KURZ INSTRUMENTS, INC.

KURZ™
AIR FLOW METER
WITH
MODEL 435R₁
SYSTEM TRANSMITTER

CALIBRATION
MANUAL

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Section 1: Introduction

1.1 General Overview

The calibration procedures[1] reviewed in this manual pertain to the Kurz air flow meter which comprises of a Model $435R_1$ Power Supply and Analog Linearizer Board and a Kurz thermal mass flow sensor, whether it be a Series 450 Insertion Mass Flow Element or a Series 500 In-Line Mass Flow Element. In association with the sensor is a Model $465R_x$ Current-Transmitter Board serialized with a corresponding identification number.

Note: The sensor and its associated bridge circuitry on the current-transmitter board are matched by serial number. This is due to the technical aspect of the bridge circuit being set up during a part of the calibration process at the Kurz factory we call *temp comp*. In general, the process consists of determining the balance point of the bridge circuit in reference to the amount of power supplied to the velocity winding (R_p, for resistor, probe) to maintain a constant temperature differential or overheat, above the temperature of the passive temperature compensation winding, we call R_{tc}, for resistor, temperature compensation. Thus, in no event should a sensor be interchanged with an unmatched current-transmitter board.

The calibration procedures are only applicable with the Kurz Instruments' Series 400 Air Velocity Calibration Systems; i.e., the 400A, 400B and 400BL Models (vacuum devices); and the 400B-P and 400C-P Models (pressure devices).

As a prerequisite course to performing the calibration procedures, you should review and perform the maintenance and trouble-shooting procedures discussed in Section 4. It is recommended that the unit be returned to the Kurz factory if repairs are needed. This is usually the most cost effective and reliable means.

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[1] Given that "temp comp" is current (I) mode, the calibration procedure doesn't comply with Kurz air flow meters "temp comp" for voltage (E) mode. Though, similarities in the preliminary phases of the procedures for calibration do exist for E-mode, we recommend that you consult with the Customer Service Dept. at Kurz Instruments, Inc. for procedures pertaining to E-mode system configuration to simplify the calibration procedures.

1.2 Principle of Calibration — An Overview

The Kurz air flow meter is calibrated in a Series 400 Air Velocity Calibration System with reference to a precise, NIST-traceable laminar-flow type mass flow meter used to measure the total air flowing through the calibrator. This air flows through a well-shaped nozzle to form a free-jet of air having a very uniform, flat velocity profile, which is provided by a flow straightener and air filter. The Kurz thermal mass flow sensor is inserted in the center of a free-jet of air (the free-jet is external with the Model 400B-P and C-P calibrators)[2]. Turbine-type vacuum supplies are used to "pull" the air flow through the test section except for a Model 400B-P and C-P calibrators where the air flow is "pushed". By varying the voltage to the motor(s) by means of a variable autotransformer, the velocity of the free-jet of air impinging on the sensor may be adjusted over the full range. A precise, inclined water manometer is used to measure the differential pressure (ΔP) across the pressure taps in the mass flow meter section of the Model 400 calibrator. This differential pressure is measured, corrected for nonstandard conditions and the air velocity is determined through the use of the calibration data supplied[3].

As for the system's technical aspect of calibration, dependent on the amount of air velocity measured by the Kurz thermal mass flow sensor, the current-return signal from the Model 465Rx Current-Transmitter Board (range of 100 to 600 mA) is drawn across a resistor (R_8) on the Model 435R_1 Power Supply and Analog Linearizer Board, resulting in a current-sense voltage signal (range of 0.600 to 3.000 Vdc). This current-sense voltage signal at zero and specified maximum flow rate are then adjusted in the nonlinear circuitry of the linearizer board in association with the "zero" and "span" control-potentiometers to a nonlinear 0.000 to 5.000 Vdc signal. The nonlinear voltages for each calibration point or flow rate are recorded and then plotted on a curve; whereas, break-point voltages are plotted on the same curve and linear voltage points are selected in retrospect to the break-point voltages on the curve to be used in linearizing the nonlinear signal.

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[2] Center of velocity winding (Rp) should be at a point of average flow (normally at center-line of nozzle).

[3] Local temperature and barometric pressure are measured, and correction factors are applied to correct to standard conditions referenced to a temperature of +77° Fahrenheit (F) or +25° Celsius (C) and an atmospheric pressure of 29.92 inches (760 mm) of mercury (Hg).

The linearizer circuitry on the linearizer board being an analog offset type, the number of amplifier stages shift the linear voltage points up or down to a approximate a linear curve within the range of a linear 0.000 to 5.0000 Vdc signal that is in direct representation to the amount of air flow being measured by the sensor: 0.000 Vdc represents no flow conditions, 2.500 Vdc indicates a representation of flow exactly half of the maximum flow, and 5.000 Vdc represents maximum flow.

Note: There is a maximum on one current-return signal input per linearizer board; however, a maximum of two analog outputs. One output is scaled 0.000 to 5.000 Vdc for the selected velocity or mass flow calibration; whereas, the other is scaled for mass flow rate for specified duct or pipe area, flow profile factor[4], and full scale flow rate and units.

