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.

Table of Contents

Figures

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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

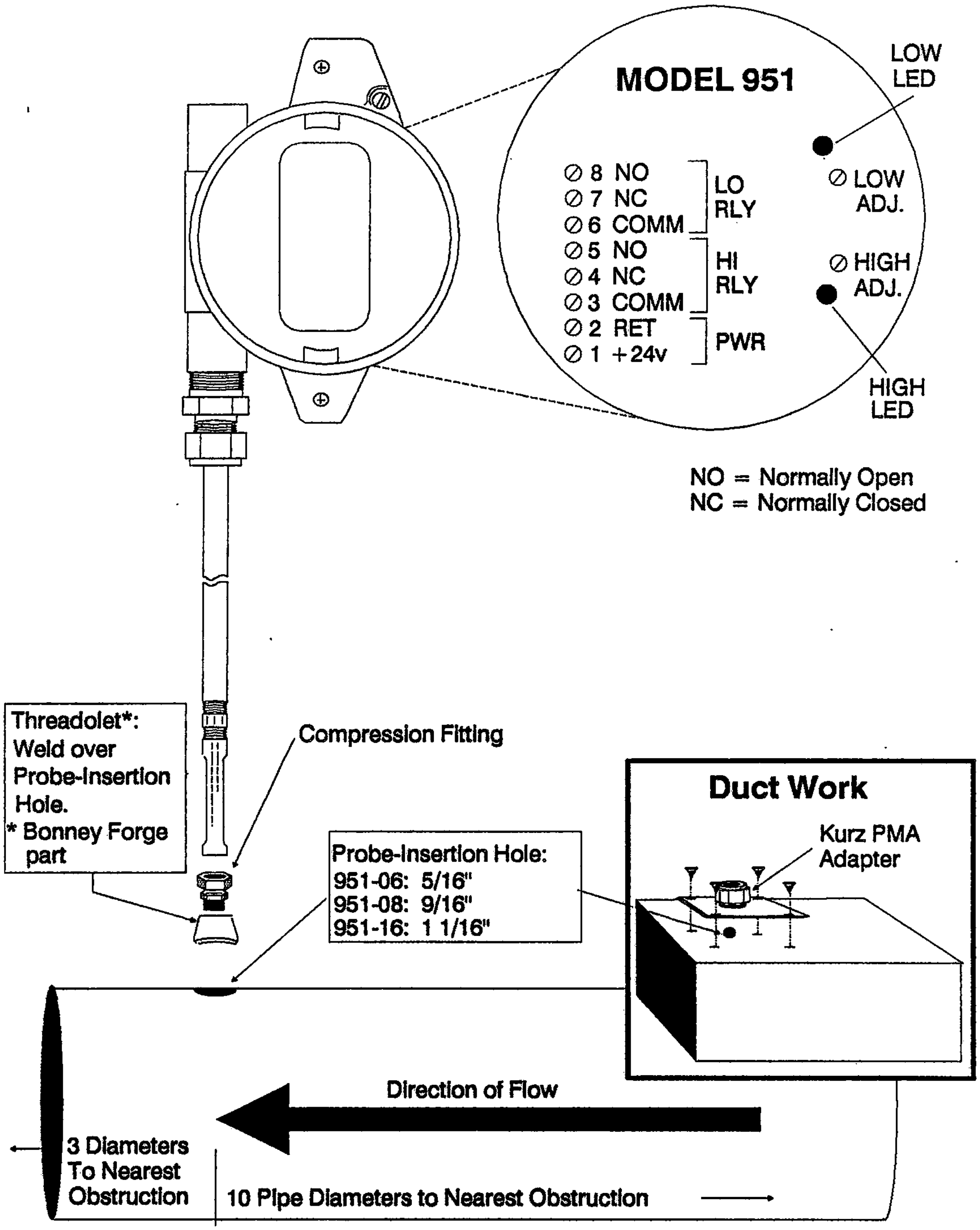
The appendix contains detailed component layout drawings and circuit diagrams of the various components of the 950. This information is not needed by most 950 users in routine operation of the unit. It is provided as an aid to those users who want to perform more detailed maintenance and testing operations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

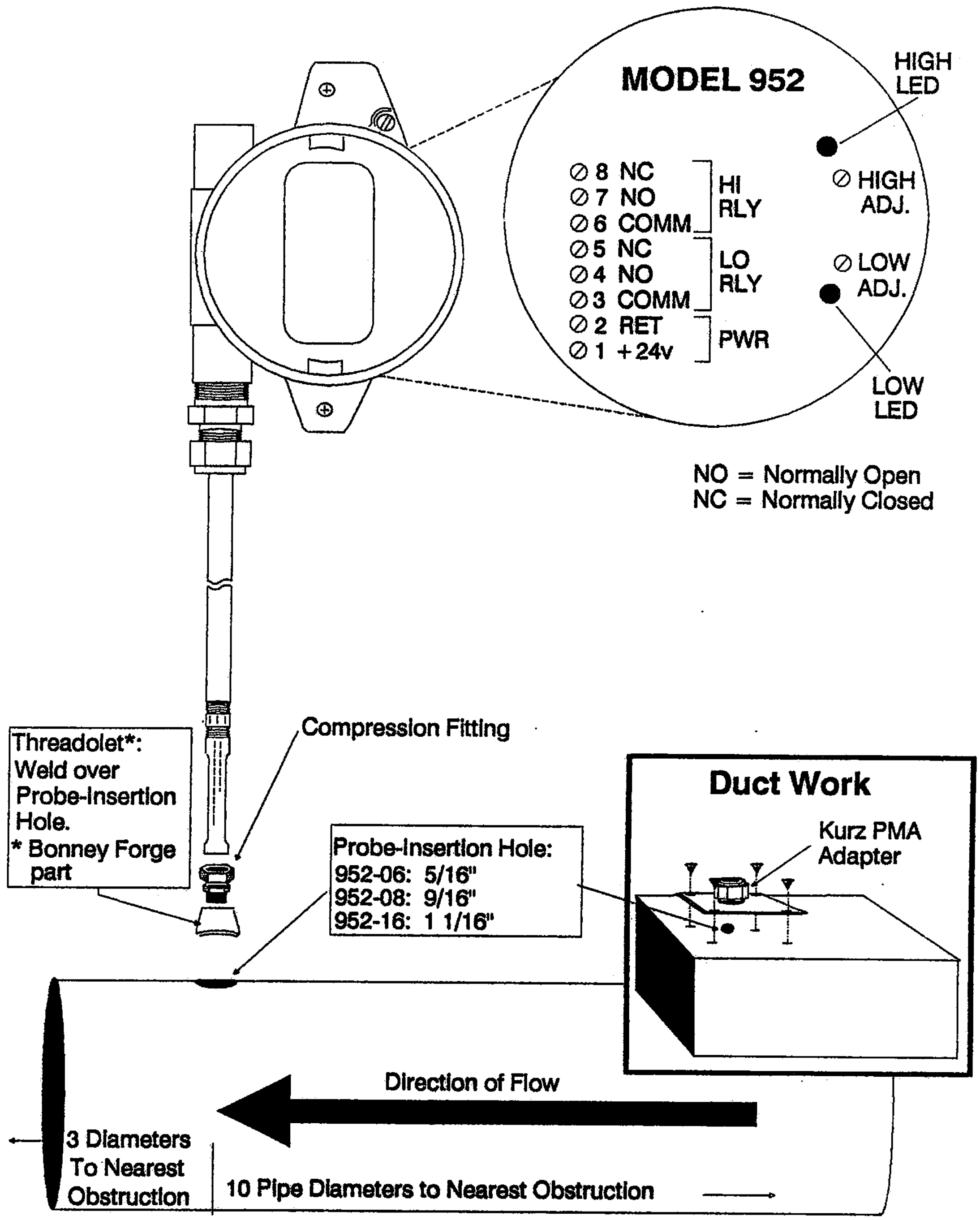
Quick Set-Up Guide - Model 951 Flow Switch

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.

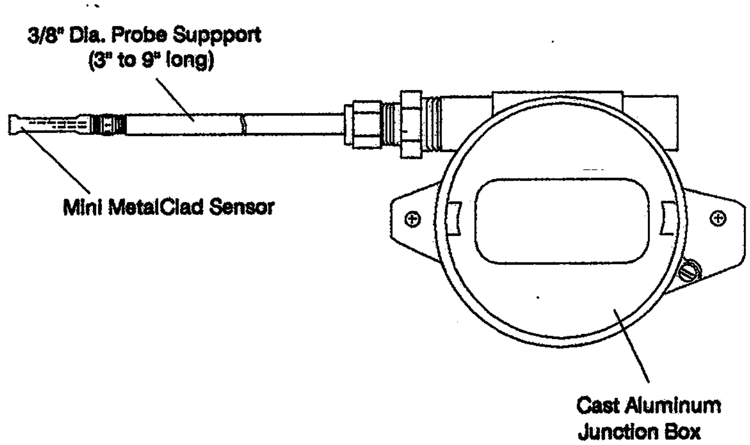
Table 1-1. *950 Series Flow Switch Configurations*

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

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.

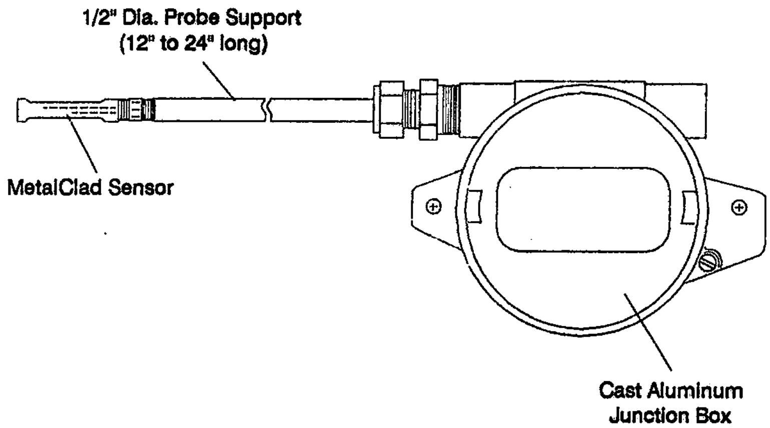
The 950-06 series has the smallest probe (3/8" diameter, 3", 6", or 9" length) which allows it to be installed in pipes or ducts as small as 2 inches in diameter up to 18 inches in diameter.

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).

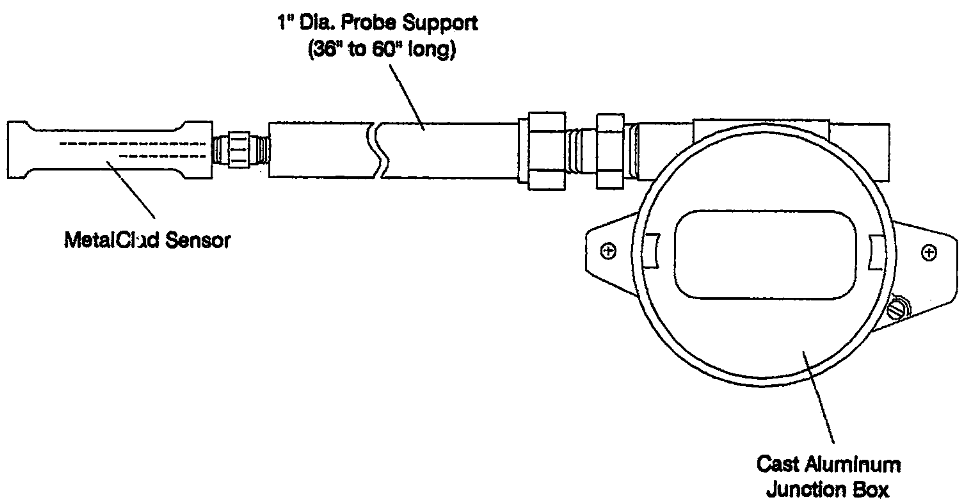
Figure 1-2. *950-08 Series Basic Components*



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.

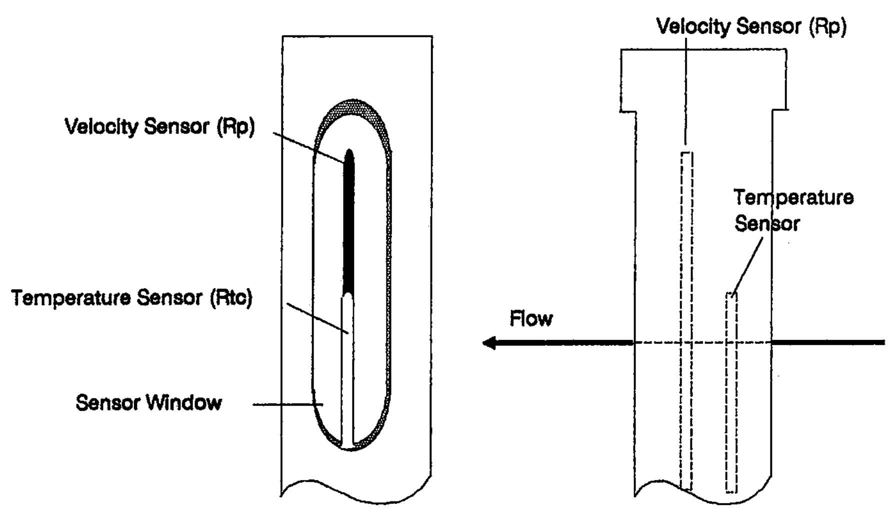
Figure 1-3. *950-16 Series Basic Components*



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.

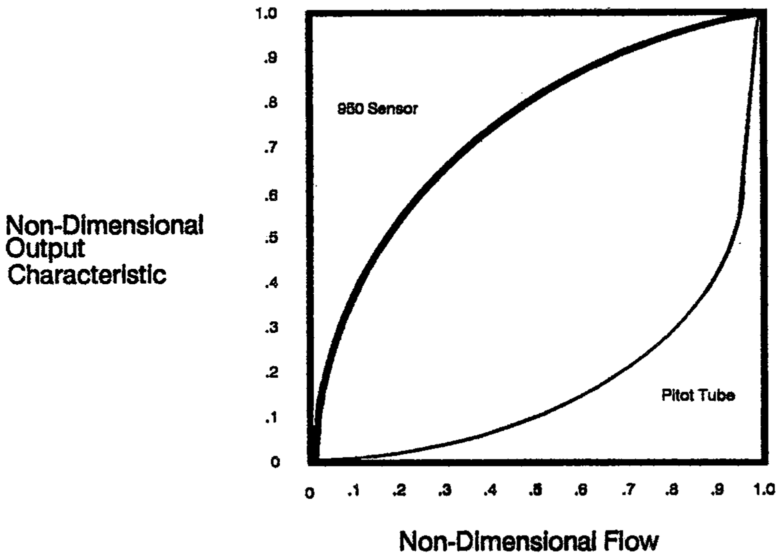
CAUTION: The 950 sensor's standard rating is for nonexplosive gases. Contact Kurz Instruments for more information on using the 950 sensor in explosive gas flows.

