



# Installation Operation Maintenance

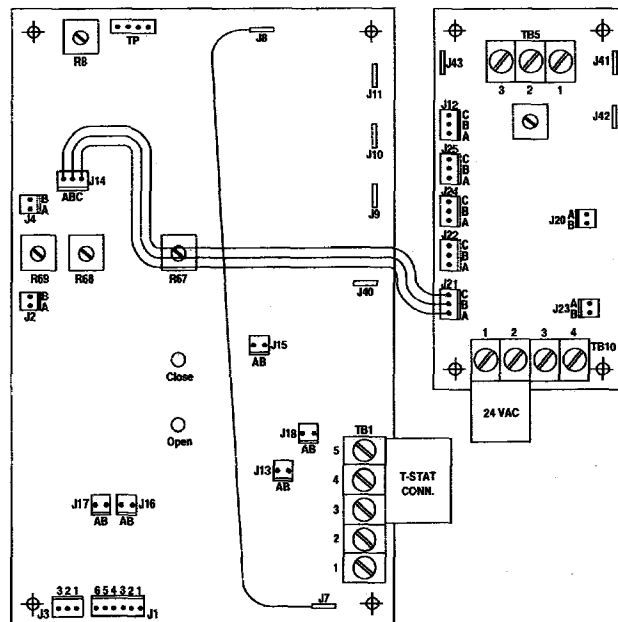
## VAV-IOM-7

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Product Section	Air Terminal Devices & Heating Products
Product	Variable Air Volume Units
Model	VariTrane®
Literature Type	Installation/Operation/Maintenance
Sequence	7
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Supersedes	VAV-M-3

## VariTrane® Systems Variable Air Volume Units

### Analog Electronic Control Option

For use with:  
Shutoff Cooling Units  
Shutoff Reheat Units  
Double-Duct Units  
Series Fan-Powered Units  
Parallel Fan Powered Units



Since the Trane Company has a policy of continuous product improvement, it reserves the right to change specifications and design without notice. The installation and servicing of the equipment referred to in this booklet should be done by qualified, experienced technicians.

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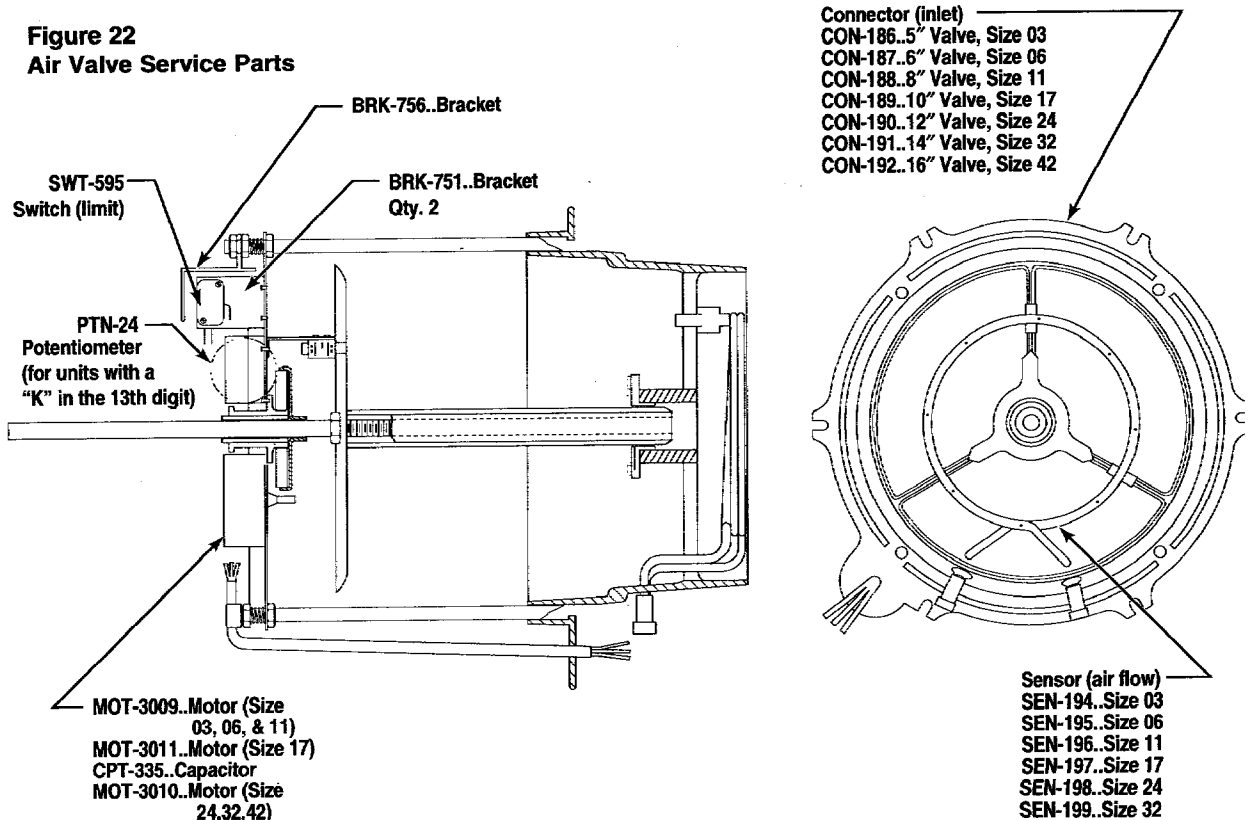
# Model Number History

**Figure A**  
**Model Number Conversion Table**

<b>Shutoff Model</b>					
	Prior to 12/87	1/88-5/91	6/97-3/93		
	Model	Model	Model	UNHT	Current Model
Shutoff only	VCCC	VCCD	VSDD	NONE	VCEE
Shutoff w/elec. heat	VCEC	VCED	VSDD	ELEC	VCEE
Shutoff w/hot water	VCWC	VCWD	VSDD	1RWH, 2RHW	VCWE
<b>Fan Powered Model</b>					
	Prior to 12/87	1/88-5/91			
	Model	Model	Current Model	Type	UNHT
Parallel Fan Powered	VFCC	VFCD	VFPE	PAR	NONE
Parallel w/elec. heat	VFEC	VFED	VFPE	PAR	ELEC
Parallel w/hot water	VFWC	VFWD	VFPE	PAR	1RWH, 2RHW
Series Fan Powered	VSCC	VSCD	VFPE	SER	NONE
Series w/elec. heat	VSEC	VSED	VFPE	SER	ELEC
Series w/hot water	VSWC	VSWD	VFPE	SER	1RWH, 2RHW

<b>Board Number (BRD)</b>		
	(PI)	(PD)
Cooling only	597	603
Changeover	598	604
Reheat	599	605
Dual Duct	599	605
Relay Board	602	602
Transducer	TDR 193	

**Figure 22**  
**Air Valve Service Parts**



# General Information

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## Literature Contents

This is an update revision manual that describes the operation, calibration, and set-up of VariTrane® VAV Shutoff and Fan-Powered units with Electronic Controls. This IOP replaces M-3 for all electronic controls.

## Receiving and Handling

VariTrane Units are shipped assembled except for the optional attenuator section and filters. Upon receiving, please inspect each unit and the components for shipping damage. Locate the model number and nameplate and check that the correct units have been received.

Claims for in-transit damage must be filed immediately with the delivering carrier.

After receiving the units, complete the following:

1. Inspect the control units and air valve casing for dents or punctures.
2. Verify that all options have been included, such as filters, attenuators, controls, heating coils, etc. Also check that unit voltages are correct.
3. Manually rotate the fan to insure that there are no obstructions within the housing.

4. For reheat units, check the coil fins or heating elements to see that the coils are not damaged.

5. Locate and verify that the correct thermostats are with the order. These will be in the shipping box marked with an orange "Accessories Enclosed" label. Store in secure place until needed. Accessories lost at a job site are NOT covered by Trane's warranty.

6. If a discrepancy occurs between what was ordered and what is received, contact your local Trane representative immediately.

7. Read the unit installation procedures prior to actual start of installation.

**WARNING: Do not lift unit without test-lifting for balance and rigging to prevent injury, death, or equipment damage.**

# Unit Information

## Unit Type Description

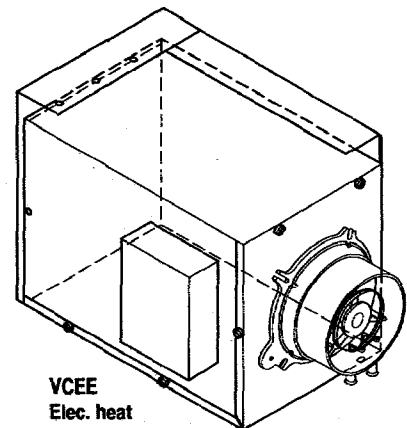
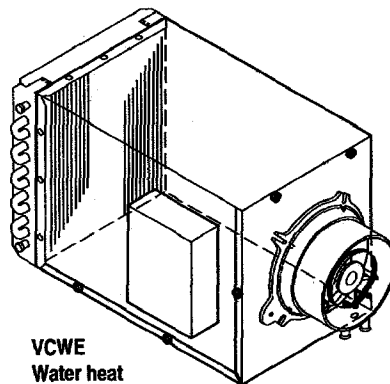
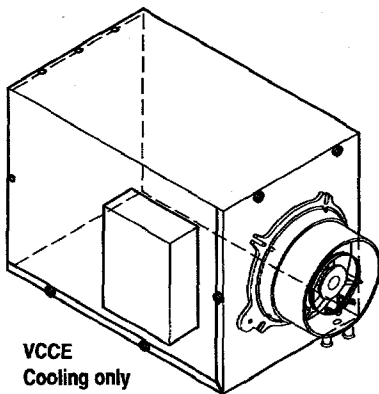
VariTrane® Units use an electronically controlled air valve for primary air modulation. The unit types available are shutoff VAV Single Duct Units (VCCE, VCEE, VCWE) and Fan-Powered Units (Series VFPE, VFPE Elec., VFPE 1RHW, 2RHW), (Parallel, VFPE, VFPE Elec., VFPE 1RHW, 2RHW), Dual-Duct Units (VDDE), and Bypass Units (VBDD prior to 3-1-93).

