



Energy Wise HVAC Equipment

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OVERVIEW

Variable Air Volume (VAV) systems have become an everyday option in the design engineers manual. The advantages of this system are making it more attractive as energy considerations and design flexibility become more important to the developer and engineer.

A critical factor in the successful application of this system is the equipment that is used in the installation. As efficient, reliable self contained packaged units having VAV capabilities incorporated into them become available, the engineering community will acknowledge their advantages and use them as the basis of their design and specifications.

FHP has recognized the need for a self contained unit with an energy efficient variable frequency drive package and now offers this option on units from 6 through 60 tons in vertical configurations.

Included in this bulletin is some background information on VAV systems and details of the drive package offered by FHP.

APPLICATION

VAV SELF CONTAINED UNITS

ISO 9001:2000 Certified

MANUAL

In central station air conditioning systems there are two basic methods for delivering air to the conditioned space and satisfying the load - Constant Volume and Variable Air Volume (VAV) systems. As the name implies, Constant Volume Systems deliver a constant air volume to the conditioned space irrespective of the load with the air conditioner cycling on and off as the load varies. The fan may or may not continue to run during the off cycle. VAV Systems, on the other hand, operate on the principle that space temperature can be maintained by varying the volume of constant temperature air delivered to the area as the load changes. Typically the fan will operate continuously. The popularity of VAV systems has grown rapidly due to their ability to save large amounts of heating, cooling and fan energy when compared to other HVAC systems. An additional advantage of VAV systems is the flexibility afforded to the designer when air conditioning large commercial spaces with diversified load profiles. The reason for this is the ability of the system to handle varying and non-compatible loads in an economic way.

These systems come in all varieties and complexities, however, in general a VAV system delivers air at a constant low temperature to a control terminal (VAV terminal box). As the load decreases in the space the terminal box throttles the airflow matching the space requirements. Should heating be required it is then provided by a reheat coil installed in the VAV terminal box. As the terminal box open and close the static pressure in the ducting increases and decreases. This change in pressure is sensed by the VAV controller which reacts to vary the air delivered by the unit.

GENERAL INFORMATION

ADVANTAGES OF A VAV SYSTEM

- It has the ability to control temperatures in interior and exterior zones without under or overcooling
- It includes the capability of taking advantage of varying loads as a result of the sun's diversity
- Low installed first cost
- It is readily adaptable to night set back and compatibility with energy management systems
- The system is economical to operate since the amount of air being moved is only that required to satisfy the load
- It is suitable for partial operation of a building such as overtime or weekend usage of a particular area

FAN POWER CONSUMPTION

Basic fan laws state that fan brake horsepower (BHP) varies as the cube of the fan speed. Therefore, when the fan is slowed down by the use of a variable speed control device, the total BHP requirements are reduced. This may be expressed as follows:

$$HP2 = HP1 \times (RPM2/RPM1)^3$$

For example: A fan delivers 20,000 CFM against a total static pressure of 3.0 w.g. running at 1,000 rpm. The power required at this condition is 15 BHP. If the fan speed were reduced to 700 rpm the BHP would now be reduced to 5.1. By further reducing the fan speed to 500 rpm the required BHP would be 1.9. This assumes no losses in the drives at varying rpm levels. As can be seen from this example, the use of variable speed control can offer substantial savings in BHP at reduced speeds

TYPES OF VARIABLE AIR VOLUME SYSTEMS AND SPEED CONTROL

There are various types of VAV systems in operation today ranging from hybrid systems which are not in effect true VAV systems to those with sophisticated electronically controlled drives.

An example of a hybrid system is a constant volume self contained unit supplying constant volume air flow to a duct system equipped with VAV terminal boxes and dump boxes that bypass supply air directly into the return air plenum as space VAV boxes throttle closed. These hybrid systems offer low initial cost due to the elimination of mechanically operated inlet guide vanes, eddy current clutches, or variable speed inverters. However, increased field duct requirements for these systems may off-set these initial savings and as the volume of air delivered by the unit remains constant the brake horsepower requirements remain constant resulting in no energy savings during operation. Space temperature control becomes more difficult to achieve based on radical swings in return air temperature when dump boxes open.

METHODS OF VARIABLE AIR FLOW

There are four basic control techniques used to vary the airflow rate - (i) riding the fan curve (ii) by system dampers on the outlet side of the fan, (iii) inlet guide vanes on the fan and (iv) variable speed control of the fan. This last method may be accomplished either by a mechanical device or electronically.

- (i) The simplest form of fan modulation is the practice of riding the fan curve. What this involves is simply allowing the forward curved fans operating point to rise to the left on its constant RPM line in response to an increase in system static pressure which occurs when the VAV boxes start to close. This method carries the danger of over-pressurizing the ductwork and has the least potential for savings in BHP. There is also a potential for noise problems in the conditioned space that would occur when the VAV terminals begin to close.
- (ii) Discharge dampers reduce the possibility of over-pressurization and noise. As the discharge dampers begin to close a greater pressure drop is seen over the damper. As this static pressure increases it causes the operating point of the fan to move upwards to the left along the constant RPM line resulting in a reduction in static pressure on the discharge side of the dampers. This method offers initial first cost savings and low maintenance costs but is the least effective in energy savings. Horsepower is increased at full capacity with an increase in sound power. Fan curve characteristics are critical for the successful application of this method.
- (iii) Inlet guide vanes are possibly the most common method of fan modulation. The vanes are controlled through mechanical linkages and actuators based on a change in external static pressure. As static pressure in the supply plenum rise, indicating a closure of terminal VAV boxes as space conditions are satisfied, the inlet guide vanes begin to close reducing the inlet area to the blower enclosure thereby reducing the air volume. Some advantages to using inlet guide vanes include low first cost and operator familiarity, disadvantages include actuator and linkage failures or mis-calibration, noise generation when operating in unstable portion of fan curve, and large physical size and weight requirements inside the self contained unit. Since inlet guide vanes do create an obstruction to airflow there will be an increase in both BHP and sound power even when the vanes are fully open. BHP savings, while greater than discharge dampers are still not as much as with variable speed drives.
- (iv) The fastest growing method of VAV modulation today is the use of variable speed controllers. There are several methods within this category of controlling fan speed.

