Service Guide

Water Source Heat Pump
Axiom™ Variable Speed —VSH/VSV

24–60 MBtuh, 60 Hz

Model Numbers:

VSHE024-060	60 Hz
VSVE024-060	60 Hz

⚠ SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

May 2020 **WSHP-SVG02C-EN**

Warnings, Cautions and Notices

Warnings, Cautions and Notices. Note that warnings, cautions and notices appear at appropriate intervals throughout this manual. Warnings are provide to alert installing contractors to potential hazards that could result in death or personal injury. Cautions are designed to alert personnel to hazardous situations that could result in personal injury, while notices indicate a situation that could result in equipment or property-damage-only accidents.

Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

Read this manual thoroughly before operating or servicing this unit.

ATTENTION: Warnings, Cautions and Notices appear at appropriate sections throughout this literature. Read these carefully:

⚠WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.
NOTICE	Indicates a situation that could result in equipment or property-damage only

Important Environmental Concerns!

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants-including industry replacements for CFCs such as HCFCs and HFCs.

Responsible Refrigerant Practices!

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified. The Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠WARNING

Proper Field Wiring and Grounding Required!

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes. Failure to follow code could result in death or serious injury.

⚠WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labeling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

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Variable-Speed WSHP UC400 Controller

I/O Definitions

Hard-wired input/outputs for the variable-speed WSHP UC400 controller are defined in Table 1.

Table 1. UC400 hard wired input/output definitions

Connection type	UC400 terminal	Variable-speed WSHP configuration	Connection specifications[a]	Valid range
Analog Inputs	AI1	Zone Temp Sensor/Timed Override and Timed Override Cancel	10 kΩ Thermistor	-40-212°F
	AI2	Zone Setpoint	0-1000 Ω	40-115°F
	AI3	Fan Mode (Control Auto/Off) AHRI Audit Test Mode Initiate	200-100 kΩ	Auto/Off Test Mode Active/Inactive
	AI4	Heat Sink Temperature Sensor	10 kΩ Thermistor	-40-212°F
	AI5	Entering Water Temperature Sensor	10 kΩ Thermistor	-40-212°F
Universal Inputs	UI1	Relative Humidity Sensor	4–20 mA	0-100%RH
	UI2	Leaving Water Temperature	10 kΩ Thermistor	-40-212°F
Binary Inputs	BI1	Local Occupancy	24 Vac detect	Normally Open Occ./Unocc
	BI2	Condensate Overflow		Normally Closed Okay/Failed
	BI3	Compressor Protection Status – Discharge Line Thermostat/Low/High Pressure Cut Out/ Overload Relay Status		Normally Closed Okay/Failed
Binary Outputs (Relay) [b]	BO1	Supply Fan On/Off Control	2.88 A @24 Vac pilot duty	Energized/De-Energized
	BO2	Isolation Valve		Energized/De-Energized
	BO3	Compressor 1		Energized/De-Energized
Binary Outputs (Triac)[c]	BO4	NA	0.5 A max @24–277 Vac, resistive and pilot duty	Energized/De-Energized
	BO5	NA		Energized/De-Energized
	BO6	NA		Energized/De-Energized
	BO7	Reversing Valve		Energized/De-Energized
	BO8	NA		Energized/De-Energized
	BO9	NA		Energized/De-Energized
Analog Outputs/ Binary Inputs	AO1/ BI4	Supply Fan Motor Control Signal	PWM Output: 80Hz	0-100% Duty Cycle
	AO2/ BI5	Variable Speed Compressor Control Signal	0-10Vdc	0-100% Compressor Output
Communication	IMC +	NA	Comm.	NA
	IMC -	NA	Comm.	NA
	LINK +	BACnet Comm. +	Comm.	NA
	LINK -	BACnet Comm. -	Comm.	NA
Pressure Inputs	PI1	Test Mode Input	3-Wire:+5Vdc, Signal, Gnd	0Vdc/5Vdc (Normal/Test Mode Active)
	PI2	Feedback from Compressor VFD	3-Wire:+5Vdc, Signal, Gnd	0Vdc/5Vdc (Okay/Drive Disabled or Failed)

(a) For more information on the UC400 connection specifications, refer to the UC400 installation sheet; Literature Order Number X39641064-01.
(b) For Triac output control, 24VAC will be supplied to the Triac Supply input to be used for the Triac outputs.
(c) 24 Vac will be connected to the binary outputs and the UC400 will provide a contact closure for output control.

UC400 Setpoints and Setup Parameters

The setpoints shown in Table 2 are available for modification through the Tracer TU Field Service Tool if changes from the factory default values are required.

Table 2. UC400 setpoints

Input Name	Selections	Default
Default Setpoint		
Unoccupied Cooling Setpoint	40°F to 115°F	85°F
Unoccupied Heating Setpoint	40°F to 115°F	60°F
Occupied Offset	0.9°F to 18°F	1.5°F
Standby Offset	0.9°F to 18°F	7.5°F
Space Temperature Setpoint Default	40 to 115°F	72.5°F
Setpoint Limits		
Cooling Setpoint High Limit	40 to 115°F	110°F
Cooling Setpoint Low Limit	40 to 115°F	40°F
Heating Setpoint High Limit	40 to 115°F	105°F
Heating Setpoint Low Limit	40 to 115°F	40°F
Humidity Setpoint	40–100%	60%

The setup parameters shown in Table 3 are available for modification through the Tracer TU Field Service Tool if changes are required

Note: *Table 3 indicates only product-specific setup parameters and does not include standard Tracer TU parameters (for example, units of measure).*

Table 3. UC400 setup parameters

Input Name	Range	Default
Device		
Occupancy Request Source	Local Source BAS	Local Source
Heat Cool Mode Request Source	Local Source BAS	Local Source
Emergency Override Command Source	Local Source BAS	Local Source
Space Temperature Source	Local Source BAS	Local Source
Space Humidity Source	Local Source BAS	Local Source
Entering Water Temperature Source	Local Source BAS	Local Source
Supply Fan		
Supply Fan Configuration Command	Continuous(a) Cycling with capacity	Continuous
Enable Local Supply Fan Switch Control	Enable Disable	Enable
Supply Fan Speed Low Limit	33-100%(b)	33%
Space Temperature Setpoint Source	BAS Default	Local Source

Table 3. UC400 setup parameters (continued)

Input Name	Range	Default
Supply Fan Speed High Limit	75-110%	100%
Filter Runtime Hours Enable	Enable Disable	Enable
Filter Runtime Hours Setpoint	0-10000 hours	600 hrs.
Bypass Time		
Occupied Bypass Time(c)	0-240 minutes	120 min.
Humidity/Dehumidification		
Space Dehumidification Setpoint Default	40-100%	60%

(a) Fan will cycle when unoccupied.
(b) The Minimum Supply Fan Speed percentage is dependent upon the Maximum Supply Fan Speed PWM percentage. The Maximum Supply Fan Speed percentage is based on the user selected maximum and is the highest fan speed the unit will run: 100% Cool output.
(c) The occupied bypass timer is used for timed override applications.

Supply Fan Output Signal Control

Variable Speed Water Source Heat Pump units will utilize variable speed Supply Fan output control in addition to the variable speed compressor. The variable speed supply fan control requires a true PWM output signal from the UC400 for fan speed control. A slew rate is also implemented on the PWM output control signal to limit the rate of change on the supply fan speed; as the unit adjusts the supply fan speed, the slew rate will be in effect. However, there will be no slew rate limit upon a request for Fan Start (ON) or Fan OFF.

The variable speed supply fan control also requires a 24 Vac signal input for On/Off control from the UC400. When the supply fan is required to run, the 24 Vac output shall be energized along with the appropriate PWM signal. Refer to the Sequence of Operation section(s) below for more detailed unit operation.

Maximum supply fan output

The user shall have the ability to select the maximum supply airflow that will be provided from the unit in order to meet requirements of the application. There will be a +10/- 25% adjustment from the maximum default airflow allowed; the +10/- 25% will be applied over the entire range of the fan speed operation.

Note: *The actual PWM percentage output will be limited between 30.5-100% PWM.*

The user will have the adjustment capability through Tracer TU for the Supply Fan Speed High Limit over the range of 75-110% supply fan capacity and the actual PWM percentage will be dependent upon the unit tonnage.

Minimum supply fan output

The user shall also have the ability to select the minimum supply airflow that will be provided from the unit in order to meet requirements of the application. The selectable range for the Supply Fan Speed Low Limit is 33-100% of the unit specific supply airflow. This selection will be the minimum fan output that will be used during all unit modes. Note that the actual minimum speed of the fan will be limited based on the unit tonnage.