## Shutoff VAV Single-Duct Units (VCCE, VCEE, VCWE)

The basic unit consists of an air valve mounted in a sheet metal casing which is used to control the volume of air introduced to the occupied zone. The unit is designed to throttle either cooling or heating air. The basic cooling only unit can be equipped with reheat coils located at the discharge of the unit. Standard choices include an electric coil with up to three stages of heat or a hot water coil.

Figure 1 illustrates the current model shutoff boxes.

Figure 1  
VAV Shutoff Boxes



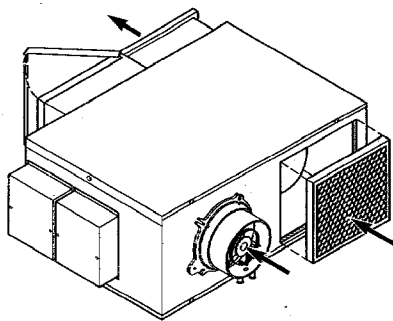
**Series Fan-Powered (VFPE, VFPE Elec., VFPE 1RHW, 2RHW)**

See Figure 2. Series Fan-Powered units consist of an air valve in series with the fan. The fan sits in the primary airstream and runs continuously, drawing both conditioned air and plenum air to deliver a relatively constant volume of variable temperature air. Reheat coils may be attached to the discharge of the unit. An electric coil with up to two stages of heat (VFPE) or a hot water coil with one stage of heat (VFPE) are available.

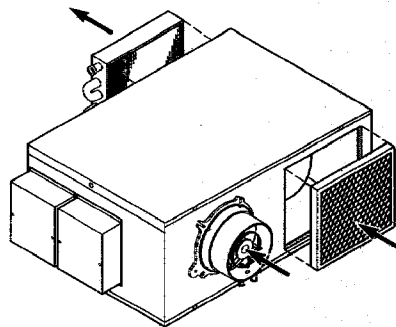
**Parallel Fan-Powered (VFPE, VFPE Elec., VFPE 1RHW, 2RHW).**

See Figure 3. Parallel Fan-Powered units consist of an air valve working in parallel with a fan. The fan sits outside the primary airstream allowing intermittent fan operation. Cooling only units can satisfy a small net heating load, using return or plenum air typically warmer than the room itself, due to convection from the heat of lights when applied. With an electric coil, up to two stages of heat are available in addition to the fan for reheat. A hot water coil with one stage of heat is also available. A backdraft damper is supplied to prevent reverse air flow when the fan is not operating.

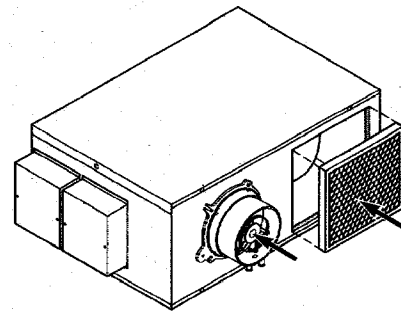
**Figure 2  
Series Fan-Powered Unit**



Series with electric heat

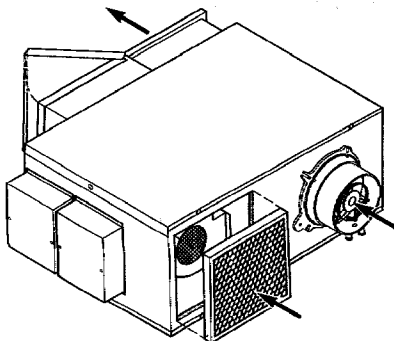


Series with hot water heat

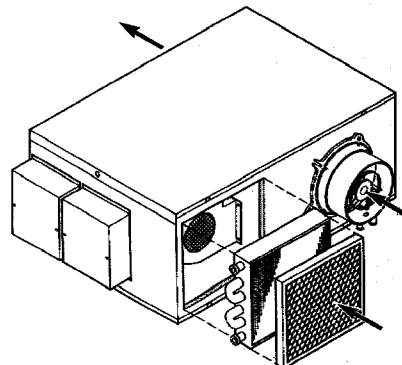


Series without heat

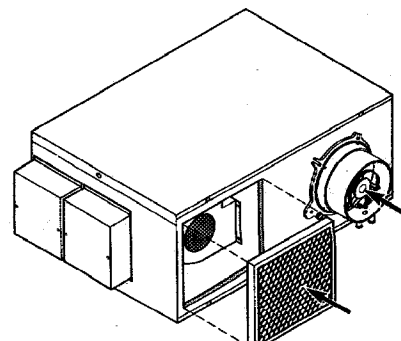
**Figure 3  
Parallel Fan-Powered Unit**



Parallel with electric heat



Parallel with hot water heat

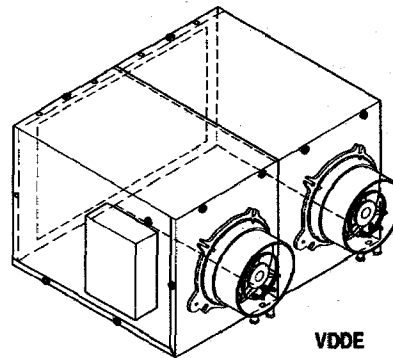


Parallel without heat

### Dual-Duct Units

See Figure 4. Dual-Duct units are a sheet metal casing with two air valves. One air valve supplies cooling primary air and the other supplies heating primary air. Both discharge into a common duct which leads to the zone being controlled.

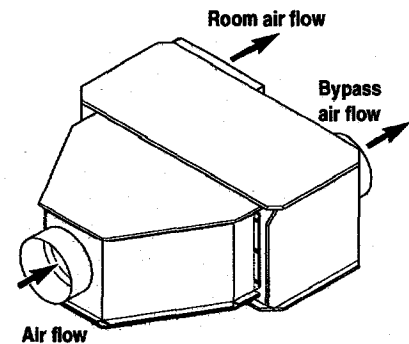
**Figure 4**  
**Dual-Duct Unit**



### Bypass Units Discontinued 3/1/93

See Figure 5 which illustrates the Bypass unit. Bypass units are a sheet metal casing that contains two air valves which share a common inlet. The output of one valve goes to the zone being controlled, the other valve goes to the plenum or return duct. The control system is designed such that the primary air flow into the VAV box remains constant. These boxes are available in a pressure dependent control configuration only.

**Figure 5**  
**Bypass Unit**



# Operating Description

## Electric Air Valve

A sectional view of the basic electric VAV air valve is shown in Figure 6. Air enters from the right to the left through aluminum die cast inlet. An averaging flow ring is used to sense a delta P signal for flow control (on pressure independent). The valve damper moves axially and is attached to a guide shaft and lead screw. The damper moves from open to close to throttle air into the occupied zone. In the fully closed position, the damper seats on a ridge cast into the inlet. The guide shaft, splined to prevent the damper

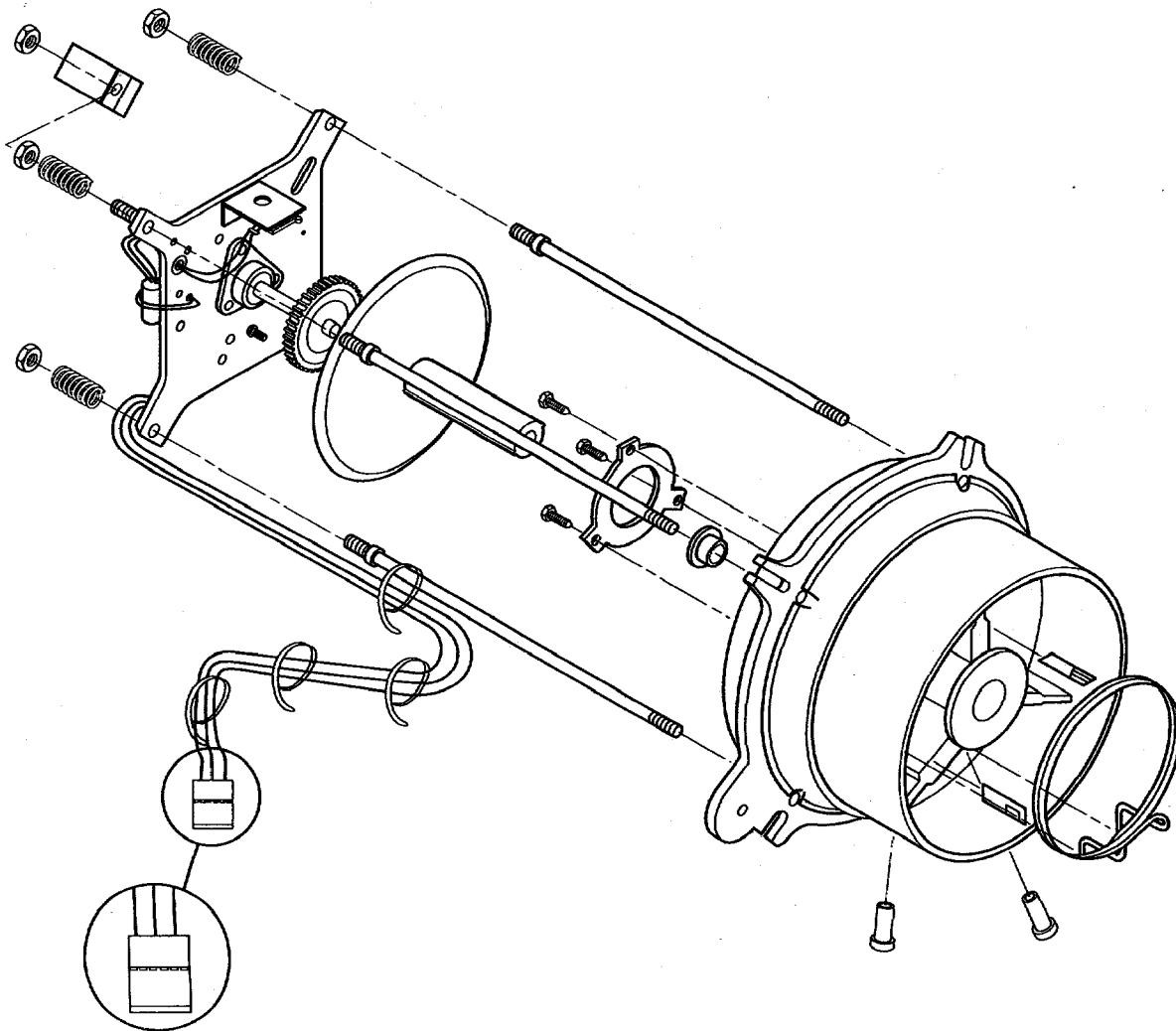
from rotating, is centered in the inlet and slides on a bearing, which is also splined. To move the damper, an electric motor, with gears directly attached to the motor shaft, drives another gear threaded to directly drive the lead screw. A limit switch is used to prevent the motor from stalling at the extreme valve positions. The limit switch will stop the motor when the valve is fully open, and fully closed. The backplate assembly, containing the motor and limit switch, is spring-loaded to the tie rods with springs secured by nuts.

