

SERIES **454FTB**

SINGLE-POINT INSERTION THERMAL MASS FLOW TRANSMITTERS



DESCRIPTION

The Series 454FTB represents the newest addition to the Kurz family of state-of-the-art microprocessor based, industrial quality, Single-Point Insertion Mass Flow Transmitters for industrial gases. It has many improvements and features that greatly enhance the performance, including, the new FD2-HT Sensor rated at 260°C, electronic self-check functions, a flow control valve PID controller, a Patent Pending digital thermal anemometer bridge, a more convenient remote electronic mounting configuration, a one-piece PCB for improved reliability and ease-of-use, built-in sensor cleaning purge timer, external input for other process signals such as pressure and other unique Kurz engineering and functional features. The 454FTB includes the most advanced temperature compensation, microprocessor technology and the highest repeatability, accuracy, and reliability available. The 454FTB has CE Compliance, non-incendive hazardous gas safety approvals and a Canadian Registration Number for most applications. Kurz has world-class calibration facilities, and is ISO 9001:2000 certified.

KEY FEATURES

- Easy-to-use menu for display and set-up with HELP screens.
- Two-line 16 character, back-lit LCD with twenty button keypad (optional).
- User selectable scrolling display.
- Adjustable LCD/Keypad orientation allowing ease of reading the display for horizontal or vertical installations.
- Process Temperature Rating of -40°C to +260°C (HT) or -40°C to +500°C (HHT).
- PID Flow Controller.
- Two optically isolated loop-powered 4-20 mA outputs, one for mass flow rate or mass velocity, one for process temperature or for PID application.
- 4-20 mA outputs meet NAMUR NE43 recommendations.
- Two optically isolated solid-state alarm/relays (optional).
- Pulsed output for use as a remote flow totalizer (optional).
- User selected English or Metric units (SFPM, SCFM, SCFH, PPM, PPH, °F; NMPS, NLPM, NCMH, KGM, KGH, °C).
- Multi-Point calibration correction factors for Flow and Temperature.
- User-entered METER ID.
- User-entered flow area.
- Programmable sensor out-of-tolerance indication and alarm functions.
- User may change STP reference condition.
- User-selectable digital filtering for each METER.
- Built-in flow totalizers and elapsed time.
- User Access Code.
- USB port for terminal operation.
- Modbus ASCII or RTU communications.
- IP66/NEMA 4X/7 dual chamber epoxy painted electronics enclosure.
- CE Compliance, including the current EMC, ATEX, LVD and PED Directives.
- Configuration upload/download software using a PC and USB connection.
- Velocity/Temperature/Mapping (VTM) for wide ranging velocity and temperature.
- Input power options of 85 to 265 VAC 47/63 Hz or 24 VDC.
- Remote Electronics Enclosure option.
- Velocity range of 0-24,000 SFPM (112 NMPS).
- New Patent Pending digital sensor control.
- Single PCB main electronics.

- Built-in purge timer and "hold value" feature during purge for use with Model 146 Sensor Cleaning System.
- Optional Air Purge Sensor Cleaning System.
- Electronics operating temperature range of -25°C to +65°C, non-condensing, and -40°C to +65°C without the LCD/Keypad option.
- Process Pressure Rating of 300PSIG.
- Alloy C-276 all-welded sensor construction.
- Fastest response to temperature and velocity changes in the industry.
- Insensitive to orientation
- Sensor lead length independent circuitry.
- Non-Incendive Safety Approvals (ATEX, CSA).
- All components pass an extensive burn-in test for high reliability.
- Zero velocity cut-off.
- Automatic Sensor Blockage Correction Factor (SBCF).
- Built-in zero-midspan-span CEM electronics drift check circuits.
- Two digital inputs (optional).
- One 4-20mA input (optional).

APPLICATIONS

- Industrial and process gas mass flows
- Combustion air flow measurements
- EPA Flow Monitors
- Flare stack metering
- Aeration air flow and digester off-gas flow
- Landfill vapor recovery
- Incinerator stack mass flow
- Solvent recovery system mass flow
- VOC mass flow
- Cement plants
- Coal-fired boiler combustion air
- Compressed air
- Natural gas, and most industrial gases
- Semi-conductor processing gas metering
- Nuclear power plants
- Air sampling in D.O.E. facilities
- O.E.M. applications

OUR MISSION

To manufacture and market the best thermal mass flow meters available and to support our customers in their efforts to improve their business.

SERIES 454FTB SINGLE-POINT INSERTION THERMAL MASS FLOW TRANSMITTERS

PRINCIPLE OF OPERATION

The Series 454FTB uses the well-recognized Kurz thermal convection mass flow measurement method by detecting the heat transfer from the heated RTD sensor (Rp) referenced to the temperature of the ambient gas stream RTD sensor (Rtc). A constant temperature difference between the heated sensor and the temperature sensor is maintained with a new patent pending digital control circuit providing unexcelled speed of response and the many other advantages of constant temperature thermal anemometry. The microprocessor-based electronics measures the heat transfer, computes the standard velocity and ambient gas temperature, and allows the user to configure and set-up the 454FTB to fit all flow requirements. Display screens are easy-to-use and provide all the flow and temperature and diagnostic information. For a more detailed description of Kurz technology, please see Document Number 364003, "Theory and Application of Kurz Thermal Convection Mass Flow Meters" by contacting the Kurz Factory or by visiting our web site.



Figure 1—Series 454FTB LCD/Keypad with Lid Removed.



Figure 2—Fast Dual (FD2) Sensor.

CALIBRATION CURVE

Figure 3—The basic flow calibration curve is non-linear, having a non-zero output (live zero) at zero flow and a nearly constant percent of reading accuracy. Zero is a valid data point for a Kurz meter. The 454FTB electronics linearizes this non-linear Calibration Data.

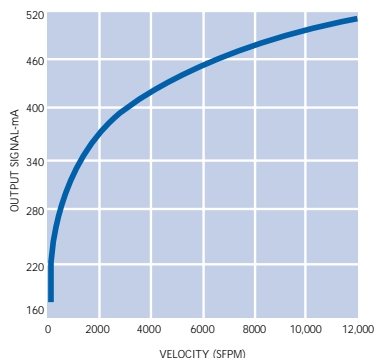


Figure 3—Calibration Curve.

TIME RESPONSE TO FLOW AND TEMPERATURE CHANGES

Figure 4—Shows the response of a Kurz Fast Dual (FD2) MetalClad™ sensor to a step change in velocity. Kurz manufactures the fastest industrial quality sensors available.