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.

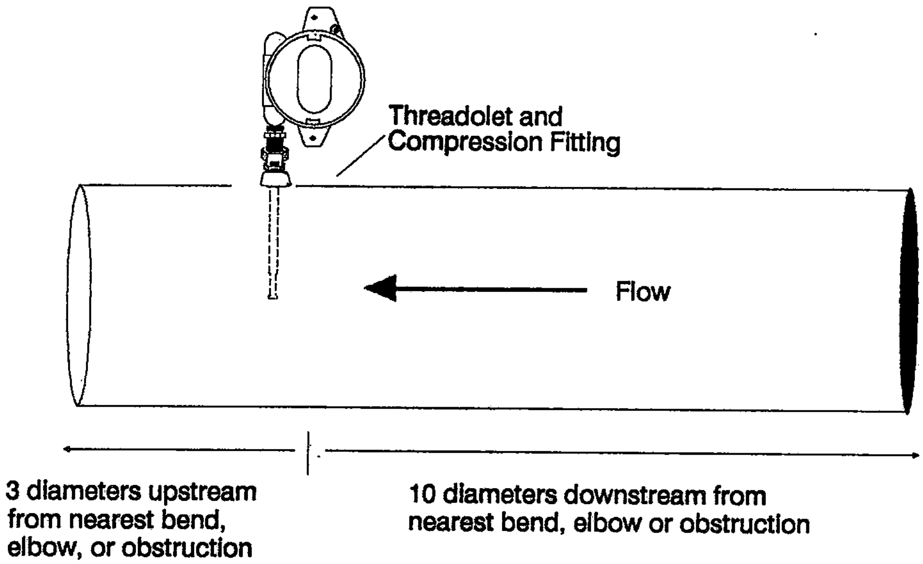
The Unit Description Sheet in the front of this manual contains a checklist of features provided with your particular flow switch. If there is a discrepancy between what you ordered and what is indicated on the Unit Description Sheet or a visually apparent difference in probe diameter or length, please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

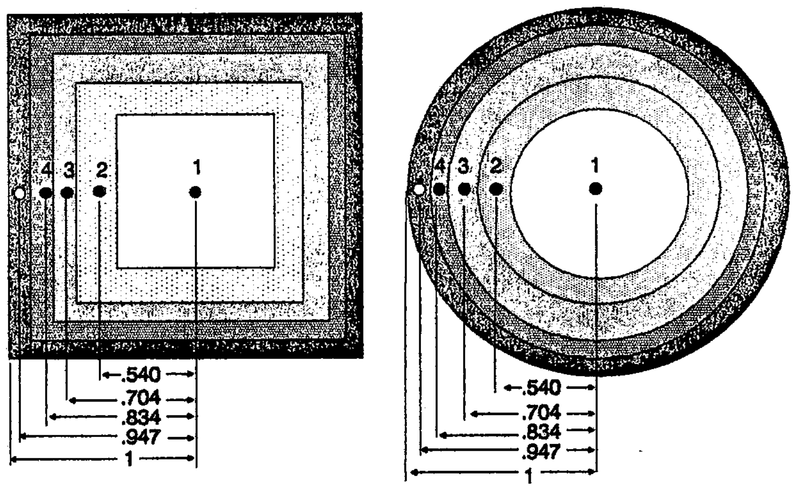
Step 6: Select the point at which you will permanently mount the sensor. This should be the point whose velocity reading most nearly approximates the average velocity computed at Step 5.

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.

Table 2-1. *Half-Traverse Velocity Averaging Example*

Point	Velocity Reading (SFPM)
1	1000
2	950
3	800
4	700
5	500
Total:	3950
Average:	790

In the example, the average velocity from the five points sampled is 790 SFPM. Point 3, with a measured velocity of 800 SFPM, is closest to the average velocity. You would therefore permanently mount the 950 with its probe inserted to the correct depth to align the sensor with Point 3.

2.3.3 Double-Traverse Averaging

Double-traverse averaging is similar to half-traverse averaging, but requires a second probe-insertion hole and more monitoring points. 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 2-3, page 2-8). 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 four points to monitor for each area (see Figure 2-3, page 2-8)[3].

3 Note that the center contains only one monitoring point. The reading from that point must be counted four times in the averaging operation to give each area equal weight.

Step 3: Drill two holes in the pipe or duct at right angles to each other. The size of the holes 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 through one of the probe-insertion holes and take a velocity reading at each of the points in line with that hole.[4] Repeat the process for the other hole.

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 window of the probe's protective shield 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. Count the single Point-1 reading four times in determining the average.

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.

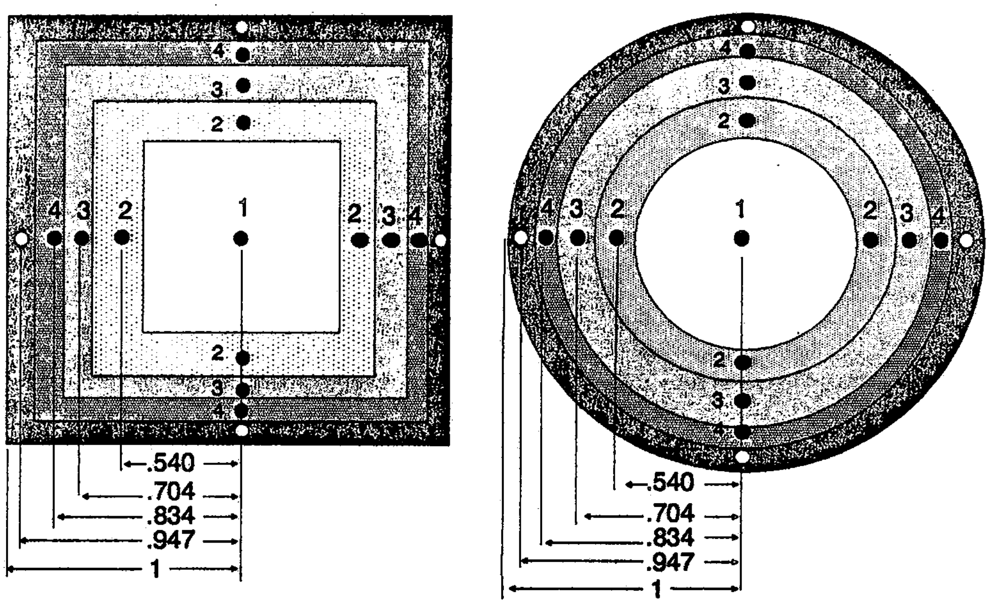
If none of the points monitored yields a reading sufficiently close to the computed average, you may want to repeat the procedure, using a larger number of areas and points.

4 Do not take a reading at the point nearest the probe-insertion hole; such a reading might be influenced by leakage or turbulence caused by the hole. Instead, substitute the reading from the corresponding point nearest the far wall of the duct or pipe. Be sure to remove the protective rubber cap from the 950's sensor before you attempt to take readings.

Step 7: Be sure you seal the probe-insertion hole that will **not** be used when you permanently mount the probe.

Figure 2-3 shows cross sections of both square and round ducts, each with five areas and 17 monitoring points for a double-traverse averaging operation.

Figure 2-3. *Equal-Area Double Traverse*



In Figure 2-3, the unshaded area of each duct, which 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 2-2 shows an example of averaging readings from a duct like one of those shown in Figure 2-3.

Table 2-2. *Double-Traverse Velocity Averaging Example*

From\Points	1	2	3	4	5	Sum	Average
Left	1200	1150	1100	1000	700	5150	1030
Right	1200	1140	1115	1020	700	5175	1035
Top	1200	1200	1175	1100	800	5475	1095
Bottom	1200	1175	1150	1050	800	5375	1075
Sum:	4800	4665	4540	4170	3000	21,175	4235
Average:	1200	1166	1135	1043	750	5294	1059

In the example, the average velocity from the 20 points sampled[5] is 1059 SFPM. The bottom Point 4, with a measured velocity of 1050 SFPM, is closest to the average velocity. You would therefore permanently mount the 950 with its probe inserted to the correct depth to align the sensor with the bottom Point 4.

If you find that the flow profile within the pipe or duct you are monitoring changes, or if you cannot find a single point that closely enough approximates the computed average velocity, you may want to consider moving to a multi-point, multi-sensor velocity averaging array such as the Kurz EVA 4000 or EVA 4100. In all cases, Kurz Instruments recommends a multi-sensor EVA system for monitoring velocity in lines over 48 inches in diameter.

2.4 Installing the Probe

Unless you are going to adjust the high and low setpoints in the same environment where you are installing the flow switch, you may want to consider making these adjustments before you complete the installation. For information on how to adjust these setpoints, refer to Section 2.8 on the page 2-19.

5 Point 1 is counted four times.

In most cases the 950 flow switch is held in place by means of a compression fitting attached to the outside of the pipe or duct in which the probe is to be mounted. The hardware and procedures necessary to attach the compression fitting vary, depending on whether the installation is for a pipe or or for a sheet-metal duct. Installations of both kinds are described in this section.

NOTE: The 950 is shipped with a protective rubber cap covering the sensor. Make sure you remove the cap before you install the probe.

2.4.1 Pipe Mounting

All hardware needed to mount the 950 in a pipe is readily available from most hardware supply dealers. You can, however, order the necessary hardware from Kurz Instruments if you want to.

You will need:

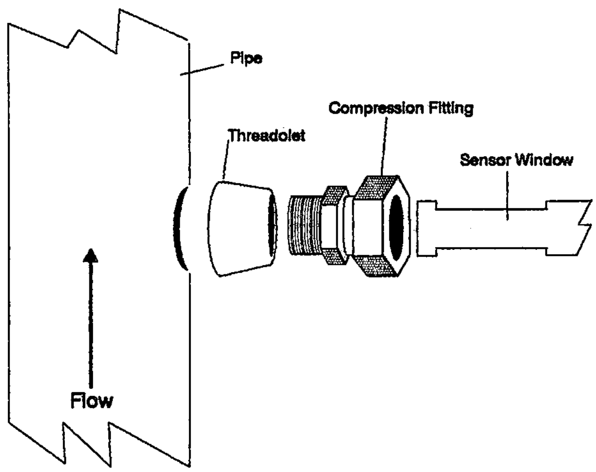
- **Threadolet™ carbon steel coupler**[6]. If you order the Threadolet from Kurz, you must specify the size of NPT (National Pipe Thread) pipe the Threadolet is to be welded to, as well as the wall thickness of that pipe (Schedule 40, 80, etc.). The Threadolet must accept the appropriate MNPT (Male National Pipe Thread) fitting to match the type of 950 flow switch to be installed (see "Tube compression fitting" below.)
- **Tube compression fitting**[7]. The following tube compression fitting should be used for each of the size of 950 flow switch listed below:
  950-06: 0.375" AD 0.375" MNPT tube compression fitting
  950-08: 0.5" AD 0.5" MNPT tube compression fitting
  950-16: 1" AD 1" MNPT tube compression fitting
- **Adjustable stop collar with setscrew (optional).** The optional stop collar (available for the 950-08 and 950-16 models only) can attach to the probe to ensure that the probe is not inserted beyond the selected depth.

Figure 2-4 shows the hardware needed to mount the flow switch in a pipe.

6 Threadolet fittings are also available in aluminum and stainless steel.

7 Standard compression fitting is bored-thru 316 stainless steel with teflon ferrules. Optional stainless steel ferrules are available for permanent compression on probe.

Figure 2-4. *Mounting Hardware, Pipe*



Weld the Threadolet coupler directly over the probe-insertion hole in the pipe in which you are installing the 950 (refer to Section 2.2 for determining the location of the probe-insertion hole). Then thread the tube compression fitting firmly into the coupler.

Once you have mounted the compression fitting to the pipe or duct, installing the probe consists simply of inserting the probe to the predetermined depth (see Section 2.3) and tightening the compression fitting to hold the probe in place. The optional metal stop collar, available for the 950-08 and 950-16, is a convenient way of ensuring proper probe insertion depth.

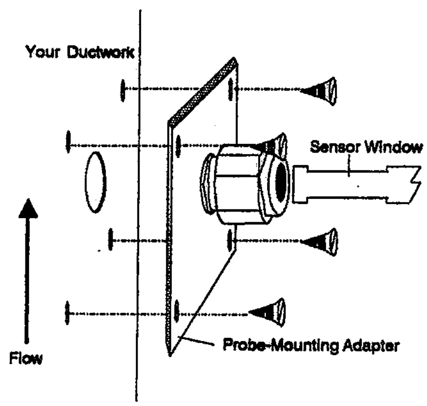
This type of installation allows the 950 to be readily removed for cleaning or maintenance by simply untightening the compression fitting and sliding the probe out the pipe.

2.4.2 Duct Mounting

To mount the 950 in a duct constructed of thin-wall sheetmetal, order one of the following mounting adapters for the model purchased:
950-06: PMA-06, 3/8" compression fittting
950-08: PMA-08, 1/2" compression fittting
950-16: PMA-16, 1" compression fittting
Each mounting adapter consists of a compression fitting welded to a 3"-by-3" steel plate with four corner mounting holes, as shown in Figure 2-5.

Curved probe mounting adapters (CPMA) are also available for curved ductwork. Specify the CPMA-06-*radius* for the 950-06, the CPMA-08-*radius* for the 950-08, or the CPMA-16-*radius* for the 950-16, where *radius* is replaced by the actual radius of your ductwork.

Figure 2-5. *PMA Mounting Adapter for Duct Installation*



2.4.3 Sensor Alignment

Make sure the probe is rotated such that the window of the sensor shield allows unobstructed flow of air over the sensor and the shorter Rtc element is upstream of the longer Rp element (see Figure 1-4 on page 1-5).

2.4.4 Very Low Velocity Installations

The 950's Mini MetalClad and MetalClad sensors are exceptionally accurate at flow rates well below those that can be accurately measured by pitot-tube or orifice-plate type installations. The 950 can accurately monitor flows down to 20 SFPM - the equivalent of less than 1/4 mile per hour (or walking across a room very slowly).

2.4.5 Medium-Temperature Installations (0° to 125° C)

If the ambient temperature of the air or gas flow to be monitored exceeds 65° C, a 950-MT Flow Switch should be used. However, the electronics for the flow switch can not be guaranteed to operate at temperatures above 60° C.

