KURZ
INSTRUMENTS INC.

Series 950 Flow Switch
User's Guide

Feb 1989

Unit Description Sheet

Complete Model Number: _____

Serial Number: _____

Kurz Order Number: _____

Customer P. O. Number: _____

Power Supply Input: ____ Standard (18-24 Vdc)

____ Other (specify): _____

-06 Probe & Sensor (3/8" Probe Diameter):

____ 3" Probe Length

____ 6" Probe Length

____ 9" Probe Length

-08 Probe & Sensor (1/2" Probe Diameter):

____ 12" Probe Length

____ 18" Probe Length

____ 24" Probe Length

-16 Probe & Sensor (1" Probe Diameter):

____ 36" Probe Length

____ 48" Probe Length

____ 60" Probe Length

Environmental: ____ AT (Ambient Temperature)

____ MT (Medium Temperature)

Gas or Liquid: Specify: _____

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Warranty Statement

The Kurz Series 950 Flow Switch is 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.

Transportation charges for material shipped to the factory for warranty repair are to be paid for by the shipper. Kurz will return items repaired or replaced under warranty prepaid. No items shall be returned for warranty repair without prior authorization from Kurz. Call Kurz Instruments service department at (408) 646-5911 to obtain a return authorization number.

This warranty contains the entire obligation of Kurz Instruments Incorporated. No other warranties, expressed, implied, or statutory are given.

Special Precautions for Installation with Hazardous Gases

We at Kurz have done everything reasonable to ensure the safety of users of Kurz equipment. Even so, we are aware that special situations can arise that can result in an unsafe condition if hazardous gases are involved.

It is the responsibility of the user to properly install the product and especially to check for leakage in the extended plumbing and to properly seal conduit fittings, etc., according to the relevent codes.

An example is the installation of a Model 555 insertion mass flow meter in which the Model 455 probe is inserted into the ball valve retractor assembly. It is the responsibility of the user to ensure that the assembly does not leak upon initial installation and to perform rountine maintenance (such as replacing the seals, etc.) on a regular basis and to verify the safety of the entire installation.

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About This Book

This book contains five sections and an appendix, each of which is briefly described below. The book also contains a Unit Description Sheet and a Quick Set-Up Guide. The book is not designed to be read cover to cover; rather, it is designed to present information to the user in as accessible a manner as possible.

Because the 950 Series is comprised of several models that have the many common features and options, most of the manual will reference them generically as the 950 or 950 Series Flow Switch. Where a unique feature of a particular configuration is being described, a specific configuration number will be referenced (i.e. 951 or 952; 950-06, 950-08, or 950-16). Section 1 describes the available configurations.

Organization

Unit Description Sheet

This sheet is found in the front of the book, immediately following the title page. It contains important identifying information about your Model 950 Flow Switch, including model number, serial number, Kurz order number, and customer purchase order number. It also lists any options you ordered with your 950. Check the options listed against your original order and against the actual contents of the shipping carton. Report any discrepancies immediately to Kurz Instruments Incorporated at (408) 646-5911.

Quick Set-Up Guide

The Quick Set-Up Guide is a chart summarizing much of the information presented in the rest of the manual. You can use the chart to refresh your memory after you read the relevant sections of the manual. Or, if you feel that you do not need the more detailed information presented in the rest of the manual, you can attempt to install your 950 referring only to the Quick Set-Up chart. Kurz Instruments does **not**, however, recommend the latter approach.

Section 1: Product Overview

This section introduces you to the purpose, applications, configurations, features, and principles of operation, of the Series 950 Flow Switch. You can safely skip this section if you are already familiar with that information.

Section 2: Installation

Section 2 explains, in necessarily general terms, how to install your 950. This section explains how to determine the correct location for installation, as well as how to perform the physical installation in pipes and flat or round ductwork. You should read thoroughly the parts of this section that apply to your installation before you install the 950. **You may also want to read Section 5, "Testing," before you install the 950.**

This section also explains how to set the alarm thresholds and how to connect external devices to the alarm relays.

Section 3: Operation and Routine Maintenance

Once the 950 is installed and connected to a power source, it operates for prolonged periods without intervention. Section 3 also explains how and when to clean the sensor. Refer to this section as needed.

Section 4: Options

This section lists and explains most of the options available with the 950. Contact Kurz Instruments for a complete, up-to-date list of available options.

Section 5: Testing

This section explains some of the tests you can perform on the 950 to determine whether or not it is operating properly. Although the 950 is thoroughly tested before it leaves the factory, you may want to run the tests described in Section 5 to make sure that the unit has not been damaged in transit. Whether or not you do so depends largely on your judgment of the complexity of your installation: If installation and possible later removal are relatively easy, it probably makes more sense to go ahead and install the unit without extensive preinstallation testing. If your installation is a difficult one, and removing the unit later for testing would be more time consuming than the testing procedures themselves, you should probably test before you install.

