



Turn to the experts

Product Data

Omnizone™ Water Source Cooling Only and Heat Pump Units

18 to 60 Nominal Tons



50BVJ020-034
SINGLE PIECE OMNIZONE UNIT



50BVT,V,W034-064
MODULAR OMNIZONE UNIT

Omnizone 50BV020-064 indoor cooling only and cooling/heating water source heat pumps with Puron® (R-410A) refrigerant, high-efficiency scroll compressors, and optional constant or variable air volume

Omnizone 50BV units are packaged, indoor cooling only and cooling/heating water source heat pumps.

Omnizone 50BV units offer:

- Puron® (R-410A) refrigerant
- High-boy modular units that break down to fit through a standard 36-in. doorway
- Either two or four high-efficiency scroll compressors for efficient part load control, quiet operation, and system redundancy
- Optional constant volume (CV) or variable air volume (VAV) configurations
- Factory installed 1 in. (50BVJ) or 4 in. (50BVT,W,V) filter rack with filters

Flexible, efficient, and economical

Units are available for constant volume (CV) or variable air volume (VAV) applications (with the exception of heat pumps) in both modular and single-piece construction. Single-piece units are completely factory wired, piped, and charged, ready for installation. Modular units are factory piped and charged, and ship partially disassembled for easy field installation.

Units include a direct expansion refrigerant to air coil, coaxial refrigerant to water coil, compressors, belt drive supply fan, and reversing valve (heat pump units only). VAV units also include VFD driven supply fan, a factory installed and configured VAV DDC control, factory installed hot gas bypass (HGBP) for low load control, and a modulating hot gas reheat (HGRH) coil for supply air temperature control.

These WSHP units are built and designed for comfort cooling and heating duty in commercial buildings, such

as offices, retail, and schools. 50BV units are not intended for industrial or process applications.

Each refrigerant circuit is equipped with a coaxial water to refrigerant heat exchanger for maximum heat transfer efficiency and performance. The coaxial coils are headered together to provide a single water supply and return connection for easy installation. All condensers are rated at 600 psig operating refrigerant pressures and 450 psig water-side pressures. Compressors are mounted on a floating basepan with rubber isolation for vibration control.

Indoor air coils are enhanced fin, rifled tube type for maximum performance. Large face areas ensure low airside pressure drops and reduced face velocities to prevent condensate carry over and maximum moisture removal.

Coils are either three or four rows deep depending on unit model and mounted above stainless steel condensate drain pans, which help resist corrosion.

Units contain either one or two forward curved fan assemblies, depending on the model and size. Fans are double width, double inlet welded assemblies statically and dynamically balanced.

Puron refrigerant

All Carrier 50BV units utilize Puron refrigerant. Puron refrigerant is a non-chlorine based (R-410A) refrigerant. Puron refrigerant characteristics, compared to R-22, have:

- Binary and near azeotropic mixture of 50% R-32 and 50% R-125.
- Non-ozone depleting potential.
- Virtually no glide. Unlike other alternative refrigerants, the two components in Puron refrigerant have virtually the same leak rates. Therefore, refrigerant can be added if necessary without recovering the charge.

Adaptable and flexible controls

CV units include a terminal strip for use with field provided and installed Carrier or third party thermostat or with a field provided and installed Carrier Open or third party DDC control.

All VAV units include a factory installed, programmed, and run-tested DDC control configured for multi-zone VAV operation and can be configured using the virtual BACview¹ software. VAV units can operate stand alone or integrated in a Building Automation System using open protocols BACnet², Modbus³, N2, or LonWorks⁴. Local interface to the DDC control for start-up, commissioning, or troubleshooting is accomplished through the Virtual BACview PC software and USB Link cable.

- Leaving-air temperatures and water temperatures can be monitored from the building automation system or local Virtual BACview interface.

Reliable operation and easy to service

Each compressor has its own independent refrigerant circuit and is protected by individual branch fusing. Additional protection is provided by thermal overloads and high and low-pressure safety switches.

- High and low-pressure switches on each circuit.
- Thermostatic expansion valves (TXV) on each circuit mounted outside the airstream.
- Integrated unit protection module (UPM) protects unit components and acts as a unit interface for thermostat or VAV control. The UPM also features integrated alarm function with LED indicator for easy troubleshooting.
- All units are ETL listed for compliance with UL-1995.
- All units are backed by a standard one-year parts warranty with options for extended parts and labor warranties for up to five years.
- Stainless steel condensate pan.
- Condensate overflow switch provides protection against condensate overflow.

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1. BACview is a registered trademark of Automated Logic Corporation.
 2. BACnet is a trademark of ASHRAE.
 3. Modbus is a registered trademark of Schneider Electric.
 4. LonWorks is a registered trademark of Echelon Corporation.

Features/Benefits (cont)

- Freeze protection switch provides evaporator coil protection against freezing.
- Single point electrical connections and piping connections.

Standard Features

Unit Protection Module (UPM)

All 50BV units include a factory installed unit protection module (UPM), monitors the unit operation and safety devices to ensure reliable operation and simplify troubleshooting.

The UPM monitors the unit safeties, including high and low refrigerant pressure switches, condensate overflow switches, and freeze switches. The UPM includes functionality such as short compressor cycle prevention, random start relay, low pressure bypass typer, brownout/surge/power interruption protection, alarm lockout and automatic reset, and an alarm contact.

The UPM also includes two LEDs to assist with troubleshooting the unit, a power LED to indicate when the board has power, and a fault indicator with blink codes to indicate when the unit is in alarm and indicate the type of fault.

Single Piece Construction

All 50BVJ units are factory assembled, piped, and wired, and ship as a single piece to the job site for easy installation. See the 50BVJ drawings for

details. A special order (ETO) for take-apart construction is available to allow the units to be field split to allow for easier maneuvering through tight spaces for installation.

Modular Construction

All 50BVT,W,V units are designed to allow for installation flexibility without breaking refrigerant piping and are available in two styles, high boy and low boy.

High boy units are tall and ship as two (size 034) or four (size 044-064) modules. High boy units can have the filter/economizer field removed to allow every piece of the unit to fit through a standard 36-in. door for easy installation. See 50BV high boy field and shipping split drawings for details.

Low boy units are short and ship as one (size 034) or two (size 044-064) pieces. The filter/economizer section can be field removed to allow the unit to fit through a 50-in. opening. See 50BV low boy field and shipping splits for details.

Constant Volume (CV) Control

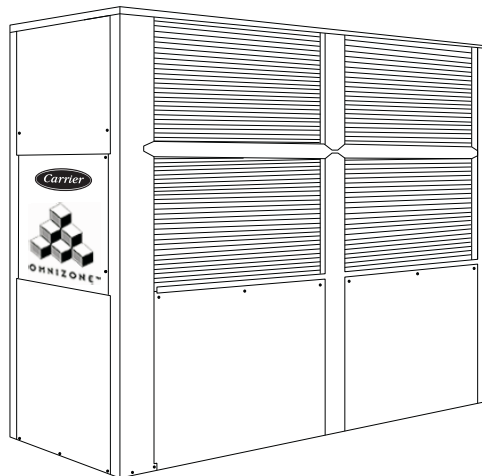
50BVT,V constant volume units are a great fit for single zone applications that require simple control. All constant volume units include a thermostat style inputs for use with thermostat or field provided DDC controls to provide two stage (size 020-034) or four stage (size 044-064)

cooling. 50BVV units also provide two stage (size 020-034) or four stage (size 044-064) heat pump heating. A special order (ETO) is available for staged air volume (SAV™) two speed fan control and for condenser-less units for use with field provided remote condensers.

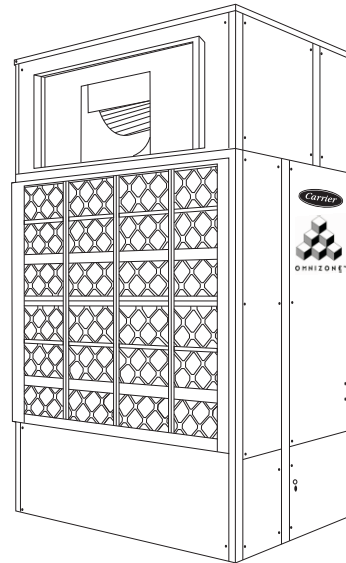
Variable Air Volume (VAV) Control

50BVJ and W units are designed for use in multi-zone VAV applications to act as a cooling only VAV air source. All VAV units include a factory installed and configured DDC controller that is set up for multi-zone VAV control. VAV units include a supply fan VFD that is operated by the DDC controller to maintain duct static pressure using the included duct pressure transducer (field-installed).

The refrigeration circuits of the 50BVJ and W units are also optimally configured to maximize performance in a VAV system with either two stage (size 020-034) or four stage (size 044-064) cooling with hot gas bypass (HGBP) on every circuit. All VAV units include a modulating hot gas reheat (HGRH) coil to help prevent low supply air temperatures. The DDC controller operates the unit refrigeration components to maintain supply air temperature using the factory provided, field installed return air temperature sensors and factory installed supply air temperature sensor (requires field relocation).



50BVJ020-034
Single Piece Omnizone Unit



50BVT,V,W034-064
Modular Omnizone Unit

Model number nomenclature



50BV	J	020	-	B	-	6	-	E	- -																																
Model Series 50BV – OMNIZONE Indoor Self-Contained Unit				Factory-Installed Options																																					
Unit Type J – (VAV) Cool Only, W/C, Single Piece† ** T – (CV) Cool Only, W/C, Modular* V – (CV) Heat Pump, W/C, Modular* W– (VAV) Cool Only, W/C, Modular† **				Revision D – Current Build with factory-installed 6126 controller (50BVJ,W)† E – Current Build with no controller (50BVT,V)*																																					
Nominal Capacity 50BVJ 020 – 18 Tons†† 028 – 25 Tons 024 – 20 Tons 034 – 30 Tons 50BVT, 50BVV, 50BVW 034 – 30 Tons 054 – 50 Tons 044 – 40 Tons 064 – 60 Tons				Design Changes - – Standard Design (50BVJ) 1 – High-Boy Design (50BVT,W,V) 2 – Low-Boy Design (50BVT,W,V) NOTE: See dimensional diagrams for physical size difference between High and Low-Boy.																																					
Economizer and Hot Gas Reheat Options - – None A – Water Economizer with 3-Way Valve C – Cycling Hot Gas Reheat Coil D – Cycling Hot Gas Reheat and Economizer with 3-Way Valve F – Modulating Hot Gas Reheat*** G – Modulating Hot Gas Reheat and Economizer with 3-Way Valve***				Voltage Description 1 – 575-3-60 5 – 208/230-3-60 6 – 480-3-60 Airflow Configuration - – Front Return, Top Supply B – Front Return, Rear Supply C – Rear Return, Top Supply D – Rear Return, Front Supply E – Rear Return, Rear Supply 50BVJ may select - B, C, or D 50BVT, W, V (Low-Boy) may select C or D only 50BVT, W, V (High-Boy) may select D or E only																																					
LEGEND CV – Constant Volume HP – Horsepower VAV – Variable Air Volume W/C – Water-Cooled * CV units (50BVT and 50BVV) do not receive factory-installed controls and can only have the no-controller option. † Only VAV units (50BVJ and 50BVW) will have the factory-installed controller. ** VAV requires factory-installed modulating hot gas reheat. †† 50BVJ only. *** F or G required for VAV units (50BVJ and 50BVW).																																									
Indoor Motor and Drive Options <table><thead><tr><th>HP</th><th>STD</th><th>MED STATIC</th><th>HIGH STATIC</th></tr></thead><tbody><tr><td>2</td><td>C</td><td>N</td><td>n/a</td></tr><tr><td>3</td><td>D</td><td>P</td><td>3</td></tr><tr><td>5</td><td>E</td><td>n/a</td><td>n/a</td></tr><tr><td>7.5</td><td>F</td><td>R</td><td>5</td></tr><tr><td>10</td><td>G</td><td>S</td><td>6</td></tr><tr><td>15</td><td>H</td><td>T</td><td>7</td></tr><tr><td>20</td><td>J</td><td>U</td><td>8</td></tr></tbody></table> NOTE: HP ratings are per motor. Most 50BV units have two indoor-fan motors. See price pages for additional information.										HP	STD	MED STATIC	HIGH STATIC	2	C	N	n/a	3	D	P	3	5	E	n/a	n/a	7.5	F	R	5	10	G	S	6	15	H	T	7	20	J	U	8
HP	STD	MED STATIC	HIGH STATIC																																						
2	C	N	n/a																																						
3	D	P	3																																						
5	E	n/a	n/a																																						
7.5	F	R	5																																						
10	G	S	6																																						
15	H	T	7																																						
20	J	U	8																																						

Efficiency and capacity ratings



Efficiency and Capacity Ratings^a

UNIT	SIZE	COOLING CAPACITY (BTUH)	COOLING EFFICIENCY (EER)	HEATING CAPACITY (BTUH)	HEATING EFFICIENCY
50BVJ	020	220,000	14.6	—	—
	024	248,000	14.4	—	—
	028	295,000	13.0	—	—
	034	386,000	14.8	—	—
50BVT, W	034	391,200	18.6	—	—
	044	500,000	19.0	—	—
	054	637,200	19.0	—	—
	064	783,600	18.6	—	—
50BVV	034	391,200	18.6	386,900	5.5
	044	500,000	19.0	623,000	5.4
	054	637,200	19.0	731,800	5.4
	064	783,600	18.6	773,800	5.5

NOTE(S):

a. Ratings are at AHRI/ISO 13256-1 water loop conditions.

LEGEND

EER — Energy Efficiency Ratio
COP — Coefficient of Performance

Physical data - 50BVJ units



Physical Data — 50BVJ

UNIT 50BVJ	020	024	028	034
NOMINAL CAPACITY (Tons)	18	20	25	30
OPERATING WEIGHT (lb)	1,090	1,310	1,530	1,650
SHIPPING WEIGHT (lb)	1,180	1,400	1,630	1,750
COMPRESSOR	Copeland Scroll			
Quantity	2	2	2	2
Number of Refrigerant Circuits	2	2	2	2
REFRIGERANT TYPE	R-410A			
Expansion Device	TXV	TXV	TXV	TXV
Operating Charge (oz) per Ckt	130	145	145	288
CONDENSER	Tube-in-Tube Coaxial			
Quantity of Manifolded Coils	2	2	2	2
Nominal Flow Rate (gpm)	50	60	75	90
Water Flow Range (gpm)	36-72	40-80	50-100	60-120
Max Water Working Pressure (psig)	450	450	450	450
Max Refrig. Working Pressure (psig)	600	600	600	600
Water Connection Size (in.)/Type (Qty)	2 FPT(1)	2 FPT(1)	2 FPT(1)	2 FPT(1)
Volume (gal)	3.0	3.4	3.4	3.3
EVAPORATOR COIL				
Rows...Fins/in.	3...14	3...14	3...14	3...14
Total Face Area (sq ft)	18.1	18.1	18.1	27.1
EVAPORATOR FAN				
(Quantity) Size	(2)15x15	(2)15x15	(2)15x15	(2)15x15
Type Drive	Belt	Belt	Belt	Belt
Nominal cfm	7,000	8,000	10,000	12,000
Motor Quantity	2	2	2	2
Motor HP Options	2, 3, 5	2, 3, 5	3, 5	5
Motor Nominal rpm (2, 3 HP)	1,725	1,725	1,725	—
Motor Nominal rpm (5 HP)	3,450	3,450	3,450	3,450

LEGEND

TXV — Thermostatic Expansion Valve

Physical data - 50BVT, V, W units



Physical Data — 50BVT, V, W

UNIT 50BVT,V,W	034	044	054	064
NOMINAL CAPACITY (Tons)	30	40	50	60
OPERATING WEIGHT (lb)	2,650	4,750	5,500	5,550
SHIPPING WEIGHT (lb)	2,866	4,846	5,700	5,732
COMPRESSOR	Copeland Scroll			
Quantity	2	4	4	4
Number of Refrigerant Circuits	2	4	4	4
REFRIGERANT TYPE	R-410A			
Expansion Device	TXV	TXV	TXV	TXV
Operating Charge (oz per Ckt)	288	160	288	288
CONDENSER	Tube-in-Tube Coaxial			
Quantity of Manifolded Coils	2	4	4	4
Nominal Flow Rate (gpm)	90	120	150	180
Water Flow Range (gpm)	60-120	80-160	100-200	120-240
Max Water Working Pressure (psig)	400	400	400	400
Max Refrig. Working Pressure (psig)	600	600	600	600
Water Connection Size (in.)/Type (Qty)	2.5 FPT(1)	2.5 FPT(1)	3 FPT(1)	3 FPT(1)
Volume (gal)	5.4	7.2	10.8	10.8
EVAPORATOR COIL				
Rows...Fins/in.	4...12	3...12	4...12	4...12
Total Face Area (sq ft)	22.4	44.8	44.8	44.8
EVAPORATOR FAN				
Quantity...Size	1...18x18	2...18x18	2...18x18	2...18x18
Type Drive	Belt	Belt	Belt	Belt
Nominal cfm	12,200	16,000	20,000	24,000
Motor HP Options	1	2	2	2
Supply Fan Motor HP Range	7.5, 10, 15, 20	7.5, 10, 15	7.5, 10, 15, 20	7.5, 10, 15, 20
Motor Nominal rpm	1750	1750	1750	1750
Fan rpm (Range)	794-1,256	794-1,256	794-1,256	794-1,256
Motor Bearing Type	Ball	Ball	Ball	Ball
RETURN AIR FILTERS				
Quantity...Size (in.)	8...17x27x4	16...17x27x4	16...17x27x4	16...17x27x4

LEGEND

TXV — Thermostatic Expansion Valve

Waterside economizer

Available on both CV and VAV units, the waterside economizer allows the 50BV unit to use cool loop water to provide free cooling for energy savings.

