KURZ
INSTRUMENTS INC.

Series 4440 Ruggedized Digital Portable Air Velocity Meter User's Guide

August 1990

Unit Description Sheet

Complete Model Number: ______________________________

Serial Number: ______________________________

Kurz Order Number: ______________________________

Customer P. O. Number: ______________________________

Calibration Temperature:
- ☐ Standard (25° C, 77° F)
- ☐ Other (specify): ____________________

Calibration Pressure:
- ☐ Standard (760 mm Hg, 29.92 in Hg)
- ☐ Other (specify): ____________________

Velocity Ranges:
- ☐ 0-2,000 & 0-6,000 SFPM
- ☐ 0-2,000 & 0-12,000 SFPM
- ☐ 0-10 & 0-30 SMPS
- ☐ 0-10 & 0-60 SMPS
- ☐ Other (specify): ____________________

Probe-Support Construction:
- ☐ 316 Stainless Steel

Probe-Support Extenders:
- ☐ 4 18"
- ☐ Other Number: _____ Length: _____

Sensor:
- ☐ Standard Rated to 250° C
- ☐ HHT Rated to 500° C
- ☐ Custom Cable Length: ____________________

Notes:

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Warranty Statement

The Kurz Model 4440 Portable Digital Air Velocity and Temperature Meter 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.

Important Notice

The MetalClad sensor used in the 4440 Portable Digital Air Velocity and Temperature Meter produces heat during normal operation. The sensor is designed for use in flows of air and other NONEXPLOSIVE gases. **DO NOT USE THIS SENSOR IN FLOWS OF EXPLOSIVE GASES. FAILURE TO HEED THIS WARNING COULD RESULT IN EXPLOSION, DAMAGE TO FACILITIES, SERIOUS INJURY, OR DEATH.**

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About This Book

This book contains four sections and an appendix, each of which is briefly described below. The book also contains a Unit Description Sheet and an index. The book is not designed to be read cover to cover; rather, it is designed to present information to the 4440 user in as accessible a manner as possible.

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 4440 Portable Digital Air Velocity and Temperature Meter, including model number, serial number, Kurz order number, and customer purchase order number. It also lists any options you ordered with your 4440. 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 some of the information presented in the rest of the manual. It shows you how to hook up the 4440 for use and how to charge the external battery pack.

Section 1: Product Overview

This section introduces you to the purpose, principles of operation, and features of the Model 4440. You can safely skip this section if you are already familiar with that information.

Section 2: Assembly and Orientation

Section 2 explains how to assemble the 4440 and provides detailed explanations of each of the unit's controls and connectors.

Section 3: Operation

This section explains how to obtain accurate velocity and temperature readings with the 4440, how to average velocity readings, and how to calculate actual velocities from the standard velocities reported by the 4440.

Section 4: Maintenance

This section explains how to take care of the 4440's external battery pack, how to clean the sensor when necessary, and how to get your 4440 periodically recalibrated.

Appendix A: Component Layout and Schematic Drawings

The appendix contains detailed component layout drawings and circuit diagrams of the 4440. This information is not needed by most 4440 users in routine operation of the unit. It is provided as an aid to those users who want to perform detailed maintenance and testing.

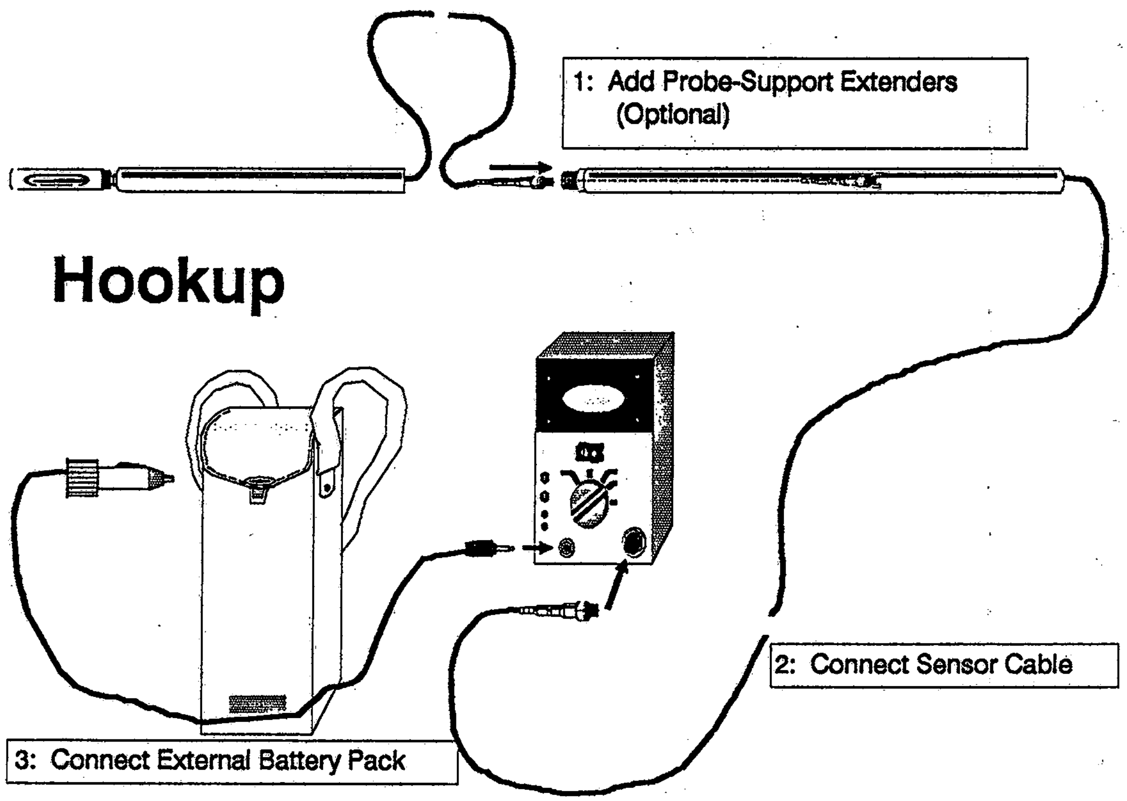
About the Art in This Book

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.