In these installations a longer probe is required so that the aluminum junction box (which contains the 950 electronics circuitry) can be located at least 12 inches from the hot duct or pipe. That space helps keep the electronics at or below their rated temperature of 60° C, even when the temperature of the flow inside the pipe or duct may reach 125° C.

2.4.6 High-Temperature Installations (0° to 250° C)

The standard 950 Series flow switch can not be used in high temperature applications. Call Kurz Instruments for further information on high temperature applications.

2.5 Connecting the 950 to an 18-24Vdc Input

The 950 Flow Switch must be connected to a regulated 18-24 Vdc, 600mA source and ground from a power supply. Barrier strip terminals inside the junction box are provided for these connections. Connect the 18-24 Vdc source to terminal 1 and power supply ground to terminal 2.

An aluminum cover plate inside the junction box provides information on the location of the terminals required for the proper connection to the power supply. Remove the cover plate for access to the terminal strip located on the electronics board. The Quick Set-Up Guides for the 951 and 952 (provided in the front of this manual) and Figures 2-6 and 2-7 on the following pages show the location of the terminals inside the 951 and 952 junction box.

2.6 Adjusting the Alarm Thresholds

If the high and low alarm thresholds have not been previously set by Kurz Instruments (available optionally) you will need to adjust the high and low adjust potentiometers. These potentiometers are easily accessed through holes in the cover plate protecting the 950 electronics inside the junction box. The cover plates for the 951 and 952 are labeled to identify the location of the potentiometers and the connections to the terminal strip. The cover plates are illustrated in the Quick Set-Up Guides at the front of this manual.

To set the high alarm value, you must, with the Series 950 Flow Switch properly installed, run a flow whose velocity represents the desired high flow rate limit past the sensor. You then adjust the high-adjust potentiometer until the high relay LED lights. For example, you might set the high relay potentiometer so that the high relay LED lights when the flow rate reaches or exceeds 10,000 FPM (Feet Per Minute).

To set the low alarm value, you must run a flow whose velocity represents the desired low flow rate limit past the sensor. You then adjust the low-adjust potentiometer until the low relay LED lights. For example you might set the low relay potentiometer so that the low relay LED lights when the flow rate falls to 1,000 FPM or less.

2.7 Connecting Electrical Devices to the 951 Relays

Typically these relays are used to activate alarms (lights, bells, buzzers, or activation of other electronic circuitry) to indicate that the flow has reached a high set-point or that flow has dropped below a specified low set-point. However, the 950 can be used to monitor flow for two high set-points or two low set-points, one having a lower threshold than the other.

You can connect the electrical devices or signals to either the normally open (NO) or normally closed (NC) side of the relays in 951 Flow Switch. The side of the relay you use depends on the type of device or signal you are interfacing to and whether or not you want to monitor for two high flow rates, two low flow rates, or one high and one low flow rate.

Table 2-3 compares the flow conditions and the state of the high and low relays (open or closed) depending on the side of the relay connected to the external device or signal.

Table 2-3. *951 Relay Connections*

951 RELAY	FLOW CONDITION	TERMINAL CONNECTIONS	
		TO OPEN RELAY	TO CLOSE RELAY
High Relay	Flow is Equal to or Greater Than the Set-Point	3 (COMM) & 4 (NC)	3 (COMM) & 5 (NO)
High Relay	Flow is Below the Set-Point	3 (COMM) & 5 (NO)	3 (COMM) & 4 (NC)
Low Relay	Flow is Equal to or Below the Set-Point	6 (COMM) & 7 (NC)	6 (COMM) & 8 (NO)
Low Relay	Flow is Greater Than the Set-Point	6 (COMM) & 8 (NO)	6 (COMM) & 7 (NC)

The placement of the terminal strip on the electronics board in the 951 junction box is illustrated in Figure 2-6. Terminal connections are listed in Table 2-4.

Figure 2-6. *Location of Terminals for the 951 Flow Switch*

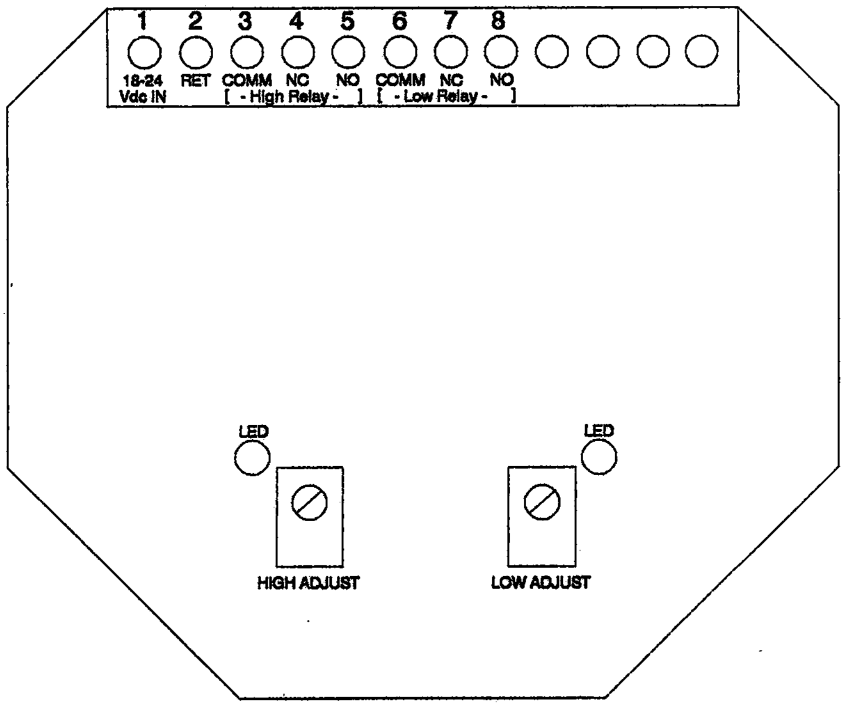


Table 2-4. *951 Terminal Connections*

951 TERMINAL CONNECTIONS	
1	18-24 Vdc Input
2	Power Supply Ground (Return)
3	High Relay, Common
4	High Relay, Normally Closed
5	High Relay, Normally Open
6	Low Relay, Common
7	Low Relay, Normally Closed
8	Low Relay, Normally Open
9	No Connect
10	No Connect
11	No Connect
12	No Connect

2.7.1 Using the 951 to Monitor High and Low Flow Rates

Let's assume for the sake of example that you want to sound a bell when the flow rate is equal to or greater than 10,000 FPM (Feet Per Minute) and that you want to activate a warning light when flow falls to 1,000 FPM or less.

The high relay on the 951 closes when flow is equal to or above the high set point value. In this example you would set the high relay potentiometer so that the relay closes and the high relay LED lights when the flow rate reaches or exceeds 10,000 FPM.

To close the circuit to the electronic bell when the high limit is reached (flow is 10,000 FPM or more), you should connect the bell to the normally open (NO) and ground terminals of the high relay (terminals 3 and 5). As long as the flow is below 10,000 FPM, the relay remains open, the high relay LED is off, and the bell does not sound. When the flow rate reaches 10,000 FPM or more, the high relay closes, the high relay LED lights, and the bell sounds.

The low relay on the 951 closes when flow is equal to or less than the low set point value. In this example you would set the low relay potentiometer so that the relay closes and the low relay LED lights when the flow rate falls to 1,000 FPM or less.

To close the circuit to the warning light when the low limit is reached (flow is 1,000 FPM or less), you should connect the warning light to the normally open (NO) and ground terminals of the low relay relay (terminals 6 and 8). As long as the flow is above 1,000 FPM, the relay remains open, the low relay LED is off, and the warning light is off. When the flow rate falls to 1,000 FPM or less, the low relay closes, the low relay LED lights, and the warning light is on.

2.7.2 Using the 951 to Monitor Two Low Flow Rates

You may want to use the 951 flow switch to detect two low flow rates, one flow rate lower than the other. For example, you might want to have a warning light activate when the flow drops below 1,000 FPM (Feet Per Minute) and have an electronic buzzer sound if it drops down to 500 FPM or below.

The high relay on the 951 closes when flow is equal to or above the high set point value. In this example you would set the high relay potentiometer so that the relay closes and the high relay LED lights when the flow rate reaches or exceeds 1000 FPM.

To close the circuit to the warning light when flow is below 1000 FPM, you should connect the light to the normally closed (NC) and ground terminals of the high relay (terminals 3 and 4). As long as the flow is 1000 FPM or more, the relay remains closed, the high relay LED is on, and the warning light is off. When the flow rate falls below 1000 FPM, the high relay opens, the high relay LED is off, and the warning light is on.

The low relay closes when the flow rate is equal to or below the low set point. In this example you would set the low relay potentiometer so that the relay closes and the low relay LED lights when the flow falls to 500 FPM or less.

To close the circuit to the electronic buzzer when flow is 500 FPM or less, you should connect the light to the normally open (NO) and ground terminals of the low relay (terminals 6 and 8). As long as the flow is above 500 FPM, the relay is open, the low relay LED is off, and the alarm buzzer is off. When the flow rate falls to 500 FPM or less, the low relay is closed, the low relay LED is on, and the alarm buzzer sounds. The warning light associated with the high relay is also on.

2.7.3 Using the 951 to Monitor Two High Flow Rates

You may want to use the 951 flow switch to detect two high flow rates, one flow rate higher than the other. For example, you might want to have a warning light activate when the flow reaches 10,000 FPM (Feet Per Minute) or more and have an electronic buzzer sound if it reaches 15,000 FPM or more. The low relay should be used to monitor the lower of the two flow rates, or what might be considered the first warning signal.

The low relay closes when the flow rate is equal to or below the low set point. In this example you would set the low relay potentiometer so that the relay closes and the low relay LED lights when the flow is less than 10,000 FPM.

To close the circuit to the warning light when flow exceeds 10,000 FPM, you should connect the light to the normally closed (NC) and ground terminals of the low relay (terminals 6 and 7). As long as the flow is 10,000 FPM or less, the relay is closed, the low relay LED is on, and the warning light is off. When the flow rate exceeds 10,000 FPM, the low relay is open, the low relay LED is off, and the warning light is on.

The high relay on the 951 closes when flow is equal to or above the high set point value. In this example you would set the high relay potentiometer so that the relay closes and the high relay LED lights when the flow rate reaches or exceeds 15,000 FPM.

To close the circuit to the electric buzzer when flow is 15,0000 FPM or more, you should connect the light to the normally open (NO) and ground terminals of the high relay (terminals 3 and 5). As long as the flow is below 15,000 FPM, the relay is open, the high relay LED is off, and the buzzer is off. When the flow rate is 15,000 or above, the high relay closes, the high relay LED is on, and the buzzer sounds.

2.8 Connecting Electrical Devices to the 952 Relays

Typically these relays are used to activate alarms (lights, bells, buzzers, or activation of other electronic circuitry) to indicate that the flow has reached a high set-point or that flow has dropped below a specified low set-point. However, the 952 can be used to monitor flow for two high set-points or two low set-points, one having a lower threshold than the other.

The high and low relays in the 952 are normally closed when power to the flow switch is present. If either or both of the setpoint conditions are met, the corresponding relay(s) open. If power fails, both relays open.

You can connect the electrical devices or signals to either the normally open (NO) or normally closed (NC) side of the relays in 952 Flow Switch. The side of the relay you use depends on the type of device or signal you are interfacing to and whether or not you want to monitor for two high flow rates, two low flow rates, or one high and one low flow rate.

Table 2-5 compares the flow conditions and the state of the high and low relays (open or closed) depending on the side of the relay connected to the external device or signal.

Table 2-5. *952 Relay Connections*

952 RELAY	FLOW CONDITION	TERMINAL CONNECTIONS	
		TO OPEN RELAY	TO CLOSE RELAY
High Relay	Flow is Equal to or Greater Than the Set-Point	6 (COMM) & 8 (NC)	6 (COMM) & 7 (NO)
High Relay	Flow is Below the Set-Point	6 (COMM) & 7 (NO)	6 (COMM) & 8 (NC)
Low Relay	Flow is Equal to or Below the Set-Point	3 (COMM) & 5 (NC)	3 (COMM) & 4 (NO)
Low Relay	Flow is Greater Than the Set-Point	3 (COMM) & 4 (NO)	3 (COMM) & 5 (NC)

The placement of the terminal strip on the electronics board in the 952 junction box is illustrated in Figure 2-7. Terminal connections are listed in Table 2-6.

Figure 2-7. *Location of Terminals for the 952 Flow Switch*

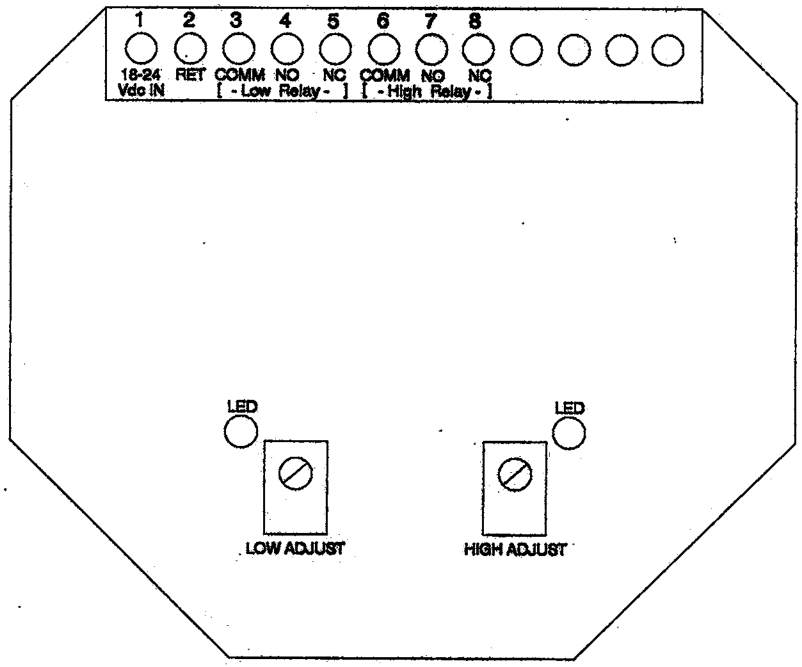


Table 2-6. *952 Terminal Connections*

952 TERMINAL CONNECTIONS	
1	18-24 Vdc Input
2	Power Supply Ground (Return)
3	Low Relay, Common
4	Low Relay, Normally Open
5	Low Relay, Normally Closed
6	High Relay, Common
7	High Relay, Normally Open
8	High Relay, Normally Closed
9	No Connect
10	No Connect
11	No Connect
12	No Connect

2.8.1 Using the 952 to Monitor High and Low Flow Rates

Let's assume for the sake of example that you want to sound a bell when the flow rate is equal or greater than 10,000 FPM (Feet Per Minute) and that you want to activate a warning light when flow falls to 1,000 FPM or less. If power to the flow switch fails, both the bell and the warning light should turn on.

