KURZ™ INSTRUMENTS, INC.

Series 950
Mass Flow Switches
User's Guide

Customer Name: ____________________

P.O. Number: ____________________

Date of Order: ____________________

Kurz™ Model Number: ____________________

Kurz™ Order Number: ____________________

Serial Number: ____________________

Document Number: 360103, Rev. C

2411 GARDEN ROAD • MONTEREY, CA 93940 • TLX 172275 • (800) 424-7356 NATIONWIDE • (408) 646-5911 • FAX (408) 646-8901

Kurz™ Instruments, Inc.
2411 Garden Road
Monterey, CA 93940

(800) 424-7356 Tel.
408-646-8901 Fax.

President: Dr. Jerry Kurz
Engineering Manager: Mr. Brad Lesko
Literature and Design Engineer: Mr. Thomas Kobayashi, Jr.

Document Title: Series 950 Mass Flow Switches User's Guide

Document Number: 360103, Revision C
Publication Date: June 1991

Every effort has been made to supply complete and accurate information. However, Kurz™ Instruments, Inc. assumes no responsibility for its use, nor for any infringements of patents or other third parties which would result. In addition, makes no representations or warranties of any kind concerning the contents of this publication. Under no circumstances will Kurz™ Instruments, Inc. be liable for any loss or other damages pertaining to the use of this publication.

Publication is generic in nature. No guarantee is made that the publication conforms to the particular equipment produced for a particular application. As-built publication entails an additional charge. Factory and on-site training in the use and operation of Kurz™ products may be made available at the buyer's expense, subject to agreement by Kurz™ Instrument, Inc.

The information contained in this publication is subject to change without notice. Kurz™ Instruments, Inc. reserves the right to make engineering changes and product improvements at any time and without prior notice. Consult your local Kurz™ representative or a factory application engineer for information regarding current specifications.

Equipment sold by Kurz™ Instruments, Inc. is not intended for use in connection with any nuclear facility or activity unless covered by a specific quotation where the conditions of such usage will be detailed. If the equipment is used in a nuclear facility or activity without supporting quotation, Kurz™ disclaims all liability for any damage, injury, or contamination, and the buyer shall indemnify and hold Kurz™, its officers, agents, employees, successors, assigns, and customers, whether direct or indirect, harmless from and against any and all losses, damages, or expenses of whatever form or nature (including attorney's fees and other costs of defending any action) which they, or any of them, may sustain or incur, whether as a result of breach of contract, warranty, tort (including negligence), strict liability or other theories of law, by reason of such use.

Table of Contents

Section 1: Introduction

This section comprises of a profile for the Series 950 Mass Flow Switches; to include, the system overview on the principle of operation. Also, reviewed in the latter portion of this section, a synopsis on NIST-traceable calibration and unit specifications.

1.1 General Description

The Series 950 Mass Flow Switches consist of the folllowing:

- Kurz™ thermal mass flow sensor
- Probe support
- Sensor electronics enclosure
- Flow switch

1.1.1 Kurz™ Thermal Mass Flow Sensor

The Kurz™ thermal mass sensor is fabricated by using two resistance temperature-sensitive detectors (RTDs) of reference-grade 385 platinum-type windings around a high purity ceramic core, shielded in an all-welded metal sheath (316 stainless steel being standard; other materials and coatings are optional). The temperature compensation winding (R_{tc}, for resistor, temperature compensation) and velocity winding (R_p, for resistor, probe) are mounted in seperate mandrels (or "stings"); thus, providing thermal isolation from the probe mounting structure and a fast response time to process temperature changes. (**Note:** Known as the Kurz™ "dual-sting" MetalClad™ sensor.)