EDDY CURRENT CLUTCH

An eddy current clutch system consists of a constant speed A.C. motor coupled to an electro-magnetic eddy current clutch and solid state controller. Typically an eddy current clutch system comprise an input member connected to the shaft of the motor and an output member which is free to rotate within the input member and is connected to the fan. The controller sets up a magnetic field that “binds” the input and output shafts together. The varying speed of the clutch is accomplished by varying the strength of the magnetic field around the clutch. The controller receives its commands from an electronic static pressure transducer located in the supply air plenum. Eddy current clutch systems have a turn down range of approximately 30:1 making it capable of extremely low airflow delivery volumes.

Some disadvantages of this system include: efficiency losses at lower speeds, large physical size, and in case of failure the motor can not be operated independently.

VARIABLE FREQUENCY A.C. DRIVES

Adjustable frequency speed control is accomplished by converting A.C. power into variable voltage D.C. This adjustable D.C. voltage is then fed through an inverter resulting in an adjustable frequency A.C. output. The inverter is controlled by a 4-20 ma or 0-10 volt signal provided by an electronic static pressure controller.

The variable speed inverter drive offers the advantages of good power savings, wide modulation range, no sound power increase, and power savings that are equally good on Airfoil, Backward Inclined and Forward Curved fans. Another big advantage is that, in the event of a drive failure, the fan can still be run with the motor at full speed. One disadvantage is a higher first cost, however, with improved drive technology this has been reduced significantly. With the advent of more user-friendly controls the need for specialized service personnel to service the drive is no longer a major factor.

Energy savings with the various control methods are significantly different. If we consider a system in Washington D.C. the comparative fan energy consumption for the different methods are:

Flow Control	Relative Fan Energy Consumption
System Damper	1.000
Inlet Vanes	0.826
Variable Speed	0.287

DUCT DESIGN, EQUIPMENT SELECTION, AND VAV TERMINAL BOX CONSIDERATIONS

Adequate and proper duct design is the most critical item in the design of a good VAV system. This is the least understood and the cause of most problems in VAV systems. A good duct system must be able to deliver air at approximately the same pressure to all the VAV boxes served by the ductwork system and be able to withstand the pressures that may be encountered with not more than 5% leakage. The duct system must also be designed to deliver air to the spaces without excessive noise. The worst condition that will exist is after a weekend shut down, when the system is required to provide morning warm up or cool down. All the VAV boxes will be wide-open calling for maximum CFM from the system.

When self contained package VAV units are specified it is imperative that the equipment selected can deliver the air flow quantities at the highest specified static pressures it may see.

Previously many manufacturers have not provided the high static drive packages, but with the advent of air foil, backward inclined and forward inclined class II blowers, today's equipment proves equal to the task. In the past VAV terminal boxes were nothing more than simple damper controlled boxes with poor throttling characteristics but, as with the self contained units, these boxes have become much more sophisticated as the systems have grown in popularity. Reliable electronically controlled VAV boxes are now available from many major VAV manufacturers and they too prove equal to the task.

FHP EQUIPMENT

FHP MANUFACTURING SELF CONTAINED VAV UNITS

After reviewing the various options available for VAV systems, FHP has decided to offer adjustable frequency speed controllers. The efficient, low noise and cost effective package make it an obvious choice for our units. When coupled with our self-contained units we have an offering that has multiple benefits for both the owner and contractor.

ADVANTAGES OF FHP SELF CONTAINED VAV PACKAGE UNIT

First cost installed savings:

- Factory packaging and testing reduces field wiring and piping requirements in both the material and labor areas.

- Decreased installation time, risk and improved reliability.
- Equipment delivery and start-up can match the tenant lease periods. Improved cash flow for the developer.
- Less technical maintenance knowledge than built up systems.
- Modular, smaller horsepower compressors eliminate the need for on site building engineer/operator.

CUSTOMER SATISFACTION

- Tenants can operate systems after hours, on weekends or holidays to suite their individual needs while minimizing operating expense.
- Equipment can be individually metered and charges can be assessed for actual power consumption by the tenant.
- Routine maintenance can be performed without disruption of other building occupants.

FIRST COST REDUCTION

- Tonnage can be reduced by taking advantage of building diversity and VAV flexibility.
- Piping systems can be centralized and do not require insulation.
- Factory packaged controls, drives and economizers. Reduced field labor, installation costs, and installation time.
- Large equipment rooms are not needed for equipment thus allowing for more leaseable floor space.

OPERATING EFFICIENCY

- Water-side economizer option offers free cooling/heating year round.
- One unit per floor/tenant allows only that unit to operate when needed. Large central plant equipment is not required to operate at part load condition.
- Annual system energy consumption is below central chilled water systems with significant energy consumption reductions during partial occupancy or after hours operation.
- Interface availability with Building Energy Management Systems.

UNIT OPERATING CHARACTERISTICS AND DESIGN PARAMETERS

FHP manufacturing offers VAV self-contained air conditioners and heat pumps in vertical package configurations from nominal 6 tons through 60 ton ranges. Our new high efficiency line of commercial/industrial units can be equipped with a VAV package that can form the basis of the engineer's VAV specification requirements.

The VAV packaged unit is a truly self contained unit housing all required controllers, variable speed inverter drives and hot gas bypass capacity modulation controllers.

Some field installation of front-end controllers such as static pressure sensors, discharge air sensors, remote reset controls and change over controls may be required.

All controls are 24 (or lower) volt ac or dc. This allows the use of economical low voltage wiring. Consult local codes for acceptable class II low voltage wiring methods.