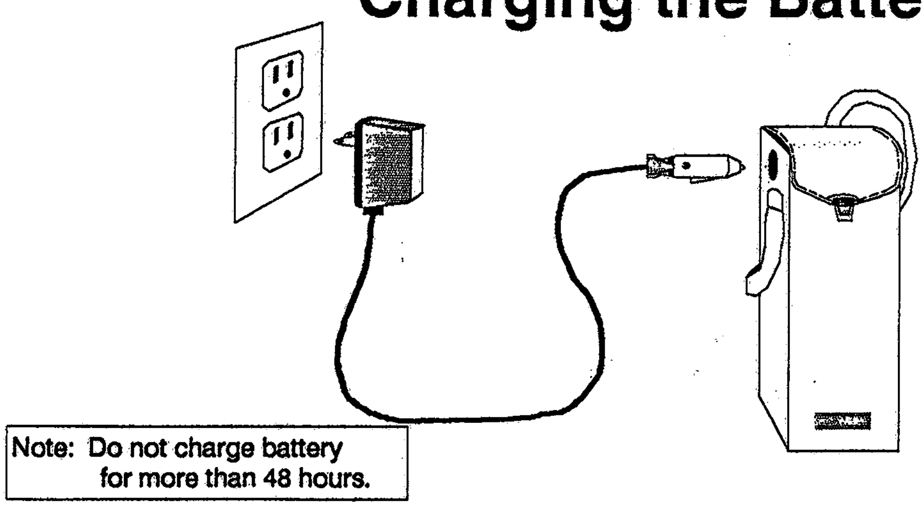
Quick Set-Up Guide

The chart below shows you how to hook up the 4440 for use and how to charge the external battery pack. Please note that the rest of the manual contains important information not covered by this chart.

Hookup



Charging the Battery



Section 1: Product Overview

This section contains a general description of the Model 4440 Portable Digital Air Velocity and Temperature Meter. It explains how the meter works and lists its features and specifications.

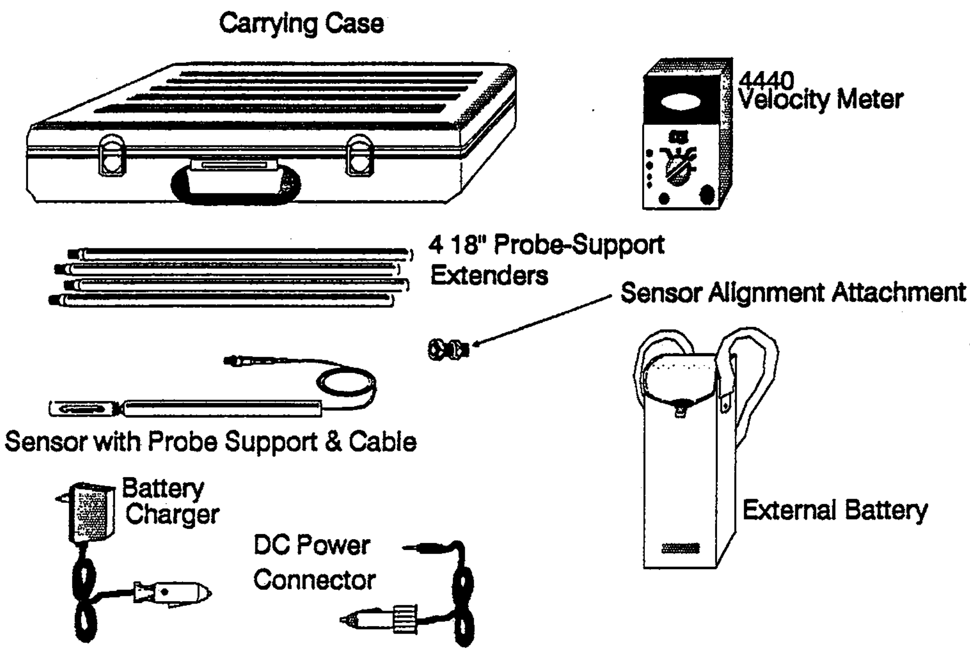
1.1 Description

The Model 4440 Portable Air Velocity and Temperature Meter is designed to monitor the velocity and temperature of air within pipes, stacks, flues, and similar enclosed channels. It can also be used for monitoring air velocity in open areas, but its extreme ruggedness and resistance to contamination render the 4440 particularly suitable for hot, dirty, or corrosive industrial environments.

The basic components of the 4440 are listed below and shown in Figure 1-1.

- The 4440 meter itself, housed in a high-impact plastic case and containing all necessary controls and connectors
- MetalClad™ all-metal flow sensor mounted inside a protective window at one end of its attached probe support
- 15 feet of sensor cable preattached to the sensor
- Stainless steel probe support
- Four 18" stainless steel probe-support extenders
- External 12 Vdc, 6 amp/hr. battery pack with carrying case and shoulder strap
- 110 Vac battery charger
- 12 Vdc power cable
- Foam-padded carrying case

Figure 1-1. *4440 Basic Components*

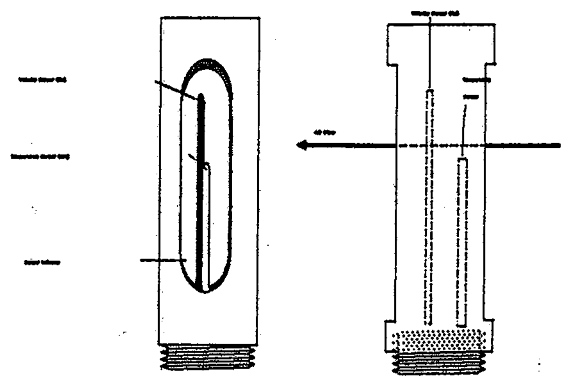


1.2 How the Sensor Works

The 4440's MetalClad sensor is in fact two sensor elements in one: a temperature sensor and a velocity sensor. Each sensor element consists of a reference-grade platinum winding wound around a ceramic mandrel and enclosed in a stainless steel sheath. The temperature sensor is the shorter of the two sensor elements housed within the MetalClad's protective window; the velocity sensor is the longer sensor element.

Figure 1-2 shows two views of the MetalClad sensor within its protective sensor window. Note the direction of the airflow shown in Figure 1-2. When you use the 4440, always make sure that the temperature sensor (R_{tc}) is upstream of the velocity sensor (R_p). This orientation results in more accurate readings.