Appendix A: Component Layout and Schematic Drawings

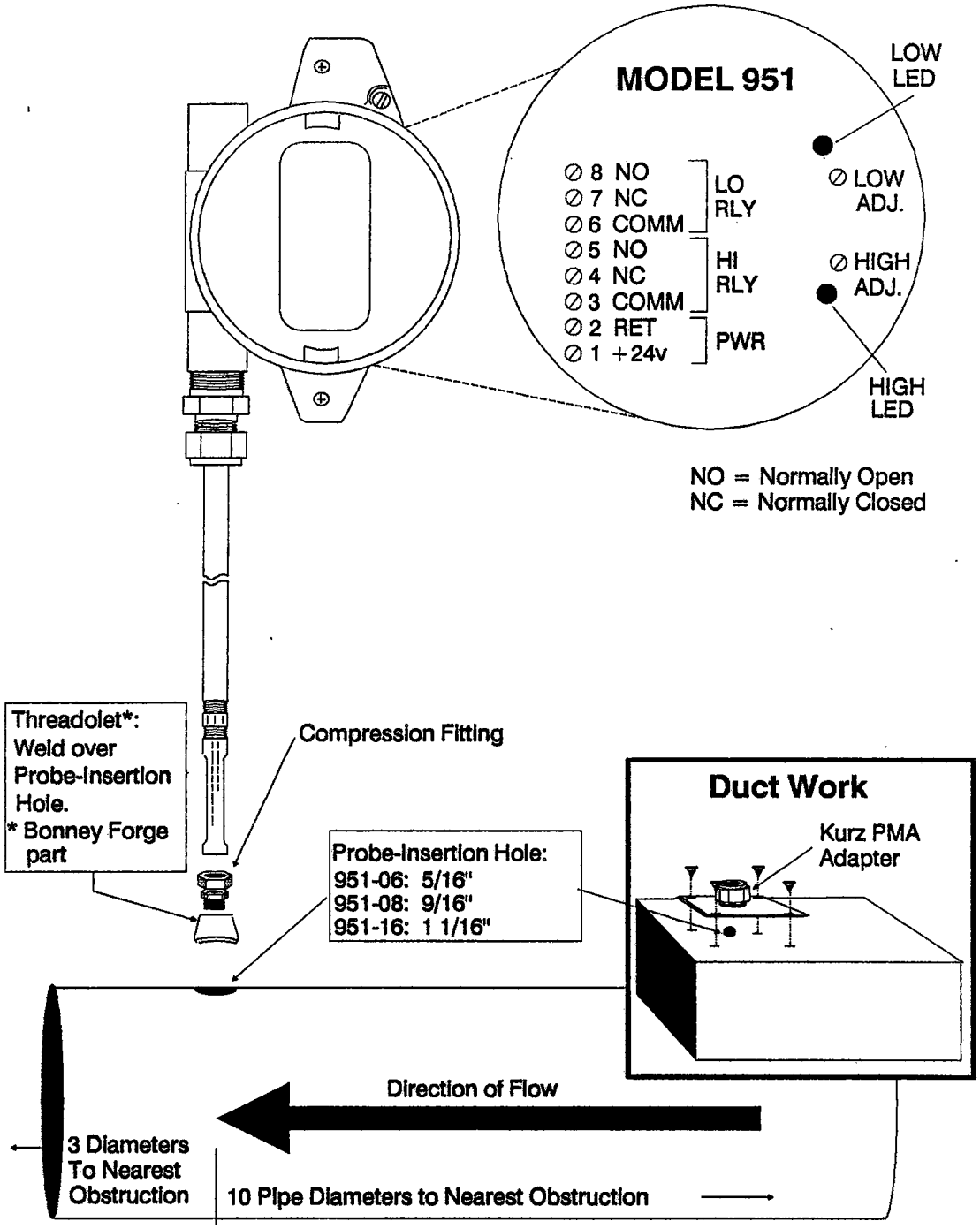
The appendix contains detailed component layout drawings and circuit diagrams of the various components of the 950. This information is not needed by most 950 users in routine operation of the unit. It is provided as an aid to those users who want to perform more detailed maintenance and testing operations than those described in sections 3 and 5.

About the Art in This Book

The computer-generated art in the main sections of this book is intended to illustrate particular points under discussion. It includes only as much detail as is relevant to the discussion at hand. No attempt has been made to accurately scale these drawings or to include details not under discussion in the text that precedes and follows each drawing. If you need more detailed and precise visual information, refer to Appendix A, which contains reproductions of actual engineering drawings.