AIRFLOW AND STATIC PRESSURE SENSOR LOCATION

The recommended minimum amount of airflow for proper temperature control and unit staging is 50 % of nominal unit rated airflow and all variable speed drives are factory programmed for 50% speed reduction. This reduction usually corresponds to the minimum position of terminal VAV boxes. For air volumes below 50% please consult factory.

On FHP units between 6 and 25 tons adjustable pitched motor sheaves are utilized. This will provide for minor field adjustments of blower RPM to meet site requirements.

Depending on the unit size either one or two motors are provided. Both motor sheaves should be set the same as each other. On 30 through 60 ton MA series units, fixed sheaves are utilized. Airflow adjustments on these units are accomplished by changing to alternate fixed sheaves available from the factory. All blower pulleys are fixed.

On 6 through 25 ton models one variable speed drive is provided to control both motors. For example, on a 20 ton unit containing two 2 hp motors, a 5 hp drive will be provided. Both motors are wired to the drive output terminal block. On MA series units, 30 through 60 tons, depending on motor HP selection, either one or two drives may be provided. For example, on a 50-ton unit containing two 15 hp motors, two drives will be provided one for each motor. The input control signal will be sent to the lead motor drive from the static pressure controller and an analogue output signal will be sent from the lead drive to the lag drive input to assure synchronized speed outputs.

Pneumatic tubing lengths between the sensor and controller should not exceed 200 feet for 1/4-inch o.d. or 400 feet for 3/8-inch o.d. tubing.

The sensor tubing sensing point should be located near the end of the main supply trunk duct in a position free from turbulence effects and at least 10 duct diameters downstream and 4 duct diameters upstream from any major transitions or branch take-offs. Improper location of the sensing point could result in improper operation of the entire VAV system. The tube end should be perpendicular to the airflow to ensure that only static pressure is sensed. A “low pressure” tube should be installed on the outside of the duct and both run back to the pressure sensor mounted on the unit. Ensure that tubing conforms to local codes.

The static pressure control should be adjusted so that, at full airflow, all of the remote VAV terminal boxes receive the minimum static pressure required plus any downstream resistance. Control the system to the lowest static pressure set point that will satisfy airflow requirements. Lower static pressure set points reduce total required brake horsepower and reduce generated sound levels.

UNIT OPTIONS, CONTROLS, AND SEQUENCE OF OPERATION

Please refer to Appendix A for typical components that make up a VAV control system.

Various unit options and control strategies are available to the specifying engineer to enable them to tailor the equipment to the application. Some options include but are not limited to:

- Free-cooling/heating water-side economizer cycle
- Hot gas bypass capacity modulation
- Straight cooling application
- Heat pump application for morning warm-up
- W7100 discharge air controller with remote reset
- MCS-8 microprocessor based discharge air controller with remote/return air reset (DDC programmable)
- Building management system relay

TYPES OF CONTROLLERS

FHP offers both the W7100 and MCS controllers. Both these controls provide excellent control of a VAV unit and the choice between the two is generally based on system requirements and first cost considerations.

Typically on VAV packages from 6 through 25 tons the W7100 controller should be considered. Systems of this size generally are less complex and do not require the enhanced capabilities of the MCS control. The W7100 is a lower cost controller that, when factored in on a cost per ton basis, is more cost effective than

the higher end MCS controller. However should the owner or specifier prefer the flexibility and communications capability of the MCS controller it is available for installation on these units.

The variable speed drive(s) is located in the unit's air handling compartment. The drives are NEMA 4/12 rated enclosures for wash down duty. The drive buss is hot at all times placing the drive in the ready mode. Input line reactors filter the power supply to the drive to protect against power spikes and noise that could be transmitted through the power lines. If the VAV boxes in the system are open, indicating a call for cooling/heating, the system external static pressure is relatively low and the factory mounted 4-20 ma transducer/transmitter signals the drive to deliver the maximum specified CFM. The transmitter is located on the upper left side of the unit along with the remote programming keypad. Depending on the drive utilized, the keypad may be integral to the drive in which case an access panel will be provided to program the drive through the outer unit panel. 1/4 Inch clear tubing is to be connected from the external static pressure port fitting on the unit to a port on the discharge air plenum for external static pressure sensing. An atmospheric port on the unit must be left unobstructed and open to atmosphere. 25 feet of tubing is provided with the unit. Zero and span adjustments on the Dwyer transmitter allow setting of E.S.P. versus milli-amp output. Manuals on the transmitter and drives, also furnished with each unit, outline the pre-programmed parameters and programming methodology. A total of 165 programmable parameters are available in the drive.

SEQUENCE OF OPERATION

A listing of the components for a typical VAV drive package is listed in appendix A. A typical wiring diagram is shown in Figure 1.

A typical sequence of operation for a VAV heat pump with two compressors and a water-side cooling economizer utilizing a W7100 discharge air controller with a morning warm-up cycle is as follows:

The optional building management relay is energized from the BMS system placing the heat pump in the ready state. The variable speed drive is activated and the fans begin to operate. The blower motor(s) and variable speed drive(s) are designed for continuous airflow when power supply is initiated.

COOLING

In the cooling mode, on a rise in discharge air temperature as detected by the discharge air

temperature sensor, the first stage of cooling (water-side economizer) is activated through the W7100 control center.

If the water loop temperature is low enough to provide free-cooling and below the set point of the water temperature controller, the 3-way motorized ball valve is energized and directs water flow through the economizer coil and then through the water to refrigerant heat exchangers. For pumping head requirements the pressure drop of the economizer coil and heat exchangers should be added. (See water-side economizer manual for coil pressure drops). Simultaneously the reversing valves are energized in anticipation of a call for additional mechanical cooling. Suction pressure activated hot gas bypass valves are utilized for capacity modulation at low load conditions and also to prevent evaporator icing.

If the discharge air temperature continues to rise the second stage of cooling is activated. This is the first stage of mechanical cooling. (Compressor 1). On a further rise in discharge air temperature the third stage of mechanical cooling is activated. This is the second stage of mechanical cooling. (Compressor 2) Discharge air set points are entered at the W7100 control module in the unit control panel. The factory set point is 55°F. A reset control set point and control band set point are located on the controller. Depending on the application these could be field adjusted to match the system requirements. (A W7100 control manual is provided with each unit for operator review). Should a remote cooling set point controller be utilized the W7100 set point should be reset to 40°F.

