Technical Reference

KURZ INSTRUMENTS INC.™

Tel: 800.424-7356
www.KurzInstruments.com

B-Series Hardware Guide

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Kurz Instruments Inc.
2411 Garden Road
Monterey, CA 93940
831-646-5911 (main)
831-646-8901 (fax)

Kurz Technical Support
Customer Service
800-424-7356 (toll free)
www.KurzInstruments.com
Service@KurzInstruments.com

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Appendix G

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Preface

Before You Begin

Important ***The device warranty is void if the device is not installed in accordance with the specified installation requirements. Read and thoroughly understand the installation requirements before attempting to install the device. If you have any questions, contact your Kurz customer service representative before attempting installation.***

Using this Manual

Kurz Instruments, Inc., documentation includes manuals, product literature, Adobe Acrobat PDF files, and application online Help files. The Kurz Instruments CD contains all the available documentation files. To read PDF files, download the free Adobe Acrobat Reader from www.adobe.com.

The Kurz Instruments Web site provides additional information:

- **World Wide Web:** www.KurzInstruments.com
- **Email:** Service@KurzInstruments.com
- Documentation links to the most current manuals and literature

You can access device support in the following ways:

- **Main:** 831-646-5911
- **Phone:** 800-424-7356
- **Fax:** 831-646-8901

Safety Symbols

The following table shows the safety symbols used on the product and/or in the manual.

Table 1. Safety Symbols

Symbol	Description
	Protective Conductor Terminal
	Documentation must be consulted in all cases where this symbol is marked in order to find out the nature of the potential hazards and any actions which have to be taken to avoid them.
	Caution possibility of electric shock.

Manual Conventions

The following table lists conventions used in the Kurz Instruments documentation, and gives an example of how each convention is applied.

Table 2. Conventions used in this manual

Convention	For Example
Text type, click, or select (for example, field names, menus, and commands) are shown in bold.	Check the **Configuration File** checkbox.
Text appearing in a display or window is shown in courier.	`PRESS ENTER TO` `SET METER DATA`
An arrow (→) is used to separate a menu name from its menu command.	Select **Start→All Programs→Kurz Instruments→KzComm**.
Simplified directory structures and path names are used in examples. Your folder names may be different.	Programs Files\Kurz Instruments\KzComm.

Chapter 1

Introduction

Overview

This chapter provides the following information:

- Communications requirements
- A configuration checklist
- A quick reference card

Technical specifications for each product are available online.

Communications Requirements

This section describes the requirements for communicating with your B-Series flow meter. KzComm is a Kurz software application that allows you to access and configure your B-Series flow meter.

Hardware Requirements

KzComm uses XMODEM, Modbus RTU, MODBUS TCP/IP, or terminal communications protocols to communicate with Kurz B-Series devices. B-Series devices use the XMODEM communication protocol via USB port, or the MODBUS protocol via RS-485 port or MODBUS TCP/IP. The Kurz USB device driver or FTDI USB device driver must be installed before attempting to connect a computer with a B-Series device via a USB cable.

The B-Series devices require:

- A two-wire (twisted pair) shielded cable for Modbus RTU.
- For the XMODEM protocol, a USB Type A-to-mini B cable.

  Note The Kurz USB device driver or FTDI USB device driver must be installed before attempting to connect a computer with a B-Series device via a USB cable.
- For the Modbus TCP/IP protocol, an Ethernet cable to a Modbus TCP/IP to RS-485 gateway.

Software Requirements

KzComm is supported on Windows XP, Windows Vista, Windows 7, Windows 8, and Windows 10. All platforms require up-to-date service packs.

Note On Windows Vista, downloading the Trend Log has infrequently caused the operating system to freeze (no screen activity). Restart the computer as described in your computer hardware manual.

Basic computer knowledge is necessary for copying and moving files, navigating file structures and identifying file types, and installing applications. You will need a decompression utility to extract files from compressed file packages.

The Kurz USB device driver or FTDI USB device driver must be installed before attempting to connect a computer with a B-Series device via a USB cable. Both drivers are available during the KzComm installation, on the Kurz customer CD in the USB Device Driver folder, and on the Kurz website (kurzinstruments.com). The FTDI USB driver is a 64-bit virtual COM port (VCP) driver available from the FTDI Chip website (ftdichip.com).

Configuration Checklist

Before installing and operating the flow meter, confirm or configure the following list of items. The parameters can be checked using the local display/keypad or a computer connected to the meter via the USB interface. KzComm can guide you through the configuration checklist and then transfer the data to the meter via the USB or Modbus interface. The configuration list is in no particular order.

Have you set the meter tag name for your process?	Yes ___	No___	Name _____
Are you using Modbus or USB to communicate with the flow meter?	Yes ___	No___	Modbus ___ USB ___
Does calibration range match your requirements?	Yes ___	No___	Range _____
Was it calibrated or correlated for your gas type?	Yes ___	No___	Gas type _____
Does the flow area in the meter match the process gas duct area?	Yes ___	No___	Duct area _____
Is flow meter damping or filtering needed for your process?	Yes ___	No___	Damping ___ Filtering ___
Does the analog output range need to be adjusted for your process?	Yes ___	No___	AO range _____
Does the analog output range match the range specified on the equipment connected to the flow meter (your PLC)?	Yes ___	No___	PLC _____
Are the flow units the same at the PLC and flow meter (metric vs. English,), velocity vs. volumetric or mass rate (SMPS, SFPM, SCFM, SCMM, PPH, KGH)?	Yes ___	No___	Units _____
Does the gas molecular weight match your gas? This is only needed if the output units are mass rate.	Yes ___	No___	Gas weight _____
Does it have the correct protocol, baud rate, and device address?	Yes ___	No___	Protocol _____ Baud rate _____ Address _____
Has the sensor insertion depth been entered to compute the SBCF?	Yes ___	No___	Insertion depth _____
Do you need a field calibration (insertion meters)?	Yes ___	No___	Calibration _____
Are you going to use a “theoretical” duct correction factor?	Yes ___	No___	Correction factor _____
EPA drift check setup?	Yes ___	No___	Drift check _____
DO or alarm set points?	Yes ___	No___	Set points _____
Flow controller setup?	Yes ___	No___	Setup _____
Built-in Totalizer setup or pulsed outputs?	Yes ___	No___	Totalizer ___ Pulsed ___
Purge sensor control setup?	Yes ___	No___	Setup _____
Did you upload a configuration file before you made any changes?	Yes ___	No___	Filename _____
Did you upload a configuration file after you made any changes?	Yes ___	No___	Filename _____

Quick Reference Card

You should have received a Quick Reference Card similar to the one shown in Figure 1-1. In the event the card is missing or you need extra cards, print the following Quick Reference Card.

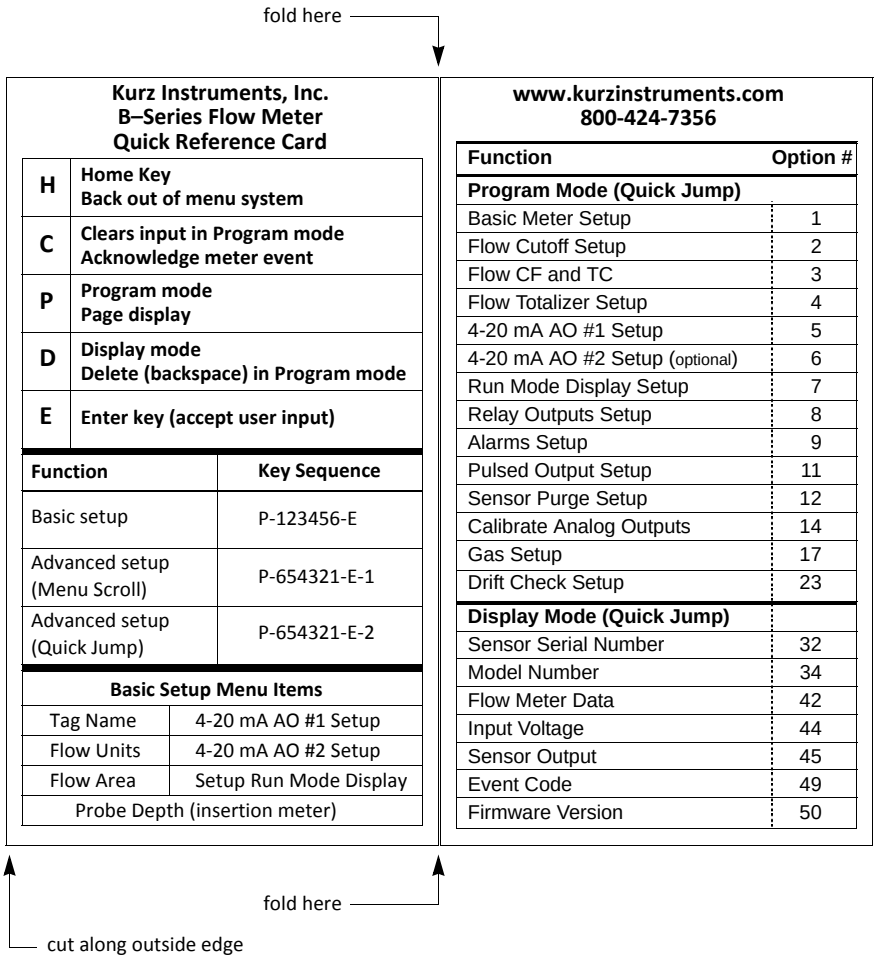


Figure 1-1. User interface quick reference card

Chapter 2

Installation

Overview

This chapter provides installation guidelines and requirements for your B-Series flow meter.

The flow meter must be installed and used as specified in the Kurz Quick Start, Hardware, and Operations guides. Failure to do so could impair the safety protections designed into the flow meter and could result in injury and void your warranty.

- Read and thoroughly understand the installation requirements before attempting to install the flow meter.
- Before you start wiring, turn off the power source and use a tester to check that the flow meter and cables are not receiving any power in order to prevent electric shock.
- For AC Powered units, install an external circuit breaker to make sure that power can be safely disconnected when wiring and servicing the meter. The circuit breaker shall be rated for the wire capacity with no more than 20 A rating and easily accessible and clearly marked as the disconnecting device for the flow meter.
- Wiring should be carried out by personnel with appropriate electrical knowledge and experience.
- For the wiring cable, the temperature rating should be 85°C or more.

If you have any questions, contact your Kurz customer service representative before attempting installation.

Mounting & Sensor Placement

Insertion flow meters have a sensor support connected to an electronics head. Remove the protective shipping cover from the tip of the probe support before installing the device. The probe sensors must have direct contact with the process flow.

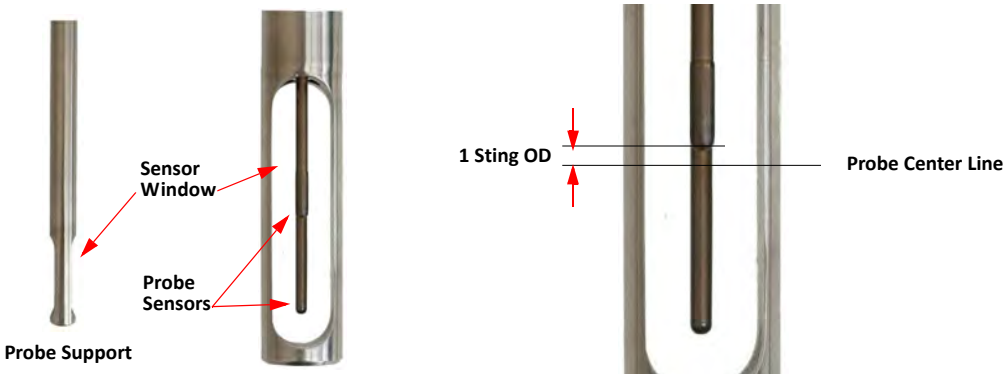


Figure 2-1. Probe support and sensors

Important ***Do not bend the probe sensors. The probe sensors get extremely hot when the flow meter is powered ON. Do not touch the sensors unless the flow meter is powered OFF and there has been sufficient time for the sensors to cool down.***

The long sensor is maintained at a specific temperature above the process flow. The short sensor acts as a thermostat to maintain the constant temperature of the long sensor.

The insertion flow meter is typically mounted with a compression fitting into a pipe, duct, or on a flange (see Figure 2-2 and Figure 2-3). Considerable force can be exerted on the probe support and flange when the process gas is under pressure. Contact Kurz for hardware mounting accessories available for your installation. Duct or pipe reinforcement may be necessary to prevent cracks and leaks at the sensor port depending on the probe mass and application vibration.

The insertion depth depends on the duct size and sensor size. The sensor should be center mounted when possible into the pipe or duct so that the sensor's center line matches that of the pipe or duct. The sensor center line can be referenced from the probe tip as given in Table 2-1. The center line placement typically has the most stable flow profile (minimum thermal gradients when the process gas is cooler or hotter than the ambient). Regardless of the chosen insertion depth, proper installation requires setting the insertion depth in the meter and using the meter correction factors to adjust for flow channel distribution. Refer to Appendix B, Calibration, for setting the correction factors.

Table 2-1. Sensor Center Line

Kurz Series	Distance from Probe Tip to Sensor Center Line
410FTB	0.71 in (18 mm)
454FTB	1.3 in (33 mm)
454PFTB	1.8 in (46 mm)

Important ***The probe support must not be altered or modified for any reason.***

Vertical down flow with the sensor in horizontally cannot be measured below ~20 SFPM (0.1 SMPS) for the 410FTB and 454FTB and below ~40 SFPM (0.2 SMPS) for the 454FTB-WGF. This is because the zero flow cutoff is set high as the heat rise off the sensor is competing with the downward flow.

Figure 2-3 shows mounting and sensor criteria for the 410FTB and 454FTB flow meters in a dry gas application.

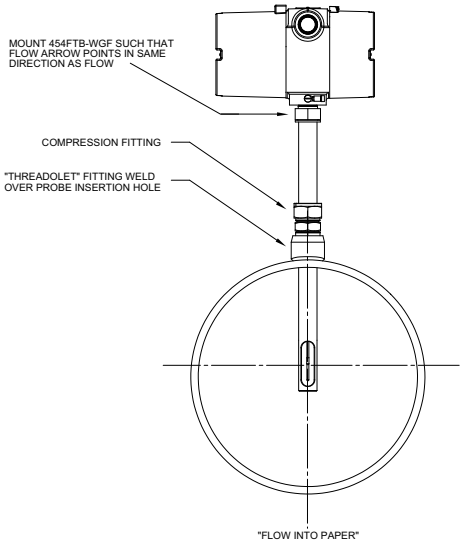


Figure 2-2. Mounting and sensor criteria for the 410FTB and 454FTB

Figure 2-3 shows mounting and sensor criteria for the 454FTB-WGF flow meter in a condensing gas application.

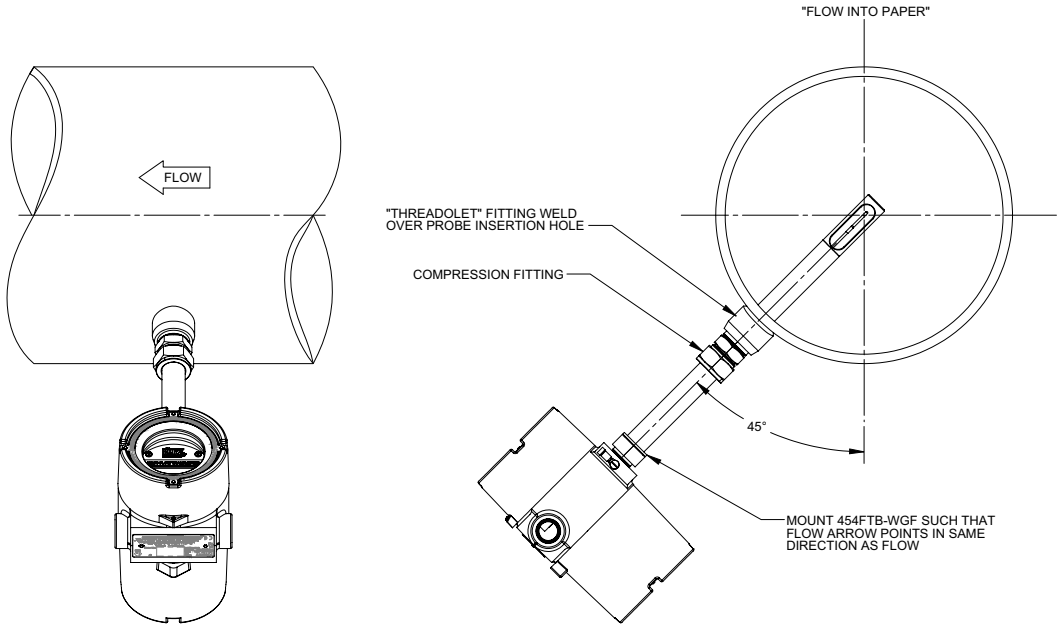


Figure 2-3. Mounting and sensor criteria for the 454FTB-WGF

For condensing gas applications, the ideal location for the 454FTB-WGF is at a 45-degrees up angle up from the bottom (see Figure 2-4) so that condensed water flows away from the sensor. While the vertical-up (6 o'clock) position is the ideal location to avoid liquid migration onto the sensor, any corrosive gas constituents (such as SO_2) collecting at the bottom of the pipe will corrode the probe. Vertical probe installations also work fine when the flow is up.

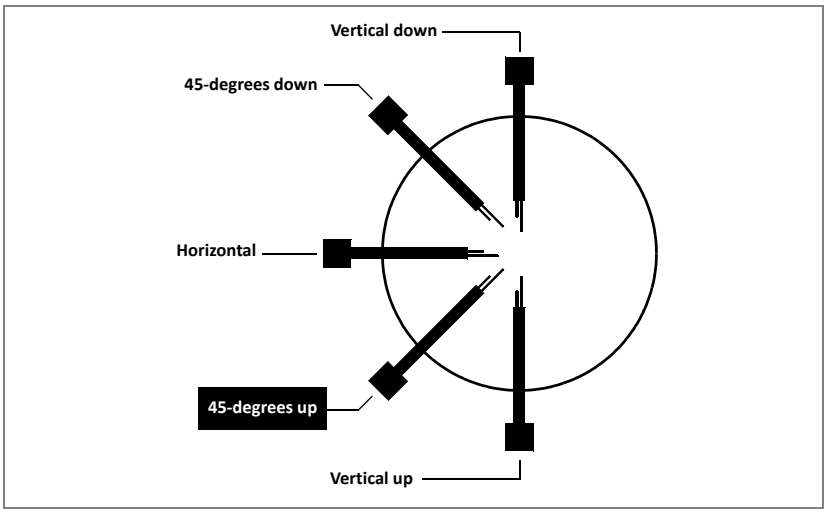


Figure 2-4. Probe sensor placement (installation angle) for condensing gas environments

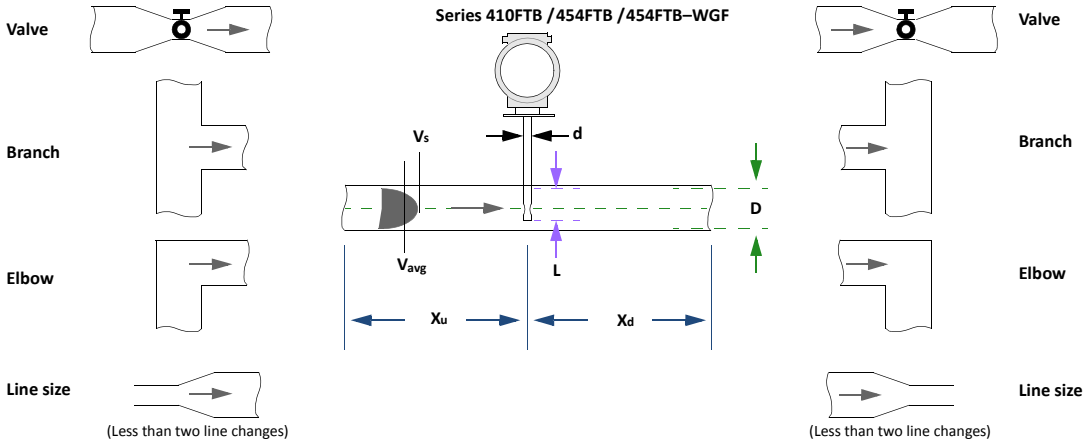
All flow meters should be installed away from flow disruptions (such as elbows or branches) to ensure the flow meter provides the best repeatability and accuracy. Based on a single sensor velocity measurement, approximately 30 duct diameters are needed to have the profile within ~1% of a long run velocity profile; less length is needed for multipoint arrays.

Placing a sensor near a fan inlet can result in extra frequent sensor cleaning to remove dirt buildup. Increased humidity near the fan inlet can increase condensation around the sensor and cause dirt to more-readily stick to the sensor. Moisture vapor (humidity less than 100%) that is dissolved in the air contributes to the total mass flow measured by the sensor.

Accuracy & Repeatability

The accuracy and repeatability of any flow meter is dependent on the flow profile and whether it is static or dynamic. For the same process flow rate: ***Static velocity flow profiles*** have the same distribution across the duct/pipe and **do not change over time** whereas ***Dynamic profiles*** **do change**. Dynamic profiles result from active process flow control elements that change like valves and branching flow splits. Heating/cooling flows can also generate Dynamic profiles.

The standard Kurz 410FTB, 454FTB or 454FTB-WGF flow meter is configured with the nominal pipe area, typical correction factor (duct average velocity/center line peak velocity), and a probe blockage factor. This configuration provides excellent repeatability provided the installation site is away from dynamic pipe changes, as shown in Table 2-2.



$A = \frac{1}{4}\pi D^2$	+	$SBCF \approx 1 - dL/A$	+	$V_{avg} / V_s = CF(v)$
where: A = area (ft^2 or m^2) D = inside diameter		*where:* L = probe depth from inside wall to probe tip (feet or meters) d = probe diameter (feet or meters)		*where:* V_{avg} = average flow velocity V_s = sensor velocity CF(v) = velocity correction factor

Table 2-2. Kurz 410FTB, 454FTB and 454FTB-WGF Single-Point Insertion Sensor Repeatability

Velocity Profile Disturbance	Repeatability (+/- % uncertainty)	
	Upstream (Xu)	Downstream (Xd)
Line size change (static)	0 D (0%)	0 D (0%)
Elbow (static)	0 D (0%)	0 D (0%)
T or branch (static)	0 D (0%)	0 D (0%)
T or branch (dynamic)	3 D (8%) 10 D (3%) 15 D (1.5%)	1 D (7%) 5 D (4%) 10 D (0.5%)
Butterfly valve (dynamic) Depends on position and flow rate	3 D (8%) 10 D (3%) 15 D (1.5%)	1 D (7%) 5 D (4%) 10 D (0.5%)
Gate valve (dynamic) Depends on position and flow rate	3 D (16%) 10 D (6%) 15 D (3%)	1 D (14%) 5 D (8%) 10 D (1%)

Improving accuracy for difficult installations is possible by implementing the variable correction factor (VCF), a one-time velocity profile traversing process. Including field calibration eliminates the uncertainty of using the point velocity calibrated sensor to measure flow. Table 2-3 provides the accuracy capability for a Kurz single-point insertion meter with VCF.

Table 2-3. Kurz 410FTB, 454FTB and 454FTB-WGF Single-Point Insertion Sensor Repeatability with VCF

Velocity Profile Disturbance	Accuracy (+/- % error) with Kurz *FlowCorrect*™	
	Upstream (Xu)	Downstream (Xd)
Line size change (static)	0 D (0%)	0 D (0%)
Elbow (static)	0 D (0%)	0 D (0%)
T or branch (static)	0 D (0%)	0 D (0%)
T or branch (dynamic)	3 D (8%) 10 D (3%) 15 D (1.5%)	1 D (7%) 5 D (4%) 10 D (0.5%)
Butterfly valve (dynamic) Depends on position and flow rate	3 D (8%) 10 D (3%) 15 D (1.5%)	1 D (7%) 5 D (4%) 10 D (0.5%)
Gate valve (dynamic) Depends on position and flow rate	3 D (16%) 10 D (6%) 15 D (3%)	1 D (14%) 5 D (8%) 10 D (1%)

Table 2-4 provides the accuracy capability for a typical, uncorrected, standard single-point insertion meter.

Table 2-4. Kurz 410FTB, 454FTB and 454FTB-WGF Single-Point Insertion Sensor Accuracy (uncorrected)

Velocity Profile Disturbance	Accuracy (+/- % error)	
	Upstream (Xu)	Downstream (Xd)
Line size change (static)	1 D (16%)	1 D (14%)
Elbow (static)	1 D (16%)	1 D (14%)
T or branch (static)	1 D (16%)	1 D (14%)
T or branch (dynamic)	3 D (18%) 10 D (13%) 15 D (11.5%)	1 D (17%) 5 D (14%) 10 D (10.5%)
Butterfly valve (dynamic) Depends on position and flow rate	3 D (18%) 10 D (13%) 15 D (11.5%)	1 D (17%) 5 D (14%) 10 D (10.5%)
Gate valve (dynamic) Depends on position and flow rate	3 D (26%) 10 D (16%) 15 D (13%)	1 D (24%) 5 D (18%) 10 D (11%)

Kurz in-line flow meters have built-in straight runs, which provides higher accuracy than an insertion meter. The Kurz 504FTB flow meter repeatability is shown in Table 2-5. The 534FTB immunity to flow profile changes is better than 2% from full scale (FS) down to FS/10.

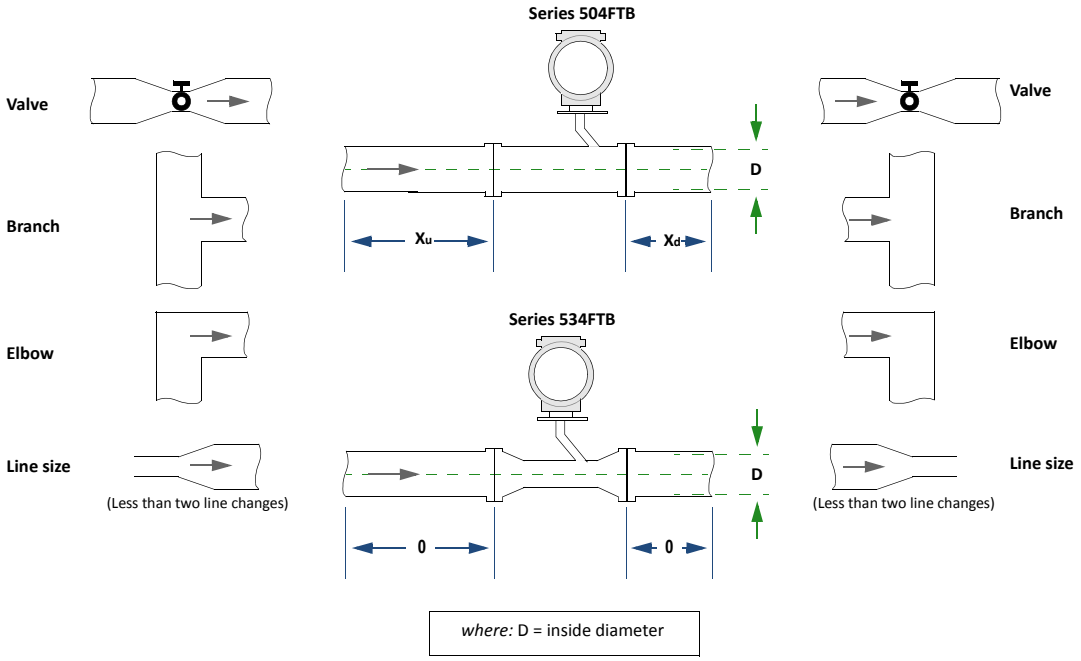


Table 2-5. Kurz 504FTB In-line Sensor Repeatability

Velocity Profile Disturbance	Repeatability (+/- % uncertainty)	
	Upstream (Xu)	Downstream (Xd)
Line size change (static)	0 D (0%)	0 D (0%)
Elbow (static)	0 D (0%)	0 D (0%)
T or branch (static)	0 D (0%)	0 D (0%)
T or branch (dynamic)	3 D (5%) 10 D (2%) 15 D (1%)	1 D (4.7%) 5 D (2.7%) 10 D (0.3%)
Butterfly valve (dynamic) Depends on position and flow rate	3 D (5%) 10 D (2%) 15 D (1%)	1 D (7%) 5 D (4%) 10 D (0.5%)
Gate valve (dynamic) Depends on position and flow rate	3 D (10.7%) 10 D (4%) 15 D (2%)	1 D (9.3%) 5 D (5%) 10 D (0.7%)

Hardware Description

The features for the B-Series flow meter shown in Figure 2-5 include:

1. ¾-inch FNPT signal and power conduit ports
2. Backlit 2x16-character display and 20-character keypad interface
3. ¾-inch FNPT sensor support port (Transmitter Attached version), conduit or cable port (Transmitter Separate version)
4. Safety label and product ID tag
5. AC power input — 85 to 265 VAC 50/60 Hz 1 phase
6. Optional hardware, AI, DO, DI, Purge valve, I/O connector TB6
7. Power indicator — green LED, right side of TB1
8. Main I/O wiring terminal block for sensor, power, RS-485 and 4-20 mA outputs, TB1
9. External and internal ground lug locations and shielded wire pig-tail termination location
10. USB mini-B connector

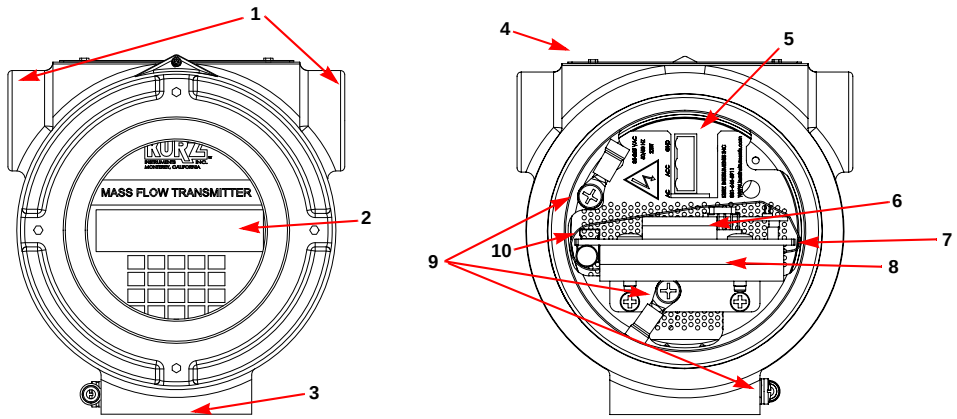


Figure 2-5. Location of 410FTB and 454FTB components

Flow Arrow

Each flow meter has a flow arrow below the sensor electronics head. The arrow indicates the direction of the process flow, as designated in your order specifications.

Figure 2-6. Flow arrow

Electronics Head Orientation

The B-Series meter head has two orientations based on the flow direction. Facing the meter display, the standard flow direction is left to right while the reverse flow direction is right to left. The meter head orientation was selected when the unit was ordered.

Important ***Rotating the head in the field can damage the sensor wires and cause a loose connection, result in water leakage, void the warranty, or create hazardous safety violations.***

The electronics head on the sensor support must be accessible for wiring. Wiring requirements include electrical and communications (computer) connections.

- For transmitter-attached (TA) devices with the display/keypad option, the area must allow for viewing and accessing the display/keypad.
- For transmitter-separate (TS) devices, the area must provide a location for mounting the transmitter electronics and a connection from the transmitter to the sensor electronics.

Display/Keypad Orientation

Important ***Turn off the power to the unit before reorienting the display/keypad to prevent damage and potential explosions ignited from electrical sparks.***

Within the electronics head, the display/keypad can be mounted in one of four positions to improve viewing and access. It mounts to four standoffs using the screws on the keypad. When rotating the display, use standard electronics handling procedures (a wrist strap) to prevent electrostatic shock/discharge from damaging the flow meter.

Figure 2-7. Display/keypad rotation (with cover removed)

Make sure to fully seat the connectors on the ribbon cable used between the sensor electronics and the display board before carefully screwing down the board (screws provided). There is a pin 1 mark on the ribbon connector that must match the circuit board connector at each end.

There is a display contrast control on the back of the display/keypad circuit board. Use a small slotted screwdriver to adjust the best viewing of the screen. It is factory set for equal viewing at 0ºC and 60ºC. The display turns white when it is too cold, and it turns dark when it is too hot.

Mounting Transmitter-Separate (TS) Models

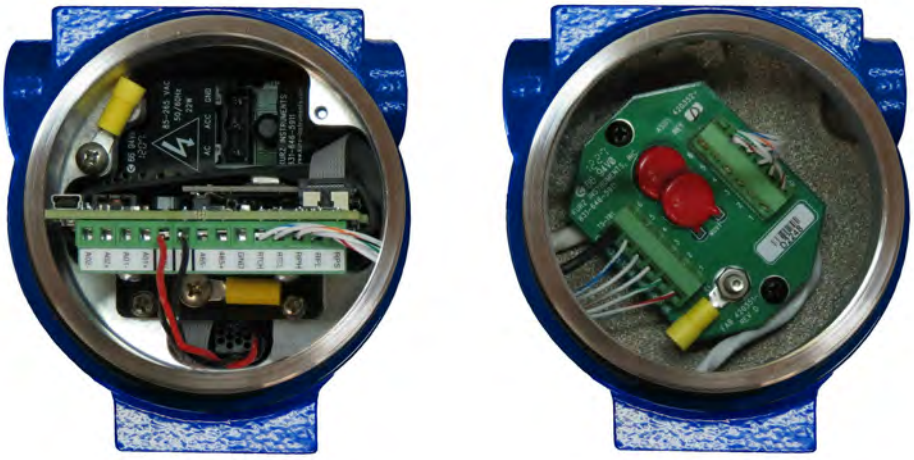
When you order a transmitter-separate (TS) configuration there are two separate enclosures:

- One enclosure is attached to the probe and sensor
- One enclosure contains the sensor electronics

The enclosure attached to the probe and sensor is always metal. The sensor electronics are in either a similar metal enclosure or a polycarbonate enclosure. If your sensor electronics are in an metal enclosure, the unit includes either a display/keypad or is blind. Electronics in a polycarbonate enclosure include a display/keypad.

Figure 2-8 shows the TS enclosures with covers removed, with the electronics enclosure (with the display/keypad option) and a probe support/sensor enclosure.

Note The electronics enclosure and probe support/sensor enclosure are matched using serial numbers. These two enclosures are not interchangeable with other TS enclosures.



Sensor Electronics Enclosure (Display/Keypad option)

Probe Support and Sensor Enclosure

Figure 2-8. TS electronics with covers removed

Using the optional Kurz universal mounting kit, the flow meter head mounts via the threaded pipe, as shown in Figure 2-9. Two U-clamps are used around the pipe nipple, which then attach to a metal mounting adaptor frame or pipe stand.

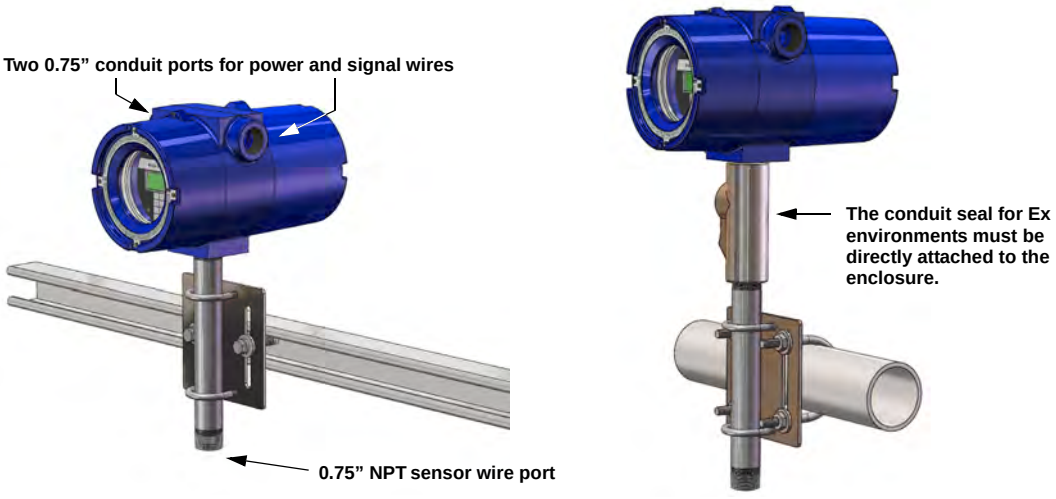
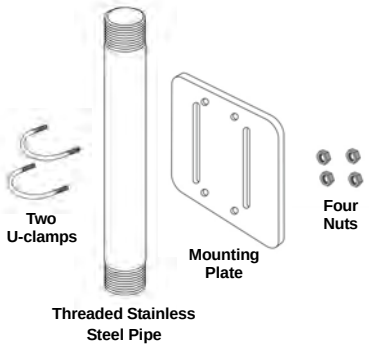


Figure 2-9. Examples of unistrut and pipe mounting using the optional mounting kit

The optional Kurz universal mounting kit includes the following:



Field Wiring

It is important to consider the several electrical issues when installing B-Series flow meters. Review the following relevant sections before installing your Kurz meter:

- Safety grounding and explosion-proof enclosure connections
- Water protection
- AC/DC power requirements and connection
- Analog output configuration and wiring of the 4-20 mA signals
- Clip-on ferrite for all signal wires (if not in shielded conduit)
- Discrete alarms
- Serial communications
- Zero-Mid-Span daily drift test (EPA 40 CFR part 60 or 75 support)
- 5-wire sensor connection for the TS configuration
- Flex wiring connection for sensor connections

Safety Grounding and Explosion Proof Connections

To ensure compliance with general safety requirements, all metal enclosures must be grounded to minimize the chance of electrical shock. For explosive atmospheres where a potential ignition source can exist outside an enclosure, properly grounding a metal enclosure minimizes the potential for sparks if a fault current was to occur. Always ground the transmitter case in accordance with national and local electrical codes. Both internal and external ground connections are available on Kurz enclosures and are identified by the protective conductor symbol (⏚). Refer to the wiring diagrams in Appendix A, Drawings & Diagrams, for additional information.

For hazardous gas areas, wiring going into and out of an explosion-proof metal enclosure must enter through a conduit seal or cable gland rated for explosion-proof applications (Class 1, Div. 1 or Zone 1) attached directly to the enclosure. These seals are not needed for Class 1 Division 2 or Zone 2 applications except where extra protection from water damage is wanted.

Caution ***For hazardous areas, do not open the metal enclosure when a potentially explosive atmosphere is present. Do not connect or disconnect any wiring when the circuits are energized to avoid sparks that could ignite.***

The metal enclosure has three 0.75-inch FNPT fittings, as shown in Figure 2-5 under "Hardware Description" on page 2-9. The bottom FNPT fitting is used for the sensor probe support or its wiring in a TS configuration. The top two ports are typically for AC/DC power and signal wiring. Consult your local electrical code for installation requirements.

Caution ***For hazardous areas, if there is an unused conduit port then an approved Ex d plug (0.75-inch) must be used on that port and fully threaded in.***

The product labels/markings are provided in Appendix F, Certifications, Compliance & Labels.

If a field replacement of the sensor control board is required, the board must be compatible with the sensor. Contact your Kurz representative for additional information.

Water Protection

Water penetration is the leading cause for a malfunctioning flow transmitter. The metal enclosures have a Type 4X, IP66 rating, but water can damage the sensor electronics or wiring terminals if the meter is not properly installed and maintained. To minimize the potential for water damage, use the following protective measures for keeping water out of the flow transmitter components:

- Install conduit seals near the enclosures on all ports.
- Most cable gland designs provide shielded cable termination an environmental seal against dirt and water.
- Routing conduit or cable using a water loop and drain near the enclosure ports.
- Keep the enclosure lids sealed tight using the supplied o-rings.
- Apply positive pressure dry purge air (a few PSI from a regulator) to the enclosure to keep condensation out.

A sensor and wiring leakage test is performed every 10 minutes that sets off an alarm (Modbus, display, NE-43, and HART) when excessive leakage occurs.

AC/DC Power Requirements & Connections

For both the AC and DC powered versions of the B-Series, refer to the summarized wiring diagrams in Appendix A, Drawings & Diagrams, for additional information. This information is for both transmitter separate (TS) and transmitter attached (TA) configurations. Examples for 4-20 mA connections and Modbus are provided with terminal definitions and cable wiring notes.

For the metal TS enclosure configuration, the 5-wire sensor connections must be made as shown in Appendix A, Drawings & Diagrams. The connection between the enclosures must be shielded to maintain the CE EMC rating.

For the polycarbonate TS enclosure configuration, the 5-wire connections must be made as shown in Appendix A, Drawings & Diagrams. The connections between the enclosures must be shielded to maintain the CE EMC rating.

24 VDC Powered Flow Transmitters

The 24 VDC power is a nominal voltage since all circuits have a regulated supply and will work between +/- 10% of 24 VDC. You can also use an unregulated power supply with 50 to 60 Hz ripple as long as the instantaneous voltage is between 21.6 and 26.4 VDC.

Surge currents during sensor warm-up could require up to 1 A and will fall off after it warms up in approximately 20 seconds. At no-flow the current will be about 0.2 A and about 0.6 A for high flow rates (20 SMPS). The power is protected against reverse polarity. If there is neither current flow nor output signal, you should check the polarity against the wiring diagram (available in Appendix A, Drawings & Diagrams).

The flow transmitter is grounded to its chassis. The 24 VDC power and 4-20 mA signal have metal oxide varistors (MOVs) to clamp voltage spikes going into the unit. These are 56 V nominal (voltage level at 1 mA) and do not conduct significant current below +/- 36 VDC relative to ground. Consequently, the isolated 4-20 mA signals and alarms cannot have a significant common mode or bias voltage to prevent leakage currents on the MOVs, which can cause an error in the flow measurement if occurring on the 4-20 mA output.

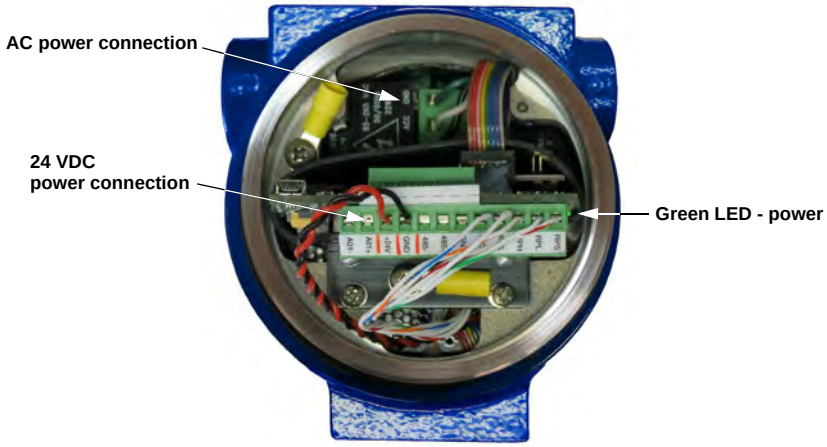


Figure 2-10. AC/DC power connection

AC Powered Units

A universal input 85-265 VAC and 50-60 Hz supply generates a nominal 24 VDC to power the device. The AC wiring uses one of the two 3/4-inch conduit ports for the signal wiring. The AC powered units have a pull tab attached (Figure 2-11) to the plug to make it easy removing the plug and connecting the AC wiring using a 1/8-inch screw driver. Discard the pull tab, and use the power wiring to guide the plug in and out of the power supply.

Figure 2-11. AC power pull tab

The power wires must be inside the plastic insulator sleeve or wiring label to prevent the wires from catching in the threads of the explosion-proof lid. The internal ground can be made via the AC power plug or a 10-32 stud on the circuit board mounting bracket. The AC wiring should be 18 to 12 AWG wire with a temperature rating of 85°C or higher. The AC power should be connected to the flow meter through an external disconnect or circuit breaker rated for the wire capacity with no more than 20 A rating. The disconnect or circuit breaker should be clearly labeled and located in the vicinity of the flow meter electronics enclosure, and where operators and maintenance personnel have quick and easy access to it.

K-BAR System Installation

Most K-BAR multipoint systems are designed for specific customer applications, and many companies contract with Kurz field service to provide the installation. Before the installation can begin:

- Find the system configuration drawings showing the dimensions and mounting requirements for the available K-BAR meters, as shown in Appendix A, Drawings & Diagrams.
- Find the wiring and programming configuration information for the flow computer setup.

Note There are additional installation requirements for the Purge version of the K-BAR 2000B.

The following materials are available when ordering the K-BAR:

- Mounting nuts and bolts
- Flange gaskets
- Raised face, flange mounting adaptor with spacing off the duct that matches the K-BAR fabrication drawing
- Duct reinforcement for the flange mount or flange mounting adapter

Important ***Read all instructions and review all relevant wiring diagrams before performing the installation. Refer to the wiring diagrams in Appendix A, Drawings & Diagrams, for K-BAR 2000B information.***

A typical installation sequence is as follows:

1. Install any access scaffolding or new walkways to support installation, maintenance, and field calibration.
2. Weld mounting flanges to duct work and any hangers needed for the flow computer.
3. Insert probes and mount the flow computer.
4. Review wiring diagram requirements to plan for the proper wire type.
5. Route conduit or braided shielded cable as needed between the K-BARs and the flow computer, and then from the flow computer to the process control system.
6. Pull wiring and terminate per the Kurz wiring drawings in Appendix A.

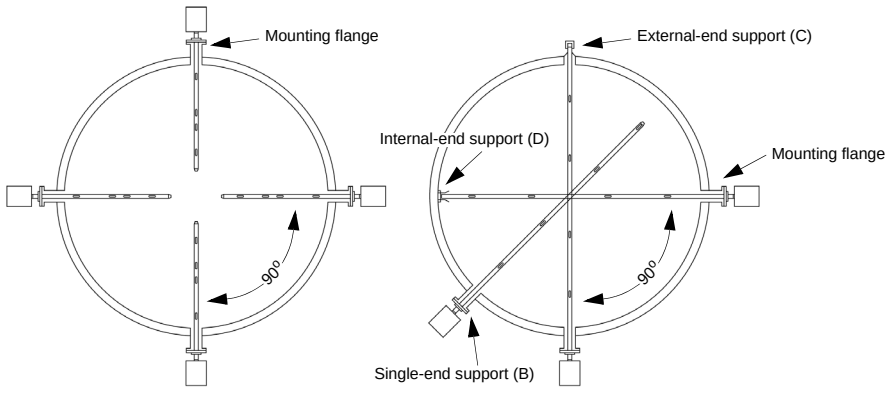
Mounting

The length of the K-BAR probe support determines the mounting requirements. The probe support must be held in place with sufficient rigidity to minimize the vibrations created by the process, and there must be enough clearance for installation and maintenance.

As shown in Figure 2-12, a single-end support installation (categories A, B, E, and F) is cantilever mounted from the flange. The size and length of the flange mounting adapter is determined by the K-BAR specifications. For high vibration applications or when access is limited to one side, a double-end mounting installation (categories C, D, G, and H) is recommended. The double-end support uses a probe support cup on the side opposite the mounting flange.

Process flows in very large stacks/ducts are best monitored with K-BARs installed on all sides, whether using half-span or full-pan K-BARs.

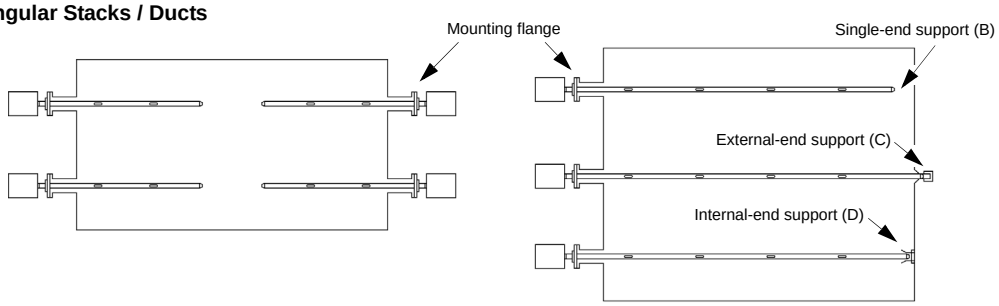
Round Stacks / Ducts



Category A: Half span, single-end support

Category B: Full span, single-end support
Category C: Full span, external-end support
Category D: Full span, internal-end support

Rectangular Stacks / Ducts



Category E: Half span, single-end support

Category F: Full span, single-end support
Category G: Full span, external-end support
Category H: Full span, internal-end support

Figure 2-12. Typical K-BAR 2000B installation configurations

Most K-BAR installations are flange mounted. In environments where the stack/duct pressure does not match ambient, the clearance gap between the K-BAR probe and flange mounting adaptor can cause significant blow-by. The K-BAR should be installed during a planned outage to reduce safety risks and improve the ease of the installation.

K-BAR Electronics Configurations

The electronics and wiring locations are determined by several factors such as the application environment, weather, temperatures, vibration, and maintenance requirements. The two most common installation types are:

- Transmitter attached
- Transmitter separate

As shown in the Figure 2-13 example, transmitter-attached installations send a linearized 4-20 mA flow signal from each flow element to the Series 155 Mass Flow Computer. In the case of the Series 255 Flow Averaging Transmitter, RS-485 Modbus communications is used for all control functions and data return signals. The reduced wire installation count is an advantage of the Series 255 over the Series 155. Each sensor has its electronics on the end of the K-BAR, which minimizes wiring and EMC requirements. Transmitter-separate installations typically use a short service loop between the transmitter electronics and the sensor wire junction box on the end of the probe. The wire gage and conduit shielding determine the length you can run the sensor wires. The wire from the K-BAR to the transmitter electronics must be shielded in solid conduit, EMT, or braided shielded cable using peripheral bonds at each end.

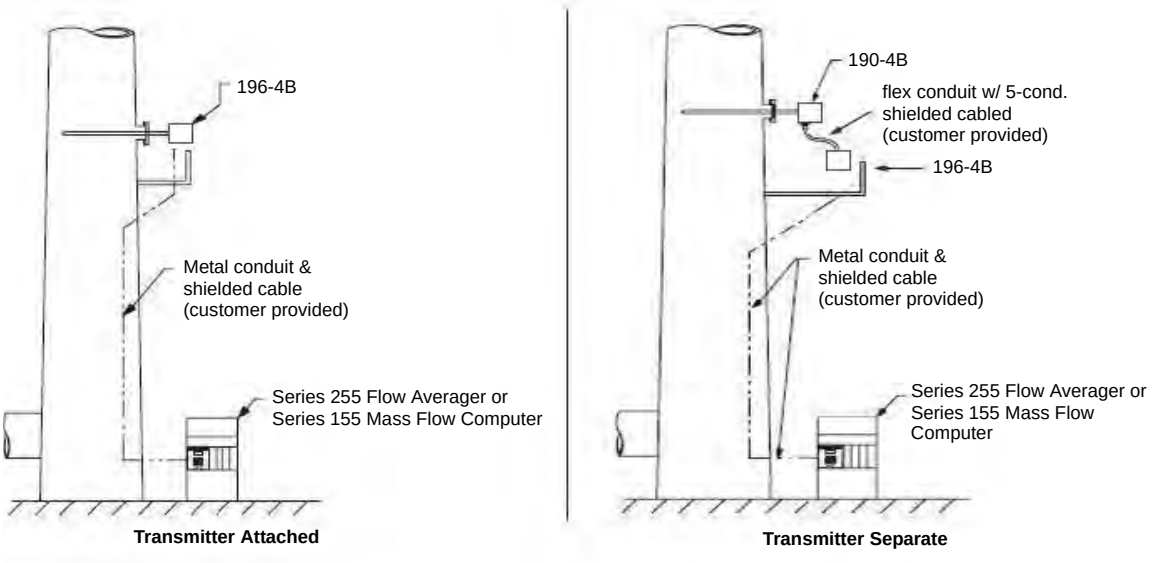


Figure 2-13. K-BAR 2000B electronics configuration examples

The averaged duct flow and temperature comes from the Series 255 Flow Averaging Transmitter or Series 155 Mass Flow Computer. The flow computer averages the data, provides 24 VDC power, and manages the individual flow sensor kick outs. Once the system is setup, most K-BAR interfacing requirements are supported using the Series 255 Flow Averaging Transmitter or Series 155 Mass Flow Computer.

EPA zero-mid-span daily drift checks are supported using either the K-BAR electronics head with a contact closure (preferred method) or the Series 255 Flow Averaging Transmitter or Series 155 Mass Flow Computer. See the K-BAR wiring diagrams in Appendix A for contact location information.

K-BAR 2000B wiring considerations include:

- Safety grounding connections
- Water ingress protection
- DC or AC power requirements and connection
- Analog output configuration and wiring of the 4-20 mA signals
- Purge sensor air solenoid
- Zero-mid-span daily drift test (EPA 40 CFR part 60 or 75 support)
- Serial digital interface
- 5-wire sensor connection for the transmitter-separate configuration (see section below)
- Clip-on ferrite for all signal wires if not in shielded conduit
- Flexible electrical connection probe for field service

See the wiring diagrams in Appendix A, Drawings & Diagrams, for K-BAR 2000B terminal and sensor information. The example K-BAR electronics shown in Figure 2-14 uses 24 VDC to the common I/O block and sends the 4-20 mA signals from the electronics boards for each sensor to the flow computer.

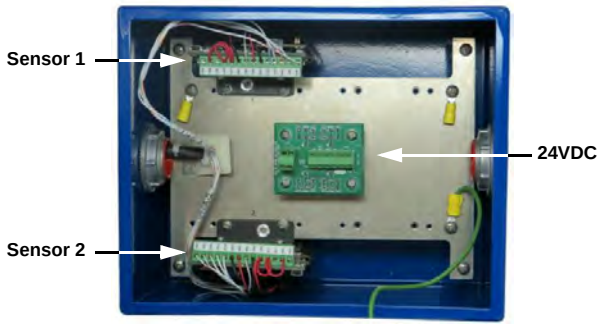


Figure 2-14. K-BAR 2000B transmitter-attached electronics example

Table 2-6 provides an example of the wiring that Figure 2-14 would require when the K-BAR is connected to a Series 155 Flow Computer. See the *Series 255 Flow Averaging Transmitter Hardware Guide* for more information on connecting to the Series 255.

Table 2-6. Wiring Example for K-BAR 2000B with Two Sensors with a Series 155

Wire #, AWG	Description	Wire Source	Wire Destination
1, 18	+24 VDC power (0.5A per sensor)	Series 155 Computer	I/O distribution board, TB-2 +
2, 18	24 VDC Ground	Series 155 Computer and chassis	I/O distribution board, TB-1 –
3, 22	Sensor 1, 4-20 mA flow	Sensor control board on sensor #1, TB1-12	Series 155 Computer
4, 22	Sensor 1, 4-20 mA temperature	Sensor control board on sensor #1, TB1-14	Series 155 Computer
5, 22	Sensor 2, 4-20 mA flow	Sensor control board on sensor #2, TB1-12	Series 155 Computer
6, 22	Sensor 2, 4-20 mA temperature	Sensor control board on sensor #2, TB1-14	Series 155 Computer

Refer to the wiring diagrams in Appendix A, Drawings & Diagrams, if the system contains purge sensor cleaning, EPA zero span triggers, or a Modbus RS-485 interface; the TB-1 terminals will be required. All optional connections (not the 4-20 mA outputs) on the I/O board are pre-wired to each sensor for a common connection.

The transmitter separate electronics are shown in the Figure 2-15 example.

Figure 2-15. K-BAR 2000B transmitter-separate electronics example

The 5-wire sensor extension to the sensor control boards requires the wiring be in a well-shielded solid conduit or braided shielded cable. The basic wiring diagram is on the inside of the enclosure lid. The sensor wires must be no more than 1 ohm per wire and matched to 0.01 ohm; larger gage wire permits longer runs. Up to 12 AWG solid wire or 14 AWG stranded can be used with a direct connection to the terminal blocks at each end.

K-BAR Purge Option

Note The following section is tailored for installation with a Series 155 Mass Flow Computer. See the Series 255 Flow Averaging Transmitter manuals for information on the purge configuration.

The K-BAR purge cleaning is best controlled at the K-BAR electronics head. The purge function holds the output during the cleaning cycle so the process can be activated automatically. However, it is important to monitor for substantial data change following a cleaning cycle as too much as too much can affect the control system. Increasing the frequency of the cleaning cycles can help avoid substantial data changes.

Each K-BAR with the Purge option (K-BAR 2000BP) has a purge gas solenoid that is activated from one of the sensor control boards via the Relay 2 output terminal using a 24 VDC, 12 W signal. The common purge initiation contact closure (as shown in Appendix A, Drawings & Diagrams) is fed from the Kurz purge timer, which provides the cycle interval and the K-BAR sequencing so only one K-BAR is cleaned at a time.

K-BAR blow-down tanks can be shared as long as the gas pressure does not drop below the peak flow during cleaning (120 SCFM per sensor); otherwise, each K-BAR must have its own blow-down tank. For example, a four-point K-BAR has approximately a 500 SCFM peak purge consumption and a 0.4 SCFM bleed flow rate. This requires a 1-inch pipe size and less than 20 feet between the blow-down tank and the K-BAR. Table 2-7 provides K-BAR requirements for the Purge option.

Table 2-7. K-BAR 2000BP Gas Requirements Per Sensor for Purge Cleaning

Parameter	Requirement
Gas	Clean air or inert gas
Pressure	105 PSIA +/– 30 PSI
Purge consumption per sensor	2 SCF per purge @ 1 second valve open time ~120 SCFM flow rate when valve is open
Bleed flow rate per sensor	0.1 SCFM

The purge timer limits the air supply requirements and frequently permits the sharing of blow-down tanks. Typical wiring between the purge timer and a four K-BAR 2000BP system is a single-wire pair, ground and contact closure from the purge timer to the K-BAR. Table 2-8 and Figure 2-16 provide example wiring between the purge timer and a four K-BAR system.

The external purge timer is not used with the Series 255 Flow Averaging Transmitter. The Series 255 communicates to the K-BAR via RS-485 Modbus communications and the purge is triggered through that network.

