KURZ INSTRUMENTS INC.

Series 950
Mass Flow Switches
User's Guide

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The Series 950 Mass Flow Switches are warranted to be free from defects in material or workmanship for one year from the date of shipment from the factory. Kurz's obligation is limited to repairing, or at its option, replacing products and components that, on verification, prove to be defective. Warranty work will be performed at the factory in Monterey, California. Kurz 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. Kurz extends this warranty only upon proper use and/or installation of the product in the application for which it is intended and does not cover products that have been serviced or modified by any person or entity other than Kurz Instruments, Incorporated and its authorized service technicians. This warranty does not cover damaged sensors, units that have been subjected to unusual physical or electrical stress, or upon which the original identifications marks have been removed or altered.

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Important Notice

The Kurz "dual-sting" MetalClad™ sensor used in the Series 950 Mass Flow Switches produces heat during normal operation. The sensor is designed for use in flows of air and other **NONEXPLOSIVE** gases. The sensor should not be used in flows of explosive gases unless it is equipped with the intrinsic safety circuit. Even when so equipped, the sensor can reach temperatures sufficient to ignite explosive gases unless the temperature of the gas flow itself is kept within established limits. **DO NOT USE THIS SENSOR IN FLOWS OF EXPLOSIVE GASES WITHOUT FIRST CONTACTING KURZ INSTRUMENTS FOR DETAILED SAFETY INFORMATION. FAILURE TO HEED THIS WARNING COULD RESULT IN EXPLOSION, DAMAGE TO FACILITIES, SERIOUS INJURY OR DEATH.**

Table of Contents

Unit Description Sheet

Customer Name: ______________________________

P.O. Number: ______________________________

Date of Order: ______________________________

Complete Model Number: ______________________________

Kurz Order Number: ______________________________

Serial Number: ______________________________

Calibration Reference

Nominal Temperature:

____ Standard +25° C (+77° F)

____ Special (specify):________________

Nominal Atmospheric Pressure:

____ Standard 760 mm (29.92 inches) of Hg

____ Special (specify):________________

Input Power:

____ Standard +18 to 24 Vdc, 0.5% regulation

____ Special (specify): ________________

Environmental Process Temperature:

____ AT (Ambient Temp.) -40° F to +257° F

____ HT (High Temp.) +32° F to +482° F

Sensor's Material:

- ____ 316 SS
- ____ Hastelloy™ C276
- ____ Monel™
- ____ Titanium
- ____ Hard Nickel-Chrome on 316 SS
- ____ Titanium Nitride on 316 SS
- ____ Special (specify): ____________________

  ____

Sensor's Support & Shield Material:

- ____ 316 SS
- ____ Hastelloy™ C276
- ____ Monel™
- ____ Titanium
- ____ Special (specify): ____________________

  ____

Probe Support Tube Length

-08 (0.5 in. diameter tube):

- ____ 3 in.
- ____ 6 in.
- ____ 12 in. (Standard, 316 SS)
- ____ 24 in. (Standard, 316 SS)
- ____ 36 in.
- ____ Special (specify): ____________________

Probe Support Tube Length (continued)

-16 (1.0 in. diameter tube):

- ____ 3 in.
- ____ 6 in.
- ____ 12 in.
- ____ 24 in.
- ____ 36 in. (Standard, 316 SS)
- ____ 48 in.
- ____ 60 in. (Standard, 316 SS)
- ____ Special (specify): ____________________

Electronic Assembly:

- ____ 10 Amp Relay Ratings
- ____ Intrinsic Safety Circuit
- ____ Factory-Set Relays
  Set-Point A (specify): ____________ Alarm
  Set-Point B (specify): ____________ Alarm
  Set-Point A (specify): ____________ Delay
  Set-Point B (specify): ____________ Delay
- ____ Special (specify): ____________________
  ____
  ____

Other (specify): ________________________________

____

____

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Section 1: Product Overview

This section contains a general description of the Series 950 Mass Flow Switch. A synopsis of the flow switch's principles of operation has been included in the latter portion of this section.

1.1 Series 950 Subassemblies

The Series 950 subassemblies primarily consist of:

- Kurz "dual-sting" MetalClad™ sensor
- Probe support
- Electronic enclosure
- Flow switch

