SERIES 454FTB

SINGLE-POINT INSERTION THERMAL MASS FLOW TRANSMITTERS

KURZ INSTRUMENTS INC.™

CE Ex ISO 9001 CERTIFIED QUALITY SYSTEM C SA US TÜV SIL1 HART COMMUNICATION PROTOCOL

SERIES 454FTB SINGLE-POINT INSERTION THERMAL MASS FLOW TRANSMITTERS

DESCRIPTION

The Series 454FTB represents the Kurz family of state-of-the-art microprocessor based, industrial quality, Single-Point Insertion Mass Flow Transmitters for industrial gases.

The 454FTB includes the most advanced temperature compensation, microprocessor technology and the highest repeatability, accuracy, and reliability available. It has many improvements and features that greatly enhance the performance including, the FD2-HT sensor rated at 260°C, electronic self-check functions, a flow control valve PID controller, a patented digital thermal anemometer bridge, a more convenient remote electronic mounting configuration, a single PCB for improved reliability and ease-of-use, built-in sensor cleaning purge timer, external inputs/outputs, and many other Kurz engineering and functional features.

The 454FTB has CE Compliance and a Canadian Registration Number for most applications. The 454FTB meets CSA (USA and Canada), IECEXand ATEX Non-Incendive and Explosion-Proof/Flame-Proof Safety Standards and are Type 4, IP66 rated. Kurz is an ISO 9001 Quality Manufacturer.

KEY FEATURES

- Constant temperature sensor control circuit.
- Fastest response to temperature and velocity changes in the industry.
- Sensors and electronics (single PCB) are interchangeable. No matched sets.
- 3-year warranty. All components pass an extensive accelerated stress test for high reliability.
- Velocity dependent correction factors for flow rate.
- Velocity-Temperature Mapping (VTM) for wide ranging velocity and temperature.
- Zero velocity is a valid data point.
- Built-in Zero-Mid-Span CEMS electronics drift check circuits.
- Automatic Sensor Blockage Correction Factor (SBCF).
- Built-in flow totalizers and elapsed time.
- PID flow controller.
- Process temperature rating from -40°C to +260°C (HT) or from -40°C to +500°C (HHT).
- Electronics operating temperature range from -40°C to +65°C, non-condensing.
- Process pressure rating up to 300 PSIG.
- Velocity range of 0-24,000 SFPM (112 NMPS).
- Input power options of 85 to 265 VAC 47/63 Hz or 24 VDC.
- Sensor lead length independent circuitry.
- Alloy C-276 all-welded sensor construction.
- Integral or remote electronics enclosure.
- Dual-chamber, polyester powder-coated aluminum (Type 4, IP66) electronics enclosure.
- Adjustable LCD/keypad orientation allows viewing the display in horizontal or vertical installations.
- Insensitive to orientation.
- Two optically-isolated, loop-powered 4-20 mA outputs (user configurable). Typically, one is configured for mass flow rate or mass velocity and the other for process temperature or for PID application (flow transmitters with the HART communication option have only one 4-20mA output).
- Easy-to-use menus for display and configuration.
- User-configurable scrolling or static displays of flow process variables.
- User selected English or Metric units (SFPM, SCFM, SCFH, PPM, PPH, °F; SMPS, NMPS, NLPM, NCMH, SLPM, SCMH, KGM, KGH, °C).
- User can change STP reference condition without affecting factory calibration data.
- Programmable alarm functions.
- User-selectable digital filtering.
- User programmable access codes.
- USB port for terminal operation.
- Modbus ASCII or RTU communications.
- Configuration upload/download software using a PC with USB connection, RS-485, or TCP/IP Modbus.
- Built-in purge timer and "hold value" feature during purge for use with Model 146 Sensor Cleaning System.
- Air Purge Sensor Cleaning System (optional).
- One 4-20mA input (optional).
- Two optically-isolated solid-state alarm/relays (optional).
- Two digital inputs dedicated to Purge and Zero-Mid-Span Drift Check (optional).
- Pulsed output for use as a remote flow totalizer (optional).
- HART 7 communication (optional).
- 4-20 mA outputs meet NAMUR NE43 recommendations.
- Meets EPA mandatory GHG Certification requirement in CFR98.34(c)(1).
- CE compliance including EMC, ATEX, LVD, PED, WEEE and ROHS EU directives.
- Non-Incendive and Explosion-Proof/Flame-Proof Safety Approvals (CSA/ATEX/IECEX).

