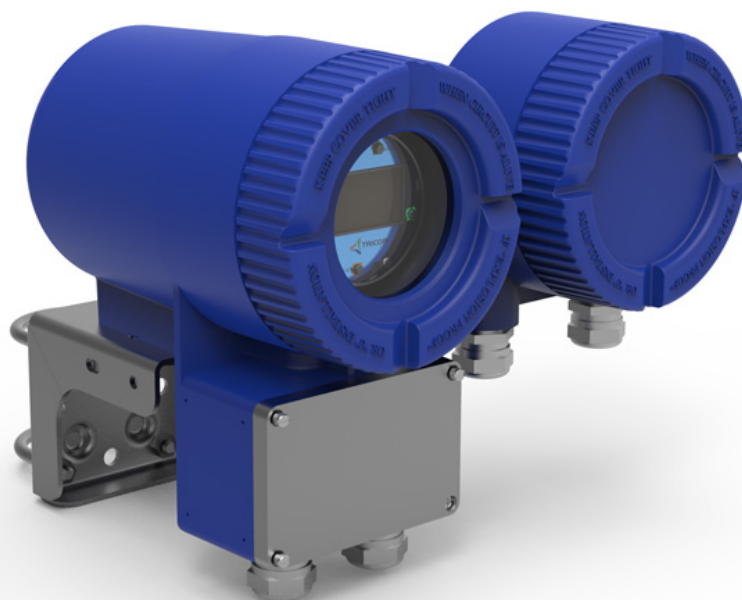


Technical Datasheet

TCE_8501_Technical_M_EN_170308_E001



TCE 8501 DSP

TRICOR® Coriolis Mass Flow Transmitter



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Manual-Version

TCE_8501_Technical_M_EN_170308_E001

Model TCE 8501 DSP Coriolis Mass Flow Transmitter combines with any TCM mass flow sensor to form a TRICOR Plus Mass Flow Meter. The TCE 8501 uses HART® or Modbus protocol for remote communications.

SW-Version

This manual is valid for

Main SW: Mv3.40 and higher

Display SW: Dv3.40 and higher

Index

1.	GENERAL INFORMATION	4
1.1.	Features	4
1.2.	Introduction	4
1.3.	Application Versality.....	5
1.4.	HART® Communication Protocol	5
1.5.	MODBUS Communication Protocol.....	5
1.5.1.	Modbus Station Addresses Supported	5
1.6.	Compliance with European Union Directives	6
1.7.	Tamperproof Sealing Option-S	6
1.8.	LCD Indicator with local configurator	6
2.	OPERATING, TRANSPORTATION AND STORAGE CONDITIONS	7
3.	SYSTEM PERFORMANCE SPECIFICATIONS	8
4.	FUNCTIONAL SPECIFICATIONS	10
5.	PHYSICAL SPECIFICATIONS	14
6.	ELECTRICAL SAFETY SPECIFICATIONS	15
7.	MODEL CODE	16
8.	DIMENSIONS - NOMINAL	17
9.	ORDERING INSTRUCTIONS	19

1. General Information

1.1. Features

- Patented digital signal processing (DSP) techniques allow:
 - Continuous 2-phase measurement
 - Partial empty tube conditions
 - Start-from-empty batching
 - On-line flow sensor verification
 - On-line pressure compensation
- User-configurable, externally powered I/O types isolated from each other include: analog current output and alarm, frequency or scaled pulse output, contact output, contact input.
- User-selectable HART® or Modbus communications via LCD Indicator pushbuttons.
- Remote communication with HART® communicator or PC-based Configurator.
- Local configuration via indicator with pushbuttons
- Available for AC or DC supply voltage applications
- Transmitter is compatible with all TCM meters
- Enclosure can be remote-mounted to a surface, o DN80 (3 inch) or DN50 (2 inch) pipe
- Enclosure meets NEMA 4X an IEC IP66/67 ratings
- Transmitter certified for use in hazardous area locations. Agency plate includes CE mark

1.2. Introduction

This TRICOR Plus mass flow meter, comprising a TCE 8501 mass flow transmitter and a TCM mass flow sensor, measures fluid mass flow rate directly, not inferentially. Direct measurement of mass eliminates the inaccuracies of multiple process measurements associated with volumetric flow devices.