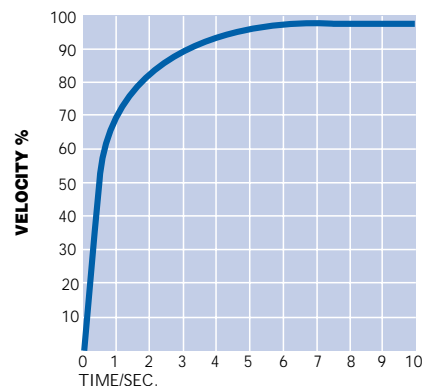


Figure 4—Sensor Flow Response.

Figure 5—Shows a typical response to a step change in temperature for a Kurz Fast Dual (FD2) MetalClad™ sensor. It is exceptional and allows use of the sensor for combustion air flow measurements in boilers that mix hot and cold air for temperature control in coal pulverizers, for example.

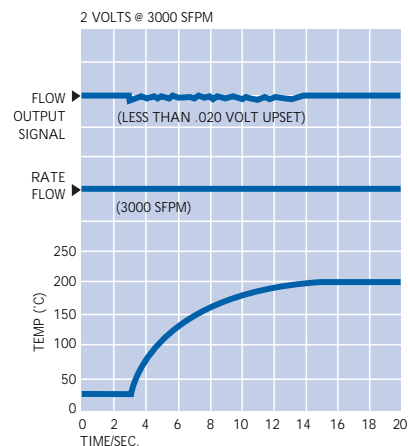


Figure 5—Sensor Temperature Response.

ORIENTATION EFFECTS

Figure 6—Shows a typical output response to changes in the incoming velocity direction. Data is shown for rotation and yaw, as defined by Figure 7. Note that the effect is small for angles up to ± 20 degrees. This is extremely important for flow applications having severe turbulence and a non-axial velocity direction.

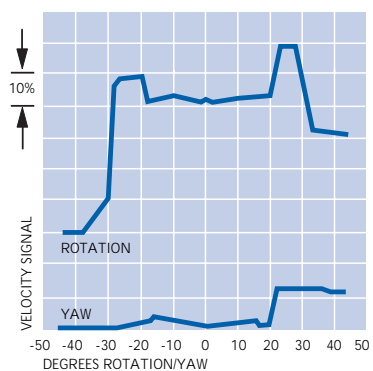


Figure 6—Sensor Measurement Error Versus Rotation/Yaw Angles.

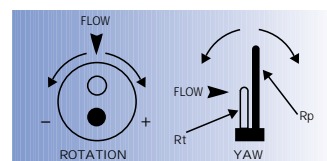


Figure 7—Sensor Rotation and Yaw Description.

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SINGLE-POINT INSERTION THERMAL MASS FLOW TRANSMITTERS

SPECIFICATIONS

Process Temperature Rating:

HT(-40°C to 260°C)

HHT(-40°C to 500°C)

Process Pressure Rating:

300 PSIG (20 BARg)

Sensor Material: Alloy C-276;

optional abrasion-resistant

Chromium Nitride coating on

Alloy C-276 sensor materials.

PTFE coating for chemical

resistance on Alloy C-276

sensor and sensor support,

HHT sensors, 260°C max.

Sensor Support Material:

316L Stainless Steel, optional

Alloy C-276.

Repeatability: 0.25%**Velocity Time Constant:**

1 second for velocity changes

at 6000 SFPM at a constant

temperature and 1 second for

temperature changes at a con-

stant velocity of 6000 SFPM.

Process Temperature**Time Constant:**

8 seconds at a velocity of

6000 SFPM.

Velocity Accuracy:

See Feature 4 for overall

accuracy including the effects

of process temperature.

Temperature Accuracy:

±(1/2% of reading +1°C) for

velocities above 100 SFPM.

Power: +24 VDC ±10%, 85-265

VAC, 47/63 Hz; 24 watts max.

Enclosure Temperature**Rating:** -25°C to +65°C

with LCD/Keypad option;

-40°C to +65°C without

LCD/Keypad option.

Enclosure: Epoxy-Painted

aluminum, IP66/NEMA 4X/7

with glass window for display

option.

Solid-State Relays:

Optically isolated, 0.5 ampere,

24 VAC/VDC maximum

Analog Outputs (4-20 mA):

Optically isolated, user loop-

powered, 12 bit resolution

and accuracy, maximum loop-

resistance is 300Ω at 18 VDC,

550Ω at 24 VDC, 1400Ω at

36 VDC; meets NAMUR NE43

recommendations.

Meter Filter Time Constant:

Selectable 0 to 600 seconds.

Continued on next page

TECHNICAL DESCRIPTION

SENSOR DESIGN

Series 454FTB Insertion Mass Flow Transmitters use

the Kurz MetalClad™ FD2 all-welded Alloy C-276

sensor. In this design, the temperature sensor and

velocity sensor are mounted in separate tubes (or

"stings"), providing exceptional thermal isolation from

the sensor support structure and fast response to

process temperature changes.

SENSOR MATERIALS AND CONSTRUCTION

The standard sensor material for all Kurz metal sen-

sors is Alloy C-276. This material is far superior to

316 Stainless Steel in high temperature and corrosive

applications. Kurz offers Chromium Nitride coating

for abrasive, dirty applications, such as in boiler coal

pulverizers. Kurz exclusively uses Inconel sheathed

mineral-insulated cable (MI cable) for temperatures

above 260°C.

PROCESS TEMPERATURE RATING

Kurz offers sensor process temperature ratings of

260°C and 500°C. Field data verifies that the lifetime

at 500°C is at least five years and the lifetime at 260°C

is at least 10 years.

TRANSMITTER CONFIGURATIONS

Two configurations are available; Directly Attached

Electronics Enclosure and Remote Electronic

Enclosure.

PROCESS TEMPERATURE COMPENSATION

The influence of temperature on the thermal proper-

ties of gases requires temperature compensation for

repeatable and accurate measurements. Standard

Temperature Compensation (STC) is used for applica-

tions in which the process temperature is below

125°C over a moderate velocity range or below 260°C

over a more limited velocity range. If the process tem-

perature and gas velocity vary widely, Velocity/

Temperature/Mapping (VTM) is recommended. VTM

includes several process temperatures and uses the

microprocessor to calculate the velocity based on the

built-in process temperature measurement.

GAS CALIBRATION

The customer has a choice of a laboratory calibration

or a gas correlation calibration. Air calibrations are

performed in the Kurz Model 400D NIST traceable

wind tunnel.

SENSOR PROTECTION

The 454FTB circuitry includes circuitry to prevent an

over-temperature condition caused by a sensor, wiring

or component failure. Our sensors will not overheat

at zero flow, unlike most competitive devices because

of our constant temperature sensor control method

and the power limiting design.