APPLICATIONS

- Industrial and process gas mass flows
- Combustion air flow measurements
- EPA flow monitors
- Flare stack metering
- Aeration air flow
- 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 DOE facilities
- OEM 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.

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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 patented 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 detailed description of Kurz technology, please see document number 364003, "Theory and Application of Kurz Thermal Convection Mass Flow Meters" by contacting Kurz or visiting our website.

***Figure 1**–Series 454FTB with LCD/Keypad Option*

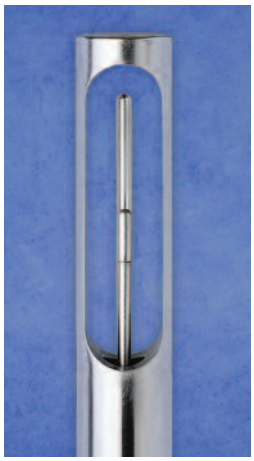

***Figure 2**–Fast Dual (FD2) Sensor*

CALIBRATION CURVE

Figure 3** shows 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.*

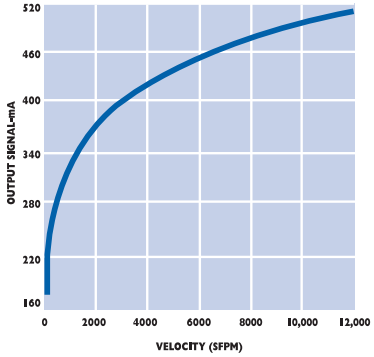

***Figure 3**–Calibration Curve*

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.*

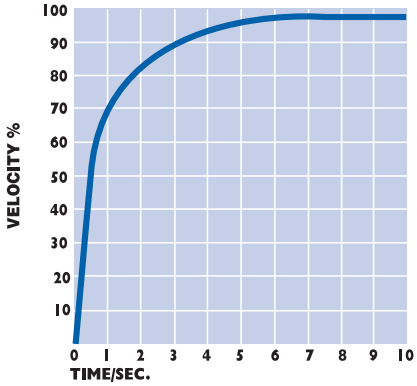

***Figure 4**–Sensor Flow Response*

***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 (for example, in coal pulverizers).*

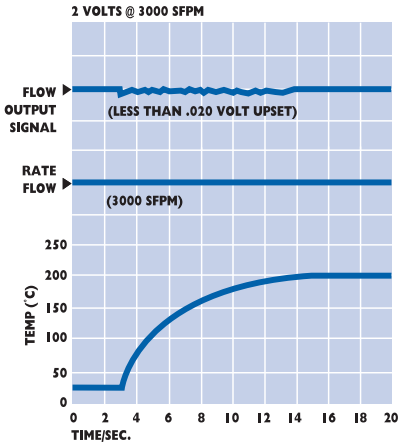

***Figure 5**–Sensor Temperature Response*

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.*

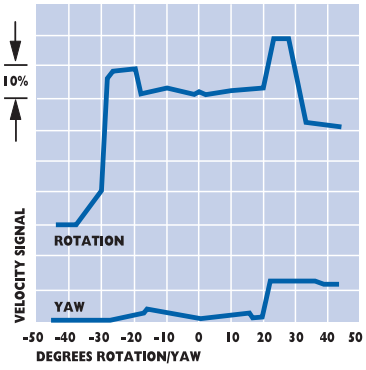

***Figure 6**–Sensor Measurement Error Versus Rotation/Yaw Angles*

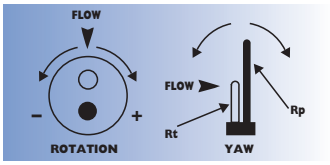

***Figure 7**–Sensor Rotation and Yaw Description*

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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 Compound coating for chemical resistance on Alloy C-276 sensor and sensor support, FD2 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 constant 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 SPFM

Power: +24 VDC ±10%, 85-265 VAC, 47/63 Hz; 24 watts max

Enclosure Temperature Rating: -25°C to +65°C for all configurations; -40°C to +65°C for DC units without Display/Keypad

Enclosures: Polyester powder-coated aluminum, Type 4, IP66 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

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 sensors 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

Three available configurations: directly attached electronics enclosure, remote mount aluminum electronics enclosure, and remote wall-mount fiberglass electronics enclosure.