The Model TCE 8501 Coriolis Mass Flow transmitter is an advanced generation of mass flow devices using DSP (digital signal processing) technology, which allows this transmitter to provide improved performance over other Coriolis flow meters.

Ideally suited for tank and railcar loading and unloading, the TCE 8501 transmitter allows for continuous 2-phase measurement, partial empty tube conditions, and start-from-empty batching. It also allows flow sensors to continue operation during transition from liquid to gas and back again.

The optional TCE 8501 LCD keypad allows you to select and use either the HART® or Modbus digital communication interface.

The transmitter provides multiple measurements, remote communications, and selectable multiple current outputs, pulse outputs, contact outputs, and contact inputs.

In addition to the above, automated manufacturing processes, coupled with superior construction and testing all add up to an ideal product for today and tomorrow's "real world" process flow applications.

1.3. Application Versality

- Programmable alarms, contacts, and relays
- Digital circuitry that eliminates zero drift
- High accuracy over a wide range of flow rates
- Remote and local configuration
- Direct measurement of mass, density, and temperature
- Density optimization that provides unsurpassed density accuracy
- Selection of measurements, such as Volume, Volume Total, Mass Total, % Concentration, % Solids, Net Flow, °Brix, and °Baumé
- Suitable for applications including:
 - Tanker unloading
 - Centrifuge bottoms
 - Ethylene oxide
 - Sanitary batching
 - Pharmaceuticals batching
 - Food, dairy, and beverage
 - Custody transfer with quadrature pulse output
 - Net oil
 - Bunker fuels transfer
 - Wet gas

1.4. HART® Communication Protocol

The HART® 4 to 20 mA output signal allows direct analog connection to common receivers while still providing full Intelligent Transmitter DSP Communications using a HART® Communicator or PC-based configurator such as the PC50 Field Device Tool or Model HHT50 Configurator.

Measurements and diagnostics are available from the communicator connected to the two-wire loop carrying the 4 to 20 mA signal by using a bidirectional digital signal superimposed on the 4 to 20 mA current signal. Multidrop configurations are also supported.

Multiple measurements are transmitted digitally in a choice of engineering units (EGUs). Transmitter diagnostics are also communicated.

Configuration and reranging can be accomplished remotely with the communicator or PC-based configurator, or locally with the LCD indicator with pushbuttons.

1.5. MODBUS Communication Protocol

Communication with host processors is made using the Modbus RTU (Remote Terminal Unit) mode over a 2-wire RS-485 multidrop serial connection.

The TCE 8501 uses the Modcom RTU mode, rather than the ASCII mode, for communication. The main advantage of the RTU mode is that its greater character density allows better data throughput than ASCII for the same baud rate. Each message must be transmitted in a continuous stream. The TCE 8501 functions as a Modbus slave device.

1.5.1. Modbus Station Addresses Supported

Supports station (or slave) addresses 1 to 247.

1.5.1.1. Modbus Floating Point Support

Floating-point numbers in the TCE 8501 are each stored in two consecutive 16-bit Modbus registers. Floating-point values are retrieved by requesting the contents of both registers with the same poll command. Both registers of a floating-point value must be written in the same Modbus message. The floating-point numbers should be interpreted according to the IEEE-754 format for 32-bit numbers. Floating point byte order is selectable.

1.6. Compliance with European Union Directives

- Complies with Electromagnetic Compatibility Requirements of European EMC Directive 2004/108/EC by conforming to the following EN and IEC Standards: EN 61326-1 and IEC 61000H4-2 through 61000-4-6.
- Complies with NAMUR NE 21 Interference Immunity requirement (EMC).
- Analog output complies with NAMUR NE 43.
- Complies with all applicable European Union Directives (CE Logo marked on product).

1.7. Tamperproof Sealing Option-S

Tamperproof sealing of the enclosure and terminal box covers is provided by selecting Option -S.

1.8. LCD Indicator with local configurator

An optional LCD indicator is used for local indication of flow measurement, total, and other menu-driven parameters. The indicator keypad's four pushbuttons also allow for flowmeter calibration, configuration, and self-test. The indicator scrolls and displays between multiple measurements.

