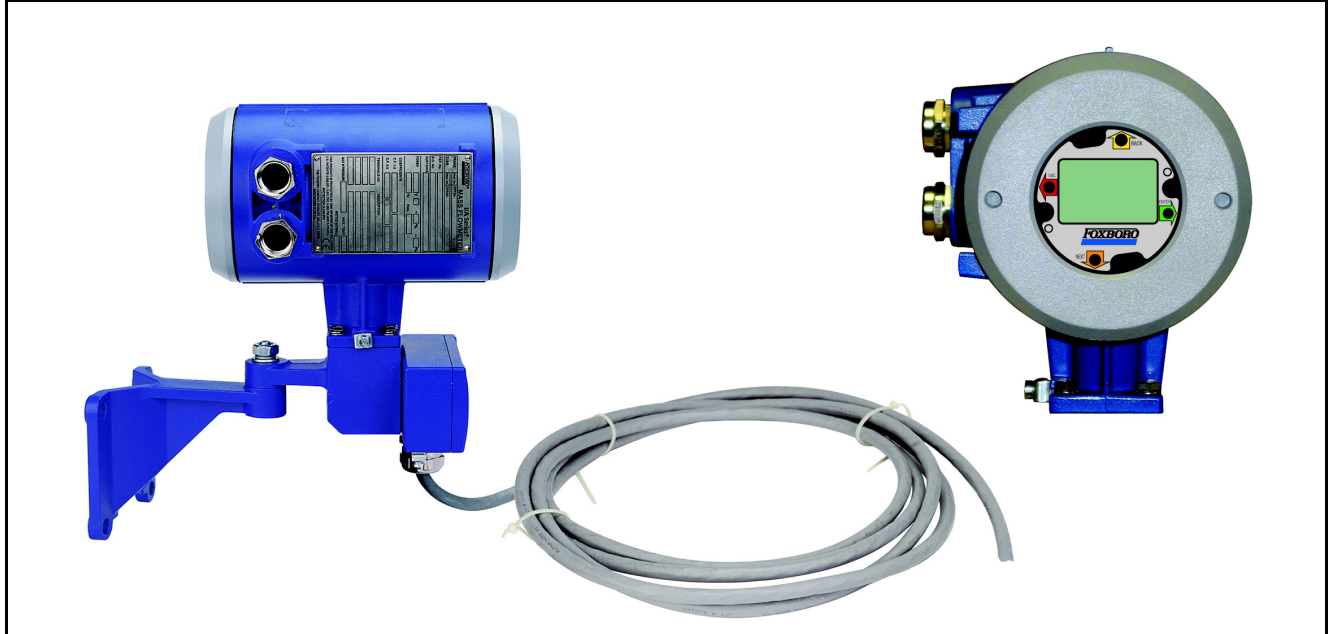


I/A Series[®] Mass Flow and Density Meters

Model CFT50 Digital Coriolis Mass Flow Transmitter with HART Communication Protocol



The Model CFT50 Digital Coriolis Mass Flow Transmitter combines with a Model CFS10 or CFS20 Mass Flowtube to form an I/A Series Mass Flow and Density Meter. This transmitter is a digital device as compared to the analog architecture of earlier transmitters. Use of digital signal processing (DSP) techniques improves flowmeter performance and minimizes the shortcomings experienced by existing transmitters. The CFT50 uses HART protocol for remote communications.