PROCESS TEMPERATURE COMPENSATION

The influence of temperature on the thermal properties of gases requires temperature compensation for repeatable 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 or below 260°C over a more limited velocity range. If the process temperature 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 incinerators 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 patented digital sensor control circuit (US Patent 7,418,878) uses an efficient switching power supply. The single PCB has an EEPROM loaded with the PCB serial number, calibration coefficients, and component values that ensures 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.

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SPECIFICATIONS cont'd.

Meter Filter Time Constant:
Selectable 0 to 600 seconds

Safety Approvals:
CSA Non-Incendive Approval:
IEC 79-15 and EN60079-0/15
ATEX Non-Incendive Approval:
EN60079-0/15 and EN61241-1

CSA Explosion-Proof Approval:
IEC 79-01 and EN60079-01

ATEX Flame-Proof Safety Approval:
EN 60079-0/1
Note: *See Kurz product manual for complete Safety Approvals Specifications.*

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

Display/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 onboard menu system is easy to use and intuitive. The flow meter data (velocity, mass rate, volumetric rate, and temperature) can be displayed in a user-selectable form and viewed through the window in the lid. A local keypad can be accessed to navigate through the onboard menu system to display various flow and diagnostic data as well as enter basic and advanced setup options. A user code is required for programming and entering configuration data or performing test and diagnostic utilities.

SELF-DIAGNOSTICS

The 454FTB performs an extensive systems check upon power-up, continuously monitors the sensor inputs/outputs, and verifies the integrity of the sensor wiring and the measurements.

PROGRAMMABLE CORRECTION FACTORS

A multi-point Variable Correction Factor can be used to correct the flow calibration data to meet in-situ flow tests over the entire velocity range such as for EPA stack flow monitors. A Sensor Blockage Correction Factor (SBCF) can be used to correct area reduction caused by the sensor support. A single-point correction factor may also be used.

METER FILTER TIME CONSTANT

A digital filter time constant can be set for the flow calculation, which affects the displayed values and the 4-20 mA outputs. The time constant can be set from 0 to 600 seconds.

COMPATIBILITY WITH SERIES 155 MASS FLOW COMPUTERS

The 454FTB is fully compatible with the inputs and features of the Series 155 Mass Flow computer. DC powered units can be directly powered by the Series 155. This feature is used when two or more Model 504FTBs 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/101.325 kPa). The user may change the STP conditions to suit his requirement without affecting the calibration data.

4-20 mA OUTPUTS

The 4-20mA outputs can be wired as optically isolated loop-powered outputs or non-isolated, self powered outputs. The user can easily re-calibrate the 4-20 mA outputs using the Calibrate Analog Output menu in the onboard menu system or through the HART interface.

NAMUR NE43 COMPLIANCE

Kurz meets the NAMUR NE43 recommendation for the 4-20 mA outputs to indicate a sensor or system fault. An NE43 alarm can be selected as high or low. This feature frees up the alarm/relays so that the user can set-up the relays for other needs.

BUILT-IN "ZERO-MID-SPAN" DRIFT CHECK/CALIBRATOR

The B-Series Flow Transmitters have a Drift Check feature that meets the U.S. EPA requirements for CEM Stack Flow Monitors. The B-Series have a built-in independent voltage source that is used to drive the 4-20mA output for the Drift Check tests. A Drift Check setup menu is available to configure the signal level and duration for the Drift Checks at Zero, Mid, and Span. Drift Checks can be initiated with a contact closure, through a MODBUS command, using an automatic internal timer, through the HART interface, or using the local onboard menu system.

GREENHOUSE GAS REPORTING

The EPA requires certain facilities to report GHG emissions. This rule is contained in US Code of Federal Regulations Title 40, Part 98. Kurz thermal mass flow meters meet the certification requirement in 40 CFR 98.34(c)(1) required by the Mandatory GHG Reporting regulation and are approved for this application.

