



**VMS Series**

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**Vari-Master Series  
Water Source Heat Pumps**

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# **Installation, Operating & Maintenance Instructions**

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# GENERAL INFORMATION

## Inspection

Upon receipt of shipment at the job site, carefully check the shipment against the bill of lading. Make sure all units have been received. Inspect the carton or crating housing of each Vari-Master Unit and inspect each unit for damage. Assure that the carrier makes proper notation of any shortages or damage on all copies of the freight bill and that he completes a Carrier Inspection Report. Concealed damage not discovered during unloading must be reported to the carrier within 15 days of receipt of shipment. **NOTE: It is the responsibility of the purchaser to file all necessary claims with the carrier.** Notify the ClimateMaster Traffic Department of all damage within fifteen (15) days of shipment.

## Introduction

This Installation and Operation Manual is for Climate Master Vari-Master Series Water Source Heat Pump systems (VMS).

ClimateMaster Vari-Master Water Source Heat Pump units are designed for multiple zone control of heating and cooling in large commercial or industrial applications requiring nominal capacities ranging from 20 to 40 tons.

*VAV (803) Heat Pump Units* operate with modulating air volume when the unit is in cooling mode and constant air volume when the unit is in heating mode.

*VAC (903) Heat Pump Units* (cooling only) operate with continuous modulating air volume.

The installation site chosen for these units must allow adequate clearance on all sides for maintenance and servicing.

Electrical data is provided in the *Installation* section of this manual. Refer to project submittal drawings for specific unit technical data and wiring diagrams.

## Storage

**CAUTION: DO NOT store or install Vari-master units in corrosive environments or in locations subject to temperature or humidity extremes (e.g., attics, garages, rooftops, etc.). Corrosive conditions and high temperature or humidity can significantly reduce performance, reliability, and service life. Always move units in an upright position. Tilting units on their sides may cause equipment damage.**

Upon the arrival of equipment at the job site, immediately store units in their shipping cartons in a clean, dry

are. **Store units in an upright position at all times. Do not stack units. Do not remove equipment from shipping carton until equipment is required for installation.**

## Unit Protection

Cover Vari-Master units on the job site with either shipping cartons, vinyl film, or an equivalent protective covering. Cap the open ends of pipes stored on the job site. In areas where painting, plastering, or the spraying of fireproof material has not been completed, all due precautions must be taken to avoid physical damage to the units and contamination by foreign material. Physical damage and contamination may prevent proper start-up and may result in costly equipment clean-up.

Examine all pipes, fittings, and valves before installing any of the system components. Remove any dirt found on these components.

## Pre-Installation

Vari-Master units are assembled, wired and factory-tested before shipment. Installation, operation and maintenance instructions are provided with each unit. Before unit start-up, read all manuals and become familiar with the unit and its operation. Thoroughly check out the system before operation.

Prepare Vari-Master units for installation as follows:

1. Compare the electrical data on the unit name plate (located on the in/out condenser panel) with ordering and shipping information to verify that the correct unit has been shipped. See Product Coding Chart (Figure 1, page 4) and Typical Installation (Figure 3, page 5) for additional information.
2. Keep the unit covered with the shipping carton until installation is complete and all plastering, painting, etc. is finished.
3. Verify that refrigerant tubing is free of kinks or dents, and that it does not touch other unit components.
4. Inspect all electrical connections. Connections must be clean and tight at the terminals.

### ▲ WARNING

**To avoid equipment damage, do not use Vari-Master units as a source of heat during the construction process. The mechanical components and filters used in these units can quickly become clogged with construction dirt and debris which may cause system damage.**

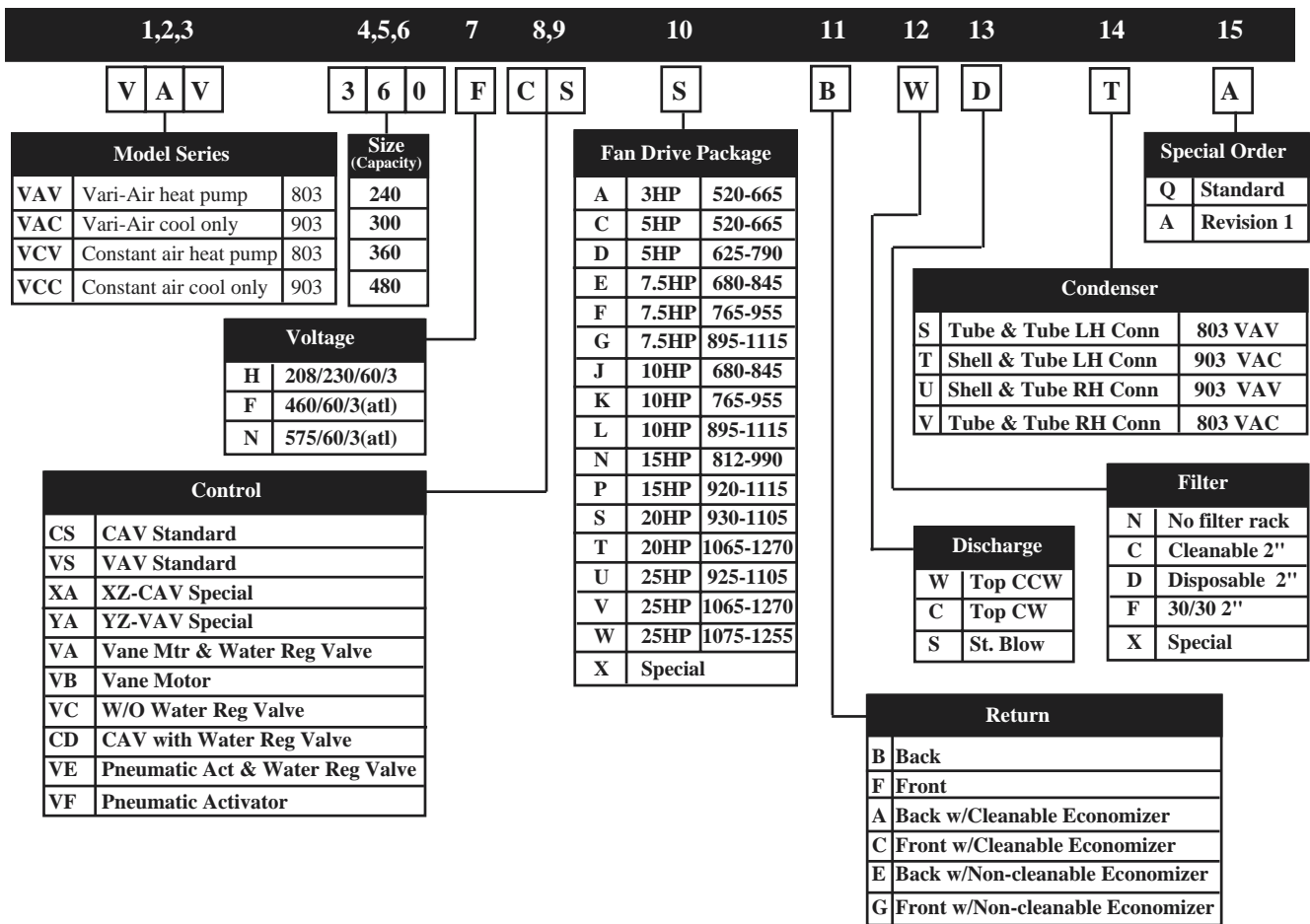


Figure 1 - Product Coding Chart

### Location and Access

Vari-Master Units are typically installed in a mechanical room. Refer to Figure 3 for an illustration of a typical installation. Install units with adequate clearance to allow maintenance and servicing. Conform to the following guidelines when selecting unit location.

