.0325	0.065	0.155	0.31	0.55	0.79	2.8
Zero Stability in lb/min	0.0012	0.0024	0.0057	0.0114	0.020	0.029	0.103
Density Measuring Range	±1.0 kg/m³ [±0.001 g/cm³]						
Density Repeatability	±0.5 kg/m³ [±0.0005 g/cm³]						
Temperature Accuracy	±1 °C ±0.5% of the measured value [±1.8 °F ±0.5% of the measured value]						
Temperature Repeatability	±0.2 °C [±0.36 °F]						
Process/Environmental Conditions							
Process Connections	Internal thread ½“ Flanges on request			Flange EN1092, ANSI B16.5			
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	Pressure loss gradients for various media on request						
Process Temperature (non Ex)	-40 °C ... +100 °C [-40 °F ... +212 °F] (standard) -40 °C ... +70 °C [-40 °F ... +158 °F] (explosion hazard zone 2)						
Ambient temperature	-40 °C ... +70 °C [-40 °F ... +158 °F]						
Storage temperature	-40 °C ... +80 °C [-40 °F ... +176 °F]						
Electr. Connections Meter Mount	None (internally connected)						
Protection Class	IP65						
General							
Tube Arrangement	2 serial	2 parallel	2 serial	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
Tube Material	1.4404 [AISI 316L]						
Housing Material	1.4404 [AISI 316L]						
Dimensions	See dimensional drawings, see chapter 7.3.6						

Max. permissible flow speed (Ma 0.5).
The measuring ranges for various sensor sizes in gas applications depend on the gas operating density, pressure, permissible pressure loss and temperature.
We recommend using our TSP (TRICOR Sizing Program) or contacting us directly for the layout of the measuring ranges.

5) Nominal flow that produces a pressure loss of approx. 3 bar [43 psi] with natural gas at an operating pressure of 50 bar [725 psi].
6) Normal conditions (Nm^3/h) are 1,013 bar and 0 °C. Standard conditions (SCFM) are 14.7 psi and 60 °F.
7) The flow and density range depend on the gas density and pressure range.

8.3.4. Accuracy for Gases

Mass Flow



Flow Rate of full Scale	Accuracy
$\geq \frac{\text{Zero Point}}{\text{Basic Accuracy}} * 100$	± 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	24V DC
Programming	Software interface
Interface	RS485 for Modbus RTU
EMC	EN 61000-6-4 and EN 61000-6-2
Power consumption	Max. 4 W
Electrical connections	M12, A-coded, external thread (I/O, power supply) M12, B-coded, internal thread (RS485, power supply) M12 MINI USB
Housing material	Die-cast aluminium (uncoated)
Temperature	Environment: -40 °C ... +70 °C [-40 °F ... +158 °F] Storage and transportation: -40 °C ... +80 °C [-40 °F ... +176 °F]
Protection Class	IP65
Analog Output	
Current Output	4 ... 20 mA active
Resolution	14-bit
Accuracy	±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
Output Signal	push-pull for mass or volume flow
Status input and output	
Status output	push-pull programmable (option) (in TOTAL mode: 0.5 – 100 Hz)
Status Input	programmable (standard: 1 input/option: 2 inputs)

NOTE:

The interface can be used for parametrisation of the flowmeter.