AIR PURGE SENSOR

CLEANING SYSTEM

The Model 454PFTB has a special nozzle in the sensor

window for use with the Model 146 Air Sensor

Cleaning System. The sensor cleaning is accomplished

by a short, high pressure blast of air (sonic velocity)

directed at the velocity and temperature sensors. Kurz

provides solenoid valves and air blow-down tanks to

allow periodic or on-demand cleaning. The 454PFTB

has a built-in timer and relay to initiate the purge

cycle. The measurement value is "held" during the

purge cycle. The air blow-down tank uses customer

supplied compressed air (instrument quality) at 60 to

125 PSIG. The average cleaning air consumption is less

than 0.125 SCFM. The Model 454PFTB is designed to

measure air flow only at ambient pressure. Canadian

Registration (CRN) is not available for the Model

454PFTB. The primary application is for extremely

dirty stacks and ducts having dry particulate matter

that may build up on the sensor. Applications include

fossil-fueled power boilers, municipal waste incinera-

tors and combustion air flow situations in which fly

ash is entrained.

SENSOR ELECTRONICS

The Series 454FTB has several innovations which

improve performance, reduce cost and provide

extraordinary flexibility. The Patent Pending digital

sensor control circuit uses an efficient switching

power supply. The single-board PCB has an EEPROM

loaded with the PCB serial number, calibration coeffi-

cients, and component values which insures the safety

of the data. The sensor electronics includes a sensor

lead resistance compensation circuit which is extremely

important for long sensor wires, rapid gas temperature

changes and large temperature gradients between the

sensor and the ambient air.

SPECIFICATIONS *Cont'd.*
Safety Approvals:

ATEX Non-Incendive
EN 60079-0/15 and
EN 61241-1
⚡ II 3 GD, EEx nA II;
IP66/NEMA 4X/7 enclosure.

Rated Input:
24 VDC, 24W
Electronics Housing: -40°C
to 50°C; T6: -40°C to 65°C; T5.
Sensing Element: -40°C to
55°C; T5: -40°C to 130°C; T3.
Maximum, Effective Sensing
Element Temp.: 70°C above
Process Temperature.

Rated Input:
85 to 265 VAC, 24 W 47-63
Hz PH1.
Electronics Housing: -40°C to
50°C; T4: -40°C to 60°C; T150°C.
Sensing Element: -40°C to
55°C; T5: -40°C to 130°C; T3.
Maximum, Effective Sensing
Element Temp.: 70°C above
Process Temperature.

CE Directives: EMC, ATEX, LVD
and PED. Consult Kurz for details.

Serial Port Baud Rate:

User selectable: 9600, 14,400,
19,200, 38,400, 57,600.

Communication Ports:

RS485 Modbus ASCII or RTU
Mode, and USB.

Digital Inputs:

Two, contact closure, TTL.

Analog Input:

One, 4-20mA, non-isolated.

LCD: Back-lit two-line alphanumeric
with 16 characters per line.

LCD Update: Every two seconds.

Keypad: 20-button membrane
mounted inside enclosure.

LCD/Keypad Orientation:

Adjustable in 90° increments
to accommodate viewing
orientation.

Electronics Enclosure

Orientation: 0° or 180° for viewing
(Feature 1).

Memory: EEPROM for all important
data, with automatic sensor
identification; Flash EEPROM for
Program Memory.

Net Weight/Shipping Weight:

DC Version: 4lbs/5lbs;
AC Version: 6lbs/8lbs,
add 4lbs/5lbs for remote option.

TECHNICAL DESCRIPTION *Cont'd.*
FIRMWARE

The Display, Executive and Programming menus are very easy-to-use and are largely self-explanatory. The flow and temperature data may be scrolled so it can be seen through the window in the cover. The user may press "D" and see the flow and temperature data, as well as the raw flow data. Pressing "H" holds the display screen (but not the readings). A user access code is required for programming, seeing data and entering configuration and other user data.

HELP SCREENS

By pressing "HH" the user can obtain important information on the use of the Series 454FTB, including the firmware version, Kurz telephone and fax numbers and the web site address, etc.

SELF-DIAGNOSTICS

The 454FTB performs an extensive check-out upon power-up and continuously monitors the sensor inputs/outputs and verifies the integrity of the sensor wiring and the measurements. The Sensor Kick-Out Feature is used to set the velocity and temperature fault limits.

PROGRAMMABLE CORRECTION FACTORS

A multi-point Variable Correction Factor (VCF) may be used to correct the flow calibration data to meet in-situ flow tests over the entire velocity range such as done for EPA Stack Flow Monitors. A Sensor Blockage Correction Factor (SBCF) can be used to correct for the area reduction caused by the sensor support. The user enters the area of the flow passage and the sensor center line distance from the inside of the flow passage and the Series 454FTB automatically calculates the SBCF.

METER FILTER TIME CONSTANT

A digital filter time constant may be set for each METER which affects the display readings and the 4-20 mA outputs. The time constant can be set from 0 to 600 seconds.

**COMPATIBILITY WITH SERIES 155
MASS FLOW COMPUTERS**

A "Blind" Series 454FTB (ordered with the two 4-20 mA Outputs and +24 VDC power input is fully compatible with the inputs and features of the Series 155 Mass Flow Computers. This Feature is used when two or more Model 454FTBs are used in a multi-point velocity array. (Please see the Series 155 Brochure).

SELECTABLE STP CONDITIONS

The mass flow calibration data is referenced to the Kurz laboratory standard of 77°F/14.69 PSIA (25° C/760 mmHg). The user may change the STP conditions to suit his requirement.

4-20 mA OUTPUTS

These loop-powered outputs are optically isolated, and include the NAMUR NE43 recommendation regarding fault detection. The fault conditions are generally set at the Kurz Factory, but may be set by the user. The user may easily re-calibrate the 4-20 mA outputs by entering "CALIB 4-20 mA OUTPUTS" measuring the output and adjusting it using the LCD/Keypad up/down buttons. The 4-20mA outputs may be set-up for non-isolated, self-powered operation.

NAMUR NE43 COMPLIANCE

Kurz meets the NAMUR NE43 recommendation for the 4-20 mA outputs, under a fault defined by the sensor Kick-Out menu, sensor or system fault. An NE43 alarm may be selected as high or low, but not both. This feature also frees up the alarm/relays so that the user can set-up the flow and temperature alarms for other needs.

TOTALIZER OUTPUT

The customer may order 0 or 2 solid-state optically isolated relays. If no relays are ordered, the alarm functions are displayed on the LCD. Both relays may be used for alarms (LO, HI and HOL) or for the Sensor Kick-Out Feature; or one relay may be used for an alarm function and one may be used as a pulsed output for use as a remote flow totalizer, or both relays may be used as pulsed outputs. Totalizers may be automatically reset at a specific total quantity (i.e., 10,000 SCF). The 454PFTB uses one relay for the purge initiation.