Figure 1-2. *MetalClad Sensor: Two Views*



The temperature sensor senses the ambient temperature of the air 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 MetalClad sensor's standard rating is for nonexplosive gases. If you plan to use it in flows of explosive gases, Kurz strongly recommends that you purchase the optional probe safety circuit. That circuit prevents the velocity sensor from ever reaching the ignition temperature of a specified gas, provided the temperature of the gas flow itself is kept within appropriate guidelines. Contact Kurz Instruments for more information on using the MetalClad sensor in explosive gas flows.

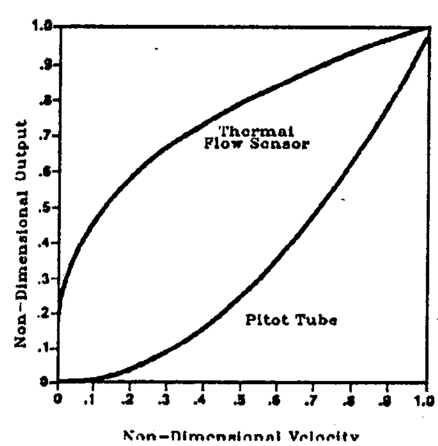
Because the temperature sensor compensates for fluctuations in ambient temperature, the amount of electrical power needed to maintain the velocity sensor's overheat is affected only by the velocity of air over the sensor: The greater the velocity of the flow, the greater its cooling effect on the sensor and the greater the electrical power needed to maintain the sensor's overheat. It is this power draw that is measured by the 4440.

Because the sensor is directly measuring mass velocity (i.e., the number of molecules carrying heat away from the velocity sensor), it is calibrated in **standard** units, which are referenced to a temperature of 25° C and atmospheric pressure of 760 mm Hg. In other words, air at 25° C and 760 mm Hg, flowing past the sensor 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 the temperature or pressure differential.

The temperature and velocity sensors form two legs of a balanced Wheatstone bridge. The bridge circuitry itself is contained in the 4440 meter box. The printed circuit board housed in the meter box has two main functions: to supply current to the sensor and to transform the nonlinear current draw received from the sensor into a linear signal that can then be digitized for display.

The draw 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 1-3 shows the MetalClad sensor's output curve as flow increases[1]. Figure 1-3 also shows the corresponding curve for a pitot-tube type sensor. Note the greatly superior sensitivity of the MetalClad sensor at low flow rates.

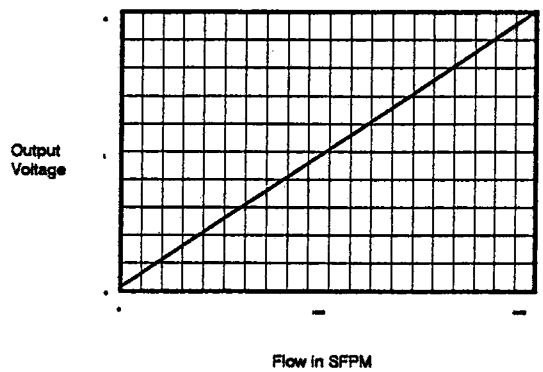
Figure 1-3. *Sensor Output vs Flow*



1 Both output and flow are generalized in Figure 1-3. The curves shown apply to 0 through full output and 0 through full flow, whatever the calibrated range of the instrument.

The linearizer converts the nonlinear draw into a linear voltage that is directly proportionate to flow velocity, as shown in Figure 1-4.

Figure 1-4. *Linearized Output*



1.3 Features and Specifications

Some of the outstanding features of the 4440 are summarized below:

Rugged Construction

The MetalClad sensor, with its 316 stainless steel sheathes, is virtually indestructible in normal use. It is highly resistant to both dirt and corrosion. Unlike pitot-tube and orifice-plate sensors, it neither clogs nor suffers significantly degraded performance when used in dirty atmospheres.

Unsurpassed Accuracy

The 4440's sensor windings are Resistor Temperature Detector (RTD)-type windings of reference-grade platinum 385.

Dual Velocity Ranges

Every 4440 is calibrated to two velocity ranges. The low range provides maximum resolution at low flow rates. The high range measures flows of up to 12,000 SFPM. The available ranges are listed below, along with the applicable 4440 model number.

Range	Model
0-6,000 SFPM 0-2,000 SFPM	4440-4
0-12,000SFPM 0-2,000 SFPM	4440-5
0-30 SMPS 0-10 SMPS	4440M-4
0-60 SMPS 0-10 SMPS	4440M-5

Note that metric models – 4440M-4 and 4440M-5 – are calibrated in standard meters per second.

Excellent Low-Speed Sensitivity

Unlike pitot-tube and orifice-plate sensors, the 4440 can accurately measure flows whose velocity is as low as 20 standard feet per minute.

Switch-Selectable Temperature Reporting

The 4440's MetalClad sensor performs both velocity and temperature sensing functions. Just flip the range selection knob on the 4440 meter box, and the digital display switches from air velocity to air temperature.

Convenient Linear Output

In addition to its built-in digital display, the 4440 also outputs a linear voltage signal suitable as input to voltmeters, chart recorders, computers, etc. Output voltage ranges are scaled to selected flow ranges and engineering units. Maximum output voltage is 2 Vdc. Refer to Table 2-1, "Linear Output Voltages," in Section 2 for a match of output voltage ranges to selected flow ranges and engineering units.

NBS-Traceable Calibration

Every 4440 is factory-calibrated in a National Bureau of Standards (NBS) traceable wind tunnel. Packaged with your 4440 is a Calibration Certificate showing output voltage vs air velocity. The specifications of the 4440 are given in Table 1-1.