The waterside economizer package includes a factory mounted and piped water to air coil (installed on the unit return air inlet or 50BVJ or in the filter/economizer section 50BVT,W,V), inlet and return water piping, a dedicated condensate drain pan, and a three way control valve. CV units include an Aquastat for economizer control. VAV units include economizer control as part of the DDC control.

When the entering water temperature is below the Aquastat or DDC controller set point, the waterside economizer coil is enabled. Cool condenser water is directed to the economizer coil to return air as it passes over the economizer coil. The water leaving the economizer coil is directed to the coaxial coil to allow the unit to provide mechanical cooling (integral economizer operation) if the economizer does not provide enough cooling capacity.

Hot water coil

A factory installed hot water coil is available in the filter/economizer section of modular CV units (50BVT,V). The hot water coil is intended to have a separate water supply and provides pre-heat operation (upstream of the evaporator coil and supply fan).

The hot water coil package includes a factory installed 1 or 2 row hot water coil installed in the filter/economizer section of 50BVT,V units. The hot water coil includes pipe connections on the side. See dimensional drawings for details.

The hot water coil requires a separate pipe connection, field provided and installed control valves and strainer, and field provided and installed control system with freeze protection. VAV units are not available with a hot water coil. Consult application engineering for applications that require both a hot water coil and a waterside economizer coil.

Hot gas reheat

A hot gas reheat (HGRH) coil is available as a factory installed option on CV units. HGRH is standard on all VAV units.

For CV units, HGRH allows the unit to dehumidify the space without over-cooling the space. When there is a call for dehumidification, the compressors and HGRH coil are activated. Air entering the unit is cooled and dehumidified by the indoor air coil. The air then passes through the HGRH coil, where it is reheated to a neutral dry bulb temperature (typically 68 to 75°F). This dehumidified, neutral

air helps to reduce space humidity levels without cooling the space.

CV units are available with on/off HGRH for DDC or thermostat control or with modulating HGRH for field installed DDC control.

All VAV units are standard with modulating HGRH for supply air temperature control. If the air leaving the indoor air coil is colder than the unit supply air temperature set point, the modulating HGRH coil is enabled to reheat the air back up to the supply air temperature set point. The modulating HGRH system is controlled by the unit DDC control for supply air temperature control only and will not operate for dehumidification purposes.

Energy management switch

The energy management switch (EMS) is available for CV units. VAV units are standard with EMS functionality as part of the DDC control.

The EMS allows an external 24V signal to disable unit operation. The EMS includes a relay that is wired to the UPM power feed. When a 24V signal is applied to the relay, power is provided to the UPM and the unit is allowed to operate. When 24V is removed from the relay, power is interrupted to the UPM and all unit functions stop. The unit is now disabled until 24V is applied to the relay.

Cupronickel coaxial coil

Cupronickel (Cu/Ni) water to refrigerant coils are available for protection in open loop systems.

Hot gas bypass

Hot gas bypass is available on CV units and is standard on VAV units to provide protection against evaporator frosting during low load or low airflow conditions.

Insulated basepan

This option is available for additional sound deadening characteristics.

Extended range option

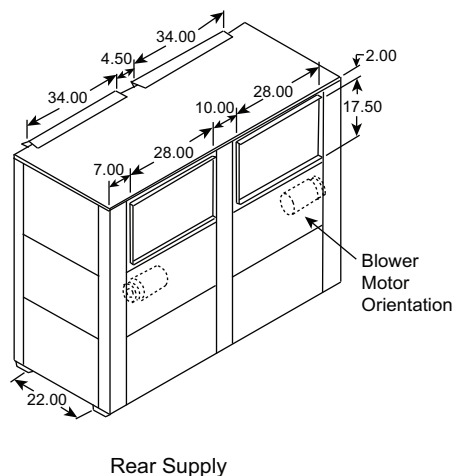
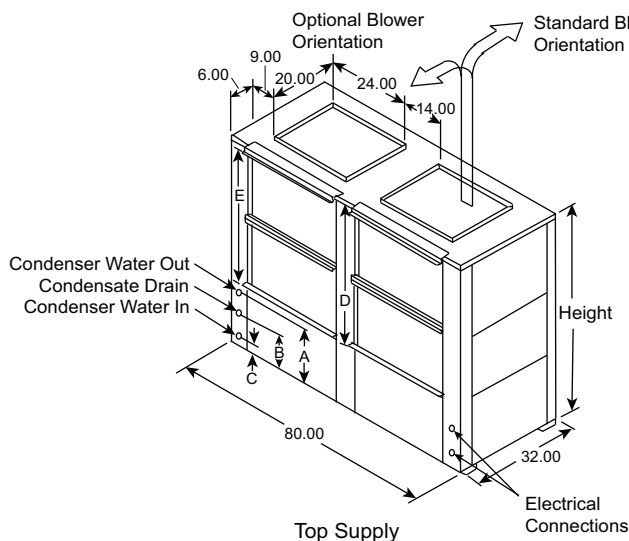
This option includes insulation on the coaxial heat exchanger and water piping to prevent condensation during low entering water temperature conditions.

Blower orientation

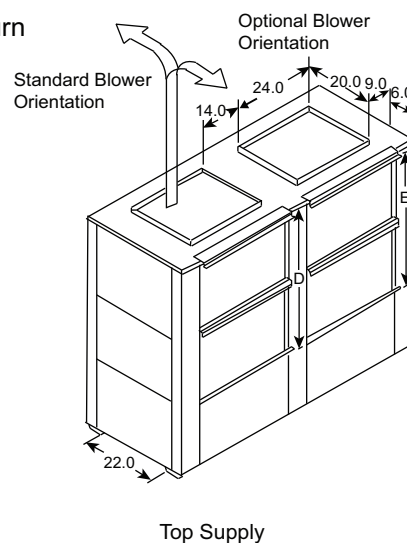
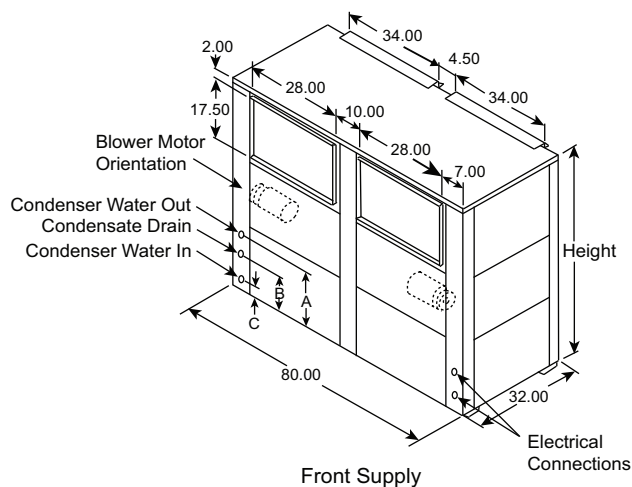
An optional (reverse) blower orientation is available for applications where the ductwork orientation is opposite of the standard unit fan discharge. The blower location remains the same (top or front). See dimensional drawings for details.

50BVJ 020-034

Front Return



Rear Return



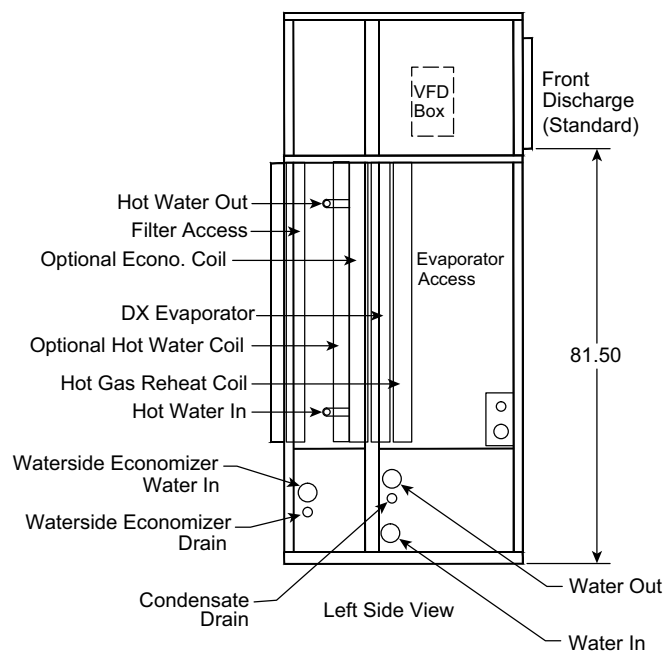
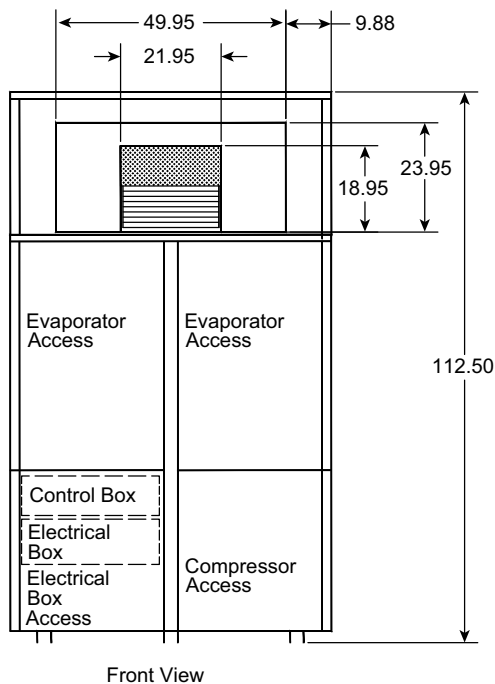
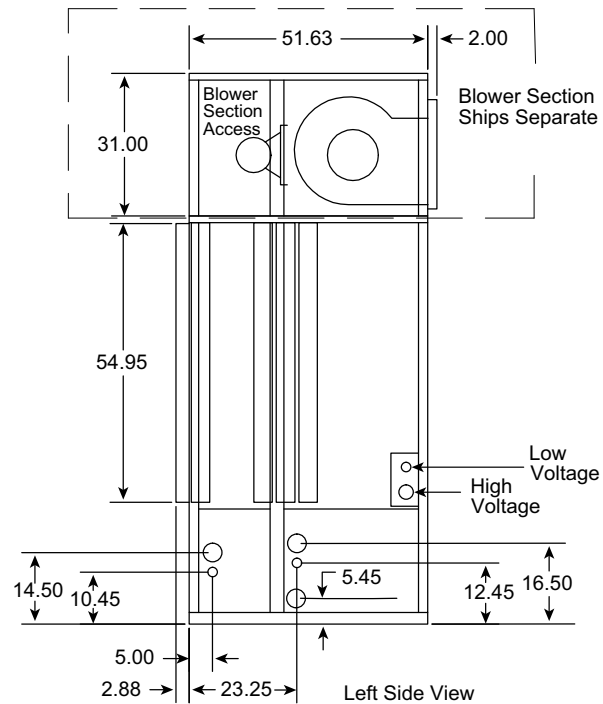
UNIT SIZE 50BVJ	HEIGHT	WIDTH	DEPTH*	CONDENSER WATER CONNECTIONS				DUCT FLANGE	FILTER RACK	REPLACEMENT FILTER SIZE (NOMINAL)
				A	B	C	Diameter (FPT)	D	E	
020	62.00	80.00	32.00	18.00	8.75	2.75	2	38.00	40.00	20 x 34-1/2 x 1 (4 per unit)
024	66.50	80.00	32.00	18.00	8.75	2.75	2	38.00	40.00	
028	66.50	80.00	32.00	18.00	8.75	2.75	2	38.00	40.00	
034	86.50	80.00	32.00	17.00	9.00	3.50	2	58.00	60.00	30 x 34-1/2 x 1 (4 per unit, size 034 only)

* When WSHP Open Controller is installed increase depth by 3.00 inches.

NOTES:

1. All dimensions in inches unless otherwise noted. All dimensions within ± 0.125 in. Specifications subject to change without notice. Condensate connections are 1.25 in. FPT on sizes 020 through 034.
2. Front of unit is side with water and electrical connections.

Diagram illustrating the Rear View of the Blower Section. The overall width is 69.50. The Blower Section Access is located at the top. The Blower Section Ships Separate. The Compressor Access is located at the bottom. The Rear View Return Air View is indicated at the bottom. A Lifting Support Rail is shown at the bottom right, with a dimension of 1.50.

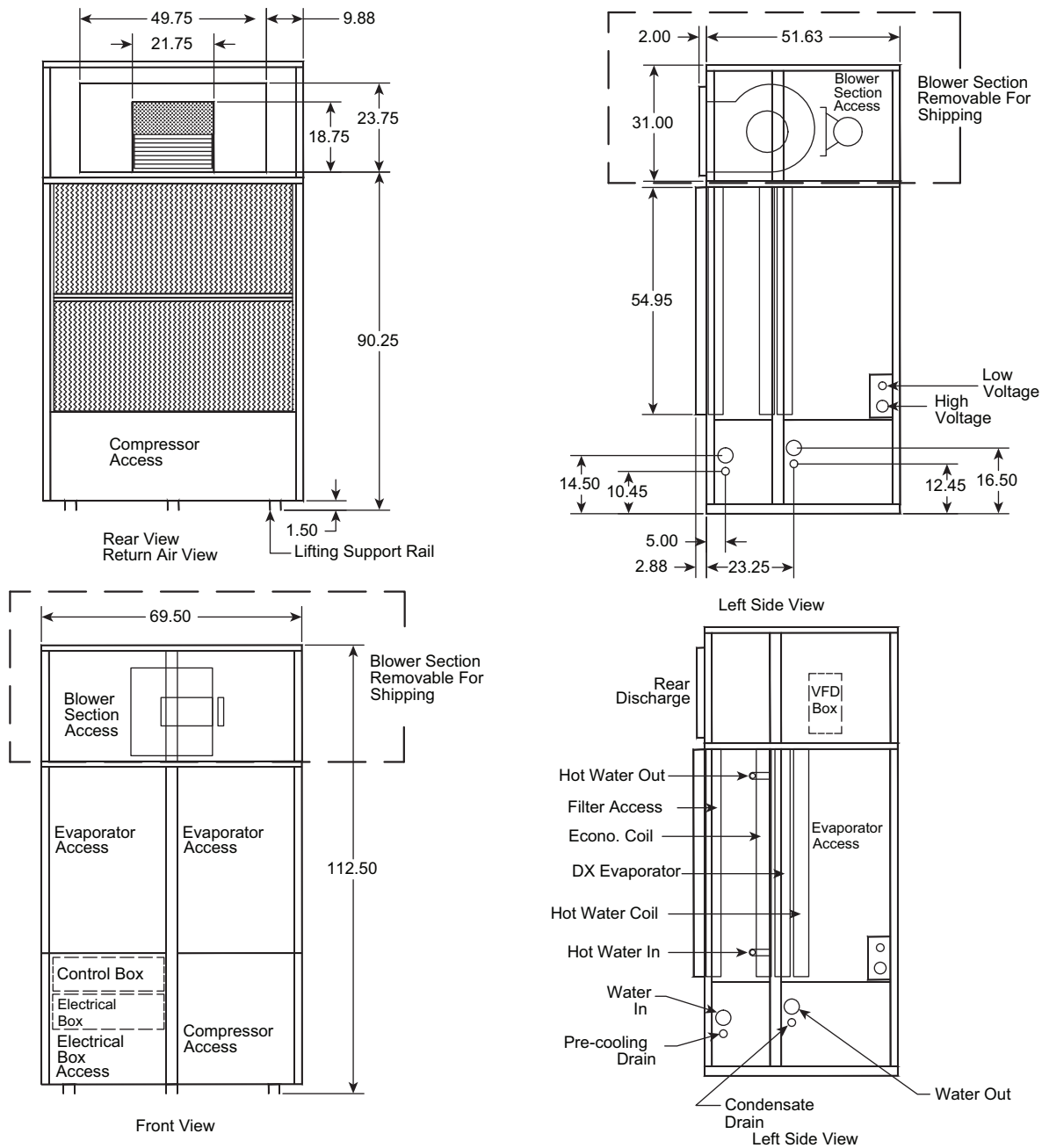


H ₂ O In*	2.5
H ₂ O Out*	2.5
Condensate*	0.75
Economizer Condensate	1.25
HW In/Out Sweat Connection	1.38

Nominal	Quantity
17 x 27 x 4	8

1. Optional hot water coil connections may add up to 3 in. on both the left and right side of the unit increasing the unit width an additional 6 in.
2. Dimensions in inches.
3. Recommended minimum service clearances are as follows:
 - a. Front and rear — 36 in.
 - b. Left of right side — 65 in. for coil removal
 - c. Side opposite coil removal — 36 in.
4. For all other airflow configuration drawings see SCUBuilder program.
5. Dimensions Include Base Rail Height (1.5 in.).