Compressor Output Requirements

The compressor output will be controlled via a 24 Vac binary output from BO-03 on the UC400. The compressor capacity will be driven from a 0–10 Vdc signal from AO-02 while adhering to an ~1 RPS (Revolutions Per Second) ramp rate. The 24 Vac output from BO-03 will be utilized to give the compressor drive a "Run" command. The following chart shows the compressor drive response in relation to the UC400 compressor outputs:

Compressor On/ Off request (BO-03)	Compressor analog signal (AO-02)	Drive response
OFF	N/A	Drive OFF-Compressor Not Running
ON	0–0.9 Vdc	Drive OFF-Compressor Not Running
ON	1–1.9 Vdc	Crankcase Heater Mode
ON	2–10 Vdc	Compressor Run

Compressor startup and shutdown requirements

There are certain requirements specified for the compressor startup and shutdown sequences by the manufacturer. Below are the sequences that the unit will follow during all normal startup and shutdown sequences:

Startup

When compressor operation is requested for heating or cooling operation, at startup the compressor outputs shall energize and the compressor speed will be ramped up to 25 RPS. Once the compressor speed reaches 25 RPS it will remain there for 120 seconds. Once the 120 second timer expires, the compressor output will be released to normal unit control and will be controlled between the minimum and maximum capacities as determined by the heating and cooling operation.

Shutdown

Once the compressor is no longer requested for heating or cooling operation, the compressor speed shall ramp down to the unit tonnage specific minimum speed and will remain there for 30 seconds. After the 30 second timer expires, the compressor speed will ramp down to 0%.

Compressor On/Off Time Requirements

A minimum OFF timer of 3 minutes shall be implemented to prevent the compressor from restarting once the compressor has de-energized.

Compressor Crankcase Heater Control

For variable-speed units, there is no external crankcase heater for the compressor. Compressor Heater operation is performed by the compressor drive. The controller will use the following to determine when to energize the compressor drive for Crankcase Heater operation:

- The compressor output is not energized for Heating or Cooling operation
- The entering water temperature (EWT) is < 50°F.

If any of the following occur, the Compressor Crankcase Heater mode will be disabled:

- Compressor output is requested for heating or cooling
- EWT > 65°F

The Compressor Crankcase Heater mode will be overridden by any protection function that overrides the compressor outputs OFF:

- Compressor protection status failure
- Compressor drive feedback failure

The Compressor Crankcase Heater Mode will not be overridden by the following:

- System Mode set to OFF (local zone sensor or through BAS)
- Condensate overflow failure
- Any sensor failure

Note: *If the EWT sensor has failed, compressor operation is inhibited, but the unit will operate in Crankcase Heater mode until a valid EWT sensor value is connected.*

Sequence of Operation

During normal operation, the compressor and supply fan outputs modulate to maintain the space temperature at the user-selected space temperature setpoint(s). Functions other than heating and cooling that are controlled by the variable-speed (VS) WSHP UC400 controller are described in this section.

Random Start Timer

At power-up, the UC400 controller will generate a random timer (unique to each controller) from 5–30 seconds. During this time period, all unit functionality will be held off until the timer expires.

Maintenance Timer

The UC400 controller will compare the amount of fan run time against an adjustable Filter Runtime Hours Setpoint (stored in the controller) to determine when maintenance is recommended for the unit (check the filter status and other routine maintenance items as necessary). The Filter Runtime Hours Setpoint can be user-edited as required through the Tracer TU service tool. The valid range for the Filter Runtime Hours Setpoint is 0 to 10000 hours and the default value is 600 hours. If the user selects a setpoint of 0, the Filter Change Required diagnostic is disabled.

Once the Filter Runtime Hours Setpoint has been exceeded, the controller generates a Filter Change Required diagnostic. The user will be notified of this diagnostic in building automation system applications or through Tracer TU.

The Filter Change Required diagnostic is cleared whenever a Filter Timer reset request is communicated to the controller and the fan run hours has exceeded the fan run hours limit. At that point, the fan run time is reset (to zero) and the process starts over.

Setpoint Arbitration

VS WSHP units will require traditional Zone Heating and Cooling Setpoints, as well as a humidity setpoint for the dehumidification feature. These setpoints will be available locally through the UC400 or may be provided from a BAS.

The UC400 has provisions for a local Zone Setpoint input with a range of 50-85°F which will be used in conjunction with the Occupied and Standby Offsets (Default 1.5°F and 7.5°F, respectively). The Local Occupied Zone Setpoints will be calculated as follows depending on the Occupancy Status of the unit:

Cooling Setpoint = Space Temp Setpoint Default + (Occupied Offset or Standby Offset)

Heating Setpoint = Space Temp Setpoint Default— (Occupied Offset or Standby Offset)

For Unoccupied Zone Setpoints, the UC400 has default values for Heating and Cooling and they are adjustable through Tracer TU. The Default Dehumidification setpoint will also only be adjustable through Tracer TU or through a BAS.

When multiple setpoint sources are available (local and BAS), the controller will use the following logic for determining which setpoint should be used for active control:

1. If a valid communicated setpoint value is present, the communicated value will be used for control.
2. If a valid communicated setpoint value is not present but a valid hard-wired setpoint value is present, the hard-wired value will be used for control.
3. If neither valid communicated or hard-wired setpoint values are present, the controller will use the default setpoints.

Sensor Arbitration

The following sensor values can be provided to the UC400 via hard-wired inputs or through BACnet communication. The controller will use a valid communicated value for unit control, regardless of the status of the hard-wired input.

- Space Temperature
- Entering Water Temperature
- Space Humidity

Occupancy Determination

The following standard occupancy modes and arbitration are supported in the VS WSHP UC400:

MSV occupancy request[a]	Local occupancy input	Bypass timer	MSV occupancy status
Occupied	Occupied	N/A	Occupied
	Unoccupied	Zero	Standby
		Not zero	Bypass
Bypass	Occupied	N/A	Occupied
	Unoccupied	Zero	Standby
		Not zero	Bypass
Unoccupied	N/A	Zero	Unoccupied
		Not zero	Bypass
Standby	N/A	Zero	Standby
		Not zero	Bypass
Auto	Occupied	N/A	Occupied
	Unoccupied	Zero	Unoccupied
		Not zero	Bypass

(a) MSV occupancy request is a communicated Occupancy Mode request from a BAS.

Occupied mode

When the controller is in Occupied mode, the unit will attempt to maintain the space temperature to the active occupied heating or cooling setpoint. Occupied mode is the default mode of the UC400 controller.

Unoccupied mode

When the controller is in Unoccupied mode, the unit will attempt to maintain the space temperature at the stored unoccupied Heating or Cooling setpoint (configurable through the BAS or Tracer TU).

Occupied Standby mode

The Occupied Standby mode allows the unit to operate at a heating or cooling setpoint between the occupied and unoccupied setpoints (Space Temperature Setpoint ± Standby Offset) to help maintain the space while decreasing energy consumption. Unit operation in this mode is identical to the occupied mode except for the different heating and cooling setpoints.

Occupied Bypass mode

The Occupied Bypass mode is used to transition the unit from the Unoccupied mode to the Occupied mode for a period of time from 0 to 4 hours (configurable through Tracer TU).

The controller can be placed in Occupied Bypass mode by either communicating an occupancy request of bypass or by using the Timed Override (for example, ON) functionality of the controller and applicable zone sensors:

Timed override operation

While the unit is operating in Unoccupied mode, if the timed override request button on the zone sensor is selected for 0.2 to 5 seconds, the unit will recognize this as a timed override request. This request is always accepted, but will only transition to Occupied Bypass mode if the controller was in Unoccupied mode. Once initiated, the unit will enter Occupied Bypass mode for the duration of the Occupancy Bypass Timer (Default 120 minutes) or until the timed override request is cancelled.

While the unit is operating in Occupied Bypass mode, the timed override operation can be cancelled by a timed override cancel request. This request is always accepted, but the unit will transition back to Unoccupied mode only if the unit is currently operating in Occupied Bypass mode.

Some Trane zone sensors have ON and CANCEL buttons for timed override operation. Pressing the ON button on the zone sensor applies a direct short across the space temperature input, as described above, and when the unit is in Unoccupied mode, initiates the Occupied Bypass mode. The CANCEL button applies 1.5 kΩ across the space temperature input and is used to return a unit operating in Occupied Bypass mode back into Unoccupied mode before the Occupancy Bypass Timer has expired.

Supply fan mode operation

VS WSHP units can be set up to have either Cycling or Continuous fan mode operation. This feature is selectable through Tracer TU or through a BAS as a communicated value. The default value for the supply fan mode is Continuous.