In combination with the discharge air sensor a remote reset discharge air to space temperature offset potentiometer and a space-reset sensor must be utilized. These controls provide the space/return air reset functionality to the control system. Reset is used to prevent overcooling or overheating of the building when there are one or more zones of abnormal demand. The discharge temperature is reset upwards as the space temperature drops, reducing cooling capacity required to satisfy building demand. To provide discharge air reset from the space the space sensor is installed in the conditioned space and connected in series with the remote set point potentiometer as shown in figure 1. To provide reset based on average zone temperature additional reset sensors need to be installed in selected zones. If the mechanical equipment room is representative of the controlled space temperature (plenum return)

then these controls may be mounted in the room otherwise they should be mounted in a location representative of the conditioned space.

As individual space loads become satisfied and terminal VAV boxes begin to close the system E.S.P. increases. The transmitter's signal increases slowing the drive and reducing total CFM output to a minimum of 50% of design. The drives are factory programmed to a specified CFM versus E.S.P. requirement through a unit mounted remote keypad. Do not attempt to re-program the drives without consulting a factory authorized representative. Doing so may void equipment warranties.

Terminal VAV box closure is an indication of reduced space/building loads thus discharge air and return air temperatures will begin to decrease. As this occurs the discharge air set points will be adjusted upwards and stage 3 cooling will deactivate followed by stage 2 cooling and finally stage 1. If full cooling is required at minimum CFM the hot gas bypass valves will begin to modulate for reduced capacity control and coil icing prevention.

HEATING

On a call from the heat/cool change over control, enabled by a field provided time clock or any appropriate contact closure, the heating mode will be initiated for morning warm-up cycle. Heating change over relays 1k and 2k are energized locking out cooling set point, space temperature reset circuit, and enabling heating functions. During the heating mode the unit operates at a constant volume delivering full design CFM

Important: when initializing morning warm-up heating mode it is imperative that terminal VAV boxes are driven full open through field provided means. Failure to do so could result in supply duct system failure due to high volume high pressure air. FHP assumes no liability in this instance

A remote heating set point potentiometer is used to control space temperatures during the morning warm-up period. On a fall in space temperature stage 1 of mechanical heating is energized. On a further fall of space temperature stage 2 of mechanical heating is energized. As the space temperature approaches set point stages drop out in reverse sequence. Heat pump heating mode will stay enabled until the morning warm-up cycle or heating cycle is terminated by field means.

The sequence of operation of the MCS + controller is similar to the W7100 controller with the following added capabilities:

- A programmable time clock feature enables the operator to program time of day schedules for morning warm-up periods.
- On heat pump models 5 stages of cooling and 3 stages of heating are provided assuming the economizer will be run as both free-cooling and heating capabilities.
- On straight cool models heating outputs are available to control electric heat.
- The digital LED control panel indicates unit operational status, set point values, external static pressure, alarm codes, etc.
- Complete self-diagnostic capabilities are provided.
- Remote or manual control outputs can be initiated.
- Temperature limits and associated fault alarms, lockouts, run times, starts can be programmed and recorded.
- PC interface and dial up modem features are available.
- BMS run/stop interface capability is provided.
- Minimum on/off times, discharge air reset values, etc. are fully programmable.

A project site manual will be delivered with each unit detailing the control methodology and programming values of the controller for the specific unit being supplied. An operator's manual will also be furnished with the controller.

UNIT SAFETY CONTROLS

Each compressor circuit is protected by a high pressure safety switch set at 380 PSIG for loss of flow protection or high side restriction protection. A low pressure switch is set at 20 PSIG for loss of charge protection.

All motors are either internally thermally protected or external motor overloads are provided. Fan motor protection is also provided by programmed limit values in the VSD themselves.

Optional safety controls consist of: condensate overflow switches and differential pressure switches (differential pressure switches must be field installed).

UNIT CONFIGURATIONS

The VAV self-contained package unit can be manufactured to fit the specific application.

Available configurations include:

- Heat pumps with or without water-side economizer
- Cooling only with or without water-side economizer

- With or without morning warm-up features
- With or without electric heat outputs for electric strip heat control. Heaters provided and installed by others.