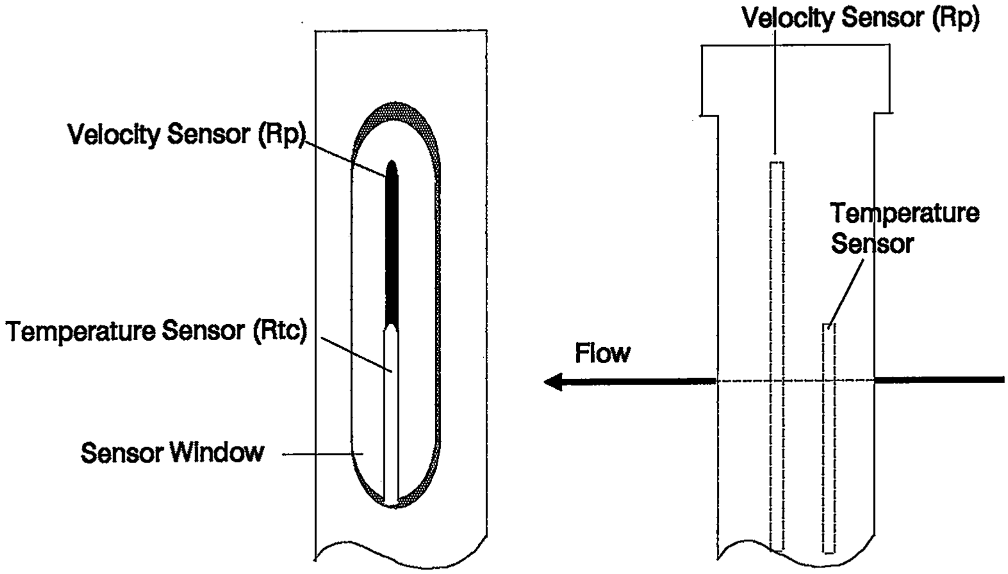
1.1.1 Kurz "Dual-Sting" MetalClad™ Sensor

The Kurz "dual-sting" MetalClad™ sensor is constructed by using two temperature-sensitive resistance temperature detectors (RTDs) of reference-grade 385 platinum windings around a high purity ceramic core, sheathed in a protective material (316 stainless steel being standard; other materials and coatings are optional).

The Kurz "dual-sting" MetalClad™ sensor is in fact two sensors in one. The "large dual-sting" (LD) MetalClad™ , all-welded metal sensor in which the temperature compensation winding (R_{tc}) and velocity winding (R_p) are mounted in seperate mandrels or stings; thus, providing much improved thermal isolation from the probe mounting structure and a fast time response to changes in temperatures. The latest sensor development of Kurz is the extremely "fast dual-sting" (FD) MetalClad™, all-welded metal sensor which has an almost instantaneous time response to fast process temperature changes.

The temperature compensation winding (R_{tc}) is the shorter of the two mandrels (stings); in that matter, the velocity winding (R_p) is the longer. Refer to Figure 1.1-1 for a close-up view of a Kurz "dual-sting" MetalClad™ sensor within its protective window.

Figure 1.1-1. *Kurz "Dual-Sting" MetalClad™ Sensor*



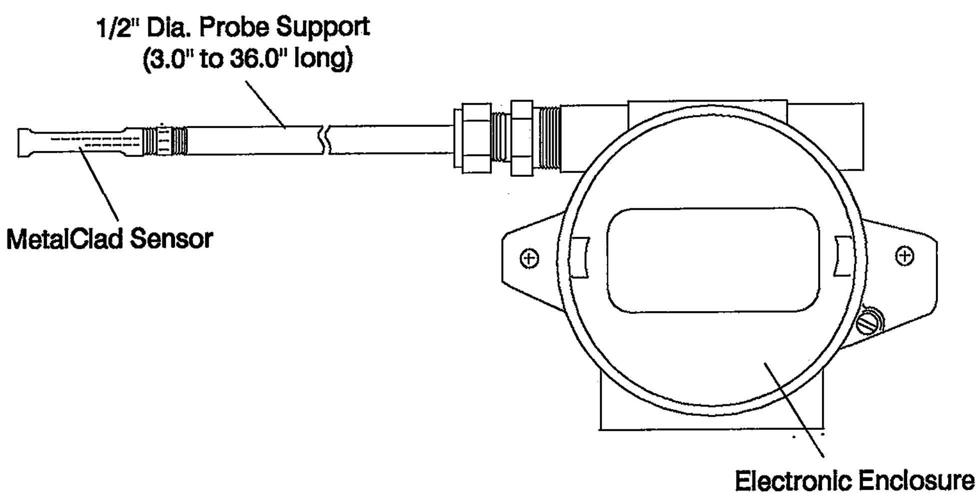
CAUTION: The Kurz "dual-sting" MetalClad™ sensor's **standard** rating is for monitoring flow rates of nonexplosive gases only; however, is equipped with an intrinsic safety circuit on the bridge board. The intrinsic safety circuit employs a ballast-resistor and zener diode combination to limit the amount of power supplied to the sensor in the unlikely event of a serious failure. Even with the intrinsic safety circuit installed, the sensor normally operates at a temperature differential (overheat) of approximately +75° to 100° Fahrenheit (F) above the ambient temperature of the gas flow it is monitoring. It is the user's responsibility to ensure that the ambient temperature of an explosive gas flow is kept at least 20% below the gas ignition temperature. For further information pertaining the specifications of the intrinsic safety circuit for process operations with flow conditions of an explosive gas or gas mixture, contact your local Kurz representative, or contact Kurz Instruments, Incorporated at (408) 646-5911.