Table 1-1. *4440 Specifications*

Sensor Construction:	Reference-grade 385 platinum RTD-type windings around high-purity ceramic cores, sheathed in 316 stainless steel
Accuracy:	+/-(2% of reading + 1/2% of full scale)
Repeatability:	+/- 0.25%
Response Time:	1 second
Calibration:	Factory calibrated in NBS-traceable wind tunnel for air at 25° C and 760 mm Hg. Includes Calibration Certificate showing output voltage vs air velocity for 11 data points, including zero flow.
Sensor Operating Temperature Range:	-55° C to +250° C standard
	HHT rated sensor optionally available for temperatures from -55° C to +500° C
Probe Construction:	Stainless Steel standard

Table 1-1 (continued)

Probe Support Dimensions:	1" outside diameter Preattached probe support is 10" long. The sensor and window are approximately 3 1/2" long. Thus, the probe support and sensor taken together are approximately 13 1/2" long. 4 18" probe support extenders are provided, for a total maximum length of approximately 7' 1 1/2".
Output:	0-2 Vdc max. (See Table 2-1 in Section 2 for actual voltages.)
Power Supply:	12 Vdc

End of Section 1

Section 2: Assembly and Orientation

This section explains how to assemble the 4440 portable digital air velocity and temperature meter. It also contains detailed descriptions of the 4440's controls and connectors.

2.1 Assembly

First unpack your 4440 and check to make sure that all the components shown in Figure 1-1 (refer to Section 1) are present. If any component is missing or appears to be damaged, contact Kurz Instruments at once to report the problem.

2.1.1 Adding Probe-Support Extenders (Optional)

Whether or not you use probe-support extenders depends entirely on the reach you require; the extenders do not affect the operation of the unit. You may want to read "Velocity Averaging" in Section 3 before you decide that you do **not** want to use any probe-support extenders.

To attach one or more probe-support extenders, follow the steps listed below:

Step 1: Remove the wire ties from the coiled sensor cable.

Step 2: Uncoil the cable, starting at the probe support and proceeding toward the cable connector.

Step 3: Insert the cable connector into the end of the probe-support extender that has male (outside) threads. Keep feeding cable into the end of the probe-support extender until the cable connector emerges from the other end of the extender.

Step 4: Pull cable through the probe-support extender until there is no slack cable between the preattached probe support and the probe-support extender.

Step 5: Thread the probe-support extender into the probe support.

Repeat steps 3 through 5 for each probe-support extender you want to attach.

2.1.2 Adding the Sensor-Alignment Attachment (Optional)

Adding the sensor-alignment attachment is optional. The attachment provides you with a visual aid in aligning the 4440's sensor with the flow being measured.

The procedure for adding the attachment is described below and illustrated in Figure 2-1.

Step 1: Turn the sensor-alignment attachment's small tightening knob back to expose as much of the attachment's threaded area as possible, leaving just enough space between the two knurled knobs to allow the tightening knob to move freely.

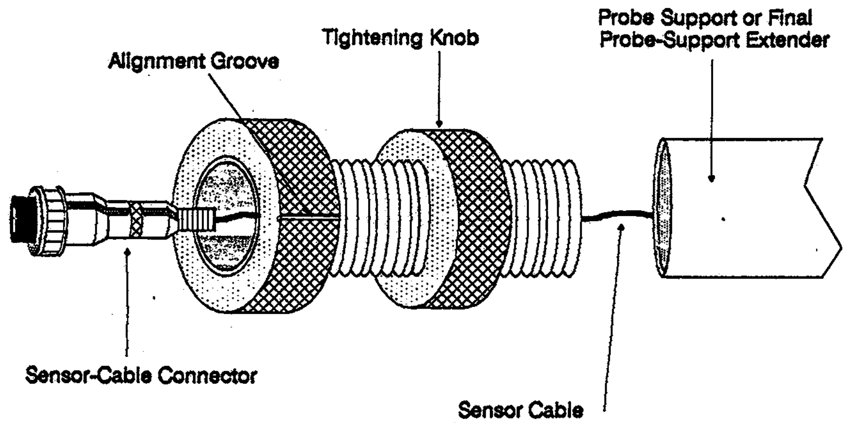
Step 2: Pass the sensor-cable connector through the threaded end of the attachment.

Step 3: Thread the attachment into the end of the probe support or probe-support extender until it is almost all the way in, but still free to turn.

Step 4: Align the groove on the large knurled knob with the shorter of the MetalClad sensor's two elements. (A straight line extended from the groove to the end of the probe should bisect the sensor window on the side of the shorter sensor element.)

Step 5: While maintaining the alignment of the groove, tighten the tightening knob against the butt of the probe support.

Figure 2-1. *Sensor-Alignment Attachment*

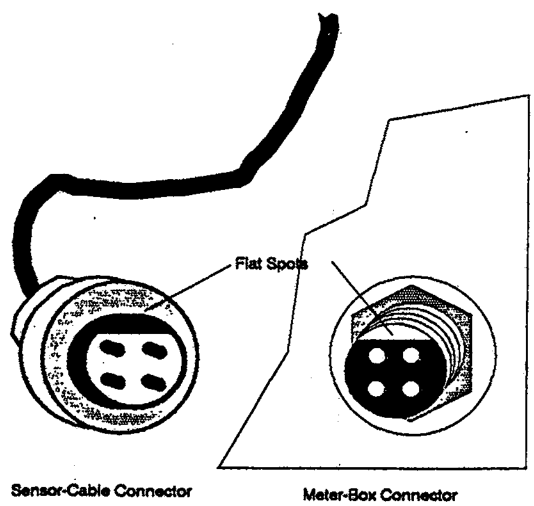


2.1.3 Connecting the Sensor Cable

Once you have attached any probe-support extenders you plan to use, you are ready to connect the sensor cable to the meter box.

The sensor cable plugs into the meter box connector labeled "PROBE". Note that both the cable connector and the connector on the meter box have flat spots on their plastic parts, as shown in Figure 2-2. You must align those flat spots before you can plug the cable connector into the meter box connector.

Figure 2-2. *Sensor Cable and Meter Box Connectors*



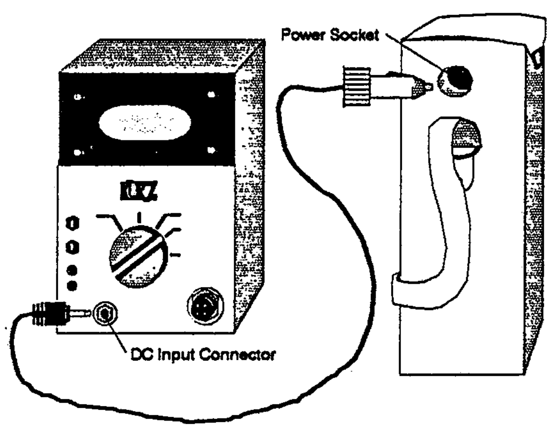
Once you have aligned the flat spots on the connectors, push the cable connector firmly into the meter box connector. Then thread the cable connector's securing ring onto the threads of the meter box connector to ensure a positive connection.