FEATURES

- Patented DSP techniques minimize shortcomings of existing Coriolis flowmeters for measurement of two-phase flow, partial empty tube conditions, and batching from empty.
- Digital precision, stability, and resolution ensure top measurement performance over analog transmitters using the same mass flowtube.
- New transmitter technology eliminates need for slug flow software.
- Numerous, separate output signal combinations, including pulse output, current output, contact output, and contact input, are selectable for HART communication protocol.
- Totally configurable from the local LCD Indicator using four pushbuttons.
- Available for ac or dc supply voltage applications.
- Weights and Measures Custody Transfer Option per NIST Handbook 44.
- Tamperproof Sealing Option for enclosure and terminal block covers.
- Transmitter bracket allows remote mounting of transmitter to a surface, or to a nominal DN 50 to DN 80 (2-in to 3-in) pipe.
- CFT50 Transmitter is backward compatible to existing CFS10 and CFS20 flowtube installations.
- Transmitter Enclosure satisfies IP66 and NEMA 4X Requirements.
- Designed for FM, CSA, and ATEX Hazardous Area locations. Applicable agency plate also includes CE mark.

INTRODUCTION

This I/A Series Mass Flowmeter, comprising a CFT50 Mass Flow Transmitter and a CFS10 or CFS20 Mass Flowtube, measures fluid mass flow rate directly, not inferentially as volumetric flowmeters do. With direct measurement of mass, the inaccuracies of multiple process measurements associated with volumetric flow devices are eliminated.

The CFT50 Mass Flow Transmitter is a new and advanced generation of mass flow devices using digital signal processing technology. The digital technology provides improved performance over existing Coriolis flowmeters. This is particularly evident when two-phase flow is present. The transmitter allows for continual operation with a large amount of entrained air. It also allows the Foxboro mass flowtubes to continue operation during transition from a liquid to a gas, and back again.

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, construction and testing all add up to an ideal product for today and tomorrow's "real world" process flow applications.

APPLICATION VERSATILITY

- Programmable Alarms, Contacts, and Relays
- Digital Circuitry eliminates Zero Drift
- High Accuracy over Wide Range of Flow Rates
- Remote and Local Configuration
- Direct Measurement of Mass, Density, and Temperature
- Density Optimization provides Unsurpassed Density Accuracy
- Selection of inferred measurements, such as Volume, Volume Total, % Concentration, Solids and % Solids, °Brix, and Brix Rate, and °Baumé
- Suitable for applications including:
 - Tanker unloading
 - Centrifuge bottoms
 - Ethylene oxide
 - Sanitary batching
 - Pharmaceuticals batching
 - Food, dairy, and beverage

HART COMMUNICATION PROTOCOL

The 4 to 20 mA output signal with HART communications allows direct analog connection to common receivers while still providing full Intelligent Transmitter Digital Communications using a HART Communicator.

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 EGU. Transmitter diagnostics are also communicated. Configuration and reranging can be accomplished remotely with the Communicator, or locally with the LCD indicator. See below.

MULTI-AGENCY APPROVAL/CERTIFICATION FOR HAZARDOUS AREA LOCATIONS

These flowmeters meet the requirements of many agencies for use in hazardous area locations. Refer to "Electrical Safety Specifications" section.

CE COMPLIANCE

CE marked; complies with all applicable European union Directives.

LCD INDICATOR WITH LOCAL CONFIGURATOR

An LCD Indicator is offered for local indication of the flow measurement and other menu-driven flowmeter parameters. The indicator, with four multifunction pushbuttons, also allows flowmeter calibration, configuration, and self-test. The indicator scrolls and displays between multiple measurements. See Figure 1.

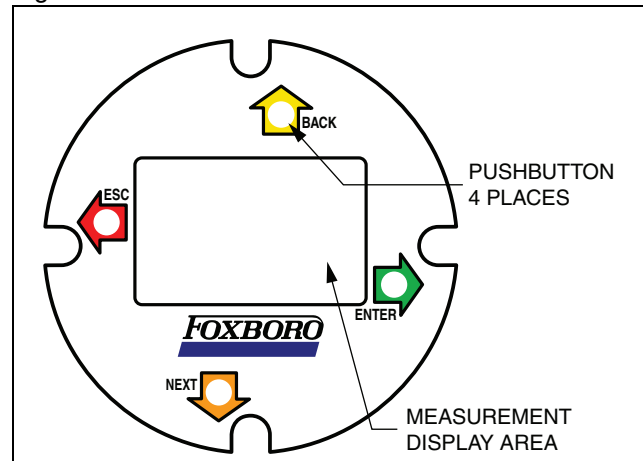


Figure 1. LCD Indicator Face Plate

CUSTODY TRANSFER OPTION

Optional Selection -T provides for Weights and Measures Custody Transfer per NIST Handbook 44. (An NTEP approved label is also applied to the enclosure.) This option incorporates the Tamperproof Sealing option below, and must be combined with CFS10 and CFS20 Flowtubes Custody Transfer Option.