Supply fan mode: Cycling

For active cooling, heating, and enhanced dehumidification operation, the supply fan will be commanded ON and will ramp up to minimum speed once the unit determines that there is a request for cooling or heating operation. Once the control determines that there is no longer a capacity request, and the compressor output is OFF, the supply fan will be de-energized once any Supply Fan Off delays have timed out. During the Supply Fan Off Delay, the supply fan will remain energized for the predetermined time at the previous unit function's minimum speed.

Note: *During heating only, there will be a 30 second Supply Fan Off delay.*

Supply fan mode: ON

For active unit control with the supply fan mode set to Continuous, the unit will energize the supply fan and hold the fan speed output at the active minimum speed until there is a request for the fan speed to increase. This will hold true for all cases except during Unoccupied periods in which the Supply Fan Mode is forced to operate in Cycling mode.

Zone sensor fan switch

The VS WSHP controller supports a fan switch selection that is selectable by an applicable zone sensor module. When the fan switch is set to AUTO, the unit will utilize the configured supply fan mode (Cycling or Continuous) for supply fan output control and will operate heating, cooling, and dehumidification in order to meet the space demand. When the fan switch is set to OFF, the unit will enter OFF mode. All heating and cooling capacity will be de-energized after the associated minimum on timers expire, the isolation valve will be de-energized, and the supply fan will de-energize once any associated off delay timer has expired; no heating, cooling, or supply fan operation will be allowed when the fan switch is set to OFF.

If required, the user can enable/disable the zone sensor fan switch functionality through BAS or the Tracer TU service tool. A fan mode can also be requested through BAS. If a requested fan mode is requested through BAS, the local setting is ignored.

Unit Mode Arbitration

Table 4. Unit operating mode based on communicated value

Heat Cool Mode Request	Effective Unit Mode Operation	Description
Auto	Auto	Mode determined by active setpoint/sensor values.
Heat	Heat	Fan Operation and Heating Operation Allowed; no Cooling or Dehumidification.
Morning worm up	Heat	Fan Operation and Heating Operation Allowed; no Cooling or Dehumidification.
Cooling	Cool	Fan Operation, Cooling Operation, Dehumidification Operation Allowed; no Heating Operation.
Night purge	Auto	Mode determined by active setpoint/sensor values.
Pre-cool	Cool	Fan Operation, Cooling Operation, Dehumidification Operation Allowed; no Heating Operation.
Off	Off	Fan, Cooling, Heating, and Dehumidification Operation disabled.
Test	Auto	Mode determined by active setpoint/sensor values.
Emergency heat	Heat	Fan Operation and Heating Operation Allowed; no Cooling or Dehumidification.
Fan only	Fan only	Fan Operation at Maximum Speed only; no Heating or Cooling available.
Free cool	Auto	Mode determined by active setpoint/sensor values.
Ice-making	Auto	Mode determined by active setpoint/sensor values.
Max heat	Auto	Mode determined by active setpoint/sensor values.
Economizing	Auto	Mode determined by active setpoint/sensor values.
Dehumidify	Auto	Mode determined by active setpoint/sensor values.
Calibrate	Auto	Mode determined by active setpoint/sensor values.

Manual mode determination

Any BAS request for AUTO mode or any other enumeration for the Heat Cool Mode Request object that results in a system mode request of AUTO will result in the unit alternating between Heating and Cooling operation automatically as described in "Auto-Changeover," p. 9. If unit mode requests for modes other than AUTO are provided through the BAS, arbitration is used to determine the active mode as follows:

Refer to the table below to determine the unit operating mode based on communicated Heat Cool Mode request values:

Note: *If the local Fan Switch functionality is enabled and the switch selection is set to OFF, the unit will be OFF regardless of the Heat Cool Mode request from the BAS.*

Auto-Changeover

When the Effective Unit Mode is Auto, the following Auto-Changeover rules are used to determine the active unit mode:

At power-up, or after a unit reset, the Active Unit Mode is set to:

- Heat, if the active space temperature < the cooling setpoint
- Cool, if the active zone temperature > the cooling setpoint

If the Active Unit Mode is Cool, the Active Unit Mode is switched to Heat when both of the following conditions are met:

- Active space temperature < the heating setpoint
- There is no longer a request for cooling

If the Active Unit Mode is Heat, the Active Unit Mode is switched to Cool when both of the following conditions are met:

- Active Zone Temperature > cooling setpoint
- There is no longer a request for Heating

Note: *Once the controller determines that there is a need to change the active unit mode, the compressor will not energize for the new mode until the compressor minimum off time has been met.*

Isolation Valve Operation

For all units, the UC400 supports a two-position water isolation valve without needing any special configuration; by default, the UC400 will control as though isolation valves are present.

Isolation Valve "ON" Control

The isolation valve output will be energized prior to the compressor (controlled open) during active compressor heating, cooling, dehumidification, and when forced open during manual output override testing. The water isolation valve will be driven open during all Heating and Cooling requests, even if the compressor output is not energized, such as during low load conditions when the compressor is operating in the duty cycle routine in order to achieve its minimum capacity. To reduce excessive cycling of the

isolation valve, once opened, the isolation valve will remain open for a minimum of 10 minutes.

Entering Water Temperature (EWT) sampling

The VS WSHP controller will sample the entering water temperature to determine proper control action for all units that utilize a hard-wired entering water temperature indication. If the entering water temperature is communicated to the controller via a BAS system, then no sampling will be required. When the EWT sampling function is invoked, the isolation valve output will be driven open for 3 minutes and the EWT reading is taken at that time.

EWT sampling will not occur automatically at power up, only when all of the following conditions are met:

- EWT is not communicated via BAS system
- There is a new request for compressor operation.
- The isolation valve is not OPEN.
- It has been more than an hour since the last time that the isolation valve was opened.

After the 3-minute EWT sampling time period expires, the isolation valve will remain open for compressor operation.

Isolation Valve "OFF" Control

The isolation valve output will be de-energized (controlled closed) when there is no longer a request for compressor operation and the 10 minute minimum on time has expired or the manual output override test has driven it closed.

Reversing Valve Operation

For normal unit operation, the reversing valve output is energized when the unit is in Cooling mode and de-energized in Heating mode. If de-energized, the reversing valve output is energized for Cooling when the compressor output is energized and the compressor speed has ramped up to its startup speed. Once energized, the reversing valve output will remain energized until the controller energizes the compressor output for heating and the compressor speed has ramped up to its startup speed or the Unit Mode is set to OFF.

Cooling and Heating Operation

For normal Cooling and Heating operation, the unit cooling or heating capacity will modulate and cycle based on a PI algorithm in order to meet the Active Space Setpoint. The following fan and compressor actions are based on the required unit capacity:

- When no unit capacity is required, the compressor output(s) will be OFF.
- When the required unit capacity is less than the compressor can provide at its minimum speed, the unit will operate in a duty cycle scheme based on a required ON/OFF time in order to meet the space demand.
- When the required unit capacity is greater than the minimum capacity for the unit, the unit will operate the compressor and fan between minimum and maximum capacity in order to meet the space demand.

Based on the required unit capacity to meet the space demand, the unit will operate in 4 states:

- **Startup**: At startup, the supply fan ramps up to minimum speed and the compressor ramps up to minimum speed based on the prescribed startup sequence.
- **Running**: During the running state, the compressor and fan speeds are modulated between the minimum and maximum values.
- **Shutdown**: During shutdown, the fan runs at the minimum speed, and the compressor operates per the prescribed shutdown sequence.
- **Unit Off**: Compressor remains OFF.

Cooling Sequence

If the unit has determined that the Active Unit Mode should be Cool and if the control determines that there is a need for active cooling capacity, the unit will energize the isolation valve and begin to control the compressor and supply fan outputs based on the space demand.

Heating Sequence

If the unit has determined that the Active Unit Mode should be Heat and if the control determines that there is a need for active heating capacity, the unit will energize the isolation valve and begin to control the compressor and supply fan outputs based on the space demand.

Unoccupied Cooling and Heating Operation

The unit will control the Zone Temperature to the Active Unoccupied Setpoints during Unoccupied periods.

Enhanced Dehumidification

The VS WSHP UC400 controller supports two versions of Enhanced Dehumidification operation. The decision to perform Enhanced Dehumidification is based on the availability of a space relative humidity value as described in this section.