When the valve is fully closed, the damper will no longer move. The gear will continue to rotate, caus-

ing the entire assembly to be moved to the left. A trip arm attached to the tie rod contacts the limit switch to shut the motor off.

With pressure dependent control systems, the position of the damper must be transmitted to the control board. This is done through a potentiometer attached to the backplate assembly. The potentiometer is not shown in Figure 6; however, the drive gear that is attached to the shaft of the potentiometer is driven directly by the valve drive gear. The air valve uses a 24 volts AC bi-directional motor (12VA) with a 6 minute drive time from full open to full closed.

**Figure 6**  
**VAV Air Valve**



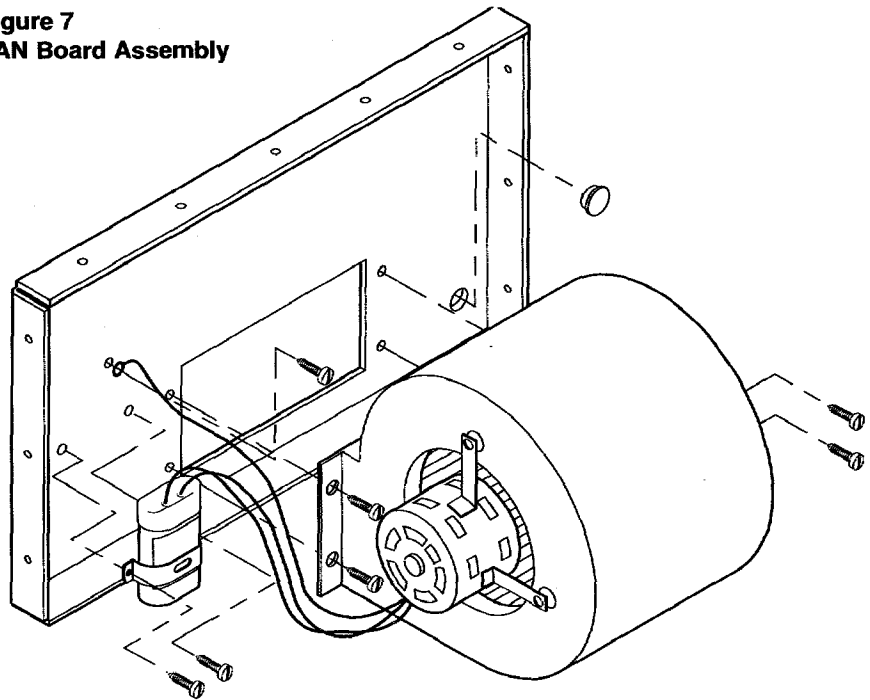
## Fan

See Figure 7. The fan in Trane VAV Fan-Powered Units is a centrifugal, forward-curved type, available in sizes 400 to 2800 cfm. The motors are three-speed (size 30 is two-speed) permanent split-capacitor type, available in 120 and 277

volts, 60 Hz as standard. Fan motors are designed for maximum of 65°C bearing temperature rise to insure long motor life. The intended ambient operating temperature range is from 30°F to 140°F. Storage temperature range is -40°F to 150°F. The following color scheme applies to all motor wires:

- Brown: Two brown wires are for connection to the phase shift capacitor.
- White: Common
- Black: High speed
- Blue: Medium speed
- Red: Low speed

**Figure 7**  
**FAN Board Assembly**



## Transducer

See Figure 8. The transducer has three wires leading from it to the control board. There is a common (green wire), a five volt input (red wire), and an output wire (black wire). The supply to the transducer is five volts. The transducer contains an internal hybrid electronic circuit which converts the delta P signal to the output voltage. The three wires are connected to an AMP pin connector which is plugged into J3 on the circuit board.

## Controls

Electronic control systems offer both pressure dependent (PD) and pressure independent (PI) operation for use on all VAV units.

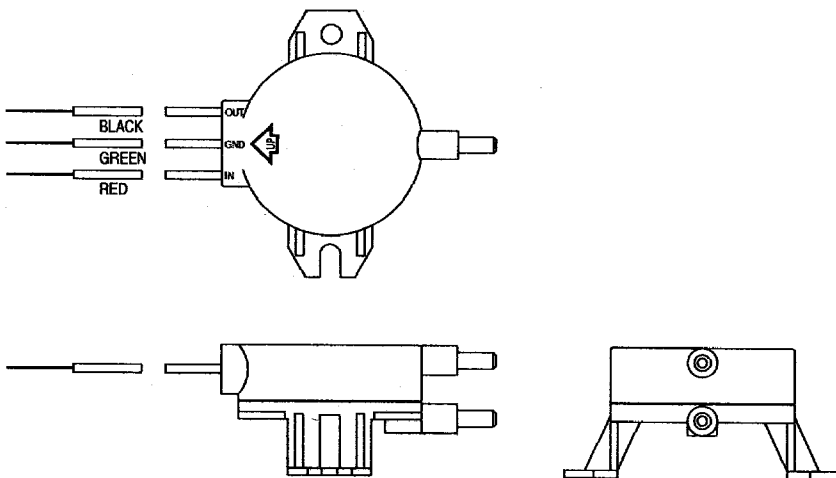
There are three differences between pressure dependent and pressure independent:

1. A pressure dependent (PD) system will control room temperature by modulating the position of the air valve in response to zone temperature only. A pressure independent (PI) system will control room temperature by adjusting air flow into the space as a function of zone temperature, while automatically adjusting for changes in inlet pressure at the air valve to maintain the desired CFM.

2. Pressure independent (PI) control utilizes a flow transducer, while pressure dependent control (PD) uses a position feedback potentiometer on the air valve.

3. A pressure independent (PI) circuit board has a three-pin connection at J3 for the transducer. On a pressure dependent (PD) board, this circuit silk screen will be present without pin connections.

Figure 8  
Transducer



# Sequence of Operation

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## Shutoff VAV Single-Duct Units

The air valve is controlled between minimum and maximum flow setpoints proportionally. When the zone temperature is approximately .5°F above the cooling setpoint, the air valve will begin to modulate to a maximum position, providing more cool air to the zone until the zone temperature reaches the zone setpoint. Once satisfied, the air valve will start to modulate to the minimum position. When the zone temperature is .5°F below the heating setpoint, the valve begins to modulate to a minimum position. When the valve is at the cooling minimum and the zone temperature is still below setpoint (cold), up to three stages of heat may be energized on a reheat unit. The first stage is activated approximately 2°F below the setpoint, the second stage is activated approximately 3°F below setpoint, and the last stage is activated approximately 4°F below the setpoint.

## Series Fan-Powered

The Series Fan-Powered unit is a constant volume, variable temperature device. The fan is energized whenever the zone is occupied. It delivers design CFM regardless of the load. The air valve controls primary air proportionally between minimum and maximum flow setpoints. When the zone temperature is approximately .5°F above setpoint, the air valve will begin to modulate to a maximum position, providing more cool air and less plenum air to the zone until the zone temperature reaches the zone setpoint. When zone temperature is .5°F below setpoint, the valve begins to modulate to its minimum position, supplying less

cold air and more warm plenum air. When the air valve is at minimum and zone temperature is still below setpoint (cold), up to two additional stages of electric heat may be energized. On an electric reheat unit, the first stage is activated approximately 2°F below the setpoint. The second stage is activated approximately 3°F below the setpoint. On Hot Water Reheat, just one stage of heat, in addition to the fan, will be activated approximately 2°F below setpoint.

## Parallel Fan-Powered

The Parallel Fan-Powered unit is a variable volume, constant temperature device at high cooling loads, and a constant volume, variable temperature device at low cooling and heating loads. The air valve controls primary air proportionally between minimum and maximum flow setpoints. When the zone temperature is approximately .5°F above the cooling setpoint, the valve will begin to modulate to its maximum position for full air flow, the fan remains de-energized. When the zone temperature is approximately .5°F below the heating setpoint, the valve will begin to modulate to a minimum position, reducing the cooling capacity. If the cooling capacity is reduced and zone temperature is still below the heating setpoint, the fan will be energized at approximately 2°F below setpoint acting as the first stage of heat. The second stage of heat (electric or hot water) is activated at approximately 3°F below setpoint and the third stage (electric) is activated at approximately 4°F below setpoint.