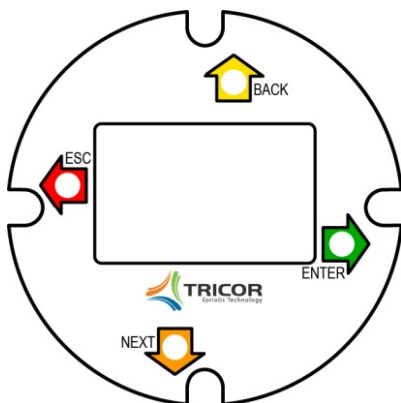


Fig. 1. LCD Indicator Face Plate

2. Operating, Transportation and Storage conditions

Influence	Reference Operating Conditions	Normal Operating Condition Limits ¹	Transportation and Storage Limits ⁵
Ambient Temperature ²	73 ± 3 °F (23 ± 2 °C)	-40 and +140 °F ^{3,4} (-40 and +60 °C)	-40 and +185 °F (-40 and +85 °C)
Relative Humidity	50 ±10 %	5 and 100 % ⁵	5 and 100 %
AC Supply Voltage and Frequency	120/240 V AC, ± 1 % 50/60 Hz, ± 1 %	120/240 V AC, +10/-15% 50/60 Hz, ± 5 %	N/A
DC Supply Voltage	24 V DC, ± 5 %	10 and 36 V DC	
Current Output:			
• Supply Voltage	• 24 V DC	• 24 V DC, ± 10 %	
• Load	• 250 Ω ⁶	• 250 Ω ⁷	
Pulse Output:			
• Supply Voltage	• 24 V DC	• 24 V DC, ± 10 %	
• Load	• 73 mA	• 80 mA	
Contact Input:			
• Supply Voltage	• 24 V DC	• 24 V DC, ± 10 %	
• Load	• 12 mA	• 15 mA maximum	
Contact Output:			
• Supply Voltage	• 24 V DC	• 24 V DC, ± 10 %	
• Load	• 100 mA	• 100 mA maximum	
RS485:			
• Receive Input Range	• ± 5 V DC	• ± 5 V DC ⁷	
Vibration	1 m/s ² (0.1 "g")	5 m/s ² (0.5 "g") from 5 to 500 Hz	11 m/s ² (1.1 "g") from 2.5 to 5 Hz (in shipping package)

¹ Values in the table apply when all transmitter covers have been properly installed and unused openings plugged according to installation instructions.

² Including condensation.

³ If the temperature is between -20 and -40 °C, the display may go blank, but the device is still operational.

⁴ Refer to the Electrical Safety Specifications section for a restriction in ambient temperature limits with certain electrical approvals and certifications.

⁵ Conditions producing sustained condensate are not allowed.

⁶ Minimum load required with HART® Communicator or PC-based Configurator is 250 Ω. Operating below the 250 Ω requirement may cause communication problems.

⁷

The Operative Limits are -7 and +12 V DC.

3. System performance specifications

- Performance specifications are stated at reference operating conditions (unless otherwise specified) using cables with the output averaged for one minute.
- All transmitters and tubes are interchangeable provided that the tube calibration parameters are loaded into the transmitter.
- Performance specifications apply to the flow sensor and transmitter combined as a flowmeter system.
- The performance specifications apply to all transmitter outputs with the following exception: The current output stage adds a maximum error of $\pm 0.1\%$ of the reading or less than 0.001% of meter capacity, whichever is greater.
- Accuracy specifications are made for flows between 100% and 1% of flow sensor Upper Range Limit (URL).
The flowmeter system will operate below 1% of URL, but no accuracy statements are made for this flow condition.

Accuracy – Mass Flow Rate (Liquids) (Includes Linearity, Hysteresis, and Repeatability)

$\pm 0.05\%$ + Zero Instability (see Zero Instability)
Accuracy in % of rate is therefore:

$$\pm \frac{\text{Zero Stability}}{\text{Mass Flow Rate}} \times 100\%$$

Accuracy – Mass Flow Rate (Gases) (Includes Linearity, Hysteresis, and Repeatability)

$\pm 0.50\%$ + Zero Instability (see Zero Instability)
Accuracy in % of rate is therefore:

Flow Rate % of Full Scale	Accuracy
10-100 %	Base Accuracy
0-10 %	$\pm \frac{\text{Zero Stability}}{\text{Measured Value}} \times 100\%$

Accuracy – Volumetric Flow Rate (Liquids Only)

Volumetric flow rate accuracy is the root sum of the squares (RSS) of Mass Flow Rate and Density accuracies. Mass Flow Rate and Density accuracies must be in the same units of measure.