Humidity Sensor Value Available

VS WSHP units will perform Enhanced Dehumidification only during low cooling load conditions when the unit is performing active Cooling operation and there is an valid Space Humidity value (local or BAS). If the valid Space Humidity value is greater than the active Dehumidification Setpoint, the supply fan speed vs. compressor speed curve will be modified to increase the dehumidification

capability of the unit. If a Space Humidity value is not present at the controller, this version of Enhanced Dehumidification will be disabled. The following transition rules are used for entering and leaving enhanced dehumidification:

If all of the following are true, the unit shall enter enhanced dehumidification:

- Unit is operating in Active Cooling Mode.
- Space Humidity Value > Active Dehumidification Setpoint.
- Space Temperature < (Active Zone Cooling Setpoint + 0.25°F)

If any of the following are true, the unit shall leave enhanced dehumidification:

- Unit is no longer operating in Active Cooling Mode.
- Space Humidity Value < Active Dehumidification Setpoint – 8%RH.
- Space Temperature > (Active Zone Cooling Setpoint +2°F)

Humidity Sensor Value Unavailable

If a valid humidity sensor value is not available from the local source or through BAS, there may still be a need to perform some level of dehumidification. If this is the case, the unit will utilize an indication from the refrigerant heat sink temperature to help determine when to perform a level of dehumidification control. The following rules shall be followed to determine when to enter the "auto" enhanced dehumidification sequence:

If all of the following are true, the unit shall enter auto enhanced dehumidification:

- Unit is operating in Active Cooling Mode.
- There is not an active call for Heating operation, Active Heat Setpoint + 1°F < Active Space Temperature < Active Cooling Setpoint.
- Space Humidity Value is invalid/unavailable.
- The compressor has run at between minimum speed and minimum speed + 3% for 30 minutes.
- Active Cooling Capacity = 0%.
- Heat Sink Temperature > 50°F.

When the above conditions are true, the unit shall operate under the following conditions for 15 minutes before ending the Cooling cycle.

- The compressor capacity shall be increased to 50%.
- The supply fan output shall remain at minimum speed.

After the above mode has timed out, the unit shall shut down as normal.

Note: *If any of the activating conditions cease to be true, or if any conditions that override cooling operation to OFF become true, this mode will be terminated.*

Demand Limit Operation

The VS WSHP controller supports a communicated request for Demand Limiting operation of the Compressor and Supply Fan outputs. Demand Limiting operates as follows: If the point is placed into the Active state, the unit limits the compressor capacity output to 50% for all unit modes (Cooling, Heating, and Dehumidification). During this period, the supply fan tracks the compressor as normal and is limited by the user-selected Minimum and Maximum Fan Speeds. Demand Limit requests do not override compressor Startup and Shutdown sequences or unit protection modes.

Emergency Override BAS

The VS WSHP controller supports a communicated request for Emergency Override Operation. When the point is In-Service, the following operations are supported:

- **Normal**: Normal operation will be allowed based on other unit operating conditions.
- **Pressurize**: If the unit receives a request to Pressurize, the following actions shall occur:
  - All compressor operation will be disabled immediately.
  - The Isolation Valve Output will be de-energized.
  - The Supply Fan output will ramp up to 100%.
- **Depressurize**: If the unit receives a request to Depressurize, the following actions shall occur:
  - All compressor operation will be disabled immediately.
  - The Isolation Valve Output will be de-energized.
  - The Supply Fan outputs will be de-energized.
- **Purge**: If the unit receives a request to Purge, the following actions shall occur:
  - All compressor operation will be disabled immediately.
  - The Isolation Valve Output will be de-energized.
  - The Supply Fan output will ramp up to 100%.
- **Shutdown**: If the unit receives a request to Shutdown, the following actions shall occur:
  - All compressor operation will be disabled immediately.
  - The Isolation Valve Output will be de-energized.
  - The Supply Fan outputs will be de-energized.
- **Fire**: If the unit receives a request for Fire, the following actions shall occur:
  - All compressor operation will be disabled immediately.
  - The Isolation Valve Output will be de-energized.
  - The Supply Fan outputs will be de-energized.

Troubleshooting

General Unit Troubleshooting

⚠WARNING

Hazardous Service Procedures!

The maintenance and troubleshooting procedures recommended in this section of the manual could result in exposure to electrical, mechanical or other potential safety hazards. Always refer to the safety warnings provided throughout this manual concerning these procedures. When possible, disconnect all electrical power including remote disconnects before servicing.

Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components per these tasks. Failure to follow all of the recommended safety warnings provided, could result in death or serious injury.

Table 5. General unit troubleshooting

Problem	Heating	Cooling	Cause	Correction
No response to any zone sensor setting	X	X	Main power off	Check fuses
	X	X	Defective control transformer	Replace
	X	X	Broken or loose connection	Repair
	X	X	Defective zone sensor	Replace
	X	X	Transformer	Reset Transformer
Unit short cycles	X	X	Zone sensor improperly located	Relocate
Blower runs but compressor does not	X	X	Supply Voltage too low	Correct
	X	X	Defective windings	Replace
	X	X	Limit switches open	Check cause/replace or repair
	X	X	Zones sensor error	Check cause/replace or repair
	X	X	Compressor drive error	Check cause/replace or repair
Insufficient capacity	X	X	Dirty filter	Replace/clean
	X	X	Blower RPM too low	Correct
	X	X	Loss of conditioned air due to leaks in ductwork	Repair leaks
		X	Introduction of excessively hot return air	Correct
	X		Introduction of excessively cold return air	Correct
	X	X	Low on refrigerant charge	Locate leak, repair and recharge by weight (not by superheat)
	X	X	Restricted thermal expansion valve	Replace
	X	X	Zone sensor improperly located	Relocate
	X	X	Unit undersized	Recalculate heat gains/losses
	X	X	Inadequate water flow	Increase GPM
	X	X	Scaling in heat exchanger	Clean or replace
		X	Water too hot	Decrease temperature
	X		Water too cold	Increase temperature
	X	X	Filter drier blocked	Replace
	X	X	Defective reversing valve	Check or replace
High pressure switch open		X	Inadequate GPM	Increase water flow to unit
		X	Water too hot	Decrease temperature
	X		Inadequate air flow	Check, clean blower and coil
	X		Dirty filter	Clean/replace
	X	X	Overcharged with refrigerant	Decrease charge
	X	X	Defective pressure switch	Check or replace

Table 5. General unit troubleshooting (continued)

Problem	Heating	Cooling	Cause	Correction
High head pressure		X	Trash in heat exchanger	Backflush
		X	Low water flow	Increase GPM
	X	X	Overcharge of refrigerant	Decrease charge
	X	X	Non-condensable in system	Evacuate and recharge by weight
	X	X	Water too hot	Decrease temperature
	X		Dirty filter	Clean/replace
	X		Inadequate air flow	Check, clean blower and coil
Low suction pressure	X	X	Undercharged	Locate leak; repair and recharge
	X	X	Restricted thermal expansion valve	Repair / replace
		X	Inadequate air flow	Check, clean blower and coil
		X	Dirty filter	Clean/replace
	X		Inadequate GPM	Increase GPM
Low pressure switch open	X		Inadequate GPM	Increase GPM
	X		Water too cold	Increase temperature
		X	Inadequate air flow	Increase CFM
		X	Dirty filter	Clean/replace
	X	X	Undercharged with refrigerant	Increase charge
	X	X	Defective pressure switch	Replace
	X	X	Heat transfer fluid too cold	Raise water temperature

Compressor Drive Troubleshooting

The variable-speed compressor drive includes internal protection functions that limit the compressor operation, or in some cases, disable compressor operation completely. If an event occurs that causes the compressor operation to shut down, the compressor drive sends a binary signal to the VS WSHP UC400 controller and a diagnostic is generated. Refer to the Table 5, p. 12 and Table 6, p. 13 for details on the drive protection functions.