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TECHNICAL DESCRIPTION Cont'd.

BUILT-IN "ZERO-MIDSPAN-SPAN"

DRIFT CHECK/CALIBRATOR

A new feature is the addition of a Daily "Zero-Midspan-Span" Electronics Drift Check meeting the U.S. E.P.A. requirement for CEM Stack Flow Monitors. A menu is entered to select the desired flow value (or 4-20 mA value) for "Zero-Midspan-Span" values and the time interval during each stepped flow value. The Drift Check is initiated by the User with a contact closure or via Modbus. An acknowledgement relay is normally activated. A solid-state relay and a digital input is needed (See Feature 11). The flow signal is compared against the expected set-point for each level of selected velocity or flow rate values. In addition, this feature can be used to check the electronics for accuracy and linearity.

PID FLOW CONTROLLER

The new 454FTB includes the capability of controlling the velocity or flow rate through the use of the user's control valve, damper or position commanded 4-20 mA interface device. The Set-Point may be internal or remote.

USB PORT

A USB port for terminal operations includes a COM emulator driver which can be accessed using a PC terminal emulator program to remotely "echo" the LCD and keypad functions and upload/download the system configuration and calibration data files using XMODEM protocol. The Series 454FTB may be operated in a manual or remote terminal manner. Measurement summary data may be initiated manually and by pushing the "L" button on the keypad or from the PC. The information may also be obtained automatically by activating the LOG interval timer using the Series 454FTB keypad or a PC.

MODBUS

The Modbus local network protocol (ASCII or RTU) is included. The use of Modbus is extremely useful, as most features may be accessed, including configuration up-load, down-load, etc.

ORDERING INFORMATION

FLOW TRANSMITTER SELECTION

Table 1 lists the Series 454FTB Model number, Parent Number and Major Features. Table 2 lists the Baseline (V*) Full Scale Velocity for each Gas Type. Table 3 lists the Flow factor (F*) Equation for each Gas Type.

TABLE 1 SERIES 454FTB SELECTION TABLE

Model Number	Parent Number	Sensor Support Dia.	Process Temp. Rating	Air Purge	Safety Approvals
454FTB-08-HT	756051	1/2"	HT	No	NI
454FTB-08-HHT	756052	1/2"	HHT	No	NI
454FTB-12-HT	756053	3/4"	HT	No	NI
454FTB-12-HHT	756054	3/4"	HHT	No	NI
454FTB-16-HT	756055	1"	HT	No	NI
454FTB-16-HHT	756056	1"	HHT	No	NI
454PFTB-16-HT	756057	1"	HT	Yes	NI
454PFTB-16-HHT	756058	1"	HHT	Yes	NI

Table 2: BASELINE V * VELOCITY RANGES (See Notes 1, 2, 3)

Model Number	VELOCITY SFPM (NMPS)					
	Gas group number and gas type					
	A Air, N ₂ , O ₂ , Ar CO ₂	C Methane Digester Gas, Dry Ammonia	D Dry Chlorine, Ethylene	E Ethane	F Helium, Propane Butane	G Hydrogen
454FTB-08-HT 454FTB-12-HT 454FTB-16-HT To 125° C	18,000 (84)	17,000 (79)	15,000 (70)	13,300 (62)	10,000 (47)	6,000 (28)
454FTB-08-HT 454FTB-12-HT 454FTB-16-HT 454PFTB-16-HT To 260° C	18,000 (84)	N/A	N/A	N/A	N/A	N/A
454FTB-08-HHT 454FTB-12-HHT 454FTB-16-HHT 454PFTB-16-HHT To 500° C	18,000 (84)	N/A	N/A	N/A	N/A	N/A

Note 1: See Nomenclature for the complete definition of Gas Group Number and Gas Type.

Note 2: SFPM: Standard Feet-Per-Minute (Ref.: 77°F, 14.69 PSIA).

NMPS: Normal Meters-Per-Second (Ref.: 0°C, 760 mm Hg).

NMPS = 0.00466 x SFPM (Approximate).

Note 3: The Baseline (V*) VELOCITY for each Mass Flow Transmitter Model Number and for each type of Gas is the maximum velocity at standard conditions (See Note 2).

TABLE 3: FLOW FACTOR (F*) EQUATIONS

Gas Type	DR _p	Equations
Group A: Air, N ₂ , Ar, CO ₂ , O ₂	Less than 1.333	F* = DR _p
	Greater than 1.333	F* = 1.333
Group C: Methane, Digester Gas, Dry Ammonia	Less than 0.945	F* = 1.059DR _p
	Greater than 0.945	F* = 1.000
Group D: Dry Chlorine, Ethylene	Less than 0.833	F* = 1.2DR _p
	Greater than 0.833	F* = 1.0
Group E: Ethane	Less than 0.739	F* = 1.353DR _p
	Greater than 0.739	F* = 1.000
Group F: Helium, Propane, Butane	Less than 0.555	F* = 1.8DR _p
	Greater than 0.555	F* = 1.00
Group G: Hydrogen	Less than 0.333	F* = 3.0DR _p
	Greater than 0.333	F* = 1.000

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NOMENCLATURE:

PROCESS TEMPERATURE RATING		
Identifier	Description	Range
HT	High Temperature	-40°F to 500°F (-40°C to 260°C)
HHT	Very High Temperature	-40°F to 932°F (-40°C to 500°C)

SENSOR TYPE	
Identifier	Description
FD2	Fast Dual Metal-Clad™ Velocity and Temperature Sensor, all-welded construction, 0.105" diameter sensor stings

SAFETY APPROVALS	
Identifier	Description
NI	Non-Incendive, ATEX and CSA Approvals

GAS GROUP AND GAS TYPE	
Group	Gas Type
A	Air, Nitrogen, Oxygen, Argon, Carbon Dioxide
C	Methane, Digester Gas, Dry Ammonia
D	Dry Chlorine, Ethylene
E	Ethane
F	Helium, Propane, Butane
G	Hydrogen

DEFINITIONS FOR THE USE OF TABLES 1, 2, 3

Equation 1: $DR_p = \frac{P_p}{P_s} \times \frac{T_s}{T_p}$

Equation 2: $V_{MAX} = F^* \times V^*$

V^* = Baseline Velocity as listed in Table 2 (SFPM for English Units or NMPS for Metric Units at Standard conditions).

V_p = Process Velocity (SFPM for English Units, NMPS for Metric Units).

V_{MAX} = Maximum Velocity for a specific Gas Type under Process Conditions.

F^* = Flow Factor.