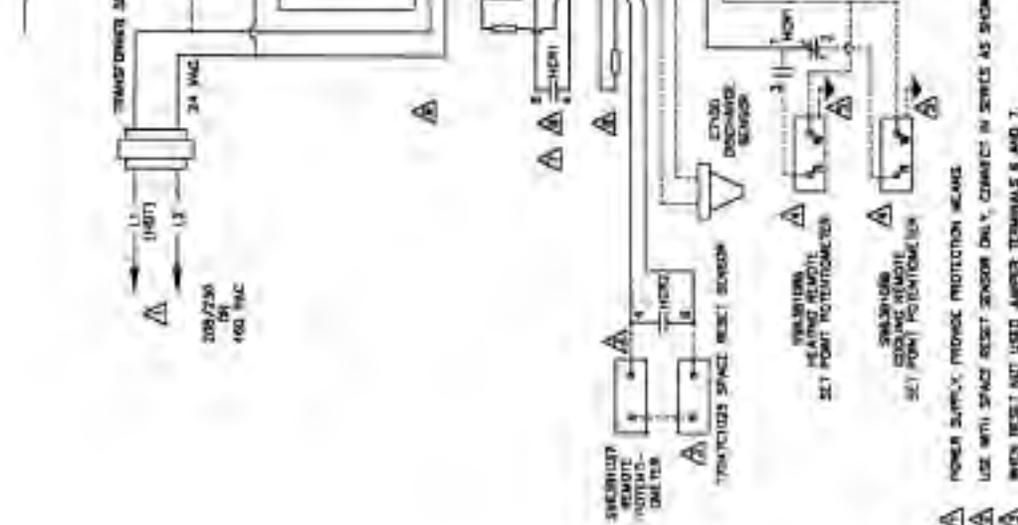
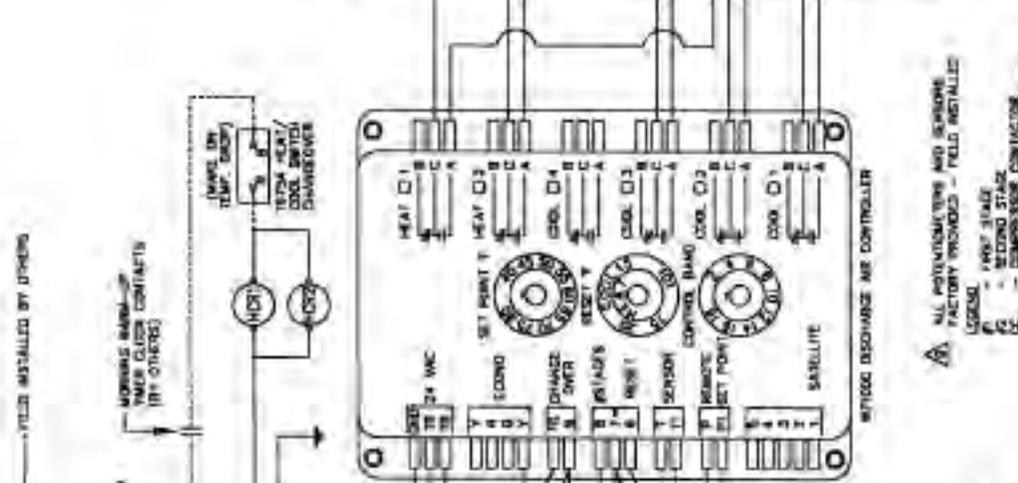
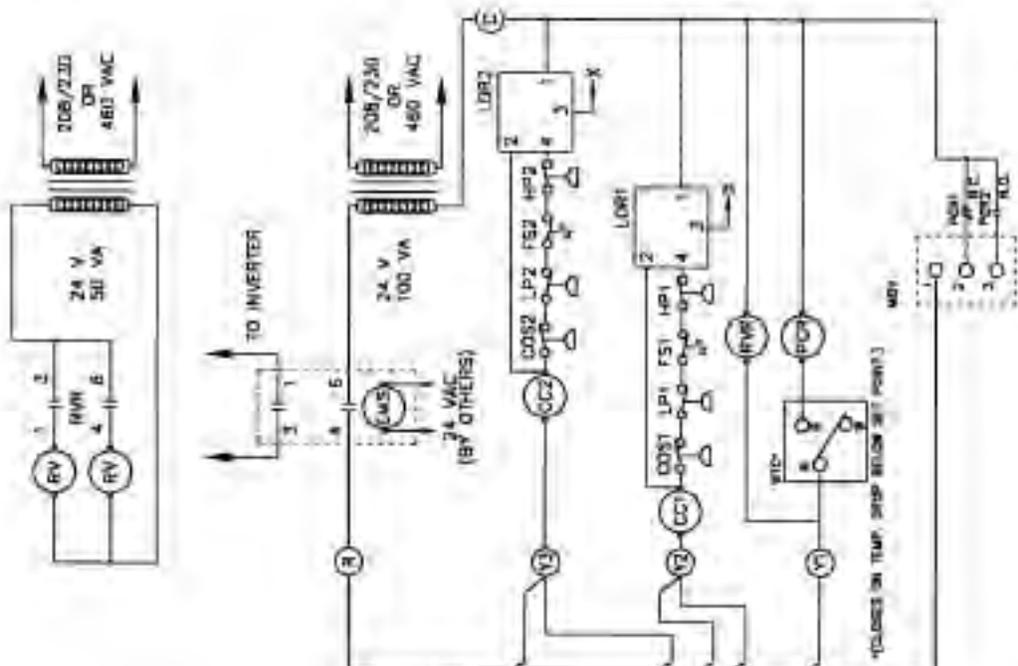
For application assistance please contact your local FHP representative or the factory.

APPENDIX A

Components of a FHP VAV Control System:

Control	Factory Installed	Function
4-20 ma Pressure transducer (W7100 controls only)	Yes	Senses duct pressure. Sends signal to drive. (W7100 controls only)
Variable speed drive package	Yes	Varies the speed of the motor in proportion to the signal from the pressure transducer.
Discharge air controller	Yes	Controls the stages of heating and cooling based on the leaving air temperature. Able to control economizer as first stage of cooling.
Discharge air sensor	No	Senses discharge air temperature. Signals back to discharge air controller.
Space reset sensor & potentiometer	No	Adjusts the discharge air set point. Allows for adjustment based on space temperature conditions.
Heat/Cool changeover Time clock or BMS input.	No	Initiates heating operation from remote signal.
Remote cool/heat potentiometers (2)	No	Sets cooling/heating set point temperatures
Hot gas bypass	Yes	Prevents low suction temperature at low load conditions or when full load cooling is required at low airflow.

Note: Standard motors are used on FHP variable air applications.