Note: *Adhere to all safety requirements when servicing or monitoring the compressor drive with the unit panel not installed.*

Table 6. 208–230 VAC Single-phase units

Unit size	Interface module[a],[b]	Protection function	Reset type	Description	Protection criteria	Reset criteria
Compressor Speed Reduction						
024/033	P - 01	Compressor Over current	Automatic	If the compressor current exceeds a predefined limit, the drive will begin to reduce the speed of the compressor until the current values stabilize or the compressor current falls below the reset value.	Compressor Current > 24 A	Compressor Current ≤ 21A
042-060					Compressor Current > 30 A	Compressor Current ≤ 27A
024/033	P - 02	Heat Sink Over-Heat	Automatic	If the Drive Heat Sink temperature exceeds a predefined limit, the drive will begin to reduce the speed of the compressor until the reset criteria is met.	Heat Sink Temp ≥ 77°C (170°F)	Heat Sink Temp ≤ 72°C (161°F)
042-060						
024/033	P - 03	AC Input Current Too High	Automatic	If the AC input current exceeds a predefined limit, the drive will begin to reduce the speed of the compressor until the current values stabilize or the AC input current falls below the reset value.	AC Input current ≥ 18 A (RMS)	AC Input current ≤ 16 A (RMS)
042-060					AC Input current ≥ 28 A (RMS)	AC Input current ≤ 26 A (RMS)

Table 6. 208–230 VAC Single-phase units (continued)

Unit size	Interface module[a],[b]	Protection function	Reset type	Description	Protection criteria	Reset criteria
Compressor Shutdown						
024/033	E - 02	Communication Error	Automatic	If the drive module loses communication with the Interface Module, compressor operation will be disabled.	No communication between drive module and Interface Module for 30 seconds.	Drive Module and Interface Module regain communication.
042-060						
024/033	E - 05	Compressor Over current	Automatic	If the compressor current exceeds a predefined limit, the drive will shut down the compressor until the current falls below the reset value.	Compressor Current > 25 A	Compressor Current at 0A
042-060					Compressor Current > 33 A	
024/033	E - 07	Heat Sink Over Heat Protection	Automatic	If the Drive Heat Sink temperature exceeds a predefined limit, the drive will shut down the compressor until the reset criteria is met.	Heat Sink Temp ≥82°C (179°F)	Heat Sink Temp ≤66℃ (150F)
042-060					Heat Sink Temp ≥82°C (179°F)	Heat Sink Temp ≤66℃ (150F)
024/033	E – 08	DC Bus Overvoltage	Automatic	If the DC Bus voltage exceeds a predefined limit, the compressor will be shut down until the DC Bus voltage reaches the reset value.	DC Bus > 440 Vdc	DC Bus < 380Vdc
042-060					DC Bus > 440 Vdc	DC Bus < 380Vdc
024/033	E - 09	DC Bus Under voltage	Automatic	If the DC Bus voltage falls below a predefined limit, the compressor will be shut down until the DC Bus voltage reaches the reset value.	DC Bus < 150 Vdc	DC Bus > 160Vdc
042-060					DC Bus < 150 Vdc	DC Bus > 160Vdc
024/033	E – 10	AC Input Voltage Too Low	Automatic	If the AC Input voltage falls below a predefined limit, the compressor will be shut down until the AC voltage reaches the reset value.	AC Input < 175 V for 10 seconds	AC Input > 195VAC for 2 seconds
042-060					AC Input < 175 V for 10 seconds	AC Input > 195VAC for 2 seconds
024/033	E - 11	AC Input Over Current	Automatic	If the AC Input current rises above a predefined limit, the compressor will be shut down until the AC input current falls below the reset limit.	Input current ≥ 20 A (RMS)	AC Input current ≤ 16A(RMS)
042-060					Input current ≥ 30 A (RMS)	AC Input current ≤ 26A(RMS)
024/033	E - 12	Heat Sink Temp Sensor Failure	Automatic	If the Heat Sink Temperature sensor on the drive is failed OPEN or SHORT, the drive will shut down the compressor operation until a valid sensor value is received.	Heat Sink Temp Sensor is OPEN or SHORTED.	Heat Sink Temp Sensor is within valid range.
042-060						
024/033	E - 13	Internal Drive Communication Failure	Automatic	If the communication between the controllers on the drive module is in error, the drive will shut down the compressor.	Loss of Communication between drive module controllers.	Once communication is re-established on the drive module, compressor operation is allowed to resume.
042-060						
024/033	E – 01[2]	Interface Module Configuration Error	Manual	If the Compressor Configuration on the Interface Module is not set correctly, compressor operation will be disabled.	Compressor configuration set to a non-recognized model.	Correct configuration must be selected and power cycled to the drive.
042-060						

Table 6. 208–230 VAC Single-phase units (continued)

Unit size	Interface module[a],[b]	Protection function	Reset type	Description	Protection criteria	Reset criteria
024/033	E-03	IPM Fault	Manual	If the drive module gets into an over current condition, the drive will shut down. The drive will attempt to restart the compressor after 120 seconds. If the drive attempts to restart more than 5 times in 30 minutes, the compressor operation will be shut down and an error code will be generated.	Power Module Current > 45 A	Power is cycled to the drive.
042-060					Power Module Current > 65 A	Power is cycled to the drive.
024/033	E-04	Compressor Operation Failure	Manual	If the drive detects that the compressor is not operating or that there is a drive hardware failure, compressor operation will be disabled The drive will attempt to restart the compressor after 15 seconds. If the drive attempts to restart more than 5 times, the compressor will be shut down and an error code will be generated.	Compressor Speed Loss, Voltage Imbalance > 5%, or Drive Hardware Damage	Power is cycled to the drive.
042-060						

(a) The error codes described in the Interface Module column refer to error codes that will be displayed on the 7-segment display on the interface module located within the compressor drive assembly. Use caution when accessing this location in the unit.
(b) Refer to Table 8, p. 17 for the DIP switch settings required for each unit model. These DIP switches are located on the interface module located in the compressor drive assembly.

Table 7. 460 VAC three-phase units

Unit Size	Interface module[a],[b]	Protection function	Reset type	Description	Protection criteria	Reset criteria
Compressor Speed Reduction						
024/033	P - 01	Compressor Over current	Automatic	If the compressor current exceeds a predefined limit, the drive will begin to reduce the speed of the compressor until the current values stabilize or the compressor current falls below the reset value.	Compressor Current > 20 A	Compressor Current ≤ 17 A
042-060					Compressor Current > 27 A	Compressor Current ≤ 24 A
024/033	P - 02	Heat Sink Over-Heat	Automatic	If the Drive Heat Sink temperature exceeds a predefined limit, the drive will begin to reduce the speed of the compressor until the reset criteria is met.	Heat Sink Temp ≥ 78°C (172°F)	Heat Sink Temp ≤ 70°C (165°F)
042-060						
Compressor Shutdown						
024/033	E - 02	Communication Error	Automatic	If the drive module loses communication with the Interface Module, compressor operation will be disabled.	No communication between drive module and Interface Module for 30 seconds.	Drive Module and Interface Module regain communication.
042-060						

Table 7. 460 VAC three-phase units

Unit Size	Interface module[a],[b]	Protection function	Reset type	Description	Protection criteria	Reset criteria
024/033	E - 05	Compressor Over current	Automatic	If the compressor current exceeds a predefined limit, the drive will shut down the compressor until the current falls below the reset value.	Compressor Current > 23 A	Compressor Current at 0A
042-060					Compressor Current >30 A	
024/033	E - 07	Heat Sink Over Heat Protection	Automatic	If the Drive Heat Sink temperature exceeds a predefined limit, the drive will shut down the compressor until the reset criteria is met.	Heat Sink Temp ≥ 83°C (181°F)	Heat Sink Temp ≤65°C (149°F)
042-060					Heat Sink Temp ≥ 83°C (181°F)	Heat Sink Temp ≤65°C (149°F)
024/033	E – 08	DC Bus Overvoltage	Automatic	If the DC Bus voltage exceeds a predefined limit, the compressor will be shut down until the DC Bus voltage reaches the reset value.	DC Bus > 800 Vdc	DC Bus < 650 Vdc
042-060					DC Bus > 800 Vdc	DC Bus < 650 Vdc
024/033	E - 09	DC Bus Under voltage	Automatic	If the DC Bus voltage falls below a predefined limit, the compressor will be shut down until the DC Bus voltage reaches the reset value.	DC Bus < 300 Vdc	DC Bus > 350 Vdc
042-060					DC Bus < 300 Vdc	DC Bus > 350 Vdc
024/033	E - 12	Heat Sink Temp Sensor Failure	Automatic	If the Heat Sink Temperature sensor on the drive is failed OPEN or SHORT, the drive will shut down the compressor operation until a valid sensor value is received.	Heat Sink Temp Sensor is OPEN or SHORTED.	Heat Sink Temp Sensor is within valid range.
042-060						
024/033	E - 13	Internal Drive Communication Failure	Automatic	If the communication between the controllers on the drive module is in error, the drive will shut down the compressor.	Loss of communication between drive module controllers.	Once communication is re-established on the drive module, compressor operation is allowed to resume.
042-060						
024/033	E – 01(b)	Interface Module Configuration Error	Manual	If the Compressor Configuration on the Interface Module is not set correctly, compressor operation will be disabled.	Compressor configuration set to a non-recognized model.	Correct configuration must be selected and power cycled to the drive.
042-060						

Table 7. 460 VAC three-phase units

Unit Size	Interface module[a],[b]	Protection function	Reset type	Description	Protection criteria	Reset criteria
024/033 042-060	E-03	IPM Fault	Manual	If the drive module gets into an over current condition, the drive will shut down. The drive will attempt to restart the compressor after 120 seconds. If the drive attempts to restart more than 5 times in 30 minutes, the compressor operation will be shut down and an error code will be generated.	Power Module Current > 40 A	Power is cycled to the drive.
024/033 042-060	E-04	Compressor Operation Failure	Manual	If the drive detects that the compressor is not operating or that there is a drive hardware failure, compressor operation will be disabled The drive will attempt to restart the compressor after 15 seconds. If the drive attempts to restart more than 5 times, the compressor will be shut down and an error code will be generated.	Compressor Speed Loss, Voltage Imbalance > 5%, or Drive Hardware Damage	Power is cycled to the drive.