1. Install the Vari-Master inside a building.
2. Provide adequate clearance for filter placement and drain pan cleaning. Do not block filter access with piping, conduit or other materials. Refer to Table 1 (page 5) for typical unit dimensions.
3. Provide access for fan and fan motor maintenance and for servicing the compressor and coils
4. Provide access to water valves and fittings. Provide screwdriver access to unit side panels, discharge collar and all electrical connections.
5. Level the unit to allow proper drainage of condensate. If isolation springs are used, install according to installation instructions shipped with the springs.

5. When the unit is securely installed, loosen the compressor mounting studs and remove the shipping spacer. See Figure 2. Insert rubber spaces into the compressor mounting holes. Spacers are shipped in the high voltage control compartment.

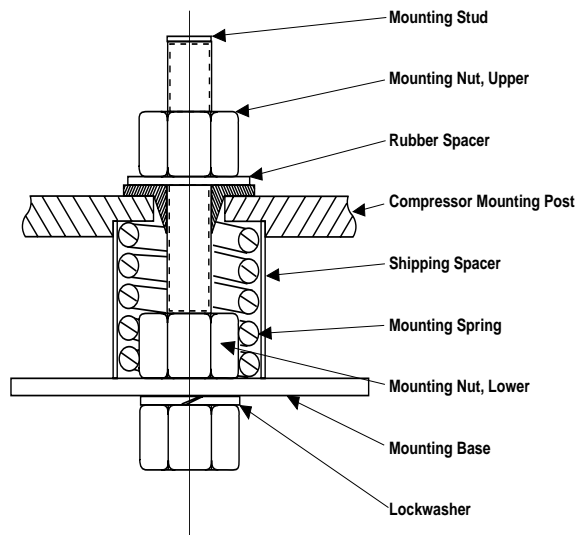


Figure 2. Compressor Mounting Assembly

# Typical Installation Self-Contained VAV Unit Vari-Master Series (without economizer)

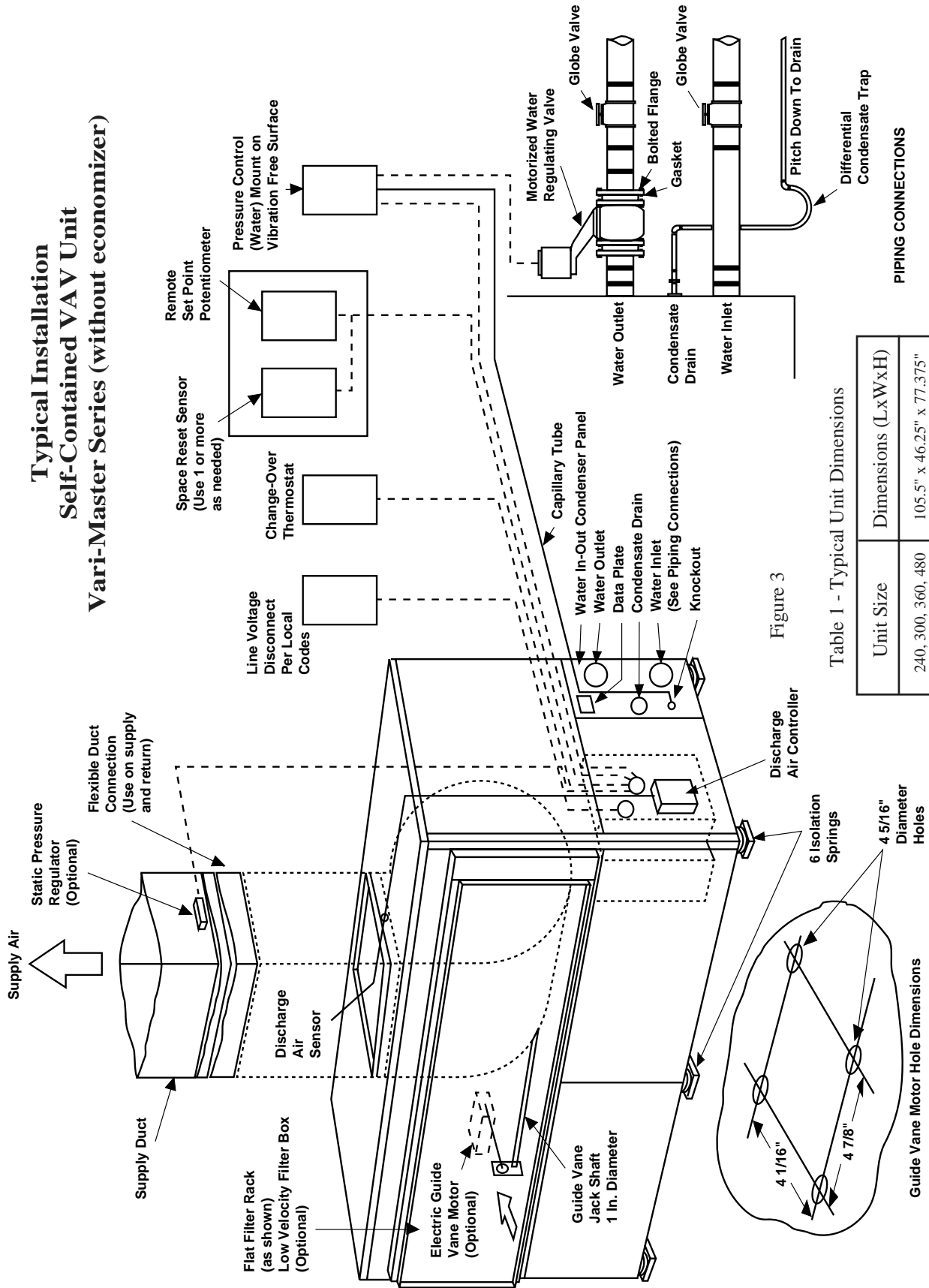


Figure 3

Table 1 - Typical Unit Dimensions

Unit Size	Dimensions (LxWxH)
240, 300, 360, 480	105.5" x 46.25" x 77.375"

*Refer to job submittal for actual unit dimensions.  
Dimensions shown above do not include duct collar*

PIPING CONNECTIONS

Guide Vane Motor Hole Dimensions

4 5/16" Diameter Holes

## INSTALLATION

The installation of Vari-Master Water Source Heat Pump units and all associated components, parts and accessories that make up the installation shall be in accordance with the regulations of ALL Authorities having jurisdiction and MUST conform to all applicable Code. It is the responsibility of the Installing Contractor to determine and comply with ALL applicable Codes and Regulations.