WARNING: Kurz Instruments, Inc. will **NOT** perform a free calibration, while the Kurz air flow meter is still under warranty, if you have already made adjustments to the "zero", "span" and, or other linearization controls.

End of Section 1

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[4] The profile factor is the ratio of the duct or pipe average velocity to the velocity value measured by the Kurz thermal mass flow sensor.

Section 2: Setup

2.1 Procedure

The inclined water manometer should be mounted on a wall, filled with fluid, and levelled by following the instructions enclosed with the manometer. Two tubing adapters and two sections of vinyl tubing are supplied; connect the downstream pressure tap of the mass flow meter section of the Model 400 calibrator to the "high" end of the manometer and the upstream pressure tap to the "low" end of the manometer. The Model 400 calibrator should be used in a safe working area and preferably on a laboratory bench. For connections between the motor(s) and the variable autotransformer(s), refer to the instructional manual enclosed with the Model 400 calibrator. The sensor to be calibrated is inserted through the compression fitting such that the center of the velocity winding (R_p) is in the center of the calibrator body and aligned to face directly upstream. (**Note:** Compression fittings are not required for the 400B-P and 400C-P Models since it calibrates externally; however, to achieve better results and accuracy, align the sensor three inches from the nozzle of the nozzle section.)

Note: If you are using a laminar flow element (LFE) to calibrate a Series 500 In-Line Mass Flow Element, the long end of the unsymmetrical flow body is installed in-line with and downstream from the LFE; i.e., the air flow enters through the long end of the flow body and exits through the short end. A flow control valve is connected to the shorter end of the flow body and a vacuum source is attached to the flow control valve. In most cases, unless otherwise specified, the flow body is orientated in a horizontal run with the flow transmitter enclosure or junction box extending straight up.

2.2 Equipment

Basically, the following accessories will be required for the calibration procedures:

a) A calibrated digital voltmeter (DVM) accurate to +/-.001 Vdc.

b) A flat-bladed screwdriver with a narrow blade and preferably with a long shaft.

c) A Model 400 calibrator and supplied Meriam LFE curve.

d) A thermometer placed in such a way as to accurately determine the immediate temperature of the air flowing through the test section of the mass flow meter (NIST-traceable), and an absolute barometer to measure actual pressure in the approximate area.

e) A Kurz calibration work sheet for recording calibration information. (**Note:** A sample Kurz calibration work sheet is provided in Appendix A.)

f) A Kurz air flow meter and for recalibration purposes, the provided Calibration Data and Certification Sheet.

End of Section 2

Section 3: Procedures for Calibration

NOTICE: A completed Kurz calibration work sheet has been provided and can be found at the end of this section. The work sheet comprises of recorded data in reference to each calibration procedure in discussion. The primary objective serves to facilitate any complications (such as misinterpretation or ambiguousness of text). Please refer to this work sheet for reference purposes only.

3.1 Recording Flow Rates

If this is a recalibration, the flow rates in velocity and, or mass flow are listed on the Calibration Data and Certification Document enclosed with the Kurz air flow meter. Refer to the appropriate serial number on the document corresponding to the matching equipment.

The following steps describe the procedure for obtaining the flow rates for a desired flow range:

Step 1. Record the selected maximum flow rate for calibration point 11 in the "Flow Rate" column. (**Note:** You will be required to record the remaining flow rates.)

Step 2. Divide this maximum flow rate by 10. The value calculated will be used as the decremental value; e.g., if the maximum flow rate is 1500 standard feet-per-minute (SFPM), then the decremental value is 150.

Step 3. To obtain the flow rate for calibration point 10, subtract the decremental value from the maximum flow rate.

Step 4. Continue to subtract the decremental value from each preceding calibration point until you have calculated the flow rate for calibration point 2.

Step 5. After you have calculated the flow rate for calibration point 2, divide this flow rate by half to obtain the flow rate for calibration point 1.

Step 6. Zero flow rate will be a value of 0 in calibration point 0.

3.2 Recording Inches of Water

A. From the Meriam LFE curve supplied with the Model 400 calibrator, find the differential pressure (H_S) corresponding for each flow rate recorded in the "Flow Rate" column. Record each value in the "Inches of H_2O" column for calibration points 0 through 11.. Refer to Figure 3.2-1 for an example of a Meriam LFE curve in cubic-feet-per-minute (CFM).