Accuracy – Density (Liquids Only)

$\pm 0.0005 \text{ g/cm}^3$, provided by built-in density calibration function.

Zero Instability			
Flow Sensor Family	Flow Sensor Model	Kg/hr	Lb/hr
TCM Sizes 03250-0230K	3 mm (1/8 in)	0.0096	0.021
	6 mm (1/4 in)	0.027	0.06
	15 mm (1/2 in)	0.1224	0.27
	20 mm (3/4 in)	0.2724	0.6
	25 mm (1 in)	0.5442	1.2
	40 mm (1 1/2 in)	1.224	2.7
	50 mm (2 in)	2.04.0	4.5
	40 mm (1 1/2 in)	1.224	2.7
	80 mm (3 in)	5.442	12
	-0325	0.0324	0.072
	-0650	0.0648	0.144
	-1550	0.156	0.342
	-3100	0.3102	0.684
	-5500	0.5502	1.212
	-7900	0.7902	1.746
	-028K	2.802	6.174
	065K	6.498	14.328

Table 1. Zero Instability⁸

Accuracy – Process Temperature

- ± 1.8 °F (± 1 °C) for process temperatures between -76 and +212 °F (-60 and +100 °C).
- ± 3 °C (± 5.4 °F) for process temperatures from -202 to -76 °F (-130 to -60 °C) and from 212 to 356 °F (100 to 180°C).

Pressure Compensation

Although flow sensors have thick walls, at elevated pressures, there is a small effect on accuracy due to pressure. TCE 8501 has a built in feature which allows pressure compensation for density and mass flow measurement, either by configuration or online pressure compensation.

The TCE 8501 supports both static and dynamic pressure compensation. Static compensation requires that the user enter a pressure value which will be stored in internal non-volatile memory and then applied during measurement calculations. Dynamic compensation requires that an external communication host provide real-time updates of internal pressure.

The default is to use a static pressure value for compensation unless an external live measurement is available. Only gauge pressure units are supported for the dynamic pressure input and the static configured value. Basic units are psi, bar, and kPa.

Ambient Temperature Effect

The effect is ± 0.0028 % of span per °C for any variation from Reference Operating Temperature within the Operating Limits.

Humidity Effect

No effect from 0 to 95 % RH, noncondensing.

⁸ In the accuracy equation, Zero Instability and Mass Flow Rate units must be the same.

Supply Voltage Effect

A change in the supply voltage of +10 or -15 % from reference voltage causes the output to change less than 0.1 % of reading or less than 0.001 % of meter capacity, whichever is greater.

Electromagnetic Compatibility (EMC)

The TCE 8501 Transmitter complies with International and European Union standards. Transmitter must be properly installed and housing earthed (grounded) per installation instructions. See Table 2 Electromagnetic Compatibility.

Parameter	IEC and CISPR Standards	EN Standard
Radiated RFI Immunity	10 V/m per IEC 61000-4-3	10 V/m per EN 61000-4-3
Conducted RFI Immunity	10 V per IEC 61000-4-6	10 V per EN 61000-4-6
RFI Radiated and Conducted Emissions	Per CISPR 11, Class A	EN 55011 Class A
ESD Immunity	6 kV contact discharge per IEC 61000-4-2	6 kV contact discharge per EN 61000-4-2
Electrical Fast Transients/Burst Immunity	2 kV per IEC 61000-4-4	2 kV per EN 61000-4-4
Surge Immunity	2 kV per IEC 61000-4-5	2 kV per EN 61000-4-5
Power Dips and Interruptions	Per IEC 61000-4-11	Per EN 61000-4-11

Table 2. Electromagnetic Compatibility

4. Functional Specifications

Power Requirements⁹

- AC SUPPLY**
 Supply Voltage: 102 to 264 V AC, 120/240 V AC Nominal
 Supply Frequency: 47 to 63 Hz, 50/60 Hz Nominal
 Power: 18 VA maximum
- DC SUPPLY**
 Supply Voltage: 10 to 36 V DC, 24 V DC nominal
 Power: 15 W maximum
 Operating Current: 1 A
 Start-up Current: 3 A

Configurable Outputs

- Direct Mass Flow Rate
- Volumetric Flow Rate
- Totalized Mass Flow Rate
- Totalized Volumetric Flow Rate
- Process Fluid Density
- Temperature
- Bidirectional Flow
- Percent Solids/Concentration
- Net Flow, Component A, Component B
- Brix and Baumé Scales

Digital Communications

The digital communication interface is selectable for HART® or Modbus via the pushbuttons on the LCD indicator keypad. The transmitter is configurable using the keypad. If a blind unit (no LCD indicator) is selected, then the transmitter will be factory configured for HART® or Modbus, as applicable, and digital communication will be via the HART® Communicator or PC-based Configurator.