### Sound Attenuation for Vari-Master Units

Sound minimization is achieved by enclosing the unit within a mechanical room. Additional measures for sound control include:

1. Insulating the mechanical room and the first 10 feet of duct work for sound absorption
2. Mounting the unit on spring isolators
3. Installing flexible duct connectors between the unit and the supply and return ducts to isolate sound and vibration from ductwork (See Figure 3 page 5)

### Installation of Ductwork

Insulate ducts passing through unconditioned spaces and cover them with a vapor barrier according to minimum installation standards published in the latest issues of SMANCA (Sheet Metal and Air Conditioning Contractors or America) and NESCA (National Environmental Contractors Association).

### Installation of Supply and Return Piping

Follow these piping guidelines. **WARNING: Piping must comply with all applicable Codes.**

1. Install a drain valve at the base of each supply and return riser to facilitate system flushing.
2. Refer to Figure 3, page 5 for examples of piping connections
3. Place strainers at the inlet of each system circulating pump.

Insulation is not required on loop water piping except where the piping runs through unheated areas or outside the building. Because loop temperature is normally between 60° F and 90° F, piping does not sweat or suffer heat loss in normal ambient conditions.

Ensure that the trap is filled with water before operating the unit to avoid condensate pan overflow at initial start-up.

### Condensate Piping

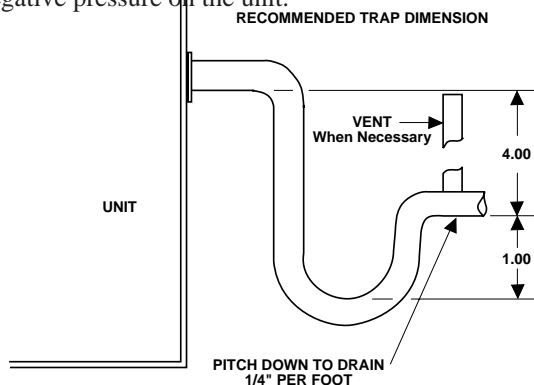
Units are typically installed directly above each other on successive floors with condensate drains located near the units.

Connect the unit condensate drain connection to the building condensate drain with a 1" drain line.

The horizontal run of a condensate hose is usually too short to cause drainage problems, however pitch the horizontal run of the condensate line at least 1/4 inch for every foot of run in the direction of flow. Avoid low points and unpitched piping since dirt collects in low or level areas and may cause stoppage and overflow.

Install a condensate trap at each unit with the top of the trap positioned below the unit condensate drain connection.

Figure 4 illustrates a typical trap and vent used with Vari-Master Heat Pumps. Design the length of the trap (water-seal) based upon the amount of negative pressure on the drain pan. As a rule, 1" of trap is required for each inch of negative pressure on the unit.



**Figure 4: Condensate Drain**

*++ When operating with less than 4" of negative pressure, this dimension can be adjusted to accommodate actual negative pressure.*

Each unit must be installed with its own, individual trap and connection to the condensate line (main) or riser. Provide a means to flush or blow-out the condensate drain line. Do not install units with a common trap and/or vent.

Install a vent in the condensate line of any application which may allow dirt or air to collect in the line. Always vent when the application requires a long, horizontal run, when some sagging in the condensate line may be anticipated (as in a long line of plastic pipe) or when "double trapping" may occur. Also vent when large units are working against higher external static pressure than other units connected to the same condensate main since

this may cause poor drainage for all units on the line. When a vent is installed in the condensate line, it must be located after the trap in the direction of condensate flow.

Refer to submittal data for condensate pipe size. See Figure 3, page 5 for typical condensate pipe installation.

## ELECTRICAL WIRING

### ⚠ WARNING

To avoid possible injury or death due to electrical shock, open the power supply disconnect switch and secure it in an open position during installation.

**CAUTION:** Use only copper conductors for field installed electrical wiring. Unit terminals are not designed to accept other types of conductors.

All field installed wiring, including electrical ground, must comply with the National Electrical Code as well as all applicable local codes. In addition, all field wiring must conform to Class II temperature limitations described in the NEC.

Refer to the unit wiring diagrams included with submittal drawings for fuse sizes and a schematic of the field connections which must be made by the installing (or electrical) contractor.

Consult the unit wiring diagram located on the inside of the compressor access panel to ensure proper electrical hookup.

All final electrical connections must be made with a length of flexible conduit to minimize vibration and sound transmission to the building.

Each Vari-Master Unit must have a separate branch circuit fused disconnect mounted nearby for easy access when servicing. Refer to the electrical specifications for proper wire and fuse sizes.

## Water Regulating Valve

A water regulating valve is shipped separately for VAV units and must be field mounted by the installer. Install a globe valve on the water inlet and also after the water regulating valve on the outlet. See typical installation diagram (Figure 3, page 5). Flanges and gaskets at the water "out" connection and globe valves are not supplied by ClimateMaster.

## Water Pressure Regulator

Mount the Water Pressure Regulator in a vibration free location. Assure that the cap tube is easily routed from

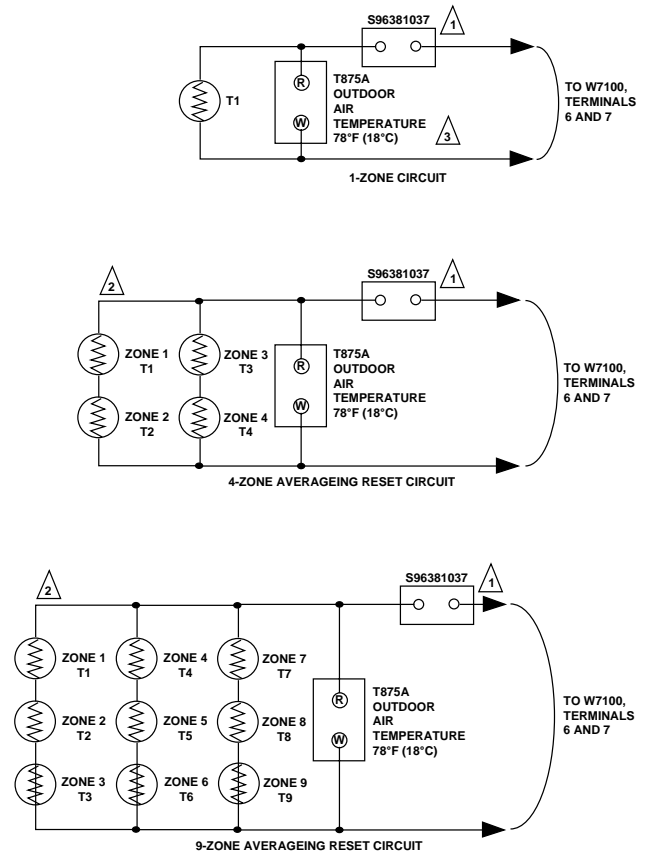
the control to the port on the liquid line shut-off valve on the VAV Unit or the access valve on the refrigerant/water heat exchanger on the VAC Unit.

Use the knockout located on the water connection panel (Figure 3, page 5) to route the cap tube to the port location. The pressure regulator is provided with a 36" long cap tube. Use an insulator to protect the cap tube from the edges of the knockout. When the distance between the unit and the water pressure regulator exceeds 36", an extension can be added to the cap tube.

On VAC Units, use a 1/4" flare swivel nut with core depressor between the water pressure regulator cap tube and the access valve on the refrigerant/water heat exchanger.

Refer to the wiring diagram located on the access panel of the control box for wiring instructions.