1.1.2 Probe Support

The metalworks of the probe support are constructed of a supportable material (316 stainless steel being standard; other materials and coatings are optional). The probe support can be ordered in two sizes which allows convenient mounting with compression fittings:

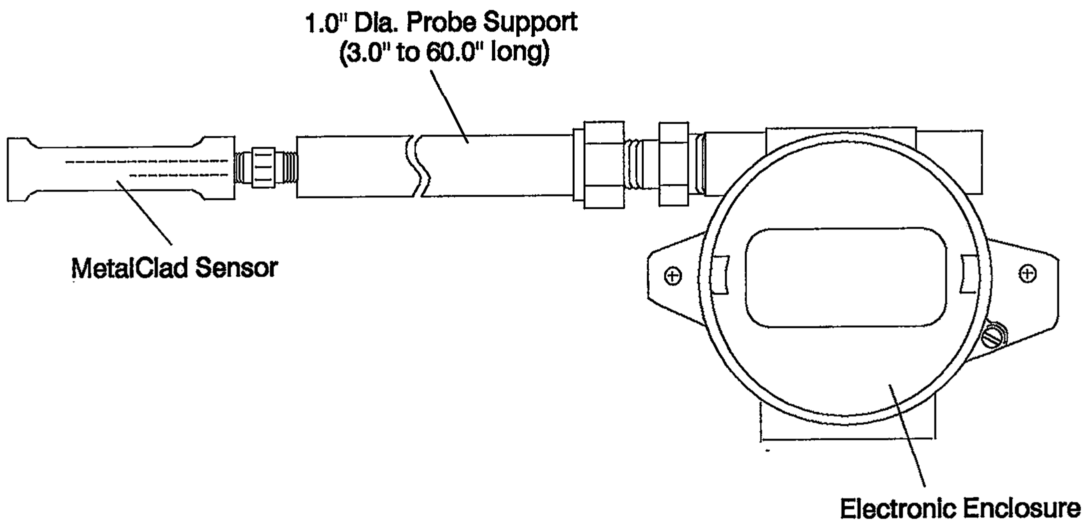
a) Series 950-08: A half (8/16) inch diameter tube having support lengths from 3.0" to 36.0" (standard lengths 12.0" and 24.0"). Ideal for small industrial ducts and pipes with diameters between 2.0" and 36.0". Figure 1.1-2 shows an example of a Series 950-08 probe assembly.

Figure 1.1-2. *Series 950-08 Probe Assembly*



b) Series 950-16: One (16/16) inch diameter tube having support lengths from 3.0" to 60.0" (standard lengths are 36.0" and 60.0"). Ideal for large industrial ducts and pipes. Figure 1.1-3 shows an example of a Series 950-16 probe assembly.

Figure 1.1-3. *Series 950-16 Probe Assembly*



1.1.3 Electronic Enclosure

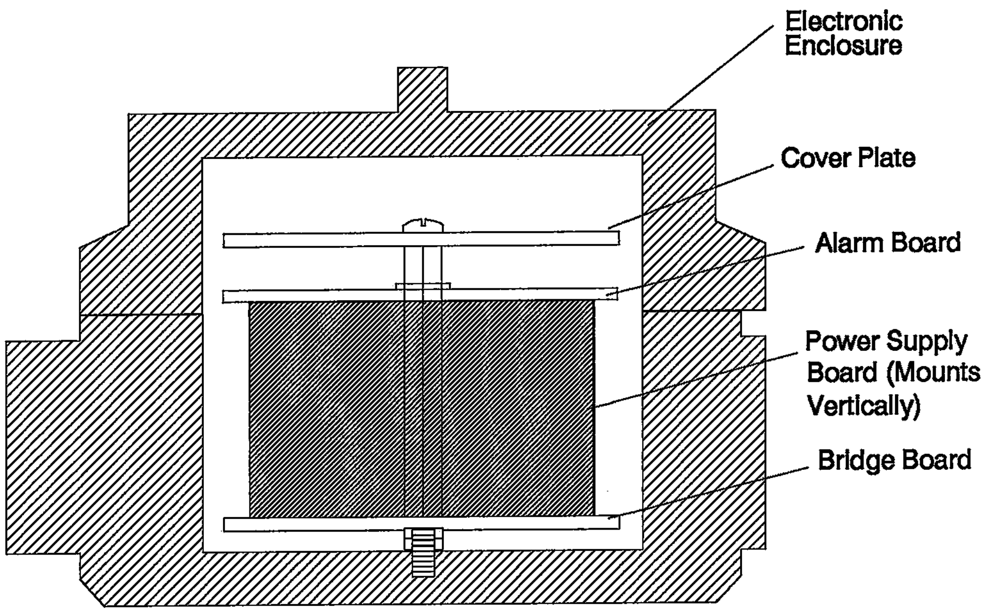
The electronic enclosure is directly attached to the probe support. This weatherproof, explosive resistant, metal enclosure also serves as a heat sink to the transistor on the bridge board.