## Dual Duct

Dual Duct units contain two air valves and two controllers. One to supply cooling and the other to supply heating. When the zone temperature is at setpoint, both valves are modulated to minimum position. When the zone temperature is approximately .5°F above setpoint, the cooling valve will begin to modulate to maximum position providing more cold air to the zone, and the heating valve remains at minimum, until the zone temperature reaches the setpoint. When zone temperature is .5°F below the heating setpoint, the cooling valve begins to modulate to minimum and the heating valve will begin to modulate to its maximum position, providing more warm air to the zone until the zone temperature reaches the setpoint.

## Bypass Unit

Bypass units (discontinued as of 3/1/93) were available in a cooling version with two standard shutoff air valves with one control. When the zone temperature is approximately .5°F above the setpoint, the supply air valve will be at maximum position for high cooling capacity and the bypass valve will operate in the opposite direction. When the zone temperature is approximately .5°F below setpoint, the return air valve will begin to modulate to open position, bypassing cold air to the plenum, and the supply air valve begins to modulates to its minimum position.

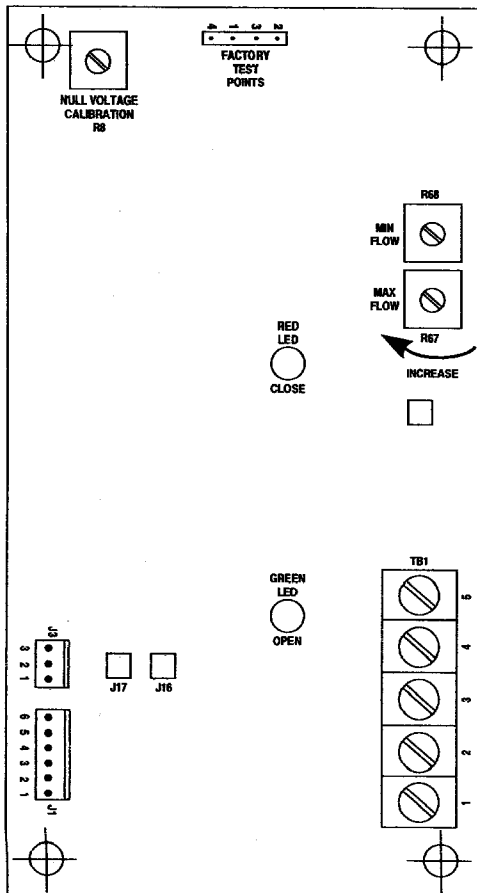
# Type of Circuit Board

There are three types of circuit boards available for pressure independent and pressure dependent control. The circuit board types are described below.

## Cooling Only

See Figure 9. This circuit board controls the air valve with a "cooling only" control action. The "cooling only" control action enables the valve to modulate open on a call for cooling and modulate towards close on a call for heating. The remote options consist of drive air valve to maximum, and drive the air valve closed.

Figure 9  
Cooling Only (PI)



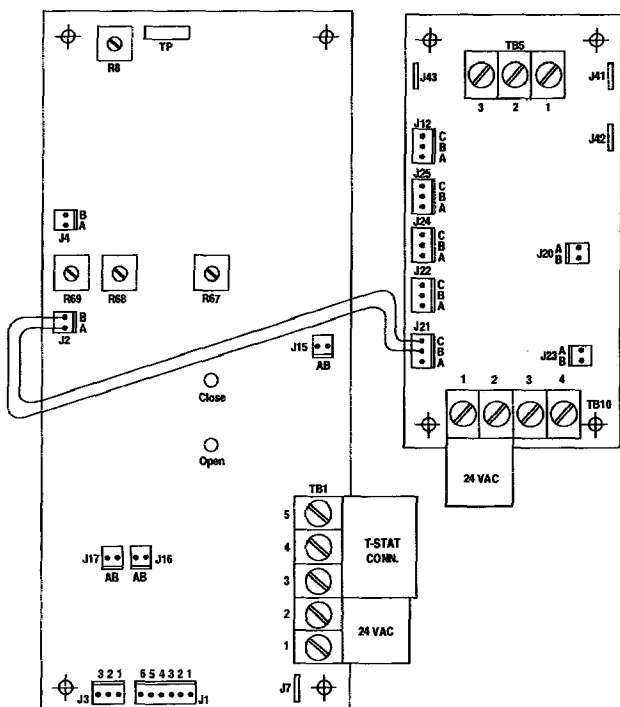
## Changeover

See Figure 10. This board can control the air valve with a control action of either "heating" or "cooling." The heating control action may be energized remotely or jumpered on the board for continuous heating control action. Other remote control options are drive to maximum, drive to minimum, and drive valve closed.

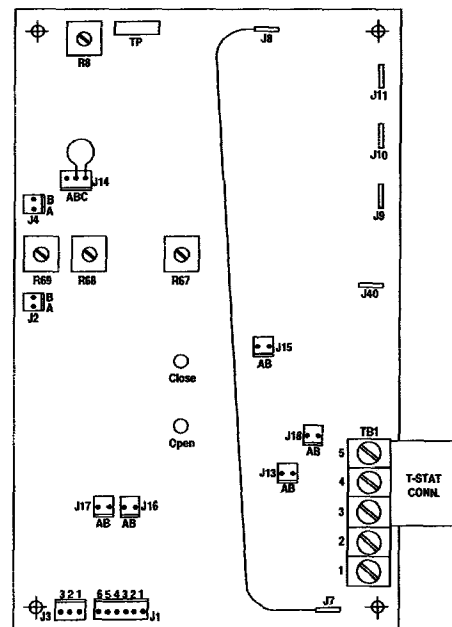
## Reheat

See Figure 11. This circuit board can operate with either heating or cooling action similar to the changeover board described above. In addition, this circuit board can utilize three dry or wet contacts that are energized upon a fall in zone temperature. These relays are typically used to energize unit fan and/or reheat. Other remote options consist of dual minimum, drive to maximum, drive closed, drive to maximum and lockout heat.

**Figure 10**  
Changeover (PI) and Relay Board



**Figure 11**  
Reheat (PI)



## Dual Duct

The dual duct box contains two controllers. Both controls consist of changeover boards with the same options.

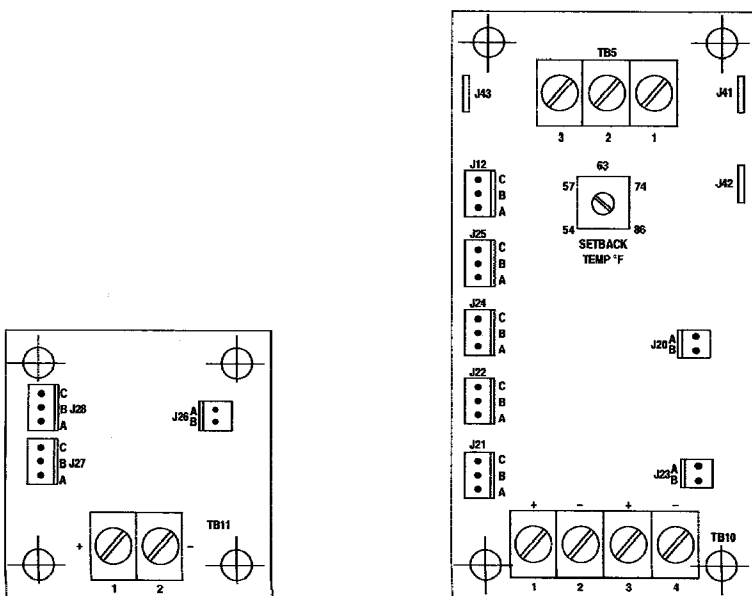
## Relay Board Operation

See Figure 12. The relay boards used with electronic control contain one or two relays that control dry contacts. Each contact contains three pins (A, B, and C). Pin B is the common, Pin A is normally closed, and Pin C is normally

open. On the dual relay board terminal 10 (TB10) has four terminals (1, 2, 3, and 4). The relay board relays are designated K1 (terminals 1, 2) and K2 (terminals 3, 4). The single relay board has its terminals located at TB11. The relay coils are activated by applying power at the appropriate terminations on TB10 or TB11. There are two voltage options available. The relays can be activated by either 24 volts AC or 12 volts DC. When 24 volts AC is used to activate the relay coils, Pins A and B of jacks J20 and J23 (J26 for the single relay board) are open. When 12 volts DC is used to operate the relay coils, then Pins A and B of jacks J20

and J23 (J26 for the single relay board) must be shorted together. It is important to note that when Pins A to B are shorted, 24 volts cannot be applied. If 24 volts AC is applied when Pin A is shorted to B, the relay will be destroyed. When applying 12 volts DC, polarity is important. The plus side of 12 volts DC must be applied to terminal 1 for K1 and 3 for K2. When K1 is energized on the dual duct relay board, J21 and J22 will change state (i.e., the normally open contact A+C will now be closed). On the single relay J27+J28 will change state. When K2 is energized J24+J25 will change state.

Figure 12  
Single Relay and Double Relay



# Remote Control Option

## Drive Valve to Maximum

See Figure 13. With this feature, when jack J15 Pin A is connected to Pin B through the relay board, the electronics will cause the air flow to go to the maximum setting and stay there. The influence of the thermostat is removed and maximum flow is maintained at all times. The operation of the three reheat relays is unaffected. Connecting Pins A and B of jack 15 will only affect the signal which goes into the section of the electronics which controls the air valve movement. The maximum flow option is obtained by saturating the temperature voltage signal so that the maximum limit is always sent on to the section of the electronics which compares the temperature voltage to the flow voltage.

## Drive Closed

With this option, the air valve can be driven physically closed. This option is activated when J16-A is connected to J16-B and J17-A is connected to J17-B. This option will not drive to either of the minimum flows; it will drive the valve physically closed so that no air will flow through the valve.