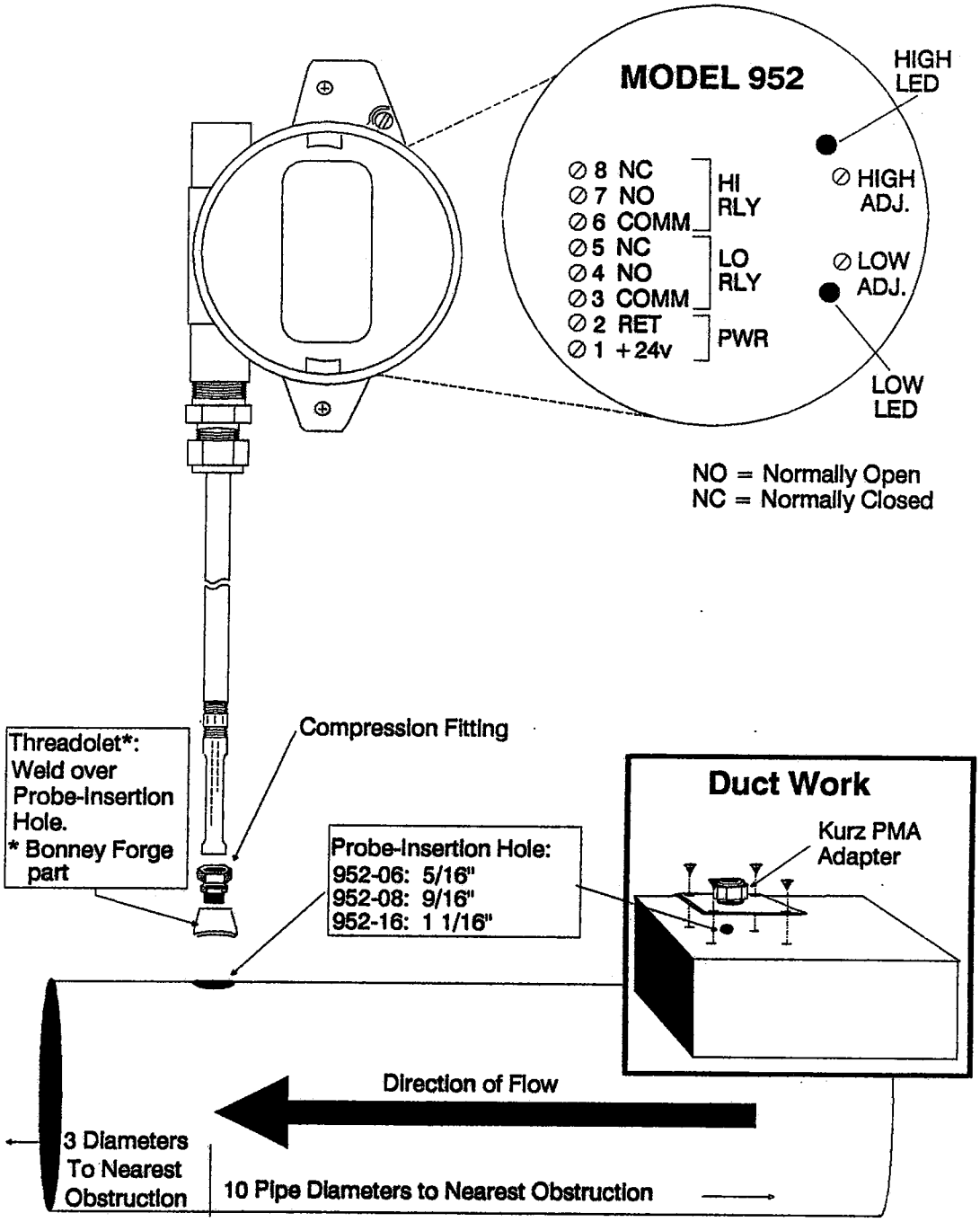
Quick Set-Up Guide - Model 951 Flow Switch

The quick set-up chart below summarizes much of the information presented in this manual. **It does not, however, contain all the information you may need for safe and satisfactory installation of your 951. Kurz Instruments recommends that you read applicable sections of the manual before attempting installation.**



Quick Set-Up Guide - Model 952 Flow Switch

The quick set-up chart below summarizes much of the information presented in this manual. **It does not, however, contain all the information you may need for safe and satisfactory installation of your 952. Kurz Instruments recommends that you read applicable sections of the manual before attempting installation.**



Section 1: Product Overview

This section contains a general description of the 950 Series Flow Switch. It explains how the flow switch works and lists the features and specifications.

1.1 Description

The Series 950 Flow Switch is designed to monitor the flow of air or other gases within pipes, stacks, flues, ductwork, and similar enclosed channels. When flow in the channel exceeds a user-selected high set point or drops below a user-selected low set point, a corresponding relay responds quickly to activate alarms, lights, or other devices connected to the terminals on the 950 series electronics board. Adjustment potentiometers provided on the electonics board allow field setting of the two trip points that activate the associated relay. An LED for each relay indicates that the relay has been triggered.