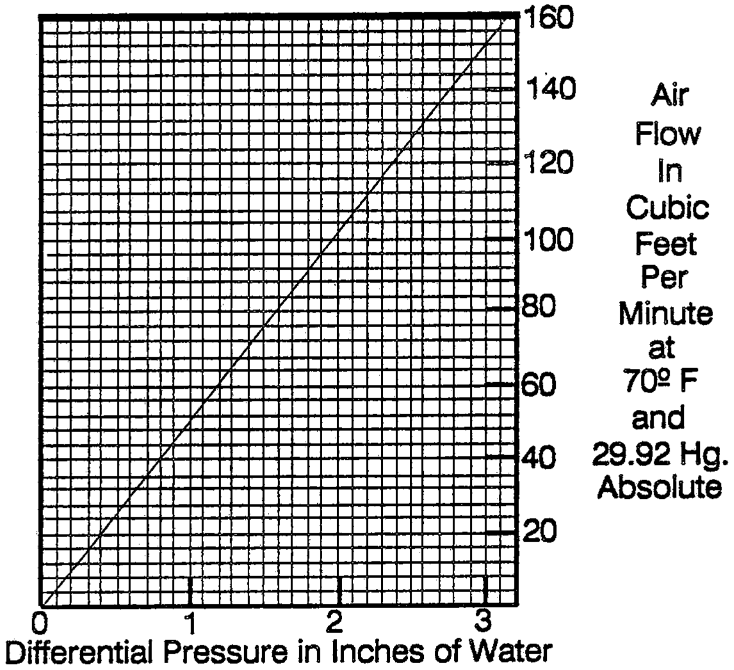
Note:

$$Velocity = \frac{SCFM}{LFE\ Area} = SFPM$$

Whereas:

$$Mass\ \ Flow = SFPM\ x\ LFE\ Area = SCFM$$

Figure 3.2-1
Example of a Calibration Curve



B. The next procedure consists of adjusting the air flow through the test section of the Model 400 calibrator. The flow will be adjusted to a specific level on the manometer. The manometer reflects flow rates according to the inches of water.

Note: If not already set, adjust the manometer to read 0.0 inches of water at zero flow rate.

However, to obtain the desired flow rates in the "Flow Rate" column, you must initially determine the temperature and pressure correction factor for the mass flow meter section; in other words, the Kurz thermal mass flow sensor, unlike the Model 400 calibrator, is a mass flow instrument and will provide readings of a flowing gas relative to a standard temperature and pressure (STP), regardless of the actual temperature and pressure. Therefore, you will need to correct for actual temperature and pressure to STP. The temperature correction factor (T_{cf}) is shown in Chart A. The pressure correction factor (P_{cf}) is the ratio of the true absolute pressure (P_a) at the inlet to the Model 400 calibrator (normally this is the same as the barometric pressure) to the standard atmospheric pressure (P_s) of 29.92 inches of Hg. Thus:

$$P_{cf}=\frac{P_a}{P_s}$$

The external flow air velocity calibrators (400B-P and 400C-P Models), are pressure devices rather than vacuum devices resulting in an external free-jet. With this principle in mind, a conversion constant (13.6) is used in the pressure correction equation. Therefore:

$$P_{cf}=\frac{\left(\frac{H_s}{13.6}\right)+P_a}{P_s}$$

Chart A
Temperature Correction Factor (Tcf)
Air Base Temperature 25° C

AIR TEMPERATURE CORRECTION CHART										
°F	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
50	1.0848	1.0810	1.0773	1.0735	1.0698	1.0661	1.0625	1.0583	1.0552	1.0516
60	1.0480	1.0444	1.0409	1.0373	1.0039	1.0303	1.0269	1.0234	1.0200	1.0165
70	1.0132	1.0097	1.0064	1.0031	.9997	.9964	.9931	.9899	.9866	.9833
80	.9802	.9769	.9738	.9705	.9674	.9643	.9611	.9581	.9549	.9519
90	.9489	.9548	.9428	.9397	.9368	.9338	.9308	.9279	.9250	.9220

Note: In some cases, there is a need to correct from actual temperatures to standard temperatures referenced to 0° C and 1 BAR pressure; for instance, European countries where nominal units are applicable. The temperature correction factor (*Tcf*) is shown in Chart B.

Chart B
Temperature Correction Factor (Tcf)
Air Base Temperature 0° C

AIR TEMPERATURE CORRECTION CHART										
°F	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
50	.9939	.9905	.9870	.9836	.9801	.9768	.9735	.9701	.9668	.9634
60	.9602	.9568	.9536	.9503	.9472	.9439	.9408	.9376	.9345	.9313
70	.9283	.9251	.9220	.9190	.9159	.9128	.9099	.9069	.9038	.9009
80	.8980	.8950	.8921	.8892	.8863	.8834	.8805	.8778	.8749	.8721
90	.8693	.8665	.8637	.8610	.8583	.8555	.8528	.8501	.8474	.8447

If it is assumed there are a certain amount of air velocities to be set up in the Model 400 calibrator, the correct differential pressure drop (ΔP) across the flow meter section must be determined. Differential pressure (H_s) in inches of water corresponds to air velocity. Because present conditions will probably be different than the basis for the calibration (25° C and 29.92 inches Hg) the indicated differential pressure (H_{ind}) must be determined as follows using the temperature (T_{cf}) and pressure (P_{cf}) correction factors:

$$H_{ind}=\frac{H_s}{P_{cf}\,x\,T_{cf}}$$

Example: Establish the proper differential pressure to set up an air velocity of 1500 SFPM. The air temperature at the inlet to a Model 400B calibrator is 90° F and the absolute pressure is 29.00 inches of Hg. Find H_{ind}.

a) From Chart A, $T_{cf}=0.9489$

b) $P_{cf}=\frac{29.00}{29.92}=0.96925$

c) From Figure 3.2-1, $H_s=1.720$ *inches of water*

d) Therefore, $H_{ind}=\frac{1.720}{0.9489\,x\,0.96925}=1.870$ *inches of water*

e) Adjust the variable transformer(s) to obtain exactly 1.870 inches of water in the manometer.