NOTE: Your 4440 is calibrated for the specific sensor with which it was shipped. Although it is physically possible to interchange sensors between two different 4440 units, **do not do so.** Using any sensor other than the one with which your unit was shipped seriously degrades the accuracy of the instrument.

2.1.4 Connecting the DC Power Cable

The DC power cable supplies power from the external battery to the meter box. The power cable ends in a jack at each end. The larger jack plugs into the socket on the side of the external battery's case. The smaller jack plugs into the unlabeled DC input connector on the front of the meter box. Figure 2-3 shows both connections.

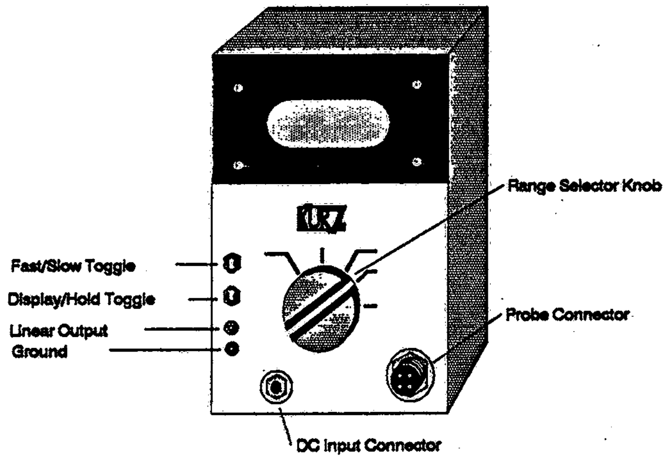
Figure 2-3. *DC Power Cable Connections*



2.2 Controls and Connectors

The 4440's controls and connectors are shown in Figure 2-3 and are explained individually below.

Figure 2-3. *4440 Controls and Connectors*



2.2.1 Range Selector Knob

You can set the range selector knob to any of five positions:

- Off
- Battery Check
- High Velocity Range (0-6,000 SFPM; 0-12,000 SFPM; 0-30 SMPS; or 0-60 SMPS)
- Low Velocity Range (0-2,000 SFPM or 0-2 SMPS)
- Temperature

Off is of course self explanatory. Turn the unit off when it is not in use. It is also a good idea to conserve battery life by turning the unit off between readings if more than a few minutes will pass between any two readings.

Battery Check lets you check the charge remaining in the external battery to make sure that you have enough power for satisfactory operations. When the battery is fully charged, the digital display should read at or near 12 volts with the range selector in the battery-check position. The lower limit for successful operation is about 9 volts. A fully charged battery should power the 4440 for about 12-16 hours of normal use. If you use the unit primarily in high-velocity flows, operating time per charge will be lower, owing to the increase in current necessary to maintain the velocity sensor's overheat in a high velocity flow.

High-Velocity Range sets the 4440 to the higher of its two velocity ranges. Use this range whenever flow velocity exceeds the upper limit of the low-velocity range.

Low-Velocity Range sets the 4440 to the lower of its two velocity ranges. You should generally use this range unless flow velocity approaches or exceeds the upper limit of the low range. Although velocities within the low range are also within the high range, the low range setting provides greater resolution for low flow rates.

Temperature converts the 4440 from velocity sensing to temperature sensing. With the standard sensor, the temperature range reported is 0-200° C[1]. With the optional HHT sensor, the temperature range reported is 0-500° C.

2.2.2 Slow/Fast Toggle

The setting of this switch determines how frequently the 4440's digital display is updated. When the switch is in the fast position, the display is updated once a second. When the switch is in the slow position, the display is updated once every three seconds.

Ordinarily, leave this switch set to fast for the most responsive operation. If you are monitoring a very turbulent and irregular flow, however, you may want to switch to the slow setting to increase the stability of the display. That is, if the rate of flow is actually changing one or more times per second, the constant changing of the display may become distracting, and you may want to slow it down.

1 The standard sensor can safely be used in flows at temperatures of up to 250° C and will accurately measure velocity in those flows. Temperatures above 200° C will be reported as 200° C, however.

2.2.3 Display/Hold Toggle

The setting of this switch determines whether or not the 4440's digital display is updated. Normally, of course, you should leave this switch in the display position (up), so that the display is constantly updated to reflect the changing flow across the sensor. You can, however, hold the display of a particular reading by flipping the toggle to the hold position (down). The reading currently displayed freezes until you return the toggle to the display position.

2.2.4 Output Connectors

The two output connectors on the front of the meter box allow you to connect the 4440 to a strip chart recorder, analog-to-digital interface, datalogger, or similar external device. Each connector is a standard female mini banana jack. The upper connector (+) outputs a positive linear voltage signal; the lower connector (-) is the ground.

The signal is scaled from 0 Vdc to a maximum of 2 Vdc and is directly proportionate to the range currently selected by the range selector knob. Suppose, for example, that the range 0-12,000 SFPM is selected. In this case, the maximum output signal—the signal corresponding to a flow of 12,000 SFPM—is 1.2 Vdc. A flow of 6,000 SFPM would produce an output signal of 0.6 Vdc. Table 2-1 matches linear output voltage ranges to selected velocity and temperature ranges.

