VT-2000

Airflow Transmitter for Smaller Ducts

INSTALLATION, OPERATION,
& MAINTENANCE MANUAL

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Protected by US Patent 4,770,035

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WARRANTY

Tek-Air Systems Inc. warrants that this product, under normal use and service as described in this Installation, Operation, and Maintenance manual, is free from defects in workmanship and material for a period of thirty-six months from the date of shipment to the customer. This limited warranty is subject to the following conditions:

With respect to any repair services rendered, Tek-Air warrants that the parts repaired or replaced will be in good working condition, under normal use, for the period of the original warranty, or for 90 days from date of shipment to the customer if the original warranty period has expired.

Unless specifically authorized by Tek-Air in writing, no warranty is made with respect to, and no liability is assumed in connection with, any goods which are incorporated into other products or equipment by the Buyer.

The foregoing is in lieu of all other warranties and is subject to the conditions and limitations stated herein. No other express or implied warranty of fitness for particular purpose or merchantability is made.

The exclusive remedy of the user or purchaser and the limit of the liability of Tek-Air or any other seller for any and all losses, injuries, or damage resulting from the use of this product shall be the return of the product and the refund of the purchase price, or, at the option of Tek-Air or any other seller, the repair or replacement of the product. In no event shall Tek-Air or any other seller be liable for any incidental or consequential damages.

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Chapter 1
Operation

A. GENERAL DESCRIPTION

The Tek-Air VorTek™ airflow measurement system consists of one or more duct insertion probes and an electronic transmitter. The VorTek measurement system is capable of measuring airflow volume in ducts of all sizes and shapes.

VorTek insertion probes have multiple velocity sensors located along their length. Each sensor measures airflow velocity using a unique, patented (4,770,035) application of the digital velocity sensing technique called vortex shedding.

Vortex shedding is the generation of eddy currents by an obstruction in an air stream. Airflow through each VorTek sensor creates a succession of eddy currents which are then sensed as pressure pulses. The frequency at which these pulses are generated is directly proportional to the velocity of airflow around the sensor.

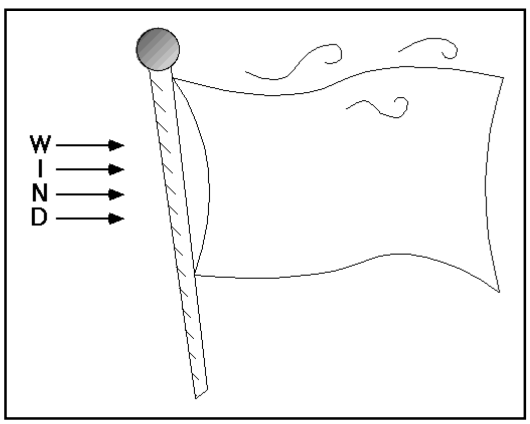
In large ducts, the profile of the air velocity across a duct is often uneven due to the bends and transitions in the ductwork. In-line devices such as dampers, elbows, and transitions also create disturbances in the flow profile. To compensate for these varying velocity profiles, multiple VorTek sensors are utilized within a duct. The frequency outputs of individual sensors are flow averaged to obtain the average duct velocity.

The VorTek transmitter totalizes the frequency signals from the individual sensors to perform true velocity averaging. From this average, an electronic signal (4-20mA, 1-5V, 2-10V) is generated for direct input to a customer's control system.

The VorTek VT-2000 transmitter is specifically designed for application in smaller ducts where one to four sensors are adequate for measurement of the air volume. This manual will cover the operation, installation, startup, and calibration of the VorTek VT-2000 probes and transmitter.

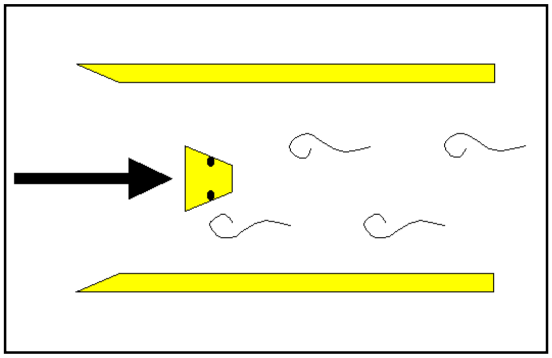
B. OPERATION OF VORTEK™ SENSORS

The VorTek sensing system measures air velocity by a physical principle called vortex shedding. The vortex shedding phenomenon can be witnessed all around us in everyday life. Swirling vortices or eddy currents, are generated whenever air or liquids flow around an obstruction in their flow path. Common examples are the eddy currents which develop behind rocks in a stream, and in the fluttering of a flag behind a flagpole. The flag and the flagpole provide the most visual example of how vortex shedding works.



Wind, Flagpole, & Flag
Figure 1-1

The flagpole presents an obstruction in the path of the airflow, which is the wind. As the wind passes around the flagpole, vortices (eddies) are created in the wake of the pole. These vortices, in accordance with the laws of nature, are developed and shed in an alternating manner, from one side of the flagpole to the other. The evidence of the shedding of vortices is in the waving of the flag itself. Refer to Figure 1-1.