This option takes precedence over the maximum flow and other control options if activated. To drive the valve closed, the circuitry which drives the motor is saturated so that any signals from the transducer or the thermostat will have no affect on operation.

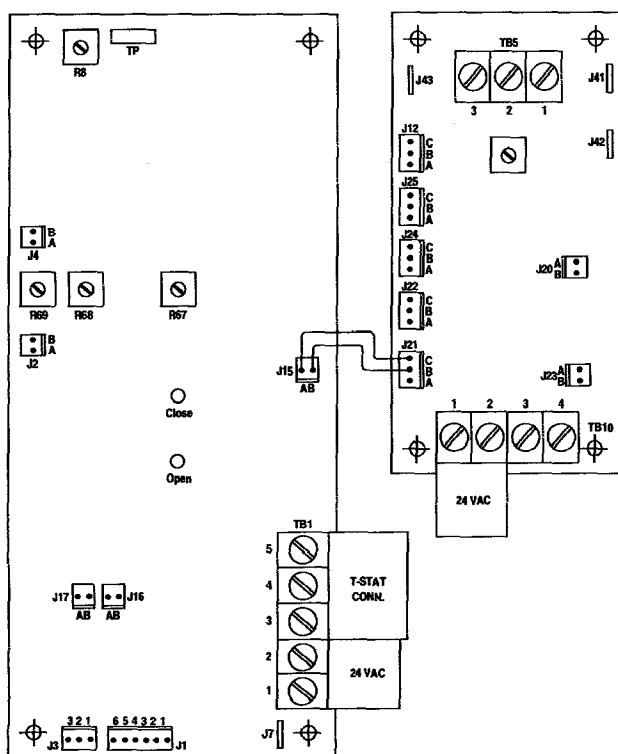
To change from the cooling mode to the heating mode, the action of the thermostat must be reversed. This is done in the electronics on the circuit card.

To activate the changeover from the cooling to the heating mode, jack J2 is utilized. When Pins A and B are connected, the unit will operate in the heating mode. When Pins A and B of jack J2 are open, the unit is in cooling mode. When the unit is put into changeover mode, the operation of the three relays which activate fans and heaters are not affected. Only the action of the air valve is reversed. Therefore, it's possible to operate the unit in heating mode and still activate the relays based on temperature dropping in the zone. Activating the changeover option has no affect on the minimum or maximum air flow setting. Only the action of the valve with respect to the zone temperature is affected.

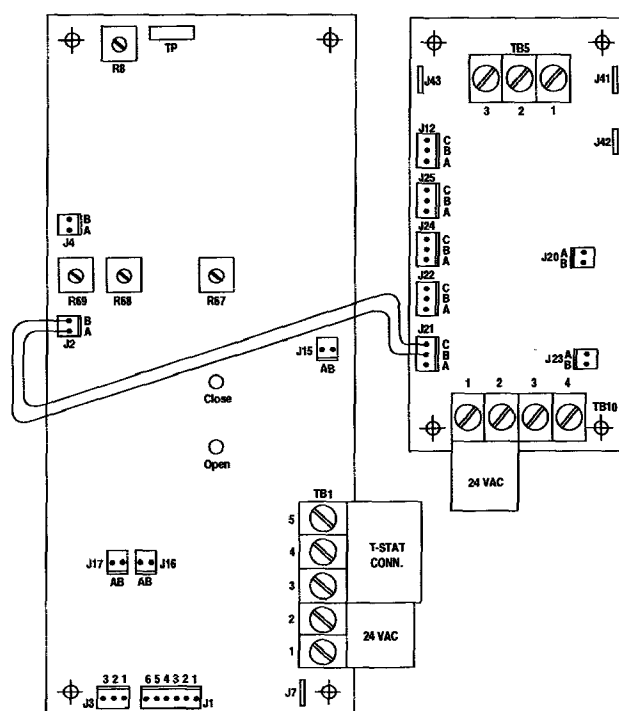
## Changeover

See Figure 14. The circuit board contains circuitry that provides the ability to *changeover from the cooling mode to the heating mode*.

**Figure 13**  
Drive to Max



**Figure 14**  
Changeover





Pin C is connected to Pin B. When the relays are not operational, then Pin B is connected to Pin A. It is important to note that in order for the relays to function, Pin B must be connected to Pin C. Therefore, when the option is not used, a jumper must be provided to make the relays function.

The reason Pin B must be connected to Pin A when the relays are locked out is that the relays can be switched on and will not go off if B is disconnected from C unless the signal is brought to ground. Therefore, the connection from B to A is necessary to insure that the relays will go off and remain off.

## Drive to Maximum and Lockout Relays (MLOH)

See Figure 16. This option drives the valve to the maximum air flow and won't allow the three relays to come on. It is activated by jumpering Pin A to Pin B of jack J13.

This option does not physically disconnect the signal to the three relay stages; however, it does remove control from the thermostat. Connecting Pin A to Pin B of jack J13 saturates the temperature input signal at 12 volts. In this manner, control is taken away from the thermostat and the electronics think the room is saturated at an extremely hot level. Since the temperature input is saturated, air flow will go to the maximum, and since the board thinks the room is extremely hot, relay stages will not be turned on.

This option is used when both driving the valve open and not allowing the heat to come on are desired at the same time (morning warm-up).

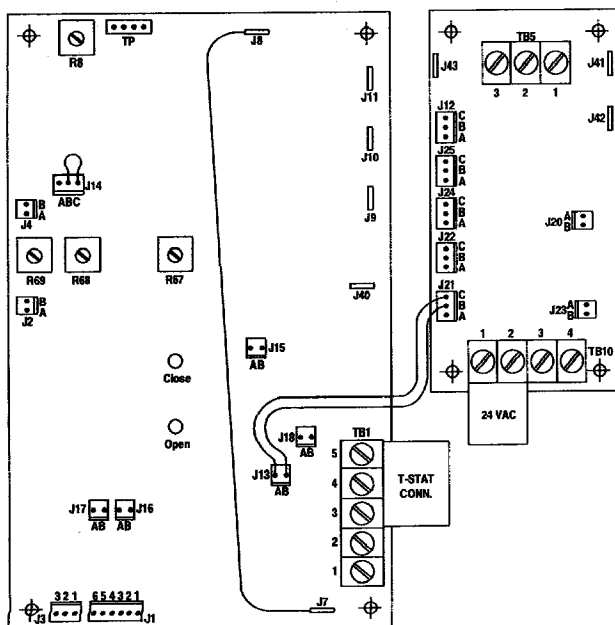
## Alternate Temperature Setpoint – Night SetBack Setpoint (ATS – NSB)

This option is not located on the main circuit card, but on the double relay option board which is used to activate the options, which have been described above. The zone sensor is connected to terminals TB5-1, 2 and 3 on the relay board and not to the main circuit card. Jack J12 is then used to switch from room thermostat control to board mounted potentiometer setpoint control.

On the Relay Board, J12 has three pins A, B, and C. If Pin C is connected to Pin B of jack J12, then the wall mounted zone sensor setpoint is in control and the system operates normally, as if the alternate setpoint circuit were not in the system. Because Pin A of jack J12 is connected to nothing, the setpoint pot on the relay board has no influence. To control setpoint on the relay board, the connection from Pin C to Pin B is open and Pin B is connected to Pin A. This allows the setpoint pot on the relay board to control the room setpoint and the setpoint pot on thermostat does nothing. Note that either Pin B must be connected to Pin C or Pin B must be connected to Pin A; but, at no time can all three be connected. If all three were connected, the signal to the circuit card would be meaningless.

*Note: terminals TB1-3, 4 and 5 are connected to 1/8" stabs J43, J42, and J41, respectively.*

**Figure 16**  
Drive Max, LOH



# Calibration

## Transducer Operation

This section discusses how the air flow through the valve is transformed into a voltage signal that can be used by the controller. The first transition from flow to voltage occurs at the Trane flow ring, where a delta P signal is generated as a function of air flow through the unit. The delta P signal consists of a high pressure signal from a total pressure tap of the air flow ring and a low pressure signal from the wake pressure side of the flow ring.

The transducer converts the pressure differential signal to an output voltage. The output of the transducer with no flow or zero delta P is .250 volts DC ( $\pm .100$ ). As flow increases, the delta P signal increases; therefore, the output voltage of the transducer increases. The gain of the transducer is .74 volts per inch of delta P.

## Null Voltage

The tolerance for the output voltage of the transducer with zero delta P signal from the flow ring is referred to as the null voltage of the transducer. The transducer has three wires leading from it to the control board. The wires include a common (green wire), an input (red wire), and an output (black wire). The input (supply) voltage to the transducer is 5 volts ( $\pm .5$ ). The acceptable voltage range of the output voltage with zero flow (between black and green) can range from .100 volts to .400 volts. To allow the controllers to coordinate with the transducer voltage, internal calibration is necessary. To accomplish this, potentiometer R8 (zero flow adjustment) is used. The flow voltage signal should be 4.8 volts

at test points #1 and #3 of the test point terminal (next to R8) with zero delta P applied. R8 is used to adjust the flow voltage to 4.8 volts when zero delta P is applied to the transducer. In this manner, variability of the null point of the transducer is compensated for. The importance of this becomes evident when minimum and maximum flows are discussed.

## Procedure for Maximum and Minimum Calibration

### Initialization

1. Monitor thermostat voltage and check it by rotating the thermostat to full heating and full cooling.

- a. Connect a voltmeter to TB1-4 (+) and TB1-3 (-).
- b. Rotate the thermostat fully clockwise (full heating). Observe the voltage. It should be less than or equal to 5.4 volts DC.
- c. Rotate the thermostat fully counter-clockwise (full cooling); voltage should go up to 6.3 volts DC or greater.

2. Set the min/max pots as follows:

- a. Rotate the max pot (R67) full clockwise.
- b. Rotate min A (R68) full counter-clockwise.
- c. Rotate min B (R69) full counter-clockwise.