Because it is rugged, resistant to contamination, and available in many configurations, the 950 Series Flow Switch is well suited for commercial applications where the flow to be monitored may be corrosive, dirty, and reach temperatures up to 125° C. The 950 Series Flow Switches are ideal for the monitoring:

- stack emissions or feed air in cogeneration systems
- air handling systems for nuclear power plants
- oxygenation and digester gas flow in waste water plants
- coal dust feed, flue gas exhaust, or feed air in combustion systems
- process control applications such as refining and refracting, mixing and blending, drying, or monitoring chemical flows and duct velocity
- cement or kiln emissions
- catalytic waste of flare gas applications
- spray drying and pulp processing used in food processing plants

1.2 Basic Components

All 950 flow switches consist of the same basic components:

- Mini MetalClad™ or MetalClad™ all metal mass flow sensor mounted in a protective window at one end of the probe

NOTE: The sensor shipped with your 950 was specifically matched to your unit's electronics during factory calibration. Sensors are **not** interchangeable between different 950s.

- 316 stainless steel probe support (diameter and length dependent upon the configuration ordered)
- Aluminum weatherproof, explosionproof junction box for housing 950 electronics
- Two SPDT (single-throw, double-throw) relays, activated by user-selected flow set points (relay contact rating of 0.2A or 10A dependent upon the configuration ordered)

1.2.1. Models Available in the 950 Series

The 950 Series consist of two models, each model having a wide range of probe lengths and diameters available.

The 951 Flow Switch has two relays that can be independently used as normally open or normally closed switches.

The 952 Flow Switch has two relays that are both normally closed when energized and open when flow set point conditions exist or DC power to the 952 flow switch has failed.

The type of flow switch used will be dependent on the size of the channel, the temperature of the gas or air flow, and the type of devices connected to the two relays. The available configurations are shown in Table 1-1.

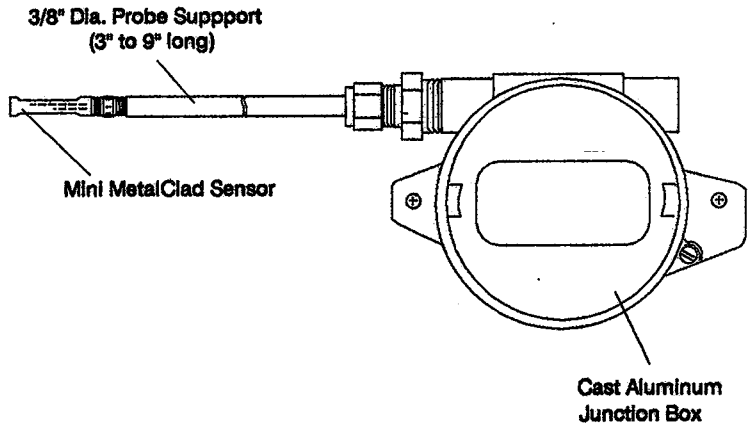
Table 1-1. *950 Series Flow Switch Configurations*

BASIC MODEL NUMBER	OPERATING TEMPERATURE	PROBE DIAMETER	PROBE LENGTH	RELAY CONTACT RATING (AMPS)	GAS OR LIQUID
951 952	-AT (0º to 65º C) -MT (0º to 125º C)	- 06 (3/8") - 08 (1/2") - 16 (1")	-06 -08 -16 3" 12" 36" 6" 18" 48" 9" 24" 60"	0.2 (Reed) 10	SPECIFY

The most notable physical difference between the various configurations of the flow switch is the probe diameter and the probe length (which is dependent on the probe diameter). Figures 1-1 through 1-3 show the basic components of the 950-06, 950-08, and 950-16 Series.

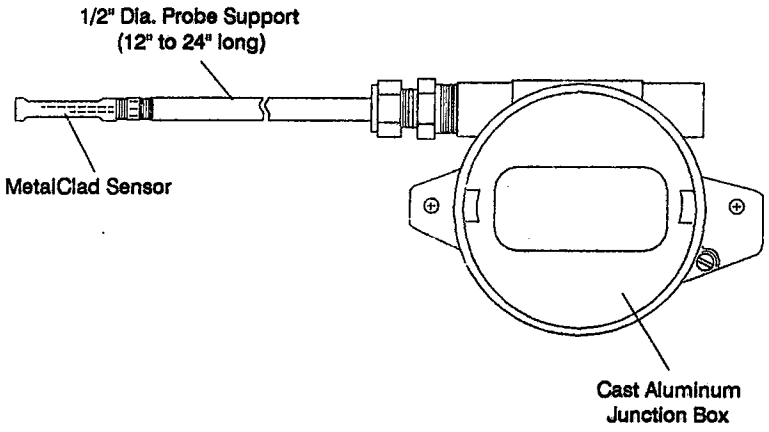
The 950-06 series has the smallest probe (3/8" diameter, 3", 6", or 9" length) which allows it to be installed in pipes or ducts as small as 2 inches in diameter up to 18 inches in diameter.