RELAYS – ALARMS/PULSED TOTALIZER OUTPUT/PURGE OUTPUT

The 454FTB can be ordered with two solid-state optically isolated relays. The relay outputs can be user configured for alarm outputs, pulsed totalizer output, or air purge cleaning. If no relays are ordered, the alarm functions are available. Totalizers can be automatically reset at a specific total quantity (10,000 SCF).

TECHNICAL DESCRIPTION cont'd.

ANALOG INPUT

One non-isolated 4-20mA input for use as a remote set-point for the built-in PID Flow Controller.

PID FLOW CONTROLLER

The 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 can be internal or remote.

USB PORT

A USB port for terminal operations includes a COM emulator driver that can be accessed using a terminal emulator program to remotely echo the display and keypad functions and upload/download the system configuration and calibration data files using XMODEM protocol. Process data can be initiated manually through the Log Mode menu from the remote terminal/keyboard or the local display/keypad. The information can also be obtained automatically by configuring the Serial Data Logging through the onboard menu system.

HART

The Series 454FTB can be ordered with the HART communication interface. The HART protocol is a recognized and accepted standard in the process control industry. This interface provides the benefits of remote configuration, remote diagnostic monitoring, and the ability to do testing online using available handheld configurators.

MODBUS

The Modbus local network protocol (ASCII or RTU) is included. Modbus is extremely useful for accessing most features, including configuration upload and download.

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. See definitions on page 11.

TABLE 1: SERIES 454FTB SELECTION TABLE

Model Number	Parent Number	Sensor Support Dia.	Process Temp. Rating	Air Purge	Safety Approvals
454FTB-08-HT	756051	½"	HT	No	NI, XP/FP
454FTB-08-HHT	756052	½"	HHT	No	NI, XP/FP
454FTB-12-HT	756053	¾"	HT	No	NI, XP/FP
454FTB-12-HHT	756054	¾"	HHT	No	NI, XP/FP
454FTB-16-HT	756055	1"	HT	No	NI, XP/FP
454FTB-16-HHT	756056	1"	HHT	No	NI, XP/FP

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

Model Number	VELOCITY SFPM (NMPS) Gas Category and Gas Type					
	1 Air, N_2, O_2, Ar, CO_2, Dry Cl_2	2 Methane Digester Gas, Dry Ammonia	3 Ethylene	4 Ethane	5 Helium, Propane Butane	6 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 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	DR_P	Equations
Category 1: Air, N_2, A_r, CO_2, O_2, Dry Cl_2	Less than 1.333	$F^* = DR_P$
	Greater than 1.333	$F^* = 1.333$
Category 2: Methane, Digester Gas, Dry Ammonia	Less than 0.945	$F^* = 1.059DR_P$
	Greater than 0.945	$F^* = 1.000$
Category 3: Ethylene	Less than 0.833	$F^* = 1.2DR_P$
	Greater than 0.833	$F^* = 1.0$
Category 4: Ethane	Less than 0.739	$F^* = 1.353DR_P$
	Greater than 0.739	$F^* = 1.000$
Category 5: Helium, Propane, Butane	Less than 0.555	$F^* = 1.8DR_P$
	Greater than 0.555	$F^* = 1.00$
Category 6: 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, CSA and ATEX
XP/FP	Explosion-Proof/Flame-Proof, CSA and ATEX

GAS CATEGORY AND GAS TYPE	
Category	***Gas Type***
1	Air, Nitrogen, Oxygen, Argon, Carbon Dioxide, Dry Chlorine
2	Methane, Digester Gas, Dry Ammonia
3	Ethylene
4	Ethane
5	Helium, Propane, Butane
6	Hydrogen