Table 2-8. K-BAR 2000BP Timer Requirements Per Sensor for Purge Cleaning

Cable #	Purge Timer	K-BAR2000PB
1	K-BAR 1 output, TB3–	K-BAR 1 TB-1 purge
1	K-BAR 1 ground, chassis GND	K-BAR 1 TB-1 GND
2	K-BAR 2 output, TB4–	K-BAR 2 TB-1 purge
2	K-BAR 2 ground, chassis GND	K-BAR 2 TB-1 GND
3	K-BAR 3 output, TB5–	K-BAR 3 TB-1 purge
3	K-BAR 3 ground, chassis GND	K-BAR 3 TB-1 GND
4	K-BAR 4 output, TB6–	K-BAR 4 TB-1 purge
4	K-BAR 4 ground, chassis GND	K-BAR 4 TB-1 GND

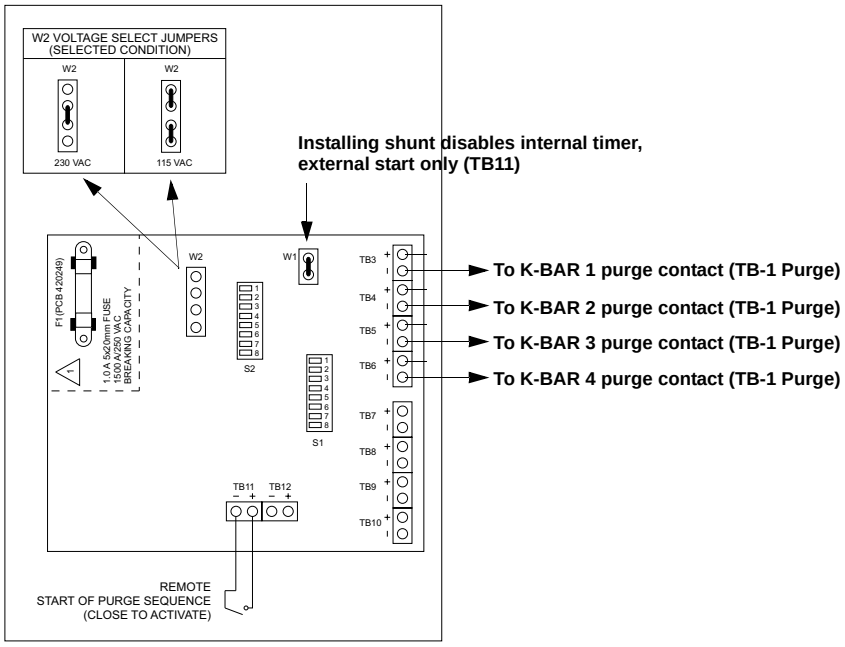


Figure 2-16. K-BAR 2000BP multipoint controller circuit board example

The purge timer control is accomplished with circuit board DIP switches and shunts. It has open collector outputs that are tied to the K-BAR purge cycle activation or trigger pin (TB-1 Purge).

Purge Recovery Settings

The purge timer is designed to clean several velocity sensors with each probe on its own control valve. A stack with four probes will clean each K-BAR separately, allowing the blow-down tank to recharge between each blast. The timer waits a programmed interval before restarting the cleaning sequence with a preset recovery time between K-BARs. The cycle time is the sum of the interval time and recovery time. Note that for a single sensor or single K-BAR cleaning, the recovery time is ignored so the cycle time equals the interval time.

One purge timer can control multiple K-BARs. The blow-down tank recovery time between purge blasts (purge delay) is programmed with S2-3 and S2-4, as defined in Table 2-9. The LED D13 near TB11 turns ON when the timer is waiting to recharge the tank between probe blasts. Adjustment to the recovery time is accomplished via R12, but has a factory default.

Table 2-9. K-BAR 2000BP Recovery Time

Recovery Time (minutes)	S2-3	S2-4
2.0	Open	Open
4.0	Closed	Open
6.0	Closed	Closed

Purge Interval Settings

The interval between the last purge and the next sequence is set by the DIP switch S2 at locations 5 to 8 in a binary code, with each value worth 5 minutes. As shown in Table 2-10, 1 equals closed, and 0 equals open. Adjustment to the purge interval time is accomplished via R14 on the circuit board but has a factory default.

Table 2-10. K-BAR 2000BP Purge Interval Time

Recovery Time (minutes)	S2-5 (5)	S2-6 (10)	S2-7 (20)	S2-8 (40)
5	1	0	0	0
10	0	1	0	0
15	1	1	0	0
20	0	0	1	0
25	1	0	1	0
30	0	1	1	0
35	1	1	1	0
40	0	0	0	1
45	1	0	0	1
50	0	1	0	1
55	1	1	0	1

Table 2-10. K-BAR 2000BP Purge Interval Time (continued)

Recovery Time (minutes)	S2-5 (5)	S2-6 (10)	S2-7 (20)	S2-8 (40)
60	0	0	1	1
65	1	0	1	1
70	0	1	1	1
75	1	1	1	1

Refer to the *B-Series Flow Meter Operations Guide* for information about setting the data hold time during a purge (blast pulse width) and the recovery time between purges.

Purge Bar Settings

You can set from 0 to 8 K-BARs per timer cycle. S1 selects the last K-BAR connected with a one-to-one selection. THe timer will not operate properly if you select more than one switch position; you must select only one switch position.

Remote Purge

The purge sequence can be remotely started by closing the two contacts at TB11, pins 1 and 2. This is a 24 VDC control signal. If an external start is preferred to the internal interval timer, then the W1 shunt can be installed to disable the internal interval timer. Once the sequence is started, the number of K-BARs and recovery time are still applicable.

Acknowledgement Output Signal

An open collector output (24 VDC max, 30 mA max) can be used for signalling a purge operation to the customer equipment (such as PLC). This output is on TB12-1 and TB12-2, with -1 being the collector and –2 being a ground. Selecting the optional W3 shunt aligns the output with the purge start trigger to the K-BARs. For example:

- To set the seconds duration, W3-1 is jumpered (shunted) to W3-2, which gives a purge trigger signal that goes low for each closure on TB12-1. With a four probe application, there would be an open collector low signal when each probe is cleaned. This pulse is at least 0.5 s but less than 2.0.
- To set the minutes duration, W3-2 is jumpered (shunted) to W3-3, which gives the interval-done or sequence started. The output (TB12-1) goes low until the last K-BAR purge trigger is given. With a four K-BAR application, there would be an open collector low signal that stays low for the entire sequence of cleaning each probe. This could take several minutes depending on the number of bars and recovery time settings. No signal is generated at the purge acknowledgement output (TB12-1 terminal) when the W3 jumper (shunt) is not installed.

Analog Output Configuration & Wiring

This section provides information about the analog output configuration and wiring.

Loop Powered Wiring

The 4-20 mA linear output is a loop powered isolated signal. The positive output terminal is diode protected against reverse voltage. The principle wiring diagrams for these are shown in Appendix A, Drawings & Diagrams.

Self-Powered Wiring

The output may be self-powered in the nonisolated mode by jumpering +24 VDC to one of the two positive 4-20 mA terminals. Then the 4-20 mA output is taken from the negative 4-20 mA terminal to ground. A simplified AO wiring drawing or this mode of operation is shown in Appendix A, Drawings & Diagrams. To use it in the nonisolated mode, the receiving current (PLC or DCS) should be sensed with an isolated input to avoid ground loop currents.

AO Capabilities

The 4-20 mA circuit has an 11 VDC compliance at the full 20 mA current. On a 24 VDC 4-20 mA circuit, at least 11 VDC will be dropped across the 4-20 mA output, the balance on the load resistor, and wiring. For example, with a 250 ohm load, at 20 mA the voltage drop will be 5 V on the load resistor, 19 V across the 4-20 mA output or AO terminals. With higher voltage supplies, there is a correspondingly higher load resistance available. As a loop-powered 4-20 mA output and a 24 VDC power supply, it can drive 600 ohm and still support the 21 mA NE-43 alarm. Do not exceed 36 VDC on the loop-powered interface or there can be leakage current from the protective MOVs causing an error in the measurement. A loop-powered configuration places a customer provided DC power source, the B-Series output, and load resistance all in series.

NE-43 Alarm

Support for the 4-20 mA signal is provided by clipping normal operation between 3.8 and 20.5 mA. Meter faults are indicated with either a low or high alarm on the 4-20 mA output. See Chapter 5, Troubleshooting, for more information.

HART

The HART version of the sensor control board can be ordered with up to two 4-20 mA (AO) signals. The HART communication is provided through channel 1 (AO1). See the Kurz *HART Interface Guide* for full list of HART commands. The DD for this device is usually all you need as it is self documented. The DD user interface is typically used on a handheld communicator, but is also available for a HART Master running on a computer.

For the K-BAR multipoint system, the individual sensor electronics boards can interface with a HART handheld computer to monitor the sensor's dynamic and status information, initiate a zero-span check, view diagnostic data, or initiate a purge cleaning cycle. HART should not be used to change an individual sensor's analog output scale or velocity; these settings must match the Series 155 Mass Flow Computer settings. The Series 255 Flow Averaging Transmitter does not require matching the sensor's setup because its communication is digital through the RS-485 Modbus connection.

Clip-on Ferrite for Signal Wires

All I/O connections, 24 VDC, Modbus, analog outputs, or analog inputs (4-20 mA) must be clipped into a ferrite (as shown in the Figure 2-17 example) to meet EMC specifications. The only exception is if the I/O wiring is in a multi-conductor braided shield cable with peripheral bonded termination or solid conduit (ridged or EMT).

Note Liquid tight flex does not provide shielding.

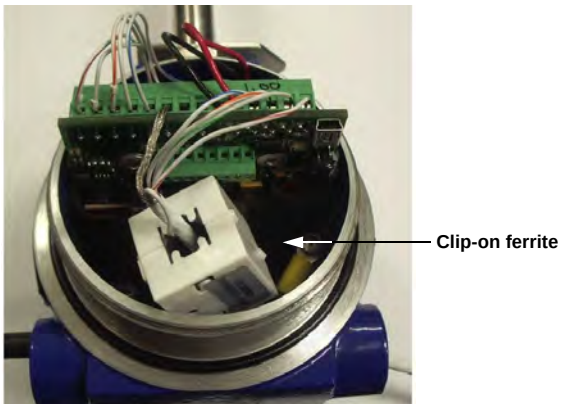


Figure 2-17. Clip-on ferrite for I/O wires

One ferrite kit ships with each meter. Additional ferrites are available from Kurz and a variety of distributors. Contact your Kurz representative for additional information.

Alarms

The two optically coupled solid state relays (SSR) can be used for most any flow logic, sensor error output, or totalizer mode pulses. Each SSR is rated for 0.5 A, 24 V AC/DC. As with the other I/O terminals, there are 48 V MOVs for surge protection on this device. Do not exceed 36 V to ground or a leakage will occur. Additionally, the MOV can overheat and become damaged, leading to its failure during a short circuit. See the wiring diagram in Appendix A, Drawings & Diagrams, for the specific alarm terminals.

Serial Communications

There are two independent serial ports on the B-Series.

- Mini-B USB port
- RS-485 port

After installing the Kurz USB driver, the USB connection can act as a COM port for remote terminal operations. After installing the KzComm application, you can view data, set/upload/download the meter configuration, and extract diagnostic data from either the USB or Modbus connection. The RS-485 port can be used for the Modbus protocol and multipoint communications so that you can have access to multiple meters from one location (for example, an office or control room).

For additional information about using the USB port and KzComm, refer to “Communications Requirements” in Chapter 1 and the *KzComm User Guide*.

USB

Accessing your flow meter via a USB port requires installing the Kurz or FTDI USB driver on the Windows computer. Both drivers are available on the Kurz customer CD. Once the USB driver is installed, you can use KzComm or a terminal emulator program to access B-Series information. Kurz recommends Tera Term, which works on all supported Windows platforms (Windows 95 to Windows 8).

The serial port settings for the terminal emulator are:

- Port number - same as the flow meter (the default is 1)
- Baud rate - 9600
- Data bits - 8
- Stop bits - 1
- Parity - no
- Flow control - no

For additional information about using the USB port, KzComm, and terminal emulators, refer to “Communications Requirements” in Chapter 1 and the *KzComm User Guide*.

RS-485/Modbus

Computers interface to RS-485 devices using a USB to RS-485 adapter. The RS-485 interface is half-duplex and supports 9600, 14400, 19200, 38400, and 57600 baud rates. Wiring is a shielded twisted pair (two signal lines and one shield connection). The signal lines can be connected in any order provided the RS-485 bus is biased so the flow meter can identify the positive signal (refer to Appendix A, Drawings & Diagrams). A junction tee between the network bus and instrument drop is recommended so devices can be removed for service without interrupting the network bus.

The USB to RS-485 adapter is optically isolated, has a screw terminal interface with metal enclosure and status LEDs, and uses a biased bus for auto-polarity detection. A USB to RS-485 adapter is available from Kurz. Contact your Kurz representative for additional information.

The Modbus interface must be set for the device address, protocol, baud rate, and byte order. Once properly connected and configured, an LED typically flashes when receiving activity and another LED flashes for transmitting or responding to the flow transmitter. B-Series devices also include two red LEDs, which indicate data transmission between the flow transmitter and the Modbus master by flashing intermittently. The full protocol specification and register variable map is found in Chapter 3, Communications Protocols.

For K-BARs using Modbus communication, the following example has 16 sensors that are divided into two independent power and RS-485 networks. This configuration is designed so a single wiring fault does not disable the whole process measurement. See the *Series 255 Flow Averaging Transmitter Hardware Guide* for best practices when using this Modbus centric device for reliable wiring installations.

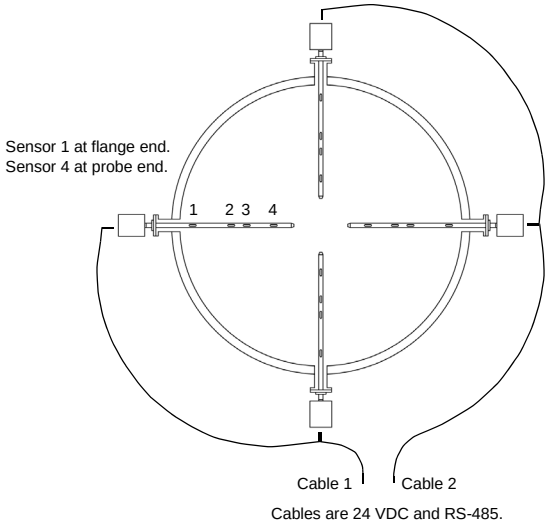


Figure 2-18. K-BAR example using Modbus communication

Flex Wiring Connection for Sensor Inspections

The sensor electrical connections should include extra length for all cables or flex conduits for supporting system maintenance. The extra length allows you to remove the sensor from the process without disconnecting the wiring. The transmitter attached (TA) versions have power and 4-20 mA wires routed out and use standard electrical wring practice as shown in Figure 2-19.

Figure 2-19. Flex sensor connection for service loop, TA version using liquid tight conduit

To meet EMC requirements on the wiring using a TS configuration, an approved shielding method must be used. Refer to "5-Wire Sensor Connections" on page 2-31 for additional information. The approved EMC tight flexible, electrical shield for the TS 5-wire sensor wiring include:

- Braided reinforced pneumatic hose, hydraulic line hose
- Corrugated stainless steel tubing with compression fitting at each end (gas appliance flex fittings may be long enough)
- Braided shielded cable with peripheral bonded shield cable glands

Figure 2-20 shows an example of each of the EMC shielding.

Metal braid hydraulic lines

Corrugated gas appliance line

Braided shielded cable

Figure 2-20. Cable and lines applicable to EMC shielding of 5-wire sensor connections

Important ***Do not use standard liquid tight flex conduit for 5-wire sensor connections. EMC shielding is not effective.***

5-Wire Sensor Connections

For the TS version you must field install the wiring between the sensor and its electronics enclosures. Refer to the field wiring diagrams in Appendix A, Drawings & Diagrams, for the TS wiring diagrams. For this 5-wire connection, use quality wire with a wire resistance less than 1 Ω per wire. Each wire must be matched within 0.01 Ω (10 mΩ) for the lead length compensation to work properly and for the factory calibration and temperature compensation to hold in the field.

If the individual wires do not meet the matching specification, the length must be trimmed or extended until matches. The terminal strip for the sensor wire will accept up to 12 AWG (2.05 mm) wire size, which is effective for up to 630 feet (192 m) between the sensor and electronics. The electronics terminal block TB1 is rated for up to 14 AWG (1.63 mm) wire size.

The 5-wire connection must have the required shielding to maintain the CE EMC compliance of the product in the TS configuration. This can be done with rigid conduit, EMT, or a braided shielded multi-conductor cable between the sensor junction box and the sensor electronics enclosures. Sealing the conduit directly to the enclosures is required to meet the explosion-proof ratings. However, using a peripherally bonded shielded cable gland or simple cable gland-and-shield pigtail ground connection is acceptable. Contact your Kurz representative for hardware accessories information with an Ex d safety rating.

Figure 2-21. Cable gland example with braided shielded cable

Table 2-11 lists the cable and conduit that cannot be used for a TS configuration.

Table 2-11. Cable and Conduit Connection Comparison

Type	Reason not to use it
Unshielded twisted Pair (UTP)	No shielding.
Armor cable	Spiral wrap armor wires are not an EMC shield. Looks like an inductor at RF frequencies.
Flex conduit	Spiral wrap shell is not an EMI shield.
Liquid tight conduit	Better shield than flex conduit but will not hold up well over time due to oxidation of the metal wrap joints that degrade the EMC shield.

Chapter 3

Communications Protocols

Overview

B-Series Mass Flow Transmitters have several methods for data communications using an RS-485 interface or Profibus DP. They are available on the B-Series firmware version 1.x or later. The available communication methods are:

- Remote terminal
- Data logging
- Modbus protocol, ASCII and RTU
- HART (v7 FSK) (refer to the *HART Reference Guide*)
- Profibus DP (refer to Chapter 4, Profibus DP)
- Foundation Fieldbus (refer to Chapter 5, Foundation Fieldbus)

Remote Terminal & Data Logging

Remote terminal and data logging use the same USB serial port so only one method can be used at time. Communication via the USB connection requires the Kurz or FTDI USB driver to facilitate communication between the flow meter transmitter and a computer.

- Remote terminal communication is provided through RS-232 via a standard USB connector on the sensor control board. Once configured, remote terminal communication allows you to configure a B-Series flow meter and upload/download configuration files using KzComm or a terminal emulator program. Refer to the *KzComm User Guide* for parameter settings and configuration information related to KzComm and terminal emulators.
- Data logging output is in a comma separated value (CSV) format so it can be imported into a spreadsheet program. Data logging can be setup for periodic time intervals.

Terminal echo should be turned OFF to prevent active display data from transmitting with logged data. However, terminal echo must be ON to use the computer keyboard for navigating the flow meter's onboard menu system.

Setting Up Remote Terminal Communications

To use the serial interface, connect the flow meter to a computer via a standard USB cable. The cable is a USB type-A male to USB type mini-b male.

The USB port on the flow meter is accessed by removing the enclosure lid on the backside of the meter, as shown in Figure 3-1. Once connected, the flow meter must be turned on to establish communication with KzComm or a terminal emulation program before you can access the communications parameters.

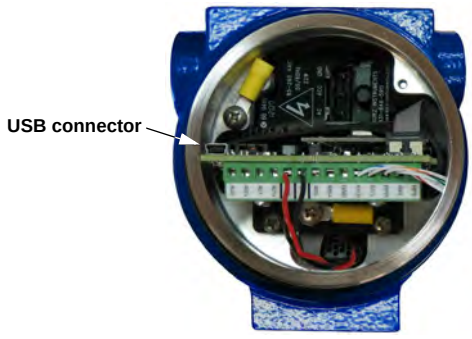


Figure 3-1. B-Series USB Connector

Any terminal emulation program can be used as a remote terminal interface to the B-Series. Tera Term (4.62 or higher) is available on the Kurz customer CD and on the Kurz website. It supports Xmodem for transferring B-Series configuration files and must be set for 9600 baud.

The computer keys used to navigate the flow meter's menu system are the lowercase equivalent of the flow meter keypad. Table 3-1 describes the keyboard keys that are equivalent to the flow meter keypad.

Table 3-1. Keyboard-Keypad Equivalent Keys

Computer Keyboard	Flow Meter Keypad	Function
p	**P**	A lowercase P invokes Program mode. An access code is required. During data entry it allows you to skip over a field without entering anything.
d	**D**	A lowercase D invokes DIsplay mode. No access code is required.
l	**L**	A lowercase L invokes Log mode. No access code is required.
<Enter>	**E**	Pressing <Enter> invokes Extended Utilities mode. An access code is required. During data entry it accepts the data.
c	**C**	During data entry, a lowercase C clears the value. It also acknowledges an active system fault.
h	**H**	A lowercase H returns to Run mode or backs out of a menu.
+		The plus key (+) toggles terminal echo On or Off.
^	**^/ Yes**	Pressing Shift-6 scrolls forward in a selection list.
v	**v / No**	A lowercase V scrolls backward in a selection list.
–	**–**	A hyphen or minus key is used for numeric and text data.
.	**●**	A period or decimal is used in floating point and text data.
0-9	**0-9**	Number keys are used for numeric data and access codes.

Refer to the *KzComm User Guide* for information about using KzComm or a terminal emulator.

Modbus

Important ***Do not connect a B-Series device to a Modbus network until it is properly configured.***

Modbus is a network communication protocol that communicates using a master-slave technique, in which one master device initiates transactions or queries to slave devices. The slave devices supply the requested data to the master or perform the action requested in the query.

Modbus RTU is the default communication protocol, although Modbus ASCII is available. The B-Series can only communicate as a slave device to a master device.

RS-485 can be used via the Modbus protocol to communicate with B-Series devices, but RS-485 must be configured as half-duplex in a point-to-point or multi-drop network. When used in a multi-drop network, each slave device must have a unique device address within the network. The individual slave device address can be assigned in the range of 1 to247.

For Modbus serial RTU, the COM port numbers and available COM port options are based on hardware and software configuration. You must use a USB-to-RS-485 converter to communicate via Modbus. A communications port option appears only when there is a physical port or a hardware device is attached to the computer and a device driver identifies it as a COM port. Refer to your converter documentation for COM port identification information. See “Identifying the COM Port” for additional information.

Identifying the COM Port

If the drop-down list for the COM Port field does not provide an identifiable name, open Windows Device Manager. You can do this by using one of the following methods:

- Select **Control Panel→Device Manager**.
- Open the Windows Computer Management window and click **Device Manager**.
- For Windows XP, choose **Start→Run**, typing **devmgmt.msc** in the Open field of the Run dialog box, and press **Enter**.
- For Windows 7 and Windows 8, choose **Start** and type **Device Manager** in the search field. You can select it when it appears as an option.

In the Device Manager window:

1> Expand **Ports (COM & LPT)**.

If you installed the Kurz USB driver and a B-Series device with a barcode lower than C51938 is currently connected, it will be labeled as **Kurz USB-HID -> COM device**.

If you installed the FTDI USB driver and a B-Series device with a barcode C51938 or higher is currently connected, it will be labeled as **USB Serial Port (COM#)**.

If a USB-to-RS-485 adapter is used, its name may reference the manufacturer.

2> To verify the port number, unplug the USB connector, and then plug it back in.

The COM port entry that disappears and reappears is the port used for the Kurz device.

Configuring a Terminal Emulator

When you are using a terminal emulator, the flow meter must be turned on and connected to the computer. The following example uses Tera Term.

1> Double-click the **Tera Term** icon.

The New Connection dialog box appears.

2> Select the **Serial** radio button.

3> In the **Port** drop-down field, select the COM port associated with either the Kurz USB driver or the FTDI driver.

Tera Term automatically configures the COM port based on the Windows Device Manager setting for the COM port. If garbage characters appear in Tera Term window, the communication parameters must be corrected.

4> Select **Setup→Serial Port**.

The Serial Port Setup dialog box appears.

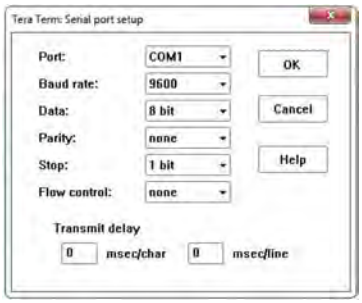


Figure 3-2. Tera Term serial port setup

5> Set the parameters as follows and then click **OK**:

- Baud rate – 9600
- Data bits – 8
- Parity – none
- Stop bits – 1
- Flow control – none

6> If garbage characters continue to appear, select **Control→Reset Port**.

When synchronized communication is established, the Tera Term window will echo all the information appearing on the B-Series display.

Note Terminal echo must be ON for using the computer keyboard to emulate the B-Series keypad. Terminal echo should be OFF if you are accessing the log files.

Disconnecting a Terminal Emulator

It is common to incorrectly exit a terminal emulator, improperly disconnect a flow meter from a computer, or simply power-down a flow meter while it is actively communicating with a computer. Resetting the communications port typically corrects the communications problem between the computer and its COM port.

Important ***Always exit/close a terminal emulator before disconnecting or powering down a flow meter.***

For example, to reset the port in Tera Term, select **Control→Reset Port**.

B-Series ASCII Commands

Using a terminal emulation program (or custom host program) and a USB connection to a B-Series device, you can access B-Series data using ASCII commands. The format of the ASCII command is:

<ESC>[command]<CR>

where:

<ESC> is the escape character 0x1B or **ESC** key

[command] is one of the commands listed in the Table below

<CR> is the carriage return character 0x0D or **Enter** key

The ASCII commands should be used while the flow meter is in Run mode. Response values are sent as printable ASCII characters terminated by a carriage return <CR> string and a new line <NL> string. Some ASCII commands initiate an XMODEM send or receive to transfer blocks of data between the computer and the flow meter.

Table 3-2 lists the supported ASCII commands. Note that the computer commands are case-sensitive and must be in lowercase as shown. These commands are only available in firmware versions 1.05 and newer.

Table 3-2. ASCII Commands

ASCII Command	Description
download	Download a configuration file from the computer to the B-Series device; this command initiates an XMODEM send.
qai1	Query the flow meter external analog input information. The format is in a comma-separated value format based on the external input usage: current (mA) *or* current, current units, engineering scaled value, engineering units
qalarm	Query the alarm status as an unsigned integer.
qao1	Query the analog output channel #1 as a floating point value.
qao2	Query the analog output channel #2 as a floating point value.
qerror	Query a meter event code as a HEX value with 8 characters.
qflow	Query the flow rate as a floating point value (*xxxx.xx*).
qfunit	Query the flow units (a string up to 4 characters).
qmeter1	Query the flow meter flow data information. The format is in a comma-separated value format: flow meter ID, runtime (hrs), flowrate, MUNIT, totalizer, TOTUNIT, elapsed time (min), velocity, VUNIT, ref. density, density unit, flow area, Area unit, correction factor, PRP or IRP, PRP/IRP value, PRP/IRP units, raw flow or velocity, raw flow or velocity unit
qmeterid	Query the flow meter tag name (a string up to 13 characters).
qrpcurrent	Query the Rp current as a floating point value.
qrppower	Query the Rp power as a floating point value.
qrpres	Query the Rp resistance as a floating point value.
qrptemp	Query the Rp temperature as a floating point value.
qrtcres	Query the Rtc resistance as a floating point value.
qruntime	Query the run-time counter as an integer value.
qsnumber	Query the flow meter serial number (a string up to 10 characters).
qtemp	Query the temperature as a floating point value.
qvel	Query the velocity as a floating point value.
upload	Upload the configuration file from the B-Series device to the computer; this command initiates an XMODEM receive.

For example, to see the velocity for the current moment you would type:

<ESC>qvel<CR> followed by the response **1000.00**

Upload and Download Commands

The Upload command allows you to backup the configuration file associated with a flow meter onto a computer. You should backup the original configuration files for all flow meters in the event the configuration becomes corrupted. The Download command allows you send a configuration file to flow meter.

Uploading or Backing Up a Configuration File

Using a terminal emulator, the Upload ASCII command initiates an XMODEM file transfer to copy/backup the flow meter configuration file, as shown in the following Tera Term example:

1> Turn terminal echo Off.

2> Type the following: **<ESC>upload<CR>**

The B-Series flow meter responds with a prompt to initiate an XMODEM file transfer:

>MFT-B Ready to Transmit File

>XMODEM Receive File from MFT-B

3> Select **Transfer→XMODEM→Receive**.

4> Choose the file location and type a filename for the flow meter configuration file.

The filename should indicate the specific flow meter (such as the tag name) and end with the CF extension (for example, digester01.cf).

An indicator shows the information is being received.

5> Click **Cancel** when you want to stop receiving data.

Downloading or Updating a Configuration File

Using a terminal emulator, the Download ASCII commands initiate an XMODEM file transfer to send/update the flow meter a configuration file, as shown in the following Tera Term example:

1> Turn terminal echo Off.

2> Type the following: **<ESC>download<CR>**

The B-Series flow meter responds with a prompt to initiate an XMODEM file transfer:

>MFT-B Ready to Receive File

>XMODEM Transmit File to MFT-B

3> Select **Transfer→XMODEM→Send**.

4> Choose the file location and filename for the flow meter configuration file.

The filename should indicate the specific flow meter (such as the tag name) and end with the CF extension (for example, digester01.cf). Each flow meter is individually calibrated. Using the incorrect configuration file could cause flow reading errors.

An indicator shows the information is being sent.

5> Click **Cancel** when you want to stop receiving data.

Note If the command times out and Xmodem cannot successfully send the file, try again.

Refer to the *KzComm User Guide* for information about using the KzComm upload/download function.

Setting Flow Meter Modbus Connectivity

For Modbus TCP/IP, enter the IP address of the Modbus TCP/IP device and the Modbus address of the device with which to communicate, as shown in Table 3-3.

Table 3-3. Modbus Communication Parameters

Modbus RTU Communication Parameters	Modbus ASCII Communication Parameters
Baud rate — 38400 default (9600-57600)	Baud rate — 38400 default (9600-57600)
Data bits — 8	Data bits — 7
Parity — None	Parity — None
Stop bits — 1	Stop bits — 2
Flow control — None	Flow control — None
Default address — 1	Default address — 1

To access the Modbus Communications menu in Program mode:

1> Press **P**.

2> Enter your password (the default is **654321**), and then press **E**.

3> Press **2** to invoke the Quick Jump option.

4> Press **19** for the Modbus Communication Setup menu, and then press **E**.

The menu prompts you for the flow meter device address.

```
DEV MODBUS ADDR
>1
```

The address can be in the from 1 to 247. The default address is **1**.

5> Press the numeric keys to enter the device address, and press then **E**.

The menu prompts you for the Modbus mode.

```
MODBUS MODE
>MODBUS ASCII ^v
```

The Modbus mode defines whether the master/slave device will communicate using the Modbus ASCII or Modbus RTU protocol. **Modbus RTU** is the default.

> **Note** The B-Series Modbus setup for ASCII transmission framing is not supported by KzComm. If KzComm is to be used over Modbus, RTU transmission framing must be used.

6> Use the arrow keys to select either Modbus ASCII or Modbus RTU, and then press **E**.

The menu prompts you for the data transmission (baud) rate.

```
MODBUS BAUD RATE
>9600 BPS ^v
```

Slower rates (9600) are commonly used for longer distances between the device and the computer, while faster rates (57600) are for much shorter distances. The rates are 9600, 14400, 19200, 38400, and 57600. The default is 9600 BPS.

7> Use the arrow keys to select a data speed, and then press **E**.

The menu prompts you for the byte order of the Modbus registers.

```
REGISTER ORDER
>BYTE #12 34 ^v
```

This parameter ensures the Modbus Master correctly interprets the floating point data from the Modbus registers. There two options indicate the order of the Modbus registers when two registers are used for a device parameter.

- **BYTE #1 2 3 4** (the default) means that the low order byte is sent first, followed by the high order byte.
- BYTE # 3 4 1 2 means that the high order byte is sent first, followed by the low order byte.

8> Use the arrow keys to select a byte order, and then press **E**.

9> Press **E** or **P** to exit the Modbus Communication Setup menu.

> **Note** If an issue occurs with reading floating point numbers, try changing the Register Order parameter.

Modbus Commands and Registers

The B-Series firmware version 1.00 and later support reading and writing coils and registers. Firmware version 1.03 and later support device identification.

- Coils are represented by a single bit.
- A register is defined as a 16-bit storage of data.

A 16-bit integer number occupies one register, 32-bit floating point numbers occupy two registers, and two 8-bit ASCII characters are stored in one register. Registers with ASCII characters are represented as a character array and need to be terminated with a null character (0x00). The B-Series support using Function 04 – Read Input Registers.

Modbus functions operate on memory mapped to registers. As shown in Table 3-4, Modbus registers are organized into the following reference types identified by the leading number of the reference address:

- The “x” following the leading character represents a four-digit address location in memory. The leading character is generally implied by the function code and omitted from the address specifier for a given function. The leading character also identifies the I/O data type.
- The on/off state of discrete inputs and outputs is represented by a 1 or 0 value assigned to an individual bit in the 16-bit data word. With respect to mapping, the Least Significant Bit (LSB) of the word maps to the lowest numbered coil of a group and coil numbers increase sequentially as you move towards the Most Significant Bit (MSB). Unused bits are set to zero.

Table 3-4. Modbus Register Reference Types

Modbus Register Reference Address	Description
0xxxx	**Read/write discrete output or coils.** A 0x reference address is used to drive output data to a digital output channel.
1xxxx	**Read discrete inputs.** The on/off state of a 1x reference is controlled by the corresponding digital input.
3xxxx	**Read input registers.** A 3x reference register contains a 16-bit number received from an external source (for example, an analog signal).
4xxxx	**Read/write output or holding registers.** A 4x register is used to store 16-bits of numerical data (binary or decimal) or to send data from the CPU to an output channel.

Table 3-5 through Table 3-9 provide details of the Modbus registers.

Table 3-5. Coil Reference 0xxxx – Function 0x05 Write Single Coil, Function 0x01 Read Coils

Coil #	Description	Hex
0	Start zero drift check.	000
1	Start mid-span drift check.	001
2	Start span drift check.	002
3	Start drift check cycle.	003
4	Abort on-going drift check.	004
5	Reserved.	005
6	Save working configuration to EEPROM	006
7	Reserved.	007
8	Start purge (requires Purge option).	008
9	Reset device totalizer	009

Table 3-6. Coil Reference 1xxxx – Function 0x02 Read Discrete Inputs Only

Coil #	Description	Hex
0	Zero drift check started.	000
1	Mid-span check started.	001
2	Span check started.	002
3	Drift check cycle started.	003
4-7	Reserved.	004-007
8	Purge cycle started.	008
9-15	Reserved.	009
16	RP resistance above high limit (error).	010
17	RP resistance below low limit (error).	011
18	RTC resistance above high limit (error).	012
19	RTC resistance below low limit (error).	013
20	Wire loop resistance above high limit (error).	014
21	RPS sensor lead open circuit (error).	015
22	High sensor or wire leakage (error).	016
23	Flow rate above design limit (error).	017
24	Meter kick-out high (error).	018
25	Meter kick-out low (error).	019
26	ADC failed to convert measurement (error).	01A

Table 3-6. Coil Reference 1xxxx – Function 0x02 Read Discrete Inputs Only (continued)

Coil #	Description	Hex
27	Sensor control drive stopped responding (error).	01B
28	Sensor over-voltage crowbar engaged (error).	01C
29	Sensor type does not match configuration (error).	01D
30	Abnormal sensor node voltages (error).	01E
31	Unable to write configuration file to EEPROM (error).	01F
32	Sensor type does not match board build (error).	-
33	External analog input out of range.	-
44	Communication subsystem not responding (HART / Profibus)	
45	Sensor leakage warning, S-Gnd below 100k (firmware v1.10+, up to 600°C).	027
46	Logging power on event (firmware v1.20 and higher).	028
47	Logging change made to the configuration event (firmware v1.20+).	029
48	Alarm 1 triggered (firmware v1.05+).	030
49	Alarm 2 triggered (firmware v1.05+).	031

Table 3-7. Coil Reference 3xxxx – Function 0x04 Read Input Registers Only

Register #	Description	Hex	Data Type C-Compilers
0-1	Flow rate.	000	Float
2-3	Velocity.	002	Float
4-5	Temperature.	004	Float
6-7	Total flow.	006	Float
8-9	Elapsed time.	008	Float
10-11	Flow rate correction factor (total).	00A	Float
12-13	Temperature correction factor (total).	00C	Float
14-15	Density.	00E	Float
16-20	Serial number (10, 8-bit ASCII characters, last must be null).	010	ASCII (char)
21-23	Velocity unit.	015	ASCII (char)
24-26	Flow rate unit.	018	ASCII (char)
27-29	Total flow unit.	01B	ASCII (char)
30-32	Temperature unit.	01E	ASCII (char)
33-34	Filtered sensor Rp current (IRP).	021	Float
35-36	Filtered sensor Rp power (PRP).	023	Float
37-38	Electronic temperature	025	Float
The following registers result from the zero-mid-span drift check.			

Table 3-7. Coil Reference 3xxxx – Function 0x04 Read Input Registers Only (continued)

Register #	Description	Hex	Data Type C-Compilers
39-40	Voltage input for zero drift check.	027	Float
41-42	Voltage output for zero drift check.	029	Float
43-44	Percentage difference of the zero drift check.	02B	Float
45-46	Voltage input for mid drift check.	02D	Float
47-48	Voltage output for mid drift check.	02F	Float
49-50	Percentage difference of the mid drift check.	031	Float
51-52	Voltage input for span drift check.	033	Float
53-54	Voltage output for span drift check.	035	Float
55-56	Percentage difference of the span drift check.	037	Float
57-58	Current runtime counter (seconds) (firmware v1.05+).	039	Unsigned 32-bit integer
59-60	AO1 current (mA) (firmware v1.05+).	03B	Float
61-62	AO2 current (mA) (firmware v1.05+).	03D	Float

Table 3-8. Coil Reference 4xxxx – Function 0x03 Read Holding Registers, Function 0x06 Write Single Register

Register #	Description	Hex	Data Type C-Compilers
0-5	Reserved.	000-005	
6-7	Flow area.	006	Float
8-14	Flow meter ID (14, 8-bit ASCII characters, last must be null).	008	
15-21	Temperature meter ID (14, 8-bit ASCII characters, last must be null).	00F	
22-23	4-20mA analog output, #1, 4 mA scale.	016	Float
24-25	4-20mA analog output, #1, 20 mA scale.	018	Float
26-27	4-20mA analog output, #2, 4 mA scale.	01A	Float
28-29	4-20mA analog output, #2, 20 mA scale.	01C	Float
Purge Read and Write Data.			
30	Purge width (ms) (unsigned 16 bit integer).	01E	Unsigned integer
31	Purge hold mask (ms) (unsigned 16 bit integer).	01F	Unsigned integer
32	Purge interval (minutes) (unsigned 32 bit integer).	020	Unsigned 32-bit integer
Drift Check.			

Table 3-8. Coil Reference 4xxxx – Function 0x03 Read Holding Registers, Function 0x06 Write Single Register (continued)

Register #	Description	Hex	Data Type C-Compilers
34	Drift check zero scale value (%).	022	Float
36	Drift check mid scale value (%).	024	Float
38	Drift check span scale value (%).	026	Float
40	Drift check zero duration (sec) (unsigned 16 bit integer).	028	Unsigned integer
41	Drift check mid check duration (sec) (unsigned 16-bit integer).	029	Unsigned integer
42	Drift check span check duration (sec) (unsigned 16-bit integer).	02A	Unsigned integer
43	Drift check time interval (hours) (unsigned 16-bit integer).	02B	Unsigned integer
Flow PID.			
44-45	PID reference data.	02C	Float

Table 3-9. Function 43 (0x2B) – Encapsulated Interface Transport (Read Device Identification), MEI Type 14 (0x0E) – Modbus Encapsulated Interface (Read Device Identification)

Object ID	Object Name	Category	Requirement	Type
0x00	Vendor name	Basic	Mandatory	ASCII string
0x01	Product code	Basic	Mandatory	ASCII string
0x02	Major minor revision	Basic	Mandatory	ASCII string

Kurz Floating Point Data Formats

Kurz implements a straight binary mapping of the 32-bit floating point variables into the Modbus registers. The Kurz byte order is 1 2 3 4 (also known as Reverse-32). When viewing variables such as temperature and flow and the data does not appear correct, use another format for interpreting the data registers.

Modbus Biasing

A B-Series slave device automatically detects the polarity of its wiring and will correct a polarity error in wiring; however, it requires a biased bus for this functionality to work properly. Refer to the wiring diagrams in Appendix A, Drawings & Diagrams, for additional information.

Modbus ASCII Compatibility Issues

The B-Series Modbus setup for ASCII transmission framing is not supported by KzComm. If KzComm is to be used over Modbus, RTU transmission framing must be used.

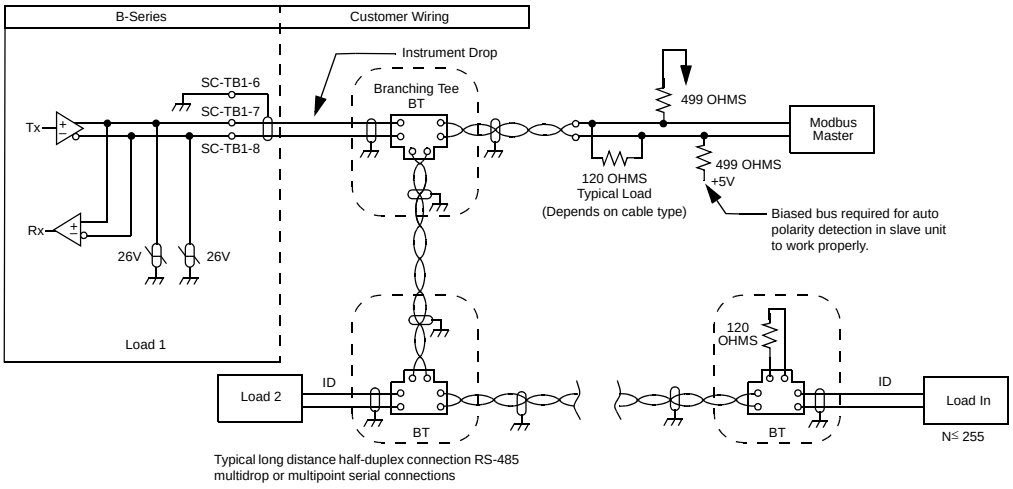


Figure 3-3. Modbus multipoint serial connections

The Modbus master issues a command with the slave responding. The RS-485 protocol stays in a listening state waiting for information to be received. As shown in Figure 3-4:

- The delay between asserting the RS-485 bus and the serial data is known as the lead time (t1-t0) or (t5-t4).
- The data packet length (t2-t1) or (t6-t5) depends on the message and the baud rate.
- The delay between the packet and release of the RS-485 bus is the lag time (t3-t2) or (t7-t6).
- The delay between the master and slave packets is the response time (t5-t2).

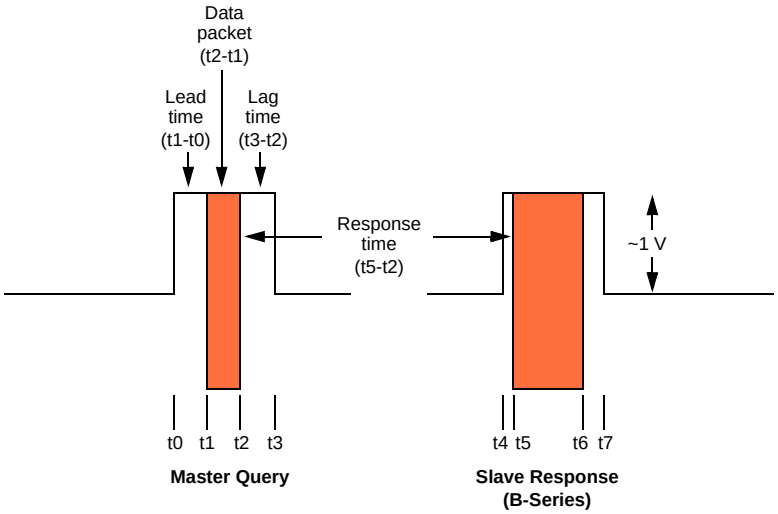


Figure 3-4. Half-duplex Modbus serial communications on an RS-485 bus

Many of the master devices have programmable parameters. Table 3-10 provides Kurz recommended settings.

Table 3-10. Modbus Master Device Settings

Modbus Master Parameter	Value
Lead time	184 us
Lag time	14 ms maximum If the master lag time is too long, the transmission will collide with the slave response and increase data transmission errors.
Response time	18 ms maximum
Baud rate	38.4 kbaud
Silent interval	35 ms
Timeout interval	100 ms
Number of retries	2
Framing	Remote Terminal Unit (RTU

Because of the lead-lag and response times, the B-Series is limited to approximately 15 transactions/sec at 38.4 kbaud. For large Kurz Multipoint Systems, this supports a 12-point duct measurement in less than one second.

A common limitation for Modbus devices is that the CPU supports multiple functions and is not always ready to respond to a command from the Modbus master. On a busy Modbus network, Kurz recommends polling a device address multiple times or bypassing an unresponsive address during a device scan. A network scan should not report device errors until a specific number of device requests are unanswered.

HART (v7 FSK)

The HART Physical Layer is based on the Bell 202 standard, using frequency shift keying (FSK) to communicate at 1200 bps. The signal frequencies representing bit values of 0 and 1 are 2200 and 1200Hz respectively. This signal is superimposed at a low level on the 4-to-20mA analog measurement signal without causing any interference with the analog signal.

The HART Data Link Layer defines a master-slave protocol - in normal use, a field device only replies when it is spoken to. There can be two masters, for example, a control system as a primary master and a handheld HART communicator as a secodary master. Timing rules define when each master may initiate a communication transaction. Up to 15 or more slave devices can be connected to a single multidrop cable pair.

The Network Layer provides routing, end-to-end security, and transport services. It manages sessions for end-to-end communication with correspondent devices.

The Data-Link Layer ensures communications are successfully propagated from one device to another. The Transport Layer can be used to ensure end-end communication is successful.

The Application Layer defines the commands, responses, data types and status reporting supported by the Protocol. In the Application Layer, the public commands of the protocol are divided into four major groups:

- Universal Commands - provide functions which must be implemented in all field devices
- Common Practice Commands - provide functions common to many, but not all field devices
- Device Specific Commands - provide functions that are unique to a particular field device and are specified by the device manufacturer
- Device Family Commands - provide a set of standardized functions for instruments with particular measurement types, allowing full generic access without using device-specific commands.

For more information, refer to the *HART Reference Guide*.

Profibus DP

PROFIBUS (Process Field Bus) is a standard for fieldbus communication in automation technology. Profibus has certain protocol features that let certain versions of it operate in multi-master mode on RS-485.

PROFIBUS DP (Decentralized Peripherals) is used to operate sensors and actuators via a centralized controller in production automation applications. In a PROFIBUS DP network, the controllers or process control systems are the masters and the sensors and actuators are the slaves.

PROFIBUS DP uses two core screened cable with a violet sheath, and runs at speeds between 9.6kbit/s and 12Mbit/s. A particular speed can be chosen for a network to give enough time for communication with all the devices present in the network. If systems change slowly, then lower communication speed is suitable. If the systems change quickly, then effective communication will happen through faster speed. The RS485 balanced transmission used in PROFIBUS DP only allows 126 devices to be connected at once; however, more devices can be connected or the network expanded with the use of hubs or repeaters.

For more information, refer to Chapter 4, Profibus DP.

Chapter 4

Profibus DP

Overview

This document provides the wiring/connection and setup/configuration of the Kurz B-Series flow meter when it is equipped with the PROFIBUS Communication option. It is intended as a supplement to the Kurz B-Series Quick Startup and Operations Guides.

PROFIBUS is an international standard for digital communication in industrial automation. Developed in Germany, PROFIBUS was established in 1989 as a national standard (DIN 19245). In 1996, the standard was then ratified as a European Standard (EN 50170) and later was adopted internationally as IEC 61158 and IEC 61784. PROFIBUS is based on a client/server architecture creating a hierarchy in a network by defining an active (master) and passive (slave) station. More detailed information about PROFIBUS can be obtained on the PROFIBUS organization website www.profibus.com.

All PROFIBUS devices within a PROFIBUS segment communicate via the same bus cable. Therefore, the installation of additional instruments to an existing field bus system is easy and requires only a small amount of electrical installation work.

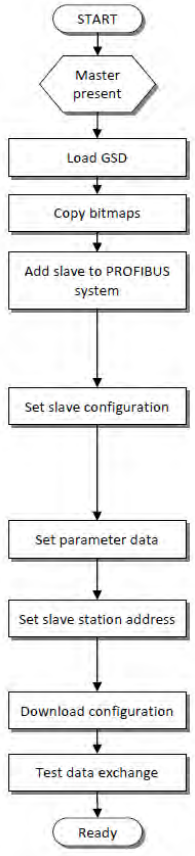
PROFIBUS delivers the measured process value in digital form. Therefore, the process value is transmitted accurately over the whole measurement range. The scaling of the process value with respect to an analogue signal is no longer needed. Since the device's data is identified by the device address no loop check is necessary.

B-Series Flow Meter Connection & Startup

The B-Series supports PROFIBUS-DP (Decentralized Periphery), which represents the majority of PROFIBUS-installed bases and features the optimum combination of data throughput, ease of installation and service, diagnostic capabilities, and error-free transmission. This option is dedicated to time-critical communication between automation systems with high-speed data communication – up to 12 Mbits/sec.

The B-Series PROFIBUS-DP flow meter includes an interface board using the Profichip VPC3 ASIC to handle the message and address identification, the data security sequences and the protocol processing for PROFIBUS-DP.

The following chart provides an overview of the steps to get a B-Series flow meter operational in your PROFIBUS network.



Make sure your master has been installed to the PROFIBUS system.

Load GSD and bitmap files into the configuration tool for the PROFIBUS Master.

Select and add the Kurz flow meter to the bus (with the PROFIBUS configuration tool).

Select the desired modules out of the available list of modules for the flow meter.
These modules are the variables (device measurements) that are available for cyclic reading by a PROFIBUS DP master. These values will be stacked into your master I/O memory. The data will be stacked in memory in the order that the modules are inserted.

These settings will be copied to the flow meter only at start-up.

The flow meter will be delivered to customers with address 126.
The station address should be set using the flow meter local display/ keypad.

Download all configuration settings into your master.

Generic Station Description

The Kurz B-Series flow meter is PROFIBUS ID number 0F99. This ID number identifies the GSD file for the device when it is added to the PROFIBUS network.

Each type of PROFIBUS DP instrument has its own GSD file with instrument specifications to tell the master configuration software which features the instrument offers to the PROFIBUS system. For the B-Series flow meter the file is called KZ_0F99.GSD. This file is provided in the customer CD shipped with each Kurz B-Series flow meter and can also be downloaded from the Kurz Instruments website.

The GSD file includes the following information:

- ID information — Model name
Vendor name
Identification number
Bitmap device name
Bitmap diagnostic name
Bitmap SF name
Revision numbers
- Hardware characteristics — VPC3+S ASIC
- Software characteristics — Supported features of PROFIBUS, such as Freeze, Sync, and Auto Baud Rate Detection
- Maximum bus data lengths — Size of data buffers
- Modules with cyclic data — Input/output variables for the instrumentation

After starting up your master configuration software, the GSD file should be loaded/imported/copied. This is needed only once, until a new revision of the GSD is released by the manufacturer of the device. The PROFIBUS communication features of the B-Series flow meter are described in the GSD file. The GSD file is needed by the PROFIBUS master configuration software to define the cyclic data that the flow meter will be transmitting.

PROFIBUS Cyclic Data Modules

The B-Series provides five modules that can be selected for cyclic input data transmission. The modules can be selected in any order, as described in Table 4-1.

Table 4-1. Cyclic Input Data Transmission Modules

Module #	Data	Number of Bytes
1	Process flow rate + status	5: 4 bytes floating point, 1 byte value qualifier
2	Process velocity + status	5: 4 bytes floating point, 1 byte value qualifier
3	Process temperature + status	5: 4 bytes floating point, 1 byte value qualifier
4	Totalized flow	4: 4 bytes floating point
5	Device status (Bitwise)	4: 4 bytes bitwise event code

Modules 1 through 3 include a value qualifier status byte. The status byte is an 8-bit indication of the current quality of the process measurement value provided by the module. The bit definitions are listed in Table 4-2.

Table 4-2. Bit Definitions

Bit #	Alarm Condition	Description
0	Failed	High severity Signal invalid due to malfunction in the device
1	Out of specification	Medium severity Permissible ambient or process conditions exceeded or the measuring uncertainty of sensors is probably greater than expected
2	Maintenance required	Low severity Although the signal is valid, a function will soon be restricted due to operational conditions
3	Check function	Signal temporarily invalid (for example, frozen) due to on-going work on the device

Slave Addressing

Before powering on the PROFIBUS network or powering on a new device added to the network, you have to assign a unique address to each of the devices/stations. PROFIBUS supports 128 different addresses, numbered 0 to 127. However, some of these addresses are reserved. It is best to follow your site specific slave addressing conventions.

The Kurz B-Series flow meter does not support the Change Station Address function. This means that the PROFIBUS slave address cannot be changed by the PROFIBUS Master. The Kurz B-Series will be delivered with PROFIBUS slave address 126. This address has been defined by the PROFIBUS organization to be available for installing new devices to the bus. The PROFIBUS slave address of the Kurz B-Series flow meter is set using its local keypad and display. The meter must be put into PROGRAM mode and the access code is entered to navigate to the PROFIBUS interface menu as describe below.

To change the default PROFIBUS slave address using the attached keypad:

1> Press **P**.

2> Enter the Advanced Access password, and then press **E**.

3> Press **2** to invoke the Quick Jump option.

4> Press **28** for the **PROFIBUS** menu, and then press **E**.

```
PROFIBUS ADDRESS
>1
```

The PROFIBUS Address prompt appears.

Note The address can be from 0 to 125, but site-specific addressing conventions should be followed.

5> Press the numeric keys to enter the device address, and then press **E**.

```
DP FIRMWARE REV.
VERSION 1
```

The current version of the B-Series PROFIBUS firmware appears. This is read only.

6> To change the value press **C** to clear all digits.

7> For each digit, press a number.

8> Press **E**, **C**, or **P** to return to the main Program mode prompt.

9> Press **H** to save the change to the EEPROM.

The address change will not take effect until the flow meter is power cycled.

PROFIBUS Data Rates

A PROFIBUS network runs at the data rate (also called “bit rate” or “baud rate”) specified in the PROFIBUS Master. Standard PROFIBUS data rates are:

- 9.6 kbits
- 19.2 kbits
- 93.75 kbits
- 187.5 kbits
- 500.0 kbits
- 1.5 Mbits
- 3.0 Mbits
- 6.0 Mbits
- 12.0 Mbits

B-Series flow meters support all of these data rates, and the flow meter automatically synchronizes the data rate with the PROFIBUS Master before entering data exchange. However, all devices on the PROFIBUS network must use the same data transmission rate.

Device Connection & Wiring

PROFIBUS is based on RS-485 communication. The PROFIBUS cable is a twisted-pair cable with a braided shield. The cable properties used for PROFIBUS DP networks and specified by IEC 61784-5-3 are:

Parameter	Specified limits
Impedance	135 to 165 Ohm with f=3 to 20 MHz
Operation capacity	$\leq$ 30 pF/m
Loop resistance	$\leq$ 110 Ohm/km
Wire gauge	> 0.64 mm
Conductor area	> 0.34 mm^2

The two wires are color coded (typically green and red), where one color (green) is used for the A- transmit/receive line and the second color (red) for the B+ transmit/receive line. It is important to consistently use the color-coded A and B lines throughout the network to ensure proper operation.

Important ***The shield of the PROFIBUS cable must be connected to ground at each slave device, and all slave devices must use a common ground (such as a ground rail) to ensure that cable shield current does not flow over the device.***

If the bus cable is daisy-chained (as shown in Figure 4-1), you can disconnect bus connectors from the PROFIBUS-DP interface at any time without interrupting traffic on the bus.

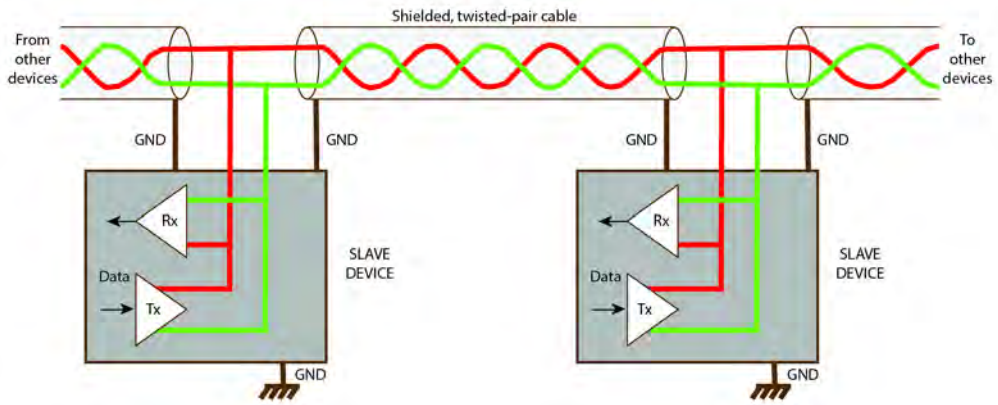


Figure 4-1. Grounding the PROFIBUS Cable

Maximum Cable Length

The maximum transmission distance (trunk line) that can be achieved using appropriate copper cables is directly related to the transmission speed chosen for the PROFIBUS DP network. As a result, these two variables should be considered together. The data transmission rate of PROFIBUS DP is between 9.6 kbits/s and 12 Mbits/s and must be identical for all segments of a PROFIBUS line. Table 4-3 shows the maximum possible transmission distances that can be reached when using copper cables. The specified cable length can be increased by the use of repeaters. A repeater divides the bus into bus segments.

Table 4-3. Transmission Rates and Transmission Distance

Data Transmission Rate (kbits/s)	Maximum Transmission Distance (m)
9.6	1200
19.2	1200
93.75	1200
187.5	1000
500.0	400
1500.0	200
3000.0	100
6000.0	100
12000.0	100

Note: Calculated for PROFIBUS cable type A at 30 pF/m using copper cables.