Although the sensor is capable of extremely high and low temperatures, the enclosure must be maintained between -25° to +65° Celsius (C). The electrical components of the electronic assembly are not warranted by their respective manufacturers to operate above +65° C. To prevent excessive heating of the enclosure and the associated circuitry of the flow switch, the probe support should be ordered to an extended length.

1.1.4 Flow Switch

The electronic assembly of the flow switch consists of three circuit boards that are assembled together and mounted in the electronic enclosure. Figure 1.1-4 illustrates the placements of the electronic assembly in the electronic enclosure.

Figure 1.1-4. *Electronic Assembly of the Flow Switch*



The bridge board contains a classical Wheatstone bridge and associated circuitry. The primary function of the circuitry is to electrically balance the sensor's current signal (100-600 mA range) with reference to the Wheatstone bridge and from the amount of electrical energy (power) needed to maintain the sensor's temperature differential or overheat when affected by the flow of air or other gases passing the velocity winding (R_p): A contingent process on the rate of change in mass flow measured by the cooling effect of the velocity winding (R_p) against the temperature winding (R_{tc}); in which, are in a direct representation to the velocity of the air flow.

Note: The sensor's cable is an integral circuitry of the bridge board. Resistance in the cable's length is part of the calibration process we call *temp comp* in determining the balance point of the Wheatstone bridge. In no event should you alter the length of the sensor's cable.

The alarm board is considered the main circuit board because technically it contains the high and low comparators, the threshold adjust circuitry and two independent relays, each having adjustable set-point and two selectable ranges for time delay (0-30 seconds and 0-300 seconds). Each relay may be operated as either a low alarm or high alarm through the use of jumpers on the board. *Low* means a change in state of the relay occurs when the rate of flow goes below the "low" set-point vice versa *high* means a change in state of the relay occurs when the rate of flow goes above the "high" set-point. Since the relays are independent, the user can set up both relays to be low, both relays to be high or one low and one high. The time delay function initiates when the rate of flow alleviates below the "low" set-point or when the rate of flow becomes normal at any time, the relay is immediately changed to its normal state and the time delay circuit is reset. The time delay is useful to prevent relay chattering for systems that operate close to the set-point. When the rate of flow exceeds a user-selected "high" set-point or drops below a user-selected "low" set-point, a corresponding relay abruptly responds; actuating alarms, lights or other external devices connected to the appropriate terminals on Terminal Block 1 (TB1). An LED provided for each relay functions in the same manner by indicating which relay has been triggered by the offset. Normally opened (N.O.) and normally closed (N.C.) contacts are also included on the terminal strip to suit the user's needs.

The power supply board interfaces the bridge board and alarm board. The power supply board regulates the electrical energy (+24.0 Vdc input supply) to provide the necessary signals for the internal operation of the electronic assembly; i.e., reference voltages (positive and negative), and regulated or unregulated voltages. It also serves as a electrical path for either the bridge voltage or current sense voltage to be transmittted from the bridge board to the alarm board.

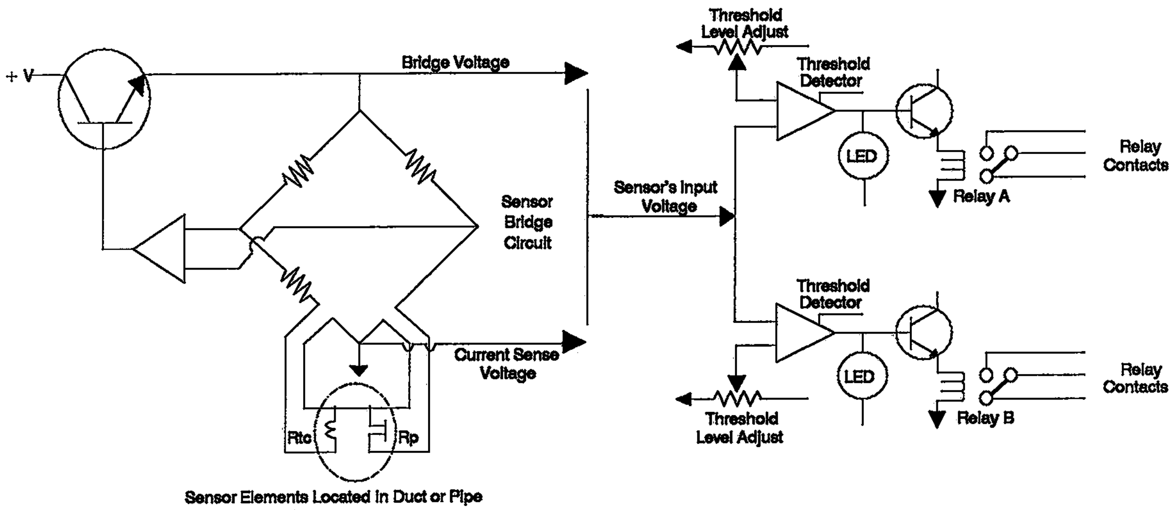
1.2 Principles of Operation

The fundamental idea behind any thermal sensor is that the rate of flow of any fluid that is capable of absorbing heat--be it air, gas or a liquid--can be inferred from the heat transferred or carried away from a well-defined, well-known, heated element.