Upper Range Value (URV) Range ability

100:1; minimum URV = 1 % of meter Upper Range Limit (URL)

Response Time (Undamped)

Transmitter response time varies with the output selected, and is defined as a 90 % recovery time to an 80 % input step per ANSI/ISA-S51.1 with zero electronic damping.

Output Selected	Response Time
Digital Output	35 ms
Analog Output	35 ms + 350 ms
Pulse Output	35 ms

Cold Power-Up/Reset Delay

Less than 2 second delay for outputs to begin to move toward measured value.

Bi-Directional Flow

All necessary functionality is available to provide all flow measurements in the forward or reverse direction. Quadrature pulse output has the ability to indicate flow direction.

Totalization

The transmitter has nonvolatile memory for the four on-board totalizers, each of which support:

- Forward Total
- Reverse Total
- Bi-directional Total

Each totalizer can be configured to have either of two levels of password protection.

Diagnostics/Alarms

Diagnostic and alarm functions are provided. The diagnostics and alarms can be configured to be visual via the local LCD indicator, as a signal output via the 4 to 20 mA and/or pulse outputs, as a contact output, or read via the digital communications interface.

Transmitter I/O

The transmitters nondigital communications I/O are user-configurable. These inputs/outputs are isolated from each other and must be externally powered. The following nondigital I/O types are available:

- Analog Current Outputs
- Analog Current Output Alarm
- Frequency or Scaled Pulse Outputs
- Quadrature Pulse Output
- Contact Output - Configurable
- Contact Input - Configurable

Analog Current Outputs

There are three independent, 4 to 20 mA outputs. HART® communication is provided on the first current output. All transmitter I/Os must be externally powered. Specifications are:

- Output Load: 0 to 680 Ω
- Supply Voltage: 24 V DC $\pm 10\%$
- Current: 22 mA maximum, 3.9 mA minimum
- Output Ripple: Less than 0.05 % of span

Analog Current Output Alarm (High/Low)

This output alarm feature allows communicating a diagnostic error to the current loop receiver. When the error is flagged, the current output can go Upscale, go Downscale, or remain at last value.

Specifications are as follows:

- Supply Voltage: 24 V DC $\pm 10\%$
- Current: 4 to 20 mA nominal
- Underrange/Overrange: 3.8 to 20.5 mA (measurement still valid)
- Alarm Range ≤ 3.6 or ≥ 21.0 mA

Selectable Pulse Outputs

There are two independent pulse outputs. Each output can be configured as a frequency output or as a frequency or scaled pulse output signal. See below.

- **Frequency Output**
This output configuration can be assigned to mass or volume flow rate, density, temperature, or percent solids measurements. The frequency can be configured to as high as 10 kHz. Frequency Output specifications are as follows:
 - Selectable Frequency: 0 to 10 kHz
 - Frequency Duty Cycle: 50 % nominal
 - Supply Voltage: 24 V DC $\pm 10\%$
 - Load Current: 80 mA maximum
- **Scaled Pulse Output**
This output drives low speed totalizers. A pulse is sent for every user-configured mass total that has accumulated. Specifications are as follows:
 - Supply Voltage: 24 V DC $\pm 10\%$
 - Load Current: 80 mA maximum
 - Pulse Width and Maximum Frequency:

Configurable Speed	Pulse Width	Maximum Frequency
SLOW	50 ms	10 Hz
FAST	5 ms	100 Hz

NOTE:

A 256 pulse buffer stores pulses in case of temporary overrange conditions.

Quadrature Pulse Output

A quadrature pulse output uses two pulsed outputs that are $\pm 90^\circ$ out of phase with one another. The polarity (\pm) indicates the flow direction. The quadrature output can be configured to output any reading that a pulsed output can.