The high relay on the 952 opens when flow is equal to or above the high set point value. In this example you would set the high relay potentiometer so that the relay opens and the high relay LED lights when the flow rate reaches or exceeds 10,000 FPM.

To close the circuit to the electronic bell when the high limit is reached (flow is 10,000 FPM or more), you should connect the bell to the normally closed (NC) and ground terminals of the high relay (terminals 3 and 5). As long as the flow is below 10,000 FPM, the relay remains closed, the high relay LED is off, and the bell does not sound. When the flow rate reaches 10,000 FPM or more, the high relay opens, the high relay LED lights, and the bell sounds.

The low relay on the 952 opens when flow is equal to or less than the low set point value. In this example you would set the low relay potentiometer so that the relay opens and the low relay LED lights when the flow rate falls to 1,000 FPM or less.

To close the circuit to the warning light when the low limit is reached (flow is 1,000 FPM or less), you should connect the warning light to the normally closed (NC) and ground terminals of the low relay (terminals 6 and 8). As long as the flow is above 1,000 FPM, the relay remains closed, the low relay LED is off, and the warning light is off. When the flow rate falls to 1,000 FPM or less, the low relay opens, the low relay LED lights, and the warning light is on.

2.8.2 Using the 952 to Monitor Two Low Flow Rates

You may want to use the 952 flow switch to detect two low flow rates, one flow rate lower than the other. For example, you might want to have a warning light activate when the flow drops below 1,000 FPM (Feet Per Minute) and have an electronic buzzer sound if it drops down to 500 FPM or below.

The high relay on the 952 opens when flow is equal to or above the high set point value. In this example you would set the high relay potentiometer so that the relay opens and the high relay LED lights when the flow rate reaches or exceeds 1000 FPM.

To close the circuit to the warning light when flow is below 1000 FPM, you should connect the light to the normally open (NO) and ground terminals of the high relay (terminals 3 and 4). As long as the flow is 1000 FPM or more, the relay remains open, the high relay LED is on, and the warning light is off. When the flow rate falls below 1000 FPM, the high relay closes, the high relay LED is off, and the warning light is on.

The low relay opens when the flow rate is equal to or below the low set point. In this example you would set the low relay potentiometer so that the relay opens and the low relay LED lights when the flow falls to 500 FPM or less.

To make connection to the electronic buzzer circuit when flow is 500 FPM or less, you should connect the light to the normally closed (NC) and ground terminals of the low relay (terminals 6 and 8). As long as the flow is above 500 FPM, the relay will remain closed, the low relay LED will be off, and the alarm buzzer will be off. When the flow rate falls to 500 FPM or less, the low relay will open, the low relay LED will be lit, and the alarm buzzer will sound. The warning light associated with the high relay is also on and the high relay LED is lit.

Note: A power-fail condition will also cause both relays to open causing the warning light to go on and the buzzer to sound. To differentiate a power-fail condition from low flow rates you must check the the high and low relay LEDs. If both alarms have activated by low flow rates the LEDs will be on. If the alarms have been activated by a power-fail condition, the LEDs wil be off.

2.8.3 Using the 952 to Monitor Two High Flow Rates

You may want to use the 952 flow switch to detect two high flow rates, one flow rate higher than the other. For example, you might want to have a warning light activate when the flow reaches 10,000 FPM (Feet Per Minute) or more and have an electronic buzzer sound if it reaches 15,000 FPM or more. The low relay should be used to monitor the lower of the two flow rates, or what might be considered the first warning signal.

The low relay opens when the flow rate is equal to or below the low set point. In this example you would set the low relay potentiometer so that the relay opens and the low relay LED lights when the flow is less than 10,000 FPM.

To close the circuit to the warning light when flow exceeds 10,000 FPM, you should connect the light to the normally open (NO) and ground terminals of the low relay (terminals 6 and 7). As long as the flow is 10,000 FPM or less, the relay is open, the low relay LED is on, and the warning light is off. When the flow rate exceeds 10,000 FPM, the low relay is closed, the low relay LED is off, and the warning light is on.

The high relay on the 952 opens when flow is equal to or above the high set point value. In this example you would set the high relay potentiometer so that the relay opens and the high relay LED lights when the flow rate reaches or exceeds 15,000 FPM.

To close the circuit to the electric buzzer when flow is 15,0000 FPM or more, you should connect the light to the normally closed (NC) and ground terminals of the high relay (terminals 3 and 5). As long as the flow is below 15,000 FPM, the relay is closed, the high relay LED is off, and the buzzer is off. When the flow rate is 15,000 or above, the high relay opens, the high relay LED is on, and the buzzer sounds.

Note: A power-fail condition will also cause both relays to open causing the warning light to go on and the buzzer to sound. To differentiate a power-fail condition from high flow rates you must check the the high and low relay LEDs. If both alarms have activated by high flow rates the LEDs will be on. If the alarms have been activated by a power-fail condition, the LEDs wil be off.

End of Section 2

Section 3: Operation and Routine Maintenance

3.1 Operation

Once you have installed the 950 as described in Section 2, operation is primarily a matter of maintaining the 18-24Vdc power source to the 950. As long as power is supplied to this unit, the probe is correctly installed in the pipe or duct to be monitored, and all wiring connections are correct, the 950 will continue to operate for prolonged periods without intervention.

3.2 Routine Maintenance

The 950 is virtually maintenance free. The only routine maintenance operation required is an occasional cleaning. The 950's sensor is far more resistant to particulate contamination than pitot tube or orifice plate sensors. Nevertheless, the 950 performs best when it is kept relatively free of contamination. You should therefore remove the probe and check the sensor at regular intervals, cleaning it if necessary.

The 950's MetalClad sensor should be periodically examined twice a year for typical applications. When the sensor is operating in particlarly dirty or particle-laden environments, it should be checked every 60 days. If the sensor is operating in clean-air applications an inspection of the sensor once a year may be sufficient. You can move to longer intervals if the sensor is not becoming heavily loaded between checks.

If the sensor needs cleaned, use any solvent you believe is effective in removing the contaminants. Use a fine wire brush, crocus cloth, or fine grit emery cloth to remove built-up contamination from the sensor. Clean the sensor only when power is off.

While the MetalClad sensor is rugged, it can be bent or broken by careless treatment. A bent sensor may develop a short and need to be replaced.

End of Section 3

Section 4: Options

This section lists and describes some of the more popular options available for the 950 Seies Flow Switch. The options discussed in this section are:

- Custom Probe Length
- Custom Sensors
- Factory Set Alarms

4.1 Custom Probe Lengths

The standard probe lengths for the 950-06 are 3", 6", and 9".
The standard probe lengths for the 950-08 are 12", 18", and 24".
The standard probe lengths for the 950-16 are 36", 48", and 60".

Other probe lengths are optionally available, consult Kurz Instruments for further information. If you have purchased your flow switch with a custom probe length it has been noted on the Unit Description Sheet in the front of this manual.

4.2 Custom Sensors

The 950's Mini MetalClad and MetalClad sensors can be coated to provide additional resistance to corrosive gases and contaminants. The type of coating that is applied to the sensors will be dependent on the type of gas flow.

If the 950 Flow Switch is used in to monitor flow in a corrosive environment a Hastelloy, Monel, or Titanium alloy sensor can be substituted for the standard stainless steel sensor. Consult Kurz Instruments for pricing.

4.3 Factory-Set Alarms

The 950 Flow Switch high and low alarms can be factory-set to trip at your specified flows. There is a small additional charge for factory alarm setting. If performed at the factory the high and low alarm trip-points will be noted on the Unit Description Sheet at the front of this manual.

Flow meters available from Kurz Instruments are calibrated in **standard** units, which are referenced to a temperature of 25° C (77° F) and a pressure of 760 mm (29.92 inches) of mercury (Hg). In other words, air at 25° C and 760 mm Hg, flowing at 100 feet per minute (FPM) will produce a reading of 100 **standard** feet per minute (SFPM). A 100 FPM flow at a different temperature or pressure produces a reading in SFPM that accurately compensates for non-standard temperature or pressure conditions. Therefore a velocity reading obtained for air at a different temperature and/or pressure will not be actual velocity, but rather a velocity already corrected back to standard conditions (of temperature and pressure).

The 950 can be factory-set in other units of measurement. If you prefer a unit not listed, contact Kurz Instruments for more information.

- Standard Cubic Feet per Minute per square foot (SCFM/ft^2).
- Pounds Mass per Minute per square foot.
- Standard Cubic Feet per Minute (SCFM). SCFM, unlike SCFM/ft^2, is a direct measure of the mass of air flowing through your pipe or duct. If you want flow switch activation in SCFM you must supply Kurz with the exact cross-sectional area (in square feet) of your pipe or duct at the point where the sensor will be permanently mounted.
- Pounds per Minute (lbs/min). Again, this is a direct measure of the mass of air flowing through your pipe or duct. If you want switch points factory-set in lbs/min you must supply Kurz with the exact cross-sectional area (in square feet) of your pipe or duct at the point where the sensor will be permanently mounted.
- Standard Meters per Second (SMPS)

4.3.1 Calculating Actual Velocities

Generally, standard velocity is a much more useful measurement than actual velocity. Sometimes, however, you may want to calculate the **actual** velocity of an airflow at a non-standard temperature or pressure.

The formula for deriving actual velocity from standard velocity is given below:

$$V_{act} = V_{ind} \frac{d_s}{d_a}$$

where:

d_s = Standard air density (25° C; 760 mm Hg).

d_a = Actual air density at local temperature and barometric pressure.

V_{ind} = Indicated velocity in standard feet per minute.

V_{act} = Actual air velocity in feet per minute.

Although the intermediate steps are not shown here, by dividing out the known quantities, the formula can be restated as

$$V_{act} = V_{ind} \; 0.05578 \; \frac{T_a}{P_a}$$

where

T_a = Actual temperature in degrees Rankine (degrees R = Degrees F + 459.67).

P_a = Actual pressure in inches of mercury.

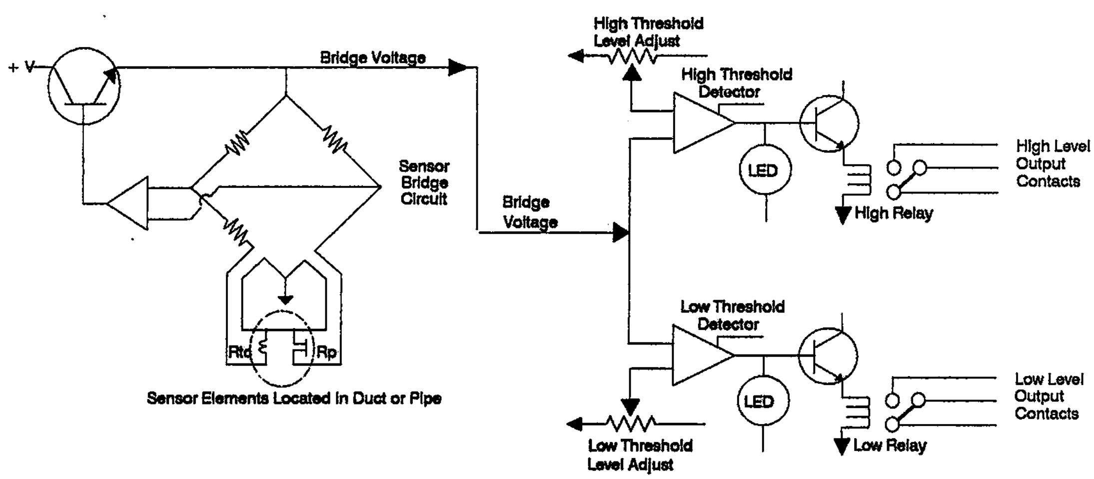
End of Section 4

Section 5: Testing

5.1 Theory of Operation

A simplified diagram of the electronics in the 950 Flow Switch is provided in Figure 5-1. As shown, the temperature and velocity elements of the 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 resister to generate a 0.8 to 2.5 Vdc signal.

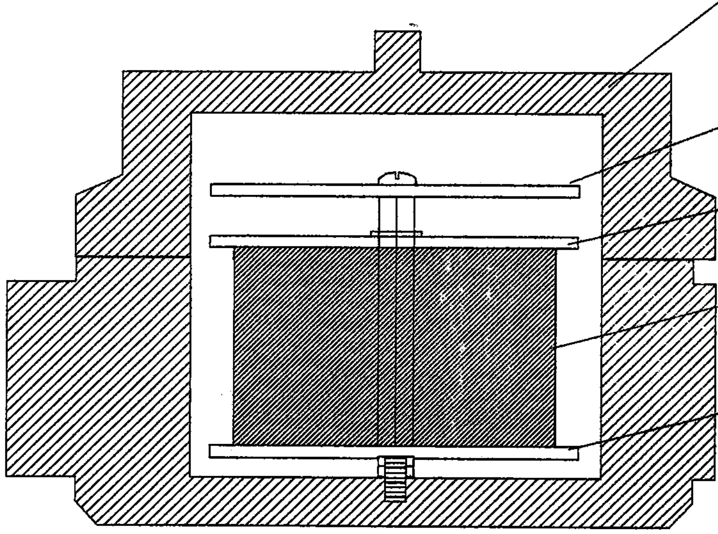
Figure 5-1. *Diagram of the Series 950 Flow Switch Electronics*



This signal is then input to the high and low comparators. These comparators are used as high and low threshold detectors, which are set by high and low threshold adjust potentiometers (R21 and R18 respectively). If the signal equals the threshold value, the corresponding relay is activated. The relays in the 951 flow switch close when activated, while the relays in the 952 open when the flow threshold value is met.

The electronics in the Series 950 Flow Switch consists of three small circuit boards that are assembled together in the aluminum junction box. This assembly is held in place by an 8-32 pan head screw which threads through a standoff then directly into the junction box. Figure 5-2 illustrates the position of the three circuit boards in this assembly.

Figure 5-2. *950 Flow Switch Electronic Assembly*



The bridge board, part number 420146-03, is on the bottom and contains the bridge circuit and associated circuitry.

The alarm board, part number 420146-01, is on the top and contains the high and low comparators, the threshold adjust circuitry, and the relays. The barrier strip on this board makes it easy to connect the flow switch to the +24 Vdc power supply and to the external devices activated by the relays.