VorTek Sensor
Figure 1-2

Tek-Air's unique VorTek flow sensors use a trapezoidal shaped obstruction placed in a small tube section to generate stable vortices over a wide range of low velocities. Pressure sensors sense the passing of individual eddies. Refer to Figure 1-2. Multiple VorTek sensors are mounted on probe supports to provide ample coverage of the duct cross section.

C. TRANSMITTER OPERATION

The VT-2000 transmitter is normally supplied with either one or two duct insertion probes. Both probes connect to the electronics by a flexible umbilical cord.

The VT-2000 transmitter is capable of accepting inputs from a minimum of one to a maximum of four VorTek sensors. These can be located on one or two probe bars.

In the simplest sense, the transmitter electronics can be considered a pulse to analog converter. The transmitter receives electronic pulses from each of the VorTek sensors. As every pulse represents the same increment of velocity, the pulses need only be summed together and integrated over time to determine velocity. Additional circuitry converts the total pulses per second into an analog, 4-20mA signal which is scaled to be proportional to either CFM or FPM.

The VorTek transmitter performs two functions electronically. The amplifier section performs the required signal conditioning for up to four VorTek sensor inputs. The summing section accepts the conditioned pulses from the amplifier section, sums them, integrates them, and then converts them into a 4-20mA output signal. The summing section also provides the power supply and calibration adjustments.

Because airflow is inherently turbulent, the output signals produced by the electronics tend to fluctuate. To eliminate these fluctuations, the transmitter has damping built into the electronics, with a time constant of 0.67 seconds.

D. SPECIFICATIONS

Sensors and Probes

- Sensor Type: Vortex shedding
- Velocity Range: 350 to 7000 FPM
- Probe Length: 8" to 36"
- Probe Configuration: Rectangular, round, oval
- Materials of Construction; Standard:
  Mounting Plate: Galvanized steel or aluminum
  Probe Bar: Extruded aluminum
  Sensor Assembly: Polycarbonate and ABS
  Miscellaneous: EPDM finishing strip
- Materials of Construction; Fume hood:
  Mounting Plate: Stainless steel
  Probe Bar: CPVC
  Sensor Assembly: Polycarbonate and ABS
- Materials of Construction; Stainless steel:
  Mounting Plate: Stainless steel
  Probe Bar: Stainless steel
  Sensor Assembly: Stainless steel
- Probe Support Mounting: Flange plate and threaded rod
- Sensors Per Probe Bar: 1 to 4 per Bar
- Number of Probe Bars per Transmitter: 1 to 2
- Total Number of Sensors: Cannot Exceed 4
- Probe Temperature Limit: Standard
  -20° to 200°F
- Probe Temperature Limit: Fume hood:
  0° to 170°
- Weight: Function of probe configuration

Transmitter Electronics

- Input: One to four sensor inputs
- Output: 4-20mA, 1-5V, 2-10V; jumper selectable
- Load Capability: 650 ohms
- Voltage: 15-35 VDC or 12 to 28 VAC
- Power: 50 mA at 24 VDC or 24 VAC
- Calibration: Adjustable from 0-1000 to 0-7000 FPM;
- Operational Temperature: 40° to 130° F
- Frequency Conversion Error: Less than ±0.25% FS (4 sensors)
- Temperature Error: Less than ±0.5% over 25° to 125°F
- Low Frequency Cutout: ~300 FPM/50Hz (fixed)
- Time Constant: 0.67 seconds (fixed)
- Housing: NEMA 1 type, use indoors only
- Dimensions: 6" x 6" x 2" (WxHxD)
- Weight: 5 lbs with probes
- Mounting: Duct bracket provided
- Probe Connection: 16" umbilical

END OF CHAPTER 1

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Chapter 2
Transmitter Mounting and Location

A. INSTALLATION

The VT-2000 measurement system consists of two basic elements which are connected; the probes and the transmitter. The VorTek sensing probes are inserted into the duct and measure the velocity of the air moving through the duct. The VorTek transmitter, which is connected to the probes, converts the electronic pulses generated by the sensors into an electronic signal compatible with any DDC control system.

The following details are provided on the mounting and installation of the VorTek transmitter and flow probes. Please read this data carefully and install the equipment in strict accordance with the instructions provided. Should you have any questions, contact Tek-Air directly.

B. PROBE MOUNTING AND LOCATION

General - VorTek probes are designed for installation in ducts, regardless of the duct size. Usually, the larger the duct, the more sensing points required to provide an accurate measurement of airflow volume. In a typical application, multiple probe support bars are directly inserted in the duct. Each probe bar has multiple VorTek sensors for measurement of the air velocity in the area of the duct it serves.

Turbulent Airflow - Probe design allows for installation in ductwork without the requirement for special air straighteners. However, care should be taken to avoid installation within close proximity to:

- Balancing dampers
- Modulating opposed blade dampers
- Non-airfoil type, normally open dampers
- Elbows without turning vanes
- Expanding transitions
- Humidifiers
- Coils

For the minimum acceptable installation criteria for specific applications, refer to Appendix A-C, the drawing "Minimum Recommended Installation Requirements." If more space is available, probes should be located so that they have two thirds of the straight duct length upstream of the probe. Keep in mind that locations other than those specified as minimums often have areas with very high turbulence and reverse flow. Accurate and repeatable airflow measurement is impractical in these locations.