TAMPERPROOF SEALING OPTION

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

OPERATING, TRANSPORTATION, AND STORAGE CONDITIONS

Influence (a)	Reference Operating Conditions	Normal Operating Condition Limits	Transportation and Storage Limits
Ambient Temperature	23 ±2°C (73 ±3°F)	-20 and +60°C (-4 and +140°F)	-40 and +85°C (-40 and +185°F)
Relative Humidity	50 ±10%	5 and 100% (b)	5 and 100% (b)
Supply Voltage and Supply Frequency, ac	120/240 V ac, ±1% 50/60 Hz, ±1%	120/240 V ac, +10/-15% 50/60 Hz, ±5%	N/A
Supply Voltage, dc	24 V dc, ±1%	10 and 36 V dc	N/A
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)

- (a) See Functional Specifications section further in document for contact output and contact input specifications, and additional specifications for current output and pulse output.
 (b) Relative humidity specifications listed apply when transmitter covers are properly installed. Also, conditions producing sustained condensate are not allowed.

SYSTEM PERFORMANCE SPECIFICATIONS ⁽¹⁾
(Under Reference Operating Conditions unless Otherwise Specified)

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

±0.10% + Zero Instability (see Table 1)

Accuracy in % of rate is therefore,

$$\text{Accuracy} = \pm 0.10\% + \left(\frac{\text{Zero Instability}}{\text{Mass Flow Rate}} \times 100 \right)\%$$

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

±0.50% + Zero Instability (see Table 1)

Accuracy in % of rate is therefore,

$$\text{Accuracy} = \pm 0.50\% + \left(\frac{\text{Zero Instability}}{\text{Mass Flow Rate}} \times 100 \right)\%$$

Accuracy - Density

±0.0005 g/cm³ with both CFS10 and CFS20 mass flowtubes, provided by built-in density optimization function.

Accuracy - Process Temperature

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

Table 1. Zero Instability (a)

Flowtube Model	Flowtube Size	Zero Instability	
		kg/min	lb/min
CFS10	3 mm (1/8 in)	0.000016	0.00035
	6 mm (1/4 in)	0.00045	0.001
	15 mm (1/2 in)	0.00204	0.0045
	20 mm (3/4 in)	0.00454	0.010
	25 mm (1 in)	0.00907	0.020
	40 mm (1 1/2 in)	0.0204	0.045
CFS20	50 mm (2 in)	0.0340	0.075
	40 mm (1 1/2 in)	0.0204	0.045
	80 mm (3 in)	0.0907	0.200

(a) 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.

Humidity Effect

No effect from 0 to 95% RH, noncondensing.

Ambient Temperature Effect

(For any variation from Reference Operating Temperature within the Operating Limits)
 ±0.0028% of span per °C

(1) Accuracy specifications listed for flows between 100 and 1% of flowtube URL. Flowmeter will operate below 1% of URL, but no accuracy statements made at these conditions. Also, transmitters and flowtubes are interchangeable provided calibration parameters are loaded into transmitter. CFT50 Transmitters are backward compatible with existing CFS10 and CFS20 Flowtubes.

SYSTEM PERFORMANCE SPECIFICATIONS (Cont.)

Electromagnetic Compatibility (EMC)

The CFT50 Transmitter complies with International and European Union standards. Transmitter must be

properly installed and housing earthed (grounded) per installation instructions. See table below.