The minimal cable distance between two devices on the line is one meter. The PROFIBUS interface connection on the B-Series is located on the electronics board in the form of a 3-position terminal block. The terminals on the block are labeled GND, A(-), and B(+), as shown in Figure 4-2.

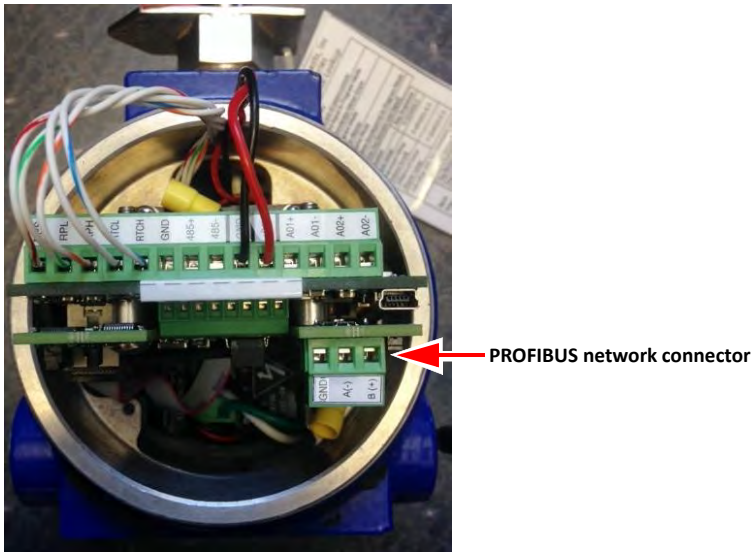


Figure 4-2. PROFIBUS Network Connector

Table 4-4 describes each of the connector positions and corresponding connection on the PROFIBUS network cable.

Table 4-4. B-Series Connector Positions

Signal	Description	Cable
GND	Digital ground	N/A
A-	Negative RS-485 RxD/TxD	Green
B+	Positive RS-485 RxD/TxD	Red
	Note: Shield to be grounded at chasis.	

Table 4-5 provides the connection information for standard PROFIBUS connectors to the B-Series flow meter terminal block for the DB-9 connector.

Table 4-5. B-Series Terminal Block to PROFIBUS DB-9 Connector

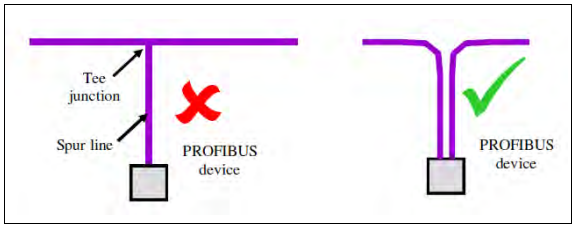
B-Series Terminal Block	PROFIBUS D-Sub	Description
GND	Not connected	Data ground
A-	Pin 8: –TxD/RxD	Data line minus (A line)
B+	Pin 3: +TxD/RxD	Data line plus (B line)

Table 4-6 provides the connection information for standard PROFIBUS connectors to the B-Series flow meter terminal block for the M12 connector.

Table 4-6. B-Series Terminal Block to PROFIBUS M12 Connector

B-Series Terminal Block	PROFIBUS D-Sub	Description
GND	Not connected	Data ground
A-	Pin 2: –TxD/RxD	Data line minus (A line)
B+	Pin 4: +TxD/RxD	Data line plus (B line)

When connecting devices to the PROFIBUS network, spur lines (also called “stub lines” or “drop lines”) should generally be avoided. The reason for this is that they introduce additional capacitance on the main trunk line where the spur tee junction is located. Each segment should ideally be connected as a single linear bus. That is, the cable should daisy chain from device to device, as shown in the following example.



Repeaters can be used to avoid spur lines, by isolating the branch cable that goes to a device. This is especially true for devices that have non-standard bus connectors.

Figure 4-3 shows one recommended wiring connection for the B-Series into the PROFIBUS network to avoid creating a spur line. In this method, two PROFIBUS cables are directly wired into the B-Series terminal block to create and continue the daisy chaining of devices in the network.

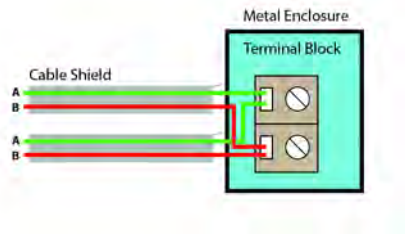


Figure 4-3. PROFIBUS Daisy Chain Connections for B-Series Flow Meters

A spur line in a PROFIBUS network is not an issue if the network bit rate is 1500 kBit/s or less. Refer to IEC 61158-2, section 22.1, for capacitance requirements.

Figure 4-4 shows a recommended wiring connection for the B-Series into the PROFIBUS network with a spur line.

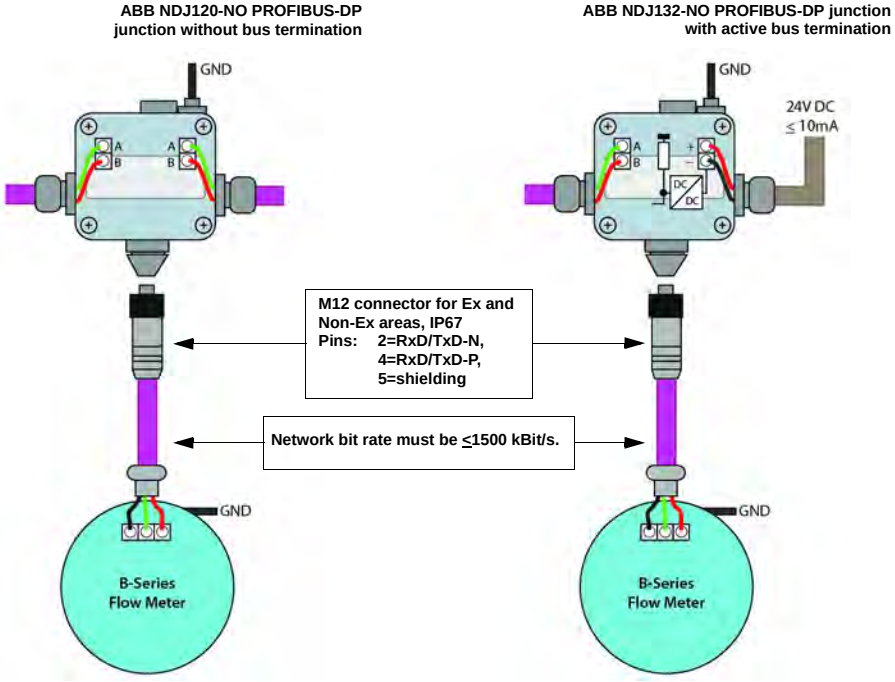
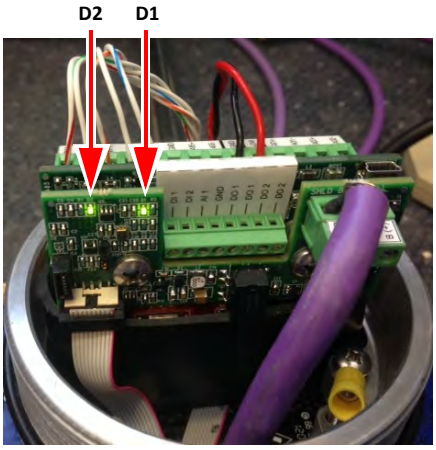


Figure 4-4. Recommended Wiring Connection with a Spur Line

LED Indicators

The Kurz PROFIBUS interface has two green LEDs (D1 and D2) mounted at the top of the PROFIBUS interface board that indicate the status of the PROFIBUS interface, as shown in Figure 4-5.

- D1 is connected to the supply voltage of the PROFIBUS module and lights when the PROFIBUS module receives power from the flow meter sensor control board.
- D2 is controlled by the PROFIBUS ASIC and lights when the PROFIBUS device is in a Data Exchange state.



D1 LED: Power

D2 LED: Data Exchange Active

Figure 4-5. B-Series PROFIBUS Indicators

Measurement Units

After data exchange between the PROFIBUS Master and the B-Series flow meter is established, confirm that the flow measurement units match. The PROFIBUS Master's flow measurement units must match the flow meter measurement units.

Display mode allows view-only access to the meter configuration and parameter settings.
To view the flow meter units within Basic Setup menu of Display mode:

1> Press **D**.

2> Press **2** to invoke the Quick Jump option.

3> Press **1** for the Basic Setup menu, and then press **E**.

4> Press **P** until you see the FLOW UNITS prompt.

```
FLOW UNITS
>SCMH       ^v
```

The flow units determine the units that appear for velocity and temperature.
The flow rate options are NCMH, NLPM, SCFH, SCFM, SCMH, and SLMP.
The mass rate options are KGH, KGM, PPH, and PPM.

5> Press **P** to continue through the Basic Setup parameters and ensure all parameters, such as FLOW AREA and PROBE DEPTH, are properly configured.

Refer to the *Kurz Operations Guide* for additional configuration information.

6> Press **H** to exit.

The main Display mode (DSP) prompt appears.

Important ***If the flow measurement units are different than the PROFIBUS master, then the flow meter measurement units must be changed.***

To update the flow meter measurement units to match PROFIBUS Master's flow measurement units, you must update the flow meter configuration using Basic Setup.

To access the Basic Setup menu in Program mode:

1> Press **P**.

2> When you enter the basic password, only Basic Setup is available. Press **E** to continue.

```
! WARNING !
OUTPUT WILL STOP
```

The warning message appears followed by a general description of the meter type (either insertion or in-line).

```
METER TYPE IS
INSERTION FLOW
```

3> Press **E** until you see the FLOW UNITS prompt.

```
FLOW UNITS
>SCMH     ^v
```

The flow units also determine the units that appear for velocity and temperature. The flow rate options are NCMH, NLPM, SCFH, SCFM, SCMH, and SLMP. The mass rate options are KGH, KGM, PPH, and PPM.

4> Use the arrow keys to select the flow units, and then press **E**.

5> Press **E** until you see the RUN MODE DISPLAY prompt.

```
RUN MODE DISPLAY
>STATIC       ^v
```

The Run Mode options are static variables and scrolled variables.

Run mode is the normal operational state of the meter after Boot-Up mode. The default display format in Run mode is “scroll all.” The following example shows the flow meter’s tag name and flow:

```
TAG NATURAL GAS1
FLOW 0.0000 SCFM
```

6> Use the arrow keys to select the Run Mode Display, and then press **E**.

Depending on the run mode selection, the static variable or scrolled variables prompt appears.

Scrolled Variables		Static Variables	
SCROLL ALL	FLOW+TOT	FLOW ONLY	TAG+FLOW
FLOW ONLY	FLOW+VEL	FLOW+TOT	FLOW+TEMP
DAILY ONLY	TAG+FLOW	FLOW+VEL	VEL+TEMP
TOTAL ONLY	TAG+FLOW+VEL	FLOW+DAILY	
FLOW+TEMP	FLOW+TOT+VEL		
FLOW+DAILY	FLOW+TEMP+VEL		

7> Use the arrow keys to select the variables that appear during Run mode, and then press **E**.

```
SCROLL INTERVAL
>2          SEC
```

The Scrolled Variable option also allows you to determine the length of time (between 2 and 8 seconds) that information appears on the display before changing to the next value.

8> Use the number keys to set the seconds, and then press **E**.

9> Press **H** to exit Program mode and save your changes.

Table 4-7 shows the measurement units that will appear in the Run Mode display based on the selected unit for flow measurement.

Table 4-7. B-Series Measurement Variables & Associated Measurements

Selected Flow Unit	Total Flow	Velocity	Temperature
SCFM	SCF	SFPM	DEGF
SCFH			
PPM	LBS		
PPH			
NLPM	NL	NMPS	DEGC
NCMH	NCM		
SLPM	SL	SMPS	
SCMH	SCM		
KGM	KGS		
KGH			

Bus Start-up

After configuration is complete, the master can be put into operate mode where it goes into data exchange with the configured slaves. However, in order to make sure that the configuration is valid, the controlling master performs several checks before entering data exchange with the slave.

1. The master first checks that the slave is present on the bus and is not controlled by another master with a Diagnostic request. The slave, if correctly addressed, will respond with a diagnostic response. The master thus knows that there is a slave present at the correct address.
2. The master next checks that the device is of the correct type by checking the ID number and setting device parameters. This is done with a “Set Parameters” telegram.
3. The master then checks that the allocated I/O is present and available on the slave. This is done with a “Check Configuration” telegram.
4. A second diagnostic request is then sent to the slave to check that the Set Parameters and Check Configuration telegrams were checked as okay.
5. The slave will only enter data exchange if the checks are passed without error.

Data Exchange

During cyclic data exchange, the master continually checks that the slave is responding and healthy by looking for the slave responses. Should a slave fail to respond, the master will normally retry immediately. If the retry also fails, then the master will indicate a “bus fault” by illuminating a red LED on the PLC. When a bus fault is detected the master will try to establish data exchange once again by running through the start-up sequence again for the missing slave.

Example Process for Configuring PROFIBUS with Slave Devices

Configuring the B-Series flow meter for the PROFIBUS-DP network is performed on the PLC side with the PROFIBUS master. Most PLCs with the PROFIBUS Master function provide the software for configuring slave devices. Configuring the PLC:

- Identifies the slave devices connected to the PROFIBUS network.
- Specifies the I/O layout of each slave device and maps it in internal PLC memory.
- Defines the main characteristics of each slave device.
- Obtains the start-up setting for each slave device, which send this data to a slave device each time communication with the slave is established or re-established.

The examples in this section use the Siemens Simatic S7-1200. The Siemens TIA v13 (Total Integrated Automation) portal is used for hardware configuration and programming. The following processes are shown:

1. Creating a project from the TIA.
2. Configuring the hardware.
3. Adding the B-Series device KZ_0F99.GSD file to the TIA.
4. Configuring the PROFIBUS-DP network.
5. Assigning the IP address of the PLC.
6. Accessing data from the PROFIBUS network.
7. Compiling and downloading the hardware configuration.
8. Viewing live data from the PROFIBUS network.

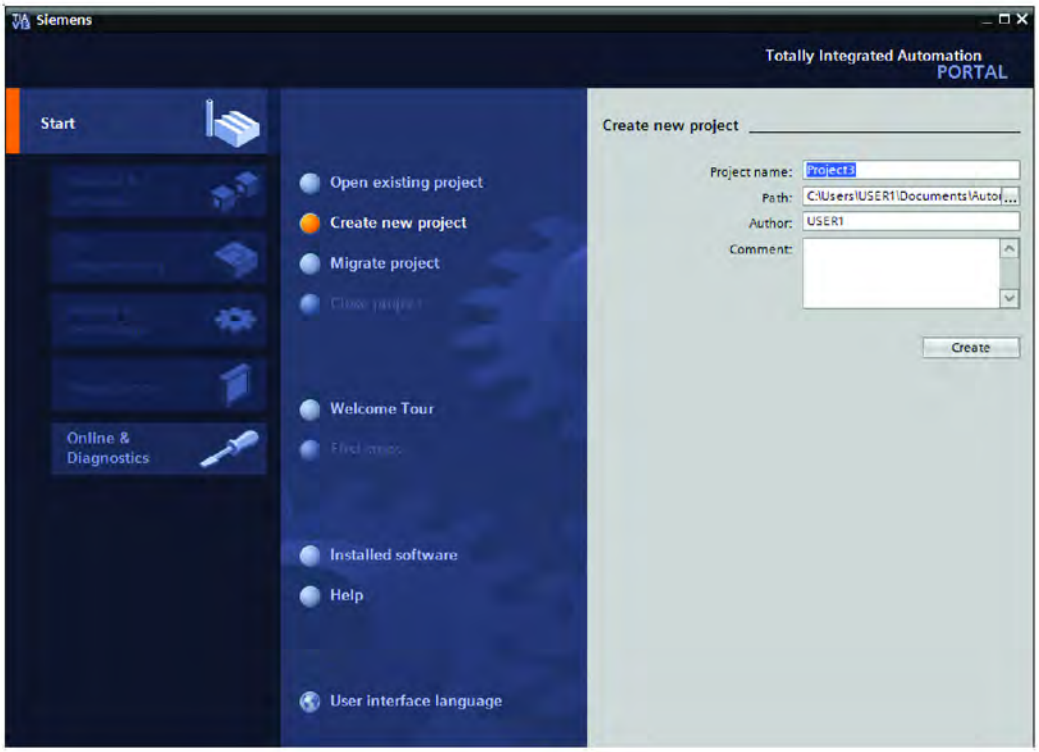
Note This section provides examples related only to connecting a B-Series flow meter to the network. Refer to the Simatic S7-1200 configuration guide for additional information.

Connecting the Simatic S7-1200 to the Host Computer

Use an Ethernet cable to connect the Simatic S7-1200 to the host computer. The cable should be connected to the X1P1 port of the CPU 1211C and to the Ethernet port of the host computer. If you use a router, refer to the manual for proper connections.

Creating a Project from the TIA

To create a project, start the TIA program on the host computer. The window will look similar to the following:

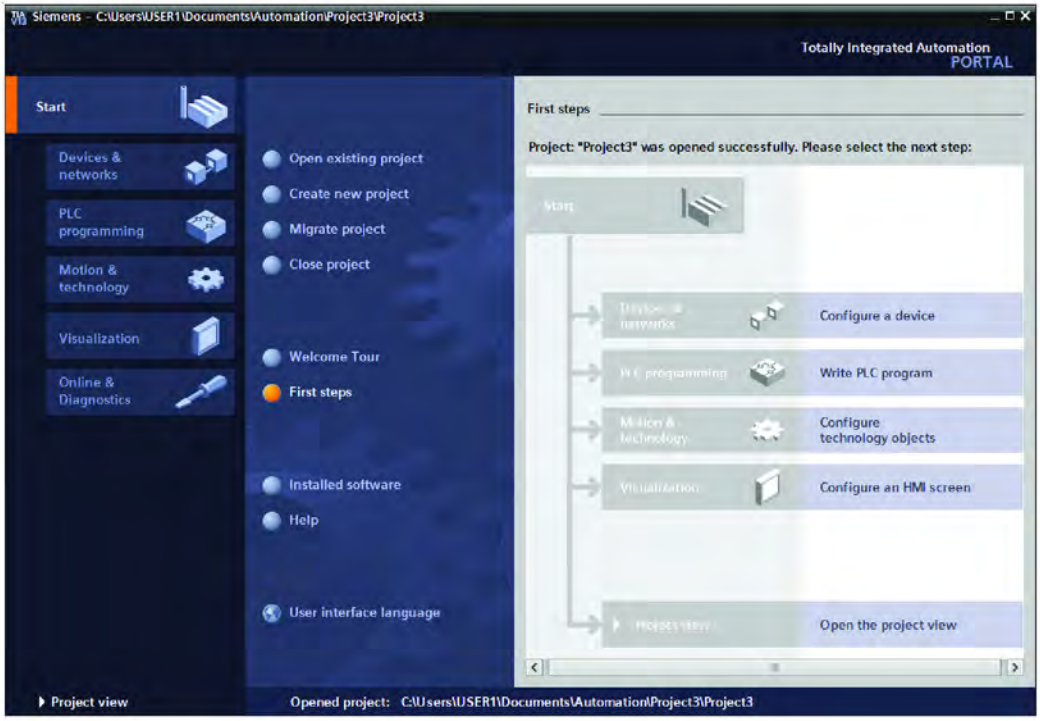


1> Select **Create new project**.

2> Enter a project name, path, author, and any comments.

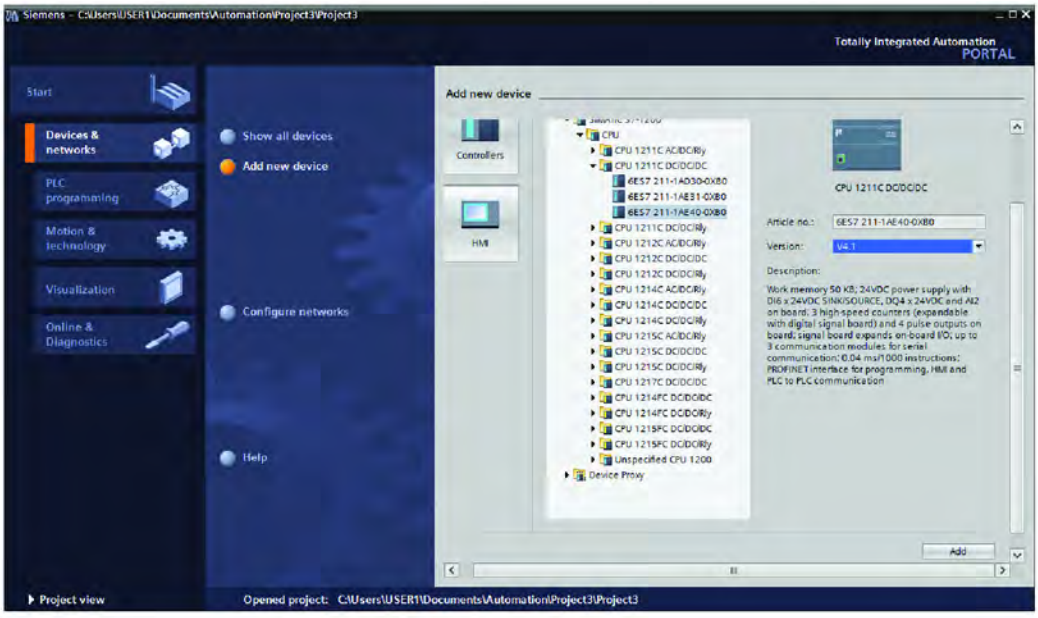
3> Click **Create** to open the **First steps** pane of the new configuration window.

Configuring the PLC Master



This panel represents the devices that can be added to the project.

1> Click **Configure a device** to add a device to the PROFIBUS network.

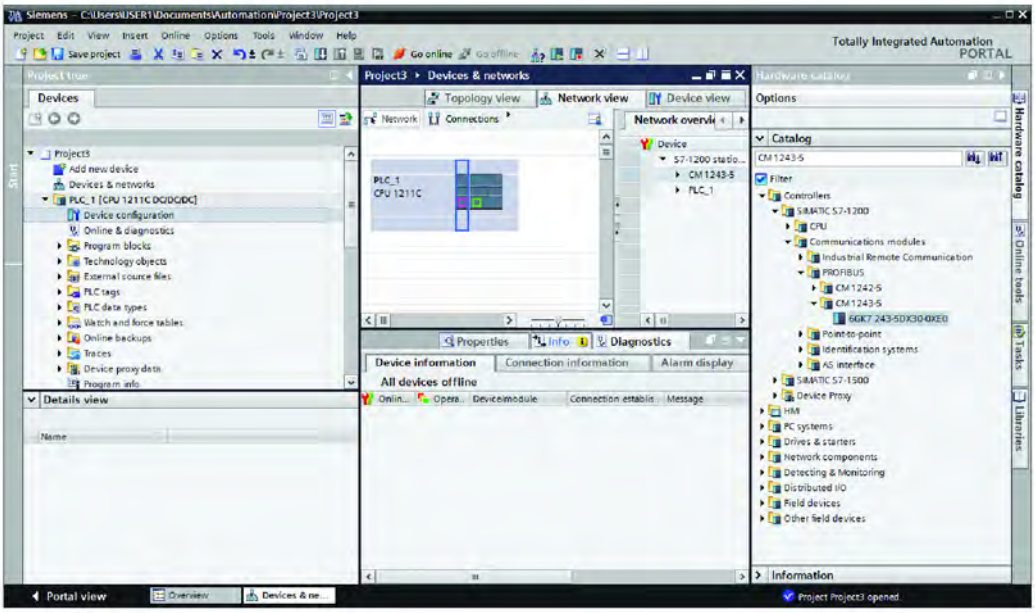


2> Select **Add new device** and then click **Controllers**.

3> Expand the **CPU** folder by selecting the arrow next to the folder name.

4> Expand the **CPU 1211C DC/DC/DC** folder by selecting the arrow next to the folder.

5> Select **6ES7 211-1AE40-0XB0**, and then click **Add**.



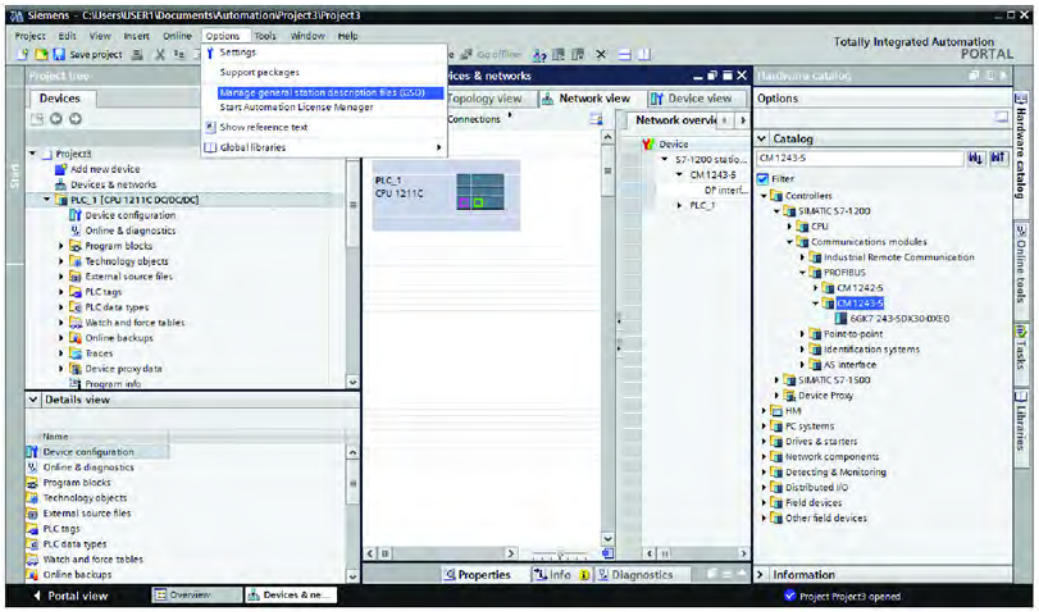
The device overview window appears.

6> Select the **Network view** tab in the center pane to show a graphical representation of the selected CPU.

7> In the **Hardware catalog** pane, expand the Controllers folder, then expand **SIMATIC S7-1200 | Communications modules | PROFIBUS | CM 1243-5**.

8> Click and drag **6GK7 243-5DX30-0XE0** onto PLC_1 on the left in the Network view.

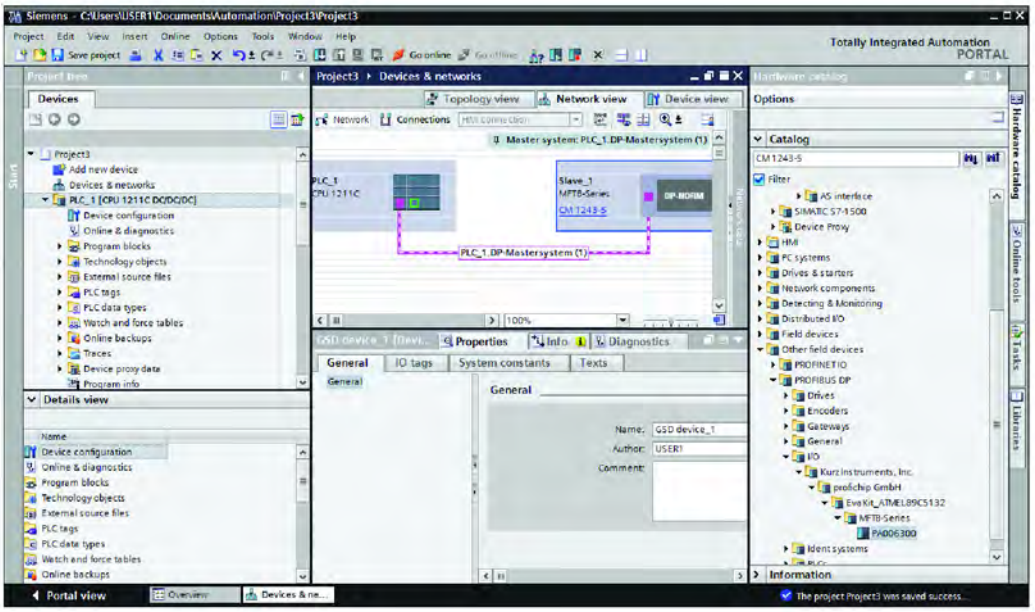
Adding the B-Series Device KZ_0F99.GSD File to the TIA



1> Select **Options | Manage general station description files (GSD)**.

2> Navigate to the location of the **KZ_0F99.GSD** file, select the file, and click the **Install**.

Configuring the PROFIBUS-DP Network



1> Select the **Network view** tab to view the graphical component of the network.

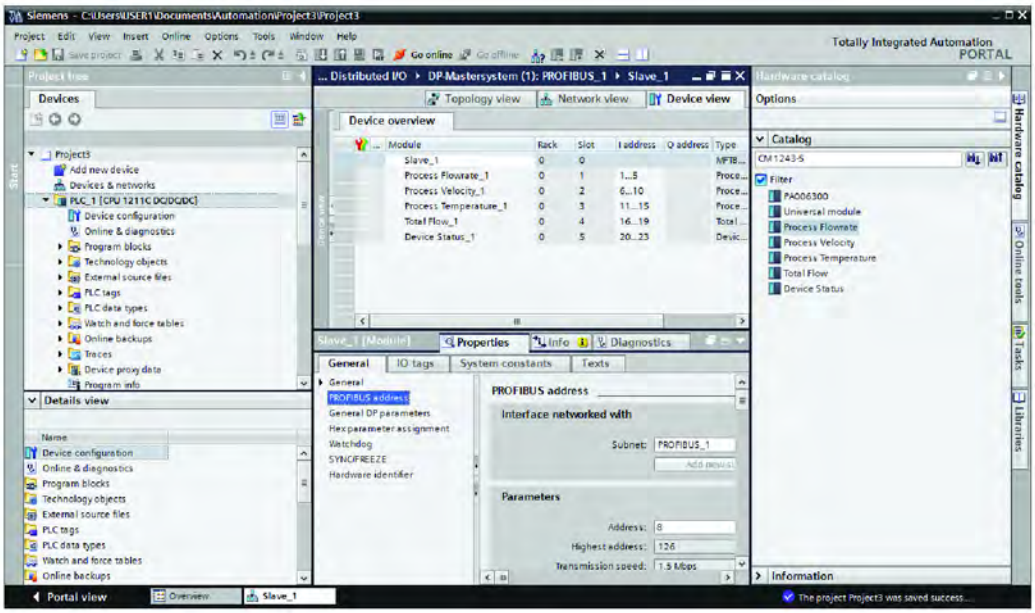
2> In the **Hardware catalog** pane, find the B-Series flow meter, and then select and drag the device name into the **Network view** tab beside the PLC_1.

In this example, the device name resides in **Other field devices | PROFIBUS DP | I/O | Kurz Instruments, Inc. | profichip GmbH | EvaKit_ATMEL89C5132 | MFTB-Series | PA006300**. Select **PA006300** and drag it into the **Network view** pane on the right side of PLC_1.

3> Click the pink square connector of **PLC_1** and drag it over to the **Slave_1** pink square connector to establish connection between the slave and the master.

The “not assigned” status will change to CM 1243-5.

4> Double-click on **Slave_1 MFTB Series** (which represents the B-Series flow meter) on the **Network view** tab.

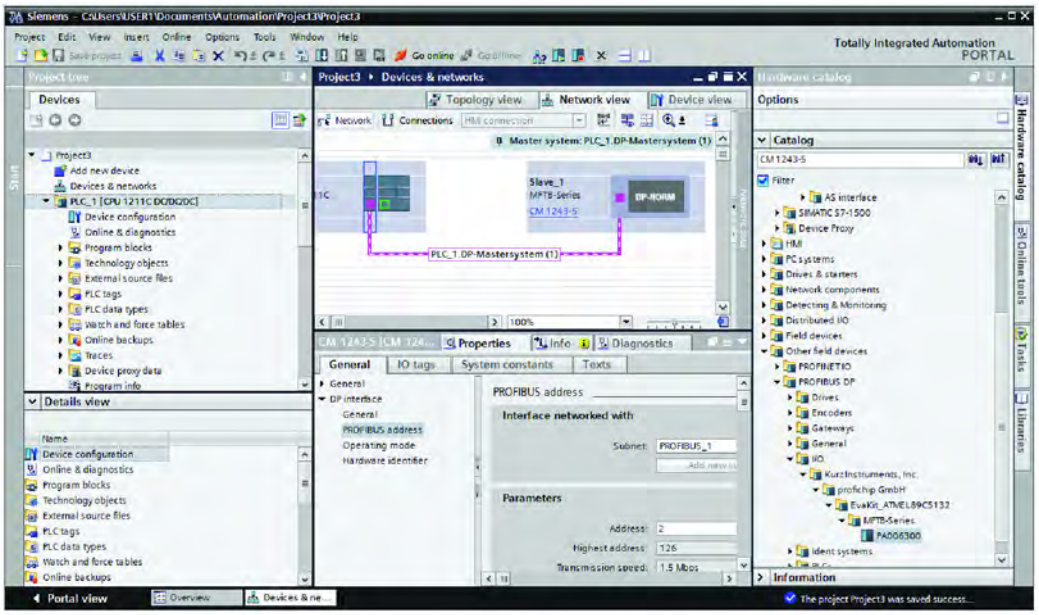


5> This changes the middle pane to the **Device view** tab showing the **Device overview**.

6> In the Hardware catalog pane, expand the **Filter** settings and select **Process Flowrate**, **Process Velocity**, **Process Temperature**, **Total Flow**, and **Device Status** and drag them into the Device overview area.

The Input address indicated by the uppercase “i” is assigned automatically once the connection to the master is established.

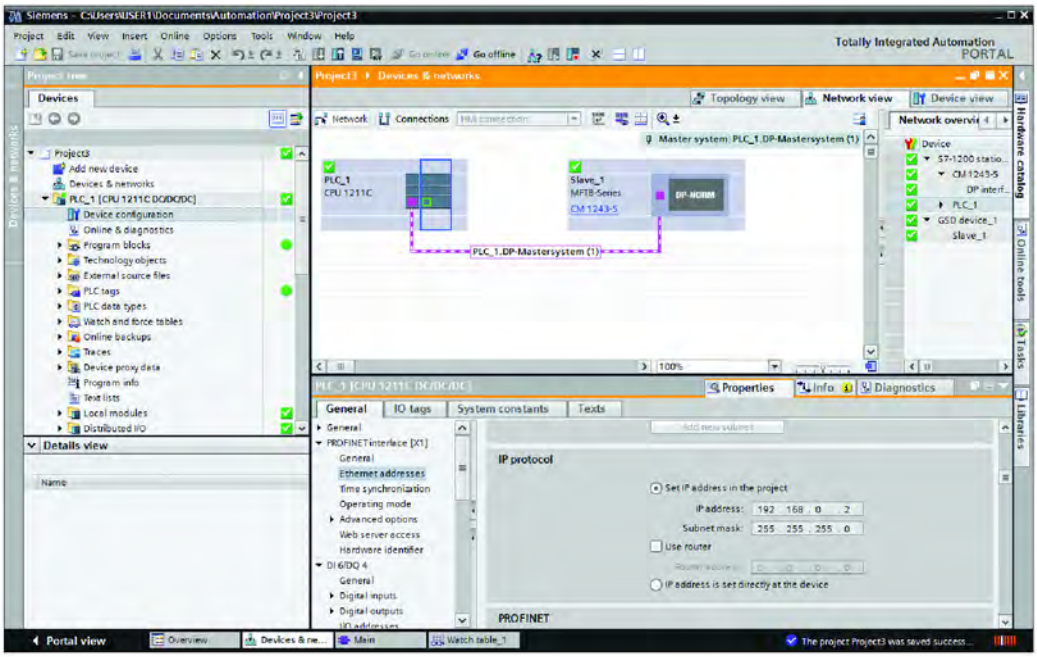
7> Select **Slave_1** under the **Module** column to set its properties. The PROFIBUS address is set in the **General** tab of the **Properties** pane. In this example, the PROFIBUS address is set to **8**.



8> Select the **Network view** tab then click the **CM 1243-5** module to view its properties.

The PROFIBUS master address is set in the **General** tab of the Properties window. In this example, the PROFIBUS master address is set to 2.

Assigning the IP Address of the PLC



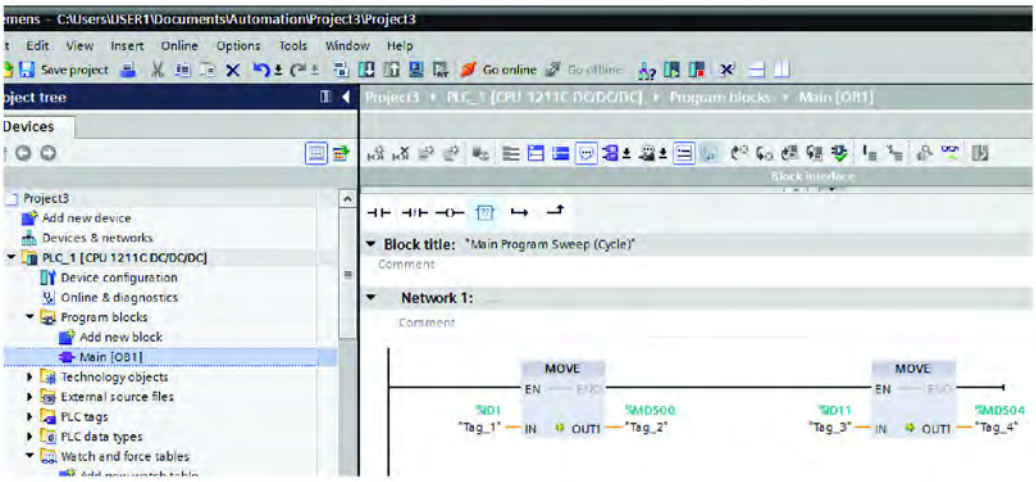
1> On the **Network view** tab, click the green square connector on the **PLC_1** CPU module to view its properties.

2> In the **Properties** tab, select **Ethernet addresses** under the PROFINET interface category.

3> Enter the IP address.

In the example below, the **IP address** is set to 192.168.0.2 and **Subnet mask** is set to 255.255.255.0. Make sure that the host computer has the same subnet. The new IP address is activated when the new hardware configuration is downloaded to the PLC.

Accessing Data from the PROFIBUS Network



1> In the **Project tree** pane, expand **PLC_1 | Program blocks** and double-click **Main**.

A Block interface diagram pane appears.

2> Select an empty **Network** and add two programming icons named **MOVE** memory. For each icon, click the **Empty box** icon in the programming icons bar and drag it to the selected network.

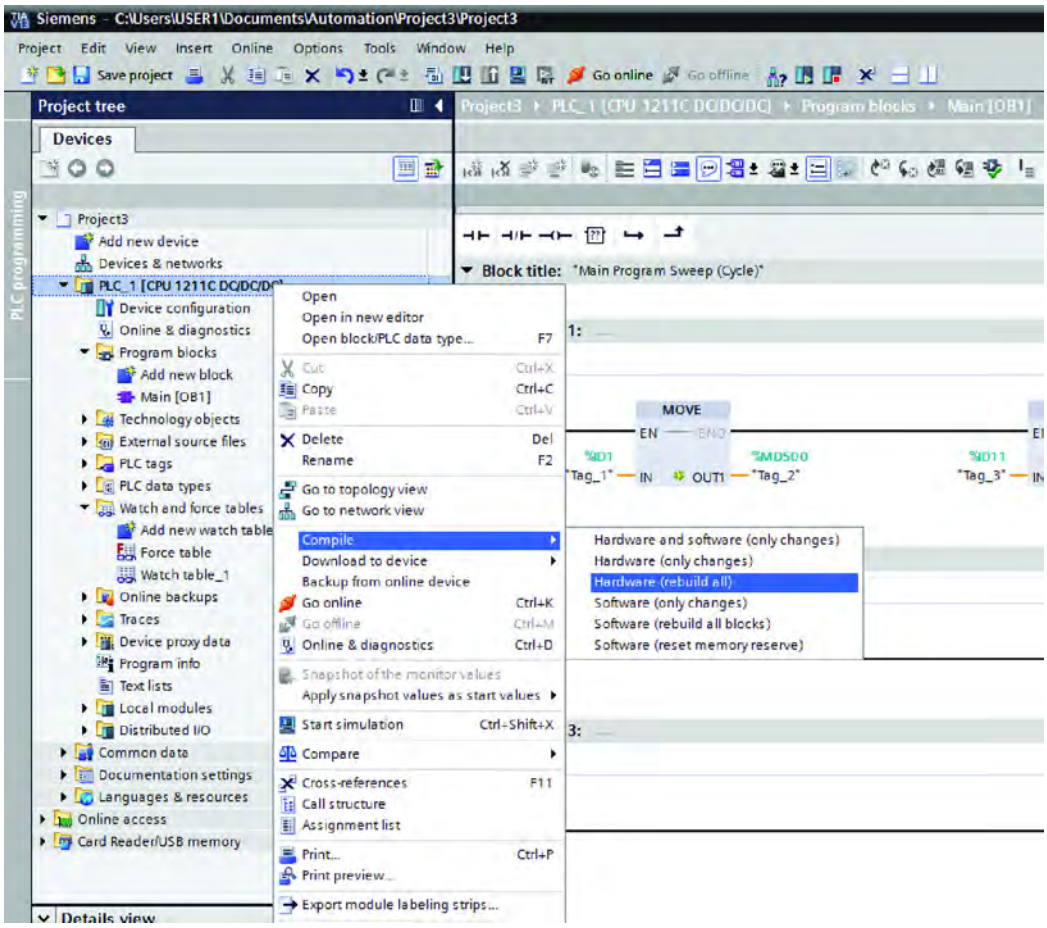
3> Configure each of the empty boxes to a **MOVE** memory instruction by clicking the two **??** and enter the name **MOVE**.

4> Configure the input of the first box with **%ID1** (the address of the Process Flowrate of the PROFIBUS Slave_1) and the output with **%MD500** (the address of the PLC_1 to move the data).

5> Configure the input of the second box with **%ID11** (address of the Process Temperature of the PROFIBUS Slave_1) and the output with **%MD504** (address of the PLC_1 to move the data).

A tag name is automatically assigned and can be modified if needed. In this example, the Process Flowrate is labeled as “Tag_2” and the Process Temperature is labeled as Tag_4.

Compiling & Downloading the Hardware Configuration



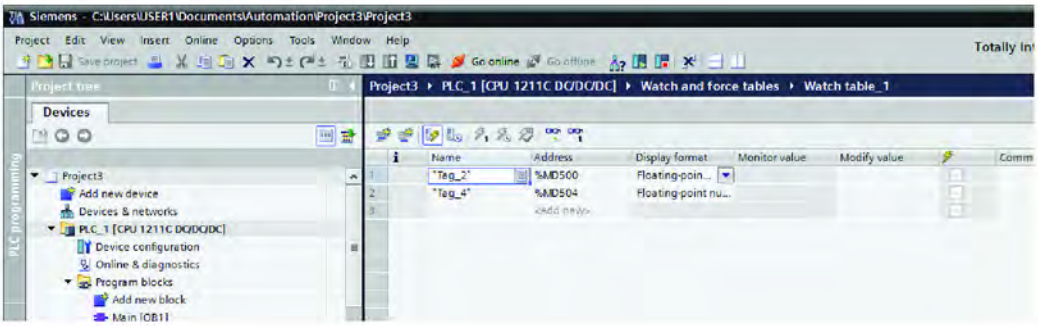
1> In the Project tree pane, right-click the **PLC_1** folder and then select **Compile |Hardware (rebuild all)**.

2> If no errors occur, right-click the **PLC_1** folder and then select **Download to device | Hardware and Software (only changes)**.

If the PLC is not currently connected to the TIA program, follow the prompts to search for the PLC.

Viewing Live Data from the PROFIBUS Network

The live data is available only if the PROFIBUS master and slaves have established connections and are in a data exchange state, as indicated by a solid green light on the CM 1243-5.



1> In the project tree panel, expand the **PLC_1** node.

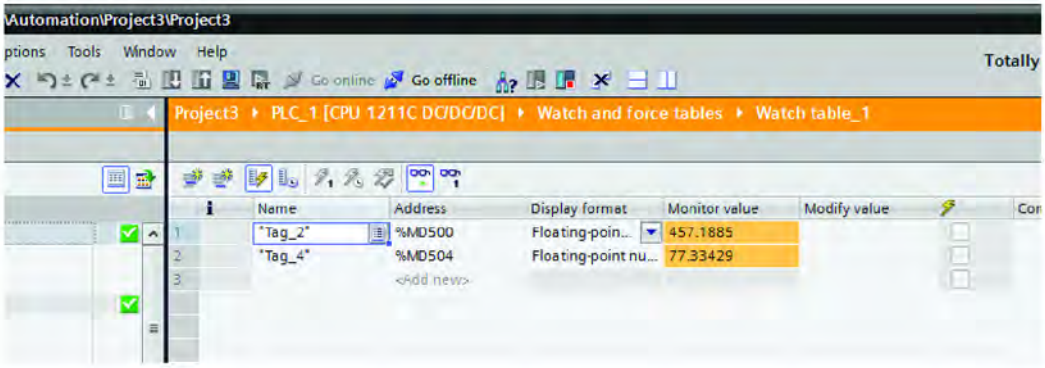
2> Expand the **Watch and force tables** node and double-click **Add new watch table**.

Watch table_1 configuration window appears.

3> For this example, enter **Tag_2** and **Tag_4** to view the live data for Process Flow rate and Process Temperature. Configure the following:

Tag_2 as Address= **%MD500** and Display format= **Floating-point number**

Tag_4 as Address= **%MD504** and Display format= **Floating-point number**



4> Click the **Go online** icon to connect the TIA to the PLC on the main menu bar.

5> Once it is online, click the **Monitor all** (eyeglasses with right arrow) icon in the **Watch table_1** window.

The live Process Flow rate and Process Temperature values appear in the Monitor value column.

Chapter 5

Troubleshooting

Overview

The chapter provides information for troubleshooting possible configuration issues for B-Series Mass Flow Meters. It includes:

- Data Logging & Reporting
- Built-In Diagnostics
- Event Code Log
- Internal Volatile RAM Data Logging
- Diagnostic Error Limits
- Single-Wire Fault Codes
- Modbus Registers
- Typical Symptoms of a Damaged Display
- Advanced Diagnostics Menus
- Limited Warranty
- Returning Equipment

Data Logging & Reporting

Data logging typically occurs for:

- Field calibration process
- Troubleshooting a process flow
- Troubleshooting meter readings

The B-Series records historical data via the 4-20 mA interface, in addition to supporting four types of data reporting:

- USB port data logging in CSV-formatted output based an internal timer
- USB port, ASCII escape commands
- Modbus command queries
- Internal volatile RAM logging which can be extracted using KzComm

Refer to “Built-In Diagnostics” in this chapter for information about the Log Reports capability, and also the *KzComm User Guide* for accessing configuration and log files.

USB Port Data Logging

Using a USB port, the continuous data is captured in a remote terminal emulator (such as Tera Term). A Kurz USB driver must be installed on the computer connected to the flow meter. The data output is a string of comma-delimited values in CSV format that can be read using a text application or imported into spreadsheet application for additional manipulation or plotting.

To access the Data Logging menu in Program mode:

1> Press **P**.

2> Enter your password, and then press **E**.

3> Press **2** to invoke the Quick Jump option.

4> Press **18** for the Data Logging menu, and then press **E**.

The menu prompts you for enabling the data log.

```
ENABLE DATA LOG
>OFF          ^v
```

5> Use the arrow keys to select **ON**, and then press **E**.

The LOG INTERVAL prompt defines the frequency (in seconds) of data logged to the USB port. The interval can be between 1 second and 32,768 seconds (approximately 9.1 hours).

```
LOG INTERVAL SEC
>300
```

6> Enter the LOG INTERVAL value using the number keys, and then press **E**.

USB Port ASCII Commands

ASCII commands allow communicating with the flow meter using a custom software application or a terminal emulator. ESC commands allow you to obtain the process data of the meter. Refer to “B-Series ASCII Commands” in Chapter 3 for information about issuing ASCII commands.

Built-In Diagnostics

The flow meter has an extensive set of internal and external sensor and wiring checks it performs and reports. The diagnostic tools provide service technician support and minimize the amount of meter down-time. Intermittent events are also captured for evaluation and allow for faster corrective action. Some diagnostic tools are designed for the user interface, while other tools are used via Modbus, a terminal emulator, or KzComm. The diagnostic tools are:

- Event codes with text description appear on the display.
  (These also can be echoed to the serial USB port.)
- Internal event logs containing 200 FIFO records of the event code and meter runtime.
- Min/max event memory records 20 daily extremes each for velocity, flow rate, process temperature, electronics temperature, and the occurrence runtime.
- Trend data for 20,416 records captured every 10 seconds in volatile memory. This permits approximately 56 hours of flow rate, temperature, and run-time data while the meter is powered on.
- Current event code or meter status read via the Modbus registers, as described in “Internal Volatile RAM Data Logging ” on page 5-9.
- NE-43 alarm, below or equal to 3.6 mA or equal to or above 21 mA, which maps many of the errors to NE-43 alarms.
- Advanced diagnostic data accessible through the Display mode menu assists with troubleshooting by providing numeric data to supplement the event code. See “Advanced Diagnostics Menus” on page 5-11 for additional information.

Event Code Log

The Event log contains up to 200 of the most recent events determined and reported by the flow meter. The output provides the runtime and an event code. Table 5-1 provides error code numbers and a brief description of behavior and possible causes. In the table, x's represent leading zeros that do not appear, and the plus signs (+) represent any digits after the number that report multiple events or errors.

Table 5-1. Event Log Error Codes

Event Code	Description / Causes
xxxxxxx**1**	**RP resistance above high limit.** The velocity sensor resistance (RP) is above the normal range for the configured sensor type. This accounts for sensor core temperature up to ~650°C before setting the error or ~720°C in 600°C mode. Possible causes: Open circuit on the sensor wiring. Defective sensor or sensor control board.
xxxxxxx**2**	**RP resistance below low limit.** The velocity sensor resistance (RP) is below the normal range for the sensor type configured. This accounts for sensor core temperature down to -112°C before setting the error. Possible causes: Short in the sensor wiring. Defective sensor or sensor control board.
xxxxxxx**4**	**RTC resistance above high limit.** The process temperature sensor resistance (RTC) is above the normal range for the sensor type configured. This accounts for sensors up to 650°C for the metal sensors, FD, FD2, and MD and up to 460°C on the CD sensor. Possible causes: Open circuit on the sensor wiring. Defective sensor or sensor control board. When the meter reaches the limit, the meter turns off the sensor control drive until it cools. This can cause the sensor to regulate at this temperature and set multiple errors in the log as it goes below and above the limit.
xxxxxxx**8**	**RTC resistance below low limit.** The process temperature sensor resistance is below the normal range for the sensor type configured. This accounts for sensor down to -120°C in normal operation before setting an error. Possible causes: Short circuit on the sensor wiring. Defective sensor or sensor control board.

Table 5-1. Event Log Error Codes (continued)

Event Code	Description / Causes
xxxxxx**1+**	**Wire loop resistance above high limit.** The sensor wire resistance from the sensor to its electronics board is too high above limit (> 5.0 ohms). Loop resistance is from the electronics out to a sensor and back. Possible causes: Wire is too long for the gage being used. Loose wire joint connection (but not too loose, see code 20). Defective sensor or sensor control board.
xxxxxx**2+**	**Sensor RPs lead open circuit.** The sensor wire RPs is open circuit or not connected. Possible causes: Open circuit on the RPs wire, pin 1 of TB1. Open on the RP lead will also set this, Pin 3, TB1. Defective sensor or sensor control board.
xxxxxx**4+**	**High sensor or wire leakage.** The sensor or wiring is showing too much leakage current to ground. The trip point of this error is the equivalent of 100 kOhms leakage resistance. ***Note:*** Firmware version newer than 1.09 have a factory configuration option that allows operation up to 600°C for the FD2 sensor. The event code may be preceded by the warning code 2xxxxxxx. Possible causes: Wet or contaminated wiring or junction box. Water in the backend of a sensor. Corroded front side to a sensor. Sensor above temperature limit. Defective sensor control board. At normal temperatures, three 10 minute leakage updates are required before the error is set.
xxxxxx**8+**	**Flow rate above design limits.** Under high heat flow conditions (very high flow rates), the demand to heat the sensor may exceed the drive limits of the sensor control board. The reported flow readings at this point are compressed and lower than the true flow readings. ***Note:*** Applies to 2.x firmware.

Table 5-1. Event Log Error Codes (continued)

Event Code	Description / Causes
xxxxx**1++**	**Meter kick-out high.** If the flow rate or temperature is above the high kick-out limit in the meter. Possible causes: This is a normal alarm if the flow rate or temperature is above the kick-out set point which is user programmable. Condensate on the velocity sensor can cause high heat flow and will set this also. A change in gas composition to high heat flow gases like H2 can cause this alarm. ***Note:*** Applies to 1.x firmware.
xxxxx**2++**	**Meter kick-out low.** If the flow rate or temperature is below the low kick-out limit in the meter. Possible causes: This is a normal alarm if the flow rate or temperature is below the kick-out set point (user programmable). Drop in process pressure at very low flow rates can cause a loss in heat flow. A change in gas composition to low heat flow gases like Ar or from CH4 to air. ***Note:*** Applies to 1.x firmware.
xxxxx**4++**	**ADC failed to convert measurement.** The circuits on the sensor control board which measures the input signals are not working properly. Possible causes: The sensor control board is defective and needs to be replaced.
xxxxx**8++**	**Sensor control drive stopped responding.** The sensor drive voltage to heat the velocity sensor is not matching the set point. Possible causes: Short or miss-wiring of the sensor. Defective sensor control board needs replacing.
xxxx**1+++**	**Sensor over-voltage crowbar engaged.** The sensor drive voltage was not matching the set point and would not fall to low drive on command. The crowbar SCR was engaged to clamp the sensor drive voltage to zero. Possible causes: Sensor field wiring short to a DC power supply (4-20 mA) or 24 V supply. Defective sensor control board needs replacing.

Table 5-1. Event Log Error Codes (continued)

Event Code	Description / Causes
xxxx**2+++**	**Sensor type does not match configuration.** The sensor resistance ratio RTC/RP exceeds 10% of the normal value of the sensor for which the meter was configured. Possible causes: Wrong sensor is connected to the electronics. Confirm the serial number matches. Upset to the process temperature causing the two sensors (RP and RTC) to not match in temperatures. Defective sensor or sensor control board.
xxxx**4+++**	**Abnormal sensor node voltages.** This fault is often a redundant error to the sensor and wiring errors. It looks only at the sensor wire voltages, not the resistance values. Possible causes: Incorrectly wired sensor. Short or open circuit. Defective sensor or sensor control board.
xxxx**8+++**	**Unable to write config file to EEPROM.** The sensor and meter configuration data can not be verified after a memory write. Possible causes: Defective sensor control board. Any EEPROM read/write fault.
xxx**1++++**	**Sensor type does not match board build.** The sensor control board version is not compatible with the connected sensor type. Possible causes: Incorrect board used during production or field service. Sensor failure or sensor control board failure. ***Note:*** Applies to 2.x firmware.
xxx**2++++**	**External analog input out of range.** The measured value of the analog input is <= 3.6mA or >= 21.0 mA. This event code is applicable with the Shifting Gas Composition feature and the Multiple Gas Calibration feature.
xxx**4++++**	Reserved.
xxx**8++++**	Reserved.
xx**1+++++**	Reserved.
xx**2+++++**	Reserved.
xx**4+++++**	Reserved.
xx**8+++++**	Reserved.
x**1++++++**	Reserved.
x**2++++++**	Reserved.
x**4++++++**	Reserved.

Table 5-1. Event Log Error Codes (continued)

Event Code	Description / Causes
x**8++++++**	Reserved.
1+++++++	The subsystem responsible for communicating via the optional industrial communication protocol (HART or Profibus) is not responding. The unit will not communicate through that protocol.
2+++++++	The sensor is in a process above 100°C and is leaking current. It has 24 hours to recover to a leakage resistance above 100k ohms before the warning is converted to an error. ***Note:*** If the leakage resistance is below 20k or the process temperature is below 100°C, it automatically converts to an error. During the warning, the meter continues providing readings. Upon converting to an error, the NE-43 alarms are set and the meter no longer provides readings. This process allows the sensor to operate while drying out the MI cable. Possible causes: Wet or contaminated wiring or a junction box. Water in the backend of a sensor. Corroded front sided to a sensor. Sensor above temperature limit. Defective sensor control board. ***Note:*** Firmware version newer than 1.09 have a factory configuration option that allows operating up to 600°C for the FD2 sensor, and the warning code may be followed by the error xxxxxx4x. ***Note:*** Applies to 1.1x and 2.x firmware.
4+++++++	**Power on or power cycle.** This is a momentary code logged in the Event log for diagnostic purposes. It occurs every time the unit boots up or there is a power cycle. ***Note:*** Applies to 2.x firmware.
8+++++++	**Configuration change.** This is a momentary code logged in the Event log for diagnostic purposes. It occurs anytime the meter programming or configuration changes. If issues occur after a configuration change, this will support identifying the issue. This type of change is not recorded; only that a change occurred and the change runtime. ***Note:*** Applies to 2.x firmware.

Internal Volatile RAM Data Logging

To support of field service and troubleshooting, there is a continuous logging (every 10 seconds) of meter flow, temperature, and run time. The data is stored in the flow meter internal memory, holding approximately 20,416 samples for 56+ hours of data. However, the data is lost if the meter is turned off. The data can be extracted using KzComm then saved in a comma-delimited value file (CSV extension) for use in any spreadsheet application.