Contact Output – Configurable

A contact output is provided and configurable as:

- Hi-Lo Level Alarm Indicator
- Diagnostic Alarm Indicator
- Alarm/Diagnostic Indicator

Specifications are as follows:

- Type: Relay, 1 Form A (Isolated)
- Supply Voltage: 24 V DC $\pm 10\%$
- Current Rating: 100 mA maximum

Contact Input – Configurable

A contact input is externally powered and configurable as:

- A 4 to 20 mA Output Lock
- An External Totalizer Reset
- Initiate a Flow Zero
- Select a Zero Flow Value

Specifications are as follows:

- Type: Requires current linking device such as contact closure or transistor switch between terminal block connections provided.
- Supply Voltage: 24 V DC $\pm 10\%$
- Current Rating: 15 mA maximum

5. Physical Specifications

Transmitter Enclosure

The transmitter is comprised of a cast aluminum alloy material with three separate compartments. The main compartment houses the transmitter electronics (PWAs) and LCD indicator. A second compartment houses terminals to accommodate power and I/O cables (field wiring), and the third compartment houses terminals for sensor input and PE (physical earth) wiring. A gasketed cover is provided for each compartment. See DIMENSIONS-NOMINAL section.

The enclosure has a blue polyester paint finish, and optionally a blue epoxy powder finish. The compartment covers have a blue epoxy powder finish.

The 3-compartment enclosure and electronics design allow for use in Division 1 intrinsically safe, explosionproof, and flameproof installations. Tamperproof sealing of the enclosure covers are provided when selecting Tamperproof Sealing Option.

Transmitter Mounting

7/16-20 UNS threaded holes are provided on the surface of the enclosure on which a carbon steel mounting bracket or optional stainless steel mounting bracket can be attached. The other surface of the bracket allows for mounting to a surface, or to a nominal DN50 (2 inch) vertical or horizontal pipe, or an optional mounting bracket for a DN80 (3 inch) pipe.

Environmental Protection

Printed wiring assemblies (PWAs) are conformally coated for moisture and dust protection. The enclosure has the dust tight and weatherproof rating of IP66/67 as defined by IEC 60529, and provides the environmental and corrosion resistant protection rating of NEMA 4X.

Electrical Connections

- **Sensor Input and Physical Earth (PE) Connections**
Two 1/2 NPT threaded holes are provided in the sensor input and PE connections compartment. One hole is for sensor wires, and the other for PE wires.
- **Field Wiring Connections**
Two M20 or 1/2 NPT threaded holes are provided in the field wiring compartment. One hole is for power wires, and the other for I/O wires.
- **Earth (Ground) Connections**
In addition to internal ground connections, an external ground terminal is provided on the front surface of the enclosure.
- **Transmitter to Flow Sensor Wiring**
An interconnecting cable can be selected in lengths up to 300 meters or 1,000 feet for TCM flow sensors; up to 30 meters or 100 feet for TCM flow sensors. (See Model Code). An IPVC insulated cable is offered with a temperature range from -4 to +176 °F (-20 to +80°C). An FEP insulated cable is offered with a temperature range from -40 to +185 °F (-40 to +85°C).

LCD Indicator with Keypad

Four softkeys provide full configuration capability. The electronics compartment cover must be removed to access the keypad. See figure 1. for the indicator faceplate configuration.

Approximate Mass

20.7 lb (9.4 kg)

Dimensions

See DIMENSIONS – NOMINAL section.

6. Electrical Safety Specifications

These transmitters have been designed to meet the electrical safety specifications listed in the table below. Contact Global Customer Support for the status of agency approvals or certifications.

Testing Laboratory, Type of Protection, and Area Classification	Application Conditions
ATEX, Zone 1: Group IIC or IIB, T4	Connected to TCE 8501 Electrical Safety Code ADA
IECEX, Zone 1: Group IIC or IIB, T4	Connected to TCE 8501 Electrical Safety Code EDA
CSA/CSAus Division 2/Zone 2 Non-Incendive	Connected to TCE 8501 Electrical Safety Code CDA
Agency approvals or certifications not required	