C. If you wish to know the actual air velocity instead of the "standard" air velocity referenced to 29.92 inches Hg and 25° C. The following equation may be used:

$$V_a = \left(\frac{\rho_s}{\rho_a}\right) x\ V_s$$

Where,

V_a= velocity in actual feet-per-minute

V_s= standard velocity in feet-per-minute (SFPM)

ρ_s= standard air density

ρ_a= actual air density

Another way to write the above equation is:

$$V_a = \left(\frac{P_s\ x\ T_s}{P_a\ x\ T_s}\right) x\ V_s = 0.05578 \left(\frac{T_a}{P_a}\right) x\ V_s$$

Where,

P_s= 29.92 inches Hg pressure

P_a= actual barometric pressure (in Hg)

T_s= 25° C = 536.4° R (Rankine)

T_a= actual temperature in ° R (° R = ° F + 459.4)

3.3 Recording Current-Sense Voltage Signal

Before initiating this procedure, you will be required to check the bridge voltage (B.V.) on the Model 465R_x Current-Transmitter Board; in addition, record the voltage measurement at zero flow rate and of the known air velocity at maximum flow rate. Therefore, refer to Section 4: *Trouble-Shooting*, for your appropriate current-transmitter board and the test point placement for measuring B.V.

CAUTION: If the B.V. is 5.000 Vdc or more (with no air flow impinging on the sensor), and the voltage does not start to alleviate below 5.000 Vdc within 10 seconds, turn power OFF, immediately. Supplying power for more than 10 seconds under these conditions may result in damage to the sensor.

Note: The Kurz air flow meter must be operational, and a calibrated digital voltmeter (DVM) accurate to within ± 0/.001 Vdc must be connected between terminal block 1, terminal screw 3 (TB1-3; GND) and terminal block 1, terminal screw 9 (TB1-9; I RET).

Step 1. Check to make sure that no air flow conditions are present; i.e., the test section of the Model 400 calibrator is at zero flow. Allow the sensor and associated circuitry to stabilize. (**Note:** For an external flow air velocity calibration, cover the protective window of the sensor to prevent any air flow to impinge on the sensor.)

Step 2. While monitoring the current-sense voltage signal at TB1-9, record the voltage measurement for calibration point 0 in the "Current-Sense DC Voltage" column for zero flow rate.

Note: You should check for current-sense voltage signal immediately due to after several minutes at zero flow in a small air volume, the heat produced by the R_p winding begins to affect the R_{tc} winding.

Step 3. For calibration points 1 through 11, starting with the maximum flow rate, execute Steps 1 through 5 in Subsection 3.2, Part B. Remember to record the current-sense voltage signal for each calibration point in the "Current-Sense DC Voltage" column.

3.4 Adjustments to the Nonlinear Circuitry

3.4.1 Calculating Resistant Values for R_{17} and R_{23}

This procedure consists of calculating resistant values for resistors R_{17} and R_{23} in the nonlinear section: R_{17} is for the "zero" control-potentiometer; whereas, R_{23} is for the "span" control-potentiometer. Both R_{17} and R_{23} are located below the "zero" and "span" control-potentiometers, as shown in Figure 3.4-1.

Formula to obtain the resistant value for R_{17}:

$$R_{17} = \frac{50}{X} - 1 = \mathit{Value\ in}\ K\Omega$$

Formula to obtain the resistant value for R_{23}:

$$R_{23} = \frac{1}{(Y-X)} x\ 45.45 - 1 = \mathit{Value\ in}\ K\Omega$$

Where,

X= Current-sense voltage signal at zero flow rate

Y= Current-sense voltage signal at maximum flow rate

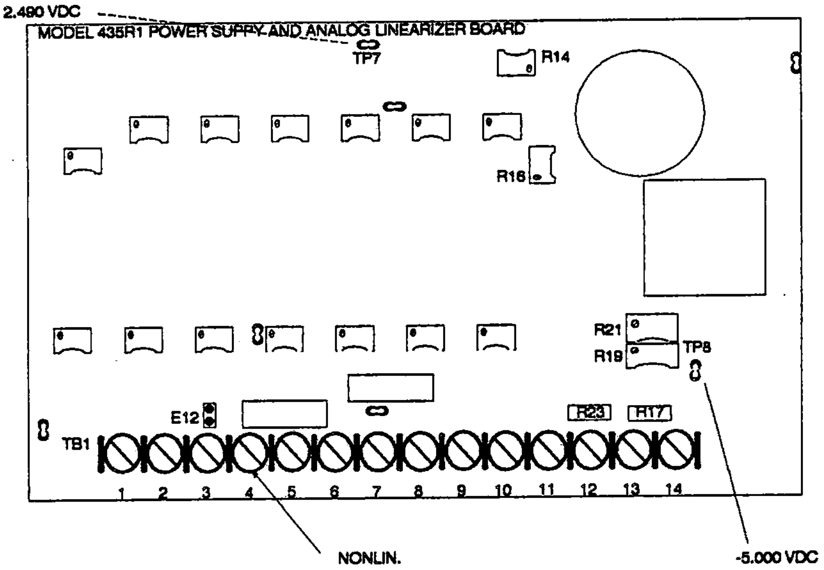
After calculating for correct resistance and solder R_{17} and R_{23} on the linearizer board. Refer to Figure 3.4-1 for the resistor placements.