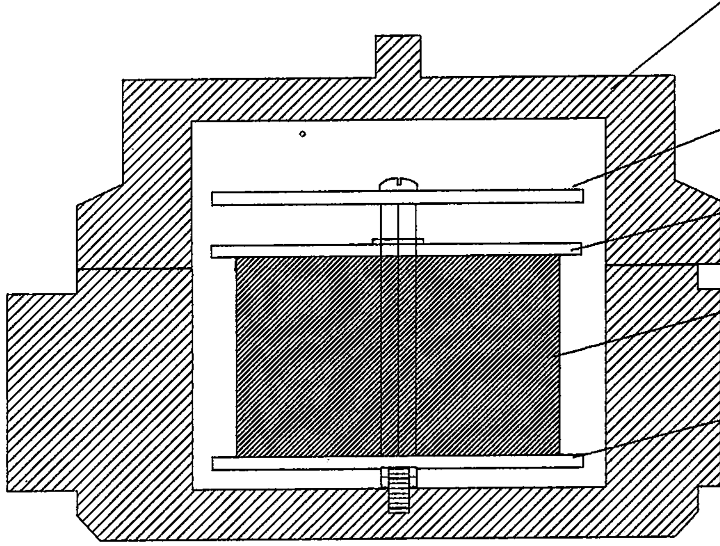
Refer to Figure 1.1-1 for a close-up view of a Kurz™ "dual-sting" MetalClad™ sensor within its protective window.

1.1.4 Flow Switch

The electronics assembly of the flow switch consists of three circuit boards that are assembled together and mounted in the sensor electronics enclosure.

Figure 1.1-2 illustrates the placement of the electronics assembly of the flow switch in the sensor electronics enclosure.

Figure 1.1-2
Electronics Assembly of the Flow Switch



A. The bridge board contains a modified Wheatstone bridge. The bridge maintains a constant overheat on the R_P winding of the sensor with respect to the measured gas flow at ambient temperature. As the gas flows over the sensor at different rates, the amount it cools the sensor is proportional to the amount of electrical energy required to maintain the constant overheat.

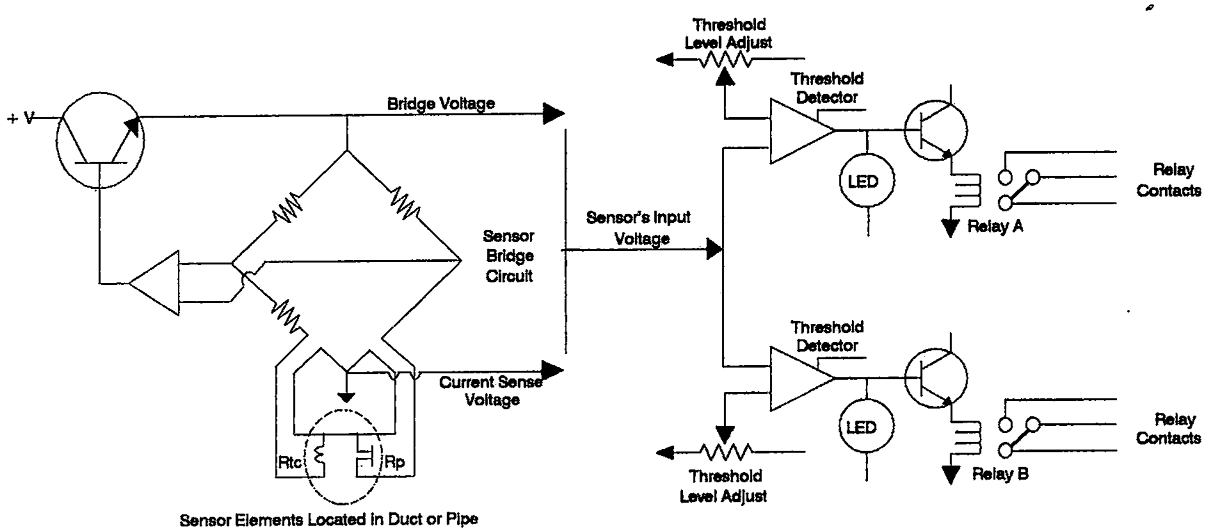
Note: The resistance in the length of the sensor's four-wire cable is an integral part of the calibration process we call *temp comp* for determining the balance point of the modified Wheatstone bridge. Therefore, in no event should the sensor's four-wire cable be altered in length.