50BVT,W,V 034 High Boy Rear Return, Rear Supply (With or Without Waterside Economizer or Hot Water Coil)



Water Connections

H ₂ O In*	2.5
H ₂ O Out*	2.5
Condensate	1.25
Pre-Cooling Drain*	1.25
HW In/Out	1.38

*F.P.T. Type Connection

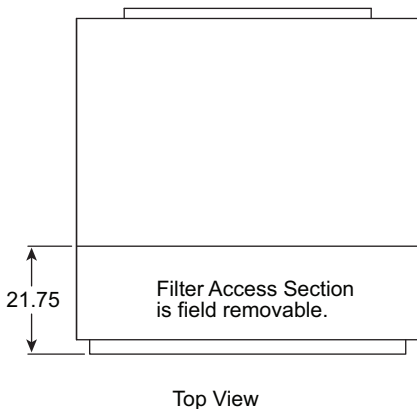
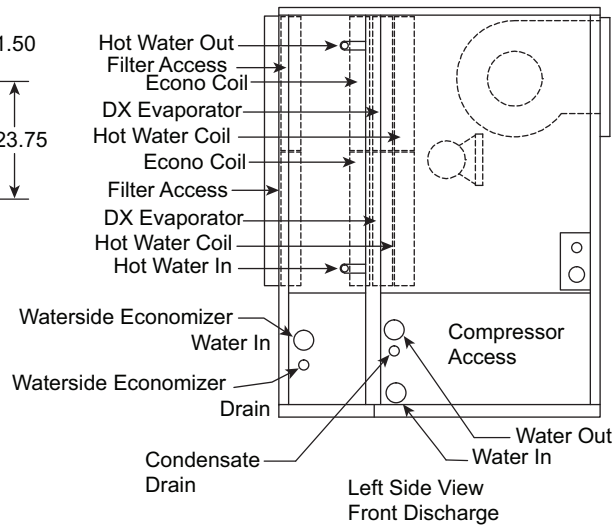
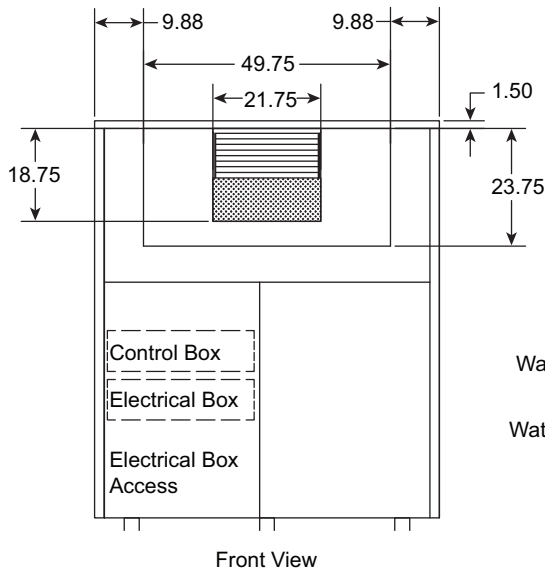
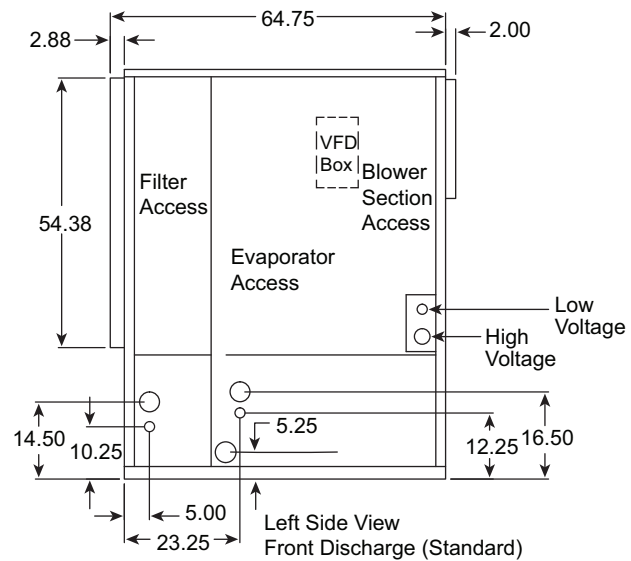
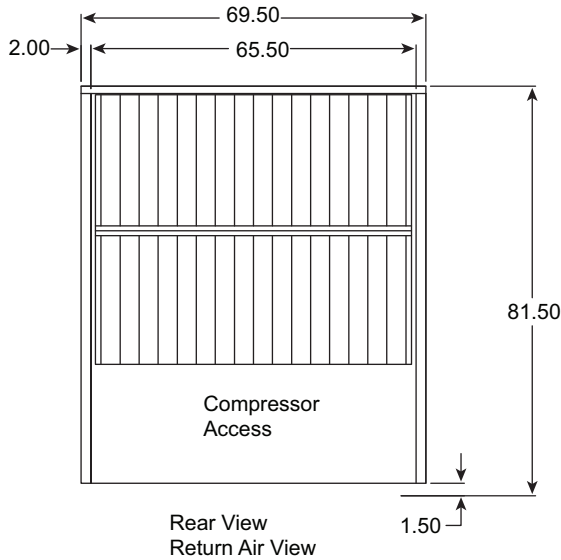
Filters

Nominal	Quantity
17 x 27 x 4	8

NOTES:

- Optional hot water coil connections may add up to 3 in. on both the left and right side of the unit increasing the unit width an additional 6 in.
- Dimensions in inches.
- Recommended minimum service clearances are as follows:
 - Front and rear — 36 in.
 - Left of right side — 65 in. for coil removal
 - Side opposite coil removal — 36 in.
- For all other airflow configuration drawings see SCUBuilder program.
- Dimensions include base rail height (1.5 in.).

50BVT,W,V 034 Low Boy Rear Return, Front Supply (With or Without Waterside Economizer or Hot Water Coil)



Filters**		
Nominal	Actual	Quantity
17 x 27	16.5 x 26.50	8

**4 in. thick

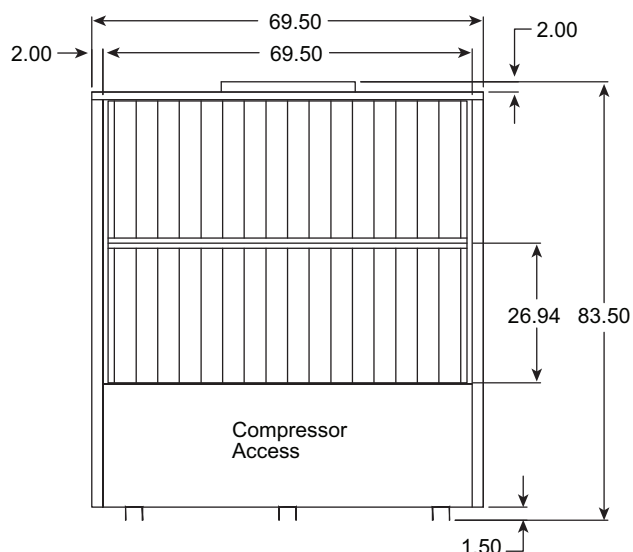
Water Connections	
H ₂ O In*	2.5
H ₂ O Out*	2.5
Condensate*	0.75
Pre-Cooling Drain	1.25
HW In/Out Sweat Connection	1.38

*F.P.T. Type Connection

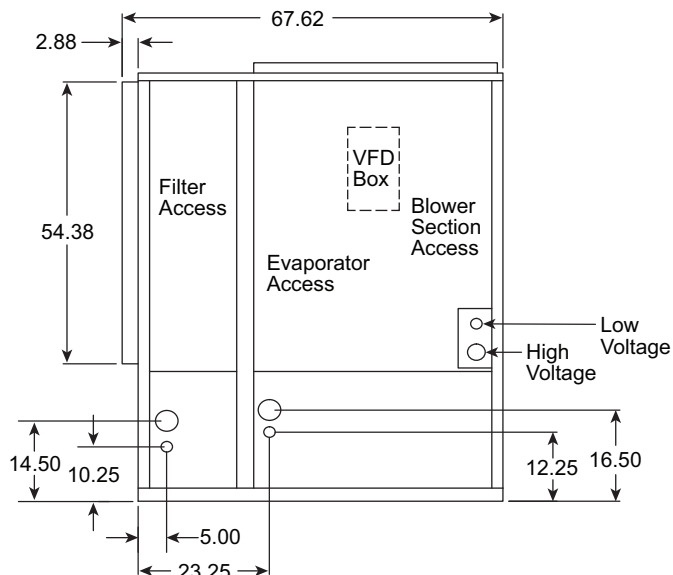
NOTES:

1. Dimensions in inches.
2. Recommended minimum service clearances are as follows:
 - a. Front and rear — 36 in.
 - b. Left and right side — 65 in. for coil removal
 - c. Side opposite coil removal — 36 in.
3. For all other airflow configuration drawings see SCUBuilder program.
4. Dimensions include base rail height (1.5 in.).

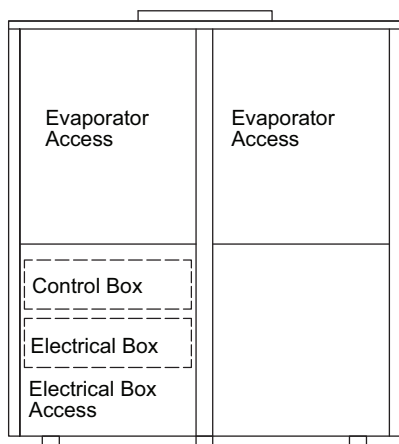
50BVT,W,V 034 Low Boy Rear Return, Top Supply (With or Without Waterside Economizer or Hot Water Coil)



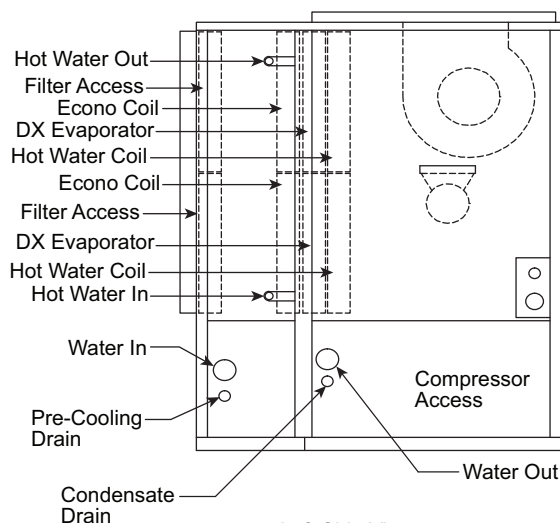
Rear View
Return Air View



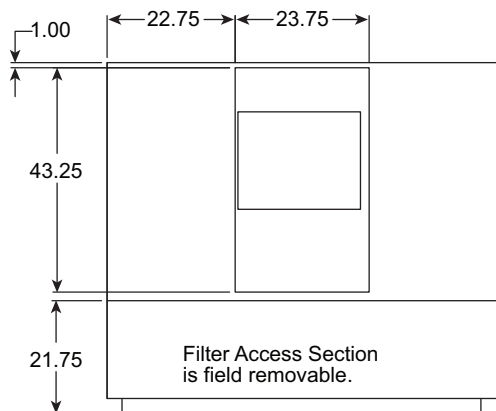
Left Side View
Top Discharge



Front View



Left Side View
Top Discharge



Top View
Top Discharge

Water Connections

H2O In*	2.5
H2O Out*	2.5
Condensate*	1.25
Pre-Cooling Drain*	1.25
HW In/Out	1.38

*F.P.T. Type Connection

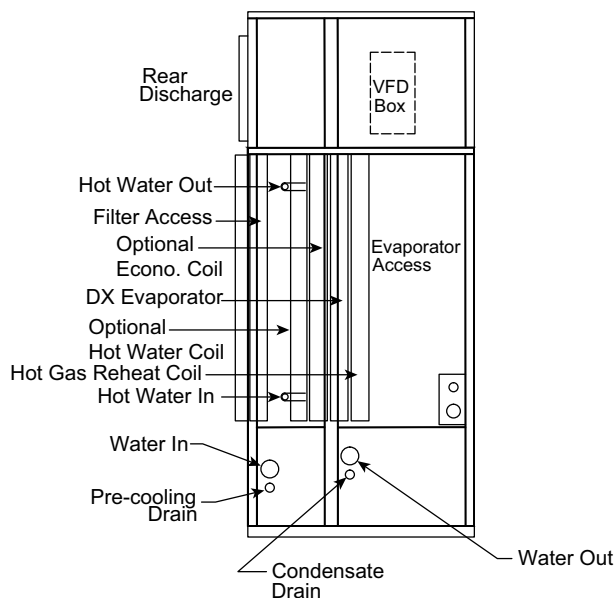
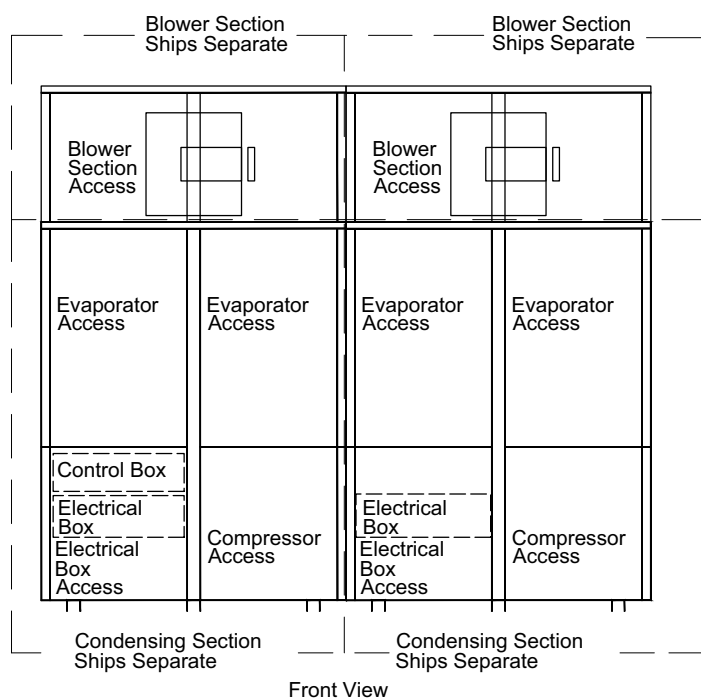
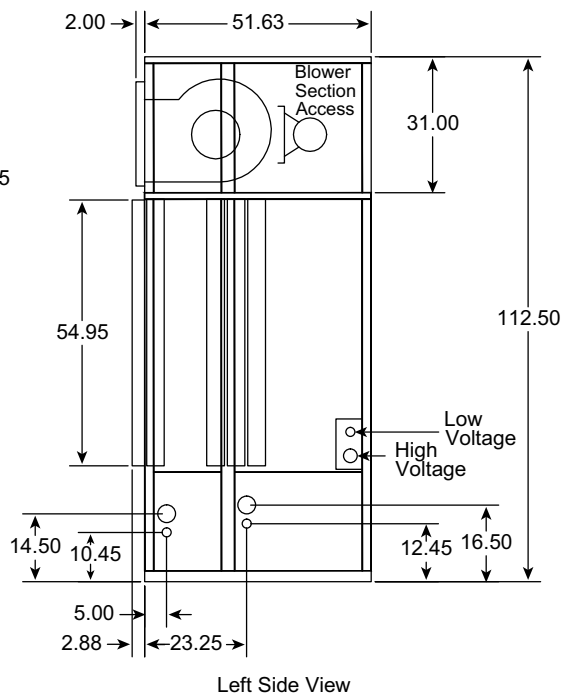
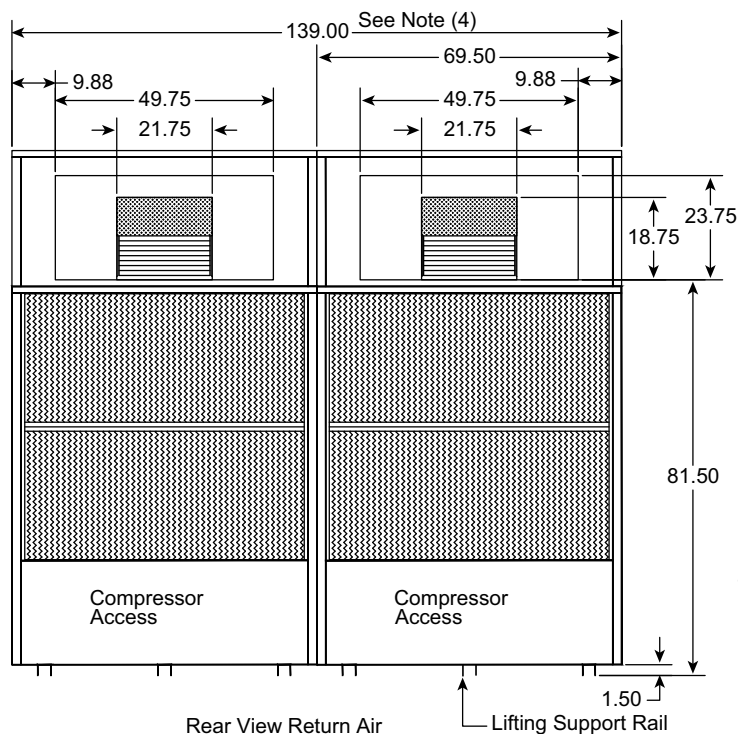
NOTES:

1. Dimensions in inches.
2. Recommended minimum service clearances are as follows:
 - a. Front and rear — 36 in.
 - b. Left and right side — 65 in. for coil removal
 - c. Side opposite coil removal — 36 in.
3. For all other airflow configuration drawings see SCUBuilder program.
4. Dimensions include base rail height (1.5 in.).