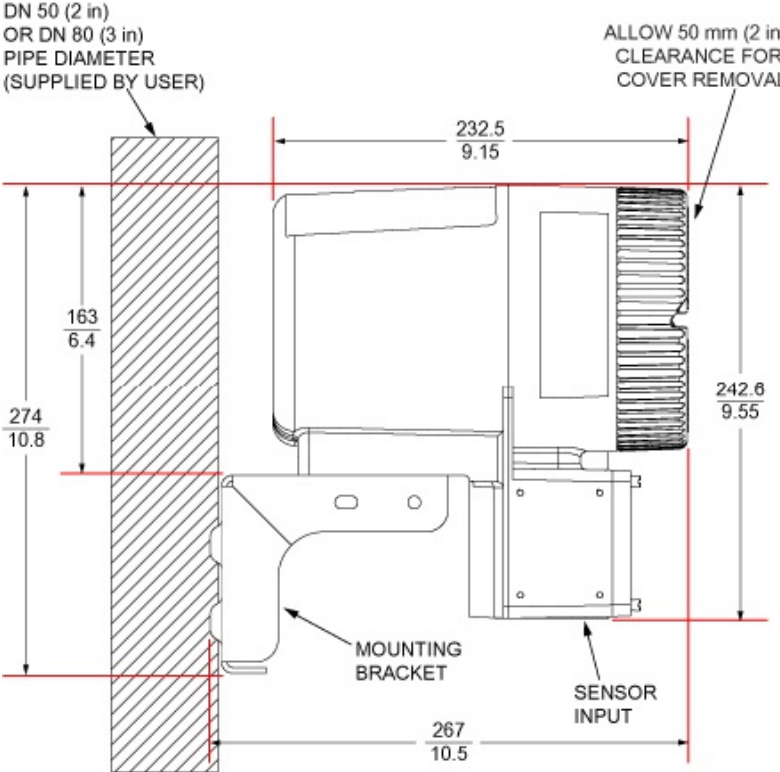
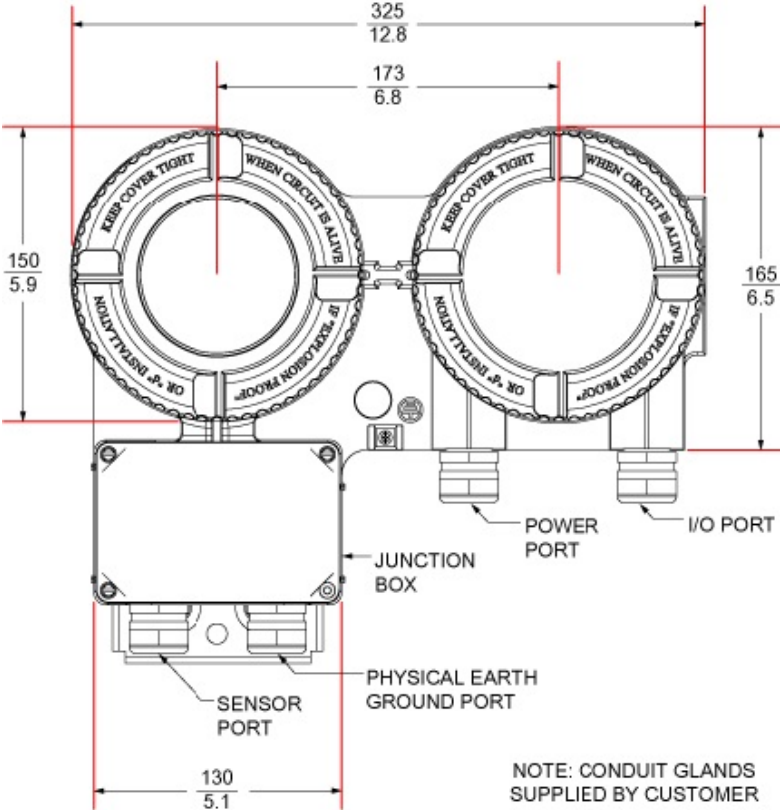
NOTE

These flow sensor have been designed to meet the electrical safety descriptions listed in the ta-ble above. For detailed information, or status of testing laboratory approvals/certifications, con-sult factory.