Figure 1-1. *950-06 Series Basic Components*



The 950-08 is best suited for monitoring velocity in lines from a minimum of twenty-four inches in diameter up to approximately 48 inches in diameter (or in ducts up to 48 inches across in their smaller dimension).

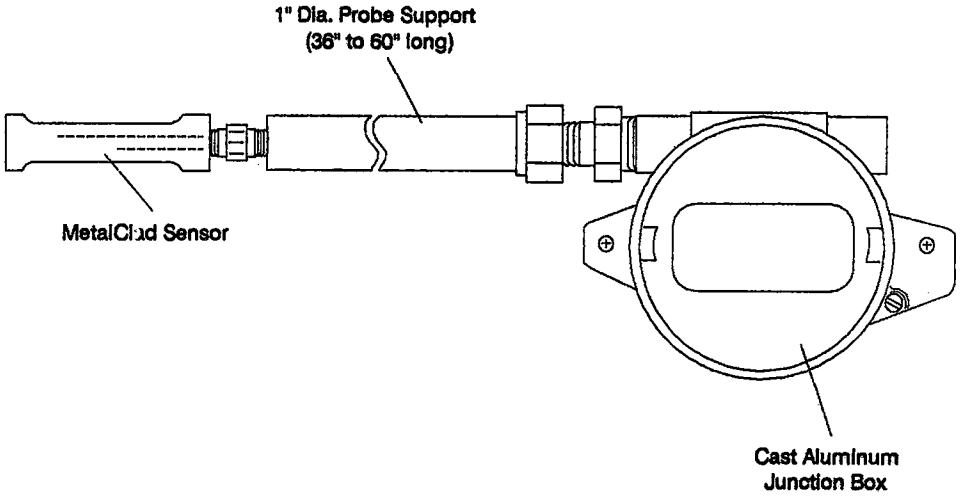
Figure 1-2. *950-08 Series Basic Components*



The 950-16 can be used in lines from 6 to 10 feet in diameter. (Kurz generally and strongly recommends considering a multi-point, multi-sensor EVA system for channels 8 feet in diameter or greater.)

For applications where the duct or pipe has an ambient temperature above 65° C, a longer 950-MT-08 or 950-MT-16 "Medium Temperature" flow switch should be used where additional probe length is needed to keep the junction box at least twelve inches beyond the hot pipe or duct. Refer to section 2.5.3 for more information on these applications.

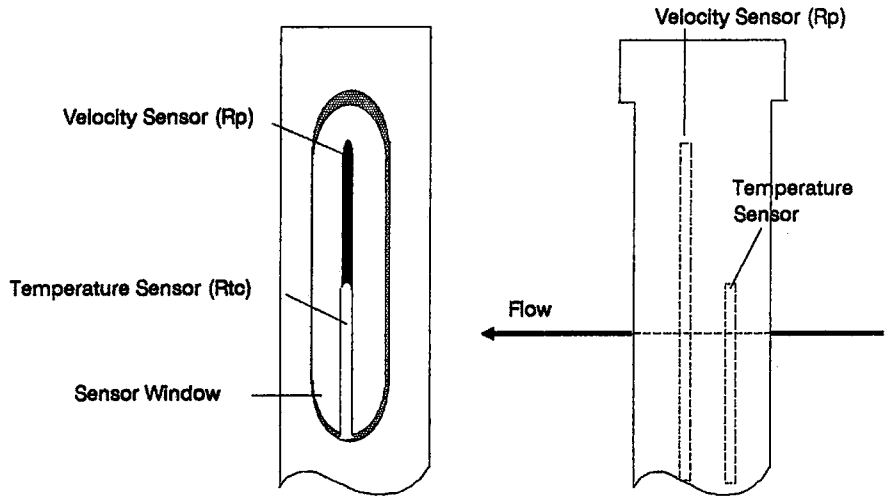
Figure 1-3. *950-16 Series Basic Components*



1.3 How the Sensor Works

The 950's Mini MetalClad (950-06) and MetalClad (950-08 and 950-16) sensor is in fact two sensors in one: a temperature sensor and a velocity sensor. The "dual-sting sensor" consists of reference-grade platinum windings wound around two ceramic mandrels enclosed in two stainless steel sheaths. The temperature sensor (R_{tc}) is the shorter of the two sensor elements. The velocity sensor (R_p) is the longer of the two elements. Figure 1-4 shows a close-up view of the 950 Series sensor within its protective sensor window.

Figure 1-4. *Two Views of The 950 Sensor*



The temperature sensor senses the ambient temperature of the flow. The velocity sensor is then heated to approximately 75° to 100° F **above** the ambient temperature and is maintained at the same level of temperature differential (overheat) above the ambient temperature regardless of changes in ambient temperature or air velocity.