Diagnostic Error Limits

Table 5-2. B-Series Diagnostic Error Limits

Parameter	Low Limit	High Limit	Comments
Vps	0.075 V	17.6 V	Sensor drive voltage (used for code 4xxx).
VII	0.002 V	1.40 V	Sensor wire voltage (used for code 4xxx).
Viph	0.002 V	1.40 V	Sensor current sense voltage (used for code 4xxx).
Vrtch	0.4136	2.55 V	RTC high side voltage (used for code 4xxx).
Vrtcl	0.310 V	2.55 V	RTC low side voltage (used for code 4xxx).
RP, velocity sensor 9/27 FD2 9/300 FD 9/100 MD 20/20 CD	Ohms 5.0 5.0 5.0 10.0	Ohms 30.0 30.0 (32.0) 30.0 60.0	RP sensor resistance, sensor and temperature dependent. 600°C mode, 1.1x or higher firmware.
RTC, process temperature sensor 9/27 FD2 9/300 FD 9/100 MD 20/20 CD	Ohms 14.0 150 50 9	Ohms 100.0 1000.0 350.0 50.0	RTC sensor resistance, sensor and temperature dependent.
Rwire	0.030	5.00	Sensor wire loop resistance (total).
Rleak	100 20		Sensor/wire leakage to ground for first 24 h in 600°C mode.
RTC/RP ratio	-10%	+10%	Sensor RTC/RP ratio. Used to know the sensor type. “Sensor type does not match.”

Single-Wire Fault Codes

Table 5-3. Single-Wire Fault Error Codes (B-Series Insertion, AC Powered)

Event Code	Event Description
0000	No events/faults.
20	RPS open circuit.
4000	RP short to GND. RTCL short to GND.
4004	RTCL open circuit. RTCH open circuit.
4008	RTCH short to GND.
401a	RPL open circuit.
4021	RP open circuit.
Shuts down, reboot attempt every 1 second.	24 V short to RPS. AC supply goes into current limit. 24 V short to RPL. AC supply goes into current limit. 24 V short to RP. AC supply goes into current limit. 24 V short to RTCL. Permanent fault. Abnormal sensor node voltages. Sensor control board must be serviced. 24 V short to RTCH. Permanent fault. Abnormal sensor node voltages. Sensor control board must be serviced.

Modbus Registers

Using Modbus for B-Series data logging permits access to the most flow meter data at any data rate. Refer to “Modbus Commands and Registers” in Chapter 3 for additional information about issuing ASCII commands.

Troubleshooting Modbus Network Wiring

Multipoint K-BAR systems using the Series 255 Flow Averaging Transmitter exclusively use Modbus to communicate with each flow element. See the Diagnostics and Troubleshooting section of the Series 255 Flow Averaging Transmitter Hardware Guide for a more comprehensive discussion on resolving issues with an industrial RS-485 network.

Typical Symptoms of a Damaged Display

A damaged display that is properly connected has a backlit glowing display showing only the following information:

```
Kurz Instruments Inc.
Display Driver 4.x
```

It will not show the normal power up information from the flow meter.

Advanced Diagnostics Menus

Advanced diagnostics are available only when instructed by Kurz service personal. Advanced diagnostic options are available Display Mode and listed in Table 5-4. The diagnostic data options provide measurements on analog parameters for the following categories:

- Input voltages (Display mode, option 44)

  Voltages measured by the ADC from which all other parameters are computed.

- Sensor output (Display mode, option 45)

  Velocity sensor current, power, resistance, temperature, and the reference sensor resistance and temperature.

- Sensor control (Display mode, option 46)

  These are the PID control values of the velocity sensor.

- Electronics temperature (Display mode, option 47)

  This is the sensor control (SC) board temperature sensor. This board will operate up to ~20°C above the ambient of the meter environmental enclosure, depending on the process flow rate. Higher flow rates will cause higher board temperatures.

- Sensor leakage (Display mode, option 48)

  This is the common mode resistance from RTCH-to-chassis ground. It is measured at boot up and every 10 minutes thereafter.

Table 5-4. Display Mode — Advanced Diagnostic Options

Option #	Function	Description / Parameters
44	INPUT VOLT	Input voltage VPs VRtcl VIph VExt VLl VTemp VLeakSense VCal VRtch
45	SENSOR OUT	Sensor output IRp TRp PRp TRtc Rp RLl Rtc
46	SENSOR CTL	Sensor control PErr DErr IErr RpSetpoint
47	ELEC TEMP	Electronics temperature
48	SENS LEAKG	Sensor leakage

To access the advanced diagnostic options in Display mode:

1> Press **D**.

2> Press **2** to invoke the Quick Jump option.

3> Press the option number for the function you want to view, and then press **E**.

4> If the function menu has multiple parameters, press **P** to scroll through the parameters.

5> Press **H** to return to the Display mode entry screen.

Limited Warranty

Liability for Repair and Replacement Only

Kurz products are warranted to be free from defects in material and workmanship from date of shipment from the Kurz manufacturing facility for 3 years for all B-Series products and 1 year for all other products. The Kurz obligation is limited to repairing, or at its option replacing, products and components that are verified and proven to be defective, at the manufacturing facility in Monterey, CA. Kurz warranty is limited to coverage of product specified and supplied by Kurz Instruments Incorporated.

Kurz extends this warranty only upon proper use and/or installation of the product in the application for which it was intended and does not cover products:

- That have been modified without the Company's approval.
- That have been subjected to unusual physical or electrical stress.
- Upon which the original identification marks have been removed or altered.

Kurz is not liable for:

- Installation charges.
- Expenses of Buyer repairs or replacement.
- Damages from delay or loss of use.
- Any indirect or consequential damages of any kind.

The customer is responsible for selecting the correct material of construction based on the material's suitability for the intended use of the Kurz equipment.

Transportation charges to the Kurz manufacturing facility for materials shipped for warranty repair are paid by the shipper. Kurz will return repaired or replaced warranty products prepaid. No products will be accepted for warranty repair without prior authorization (RMA) from Kurz Instruments. No repaired products will be shipped from Kurz Instruments without prior authorization.

Returning Equipment

If you believe your unit is working improperly, contact Kurz Customer Service:

(831) 646-5911

service@kurzinstruments.com

Before you can receive your return material authorization (RMA) number, make sure you:

- Complete the Defective Unit information
- Understand RMA requirements
- Read the cleaning and shipping requirements

Have the following information readily available for your Customer Service Representative:

Defective Unit Information

Model number	
Serial number	
Application (industry)	
Environment of installation	
Gas type	
Flow range	
Standard conditions for recalibration	
Special QA requirements (such as nuclear, military, oxygen, calibration, or certification)	
Technical contact name	
Technical contact phone number	
Billing contact name	
Billing contact phone number	
Complete shipping address	
Complete billing address	

Cleaning Equipment Before It Is Returned

Thoroughly clean all equipment you are returning to Kurz. Kurz is unable to assume the risk of receiving contaminated equipment from our customers. In the event uncleaned equipment are received, you will be contacted so arrangements can be made, at your expense, for the equipment to be picked up and cleaned before Kurz personnel handle the equipment.

Receiving an RMA Number

You will be issued an RMA number when you contact Kurz Customer Service and provide the Defective Unit information.

Important ***Kurz personnel will not accept return material shipments if an RMA number is not clearly visible on the outside of the shipping container.***

Shipping Equipment

Securely package the cleaned equipment in a sturdy container. The packing slip must reference the RMA number, model number, and serial number. ***The return address and RMA number must be clearly marked on the outside of the container.***

Ship the container prepaid to Kurz Customer Service:

Kurz Instruments, Inc.
Customer Service Dept.
2411 Garden Road
Monterey, CA 93940-5394
USA

Chapter 6

Maintenance

Overview

Kurz flow meters are virtually maintenance free. This chapter provides the following information:

- Reviewing the Log Files
- Periodic Inspection and Cleaning
- Recalibration
- Performing A Zero Flow Check
- Performing A Zero-Mid-Span Check

The frequency of any of these procedures is specific to each company and its policies.

Reviewing the Log Files

Before installing and operating the flow meter, configure the Event Log. This is a tool that gathers valuable information while the instrumentation is powered on, and this information can be used to confirm the calibration, electronics, and sensor integrity.

Output can be checked using the local display/keypad or a computer connected to the meter via the USB interface. KzComm can guide you through the configuration checklist and then transfer the data to the meter via the USB or Modbus interface.

Setting Up Data Logging

The data log outputs the flow meter's current reading at a given interval to a terminal emulator connected to the flow meter USB port for data collection. This information includes runtime, tag name, current flow rate, total flow, and temperature.

Note Data logging is separate from the flow meter's trend log.

To access the Data Logging menu in Program mode:

1> Press **P**.

2> Enter the Advanced Access password, and then press **E**.

3> Press **2** to invoke the Quick Jump option.

4> Press **18** for the Data Logging Selection menu, and then press **E**.

```
ENABLE DATA LOG
>OFF          ^v
```

The prompt for enabling data logging appears.

5> Press the arrow keys to select **ON**, and then press **E**.

```
LOG INTERVAL SEC
>300
```

The prompt for setting the log interval appears.

You can enter up to 32,765 seconds (a little more than 9 hours). However, it is important to use a value that provides a real indicator of flow activity.

6> Use the number keys to change the value and then press **E**.

B-Series Boot Mode

The B-Series device performs a boot (power-on) test to verify that configuration, sensor, and wiring settings are valid. During the boot test, the following information appears on the device display:

```
KURZ INSTRUMENTS
DISPLAY DRIVER 4.1
```

The device display or a terminal emulator will show that sensor testing is in-progress:

```
CHECKING TYPE OF
CONNECTED SENSOR
```

If an error message appears after the sensor testing then the unit is stuck in Boot mode due to a sensor mismatch, wiring, or other problem. At this point the B-Series device will not allow downloading the Min/Max Log, Event Log, and Trend Log files. To force the device to exit Boot mode, press the **C** key on the device keypad or through the terminal emulator and then disconnect from the terminal emulator.

Once Boot mode is complete the following information appears:

```
KURZ INSTRUMENTS
SERIES MFT-B
```

Followed by the final sensor test:

```
WAIT PERFORMING
SENSOR LEAK TEST
```

You can start downloading the Min/Max Log, Event Log, and Trend Log files.

Downloading a file automatically opens the file with the default application for that file type. All log files are in a comma-separated value (CSV) format and the configuration file is in a readable text format (TXT extension).

Downloading Min/Max Log and Event Log Files

The Min/Max Log file is used to determine the range of the flow rate, temperature, and electronics temperature for the process being measured by the B-Series device. The output file contains 20 records (up to one entry per day per category) for each of the following events:

- Minimum and maximum flow rate
- Minimum and maximum process temperature
- Minimum and maximum electronics temperature

The Event Log file contains up to 160 of the most recent events determined and reported by the B-Series device.

To download the Min/Max Log and Event Log files:

1> Check the **Min/Max and Event Log files** checkbox in the Download (Target to PC) dialog box and click **OK**.

2> A navigation window opens where you specify the filename and file type. A default filename appears (that can include the sensor serial number if preconfigured) appended with **minmax**, followed by another filename appended with **event**. You should accept the default file location (ProgramData\Kurz Instruments\KzComm) and default file type (CSV extension). Click **Save**.

> **Note** If an error occurs, click **OK** and verify the device is not in Boot-Up mode. Windows uses WordPad as the default application for opening CSV files unless a spreadsheet application is installed.

A viewable version of the Min/Max Log and Event Log files automatically opens.

> **Note** If an error occurs, click **OK** and verify the device is not in boot-up mode.

Downloading the Trend Log File

Important ***The log data is in volatile memory. A power cycle will clear the Trend Log file.***

The Trend Log file contains 20,416 records. Each record contains the runtime, flow rate, and process temperature data taken every 10 seconds for approximately 2.3 days. When the Trend Log file is full, the oldest data is replaced with the newest data. The data shows how the process being measured by the Kurz device changes with time. The Trend Log file will contain details if an unusual event occurs with the process. Downloading the Trend Log file takes approximately 4 minutes using Modbus RTU at 38400 baud and approximately 17 minutes using the Xmodem protocol.

To download the Trend Log file:

1> Check the **Trend Log file** checkbox in the Download (Target to PC) dialog box and click **OK**.

2> A navigation window opens where you specify the filename and file type. A default filename appears (that can include the sensor serial number if preconfigured) appended with **trend**. You should accept the default file location (ProgramData\Kurz Instruments\KzComm) and default file type (CSV extension). Click **Save**.

Note If an error occurs, click **OK** and verify the device is not in boot-up mode. Windows uses WordPad as the default application for opening CSV files unless a spreadsheet application is installed.

A graph of the Trend Log file appears, as shown in the following example.

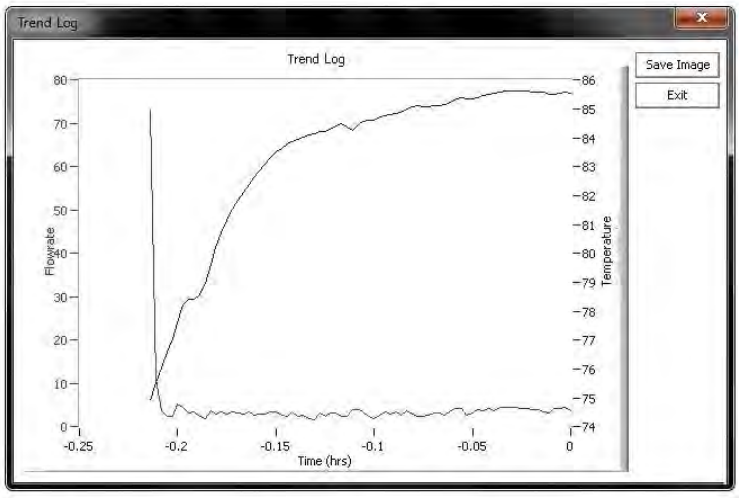


Figure 6-1. Trend Log file example

3> You can save the graph as a JGP image by clicking **Save Image**. The default filename appends “trend” to the filename.

Periodic Inspection and Cleaning

Thermal flow meters have no moving parts so there is very little maintenance, except for inspecting the sensor for corrosion or environmental damage and then cleaning the sensor as necessary. When a flow process starts-up or changes, the sensor should be inspected for dirt build-up to aide as a predictor for the maximum dirt load in determining a regular cleaning schedule.

Calibration strategies vary depending on the cleaning schedule of the sensors and site maintenance practices. This establishes the bounds on the calibration errors and/or provides the data to compensate for dirt collecting on the sensor.

There are two approaches to dirt collecting on the sensor:

- For dry powdered dirt, the sensor will reach a steady state dust load and should be field calibrated with this level of dirt on the sensor.
- For sticky dirt that just builds up over time, periodic cleaning is needed for the best results. The optional Kurz Purge feature provides an automated cleaning method to remove as much dirt buildup as possible using high velocity gas on the velocity sensor. This purge method is very effective at increasing the intervals between manual cleaning. In many cases it has altogether eliminated the need for manual cleaning, significantly reducing the cost of ownership.

Despite any dirt build-up on the sensors, thermal flow meters are more tolerant of dirt than either turbines or pitot tubes, which have a high rate of inaccuracy in flow streams with particulates. In some cases, the coating of dirt on a thermal sensor reduces the accuracy of flow readings for the specified flow rate. The best way to know the impact of the dirt is to check the calibration against some known reference (second unit or method).

When cleaning, a stiff hair brush with soap is recommended to clean the sensor. For stubborn deposits, use an appropriate solvent that is qualified safe for the Hastelloy C-276 sensor sheath material. Do not use physical or abrasive cleaning methods, such as brushes, steel wool, sandpaper, or application swabs. Sufficient force or pressure can damage the materials inside the sheath.

More aggressive cleaners should not be used. Do not bend the sensor elements as this can change the calibration or damage the unit. Corrosion of the sensor probe or probe support will eventually cause sensor or electronics errors.

Recalibration

Calibrating flow instrumentation in the field is important to ensure the accuracy of the device based on the customer's actual flow conditions, rather than relying solely on laboratory conditions. This allows for calibrating the sensor for the true average flow value in the duct or pipe.

A traverse calibration is the process of capturing the flow measurement from various, equal points in the duct or pipe and translating the flow at each point into the average flow for process at the point of measurement. Typical instrumentation to perform traverses includes Series 2440 portable flow meters and pitot tubes.

Insertion flow meters measure the point mass rate at the sensor, not the duct average. Ignoring this issue can cause a 40% error at low flow that diminishes at higher flow rates. Investing the time in field calibrations increases accuracy while eliminating the limitations of relative measurements.

- For either in-line or insertion flow transmitters, locating a sensor close to a valve either up-stream or down-stream will affect readings based on the position of the valve.
- An uninsulated pipe or duct can have a temperature profile that affects sensor readings based on the radial temperature gradient.
  - A unit inserted with the velocity element in the center or on the insertion side of center will read lower for ducts with a hot core and colder walls than the same duct with no thermal gradient.
  - Conversely, It will read high if the duct core is cold and the walls hot. A unit inserted beyond center or the far side of the duct will have the opposite drift from that described above for the same thermal gradient.

The process for recalibrating a flow meter is provided in Appendix B, "Calibration".

Performing A Zero Flow Check

The Zero Flow calibration test provides functional diagnostic information about your Kurz flow meter. This information includes sensor cleanliness, sensor and electronics functionality, and system damage or changes that caused potential calibration drift.

The process for building a zero flow chamber and performing a zero flow check is provided in Appendix C, "Zero Flow Calibration".

Performing A Zero-Mid-Span Check

The zero-mid-span check can be triggered by the drift check interval time. To configure this option, turn ON the Auto Drift Check. When it is triggered, it will perform the zero, mid, and span sequence. Change the value of the drift check interval to change the frequency that the drift check starts. Refer to the “Extended Utilities Mode” chapter in the *Kurz B-Series Operations Guide* for additional information.

The zero-mid-span drift check is an automatic calibration mode where both 4-20mA Analog Output channels report standard zero, mid, and high values for checking the calibration of the device and its data recording signal chain.

This configuration is for the internal timer to initiate the Drift Check at a specified interval. It has no effect on triggering the Drift Check function from Modbus or the digital input.

Note The zero-mid-span drift check and sensor purge features can be configured to automatically trigger on a user-configured interval. If both features are ON and scheduled to run at the same time, the features will run consecutively, not concurrently.

To access the Drift Check Setup menu:

1> Press **P**.

2> Enter the Advanced Access password, and then press **E**.

3> Press **2** to invoke the Quick Jump option.

4> Press **23** for the Drift Check Setup menu, and then press **E**.

```
AUTO DRIFT CHECK
>OFF          ^v
```

A prompt appears for setting automatic drift ON or OFF.

5> Press the arrow keys to select **ON**, and then press **E**.

```
DRIFT CHK INTRVL
>16          HOUR
```

When AUTO DRIFT CHECK is ON, the prompt appears for the Drift Check Interval.

This parameter defines the periodic interval (in hours) that the drift check sequence will be initiated by the internal timer. The interval can be between 1 to 18000 hours. The factory default is 16 hours.

6> Use the numeric keys to enter a time value, and then press **E**.
Press **P** to skip to the prompt without making changes.

A series of prompts appear for each drift check test level (zero-mid-span) regarding the amplitude of the output signal and its duration.

The amplitude is given as a percent of the FS of the independent voltage source (3.3V). In the following example, 10.0% means that 0.33V (10% of 3.3V) will be applied to the circuit inputs that are measured and reported at the 4-20 mA output for the drift check at zero.

The duration is the amount of time the specified voltage is applied to the analog outputs.

```
% FS AT ZERO
>10.000000
```

```
DURATION AT ZERO
>60         SEC
```

```
% FS AT MID
>50.000
```

```
DURATION AT MID
>60         SEC
```

```
% FS AT SPAN
>90.00000
```

```
DURATION AT SPAN
>60          SEC
```

7> Use the numeric keys to enter the time value, and then press **E**.
Press **P** to skip to the prompt without making changes.

8> After completing all prompts, the main Program mode option entry prompt appears.
Press **H** to return to Run mode.

Appendix A

Drawings & Diagrams

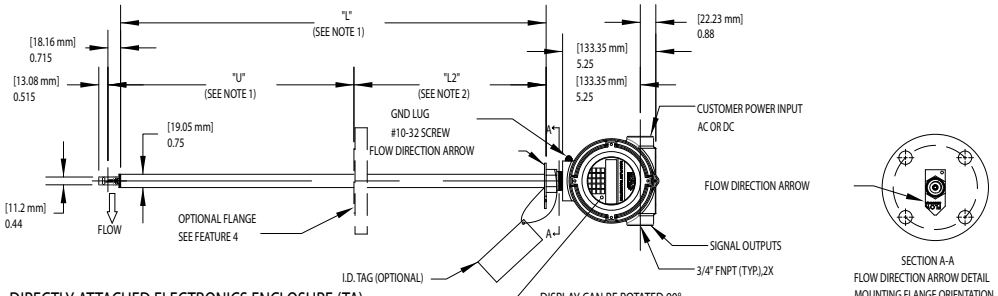
Overview

This appendix provides the drawings for the Kurz product line. It includes:

- Series 410FTB outline drawings
- Series 454FTB outline drawings
- Series 454FTB-WGF outline drawings
- Series 504FTB outline drawings
- Series 534FTB outline drawings
- Field wiring diagrams for components, 4-20 mA connections, alarms and purge connections, and Modbus connections
- Transmitter separate (TS) device wiring diagrams
- AO self-powered 4-20 mA output diagrams
- K-BAR 2000B and K-BAR 2000B-WGF outline drawings
- K-BAR 2000B wiring diagrams
- Isokinetic Systems outline drawings

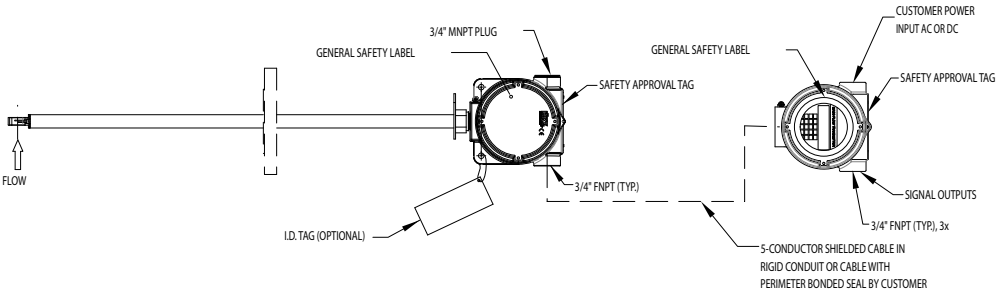
410FTB Outline Drawing (1 of 2)

SERIES 410FTB OUTLINE DRAWINGS



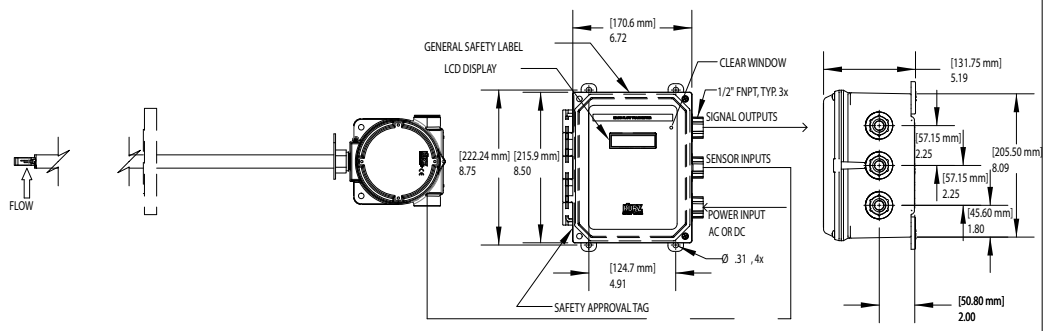
DIRECTLY ATTACHED ELECTRONICS ENCLOSURE (TA)
W/ DISPLAY & KEYPAD OPTION SHOWN IN
STANDARD ORIENTATION
(NOTE 5)

DISPLAY CAN BE ROTATED 90°
INCREMENTS FOR PROPER VIEWING
DIRECTION



PROBE ASSEMBLY FOR REMOTELY
ATTACHED ELECTRONICS ENCLOSURE (TS)
(NOTE 3 & 5)

SENSOR ELECTRONICS FOR REMOTELY
ATTACHED ELECTRONICS ENCLOSURE (TS) W/
DISPLAY AND KEYPAD OPTION (SHOWN)
(NOTE 4 & 5)

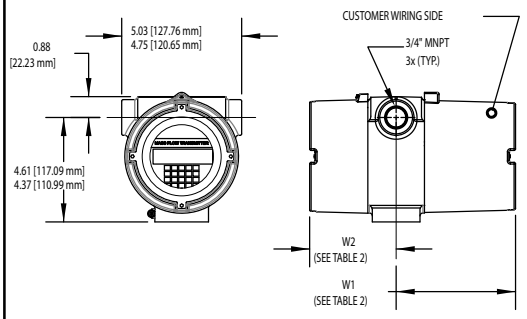


PROBE ASSEMBLY FOR REMOTELY
ATTACHED ELECTRONICS ENCLOSURE (TS)
(NOTE 5)

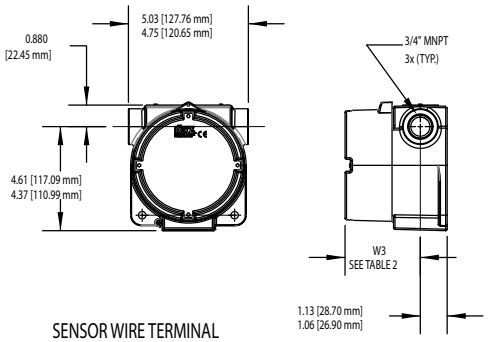
SENSOR ELECTRONICS FOR REMOTELY
ATTACHED ELECTRONICS ENCLOSURE (PTS)
(WALL MOUNT) W/ DISPLAY & KEYPAD
OPTION (SHOWN)
(NOTE 5)

410FTB Outline Drawing (2 of 2)

SERIES 410FTB OUTLINE DRAWINGS (cont'd)



DUAL CHAMBER ELECTRONICS ENCLOSURE
(SHOWN W/ WINDOW LID)
(NOTE 5)



SENSOR WIRE TERMINAL
JUNCTION BOX
(NOTE 4 & 5)

TABLE 2. ENCLOSURE DIMENSION (NOTE 5)

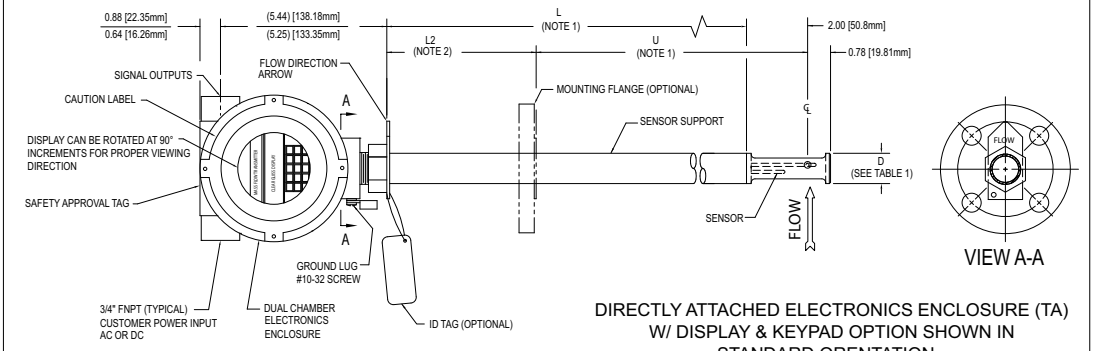
POWER/ INPUT	DISPLAY/ KEYPAD	W1 (MAX.)/(MIN.)	W2 (MAX.)/(MIN.)	W3 (MAX.)/(MIN.)
AC	YES	3.63 [92.20 mm] 3.41 [88.61 mm]	5.01 [127.25 mm] 4.69 [119.13 mm]	N/A
AC	NO	3.16 [80.26 mm] 2.81 [71.37 mm]	5.01 [127.25 mm] 4.69 [119.13 mm]	N/A
24 VDC	YES	3.63 [92.20 mm] 3.41 [88.61 mm]	5.01 [127.25 mm] 4.69 [119.13 mm]	N/A
24 VDC	NO (SEE NOTE 4)	N/A	N/A	5.01 [127.25 mm] 4.69 [119.13 mm]
SENSOR WIRE TERMINAL JUNCTION BOX (FOR REMOTE OPTION)		N/A	N/A	3.16 [80.26 mm] 2.81 [71.37 mm]

NOTES:

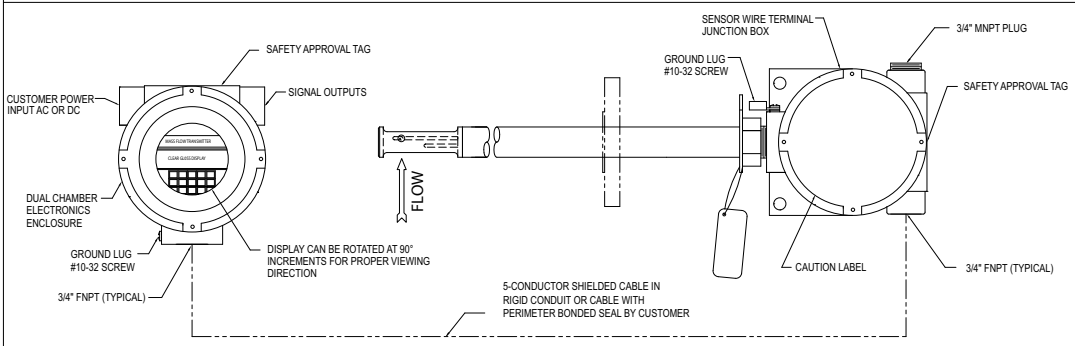
1. FOR FLANGED OPTION L = (U + L2 - 1.23 [31.24 mm]
   U (MIN.) = 4.00 [101.6 mm]
2. L2 (MIN.) = 5.00 [127.0 mm]
3. THIS PROBE CONFIGURATION ALSO USED FOR DIRECTLY ATTACHED, DC POWERED, NO DISPLAY
4. SENSOR WIRE TERMINAL JUNCTION BOX USED FOR SENSOR ELECTRONICS FOR DC POWERED, NO DISPLAY
5. ENCLOSURE STYLES AND DIMENSIONS ARE SUBJECT TO CHANGE

454FTB Outline Drawing (1 of 2)

SERIES 454FTB OUTLINE DRAWINGS



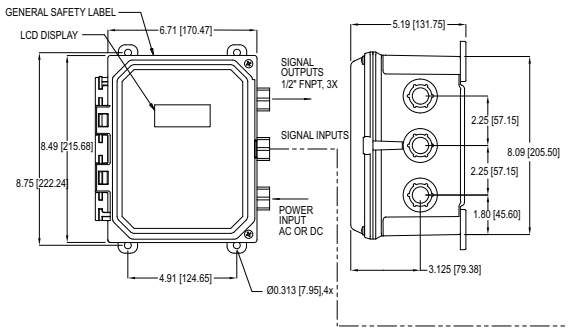
DIRECTLY ATTACHED ELECTRONICS ENCLOSURE (TA)
W/ DISPLAY & KEYPAD OPTION SHOWN IN
STANDARD ORENTATION
(NOTE 5)



SENSOR ELECTRONICS FOR
REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
W/ DISPLAY & KEYPAD OPTION (SHOWN)
(NOTE 4) (NOTE 5)

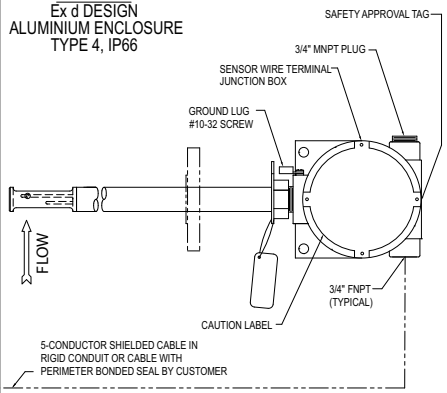
PROBE ASSEMBLY FOR
REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
(NOTE 3) (NOTE 5)

ZONE 2
Ex n DESIGN
POLYCARBONATE ENCLOSURE



SENSOR ELECTRONICS FOR REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (PTS) (WALL MOUNT)
W/ DISPLAY & KEYPAD OPTION (SHOWN)
(NOTES 5 & 6)

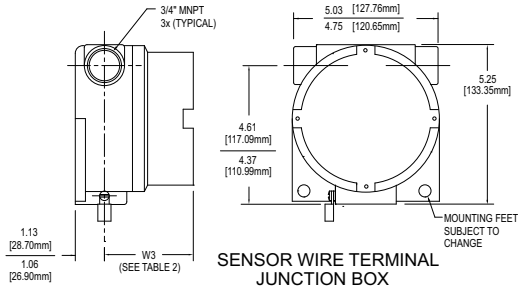
ZONE 1
Ex d DESIGN
ALUMINIUM ENCLOSURE
TYPE 4, IP66



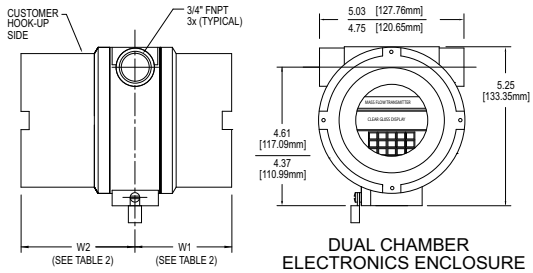
PROBE ASSEMBLY FOR REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
(NOTES 5 & 6)

454FTB Outline Drawing (2 of 2)

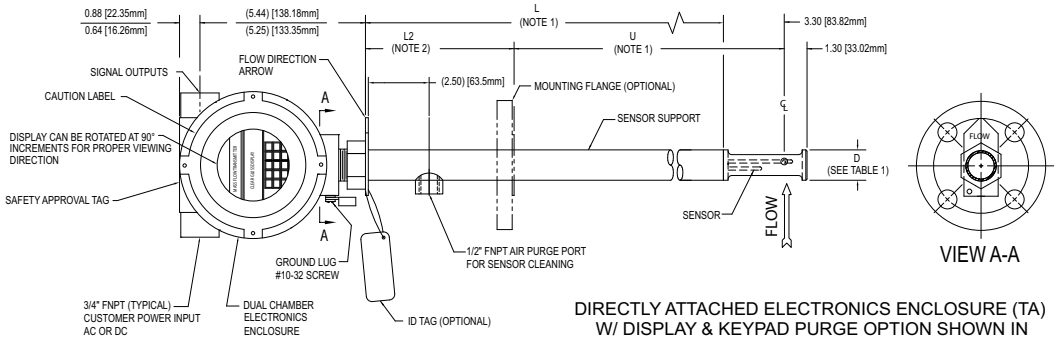
SERIES 454FTB OUTLINE DRAWINGS (cont'd)



SENSOR WIRE TERMINAL
JUNCTION BOX
(NOTE 4) (NOTE 5)



DUAL CHAMBER
ELECTRONICS ENCLOSURE
(SHOWN W/ WINDOW LID)
(NOTE 5)



DIRECTLY ATTACHED ELECTRONICS ENCLOSURE (TA)
W/ DISPLAY & KEYPAD PURGE OPTION SHOWN IN
STANDARD ORENTATION
(NOTE 5)

TABLE 1. PROBE DIAMETER DIMENSION

MODEL NO.	D
-12	0.50 [12.7mm]
-12	0.75 [19.05mm]
-16	1.00 [25.4mm]

TABLE 2. ENCLOSURE DIMENSION (NOTE 5)

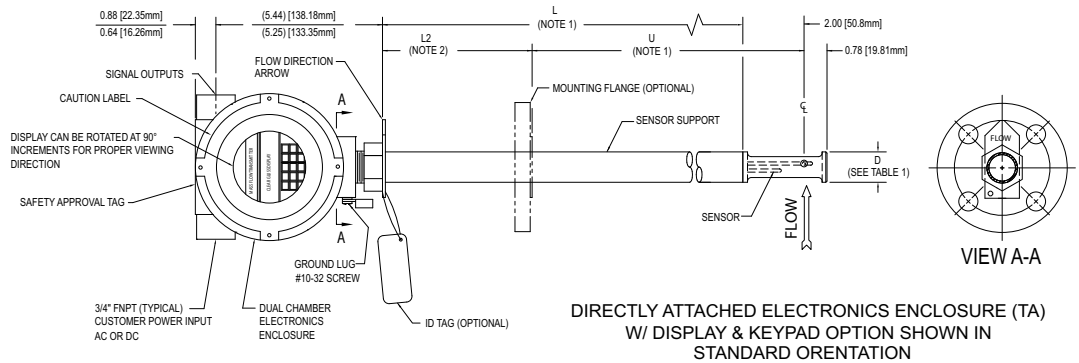
INPUT POWER	DISPLAY / KEYPAD	W1 (MAX.) / (MIN.)	W2 (MAX.) / (MIN.)	W3 (MAX.) / (MIN.)
AC	YES	3.63 [92.20mm] / 3.41 [86.61mm]	5.01 [127.25mm] / 4.69 [119.13mm]	N/A
AC	NO	3.16 [80.26mm] / 2.81 [71.37mm]	5.01 [127.25mm] / 4.69 [119.13mm]	N/A
24VDC	YES	3.63 [92.20mm] / 3.41 [86.61mm]	5.01 [127.25mm] / 4.69 [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]

NOTES:

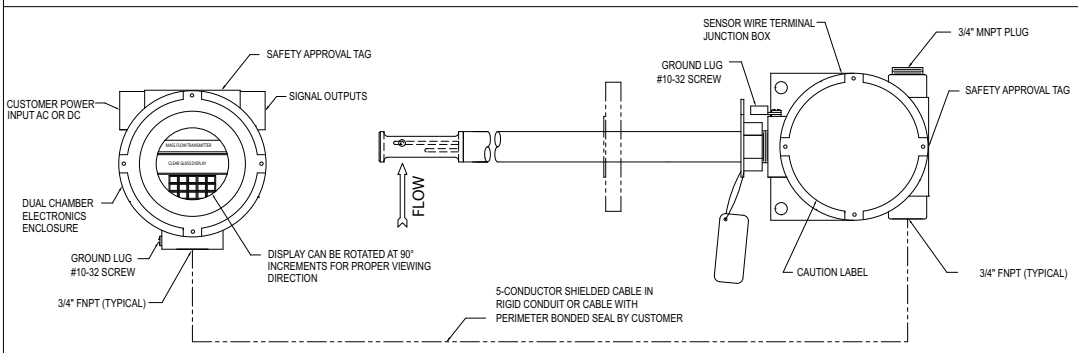
1) FOR FLANGED OPTION: L = (U + L2 - 2.00 [50.8mm]), U (MIN.) = 4.00 [101.6mm]
2) L2 (MIN.) FOR -HT TO BE 5.00 [127mm]
   L2 (MIN.) FOR -HHT TO BE 8.00 [203.2 mm]
3) THIS PROBE CONFIGURATION ALSO USED FOR DIRECTLY ATTACHED, DC POWERED, WITHOUT DISPLAY.
4) SENSOR WIRE TERMINIAL JUNCTION BOX USED FOR SENSOR ELECTRONICS FOR DC POWERED, WITHOUT DISPLAY.
5) ENCLOSURE STYLES AND DIMENSIONS ARE SUBJECT TO CHANGE.
6) DIM. FOR 454FTB-08 (.50 [12.7mm] DIA.) TO BE 0.78 [19.81mm]
   DIM. FOR 454FTB-12 (0.75 [19.05mm] DIA.) TO BE 0.78 [19.81mm]
   DIM. FOR 454FTB-16 (1.00 [25.4mm] DIA.) TO BE 0.78 [19.81mm]
   DIM. FOR 454PFTB-16 (1.00 [25.4mm] DIA.) TO BE 1.30 [33.02mm]
7) THIS CONFIGURATIONS ALLOWS FOR PROBE ASSY TO BE MOUNTED IN ZONE 1 AREA

454FTB-WGF Outline Drawing (1 of 2)

SERIES 454FTB-WGF OUTLINE DRAWINGS



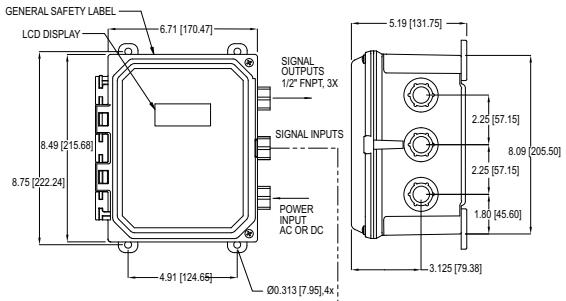
DIRECTLY ATTACHED ELECTRONICS ENCLOSURE (TA)
W/ DISPLAY & KEYPAD OPTION SHOWN IN
STANDARD ORENTATION
(NOTE 5)



SENSOR ELECTRONICS FOR
REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
W/ DISPLAY & KEYPAD OPTION (SHOWN)
(NOTE 4) (NOTE 5)

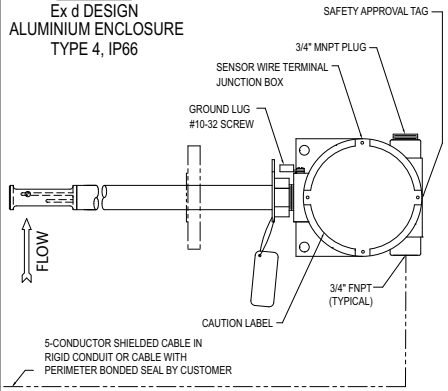
PROBE ASSEMBLY FOR
REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
(NOTE 3) (NOTE 5)

ZONE 2
Ex n DESIGN
POLYCARBONATE ENCLOSURE



SENSOR ELECTRONICS FOR REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (PTS) (WALL MOUNT)
W/ DISPLAY & KEYPAD OPTION (SHOWN)
(NOTES 5 & 6)

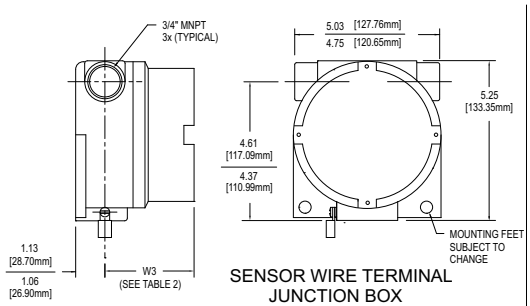
ZONE 1
Ex d DESIGN
ALUMINIUM ENCLOSURE
TYPE 4, IP66



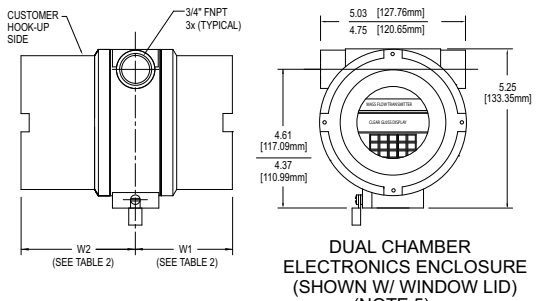
PROBE ASSEMBLY FOR REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
(NOTES 5 & 6)

454FTB-WGF Outline Drawing (2 of 2)

SERIES 454FTB-WGF OUTLINE DRAWINGS (cont'd)



SENSOR WIRE TERMINAL
JUNCTION BOX
(NOTE 4) (NOTE 5)



DUAL CHAMBER
ELECTRONICS ENCLOSURE
(SHOWN W/ WINDOW LID)
(NOTE 5)

TABLE 1. PROBE DIAMETER DIMENSION	
MODEL NO.	D
-12	0.75 [19.05mm]
-16	1.00 [25.4mm]

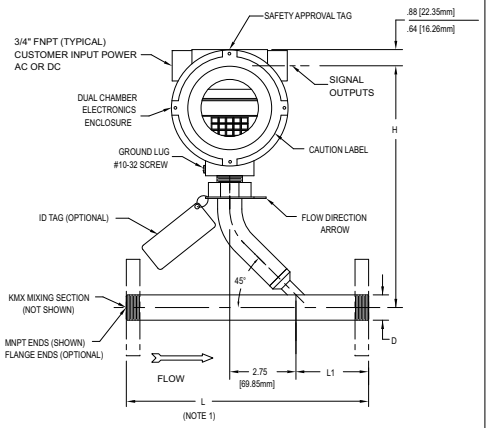
TABLE 2. ENCLOSURE DIMENSION (NOTE 5)				
INPUT POWER	DISPLAY / KEYPAD	W1 (MAX.) / (MIN.)	W2 (MAX.) / (MIN.)	W3 (MAX.) / (MIN.)
AC	YES	3.63 [92.20mm] / 3.41 [86.61mm]	5.01 [127.25mm] / 4.69 [119.13mm]	N/A
AC	NO	3.16 [80.26mm] / 2.81 [71.37mm]	5.01 [127.25mm] / 4.69 [119.13mm]	N/A
24VDC	YES	3.63 [92.20mm] / 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]

NOTES:

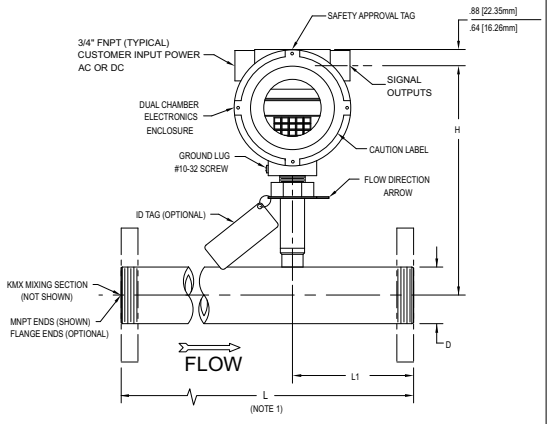
1) FOR FLANGED OPTION: L = (U + L2 - 2.00 [50.8mm]), U (MIN.) = 4.00 [101.6mm].
2) L2 (MIN.) FOR -HT TO BE 5.00 [127mm].
3) THIS PROBE CONFIGURATION ALSO USED FOR DIRECTLY ATTACHED, DC POWERED, NO DISPLAY.
4) SENSOR WIRE TERMINIAL JUNCTION BOX USED FOR SENSOR ELECTRONICS FOR DC POWERED, NO DISPLAY.
5) ENCLOSURE STYLES AND DIMENSIONS ARE SUBJECT TO CHANGE.
6) THIS CONFIGURATIONS ALLOWS FOR PROBE ASSY TO BE MOUNTED IN ZONE 1 AREA AND FOR REMOTE ELECTRONICS TO BE MOUNTED IN ZONE 2 AREA.

504FTB Outline Drawing (1 of 2)

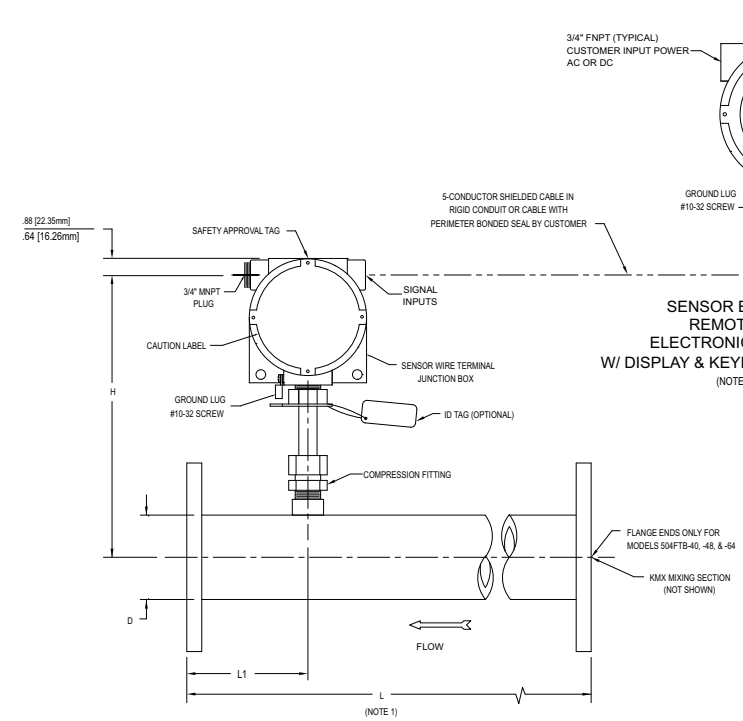
SERIES 504FTB OUTLINE DRAWINGS



MODELS 504FTB-6A, -6, -8, -12, & -16
SHOWN DIRECTLY ATTACHED WITH STANDARD
DISPLAY ORIENTATION (NOTE 5)



MODELS 504FTB-24, & -32
SHOWN DIRECTLY ATTACHED WITH STANDARD
DISPLAY ORIENTATION (NOTE 5)



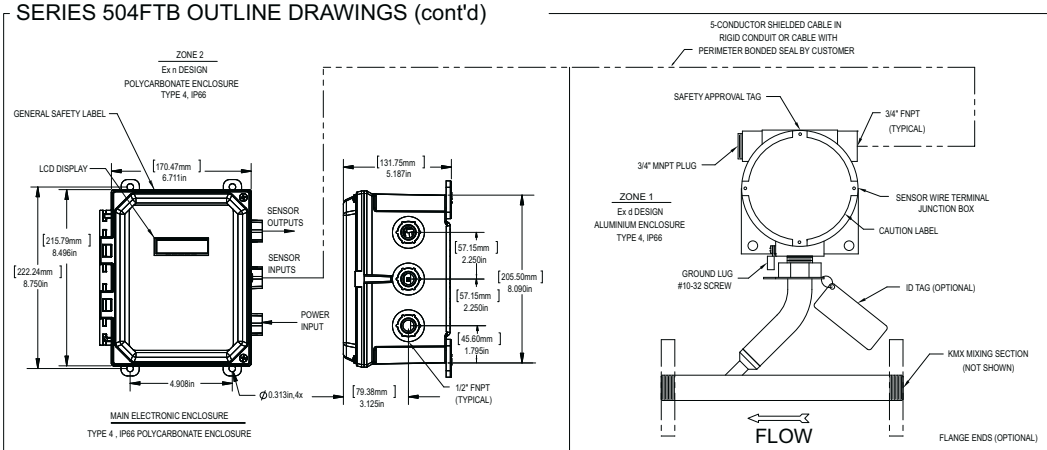
SENSOR ELECTRONICS FOR
REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
W/ DISPLAY & KEYPAD OPTION (SHOWN)
(NOTE 4) (NOTE 5)

MODELS 504FTB-40, -48, & -64
SHOWN REMOTELY ATTACHED

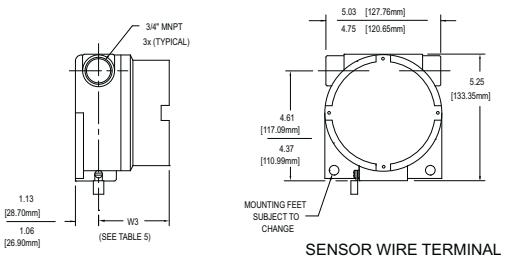
MODELS 504FTB-40, -48, & -64
FLOW BODY ASSEMBLY SHOWN
FOR REMOTELY ATTACHED
ELECTRONICS ENCLOSURE (TS)
(NOTE 3) (NOTE 5)

504FTB Outline Drawing (2 of 2)

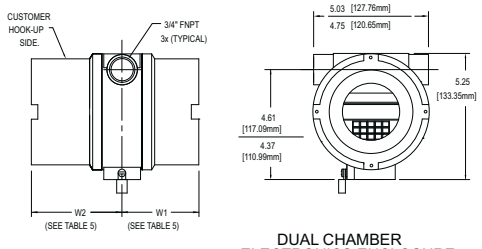
SERIES 504FTB OUTLINE DRAWINGS (cont'd)



MODEL 504FTB-6A, -6, -8, -12, & -16
FLOW BODY ASSEMBLY FOR REMOTELY ATTACHED ELECTRONICS ENCLOSURE (TS) SHOWN
(NOTES 3, 5, & 6)



SENSOR WIRE TERMINAL JUNCTION BOX
(NOTE 4) (NOTE 5)



DUAL CHAMBER ELECTRONICS ENCLOSURE (SHOWN W/ WINDOW LID)
(NOTE 5)

TABLE 4 SERIES 504FTB IN-LINE MASS FLOW TRANSMITTERS DIMENSIONS

MODEL NUMBER	NOMINAL PIPE SIZE (INCHES)	D INCHES [mm]	NOMINAL FLANGE SIZE (INCHES)	L (NOTE 1) INCHES [mm]	L1 INCHES [mm]	H INCHES [mm]	NET WEIGHT (APPROX.) LBS. [kg] (NOTE 2)		
							THREADED	CL150 FLANGED	CL300 FLANGED
504FTB-6A	3/8	0.675 [17.15mm]	1/2	7.00 [177.80mm]	2.50 [63.50mm]	9.94 [252.48mm]	7.00 [3.18kg]	9.00 [4.08kg]	11.00 [4.99kg]
504FTB-6	3/8	0.675 [17.15mm]	1/2	7.00 [177.80mm]	2.50 [63.50mm]	9.94 [252.48mm]	7.00 [3.18kg]	9.00 [4.08kg]	11.00 [4.99kg]
504FTB-8	1/2	0.840 [21.34mm]	1/2	8.00 [203.20mm]	3.00 [76.20mm]	10.02 [254.51mm]	7.50 [3.40kg]	9.50 [4.31kg]	11.50 [5.22kg]
504FTB-12	3/4	1.050 [26.67mm]	3/4	10.00 [254.00mm]	3.00 [76.20mm]	10.13 [257.30mm]	8.00 [3.63kg]	11.50 [5.22kg]	13.50 [6.12kg]
504FTB-16	1	1.315 [33.40mm]	1	12.00 [304.80mm]	3.50 [88.90mm]	10.25 [260.35mm]	8.50 [3.86kg]	12.50 [5.67kg]	14.50 [6.58kg]
504FTB-24	1-1/2	1.900 [48.26mm]	1-1/2	18.00 [457.20mm]	4.00 [101.60mm]	9.30 [236.22mm]	10.50 [4.67kg]	19.00 [8.62kg]	23.00 [10.43kg]
504FTB-32	2	2.375 [60.33mm]	2	24.00 [609.60mm]	5.00 [127.00mm]	9.54 [242.32mm]	14.00 [6.35kg]	24.00 [10.89kg]	30.00 [13.61kg]
504FTB-40	2-1/2	2.875 [73.03mm]	2-1/2	24.00 [609.60mm]	5.00 [127.00mm]	11.78 [299.21mm]	N/A	32.50 [14.74kg]	42.50 [19.28kg]
504FTB-48	3	3.500 [88.90mm]	3	24.00 [609.60mm]	5.00 [127.00mm]	11.78 [299.21mm]	N/A	40.00 [18.14kg]	54.00 [24.49kg]
504FTB-64	4	4.500 [114.30mm]	4	24.00 [609.60mm]	5.00 [127.00mm]	11.78 [299.21mm]	N/A	62.50 [28.35kg]	82.50 [37.42kg]

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]

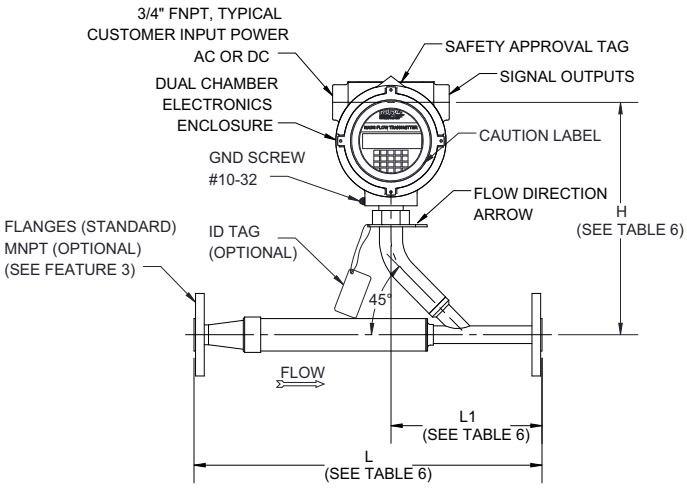
NOTES:

1) L DIMENSION IS OVERALL END TO END.
2) WEIGHTS SHOWN ARE FOR DIRECTLY ATTACHED AC POWER W/ DISPLAY. FOR REMOTELY ATTACHED VERSIONS ADD 4.0 LBS. [1.82kg].
3) THIS PROBE CONFIGURATION ALSO USED FOR DIRECTLY ATTACHED, DC POWERED, NO DISPLAY.
4) SENSOR WIRE TERMINIAL JUNCTION BOX USED FOR SENSOR ELECTRONICS FOR DC POWERED, NO DISPLAY.
5) ENCLOSURE STYLES AND DIMENSIONS ARE SUBJECT TO CHANGE.
6) THIS CONFIGURATIONS ALLOWS FOR PROBE ASSY TO BE MOUNTED IN ZONE 1 AREA AND FOR REMOTE ELECTRONICS TO BE MOUNTED IN ZONE 2 AREA.