T_s = Standard Absolute Temperature: 537°R (77°F + 460) for English Units or 273°K (0°C) for Metric Units.

T_p = Process Absolute Temperature: °R (T°F + 460) for English Units or °K (T°C + 273°C) for Metric Units.

P_s = Standard Absolute Pressure (14.69 PSIA for English Units and 760mm Hg for Metric Units).

P_p = Process Absolute Pressure (PSIA for English Units and mm Hg for Metric Units).

DR_p = Process Gas Density Ratio.

Example: Calculate the maximum allowable Gas Velocity (V_{MAX}) for compressed air at 100°F and 135 PSIA for the Model 454FTB-12-HT.

a) From Table 2, $V^* = 18,000$ SFPM

b) Calculate DR_p from Equation 1:

Equation 1: $DR_p = \frac{P_p}{P_s} \times \frac{T_s}{T_p} = \frac{135}{14.69} \times \frac{537}{560} = 8.81$

c) Using Table 3 for Group A, Air: $F^* = 1.333$ (DR_p greater than 1.333)

d) Using Equation 2: $V_{MAX} = F^* \times V^* = 23,944$ SFPM (111.8 NMPS)

Part Number Generation Procedure

With the selected Parent Number, specify the entire Part Number by selecting an Option for each Feature as shown in the example below. Feature Options in Bold type indicate the most available Models, other options usually require a longer delivery time.

Example Part Number for a Model 454FTB-16-HHT:

756056	D	32	F	4	F	077	M	01	A	015	B	1392
Parent Number	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12

SUMMARY OF FEATURES	
Feature	Feature Description
1	Electronics Enclosure Configuration and Input Power, LCD/Keypad
2	Sensor Material/Sensor Support and Flange Material
3	Sensor Support Length
4	Process Temperature Compensation
5	Optional Flange Connection Size and Rating
6	Optional Flange U Dimension
7	Gas Velocity Calibration Data Range
8	Specialty Gas Velocity Calibration
9	Safety Approvals
10	Process Pressure
11	Analog & Digital Inputs/Outputs
12	Process Temperature

FEATURE 1: ELECTRONICS ENCLOSURE CONFIGURATION AND INPUT POWER (See Note 1)	
Option	Description
A	Directly Attached Dual-Chamber Electronics Enclosure, AC-Power, LCD/Keypad.
B	Directly Attached Dual-Chamber Electronics Enclosure, AC-Power, without LCD/Keypad.
C	Directly Attached Dual-Chamber Electronics Enclosure rotated 180° for viewing, AC Power, LCD/Keypad.
D	Remote Dual-Chamber Electronics Enclosure, AC-Power, LCD/Keypad.
E	Remote Dual-Chamber Electronics Enclosure, AC-Power, without LCD/Keypad.
F	Directly Attached Dual-Chamber Electronics Enclosure, 24VDC-Power, LCD Keypad.
G	Directly Attached Dual-Chamber Electronics Enclosure rotated 180° for viewing, 24VDC-Power, LCD/Keypad.
H	Directly Attached Single-Chamber Electronics Enclosure, 24VDC-Power, without LCD/Keypad.
I	Remote Dual-Chamber Electronics Enclosure, 24 VDC-Power, LCD/Keypad.
J	Remote Single-Chamber Electronics Enclosure, 24 VDC-Power, without LCD/Keypad.

Note 1: The temperature storage and operating rating of the Electronics Enclosure is -25°C to +65°C with the LCD/Keypad and -40°C to +65°C without the LCD/Keypad. The conduit or cable seal must be installed by an experienced and careful installer to prevent water intrusion into the enclosure and to maintain the enclosure rating. Failure to properly install the conduit seals may void the Kurz warranty and may compromise the safety approval rating.

Note 2: Stainless Steel Identification Tags are available. Customer must provide labeling information up to four lines of text with 32 characters each line.

SERIES 454FTB SINGLE-POINT INSERTION THERMAL MASS FLOW TRANSMITTERS

FIRST DIGIT OF FEATURE 2: SENSOR MATERIAL	
Option	Description
3	Alloy C-276
7	Alloy C-276 with Abrasion-Resistant Chromium Nitride Coating (CrN)

SECOND DIGIT OF FEATURE 2: SENSOR SUPPORT AND FLANGE MATERIAL	
Option	Description
2	316L Stainless Steel
3	Alloy C-276
8	Alloy C-276 with PTFE Teflon Coating cured for chemical resistance. Includes support, sensor and flange; FD2-HHT sensors only, temperature rating of 260°C Max.

FEATURE 3: SENSOR SUPPORT LENGTH L			
Option	Support Length L	Option	Support Length L
B	6" (125°C Max)	J	30"
C	9" (260°C Max)	K	36"
D	12"	M	48"
F	18"	P	60"
H	24"		

FEATURE 4: PROCESS TEMPERATURE COMPENSATION	
<p>The influence of temperature on the thermal properties of gases requires temperature compensation of the Thermal Mass Flow Sensor for repeatability and accurate measurements. Standard Temperature Compensation (STC) is used for applications in which the process temperature is below 125°C over a moderate velocity range (Option 1); or below 260°C over more limited velocity range (Option 2).</p> <p>If the process temperature and gas velocity vary widely, Velocity/Temperature/Mapping (VTM) is recommended. VTM (Options 3, 4) includes several calibrations. The multiple velocity calibrations are entered into the Microprocessor which performs a double interpolation between the velocity calibration curves using the built-in process gas temperature measurement. The temperature compensation is based upon air, therefore, the accuracy at a high temperature when using gases other than Air, Nitrogen or Oxygen may be reduced.</p>	
Option	Description
1	Standard Temperature Compensation (STC) over process temperature range of -40°C to +125°C. Accuracy: $\pm [(1\% + .025\%/^{\circ}\text{C}) \text{ reading} + 20 \text{ SFPM}/^{\circ}\text{C}]$ Above or below 25°C, all gases.
2	Standard Temperature Compensation (STC) over process temperature range of 0°C to 260°C. Accuracy: $\pm [(2\% + .025\%/^{\circ}\text{C}) \text{ reading} + (20 \text{ SFPM} + .25 \text{ SFPM}/^{\circ}\text{C})]$ Above or below 125°C: Air, O ₂ and N ₂ only.
3	Velocity/Temperature/Mapping (VTM) with data sets over process temperature range of 0°C up to 260°C. Accuracy: $\pm (2\% \text{ reading} + 20 \text{ SFPM})$, Air, O ₂ and N ₂ only.
4	Velocity/Temperature/Mapping (VTM) with data sets over the process temperature range of 0°C up to 500°C. Accuracy: $\pm (3\% \text{ reading} + 30 \text{ SFPM})$, Specify Process Temperature Range, Air, O ₂ and N ₂ only. HHT Models.