1.2 Principle of Operation — An Overview

The Kurz™ thermal mass flow sensor and associated electronics assembly produces as its output a voltage that is proportional to the gas flow. This signal is inert to ambient temperature and pressure.

A simplified diagram of the electrical assembly of the Series 950 Mass Flow Switch is provided in Figure 1.2-1.

Figure 1.2-1
Simplified Diagram of the Electrical Assembly



As shown, the R_{tc} and R_p windings of the sensor form two legs of a balanced Wheatstone bridge. As flow increases, the bridge draws more current to stay balanced. This current is drawn across a resistor in the bridge section to generate a bridge voltage signal of 3.500 Vdc to 9.000 Vdc, typically. This amount of D.C. voltage means there is plenty of sensitivity in the Kurz™ thermal mass flow sensor to detect velocity differences of only a few feet-per-minute.

1.4 Specifications

All specifications are subject to change without notice due to the continuous improvements in design and manufacturer by Kurz™ Instruments, Inc.

VELOCITY RANGE

Minimum:	100 SFPM or 0.5 SMPS (Standard)
Maximum:	12,000 SFPM or 60 SMPS (Standard)

TEMPERATURE RANGE

Ambient Temp. (AT):	-40° F to 257° F (-40 C to 125° C)
High Temp. (HT):	32° F to 482° F (0° C to 250° C)

INPUT POWER	18.000 Vdc to 24.000 Vdc ± 10.0% @ 600 mA, regulated
RELAY RATINGS	10 Amperes
TIME CONSTANT	1 second at midrange
REPEATABILITY	± 0.25% full scale
ACCURACY	± 2.0% of reading (± 0.5% full scale)
WETTED MATERIALS	316 stainless steel (Standard)

End of Section 1

Section 2: Installation

Even though, portions of the installation procedures described in this section may not apply to your mounting configuration, as a prerequisite, we recommend you to thoroughly review this section. If further assistance is needed with your installation, please contact your local Kurz™ representative, or contact Kurz™ Instruments, Inc. at (800) 424-7356.

2.1 Receipt of Equipment

When the equipment is received, carefully check the outside packing carton for damage incurred in shipment. If the packing carton is damaged, the local carrier should be notified at once regarding their liability. A report should be submitted to Customer Service, Kurz™ Instruments, Inc., 2411 Garden Road, Monterey, CA 93940. Remove the packing slip from its envelope and check that the carton contains all parts listed. Make sure spare parts or accessories are not discarded with the packing material. In case of shortages, contact Customer Service at our toll-free number listed above.

2.2 Return Shipment

Do not return any equipment without a Return Material Authorization, obtainable from the Customer Service Department. Information describing the problem, corrective action or work to be accomplished at the Kurz™ factory, purchase order number the equipment was purchased under and name of person to contact must be included with the returned equipment.

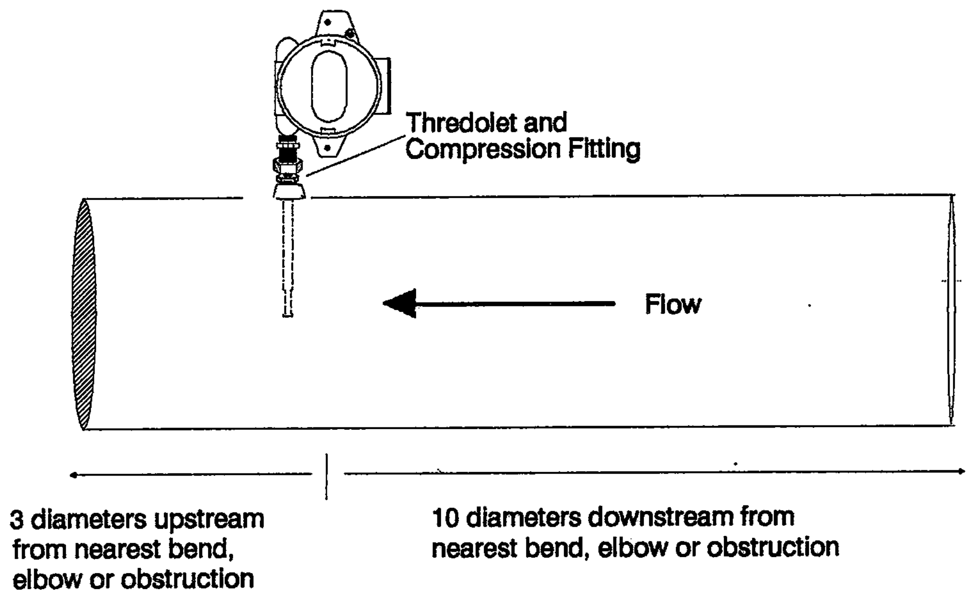
Return shipping address:

KURZ ™ INSTRUMENTS, INC.
2411 GARDEN ROAD
MONTEREY, CA 93940

ATTN: CUSTOMER SERVICE DEPT.

Note: Transportation charges for equipment shipped to the Kurz™ factory for warranty repair are to be paid by the shipper. We will return the equipment under warranty prepaid.

Figure 2.3-1
Ideal Probe Assembly Location

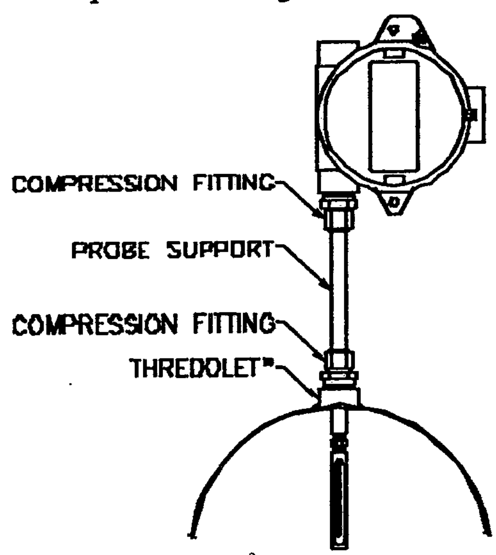


2.3.2 Installing and Securing the Probe Assembly

In most cases, the probe assembly is held in place by means of a compression fitting attached to the outside of the pipe or duct. The mounting hardware and procedures to attach the compression fitting vary, depending on whether the installation is for a pipe or for a sheet metal duct. Installations for both mounting configurations are provided.

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

Figure 2.3-2
Compression Fitting Installation



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

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

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

Step 3. Insert the probe support to the predetermined depth[4]. Make sure that the probe assembly is rotated such that the sensor's protective window allows unobstructed flow to pass the sensor.

Note: The shorter mandrel (or "sting") is to face into air flow stream.

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

B. Duct Mounting

4 Center of velocity coil (Rp) should be at a point of average flow (normally at center-line of pipe).

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

Step 2. Drill or tap four holes concentric to the four corner mounting holes on the appropriate stainless steel plate.

Step 3. Place the plate directly over the probe-insertion hole and secure it using the highest quality fasteners.

Step 4. Insert the probe support to the predetermined depth[6]. Make sure that the probe assembly is rotated such that the sensor's protective window allows unobstructed flow to pass the sensor.

Note: The shorter mandrel (or "sting") is to face into air flow stream.

Step 5. Tighten the tube compression fitting until the probe assembly is held firmly in place

6 Center of velocity coil (Rp) should be at a point of average flow (normally at center-line of pipe).

CAUTION: If the probe assembly is used with the ball valve retractor in flows of explosive gases, you must be extremely careful to ensure that both the probe support and the ball valve retractor are properly sealed to prevent gas leaks. Do not use the ball valve retractor in lines subjected to pressure in excess of 75 psi absolute due to the probe assembly may eject from the duct at high velocity. Such an ejection is extremely dangerous and exposes personnel to the risk of serious injury or death.

A. The steps necessary to perform a "cold tapping" installation are as follows:

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

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

Step 3. Fasten the ball valve retractor firmly together to the Thredolet™ coupler.

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

Step 5. Open the ball valve and insert the probe support to the correct depth (until the stop collar abuts with the tube compression fitting).