Table 2-1. *Linear Output Voltages*

Range Selected	Output Voltage Range
0-2,000 SFPM	0-2 Vdc
0-6,000 SFPM	0-0.6 Vdc
0-12,000 SFPM	0-1.2 Vdc
0-10 SMPS	0-1 Vdc
0-30 SMPS	0-0.3 Vdc
0-60 SMPS	0.0.6 Vdc
0-200° C	0-2 Vdc

End of Section 2

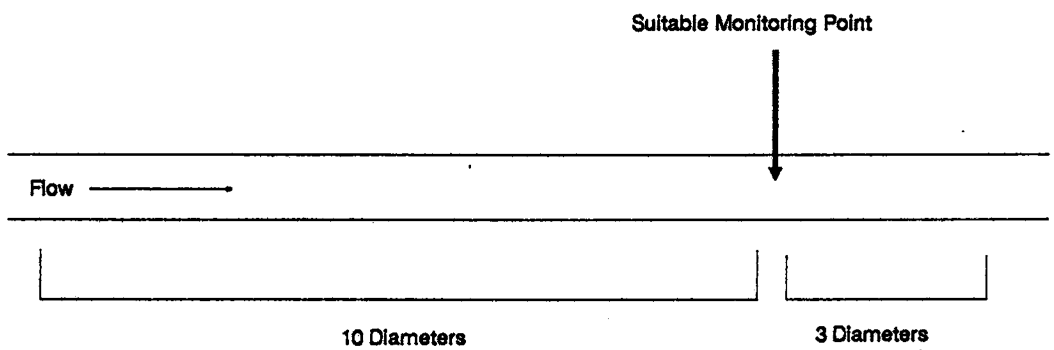
Section 3: Operation

This section explains how to operate the 4440 portable digital air velocity and temperature meter. It contains subsections on selection of monitoring points, velocity averaging, and calculating actual (as opposed to standard) velocities.

3.1 Selecting a Location

If possible, you should select a monitoring point at least three pipe diameters upstream and ten diameters downstream from the nearest bend, elbow, or other obstruction in the line to be monitored. The chosen location should also provide sufficient clearance for inserting and removing the probe; that is, the clearance between the line and any obstruction should equal at least the length of the probe support, plus two or three inches for maneuver. Correct probe location is illustrated in Figure 3-1.

Figure 3-1. *Probe Location*



3.2 Taking a Velocity Reading

To take a velocity reading with the 4440, follow the steps listed below. This procedure assumes that you have already assembled the 4440 as instructed in Section 2.

Step 1: Turn the range selector knob to the desired velocity range. If you believe the flow to be measured falls within the low velocity range, use that range; it will yield more accurate results at low flow velocities. If you believe the flow to be measured exceeds the upper limit of the low velocity range, use the high velocity range. If you are unsure, use the high velocity range, and then switch to the low range later if actual measurements fall within the limits of the low range.

Step 2: Allow the unit to warm up for approximately 30 seconds. During this time the meter will display spurious readings, starting with a very high number and then rapidly falling. During this period the unit is establishing the correct R_p overheat. When the displayed reading stabilizes, go on to Step 3.

Step 3: Insert the sensor in the flow to be measured. You should generally insert the probe well into the flow—to the approximate center of the pipe, stack, or duct if you plan to take a reading of only one point (see "Velocity Averaging" below for a different strategy).

Make sure the sensor window is aligned with the air flow so that the flow passes unobstructed over the sensor elements[1]. If you are using the sensor-alignment attachment (described in Section 2.1.2), make sure the alignment groove is facing toward the oncoming air flow. This ensures that the R_{tc} sensor element—the shorter of the two sensor elements—is upstream, i.e., facing into the air flow.

1 It is not necessary to align the sensor with great precision. As long as the sensor window is within about 15° of parallel to the air flow, measurement accuracy is undiminished. You can experimentally rotate the sensor and observe when the velocity reading begins to drop off.

It is important to put R_{tc} upstream because the sensor is factory calibrated in this orientation. **Reversing the orientation of the two sensor elements will significantly degrade the accuracy of your readings.**

Step 4: Allow approximately one second for the sensor to respond to the flow before you record the velocity reading. If the temperature of the flow is very different from the ambient temperature, you may have to allow a few seconds longer before the reading stabilizes.

Step 5: Take your reading.

If the flow is turbulent and irregular, use the Fast/Slow toggle to select slow display refresh (refer to Section 2).

If you want to hold the reading on the display for later reference, flip the Display/Hold toggle to the hold position (refer to Section 2).

3.3 Taking a Temperature Reading

The procedure for taking a temperature reading is identical to that for taking a velocity reading, except that you select "Temperature" with the range selection knob.

3.4 Velocity Averaging

When you use the 4440 to measure velocity in a line more than a few inches in diameter, it is a good idea to take readings at several points within the line and average those readings. Two related methods of velocity averaging are described below, half-traverse averaging and double-traverse averaging. Of the two, half-traverse averaging is simpler; double-traverse averaging is more accurate. Select the method that best suits your needs.

3.4.1 Half-Traverse Averaging

You can, with a fair degree of accuracy, determine the average velocity within a line by traversing the sensor once across the center line of the pipe, from the far wall to the center. The procedures for performing the traverse and obtaining an average are described below:

Step 1: Divide a cross section of the line into a number of equal, concentric areas (see Figure 3-2). The number of areas you use depends on the the uniformity of flow within the line 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 3-2).

Step 3: Drill a 1 1/16" hole in the line (or open an existing monitoring port in the line).

Step 4: Insert the probe into the line and take a reading at each of the points selected at Step 2.

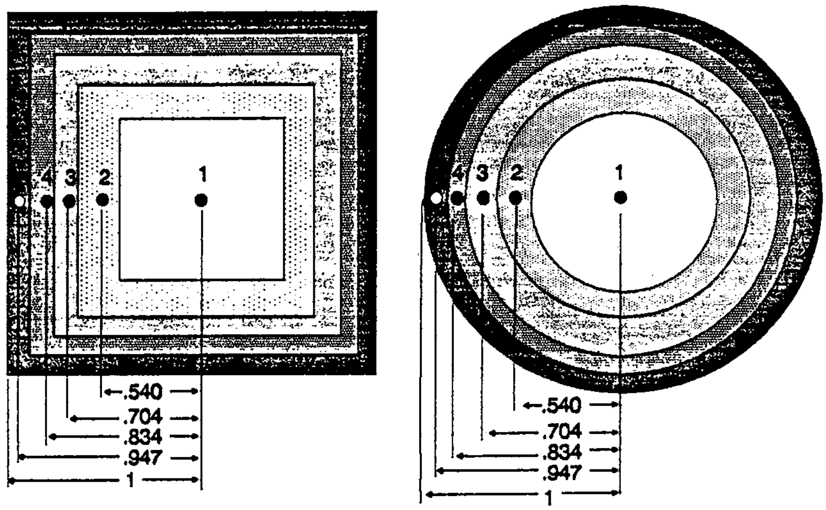
You can most easily determine the position of the sensor within the line by using a pencil or other marker to mark off appropriate measurements on the probe support before you insert it.