Electromagnetic Compatibility

Parameter	IEC Standard	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	CISPR, 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	4 kV per IEC 61000-4-5	4 kV per EN 61000-4-5
Power Dips and Interruptions	IEC 61000-4-11	EN 61000-4-11

FUNCTIONAL SPECIFICATIONS

Power Requirements

ac SUPPLY

- Supply Voltage: 102 to 264 V ac
- Supply Frequency: 47 to 63 Hz
- 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

Transmitter Capabilities

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

Totalization

The transmitter has nonvolatile RAM for the following:

- Forward Total
- Reverse Total
- Net Total
- Grand Total

Diagnostics/Alarms

Diagnostic and alarm functions are provided. These can be configured to be visual via the local display/ keypad, as a signal output via the 4 to 20 mA outputs, or as a contact output.

Response Time (Undamped)

The undamped transmitter response time is 50 ms.

Transmitter I/O (also see paragraphs that follow)⁽¹⁾

- Analog Current Outputs (Multiple)
- Analog Current Output Alarm
- Selectable Frequency Output
- Scaled Pulse Output
- Contact Output
- Contact Input

Analog Current Outputs

Three independent, 4 to 20 mA analog outputs are provided. HART communication is provided on the first current output (refer to Model Code section). All transmitter I/Os must be externally powered, and are connected at the positive power input. Specifications are as follows:

- Output Load: 0 to 680 Ω
- Supply Voltage: 24 V dc ±10%
- Current: 22 mA maximum, 3.9 mA minimum

Analog Current Output Alarm

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.

(1) All transmitter I/O must be externally powered, and are connected at the positive power input.

FUNCTIONAL SPECIFICATIONS (Cont.)

Frequency/Pulse Output

This output is a transistor switch which can be configured as a frequency or pulse output signal.
FREQUENCY OUTPUT SIGNAL

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 SIGNAL

This output is used to drive 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: See table below
- Maximum Frequency: See table below

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.

Contact Output - Configurable

A contact output is provided and configurable as:

- A Flow Direction Indicator
- Or a Range Indicator
- Or an Alarm

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 provided and configurable as:

- A 4 to 20 mA Output Lock
- Or an External Totalizer Reset
- Or an Alarm Reset
- Or Zero Flow Calibration

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

HART Remote Communications

See Table 2 for HART communication parameters, and see Figures 2 and 3 for typical block diagrams.

Table 2. HART Communication Parameters

Parameter	Analog Mode	Multidrop Mode
Communication Rate	1200 baud	1200 baud
Communication Distance	3050 m (10 000 ft)	1525 m (5000 ft)
Minimum Loop Load Required	250 Ω	250 Ω
Meas. Updates	4 times/s	4 times/s
Temp. Updates	1 time/s	1 time/s
Number of Devices	One Device in Loop	Fifteen Devices Maximum on Bus