Step 6. Make sure that the probe assembly is rotated or such that the sensor's protective window allows unobstructed flow to pass the sensor.

Note: The shorter mandrel (or "sting") is to face the upstream flow.

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

Step 11. Position the adjustable stop collar on the shaft of the probe support to the predetermined depth and tighten the set screw.

Step 12. With the ball valve still closed, insert the probe support through the compression fitting at the end of the ball valve retractor until it will go no further.

Step 13. Open the ball valve and insert the probe support to the correct depth (until the stop collar abuts with the tube compression fitting).

Step 14. Make sure that the probe assembly is rotated or such that the sensor's protective window allows unobstructed flow to pass the sensor.

Note: The shorter mandrel (or "sting") is to face the upstream flow.

Step 15. Tighten the tube compression fitting until the probe assembly is held firmly in place.

Note: Once you have mounted the ball valve retractor to the duct, you can insert or retract the probe support with or without a pressurized flow in the line. If, however, pressure in the line exceeds approximately 50 psi, you should alleviate the flow before inserting or retracting the probe support.

CAUTION: To verify that the ball valve retractor is properly sealed and to ensure safe operation of the probe assembly, you should pressure-test all joints with soap bubble solution.

Table 2.4-1

APPROXIMATE LOOP RESISTANCE CHART @ 65° F (18° C)				
AWG Number	Ohms Per Ft	Maximum Cable Per Ft		Description
		Loop	Run	
4	.0003	13,333	6,667	Optionally available from the Kurz™ factory are two-wire conductor cable up to 250 feet (shielded, vinyl insulation, 18 gauge; radiation resistant feature also available).
8	.0005	8,000	4,000	
10	.0008	5,000	2,500	
12	.002	2,000	1,000	
14	.003	1,333	667	
16	.005	800	400	
18	.008	500	250	
20	.012	333	167	
22	.019	211	105	
24	.030	133	67	
28	.077	52	26	

2.5 Verifying Wiring Connections

Perform point-to-point tests to ensure that signal cables, power cables, ground wires and other system connections are complete. This will minimize any equipment failures caused by improper wiring.

Check system wiring against the Kurz™ system drawings provided with your equipment and against the architect/engineer or O.E.M. equipment vendor drawing to ensure that terminations have not been changed or altered during the design process or during installation.

WARNING: Do **NOT** supply power to the unit this check-out procedure is satisfactorily completed.

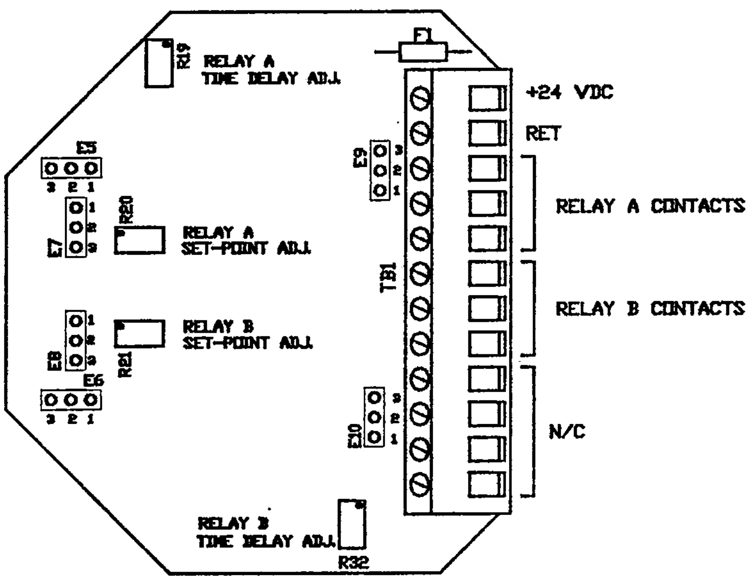
End of Section 2

Section 3: Field Calibration Procedures

The flow switch may have been pre-set at the Kurz™ factory (optionally available). However, should you need to configure the flow switch to your specifications, review the field calibration procedures in this section.