Be sure the window of the probe is aligned with the direction of flow and that the temperature sensor is upstream of the velocity sensor.

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

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

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



In Figure 3-2, 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 line is five square units.

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

Table 3-1 shows an example of averaging readings from a line like one of those shown in Figure 3-2.

Table 3-1. *Half-Traverse Velocity Averaging Example*

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

3.4.2 Double-Traverse Averaging

Double-traverse averaging is similar to half-traverse averaging, but requires two probe-insertion holes at right angles to each other 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 line into a number of equal, concentric areas (see Figure 3-3). The number of areas you use depends on the the uniformity of flow within the line 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 3-3)[2].

Step 3: Insert the probe into the line through one of the probe-insertion holes and take a reading at each of the points in line with that hole.[3] Repeat the process for the other hole.

2 **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.**

3 **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.**

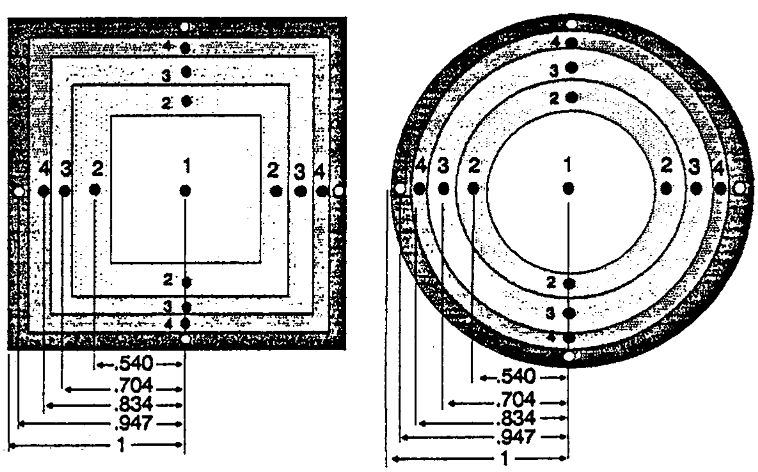
You can most easily determine the position of the sensor within the line by using a pencil or other marker to mark off appropriate measurements on the probe before you insert it.

Be sure the window of the probe's protective shield is aligned with the direction of flow and the temperature sensor is upstream of the velocity sensor.

Step 4: Compute an arithmetic average of the readings obtained at Step 3. Count the single Point-1 reading four times in determining the average.

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

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



In Figure 3-3, the unshaded area of each line, 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 line is five square units.

The numbers shown below the lines give the positions of points 2, 3, 4, and 5 relative to the distance from Point 1 to the wall of the line. That is, from Point 1 to Point 2 is 54% of the distance from Point 1 to the wall of the line; from Point 1 to Point 3 is 70.4% of the distance from Point 1 to the wall of the line; and so on. You can extrapolate from these numbers the actual measurements for any square or round line divided into five equal areas. Table 3-2 shows an example of averaging readings from a line like one of those shown in Figure 3-3.

Table 3-2. *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 flow across the 20 points sampled[4] is 1059 SCFM.

3.5 Calculating Actual Velocities

For most air-flow monitoring applications, the mass of the flowing gas is the relevant variable. The 4440's MetalClad sensor was designed with this fact in mind. The MetalClad sensor accurately registers mass velocity at any temperature and pressure. Its output is therefore calibrated in standard units.

4 Point 1 is counted four times.

Those units are referenced to a standard temperature of 25° C (77° F) and standard atmospheric pressure of 760 mm (29.92 inches) of mercury. A velocity reading obtained for air at a different temperature and/or pressure will not be the exact actual velocity of that air. Generally, standard velocity is a much more useful measurement than actual velocity. Sometimes, however, you may want to calculate the **actual** velocity of air whose temperature or pressure differs significantly from the standard temperature and pressure.

The formula for deriving actual velocity from indicated 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_{act} = Actual air velocity in feet per minute.

V_{ind} = Indicated velocity in standard 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 3

Section 4: Maintenance

The 4440 requires very little maintenance. This section describes the few maintenance procedures that are required. It contains information of taking care of the external battery, cleaning the MetalClad sensor, and recalibrating the unit.

4.1 Taking Care of the External Battery Pack

If properly cared for, the external battery pack provided with the 4440 should yield several years of satisfactory service. To maximize battery life, please follow these suggestions:

- When the battery pack's charge drops below 9 volts (see "Battery Check" in Section 2), recharge the battery immediately, or within 24 hours at the latest.

- Never charge the battery pack continuously for more than 48 hours.

- Recharge the battery pack fully before you store it for a prolonged period.

- If you store the unit for very long periods between use, you should recharge the battery pack every six months.

- Store the battery pack at or below normal room temperature (68° F).

The amount of time you can operate the 4440 on one battery charge varies greatly and depends primarily on the velocities of the air flows you measure. The greater the velocity of the air flow, the greater the power requirement of the 4440. Under average operating conditions, one battery charge should last approximately 12-16 hours.

When the external battery pack's charge drops below 9 volts, recharge it, following the directions below:

Step 1: Insert the cigarette-lighter plug of the battery charger into the receptacle on the side of the battery pack.

Step 2: Plug the battery charger into a standard, 115 Vac wall receptacle.

Let the battery pack charge for between 16 and 24 hours.

CAUTION: Do not leave the battery charger plugged in and connected to the battery pack for more than 48 hours. Doing so may damage the battery pack.

4.2 Cleaning the Sensor

The large diameter of the sensor elements renders them relatively immune to particulate contamination in most environments. Continuous use in dirty environments may, however, eventually result in the sensor's becoming sufficiently loaded with contaminants to degrade performance. If this should occur, use a fine wire brush, crocus cloth, or fine-grit emery cloth to remove built-up contamination from the sensor. Always turn the 4440 off before you clean the sensor. For even greater safety, disconnect the sensor cable from the meter box before you clean the sensor.