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 Electronics Dual-Chamber Enclosure, AC power, LCD/Keypad.
B	Directly Attached Electronics Dual-Chamber Enclosure, AC power, without LCD/Keypad.
C	Directly Attached Electronics Dual-Chamber Enclosure rotated 180° for viewing, AC power, LCD/Keypad.
D	Remote Electronics Dual-Chamber Enclosure, AC power, LCD/Keypad.
E	Remote Electronics Dual-Chamber Enclosure, AC power, without LCD/Keypad.
F	Directly Attached Electronics Dual-Chamber Enclosure, 24V DC power, LCD/Keypad.
G	Directly Attached Electronics Dual-Chamber Enclosure rotated 180° for viewing, 24V DC power, LCD/Keypad.
H	Directly Attached Electronics Single-Chamber Enclosure, 24V DC power, without LCD/Keypad.
I	Remote Electronics Dual-Chamber Enclosure, 24 V DC power, LCD/Keypad.
J	Remote Electronics Single-Chamber Enclosure, 24 V DC power, without LCD/Keypad.

Note 1: *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.*

FIRST DIGIT 0F 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 (Note 1)	
Option	***Description***
2	316L Stainless Steel
3	Alloy C-276
8	Alloy C-276 with PTFE Compound Coating cured for chemical resistance. Includes support, sensor and flange; FD2 sensors only, temperature rating of 260°C Max.

Note 1: *Sensor Support Material and Optional Flange Material must be the same, see Feature 5.*

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

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).

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 unless a gas correlation is specified (see feature 8).

Option	***Description***
1	Standard Temperature Compensation (STC) over process temperature range from -40°C to +125°C. Accuracy: ± (1% Reading + 20 SFPM) above or below 25°C (see note 1).
2	Standard Temperature Compensation (STC) over process temperature range from 0°C to 260°C. Accuracy: ± (2% Reading + 20 SFPM) above or below 125°C (see note 1).
3	Velocity-Temperature Mapping (VTM) with data sets over process temperature range from 0°C to 260°C. Accuracy: ±(2% reading + 20 SFPM).
4	Velocity-Temperature Mapping (VTM) with data sets over the process temperature range from 0°C to 500°C. Accuracy: ±(3% reading + 30 SFPM), specify process temperature range. HHT Models.

Note 1: *An accuracy specification of ± (0.025%/°C Reading + 0.25 SFPM/°C) should added for temperatures above or below standard.*

FEATURE 5: OPTIONAL FLANGE CONNECTION SIZE AND RATING

How to determine the U, L, and L2 dimensions for a flange connection

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 2).*

U = The dimension between the centerline of the mass flow sensor and the flange mounting surface. The minimum U dimension is 4.0".
L = The length of the sensor support tube (Feature 3).
L2 = The length of sensor support between the flange mounting surface and the sensor support fitting. The minimum L2 is 5" for HT process temperatures and 8" for HHT process temperatures.
L = U + L2 – 2.00"

Option	***Sensor Support Diameter***	***Description***
A	½", ¾", 1"	No flange connection
B	½"	½", Class 150, ANSI B16.5
C	½"	½", Class 300, ANSI B16.5
D	½", ¾"	¾", Class 150, ANSI B16.5
E	½", ¾"	¾", Class 300, ANSI B16.5
F	½", ¾", 1"	1", Class 150, ANSI B16.5
G	¾", 1"	1", Class 300, ANSI B16.5
H	¾", 1"	1¼", Class 150, ANSI B16.5
I	¾", 1"	1¼", Class 300, ANSI B16.5
J	¾", 1"	1½", Class 150, ANSI B16.5
K	¾", 1"	1½", Class 300, ANSI B16.5
L	¾", 1"	2", Class 150, ANSI B16.5
M	¾", 1"	2", Class 300, ANSI B16.5
N	1"	2½", Class 150, ANSI B16.5
P	1"	2½", 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

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"

Example: The U Dimension is 7.74"; Enter 077.

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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 (V_p) must be equal to or less than V_{MAX} for the Process Absolute Temperature and Pressure and for the specific Gas Category and Gas Type as determined using Tables 2, 3 and Equations 1, 2.*

FEATURE 8: SPECIALTY GAS VELOCITY CALIBRATION

There are two Specialty Gas Velocity Calibration methods available:
1. Laboratory Gas Velocity Calibration.
2. Correlation Gas Velocity Calibration in which the Insertion Mass Flow Transmitter is calibrated in air and experimentally derived correlation factors are used to obtain calibration data for the specialty gas.