The Kurz "dual-sting" MetalClad™ sensor, then, can be constructed and operated as constant-temperature thermal anemometer by using two temperature-sensitive resistance temperature detectors (RTDs), one that detects ambient temperature and factors it out, and one that is heated to a specified overheat above the ambient temperature, approximately +75° to +100° Fahrenheit (F). The sensor, once constructed, is operated by a classical Wheatstone bridge. The two windings function as legs of a balanced Wheatstone bridge circuit. The larger winding, we call R_{tc}, for resistor, temperature compensation. This winding is used to measure the ambient temperature of the flow in which the sensor is inserted. The bridge circuit is set up during a part of the calibration process we call *temp comp* to supply sufficient power of the smaller winding (R_p, for resistor, probe) to maintain a constant temperature differential or overheat, above the temperature of the passive R_{tc} winding. The greater the rate of flow passing the sensor, the more current is required to maintain the temperature differential (overheat) constant. Subsequently, the circuit produces as its output a voltage that represents the heat transfer between the heated winding and the gas stream. Thus, you have a signal indicative of the rate of flow of the fluid, with temperature variations already factored out. The thermal sensor, because it responds to the amount of heat being carried away, and because heat is carried away by molecules, inherently and automatically compensates for variations in density or pressure (more pressure means more molecules, which means more mass flow).

A simplified diagram of the flow switch's electrical assembly is provided in figure 1.2-1. As shown, the temperature and velocity windings of the Kurz "dual-sting" MetalClad™ sensor form two legs of a balanced Wheatstone bridge. As flow increases, the bridge draws more current to stay balanced. This current is drawn across a resistor to generate either a bridge voltage or a current sense voltage signal.

Figure 1.2-1. *Simplified Diagram of the Electrical Assembly*



This signal is then transmitted to the main circuit board as the inputs to the high and low comparators. These comparators are used as high and low threshold detectors, which are set by high and low threshold adjustment potentiometers. Two modes of operation are selectable from the high and low threshold adjustment potentiometers through the placement of jumpers on the main circuit board:

a) Normal Mode b) Fail-Safe Mode

Normal Mode basically means the relay coil is not energized in normal flow operating range; i.e., whenever the rate of flow alleviates below a "low" set-point or deviates above a "high" set-point, the relay is activated. Thus, a N.O. contact would switch to the closed position.

Fail-Safe Mode means the relay coil is energized whenever the rate of flow is above a "low" set-point and below a "high" set-point in normal flow operating range. Therefore, the N.O. contact becomes a closed contact and opens upon abnormal flow conditions. It is called *Fail-Safe* because the loss of power also causes the normally energized relay to open, and a relay coil failure will also open the contacts.

End of Section 1

Section 2: Installation

The instructions given in this section are necessarily general in nature. Refer to the appropriate engineering drawings in Appendix A for the probe assembly dimensions and field wiring interconnect information. If you need further assistance with your installation, contact your local Kurz representative, or contact Kurz Instruments, Incorporated at (408) 646-5911.

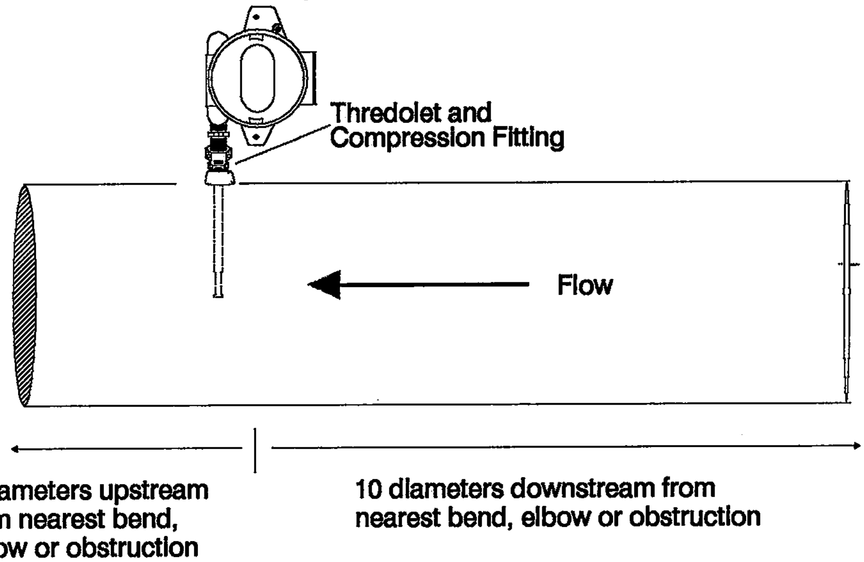
2.1 Determining Probe Assembly Location

If possible, you should locate the probe assembly at least three pipe or duct diameters upstream and 10 diameters downstream from the nearest bend, elbow or other obstruction in the pipe or duct. The chosen location should also provide sufficient clearance for inserting and removing the probe assembly; i.e., the clearance between the pipe or duct and any obstruction should equal at least the length of the probe support which includes the sensor's electronic enclosure plus two or three inches for maneuverability.