Figure 5: Multiple Sensor Installation



1. S96381037 Remote Setpoint potentiometer required to permit adjustment of reset control point (use only with space sensors. Do not use with outdoor sensors)
2. All space sensors are T7047C1025 Type wired in Series/parallel connection
3. Lock out reset under high humidity conditions, set at 60° F

## Remote Potentiometer

Mount the remote potentiometer in a locations where settings are not subject to tampering by unauthorized personnel. Install the potentiometer in a standard 2 x 4 outlet box which is at least 1-3/4" deep. The box may be surface mounted or recess mounted.

## Space Sensors

Locate Space Temperature Sensors on an inside wall and approximately 5 feet from the floor in an area where air circulates freely and average room temperature can be accurately measured. One or more sensor may be used.

Refer to Figure 5 (page 7) for an illustration of the installation of more than one sensor.

DO NOT locate space sensor in return air ducts. For return air duct applications, contact the factory for recommended sensor model.

## Change over Thermostat

Mount the Change over Thermostat in an area exposed to average return air temperature or other area where change over temperature may be measured. Attach the sensing element with a capillary holder or compression fitting. Carefully coil excess capillary tubing and place underneath the controller.

**NOTE:** For accurate temperature readings, do not bend or kink the capillary tubing. Sharp bends or kinks in the capillary tubing may reduce the accuracy of the temperature reading and the efficiency of the controller.

Refer to the electrical diagram on the access panel of the unit control box for wiring instructions.

## Static Pressure Regulator

When a static pressure regulator is provided by Climate Master, it must be field installed and wired. Refer to the electrical diagram on the unit access panel of the control box for wiring instructions

## Damper Motor Installation

Blower guide vane linkage and jack shaft are provided with the Vari-Master Unit. The damper motor rotor is not provided as standard equipment, however a factory mounted damper can be provided when specified.

When installing a motor in the field, mounting adaptors may be required. Refer to Figure 3, page 5 for the placement of mounting holes.

Linkage from the motor to the jack shaft is provided by the installer.

## Operating Limits

**Environment** -This unit is designed for indoor installation ONLY.

**Water Pressure Regulator** - Set the water pressure regulator at 210 PSI and the differential at minimum.

**Power Supply** - A voltage variation of +/- 10% of nameplate utilization voltage is acceptable. Three-phase system imbalance should not be allowed to exceed 2%.

**Table 2: Operating Limits**

<b>Air Limits</b>	<b>Cooling</b>	<b>Heating</b>
Min Ambient Air	40° F	40° F
Rated Ambient Air	80° F	70° F
Max. Ambient Air	100° F	85° F
Min. Entering Air	50° F	40° F
Rated Entering Air db/wb	80/67° F	70° F
Max Entering Air db/wb	110/83° F	80° F
<b>Water Limits</b>		
Min. Entering Water	40° F	40° F
Normal entering Water	85° F	70° F
Max Entering Water	110° F	90° F

## Starting Conditions

Vari-Master Units start and operate in an ambient of 40° F with entering air at 40° F, entering water at 40° F, and with both air and water at the stated flow rates of ARI Standard 320-96 rating test for initial winter start-up.

### NOTES

1. These are not normal or continuous operating conditions. It is assumed that winter start-up is to bring the building space up to occupancy temperatures.
2. Voltage utilization range complies with ARI Standard 110.
3. When using 100 percent outside air as a source of ventilation, a 40° F DB minimum and a 78° F WB are acceptable. However, the cabinet may sweat during hot weather.
4. Determination of operating limits is dependent primarily upon 3 factors: 1) return air temperature 2) water temperature and 3) ambient temperature. When any one of these factors is at minimum or maximum levels, the other two factors should be at normal levels to ensure proper unit operation.



5. Extreme variations in temperature and humidity, and corrosive water or air adversely affects unit performance, reliability and service life.

## Discharge Air Controller (DAC)

The discharge air controller is a microprocessor based controller that maintains average discharge air temperatures by sequentially staging mechanical cooling and heating. The DAC matches equipment operation to required load. LED's on the DAC indicates the active stage of heating or cooling.

A typical DAC operating sequence follows: Refer to Figure 6 for a graphic representation of the controls sequence.

As building load increases, discharge temperature rises to the upper limit of the control band (point A to point B) at which time the first stage of cooling energizes for a minimum of 4 minutes. This reduces discharge air temperature to within the control band. After 4 minutes, the first stage turns off (point C) and the temperature again begins to rise. After at least 4 additional minutes, the first stage re-activates (point D).

When building load increases until space temperature rises to exceed the maximum limit (point E), the first stage locks on and the second stage cycles on to maintain discharge temperature within the control band. This process is repeated through all connected stages, with the lowest numbered active stages locked on and the highest numbered active stage cycling to maintain discharge temperature within the desired range.

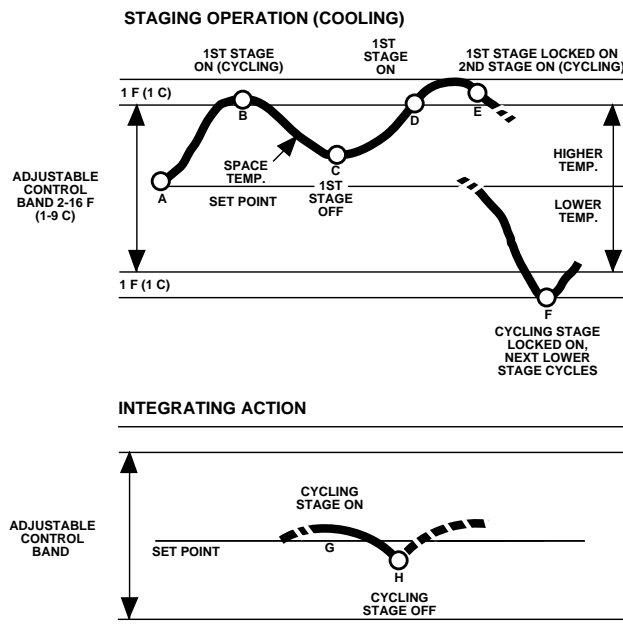


Figure 6: DAC Operating Sequence

## DAC Reset

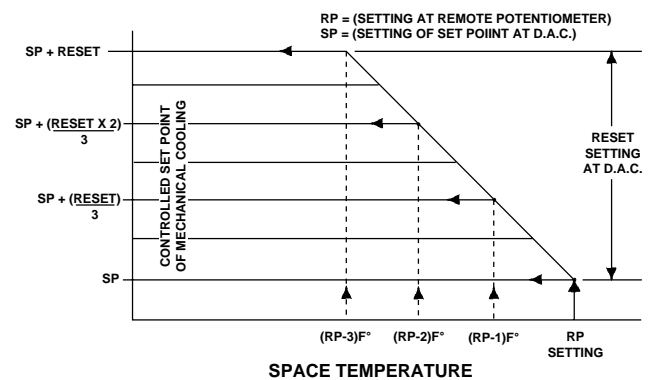
The space reset sensors and the remote potentiometer work in conjunction to control DAC reset functions. The potentiometer is used to set space temperature control points and the sensors relay detected space temperature to the DAC.

When average temperature is 3° F or more below the potentiometer set point, the mechanical cooling set point in the DAC is reset upward by the reset amount stored in the DAC.