FEATURE 8: SPECIALTY GAS VELOCITY CALIBRATION (Note 1)		
Laboratory Calibration Option	*Gas Type Option*	*Correlation Calibration Option*
01	Air	_
07	Compressed Air	–
–	Dry Ammonia	**56**
08	Argon	**58**
–	Butane	**60**
14	Carbon Dioxide	**64**
–	Dry Chlorine	**68**
20	Ethane	**70**
22	Ethylene	**72**
26	Helium	_
28	Hydrogen	_
32	Methane	**82**
35	Digester Gas 50% CH_4, 50% CO_2	**85**
36	Digester Gas 60% CH_4, 40% CO_2	**86**
37	Digester Gas 70% CH_4, 30% CO_2	**87**
40	Nitrogen	**90**
44	Oxygen (Note 2)	**94**
46	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). Propane to 50 PSIA, all other gasses to 150 PSIA. 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. All correlations include VTM.*
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. (Oxygen cleaning is optional.)*

FEATURE 9: SAFETY APPROVALS/ENCLOSURE MATERIAL (Note 1)	
Option	*Description*
A	Non-Incendive (NI), CSA, ATEX, and IECEx Aluminum enclosures Type 4, IP66 Ex nA II Gc, T6, T5, T4 or T130°C (electronics enclosure) Ex nA II Gc, T5 or T3 (sensing element) Applies to Feature 1, options A through J
B	Explosion-Proof/Flame-Proof, CSA, ATEX, and IECEx Aluminum enclosures Type 4, IP66 Ex d IIB + H2 Gb, T6, T4, T110°C or T130°C (electronics enclosure) Ex d IIB + H2 Gb, T4 or T3 (sensing element) Applies to Feature 1, options A through J

Note 1: *See Specifications, Page 5.*

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/COMMUNICATIONS							
	Analog & Digital Inputs				*Communication Protocols*		
Option	*No. of Alarm Relay Outputs (DO)*	*No. of 4–20mA Outputs (AO)*	*No. of Digital Inputs (DI)*	*No. of 4–20mA Inputs (AI)*	*USB*	*Modbus RS-485 RTU or ASC II*	*HART (FSK 7.0)*
B	0	2	0	0	Yes	Yes	No
C	2	2	2	1	Yes	Yes	No
E	2	1	2	1	Yes	Yes	Yes

Option B provides:
- Two 4-20 mA outputs for flow rate and/or temperature, NAMUR NE-43 compliance.
- USB, Modbus, and RS-485 communication protocols.

Option C provides:
- Two 4-20 mA outputs for flow rate, temperature, EPA Zero-Mid-Span Drift check [3] or PID Flow Control [1,2], NAMUR NE-43 compliance.
- Two alarm relays for flow rate, temperature, or pulsed flow totalizer.
- External 4-20 mA input.
- Two DI for EPA Zero-Mid-Span Drift Check or Purge Cycle Cleaning.
- USB, Modbus, and RS-485 communication protocols.

Option E provides:
- One 4-20 mA output for flow rate, temperature, EPA Zero-Mid-Span Drift check [3] or PID Flow Control [1,2], NAMUR NE-43 compliance.
- Two alarm relays for flow rate, temperature, or pulsed flow totalizer.
- External 4-20 mA input.
- Two DI for EPA Zero-Mid-Span Drift Check or Purge Cycle Cleaning.
- HART Communication Interface, USB, Modbus, and RS-485 communication protocols.

Notes:
1. *The PID Flow Controller uses one 4-20 mA output for the flow controller.*
2. *The External Input PID Controller requires a 4-20 mA flow reference Input.*
3. *EPA Zero-Mid-Span Drift check normally requires a contact closure to verify that the Drift Check has been truly indicated. The contact closure is generated by the Continuous Emissions Monitor Computer at a specific time every day to indicate the Daily Drift Check. Both 4-20mA outputs are used during the Drift Check Calibration procedure.*

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.