3. With both of the transducer ports open to ambient (0 delta P), read the output voltage at TP4. (Ground is either TP3, TB1-2, or TB1-3.) The value of the null transducer voltage output must be between 0.1 and 0.4 volts DC. Nominal is .250 volts DC.

4. Monitor TP1 (+) voltage (zero flow adjustment) and adjust R8 until 4.8 volts DC  $\pm .010$  volts is read at TP1.

## Set Maximum Flow

Set the thermostat knob to the full cool position (fully counter-clockwise) thermostat voltage should go over 6.2V DC. Connect a pressure gage "T'd" into the high and low port flow ring of the transducer and input the maximum delta P. Refer to the flow vs. delta P chart on the unit to obtain the proper delta P signal desired. Adjust the max pot (R67) so that both the red and green light are out. When both lights are out, this indicates that equilibrium has been established with the delta P input to the transducer.

## Set Minimum Flow(s)

In this section, three procedures for setting minimums will be discussed.

### No Dual Minimum

Adjust the thermostat knob to the full heat position (full clockwise). Monitor the delta P of the transducer with a pressure gauge (high port first and low port). Refer to the calibration label on the side of the unit which relates CFM to delta P. Adjust R68 (minimum A) so that both the red and green lights are out. If the minimum setting is to be zero flow, then leave the minimum pot (R68) full counter-clockwise so that the red light remains on even when no delta P is applied to the transducer. This will ensure that the unit will always go to closed when minimum is desired.

### **Dual Minimum by Operating Jack J4**

Set the thermostat to the full heat position (full clockwise). With jack J4-A+B open (cooling minimum) adjust minimum A pot (R68) so that both the red and green lights are out. If zero flow is desired, leave the pot fully counter-clockwise so that the red light remains on continuously.

Jumper J4-A to J4-B. (reheat minimum); adjust potentiometer R69 (Minimum B) so that both the red and green light are out at the desired flow. If zero flow is desired, leave pot R69 full counter-clockwise so that the red light remains on continuously when no delta P is applied to the transducer.

Remove the jumper from J4-A to J4-B.

### **Auto Dual Minimum**

Set the thermostat to the full heat position (full-clockwise).

Jumper J4-A to J4-B and insure that J18 is open. Heating minimum would be the minimum at which the valve is controlled before the fan on a fan-powered unit is activated or before the first stage of heat is activated on a reheat unit.

Adjust minimum potentiometer R69 (Minimum B) so that both the red and green light are out. If this setting is to be zero, leave the potentiometer fully counter-clockwise so that the red light remains on with no delta P applied to the transducer.

Remove the jumper from J4-A to J4-B. This puts the unit into the mode where minimum A is now in control (cooling minimum).

Adjust R68 (Minimum A) so that the red and green light are both out. If zero minimum is desired, leave pot R68 full counter-clockwise so that the red light is on continuously with zero delta P applied to the transducer.

### **Restore Unit to Operating Condition**

Remove magnehelic gages and replace all tubing on the air valve by reinstalling the high port first and then the low. Replace all jumper wiring which was removed during set-up. Set the thermostat to the desired setpoint.

# Balancing

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The following tools are required to properly adjust and calibrate the electronic controls:

- Digital voltmeter
- 0-2" W.G. magnehelic gage (or inclined manometer)
- Tubing and fitting to connect gage to flow ring tees ( $5/32$ " and  $1/4$ " tubing).
- Mechanic tools (screwdriver, pliers, etc.)

## Balancing Procedure

1. Check the 24 volts AC supply voltage to the circuit card, terminals TB1-1 to TB1-2. Acceptable range = 21.6 to 26.4 volts AC.
2. Check the 12 volts DC power supply of the circuit card terminals TB1-5 (+) to TB1-3 (-). Acceptable range = 11.6 to 12.4 volts DC.
3. Install the magnehelic gauge to observe delta P. When connecting to the test tees, be careful not to create an excessively low pressure on the transducer (when used). The following procedure should be followed.
  - a. Remove low pressure cap from test tee.
  - b. Remove high pressure cap from test tee.
  - c. Connect gage to high pressure side.
  - d. Connect gage to low pressure side.
4. Disconnect connector from J8 to prevent heaters or fans from energizing.
5. If a remote relay card is being used, be sure that the relays are in the "Occupied, Cooling" mode of operation.

## Adjustments (Set Maximum and Minimum Flows)

To set minimum and maximum flows to the desired setting, refer to the calibration section.

# Installation and Wiring

The general layout of the reheat circuit board is shown in Figure 17. In this figure, the flow transducer, position potentiometer on the air valve, the motor, zone sensor, and heater stages are all shown schematically. The layout of the circuit card shows the physical location of each item. Basic connections are as follows:

1. Power is connected to TB1-1 and TB1-2 located in the lower right-hand corner of the circuit card. The power requirement is 24 volts AC ( $\pm 10\%$ ).

2. The zone sensor is connected to terminals TB1-3, 4, and 5. These screw terminals are part of the 5 position barrier strip in the lower right-hand corner of the circuit card. It is very important not to connect power to these terminals, since applying power to the wrong terminal will destroy the card. For Night Set Back (NSB), the zone

sensor is connected to TB5 1, 2, and 3 on the dual relay board.

3. The motor and position potentiometer (pressure dependent) are connected via jack J1.

4. The transducer (pressure independent) is connected to jack J3.

5. Reheat stages (or fan on fan-powered units) are connected at jacks J40 (Common), J9, J10, and J11.

*Note: Wet contact supplies the voltage, but dry contact is just a switch. In the circuit board when J7 is jumped to J8, these relays are wet contacts.*

6. Various options to cause changes to the operation of unit are input at jack J4, J2, J14, J17, J16, J13, J18, and J15. The operation of these options have been discussed in the Remote Option section.

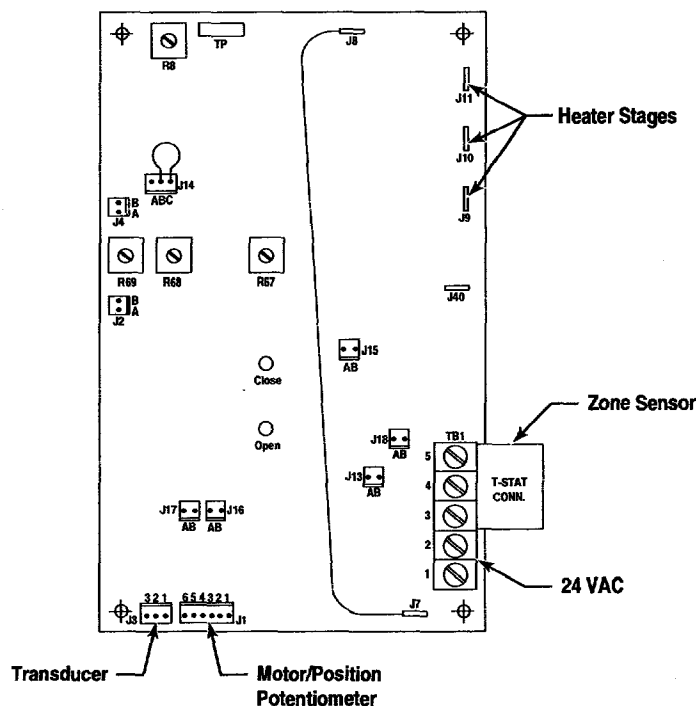
7. There are various adjustments on the circuit card as discussed in detail in the Calibration section.

- a. Maximum flow (or position) adjustment is R67. Turning clockwise increases the maximum flow.
- b. There are two minimum flow adjustments labeled R68 and R69. Turning clockwise increases the minimum flow.
- c. There is a zero flow adjustment used in initial calibration and set-up of the circuit card. This is R8.

8. There are four test points for the convenience of servicing in the field. These test points include:

- TP4: Transducer output
- TP1: Flow voltage (null calibration)
- TP2: Temperature voltage
- TP3: A common to make application of clip leads easy.

**Figure 17**  
**Reheat (PI)**



# Zone Sensor

## Zone Sensor Operation

This section explains how the zone sensor operates.

Temperature is sensed using a thermistor. The thermistor changes resistance with a change in temperature. The resistance of thermistor decreases as temperature increases. By using a voltage divider circuit, the deviation from the room setpoint is determined.

Referring to Figure 19C, note the schematic representation of the zone sensor. There are three connections to the zone sensor:

1. 12 volts DC is supplied from TB1-5 on the circuit card to terminal 1 on the zone sensor.
2. The zone sensor output signal is connected from terminal 2 of the zone sensor to TB1-4 on the circuit card.

3. A common (ground) is supplied from TB1-3 on the circuit card to terminal 3 on the zone sensor. At setpoint, the input to the circuit card is 6 volts measured across terminals 2+3. Therefore, with 12 volts input between terminals 1 and 3, the voltage drop across the thermistor will equal the voltage drop between terminal 2 and terminal 3. With the voltages being equal the room temperature is considered satisfied and all output relays are de-energized. If the temperature in the zone goes up, the resistance of the thermistor will go down, causing a voltage increase which will drive the air valve open. Conversely, if the room temperature goes down, the thermistor resistance goes up causing a decrease in the output signal, which will drive the air valve to minimum and energize the relay output. To determine the

setpoint, the setpoint potentiometer is moved, changing the resistance between terminals 2 and 3. By changing the setpoint potentiometer, the temperature at which the output signal equals 6 volts will be changed. Therefore, the setpoint potentiometer moves the setpoint up and down.