Direction of Airflow - VorTek airflow probes must be mounted so that airflow direction corresponds to the direction indicated by the flow arrow on the duct mounting flange. Failure to mount the units properly will result in a "no flow" output. Probes can be mounted in any plane, vertical or horizontal, without affecting the measurement quality.

Temperature - VorTek probes are designed for use in normal HVAC applications. Continuous operation with temperatures over 200°, with standard materials of construction is not recommended. Fume hood exhaust sensors with CPVC construction have a limit of 170°. Close proximity to steam humidifiers and coils is not recommended. Should a steam valve leak when air is not flowing, temperatures in excess of the recommended maximum can occur. Stainless steel probes may be used as high 325°, if ordered for high temperature service, otherwise 200° is maximum.

Airborne Contaminants - Normal dirt and dust associated with air conditioning and fume hood applications will not affect probe performance. The presence of severely agglomerating or sticky particles can cause performance problems and should be avoided. However, should this occur, the probes can be cleaned with soapy water. In cases where high particulate loading is considered normal, the probes may be ordered with an integral air purge option.

Inspection - Carefully unpack and inspect the probes. If probes have been bent or broken in shipment, advise Tek-Air immediately.

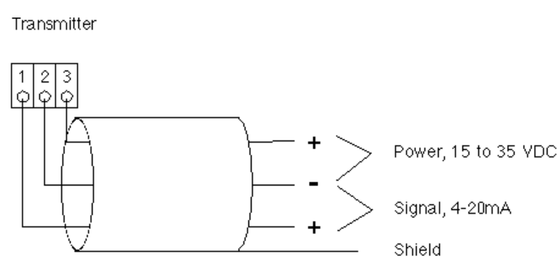
Installation - Probes are mounted across the duct and attach to the duct on both sides. A 3.5" diameter hole should be located on the side of the duct where the probe will be inserted. On probes longer than 12", a 5/16" diameter hole is required in the duct wall, on the opposite side of the duct. Refer to details in Appendix A-2 for different configurations.

The sensor flange plate is provided with a neoprene gasket and does not require the application of special sealants. The flange plate should not be insulated either, to allow for easy removal, if ever desired.

C. TRANSMITTER MOUNTING AND LOCATION

General - The transmitter is typically located in close proximity to the probes and transmits a 4-20mA signal, over short or long distances, to the customer's control system. Refer to Appendix A-2 for mounting details.

Transmitter Location - The VorTek transmitter is small and is designed for mounting on the duct in close proximity to the point of measurement. The transmitter housing is a general purpose enclosure and is not designed for mounting outdoors or in areas requiring explosion-proof classification. Areas where the temperatures are expected to exceed 130°F for extended periods of time are to be avoided.



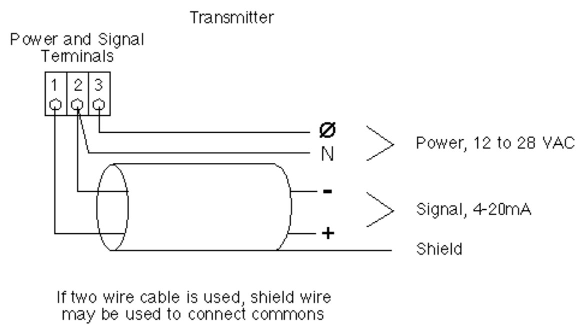
DC Wiring
Figure 2-1

D. TRANSMITTER WIRING

Terminations - Inside the transmitter enclosure, in the center of the electronics board, are three removable termination points. These are for the termination of power and signal wiring. Power may be either DC or polarized AC. Connections for DC power are to be made as in Figure 2-1.

With DC power, signal and power wiring should be run in a common shielded cable. Shields should be terminated at only one end and taped back on the other. Shields should be terminated at the controller in accordance with the DDC controller manufacturer's instructions. If the shield wire is normally tied to the controller common, the shield (or drain) wire may be used to connect the transmitter common to the controller common. Refer to the Appendix for additional DC wiring possibilities.

If AC power is used, signal and power wiring can be run together in the same conduit, but only the signal should be run in a shielded cable. Shields should be terminated at only one end and taped back on the other. Shields should be terminated at the controller, in accordance with the controller manufacturer's instructions. Refer to Figure 2-2.



Wiring for AC Power

NOTE: Special care must be taken if one AC power transformer is used to power multiple units. Polarization must be maintained or a short circuit may be created. In addition, it is not recommended that the same transformer be used to power the VT-2000 transmitter and the DDC controller, unless the controller is fully isolated from 24 VAC power.

<u>Output Signal</u> - The transmitter output is 4-20mA and is capable of driving up to 650 ohms of load. Control equipment which accepts voltage inputs can be accommodated by the installation of an appropriate dropping resistor at the controller input terminals. A 500 ohm resistor will provide a 2-10 volt signal; a 250 ohm resistor will provide a 1-5 volt signal.

Integral dropping resistors to accommodate 1-5 and 2-10 volt requirements are also provided on the circuit board. A 1-5 volt output is selected by placing jumpers over both pin sets JP4 and JP5. A 2-10 volt output is selected by placing jumpers over either pin set JP4 or JP 5. Refer to Chapter 3, Figure 3-1 for jumper location on circuit board.