(a) The error codes described in the Interface Module column refer to error codes that will be displayed on the 7-segment display on the interface module located within the compressor drive assembly. Use caution when accessing this location in the unit.
(b) Refer to Table 8, p. 17 for the DIP switch settings required for each unit model. These DIP switches are located on the interface module located in the compressor drive assembly.

Table 8. DIP switch settings

Unit Size	SW1	SW2	SW3	SW4	SW5	SW6
024-033	OFF	OFF	OFF	OFF	OFF	OFF
042-060	OFF	OFF	OFF	OFF	OFF	ON

Test Modes

The VS WSHP controller supports a single field test mode sequence that can either be initiated through the Tracer TU field service tool or locally through the low-voltage terminal block on the unit. Refer to the descriptions below for stepping the unit through Service Test Mode using the available Tracer TU Initiated Service Test Mode.

Tracer TU Initiated Service Test Mode

Using the Tracer TU service tool, the user has the ability to command the unit into pre-defined Test Mode steps for unit troubleshooting and servicing. This functionality is available through the Commissioning tab of the Equipment Utility page for the VS WSHP UC400 controller. The user will need to select the Start option for the Step Test option and then step the unit through each test mode via the Step button.

Note: *The controller will enforce the proper sequence for compressor startup and shutdown during each test step.*

After all requirements have been met for the compressor operation, the Step button becomes available for use; the user will not be able to force the unit through Service Test steps until all requirements have been met. At any time during the test mode, the user will have the ability to select Cancel, which will override the unit out of Test Mode operation.

Local Service Test Mode Operation

The Local Service Test Mode operation is initiated by shorting the P1 Signal Input to 5 Vdc on the UC400 after first being OPEN. The Service Test Mode terminals are available through the low-voltage terminal block in the unit control box.

When utilizing the local input on the UC400 to initiate the Test Mode states, the unit state change is initiated whenever the input is shorted for 8 seconds after first being open. After the unit has been placed into a test step, the unit continues to operate in the active state for up to 1 hour after which the unit will automatically revert to normal operation.

Table 9. Service Test Mode steps

Step	Mode[a]	Supply Fan	Supply Fan % (AO1)[b],[c]	Compressor (BO3)	Compressor % (AO2)[c],[d]	Reversing Valve (BO7)	Isolation Valve (BO2)
1	Off	Off	Off	Off	Off	Off	Off
2	Isolation valve open	Off	Off	Off	Off	Off	On
3	Fan	On	Min	Off	Off	Off	On
4	100% Cool	On	100% Capacity	On	100% Capacity	On	On
5	Changeover (Low Heat)[e]	On	See footnote[e]	On	See footnote[e]	Off	On
6	100% Heat	On	100% Capacity	On	100% Capacity	Off	On
7	Isolation valve close	Off	Off	Off	Off	Off	Off

(a) A 60-minute time limit will be imposed on each mode step. After the timer expires, the unit transitions back to normal control.
(b) All Supply Fan percentage outputs will be in reference to the user selected Supply Fan Speed High and Low Limit percentage selections per unit tonnage.
(c) The Supply Fan and Compressor Outputs follow all Startup and Shutdown requirements prior to moving through Test Mode steps that change the states of the compressor output from ON to OFF or OFF to ON. Compressor minimum off times will be in effect during test mode.
(d) All Compressor percentage Outputs are in reference to the 100% capacity limit per unit tonnage. Note that the Supply Fan Speed Command values are based on the default Supply Fan Speed High Limit value. If the Supply Fan Speed High Limit has been adjusted, the values will be within +10%/ -25%of the values shown in Table 10, p. 18
(e) The compressor output will be at 31% (25 RPS) prior to changing the state of the reversing valve. Note that the Supply Speed Command values are based on the default Supply Fan Speed High Limit value. If the Supply Fan Speed High Limit has been adjusted, the values will be within +10%/ -25% of the values shown in Table 11, p. 18

When the unit reaches the end of the Test Mode steps, the Test Mode terminates and the system runs through a reset operation. To prevent undesired activation of Test Mode at startup, the Local Service Test Mode can only be activated after an open condition has been detected on the UC400 Test Mode terminals.

Table 9, p. 18 shows each Test Mode step and the appropriate unit operation for each mode. If the unit does not follow this sequence, refer to "Test Mode Overrides," p. 18 for possible causes.

Table 10. Default supply and compressor speed commands (100% capacity)

Unit size	Test mode	Supply Fan Speed Command (AO1)	Compressor Speed Command (AO2)
024	100% Cool	63%	49.1%
	100% Heat	63%	49.1%
033	100% Cool	83%	62.4%
	100% Heat	83%	58.8%
042	100% Cool	69%	53.6%
	100% Heat	69%	53.6%
050-060	100% Cool	79%	63.6%
	100% Heat	79%	63.6%

Table 11. Default changeover command values

Unit size	Supply Fan Speed Command (AO1)	Compressor Speed Command (AO2)
024	39.4%	31%
033	39.4%	31%
042	35.2%	31%
050-060	34.7%	31%

Failures that Do Not Override Test Mode Compressor/Fan Operation

- Zone Temperature Sensor Failure
- Zone Setpoint Failure

Test Mode Overrides

If the unit is performing normal heating or cooling operation, an active request for Test Mode (local or through Tracer TU) will override the normal unit operation. However, as the unit makes a transition from normal operation to Test Mode, the compressor and fan outputs will follow normal startup and shutdown requirements. An initiation of a Test Mode sequence will also override an OFF mode request. The following failure and override conditions will override the compressor and fan outputs during Test Mode operation:

Failures that Override Compressor Operation Only

- Compressor Protection Status Failure—Compressor OFF
- Compressor Drive Feedback Failure—Compressor OFF
- EWT Failure—Compressor OFF
- EWT Low—Compressor Minimum Speed Increases
- LWT Failure—Compressor OFF
- LWT Low—Compressor OFF
- Heat Sink Temperature Failure—Compressor OFF
- Evaporator Frost Protection—Compressor OFF

Failures that Override Compressor and Fan Operation

- Condensate Overflow Failure—Compressor and Fan OFF

- Mode Input Failure
- Humidity Sensor Failure

Note: *If a failure occurs during test mode (Local or Tracer TU initiated) that overrides the compressor to OFF, the unit will be allowed to proceed through Step 3 (Fan) of the service test sequence. However, if the user attempts to transition to Step 4, the unit will automatically transition to Step 7 (Isolation Valve Closed/All OFF). At this point, the user will need to manually transition out of test mode by proceeding to the next step or wait the 1 hour time-out period. If a failure mode occurs during compressor operation, the unit will handle the failure as in the same manner.*

If a failure occurs during test mode (Local or Tracer TU initiated) that overrides the compressor and fan outputs to OFF, the unit will automatically transition to Step 7 (Isolation Valve Closed/All OFF). At this point, the user will need to manually transition out of test mode by proceeding to the next step or wait the 1 hour time-out period.

Failure Modes and Protection Conditions

Some failure and overriding conditions require special handling of the Supply Fan and Compressor Speeds. Refer to the following sections for details on each failure mode associated with the VS WSHP and the unit response:

Analog Input Failures and Overrides

Space Temperature Sensor Failure. If the Active Space Temperature input is out of range and there is not a valid Space Temperature value being provided from a BAS or if the Space Temperature BAS point is In-Service, but there is no valid communicated Space Temperature BAS value, the following actions are taken by the control:

1. Heating, Cooling, and Dehumidification is disabled.
2. The isolation valve is de-energized.
3. The supply fan output is de-energized after the compressor is de-energized if the Supply Fan Configuration is setup for Cycling control.
4. A Space Temperature Failure diagnostic is generated by the controller.
5. A Space Temperature Failure diagnostic automatically resets after a valid Space Temperature is received by the controller.

Space Setpoint Failure. If the Active Space Temperature Setpoint input is out of range and there is not a valid Space Temperature Setpoint value being provided from a BAS or if the Space Temperature Setpoint BAS point is In-Service, but there is no valid communicated Space Temperature Setpoint BAS value, a Space Setpoint Failure diagnostic is generated.