The power supply board, part number 420146-02, interfaces the required signals between the bottom and top boards. The power board uses the +24 Vdc input to create a +15 Vdc power supply and a +5 Vdc reference voltage. These supplies are used by the circuits on the bridge and alarm boards.

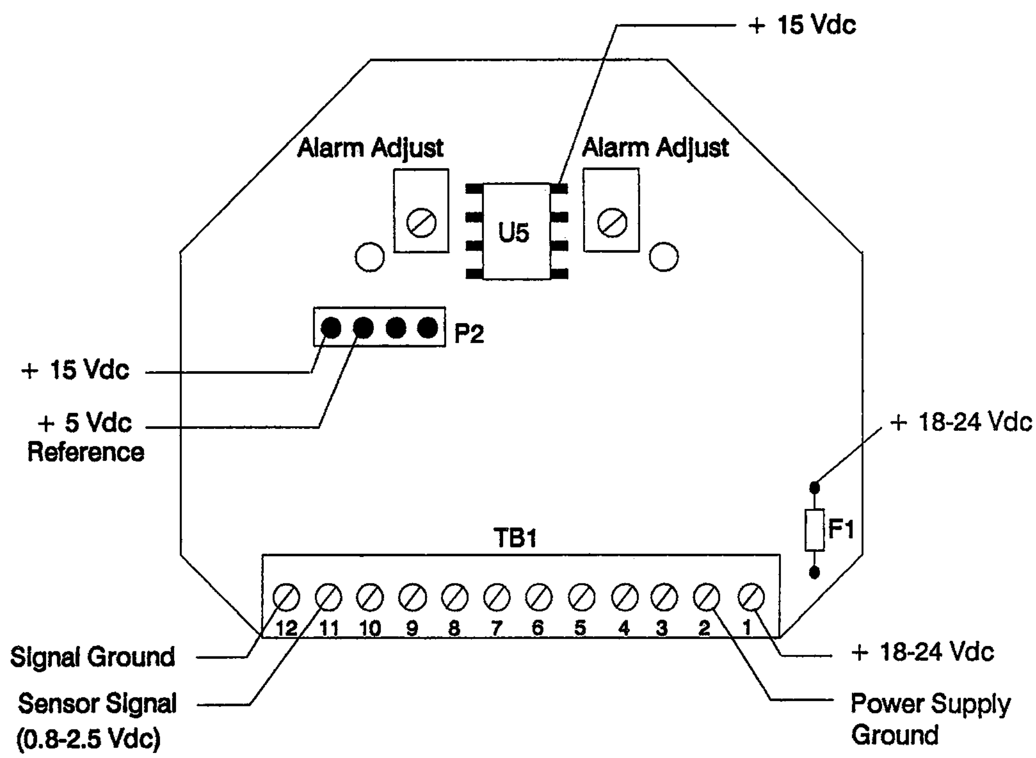
Caution: The junction box serves as a heatsink to the transister on the bridge board. If you remove the assembly from the junction box for testing, you should provide some type of heatsink to protect the transisitor.

5.2 Tesing Procedures

If your flow switch is not operating in the manner you expect, the following test points can be checked to help identify the faulty connection or module. These procedures should be done by a qualified technician, familiar with electronic test equipement and measurements.

All test points are accessible on the alarm board (the top board in the assembly) after the cover plate has been removed. You will need a Digital Multi-Meter (DMM) to make voltage and resistance measurements. Refer to Figure 5-3 for the locations of the test points.

Figure 5-3. *Location of Test Points for Series 950 Flow Switch*



5.2.1 Check the Input Voltage (+18 to + 24 Vdc)

The power supply should be connected to terminals 1 and 2 of the terminal block TB1. The +18-24 Vdc power source should be connected to terminal 1 and the power supply ground should be connected to terminal 2. With the power supply turned off, make sure these connections are secure.

With the power supply turned on, check the voltage between terminal 1 (+18-24 Vdc) and terminal 2 (power supply ground). If the input voltage is correct at the terminals, check for this voltage on the other side of the fuse F1. If the fuse is blown, replace it with a 1A, fastblow picofuse.

5.2.2 Check the Internal + 15 Vdc Supply

The power supply board uses the +24 Vdc supply to generate a +15 Vdc power supply. Measure the voltage between terminal 12 (signal ground) and pin 8 of U5 (or pin 1 of P2). The voltage measured should be +15 Vdc +-5%.

5.2.3 Check the Internal + 5 Vdc Reference Voltage

The power supply board also uses the +24 Vdc supply to generate a +5 Vdc reference voltage. Measure the voltage between terminal 12 (signal ground) and pin 1 of P2. The voltage measured should be +5 Vdc +-5%.

5.2.4 Check the Sensor Signal

The sensor signal will vary with the flow velocity. As the velocity increases, the amount of power required to maintain the standard overheat increases. To verify that the sensor and bridge circuit is operating this way, measure the voltage between terminal 12 (signal ground) and terminal 11 of TB1. This voltage should range from 0.8 to 2.5 Vdc for a flow of 0 to 18,000 FPM (feet per minute).

(If you have an optional configuration that uses the a voltage mode circuit instead of the standard current-sense voltage circuit, this voltage will range between 3 to 9 Vdc.)

If the readings are not in range, check the sensor connections. The four wires from the sensor are connected to a terminal block on the bridge board. The colors of the sensor wires may vary, depending on the kind of cable used - refer to Table 5-1.

With the power supply turned off, remove the screw that holds the electronic assembly to bottom of the junction box. Be careful not to break connections by pulling the assembly too far from the junction box.

Table 5-1. *Sensor Cable Wire Colors and Terminal Connections*

	Color			
Signal	Standard	Teflon Wire	Tefzel	Terminal
R_{tc}	White/Blue	White	White/Blue	1
R_p	White/Orange	Red	White/Orange	2
R_{tc} GND	White	White	White	3
R_p GND	White/Green	Red	White/Green	3
Shield	*shield*	N/A	*shield*	*

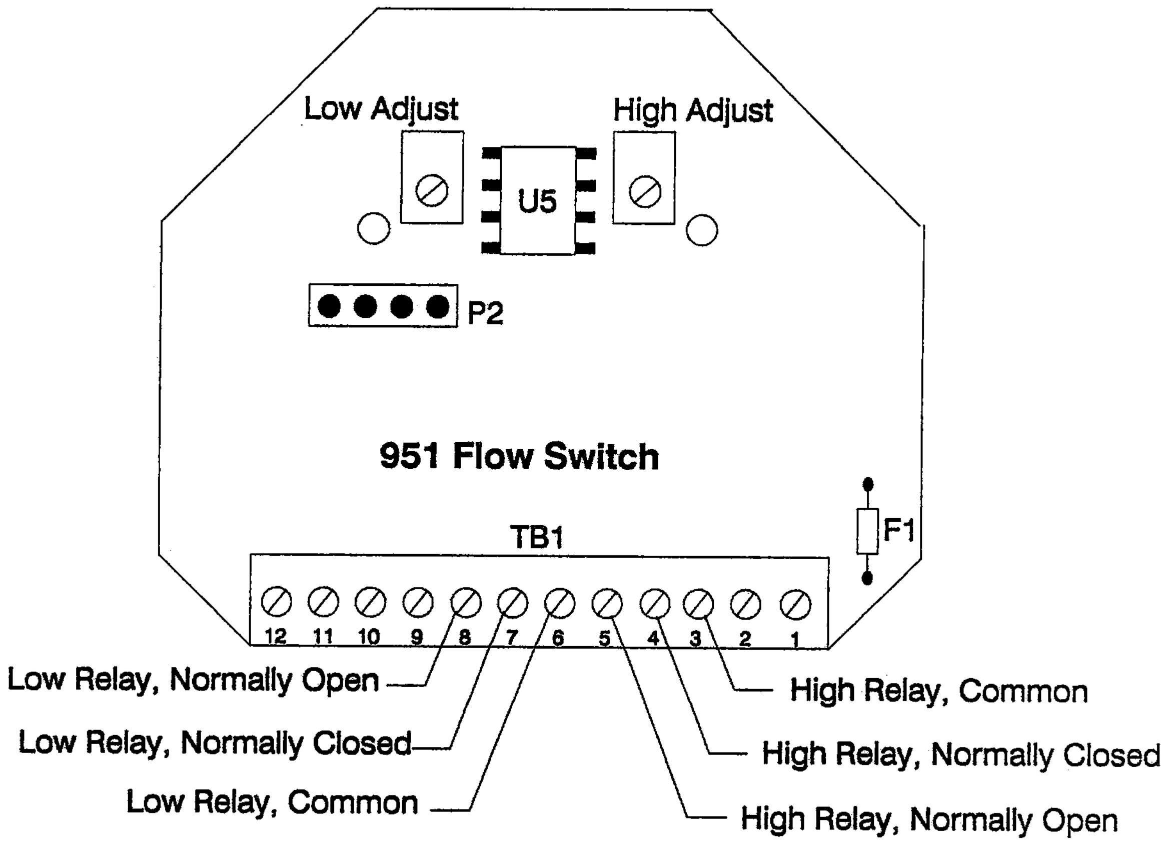
* Shield is used on remote current-transmitter electronics and is connected to earth ground at electronics. The circuit ground used on the current-transmitter board (i.e. R_{tc} GND, R_p GND, and GND) is not connected to any other ground.

5.2.5 Check the Relays

Using an ohmmeter, check that the high and low relays are switching. To do this you can either vary the flow in such a way as to activate the alarms, or you can adjust the alarm thresholds so that the flow rate is above and below the thresholds.

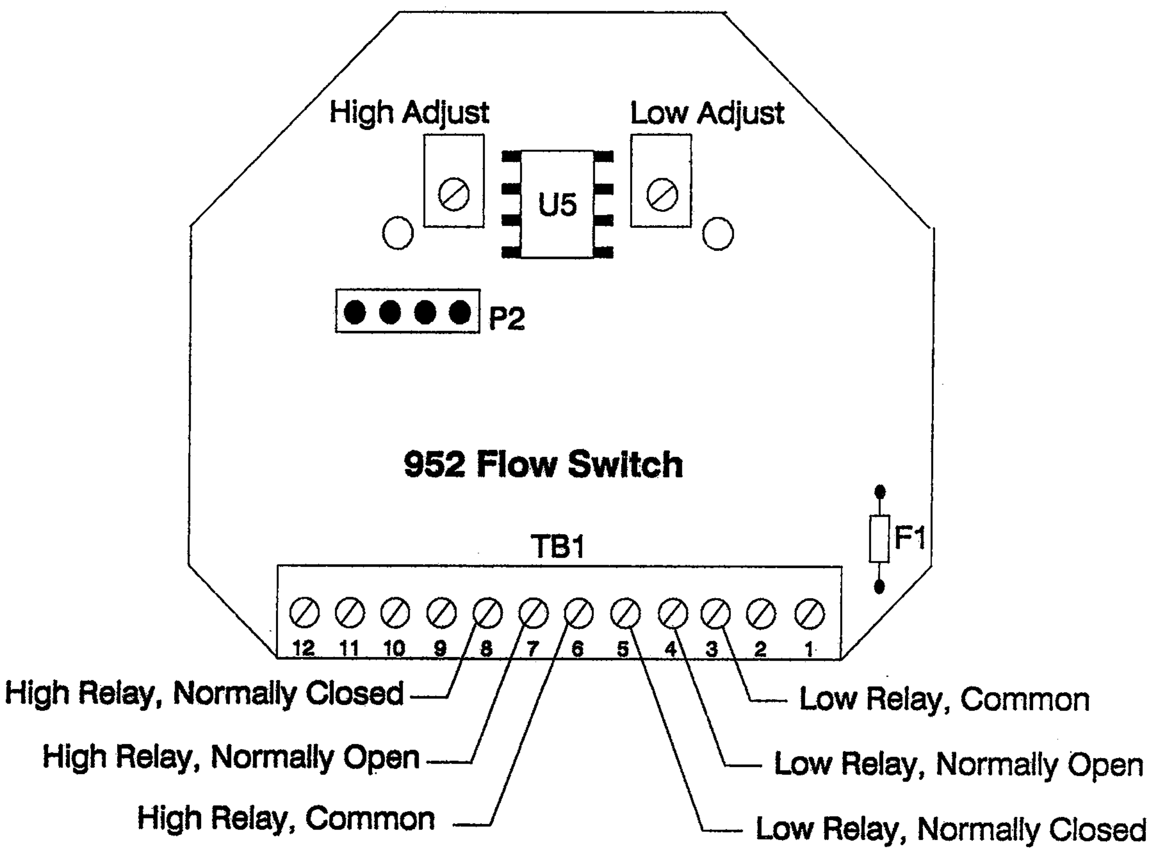
Testing the resistance between the common terminal and the normally open or normally closed terminals, the relay should look open or closed depending on the flow condition. The 951 relay connections are shown in Figure 5-4. The relay conditions that cause the 951 relays to open or close are shown in Table 2-3 on page 2-15.