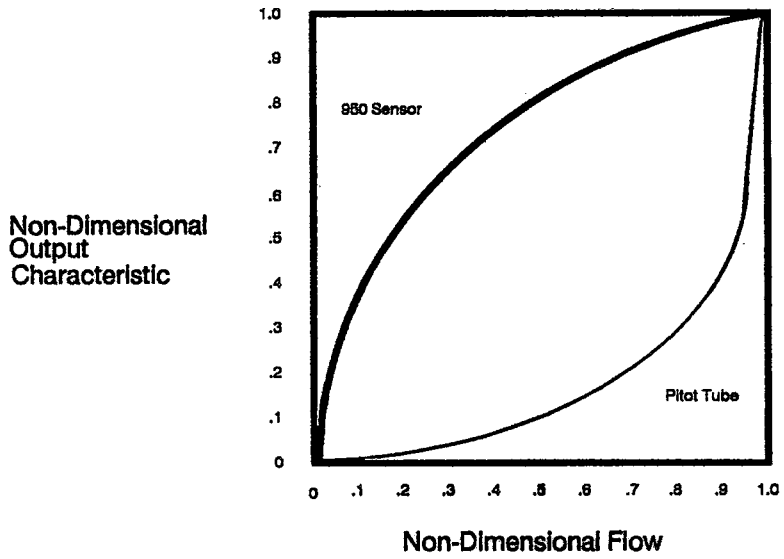
CAUTION: The 950 sensor's standard rating is for nonexplosive gases. Contact Kurz Instruments for more information on using the 950 sensor in explosive gas flows.

Because the temperature sensor compensates for fluctuations in ambient temperature, the amount of electrical power needed to maintain the velocity sensor's overheat is affected only by the flow of air or other gases over the sensor: The greater the velocity of the flow, the greater its cooling effect on the sensor and the greater the electrical power needed to maintain the sensor's overheat. It is this power or current draw that is measured by the 950. The sensor is directly measuring mass flow (i.e., the number of molecules carrying heat away from the velocity sensor).

The temperature and velocity sensors form two legs of a balanced Wheatstone bridge. The bridge circuitry itself is contained on one of the electronics boards in the aluminum junction box at the end of the probe support. The temperature sensor leg (R_{tc}) is input to the positive side of an operational amplifier as a reference. The bridge is activated through an offset differential of the two legs. The sensor is heated with current through the R_p winding. Resistance increases until it balances with the minus input of the operational amplifier, which drives a power transistor to provide bridge current.

The signal received from the sensor is nonlinear in that the amount of power needed to maintain the velocity sensor's overheat is not directly proportionate to the velocity of the airflow. Instead, the power-consumption curve is fairly steep at low flow rates and relatively flatter at higher rates of flow. Figure 1-5 shows the 950 Series metal sensor's output curve as flow increases. Figure 1-5 also shows the corresponding curve for a pitot-tube type sensor. Note the greatly superior sensitivity of the metal sensor at low flow rates.

Figure 1-5. *Sensor Output vs Flow*



1.4 Features and Specifications

Some of the outstanding features of the 950 Series Flow Switch are summarized below:

Fast Response Dual Trip-Point Flow Switch

The 950 Series Flow Switch responds quickly to activate alarms, lights, or other electronic devices when user flow rates exceed or drop below user-selected set points. The 951 Series Flow Switch will, in addition, activate both relays if power to the flow switch is absent.

Rugged Construction

The Mini MetalClad and MetalClad sensors are exceptionally durable in normal use. They are resistant to both dirt and corrosion; unlike pitot-tube and orifice-plate sensors, their performance is not significantly degraded by operation in a dirty atmosphere.

Unsurpassed Accuracy

The Mini MetalClad and MetalClad sensor windings are Resistor Temperature Detector (RTD)-type windings of reference-grade platinum 385.

Automatic Temperature and Pressure Compensation

The 950 Series Flow Switch directly measures mass velocity. No computations are necessary to compensate for temperature and pressure changes.

Excellent Low-Speed Sensitivity

Unlike pitot-tube and orifice-plate sensors, the 950 Series can accurately measure flows down to 20 SFPM.

The specifications of the 950 Series Flow Switch are given in Table 1-2.

Table 1-2. *950 Specifications*

Sensor Construction:	Reference-grade 385 platinum RTD-type windings around a high-purity ceramic core, sheathed stainless steel
Velocity Range:	0 to 18,000 FPM (Air)
Accuracy:	+/- (2% of reading + 1/2% of full scale)
Repeatability:	+/- 0.25%
Response Time:	1 second at midrange
Temperature Effect:	1/100th% per degree C (0.01% per °C)
Sensor Operating Temperature Range:	0° C to +70° C (950-AT Series) 0° C to +125° C (950-MT Series) **NOTE:** The 950 Series electronics is rated only to 60° C. High temperature 950-MT Series units should have at least 12" of probe protruding from hot pipe or duct. Consult factory for high temperature installation recommendations.