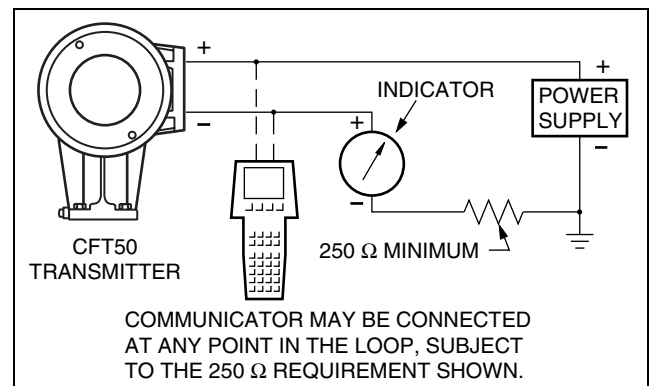


Figure 2. HART 4 to 20 mA Output Block Diagram

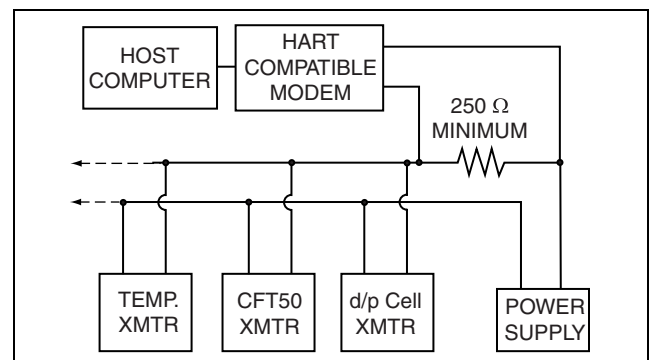


Figure 3. HART Multidrop Block Diagram

Local Interrogation/Configuration

In addition to HART remote communications, a local LCD Indicator with four multifunction pushbuttons is offered. This allows the transmitter to be a stand-alone unit that allows for local interrogation and full configuration capability. The electronics enclosure cover must be removed to access the pushbuttons.

PHYSICAL SPECIFICATIONS

Transmitter Enclosure

Two transmitter enclosures are available, one for standard installations and one for flameproof/explosionproof installations (see Model Code section for Electrical Certification Codes).

The enclosure is an aluminum alloy with an epoxy finish. A junction box is attached to the enclosure to accommodate interconnections between the transmitter and flowtube. The main enclosure comprises two compartments – one compartment for the electronics (includes LCD Indicator with local configurator, if specified), and the other compartment for the user’s field wiring. Covers are provided for the field terminals compartment, electronics compartment, and junction box.

To allow use in Division 1 explosionproof and ATEX flameproof applications, the field wiring and electronics compartments are sealed from one another. Enclosure cover locks are also provided.

Tamperproof sealing of the standard or explosionproof enclosure and junction box covers are provided when selecting either Custody Transfer Option -T, or Tamperproof Sealing Option -S. When selecting Option -T, an NTEP approved label is applied to the enclosure. Additionally, with Option -T, the customer must also select the CFS10 or CFS20 Flowtube Custody Transfer Option -T. See Figure 4.

A cover tightening and removal tool is provided for ease of tightening/removing the enclosure covers.

Transmitter Mounting

The transmitter enclosure is supported by a mounting bracket which can be attached to a surface, or to a nominal DN 50 to DN 80 (2-in to 3-in) pipe. When installed, the housing itself is rotatable in 90° increments, and the transmitter/junction box assembly can be rotated on the mounting bracket to whatever angle is desired. See Figure 4 and “Dimensions-Nominal” section.

Environmental Protection

Printed wiring assemblies (PWAs) are conformally coated for moisture and dust protection. The enclosure is dusttight and weatherproof per IEC IP66, and provides the environmental and corrosion resistant protection of NEMA Type 4X.

Electrical Connections

FIELD WIRING

Field wiring enters the field terminal compartment via two M20 conduit thread openings. Invensys Foxboro also offers 1/2 NPT and 3/4 NPT conduit thread adapters for use with the M20 conduit thread openings. Terminal blocks accept the field wires and the field wiring compartment provides adequate space for service loops.

TRANSMITTER TO FLOWTUBE WIRING

A cable interconnects the transmitter and flowtube, and terminates at a junction box at each end. The maximum cable length allowed for proper operation is approximately 305 m (1000 ft). Refer to the applicable flowtube PSSs for cable selection (type and length). Also refer to applicable installation instructions.

NOTE

As stated previously, the CFT50 is backward compatible to existing CFS10 and CFS20 flowtube installations.

TRANSMITTER JUNCTION BOX TO ELECTRONICS COMPARTMENT

Two cable assemblies are available, one for standard installations and one for flameproof/explosionproof installations (see Model Code section for Electrical Certification Codes).

Approximate Mass - Transmitter

4.2 kg (9.3 lb)

Dimensions

See “Dimensions-Nominal” section.