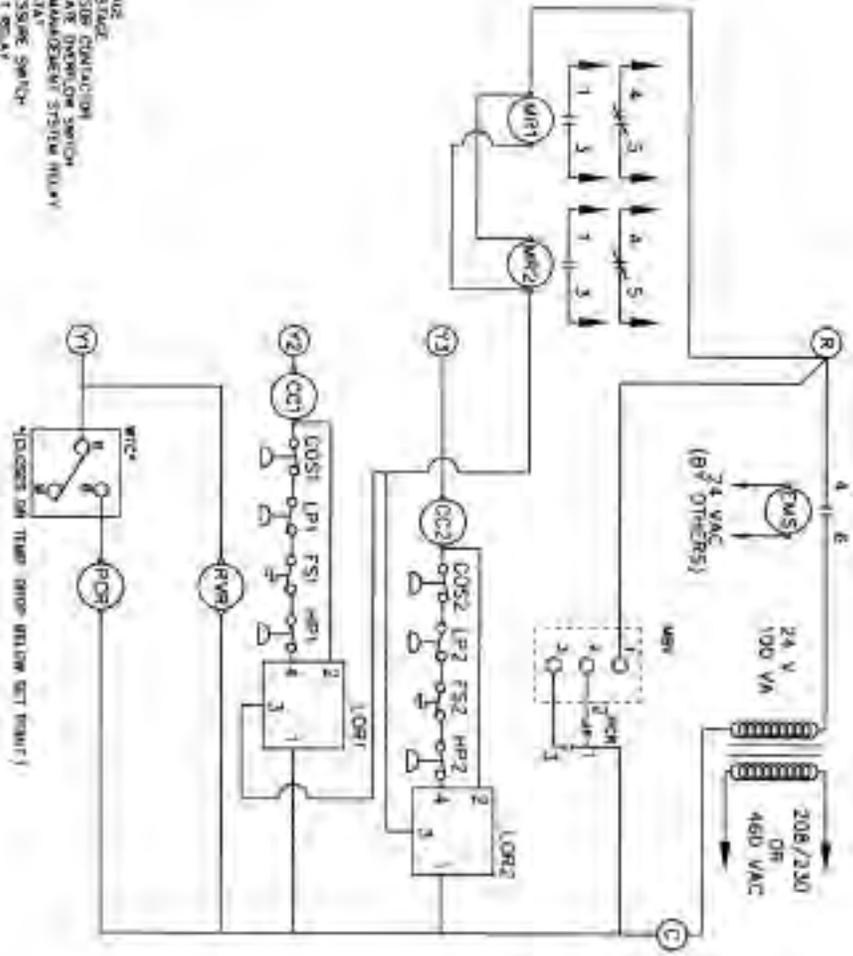
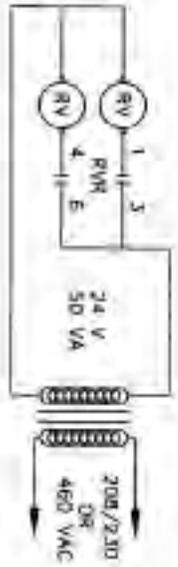
W7100 CONTROLLER



- ▲ ALL POTENTIOMETERS AND SENSORS FACTORY PROVIDED - FIELD INSTALLED
- LEGEND:
 - 1 - FIRST STAGE
 - 2 - SECOND STAGE
 - 3 - COMPRESSOR CONTACTOR
 - 4 - CONDENSATE OVERFLOW SWITCH
 - 5 - ENERGY MANAGEMENT SYSTEM RELAY
 - 6 - HEAT STAGE
 - 7 - HEATING CHANGEOVER RELAY
 - 8 - HEATING CHANGEOVER RELAY
 - 9 - HIGH PRESSURE SWITCH
 - 10 - HIGH PRESSURE SWITCH
 - 11 - LOW PRESSURE SWITCH
 - 12 - WATER TEMPERATURE SWITCH
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- ▲ POWER SUPPLY PROVIDES PROTECTION AGAINST SHORTS
- ▲ USE WITH SPACE RESET SENSOR ONLY, CONNECT AS SHOWN
- ▲ WHEN RESET NOT USED JUMPER TERMINALS 6 AND 7.
- ▲ SET HEAT AND COOL DISCHARGE SET POINTS USING REMOTE SET POINT POTENTIALS. SET POINT RANGE IS 40°F TO 140°F. THE SENSING WIRE CHANGE SET POINT RANGE TO 40°F TO 140°F.
- ▲ DURING CASE OF SET POINTS, SET POINT POTENTIALS TO PREVENT FREEZING DUE TO STATIC ELECTRICITY.
- ▲ CHANGEOVER TERMINALS 8 AND 9, USED ON HEAT/COOL MODELS. JUMPER 8, 10 TO CHANGE OVER TO HEATING (LOOKS OUT FOR HEAT/COOL MODELS). WHEN FURNACE IS NOT USED, JUMPER TERMINAL 9 AND 8 WITH A 500 OHM 1/4 WATT 5 PERCENT RESISTOR CONTAINED IN TAG ASSEMBLY A914U72.
- ▲ REMOVE FACTORY INSTALLED 480 OHM RESISTOR JUMPER AND RECONNECT FOR COOLING-ONLY MODE. 4-STAGE SENSATION (CHANGE VALUE FOR OTHER NO. OF STAGES). FOR 3 STAGES IN HEATING MODE, USE 200 OHM 1/4 WATT RESISTOR FOR BEST OPERATION.