If a "perfect" location is not available, it is usually possible to find a location and depth that has repeatable flow conditions. Since this is a flow switch and not a flow meter, this is acceptable. Usually a depth of one-third the duct diameter is sufficient for larger ducts (greater than six inches). For small pipes we recommend placing the active portion of the sensor near the pipe's center-line.

Make sure the probe assembly is rotated or such that the sensor's protective window allows an unobstructed flow to pass the sensor. The shorter mandrel or sting (R_{tc}) should be facing the oncoming flow. An example of a probe assembly location is illustrated in Figure 2.1-1.

Figure 2.1-1. *Probe Assembly Location*



2.2 Installation of the Probe Assembly

In most cases, the probe assembly is held in place by means of a compression fitting attached to the outside of the pipe or duct. The mounting hardware and procedures to attach the probe assembly vary, depending on your mounting configuration.

Note: The unit is shipped with a protective rubber cap covering the sensor. Make sure you remove this cap prior to installation.

All mounting hardware needed to mount the probe assembly in a pipe or duct are readily available from Kurz Instruments, Incorporated.

- **Extended support fitting (ESF; special).** These fittings allow installers to use a supporting pipe nipple for added rigidity and protection of the probe assembly. The Thredolet™ and nipple are supplied. The nipple length (316 stainless steel material) is used to position the sensor's depth.

- **Compression fitting (CF).** For installation in pipe, a Thredolet™ carbon steel coupler[1] can be provided for welding onto pipe. Specify size of National Pipe Thread (NPT) pipe the coupling is to be welded to, as well as the wall thickness of that pipe (Schedule 40, 80 and etc.). The coupling must accept the appropriate Male National Pipe Thread (MNPT) fitting (see "tube compression fitting").

- **Tube compression fitting**[2]. The following tube compression fitting should be used for the appropriate probe assembly:

  a) Series 950-08: 8AD8, a half inch diameter male adapter (compression fitting with a half inch MNPT).

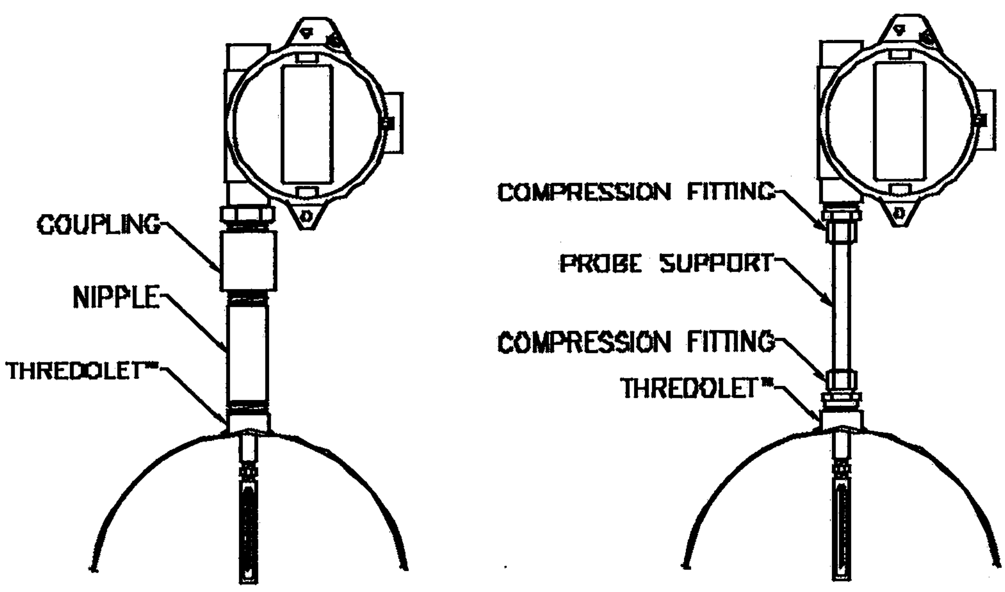
  b) Series 950-16: 16AD16, a one inch diameter male adapter (compression fitting with a one inch MNPT).

  Note: The compression fitting supplied is 304 stainless steel with a Teflon™ ferrule so that the depth of the probe assembly can be postioned as needed. Applications only for process temperatures less than +400° F.