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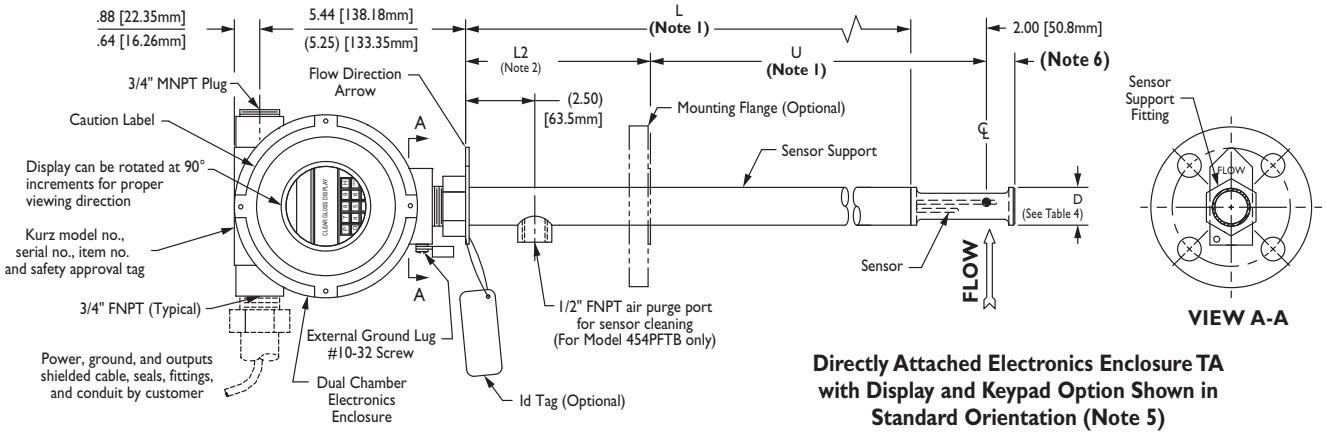
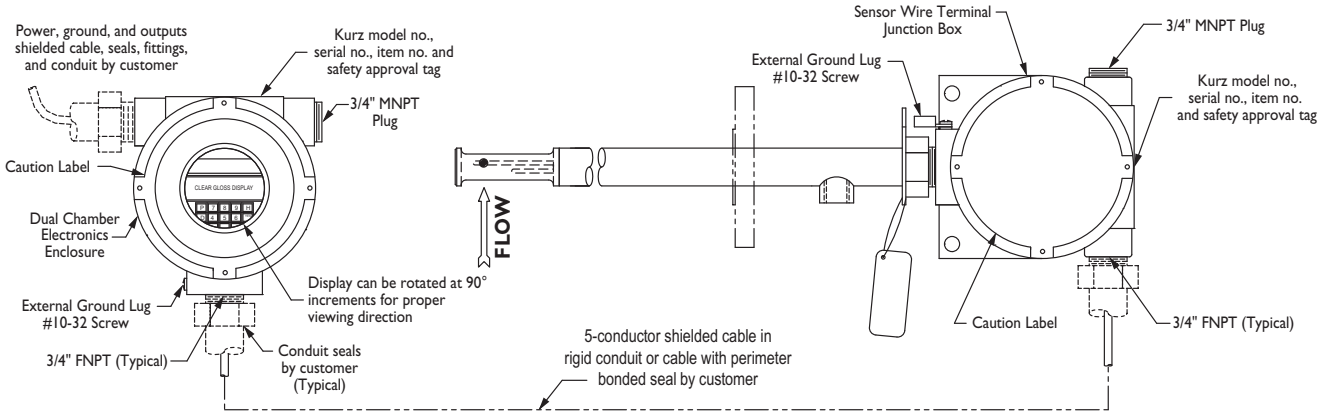


Directly Attached Electronics Enclosure TA with Display and Keypad Option Shown in Standard Orientation (Note 5)



Sensor Electronics for Remotely Attached Electronics Enclosure (TS) with Display and Keypad Option (Shown) (Note 4) (Note 5)

Probe Assembly for Remotely Attached Electronics Enclosure (TS) (Note 3) (Note 5)