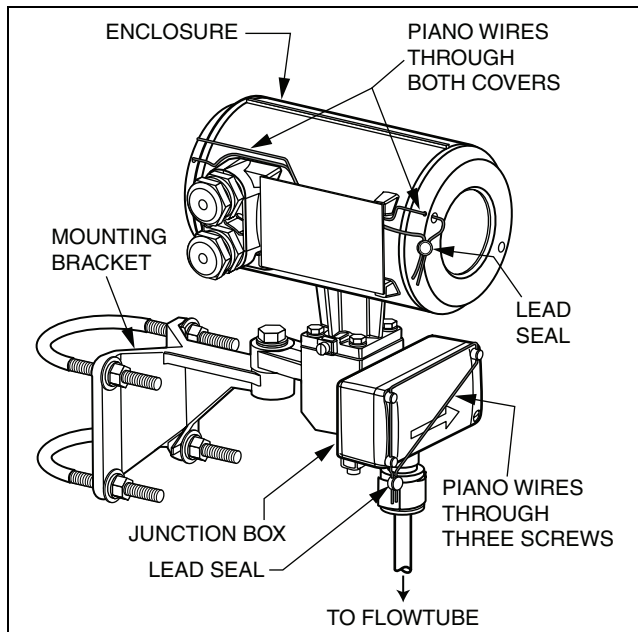


Figure 4. Tamperproof Sealing of Enclosure and Junction Box Covers provided with Option -S and -T (Standard Enclosure Shown)

ELECTRICAL SAFETY SPECIFICATIONS

Agency	Type of Protection and Code	Permitted Use	Temp. Code(a)	Electrical Safety Design Code
ATEX (KEMA)	Flameproof with intrinsically safe flowtube connections; EEx de[ib]	Zone 1, IIB	T6 at 60°C	Q
ATEX (KEMA)	Nonsparking with nonsparking flowtube connections; EEx nA [L]	Zone 2, IIC	T4 at 60°C	T
ATEX (KEMA)	Nonsparking with nonsparking I/O and intrinsically safe flowtube connections; EEx nA [L][ib]	Zone 2, IIB	T4 at 60°C	M
CSA	Nonincendive, with nonincendive flowtube connections; NI	Class I, Division 2, Groups A, B, C, and D.	T4 at 60°C	S
FM	Nonincendive with ib intrinsically safe flowtube connections; NI	Class I, Division 2, Groups A, B, C, and D.	T4 at 60°C	K
FM	Nonincendive, with nonincendive flowtube connections; NI	Class I, Division 2, Groups A, B, C, and D.	T4 at 60 C	R
FM	Explosionproof with ib intrinsically safe flowtube connections; XP	Class I, Division 1, Groups A, B, C, and D.	T6 at 60°C	N
N/A	No agency approvals or certifications required.			Z

(a) Temperature Class is at 60°C maximum ambient

NOTE

The CFT50 has been designed to meet the electrical safety descriptions listed above. For detailed information, or status of the testing laboratory approval/certification, contact Invensys.

MODEL CODE

Description

CFT50 = Digital Coriolis Mass Flow Transmitter

Mass Flowtube Interface

-B = Foxboro CFS10 and CFS20 Series Flowtubes

Transmitter Mounting

1 = Remote Mounted Transmitter (a)

Language

E = English

Nominal Supply Voltage

A = 120 to 240 V ac, 50 or 60 Hz

B = 10 to 36 V dc, with Externally Powered I/O

Output Signals and Communication Protocol

With HART Communication Protocol

Output 1 (b)	Output 2	Output 3	Output 4
1 = Current Output/HART	Contact Input	Pulse Output	Contact Output
2 = Current Output/HART	Contact Input	Current Output	Contact Output
C = Current Output/HART	Current Output	Contact Input	Pulse Output
D = Current Output/HART	Current Output	Current Output	Pulse Output
E = Current Output/HART	Current Output	Current Output	Contact Input
F = Current Output/HART	Current Output	Current Output	Contact Output