- **Adjustable stop collar with set screw (special).** The optional stainless steel stop collar can be attached to the probe support to ensure that the probe assembly is not inserted beyond the predetermined depth.

  The installations of a probe assembly using a ESF and CF fittings are shown in Figure 2.2-1.

Figure 2.2-1. *Shown Left: ESF Fitting* *Shown Right: CF Fitting*



1 Thredolet fittings are also available in aluminum and stainless steel.

2 Optional stainless steel ferrules are available for permanent compression on probe.

The steps necessary to perform a compression fitting installation are as follows:

Step 1. With minimum or no flow in the line, drill a probe-insertion hole at a selected location in the pipe. The diameter of the hole should be $^1/_{16}$ of an inch larger than the diameter of the probe support. For the Series 950-08, this means a probe-insertion hole $^9/_{16}$ of an inch and for the Series 950-16, 1 $^1/_{16}$ inches in diameter.

Step 2. Weld the Thredolet™ coupler directly over the probe-insertion hole.

Step 3. Insert the probe assembly to the predetermined depth (near the pipe's center-line). Make sure that the probe assembly is rotated such that the sensor's protective window allows unobstructed flow to pass the sensor and the shorter mandrel or sting (R_{tc}) is facing the oncoming flow.

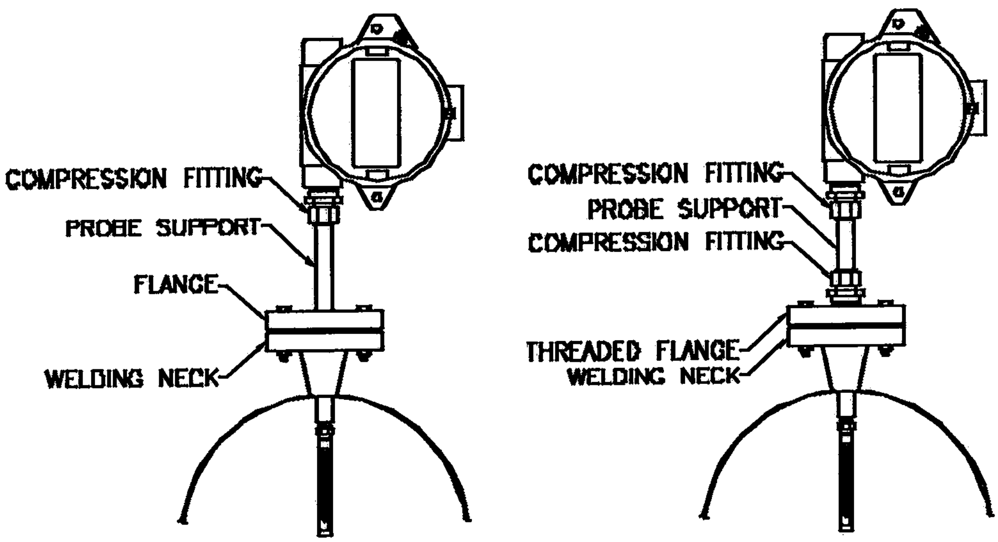
Step 4. Tighten the tube compression fitting until the probe assembly is held firmly in place.

This type of installation allows the probe assembly to be readily removed for routine maintenance by simply untightening the tube compression fitting and sliding the probe assembly out the pipe. Please note that the compression fitting installation is for low pressure applications only (less than 50 psi). If a high pressure application is necessary, a restraint chain or a flange-mounted unit should be used. **Be careful!**

- **FNG welded Flange (special).** For high-pressure and hazardous gas applications (up to 1000 psi), the probe assembly can be equipped with an integral welded flange for bolting onto a customer-supplied welding neck flange.

  The installations of a probe assembly using a FNG hardware are shown in Figure 2.2-2.

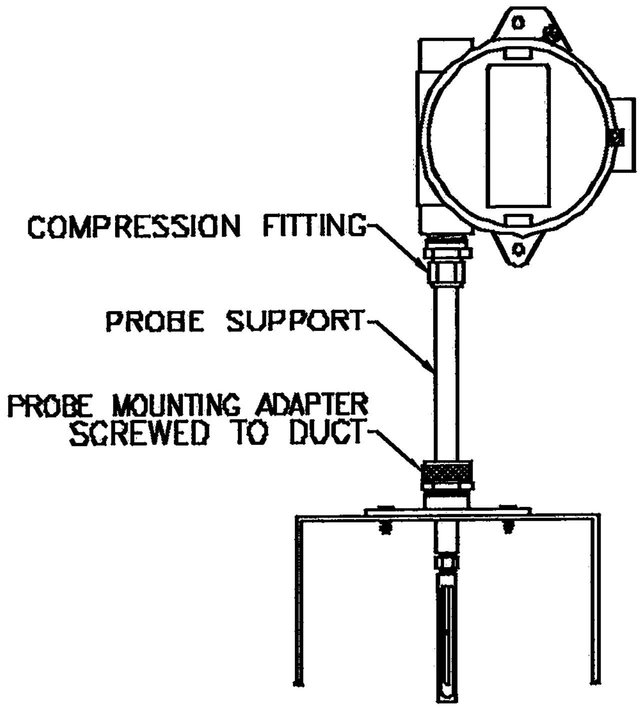
Figure 2.2-2. *FNG Mounting Installations*