Degrees in Fahrenheit	Thermistor Nominal Resistance (OHMS) ± 5%
65	4070
66	3960
67	3850
68	3750
69	3660
70	3580
71	3500
72	3420
73	3330
74	3250
75	3170
76	3080
77	3000
78	2940
79	2870
80	2810

Figure 19B  
Old Style

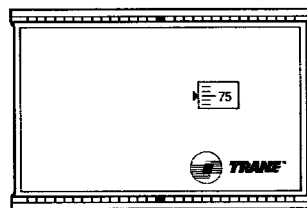


Figure 19A  
New Style

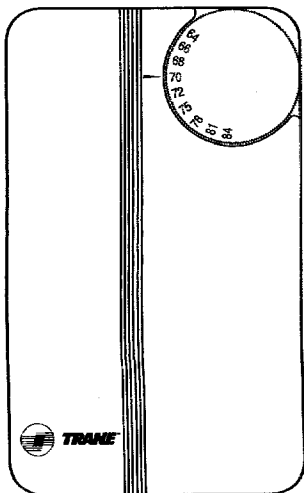
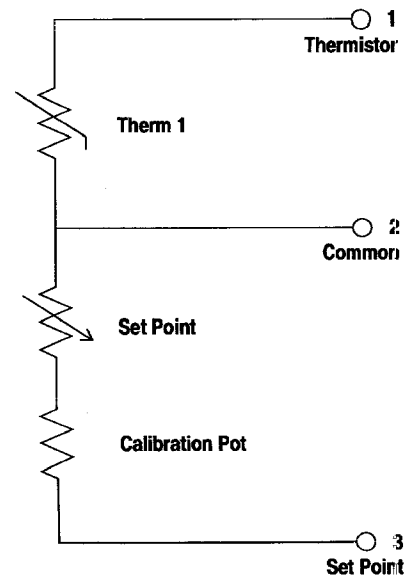


Figure 19C  
Zone Sensor



# Troubleshooting

Symptom	Probable Cause	Recommended Action
Fan not running	Faulty connection	Check wiring diagrams and inspect all connections.
	Incorrect voltage input	Compare actual voltage with supply requirement.
	Faulty fan motor	Check motor and power to the fan motor. If power is present and fan does not run, replace the motor.
	Output relays not enabled	Verify J14 B+C is jumpered.
Fan motor noise	Incorrect voltage input	Compare actual voltage input with supply requirement.
	Loose fan wheel	Adjust and tighten fan wheel.
Low CFM to unit	Supply fan not providing adequate CFM	Adjust supply fan speed. Check for proper rotation.
	Leaky duct work	Repair leak.
	Dirty filters	Replace air filters.
Improper CFM to zone	Debris is jamming valve	Clear valve damper travel.
	Damage to valve casing	Repair casing or replace valve.
	Improper wiring	Check unit diagrams for correct connection.
	Faulty circuit board	Check and replace if necessary.
	Faulty valve motor	Check and replace if necessary.
	CFM setting incorrect	Recalibrate circuit board.
	Override options enable	De-energize relay board or remove jumpers.
Incorrect air temperature delivered to the zone	Incorrect wiring to reheat coil	Check and replace if necessary. Compare wiring with diagram on unit.
	Faulty zone sensor	Check for correct zone sensor resistance.
	Faulty circuit board	Recalibrate and replace if necessary.
	Incorrect supply air temperature	Check leaving air temperature from air handling unit.
Coils do not engage on call for heat	Faulty relay coil	Check for voltage to heating coil and relay(s). Verify supply voltage matches coil voltage.
	Faulty relay board	Check for contact closure.
	Relays not enabled	Check J14 B to C.
	Board not calibrated	Calibrate.
Room temperature differs from reading on zone sensor (PI)	Erratic zone sensor	Check zone sensor voltage 12 volts DC between terminals 1 and 3.  Check DC voltage at zone sensor terminal 2 and 3 (6 volts DC). Turn zone sensor to full heating voltage; it should be equal to or less than 5.4 volts DC. Turn zone sensor to full cooling; voltage should be equal to or greater than 6.5 volts DC.  If DC voltage is not attainable, replace zone sensor.
	Zone sensor miscalibrated	Check calibration of zone sensor. See also calibration section.

## Tools and Equipment

When repairing a VariTrane product (analog control), it is important to have the necessary tools and instruments.

1. 0–2" magnehelic gage with fittings for two 1/4" outside diameter (OD) tubing.
2. Voltmeter.
3. Four jumper leads.
4. Small screwdriver 1/8" blade.

## System Check

Improper room control may be caused by areas other than the VAV boxes. Before replacing the air valve or control box, make sure that the entire system is operating properly and is supplying sufficient air to the valve. Complete the following checks.

1. Look for obvious leaks in the duct system. Ensure that sufficient static pressure is present at the air valve.
2. Inspect the supply fan and VAV fan filters. Clean or replace, if necessary.
3. Check zone sensor location, outside wall, appliances, direct sunlight, or the supply airstream may be artificially heating or cooling the zone sensor.
4. Evaluate diffuser location. Each slot diffuser should have 15" of flat ceiling surface on either side of the slot to ensure proper air distribution. Check that air flow from grills or diffusers is properly balanced.
5. For accurate flow control, there must be at least two duct diame-

ters of straight ductwork before the air valve inlet. Electric coils require four feet. of straight ductwork downstream of the coil.

6. Compare voltage requirements, as specified on the side of unit with actual voltage supplied to the unit. The control voltage requirement is 24 volts AC  $\pm$  10%.

## Air Valve and Motor Check

If problems occur with valve actuation, perform the following steps.

1. Visually inspect the air valve for loose gaskets, rust, casing damage, or restriction to damper travel.
2. Ensure that there is proper voltage supplied by checking for 24 volts at terminal 1 and 2 on the circuit board. Actual voltage range is 21.6 - 26.4 volts AC.
3. To open the valve, apply 24 volts AC to the black and blue wires on the motor plug coming from the valve. The drive takes a maximum of six minutes to fully open (D-style).
4. To close the valve, apply 24 volts AC to the red and blue wires on the motor plug coming from the valve.
5. Check for proper ohm reading across the yellow wires on the motor plug (located on pressure dependent boards only). See Figure 20.
6. If motor fails to operate from a direct 24 volts AC power source, there is no binding, obstructions, and the end switches are closed,

the motor is defective and should be replaced.

## Control Check

**WARNING: Disconnect electrical power source before connecting or disconnecting wires from the circuit board. Failure to exercise caution during electrical test may result in injury or death from electrical shock.**

1. Disconnect power source and remove zone sensor wires 3, 4, and 5. Be sure to mark the wires so that they will be correctly replaced.
2. Reconnect power to the unit. The valve should move to its minimum or fully closed position.
3. Jumper terminals 4 and 5. The green LED should light. This should cause the valve to move fully open or to its maximum flow setting (full stroke valve drive time is 6 minutes D-style).
4. Disconnect the jumper from terminals 4 and 5.
5. Jump terminals 3 and 4. The red LED should light. The valve should close to minimum and the relays (or reheat) should energize.
6. If the relay doesn't energize, check contact J9 for proper closure and connect J14 B to C.
7. Remove Jumper terminals 3 and 4.
8. If everything operates correctly, disconnect power and reconnect all wires. Check the air valve or zone sensor for further trouble analysis.

## Zone Sensor Check

To troubleshoot zone sensor, ensure that 24 volts are available at the control unit board and then complete the following procedures:

1. Move the zone sensor to full cooling. The valve should open completely. If the action is reverse, check the proper zone sensor connection. Check J2 for closure.
2. Rotate the zone sensor knob to full heat. This should cause the valve to close and fan to come on. When room setpoint is above the actual room temperature, stages of heat will be energized, if enabled.
3. If zone sensor does not operate at all, check the wiring from the board to the sensor. Reference the zone sensor section.
4. Check DC voltage at zone sensor terminal 2 and 3 (6 volts DC). Turn zone sensor to full heating voltage; it should be equal to or less than 5.4 volts DC. Turn zone sensor to full cooling; voltage should be equal to or greater than 6.5 volts DC.

## Heater Contactors Check

To troubleshoot heater contacts on units with electric reheat, complete the following procedures.

1. Disconnect power source.

**WARNING: Failure to disconnect electrical power before servicing the unit may result in injury or death.**

2. Disconnect wires from the contactor.

3. Connect an ohm meter to the contacts.

4. Apply 24 volts (from independent power supply) to the coil of relays. Check for contact closure. If contact does not close, replace the contactors.

## Fan Motor Check

To troubleshoot the fan motor, complete the following procedures.

1. Disconnect the power, check all wiring and compare to the wiring diagrams provided on the unit.

2. Turn power back on. Operate the zone sensor to see if the proper voltage is being supplied to the motor relay. If the motor does not start, check capacitor and fan motor.

3. Check the motor relay by attaching a voltmeter across the 24 volt coil of the relay. For parallel fan-powered, operate the zone sensor to energize the fan and confirm the voltage to the relay is turned on. Check for supply voltage between the common and hot side of the relay.

4. Attach a volt meter to the white common wire on the terminal block and the blue, black or red wires from the motor. If line voltage is present check for fan obstruction.

5. With power off, spin the fan wheel. If it does not run freely, check shaft alignment or housing clearances.

## Circuit Board Check

1. Remove the control box cover. Inspect all wiring and compare with the label on the control box cover. The label also indicates jumper connections. Insure that all wiring and jumpers are connected exactly as shown on the diagram. Refer to Figure 13 on page 15 for a typical example.

2. If applicable, disconnect the Jumper from terminals J7 to J8 and remove the wire connection from terminals J9, J10, J11. This will disable the heat from energizing while working on the circuit board to prevent nuisance high limit control trip outs.

*Note: When removing these connections, power must be disconnected. Also remove power from the relay boards.*

3. Measure the voltage at terminals TB1-1(+) and 2(-) on the circuit board. Voltage reading should be 24 volts AC  $\pm$  10%.

4. Measure the voltage at terminal TB1-5(+) and TB1-3(-) on circuit board. Voltage reading should be 12 volts DC  $\pm$  10% tolerance. This voltage is the output power for the zone sensor. If these voltage readings are not shown, it would indicate defective board.