3.4.2 Calibrating the Nonlinear Circuitry

The next procedure is to adjust the current-sense voltage signals at zero flow rate and maximum flow rate to a nonlinear voltage signal; i.e., adjust the "zero" control-potentiometer (R_{19}) at zero flow rate to a nonlinear 0.000 Vdc signal and adjust the "span" control-potentiometer (R_{21}) while monitoring the known air velocity at specified maximum flow rate to a nonlinear 5.000 Vdc signal. Refer to Figure 3.4-1 for the control-potentiometer placements and test point locations on the linearizer board.

Figure 3.4-1

Model 435R_1 Power Supply and Analog Linearizer Board



Step 1. Immediately after powering up the Kurz air flow meter, check the internal 2.490 Vdc reference voltage. Measure the voltage between terminal block 1, terminal screw 3 (TB1-3; GND) and test point 7 (TP7). The voltage measured should be 2.490 Vdc ± 5.0%. If necessary, adjust the contol-potentiometer (R_{14}) up or down until you get a reading of 2.490 Vdc.

Step 2. Next, check the internal -5.000 Vdc reference voltage. Measure the voltage between TB1-3 (GND) and test point 8 (TP8). The voltage measured should be -5.000 Vdc ± 5.0%. If necessary, adjust the contol-potentiometer (R_{16}) up or down until you get a reading of -5.000 Vdc.

Step 3. Check to make sure that no air flow conditions are present; i.e., the test section of the Model 400 calibrator is at zero flow. Allow the sensor and associated circuitry to stabilize. (**Note:** For an external flow air velocity calibration, cover the protective window of the sensor to prevent any air flow to impinge on the sensor.)

Step 4. Check the nonlinear voltage between terminal block 1, terminal screw 4 (TB1-4; NONLIN.) and TB1-3 (GND), adjust R_{19} up or down until you get a reading of 0.000 Vdc. (**Note:** Record this value for calibration point 0 in the "Actual Nonlin. Vdc" column.

Note: You should check for 0.000 Vdc immediately due to after several minutes at zero flow in a small air volume, the heat produced by the R_p winding begins to affect the R_{tc} winding.

Step 5. Starting with the maximum flow rate, execute Steps 1 through 5 in Subsection 3.2, Part B.

Step 6. While still measuring the nonlinear voltage at TB1-4, adjust the R_{21} up or down until you get a reading of 5.000 Vdc at specified maximum flow rate. (**Note:** Record this value for calibration point 11 in the "Actual Nonlin. Vdc" column.

Step 7. For calibration points 1 through 10, repeat step 5. Remember to record the value for each calibration point in the "Actual Nonlin. Vdc" column.

3.4.3 Verifying the Nonlinear Voltages

The nonlinear circuitry, if the "zero" and "span" control-potentiometers are adjusted properly in reference to the current-sense voltage signals at zero and specified maximum flow rate, should yield a nonlinear voltage reading approximate to those recorded in the "Actual Nonlin. Vdc" column.

Formula for calculating the nonlinear voltages, given the following:

$X=$ Current-sense voltage signal at zero flow rate

$Y=$ Current-sense voltage signal at maximum flow rate

$Z=$ Specific current-sense voltage signal of a calibration point for calculating the nonlinear voltage

Whereas:

$$\textit{Factor Constant} = \frac{Y-X}{5}$$

Thus:

$$\textit{Nonlin. Vdc} = \frac{Z-X}{\textit{Factor Constant}}$$

Example: Given the proper differential pressures to set up air velocities of 0 SFPM, 750 SFPM, and 1500 SFPM. The current-sense voltage signal measured between TB1-3 (GND) and TB1-9 (I RET) are the following: 0 SFPM is 0.900 Vdc, representing a zero flow rate; 1500 SFPM is 1.500 Vdc, representing a maximum flow rate; and 750 SFPM is 1.384 Vdc, indicating a representation of flow of exactly half of the maximum flow rate. Calculate the nonlinear voltage for the calibration point at 750 SFPM.

a) Given: $X=0.900Vdc$; $Y=1.500Vdc$; and $Z=1.384Vdc$

b) $\textit{Factor Constant} = \frac{1.500-0.900}{5} = 0.12$

c) Therefore, $\textit{Nonlin. Vdc} = \frac{1.384-0.900}{0.12} = 4.033Vdc$

3.5 Graphing Data Points

3.5.1 Plotting the Nonlinear Voltages on a Graph

This procedure illustrates the graphic technique used to plot the nonlinear voltages recorded in the "Actual Nonlin. Vdc" column against the ideal voltages in the "Desired Lin. Vdc" column. The ideal voltages are plotted on the x-axis and the nonlinear voltages are plotted on the y-axis.