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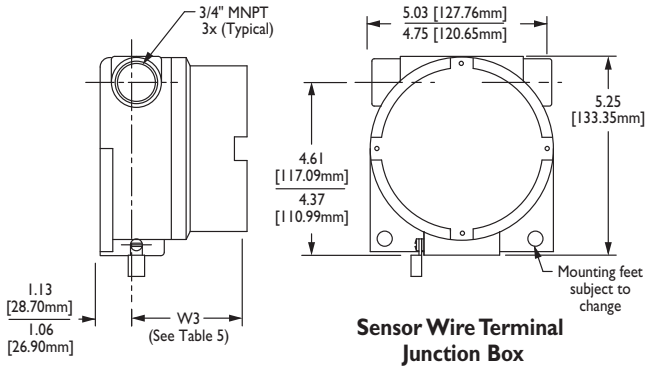
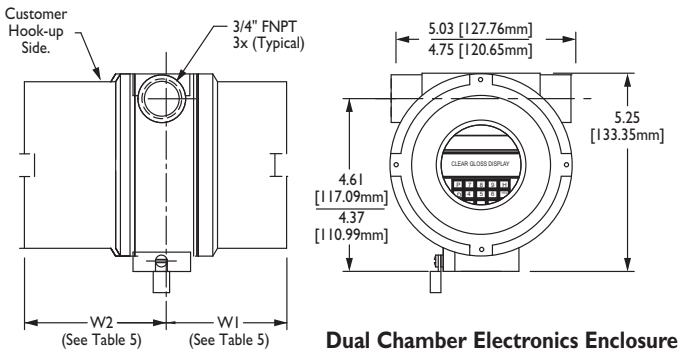


Sensor Wire Terminal Junction Box (Note 4) (Note 5)



Dual Chamber Electronics Enclosure (Shown with Window Lid) (Note 5)

Notes:

1) *For flanged option: L = (U + L2 - 2.00 [50.8mm]), U (Min.) = 4.00 [101.6mm]*
2) *L2 (Min.) for -HT to be 5.00 [127mm]*
   L2 (Min.) for -HHT to be 8.00 [203.2mm]
3) *This probe configuration also used for directly attached, DC powered, with no display.*
4) *Sensor wire terminal junction box used for sensor electronics for DC powered, with no display.*
5) *Enclosure styles and dimensions are subject to change.*
6) *Dimensions for 454FTB-08 (.50 [12.7mm] diameter) to be 0.78 [19.81mm]*
   Dimensions for 454FTB-12 (0.75 [19.5mm] diameter) to be 0.78 [19.81mm]
   Dimensions for 454FTB-16 (1.00 [25.4mm] diameter) to be 0.78 [19.81mm]
   Dimensions for 454PFTB-16 (1.00 [25.4mm] diameter) to be 1.35 [34.29mm]
7) *This configurations allows for probe assembly to be mounted in ZONE 1 area and for remote electronics to be mounted in ZONE 2 area.*

TABLE 4: PROBE DIAMETER DIMENSION

Model No	D
-08	0.50 [12.7mm]
-12	0.75 [19.5mm]
-16	1.00 [25.4mm]

TABLE 5: ENCLOSURE DIMENSION (Note 5)

Input Power	Display/ Keypad	W1 Max / Min	W2 Max / Min	W3 Max / Min
AC	Yes	3.63 [92.20mm] / 3.41 [86.61mm]	5.01 [127.25mm] / 4.69 [119.13mm]	N/A
AC	No	3.16 [80.26mm] / 2.81 [71.37mm]	5.01 [127.25mm] / 4.69 [119.13mm]	N/A
24VDC	Yes	3.63 [92.20mm] / 3.41 [86.61mm]	5.01 [127.25mm] / 4.69 [119.13mm]	N/A
24VDC	No (Note 4)	N/A	N/A	5.01 [127.25mm] / 4.88 [123.95mm]
Sensor Wire Terminal J-Box (for remote opt.)		N/A	N/A	3.16 [80.26mm] / 2.81 [71.37mm]

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 (see table 3).

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 Hg for 760mm 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:

$$DR_P = \frac{P_P}{P_S} \times \frac{T_S}{T_P} = \frac{135}{14.69} \times \frac{537}{560} = 8.81$$

c) Using **Table 3** for Category 1, Air: F^* = 1.333 (DR_P greater than 1.333)

d) Using Equation 2: $V_{MAX} = F^* \times V^*$ = 23,9444 SFPM (111.8 NMPS)

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 DCN 367521 REV. J-6