Figure 5-4. *951 Relay Connections*



The 952 relay connections are shown in Figure 5-5. The relay conditions that cause the 952 relays to open or close are shown in Table 2-5 on page 2-19

Figure 5-5. *952 Relay Connections*



End of Section 5

Appendix A: Component Layout and Schematic Drawings

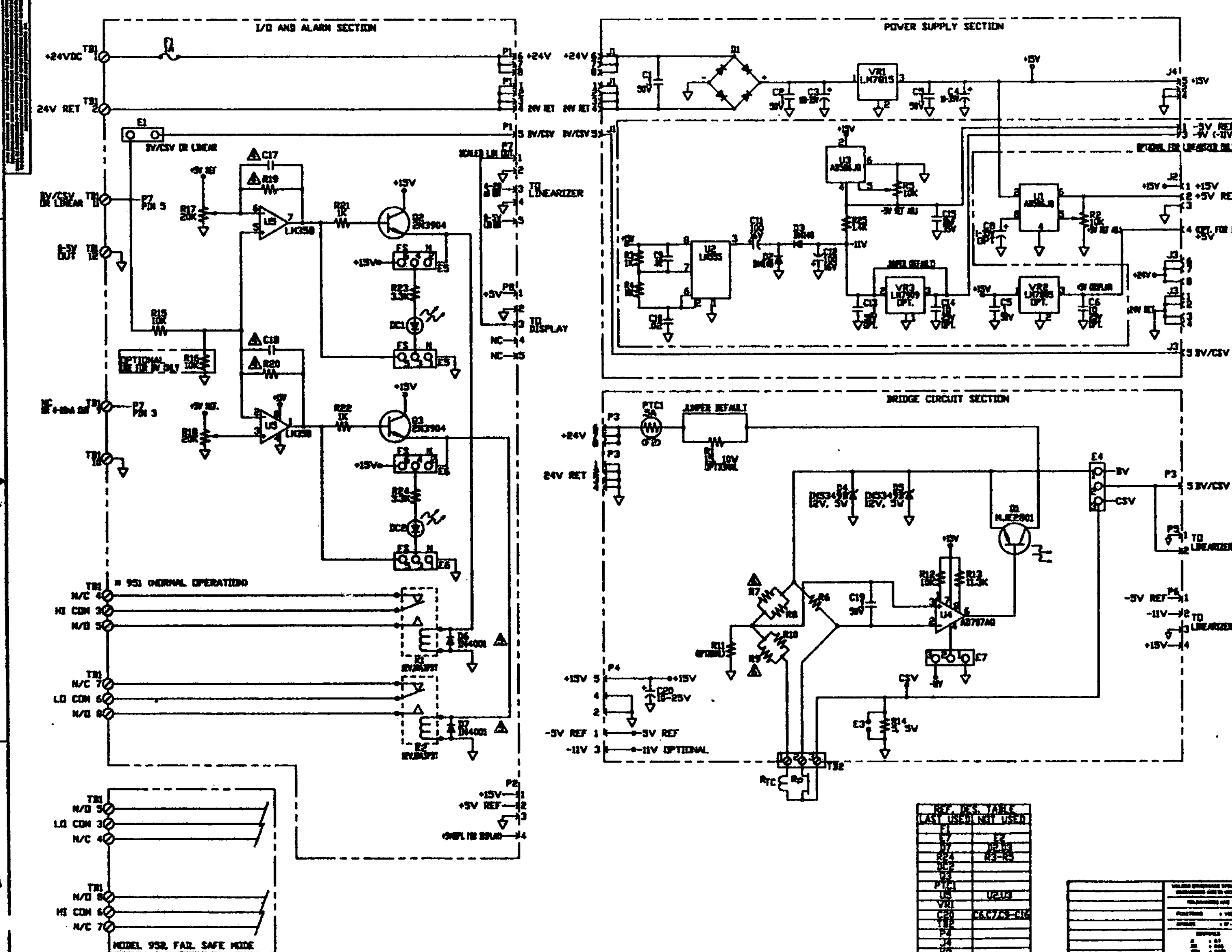
This appendix contains components layout and schematic drawings for the Model 950 and its components. These drawings are included as an aid to those users who want to perform their own testing and servicing.

NOTE: If you want to perform your own warranty service, you must first obtain written authorization from Kurz Instruments. **Unauthorized service performed during the warranty period voids your warranty.** Please read the warranty statement at the front of this guide before performing any service.

The following drawings are included in this appendix:

Drawing No.	Description
300067, Rev A	Series 950 Schematic Diagram
420146, Rev C	PCB Assembly, 950
340248, Rev 0	Wiring Diagram Series 950 Flow Switch
951-06, Rev A	Model 951-06 Flow Switch Assembly
951-08, Rev A	Model 951-08 Flow Switch Assembly
951-16, Rev A	Model 951-16 Flow Switch Assembly
952-06, Rev A	Model 952-06 Flow Switch Assembly
952-08, Rev A	Model 952-08 Flow Switch Assembly
952-16, Rev A	Model 952-16 Flow Switch Assembly

	DESCRIPTION				
A	RELEASE TO PRODUCTION PER ECO NO. 41257.	B. SAION 2-21-01		N/A	



E7		U4-PIN 4- GND (DEFAULT)
E7		U4-PIN 4- -11VDC
E6		NORMAL MODE
E6		FAIL SAFE MODE
E5		NORMAL MODE
E5		FAIL SAFE MODE
E4		FOR B.V. MODE
E4		FOR CSV MODE (DEFAULT)
E3	CLOSED	FOR B.V. MODE
E3	OPEN	FOR CSV MODE (DEFAULT)
E1	CLOSED	FOR BV/CSV SIG. (DEFAULT)
E1	OPEN	FOR HI/LO THRESHOLD CALIBRATION (OUTSIDE CALIBRATION PROCEDURE)
JUMPER ID	JUMPER POSITION	DESCRIPTION

JUMPER CONFIGURATION TABLE

NOTES: UNLESS OTHERWISE SPECIFIED

1. THIS DWG. TO BE USED IN CONJUNCTION WITH PCB ASSEMBLY DRAWING NO. 420146.
2. ALL RESISTORS ARE IN OHMS, 1/8W, 1%.
3. ALL CAPACITORS ARE IN MICROFARADS.
4. C17, C18, R19, R20 ARE OPTIONAL PARTS.
5. D6 AND D7 ARE NOT REQUIRED WHEN USING DIP STYLE RELAYS.
6. RESISTORS R6-10 ARE SELECTED VALUES.
7. NORMAL MODE:
   R17-HI THRESHOLD ADJUST POT.
   R18-LO THRESHOLD ADJUST POT.
   RELAYS DEENERGIZED IN NORMAL FLOW OPERATING RANGE.
8. FAIL SAFE MODE:
   R17-LO THRESHOLD ADJUST POT.
   R18-HI THRESHOLD ADJUST POT.
   RELAYS ENERGIZED IN NORMAL FLOW OPERATING RANGE.

REF. DES. TABLE	
LAST USED	NOT USED
F1	
E7	E2
D7	D2,D3
R24	R3-R5
DC2	
Q3	
PTC1	
U5	U2,U3
VR1	
C20	C6,C7,C9-C16
TB2	
P4	
J4	
K2	

N/A

B. SAION 1-12-01

1-12-01

N/A

5-07-01

N/A

KURZ INSTRUMENTS INC.

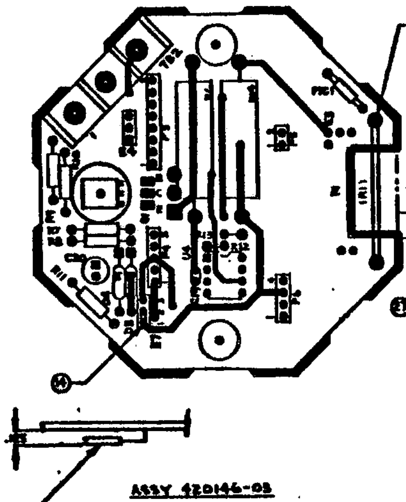
SERIES 950, SCHEMATIC DIAGRAM

D 300067 A

NONE

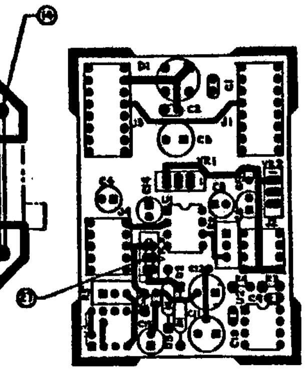
1 OF 1

LTR	DESCRIPTION				
C	RELEASE TO FABRICATION			N/A	
D	CHANGED PER ECO # 41257			N/A	

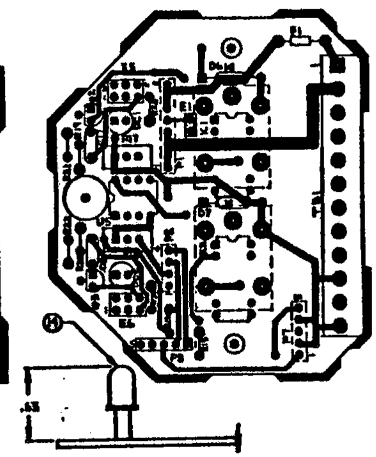


BACK SIDE OF TRANSISTOR

ASSY 420146-03



ASSY 420146-02



ASSY 420146-01

JUMPER NO	JUMPER POSITION	DESCRIPTION
E7		U4-PIN 4 GND (DEFAULT)
		U4-PIN 4 -11VDC
E6		NORMAL MODE
		FAIL SAFE MODE
E5		NORMAL MODE
		FAIL SAFE MODE
E4		FOR B.V. MODE
		FOR CSV MODE (DEFAULT)
E3	CLOSED	FOR B.V. MODE
	OPEN	FOR CSV MODE (DEFAULT)
E1	CLOSED	FOR BV/CSV SIG. (DEFAULT)
	OPEN	FOR H/LO THRESHOLD CALIBRATION (REFERENCE CALIBRATION PROCEDURE)

JUMPER CONFIGURATION TABLE

ITEM NO	QTY	REF.DES.	PART NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

420146-03 PARTS LIST

ITEM NO	QTY	REF.DES.	PART NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

420146-02 PARTS LIST

ITEM NO	QTY	REF.DES.	PART NO	DESCRIPTION
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

420146-01 PARTS LIST

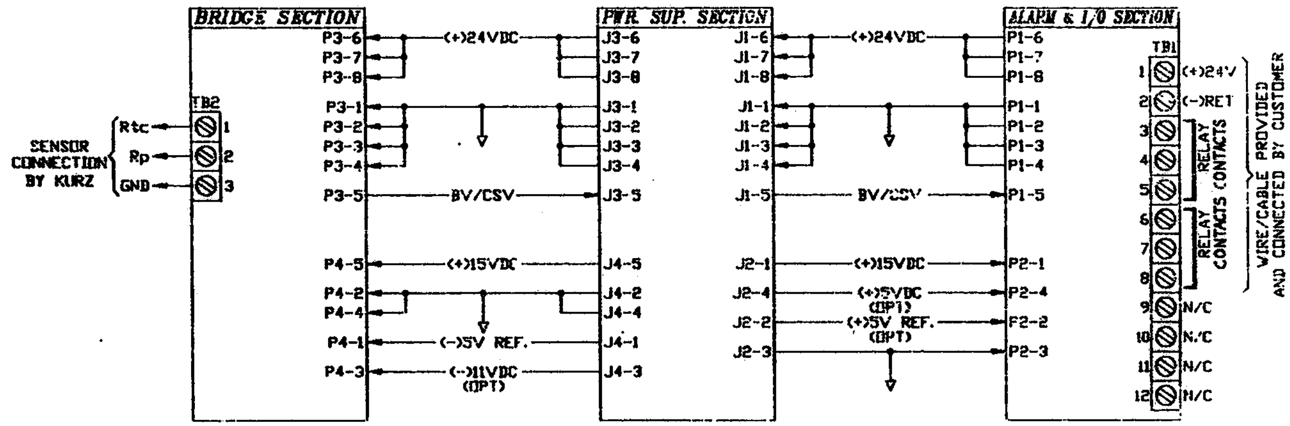
NOTES UNLESS OTHERWISE SPECIFIED
1. FINAL ASSY. AS REQUIRED BY KURZ.
2. R1 REQ'D W. PTC1 IS NOT USED.
3. U2, U3 REQ'D FOR (-10V SUPPLY AND -5V REF. ONLY.
4. VR2, C13, C14 REQ'D FOR -9V SUPPLY ONLY.
5. R16 REQ'D FOR BV MODE ONLY.
6. NORMAL MODE:
   R17-HI THRESHOLD ADJUST POT.
   R18-LO THRESHOLD ADJUST POT.
   RELAYS DEENERGIZED IN NORMAL FLOW OPERATING RANGE.
7. FAIL SAFE MODE:
   R17-LO THRESHOLD ADJUST POT.
   R18-HI THRESHOLD ADJUST POT.
   RELAYS ENERGIZED IN NORMAL FLOW OPERATING RANGE.

KURZ INSTRUMENTS INC.

P.C.B. ASSEMBLY, 450.

SIZE D — DWG NO 420146 — REV D

SCALE 2:1 — SHEET 1 OF 1



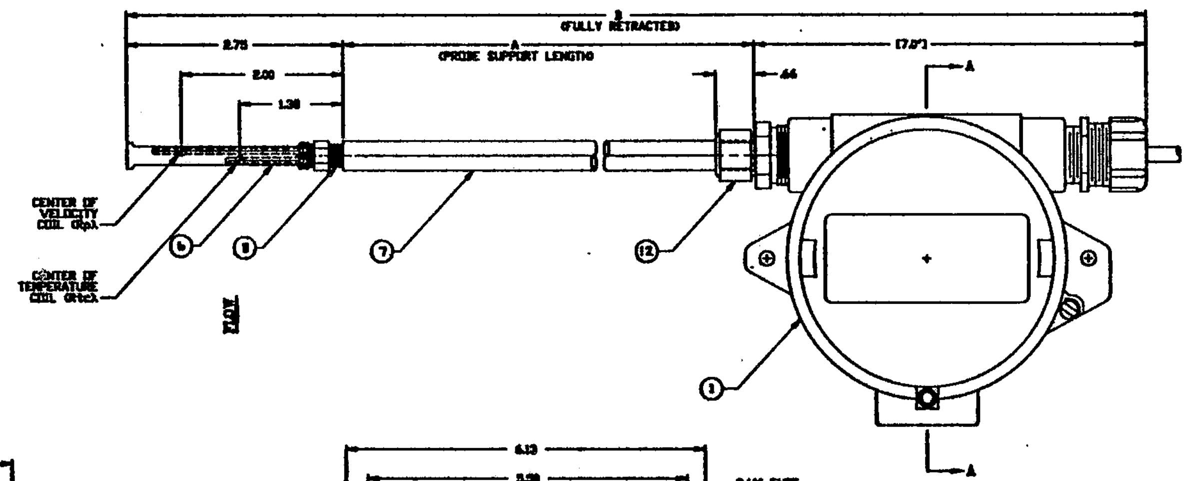
NOTES: UNLESS OTHERWISE SPECIFIED
1. REF. DES. ARE FOR REF. ONLY AND MAY NOT APPEAR ON COMPONENTS.

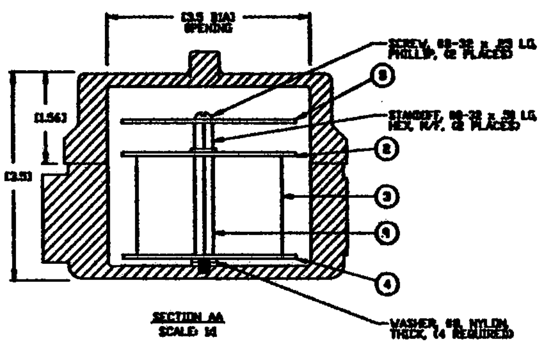
KURZ INSTRUMENTS INC.