FEATURE 5: OPTIONAL FLANGE CONNECTION SIZE AND RATING (Note 1)		
<p>How to Determine the U, L and L2 Dimensions for a Flange Connection</p> <p>When ordering a flange, you must specify the U dimension, and verify that the sensor support length L and L2 are appropriate for the Process Temperature. Kurz recommends that the centerline of the sensor be located at the center of the pipe or duct, and that experimental flow profile tests be made to obtain the velocity profile correction factor (VCF) and enter it into the 454FTB. Refer to the outline drawings in the Series 454FTB Brochure. Note: Flange material must match Sensor Support Material (Feature 4).</p> <p>U = The dimension between the centerline of the mass flow sensor and the flange mounting surface. The minimum U dimension is 4.0".</p> <p>L = The length of the sensor support tube (Feature 3).</p> <p>L2 = The length of sensor support between the flange mounting surface and the sensor support fitting. The minimum L2 is 5 inches for HT process temperatures and 8 inches for HHT process temperatures.</p> <p>L = U + L2 - 2.00"</p>		
Option	Sensor Support Diameter	Description
A	$\frac{1}{2}"$, $\frac{3}{4}"$, 1"	No flange connection
B	$\frac{1}{2}"$	$\frac{1}{2}"$, Class 150, ANSI B16.5
C	$\frac{1}{2}"$	$\frac{1}{2}"$, Class 300, ANSI B16.5
D	$\frac{1}{2}"$, $\frac{3}{4}"$	$\frac{3}{4}"$, Class 150, ANSI B16.5
E	$\frac{1}{2}"$, $\frac{3}{4}"$	$\frac{3}{4}"$, Class 300, ANSI B16.5
F	$\frac{1}{2}"$, $\frac{3}{4}"$, 1"	1" , Class 150, ANSI B16.5
G	$\frac{1}{2}"$, $\frac{3}{4}"$	1" , Class 300, ANSI B16.5
H	$\frac{3}{4}"$, 1"	1 $\frac{1}{4}"$, Class 150, ANSI B16.5
I	$\frac{3}{4}"$, 1"	1 $\frac{1}{4}"$, Class 300, ANSI B16.5
J	$\frac{3}{4}"$, 1"	1 $\frac{1}{2}"$, Class 150, ANSI B16.5
K	$\frac{3}{4}"$, 1"	1 $\frac{1}{2}"$, Class 300, ANSI B16.5
L	$\frac{3}{4}"$, 1"	2" , Class 150, ANSI B16.5
M	$\frac{3}{4}"$, 1"	2" , Class 300, ANSI B16.5
N	1"	2 $\frac{1}{2}"$, Class 150, ANSI B16.5
P	1"	2 $\frac{1}{2}"$, Class 300, ANSI B16.5
S	1"	3" , Class 150, ANSI B16.5
T	1"	3" , Class 300, ANSI B16.5
U	1"	4" , Class 150, ANSI B16.5
V	1"	4" , Class 300, ANSI B16.5

Note: Flange material must match the Sensor Support Material (Feature 2).

FEATURE 6: OPTIONAL FLANGE U DIMENSION	
Directions	
<p>Divide the U Dimension (inches) by 100, round off the resulting number to the right of the decimal point to three significant digits, enter the resulting three digit number without the decimal point. Enter 000 for no flange connection. $U_{\min} = 4"$</p> <p>Example: The U Dimension is 7.74"; Enter 077.</p>	

FEATURE 7: GAS VELOCITY CALIBRATION DATA RANGE SFPM (NMPS) (Note 1)			
Option	Velocity	Option	Velocity
A	V _{MAX}	M	6,000 (28.0)
B	300 (1.4)	P	9,000 (41.9)
C	600 (2.8)	R	12,000 (56)
E	1,000 (4.7)	T	15,000 (70)
G	2,000 (9.3)	V	18,000 (84)
I	3,000 (14)	X	24,000 (112)
K	4,000 (18.6)		

Note 1: The Gas Velocity must be greater than V_{MAX} for the Process Absolute Temperature and Pressure for specific Gas Group and Type as determined using Tables 2 & 3 and Equations 1, 2.

SERIES 454FTB SINGLE-POINT INSERTION THERMAL MASS FLOW TRANSMITTERS

FEATURE 8: SPECIALTY GAS VELOCITY CALIBRATION (Note 1)			
Laboratory Calibration		Gas Type	Correlation Calibration Option
Option	Pressure		
01	Ambient	Air	—
07	to 150 PSIA	Air	—
—	—	Dry Amonia	56
08	to 150 PSIA	Argon	58
—	—	Butane	60
14	to 150 PSIA	Carbon Dioxide	64
—	—	Dry Chlorine	68
20	to 150 PSIA	Ethane	70
22	to 150 PSIA	Ethylene	72
26	to 150 PSIA	Helium	76
28	to 150 PSIA	Hydrogen	78
32	to 150 PSIA	Methane	82
35	to 150 PSIA	"Digester Gas" 50% CH ₄ , 50% CO ₂	85
36	to 150 PSIA	"Digester Gas" 60% CH ₄ , 40% CO ₂	86
37	to 150 PSIA	"Digester Gas" 70% CH ₄ , 30% CO ₂	87
40	to 150 PSIA	Nitrogen	90
44	to 150 PSIA	Oxygen (Note 2)	94
46	to 50 PSIA	Propane	96

Note 1: Laboratory Gas calibrations are performed with gases of high purity and are NIST Traceable. Customer must specify calibration pressure. (Feature 10). Correlation calibrations are based on experimental data correlated to an air calibration at ambient pressure and temperature. The user's flow element is calibrated in air, and an additional calibration data sheet is made for the specialty gas based upon the correlation factors. Add ±5% of Reading to the accuracy specifications when using a gas correlation calibration.

Note 2: It is the customer's responsibility to insure that the Mass Flow Element is clean of Hydrocarbons and is safe for oxygen use. (See Accessories in Section C-1 for Cleaning and Bagging).

FEATURE 9: SAFETY APPROVALS	
Option	Description
A	Non-Incendive (NI), HT and HHT Models See Specifications for Details

FEATURE 10: PROCESS PRESSURE
Enter the Absolute Pressure (PSIA), rounded off to 3 digits. Example: For a Process Absolute Pressure of 14.7 PSIA, enter 015; for 150 PSIA, enter 150.