When average temperature is less than 3° F below the potentiometer set point, the mechanical cooling setpoint in the DAC is reset upward by a PERCENT of the reset amount stored in the DAC. (See Figure 7, below for the space temperature reset algorithm.)

The reset circuit operates essentially the same for both heating and cooling with the exception that the heating reset adjustment is 4 times the reset amount in the heating mode than in the cooling mode. This means that if the reset adjustment is 10° F in the cooling mode, it is 40 F in the heating mode.

Figure 7: Space Temperature Reset Algorithms



## Safety Lights

The Vari-Master is provided with three safety lights.

**Red safety light, safety circuit (PL1)** is on when the safety circuit lockout relay is activated.

**Red safety light, low oil pressure (PL2)** is on when the unit is shut down due to low oil pressure.

**White safety light, compressor (PL3)** is on when the compressor contactor is energized.

## Low Temperature Switch (Freezestat)

**Models 803 only.** The low temperature switch monitors leaving water temperature. The switch opens when leaving water temperature falls below 36° F to lockout the compressor. When leaving water temperature rises above 45° F, the switch closes. The circuit remains locked out until the system is manually reset by setting the system fan/compressor switch (SW2) to the OFF position and then back to the ON position. Refer to Figure 8 below.

## Pressure Switches

**Low pressure switch** - The low pressure switch (LP) monitors suction pressure. When suction pressure falls below the non-adjustable, cut-out pressure setting of the switch, the switch opens and locks out the compressor via the lockout relay (LR). When suction pressure increases to the cut-in pressure setting of the switch, the switch closes. The compressor remains deactivated until the system is manually reset by setting the system fan/compressor switch (SW2) to the OFF position and then back to the ON position.

**Pump down switch** (VAC 903 model units only)- The pump down switch (PD) monitors suction pressure. When suction pressure decreases below the cut-out point of the switch, the switch opens, breaking the circuit to the compressor contactor. This switch is primarily used for compressor pump down; it does not lock out the compressor. Refer to the pump down section of this manual for more information.

**High pressure switch** - The high pressure switch (HP) monitors discharge pressure. When discharge pressure

exceeds the non-adjustable, cut-out pressure setting of the switch, the switch opens and locks out the compressor via the lockout relay (LR). When discharge pressure decreases to the cut-in pressure setting of the switch, the switch closes. The compressor remains deactivated until the system is manually reset by setting the system fan/compressor switch (SW2) to the OFF position and then back to the ON position. See Table 3 for pressure settings.

**Table 3: Pressure Chart**

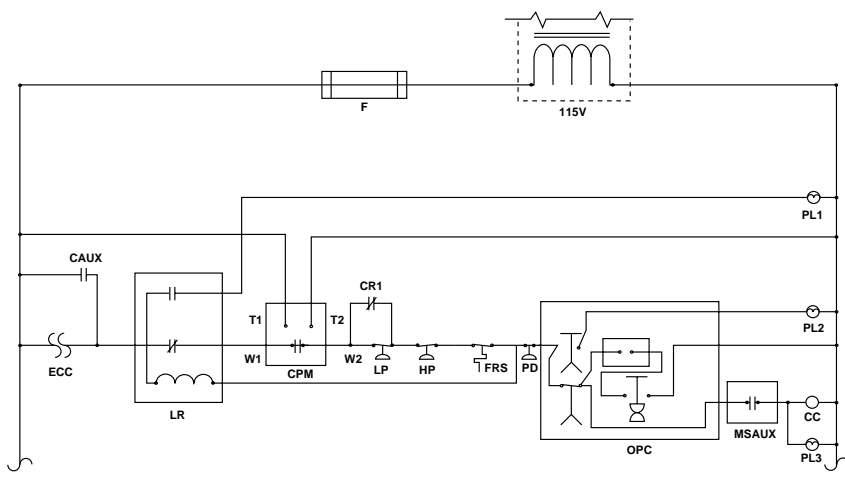
Switch	Model	Function	Pressure Cut-in PSI	Setting Cut-out PSI
Low Pressure (LP)	VAV/VAC	Open on pressure decrease	35 +/- 3	57 +/- 7
Low Pressure (LP)	VAC Pump Down	Open on pressure decrease	10 +/- 3	32 +/- 3
High Pressure (HP)	VAV (803)	Open on pressure increase	350 +/- 10	280 +/- 20
High Pressure (HP)	VAC (903)	Open on pressure increase	300 +/- 10	233 +/- 15

## Compressor Protection

(Taken from Copeland Application Engineering Bulletin AE-1264-R2)

**Sensor Resistance** - The resistance of the T.1 sensor varies from 500 ohms (cold) to 20,000 ohms (hot). Reset values after a protector trip are from 2700-4500 ohms. Three sensors are wired in parallel to one common terminal.

**Low Voltage Cut-out** - Low voltage cut-out in the 208/240 volt module is 170 +/- 8 volts in normal ambients. Cut-in voltage is 5 volts above cut-out.



Legend:

- CAUX - Compressor contactor auxiliary contact
- CC - Compressor contactor
- CPM - Compressor protection module
- CR1 - Circuit relay
- ECC - Electrical control circuit
- F - Fuse
- FRS - Freezestat (low temperature switch)
- HP - High pressure switch
- LP - Low pressure switch
- LR - Lockout relay
- MSAUX - Motor starter auxiliary contact
- OPC - Oil protection control
- PD - Pump down
- PL1, PL2, PL3 - Safety Lights
- T1, T2 - Terminals (903 Models only)
- W1, W2 - Terminals

**Figure 8: Typical Safety Circuit Schematic**

Low voltage cut-out in the 120 volt module is 85 +/- 4.5 volts in normal ambients. Cut in voltage is 4 volts above cut-out. Low voltage response delay is .2 +/- .15 seconds.

**Off-cycle timer** - The off-cycle timer cycles 120 seconds +/- 15% at normal ambients.

#### Basic Motor Protection

**Low voltage sensor** - Low voltage sensing and time delay provide protection against low voltage conditions in the pilot circuit of a three phase power supply should a single phase condition occur. The low voltage sensor locks the compressor off-line in the event of low voltage conditions until voltage rises to the cut-in setting.

**Time delay** - The time delay protects the motor against spikes in the power supply and chatter in line power.

**NOTE:** a minimum two minute time delay in motor operation is provided. This temporary motor operation delay may be mistaken for module malfunction during any service/test procedure in which power is applied, disconnected and reapplied within the time delay.

**CAUTION:** Do not attempt to adjust or repair this module. It cannot be repaired in the field. If the module cover is opened or if the module is physically damaged, the warranty on the module is void. Return defective module *intact* to the factory for replacement.

#### High-Potential Testing (Hi-Pot)

Sensor leads and compressor motor are given a high potential test at the factory. Field high potential testing is not recommended unless absolutely required. If testing is required, disconnect the sensor leads from the module and shorten together.

**NOTE:** A high potential test may damage the module even when the power and pilot circuit leads are disconnected.

The solid state sensors and electronic components used in the solid state module are delicate. *Do not expose to high voltage. Do not perform a high potential test at the sensor terminals with the sensor leads connected to the solid state module.*

### Field Trouble Shooting

If the motor compressor becomes inoperable or operates improperly, check the solid state control circuit as follows:

1. If the compressor has been operating previously, it may have tripped the protector. Allow the compressor to cool for at least one hour to allow the motor to cool and the control circuit to reset.