Figure 3-1 illustrates the location and description of the adjustment potentiometers, mode configuration jumpers and time delay range for the Series 950 Mass Flow Switches as well as the barrier terminal strip description.

Figure 3-1
Setup Configuration of the Main Circuit Board



By placing jumpers in selected positions and making adjustments to the appropriate potentiometers you can:

- Configure each alarm to operate in a Normal or Fail-Safe Mode
- Configure the alarms to monitor two low flow conditions, two high flow conditions, or a low and a high condition
- Configure the relays to activate at a specific rate of flow
- Configure the time delay for each relay so that the relay does not activate in response to brief fluctuations of flow

3.1 Normal or Fail-Safe Mode Operation

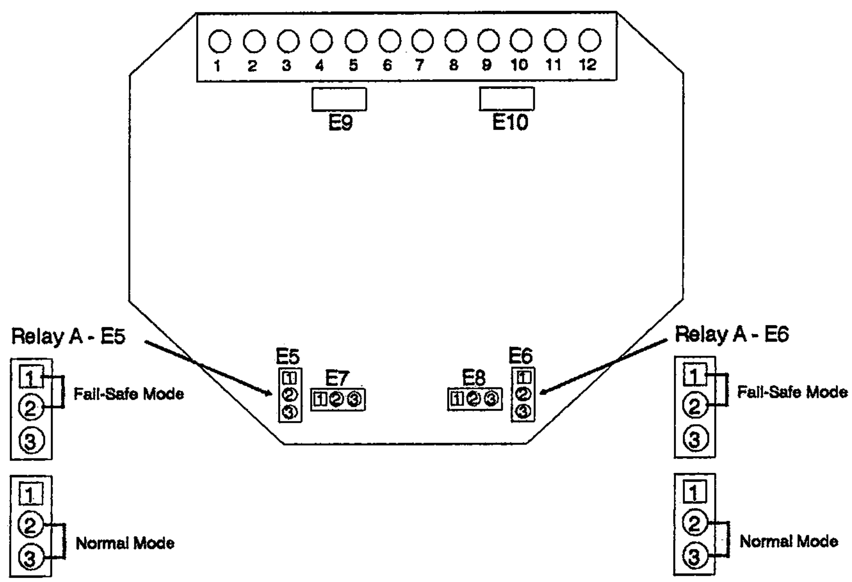
Each relay can be configured to operate in a Normal or in a Fail-Safe Mode. The relay mode selection determines the state of the relay when alarm conditions occur and also determines the type of alarm conditions that activate the relay.

The relay mode selections are summarized in Table 3.1-1. Refer to Figure 3.1-1 for the location of the jumpers used to configure the relay modes.

Table 3.1-1

RELAY MODE SELECTIONS					
Operation Mode	Jumper Configuration: Relay A	Jumper Configuration: Relay B	Flow Conditions That Activate the Relay	Normal State	Activated State
"normal"	E5(2-3)	E6(2-3)	Flow out of range	Open	Closed
"fail-safe"	E5(1-2)	E6(1-2)	Flow out of range or power has failed	Closed	Open

Figure 3.1-1
Jumpers E5 and E6 for Relay Mode Operation



3.1.2 Fail-Safe Mode Operation

To configure Relay A for Fail-Safe Mode operation, place a shunt between pins 1 and 2 of jumper E5; to configure Relay B, place a shunt between pins 1 and 2 of jumper E6. If a relay is configured to operate in this mode, the relay coil is energized and the relay closes when power is initially applied to the flow switch; remains closed at all times **except** when flow conditions are outside of the user-selected set-point ranges or power to the flow switch is absent. When a relay is configured in this way, it is referred to as a "normally closed" (N.C.) relay. The conditions that cause the "fail-safe" relay to activate and open are:

a) The rate of flow is equal to or above the high (Relay A) or high (Relay B) set-point.