5. If 12 volts DC is present, rotate zone sensor thumbwheel and check for voltage change across zone sensor terminals 2+3.

6. Adjust minimum fully counter clockwise and maximum fully clockwise.

7. Verify the red and green lights change when rotating the thumb-wheel.

8. If any step does not work, replacement of the board may be necessary. If all steps work, proceed with further component checks.

## Transducer Check

1. Disconnect the tubing to the flow sensor, remove the low pressure line first, then the high side. Transducer damage may result if procedure is not followed.

2. Attach volt meter to terminals TP4(+) and ground, B1-2 or 3, or TP3. Voltage on these terminals should be between .1 to .4 volts DC, the ideal is .254 volts DC.

3. Connect volt meter to terminals TP1(+) and ground. Voltage at these terminals should be 4.78 to 4.82 volts DC. If the voltage at these terminals is lower or greater than the specified tolerance, this could be the cause for not obtaining correct minimum or maximum flow. This causes the controller to not operate within the specified minimum and maximum value even with the minimum potentiometer fully counter-clockwise. Adjust R8 for 4.8 volts DC.

4. Reconnect the air valve and drive to maximum position, voltage should increase on TP4 to TP3.

5. If voltage does not increase verify with a magnehelic that the delta P is increasing.

6. Replace the transducer if delta P increases and voltage does not change.

*Note: A faulty transducer will cause an air valve to function improperly.*

**Figure 20**  
**Pressure Dependent**  
**Potentiometer Settings**

<b>C Style Valves (1987 and prior)</b>		
Size	Closed	Open
02-20	.5K	8-10K
<b>D Style Valves (1988 to present)</b>		
Size	Closed	Open
03, 06, 11	14.7K	4.63-4.77K
17	23.2K	4.63-4.77K
24, 32, 42	18.45K	4.63-4.77K

## Relay Output Check

1. If optional relay boards are used, make sure boards are in day operating mode (typically de-energized).

2. Ensure that zone sensor operation is correct and, if applicable, which zone sensor is under control. Refer to prior sections for step by step procedures.

3. Remove all connections from terminals J7 to J8 and the connections to J9, J10, and J11.

4. Place a jumper between jack J14-B to jack J14-C. This will enable the reheat relays for the following tests.

5. Set the zone sensor to the full cooling position.

6. Check continuity between the following pairs of connectors: J8 to J9, J8 to J10, J8 to J11. There should be no continuity between these contacts (open circuit).

7. Slowly increase the zone sensor setting from full cooling to heating. At a position on the zone sensor near room temperature, relay #1 which connects J8 to J9 should close. Next, relay 2 which connects J8 to J10 should energize, and finally the relay 3 which connects J8 to J11 should energize. When the zone sensor is rotated to the full heating position, a continuity check should show that contact closures between J8 and J9, J8 and J10, and J8 and J11 have been made (closed).

8. If continuity is not present at all stages, replace the board or use an unused relay for reheat control.

## Auto Dual Minimum Check

A digital volt meter will be required to make the voltage checks described in this procedure. Note the following differences in labeling of adjustment potentiometer described in the following steps:

Circuit Board Label	
R8	Null voltage calibration
R67	Max Flow
R68	Min Flow A
R69	Min Flow B

1. Refer to Preliminary Setup steps 1 through 4. Make changes as described in the following steps.
2. Jumper between terminals J4-A and J4-B.
3. Jumper between terminals J18A to J18B.
4. Jumper between terminals J14B to J14C.
5. Rotate the zone sensor to the full cool position. The green LED should be illuminated on the circuit board and voltage present at terminals J1-3 to J1-1. The voltage at terminal TP2 to ground should be 5.9 volts DC or higher.
6. Slowly rotate the zone sensor until the red LED on the circuit board illuminates. Voltage at terminal TP2 to ground should be approximately 3.2 volts DC.
7. Continue rotating the zone sensor until the first stage of heat energizes. This can be determined by a soft, audible click and voltage across terminals J8 to J9. At this point, the green LED on the circuit

board should illuminate. Voltage at terminal TP2 to ground should be 3.9 volts DC or higher. R68 should be in control.

8. Now adjust the zone sensor so that the output voltage at terminals 2 and 3 is 6.0 volts DC, +.01 volts DC, -.01 volts DC.
9. Compare the actual zone sensor to the indicated setpoint on the dial of the zone sensor. If the two readings are within 3°F of each other, then the zone sensor is within standard calibration tolerance. Calibration procedures are described in the Calibration Section in this manual.

10. Note position of R69. Rotate potentiometer R69 clockwise and counter-clockwise while watching the red and green LED's to insure that control is now with minimum potentiometer R69.

11. Return R69 to original position. Remove the jumpers described in the above Steps 3 through 5.

## Electronic Zone Sensor Check

*Note: The following checkout procedures will be used when power is applied to the electronic zone sensor.*

1. Room temperature must be between 65°F and 80°F. Ensure also that placement of the zone sensor is satisfactory. It should not be located in direct sunlight, on cold or hot wall surfaces, etc. A zone sensor or other accurate temperature measuring device should be installed next to the zone sensor. It is preferable to mount the temperature sensing

element under the zone sensor cover next to the thermistor of the zone sensor. (The thermistor is a small electronic temperature sensing device imbedded in a glob of silicone cement.)

2. Remove the zone sensor cover.
3. Attach a volt meter to terminals 2(+) and terminal 3(-).
4. Record temperature in zone. It should be between 65°F and 80°F.
5. Check the voltage at terminals 2(+) and terminal 3(-). If the zone temperature and the zone sensor setpoint are at equilibrium, the voltage at this point should be 6.00 volts DC.
6. Rotate the zone sensor to the full heating position. Allow 5 minutes for the zone sensor to equalize setpoint. The voltage on terminals 2 and 3 should drop to 5.5 volts DC or less.
7. Rotate the zone sensor to the full cooling position. The voltage on terminals 2 and 3 should rise to 6.3 volts DC or higher.

## Double Relay Board Check

1. Remove all jumpers connecting the relay board to the main circuit board. Be sure to note their location, compare the jumper location to the wiring diagram on the unit. See Figure 13 on page 15 for typical jumpers.
2. If 24 volts AC remote control voltage is used, follow steps 3 through 6. If 12 volts DC remote

control voltage is used, follow steps 7 and 8.

3. With no power to terminals TB10-1, 2, 3, or 4, the following contacts should be closed. Pins A to B of jacks J21, J22, J24, and J25. Pins B to C on these jacks should all be open.

4. Apply 24 volts AC power to terminals 1 and 2 and in parallel terminals 3 and 4 on terminal TB10.

**CAUTION: Jumpers at J20 and J23 must be removed or else the relay board will be damaged.**

---

5. With power applied to the TB10 terminals, the A to B contacts should be open of jacks J21, J22, J24, and J25. Pins B to C of the relay jacks should all be closed. If not, replace relay board.

6. Disconnect the 24 volt AC power.

7. Install a jumper between J20A to J20B and jumper between J23A and J23B.

**CAUTION: The circuit board will now operate with incoming power of 12 volts DC with jumpers on J20 and J23; 24 volts applied to terminals 1, 2, 3, and 4 of TB10 will destroy the circuit board.**

8. Apply 12 volts DC to terminals TB10-1 (+) and TB10-2 (-) and apply 12 volts DC to TB10-3 (+) and TB10-4 (-).

**CAUTION: Connect 12 volts DC in the polarity described. Reversal of polarity will damage the circuit board. Check the relay contacts on J21, J22, J24, and J25 as described in Step 4 above. In these cases, pins A to B should be open and pins B and C should be closed.**

## Auto Zone Sensor Setpoint Check (NSB)

1. Remove all jumpers and disconnect incoming power to the relay board. Locate the potentiometer marked setback temperature just under terminal strip TB5.

*Note: Record original setting of potentiometer.*

2. Rotate the potentiometer labeled "Setback Temp F" fully counter-clockwise.

3. With an ohmmeter, measure the resistance between pins J12-A and jack J42. Resistance should be 5.43 ohms.

4. Now rotate the potentiometer fully clockwise.

5. With an ohmmeter, check resistance between terminals J12-A and J42. Resistance should be 2.37K ohms.

6. Replace all jumpers as marked or as described by the wiring label on the control box cover.

7. Rotate potentiometer to original setting.

**Figure 21**  
Jack Numbering Designations for all VAV Circuit Cards

Jack	Function
J1	Motor and valve potentiometer (when required)
J2	Changeover
J3	Transducer
J4	Dual minimum
J5	Motor #2 (when required)
J6	Transducer #2 (when required)
J7	24 volts AC
J8	Heater stage relay contacts (common)
J9	Stage 1 contact
J10	Stage 2 contact
J11	Stage 3 contact
J12	Night setpoint setback
J13	Open to maximum and lockout heat stages
J14	Lockout all heat relay stages
J15	Open to maximum flow
J16	Drive valve physically closed
J17	Drive valve physically closed
J18	Dual minimum on first reheat stage lockout
J19	Heater stage operation test points
J20	Double relay board, relay 1 voltage selection
J21	Double relay board, relay 1 contacts
J22	Double relay board, relay 1 contacts
J23	Double relay board, relay 2 voltage selection
J24	Double relay board, relay 2 contacts
J25	Double relay board, relay 2 contacts
J26	Single relay, coil voltage selection
J27	Single relay board, relay contacts
J28	Single relay board, relay contacts
J40	Common
J41	Common to TB5-A on double relay board
J42	Common to TB5-B on double relay board
J43	Common connection to main circuit board
TB1	Common connections on analog circuit cards are unchanged
TB5	Customer T-stat connections on analog double relay board
TB10	Double relay board coil voltage connections
TB11	Single relay board coil voltage connections