TITLE: WIRING DIAGRAM SERIES 960, FLOWSWITCH

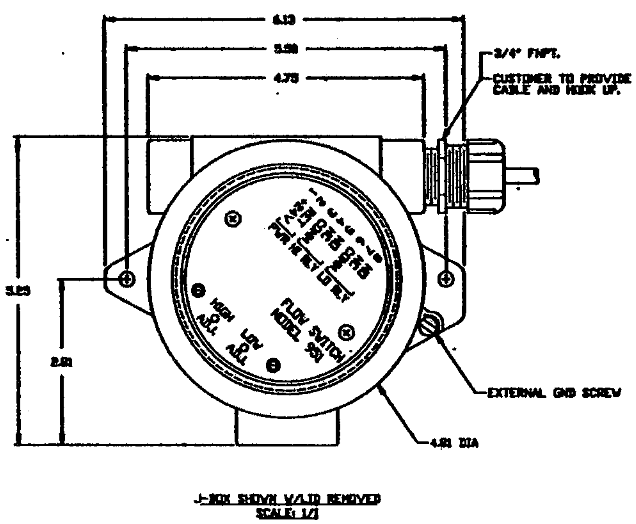
DWG SIZE: C
DWG NO: 340248
REV: 0
SCALE: NONE
SHEET 1 OF 1

A	REVISED PER ECO NO. 47257		N/A





SECTION AA
SCALE: 1:1



J-BOX SHOWN W/LID REMOVED
SCALE: 1/1

DIMENSION TABLE	
A	B
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

ITEM	QTY.	STOCK NO.	DESCRIPTION
12	1	010390	FITTING, COMP., .38 OD x .75 MNPT, BRS
11	1	580047	KOOLEX PAD.
10	2	580044	WASHER, CUSHION
9	2	190267	STANDOFF, #8-32, 1.94 LG.,M/F, HEX.
8	1	130203	PRB, SENSOR, MINI DUAL, TEFLON, 1FT
7	1	150213	PROBE SUPPORT, .38 DIA.
6	1	150200	PROBE, WINDOW, -06
5	1	140175	FACEPLATE, COVER, 951
4	1	420146-03	PCB, ASSY, SERIES 950, BRIDGE
3	1	420146-02	PCB, ASSY, SERIES 950, PWR SUP.
2	1	420146-01	PCB, ASSY, SERIES 950, ALARM
1	1	900583	ENC, J-BOX, KILLARK, SUB-ASSY.

PARTS LIST

NOTES: UNLESS OTHERWISE SPECIFIED
1. CENTER OF VELOCITY COIL (Rp) SHOULD BE @ A POINT OF AVERAGE FLOW (NORMALLY @ CENTER OF THE PIPE/DUCT).
⚠ NOT SHOWN FOR CLARITY.

N/A

B. SAXON

N/A

N/A

KURZ INSTRUMENTS INC.

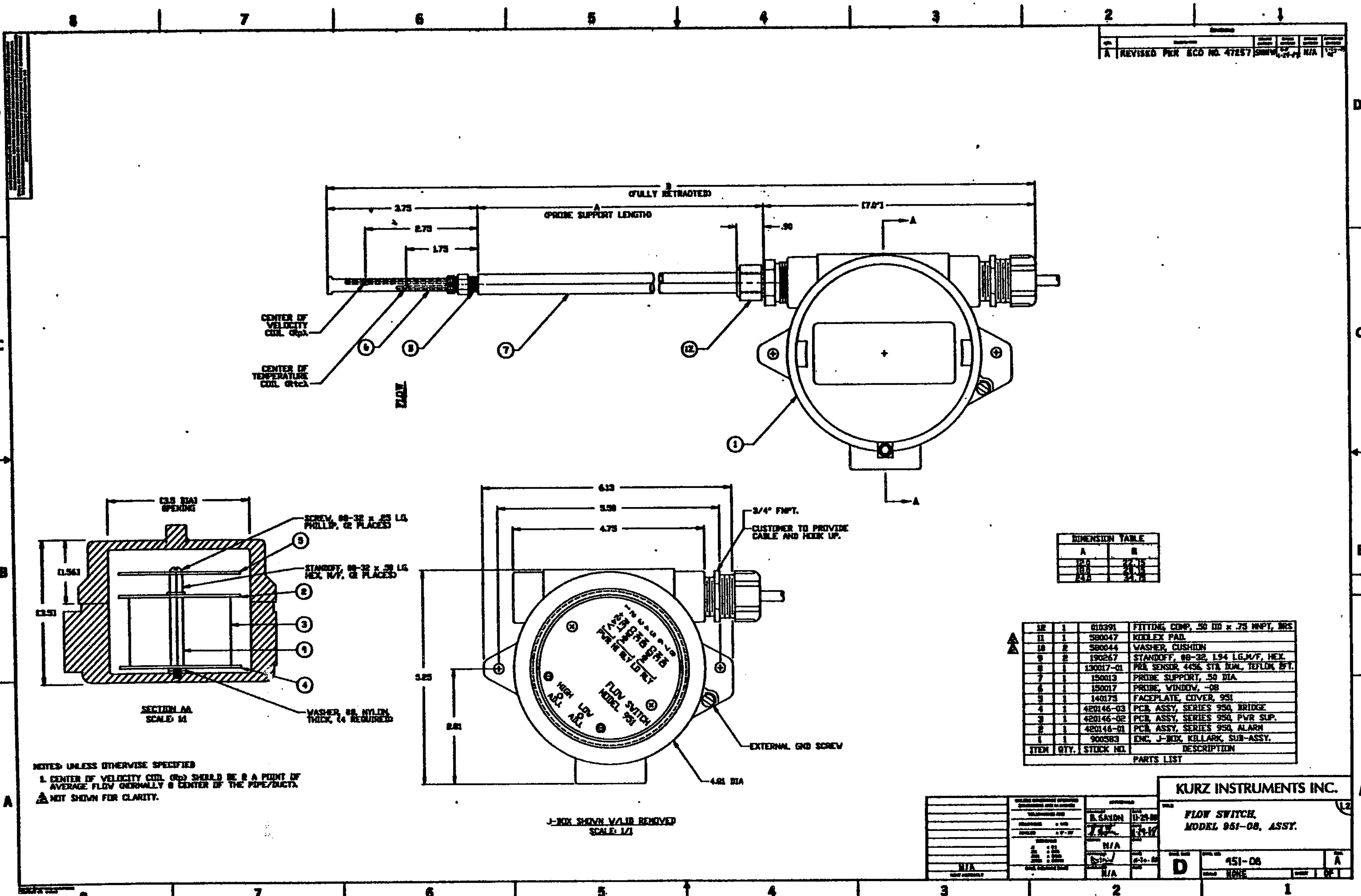
FLOW SWITCH,
MODEL 951-06, ASSY.

D

951-06

A

NONE



DIMENSION TABLE	
A	B
12.0	22.75
18.0	28.75
24.0	34.75

ITEM	QTY.	STOCK NO.	DESCRIPTION
12	1	010391	FITTING, COMP, .50 OD x .75 MNPT, BRS
11	1	580047	KOOLEX PAD.
10	2	580044	WASHER, CUSHION
9	2	190267	STANDOFF, #8-32, 1.94 LG.,M/F, HEX.
8	1	130017-01	PRB. SENSOR, 4456, STB, DUAL, TEFLON, 8FT.
7	1	150013	PROBE SUPPORT, .50 DIA.
6	1	150017	PROBE, WINDOW, -08
5	1	140175	FACEPLATE, COVER, 951
4	1	420146-03	PCB, ASSY, SERIES 950, BRIDGE
3	1	420146-02	PCB, ASSY, SERIES 950, PWR SUP.
2	1	420146-01	PCB, ASSY, SERIES 950, ALARM
1	1	900583	ENC, J-BOX, KILLARK, SUB-ASSY.

PARTS LIST

NOTES: UNLESS OTHERWISE SPECIFIED

1. CENTER OF VELOCITY COIL (Rp) SHOULD BE @ A POINT OF AVERAGE FLOW (NORMALLY @ CENTER OF THE PIPE/DUCT).

⚠ NOT SHOWN FOR CLARITY.

KURZ INSTRUMENTS INC.

FLOW SWITCH, MODEL 951-08, ASSY.

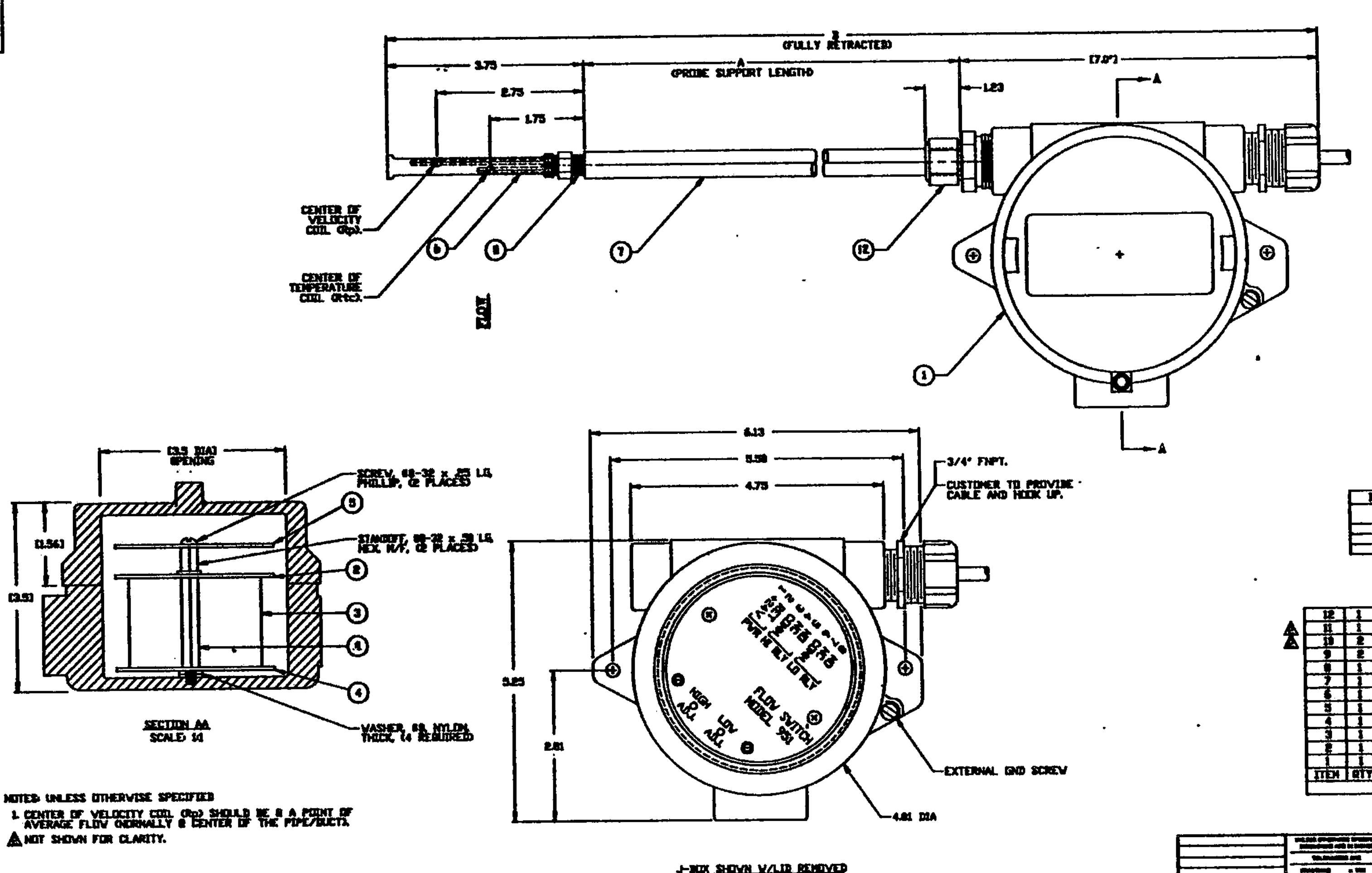
B. SANJON 11-29-88

N/A

D 451-08 A

SCALE NONE

A	REVISED PER ECO NO. 4785 T			N/A	



DIMENSION TABLE	
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[illegible]	[illegible]
[illegible]	[illegible]

ITEM	QTY.	STOCK NO.	DESCRIPTION
12	1	010392	FITTING, COMP, 1.0 OD x .75 MNPT, BRS
11	1	580047	KOOLEX PAD.
10	2	580044	WASHER, CUSHION
9	2	190267	STANDOFF, #8-32, 1.94 LG.,M/F, HEX.
8	1	130017-02	PRB, SENSOR, 445G, STD, DUAL, TEFLON, 8 FT.
7	1	150144-01	PROBE SUPPORT, 1.0 DIA.
6	1	150018	PROBE, WINDOW, -16
5	1	140175	FACEPLATE, COVER, 951
4	1	420146-03	PCB, ASSY, SERIES 950, BRIDGE
3	1	420146-02	PCB, ASSY, SERIES 950, PWR SUP.
2	1	420146-01	PCB, ASSY, SERIES 950, ALARM
1	1	900583	ENC, J-BOX, KILLARK, SUB-ASSY.

PARTS LIST

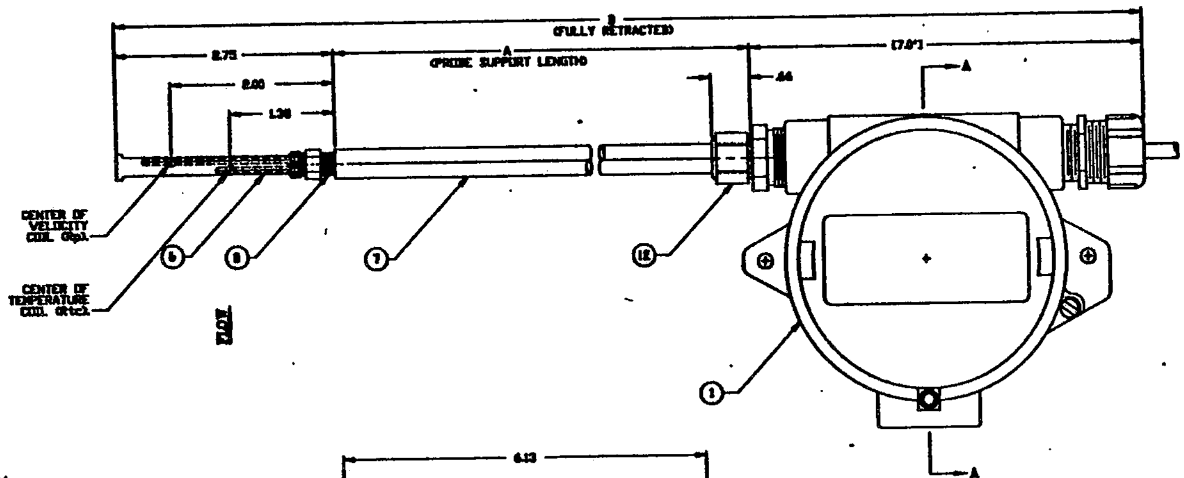
NOTES: UNLESS OTHERWISE SPECIFIED
1. CENTER OF VELOCITY COIL (Rp) SHOULD BE @ A POINT OF AVERAGE FLOW (NORMALLY @ CENTER OF THE PIPE/DUCT).
⚠ NOT SHOWN FOR CLARITY.