Filters

Nominal	Actual	Quantity
17 x 27	16.5 x 26.50	8

50BVT,W,V044-064 High Boy Rear Return, Rear Supply (With or Without Waterside Economizer and Hot Water Coil)



Water Connections			
Model	44	54	64
H ₂ O In*	2.5	3.0	3.0
H ₂ O Out*	2.5	3.0	3.0
Condensate*	0.75	0.75	0.75
Economizer	1.25	1.25	1.25
HW In/Out Sweat Connction	1.38	1.38	1.38

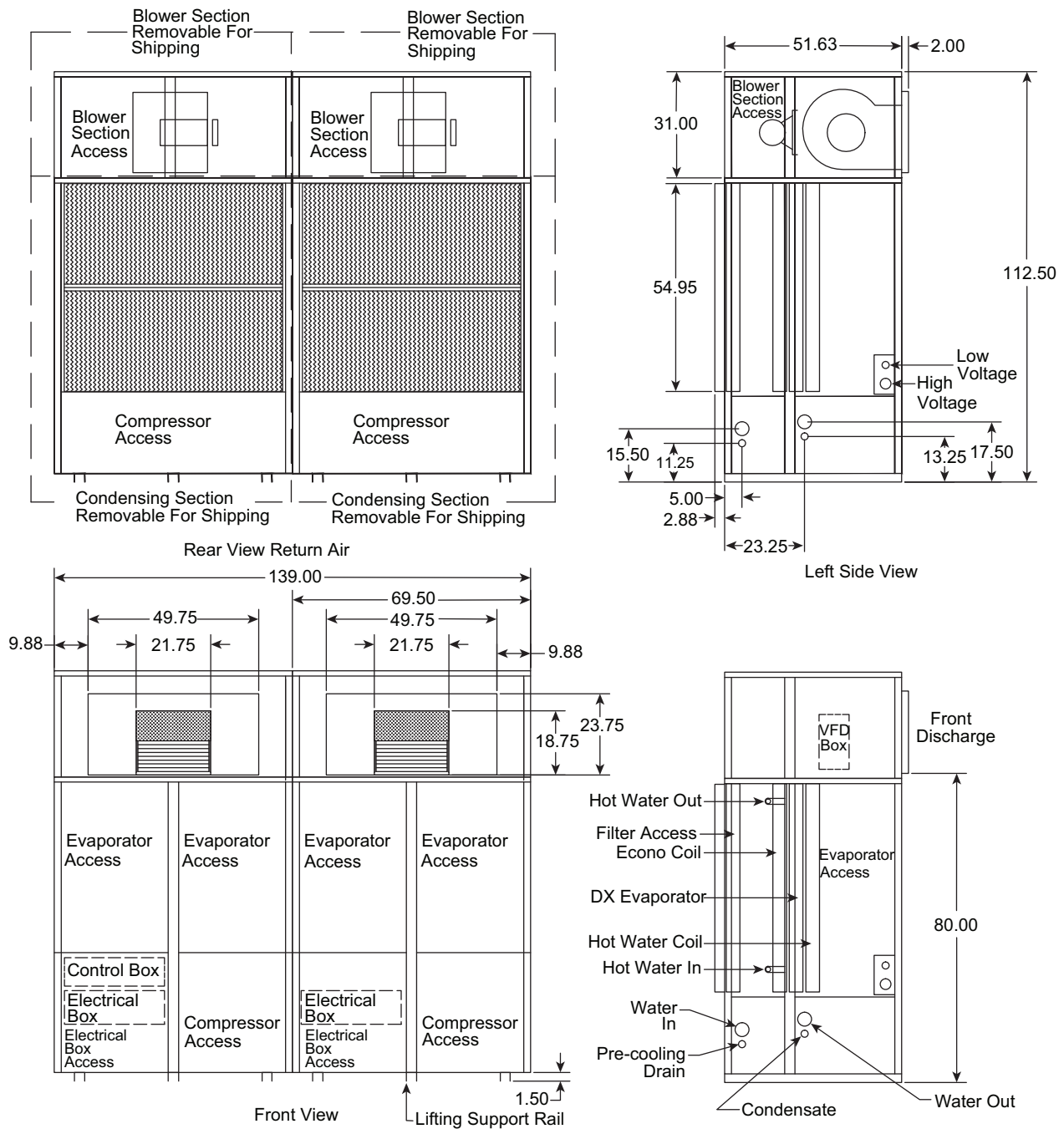
*F.P.T. Type Connection

Filters		
Nominal	Actual	Quantity
17 x 27 x 4	16.5 x 29.75 x 4	16

NOTES:

- Dimensions in inches.
- Recommended minimum service clearances are as follows:
 - Front and rear — 36 in.
 - Left or right side — 65 in. for coil removal
- For all other airflow configuration drawings see SCUBuilder program.
- Dimensions include base rail height (1.5 in.).

50BVT,W,V 044-064 High Boy Rear Return, Front Supply (With or Without Waterside Economizer or Hot Water Coil)

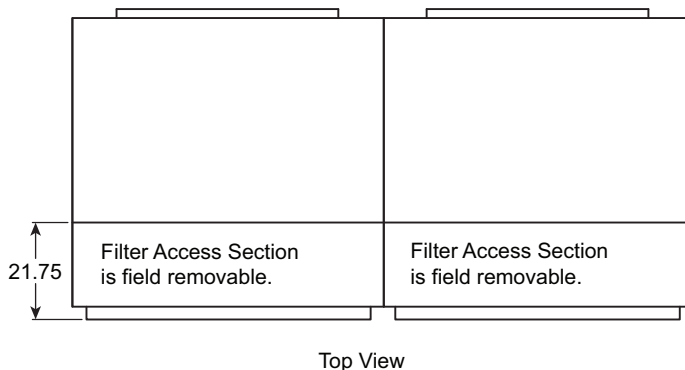
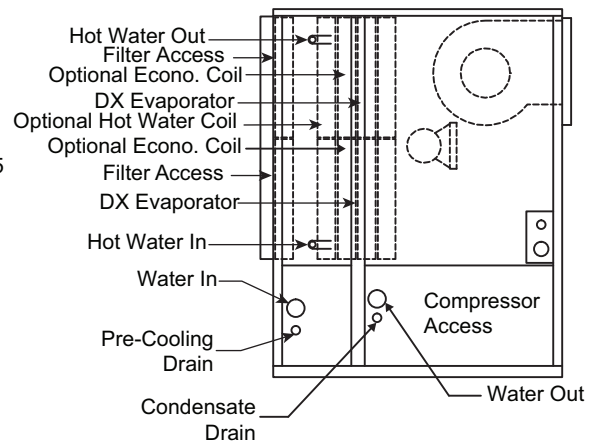
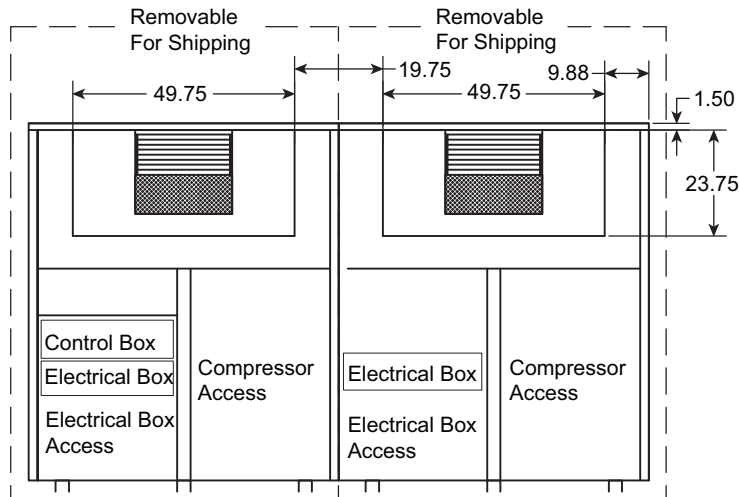
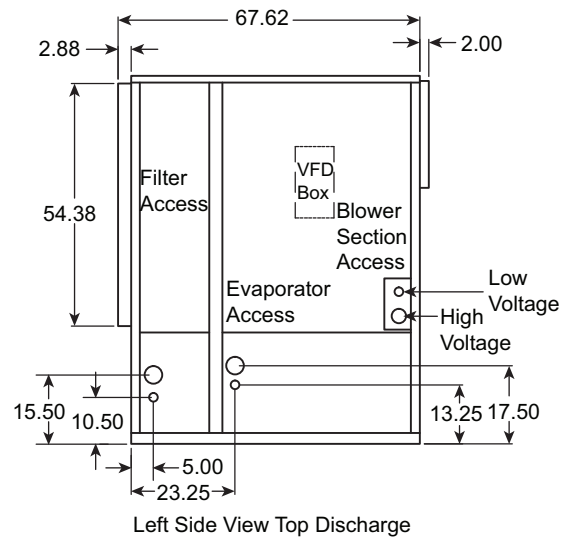
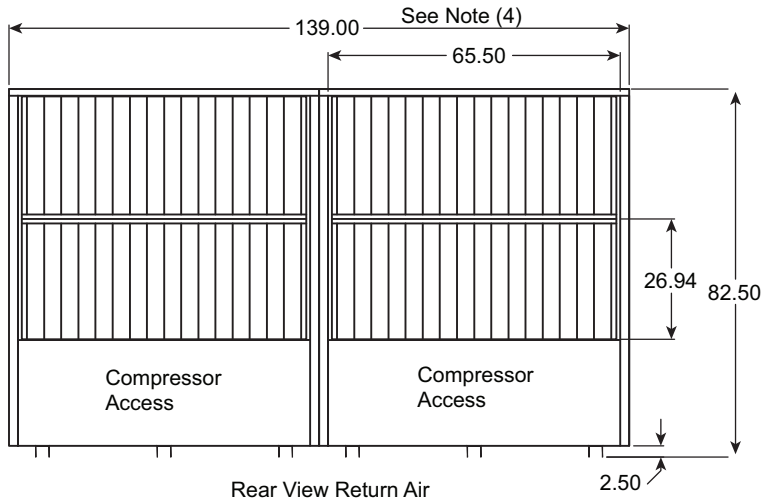


Water Connections	
Model	360
H2O In*	2.5
H2O Out*	2.5
Condensate	1.25
Pre-Cooling Drain	1.25
HW In/Out	1.38

Filters		
Nominal	Actual	Quantity
17 x 27 x 4	16.5 x 29.75 x 4	16

*F.P.T. Type Connection

50BVT,W,V 044-064 Low Boy Rear Return, Front Supply (With or Without Waterside Economizer and Hot Water Coil)



Filters		
Nominal	Actual	Quantity
17 x 27 x 4	16.5 x 29.75 x 4	16

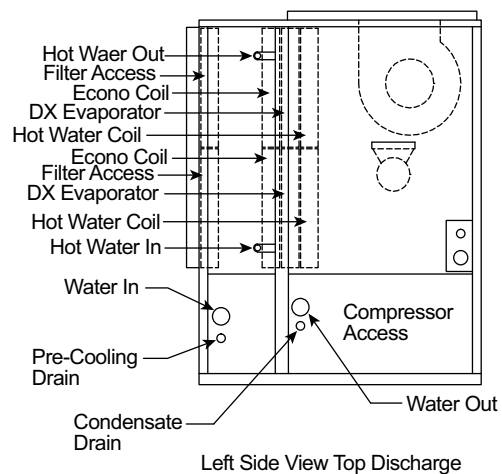
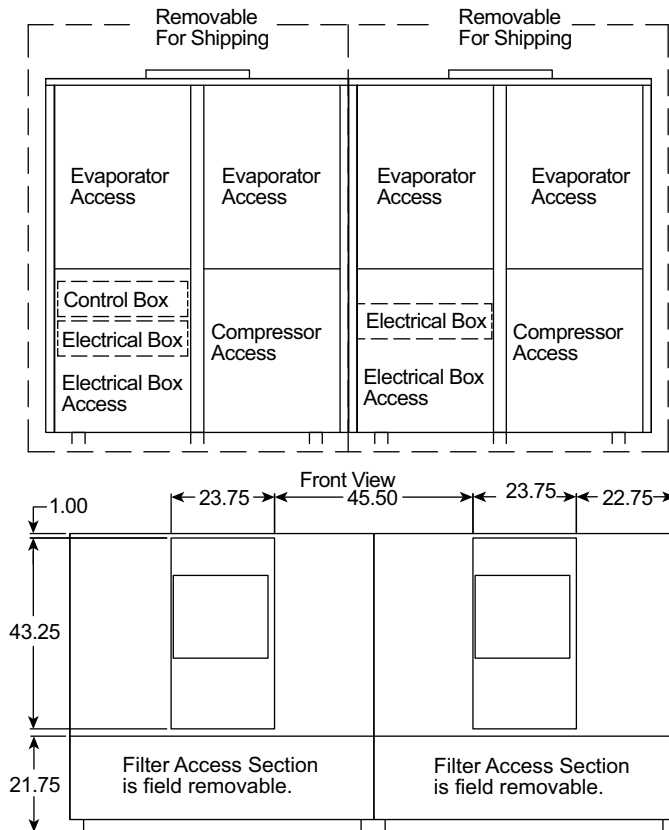
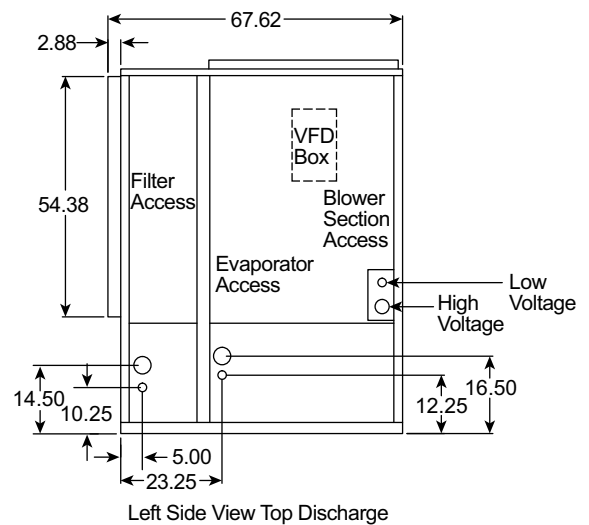
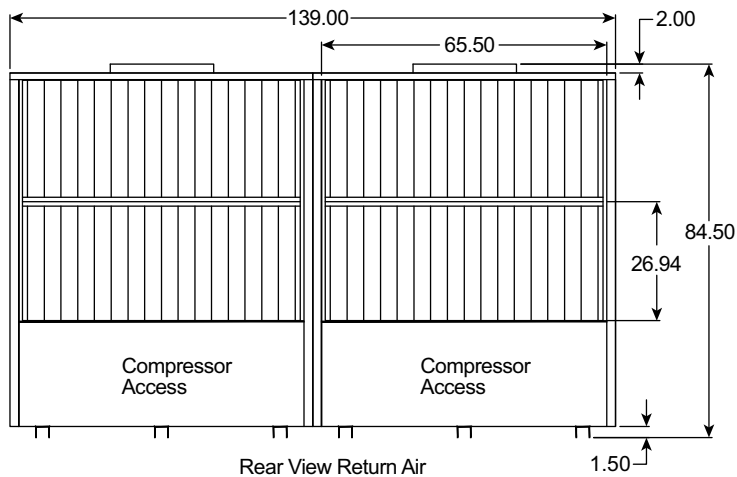
Water Connections			
Model	44	54	64
H2O In*	2.5	3.0	3.0
H2O Out*	2.5	3.0	3.0
Condensate*	1.25	1.25	1.25
Pre-Cooling Drain*	1.25	1.25	1.25
HW In/Out Sweat Connection	1.38	1.38	1.38

*F.P.T. Type Connection

NOTES:

1. Dimensions in inches.
2. Recommended minimum service clearances are as follows:
 - a. Front and rear - 30 in.
 - b. Left or right side - 65 in. for coil removal
3. For all other airflow configuration drawings, see SCUBuilder program.
4. Dimensions include base rail height (1.5 in.).

50BVT,W,V 044-064 Low Boy Rear Return, Top Supply (With or Without Waterside Economizer and Hot Water Coil)



Top View (Top Discharge)

Left Side View Top Discharge

Water Connections			
Model	44	54	64
H ₂ O In*	2.5	3.0	3.0
H ₂ O Out*	2.5	3.0	3.0
Condensate*	0.75	0.75	0.75
Pre-Cooling Drain*	1.25	1.25	1.25
HW In/Out Sweat Connection	1.38	1.38	1.38

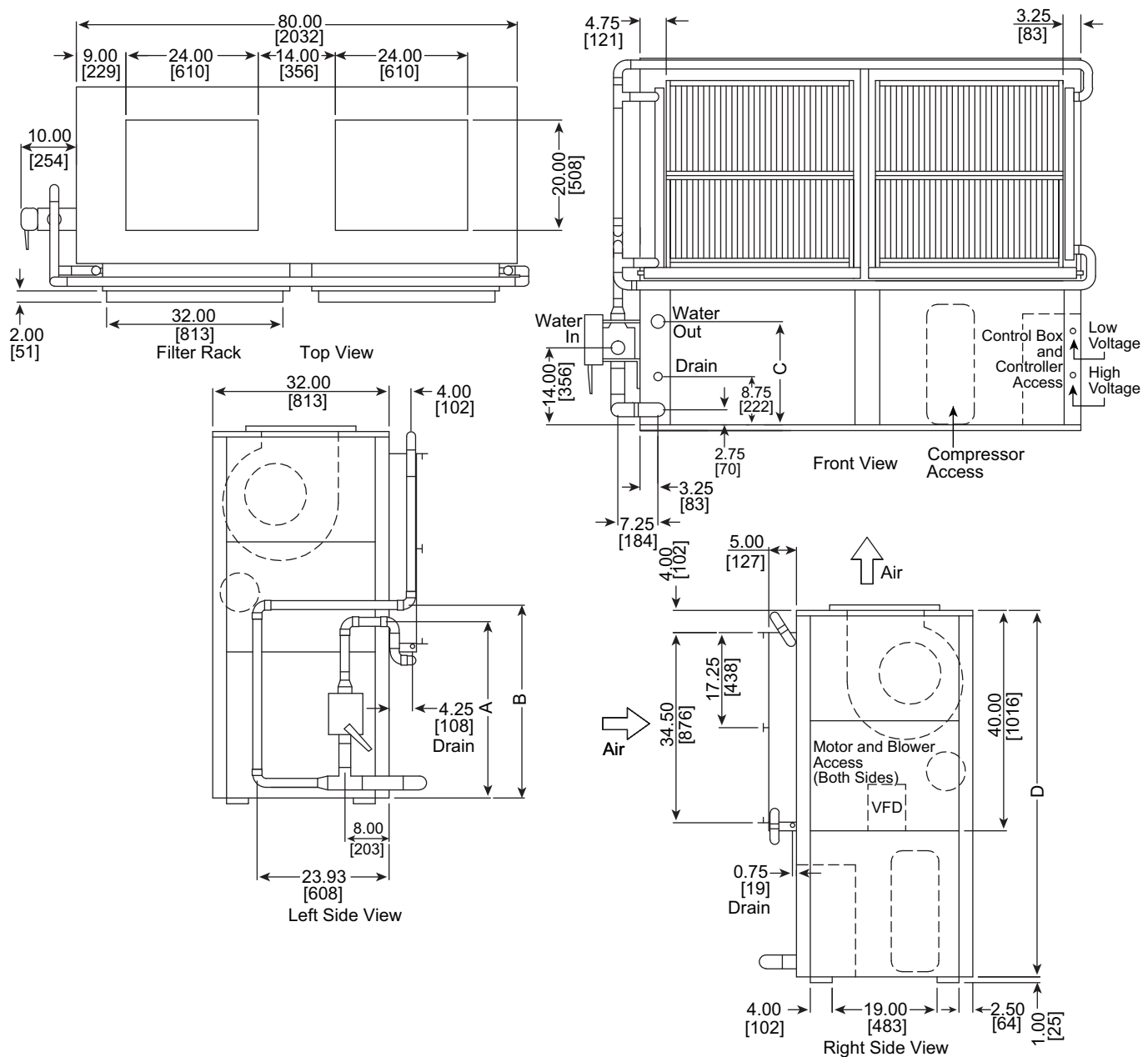
*F.P.T. Type Connection

Filters		
Nominal	Actual	Quantity
17 x 27	16.5 x 29.75	16

NOTES:

- Dimensions in inches.
- Recommended minimum service clearances are as follows:
 - Front and rear — 36 in.
 - Left or right side — 65 in. for coil removal
 - Side opposite coil removal — 36 in.
- For all other airflow configuration drawings see SCUBuilder program.
- Dimensions include base rail height (1.5 in.).