Some MetalClad sensors may have small specks of excess metal adhering to their stainless steel sheaths. This is normal and in no way degrades the performance of the 4440. Do not attempt to remove such specks; doing so may change the unit's calibration.

4.3 Recalibration

The factory calibration of the 4440 should remain stable for long periods of time. To maintain NBS traceability, however, Kurz recommends that your 4440 be recalibrated annually.

You can return your 4440 to Kurz Instruments or to an authorized service center for recalibration. Be sure to include the entire unit, as well as your name, address, and telephone number. Call Kurz Instruments at (408) 646-5911 for information on fees and on the location of the nearest authorized service center.

Alternatively, you can perform the recalibration yourself. Air velocity calibration systems are available from Kurz—consult our factory or you local Kurz representative for information on series 400 air velocity calibration systems. **Attempting to recalibrate your 4440 with equipment other than that supplied by Kurz voids your warranty.**

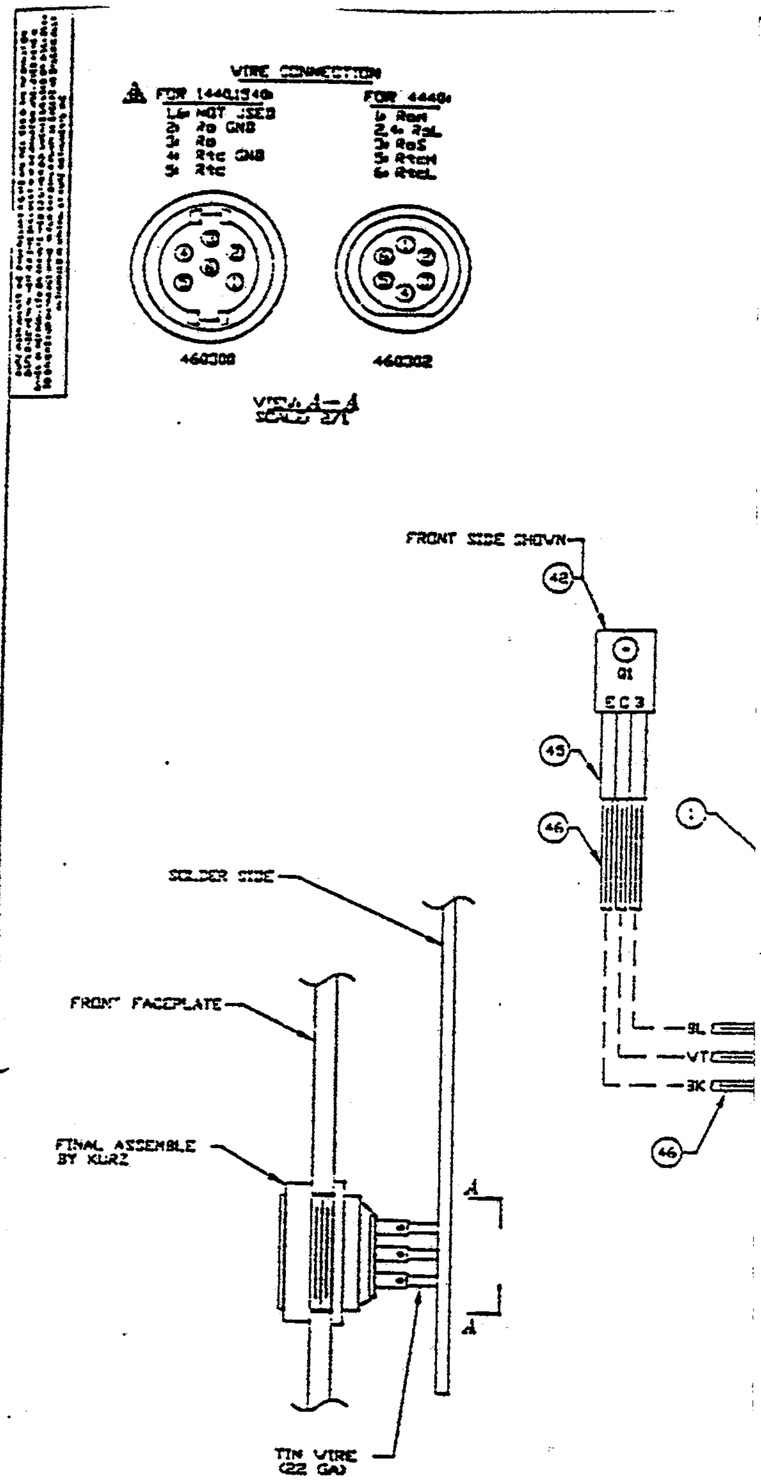
End of Section 4

Appendix A

This appendix contains components layout and schematic drawings of the 4440. 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 drawings included in this appendix are listed below:

Drawing Number	**Description**
D420175	PCB Assy. Pwr. Sup. Section



NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC SEE DWG.#300077.
2. (△) DL2,3,D4 TO BE ASSEMBLED WITH 1/8"±1/16" FROM PCB.
3. (△) CUT Q1 LEADS TO 3/16"±1/16" LONG BEFORE SOLDERING TO WIRES.
4. (△) ROTARY SWITCH AND MOUNTING HARDWARE TO BE COMPLETELY ASSEMBLED BEFORE APPLYING SOLDER FOR GOOD ALIGNMENT.
5. THE FOLLOWING HOLES NEED TO BE MASKED-OFF BEFORE WAVE SOLDERING: R1-5,10,11,17,18, E4-6, C14-20, J3,4, S2,3, J11,12.
6. (△) MODIFY TO HAVE 4 PIN DUAL ROW BEFORE INSTALLING.
7. RESISTORS R45,46 & PTC1 TO HAVE A SOLID JUMPER WIRE (22 AWG) SOLDERED IN INSTEAD OF COMPONENT.
8. (△) FOR A 4-WIRE SENSOR REMOVE U5 & CLOSE W1 WITH JUMPER WIRE.
9. (△) INSTALL BY KURZ AS REQUIRED.

*ADJ. STOPS TO
a)POSITION 6
b)POSITION 6
c)POSITION 5
d)POSITION 5

KURZ INSTRUMENTS INC.

TITLE: PCB. ASSY., 1440R2 PWR. SUP. SECTION

SIZE	DWG NO	REV
D	420175	0

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