2. Connect a jumper wire across the control circuit terminals on the terminal board to bypass the control circuit terminals on the module. If the compressor operates with the jumper wire installed, the problem is external to the solid state protection system. If the compressor operates when the jumper wire is attached, but fails to operate when the jumper wire is removed, the control circuit relay in the module is locked open.
3. Allow time for the motor to cool. If the protector remains open, check the motor sensors as follows:
  - a. Remove wiring connections from the sensor and common terminals on the terminal board.
  - b. Warning: Use ohmmeter only (6 volt maximum) for checking. Do not check continuity through the sensors. The sensors are easily damaged. Any external voltage or current applied to the sensors may cause damage requiring compressor replacement.
  - c. Measure the resistance from each sensor terminal to the common terminal. Resistance should be in the range of 500 ohms (cold) to 20,000 ohms (hot).

Proper operation of the control system depends on a continuous parallel circuit through all three sensors with no individual reading higher than 10,000 ohms. Resistance readings approaching zero indicate a short. Resistance readings approaching infinity indicate an open connection.

On start-up after module trip due to high temperatures, resistance of the sensors must be below the reset point in order for the module relay contacts to close. Reset values are 2700-4500 ohms.

4. If the sensors have proper resistance and the compressor runs when the control circuit module is bypassed but fails to run when connected properly, the solid state module is defective and must be replaced. Select a replacement module of the same voltage and by the same manufacturer as the original control module on the compressor.

### Emergency Bypass of a Damaged Solid State Sensor

Should a sensor fail with an open circuit, the control module prevents compressor operation even though the motor may be in perfect operating condition. As a means of restoring compressor operation until the defective control module can be replaced, a resistor may be added between the terminal of the open sensor and the common

sensor terminal in the compressor terminal box. (Refer to Figure 9). The resistor provides acceptable resistance to the control module to activate the compressor.

The resistor specified should be one watt, 2200 ohms +/- 10%.

If an internal sensor is shorted, disconnect the wire from the sensor to the sensor terminal before installing the resistor. Protector cut-in and cut-out points are reduced by approximately 7° F to 10° F which should not be a problem under normal operation conditions.

Although two leg compressor protection does not provide the same degree of safety as three leg protection, it does provide reasonable protection for interim operation until a new control module can be installed.

## Replacement Compressors

Copeland wholesalers typically stock replacement TSK compressors with 220 volt modules only, but they also maintain a stock of 120 volt control modules. Should a replacement control module be required, it is necessary that the wholesalers change the module.

## Oil Protection Control

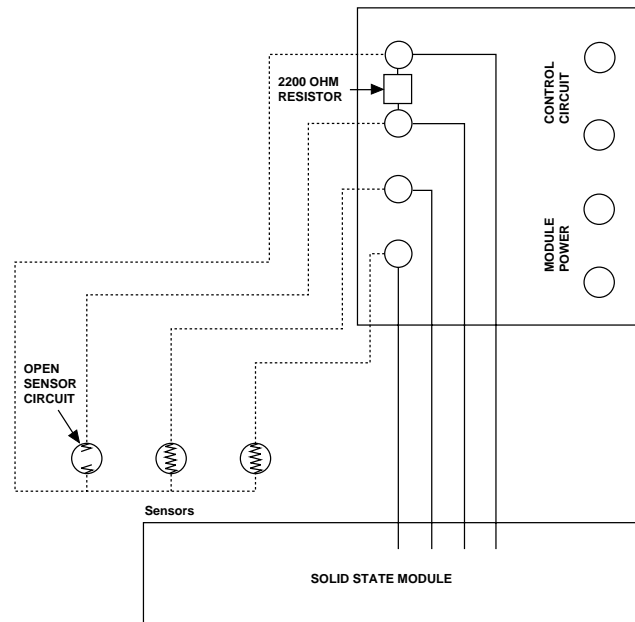
Refer to Figure 8 (page 10) for safety circuit schematic. The solid state oil protection control module (Robertshaw LG Series Gard-Pak IV) simultaneously monitors suction pressure at the crankcase port and oil pressure at the oil pump port. The control operates based on the pressure differential between the high pressure line ("Lube") and the low pressure line ("Suction"). When the differential is reduced to a preset trip point of 9 PSI, the control shuts down the compressor after a time delay of 120 seconds.

**NOTE:** Pressure differential is oil pump pressure minus crankcase (suction) pressure. It is not the same as the oil pressure gauge reading.

Under normal conditions, the solid state network is energized, the control is closed and the compressor is running. If oil pressure drops below 9 PSI, the pressure transduces opens and starts the time delay. If proper oil pressure is not reached within the 120 second time delay period, compressor operation is stopped.

To re-start the compressor after a lock-out, push the manual reset button. If oil pressure remains below 9 PSI, the compressor resumes operation and then stops again after the time delay.

**Figure 9: Emergency bypass of damaged solid state sensor**



If the reset button is pushed during normal operation, the compressor stops operation until the reset button is released. At that time compressor operation resumes.

## Testing Controls for Proper Operation

Test the time delay mechanism of the oil protection control at installation and periodically thereafter to assure proper operation as follows:

1. Turn off line power
2. Remove oil control module cover. One screw on the top of the cover locks the cover in place. This exposes a test terminal and a jumper wire
3. Disconnect the jumper terminal
4. Close the line switch
5. The compressor should run for the duration of the factory-set time delay and then stop
6. After testing, replace the jumper in its original position
7. Replace cover
9. Return power to unit

## Water Valve Operation

In cooling mode, the water valve regulates water flow to the heat exchanger. The water pressure regulator senses pressure at the liquid line service valve which opens and closes the motorized water valve to maintain constant liquid line pressure.

In heating mode, the water valve is in the full open position during operation and closes during the off cycle.

The linkage at the motorized water valve is factory adjusted. See Table 4 for proper setting of the water pressure regulator.

## Change Over Thermostat

The change over thermostat has a setpoint adjustable from 0° F to 100° F with a 3° F to 10° F differential. Contacts between R and B close when temperature falls below the setpoint minus the differential, changing the unit into heating mode. Contacts open at the setpoint changing the unit back into cooling mode. **NOTE:** The maximum safe dry bulb temperature is 125° F.

See the unit wiring diagram for field connections.

**Table 4: Suggested Control Settings**

<b>Discharge Air Controller</b> Setpoint Reset Control Panel	60° F 10°/40° F 16° F
<b>Remote Potentiometer</b>	75° F
<b>Water Regulating Valve</b> Minimum Differential Setting	210 PSIG
<b>Change Over Thermostat</b> Differential	70° F 10° F

# START-UP PREPARATION

## System Cleaning and Flushing

Cleaning and flushing the unit is the single most important step to ensure proper start-up and continued efficient operation of the system.

Follow the instructions below to properly clean and flush the system:

### **▲ WARNING**

**To prevent injury or death due to electrical shock or contact with moving parts, open unit disconnect before servicing unit.**

1. Verify that electrical power to the units is disconnected.
2. Connect the supply water pipe and the return water pipe together for system flushing. No water should be routed through the unit until flushing is complete.
3. Open all air vents. Fill the system with water. Do not allow system to overflow. Bleed all air from the system. Check the system for leaks and repair appropriately.