BVJ 020-028 Front Return, Top Supply (With Optional Waterside Economizer)

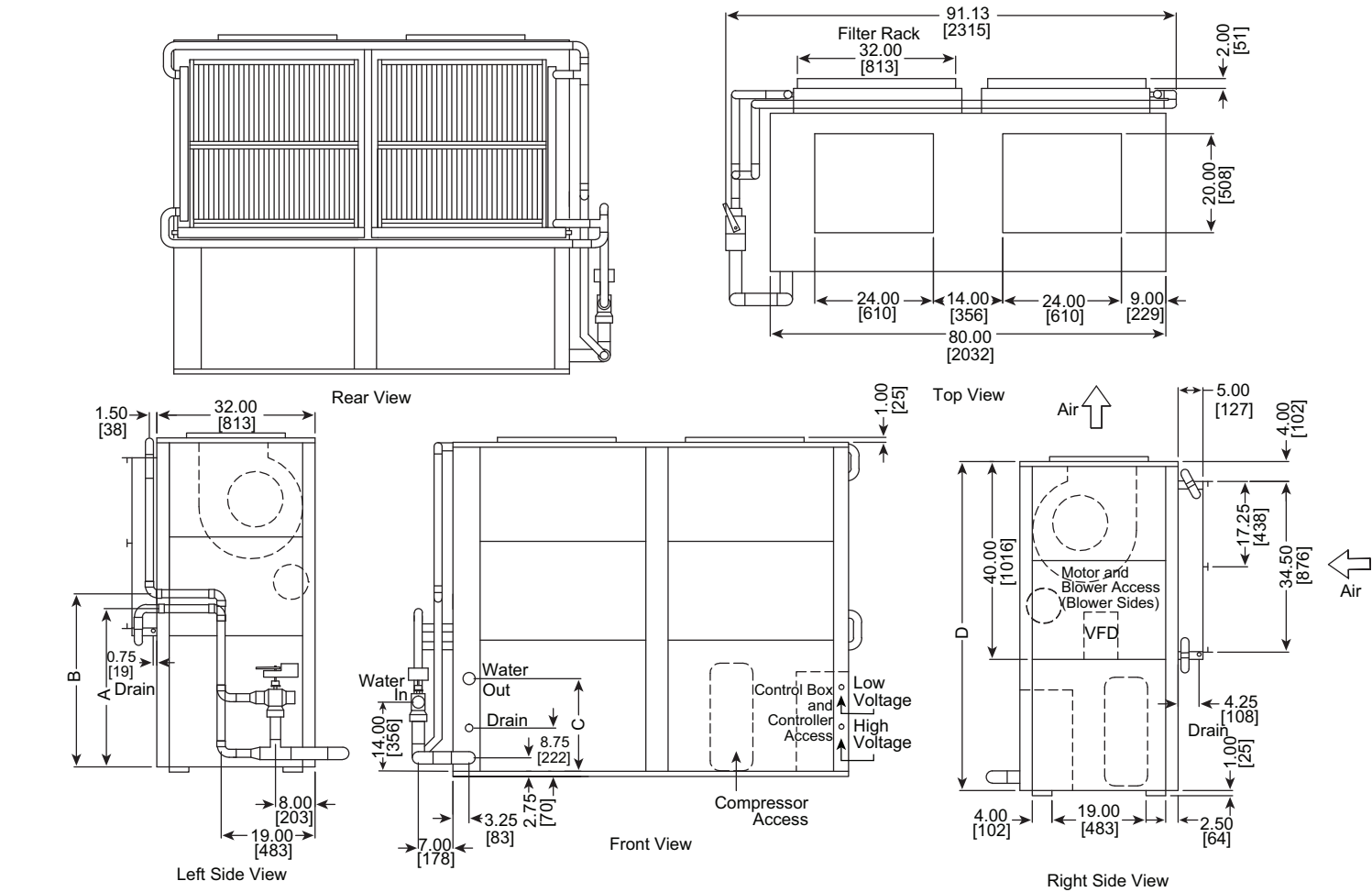


Size	020	024	028
Filter Qty. and Size	(4) 17 X 34-1/2 X 1"	(4) 17x 34-1/2 X 1"	(4) 17x 34-1/2 X 1"
Condensate Conn.	1-1/4" FPT	1-1/4" FPT	1-1/4" FPT
Water Conn.	2" FPT	2" FPT	2" FPT
D	62"	66.5"	66.5"
C	17.5"	18.75"	18.75"
B	31"	35"	35"
A	28"	32"	32"

NOTES:

1. Dimensions in inches [mm].
2. Refer to base unit certified drawing for additional unit dimensions, service clearance, and alternate airflow configurations.
3. For all other airflow configuration drawings see SCUBuilder program.
4. 50BVJ are Rear Return, Top Supply only.

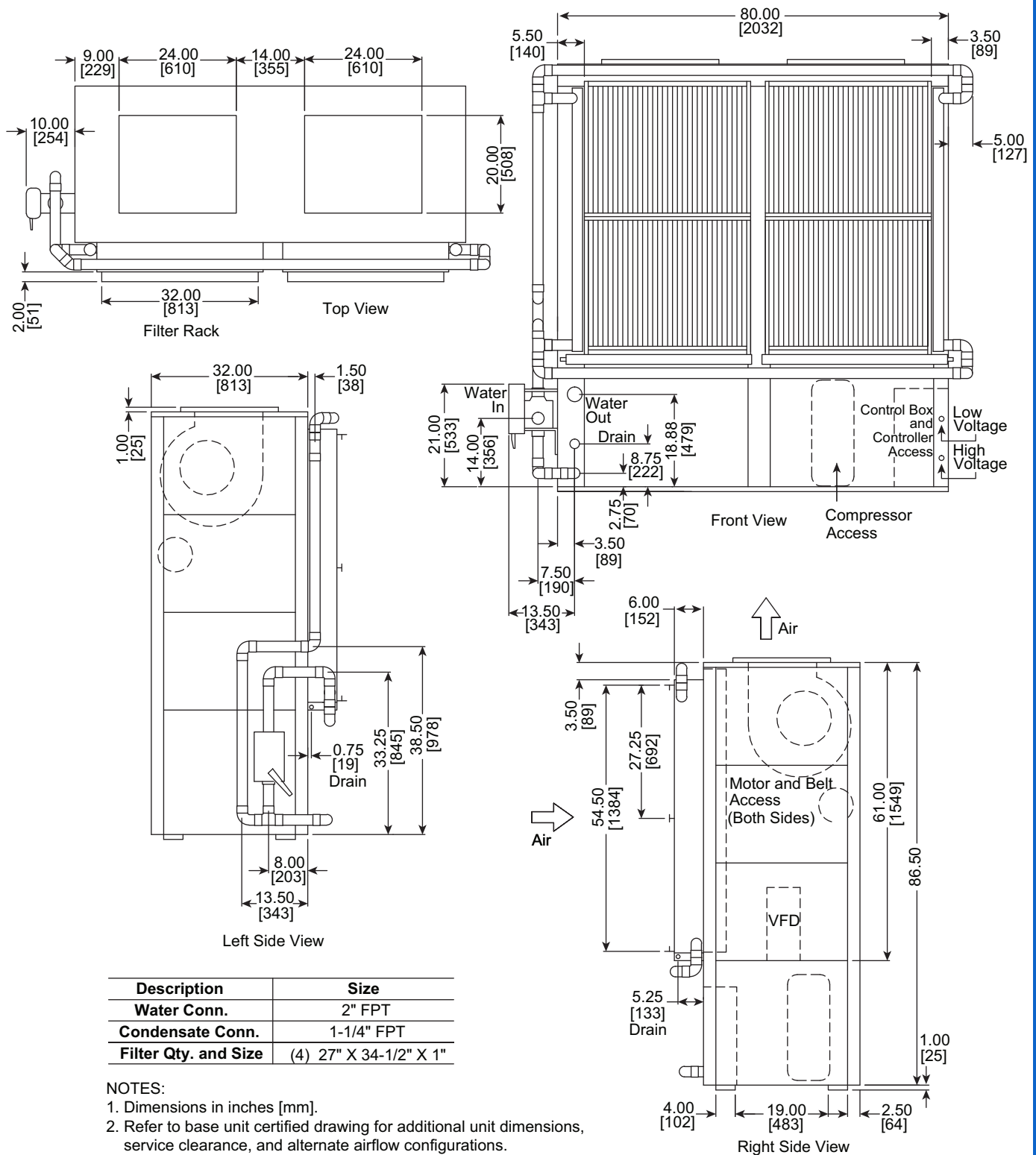
50BVJ 020-028 Rear Return, Top Supply
(With Optional Waterside Economizer)



Size	020	024	028
Filter Qty. and Size	(4) 17 X 34-1/2 X 1"	(4) 17x 34-1/2 X 1"	(4) 17x 34-1/2 X 1"
Condensate Conn.	1-1/4" FPT	1-1/4" FPT	1-1/4" FPT
Water Conn.	2" FPT	2" FPT	2" FPT
D	62"	66.5"	66.5"
C	17.5"	18.75"	18.75"
B	31"	32"	32"
A	28"	32"	32"

- NOTES:
1. Dimensions in inches [mm].
 2. Refer to base unit certified drawing for additional unit dimensions, service clearance, and alternate airflow configurations.
 3. For all other airflow configurations drawings see SCUBuilder program.

50BVJ 034 Front Return Top Supply (With Optional Waterside Economizer)

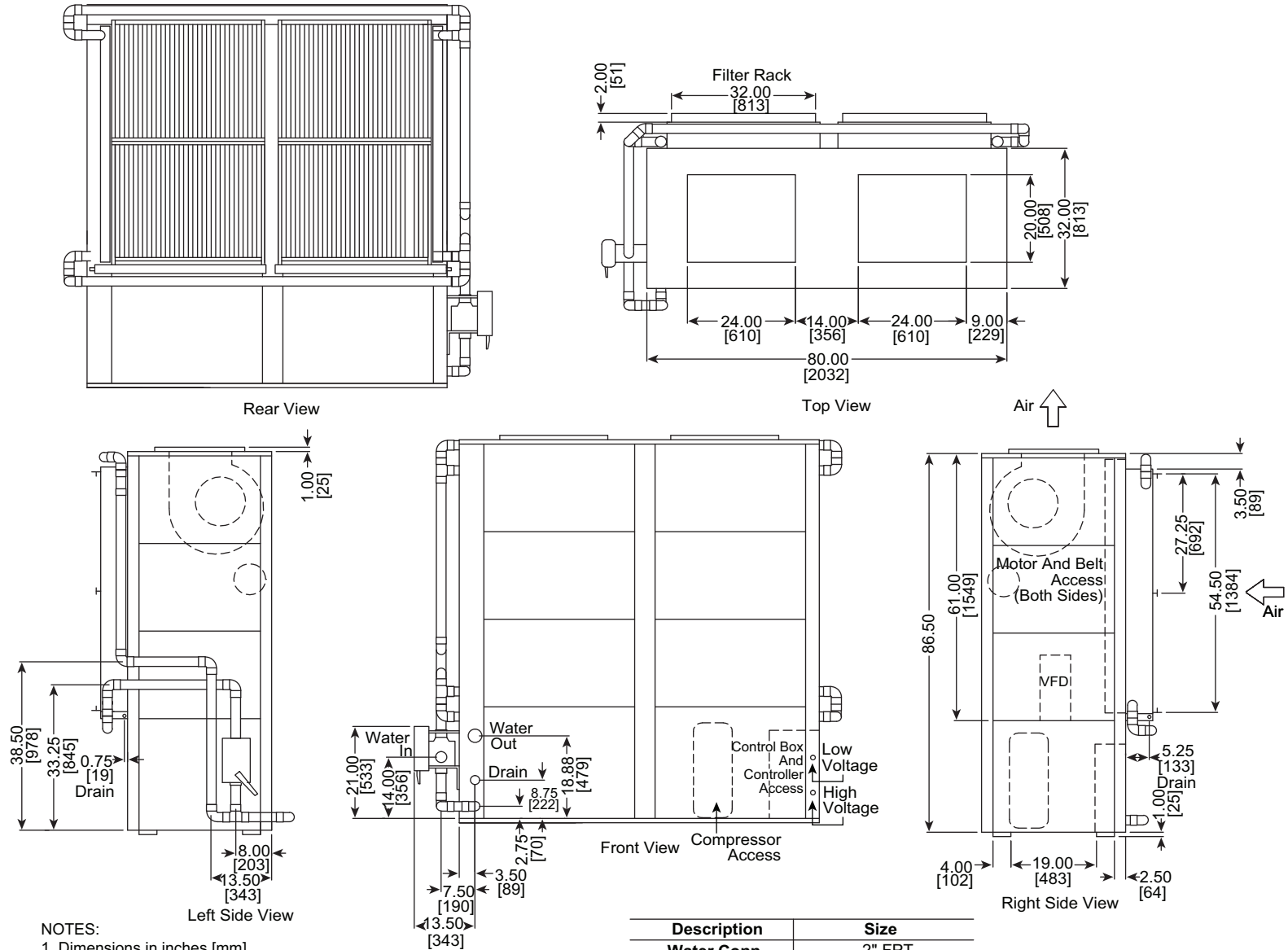


Description	Size
Water Conn.	2" FPT
Condensate Conn.	1-1/4" FPT
Filter Qty. and Size	(4) 27" X 34-1/2" X 1"

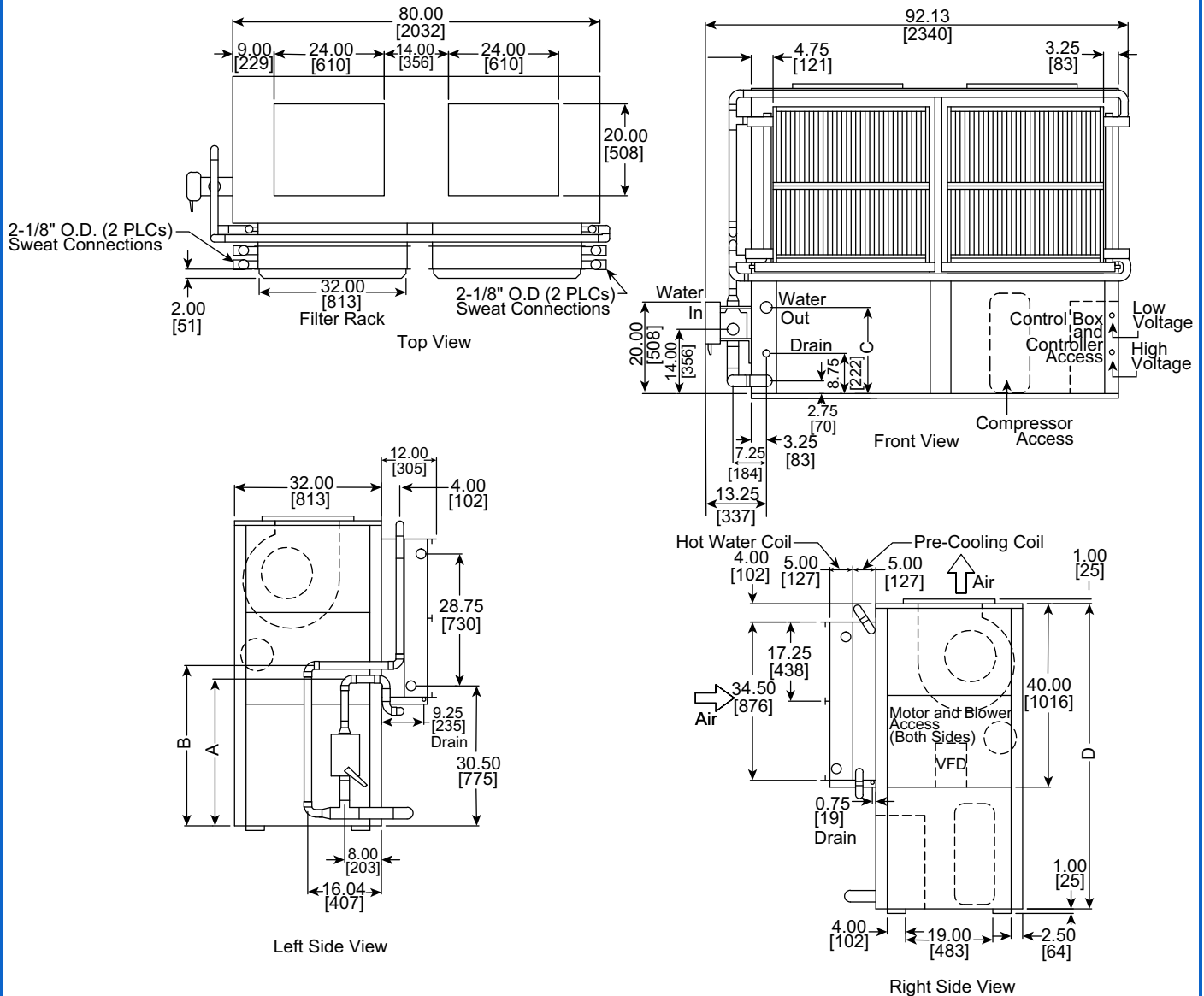
NOTES:

1. Dimensions in inches [mm].
2. Refer to base unit certified drawing for additional unit dimensions, service clearance, and alternate airflow configurations.
3. For all other airflow configuration drawings see SCUBuilder program.