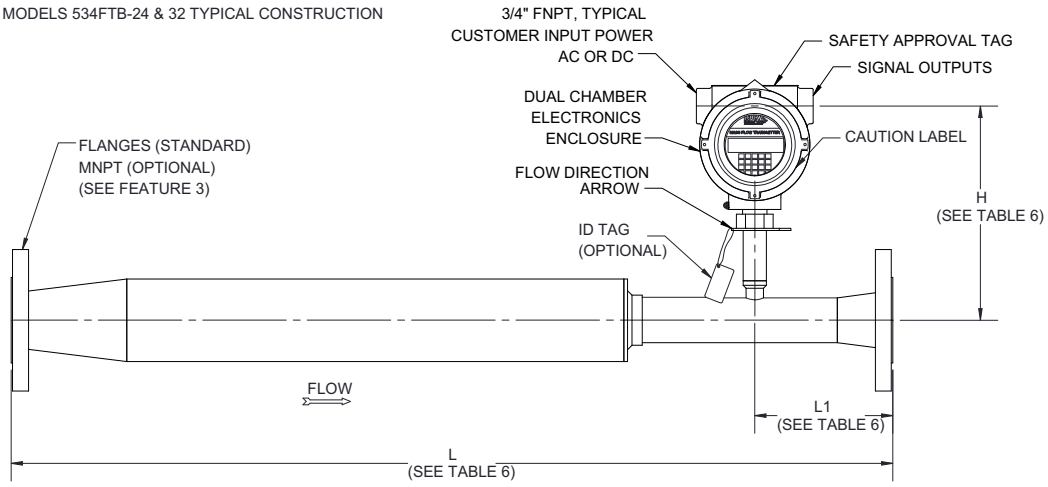
534FTB Outline Drawing (1 of 4)

SERIES 534FTB OUTLINE DRAWINGS

DIRECTLY ATTACHED ELECTRONICS ENCLOSURE (TA)
SHOWN WITH MODEL 534FTB-08A
SHOWN WITH DISPLAY IN STANDARD ORIENTATION
MODELS 534FTB-06A,06,-08,-12 & -16 TYPICAL CONSTRUCTION



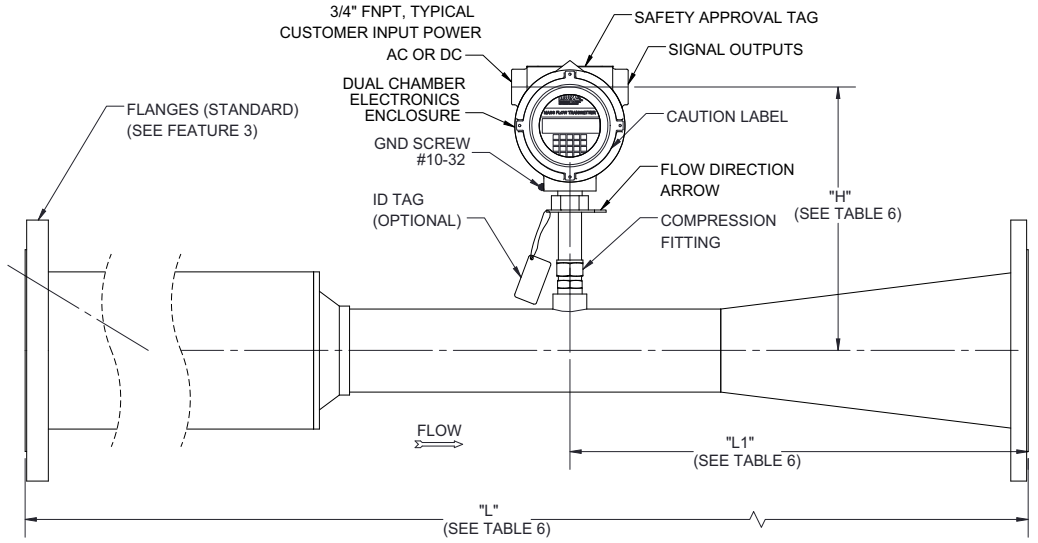
DIRECTLY ATTACHED ELECTRONICS ENCLOSURE (TA)
SHOWN WITH MODEL 534FTB-24B
SHOWN WITH DISPLAY IN STANDARD ORIENTATION
MODELS 534FTB-24 & 32 TYPICAL CONSTRUCTION



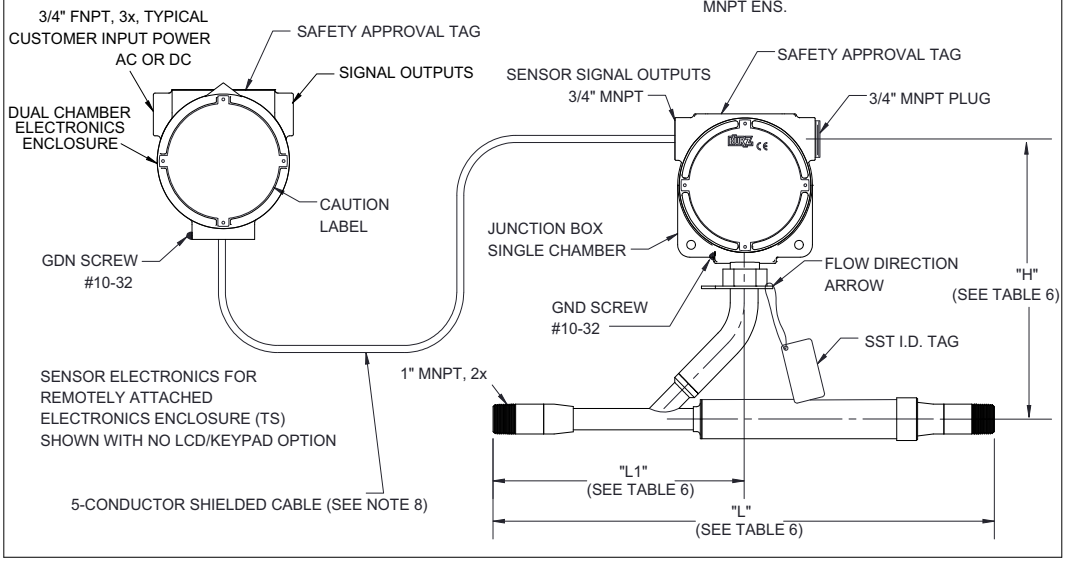
534FTB Outline Drawing (2 of 4)

SERIES 534FTB OUTLINE DRAWINGS (cont'd)

DIRECTLY ATTACHED ELECTRONICS ENCLOSURE (TA)
SHOWN WITH MODEL 534FTB-48A
SHOWN WITH DISPLAY IN STANDARD ORIENTATION
MODELS 534FTB-48 THRU -96 TYPICAL CONSTRUCTION

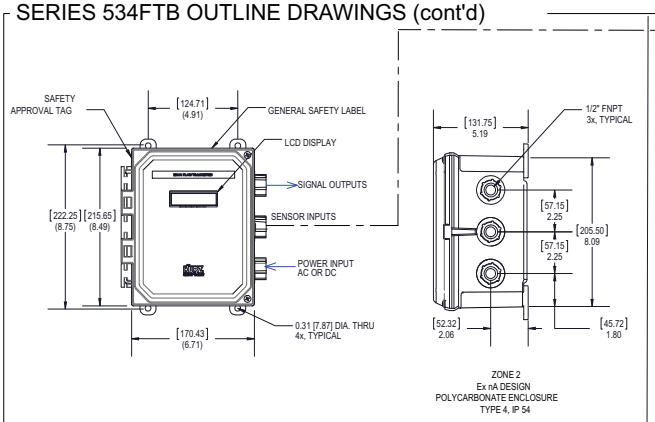


REMOTE ELECTRONICS ENCLOSURE
SHOWN WITH MODEL 534FTB-08B WITH
MNPT ENS.

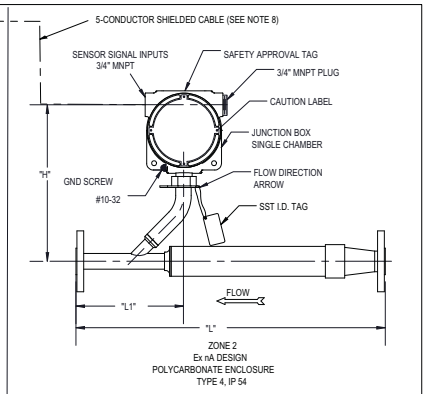


534FTB Outline Drawing (3 of 4)

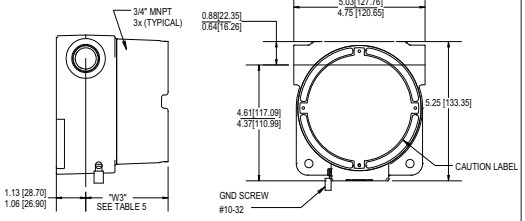
SERIES 534FTB OUTLINE DRAWINGS (cont'd)



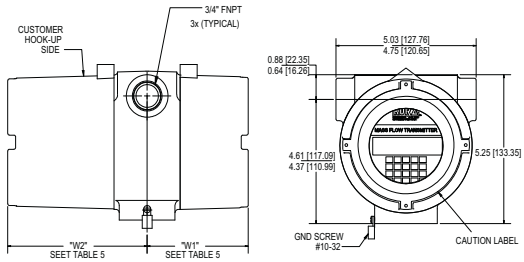
SENSOR ELCTRONICS FOR REMOTLEY ATTACHED
ELECTRONICS ENCLOSURE (TS) WALL MOUNT
WITH DISPLAY & KEYPAD
(SEE NOTES 3 & 4)



REMOTE SENSOR ELECTRONICS (TS)
SHOWN MODEL No. 534FTB-12A
ALSO CONSTRUCTION FOR DC POWER, NO DISPLAY
CONFIGURATION



SENSOR WIRE TERMINAL
JUNCTION BOX
(NOTE 4 & 5)



DUAL CHAMBER
ELECTRONICS ENCLOSURE
(SHOWN WITH WINDOW LID)
(SEE NOTE 5)

TABLE 5. ENCLOSURE DIMENSION, ALL DIMENSION IN INCHES [ ] IN mm (NOTE 3)

INPUT POWER	DISPLAY/KEYPAD	W1 (MAX) / (MIN)	W2 (MAX) / (MIN)	W3 (MAX) / (MIN)
AC	YES	3.63 [92.20] / 3.41 [86.61]	5.01 [127.25] / 4.69 [119.13]	N/A
AC	NO	3.16 [80.26] / 2.81 [71.37]	5.01 [127.25] / 4.69 [119.13]	N/A
24 VDC	YES	3.63 [92.20] / 3.41 [86.61]	5.01 [127.25] / 4.69 [119.13]	N/A
24 VDC	NO (SEE NOTE 4)	N/A	N/A	5.01 [127.25] / 4.88 [123.95]
SENSOR WIRE TERMINAL J-BOX (FOR REMOTE OPT.)		N/A	N/A	3.16 [80.26] / 2.81 [71.37]

NOTES: UNLESS OTHERWISE SPECIFIED ALL DIMENSION ARE IN INCHES [ ] IN mm.

1. THIS PROBE CONFIGURATION ALSO USED FOR DIRECTLY ATTACHED, DC POWERED WITH NO DISPLAY.
2. SENSOR WIRE TERMINAL JUCTION BOX USED FOR SENSOR ELECTRONICS AND FOR DC POWERED, WITH NO DISPLAY OPTIONS
3. ENCLOSURE STYLES AND DIMENSIONS ARE SUBJECT TO CHANGE.
4. THIS CONFIGURATION ALLOWS FOR PROBE ASSEMBLY TO BE MOUNTED IN ZONE 1 AND REMOTE ELECTRONICS CAN BE IN ZONE 2 APPLICATIONS.
5. L DIMENSION IS OVERALL END TO END.
6. ADD 3.00 [76.2] TO L AND L1 DIMENSIONS FOR MNPT OPTION.
7. WEIGHTS SHOWN ARE FOR DIRECTLY ATTACHED AC POWER WITH DISPLAY FOR REMOTE ATTACHED VERSIONS ADD 4.0 LBS (1.82) kg.
8. SHIELDED CABLE IN RIGID CONDUIT OR CABLE WITH PERIMETER BONDED SEAL (BY CUSTOMER).

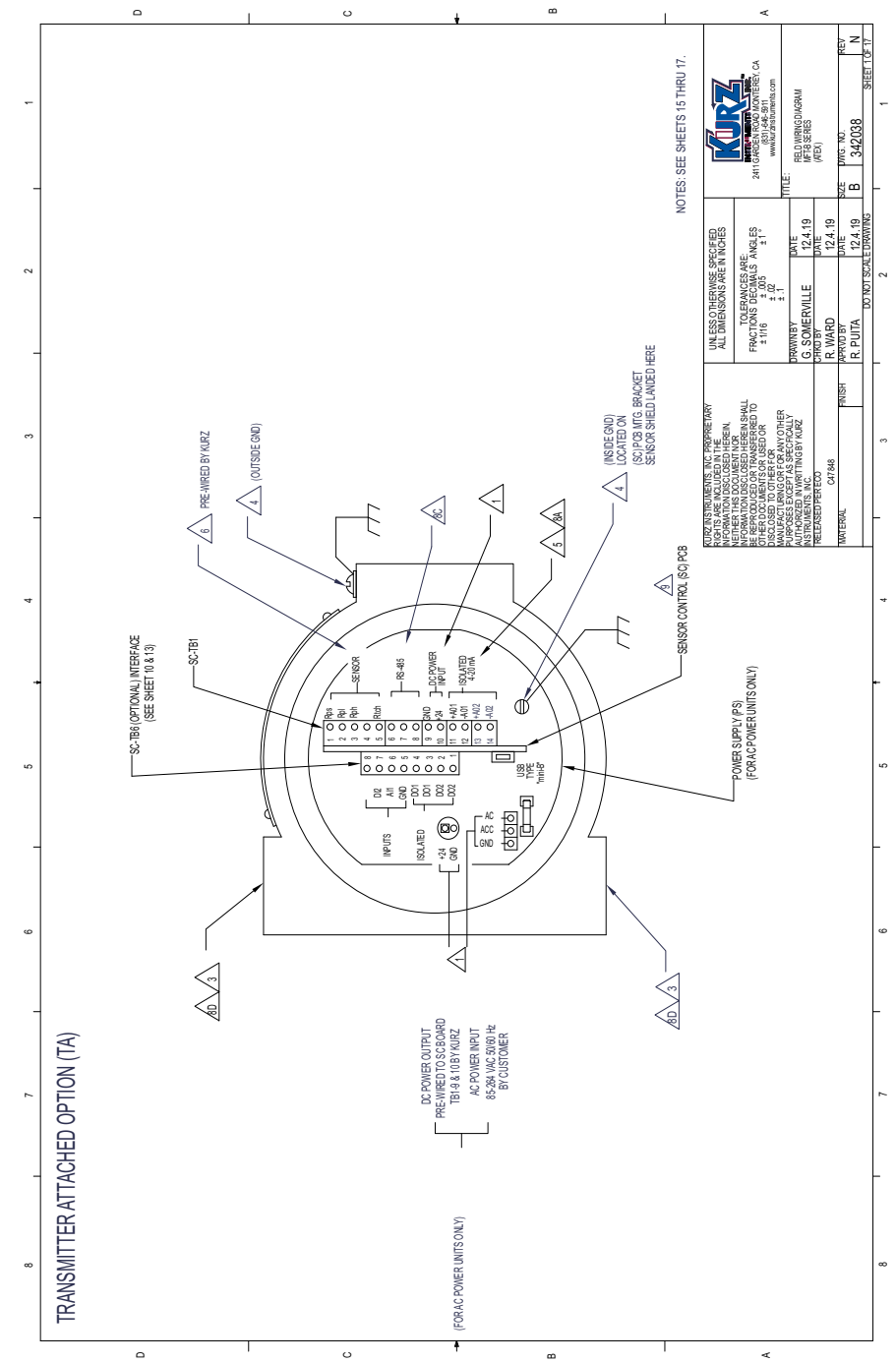
534FTB Outline Drawing (4 of 4)

SERIES 534FTB OUTLINE DRAWINGS (cont'd)

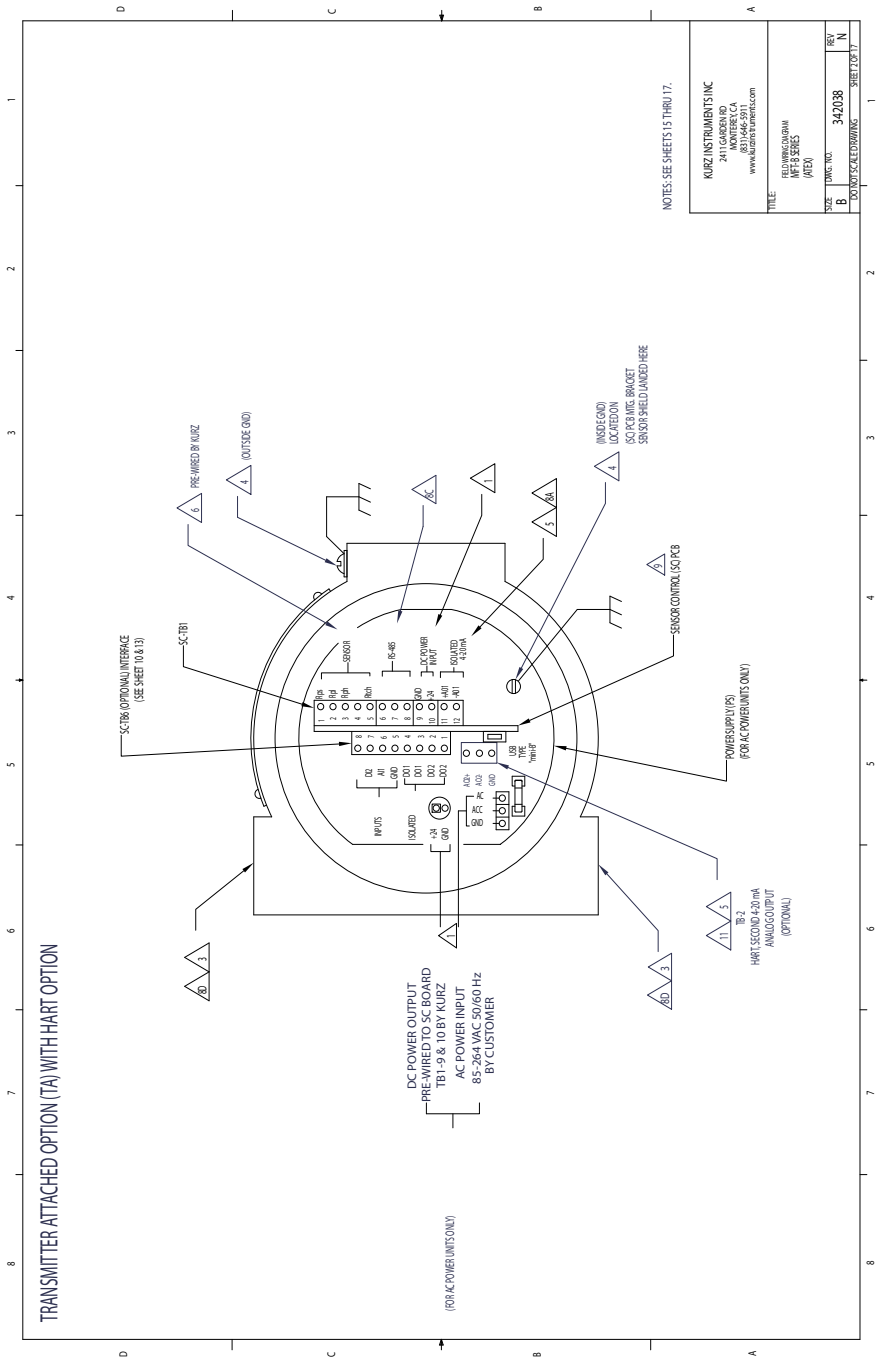
TABLE 6 SERIES 534FTB IN-LINE THERMAL MASS FLOW TRANSMITTER DIMENSIONS & WEIGHTS

MODEL NUMBER	NOMINAL PIPE SIZE (INCHES)	DIMENSIONS INCHES [mm] (NOTES 5 & 6)			NET WEIGHT (APPROX.) LBS. (kg) (NOTE 7)		
		(L)	(L1)	(H)	MNPT	CL150	CL300
534FTB-06A	1/2"	9.0 [228.6]	6.17 [228.6]	9.96 [253.0]	6.7 (3.04)	8.2 (3.72)	9.2 (4.17)
534FTB-06B	3/4"	9.0 [228.6]	6.17 [228.6]	9.96 [253.0]	6.8 (3.08)	9.1 (4.13)	11.2 (5.08)
534FTB-06C	1"	9.0 [228.6]	6.17 [228.6]	9.96 [253.0]	7.0 (3.17)	10.1 (4.58)	12.6 (5.71)
534FTB-08A	1/2"	15.0 [381.0]	6.23 [158.2]	9.96 [253.0]	7.4 (3.36)	8.9 (4.04)	9.9 (10.35)
534FTB-08B	3/4"	15.0 [381.0]	7.23 [183.6]	9.96 [253.0]	7.6 (3.45)	9.9 (10.35)	12.0 (5.44)
534FTB-08C	1"	15.0 [381.0]	8.23 [209.0]	9.96 [253.0]	7.6 (3.45)	10.7 (4.85)	13.2 (5.99)
534FTB-12A	3/4"	20.0 [508.0]	6.67 [169.4]	10.08 [256.0]	9.6 (4.35)	11.9 (5.40)	14.0 (6.35)
534FTB-12B	1"	20.0 [508.0]	7.54 [191.5]	10.08 [256.0]	9.3 (4.22)	12.4 (5.62)	14.9 (6.76)
534FTB-12C	1-1/2"	20.0 [508.0]	9.98 [253.5]	10.08 [256.0]	9.9 (4.49)	15.0 (6.80)	20.0 (9.07)
534FTB-16A	1"	26.0 [660.4]	7.48 [190.0]	10.21 [259.3]	11.9 (5.40)	15.0 (6.80)	17.5 (7.94)
534FTB-16B	1-1/2"	26.0 [660.4]	9.79 [248.7]	10.21 [259.3]	11.8 (5.35)	16.9 (7.66)	21.9 (9.93)
534FTB-16C	2"	26.0 [660.4]	11.67 [296.4]	10.21 [259.3]	12.5 (5.67)	20.5 (9.30)	23.6 (10.70)
534FTB-24A	1-1/2"	38.0 [965.2]	4.00 [101.6]	9.28 [235.7]	18.5 (8.39)	23.6 (10.70)	28.6 (12.97)
534FTB-24B	2"	38.0 [965.2]	5.96 [151.4]	9.28 [235.7]	18.8 (8.53)	26.8 (12.15)	29.9 (13.56)
534FTB-24C	3"	38.0 [965.2]	10.75 [273.1]	9.28 [235.7]	N/A	35.2 (15.96)	42.6 (19.31)
534FTB-32A	2"	48.0 [1219.2]	4.87 [121.4]	9.54 [242.3]	26.6 (12.06)	34.6 (15.69)	37.7 (17.09)
534FTB-32B	3"	48.0 [1219.2]	9.52 [241.8]	9.54 [242.3]	N/A	42.9 (19.46)	50.3 (22.81)
534FTB-32C	4"	48.0 [1219.2]	13.68 [347.5]	9.54 [242.3]	N/A	49.0 (22.22)	N/A
534FTB-48A	3"	72.0 [1828.8]	7.18 [182.4]	13.18 [334.8]	N/A	72.4 (32.83)	N/A
534FTB-48B	4"	72.0 [1828.8]	11.24 [285.5]	13.18 [334.8]	N/A	78.6 (35.65)	N/A
534FTB-48C	6"	72.0 [1828.8]	20.00 [50.8]	13.18 [334.8]	N/A	87.5 (39.68)	N/A
534FTB-64A	4"	94.0 [2387.6]	9.18 [233.2]	13.18 [334.8]	N/A	122.6 (55.60)	N/A
534FTB-64B	6"	94.0 [2387.6]	17.82 [452.6]	13.18 [334.8]	N/A	131.4 (59.60)	N/A
534FTB-64C	8"	94.0 [2387.6]	26.12 [663.4]	13.18 [334.8]	N/A	151.9 (68.89)	N/A

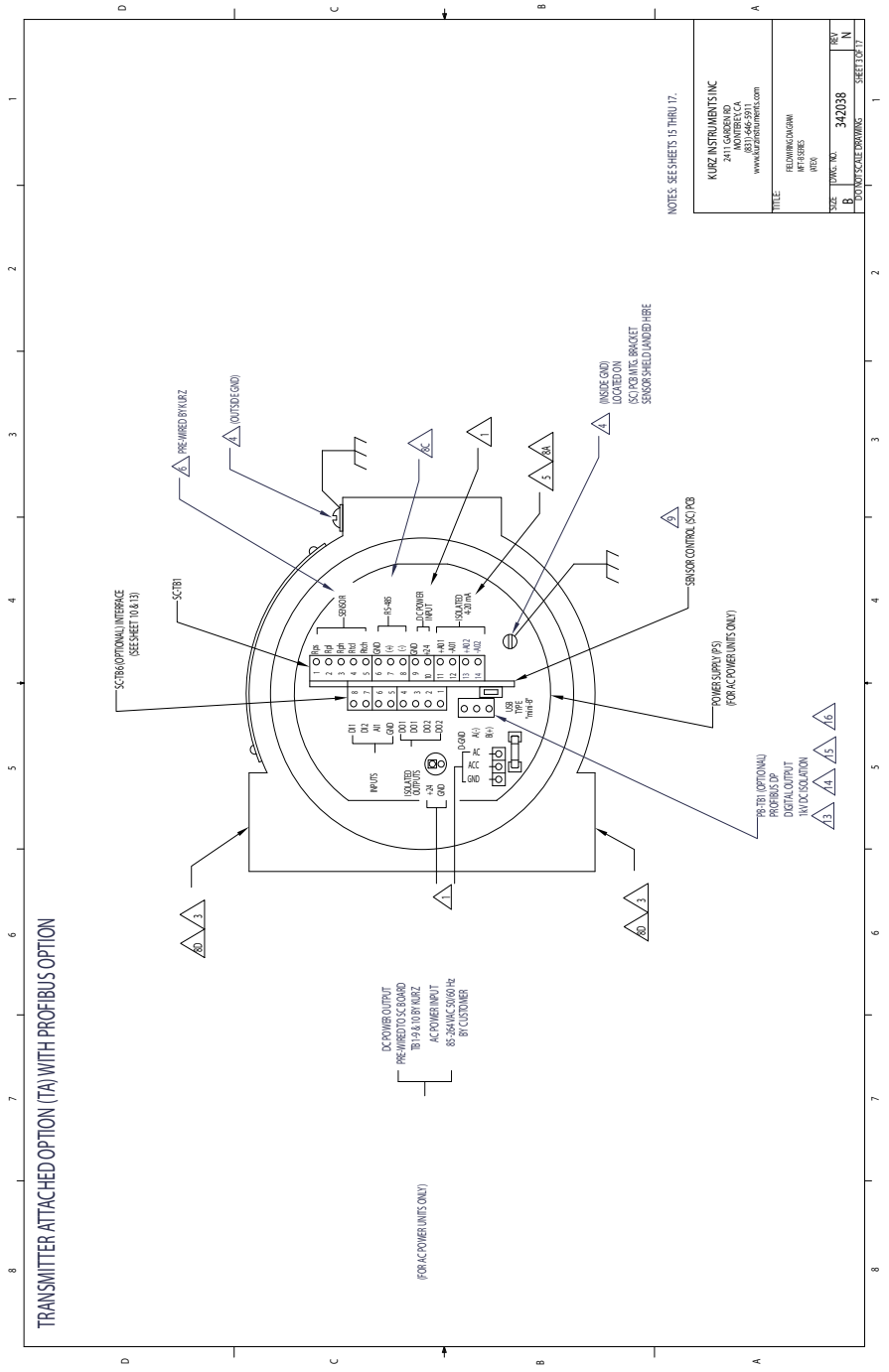
Field Wiring Diagram (1 of 17) — Transmitter Attached



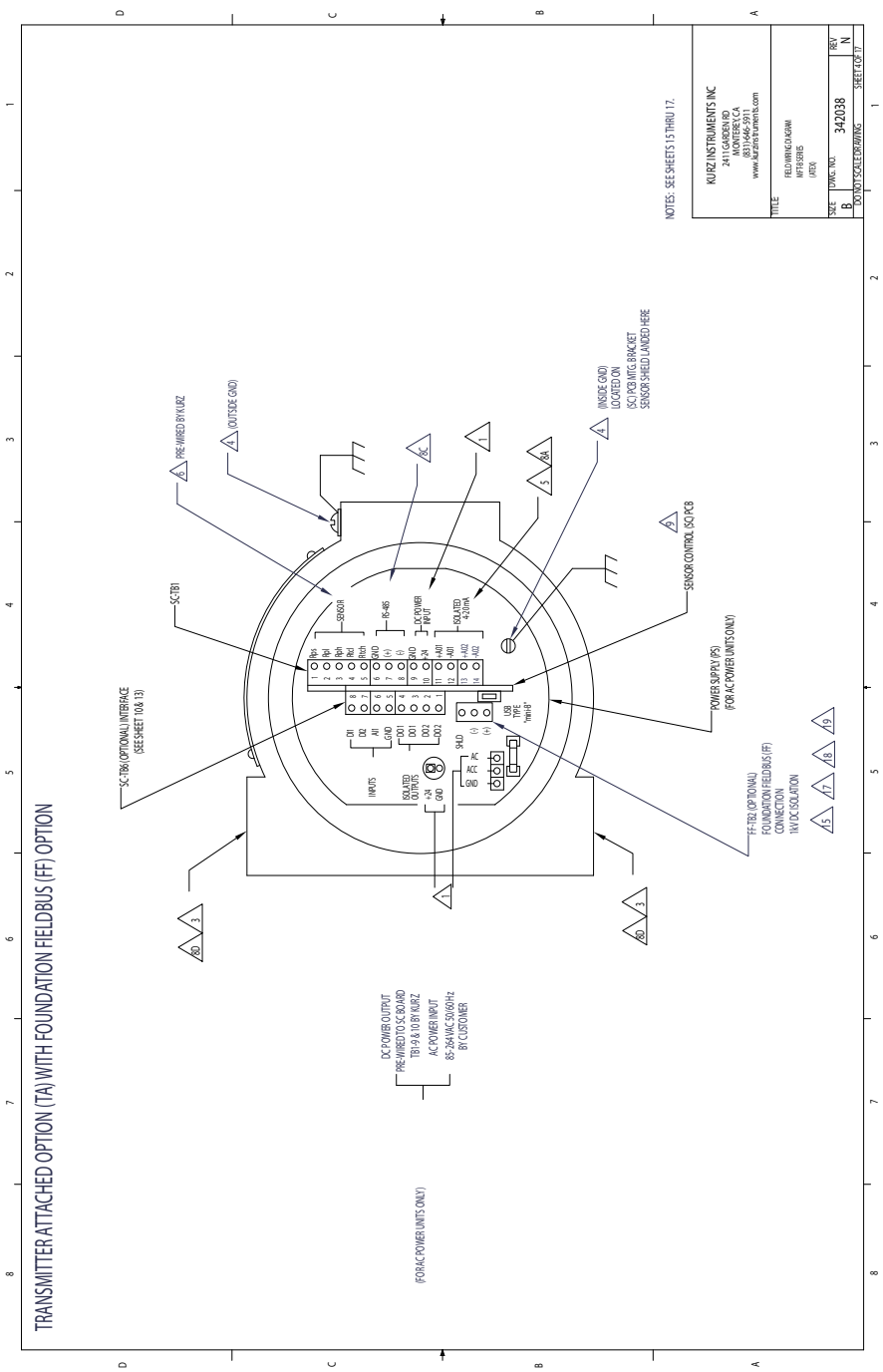
Field Wiring Diagram (2 of 17) — Transmitter Attached w/ HART Option



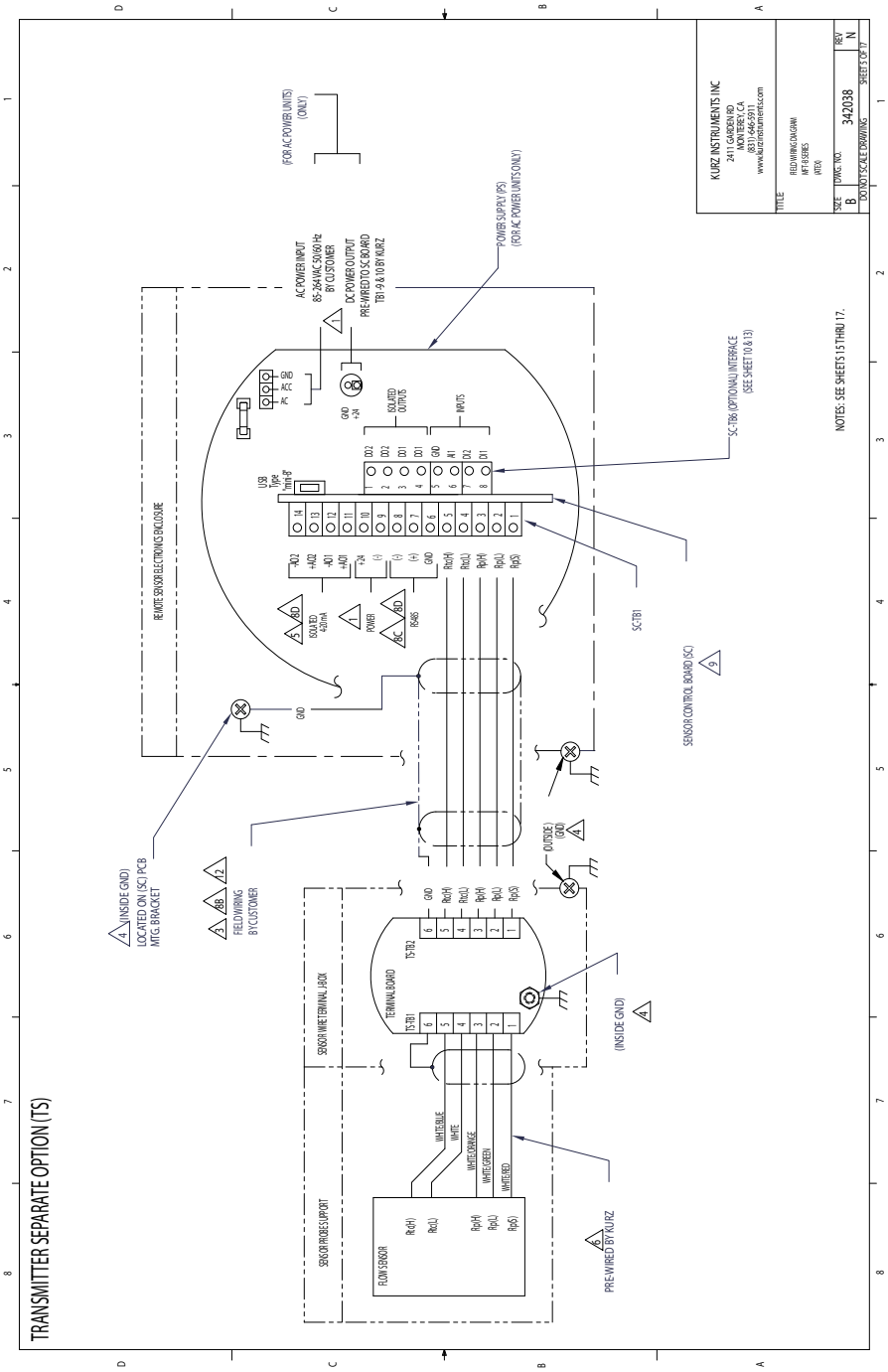
Field Wiring Diagram (3 of 17) — Transmitter Attached w/ Profibus Option



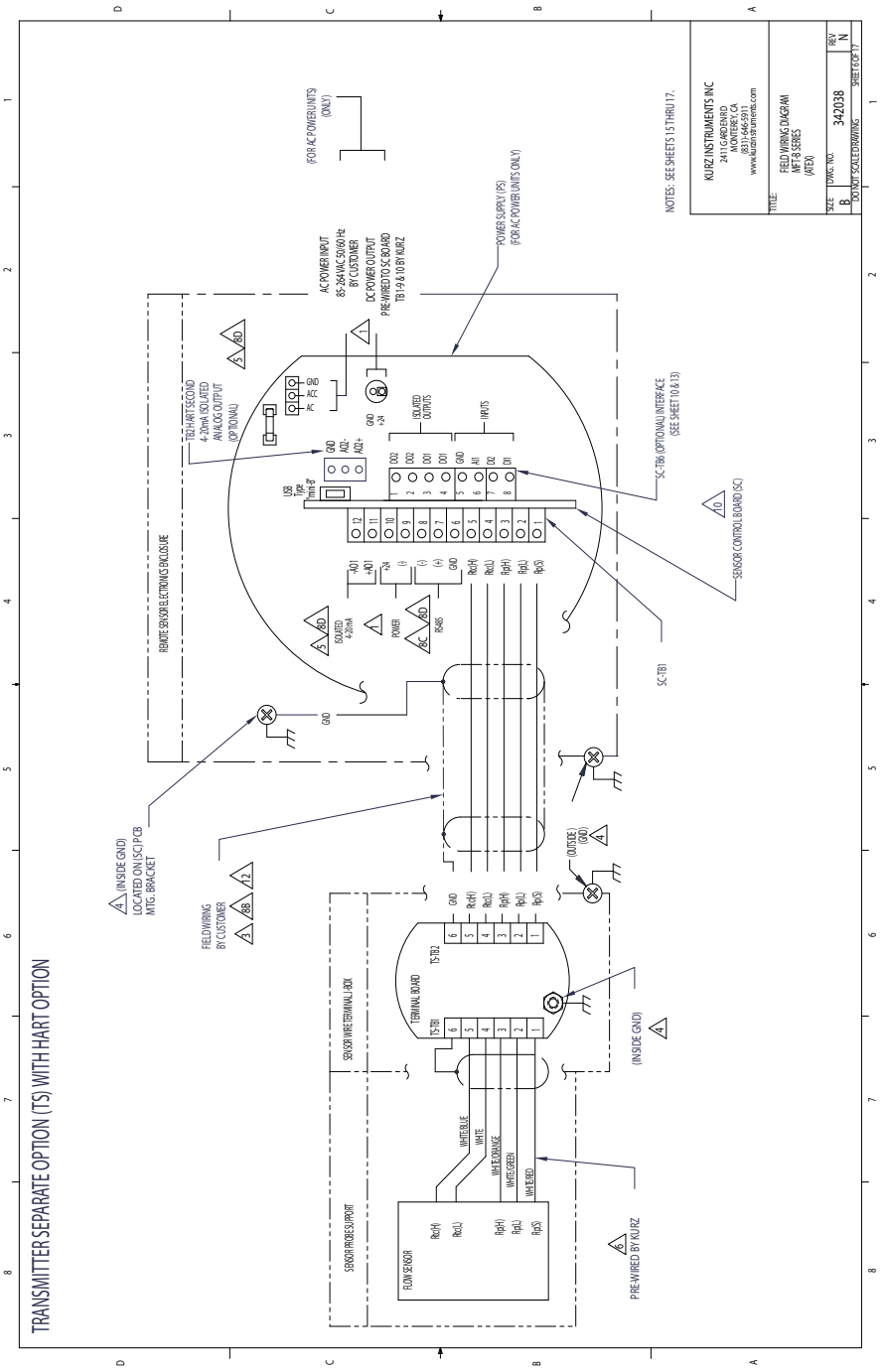
Field Wiring Diagram (4 of 17) — Transmitter Attached w/ Foundation Fieldbus Option



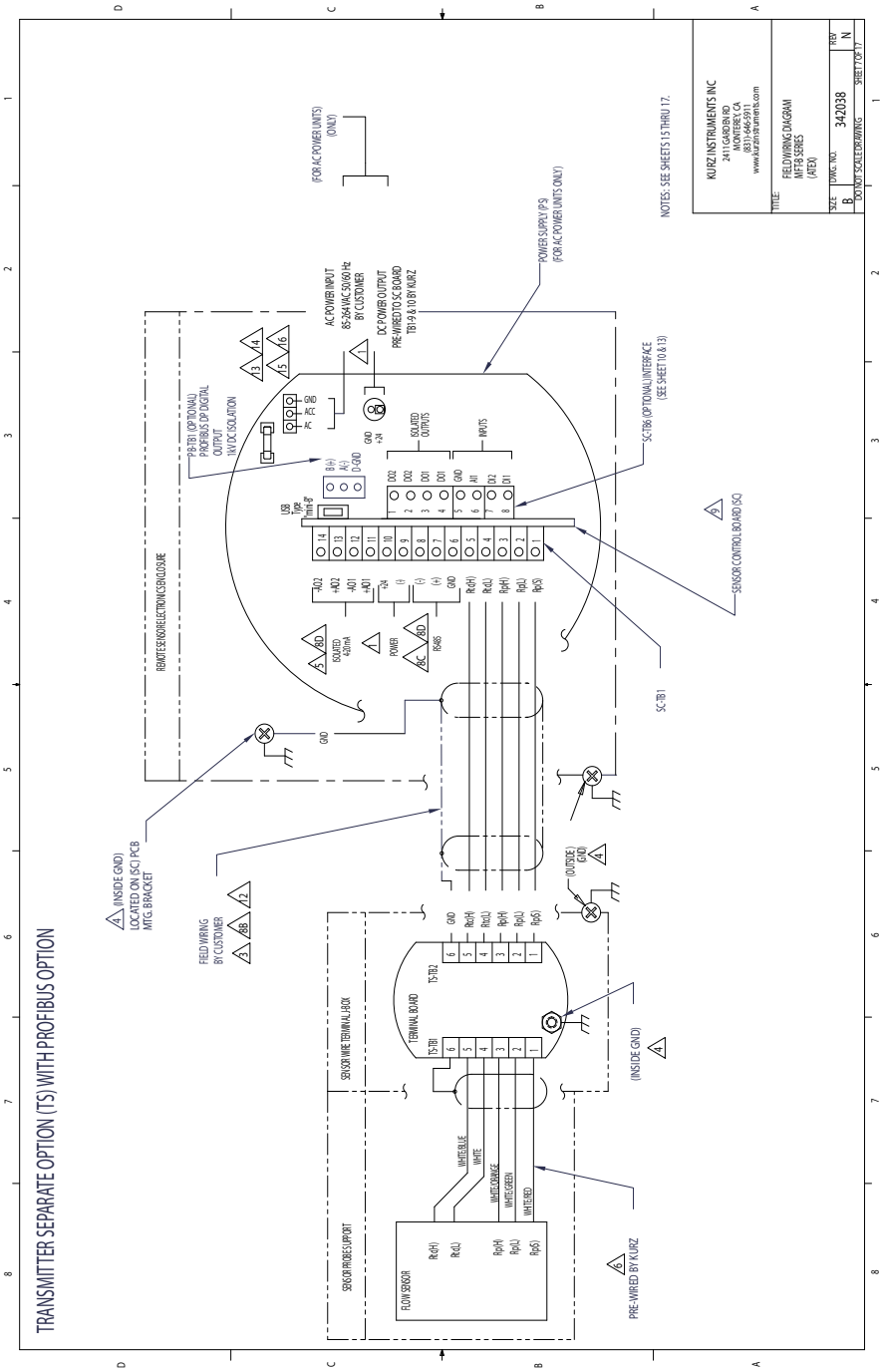
Field Wiring Diagram (5 of 17) — Transmitter Separate



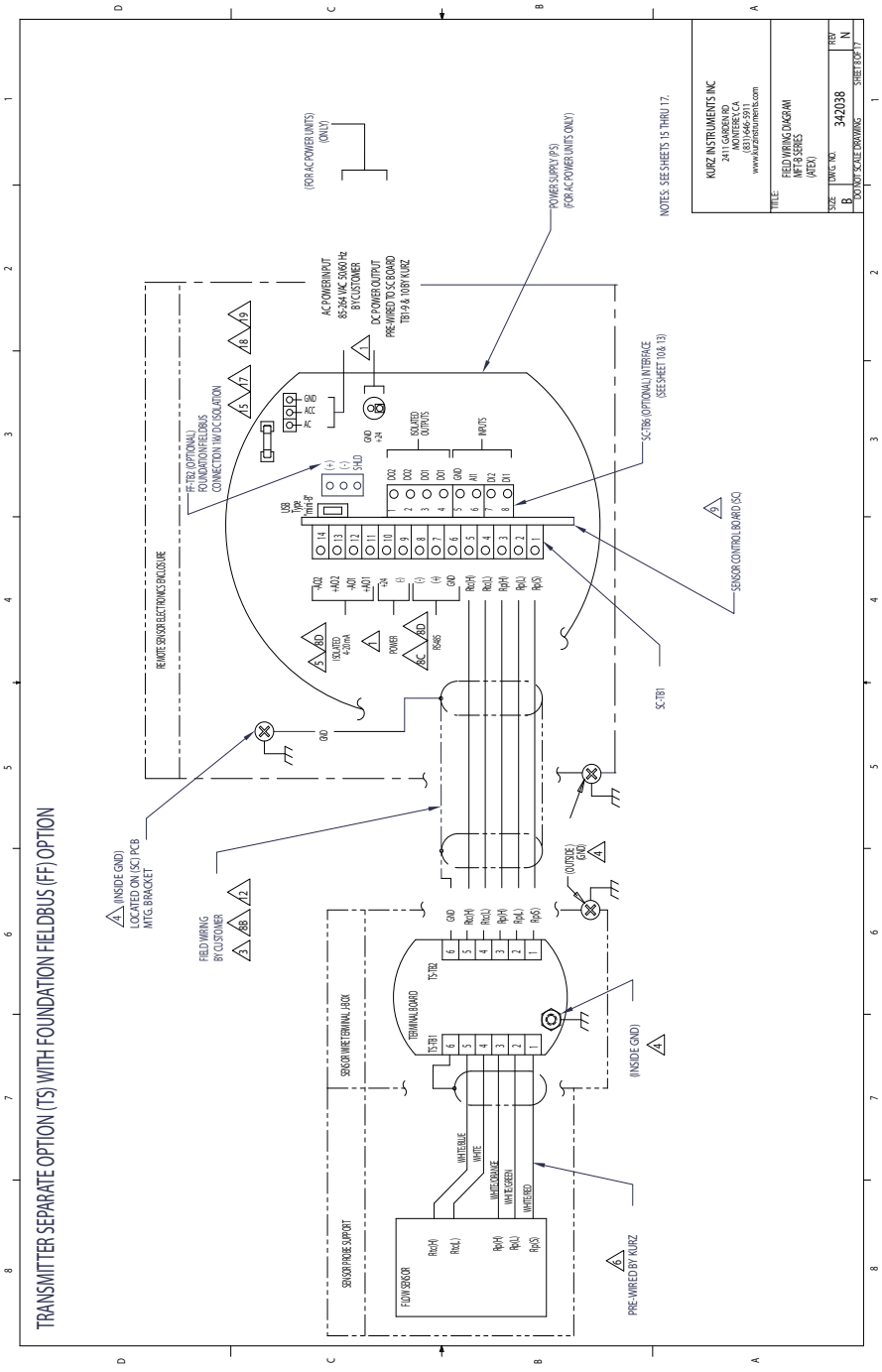
Field Wiring Diagram (6 of 17) — Transmitter Separate w/ HART Option



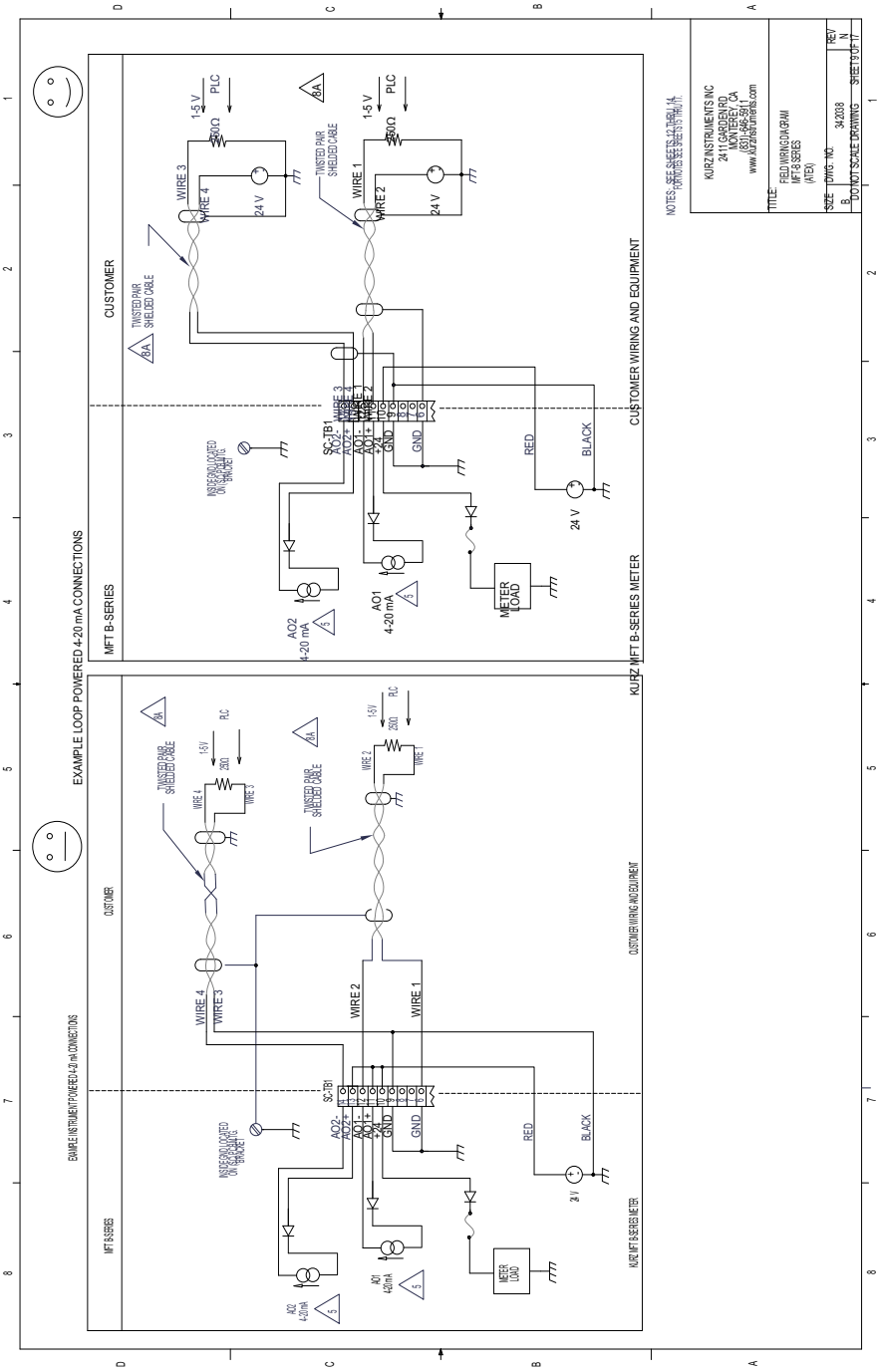
Field Wiring Diagram (7 of 17) — Transmitter Separate w/ Profibus Option



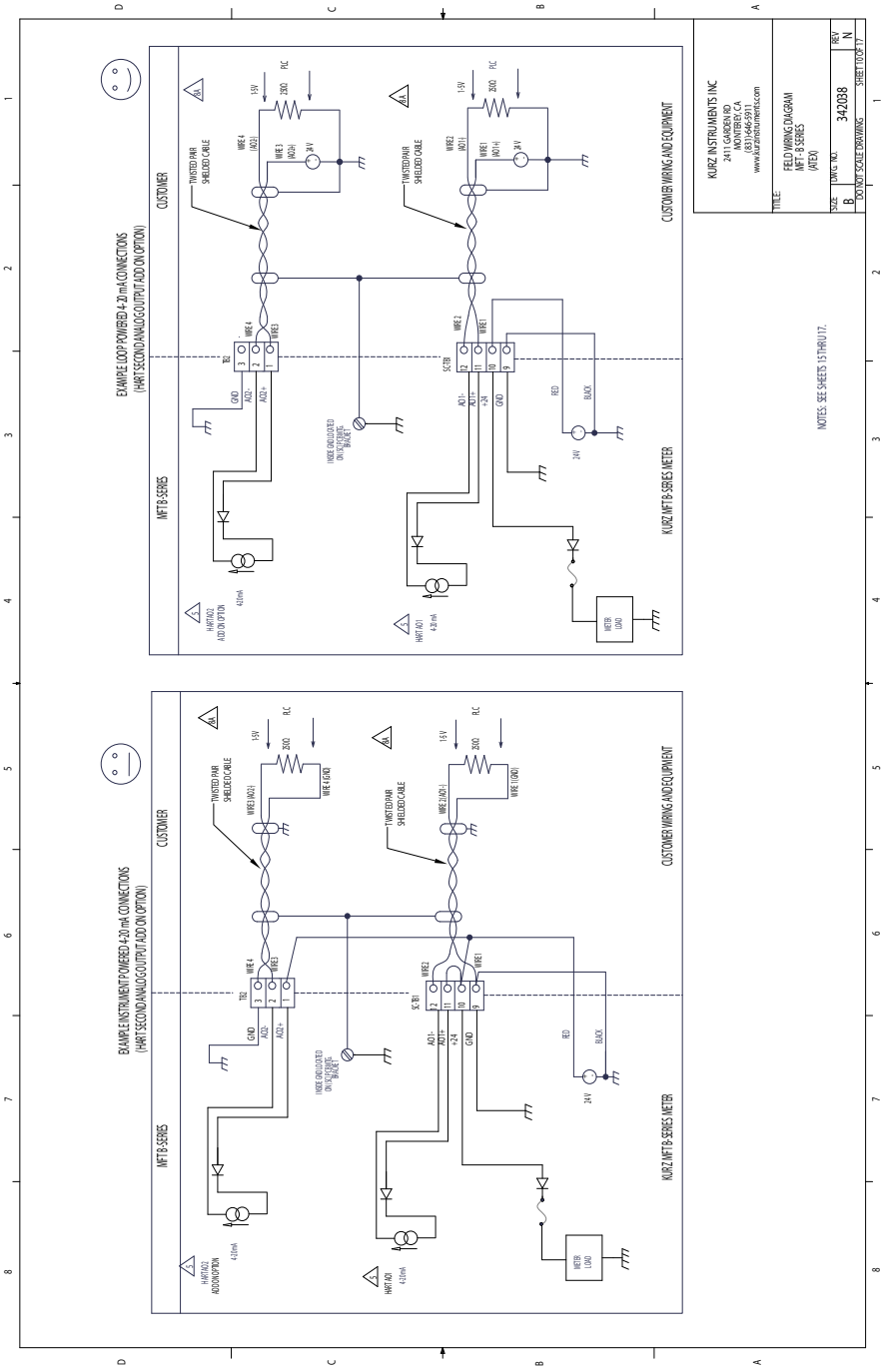
Field Wiring Diagram (8 of 17) — Transmitter Separate w/ Foundation Fieldbus Option



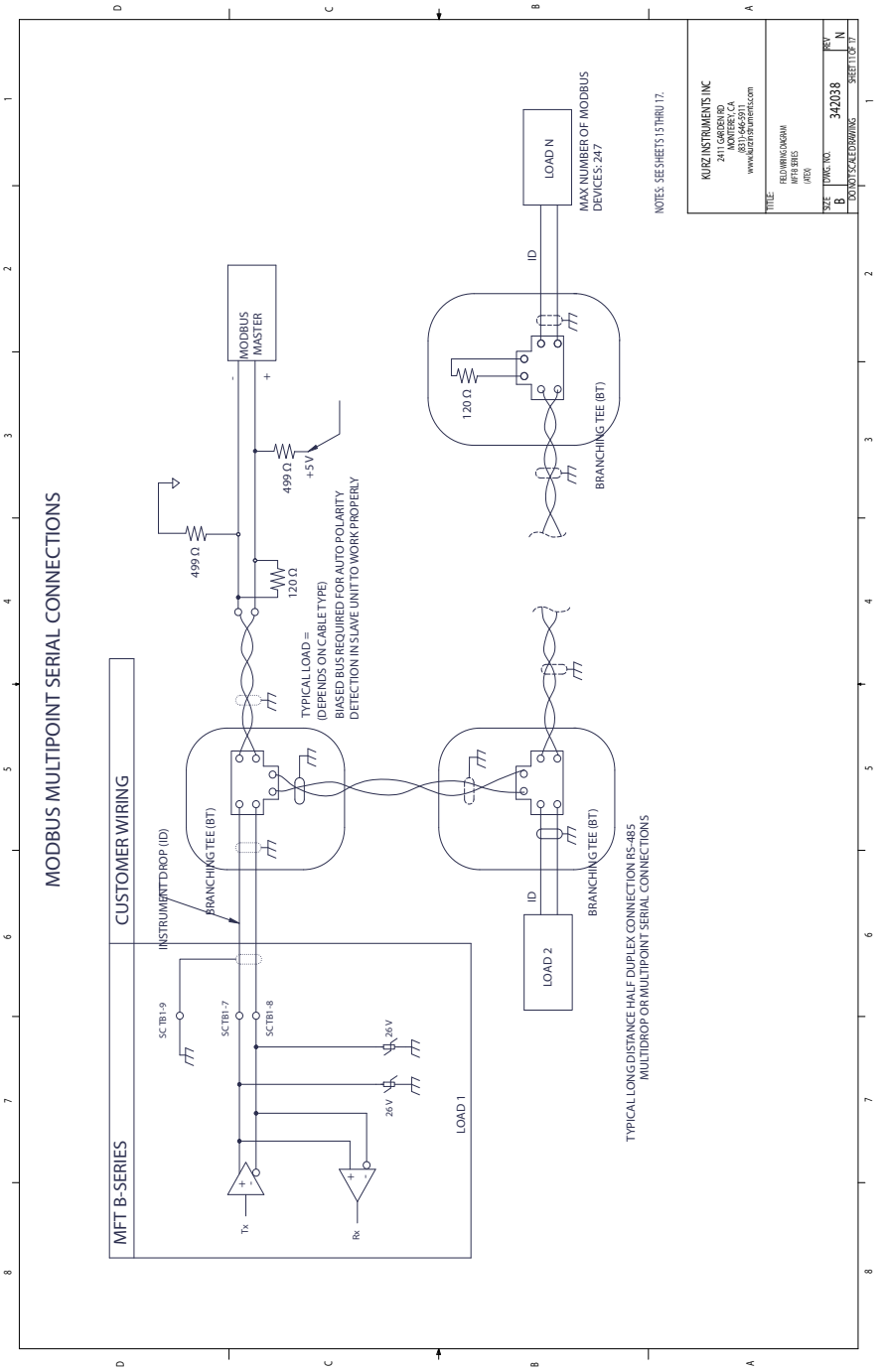
Field Wiring Diagram (9 of 17) — 4-20 mA Connections