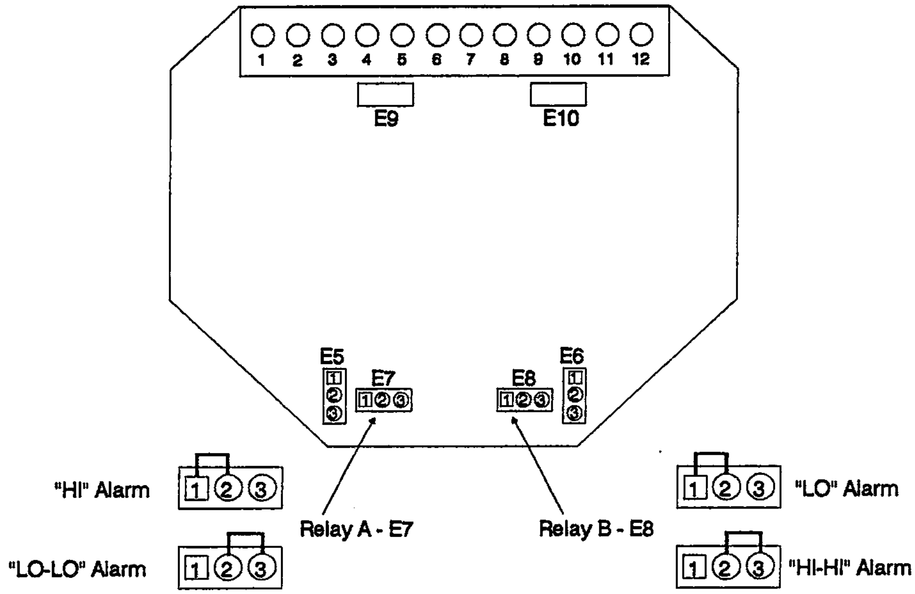
b) The rate of flow is equal to or less than the low (Relay B) or low (Relay B) set-point and, or the power to the flow switch has failed regardless of flow conditions.

The non-activated and activated states of the "fail-safe" relay are shown in Table 3.1-3.

Table 3.1-3

NON-ACTIVATED AND ACTIVATED STATES OF A RELAY CONFIGURED FOR FAIL-SAFE MODE OPERATION			
Alarm Condition	**Fail-Safe Mode Relay Contacts**		**Flow Conditions That Activate the Relay**
	Relay A	**Relay B**	
High	Open (3&5) Closed(3&4)	Open (6&8) Closed(6&7)	Flow above set-point
High	Closed(3&5) Open (3&4)	Closed(6&8) Open (6&7)	Flow below set-point
Low	Closed(3&5) Open (3&4)	Closed(6&8) Open (6&7)	Flow above set-point
Low	Open (3&5) Closed(3&4)	Open (6&8) Closed(6&7)	Flow below set-point
Power-Failure	Open (3&5) Closed(3&4)	Open (6&8) Closed(6&7)	Unknown

Figure 3.2-1
Jumpers E7 and E8 for the Alarm Conditions



3.3 Adjusting the Alarm Set-Points

If the alarm set-points have not been preset by Kurz™ Instruments, Inc. (optionally available), you will need to adjust the respective set-point potentiometers. A label on the top of the cover plate identifies the configuration of the alarms (LL/LO, LO/HI and HI/HH) and the location of the set-point A and set-point B potentiometers and LEDs. The potentiometers are easily accessed and the LEDs are visible through holes in the cover plate that protects the electronic assembly inside the sensor's electronic enclosure.

First, the time delay adjustment potentiometer should be set to "zero" and the 0-30 seconds jumper should initially be selected (change it after the set-point is established). It is very difficult to make the set-point adjustment if the time delay is not set at "zero" delay. To set the high alarm for either Relay A or B, adjust the rate of flow to the "high" set-point value and adjust the set-point potentiometer until the relay LED lights up. To set the low alarm for either Relay A or B, adjust the rate of flow to the "low" set-point value and adjust the set-point potentiometer until the relay LED lights up.

Please note that even though the adjustment potentiometer can be turned to an equivalent sensor voltage level below "zero" flow, the "low" set-point must be set up above "zero" flow to function reliably.