50BVJ 034 Rear Return Top Supply (With Optional Waterside Economizer)



50BVJ 020-028 Front Return, Top Supply With (Waterside Economizer and Hot Water Coil)

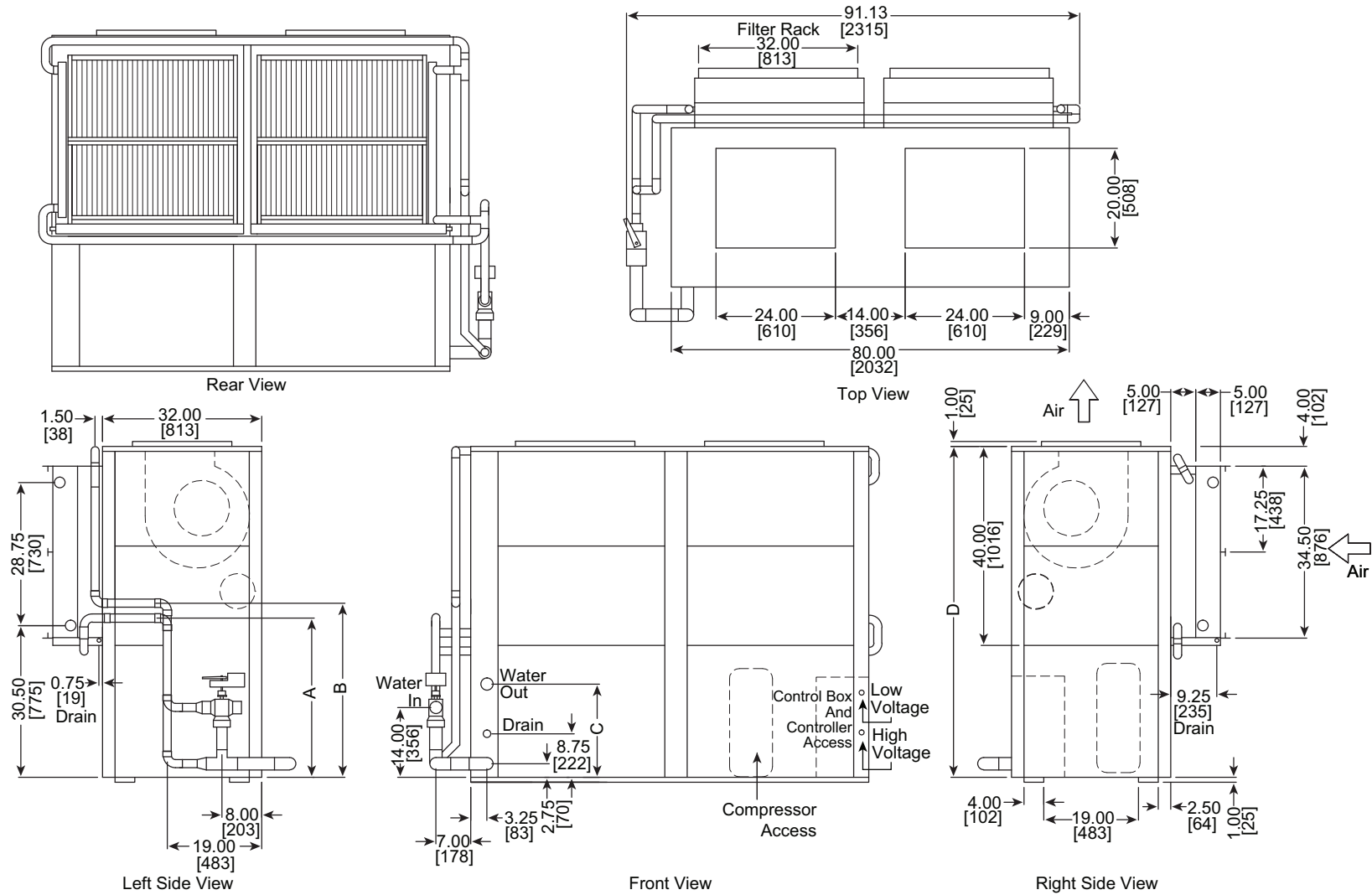


Size	020	024	028
Hot Water Coil Conn.	(4) 2-1/8" O.D.	(4) 2-1/8" O.D.	(4) 2-1/8" O.D.
Filter Qty. and Size	(4) 17 X 34-1/2 X 1"	(4) 17x 34-1/2 X 1"	(4) 17x 34-1/2 X 1"
Condensate Conn.	1-1/4" FPT	1-1/4" FPT	1-1/4" FPT
Water Conn.	2" FPT	2" FPT	2" FPT
D	62"	66.5"	66.5"
C	17.5"	18.75"	18.75"
B	31"	35"	35"
A	28"	32"	32"

NOTES:

1. Dimensions in inches [mm].
2. Refer to base unit certified drawing for additional unit dimensions, service clearance, and alternate airflow configurations.
3. For all other airflow configuration drawings see SCUBuilder program.

50BVJ 020-028 Rear Return, Top Supply (With Waterside Economizer and Hot Water Coil)

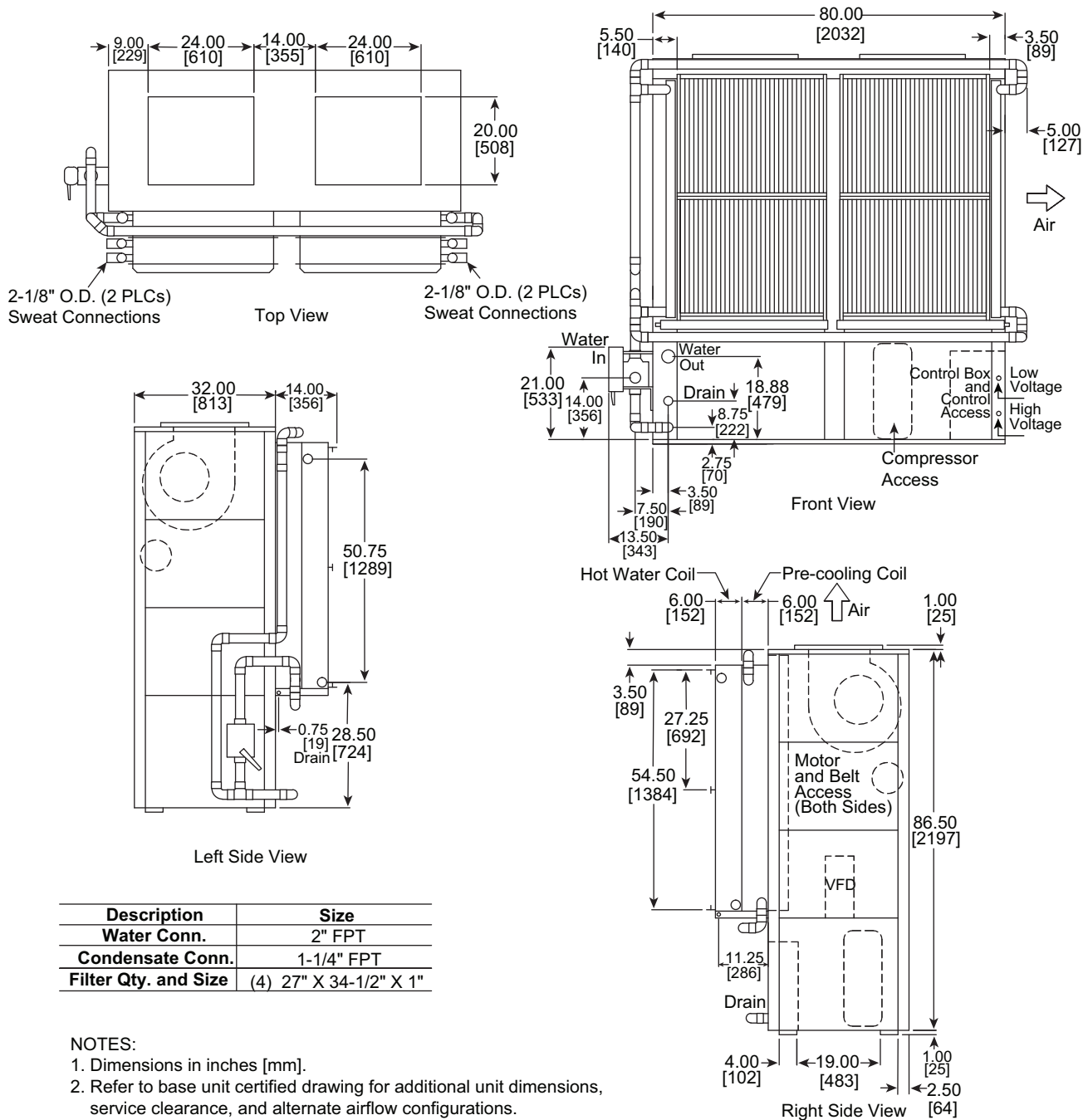


Size	020	024	028
Filter Qty. and Size	(4) 17 X 34-1/2 X 1"	(4) 17x 34-1/2 X 1"	(4) 17x 34-1/2 X 1"
Condensate Conn.	1-1/4" FPT	1-1/4" FPT	1-1/4" FPT
Water Conn.	2" FPT	2" FPT	2" FPT
D	62"	66.5"	66.5"
C	17.5"	18.75"	18.75"
B	31"	32"	32"
A	28"	32"	32"

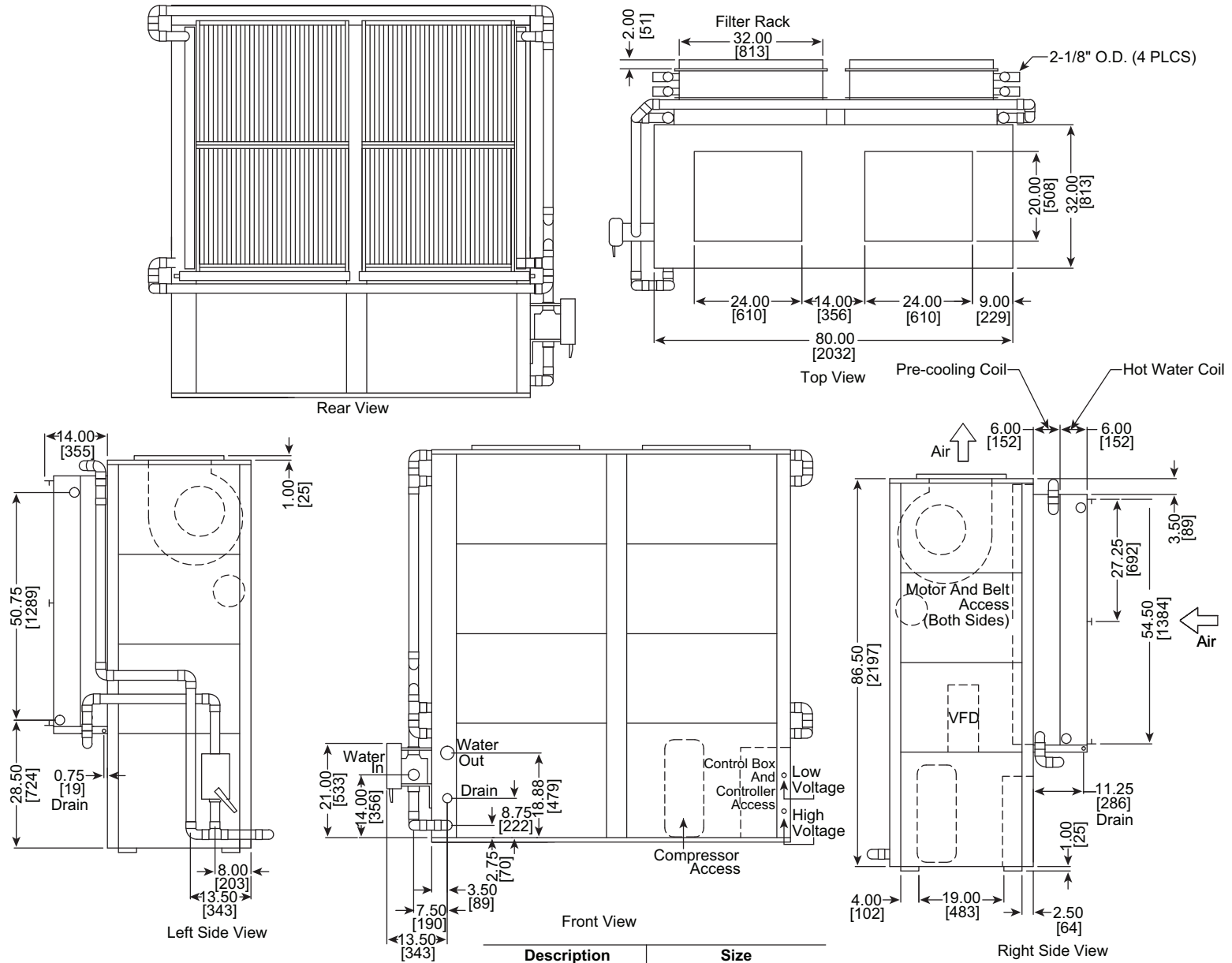
NOTES:

1. Dimensions in inches [mm].
2. Refer to base unit certified drawing for additional unit dimensions, service clearance, and alternate airflow configurations.
3. For all other airflow configurations drawings see SCUBuilder program.

50BVJ 034 Front Return, Top Supply (With Waterside Economizer and Hot Water Coil)

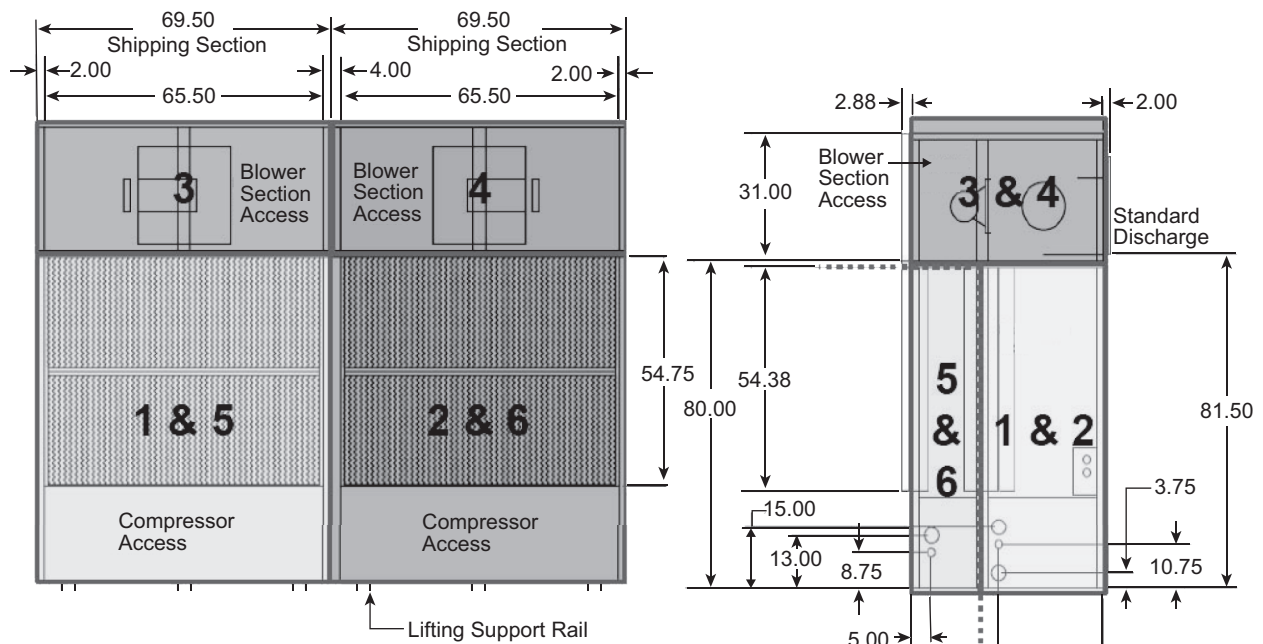
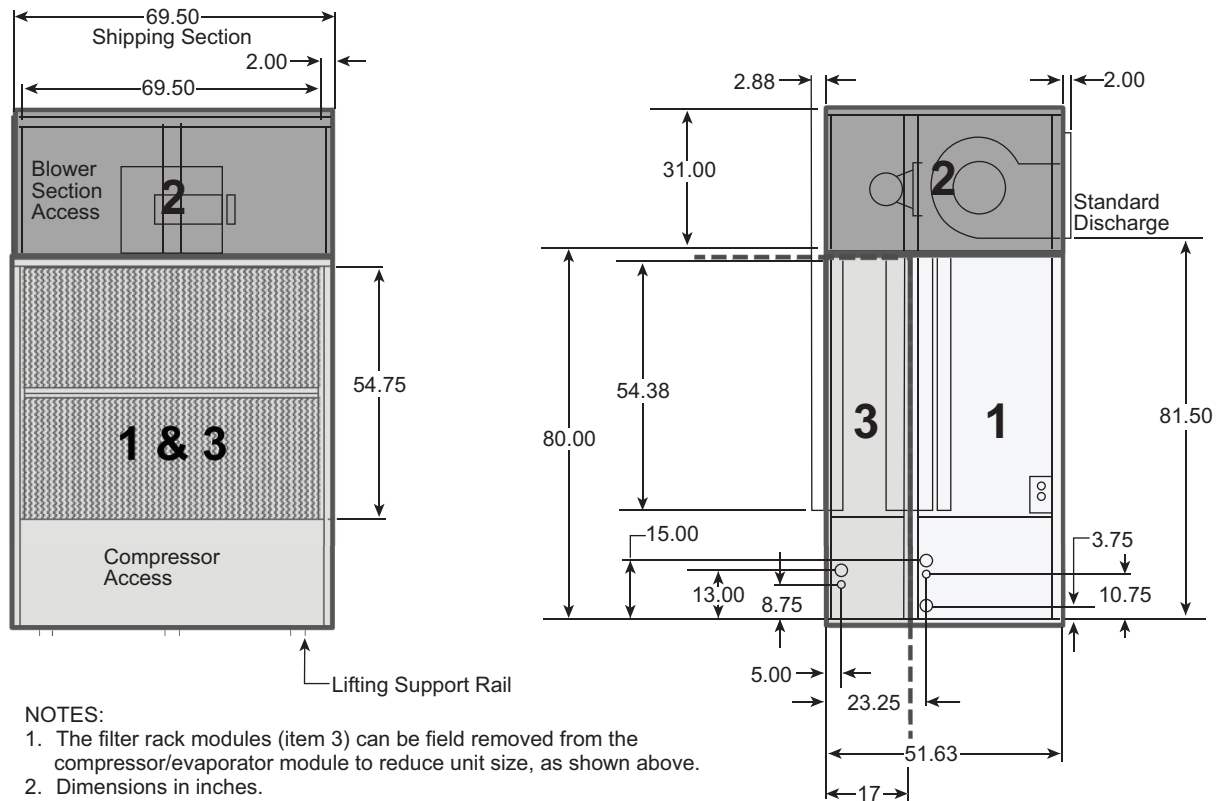