LCD Indicator with Pushbuttons

A = None - Blind Unit

B = Integral LCD Indicator with Pushbuttons for Local Configuration

Electrical Safety (Also see Electrical Safety Specifications section)

Q = ATEX (KEMA), Flameproof, II 2 G, EEx de[ib], IIB, Zone 1, T6 at 60°C

T = ATEX (KEMA), Nonsparking, II 3 G, EEx nA [L], IIC, Zone 2, T4 at 60°C

M = ATEX (KEMA), Nonsparking, II 3 (2) G, EEx nA[L][ib], IIB, Zone 2, T4 at 60°C

S = CSA, Nonincendive, NI Connection, Class I, Div. 2, Groups A, B, C, D, T4 at 60°C

K = FM, Nonincendive, IS Connection, Class I, Div. 2, Groups A, B, C, D, T4 at 60°C

R = FM, Nonincendive, NI Connection, Class I, Div. 2, Groups A, B, C, D, T4 at 60°C

N = FM, Explosionproof, IS Connection, Class I, Div. 1, Groups A, B, C, and D, T6 at 60°C

Z = No Approvals or Certifications required.

Optional Selections

-A = 1/2 NPT Cable Gland adapted to M20 thread in housing

-B = 3/4 NPT Cable Gland adapted to M20 thread in housing

-S = Tamperproof Sealing for Terminal Block and Housing Covers (c)(d)

-T = Weights and Measures Custody Transfer/NTEP (c)(e)

- Includes Optional Selection -S (Tamperproof Sealing)

- Must be combined with CFS10 and CFS20 Option -T (Custody Transfer)

Example: CFT50-B1EA2BK-A

(a) The maximum cable length allowed between transmitter and flowtube for proper operation is 305 m (1000 ft).

(b) The HART Communicator can be used with the 4 to 20 mA current output signal 1 only.

(c) Optional Selections -S and -T are not available when the LCD Indicator, Code B, is selected.