END OF CHAPTER 2

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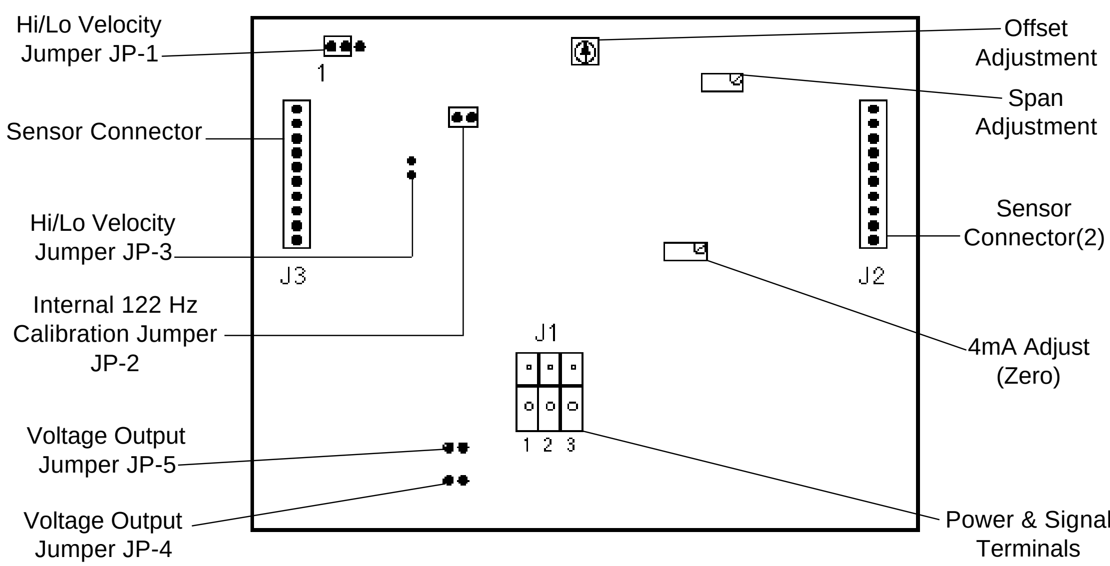
Chapter 3
Calibration & Maintenance

Calibration of the electronics can be performed either in the field or on the bench. The VT-2000 Transmitter comes calibrated for the CFM or FPM specified by the user. The calibration factor is established as a function of the type of VorTek sensor utilized in the construction of the probe bars. Calibration constants are always expressed in terms of average sensor Hz (cycles per second.)

Calibration factors are established by a wind tunnel test and represent flow conditions expected when minimum up and downstream recommendations are observed. Calibration data for a particular sensor is provided on a label directly attached to the circuit board. Three parameters are expressed on the calibration tag; full scale CFM or FPM, full scale Hz, and span in Hz. Minimum transmitter output (4mA) is always representative of zero CFM or FPM and zero Hz.

Before making any adjustments, the user should become familiarized with the electronics circuit board and the layout of components on it. Refer to Figure 3-1.



VT-2000 Board Layout

Figure 3-1

The following adjustments and jumpers are available for calibrating the unit to a specific application.

4mA Adjust Potentiometer - Provides adjustment of 4mA output with no flow present (zero CFM and zero Hz.)

Span Potentiometer - Provides for the adjustment of the slope of the output signal, proportional to the change in input frequency.

Offset - Provides for the adjustment of the zero offset in the CFM versus frequency relationship.

Jumpers JP-1 and JP-3 - Provides for the selection of either normal (0 to 4000 FPM) or high velocity (0 to 7000 FPM) operation. Place jumper across JP-1 pins 1 and 2 for high velocity, 2 and 3 for low velocity. Place jumper across JP-3 pins 1 and 2 for high velocity, but leave off for low velocity.

Jumper JP-2 - Provides access to an internal 122 Hz clock for checking the transmitter calibration. Place the jumper across pins 1 and 2 to simulate a 122 Hz input signal.

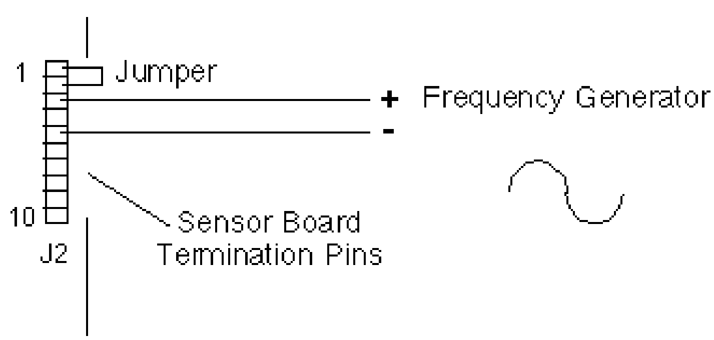
Jumpers JP-4 and JP-5 - Used to configure the 4-20mA output for either a 1-5 or 2-10 volt signal by putting the appropriate dropping resistors in, paralleled with the output. No jumpers are installed if a 4-20mA output is required. A jumper must be placed between pins 1 and 2 of JP-4 and JP-5 for 1-5 volt output. A jumper must be placed between pins 1 and 2 of either JP-4 or JP-5 for 2-10 volt output.