4. Verify that all strainers are in place. Start the pumps and systematically check each vent to ensure that all air is bled from the system.
5. Verify that make-up water is available. Adjusted make-up water appropriately to replace the air which was bled from the system. Check and adjust the water/air level in the expansion tank.
6. Set the boiler to raise the loop temperature to approximately 85° F. Open a drain at the lowest point in the system. Adjust the make-up water replacement rate to equal the rate of bleed.
7. Refill the system and add trisodium phosphate in a proportion of approximately one pound per 150 gallons of water. Reset the boiler to raise the loop temperature to about 100° F.

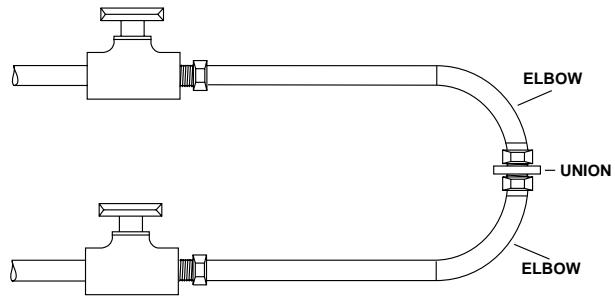
**CAUTION: To avoid possible damage to piping systems constructed of plastic piping, DO NOT allow loop temperature to exceed 110° F.**

Circulate the solution for a minimum of eight to 24 hours. At the end of this period, shut off the circulating pump and drain the solution. Repeat system cleaning if desired.

8. When the cleaning process is complete, remove the short-circuited hoses. Re-connect the hoses to the proper supply and return the connections to each of the Horizontal and Vertical units. Refill the system and bleed off all air.
9. Test the system pH with litmus paper. The system water should be slightly alkaline ( pH 7.5 to 8.5). Add chemicals as appropriate to maintain acidity levels.

**CAUTION: Do Not use “Stop-Leak” or any similar chemical agent in this system. Addition of these chemicals to the loop water can foul the system and inhibit unit operation.**

10. When the system is successfully cleaned, flushed, refilled and bled, check the main system panels, safety cutouts, and alarms. Set the controls to properly maintain loop temperatures.



**Figure 10: Temporary Connection for Flushing System Piping**

# SYSTEM CHECKOUT

When the installation is complete and the system is cleaned and flushed, follow the System Checkout procedure outlined below .

- 1. Voltage: Ensure that voltage is within the utilization range specifications of the unit compressor and fan motor and the correct fuse is in place.
- 2. System Water Temperature: Ensure that it is within an acceptable range to facilitate start-up. (When conducting this check, also verify proper heating and cooling set points.)
- 3. System Water pH: Verify system water acidity. (pH = 7.5 or 8.5) Proper pH promotes the longevity of hoses and heat exchangers.
- 4. System Flushing: Properly clean and flush system periodically. Ensure that all supply and return piping is connected end-to-end to facilitate system flushing and prevent fouling of the heat exchanger by system water.  
  
Water used in the system must be of potable quality and clean of dirt, piping slag, and chemical cleaning agents.
- 5. Closed-Type Cooling Tower (Open Tower with Heat Exchanger): Check equipment for proper temperature set points and operation.
- 6. Balanced Water Flow Rate to Heat Pump:
- 7. Standby Pump: Verify that the standby pump is properly installed and in operating condition.
- 8. System Controls: To ensure that no catastrophic system failures occur, verify that system controls are functioning and that the sequencing is correct.
- 9. Freeze Protection for Water System: Verify that freeze protection is provided for the outdoor portion of the loop water system. Inadequate freeze protection can lead to expensive tower and system piping repairs.  
  
Note: Do not allow the construction site to fall below freezing once the system is installed and tested. Condenser coils never fully drain by themselves and freeze unless winterized with glycol.
- 10. System Water Loop: Verify that all air is bled from the system. Air in the system impedes unit operation and causes corrosion in the system piping.
- 11. Unit Filters: To avoid system damage, ensure that the unit filter is clean.
- 12. Unit Fans : Manually rotate fans to assure free rotation. Ensure that fans are properly secured to the fan shaft. Do not oil fan motors on start-up since they are lubricated at the factory.
- 13. System Control Center: To ensure control of the temperature set-points for operation of the system's heat rejector and boiler, examine the system control and alarm panel for proper installation and operation.
- 14. Miscellaneous: Verify that compressor hold down clamps are removed, that the guide vane control and VAV boxes are in operation and that the proper condensate trap is installed. Also verify that water is added to the trap prior to start-up.
- 15. Note any questionable aspects of the installation.

# UNIT START-UP

Use the procedure outlined below to initiate proper unit start-up:

## ▲ WARNING

**When the disconnect switch is closed, high voltage is present in some areas of the electrical panel. Exercise caution when working with energized equipment.**

1. Energize crankcase heater 24 hours prior to start-up by connecting the main power and setting system switch 1 (SW1) to the ON position. System switch 2 (SW2) must remain in the OFF position.
2. Disconnect power at the main disconnect.
3. Remove blower panels and inspect belts, pulleys and blower wheels for loose connections.
4. Record full load amps from the blower motor nameplate.
5. With the blower panels off, reconnect power at the main disconnect and set system switch 1 (SW1) to the ON position. Set system switch 2 (SW2) to the FAN position. The blower should now run.
6. Check motor for proper rotation and correct if necessary.
7. Turn the blower motor off and set the system switch 2 (SW2) in the OFF position.
8. Replace blower panels.
9. Verify that the VAV boxes are fully open.
10. Check amperage at full air flow. If amps are higher than the rated full load amps of the motor, adjust the motor pulleys to slow down the blower as follows:
  - a. Loosen the set screw on the motor pulley
  - b. Unscrew the adjustable end
  - c. Retighten blower belts and
  - d. Recheck amperage
  - e. Repeat steps a-d until blower motor amperage is within rated range
11. Adjust all valves to their full open position. Turn on the line power to all heat pump units.
12. Refer to Table 2 (page 15). Set all controls as recommended.
13. Adjust change over thermostat to initiate either heating or cooling.

**NOTE:** Vari-Master heat pumps are designed to start heating at a minimum return air temperature of 40° F with normal water flow rate and ambient temperature.

When ready to start-up unit perform the following procedures:

1. Set system switch 1 (SW1) to the ON position.
2. Set system switch 2 (SW2) to the FAN/COMP position.
3. After a 4 second delay, the compressor should start.
4. Force all stages of cooling by adjusting the set point of the discharge air controller (DAC) blower 60° F.  
**NOTE:** There is a 4 second time delay between each stage.
5. Operate each unit in the cooling cycle. Room temperature should be approximately 70° to 75° F DB, and 61° to 65° F WB. Loop water temperature entering the heat pumps should be between 70° F and 110° F.  
  