FEATURE 11: ANALOG AND DIGITAL INPUTS/OUTPUTS	
Option	Description
B	Two 4-20 mA Optically Isolated Outputs (Note 1).
C	Two 4-20 mA Optically Isolated Outputs, two solid-state Relays (maximum 12 watts), one external non-isolated 4-20 mA Input, two non-isolated Digital Inputs (Note 2)

Note 1: For Process Measurement Analog Outputs, NAMUR NE43 Alarms, and Internal Set-Point, PID Flow Control.

Note 2: Required for Process Measurement Analog Outputs, NAMUR NE43 Alarms, Remote set-Points, PID Flow Control, Daily "Zero-Midspan-Span" Drift Check and Acknowledgement, Alarm Relays, Automatic Sensor Cleaning Purge Timer and "Hold-Reading" Feature, and Pulsed Flow Totalizer. See the chart which follows as not all functions can be used due to the available number of inputs and outputs.

SERIES 454FTB & 454PFTB AVAILABLE FUNCTIONS VERSUS INPUT/OUTPUT OPTIONS OF FEATURE 11				
Series 454FTB 454PFTB Functions	Relays (2 Max.)	4-20mA Outputs (2 Max.)	Digital Inputs (2 Max.)	4-20mA Inputs (1 Max.)
Flow Rate or Temp. Relay Alarm Outputs	2 (Note 1)	—	—	—
Flow Rate or Temp. Analog Outputs	—	2	—	—
Pulsed Flow Totalizer Output	1	—	—	—
PID Flow Controller, Internal Set-Point	—	1 (Note 2)	—	—
PID Flow Controller, External Set-Point	—	1 (Note 2)	—	1 (Note 3)
Daily EPA Zero-MidSpan-Span Drift Check	1 (Note 4)	2 (Note 5)	1 (Note 6)	—
Auto Sensor Cleaning Purge Model 454PFTB Only	1 (Note 7)	—	1 (Note 8)	—

Note 1: Flow Rate, Temperature and other alarms may be programmed to activate with the available relays. The LCD will display these alarms, even if relays are not available.

Note 2: The PID Controller uses one 4-20 mA output for the flow controller.

Note 3: The External Input PID Controller requires a 4-20 mA flow reference input.

Note 4: This function normally requires an acknowledgement contact closure to verify that the Drift Check has been truly initiated.

Note 5: Both 4-20 mA outputs are used during the Drift Check Calibration Procedure.

Note 6: This contact closure is generated by the Continuous Emissions Monitor Computer at a specific time every day to indicate the Daily Drift Check.

Note 7: The built-in Purge Timer activates one of the Relays to open the customer's air solenoid. This is a pre-set at the factory. This leaves one relay left for other functions.

Note 8: The purge cycle is initiated by an external contact closure from the customer or by the built-in timer, or via modbus.

Example:

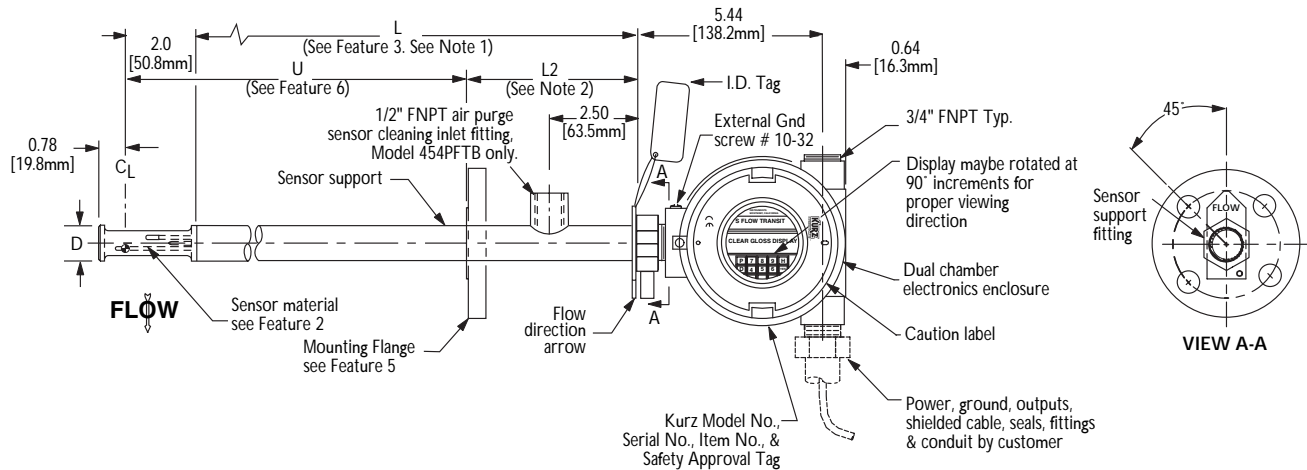
Assume a Model 454FTB is to be used as an EPA Flow Monitor. Feature 11, Option C is selected. The Daily Drift Check is needed, which requires:

One Relay, two 4-20 mA Outputs, one Digital Output

This leaves one relay, and one digital input for other functions. The possibilities are:

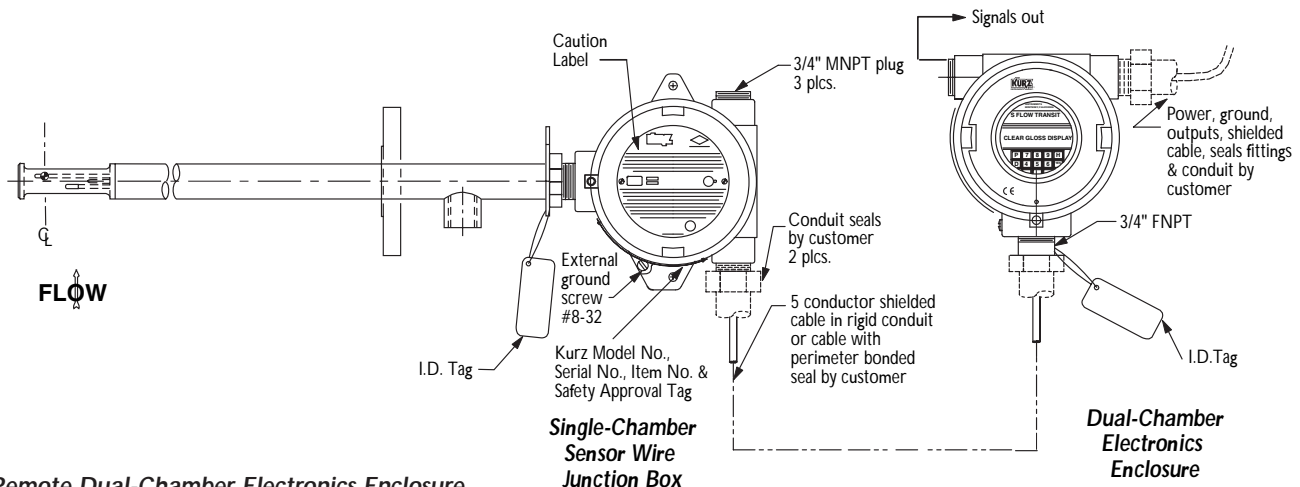
- One Flow Rate or Temperature Alarm Relay.
- A Pulsed Flow Totalizer Relay Output.