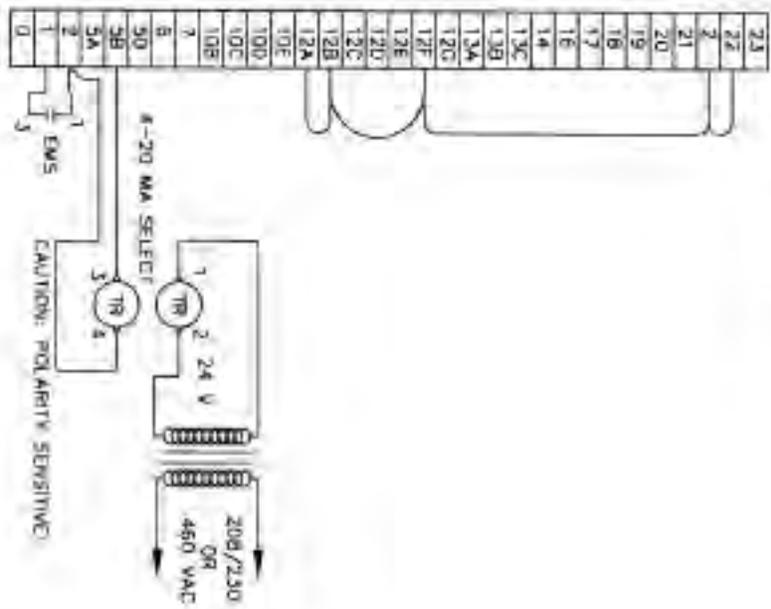
FIELD INSTALLED BY OTHERS

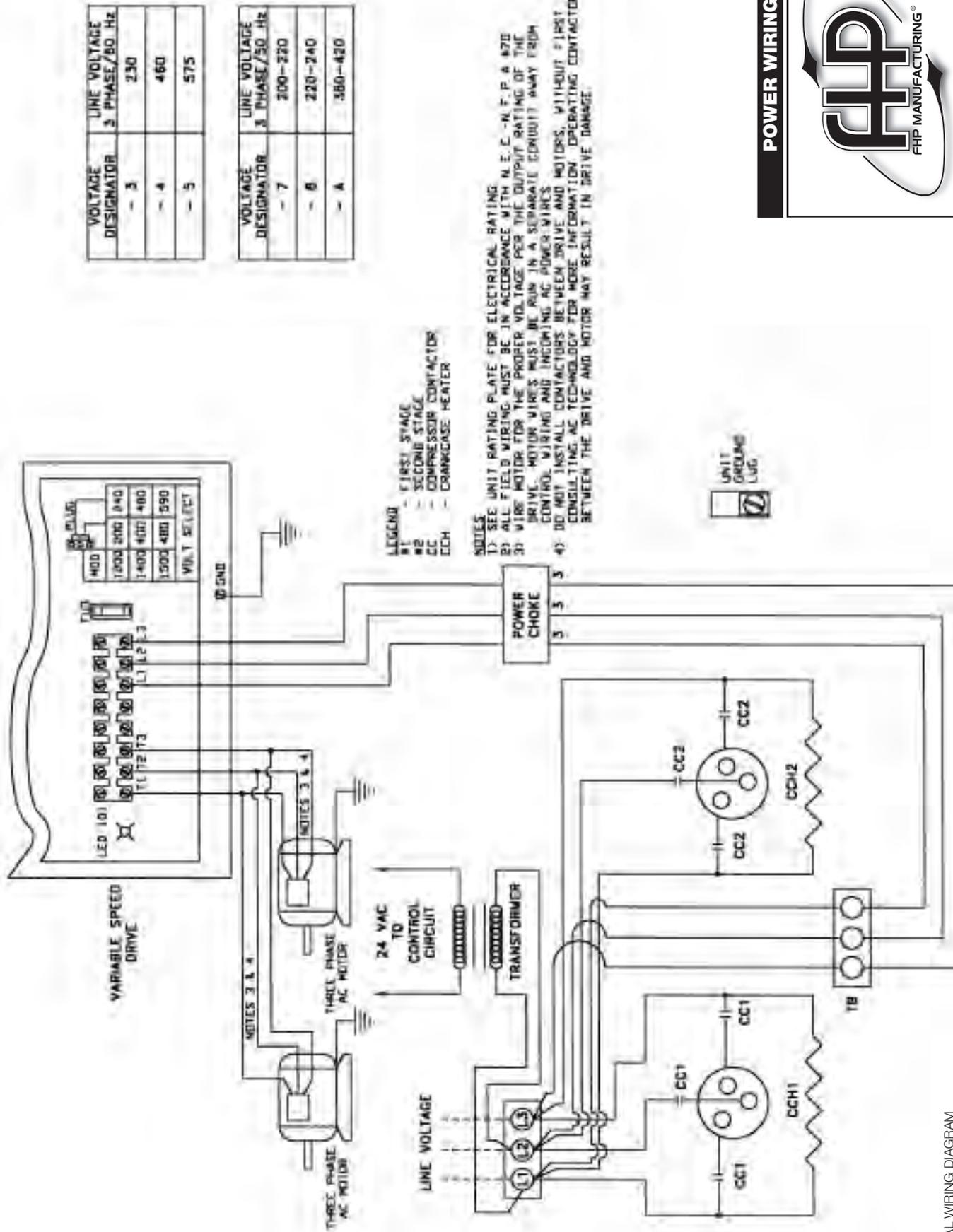


- LEGEND
- R - FIELD STATUS
 - E - EXTEND STATUS
 - OC - COMBINATION CONTACTOR
 - OC2 - COMBINATION CONTACTOR
 - EMS - EMERGENCY STOP/STOP SWITCH
 - FS - FIELD STATUS
 - HP - HIGH PRESSURE SWITCH
 - LOP - LOW PRESSURE SWITCH
 - HP2 - HIGH PRESSURE SWITCH
 - LOP2 - LOW PRESSURE SWITCH
 - HP3 - HIGH PRESSURE SWITCH
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 - HP100 - HIGH PRESSURE SWITCH
 - LOP100 - LOW PRESSURE SWITCH

TYPICAL WIRING DIAGRAM

VARIABLE SPD DRIVE TERMINAL STRIP





VOLTAGE DESIGNATOR	LINE VOLTAGE 3 PHASE/50 Hz
- 3	230
- 4	460
- 5	575

VOLTAGE DESIGNATOR	LINE VOLTAGE 3 PHASE/50 Hz
- 7	200-220
- 6	220-240
- A	380-420

LEGEND

- #1 - FIRST STAGE
- #2 - SECOND STAGE
- CC - COMPRESSOR CONTACTOR
- ECH - CONDENSER HEATER

NOTES

- 1) SEE UNIT RATING PLATE FOR ELECTRICAL RATING
- 2) ALL FIELD WIRING MUST BE IN ACCORDANCE WITH N.E.C. - N.F.P.A #70
- 3) WIRE MOTOR FOR THE PROPER VOLTAGE PER THE OUTPUT RATING OF THE DRIVE. MOTOR WIRES MUST BE RUN IN A SEPARATE CONDUIT AWAY FROM CONTROL WIRING AND INCLUDING AC POWER WIRES
- 4) DO NOT INSTALL CONTACTORS BETWEEN DRIVE AND MOTORS, WITHOUT FIRST CONSULTING AC TECHNOLOGY FOR MORE INFORMATION. OPERATING CONTACTORS BETWEEN THE DRIVE AND MOTOR MAY RESULT IN DRIVE DAMAGE.