- **Probe mounting adapter (PMA; special).** For sheet metal and light pipe, the simple probe mounting adapter is often sufficient. For a Series 950-08, a PMA-08 attached to a 2.0" x 2.0" stainless steel plate with four corner mounting holes is used. For a Series 950-16, a PMA-16 attached to a 3.0" x 3.0" stainless steel plate with four corner mounting holes is used. The PMA-08 has a half inch bored-through compression fitting while the PMA-16 has a one inch bored-through compression fitting.

  The installation of a probe assembly using a PMA hardware is shown in Figure 2.2-3. For round ducts, curved probe mounting adapters are available upon special order (specify radius).

Figure 2.2-3. *PMA Installation*

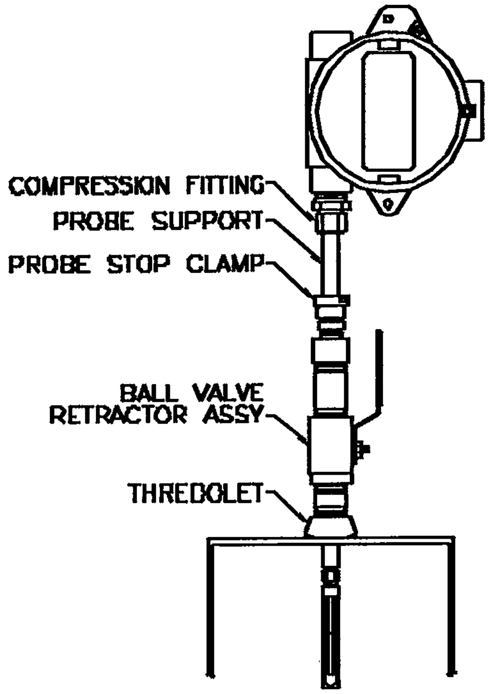


- **Ball valve retractor (BVR) assembly.** Designed for installation in existing lines without shutdown of flow ("hot tapping") or with shutdown of flow ("cold tapping"). The BVR assembly includes a Thredolet™ carbon steel coupler to be welded to a pipe. The tube compression fitting on the uppermost section of the BVR assembly provides a good seal when tightened down. A stainless steel stop collar is also included to set in advance the placement depth of the probe assembly.

  The ball valve allows free passage of the probe assembly when open, yet seals off the flow when closed to allow retraction of the probe assembly; in addition, is used during initial drilling into the pipe using a standard hot-tap or pressurized drill.

  Figure 2.2-4 illustrates the BVR assembly hardware installed with the probe assembly.

Figure 2.2-4. *BVR Assembly Installation*



CAUTION: If the probe assembly is used with the BVR assembly in flows of explosive gases, you must be extremely careful to ensure that both the probe and the BVR assembly are properly sealed to prevent gas leaks. Do not use the BVR assembly in lines pressurized above 75 psi absolute. After proper installation in the BVR assembly, the probe assembly will remain secure under normal operating conditions. However, if the unit is subjected to pressure in excess of 75 psi absolute, the probe assembly may eject from the BVR assembly at high velocity. **Such an ejection is extremely dangerous and exposes personnel to the risk of serious injury or death.**

Cold Tapping

The steps necessary to perform a cold-tap installation are as follows:

Step 1. With minimum or no flow in the line, drill a probe-insertion hole at a selected location in the pipe. The diameter of the hole should be $^1/_{16}$ of an inch larger than the diameter of the probe support. For the Series 950-08, this means a probe-insertion hole $^9/_{16}$ of an inch and for the Series 950-16, 1 $^1/_{16}$ inches in diameter.

Step 2. Weld the Thredolet™ coupler directly over the probe-insertion hole.

Step 3. Fasten the BVR assembly firmly together to the Thredolet™ coupler.

Step 4. Position the stop collar on the probe support to the predetermined depth and tighten the set screw.

Step 5. Open the ball valve and insert the probe assembly until the stop collar abuts with the tube compression fitting.

Step 6. Make sure that the probe assembly is rotated or such that the sensor's protective window allows unobstructed flow to pass the sensor and the shorter mandrel or sting (R_{tc}) is facing the oncoming flow.

Step 7. Tighten the tube compression fitting until the probe assembly is held firmly in place.

Step 8. To verify that the BVR assembly is properly sealed and to ensure safe operation of the probe assembly, you should pressure-test all joints with soap bubble solution.