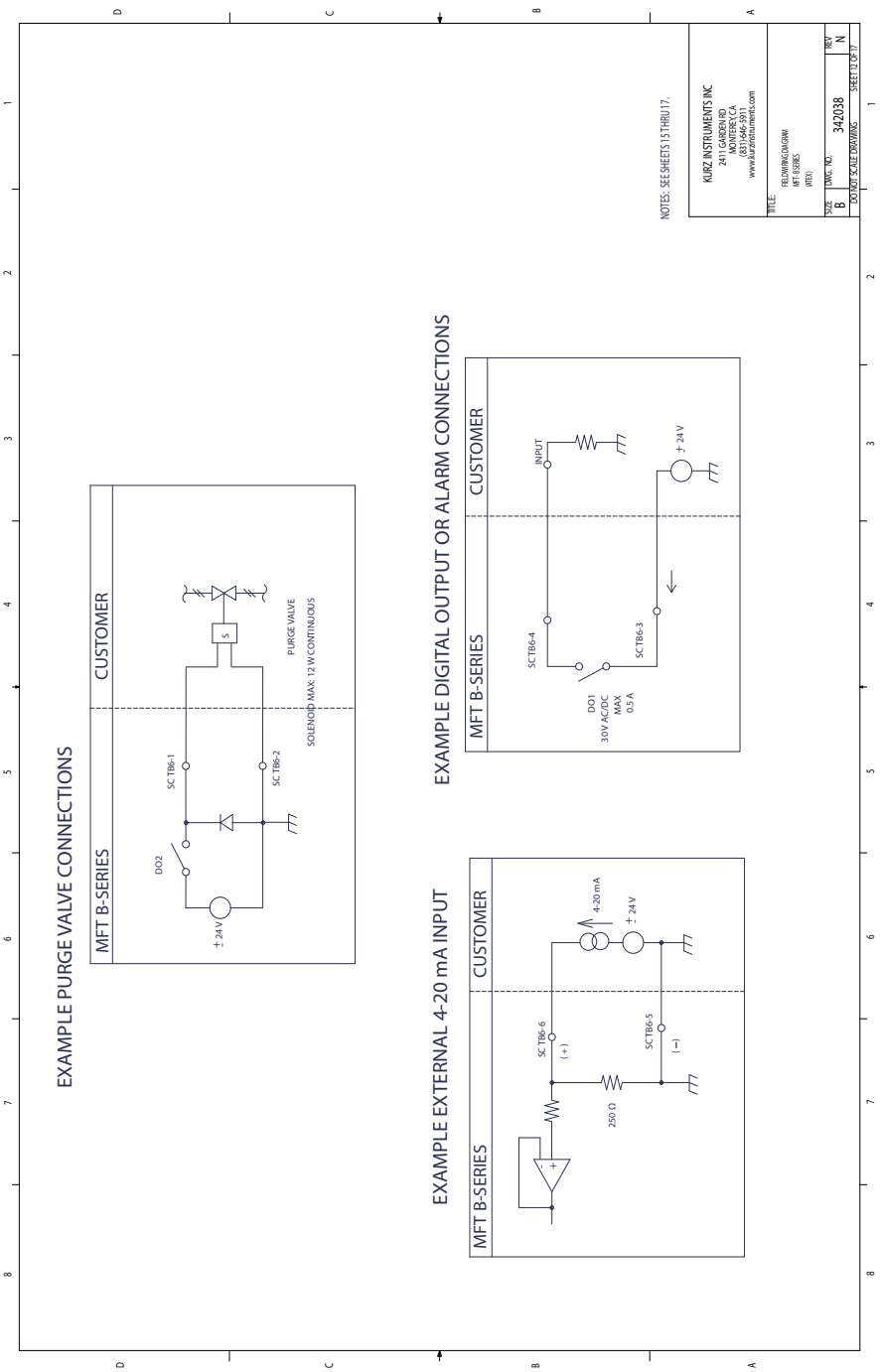
Field Wiring Diagram (10 of 17) — 4-20 mA Connections w/ Second Output



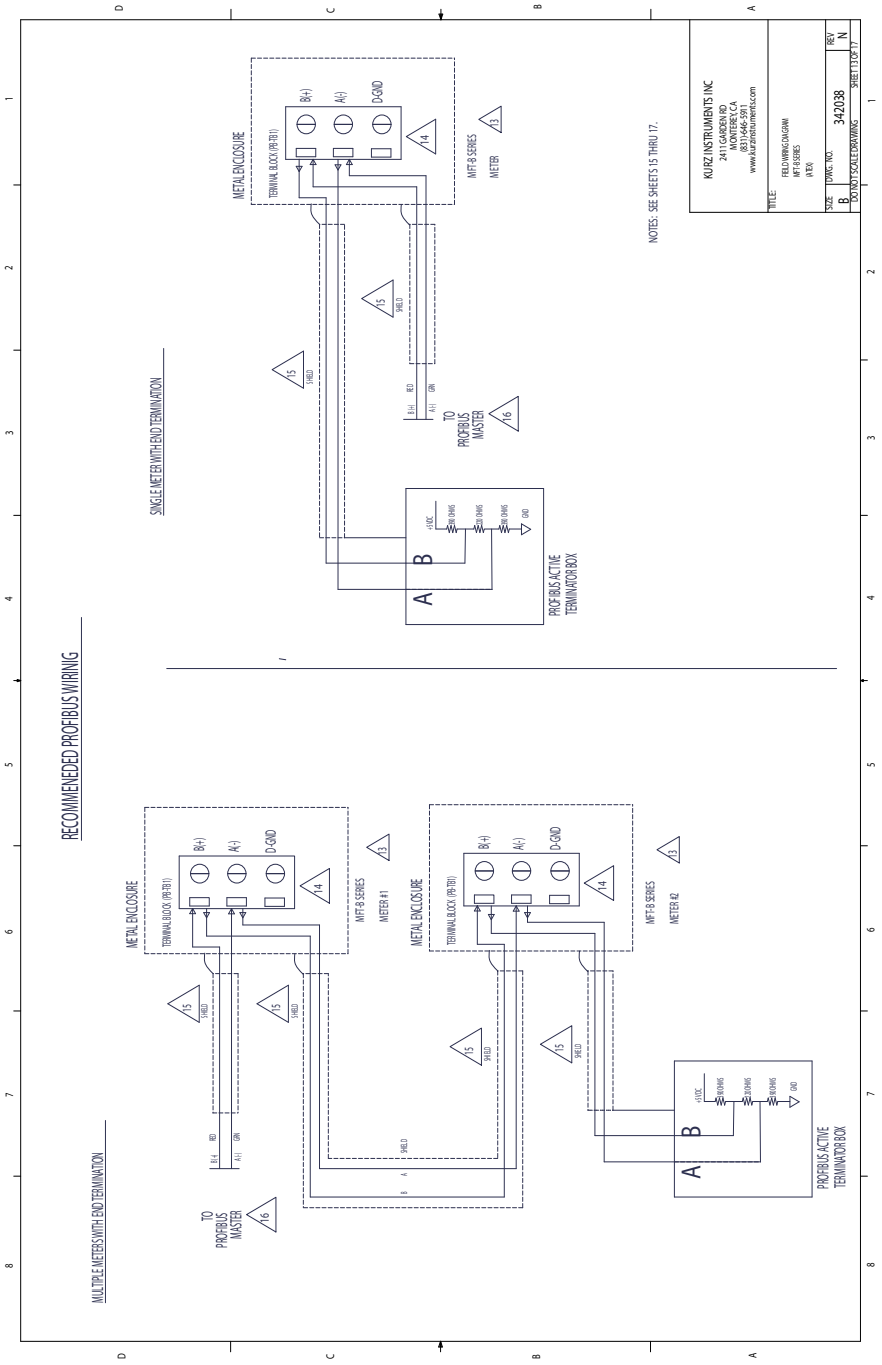
Field Wiring Diagram (11 of 17) — Modbus Serial Connections



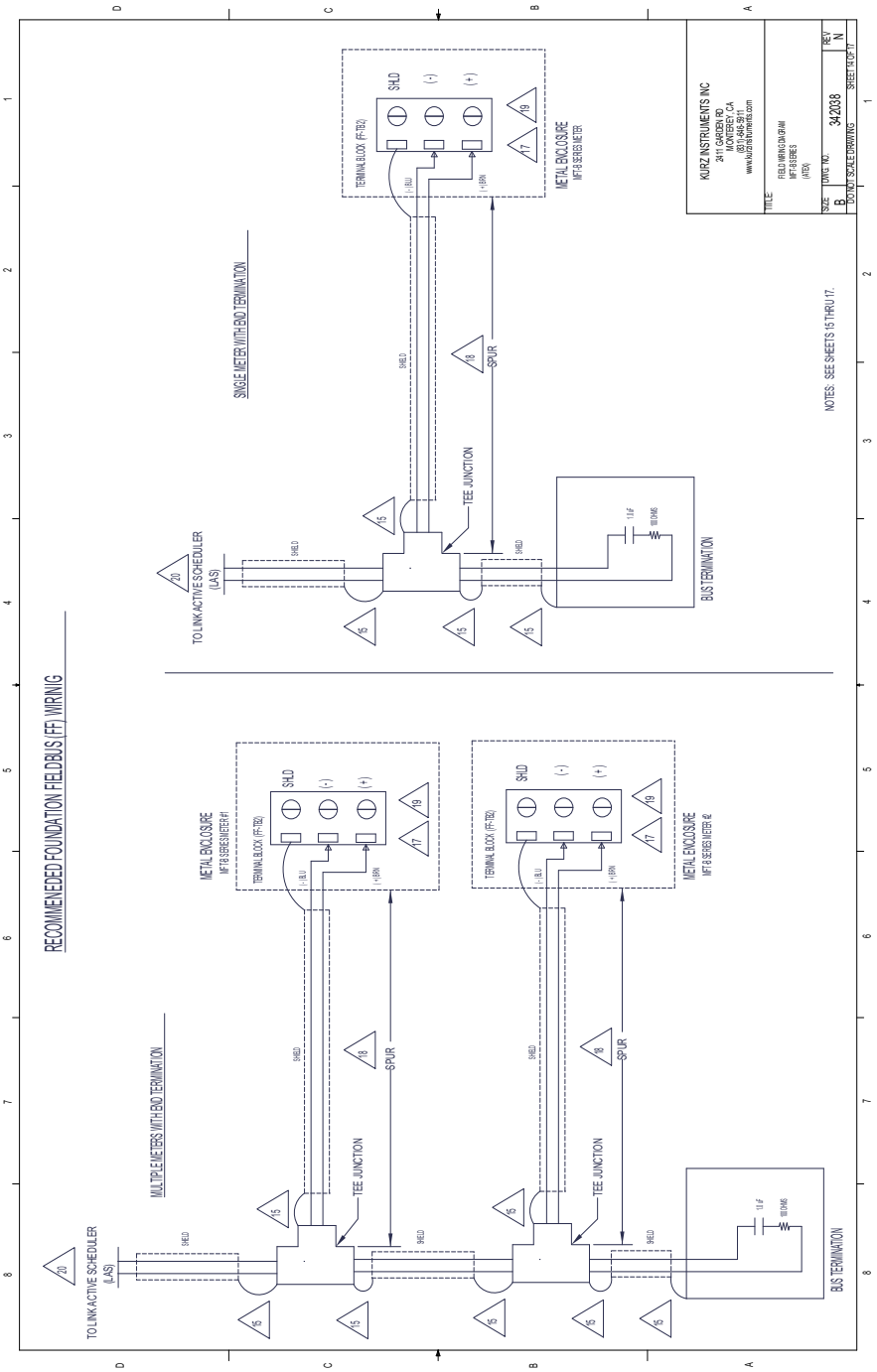
Field Wiring Diagram (12 of 17) — Purge Valve and Alarm Connections



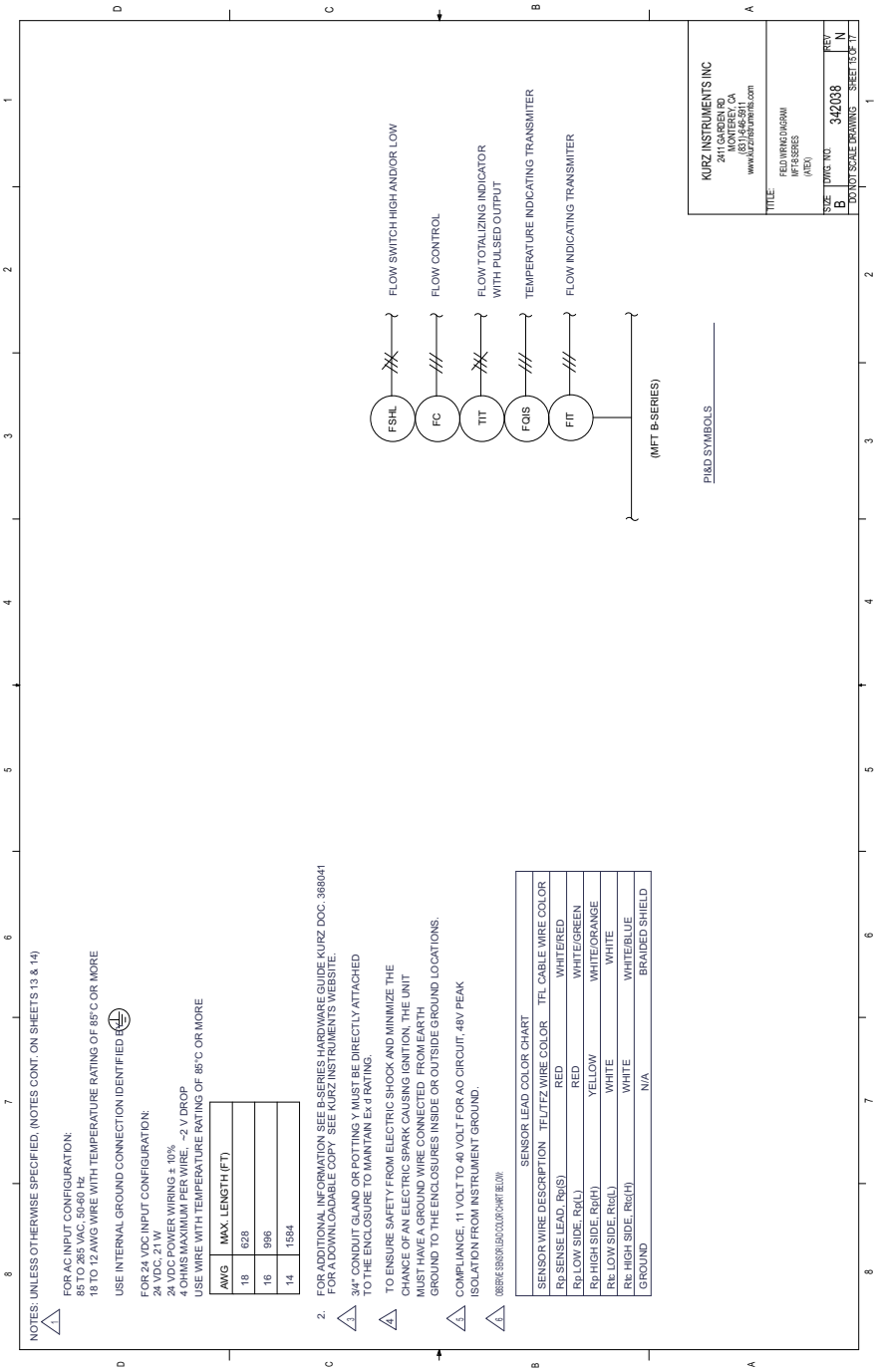
Field Wiring Diagram (13 of 17) — Profibus Wiring



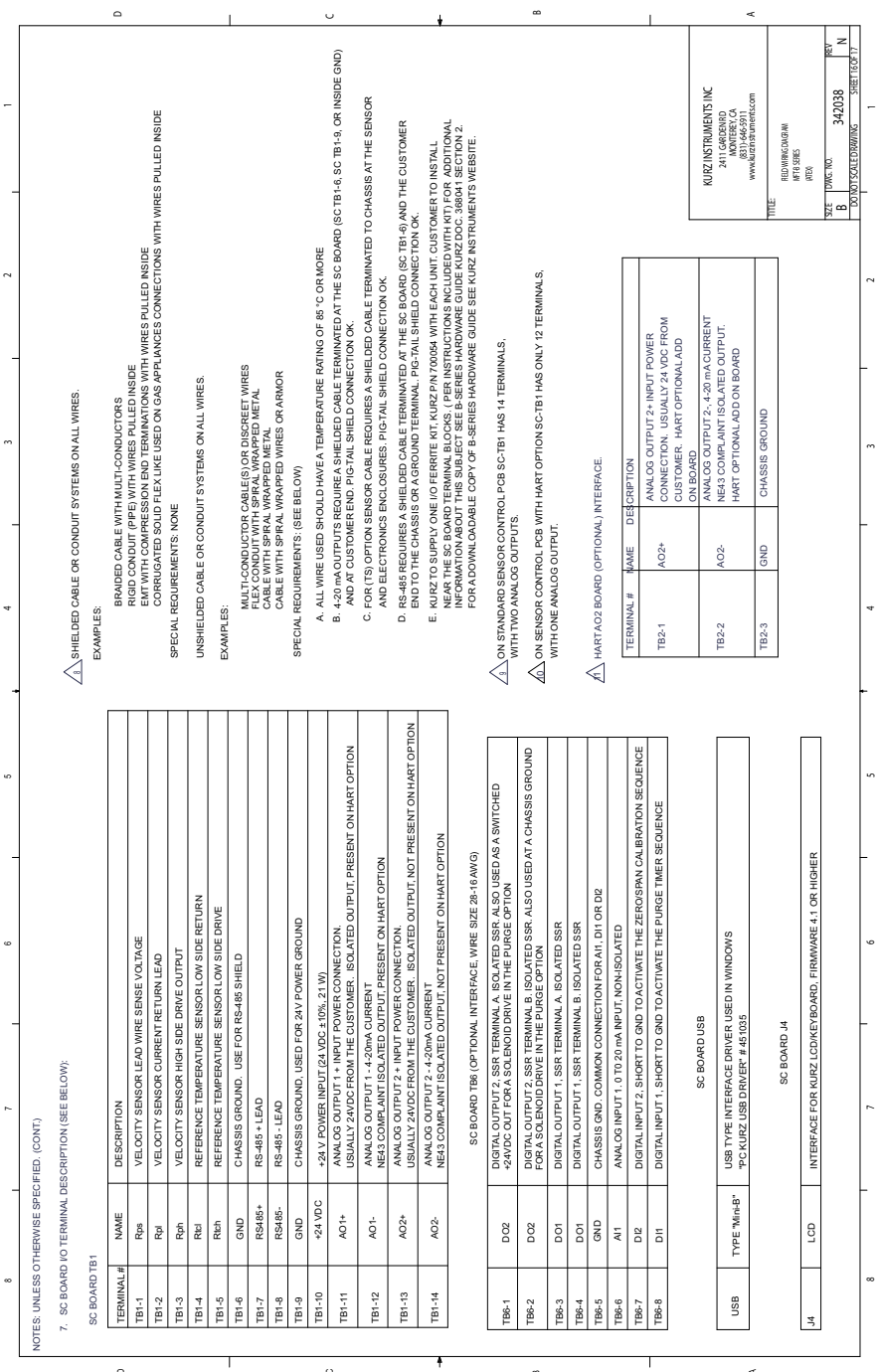
Field Wiring Diagram (14 of 17) — Foundation Fieldbus Wiring



Field Wiring Diagram (15 of 17) — Notes



Field Wiring Diagram (16 of 17) — Notes



NOTES: UNLESS OTHERWISE SPECIFIED. (CONT.)

7. SC BOARD I/O TERMINAL DESCRIPTION (SEE BELOW):

SC BOARD TB1

TERMINAL #	NAME	DESCRIPTION
TB1-1	Rps	VELOCITY SENSOR LEAD WIRE SENSE VOLTAGE
TB1-2	Rpl	VELOCITY SENSOR CURRENT RETURN LEAD
TB1-3	Rph	VELOCITY SENSOR HIGH SIDE DRIVE OUTPUT
TB1-4	Rtd	REFERENCE TEMPERATURE SENSOR LOW SIDE RETURN
TB1-5	Rth	REFERENCE TEMPERATURE SENSOR LOW SIDE DRIVE
TB1-6	GND	CHASSIS GROUND. USE FOR RS-485 SHIELD
TB1-7	RS485+	RS-485 + LEAD
TB1-8	RS485-	RS-485 - LEAD
TB1-9	GND	CHASSIS GROUND, USED FOR 24V POWER GROUND
TB1-10	+24 VDC	+24 V POWER INPUT (24 VDC ± 10%, 21 W)
TB1-11	AO1+	ANALOG OUTPUT 1 + INPUT POWER CONNECTION. USUALLY 24VDC FROM THE CUSTOMER. ISOLATED OUTPUT, PRESENT ON HART OPTION
TB1-12	AO1-	ANALOG OUTPUT 1 - 4-20mA CURRENT NE43 COMPLAINT ISOLATED OUTPUT, PRESENT ON HART OPTION
TB1-13	AO2+	ANALOG OUTPUT 2 + INPUT POWER CONNECTION. USUALLY 24VDC FROM THE CUSTOMER. ISOLATED OUTPUT, NOT PRESENT ON HART OPTION
TB1-14	AO2-	ANALOG OUTPUT 2 - 4-20mA CURRENT NE43 COMPLAINT ISOLATED OUTPUT, NOT PRESENT ON HART OPTION

SC BOARD TB6 (OPTIONAL INTERFACE, WIRE SIZE 28-16 AWG)

TB6-1	DO2	DIGITAL OUTPUT 2, SSR TERMINAL A. ISOLATED SSR. ALSO USED AS A SWITCHED +24VDC OUT FOR A SOLENOID DRIVE IN THE PURGE OPTION
TB6-2	DO2	DIGITAL OUTPUT 2, SSR TERMINAL B. ISOLATED SSR. ALSO USED AT A CHASSIS GROUND FOR A SOLENOID DRIVE IN THE PURGE OPTION
TB6-3	DO1	DIGITAL OUTPUT 1, SSR TERMINAL A. ISOLATED SSR
TB6-4	DO1	DIGITAL OUTPUT 1, SSR TERMINAL B. ISOLATED SSR
TB6-5	GND	CHASSIS GND. COMMON CONNECTION FOR AI1, DI1 OR DI2
TB6-6	AI1	ANALOG INPUT 1, 0 TO 20 mA INPUT, NON-ISOLATED
TB6-7	DI2	DIGITAL INPUT 2, SHORT TO GND TO ACTIVATE THE ZERO/SPAN CALIBRATION SEQUENCE
TB6-8	DI1	DIGITAL INPUT 1, SHORT TO GND TO ACTIVATE THE PURGE TIMER SEQUENCE

SC BOARD USB

USB	TYPE "Mini-B"	USB TYPE INTERFACE DRIVER USED IN WINDOWS "PC KURZ USB DRIVER" # 451035

SC BOARD J4

J4	LCD	INTERFACE FOR KURZ LCD/KEYBOARD. FIRMWARE 4.1 OR HIGHER

⚠1 SHIELDED CABLE OR CONDUIT SYSTEMS ON ALL WIRES.

EXAMPLES:

BRAIDED CABLE WITH MULTI-CONDUCTORS.
RIGID CONDUIT (PIPE) WITH WIRES PULLED INSIDE
EMT WITH COMPRESSION END TERMINATIONS WITH WIRES PULLED INSIDE
CORRUGATED SOLID FLEX LIKE USED ON GAS APPLIANCES CONNECTIONS WITH WIRES PULLED INSIDE

SPECIAL REQUIREMENTS: NONE

UNSHIELDED CABLE OR CONDUIT SYSTEMS ON ALL WIRES.

EXAMPLES:

MULTI-CONDUCTOR CABLE(S) OR DISCREET WIRES
FLEX CONDUIT WITH SPIRAL WRAPPED METAL
CABLE WITH SPIRAL WRAPPED METAL
CABLE WITH SPIRAL WRAPPED WIRES OR ARMOR

SPECIAL REQUIREMENTS: (SEE BELOW)

A. ALL WIRE USED SHOULD HAVE A TEMPERATURE RATING OF 85 °C OR MORE
B. 4-20 mA OUTPUTS REQUIRE A SHIELDED CABLE TERMINATED AT THE SC BOARD (SC TB1-6, SC TB1-9, OR INSIDE GND) AND AT CUSTOMER END. PIG-TAIL SHIELD CONNECTION OK.
C. FOR (TS) OPTION SENSOR CABLE REQUIRES A SHIELDED CABLE TERMINATED TO CHASSIS AT THE SENSOR AND ELECTRONICS ENCLOSURES. PIG-TAIL SHIELD CONNECTION OK.
D. RS-485 REQUIRES A SHIELDED CABLE TERMINATED AT THE SC BOARD (SC TB1-6) AND THE CUSTOMER END TO THE CHASSIS OR A GROUND TERMINAL. PIG-TAIL SHIELD CONNECTION OK.
E. KURZ TO SUPPLY ONE I/O FERRITE KIT, KURZ P/N 7000054 WITH EACH UNIT. CUSTOMER TO INSTALL NEAR THE SC BOARD TERMINAL BLOCKS. (PER INSTRUCTIONS INCLUDED WITH KIT) FOR ADDITIONAL INFORMATION ABOUT THIS SUBJECT SEE B-SERIES HARDWARE GUIDE KURZ DOC. 368041 SECTION 2. FOR A DOWNLOADABLE COPY OF B-SERIES HARDWARE GUIDE SEE KURZ INSTRUMENTS WEBSITE.

⚠2 ON STANDARD SENSOR CONTROL PCB SC-TB1 HAS 14 TERMINALS, WITH TWO ANALOG OUTPUTS.

⚠3 ON SENSOR CONTROL PCB WITH HART OPTION SC-TB1 HAS ONLY 12 TERMINALS, WITH ONE ANALOG OUTPUT.

⚠4 HART AO2 BOARD (OPTIONAL) INTERFACE.

TERMINAL #	NAME	DESCRIPTION
TB2-1	AO2+	ANALOG OUTPUT 2+ INPUT POWER CONNECTION. USUALLY 24 VDC FROM CUSTOMER. HART OPTIONAL ADD ON BOARD
TB2-2	AO2-	ANALOG OUTPUT 2-, 4-20 mA CURRENT NE43 COMPLAINT ISOLATED OUTPUT. HART OPTIONAL ADD ON BOARD
TB2-3	GND	CHASSIS GROUND

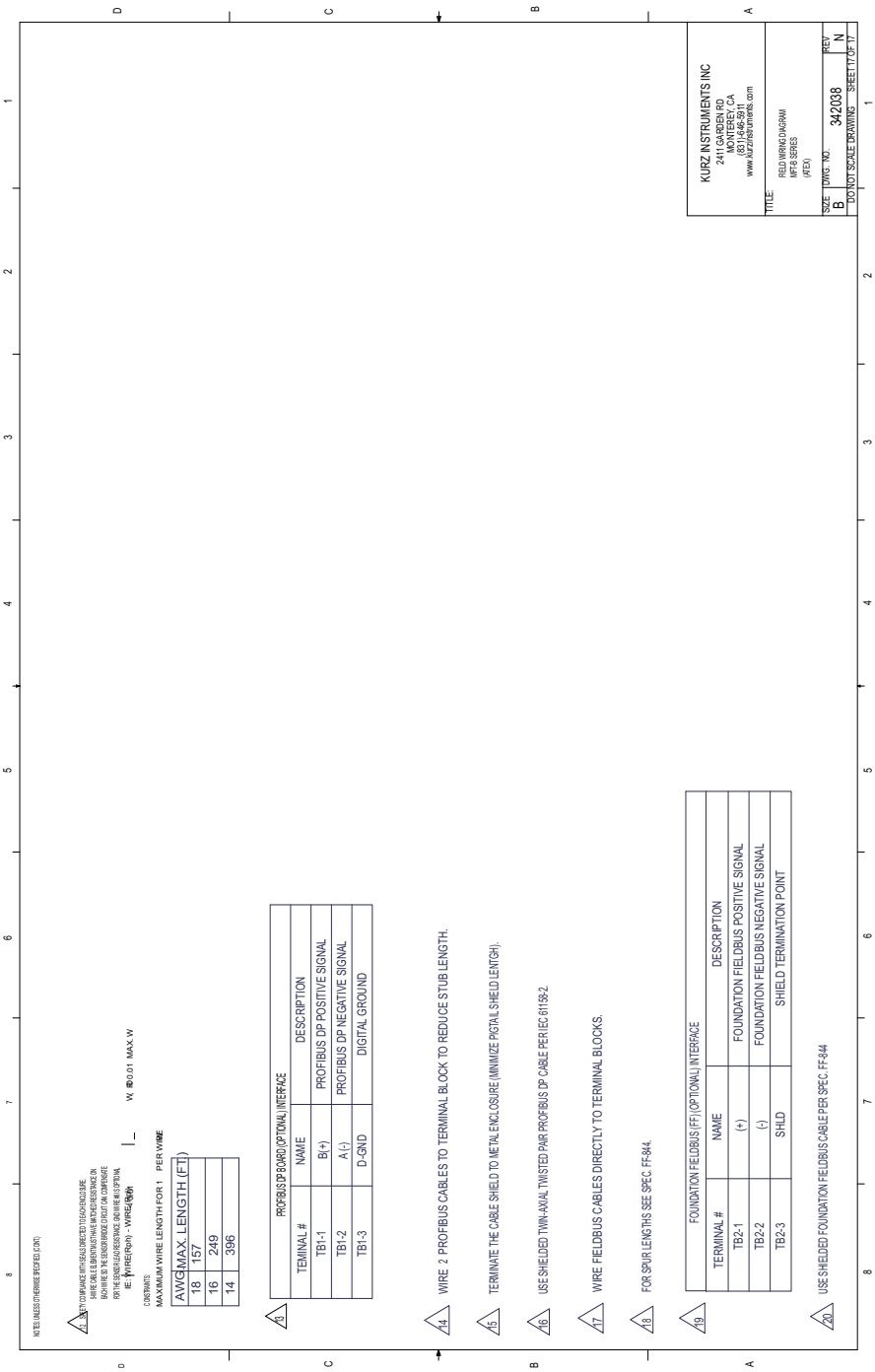
KURZ INSTRUMENTS INC
2411 GARCIA AVE.
MONTEREY, CA
(831) 646-5911
www.kurzinstruments.com

TITLE: FIELD WIRING DIAGRAM
MT18 SERIES
(VT)(X)

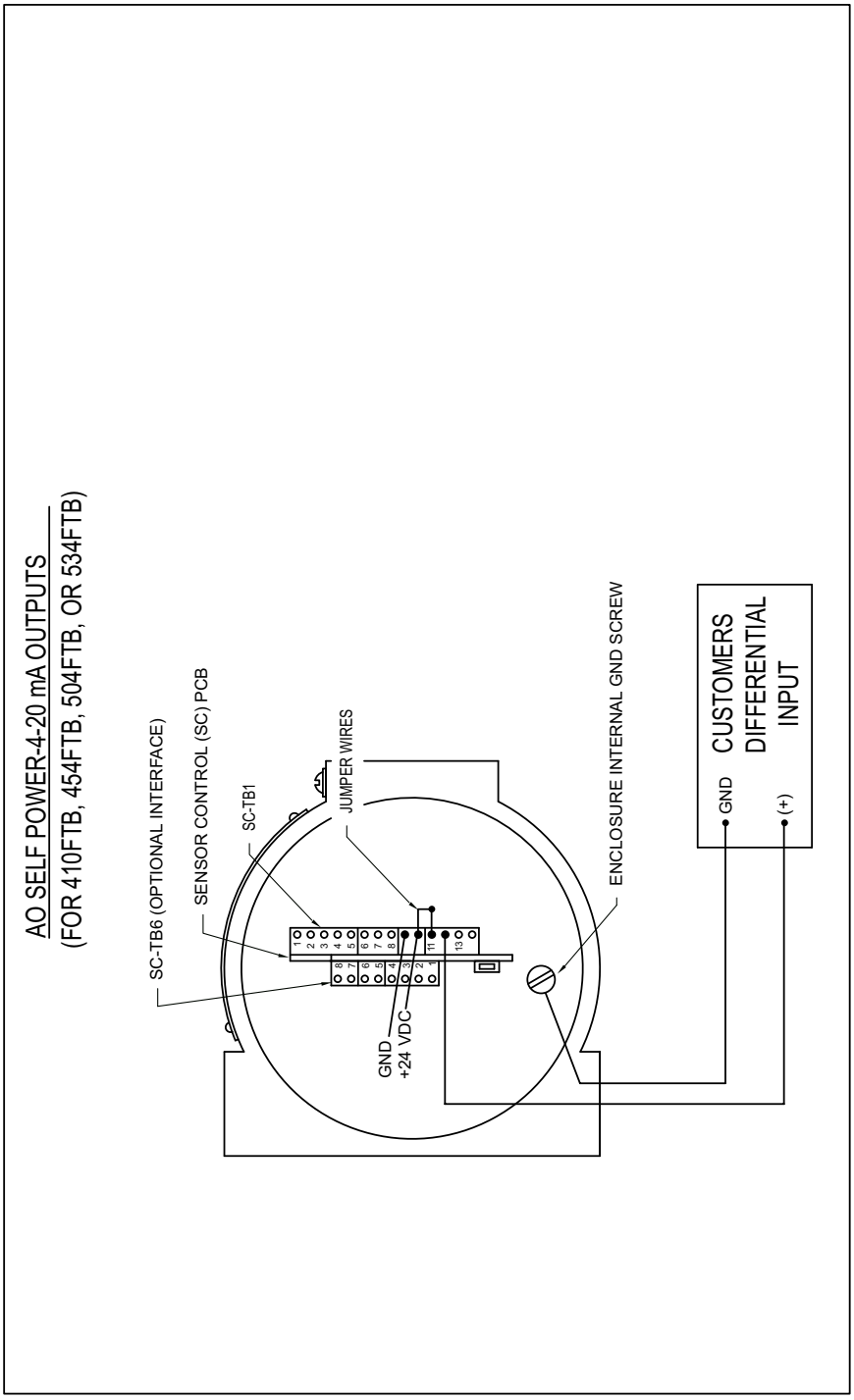
SIZE: B | DWG. NO.: 342038 | REV: N

DO NOT SCALE DRAWING | SHEET 16 OF 17

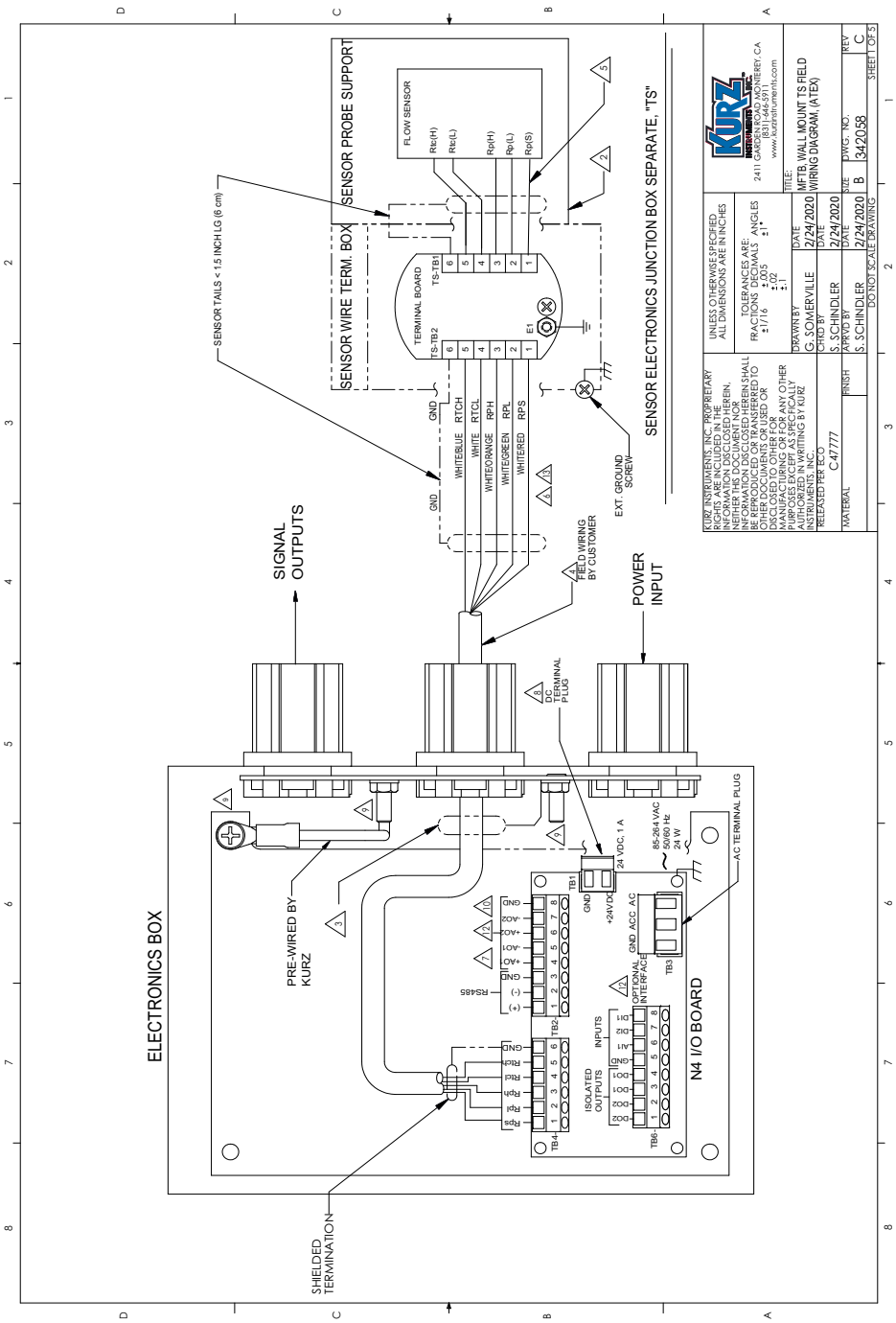
Field Wiring Diagram (17 of 17) — Notes



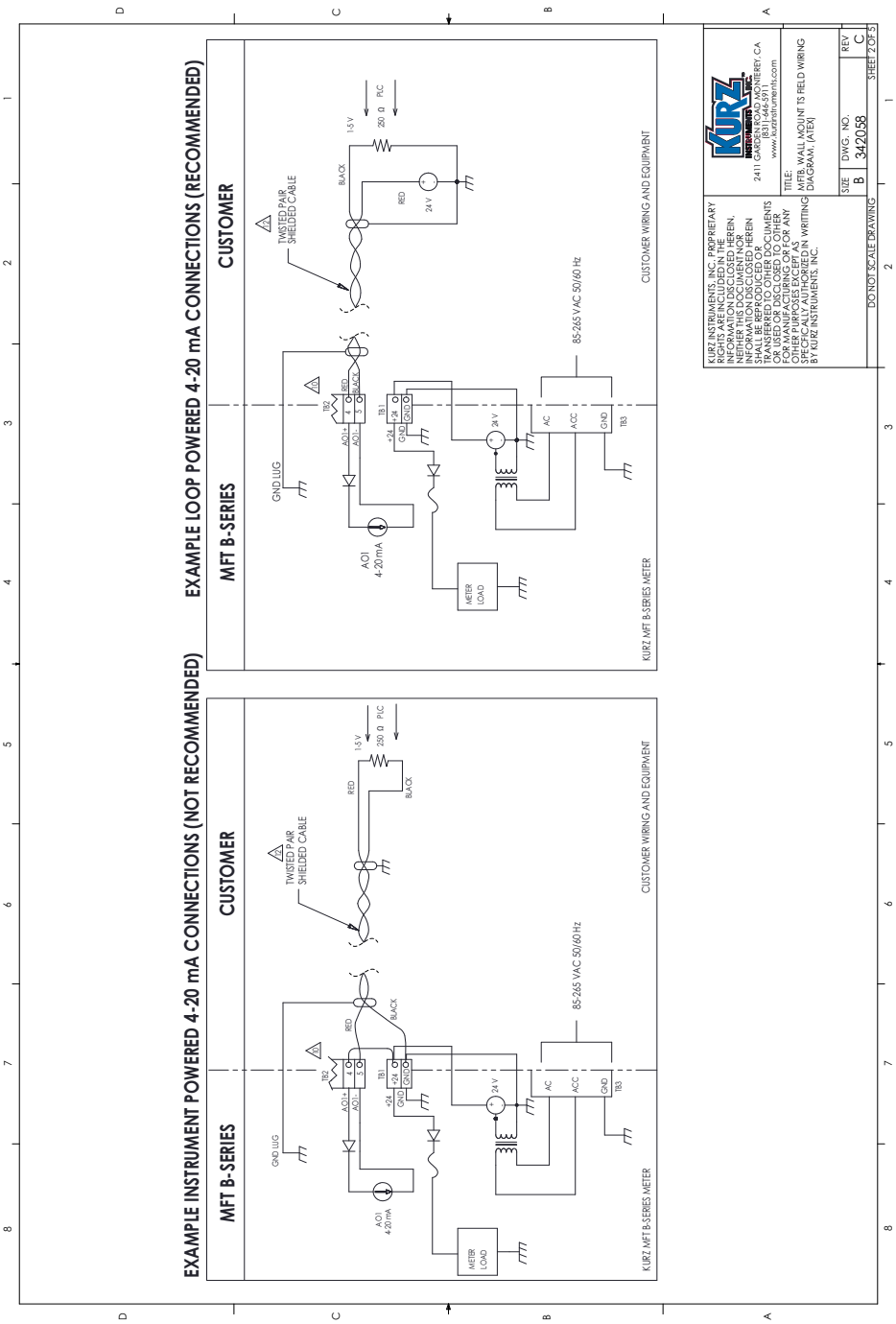
AO Self-Powered Outputs (1 of 1)



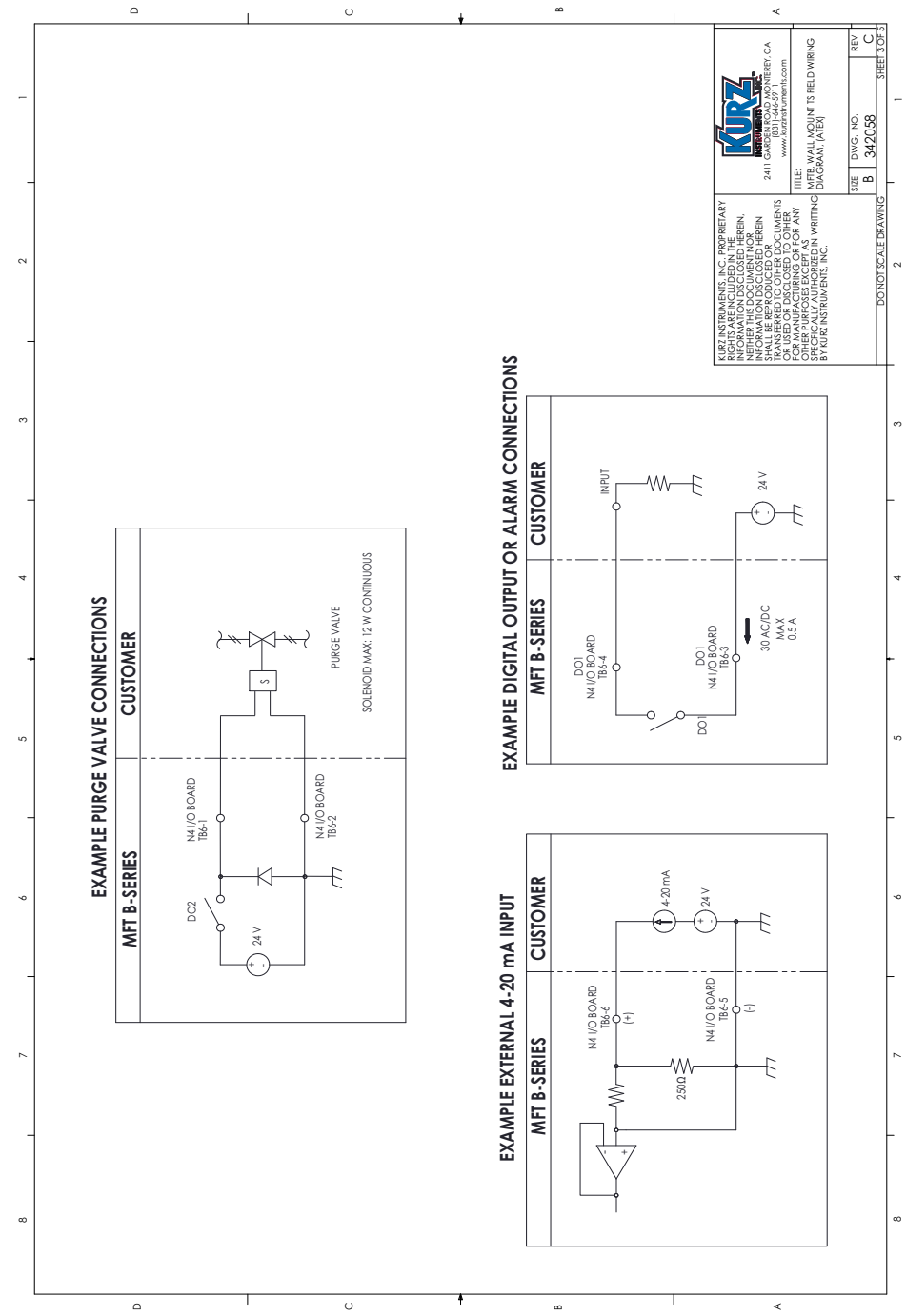
Field Wiring Diagram (1 of 5) — Polycarbonate Wall Mount Component Diagram



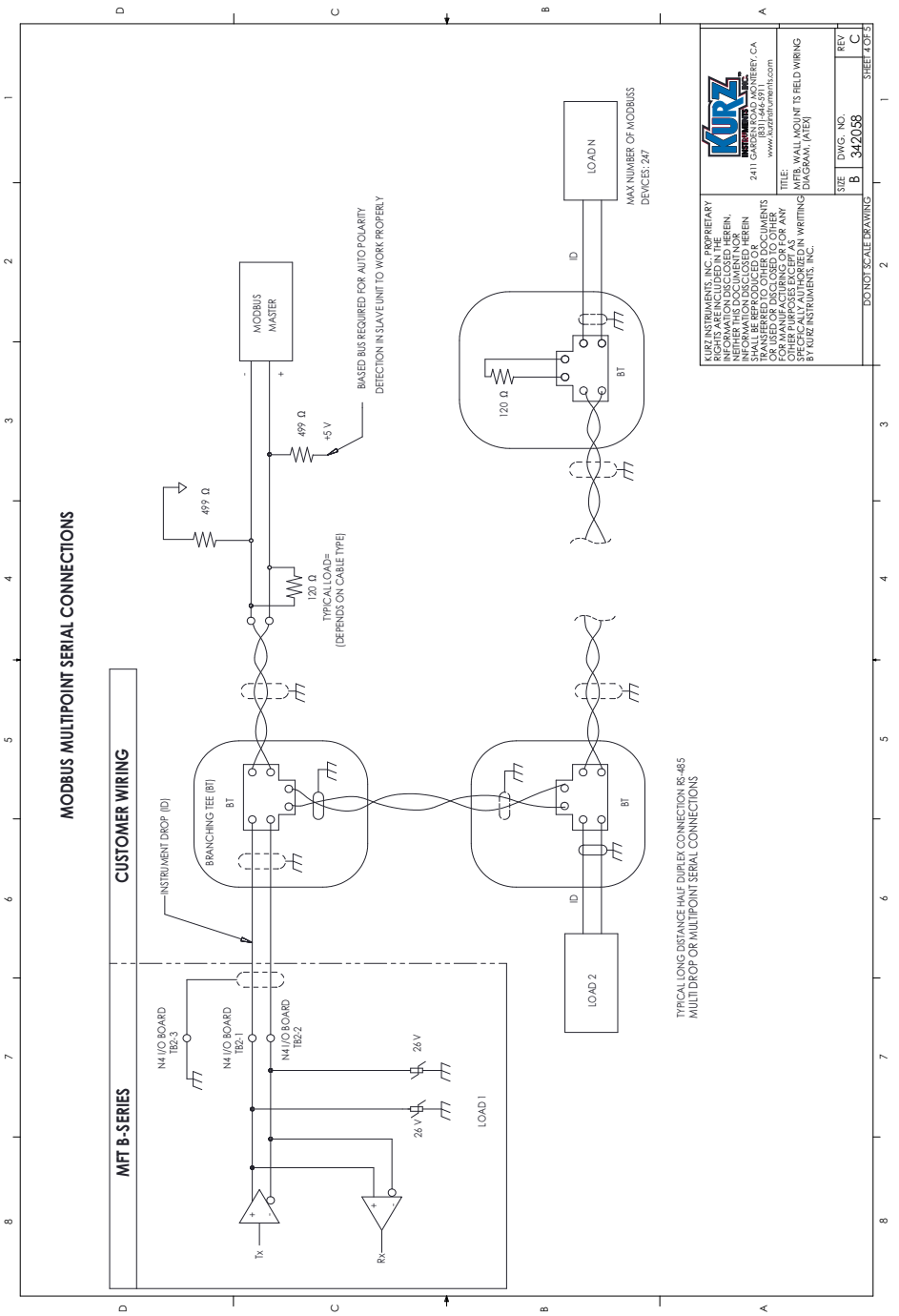
Field Wiring Diagram (2 of 5) — Polycarbonate Wall Mount 4-20 mA Connections



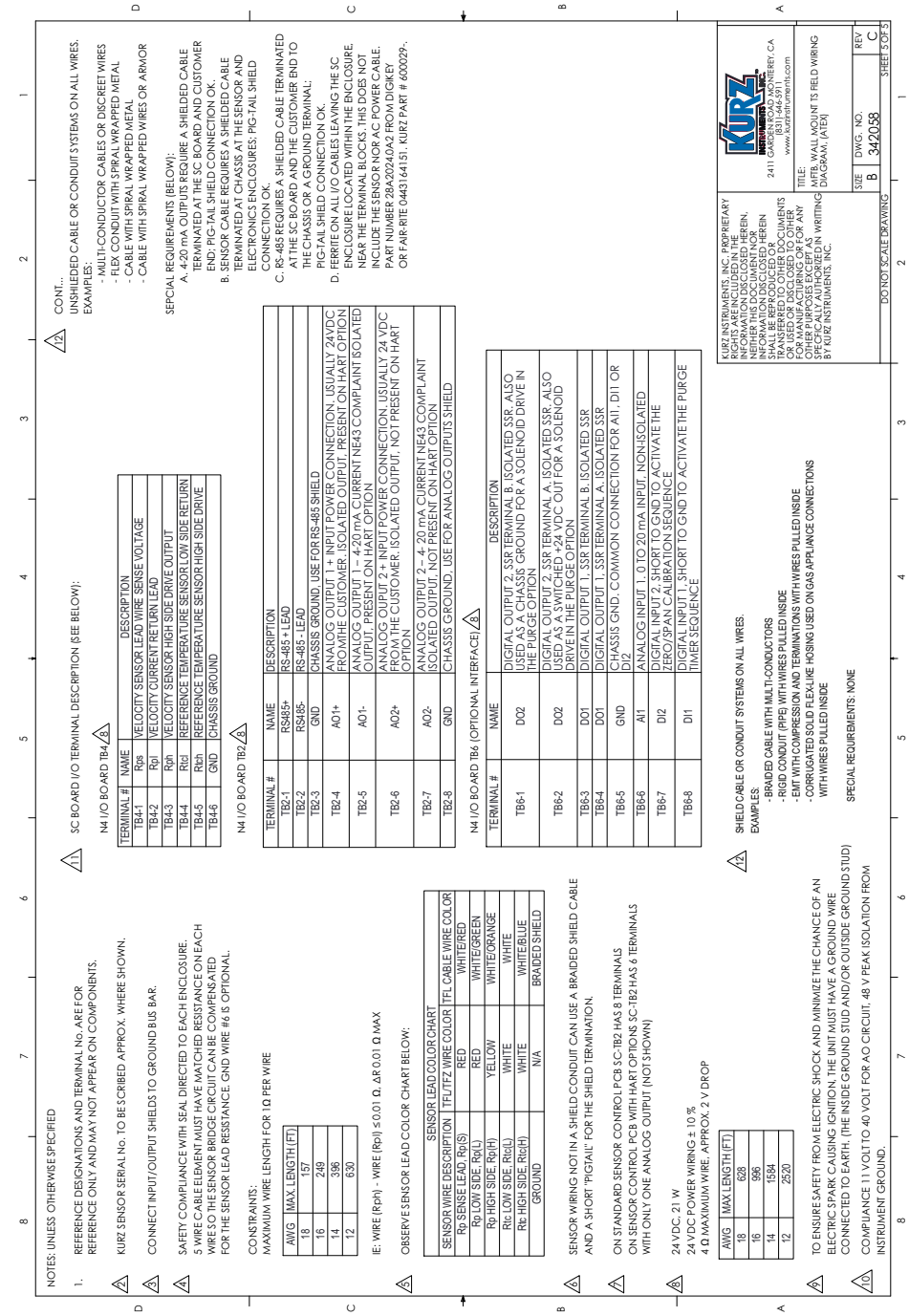
Field Wiring Diagram (3 of 5) — Polycarbonate Wall Mount Alarms & Purge Components



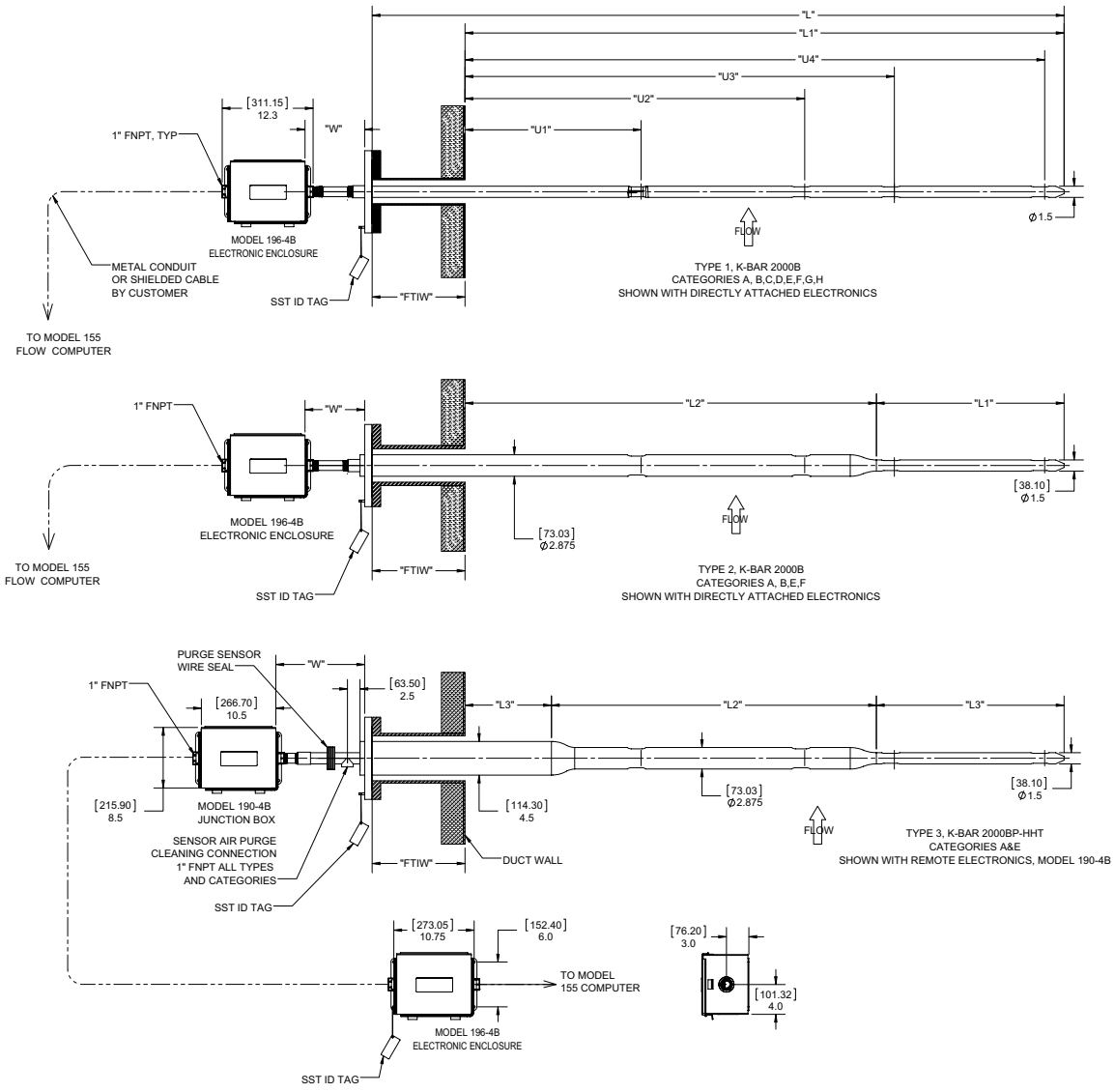
Field Wiring Diagram (4 of 5) — Polycarbonate Wall Mount Modbus Connections