Example: Provided data representing the values of the variable quantities on the y-axis vs. the values of the constant quantities on the x-axis. The ideal voltages, across the horizontal axis, correspond to a linear 0.000 to 5.000 Vdc output, with the vertical axis corresponding to nonlinear 0.000 to 5.000 Vdc input. Figure 3.5-1 shows this data plotted on a graph. Figure 3.5-2 shows a curve through the data points with one continual slope, avoiding a straight point-to-point connection of data points.

X-Axis (Ideal Voltages)	Y-Axis (Nonlinear Voltages)
0.000 Vdc	0.000 Vdc
0.250 Vdc	1.460 Vdc
0.500 Vdc	2.140 Vdc
1.000 Vdc	2.923 Vdc
1.500 Vdc	3.410 Vdc
2.000 Vdc	3.740 Vdc
2.500 Vdc	4.037 Vdc
3.000 Vdc	4.270 Vdc
3.500 Vdc	4.490 Vdc
4.000 Vdc	4.664 Vdc
4.500 Vdc	4.855 Vdc
5.000 Vdc	5.000 Vdc

Figure 3.5-1

Graph of Plotted Nonlinear Voltages vs. Ideal Voltages

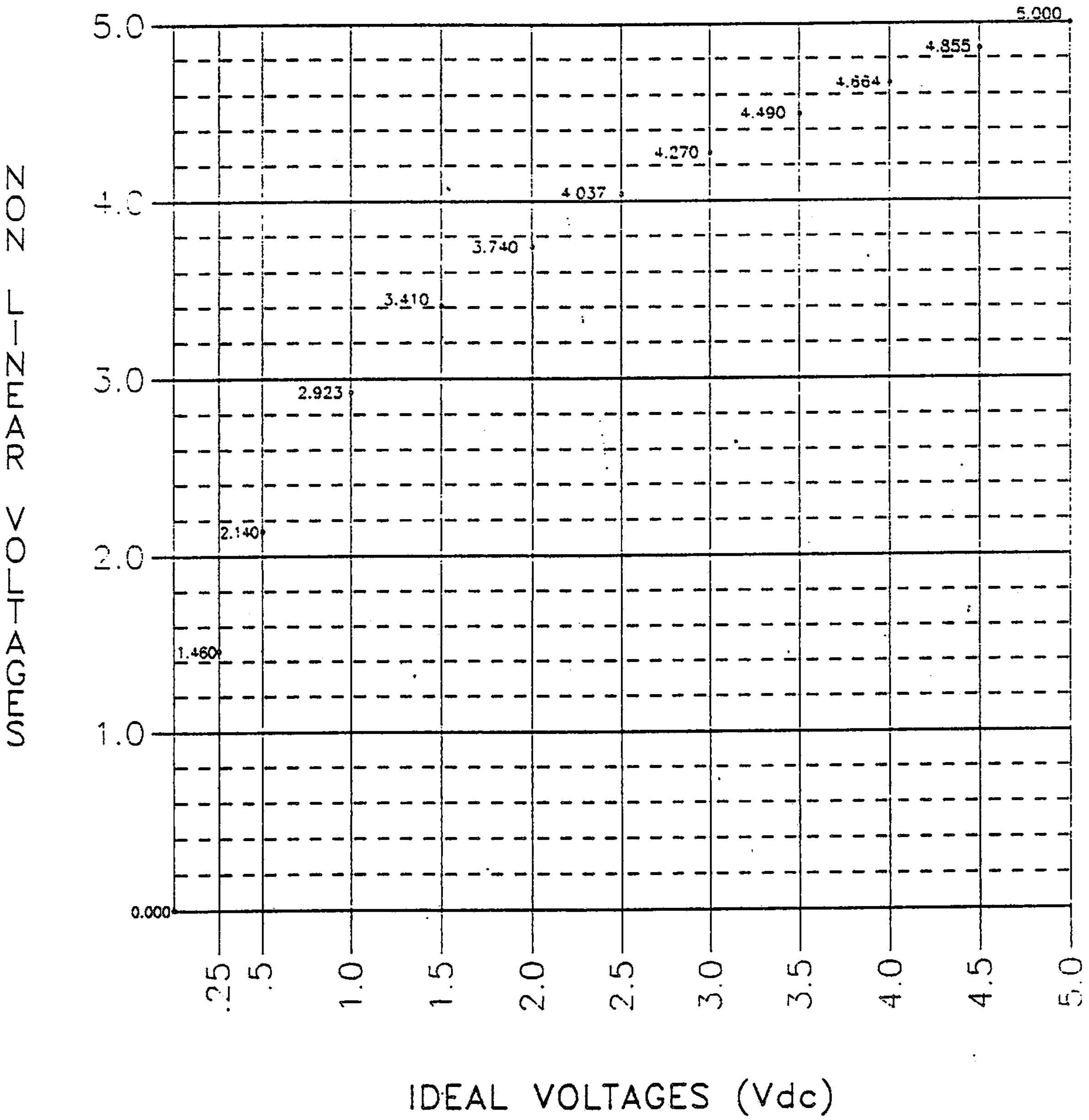
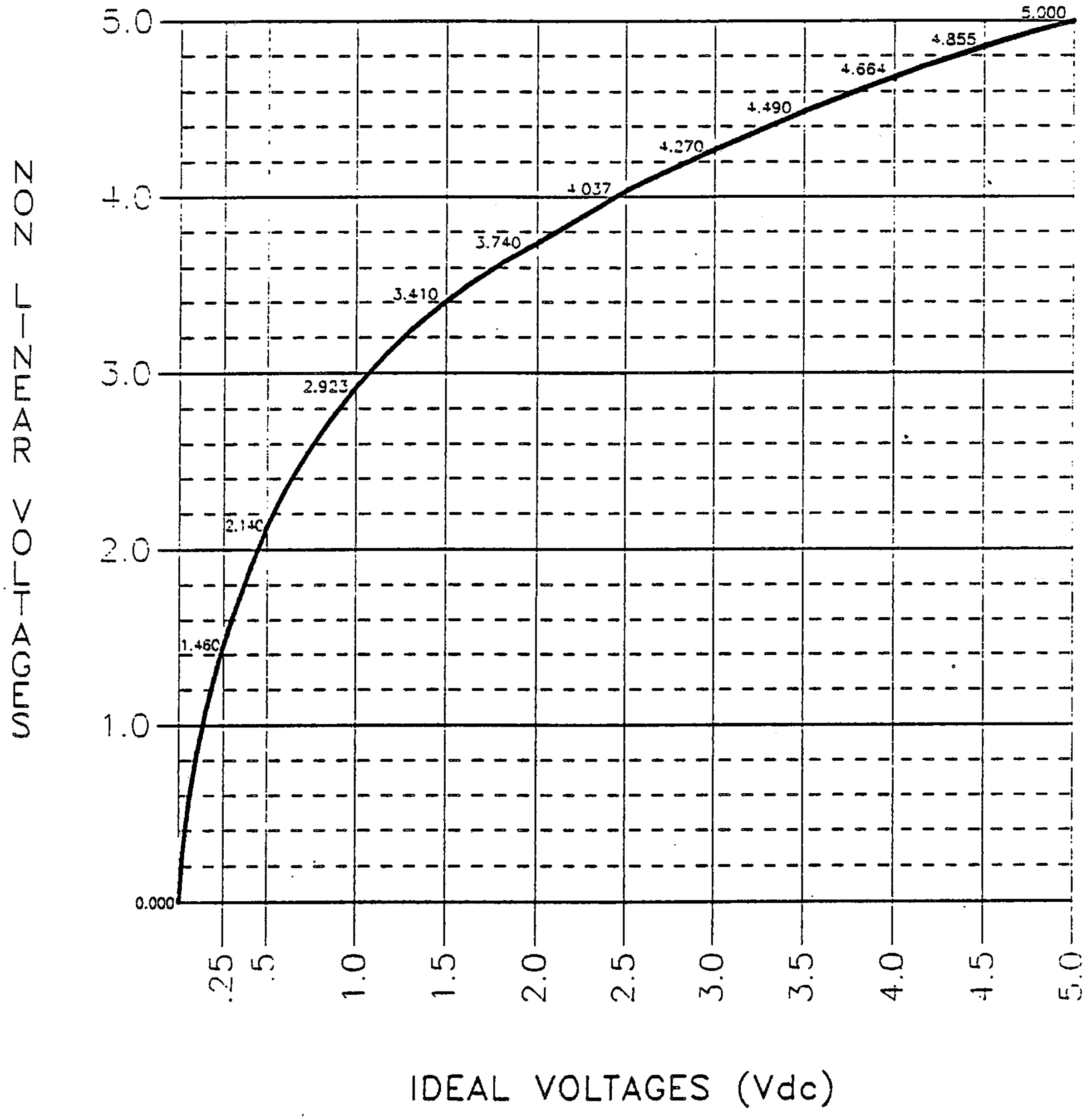