50BVJ 034 Rear Return Top Supply (With Waterside Economizer and Hot Water Coil)

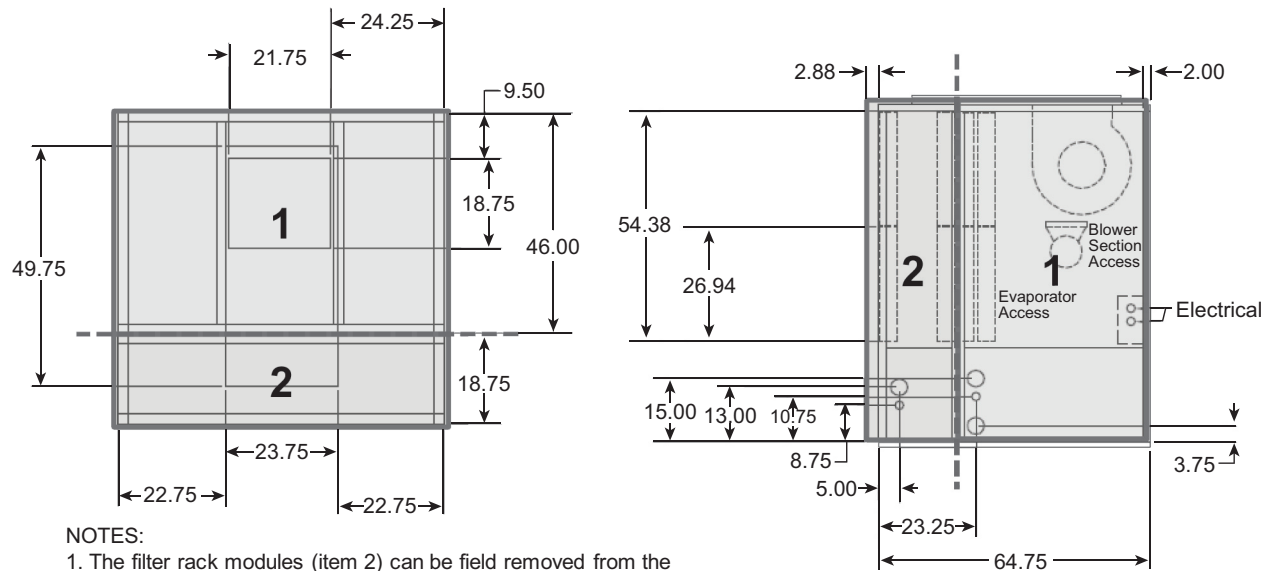


Description	Size
Water Conn.	2" FPT
Condensate Conn.	1-1/4" FPT
Filter Qty. and Size	(4) 27" X 34-1/2" X 1"

50BVT,W,V High Boy Field Split



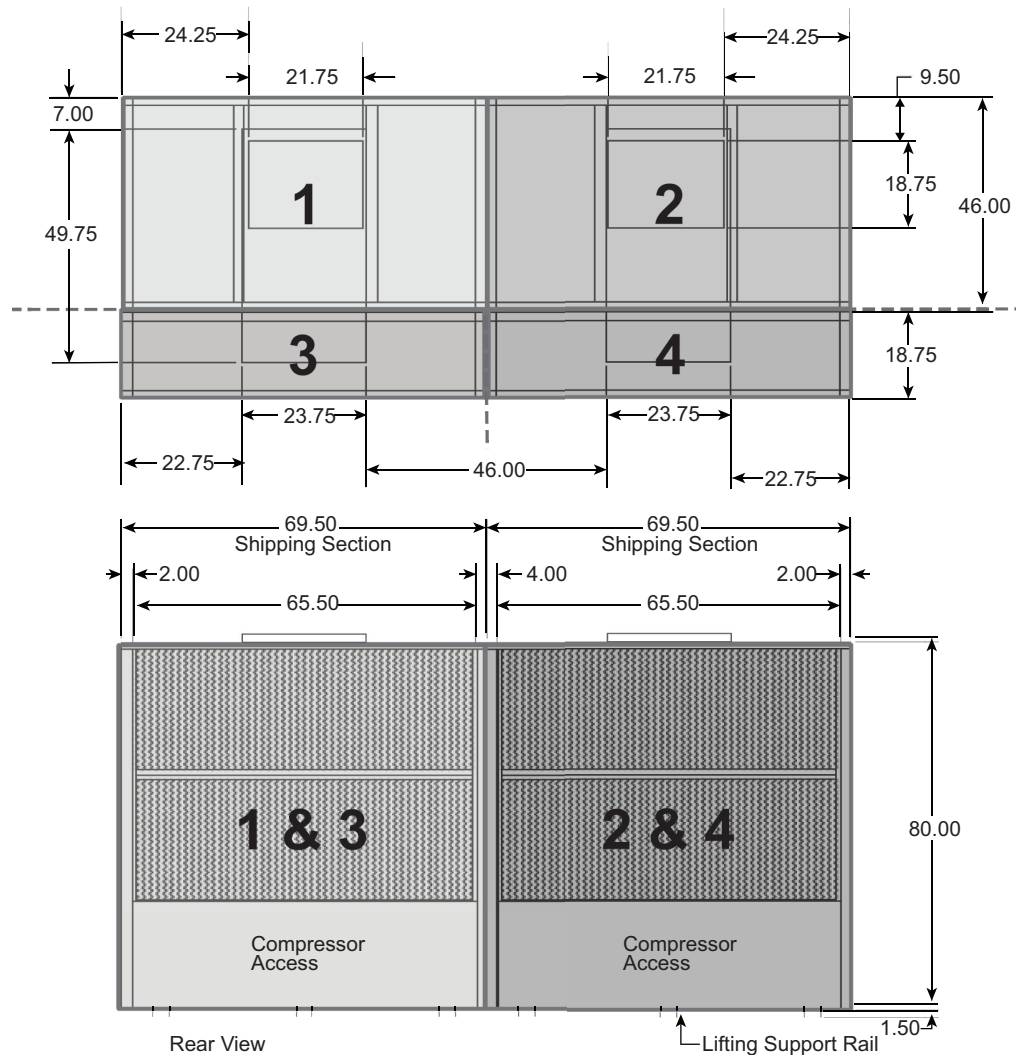
50BVT,W,V 034 Low Boy Field Split



NOTES:

1. The filter rack modules (item 2) can be field removed from the compressor/evaporator module to reduce unit size, as shown above.
2. Dimensions in inches.

50BVT,W,V 044-064 Low Boy Field Split



Fan Performance — 50BVJ020 a,b,c,d,e,f,g

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	0.2			0.4			0.6			0.8			1.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
4500	—	—	—	—	—	—	623	459	0.52	—	—	—	—	—	—
5000	—	—	—	—	—	—	638	545	0.61	—	—	—	—	—	—
5500	—	—	—	—	—	—	655	641	0.72	725	755	0.85	—	—	—
6000	—	—	—	608	641	0.72	676	755	0.85	742	878	0.99	807	1001	1.13
6500	—	—	—	636	755	0.85	699	878	0.99	761	1010	1.14	821	1142	1.29
7000	604	774	0.87	666	906	1.02	726	1029	1.16	784	1170	1.32	841	1311	1.48
7500	634	916	1.03	693	1057	1.19	750	1189	1.34	805	1330	1.50	858	1480	1.67
8000	667	1085	1.22	723	1226	1.38	777	1377	1.55	829	1526	1.72	880	1676	1.89
8500	700	1273	1.43	753	1423	1.60	804	1573	1.77	853	1732	1.95	902	1836	2.13
9000	735	1480	1.67	785	1638	1.84	833	1745	2.02	881	1908	2.21	927	2071	2.40

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	1.2			1.4			1.6			1.8			2.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
4500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6500	881	1283	1.44	—	—	—	—	—	—	—	—	—	—	—	—
7000	897	1451	1.63	951	1601	1.80	—	—	—	—	—	—	—	—	—
7500	911	1629	1.83	963	1727	2.00	1014	1881	2.18	—	—	—	—	—	—
8000	930	1781	2.07	979	1935	2.24	1028	2098	2.43	1076	2260	2.62	1124	2422	2.81
8500	950	1989	2.31	997	2152	2.50	1043	2323	2.69	1089	2485	2.88	1134	2697	3.09
9000	973	2233	2.59	1018	2404	2.79	1062	2576	2.99	1106	2779	3.18	1149	2960	3.39

NOTE(S):

- Units are available with the following motor and drive combinations: 2, 3, 5 hp standard drive; 2, 3 hp medium static drive. For 2, 3 hp standard drives, the drive range is 753 to 952 rpm. For medium static drives, the drive range is 872 to 1071 rpm. For 5 hp standard drives, the drive range is 967 to 1290 rpm.
- Bold italics** indicates field-supplied drive required.
- Do not operate in shaded area.
- Static pressure losses must be applied to external static pressure before entering the fan performance table.
- Interpolation is permitted; extrapolation is not.
- Fan performance is based on filter, unit casing, and wet coil losses.
- Bhp values are per fan. Watts values are per motor. Unit has 2 supply fans and 2 motors.

LEGEND

bhp — Brake Horsepower Input to Supply Fan
Watts — Input Power to Supply Fan Motor

Performance data (cont)



Fan Performance — 50BVJ024 a,b,c,d,e,f,g

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	0.2			0.4			0.6			0.8			1.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
5,000	—	—	—	—	—	—	638	545	0.61	—	—	—	—	—	—
5,500	—	—	—	—	—	—	655	641	0.72	725	755	0.85	—	—	—
6,000	—	—	—	608	641	0.72	676	755	0.85	742	878	0.99	807	1001	1.13
6,500	—	—	—	636	755	0.85	699	878	0.99	761	1010	1.14	821	1142	1.29
7,000	604	774	0.87	666	906	1.02	726	1029	1.16	784	1170	1.32	841	1311	1.48
7,500	634	916	1.03	693	1057	1.19	750	1189	1.34	805	1330	1.50	858	1480	1.67
8,000	667	1085	1.22	723	1226	1.38	777	1377	1.55	829	1526	1.72	880	1676	1.89
8,500	700	1273	1.43	753	1423	1.60	804	1573	1.77	853	1732	1.95	902	1836	2.13
9,000	735	1480	1.67	785	1638	1.84	833	1745	2.02	881	1908	2.21	927	2071	2.40
9,500	769	1713	1.93	816	1827	2.12	863	1989	2.31	908	2152	2.50	952	2323	2.69
10,000	802	1908	2.21	848	2080	2.41	892	2251	2.61	936	2422	2.81	978	2624	3.01

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	1.2			1.4			1.6			1.8			2.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
5,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5,500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6,500	881	1283	1.44	—	—	—	—	—	—	—	—	—	—	—	—
7,000	897	1451	1.63	951	1601	1.80	—	—	—	—	—	—	—	—	—
7,500	911	1629	1.83	963	1727	2.00	1014	1881	2.18	—	—	—	—	—	—
8,000	930	1781	2.07	979	1935	2.24	1028	2098	2.43	1076	2260	2.62	1124	2422	2.81
8,500	950	1989	2.31	997	2152	2.50	1043	2323	2.69	1089	2485	2.88	1134	2697	3.09
9,000	973	2233	2.59	1018	2404	2.79	1062	2576	2.99	1106	2779	3.18	1149	2960	3.39
9,500	996	2494	2.89	1039	2697	3.09	1081	2879	3.30	1123	3060	3.51	1165	3251	3.73
10,000	1020	2806	3.22	1061	2988	3.42	1102	3178	3.64	1142	3360	3.85	1182	3559	4.08

NOTE(S):

- Units are available with the following motor and drive combinations: 2, 3, 5 hp standard drive; 2, 3 hp medium static drive. For 2, 3 hp standard drives, the drive range is 753 to 952 rpm. For medium static drives, the drive range is 872 to 1071 rpm. For 5 hp standard drives, the drive range is 967 to 1290 rpm.
- Bold italics** indicates field-supplied drive required.
- Do not operate in shaded area.
- Static pressure losses must be applied to external static pressure before entering the fan performance table.
- Interpolation is permitted; extrapolation is not.
- Fan performance is based on filter, unit casing, and wet coil losses.
- Bhp values are per fan. Watts values are per motor. Unit has 2 supply fans and 2 motors.

LEGEND

bhp — Brake Horsepower Input to Supply Fan
Watts — Input Power to Supply Fan Motor

Fan Performance — 50BVJ028 a,b,c,d,e,f,g

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	0.2			0.4			0.6			0.8			1.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
6,250	—	—	—	624	678	0.79	689	797	0.92	753	917	1.06	815	1045	1.21
7,000	604	751	0.87	666	880	1.02	726	999	1.16	784	1136	1.32	841	1273	1.48
7,500	634	889	1.03	693	1027	1.19	750	1155	1.34	805	1291	1.50	858	1437	1.67
8,000	667	1054	1.22	723	1191	1.38	777	1337	1.55	829	1482	1.72	880	1627	1.89
8,500	700	1237	1.43	753	1382	1.60	804	1528	1.77	853	1682	1.95	902	1836	2.13
9,000	735	1437	1.67	785	1591	1.84	833	1745	2.02	881	1908	2.21	927	2071	2.40
9,500	769	1664	1.93	816	1827	2.12	863	1989	2.31	908	2152	2.50	952	2323	2.69
10,000	802	1908	2.21	848	2080	2.41	892	2251	2.61	936	2422	2.81	978	2624	3.01
10,500	835	2179	2.53	879	2350	2.73	921	2531	2.93	963	2742	3.14	1004	2924	3.35
11,000	870	2467	2.86	912	2688	3.08	952	2870	3.29	992	3060	3.51	1032	3251	3.73
11,500	904	2824	3.24	944	3015	3.46	983	3206	3.67	1022	3405	3.90	1060	3605	4.13
12,000	937	3169	3.63	976	3369	3.86	1014	3569	4.09	1051	3777	4.33	1088	3985	4.57
12,500	972	3550	4.07	1010	3759	4.31	1046	3967	4.55	1082	4184	4.80	—	—	—

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	1.2			1.4			1.6			1.8			2.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
6,250	877	1173	1.36	—	—	—	—	—	—	—	—	—	—	—	—
7,000	897	1410	1.63	951	1555	1.80	—	—	—	—	—	—	—	—	—
7,500	911	1582	1.83	963	1727	2.00	1014	1881	2.18	—	—	—	—	—	—
8,000	930	1781	2.07	979	1935	2.24	1028	2098	2.43	1076	2260	2.62	1124	2422	2.81
8,500	950	1989	2.31	997	2152	2.50	1043	2323	2.69	1089	2485	2.88	1134	2697	3.09
9,000	973	2233	2.59	1018	2404	2.79	1062	2576	2.99	1106	2779	3.18	1149	2960	3.39
9,500	996	2494	2.89	1039	2697	3.09	1081	2879	3.30	1123	3060	3.51	1165	3251	3.73
10,000	1020	2806	3.22	1061	2988	3.42	1102	3178	3.64	1142	3360	3.85	1182	3559	4.08
10,500	1044	3106	3.56	1084	3296	3.78	1123	3496	4.01	1161	3686	4.23	1200	3886	4.45
11,000	1070	3451	3.95	1109	3641	4.17	1146	3840	4.40	1184	4049	4.64	1220	4248	4.87
11,500	1097	3804	4.36	1134	4012	4.60	1170	4221	4.84	1206	—	—	—	—	—
12,000	1124	4193	4.81	—	—	—	—	—	—	—	—	—	—	—	—
12,500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

NOTE(S):

- Units are available with the following motor and drive combinations: 2, 3, 5 hp standard drive; 2, 3 hp medium static drive. For 2, 3 hp standard drives, the drive range is 753 to 952 rpm. For medium static drives, the drive range is 872 to 1071 rpm. For 5 hp standard drives, the drive range is 967 to 1290 rpm.
- Bold italics** indicates field-supplied drive required.
- Do not operate in shaded area.
- Static pressure losses must be applied to external static pressure before entering the fan performance table.
- Interpolation is permitted; extrapolation is not.
- Fan performance is based on filter, unit casing, and wet coil losses.
- Bhp values are per fan. Watts values are per motor. Unit has 2 supply fans and 2 motors.