FEATURE 12: PROCESS TEMPERATURE
Enter the Absolute Process Temperature (°Rankin = °F + 460) rounded off to 4 digits. Example: For a Process Temperature of 77°F, enter 0537; for 932°F, enter 1392.

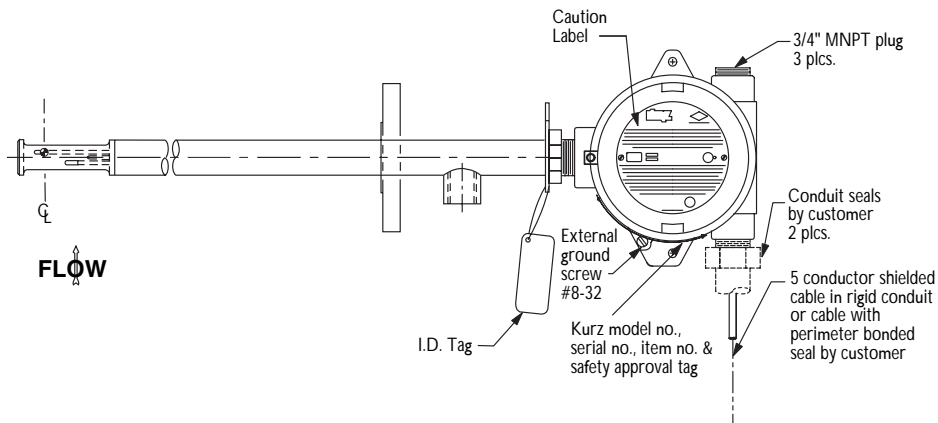


Directly Attached Dual-Chamber Electronics Enclosure
Feature 1, Options A, F (Shown with Standard Display Orientation)

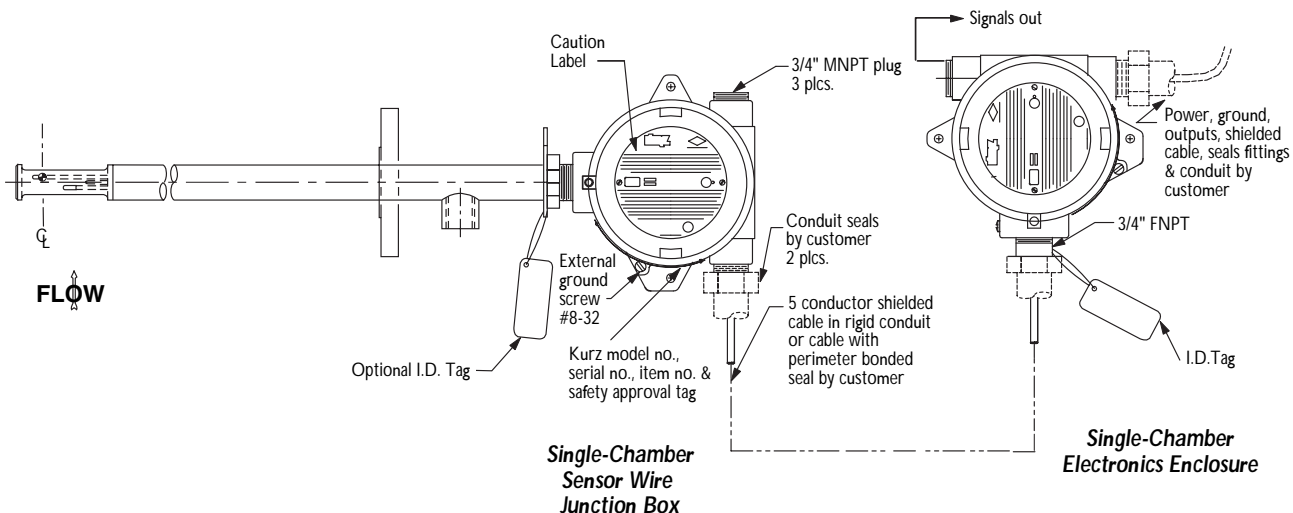
Note 1: $L = U + L2 - 2.00"$, $U(\min) = 4"$
Note 2: $L2(\min) = 5"$ for HT Models and $8"$ for HHT Models



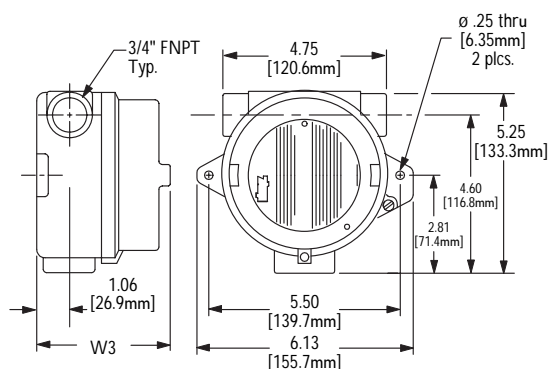
Remote Dual-Chamber Electronics Enclosure
Feature 1, Options D, I



Directly Attached Single-Chamber Electronics Enclosure
Feature 1, Option H

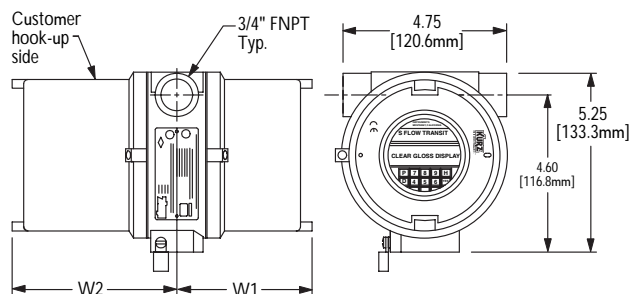


**Remote Single-Chamber Electronics Enclosure
Feature 1, Option J**



**Single-Chamber Sensor Wire Junction Box,
Single-Chamber Electronics Enclosure Dimensions**

Enclosure Type	W ₃
Junction Box	3.88 [99mm]
Electronic Enclosure	5.94 [151mm]



**Dual-Chamber Electronics Enclosure Dimensions
(Shown with Display)**

Input Power	Display/Keypad	W ₁	W ₂
AC	Yes	3.41" (87mm)	4.69" [119mm]
AC	No	2.75" [70mm]	4.69" [119mm]
24 VDC	Yes	3.41" [87mm]	4.69" [119mm]

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