A. FIELD CALIBRATION

When ideal conditions are not present and duct turbulence is a problem, corrections may be required to match flow transmitter output to readings observed by a balancer's manual traverse. In these cases, the user has the choice of either adjusting the software constants or the transmitter span to achieve a match in readings. Adjustment of span will not affect transmitter zero. If factory calibration settings are to be maintained, Tek-Air recommends that corrections be made by adjusting the software scaling constants.

B. BENCH CALIBRATION

The transmitter is normally calibrated at a bench, although it is possible to bring the bench calibration instruments to the transmitter in the field. Connect a power supply and digital voltmeter in the mA mode to the transmitter as shown in Figure 3-2. With the sensor boards unplugged, connect a jumper wire and frequency generator as shown in Figure 3. The frequency generator must be set to an output voltage of *less* than 250 mV. To achieve the best accuracy, the frequency generator can be used in conjunction with a frequency counter. The full procedure is as follows:



Frequency Calibration Connections

Figure 3-2

Preset Offset - To set the offset at zero Hz and eliminate the effect of this adjustment, turn the “OFFSET” potentiometer fully counterclockwise.

Set Zero - With the jumper installed as shown in Figure 3-2 and the frequency generator disconnected, adjust the “4mA OFFSET” potentiometer until 4.00 mA is read at the digital voltmeter.

Set Span - Connect the negative lead of a frequency generator to one of the two center pins on one of the sensor board connectors. Connect the positive lead to the third pin from either end. Refer to Figure 3-2. Set the frequency generator to the Span Hz indicated on the transmitter calibration label. Set the frequency generator to sinusoidal wave and the output voltage to the minimum level possible. Adjust the “SPAN” potentiometer to achieve a 20.0 mA output. Any linearity checks on frequency versus mA output should be made at this point.

Set Offset - While vortex shedding provides a true linear output, the intercept of the line does not pass through zero. The “OFFSET” potentiometer corrects for this. Set the frequency generator to the Full Scale Hz value indicated on the transmitter calibration label. The mA reading should rise above 20.0 mA. Adjust the “OFFSET” potentiometer until the 20mA output is restored.

Threshold Operation - To eliminate a “false” flow reading when flow is not present, a sensing threshold cutoff is provided The threshold level is set at approximately 50Hz (~300 FPM) and unlike previous versions of the VT-2000 circuit board, it cannot be adjusted.

C. USING THE INTERNAL CALIBRATION CHECK

The user may check the calibration of a particular unit in the field at any time, using the internal frequency generator provided. This generates a frequency which is fed into the input circuit anytime jumper J-2 is placed between pins one and two. *CAUTION: Using this feature is not straightforward and the user must be fully cognizant of the theory and method before using it. While the unit cannot be damaged, an erroneous calibration could occur.*

STEP1: Remove the sensor boards for the left and/or right hand sensor connectors on the main circuit board. *NOTE: This will cause the mA output to temporarily go high.*

STEP 2: Determine the full scale calibration value from the tag on the circuit board. You will require a calibration standard frequency below this value. Determine the number of jumpers required to establish a calibration frequency just below the FS Hz from the following table.

Jumpers	Frequency in Hz
1	488
2	244
3	163
4	122

STEP 3: Given the number of jumpers determined in step 2, you must install the proper total of one, two, three, or four jumpers on pins 1 and 2 and/or 9 and 10, on one or both of the sensor connectors as shown in figure 3-2.

STEP 4: With jumper J-2 removed, the milliamps reading should be 4mA, ±.06. This can be adjusted using the “4mA Adjust” potentiometer.

STEP 5: With jumper J-2 in place, the correct output in milliamps can be determined from the following formula (tolerance is ±.06 mA:)

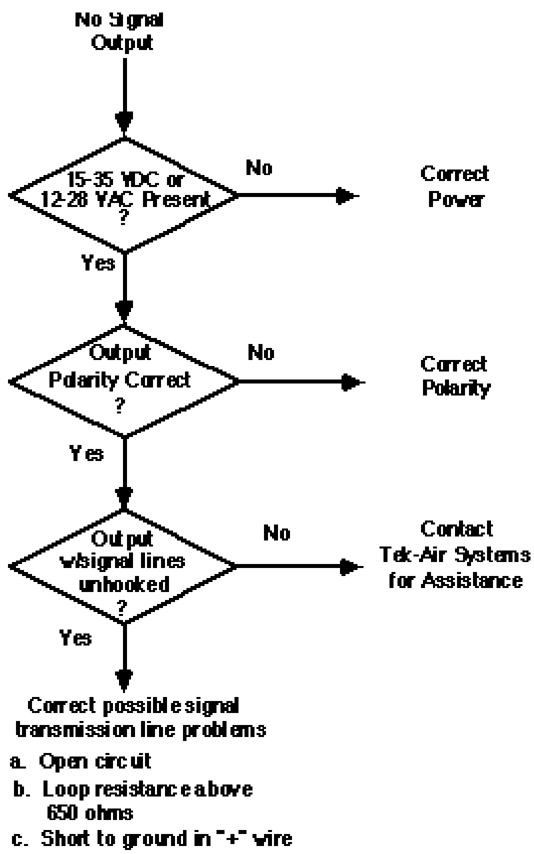
$$\text{mA Output} = 4+16 \times \left(\frac{\text{Cal Freq.}-(\text{F.S Freq.}-\text{Span Freq.})}{\text{Span Frequency}}\right)$$

STEP 6: Remove the J-2 jumper and any jumpers placed on pins 1 and 2 and/or 9 and 10, on one or both of the sensor connectors. Plug the sensor board(s) back in the sensor connectors and place the unit back on line.