8.3.6. Dimensions Drawings

Dimensional Drawing TCM 0325 to TCM 0650

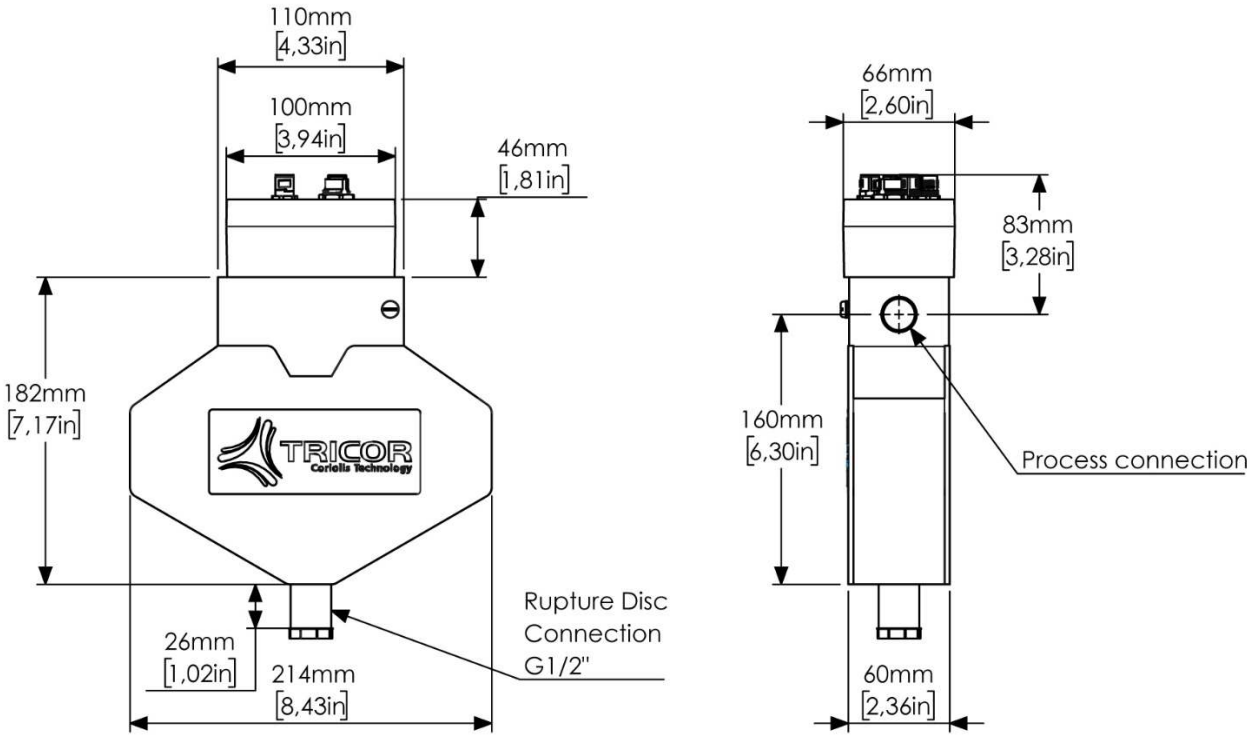


*Fig. 10: Dimensions TCM 0325-**-****-**** through TCM 0650-**-****-****

Dimensional Drawing TCM 1550 to TCM 3100

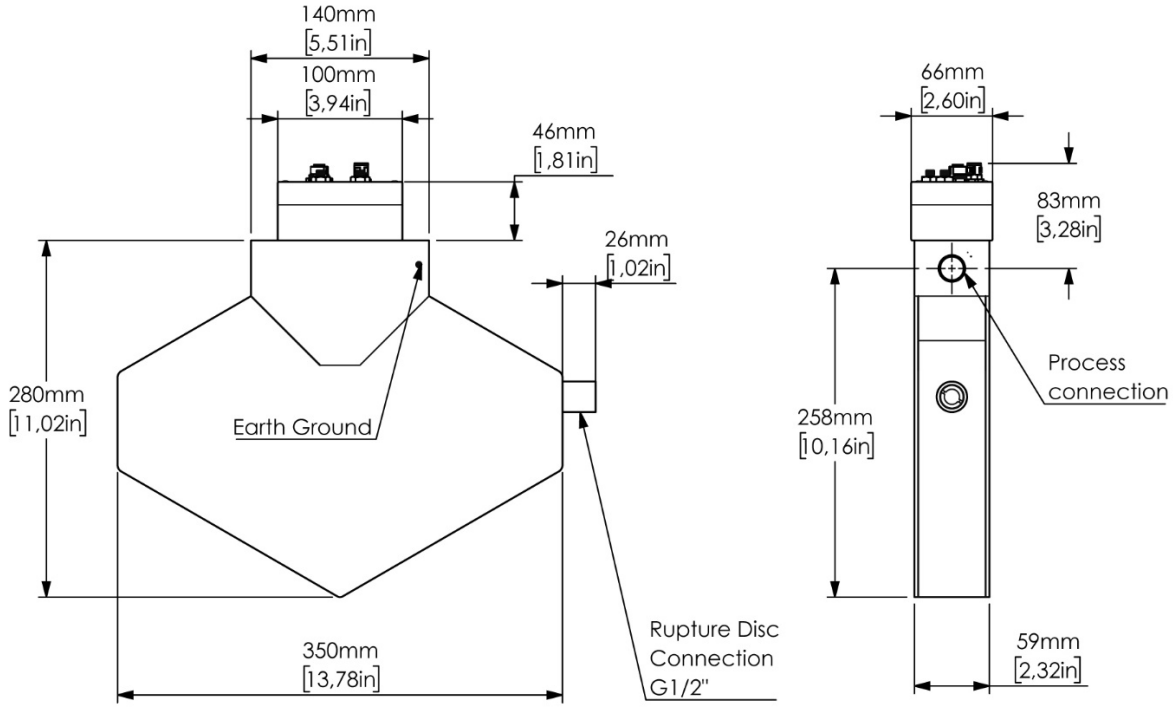


*Fig. 11: Dimensions TCM 1550-**-****-**** through TCM 3100-**-****-****

Dimensional Drawing TCM 5500 to 028K

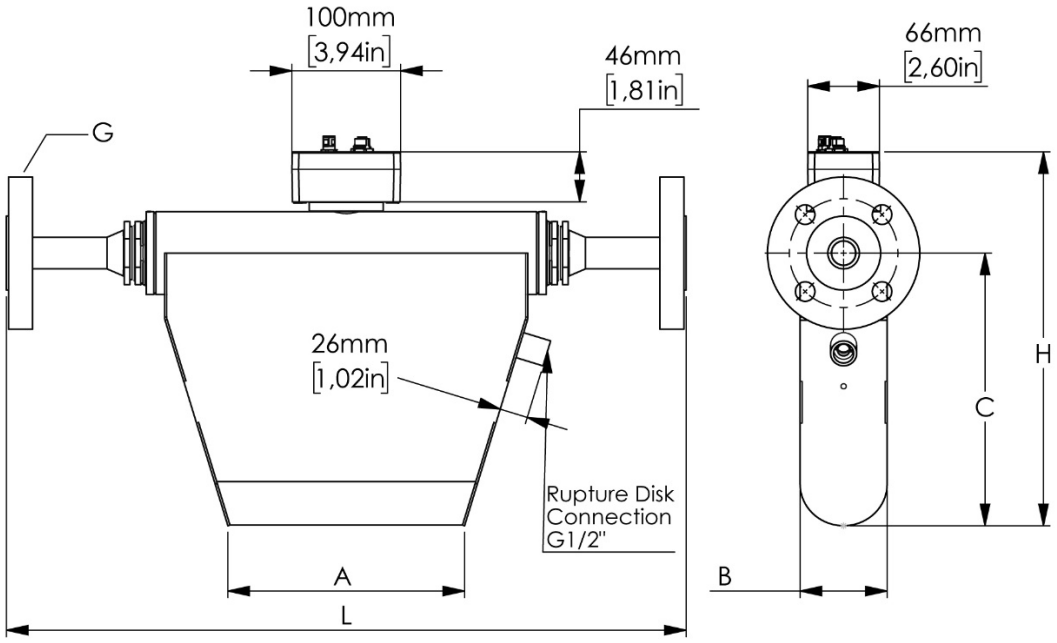


*Fig. 12: Dimensions TCM 5500-**-****-**** through TCM 028K-**-****-****

Sensor type	A	B	C	H	L[8)]	Connection G[9)]
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

[8)] Other connections on request.
[9)] Other lengths on request.

8.4. WEEE and RoHS

The devices described here are not subject to the WEEE Directive and the corresponding national laws. Dispose of used devices properly and not in household waste.

The devices described here fully comply with the RoHS Directive.

9. List of Figures

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