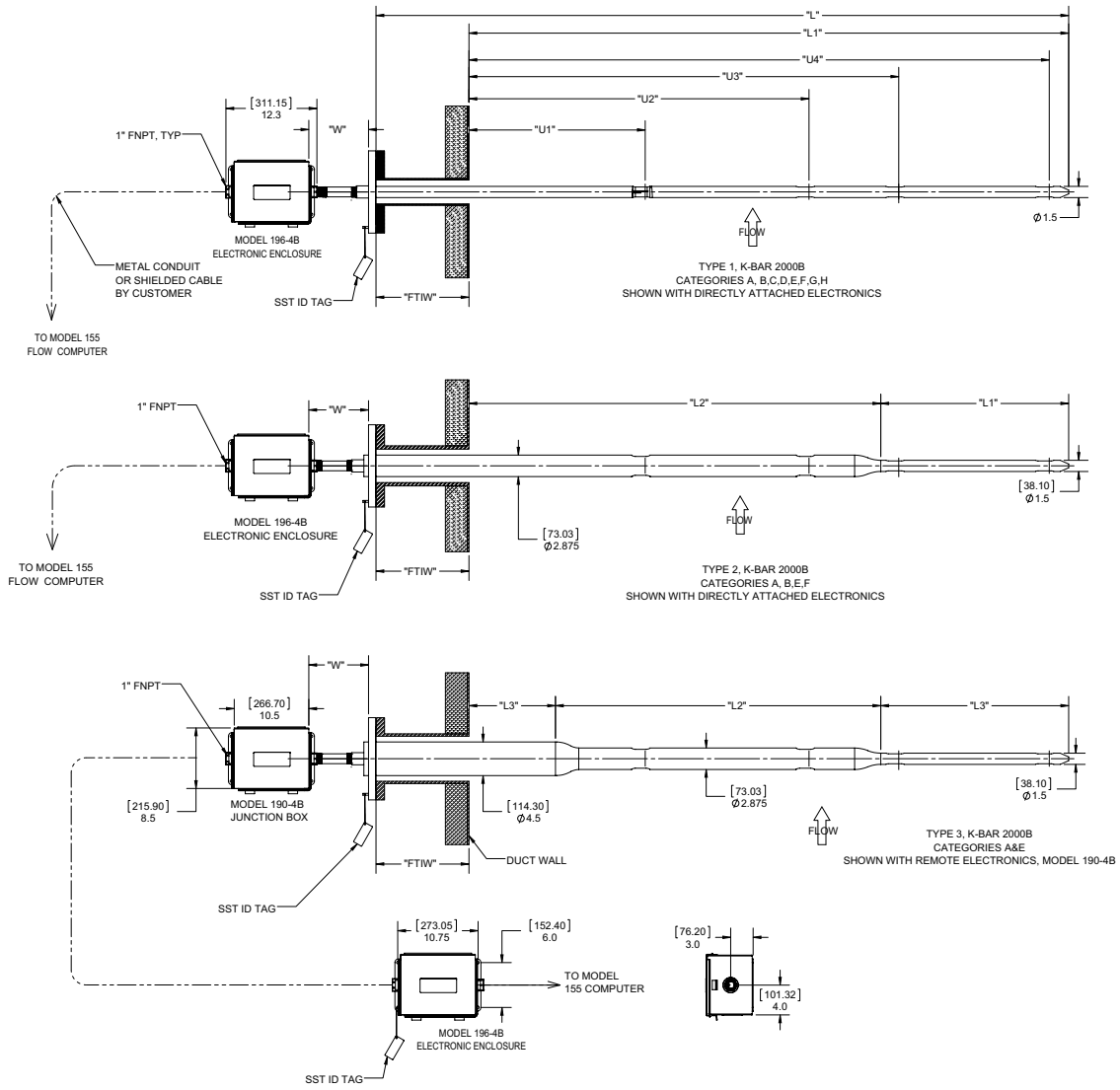
Field Wiring Diagram (5 of 5) — Polycarbonate Wall Mount Notes



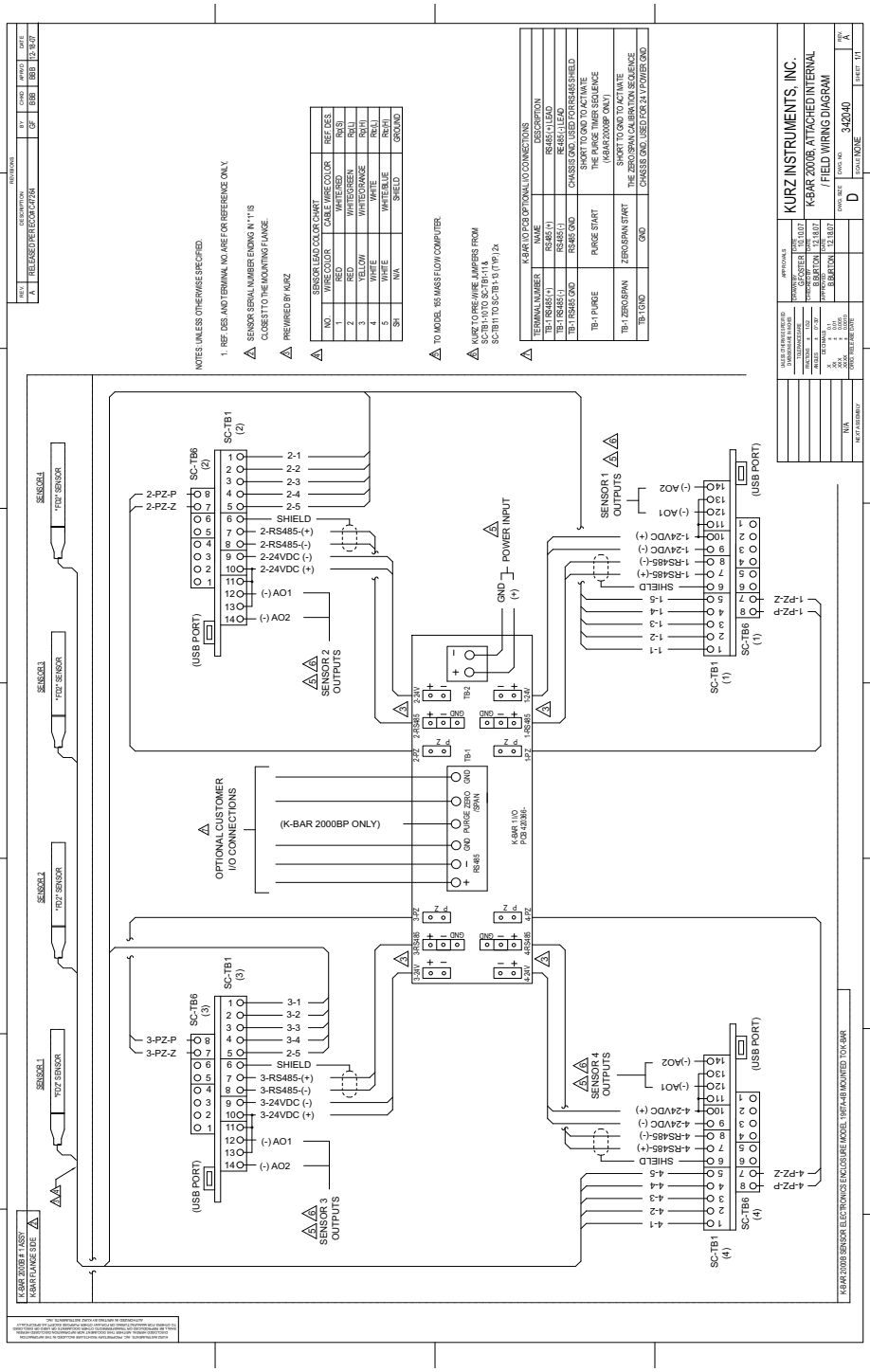
K-BAR 2000B Diagram (1 of 1)



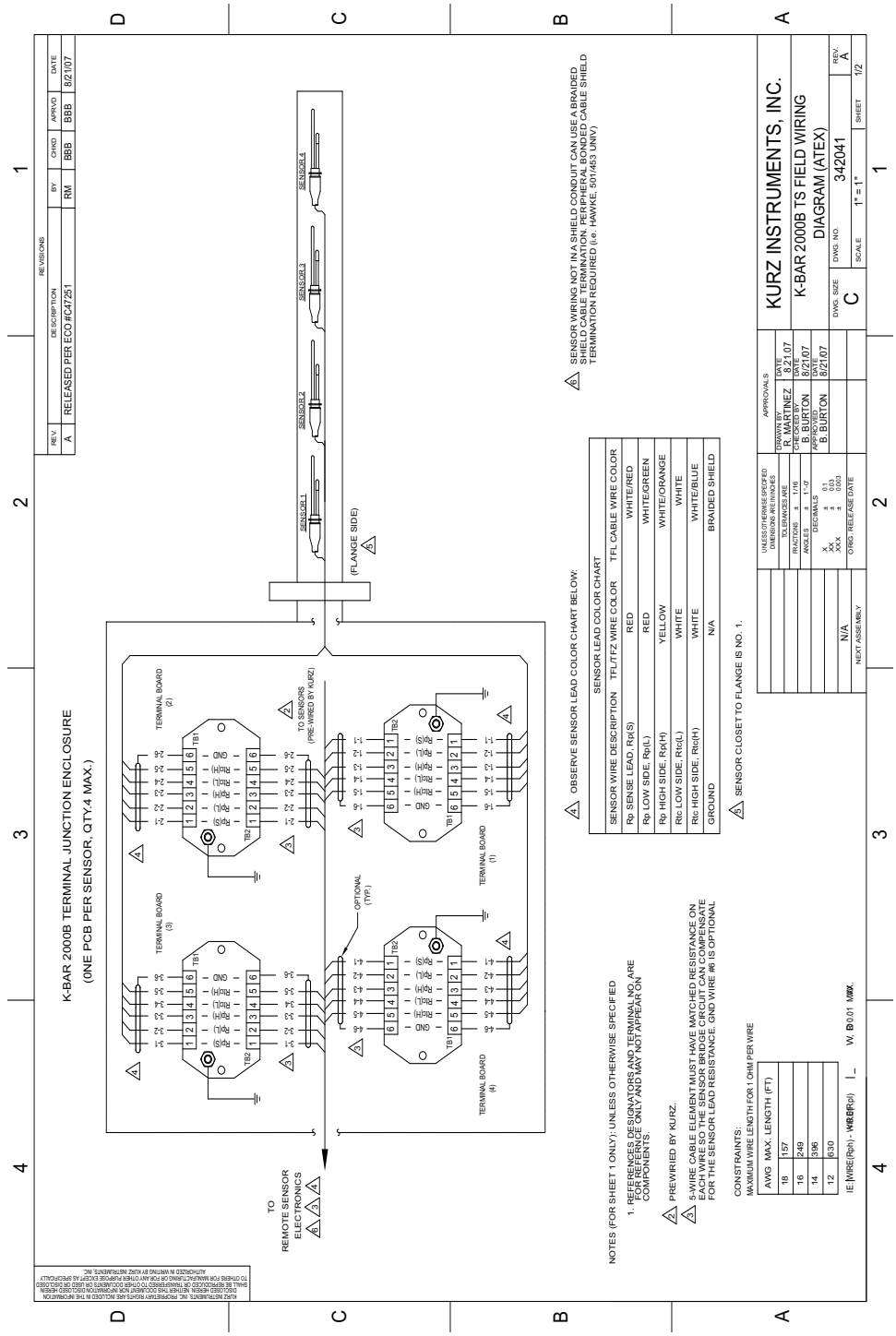
K-BAR 2000B-WGF Diagram (1 of 1)



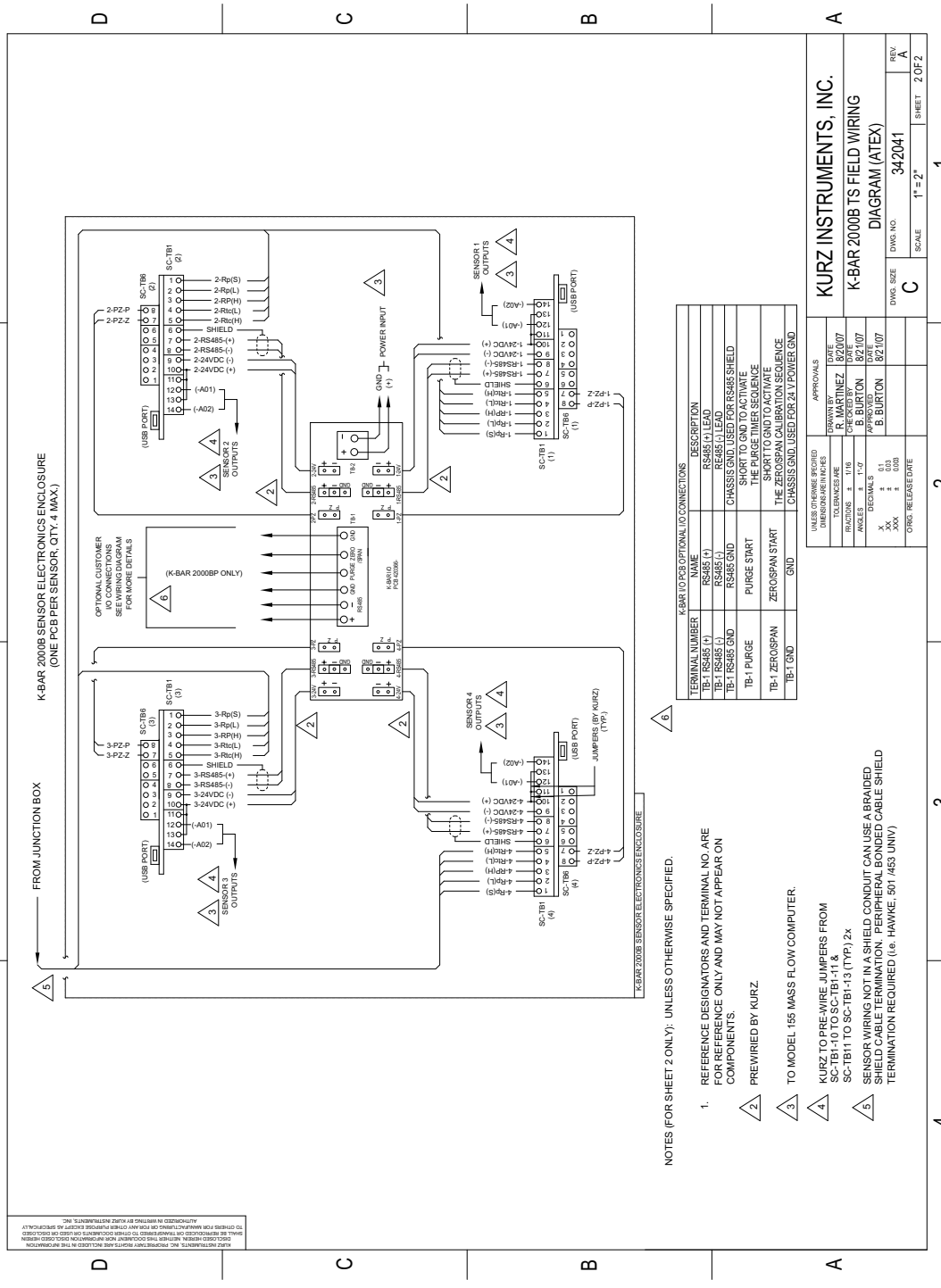
K-BAR 2000B Wiring Diagram (1 of 4)



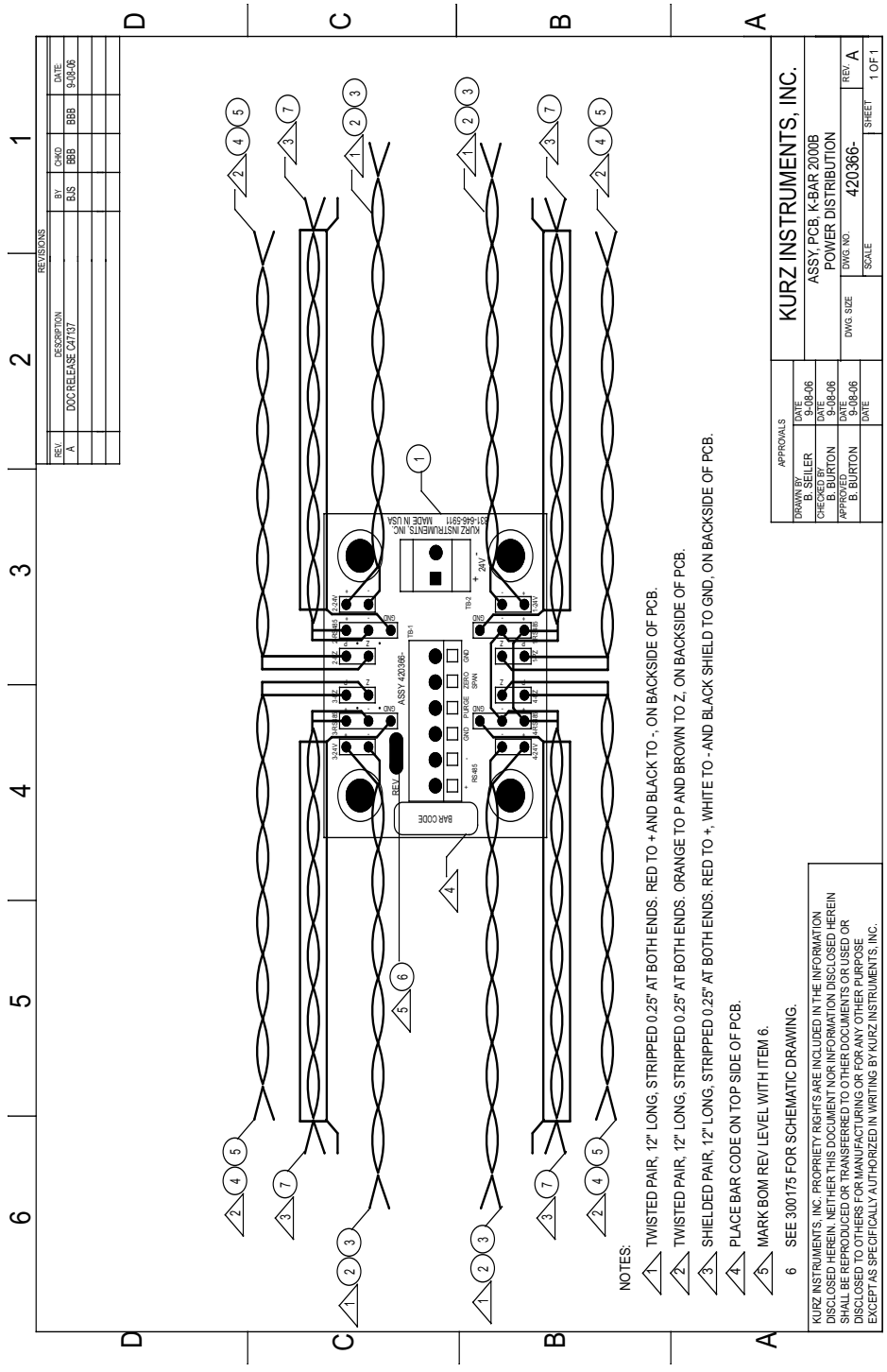
K-BAR 2000B Wiring Diagram (2 of 4)



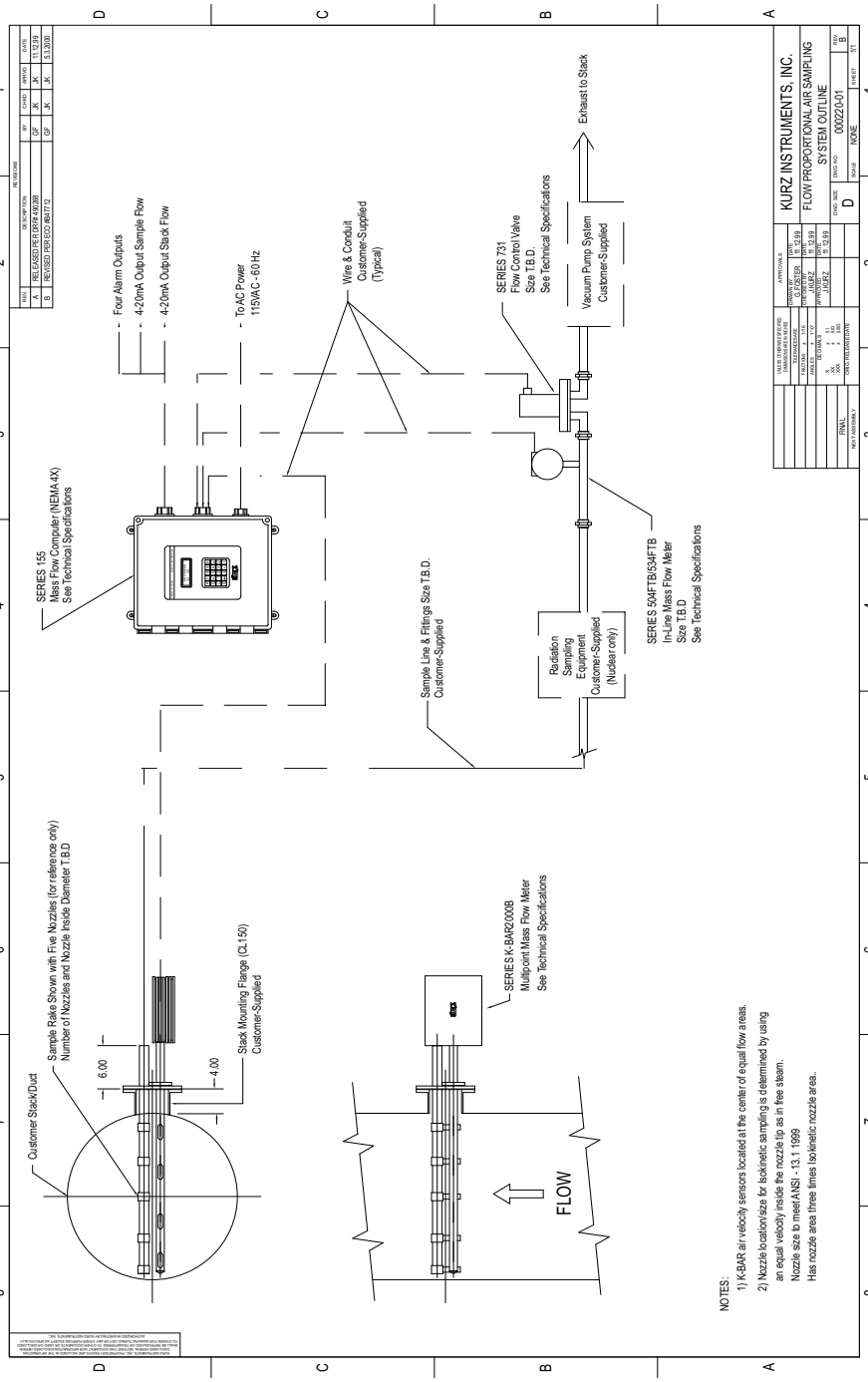
K-BAR 2000B Wiring Diagram (3 of 4)



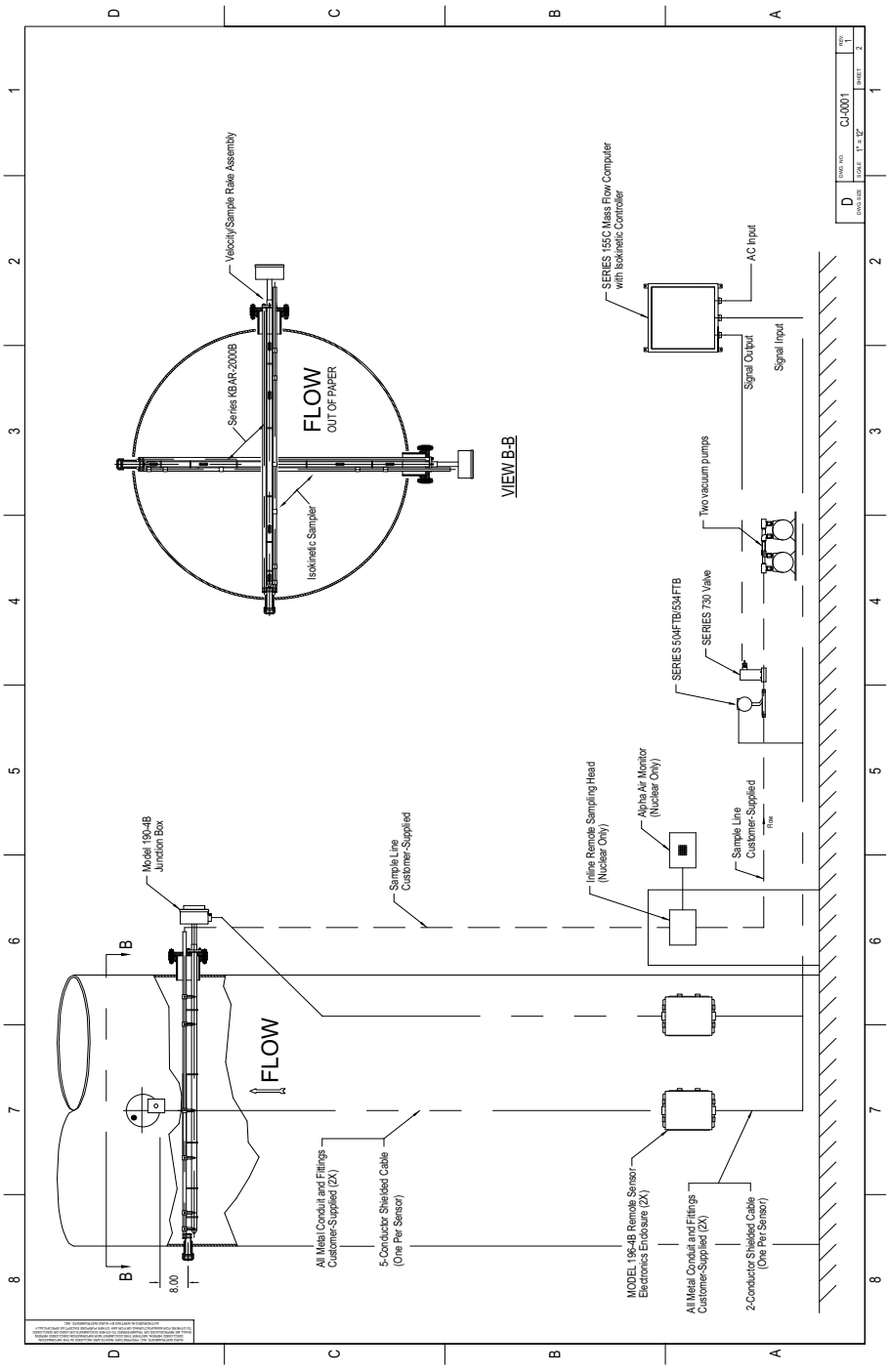
K-BAR 2000B Wiring Diagram (4 of 4)



Isokinetic System (1 of 2)



Isokinetic System (2 of 2)



Appendix B

Calibration

Overview

The appendix provides information on checking or calibrating an installed flow meter to ensure absolute accuracy based on local factors that can influence readings, such as the velocity profile.

Note This appendix is based on the Kurz field calibration procedure (CAL-016) for doing field traverse calibration with a Pitot Tube or thermal flow meter. A newer version, CAL-026, and its companion spreadsheet, 180227, are available upon request. CAL-026 is tailored for the MFT B-Series single point flow meters and is used for Kurz Factory supported field calibrations.

The procedures in this appendix are intended for engineers and technicians who are familiar with performing the velocity traverses required for the reference flow measurements and capable of setting the correction factors in program mode for the Series 155 or Series 255.

Note Trace gas dilution field calibration is not provided.

Raw Velocity

Using raw velocity and reference velocity ensures the proper correction factors are loaded into a flow meter for new and recalibrated systems.

To set the calibration, you must measure the average flow or velocity using a reference method for each specified flow rate and know the flow rate and correction factor (CF) configured for the device under test (DUT). The correction factor is based on the velocity of the current flow rate, both of which are used for computing the raw indicated velocity:

Raw velocity = indicated flow/(area * CF)

The output from a multipoint K-BAR system is generally raw velocity. Single point flow meters require back-computing the raw velocity data to determine the flow output. The Kurz Modbus Client utility supports flow meter data logging in a comma-separated value (CSV) format, which can be imported into a spreadsheet application conversion. The flow meter data can then be computed to raw velocity.

Note Using an older Series 155 data logging utility to monitor the DUT during the field calibration will require you to temporarily assign a meter to each input channel to record the raw velocity from each sensor.

Note The Series 255 allows data logging to a comma-separated value (CSV) format.

To compute the correction factors for the DUT, enter the reference velocity and indicated raw velocity for each sensor and for each flow rate into the DUT. Any bias or Sensor Blockage Correction Factors (SBCFs) must be accounted for when loading new variable correction factor (VCF) or configuration correction factor (CCF) data. The logged correction factor results from bias * SBCF * VCF. After loading the new VCF/CCF data, the DUT will read the flow rate as measured by the reference method.

Velocity Traverse Data Acquisition

The traverse average velocity is acquired using either of the velocity traverse reference methods. The process flow rate must be at equilibrium so the computed average from the traverse reflects the same flow rates on all access points.

Developing the insertion depth information requires the following:

- Noting the sensor center line. See Table 2-1 for meter dependent measurements.
- Determining the start point, which is a variable distance beyond the compression fitting's outside edge based on conditions that include duct wall thickness and tread adaptors.
- Locating the probe center at the near wall edge, and marking the probe support with a permanent marker next to the compression fitting collar.
- Using a tape measure to mark the additional traverse locations based on your initial mark.

Velocity Traverse Reference Method

You can compute the average velocity in a large process duct or stack by performing a velocity traverse. The velocity traverse method for this in-situ calibration involves dividing the duct area into equal areas and then measuring the velocity in the center of each area. The average velocity is determined by numerically averaging the data (sum the data and divide by the number of samples). The following table provides information for determining the minimum number of sample points to be taken for each flow rate.

Table B-1. Minimum Number of Sample Points

Cross-sectional area of sampling site		Diameters downstream from the nearest flow disturbance such as a bend, expansion, or contraction assuming less-than two diameters upstream from the nearest flow disturbance.				
		>8	>6 to 8	4 to 6	2 to <4	<2
m^2	ft^2	Minimum number of sample points per flow rate.				
<0.2	<2	4	6	8	Determined case-by-case	Unusable data
0.2-2.3	2-25	12	18	24	Determined case-by-case	Unusable data
>2.3	>25	20	30	40	Determined case-by-case	Unusable data

Equal Areas for a Rectangular Duct

The sample locations for rectangular ducts are determined by simply dividing a cross-section of the duct into small equal-area rectangles and then measuring at the center of each rectangle. You can achieve an accurate estimate of the duct's flow profile if there are sufficient access points; at least eight equivalent diameters downstream and at least two equivalent diameters upstream from the nearest flow disturbance such as a bend, expansion or contraction.

The recommended access points use 19.05 mm (0.75 inches) compression fittings with a nylon, teflon, or other plastic ferrule that will not permanently adhere to the test probe.

Use the following equation to find the equivalent diameter for a rectangular duct based on the minimum sample points specified in Table B-1:

$$ED = (2HW) \div (H + W)$$

where:

ED is the equivalent diameter of a rectangular duct.

H is the height of the duct.

W is the width of the duct.

Use the following equation to find the correct sensor insertion depth for each rectangle along the traverse axis at a particular access point:

$$i = 1 \ldots n,\ ID_i = \{(i - 0.5) \div n\} \times TD$$

where:

i indicates the specific rectangle being measured starting from the wall closest to the access point and continuing along the traverse axis.

n is the number of rectangles along the traverse axis.

ID_i is the sensor insertion depth for each specific rectangle along the traverse axis.

TD is the traverse dimension for the inner duct dimension along the traverse axis.

Example 1

As shown in the following example, a test matrix with six traverse positions (at different insertion depths) along the traverse axis and five access points perpendicular to the traverse axis provide 30 test points.

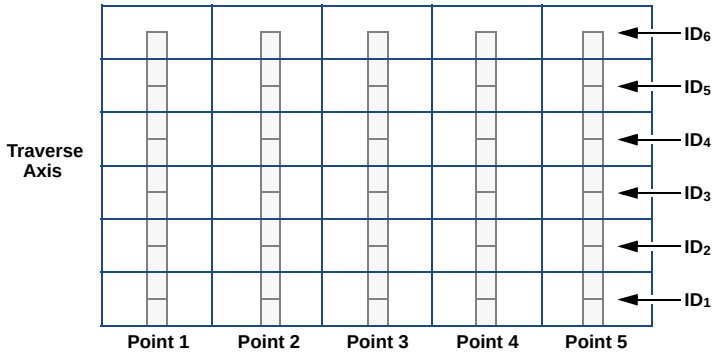


Figure B-1. Example of rectangular duct cross-section perpendicular to flow

1. A rectangular duct with a 1000 mm (39.4 inches) inner duct dimension along the traverse axis with six insertion depths has the following test points:

   $ID_1 = [(1 - 0.5) \div 6] \times 1000 \text{ mm} = 83 \text{ mm}$

   $ID_2 = [(2 - 0.5) \div 6] \times 1000 \text{ mm} = 250 \text{ mm}$

   $ID_3 = [(3 - 0.5) \div 6] \times 1000 \text{ mm} = 417 \text{ mm}$

   $ID_4 = [(4 - 0.5) \div 6] \times 1000 \text{ mm} = 583 \text{ mm}$

   $ID_5 = [(5 - 0.5) \div 6] \times 1000 \text{ mm} = 750 \text{ mm}$

   $ID_6 = [(6 - 0.5) \div 6] \times 1000 \text{ mm} = 917 \text{ mm}$

2. Collect data for each traverse point at each insertion depth.

Flow Rate 1 Example, 30 Points (75 max. per set)

ID_n	Insertion Depth (mm)	Velocity				
		Point 1	Point 2	Point 3	Point 4	Point 5
ID_1	83					
ID_2	250					
ID_3	417					
ID_4	583					
ID_5	750					
ID_6	917					

3. Compute the average fluid velocity by summing the data and dividing by the number of points.

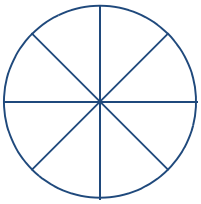
   The Series 2440 provides internal data logging and computations.

4. This process is repeated at each flow rate.

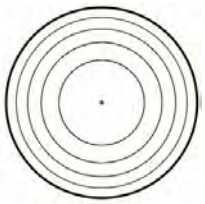
   The Series 255 allows for up to 6 sets, using VCF, and the Series 155 allows up to four sets, using CCF.

Equal Areas for a Circular Duct

A circular duct can be divided along the circumference into equal area wedges like slices of a pie and/or along the radius into equal area concentric rings. The concentric rings are spaced closer and closer as you move to the full diameter of the duct since the equal areas scale by the radius squared.



Wedge



Concentric

Refer to Table B-1 for the minimum number of sample points based on duct size and upstream disturbances.

The recommended access points use 19.05 mm (0.75 inches) compression fittings with a nylon, teflon, or other plastic ferrule that will not permanently adhere to the test probe.

Example 2

As shown in the following example, a test matrix with five traverse positions (at different insertion depths) at four access points spaced 90° apart along the duct radius provide 20 test points.

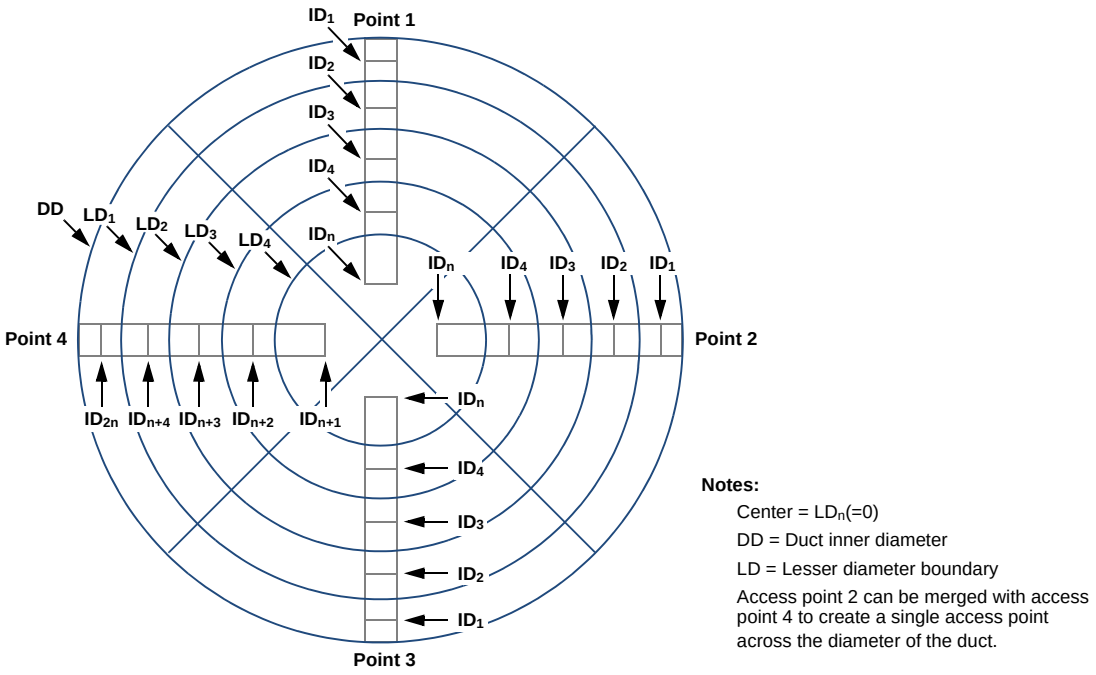


Figure B-2. Example of circular duct cross-section perpendicular to flow

Use the following equation to divide the duct along the radius into equal area concentric rings:

$$i = \ldots n,\ LD_i = \sqrt{1 - (i \div n)} \times DD$$

where:

- **i** identifies the specific ring being measured along the duct radius referenced to the inner duct wall.
- **n** is the total number of rings being measured.
- **LD_i** is the lesser diameter boundary of the specific ring being measured along the duct radius referenced to the inner duct wall.
- **DD** is the inside diameter of the duct wall.

After you determine the number and location of the access points, you must find insertion depth for each sector by using the following equations:

$$i = 1 \ldots n,\ ID_i = \{2 - \sqrt[2]{1 - [(i - 1) \div n]} - \sqrt[2]{1 - (i \div n)}\} \times DD \div 4$$

$$i = n + 1 \ldots 2n,\ ID_i = \{2 + \sqrt[2]{[(i - 1) \div n] - 1} + \sqrt[2]{(i \div n) - 1}\} \times DD \div 4$$

where:

i indicates the sector being measured along the duct radius referenced to the inner duct wall closest to the access point.

n is the total number of sectors being measured along the duct radius between the duct wall closest to the access point and the center of the duct. Do not include sectors on the other side of the center of the duct from the access point.

ID_i is the sensor insertion depth for the sector being measured along the duct radius referenced to the inner duct wall closest to the access point.

DD is the inside diameter of the duct.

1. A circular duct with a 1400 mm (55 inches) diameter, assuming five insertion depths each access points 1 and 3 and ten insertion depths for a merged access point 2, has the following insertion depths:

$$ID_1 = \{2 - \sqrt{1 - [(1 - 1) \div 5]} - \sqrt{1 - (1 \div 5)}\} \times 1400 \text{ mm} \div 4 = 37 \text{ mm}$$

$$ID_2 = \{2 - \sqrt{1 - [(2 - 1) \div 5]} - \sqrt{1 - (2 \div 5)}\} \times 1400 \text{ mm} \div 4 = 116 \text{ mm}$$

$$ID_3 = \{2 - \sqrt{1 - [(3 - 1) \div 5]} - \sqrt{1 - (3 \div 5)}\} \times 1400 \text{ mm} \div 4 = 208 \text{ mm}$$

$$ID_4 = \{2 - \sqrt{1 - [(4 - 1) \div 5]} - \sqrt{1 - (4 \div 5)}\} \times 1400 \text{ mm} \div 4 = 322 \text{ mm}$$

$$ID_5 = \{2 - \sqrt{1 - [(5 - 1) \div 5]} - \sqrt{1 - (5 \div 5)}\} \times 1400 \text{ mm} \div 4 = 543 \text{ mm}$$

$$ID_6 = \{2 + \sqrt{[(6 - 1) \div 5] - 1} + \sqrt{(6 \div 5) - 1}\} \times 1400 \text{ mm} \div 4 = 857 \text{ mm}$$

$$ID_7 = \{2 + \sqrt{[(7 - 1) \div 5] - 1} + \sqrt{(7 \div 5) - 1}\} \times 1400 \text{ mm} \div 4 = 1078 \text{ mm}$$

$$ID_8 = \{2 + \sqrt{[(8 - 1) \div 5] - 1} + \sqrt{(8 \div 5) - 1}\} \times 1400 \text{ mm} \div 4 = 1192 \text{ mm}$$

$$ID_9 = \{2 + \sqrt{[(9 - 1) \div 5] - 1} + \sqrt{(9 \div 5) - 1}\} \times 1400 \text{ mm} \div 4 = 1284 \text{ mm}$$

$$ID_{10} = \{2 + \sqrt{[(10 - 1) \div 5] - 1} + \sqrt{(10 \div 5) - 1}\} \times 1400 \text{ mm} \div 4 = 1363 \text{ mm}$$

2. Collect data for each traverse point at each insertion depth.

Flow Rate 2 Example, 30 Points (75 max. per set)

ID_n	Insertion Depth (mm)	Velocity		
		Point 1	Point 2	Point 3
ID_1	37			
ID_2	116			
ID_3	208			
ID_4	322			
ID_5	543			
ID_6	857	N/A		N/A
ID_7	1078	N/A		N/A
ID_8	1192	N/A		N/A
ID_9	1284	N/A		N/A
ID_{10}	1363	N/A		N/A

3. Compute the average fluid velocity by summing the data and dividing by the number of points.

   The Series 2440 provides internal data logging and computations.

4. This process is repeated at each flow rate.

   The Series 255 allows for up to 6 sets, using VCF, and the Series 155 allows up to four sets, using CCF.

Traverse Probe Blockage

Small ducts must account for sensor and probe support blockage. The deeper the probe is inserted into the duct blocks more flow and causes an increase in local velocity because of the reduced internal area. When this blockage error is greater than 0.25% you can define a Sensor Blockage Correction Factor (SBCF) to make the observed reading account for the blockage as though it did not exist.

Use the following equation to determine if a SBCF is needed:

$$\mathbf{ID_i} \geq \mathbf{0.0025} \times \mathbf{AD} \div \mathbf{DP}$$

where:

ID_i is the sensor insertion depth for the specific cell being measured.

AD is the inner cross-sectional area of the duct.

DP is the diameter of the probe.

Example 3

Using a 19.05 mm (0.75 inches) diameter probe to sampling a circular duct with an inner diameter of 1400 mm (55 inches) requires the following minimum insertion depth to account for blockage:

$ID_i \geq 0.0025 \times \pi \times (1400\ mm)^2 \div 4 \div 19.05\ mm = 202\ mm$

The SBCF can be defined with the following equation:

$$\mathbf{SBCF_i = 1 - [(ID_i \times DP) \div AD]}$$

where:

$SBCF_i$ is the SBCF at the specific insertion depth being measured.

ID_i is the sensor insertion depth for the specific cell being measured.

DP is the diameter of the probe.

AD is the inner cross-sectional area of the duct.

Example 4

Using a 19.05 mm (0.75 inches) diameter probe to sampling a circular duct with an inner diameter of 1400 mm (55 inches) at a depth of 1363 mm (54 inches) for the 10th sampling point of an access point has the following SBCF:

$SBCF_{10} = 1 - \{(1363\ mm \times 19.05\ mm) \div [\pi \times (1400\ mm)^2 \div 4]\} = 0.9831$

The true velocity (VT) is found using the following equation:

$$\mathbf{VT = VI \times SBCF}$$

where:

VT is the true velocity.

VI is the indicated velocity.

Series 2440 Configuration

A thermal anemometer reads standard velocity corrected to reference conditions. For example:

25°C, 101.325 kPa

The readings are logged and then directly averaged using the equal area method.

The Series 2440 portable flow meter can average a set of traverse data of equal areas by creating a test-set memory log the same size as the traverse array. This method is faster and less error prone than filling out the tables shown in previous examples.

To configure the Series 2440 to internally log data to its test-set memory, you must setup the internal memory log with enough memory to account for the traverse size. The internal memory log has 2,300 points for trending and test-set data storage. Up to 90% of the storage is allocated to trend memory, so minimally 10% can be allocated to test-set memory.

Configuring Internal Memory Log

Note Most menus automatically exit to the main view after 2 minutes of inactivity.

To configure the internal memory log:

1> Enter Program mode by pressing **P**.

2> Enter the user code (the default is 123456).

3> Press **E**.

4> Press **P** until the **Memory Data Log** menu appears.

```
PRESS E TO SET
MEMORY DATA LOG
```

5> Press **E**.

```
SETUP: TRENDS
NEXT CHOICE ^v
```

The Setup options are **Events**, **Tests**, and **Trends**.

6> Press an arrow key to select **Trends** setup, and then press **E**.

```
TRENDS LOG: ON
^=ON  v=OFF
```

7> Press an arrow key to turn the Trend Log **ON**, and then press **E**.

```
LOG DATA MAY BE
LOST IF CHANGED
```

A warning or new value accepted message appears.

8> Press **E** to continue if necessary.

```
ENTER PERCENT OF
MEMORY USE: 50
```

9> Use the number keys to enter 50 percent, and then press **E**.

```
RESET TREND/TEST
MEMORY?     YES
```

10> If prompted press an arrow key to rest the trend/test memory **YES**, and then press **E**.

11> Press **P** to return to the setup options.

```
SETUP: TESTS
NEXT CHOICE ^v
```

12> Press an arrow key to select **Tests** setup, and then press **E**.

```
TESTS LOG: ON
^=ON  v=OFF
```

13> Press an arrow key to turn the Test Log **ON**, and then press **E**.

```
LOG DATA MAY BE
LOST IF CHANGED
```

A warning message appears.

14> Press **E** to continue.

```
ENTER MAX # OF
TEST SETS 10
```

For this example, this splits 50% of 2300 into 10 units of equal size (115 samples).

15> Press **E** to accept the default value (**10**).

```
MAX SAMPLES PER
TEST SET IS 115
```

16> Press **E** to continue or press **C** until you exit the setup options.

Storing Data in Test Memory

To store data in test memory:

1> Enter Program mode by pressing **P**.

2> Enter the user code (the default is 123456).

3> Press **E**.

4> Press **P** until the **Access Memory Log** option appears.

```
PRESS E TO
ACCESS MEM LOG
```

The memory log is used to record traverse data.

The Series 155 supports calibrating up to four flow rates, while the Series 255 and Series 2440 allows more than four test flow rates. If more flow rates information is gathered and the Series 155 is used, the additional Series 155 traverse results must be recorded elsewhere.

5> Press **E**.

```
SELECT TASK ^v
RECORD TEST DATA
```

The Task options are **Record Test Data**, **View Test Data**, and **Log to COM port**.

6> Press an arrow key to select **Record Test Data**, and then press **E**.

```
ENTER TEST SET
NUMBER: 4
```

7> Use the number keys to enter the number of test flow rates, and then press **E**.

You might be prompted to overwrite existing data. If you choose No, you will be prompted for another test set number.

8> Press an arrow key to select **Yes**, and then press **E**.

```
ENTER # OF TEST
SAMPLES: 30
```

The number of test samples should be less than max samples per test set. In the previous example, this was 115 samples.

9> Use the number keys to enter the traverse array size for the specified test set, and then press **E**.

```
LOG IS AUTO: NO
^=YES  v=NO
```

Automatically spaced timing requires you to move the probe to each point on the specified time interval.

10> Press an arrow key to select **No**, and then press **E**.

```
PRESS E TO START
AND E TO RECORD
```

11> Press **E**.

```
10.98 SMPS
24.6 DEGC
```

The filtered velocity and temperature settings appear. The appearance of velocity and temperature data can be modified to show temperature and flow data or flow and velocity data by pressing the arrow keys.

The standard 2-minute time-out does not apply to this prompt. It will not update until you accept the data as a test-set sample.

12> Press **E**.

```
SAMPLE #1
IS RECORDED
```

A momentary message appears showing the logged test-set number. This process continues until the entire test-set sample is defined (for this example, there are 115 samples.). When the test-set completes, the Series 2440 returns to the task prompt.

```
SELECT TASK ^v
RECORD TEST DATA
```

13> Press **E** to continue or press **C** until you exit the setup options.

Viewing the Data Stored in the Test Memory

To view the data from a test-set:

1> Enter Program mode by pressing **P**.

2> Enter the user code (the default is 123456).

3> Press **E**.

4> Press **P** until the **Access Memory Log** option appears.

```
PRESS E TO
ACCESS MEM LOG
```

The memory log is used to view traverse data.

The Series 155 supports calibrating up to four flow rates, while the Series 255 and Series 2440 allows more than four test flow rates. If more flow rates information is gathered and the Series 155 is used, the additional Series 155 traverse results must be recorded elsewhere.

5> Press **E**.

```
SELECT TASK ^v
VIEW TEST DATA
```

The Task options are **Record Test Data**, **View Test Data**, and **Log to COM port**.

6> Press an arrow key to select **View Test Data**, and then press **E**.

```
ENTER TEST SET
NUMBER: 1
```

7> Use the number keys to specify the test-set data you want to view, and then press **E**.

```
VIEW: FLOW RATE
NEXT CHOICE ^v
```

You can view the velocity, temperature, or flow rate by pressing the arrow keys.

8> Use the number keys to enter the number of test-set you want to view, and then press **E**.

```
AVERAGE DATA
10.98 SMPS
```

Use the arrow keys to scroll through the average data, standard deviation, maximum and minimum values, and the velocity, temperature, or flow rate for each test-set sample.

9> Press **C** until you exit the setup options.

Velocity Probe & the Pitot Tube

The classic Pitot tube is a velocity-sensing device based on the principle of converting kinetic energy of a flow stream to potential energy as a pressure by stopping the flow. It has an impact port and a static port that do not receive any kinetic contribution. The classic Pitot tube has a velocity-dependent correction factor K of 1.0 by definition.

The S-Type Pitot tube has an upstream impact port and downstream port under slight vacuum that generates a higher differential signal and improves the turn-down ratio. This increased differential pressure (dP) comes at the price of a correction factor K (which is velocity-dependent), so the device must be calibrated against the classic Pitot design.

The basic Pitot tube equation (in actual velocity) is as follows:

$$\mathbf{v = k\ (2gdP \div Dg)^{0.5}}$$

where:

k is the correction factor, 1.0 for classic Pitot and 0.84 for S-type Pitot.

g is the acceleration of gravity, 32.2 ft/s^2.

dP is the differential pressure between the impact and static ports in lb/ft^2.

Dg is the density of the gas, lb/ft^3.

Additional calculations involve converting the dP units to inches of water and converting the gas density to a function of pressure and temperature. The results are converted to standard velocity instead of actual velocity.

The following formula converts gas density to pressure and temperature:

$$\mathbf{Dg = Ds\ (Ts \div Ta)(Pa \div Ps)}$$

where:

Ds is the standard gas density, 0.07387 lb/ft^3.

MW is the gas molecular weight, MW = 28.96.

Ts is 77°F or 25°C in absolute units so 460 + °F or 273.15 + °C.

Ta is the actual temperature in absolute units.

Pa is the actual pressure in absolute units, in PSIA or Hg.

Ps is the standard pressure which is 101.325 kPa, 14.69 PSIA, 760 mmHg or 29.92 in Hg.

The following formula converts the differential pressure (dP) from inches H_2O into lb/ft^2:

$$\text{inches } H_2O \div (27.68 \text{ in } H_2O \div lb \div in^2) \times (144\ in^2/ft^2) = (144 \div 27.68) \times lb/ft^2$$

Use the following formula to make the final calculation to convert standard velocity to actual velocity:

$V = k\ [dP\ (144 \div 27.68)\ (2)\ (32.2) \div (MW\ 0.07387 \div 28.96)\ (Ts \div Ta)\ (Pa \div Ps)]^{0.5}\ (60)$

$V = 21745\ k\ [(dP \div MW)\ (Ta \div Ts)\ (Ps \div Pa)]^{0.5}\ FPM$

Note $X^{0.5}$ is the same as the square root of *X*.

The molecular weight (MW) of Air is equal to 28.96, which further reduces the calculation:

$V = k\ 4041\ [dP\ (Ta \div Ts)\ (Ps \div Pa)]^{0.5}\ FPM$

where:

V is actual velocity in ft/min, dP is in H_2O.

k is the correction factor.

The formula for standard velocity (SFPM) is:

Vs = V (Ts ÷ Ta) (Pa ÷ Ps)

The calculation appears as follows:

$Vs = 21745\ k\ [(dP \div MW)\ (Ts \div Ta)\ (Pa \div Ps)]^{0.5}\ SFPM$

The calculation for Air appears as follows:

$Vs = 4041\ k\ [dP\ (Ts \div Ta)\ (Pa \div Ps)]^{0.5}\ SFPM$

Pitot Tube Examples

Example A The measured dP is 7.53 in H_2O on a classic Pitot tube, the gas is Air, temperature is 20.1 °C, and pressure is 28.05 Hg. To determine the standard velocity:

$Vs = 4041\ (1.0)\ [7.53\ (273.15 + 25) \div (273.15 + 20.1)\ (28.05 \div 29.92)]^{0.5} = 10826\ SFPM$

Example B For measuring flue gas from a typical power plant with the following attributes:
an S-type Pitot measured at dP of 2.04 in H_2O, temperature is 460°F, pressure is 28.45 Hg in the stack with a gas mix of 15% CO_2, 10% H_2O, 73% N_2, 2% 0_2.
To determine the actual velocity and standard velocity:

Molecular weight:

$MW = 0.15 \times (12 + 2 \times 16) + 0.10\ (2 \times 1{+}16) + 0.73\ (2 \times 14) + 0.02\ (2 \times 16) = 29.48$

Actual velocity:

$V = 21745\ (0.84)\ [2.04 \div 29.48\ (460 + 460) \div (460 + 77)(29.92 \div 28.56)]^{0.5} = 6437\ FPM$

Standard velocity:

$Vs = 21745\ (0.84)\ [2.04 \div 29.48\ (460 + 77)\ /(460 + 460)(28.56 \div 29.92)]^{0.5} = 3587\ SFPM$

Example C For measuring digester gas flow rate with the following attributes:
8" schedule 40 pipe with gas composition is 70% CH_4 and 30% CO_2, using an S-type Pitot to record data where dP = 0.42 in H_2O, temperature is 37.2°C, and the pressure is 0.68 PSIG. The ambient air pressure is 27.56 Hg.

Convert pressure into the same units:
Pa = (0.68 PSIG ÷ 14.69PSI) × 29.92 in Hg **+** 27.56 in Hg = 28.94 in Hg

Compute the MW of the gas mix:
MW = 0.7 (12 **+** (4 × 1)) **+** (0.3 (12 **+** (2 × 16))) = 24.4

Compute the standard velocity:
$Vs = 21745\ k\ [(dP \div MW)\ (Ts \div Ta)\ (Pa \div Ps)]^{0.5}$ SFPM
$Vs = 21745\ (0.84)\ [0.42 \div 24.4\ (273.15 + 25) \div (273.15 + 37.2)(28.94 \div 29.92)]^{0.5}$
= 2310 SFPM

Assuming the measurement was from the center of the 8" duct and
the ID = 7.981 results in the following flow rate:

$SCFM = SFPM \times Area \times CF = 2310 \times 3.1416\ (7.981 \div 2 \div 12)^2 \times 0.80 = 642$ SCFM

This would be a large digester flow on a good day.

The 0.80 CF is a typical Va/Vp correction factor observed with tracer gas testing on an 8" line. Accounting for the Pitot tube blockage during the measurement results in an area reduction by (0.25 inch x 4") = 1 in^2. Converting this value to ft^2 with the previous calculations:

$SCFM = 2310 \times [3.1416\ (7.981/2/12)^2 - 1 \div 144] \times 0.8 = 629$ SCFM

Accounting for the test probe blockage is a 2% lower flow rate but slightly more accurate calculation.

Appendix C

Zero Flow Calibration

Overview

The Zero Flow calibration test provides functional diagnostic information about your Kurz flow meter. This information includes sensor cleanliness, sensor and electronics functionality, and system damage or changes that caused potential calibration drift.

Note The Zero Flow calibration test only demonstrates that minimum functionality of the flow meter has been maintained after installation. The test does not account for field-specific installation criteria.

This appendix assumes you are familiar with B-Series login and menu structure. Refer to the *B-Series Operations Guide* for additional information.

Before performing this test, you will need:

- A Zero Flow calibration chamber. Kurz recommends the chamber specified in “Zero Flow Assembly Parts” on page C-6 and shown in Figure C-5 and Figure C-6.

- The Calibration Data and Certification document for the device under test. Contact Kurz if you are unable to locate your original documentation.

Performing A Zero Flow Calibration Test

To perform a Zero Flow calibration test:

1> Remove the probe support from the process.

Follow all required safety precautions, as determined by company policy.

2> Visually inspect sensor for cleanliness.

If the sensor appears dirty, gently use a cellulose/synthetic fiber scour pad (such as Scotch-Brite®) or emery cloth to remove hard deposits.

Example of Dirty Sensor

Example of Clean Sensor

Figure C-1.Dirty and clean sensors

Important ***Do not use harsh abrasives such as sandpaper, steel wool, or a sharp edge to remove any deposits. These can damage the sensors. Use an acid-based solvent if necessary.***

Be careful handling the sensors.

Important ***Applying too much pressure on the sensors can bend or damage them.***

3> Use a suitable chamber for Zero Flow testing.

Kurz recommends the chamber specified in “Zero Flow Assembly Parts” on page C-6 and shown in Figure C-5 and Figure C-6.

4> Slide the Zero Flow chamber over the probe support so that the sensing element is located in the center of the chamber and the Y-Port is down.

5> Hand-tighten the Swagelock assembly.

6> Ensure the probe support is horizontal with the flow arrow pointing horizontally, as shown in Figure C-2 and Figure C-3.

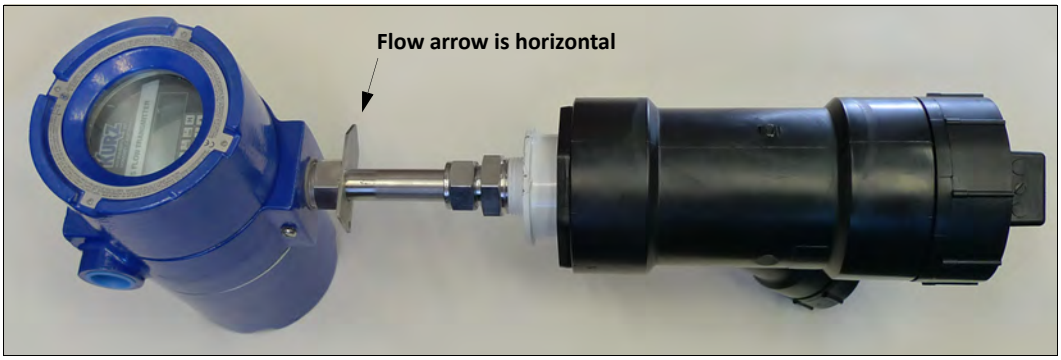


Figure C-2.Flow meter position for Zero Flow calibration test — example

The flow meter was originally calibrated horizontally, and changing the position will change the reading.