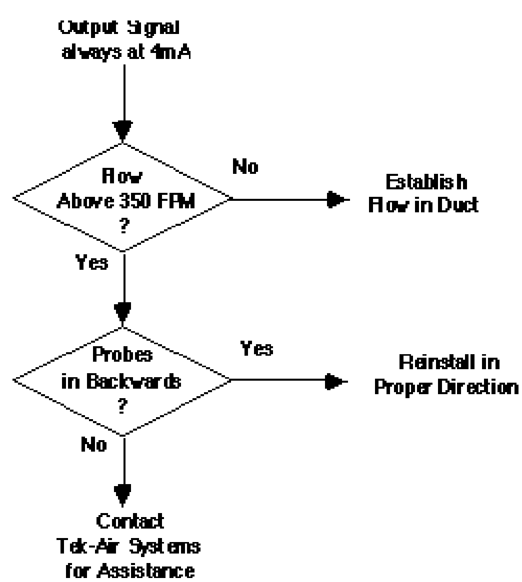
Chapter 4
Troubleshooting

A. TROUBLESHOOTING
Should problems be experienced in commissioning the airflow measurement system, the following flow charts are designed to aid in troubleshooting the transmitter and flow sensors.

NO OUTPUT SIGNAL PRESENT



OUTPUT SIGNAL ALWAYS 4mA



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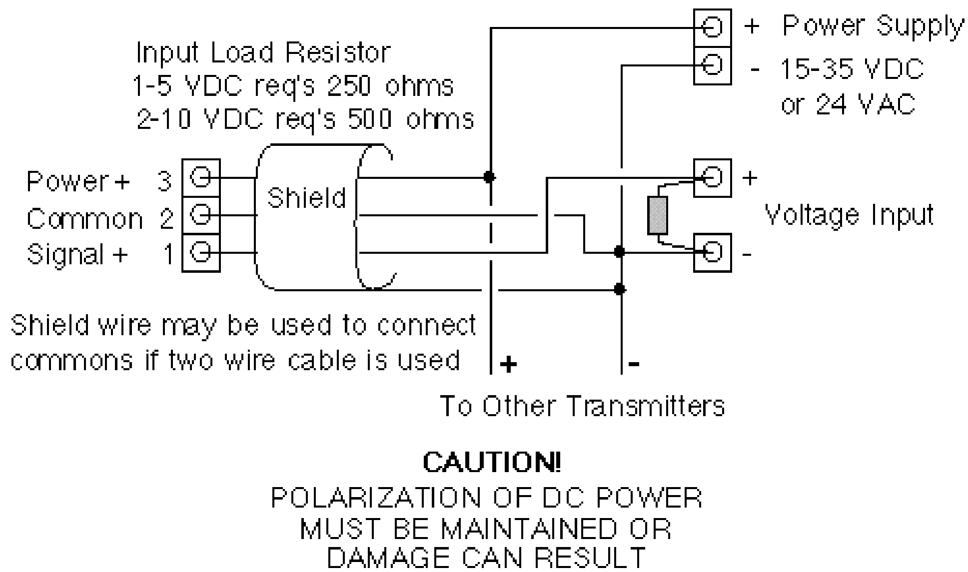
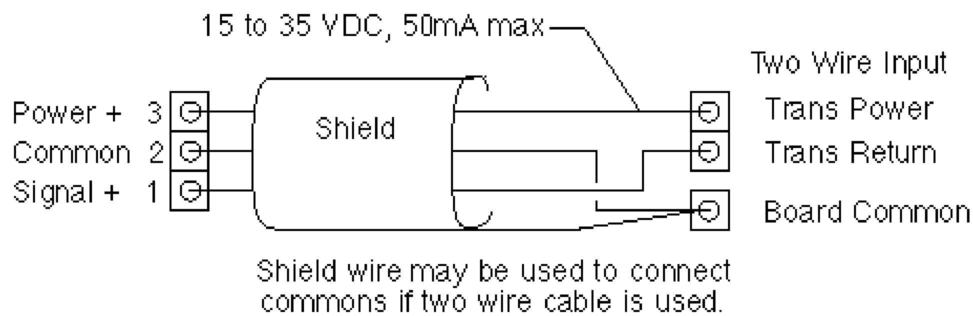
APPENDIX A: SAMPLE TERMINATIONS

The following wiring configuration can be used for multiple transmitters, powered from a common supply, inputting to a voltage type input channel. Do not provide resistor if input is 4-20mA type, or if internal jumpers for voltage output are set.