Figure 3.5-2

Curve for Plotted Nonlinear Voltages vs. Ideal Voltages



3.5.2 Plotting Break-Point Voltages on the Curve

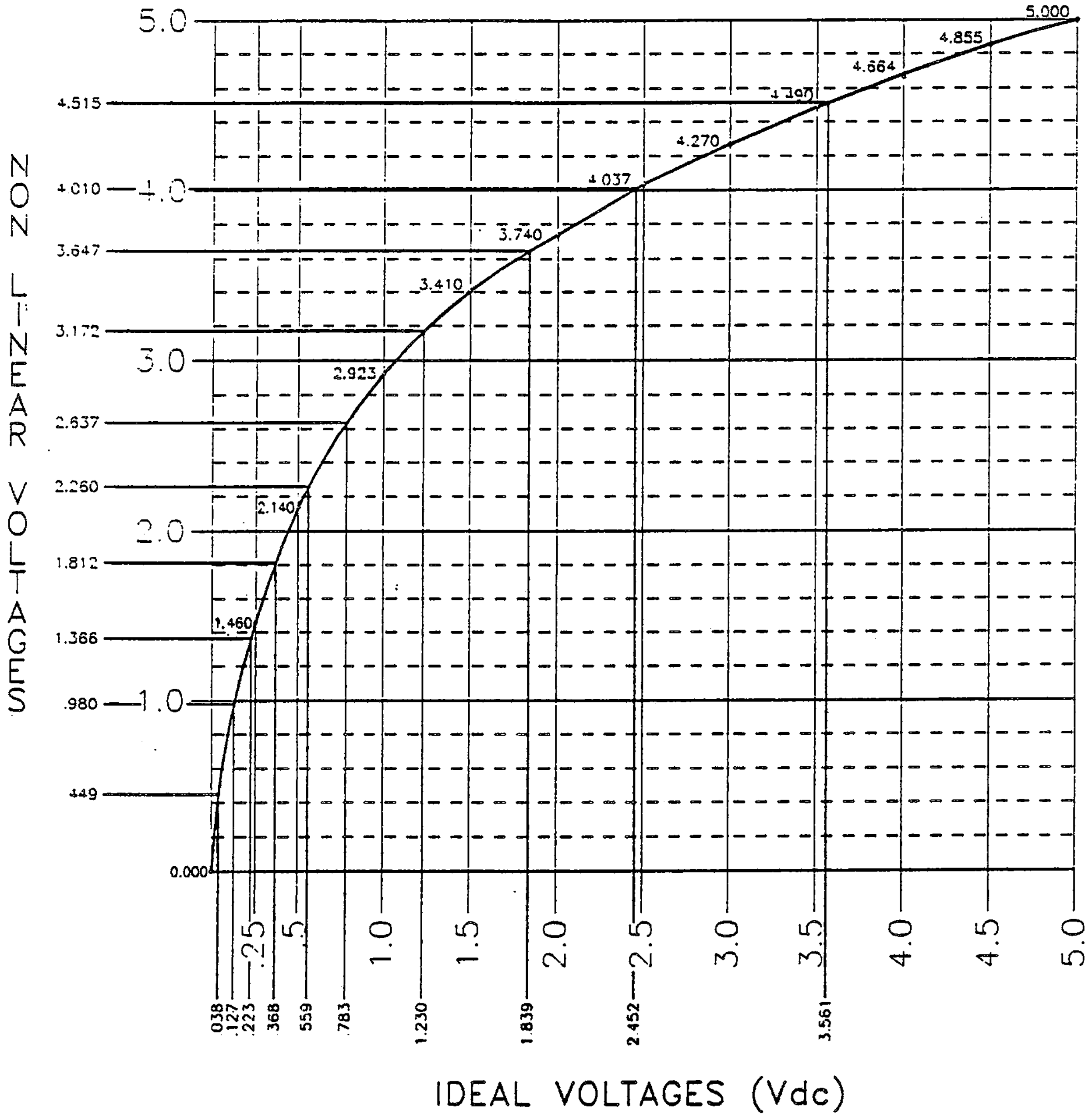
Step 1. Identify on the curve the break-point voltages listed in the "Break-Points" column.

Step 2. Draw a horizontal line from each break-point voltage on the curve to the base line of the y-axis. From each break-point voltage on the same curve, draw a vertical line down to the base line of the x-axis.

Step 3. The data extracted from the x-axis represents data points that will used in linearizing the nonlinear 0.000 to 5.000 Vdc input signal to a linear 0.000 to 5.000 Vdc output signal. Record the obtained data for calibration points 0 to 11 in the "Linear Vdc Points" column.

For example, the curve now have the linearized "ideal voltages" from each of the break-point voltages as shown in Figures 3.5-3.

Figure 3.5-3
Linear Voltage Points on the Curve



3.6 Adjustments to the Linear Circuitry

3.6.1 Calibrating the Linear Circuitry

This procedure primarily consists of inputting each break-point voltage listed in the "Break-Points" column to the linear circuitry of the linearizer board, and adjusting the appropriate control-potentiometer for each data point recorded in the "Lin. Vdc Points" column, respectively.

Note: A calibrated digital voltmeter (DVM) accurate to within ± 0.001 Vdc must be connected between terminal block 1, terminal screw 2 (TB1-2; LIN. OUT) and terminal block 1, terminal screw 3 (TB1-3; GND), and a variable power supply capable of up to 5.000 Vdc connected to test point 9 (TP9) and TB1-3 (GND).

Step 1. As a precaution, before supplying input power to the linearizer board, we recommend the two-wire conductor cable be disconnected from the linearizer board to prevent any damages that may may be incurred to the sensor and its associated circuitry during this calibration procedure.

Step 2. Pull out jumper E_{12} from the linearizer board. Removing jumper E_{12} isolates the actual nonlinear signal that would be transmitted to the linear section in normal operations when the Kurz air flow meter is operational. Refer to Figure 3.6-1 for a simplified component diagram of the linearizer board. (**Note:** You will be adjusting the control-potentiometers shown within the dotted lines; i.e., by working clockwise starting from R_{62}, R_{63}, R_{75}...R_{68}.)