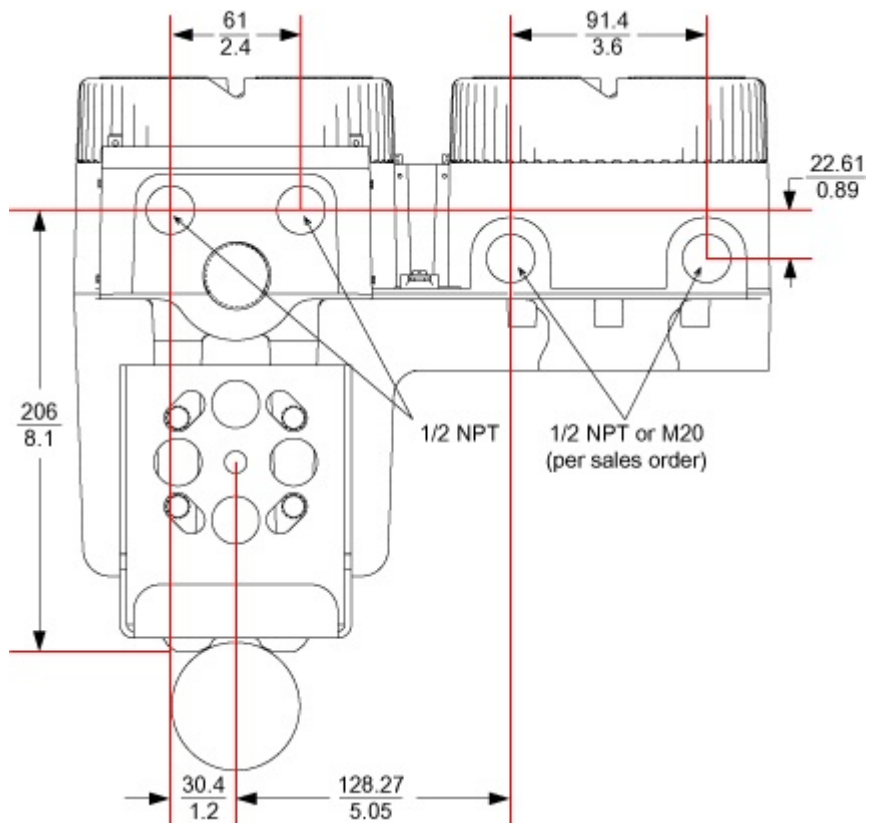
7. Model Code

	TCE 8501	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Communication Interface¹⁰																		
HART® Communication Protocol			T															
Modbus Communication Protocol			M															
Mass Flow Sensor																		
Models TCM Mass Flow Sensor				B	D													
Transmitter Mounting																		
Remote Mounted Transmitter						1												
Language																		
English																		E
Supply Voltage																		
120/240 V AC, 50/60 Hz, Externally Powered I/O																		A
10 to 36 V DC, Externally Powered I/O																		B
Display																		
None																		A
Integral LCD Indicator with Keypad																		B
Output and Power Cable Entrance																		
1/2 NPT Connection (Two places)																		A
M20 Connection (Two places)																		B
Interconnecting Cable Insulation Material																		
No Cable																		N
IPVC Insulated Cable; Temperature Range from -4 to +176 °F (-20 to +80 °C)																		P
FEP Insulated Cable; Temperature Range from -40 to +185 °F (-40 to + 85 °C)																		F
Interconnecting Cable Length																		
No Cable																		N
20 foot cable/6 meter cable																		G
50 foot cable/15 meter cable																		P
100 foot cable/31 meter cable																		H
Electrical Safety (Also see Electrical Safety Specifications)																		
ATEX flameproof with intrinsically flow sensor connections																		ADA
CSA/CSAus explosionproof with intrinsically safe flow sensor connections																		CDA
IECEX flameproof with intrinsically safe flow sensor connections																		EDA
No Certifications																		ZZZ
Tamperproof Sealing																		
Tamperproof Sealing for Housing and Terminal Block Covers																		S
Paint Options																		
Epoxy Paint ¹¹																		E
Mounting Bracket Material and Pipe Size																		
Stainless Steel																		F
Carbon Steel, 3-inch pipe																		G
Stainless Steel, 3-inch pipe																		H

8. Dimensions - nominal



Dimensions - nominal



9. Ordering Instructions

- 1. Model Number.
- 2. Process data and gas or liquid applications.
- 3. If ordering a replacement for a TCE 8501 Mass Flow Transmitter, specify the meter serial number.
- 4. Flow Sensor Model used.
- 5. User Tag Data.

REFERENCE DOCUMENTS

Description	Doc Number
TCM Mass Flow Sensor; 3 to 50 mm (1/8 to 2 in) Sizes TCM Mass Flow Sensor; 40 and 80 mm (1.5 and 3 in) Sizes TCM Mass Flow Sensors	TCM_E68_D_EN_160520_E005

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