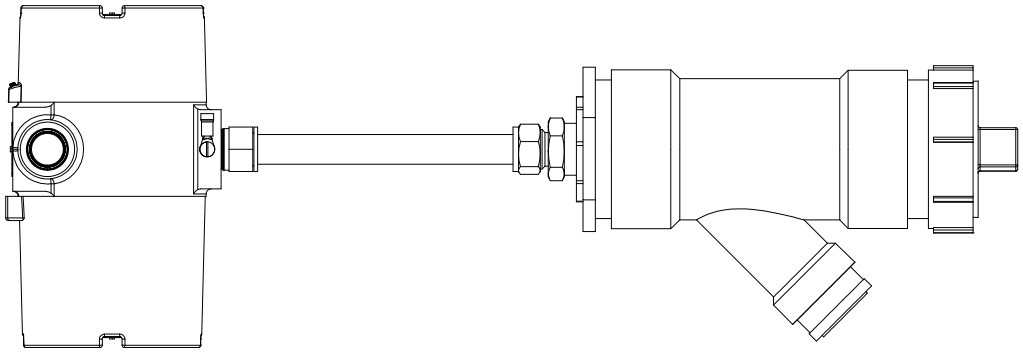


Figure C-3.Flow meter position for Zero Flow calibration test — illustration

7> Power the meter on and wait for it to complete its startup self-diagnostics.

8> Remove the enclosure lid to access the display/keypad.

9> To view the Flow Data information in Display mode:

a> Press **D**.

b> Press **2** to invoke the Quick Jump option.

c> Press **42** for the Flow Data menu, and then press **E**.

```
TAG 500000A
RT 6649.86    HRS
```

d> Press **D** until the PRP prompt appears.

```
PRP=    x.xxxx W
AT x.xxxx SCMH
```

Note The Rp Power value (PRP field), Velocity value (AT field), and flow units are specific to your flow meter. The flow units can be KGH, KGM, PPH, PPM, NCMH, NLPM, SCFH, SCFM, SCMH, or SLPM.

The data is unfiltered and unaltered by any programmed bias, blockage, or velocity correction factors defined for the flow meter.

e> Wait 2 minutes and record the Rp Power value in Watts. If higher accuracy is required, wait up to 20 minutes before recording the Rp Power value.

f> Press **H** twice to exit.

10> Locate the zero flow Rp Power column in the Calibration Data and Certification Document provided with the flow meter, or contact Kurz if you are unable to locate your original documentation.

Figure C-4 shows an example of a Calibration Data and Certification Document. The zero flow point is highlighted with Rp Power = 1.9357 W.

CALIBRATION DATA AND CERTIFICATION DOCUMENT
KURZ INSTRUMENTS, INC.
2411 GARDEN ROAD
MONTEREY, CA 93940
1(800) 424-7356 831 646-5911 FAX 831) 646-8901
www.kurzinstruments.com

SENSOR CALIBRATION DATA

Serial No/Filename:	007VC
Calibration Date:	09/01/2013
Customer Code/CUstomer Name:	007VALUEDCUSTOMER
Purchase Order No:	7500F2
Model No:	454FTB
Part Number:	500000-A-3000-B-1-C-200-D-10-E-1-F-3000
MAPICS Item No:	0007500
Flow Units:	SMPS
Reference Fluid:	Air
Standard Conditions (English & Metric Units):	_25 Degrees C and _760 mmHg

	Point No.	Rp Power W dc	Velocity SFPS	Velocity SFPM
Zero flow point	1	1.9357	0.0000	0.0000
	2	2.4478	0.2735	53.841
	3	3.3930	0.8331	164.010
	4	4.8758	2.8006	551.332
	5	7.1551	9.6224	1894.258

NOTE: Power was measured directly by the calibrated unit.

VTM Data Derived from the following Measurement Components

FLOW ELEMENT CALIBRATION REFERENCE	DATA ACQUISITION SYSTEM
Model No: 454-08 S/N:DL11001A	Model No: 615MF-0900
NIST Calibration Due Date:09-09-2013	Serial No: 010101A

This instrument was calibrated with measuring and test equipment with certified NIST traceability. Copies with applicable NIST number are available upon request. The calibration of this instrument was performed in accordance with the requirements of ISO-9001, ANSI/NCSL Z540 and ISO/IEC GUIDE 25.

WIND TUNNEL OPERATOR:_____ DATE:_____
QUALITY CONTROL:_____ DATE:_____

Figure C-4.Calibration Data and Certification Document example

11> Calculate the error associated with the data collected above and the zero flow point data on the Certification document.

Equation : $\%\ \text{Error} = \frac{|\ \text{Disp PRP} - \text{Cal PRP}\ |}{\text{Cal PRP}} \times 100$

where:

Disp PRP = Zero flow point value (W) recorded from the display

Cal PRP = Zero flow point value (W) on the certificate

Example : $2\%\ (\text{pass}) = \frac{|\ 1.9746 - 1.9357\ |}{1.9357} \times 100$

If the Rp Power reading is within +/-3% then the sensor is clean and the flow calibration has not drifted. If it is not within 3% then gently clean the sensor as described in Step 2 on page C-2. Repeat the test to obtain a new Rp Power value. If 3% is not achievable then return the device to Kurz for evaluation and possible re-calibration.

Zero Flow Assembly Parts

Table C-1 lists the parts used for building a Zero Flow chamber shown in Figure C-5.

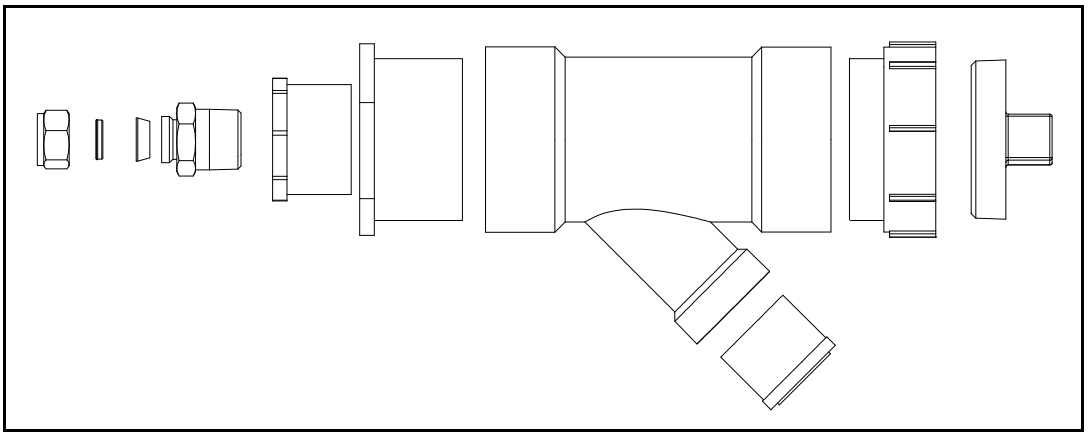


Figure C-5. Zero Flow calibration chamber — exploded view

Table C-1. Zero Flow Chamber Parts List

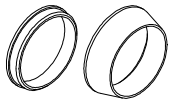
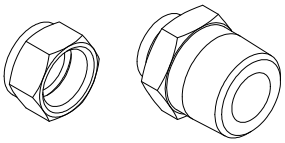
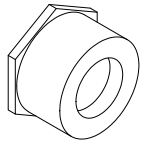
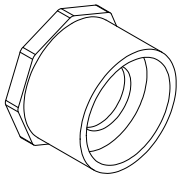
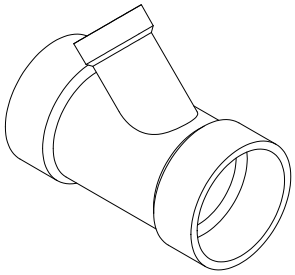
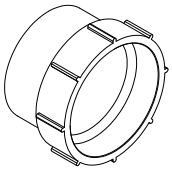
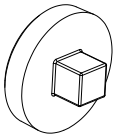
Quantity	Description	Image
1	Nylon front and back ferrules	
1	1” MNPT Swagelock assembly with ¾” or 1” through hole (based on probe support diameter)	
1	1” to 2” FNPT PVC bushing reducer **Note:** A single 1” to 3” bushing reducer can replace the 1” to 2” and 2” to 3” bushing reducers.	
1	2” to 3” FNPT PVC bushing reducer **Note:** A single 1” to 3” bushing reducer can replace the 1” to 2” and 2” to 3” bushing reducers.	
1	3” x 1½” ABS Y-branch fitting	
1	1½” PVC plug	
1	3” FNPT ABS coupler	

Table C-1. Zero Flow Chamber Parts List (continued)

Quantity	Description	Image
1	3” MNPT ABS end cap	
	ABS or PVC cement	

Assemble and glue the parts together as shown in Figure C-6.

Figure C-6. Zero Flow calibration chamber — assembled

Appendix D

Retractor/Restraint Installation

Overview

The Kurz Instruments retractor/restraint adapter is used to restrain a flow meter that is not permanently installed in a pipe when the gas flow is under pressure. It is also used to stabilize a flow meter with a long sensor support.

Before You Begin

These instructions are for the retractor/restraint with flange mounting adapter. Figure D-1 shows the Retractor/Restraint Adapter components and the tools required for the installation.

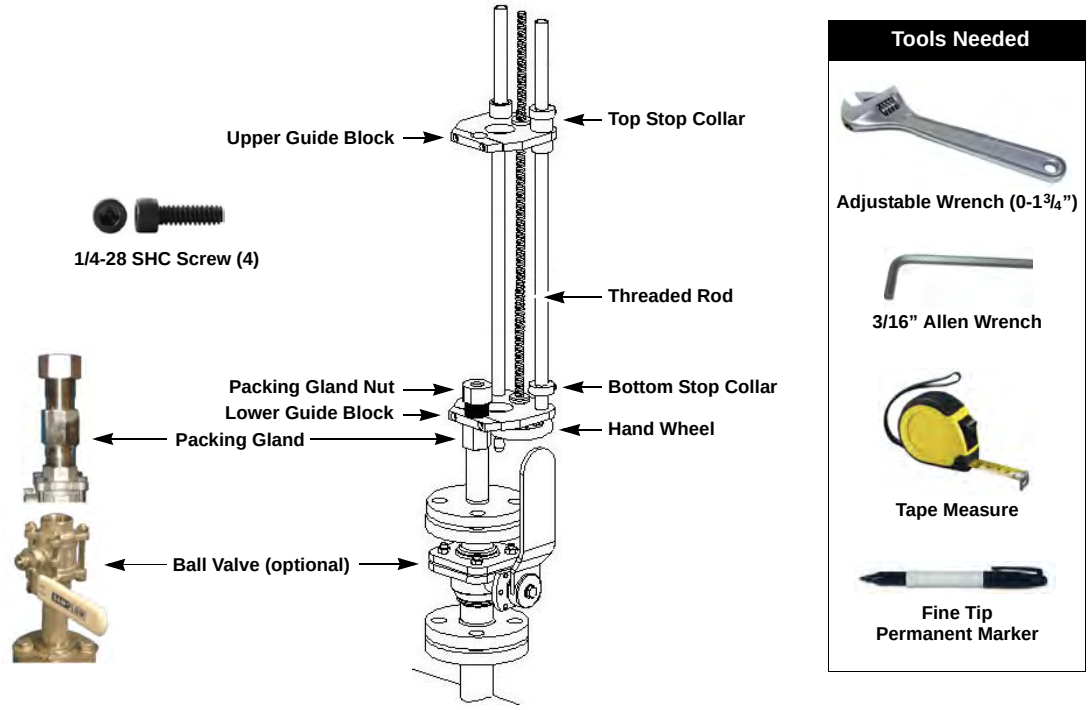


Figure D-1. Retractor/Restraint Adapter components and required tools

The lower and upper guide blocks each have a specific bracket that attaches around the packing gland and the sensor support, respectively.

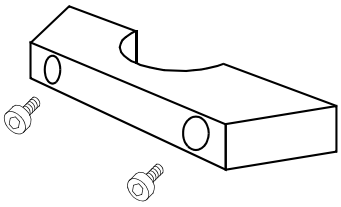


Figure D-2. Guide block bracket

Measuring For Sensor Placement

There are two stop collars:

- The top stop collar is intended to be the upper point where the end of the sensor support clears the ball valve so the ball valve can be closed.
- The bottom stop collar is intended to place the sensor probe in the correct position within the pipe. The bottom stop collar must also be at least slightly above the packing gland nut just enough so the nut can be tightened and loosened as needed; this is approximately 2 inches from the lower guide block.

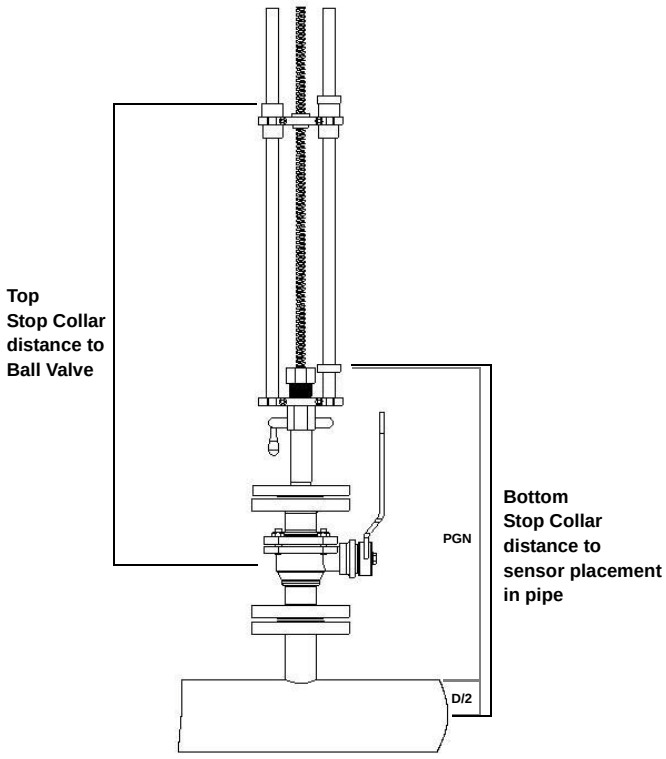


Figure D-3.Stop collar placement

Definitions

PL is the probe length. The probe length appears on the label attached to the side of the meter in the line appearing as MODEL: *model-xx-PL* where PL is the probe length.

D/2 is half of the pipe diameter.

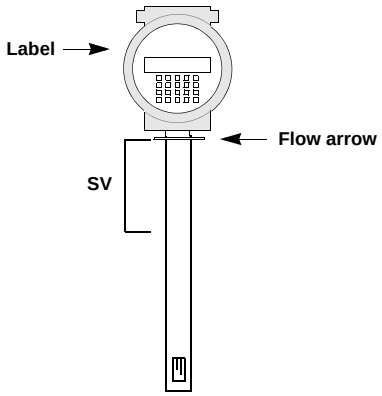
PGN is the distance from the top of the pipe to the top of the packing gland nut.

C_L is the distance from the tip of the probe to the sensor center line. See Table 2-1 for meter dependent measurements.

SV is the stroke value measured down the probe support from the flow arrow.

SP is the optimal sensor placement.

Pre-Assembled

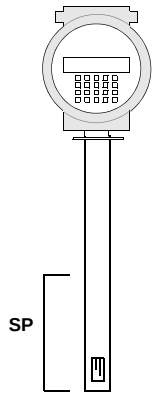


For configurations with the flow meter and retractor/restraint pre-assembled, the top stop collar should be in the correct position. To determine the placement for the bottom stop collar, use the formula

SV = PL - (D/2 + PGN + C_L).

Mark this distance with a marker and lower the probe until this mark is just above the packing gland nut. This is the position for the bottom stop collar that correctly positions the sensor within the flow stream.

Separate Components



For configurations where the flow meter and retractor/restraint adapter are *not* pre-assembled, you must determine the meter support position before attaching the meter to the adapter.

To determine the bottom stop collar position, use the formula

SP = D/2 + PGN + C_L.

You will use this formula and mark the probe support during the installation to correctly position the sensor within the flow stream.

Note The remaining portion of these instructions are for configurations that are not pre-assembled.

Installing the Adapter

Important ***Follow your company's safety procedure whenever working with any Kurz Instruments devices. Read all of the instructions completely before proceeding.***

1> Thread or bolt the ball valve into the location where you are installing the flow meter. Ensure the handle is in the closed (horizontal) position.

Note The ball valve is optional but highly recommended. It allows you to easily close the sensor support opening if you remove the flow meter.

2> Thread or bolt the packing gland onto the ball valve and tighten it by hand, followed by a one-quarter turn with a wrench.

3> On the retractor/restraint adapter, remove the upper and lower guide block brackets and loosen the screws keeping the top and bottom stop collars in place.

4> Lift the retractor/restraint adapter and place the packing gland in the rounded cutout of the lower guide block.

5> Screw the bracket and lower guide block together using two ¼-28 SHC screws.

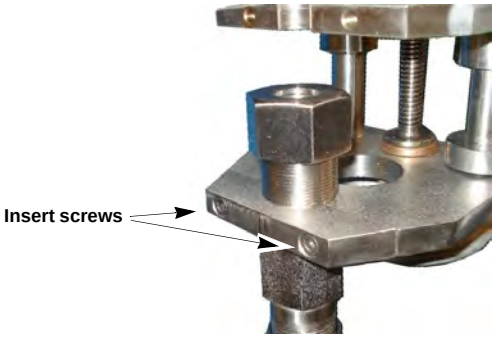


Figure D-4.Lower guide block

6> Use the formula described in “Measuring For Sensor Placement” to take the measurements for determining the optimal sensor placement for the bottom stop collar.

a> Place the flow meter on a flat surface.

b> Measure along the probe support from the tip of the probe to the point determined to provide the optimal sensor placement.

c> Using a permanent marker, mark the measurement on the probe support.

When you insert the probe into the packing gland, the mark should be visible just above the packing gland nut.

7> Using the hand wheel, move the upper guide block most of the way to the top.

8> To set the top stop collar:

a> Close the ball valve.

b> Place the tip of the sensor support through the packing gland until it rests on the closed ball valve.

c> Place the sensor support into the rounded cutout of the upper guide block, and then lift the meter approximately 1/4-inch.

d> Use the hand wheel to adjust the upper guide block as needed.

The distance between the top and bottom stop collars must be equal to or greater than the distance specified for the optimal sensor placement.

e> Make sure the top stop collar is flush against the upper guide block, and tighten the SHC screw for the top stop collar.

9> Screw the bracket and upper guide block together using two ¼-28 SHC screws.

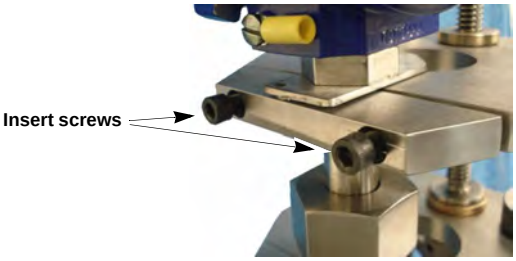


Figure D-5.Upper guide block

The wiring side of enclosure should be on the opposite side of the threaded rod, and the flow direction arrow on the probe must be in the same direction as the flow in the pipe.

Figure D-6.Flow arrow direction

10> Open the ball valve, and use the hand wheel to lower the flow meter until the mark you made on the sensor support is visible just above the packing gland nut.

11> Raise the bottom stop collar until it is flush against the upper guide block, and tighten the SHC screw in the bottom stop collar.

12> Hand tighten the packing gland nut, followed by a half turn with a wrench.

Your installation is complete.

Appendix E

SIL Safety for B-Series Flow Meters

Overview

This section provides information necessary to meet the compliance requirements of the IEC 61508 and/or IEC 61511 functional safety standards when incorporating a Kurz B-Series thermal mass flow meter into a safety-related system or subsystem.

- IEC 61508: Functional safety of electrical/electronic/programmable electronic safety related systems
- IEC 61511: Functional safety-Safety Instrumented Systems for the process industry sector

Kurz B-Series flow meters are used to measure the mass flow rate of gases. The Kurz B-Series includes the 454FTB, 534FTB, 504FTB, and K-BAR 2000B. For additional information, including environmental and maintenance requirements, refer to the following literature:

- Document # 367551, Technical Specification for Series 454FTB
- Document # 367543, Technical Specification for Series 534FTB
- Document # 367547, Technical Specification for Series 504FTB
- Document # 367542, Technical Specification for Series K-BAR 2000B
- Document # 368042, Kurz Operations Guide for B-Series Flow Meters

Terms & Definitions

Dangerous failure	Failure with the potential to bring the safety instrumented system into a dangerous or non-functional state.
FMEDA	Failure Modes Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance, ability of a hardware to continue to perform a required function in the presence of faults or errors.
MTBF	Mean Time Between Failures
PFD	Probability of Failure on Demand, Probability of hazardous failures for a safety function on demand.
Safety function	The ability of a system to carry out actions necessary to maintain a defined safe state for a process, equipment, or a plant.
Safety-related system	A safety-related system performs the safety functions that are required to maintain a safe condition (for example, a flow meter, a burner, and a PLC).
SFF	Safe Failure Fraction, percentage of failures that do not have the potential to put the safety-related system in a hazardous state.
SIL	Safety Integrity Level, IEC 61508 defines four Safety Integrity Levels (SIL1 through SIL4). Each level corresponds to a level of probability for the failure of a safety function.
SIS	Safety Instrumented System, implementation of one or more safety instrumented functions.

Safety Function

Kurz B-Series thermal mass flow meters are intended to be part of a SIS subsystem, as defined per IEC 61508. The achieved SIL level of the designed function must be verified by the designer.

The B-Series flow meters generate a current output proportional to the mass flow rate of a process gas. All safety functions refer only to this analog output (AO) signal.

During normal operation, the flow meter output is between 3.8 mA and 20.5 mA. Faults are indicated less than or equal to 3.6 mA (the default LOW ALARM setting) or greater than or equal to 21 mA, depending on the configuration of the NE-43 alarm. The default LOW ALARM setting is recommended when the flow meter is used in a Safety Instrumented System. The flow meter enters an NE-43 alarm state during flow meter boot-up and sensor warm-up, indicating a detected failure to function for approximately 30 seconds. In the event there is a loss of power to the flow meter, the output will indicate 3.6 mA or less regardless of the NE-43 alarm configuration.

Fault Conditions

Continual internal diagnostics are present within B-Series flow meters. The diagnostic features which only operate on start-up are not considered part of the safety function. Table E-1 lists fault conditions that are detected and can be programmed to result in an output less than or equal to 3.6 mA or greater than or equal to 21 mA.

Table E-1. Fault Conditions

Error Code	Fault Condition
xxxxxxx1	**RP resistance above high limit.** The velocity sensor resistance (RP) is above the normal range for the configured sensor type. Possible causes: Open circuit on the sensor wiring. Defective sensor or sensor control board.
xxxxxxx**2**	**RP resistance below low limit.** The velocity sensor resistance (RP) is below the normal range for the sensor type configured. Possible causes: Short in the sensor wiring. Defective sensor or sensor control board.
xxxxxxx**4**	**RTC resistance above high limit.** The process temperature sensor resistance (RTC) is above the normal range for the sensor type configured. Possible causes: Open circuit on the sensor wiring. Defective sensor or sensor control board.
xxxxxxx**8**	**RTC resistance below low limit.** The process temperature sensor resistance is below the normal range for the sensor type configured. Possible causes: Short circuit on the sensor wiring. Defective sensor or sensor control board.
xxxxxx**1+**	**Wire loop resistance above high limit.** The sensor wire resistance from the sensor to its electronics board is above limit (> 5.0 ohms). Possible causes: Wire is too long for the gage being used. Loose wire joint connection (but not too loose, see code 20). Defective sensor or sensor control board.

Table E-1. Fault Conditions (continued)

Error Code	Fault Condition
xxxxxx**2+**	**Sensor RPs lead open circuit.** The sensor wire RPs is open circuit or not connected. Possible causes: Open circuit on the RPs wire, pin 1 of TB1. Open on the RP lead will also set this, Pin 3, TB1. Defective sensor or sensor control board.
xxxxxx**4+**	**High sensor or wire leakage.** The sensor or wiring is showing too much leakage current to ground. The trip point of this error is the equivalent of 100 kOhms leakage resistance. Possible causes: Wet or contaminated wiring or junction box. Water in the backend of a sensor. Corroded front side to a sensor. Sensor above temperature limit. Defective sensor control board.
xxxxxx**8+**	**Flow rate above design limits.** Under high heat flow conditions (very high flow rates), the demand to heat the sensor may exceed the drive limits of the sensor control board. The reported flow readings at this point are compressed and lower than the true flow readings.
xxxxx**4++**	**ADC failed to convert measurement.** The circuits on the sensor control board which measures the input signals are not working properly. Possible causes: The sensor control board is defective and needs to be replaced.
xxxxx**8++**	**Sensor control drive stopped responding.** The sensor drive voltage to heat the velocity sensor is not matching the set point. Possible causes: Short or miss-wiring of the sensor. Defective sensor control board needs replacing.
xxxx**1+++**	**Sensor over-voltage crowbar engaged.** The sensor drive voltage was not matching the set point and would not fall to low drive on command. The crowbar SCR was engaged to clamp the sensor drive voltage to zero. Possible causes: Sensor field wiring short to a DC power supply (4-20 mA) or 24 V supply. Defective sensor control board needs replacing.

Table E-1. Fault Conditions (continued)

Error Code	Fault Condition
0x2000	**Sensor type does not match configuration.** The sensor resistance ratio RTC/RP exceeds 10% of the normal value of the sensor for which the meter was configured. Possible causes: Wrong sensor is connected to the electronics. Confirm the serial number matches. Upset to the process temperature causing the two sensors (RP and RTC) to not match in temperatures. Defective sensor or sensor control board.
0x4000	**Abnormal sensor node voltages.** This fault is often a redundant error to the sensor and wiring errors. It looks only at the sensor wire voltages, not the resistance values. Possible causes: Incorrectly wired sensor. Short or open circuit. Defective sensor or sensor control board.
0x8000	**Unable to write config file to EEPROM.** The sensor and meter configuration data can not be verified after a memory write. Possible causes: Defective sensor control board. Any EEPROM read/write fault.

SIL Capability

Kurz B-Series flow meters have met design process requirements according to IEC 61508 for Safety Integrity Level (SIL) 1.

- Kurz B-Series flow meters are considered to be a Type B element with a Hardware Fault Tolerance (HFT) of 0.
- The Safe Failure Fraction is calculated to be 79%.

A detailed FMEDA report is available by contacting Kurz Instruments Customer Services. The report details the failure modes and failure rates of the critical components in the flow meter. FMEDA assumptions are listed within the FMEDA report. The FMEDA was carried out by TUV Rheinland and the results are summarized in Table 1.

Table 1. FMEDA Report Summary

Description	Parameter
HFT – Hardware Fault Tolerance	0
Device Type	B
Failure Mode λ Total λs Safe Failures λd Dangerous Failures λdd Dangerous Detected λdu Dangerous Undetected	 299 FIT 150 FIT 149 FIT 87 FIT 62 FIT
SFF Safe Failure Fraction	79%
For High Demand or Continuous Mode PFH	62 FIT
For Low Demand PFDavg PTI 10 years PTI 5 years PTI 2 years PTI 1 year	 27.3E-04 13.6E-04 5.45E-04 2.72E-04
Diagnostic time interval	Zero-mid-span test cycle controlled by the PLC Note: Zero-mid-span test cycle shall be 100x the demand rate of the safety function.

Note Unit of Failure rate FIT (Failure in Time) is number of failures per 10^{**9} hours.

Proof Test

The objective of the proof test is to detect failures that are not detected by automatic system diagnostics. The frequency of a proof test is determined by the reliability calculations of the SIS functions where the B-Series flow meter is installed. The frequency of proof testing should be adjusted to maintain the required integrity of the SIS function.

The following proof test is recommended:

1. Prior to beginning the proof test, bypass the safety function or take other appropriate action to avoid a false trip.
2. Generate or simulate an alarm condition to force the B-Series flow meter to indicate an alarm current output <= 3.6 mA and verify that the analog current reaches that value. See Table 1 for events that generate an alarm.
3. Remove the alarm condition and verify that the analog current recovers to the normal range.
4. Remove power from the flow meter.
5. Verify that the analog current at the PLC or safety DCS indicates <= 3.6 mA.
6. Restore power to the flow meter and verify that the analog current recovers to the normal range.
7. Perform a low-point and high-point calibration check by comparing the flow meter display readings and the AO current level values at each calibration point to known reference measurements.
8. If the calibration is within tolerance at both calibration points, the proof test is complete. Proceed to step 12.
9. If the calibration check is out of tolerance by more than 5%, remove the flow meter probe from the process and inspect the probe for dirt buildup. Clean the probe if necessary.
10. Repeat the low-point and high-point calibration checks specified in Step 7.
11. If the calibration is still out of tolerance, contact Kurz Instruments Technical Support for assistance.
12. After completing the proof test, remove the bypass from the safety function or otherwise restore normal operation.
13. The results of the proof test must be accurately recorded and archived.

Returning Equipment

If you believe your instrumentation is working improperly or needs to be recalibrated, contact Kurz Customer Service. Follow the directions in Chapter 5, Troubleshooting, “Returning Equipment”.

Appendix F

Certifications, Compliance & Labels

Overview

This appendix provides:

- A list of certifications, approvals, and compliance for Kurz devices with the associated region of acceptance.
- An example of the flow device label and explains the content.

Certifications, Approvals, and Compliance

The following table lists certifications, approvals, and compliance covering the entire Kurz product line. Table F-2 and Table F-3 specify by model the certifications, approvals, and compliances that apply to each Kurz product. It also lists the area of origination:

Table F-1. Certifications, Approvals, and Compliance

Symbol	Origin	Organization/Description
ATEX Ex	European Union	**ATEX** (2014/34/EU) The ATEX Directives require employers to classify where hazardous explosive atmosphere can occur and equipment used in potentially explosive environments. Mechanical and electrical equipment, as well as protective systems, must comply with the ATEX (ATmospheres EXplosibles) Directive. ATEX certification allows the CE and Ex marks. Approved models and their ATEX safety rating are listed in the EU Declaration of Compliance.
CCC	China	**CCC** The China Compulsory Certificate (CCC) mark issued by the China Certification and Accreditation Administration (CNCA) is a compulsory safety mark for both domestically manufactured products and products imported, sold, or used in the Chinese market.
CE	European Union	**CE** A valid CE mark affixed to a product indicates that it complies with the relevant European Union product safety directives.
CRN	Canada	**CRN** The Canadian Registration Number is issued by each Canadian province or territory. It covers pressure vessels, fittings, or pressure piping. It is a necessary authorization allowing these components to be in operation in Canada.
C SA US	Canada and United States	**CSA** CSA certification indicates that a product, process or service has been tested to a Canadian or U.S. standard and it meets the requirements of an applicable Canadian Standards Association (CSA) standard or another recognized document used as a basis for certification. It provides an increased assurance of quality and safety. In the U.S., CSA International is accredited by the Occupational Health and Safety Administration (OSHA). (Certificate #2074191)

Table F-1. Certifications, Approvals, and Compliance (continued)

Symbol	Origin	Organization/Description
	European Union	**EMC** (2014/30/EU) The Electromagnetic Compatibility Directive applies to all electronic or electrical products liable to cause or be disturbed by electromagnetic interference (EMI). Compliance allows a manufacturer to use the CE marking.
	United States	**Environmental Protection Agency** Kurz meets the certification requirements for: Greenhouse gas (GHG) reporting (CFR Title 40, Part 98.34 (c) and Relative accuracy and zero-span drift check. (CFR Title 40, Part 75)
	Global	**ETL** Intertek certification indicates that a product, process or service has been tested to a Canadian or U.S. standard and it meets the requirements of the tested standard.
	Russian Federation	**GOST** Technical standards are maintained by the Euro-Asian Council for Standardization, Metrology and Certification (EASC). GOST standards are regional, and GOST R standards are national.
	Global	**HART** The Hart Protocol is a global standard for bidirectional (sending and receiving) digital communication between smart devices/field instruments and control or monitoring host system (such as a technician's hand-held device or laptop, a plant's process control, or asset management, safety or other system using any control platform). (Certification #L2-06-1000-059)
	International	**IECEx** (60079-0, 60079-1) The International Electrotechnical Commission determines the suitability of electrical equipment in flammable or explosive gas atmospheres.

Table F-1. Certifications, Approvals, and Compliance (continued)

Symbol	Origin	Organization/Description
	Global	**ISO 9001** The International Standards Organization defines quality system requirements for design/development, production, installation and servicing. It applies to manufacturing and service businesses engaged in all these activities. (Certification #990108.1) **FM** Factory Mutual is a certification company offering ISO9000 approval, accreditation, and global conformity in the manufacture and assembly of products. (Certification #990108.1)
	European Union	**LVD** (2014/34/EU) The Low Voltage Directive ensures that electrical equipment within certain voltage limits both provides a high level of protection. It covers electrical equipment with a voltage between 50 and 1000 V for alternating current and between 75 and 1500 V for direct current.
	International	**NAMUR** (NE43) NAMUR (an international association of process instrumentation user companies) recommends a standardized signal level for transmitter failure. The measurement information range is 3.8 to 20.5 mA, with measurements below and above that range indicating failure information.
	European Union	**PED** (97/23/EC) The Pressure Equipment Directive defines the design, manufacture, testing, and conformity assessment of pressure equipment and assemblies of pressure equipment. A company that meets the directive can use the CE mark.
	Korean Safety Law	**EK** The Korean EK mark is equivalent to the IEC standards except for the power supply (220V, 60Hz) and the type of plug.

Table F-1. Certifications, Approvals, and Compliance (continued)

Symbol	Origin	Organization/Description
	Europe	**QAL1** QAL1 applies to ambient air and continuous emission monitoring based on Directive EN 15267, as part of supporting optimal pollution control. (Certificate #0000040211) The approval process for Continuous Emissions Monitoring Systems and Automated Monitoring Systems in Germany is administered by TUV and UBA (the Federal Environment Agency). Both are recognized internationally due to their extensive certification process and experience. TUV/UBA adopted the European standard EN 15267 Part 3 and incorporated the German domestic requirements (BImSchV 17: suitable for incineration plant, BImSchV 13: suitable for large combustion plant, and BImSchV 27 and 30: suitable for other types of plants) in developing the QAL1 standard.
	European Union	**RoHS** (2011/65/EC) All the electronics, enclosure parts, paints, etc., used in this design comply with Article 4 requirements of the RoHS Directive. We take exemption (Introduction paragraph 18 and article 12, paragraph 4d, 4e, and 4j) to the lead-free solder as this has a low activation temperature flux that shorts-out components and thus disables the measurement instrument for the high ambient temperatures expected for this type of high-reliability product. Being used as industrial measurement and control equipment, its reliability and the safety for the process with which it is associated, takes precedence.
	European Union	**WEEE** (2002/96/EC) The Waste Electrical and Electronic Equipment Directive was introduced in 1970 to improve the environmental performance of businesses that manufacture, supply, use, recycle, and recover electrical and electronic equipment.

Table F-2. Kurz Product Certifications, Approvals, and Compliance - Active Product Lines

Product	ISO	ATEX	CE	CSA	CRN	EMC	EPA	GOST	HART	IECEx	EK	LVD	NAMUR	PED	QAL1	RoHS	WEEE
Series 155	•	•	•	•		•	•					•			•	•	•
Series 220	•																
Series 255	•	•	•			•	•		•	•		•	•		•	•	•
Series 410FTB	•		•			•	•		•			•	•	•		•	•
Series 454FTB	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•
Series 454FTB-WGF	•	•	•	•	•	•	•		•	•		•	•	•		•	•
Series 490	•																
Series 504FTB	•	•	•	•		•	•	•	•	•		•	•	•		•	•
Series 534FTB	•	•	•	•		•	•	•	•	•		•	•	•		•	•
Series 730	•																
K-BAR 2000B	•	•	•			•	•	•	•			•	•		•	•	•
K-BAR 2000B-WGF	•	•	•			•	•		•			•	•			•	•
Series 2440	•					•							•				

Note: • Contact Kurz or a Kurz representative for specific product certifications, approvals, or compliance information.

Table F-3. Kurz Product Certifications, Approvals, and Compliance - Informal & Legacy Product Lines

Product	ISO	ATEX	CE	CSA	CSA	EMC	EPA	GOST	HART	IECEx	KEA	LVD	NAMUR	PED	QAL1	RoHS	WEEE
Series 410	•	•	•														
Series 452	•		•	•		•						•				•	•
Series 454FT	•	•	•	•		•					•		•	•			
Series 502	•		•	•		•						•				•	•
Series 504FT	•	•	•	•		•						•	•	•		•	•
Series 522-UHP	•		•	•								•	•	•		•	•
Series 524FT-UHP	•	•	•	•		•						•	•	•		•	•
Series 524FT	•	•	•	•		•			•	•		•	•	•		•	•
Series 534FT	•	•	•	•		•						•	•	•		•	•
K-BAR 16	•		•											•			
K-BAR 24	•		•														
K-BAR 2000	•	•	•			•						•				•	•

Note: • Contact Kurz or a Kurz representative for specific product certifications, approvals, or compliance information.

Certifications & Safety Labels

The 410FTB, while based on the B-Series hardware and firmware design is only certified for ordinary location service, **OrdLoc**. It cannot be used in hazardous area service, **HazLoc**. The 410FTB has been approved to the industrial general safety standard IEC 61010-1:2010 Ed. 3 and UL 61010-1:2012 Ed. 3 + R:29Apr2016.

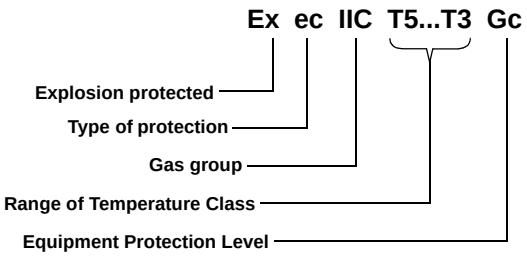
The B-Series flow meters (4xx and 5xx models) have been tested, evaluated, and certified by an independent accredited certification body and are in compliance with the following international, European, and North American industrial equipment standards:

- Safety requirements for electrical equipment for measurement, control, and laboratory (use Part 1: General Requirements).
  - IEC 61010-1:2010 Ed. 3
  - UL 61010-1:2012 Ed. 3 + R:29Apr2016
  - CSA C22.2#61010-1-12:2012 Ed. 3 + U1
- Hazardous locations and potentially explosive atmosphere requirements
  - IEC 60079-0:2017 Ed. 7
  - IEC 60079-1:2014 Ed. 7
  - IEC 60079-7:2017 Ed. 5.1
  - EN 60079-0:2018
  - EN 60079-1:2014
  - EN IEC 60079-7:2015/A1:2018
  - CSA C22.2#213:2017 Ed. 3
  - UL 60079-0:2019 Ed. 7
  - UL 60079-1:2015 Ed. 7
  - UL 60079-7:2017 Ed. 5
  - UL 1203:2013 Ed. 5 + R:16Oct2018
  - UL 121201:2017 Ed. 9
  - C22.2 No. 30-M1986 Ed. 3 (reaffirmed 2016)

Specific Conditions for Safe Use

- All sealing devices including cable glands, blanking elements, thread adapters and stopping plugs are required to be certified to type of protection Ex ‘db’ or ‘ec’ as applicable; be suitable for use in the ambient temperature range and group of the equipment; carry the same IP rating of the equipment as a minimum and be suitably sized for the cabling which is carried. Installation shall take into account any applicable special conditions for safe use and all relevant installation requirements of IEC 60079-14.
- External non-metallic materials pose a potential electrostatic charging hazard. To minimize the risk from electrostatic discharge clean only with a damp cloth.
- Flameproof joints are not intended to be repaired.
- Each enclosure entry shall have no more than one thread adapter when an adapter is used. A blanking element shall not be used with an adapter.
- Flow element sensor (sting) shall only be installed in areas where the presence of ignitable gas concentrations does not exceed Zone 1 limits.

The Kurz meters, with the exception of the 410FTB, are certified suitable for use in a hazardous area and the marking on the safety labels specify the criteria that the product meets in relation to the Hazardous Locations/Explosive Atmosphere regulations and determines the type of environments the meter is safe to operate in. For example, the following marking appears on the models used in applications where an explosive atmosphere is not likely to occur during normal operations:



The temperature class on the label defines the maximum surface temperature at which the device is allowed to operate. Temperature class is referenced to an ambient of -20°C to +40°C unless specified otherwise. According to the type of explosion protection used on the product, the temperature corresponds either to the maximum temperature of the external surface of the product or to the maximum temperature of the internal surface of the product.

The T value provides information to ensure the temperature class of the device is below the minimum ignition temperature of the explosive atmosphere where it will be installed.

T1	T2	T3	T4	T5	T6
450°C	300°C	200°C	135°C	100°C	85°C

The safety label also defines the application temperature flexibility so you can trade off ambient or process temperature against the Auto Ignition Temperature (AIT) of the potentially flammable gases. There are graphs showing the safety AIT for the process or sensor environment and the electronics or ambient environment.

Contact your Kurz representative or Kurz Instruments if you need assistance in evaluating the suitability of the device in your environment. Contact information is provided on the inside cover of this guide.

ATEX Standards

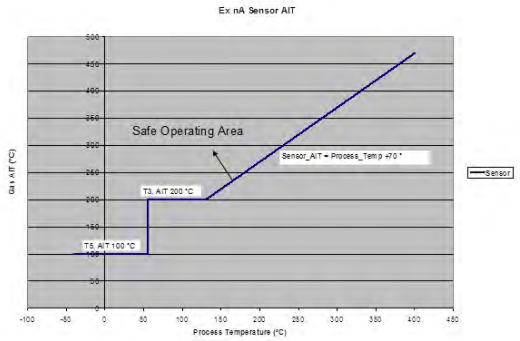
The ATEX directive covers potentially explosive atmospheres. The directives apply to electrical and nonelectrical equipment and devices. Kurz offers two safety approaches:

Ex e — The enclosure and components in the design prevent internal sparking and excessive heating in occasionally explosive atmospheres.

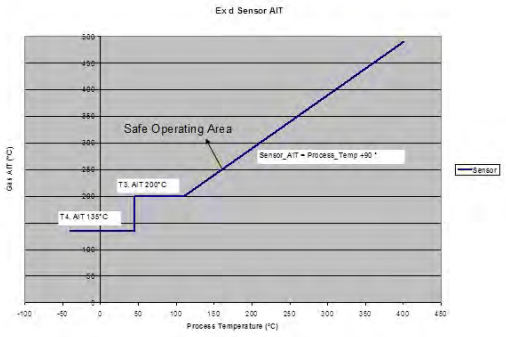
Ex d — The external enclosure of flameproof equipment is designed to withstand an internal explosion. The enclosure joints permit the products of combustion, and the resulting expansion of gases, to be relieved through the joints and not to permit that explosion to transmit through to the external atmosphere.

Process and Ambient Temperatures

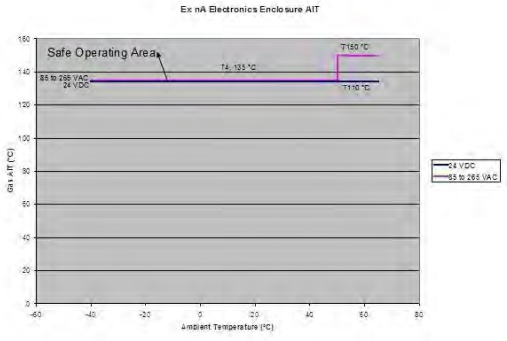
Figure F-1 shows the sensor and electronics AIT versus the process and ambient temperature for EX nA and Ex d environments. If the hazardous gas AIT is above the meter rating, the application is safe.



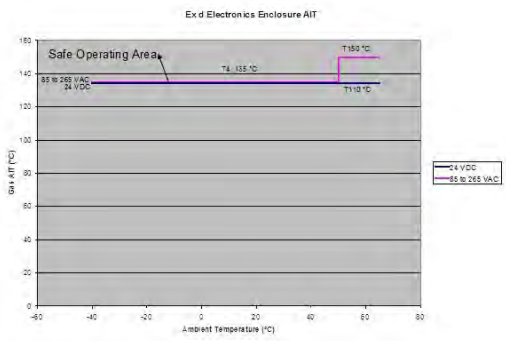
Ex nA application, sensor AIT vs. process temperature



Ex d application, sensor AIT vs. process temperature



Ex nA application, electronics enclosure AIT vs. ambient temperature

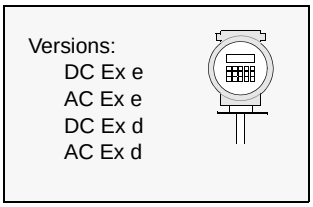


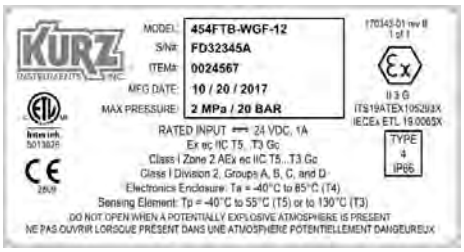
Ex d application, electronics enclosure AIT vs. ambient temperature

Figure F-1. Sensor AIT and Electronics Enclosure AIT vs. Process and Ambient Temperature

Transmitter-Attached and Transmitter-Separate Labels

Figure F-2, Figure F-3, and Figure F-4 provide examples of the labels used to indicate the safety ratings for the sensors and electronics used with transmitter-attached and transmitter-separate configurations.





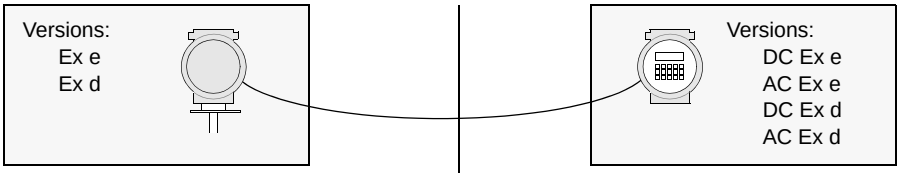
Transmitter-Attached, DC, Increased Safety (Ex e)

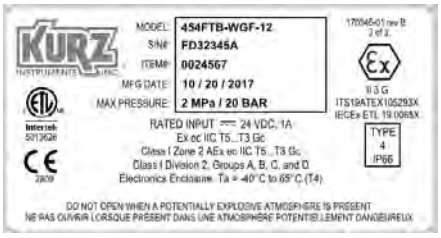
Transmitter-Attached, AC, Increased Safety (Ex e)

Transmitter-Attached, DC,
Flame Proof/Explosion Proof (Ex d)

Transmitter-Attached, AC,
Flame Proof/Explosion Proof (Ex d)

Figure F-2. Safety Label for Transmitter-Attached, Aluminum Enclosure (example only)





Transmitter-Separate, DC,
Increased Safety (Ex e)

Transmitter-Separate, Sensor,
Increased Safety (Ex e)

Transmitter-Separate, AC,
Increased Safety (Ex e)

Transmitter-Separate, Sensor,
Flame Proof/Explosion Proof (Ex d)

Transmitter-Separate, Aluminum, DC,
Flame Proof/Explosion Proof (Ex d)

Transmitter-Separate, Aluminum, AC,
Flame Proof/Explosion Proof (Ex d)

Figure F-3. Safety Label Combinations for Transmitter-Separate, Aluminum Enclosure (example only)

Appendix G

Standard Terms & Conditions of Sale

Overview

The appendix provides the terms and conditions related to the following:

- Orders
- Quotation and Published Prices
- Taxes
- Terms
- Packing
- Delivery
- Shipping Costs & Insurance
- Changes
- Cancellation
- Acceptance — Product
- Patent & Trademark Indemnity
- Documentation & Training
- Proprietary Rights
- Substitutions & Modifications
- Tools
- Construction
- Regulatory Laws and/or Standards
- Excusable Cessation of Performance for Non-Payment
- Nuclear Qualification
- Limited Warranty — Product (Liability for Repair and Replacement Only)

Orders

All orders are received subject to acceptance by Kurz Instruments, Inc. at the factory in Monterey, CA, U.S.A., herein referred to as “Company”, and may be accepted only on Company’s printed acknowledgement form. Purchase orders for Company products and services must be made out to the Company and must be received in writing at Monterey, CA, before performance is completed unless otherwise approved by the company.

Quotation and Published Prices

Until acceptance, all written quotations are subject to change upon written notice to the buyer and are void after 30 days unless otherwise specified on quote. Verbal quotations are good only on the day on which they are made by an authorized representative of the Company.

The prices shown on the published price lists and other published literature issued by the Company are not offers to sell and are subject to confirmation by specific quotation and acknowledgement. All published prices and discounts are subject to change without notice.

Sealed bids are subject to these Standard Conditions of Sale unless specified otherwise in bid and agreed to by the Company.

Taxes

Prices are exclusive of all foreign, federal, state, municipal, or other government excise, sales, use, occupational, duty, or like taxes now in force, or enacted in the future and therefore are subject to an increase equal in amount to any tax the Company may be required to collect or pay upon the sale or delivery of the items purchased.

Terms

The terms of sale shown in the published price list shall apply from the date of shipment by the Company.

If the Company in its judgment at any time deems that by reason of the financial condition of the Buyer or otherwise the continuance of production or shipment on the terms specified herein is not justified, the Company may require full or partial payment in advance. Certain orders may, in the judgment of the Company, because of their nature or the delivery involved, require progress payments. Pro rate payments shall become due as shipments are made. Terms are cash net 10 days. Amounts past due are subject to a service charge of 1.5% per month (or fraction thereof).

Should the Buyer be in default of the terms stated above, the Company shall add to the Buyer’s account, all reasonable costs, including attorneys’ fees, filing fees, and any other fees or expenses deemed reasonable by the Company in collecting the amounts due.

Packing

The Company makes no charge for its standard packing for domestic shipment. The Buyer may be charged for export packing or other special packing required, the cost of which will be quoted upon request. No credit or deduction will be allowed if no packing is required.

Delivery

Shipping dates given by the Company are approximate and are based on prompt receipt of all necessary information regarding the order. The Company will use its best efforts to meet the ARO date provided the Buyer sup- plies all necessary information and data promptly, but cannot be held responsible for causes beyond its reasonable control. The Company shall in no event be responsible for loss of profits, damages incurred by the buyer to its customers, or other consequential damages resulting from Company's failure to deliver within the time specified herein.

In the event of any delay requested by the Buyer or any delay caused by lack of shipping instructions, the Company will store all items ordered at the Buyer's risk and expense, and will invoice the Buyer for the full contract price of the apparatus on or after the date on which the same is ready for delivery. If manufacture is delayed by the Buyer, payment shall be made based on the percent of completion and the contract price.

Shipping Costs & Insurance

Shipments are f.o.b. factory, Monterey, CA, freight and insurance prepaid and added, or freight collect unless otherwise requested and agreed to by the Company. If insurance is being provided by the Buyer a formal statement of Buyer responsibility must accompany purchase order. Customer is responsible for notification in writing to the Company within 72 hours of any loss or damage of the shipment if the shipment was made F.O.B. destination. In the absence of specific instructions, the Company will select the carrier.

Changes

The Buyer may from time to time, but only with the written consent of the Company, make any change in the order. In the event of any such change, the Buyer shall pay to the Company the reasonable costs and other expenses (including engineering expenses and all commitments to its suppliers and subcontractors incurred by the Company prior to receipt of notice of such change for all work rendered unnecessary by such change or incurred by the Company thereafter for all work required to effect such change. In either case, an amount determined by the Company in its discretion by applying to the amount such costs and other expenses and the Company's usual rate of profit for similar work. In the event of any such change, the Company shall further be entitled to revise its price and delivery schedules to reflect such change.

Cancellation

In the event of cancellation, the Buyer shall be liable for the payment of reasonable cancellation charges, which shall not exceed the unit retail list price of the items cancelled and shall include among other things expenses already incurred by the Company, actual liabilities against Commitments incident to the order involved, and properly allowable indirect charges as well as a reasonable profit. No delivery delay requested by Buyer on an order placed under this Agreement shall be effective unless covered by an amendment to the order that provides for the payment of any agreed upon costs the delay imposes on the Company and that is accepted on the Company's printed acknowledgement form. Standard products only once delivered may be returned to the Company's discretion and upon approval from the Company in Monterey, CA, at a minimum charge for restocking of 20% of list price. Return shipping charges are at Buyer's expense.

If the Buyer makes an assignment for the benefit of creditors, if a voluntary or involuntary petition or other action in bankruptcy or for reorganization or under any other insolvency law shall be filed by or against the Buyer, if the Buyer shall admit inability to pay its debts, if trustee, receiver or liquidator is appointed for any part of the assets of the Buyer, or if the Buyer fails to make payments to the Company in accordance with the terms hereof, the Company may at its option cancel all undelivered parts of any order by written notice to the Buyer at no expenses to the Company.

Acceptance — Product

Unless otherwise agreed to by the Company, the criterion for acceptance of the Company's products including options shall be the successful operation of the product and options using the Company's standard test procedures applicable to the product and options involved. All acceptance tests shall be run by Company personnel at the Company's factory, unless otherwise allowed for and agreed to by the Company.

Limited Warranty — Product (Liability for Repair and Replacement Only)

The Company's products are warranted to be free from defects in material and workmanship for one year (three years for B Series products) from date of shipment from the factory. The Company's obligation is limited to repairing, or at their option, replacing products and components which, on verification, prove to be defective, at the factory in Monterey, CA. The customer is responsible for materials of construction selection and for materials suitability for the intended use of Kurz equipment. The Company shall not be liable for installation charges, for expenses of Buyer for repairs or replacement, for damages from delay or loss of use, or other indirect or consequential damages of any kind. The Company extends this warranty only upon proper use and/or installation of the product in the application for which intended and does not cover products which have been modified without the Company's approval or which have been subjected to unusual physical or electrical stress, or upon which the original identification marks have been removed or altered.

Whenever the design of the equipment to be furnished of the system in which it is to be incorporated originate with the buyer, manufacturer's warranty is limited specifically to matters relating to furnishing of equipment free of defects in material and workmanship and assume no responsibility for implied warranties of fitness for purpose or use.

Transportation charges for material shipped to the factory for warranty repair are to be paid by the shipper. The Company will return items repaired or replaced under warranty prepaid. No items shall be returned for warranty repair without prior authorization from the Company.

Patent & Trademark Indemnity

The Company will, at its own expense, defend any suit against the Buyer for the infringement of United States patents and trademarks by products purchased from the Company and in any such suit will satisfy any final award for infringement: except that the Company assumes no obligation to defend or assume liability for damages (consequential or otherwise) resulting from infringements (a) of patent claims covering any other products or any contemplated equipment or any assembly, combinations, method or process, in which, or in the manufacture or testing of which any such products purchased from the Company may be used (not with-standing that such products purchased from the Company may have been designed only for use in or may only be useful in such other patented products or such patented equipment, assembly, circuit, combination, method, or process, or in the manufacture or testing thereof and that such products purchased from the Company may have been purchased and sold for such use), or (b) resulting from designs supplied by the purchaser, or for any trademark infringement involving any marketing or branding applied by the Company or involving any marking or branding applied at the request of the buyer.

The indemnity is upon the condition that the Buyer gives the Company prompt notice in writing of any such suit for infringement or threat of such suit and full opportunity to conduct the defense thereof. No costs or expenses shall be incurred for the account of the Company without its written consent. At its option, the Company may, at any time, replace or modify any products sold under this contract to avoid patent or trademark infringement provided such replacement or modification does not materially affect performance. The Company's liability under this indemnity shall not exceed the purchase price of the infringing product.

Documentation & Training

In no event shall orders be accepted where payment is contingent on provision of documentation, unless agreed to in advance. Documentation is generic in nature, no guarantee is made that the documentation conforms to the equipment produced as built. As-built documentation entails an additional charge.

The Company will supply reasonable written documentation including operator instructions. Factory and on-site training in use and operation of the Company's products may be made available at Buyer's expense, subject to acceptance by the Company.

Proprietary Rights

Kurz Instruments, Inc. proprietary rights are included in information disclosed in instruction manuals, user guides, drawings and quotations or any other document or information disclosed. No Kurz document or information disclosed therein shall be reproduced or transferred to other documents or used by others for manufacturing or for any other purpose except as specifically authorized in writing by Kurz Instruments, Inc.

Substitutions & Modifications

The Company assumes the right to make substitutions and modifications in the specifications of equipment designed by the Company providing that such substitutions or modifications will not materially affect performance in the intended application.

Tools

The Company shall retain title to and possession of any models, patterns, dies, molds, jigs, fixtures, and other tools made for or obtained in connection with this contract unless otherwise agreed to by the Company.

Construction

All quotations are made and all orders are accepted by the Company with reference to the laws of the State of California, the rights and duties of all persons and the construction and effect of all provision thereof shall be governed by and construed according to the laws of the state.

Should any term or provision contained in these conditions contravene or be invalid under applicable law, the contract of which these conditions form a part shall not fail by reason thereof but shall be construed in the same manner as if such terms or provision had not appeared herein.

Regulatory Laws and/or Standards

The Company makes no promise or representation that its product will conform to any state or local laws, ordinances, regulations, codes or standards, except as particularly specified and agreed upon for compliance in writing as part of the contract between Buyer and the Company. The Company's prices do not include the cost of any related inspections or permits or inspection fees.

Excusable Cessation of Performance for Non-Payment

Whenever Buyer fails to meet the payment requirements set forth in this condition, manufacturer may cease performance and delivery and accelerate payment of any and all unpaid charges, such cessation of performance shall not be construed to be a breach of any contract or agreement and manufacturer will resume production as soon as reasonably possible upon receipt of payment of all balances due.

Nuclear Qualification

Equipment sold by Kurz Instruments, Inc. is not intended for use in connection with any nuclear facility or activity unless covered by a specific quotation where the conditions of such usage will be detailed. If equipment is used in a nuclear facility or activity without a supporting quotation, Kurz disclaims all liability for any damage injury or contamination, and the buyer shall indemnify and hold Kurz, its officers, agents, employees, successors, assigns and customers, whether direct or indirect, harmless from and against any and all losses, damages or expenses of whatever form or nature (including attorney's fees and other costs of defending any action) which they, or any of them, may sustain or incur, whether as a result of breach of contract, warranty, tort (including negligence), strict liability or other theories in law, by reason of such uses.

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