If neither a hard-wired nor communicated setpoint is present, the controller uses the stored default configured setpoints:

- Space Temperature Setpoint Default
- Occupied Offset
- Standby Offset
- Unoccupied Setpoints

Fan Mode Input. If the Active Supply Fan Mode Input is out of range and the point is in-service, a Fan Mode Input Invalid diagnostic is generated.

When no fan mode is hard-wired or communicated, a fan mode of AUTO will be utilized as the default mode.

The Fan Mode Input Invalid diagnostic shall automatically reset once a valid Fan Mode request is received by the controller.

Heat Sink Temperature. If the Heat Sink Temperature sensor value is out of range/invalid, the following actions are taken by the unit controls:

1. A Heat Sink Temperature Invalid/Out of Range diagnostic is generated.
2. All compressor operations are disabled.
3. The supply fan output is de-energized after the compressor is de-energized if the Supply Fan Configuration is setup for Cycling control.
4. The isolation valve closes.

The Heat Sink Temperature Invalid/Out of Range diagnostic automatically resets if a valid value is received by the controller.

Entering Water Temperature. If the Entering Water Temperature input is out of range and there is not a valid Entering Water Temperature value being provided from a BAS or if the Entering Water Temperature BAS point is In-Service, but there is no valid communicated Entering Water Temperature value, the following actions are taken by the control:

1. An Entering Water Temperature Invalid/Out of Range diagnostic is generated.
2. Heating, Cooling, and Dehumidification is disabled.
3. The supply fan output is de-energized after the compressor is de-energized if the Supply Fan Configuration is setup for Cycling control.
4. The Isolation Valve closes.

The Entering Water Temperature Invalid/Out of Range diagnostic automatically resets if a valid value is received by the controller.

Space Humidity Input. If at power up the Space Humidity input is out of range, there is no valid Space Humidity value being provided from a BAS, and the BAS point is not In-Service, a Space Humidity input diagnostic is not generated. If after power up the unit has had a valid Space Humidity value and the present Space Humidity

value is out of range, or if the Space Humidity BAS point is In-Service, but there is no valid communicated Space Humidity value, Dehumidification operation is disabled and a Humidity Input Failure diagnostic is generated.

After the Humidity Input Failure diagnostic is generated, it will be automatically reset if a valid humidity value is received by the controller.

Leaving Water Temperature. If the Leaving Water Temperature sensor value is out of range/invalid, the following actions are taken by the unit controls:

1. A Leaving Water Temperature Invalid/Out of Range diagnostic is generated.
2. Heating, Cooling, and Dehumidification is disabled.
3. The supply fan output is de-energized once the compressor is de-energized if the Supply Fan Configuration is setup for Cycling control.
4. The Isolation Valve closes.

The Leaving Water Temperature Invalid/Out of Range diagnostic automatically resets if a valid value is received by the controller.

Protection Functions

Evaporator Frost Protection. In order to detect potential frost buildup on the evaporator, the controller will calculate a saturated suction temperature during certain operating conditions to correlate to a potential frosting condition. The unit will then compare the saturated suction temperature to a low-limit value to determine when to shut down the compressor. If the calculated saturated suction temperature falls below the low-limit value, the following takes place:

1. Compressor operation shuts down following the proper shutdown sequence.
2. Supply Fan output is operated at the greater of the User Selected Minimum Speed or 50% capacity.
3. The Frost Protection diagnostic is activated.

If the saturated suction temperature falls below the low limit five times within 4 hours, a Manual Reset diagnostic is generated. During the manual diagnostic condition, compressor operation is inhibited. However, the supply fan will be allowed to operate if the fan mode is set to Continuous.

When all of the following conditions are true, the compressor operation is re-enabled:

- Heat sink temperature ≥ 40°F.
- Compressor 3-minute minimum off timer has expired.
- Total number of Frost Protection trips < 5 within the 4 hour timer.

Or...

- Heat sink temperature ≥ 40°F.
- Compressor 3-minute minimum off timer has expired.
- Total number of Frost Protection trips = 5 within the 4 hour timer *and* a manual diagnostic reset condition has been activated.

Leaving Water Temperature Too Low. If the Leaving Water Temperature sensor value is below the safe operating temperature for unit operation (below the Loop Configuration temperature), the following actions are taken by the controls:

1. A Leaving Water Temperature Too Low diagnostic is generated.
2. The Compressor output ramps down to 0%.
3. The supply fan output is de-energized after the compressor is de-energized if the Supply Fan Configuration is setup for Cycling control.
4. The Isolation Valve closes.

The Leaving Water Temperature Too Low diagnostic automatically resets after the Leaving Water Temperature rises to the configured Loop Configuration Temperature (20°F or 35°F) + 15°F.

Low Refrigerant Flow Rate Control

- **Low Entering Water Temperature**: During Low Entering Water Temperature conditions, it is necessary to modify the minimum compressor capacity based on the active operating mode and the entering water temperature.

  Note: *The supply fan will continue to track with the compressor output regardless of the low limit.*

- **Extended Time @ Compressor Low Speed (Oil Recovery Mode)**: If the compressor operates for 90 continuous minutes at the minimum speed, the compressor speed shall ramp to 50% capacity for 3 minutes and then will be released back to normal operation.

Condensate Overflow Detection. A Condensate Overflow condition will be detected by a condensate overflow float switch. The condensate overflow switch is hard-wired to a binary input of the controller (BI-02). When the condensation level reaches the trip point, the binary input will detect the diagnostic condition. When the Condensate Overflow input OPENS, the following actions are taken by the controller:

1. A Condensate Overflow diagnostic is generated.
2. The Isolation Valve closes after the compressor de-energizes.
3. Heating, Cooling, and Dehumidification are disabled.
4. Supply Fan operation is shut down after the compressor shuts down

Although the actual condensate overflow switch automatically resets when the condensation returns to a normal level, the condensate overflow diagnostic must be manually reset to clear the diagnostic from the controller and restart the unit operation.

Compressor Protection Status—TDL, HPC, LPC, (TDL is Discharge Line Temp 2B1S3, HPC is High Pressure Switch 2B1S1, LPC is Low Pressure Switch 2B1S2) Drive Overload. The Normally Closed Compressor Protection Status input will be used to monitor the status of the Compressor Protection circuitry. If the Compressor Protection Status input Opens, the following occurs:

1. Compressor Outputs is de-energized immediately.
2. Isolation Valve Output is de-energized after its minimum ON timer has expired.
3. Supply Fan is de-energized unless the fan is operating in Fan Continuous mode.
4. A Compressor Protection Status Failed diagnostic is generated.

The UC400 controller will attempt to automatically recover when the Compressor Protection Status Failed diagnostic occurs. After the controller detects the Compressor Protection Status diagnostic, the UC400 will wait 30 minutes before attempting the automatic diagnostic reset function. The automatic diagnostic reset function will clear the diagnostic and the controller will resume normal operation until another diagnostic occurs. If a Compressor Protection Status diagnostic reoccurs within 24 hours after an automatic diagnostic reset, a manual reset diagnostic shall be generated.

Compressor Drive Protection Mode. The compressor drive will provide a 5 Vdc signal into the P2 input on the UC400 to indicate a failure condition. If any drive failure condition occurs, the UC400 will shutdown the compressor outputs and report a Compressor Drive Failure diagnostic. Refer to the "Compressor Drive Troubleshooting" section for details on the conditions that cause the drive to indicate a failure.

The Compressor Drive Failure diagnostic will be reset automatically after the failure condition is no longer present.

Diagnostic Indication

Viewing active diagnostics will be possible through the Tracer TU Service Tool or through a BAS. In addition to system indication, if any of the diagnostics below are generated, the System LED will flash red on the UC400:

- Diagnostic: Compressor Drive Failure
- Diagnostic: Compressor Protection Status Failed
- Diagnostic: Condensate Overflow
- Diagnostic: Entering Water Temperature Invalid/Out of Range
- Diagnostic: Fan Mode Input Invalid
- Diagnostic: Filter Change Required
- Diagnostic: Frost Protection
- Diagnostic: Heat Sink Temperature Invalid/Out of Range
- Diagnostic: Humidity Input Failure
- Diagnostic: Leaving Water Temperature Invalid/Out of Range
- Diagnostic: Leaving Water Temperature Too Low
- Diagnostic: Space Setpoint Failure
- Diagnostic: Space Temperature Failure

Refer to the "Failure Modes and Protection Conditions," p. 19 for an explanation of the conditions that cause these diagnostics to be generated.