Table 1-2 (continued), *950 Specifications*

Probe Construction:	316 stainless steel and epoxy wetted parts All welded probe support optionally available
Probe Dimensions:	950-06 Series - 3/8" outside diameter; 3", 6", or 9" length 950-08 Series - 1/2" outside diameter; 12", 18", or 24" length 950-16 Series - 1" outside diameter; 36", 48", or 60" length
Electronics Enclosure:	Cast aluminum weatherproof, explosionproof enclosure.
Power Required:	Customer to supply 18-24Vdc @ 600 mA, regulated
Electronics Hookup:	Barrier strip terminals provided inside junction box for all connections
Setpoint Range:	0 to 100%
Relay Ratings:	Choice of 0.2A or 10A SPDT (Single Pole, Double Throw) relays User can connect to normally open (NO) or normally closed (NC) terminal for each relay.

End of Section 1

Section 2: Installation

This section explains how to install your Model 950 Series Flow Switch. The instructions given in this section are necessarily general in nature; every installation is unique. If you need further assistance with your installation, contact your local Kurz representative, or contact Kurz Instruments, Inc. at (408) 646-5911.

2.1 Checking the Contents of the Shipping Carton

Open the shipping carton and remove the protective foam packaging material that covers the flow switch. Check to see that the shipping carton contains the correct configuration of the flow switch you ordered. The contents of the shipping carton should be as shown in Figure 1-1, 1-2, or 1-3, dependent on the flow switch's probe diameter and length.

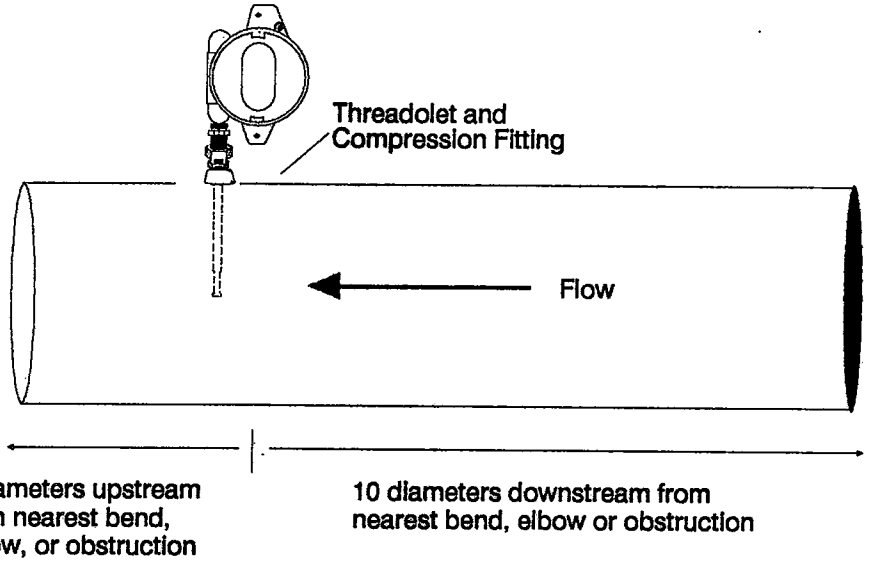
The Unit Description Sheet in the front of this manual contains a checklist of features provided with your particular flow switch. If there is a discrepancy between what you ordered and what is indicated on the Unit Description Sheet or a visually apparent difference in probe diameter or length, please contact Kurz Instruments, Inc. at the number listed above.

If the contents of the shipping carton are correct, proceed with the installation. (If you prefer to test the unit before you install it, refer now to Section 5, "Testing.")

2.2 Determining Probe Location

If possible, you should locate the probe at least three pipe or duct diameters upstream and ten diameters downstream from the nearest bend, elbow, or other obstruction in the pipe or duct to be monitored. The chosen location should also provide sufficient clearance for inserting and removing the 950 probe; that is, the clearance between the pipe or duct and any obstruction should equal at least the length of the probe, plus the junction box, plus two or three inches for maneuver. Correct probe location is illustrated in Figure 2-1.

Figure 2-1. *Probe Location*



2.3 Determining Probe Insertion Depth

Because the 950's sensor can, at any one time, monitor velocity at only one point within your pipe or ductwork, it is important that the sensor be mounted at a point where velocity closely approximates the average velocity within the pipe or duct. You can approach the problem of determining a point of average velocity in a variety of ways, depending primarily upon the accuracy your application requires.

2.3.1 Center Mounting

Under some circumstances, it may be appropriate to assume that the center point of the pipe or duct represents a point of average velocity. Such circumstances include the following:

- A high degree of accuracy is not critical to your application.
- The pipe or duct to be monitored is so small that it is impractical to mount the sensor anywhere other than at the center of the pipe or duct.

- Flow profile is known to be turbulent and of high velocity; many points of average velocity are likely.

- Flow profile is known to be very uniform.

Even under the circumstances listed above, however, you may want to calculate at least a half traverse average (described below at 2.3.2) or possibly a double traverse average (described in section 2.3.3) before deciding on center mounting.