3.5 Hypothetical Situation

Lets assume that we wish to use a Model 952 Mass Flow Switch from the Kurz™ 950 Series as a low combustion airflow interlock switch. The chosen output relay (lets select Relay A) is wired in series with the control wires for the fuel solenoid valve such that the fuel will shut off in the event of a loss of combustion air. We will choose the Fail-Safe Mode so that the loss of power to the flow switch will also shut off the fuel valve.

The time delay potentiometer is set to "zero" since we want a fast response to a loss of air flow. The low alarm set-point is field-adjusted to a value substantially below the normal operating point since a fan failure most likely represents no air flow.

Note: We recommend that the set-point potentiometers be factory-adjusted in a wind tunnel, if a precise velocity is desired.

Following Table 3-1 and Figure 3-1 on pages 1 and 2, respectively, the following setup will be used for Relay A in Table 3.5-1:

Table 3.5-1

FLOW SWITCH SETUP CONFIGURATION		
Setup	**Jumper Configuration**	**Terminal Hook-up**
Fail-Safe Mode	E5 (2 & 3)	TB1-1 (24.000 Vdc)
Low Alarm	E7 (2 & 3)	TB1-2 power supply return (RET)
Time Delay	E9 (1 & 2)	TB1-3 low side of solenoid power
		TB1-4 no connection (N/C)
		TB1-5 high side of solenoid power

In "normal" operation, Relay A contacts (3 & 5) are closed energizing the fuel solenoid valve. If the low set-point is reached the contact opens shutting off the power to the fuel solenoid. Also, if the 24.000 Vdc power is lost or if the Relay A coil were to become an open circuit, contacts 3 & 5 will open, shutting off the fuel.

Section 4: Service

This section describes the routine maintenance and trouble-shooting procedures pertaining to the Series 950 Mass Flow Switches. Nonetheless, it is recommended that the unit be returned to the Kurz™ factory if repairs and, or recalibration are needed. This is usually the most cost effective and reliable means.

4.1 Routine Maintenance

The Series 950 Mass Flow Switches are virtually maintenance free. Though, when required, the following are recommended:

- Electronics maintenance
- Mechanical maintenance

CAUTION: When dismantling the unit for repair, recalibration and, or cleaning, make sure the power is off.

4.1.1 Electronics Maintenance

The electronic components of the flow switch essentially requires no maintenance; however, should be periodically inspected and cleaned.

The factory calibration of the Series 950 Mass Flow Switches remain stable over a duration of up to several years. However, in order to maintain NIST-traceability, annual recalibrations are recommended.

Note: If the unit requires recalibration while still under warranty, contact Kurz™ Instruments, Inc. at (800) 424-7356 and ask for Customer Service. We will NOT perform a free calibration under warranty, if you have already made adjustments to the zero, span or linearization controls.

4.2 Trouble-Shooting

The following test procedures are provided to help locate the section of the Series 950 Mass Flow Switches at fault. It is not intended to be an all inclusive repair manual. The corrective actions to be taken usually recommend electronic components or wiring connections to be corrected, replaced and, or repaired by a certified electrical technician familiar with electronic test equipment and measurements. In most major repairs, the unit should be returned to the Kurz™ factory for service. Kurz™ Instruments, Inc. will provide technical assistance over the phone to qualified repair personnel. For more information, please call Customer Service Department (800) 424-7356.

Once installed properly, operation of the unit is primarily a matter of maintaining the 18.000 Vdc to 24.000 Vdc power source. The unit will continue to operate for prolonged periods without intervention. However, when it is suspected that the unit is not operating correctly, the following test procedures can be performed before dismantling for repair:

- Power-on voltage test for the electronics assembly of the of the flow switch
- Checking the sensor's return signal
- Verifying the sensor's integral resistance and electrical continuity in the RTD-windings
- Verifying the relays to be operating

All test points are accessible on the alarm board (the top board in the electonic assembly) after the cover plate has been removed. You will need a calibrated digital voltmeter (DVM) accurate to within ± 0.001 Vdc; to make voltage and resistance measurements.

Refer to Figure 4.2-1 for the locations of the test points on the alarm board.