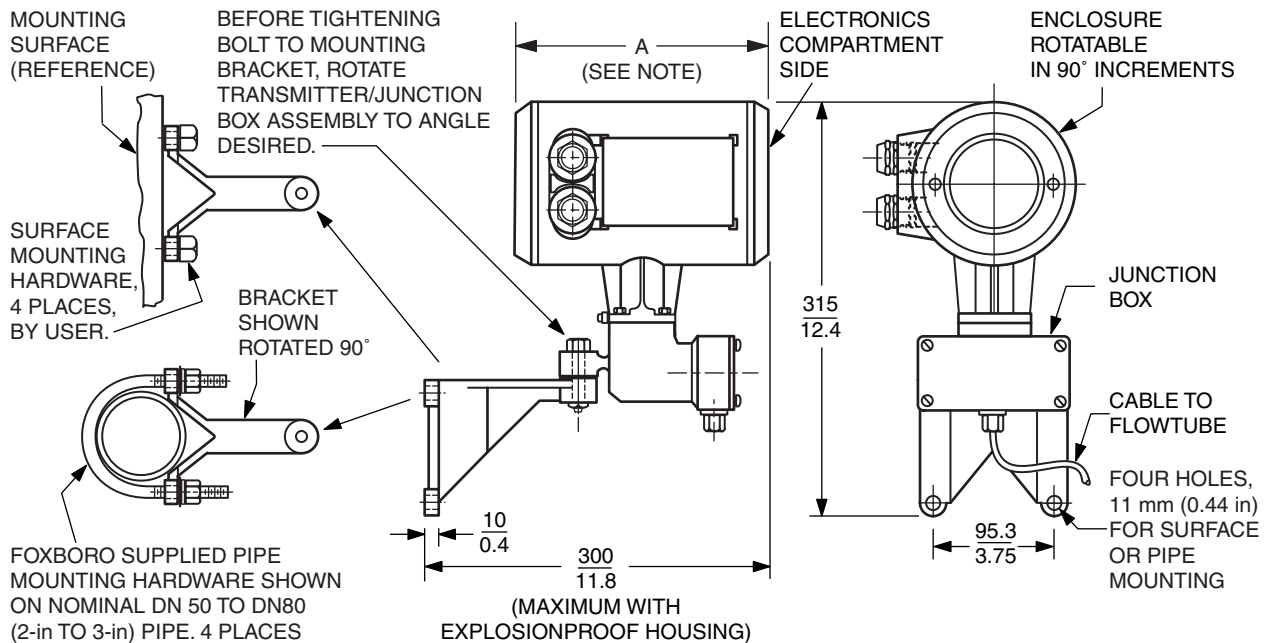
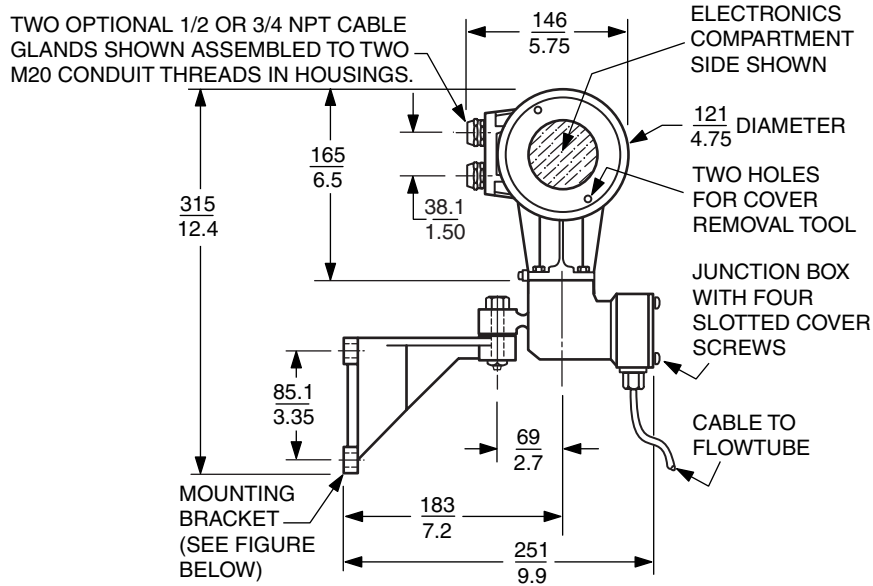
(d) Optional Selection -S is not available with Electrical Safety Codes M, Q, T, and S.

(e) Optional Selection -T is not available with Electrical Safety Codes M, Q, and T.

DIMENSIONS - NOMINAL

**mm
in**

REMOTE MOUNTED TRANSMITTER



NOTE

Dimension A is 210 mm (8.25 in) for standard housing and 239 mm (9.4 in) for explosionproof housing.

REFERENCE DOCUMENTS

PSS Number	Description
1-2B1 A	CFS10 Mass Flowtube, 3 to 50 mm (1/8 to 2 in) Sizes
1-2B1 A	CFS20 Mass Flowtube, 40 and 80 mm (1.5 and 3 in) Sizes

ORDERING INSTRUCTIONS

1. Model Number.
2. Process Conditions.
3. Gas or Liquid Applications from Sizing Program.
4. If cable is required, refer to PSS 1-2B1 A (CFS10 and CFS20 Mass Flowtubes).
5. If ordering a replacement for a CFT10 or CFT15 Mass Flow Transmitter, specify serial number.
6. Flowtube Model Used.
7. User Tag Data.

OTHER M&I PRODUCTS

Invensys Foxboro provides a broad range of measurement and instrument products, including solutions for pressure, flow, analytical, positioners, temperature, controlling and recording. For a listing of these offerings, visit the Invensys Foxboro web site at:

www.foxboro.com/instrumentation

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