When the unit is operating in the cooling mode under ARI conditions, the leaving water temperature is approximately 10° F warmer than the entering water temperature at 3 GPM / ton.
6. Force all stages of heating by adjusting the set point of the discharge air controller (DAC) above 60° F and adjust the remote potentiometer until it is 3° F or more above space temperature.
7. Operate each heat pump in the heating cycle immediately after checking cooling cycle operation. A time delay prevents the compressor from re-starting for approximately 3 minutes.
8. Check for proper operation. Refer to Table 6 for sequence of operation. Refer to Table 5 for operating pressures.

**Table 5: Pressure Chart**

Mode	Suction Pressure	Discharge Pressure	Return Air	Entering Water	Leaving Water
Cooling*	70 to 80 PSI	225 to 240 PSI	80°F/87°F	85°F	95°F
Heating*	45 to 70 PSI	210 to 240 PSI	70°F	70°F	

*\*Based on standard ARI conditions. Operating at 400 CFM/ton*

**NOTE:** Control adjustments are for start-up purposes only. After start-up, readjust controls to suggested control settings. Deviations from suggested settings should be made *only after careful evaluation of system operating requirements*. maximum level, the other two factors must be at normal levels to ensure proper unit operation.



**Table 6- Vari-Master Sequence of Operation**

Model	Mode	Heating Relay HR	Cooling Relay CR	Unloading Solenoid US1	Unloading Solenoid US2	Liquid Line Solenoid LLS	Reversing Valve Solenoid (RVS)	Hot Gas Bypass HGB	Relay R	Compressor Contractor CC	Crankcase Heater CCH
VAV (803) 300	Cooling 1st Stage	O	X	X	O	O	X	X	O	X	O
	Cooling 2nd Stage	O	X	X	O	X	X	O	O	X	O
	Cooling 3rd Stage	O	X	O	O	X	X	O	O	X	O
	Heating 1st Stage	X	O	X	O	O	O	O	O	X	O
	Heating 2nd Stage	X	O	O	O	O	O	O	O	X	O
	Oil	O	O	O	O	O	O	O	O	O	X
VAV (803) 360	Cooling 1st Stage	O	X	X	X	O	X	X	O	X	O
	Cooling 2nd Stage	O	X	O	X	X	X	O	X	X	O
	Cooling 3rd Stage	O	X	O	O	X	X	O	X	X	O
	Heating 1st Stage	X	O	O	X	O	O	O	O	X	O
	Heating 2nd Stage	X	O	O	O	O	O	O	O	X	O
	Oil	O	O	O	O	O	O	O	O	O	X
VAV (803) 400	Cooling 1st Stage	O	X	X	X	O	X	X	O	X	O
	Cooling 2nd Stage	O	X	O	X	X	X	O	X	X	O
	Cooling 3rd Stage	O	X	O	O	X	X	O	X	X	O
	Heating 1st Stage	X	O	O	X	O	O	O	O	X	O
	Heating 2nd Stage	X	O	O	O	O	O	O	O	X	O
	Oil	O	O	O	O	O	O	O	O	O	X

*When Liquid Line Solenoid is energized it is in the OPEN position*

*X= Control is energized*

*O= Control not energized*

# MAINTENANCE

## Maintenance Procedures

Perform the maintenance procedures outlined below periodically as indicated.

Establish a permanent operating record by logging unit operating conditions at initial start-up. Maintain a log of amperage values to detect deterioration prior to component failure.

### ▲ WARNING

**To prevent injury or death due to electrical shock or contact with moving parts, set the main power disconnect switch in the "OFF" position. Set system switch 1 (SW1) and system switch 2 (SW2) in the OFF position.**

**SAFETY:** Because of safety hazards from electrical components and system pressure, service of Climate Master units must be performed by qualified service personnel only.

Basic maintenance such as cleaning coils and replacing filters can be performed by supervised unskilled personnel.

**FILTERS:** Inspect filters. Establish a regular maintenance schedule. Clean filter and maintenance frequently depending upon need.

To remove the filter from a Vari-Master unit, slide the filter out of its frame located in the return air opening at the bottom front of the unit. When re-installing the filter, use the slide-in rails of the filter frame to guide the filter into the proper position.

**CAUTION:** To avoid fouled machinery and extensive unit clean-up, do not operate units without filters in place. Do not use equipment as a temporary heat source during construction.

**CONDENSATE PANS:** Check condensate drain pans for algae growth every three months. If algae growth is apparent, consult a water treatment specialist for proper chemical treatment. The application of an algaecide every three months typically eliminates algae problems in most locations.

**UNIT INSPECTION:** Visually inspect the unit annually. Pay special attention to pipe assemblies.

**COMPRESSOR:** Conduct an amperage checks on the compressor annually. Amperage draw should not exceed normal full load or rated load amps by more than 10 percent of the values noted on the unit nameplate. Maintain a log of amperage values to detect deterioration prior to component failure.

**HEAT EXCHANGERS:** Clean heat exchangers annually. Inspect heat exchangers regularly and clean more frequently if the unit is located in a "dirty" environment.

**MOTOR BEARINGS:** Motor bearings are factory lubricated. *Do not lubricate during installation.*

**BLOWER SHAFT BEARINGS:** Blower shaft bearing are factory lubricated. *Do not lubricate during installation.*

## TROUBLE SHOOTING

If the unit fails to operate, conduct the following checks:

1. Check voltage and current. They should comply with the electrical specifications on the unit nameplate.
2. Look for wiring errors. Check for loose terminal screws where wire connections have been made on both the line and low-voltage terminal boards.
3. Check for dirty filters. A clogged filter can cause safety cutouts which can stop unit operation.
4. Check supply and return piping. Piping must be properly connected to the inlet and outlet connections on the unit.

5. Check the fan. If the fan fails to operate, verify that the fan wheel turns freely and that it is secured to the shaft. Also verify that the fan operates in both heating and cooling modes.

6. If the checks described above fail to reveal the problem and the unit still does not operate, contact a trained service technician to ensure proper diagnosis and repair of the equipment.

**Vari-Master CAC & VAV Units  
Mandatory and Optional Accessories**

ACCESSORY	PART NUMBER	CAV (VCV-803 & VCC-903)	VAV-803	VAC-903
Space Sensing Option Sub-base Thermostat	AC6204 AT8108	Madatory Option 1*  OR		
Return Air Sensing Option Sub-base Transmitter Return Air Sensor	AO6204 AT8206 A8466001	Mandatory Option 2*		
Remote Space Sensor	A8466000		Mandatory Option 1* OR	
Return Air Sensor	A8466001		Mandatory Option 2*	
Remote Potentiometer	A8466100		Mandatory	
Change over Thermostat	A8466200		Mandatory	
Water Reg. Valve Controller	A8465500	Optional	Mandatory	Mandatory
Water Regulator Valve	240-A8465401 300-A8465401 360-A8465401 480-A8465401	Optional	Mandatory	Mandatory
Spring Vibration Isolators	ASVIXXX	Optional	Optional	Optional
Low Velocity Filter Box	AF8-XXX	Optional	Optional	Optional
Static Pressure Regulator	A83105000		Optional	Optional
Filters**				
Disposable 2: Fiberglass	68544421	Optional	Optional	Optional
Disposable (FARR 30/30)	68301700	Optional	Optional	Optional
Cleanable	68301705	Optional	Optional	Optional

\* Either mandatory Option Package 1 or 2 must be selected

\*\* Filters Required (8) 240, 300, & 360; (9) 480)

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