Diagnostic Resetting

The VS WSHP UC400 controller has multiple manual-reset (latching) diagnostics that require the user to reset them. Manual-reset diagnostics can be reset by any of the following:

- Using the Tracer TU service tool.
- A Diagnostic Reset binary point communicated through BACnet.
- Using the Tracer SC user interface.
- Cycling power to the controller.
- Initiating a Test Mode.
- Cycling the Fan Switch from OFF to ON/AUTO.

Control Wiring

Figure 1. 208V single-phase wiring

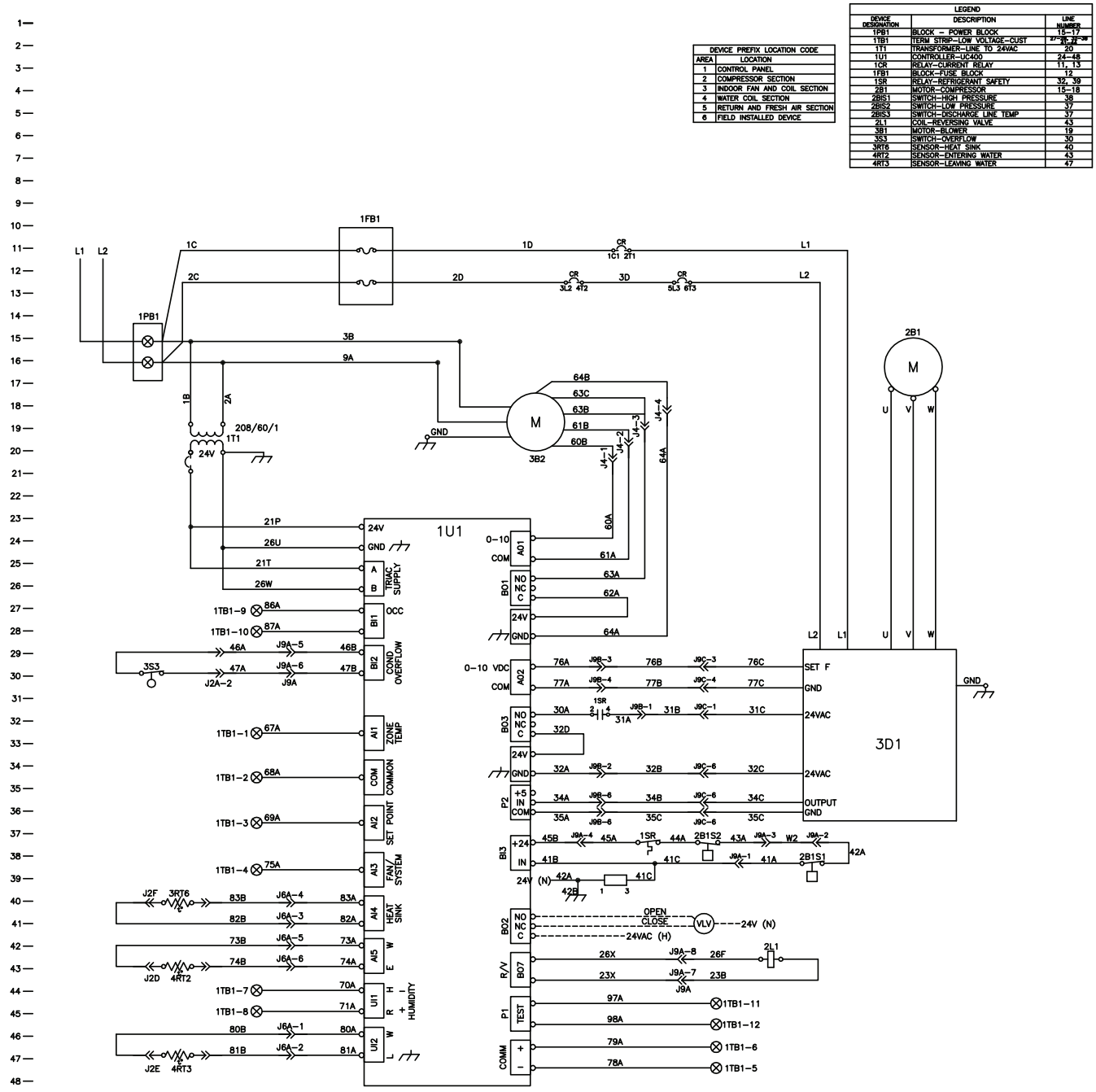
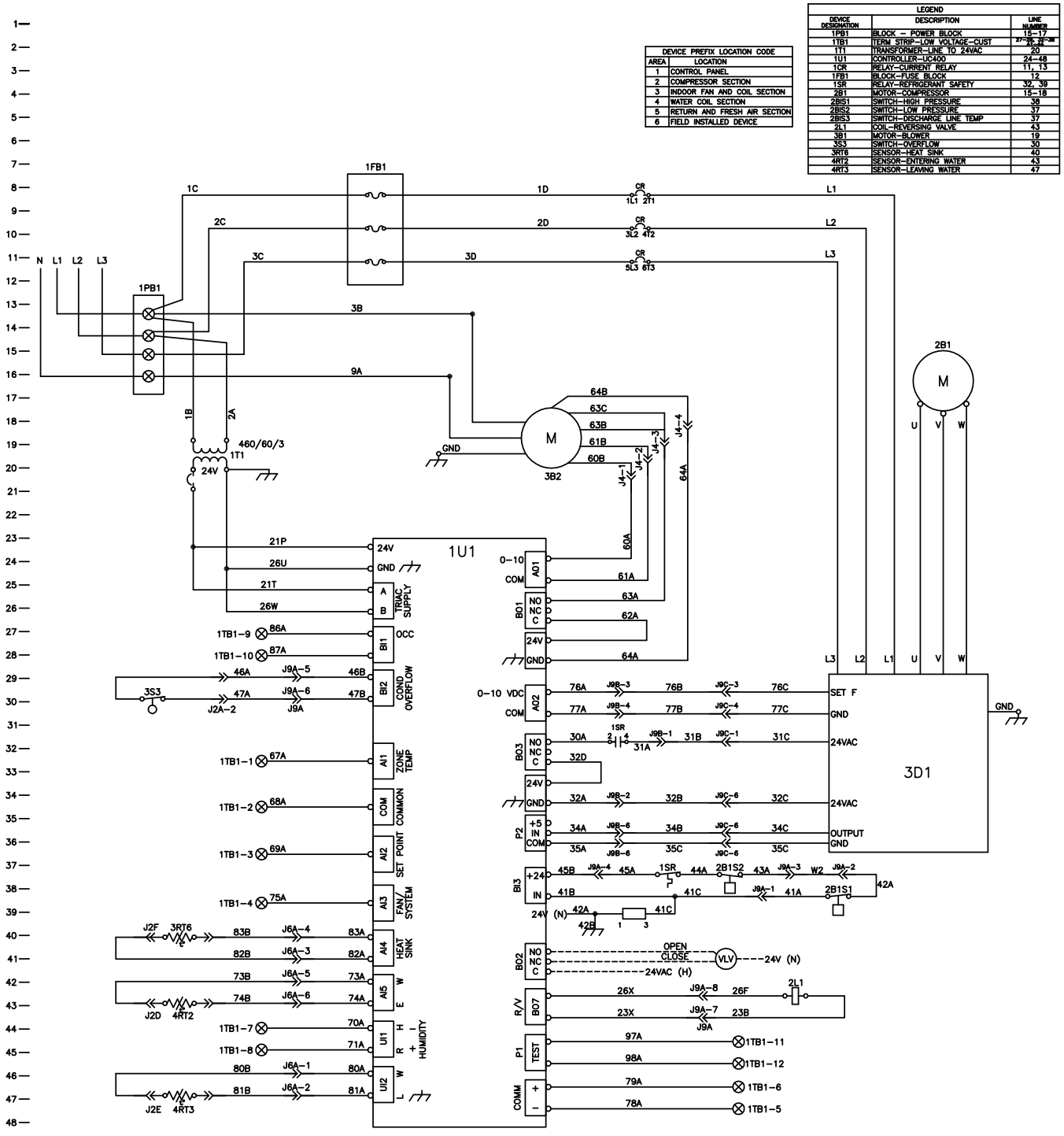


Figure 2. 460V three-phase wiring



Notes:

1. Unless otherwise noted, all switches are shown at 25°C (77°F), at atmospheric pressure, at 50% relative humidity, with all utilities turned off, and after a normal shutdown has occurred.
2. Dashed lines indicate recommended field wiring by others. Field writing to be rated for 600 V. Dashed line enclosure and/or dashed device outlines indicate components provided by the field. Solid lines indicate wiring by the Trane company.
3. Numbers along the right side of the schematic designate the location of the contacts by line number.
4. All field wiring must be in accordance with the National Electric Code (NEC) and state and local requirements.

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