To calculate a half or double traverse average you will need an air velocity meter that operates in the same temperature range as the 950-AT or 950-MT flow switch and measures air flow at rates from 0 to 18,000 FPM. Because the 950 flow switch only monitors air flow for set-point conditions and does not measure the flow, it can't be used for this purpose. Kurz Instruments makes a wide range of air velocity meters and transducers that can be used to determine the optimum position to mount the 950. These meters may also be used to measure flow rates that allow you to select the two set-points.

2.3.2 Half-Traverse Averaging

You can, with a fair degree of accuracy, determine the average velocity within a pipe or duct, and a specific point at which velocity closely approximates that average, by traversing the meter's sensor once across the center line of the pipe or duct, from the far wall to the center[1]. The procedures for performing the traverse and obtaining an average are described below:

Step 1: Divide a cross section of the pipe or duct into a number of equal, concentric areas (see Figure 2-2, page 2-5). The number of areas you use depends on the the uniformity of flow within the pipe or duct and on the degree of accuracy you require: The more areas you use, the more accurate your computed average will be.

Step 2: Identify a point to monitor for each area (see Figure 2-2, page 2-5).

1 If the size of the pipe or duct is such that the probe will not reach all the way across it, you can perform the traverse from the center to the near wall. In that case, however, you should omit the reading nearest the wall of the pipe or duct (see Figure 2-1 oon page 2-2) because that reading may be influenced by turbulence or leakage caused by the probe-insertion hole.

Step 3: Drill a hole in the pipe or duct. The size of the hole that you drill should be 1/16-inch larger than the probe diameter of the meter or transducer used to measure the flow. For convenience, you may want to use a meter or transducer that has the same probe diameter as the flow switch you have selected.

Step 4: Insert the probe into the pipe or duct and take a velocity reading at each of the points selected at Step 2[2].

You can most easily determine the position of the sensor within the pipe or duct by using a pencil or other marker to mark off appropriate measurements on the probe before you insert it.

Be sure the sensor window is aligned with the direction of flow, so that airflow over the sensor is unobstructed..

Step 5: Compute an arithmetic average of the readings obtained at Step 4.

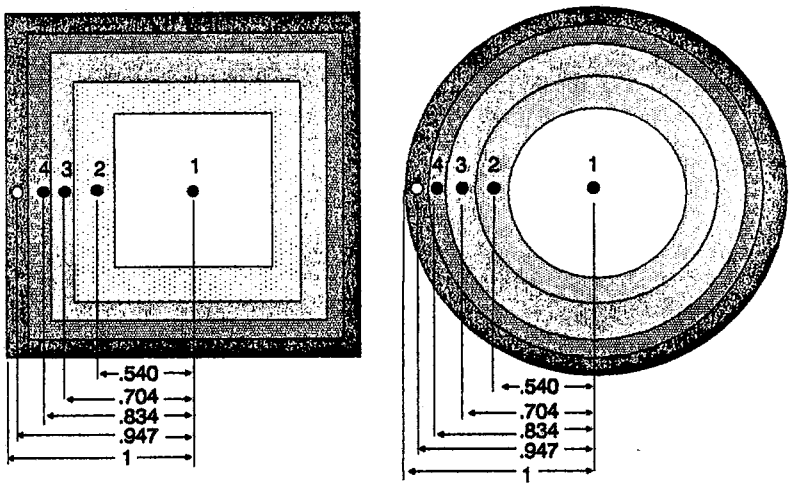
Step 6: Select the point at which you will permanently mount the sensor. This should be the point whose velocity reading most nearly approximates the average velocity computed at Step 5.

If none of the points monitored yields a reading sufficiently close to the computed average, you may want to repeat the procedure, using a larger number of areas and points. Alternatively, you may want to perform the somewhat more complicated double-traverse averaging described at 2.3.3 below.

2 The 950 is shipped with a protective rubber cap covering the sensor. You must remove the cap before you can take readings with the instrument.

Figure 2-2 shows cross sections of square and round ducts, each with five areas and five monitoring points for a half-traverse averaging operation.

Figure 2-2. *Equal-Area Half Traverse*



In Figure 2-2, the unshaded area that contains Point 1 represents one square unit. Each of the shaded areas containing points 2, 3, 4, and 5 also represents one square unit. The total cross-sectional area of each duct is five square units.

The numbers shown below the ducts give the positions of points 2, 3, 4, and 5 relative to the distance from Point 1 to the wall of the duct. That is, from Point 1 to Point 2 is 54% of the distance from Point 1 to the wall of the duct; from Point 1 to Point 3 is 70.4% of the distance from Point 1 to the wall of the duct; and so on. You can extrapolate from these numbers the actual measurements for any pipe or square duct divided into five equal areas.

Table 2-1 shows an example of averaging readings from a duct like one of those shown in Figure 2-2.