Voltage Input, Common DC Power Supply
Figure A-1

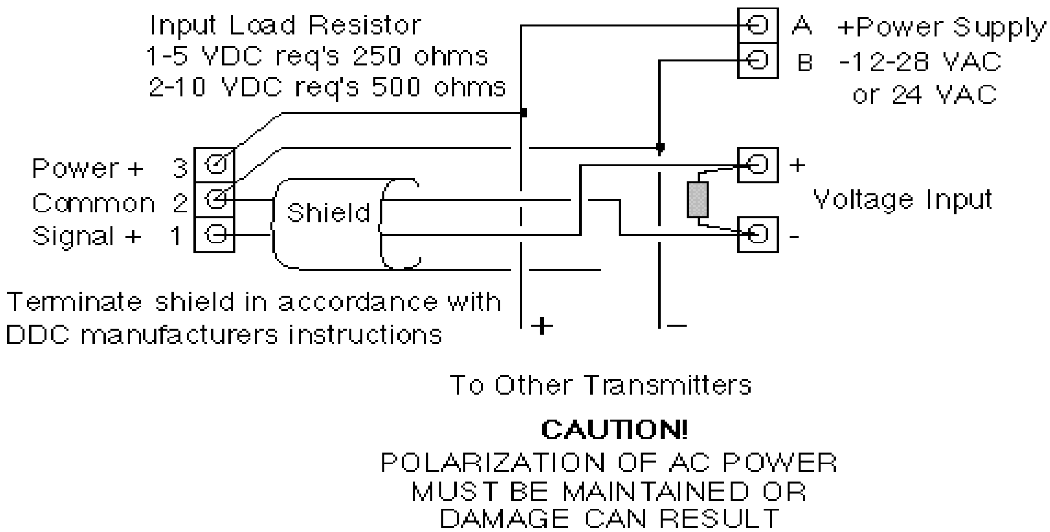
The following wiring configuration can be used where system incorporates two wire transmitter power, which is fused for current greater than 50mA.



Current Input with Integral
Loop Power Supply
Figure A-2

APPENDIX A: SAMPLE TERMINATIONS

The following wiring configuration can be used for multiple transmitters, powered from a common supply, inputting to a voltage type, input channel. Do not provide resistor if input is 4-20mA type or if internal jumpers for voltage output are set.