POWER WIRING



TYPICAL WIRING DIAGRAM



FHP MANUFACTURING
ENERGY WISE HVAC EQUIPMENT

GUIDE SPECIFICATIONS

VAV VERTICAL PACKAGE UNITS

TYPICAL SPECIFICATION

Provide where shown on the drawings a self contained packaged water source heat pump complete with factory mounted and wired variable frequency drive package and controls. Units with variable inlet vanes or other mechanical means of modulating airflow shall not be acceptable. The unit shall incorporate the following features and components:

GENERAL

Units shall be rated in accordance with A.R.I. Standard 320 and Underwriter Laboratories (UL) listed for safety. Each unit shall be pallet mounted and shrink wrapped. The units shall be warranted by the manufacturer against defects in materials and workmanship for a period of one year on all parts, and 5 years on the compressor. The units shall be designed to operate with entering fluid temperatures between 45°F (7°C) and 110°F (43°C) as manufactured by FHP Manufacturing in Fort Lauderdale, Florida.

CASING & CABINET

The cabinet shall be fabricated from heavy-gauge galvanized steel. The interior shall be insulated with 1/2" thick, multi-density, coated, glass fiber. All units shall allow sufficient service access to replace the compressors without unit removal. Multiple blower and compressor compartment access panels shall be removable with supply and return ductwork in place. A return air filter rack with disposable filters and supply air duct collar shall be provided with each unit. The units shall have an insulated divider panel between the air handling section and the compressor section on all vertical units to minimize the transmission of compressor noise, and to permit operational service testing without air bypass.

REFRIGERATION CIRCUITS

All units shall contain two or four sealed refrigerant circuits including high efficiency hermetic or scroll compressors, expansion valve metering device, finned tube air-to-refrigerant heat exchangers, refrigerant reversing valve and service ports. Compressors shall be high efficiency, designed for heat pump duty, and mounted on rubber shear vibration isolators. Compressor motors shall be equipped with internal overload protection. Refrigerant reversing valves shall be pilot operated sliding piston type with a replaceable encapsulated magnetic coil energized only during the cooling cycle. The hot gas by-pass regulator shall respond to compressor suction pressure, which results in a nearly constant evaporator load balance. The factory by-pass valves shall be set at 60 PSIG (34°F or 1°C) saturated evaporator temperature to prevent frosting of the evaporator. The finned tube coils shall be constructed of lanced aluminum fins not exceeding fourteen fins per inch bonded to rifled copper tubes in a staggered pattern not less than three rows deep and have a 450 PSIG working pressure.

The coaxial water-to-refrigerant heat exchangers shall be constructed of a convoluted copper (optional cupronickel) inner tube and steel outer tube with a designed refrigerant working pressure of 450 PSIG and 400 PSIG working water pressure.

FAN MOTOR & ASSEMBLY(S)

The fan(s) shall be belt driven DWDI forward curved type with dynamically balanced wheel(s). The housing(s) and wheel(s) shall be designed for quiet low velocity operation. The fan housing(s) shall be removable from the unit without disconnecting the supply air ductwork for servicing of the fan motor(s). The fan motor(s) shall be 1725, 1800

or 3450 RPM sealed ball bearing type. The motor(s) shall be permanently lubricated and have thermal or external overload protection.

VARIABLE FREQUENCY DRIVE

The drive package shall include the following:

- Full motor protection – Ground fault, Phase to Phase, Over Voltage, Under Voltage, Over Temperature and Current.
- Tactile feedback keypad - Choice of scrolling or direct input of values for quick easy setup.
- 32 Character backlit display - Display shall give simultaneous indication of status, speed, load direction and speed reference type.
- Built in speed/frequency, load/amp, kWh and elapsed time indicator.
- Programmable automatic restart after power outages or trip condition
- Speed follower inputs: Speed potentiometer 4 to 20 MA, 0 to 10 VDC
- Keyboard controls to Include: Stop, Start, Speed, and Manual/Automatic operation.
- Output signal proportional to load and speed.
- Two levels of password protection.
- Comprehensive diagnostics – Log of up to ten previous protection shutdowns in non-volatile memory. Time and drive operating status at time of shutdown shall be shown.
- Slip compensation for minimal speed changes during load fluctuations.
- 400 millisecond ride through to keep drive on line through short duration power dips.
- Programming of the drive shall be menu driven in plain English rather than codes or symbols.

DISCHARGE AIR CONTROLLER

Microprocessor based controller shall maintain an average discharge air temperature by modulating an economizer control valve (when supplied) and sequencing stages of mechanical cooling. The controller shall be capable of discharge air reset based on a field installed space sensor. The controller shall be capable of providing morning warm up based on a signal from a remote source. The controller shall have the capability to control multiple stages of cooling and heating.

ELECTRICAL

Controls and safety devices will be factory wired and mounted within the unit. Controls shall include fan relay(s), compressor contactors, 24V transformer, reversing valve coils and unit safety protection. Units below 30 tons shall have a lockout control circuit and units 30 tons and above shall have safety protection that will shut down the unit in the event of a safety alarm and allow automatic start up if the fault condition no longer exists. Lockout fault conditions shall require manual reset of the unit. Safety devices include a low-pressure cutout set a 20 PSIG for loss of charge protection (freezestat is not acceptable) and a high-pressure cutout control set at 380 PSIG. An optional condensate overflow switch shall be factory installed to stop compressor operation to prevent drain pan overflow. An optional energy management relay to allow unit control by an external source shall be factory installed.

PIPING

Supply, return water and condensate drain connections shall be brass or wrought copper female pipe thread fittings and mounted flush to cabinet exterior with optional stainless steel, braided hose kit with swivel connectors.