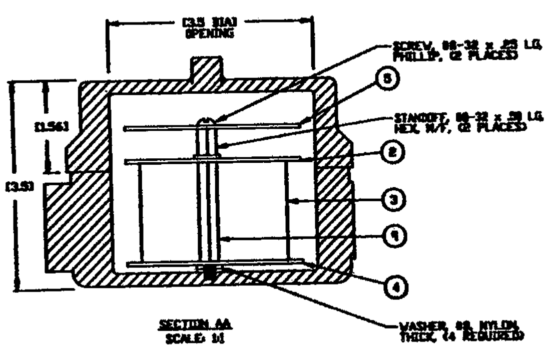
KURZ INSTRUMENTS INC.

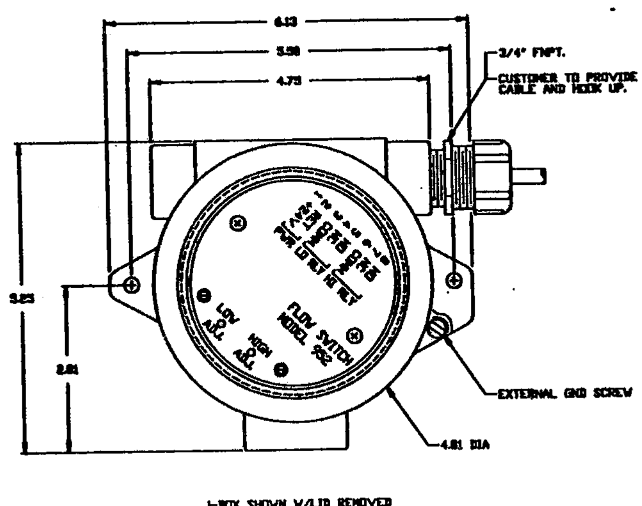
FLOW SWITCH, MODEL 951-16, ASSY.

B. SAXON
N/A
D
951-16
NONE
A

	A	REVISED PER ECO NO. 41251		N/A







J-BOX SHOWN W/LID REMOVED
SCALE: 1/1

DIMENSION TABLE	
A	B
3.0	12.75
6.0	15.75
9.0	18.75

ITEM	QTY.	STOCK NO.	DESCRIPTION
12	1	010390	FITTING, COMP., .38 OD x .75 MNPT, BRS
11	1	380047	KOOLEX PAD.
10	2	380044	WASHER, CUSHION
9	2	190267	STANDOFF, #8-32, 1.94 LG.,M/F, HEX.
8	1	130203	PRB, SENSOR, MINI DUAL, TEFLON, 1FT
7	1	150213	PROBE SUPPORT, .38 DIA.
6	1	150200	PROBE, WINDOW, -06
5	1	140182	FACEPLATE, COVER, 952
4	1	420146-03	PCB, ASSY, SERIES 950, BRIDGE
3	1	420146-02	PCB, ASSY, SERIES 950, PWR SUP.
2	1	420146-01	PCB, ASSY, SERIES 950, ALARM
1	1	900583	ENC, J-BOX, KILLARK, SUB-ASSY.

PARTS LIST

NOTES: UNLESS OTHERWISE SPECIFIED
1. CENTER OF VELOCITY COIL (Rp) SHOULD BE @ A POINT OF AVERAGE FLOW (NORMALLY @ CENTER OF THE PIPE/DUCT).
2. NOT SHOWN FOR CLARITY.

N/A

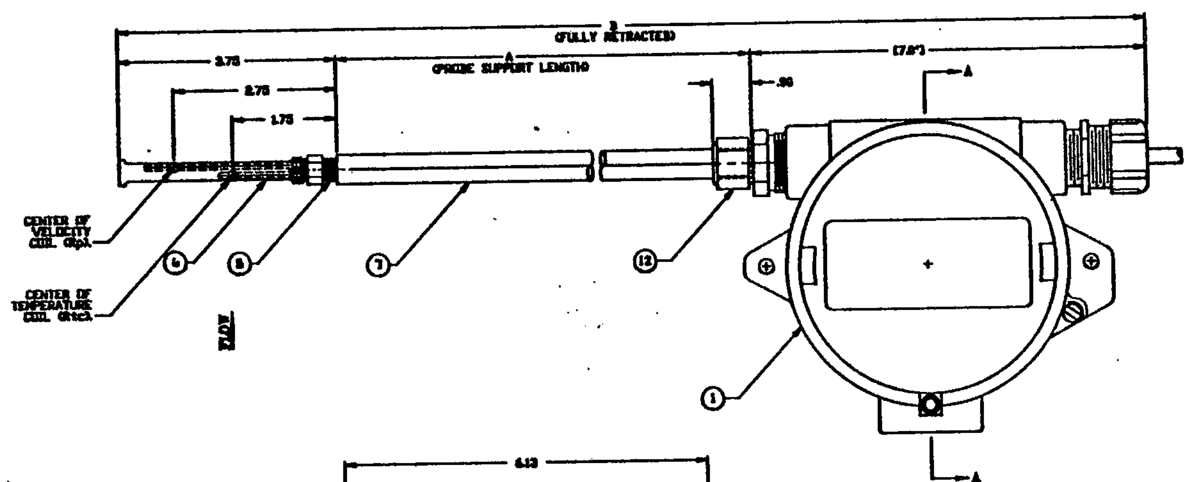
B.SAYON 2-25-91
N/A
N/A

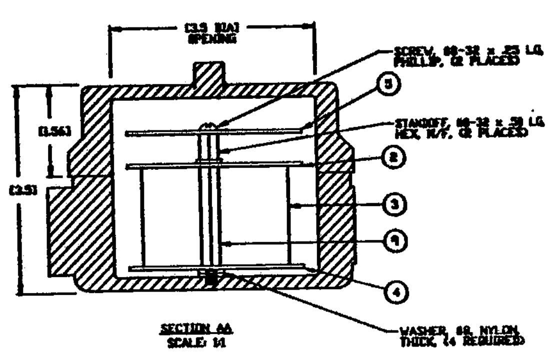
KURZ INSTRUMENTS INC.

FLOW SWITCH,
MODEL 952-06, ASSY.

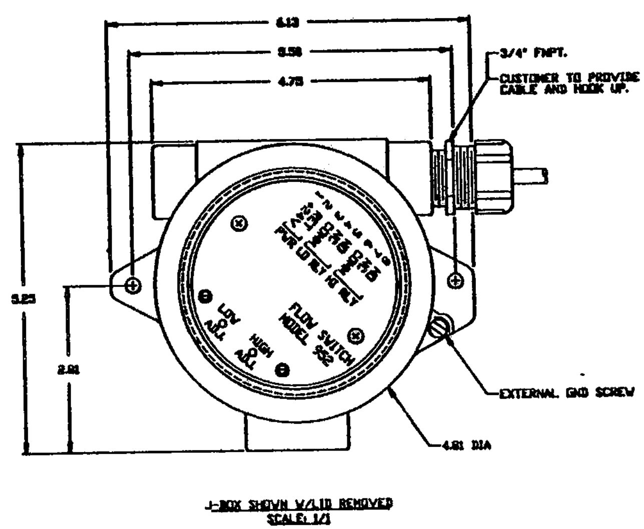
D | 952-06 | A
NONE | SHEET 1 OF 1

REV	DESCRIPTION				
A	REVISED PER ECO NO. 41257			N/A	





SECTION AA
SCALE: 1:1



J-BOX SHOWN W/LID REMOVED
SCALE: 1/1

DIMENSION TABLE	
A	B
12.0	22.75
18.0	28.75
24.0	34.75

ITEM	QTY.	STOCK NO.	DESCRIPTION
12	1	010391	FITTING, COMP, .50 OD x .75 MNPT, BRS
11	1	580047	KOOLEX PAD.
10	2	580044	WASHER, CUSHION
9	2	190267	STANDOFF, #8-32, 1.94 LG.,M/F, HEX.
8	1	130017-01	PRB, SENSOR, 445G, STD, DUAL, TEFLON, 2FT.
7	1	150013	PROBE SUPPORT, .50 DIA.
6	1	150017	PROBE, WINDOW, -08
5	1	140182	FACEPLATE, COVER, 952
4	1	420146-03	PCB, ASSY, SERIES 950, BRIDGE
3	1	420146-02	PCB, ASSY, SERIES 950, PWR SUP.
2	1	420146-01	PCB, ASSY, SERIES 950, ALARM
1	1	900583	ENC, J-BOX, KILLARK, SUB-ASSY.

PARTS LIST

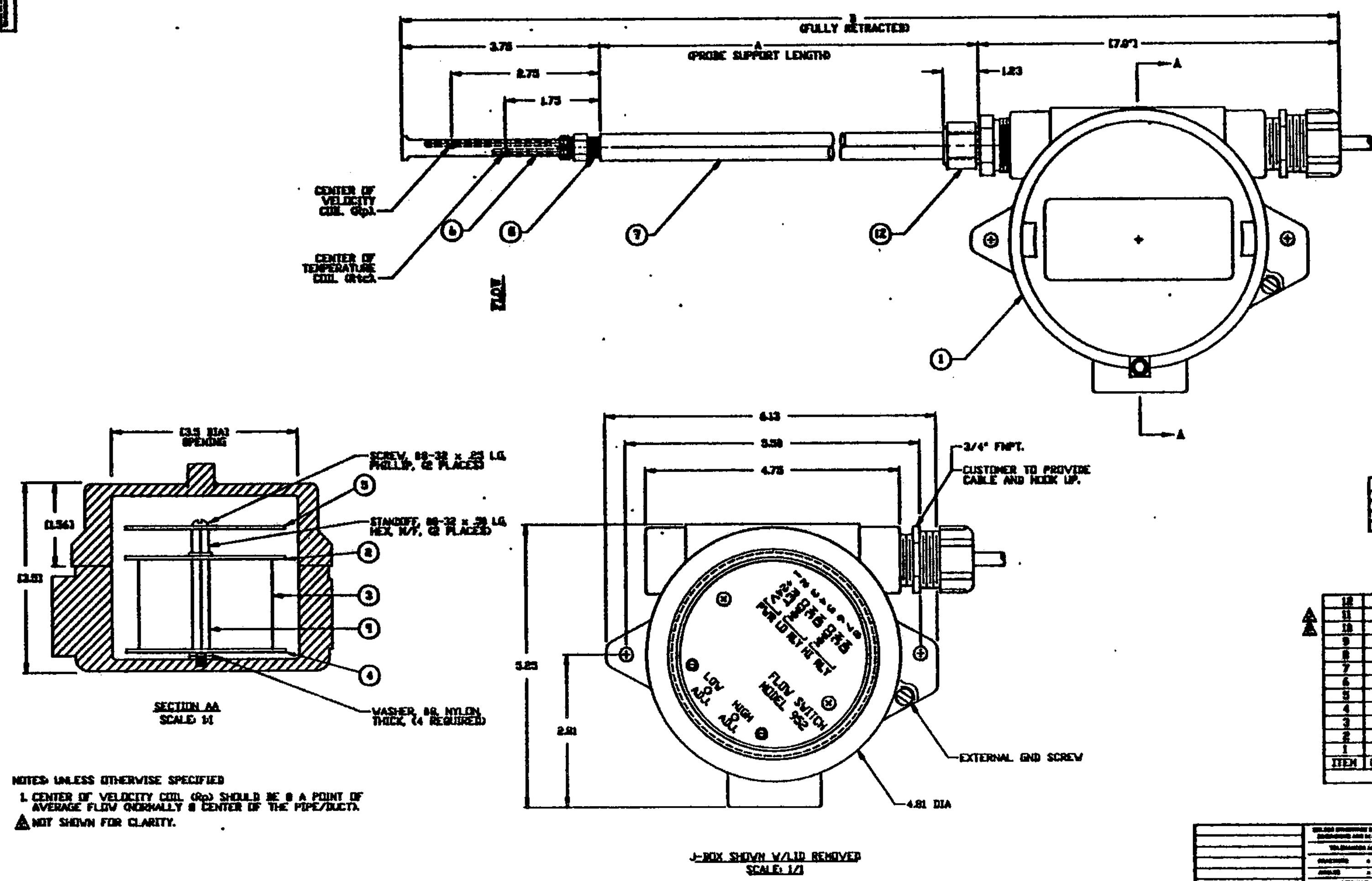
NOTES: UNLESS OTHERWISE SPECIFIED
1. CENTER OF VELOCITY COIL (Rp) SHOULD BE @ A POINT OF AVERAGE FLOW (NORMALLY @ CENTER OF THE PIPE/DUCT).
2. NOT SHOWN FOR CLARITY.

KURZ INSTRUMENTS INC.

FLOW SWITCH,
MODEL 952-08, ASSY.

B. SAXON 2-25-91
N/A
D | 952-08 | A
SCALE NONE | SHEET 1 OF 1
N/A

A	REVISED PER E.C.O NO. 47257			N/A	



DIMENSION TABLE	
A	B
36.0	46.75
48.0	58.75
60.0	70.75

ITEM	QTY.	STOCK NO.	DESCRIPTION
12	1	010392	FITTING, COMP, 1.0 OD x .75 MNPT, BRS
11	1	580047	KOOLEX PAD
10	2	580044	WASHER, CUSHION
9	2	190267	STANDOFF, #8-32, 1.94 LG.,M/F, HEX.
8	1	130017-02	PRB, SENSOR, 4456, STD, DUAL, TEFLON, 8 FT.
7	1	150144-01	PROBE SUPPORT, 1.0 DIA.
6	1	150018	PROBE, WINDOW, -16
5	1	140182	FACEPLATE, COVER, 952
4	1	420146-03	PCB, ASSY, SERIES 950, BRIDGE
3	1	420146-02	PCB, ASSY, SERIES 950, PWR SUP.
2	1	420146-01	PCB, ASSY, SERIES 950, ALARM
1	1	900583	ENC, J-BOX, KILLARK, SUB-ASSY.

PARTS LIST

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⚠ NOT SHOWN FOR CLARITY.

KURZ INSTRUMENTS INC.

FLOW SWITCH, MODEL 952-16, ASSY.

B. SAXON 2-25-91

N/A

D 952-16 A

SCALE NONE SHEET 1 OF 1