Voltage Input, Common AC Power Supply
Figure A-3

APPENDIX B: INSTALATION DRAWING, VT-2100

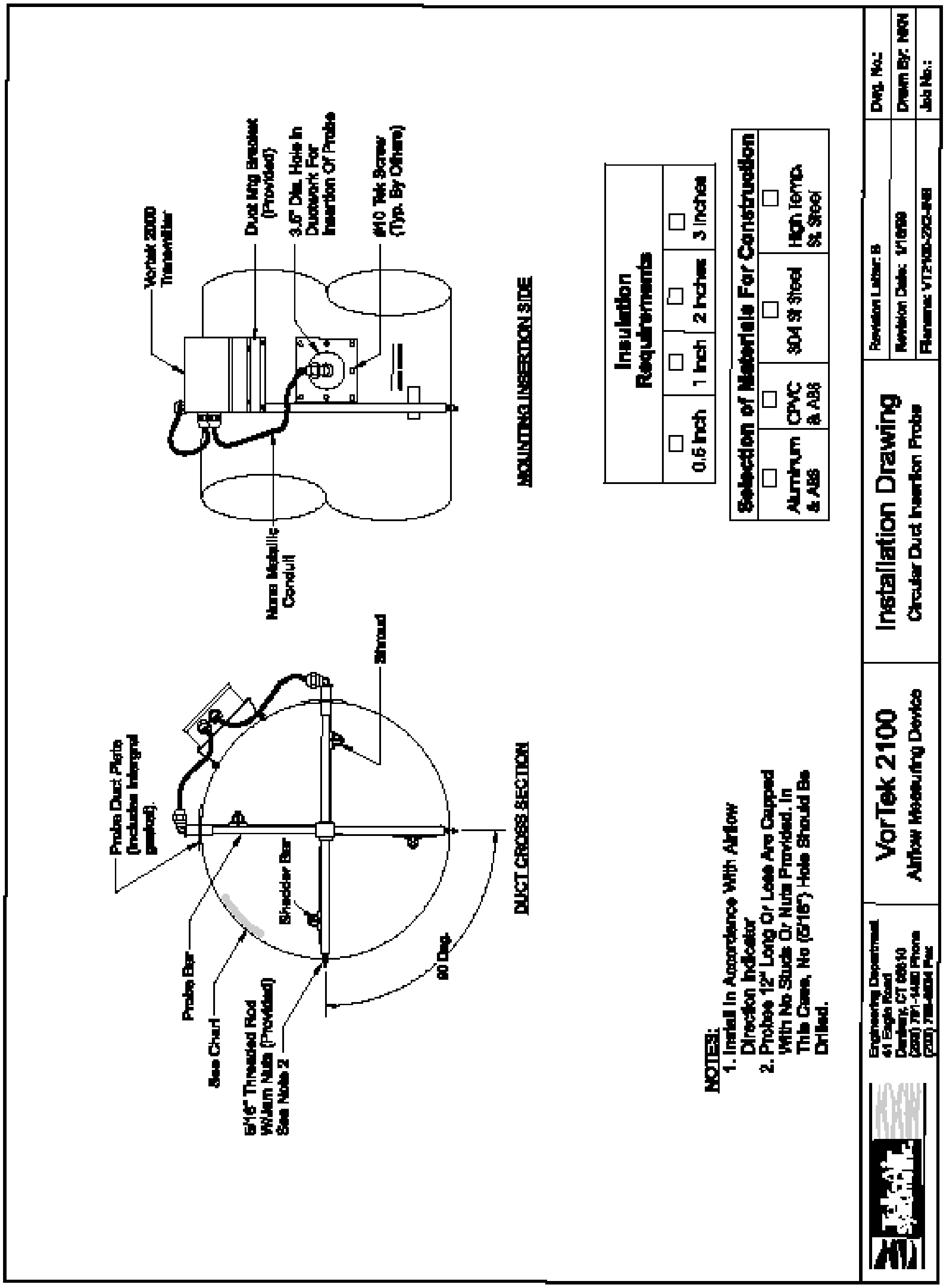


Figure B- 1

APPENDIX B: INSTALLATION DRAWING, VT-2200

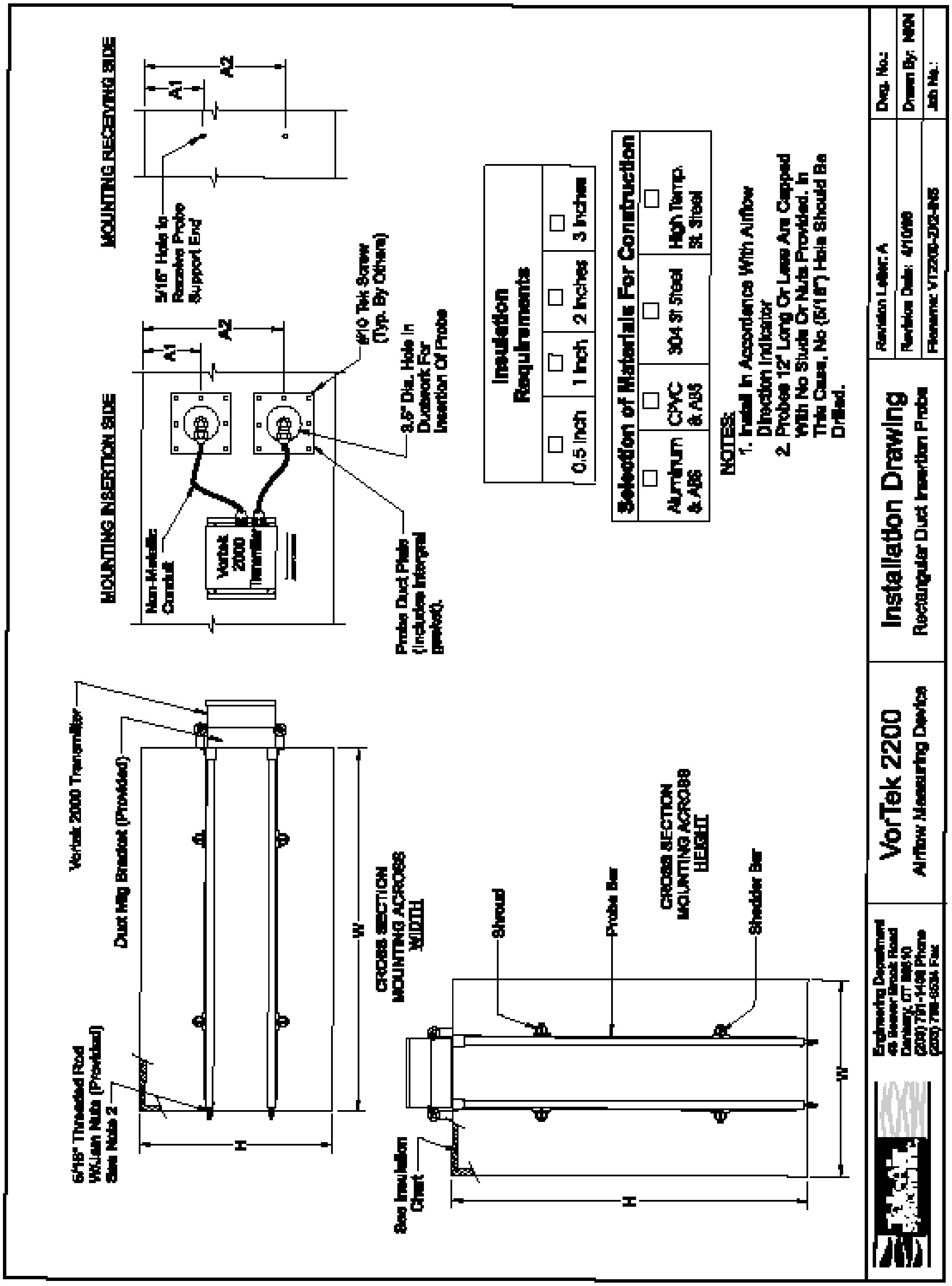


Figure B- 2

APPENDIX C: MINIMUM INSTALLATION REQUIREMENTS, IR-1

Minimum Installation Requirements
Figure C-1