LEGEND

- bhp** — Brake Horsepower Input to Supply Fan
Watts — Input Power to Supply Fan Motor

Performance data (cont)



Fan Performance — 50BVJ034 a,b,c,d,e,f,g

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	0.2			0.4			0.6			0.8			1.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
9,000	639	1187	1.36	693	1334	1.53	745	1490	1.71	795	1646	1.89	843	1802	2.07
9,500	665	1362	1.56	717	1518	1.74	766	1674	1.92	814	1839	2.11	861	2004	2.30
10,000	693	1555	1.78	743	1720	1.97	791	1894	2.17	836	2058	2.36	881	2232	2.56
10,500	721	1775	2.03	769	1949	2.23	815	2122	2.43	859	2296	2.63	902	2478	2.84
11,000	749	2004	2.30	795	2186	2.51	840	2369	2.71	882	2551	2.92	924	2742	3.14
11,500	777	2259	2.59	822	2451	2.81	864	2642	3.03	906	2833	3.25	946	3024	3.47
12,000	805	2533	2.90	848	2733	3.13	889	2933	3.36	929	3133	3.59	968	3333	3.82
12,500	835	2842	3.26	877	3042	3.49	917	3251	3.73	955	3460	3.97	993	3668	4.20
13,000	865	3169	3.63	905	3378	3.87	944	3596	4.12	981	3813	4.37	1018	4021	4.61
13,500	894	3514	4.03	933	3741	4.29	971	3958	4.54	1007	4184	4.80	—	—	—
14,000	924	3895	4.46	961	4121	4.72	998	4356	4.99	—	—	—	—	—	—

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	1.2			1.4			1.6			1.8			2.0		
	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp	rpm	Watts	bhp
9,000	890	1958	2.24	936	2122	2.43	982	2296	2.63	1026	2460	2.82	1071	2642	3.03
9,500	906	2168	2.48	950	2341	2.68	994	2515	2.88	1037	2688	3.08	1079	2870	3.29
10,000	925	2405	2.76	967	2578	2.96	1009	2760	3.16	1051	2942	3.37	1092	3124	3.58
10,500	944	2660	3.05	986	2842	3.26	1026	3024	3.47	1066	3215	3.68	1105	3405	3.90
11,000	965	2924	3.35	1004	3115	3.57	1043	3315	3.80	1082	3505	4.02	1120	3705	4.25
11,500	985	3224	3.69	1024	3414	3.91	1062	3614	4.14	1099	3813	4.37	1136	4021	4.61
12,000	1006	3532	4.05	1044	3732	4.28	1080	3940	4.52	1117	4148	4.75	1152	4356	4.99
12,500	1030	3877	4.44	1066	4085	4.68	1102	4302	4.93	—	—	—	—	—	—
13,000	1053	4239	4.86	—	—	—	—	—	—	—	—	—	—	—	—
13,500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

NOTE(S):

- Units are available with the following motor and drive combinations: 2, 3, 5 hp standard drive; 2, 3 hp medium static drive. For 2, 3 hp standard drives, the drive range is 753 to 952 rpm. For medium static drives, the drive range is 872 to 1071 rpm. For 5 hp standard drives, the drive range is 967 to 1290 rpm.
- Bold italics** indicates field-supplied drive required.
- Do not operate in shaded area.
- Static pressure losses must be applied to external static pressure before entering the fan performance table.
- Interpolation is permitted; extrapolation is not.
- Fan performance is based on filter, unit casing, and wet coil losses.
- Bhp values are per fan. Watts values are per motor. Unit has 2 supply fans and 2 motors.

LEGEND

bhp — Brake Horsepower Input to Supply Fan
Watts — Input Power to Supply Fan Motor

Blower Performance

50BV V,W,T SIZE	NOMINAL AIRFLOW (cfm)	AIRFLOW (cfm)	EXTERNAL STATIC PRESSURE (in. wg WET COIL AND FILTER INCLUDED)											
			2.00		2.50		3.00		3.50		4.00		4.50	
			rpm	HP	rpm	HP	rpm	HP	rpm	HP	rpm	HP	rpm	HP
034	12,200	9,500	813	7.5	871	15	949	10	1034	15	1111	15	1172	15
		10,000	813	7.5	916	10	949	10	1034	15	1111	15	1172	15
		10,500	842	10	916	10	982	15	1034	15	1111	15	1172	15
		11,000	842	10	916	10	982	15	1034	15	1111	15	1172	15
		11,500	871	15	916	15	982	15	1034	15	1111	15	1172	20
		12,000	871	15	949	15	982	15	1072	15	1111	20	1172	20
		12,500	871	15	949	15	1034	15	1072	20	1111	20	1172	20
		13,500	916	15	982	20	1034	20	1072	20	1149	20	—	—
044	16,000	13,000	794	7.5	916	7.5	982	7.5	1111	7.5	1200	10	1256	10
		14,000	794	7.5	871	7.5	982	7.5	1072	10	1172	10	1256	10
		15,000	794	7.5	871	7.5	982	7.5	1072	10	1172	10	1256	15
		16,000	794	7.5	871	7.5	982	7.5	1034	10	1149	10	1256	15
		17,000	794	7.5	871	7.5	982	7.5	1034	10	1111	15	1214	15
		18,000	813	7.5	871	7.5	949	10	1034	10	1111	15	1172	15
		19,000	813	7.5	871	15	949	10	1034	15	1111	15	1172	15
054	20,000	16,000	794	7.5	871	7.5	982	7.5	1034	10	1149	10	1256	15
		17,000	794	7.5	871	7.5	982	7.5	1034	10	1111	15	1214	15
		18,000	813	7.5	871	8	949	10	1034	10	1111	15	1172	15
		19,000	813	7.5	871	15	949	10	1034	15	1111	15	1172	15
		20,000	813	7.5	916	10	949	10	1034	15	1111	15	1172	15
		21,000	842	10	916	10	982	15	1034	15	1111	15	1172	15
		22,000	842	10	916	10	982	15	1034	15	1111	15	1172	15
		23,000	871	15	916	15	982	15	1034	15	1111	15	1172	20
064	24,000	24,000	871	15	949	15	982	15	1072	15	1111	20	1172	20
		19,000	813	7.5	871	15	949	10	1034	15	1111	15	1172	15
		20,000	813	7.5	916	10	949	10	1034	15	1111	15	1172	15
		21,000	842	10	916	10	982	15	1034	15	1111	15	1172	15
		22,000	842	10	916	10	982	15	1034	15	1111	15	1172	15
		23,000	871	15	916	15	982	15	1034	15	1111	15	1172	20
		24,000	871	15	949	15	982	15	1072	15	1111	20	1172	20
		25,000	871	15	949	15	1034	15	1072	20	1111	20	1172	20

Airside Pressure Drop (in. wg) ^{a,b,c}

50BVJ SIZE	AIRFLOW (cfm)	OPTIONAL COIL TYPE			FACE VELOCITY (FPM)
		ECONOMIZER	REHEAT	HOT WATER	
034	8,000	0.25	0.06	0.12	345
	10,000	0.32	0.07	0.17	431
	12,000	0.47	0.12	0.25	517
	13,000	0.56	0.15	0.29	560
044	12,000	0.15	0.02	0.06	259
	14,000	0.2	0.04	0.09	302
	16,000	0.26	0.05	0.11	345
	18,000	0.33	0.06	0.15	388
054	16,000	0.25	0.06	0.12	345
	18,000	0.28	0.07	0.16	388
	20,000	0.32	0.07	0.17	431
	22,000	0.4	0.12	0.24	474
064	20,000	0.32	0.07	0.17	431
	22,000	0.4	0.12	0.24	474
	24,000	0.47	0.12	0.25	517
	25,000	0.52	0.14	0.26	539

NOTE(S):

- a. Economizer coil shown with wet surface
- b. Reheat coil and hot water coil shown dry.
- c. Two-row hot water coil shown.

Performance data (cont)



Water Side Pressure Drop — 50BVJ ^a

50BVJ SIZE	FLOW RATE (GPM)	CONDENSERS		ECONOMIZER		HOT WATER COIL	
		PRESSURE DROP (PSIG)	PRESSURE DROP (FT OF H ₂ O)	PRESSURE DROP (PSIG)	PRESSURE DROP (FT OF H ₂ O)	PRESSURE DROP (PSIG)	PRESSURE DROP (FT OF H ₂ O)
020	10	—	—	—	—	0.3	0.7
	15	—	—	—	—	0.6	1.5
	20	—	—	—	—	1.1	2.6
	25	—	—	—	—	1.7	4.0
	30	—	—	—	—	2.5	5.8
	35	3.9	9.1	3.9	8.9	3.4	7.8
	40	4.3	9.9	5.0	11.5	4.4	10.2
	45	5.8	13.5	6.2	14.4	5.6	12.9
	50	6.5	14.9	7.6	17.6	6.8	15.8
	55	8.0	18.4	9.1	21.1	—	—
	60	8.9	20.6	10.8	24.9	—	—
	65	10.3	23.9	12.6	29.0	—	—
024	70	11.8	27.2	14.9	34.4	—	—
	10	—	—	—	—	0.3	0.7
	15	—	—	—	—	0.6	1.5
	20	—	—	—	—	1.1	2.6
	25	—	—	—	—	1.7	4.0
	30	—	—	—	—	2.5	5.8
	35	—	—	—	—	3.4	7.8
	40	2.7	6.2	4.8	11.0	4.4	10.2
	45	3.2	7.5	6.0	13.8	5.6	12.9
	50	4.0	9.3	7.3	16.9	6.8	15.8
	55	4.7	10.9	8.8	20.4	—	—
	60	5.6	12.9	10.4	24.1	—	—
028	65	6.4	14.8	12.2	28.1	—	—
	70	7.4	17.0	14.1	32.5	—	—
	75	8.3	19.2	16.1	37.1	—	—
	80	9.4	21.7	18.2	42.1	—	—
	10	—	—	—	—	0.3	0.7
	15	—	—	—	—	0.6	1.5
	20	—	—	—	—	1.1	2.6
	25	—	—	—	—	1.7	4.0
	30	—	—	—	—	2.5	5.8
	35	—	—	—	—	3.4	7.8
	40	—	—	—	—	4.4	10.2
	45	—	—	—	—	5.6	12.9
034	50	4.0	9.3	7.3	16.9	6.8	15.8
	55	4.7	10.9	8.8	20.4	—	—
	60	5.6	12.9	10.4	24.1	—	—
	65	6.5	14.9	12.2	28.2	—	—
	70	7.4	17.2	14.1	32.5	—	—
	75	8.3	19.2	16.1	37.2	—	—
	80	9.6	22.2	18.2	42.1	—	—
	85	10.4	24.1	20.5	47.4	—	—
	90	12.0	27.8	22.9	52.9	—	—
	95	13.3	30.8	25.4	58.7	—	—
	100	14.7	34.0	28.1	64.9	—	—
	30	—	—	—	—	0.0	0.1
034	35	—	—	—	—	0.0	0.1
	40	—	—	—	—	0.0	0.1
	45	—	—	—	—	0.1	0.2
	50	—	—	—	—	0.1	0.2
	55	—	—	—	—	0.1	0.3
	60	4.7	10.8	1.5	3.5	0.1	0.3
	65	5.5	12.7	1.8	4.1	0.2	0.4
	70	6.7	15.5	2.0	4.7	—	—
	75	7.3	16.9	2.3	5.4	—	—
	80	8.5	19.7	2.6	6.1	—	—
	85	9.4	21.7	3.0	6.9	—	—
	90	10.6	24.4	3.3	7.7	—	—
034	95	11.7	27.1	3.7	8.5	—	—
	100	12.8	29.5	4.1	9.4	—	—
	105	14.3	33.1	4.5	10.3	—	—
	110	15.7	36.3	4.9	11.3	—	—
	115	17.2	39.7	5.3	12.3	—	—
	120	18.7	43.2	5.8	13.4	—	—

NOTE(S):

a. All values are based upon pure water at EWT 70°F.

Performance data (cont)



Water Side Pressure Drop — 50BVT,V,W ^a

50BVT,V,W	FLOW RATE (GPM)	CONDENSERS		ECONOMIZER		HOT WATER COIL	
		PRESSURE DROP (PSIG)	PRESSURE DROP (ft of H ₂ O)	PRESSURE DROP (PSIG)	PRESSURE DROP (ft of H ₂ O)	PRESSURE DROP (PSIG)	PRESSURE DROP (ft of H ₂ O)
034	45	—	—	—	—	1.0	2.4
	50	—	—	—	—	1.3	3.0
	55	—	—	—	—	1.6	3.6
	60	3.9	8.9	5.7	13.1	1.8	4.2
	70	5.1	11.7	7.8	17.9	2.5	5.7
	80	6.5	14.9	10.2	23.5	3.3	7.5
	90	8.0	18.4	12.9	29.8	4.1	9.5
	100	10.5	24.2	16.0	36.9	—	—
	110	12.7	29.3	19.4	44.8	—	—
044	120	15.1	34.9	23.1	53.4	—	—
	80	—	—	2.5	5.8	—	—
	90	3.7	8.6	3.2	7.3	1.1	2.6
	100	4.5	10.4	3.9	9.1	1.3	2.9
	110	5.3	12.3	4.8	11.0	1.5	3.5
	120	6.2	14.4	5.7	13.1	1.8	4.2
	130	7.2	16.7	6.7	15.4	2.2	5.1
	140	8.4	19.4	7.7	17.9	2.6	5.9
	150	9.7	22.3	8.9	20.6	2.9	6.7
054	160	11.0	25.3	10.2	23.5	3.3	7.6
	170	—	—	—	—	3.7	8.6
	180	—	—	—	—	4.2	9.6
	90	—	—	—	—	1.1	2.5
	100	—	—	3.9	9.0	1.3	3.1
	110	—	—	4.8	11.0	1.6	3.7
	120	3.8	8.8	5.7	13.1	1.8	4.2
	130	4.4	10.2	6.7	15.4	2.1	4.9
	140	5.1	11.7	7.8	17.9	2.5	5.7
064	150	5.7	13.2	8.9	20.6	2.9	6.6
	160	6.7	15.5	10.2	23.5	3.2	7.5
	170	7.5	17.4	11.5	26.6	3.7	8.5
	180	8.5	19.6	12.9	29.8	4.1	9.5
	190	9.4	21.8	14.4	33.3	—	—
	200	10.5	24.2	16.0	36.9	—	—
	90	—	—	—	—	1.1	2.5
	100	—	—	—	—	1.3	3.1
	110	—	—	—	—	1.6	3.7
064	120	—	—	5.7	13.1	1.9	4.4
	130	—	—	6.7	15.4	2.2	5.1
	140	—	—	7.7	17.9	2.6	5.9
	150	5.7	13.2	8.9	20.6	2.9	6.6
	160	6.4	14.8	10.2	23.5	3.3	7.5
	170	7.2	16.6	11.5	26.5	3.7	8.5
	180	8.0	18.3	12.9	29.8	4.1	9.5
	190	9.4	21.8	14.4	33.2	—	—
	200	10.5	24.2	15.9	36.8	—	—
064	210	11.5	26.6	17.6	40.7	—	—
	220	12.6	29.2	19.4	44.7	—	—
	230	13.8	31.9	21.2	48.9	—	—
	240	15.1	34.8	23.1	53.3	—	—

NOTE(S):

a. All values are based upon pure water at EWT 70°F.

Electrical Data — with Belt Drive Motor, Inverter Duty (50BVJ)

50BVJ SIZE	RATED VOLTAGE	VOLTAGE MIN/MAX	COMPRESSOR			INDOOR FAN MOTOR			POWER SUPPLY	
			QTY	RLA (EACH)	LRA (EACH)	MOTOR HP	MOTOR QTY	FLA (EACH)	MIN CIRCUIT AMPS	MAX FUSE/ HACR
20	208-230/3/60	197/253	2	29.5	195.0	2.0	2	6.2	78.8	100
			2	29.5	195.0	3.0	2	8.8	84.0	110
			2	29.5	195.0	5.0	2	13.5	93.4	110
	460/3/60	414/506	2	14.7	95.0	2.0	2	3.1	39.3	50
			2	14.7	95.0	3.0	2	4.3	41.7	50
			2	14.7	95.0	5.0	2	6.2	45.5	60
	575/3/60	518/632	2	12.2	80.0	2.0	2	2.0	31.5	40
			2	12.2	80.0	3.0	2	3.5	34.4	45
			2	12.2	80.0	5.0	2	4.5	36.5	45
24	208-230/3/60	197/253	2	30.1	225.0	2.0	2	6.2	80.1	110
			2	30.1	225.0	3.0	2	8.8	85.3	110
			2	30.1	225.0	5.0	2	13.5	94.7	110
	460/3/60	414/506	2	16.7	114.0	2.0	2	3.1	43.8	60
			2	16.7	114.0	3.0	2	4.3	46.2	60
			2	16.7	114.0	5.0	2	6.2	50.0	60
	575/3/60	518/632	2	12.2	80.0	2.0	2	2.0	31.5	40
			2	12.2	80.0	3.0	2	3.5	34.4	45
			2	12.2	80.0	5.0	2	4.5	36.5	45
28	208-230/3/60	197/253	2	48.1	245.0	3.0	2	8.8	125.8	150
			2	48.1	245.0	5.0	2	13.5	135.2	175
	460/3/60	414/506	2	18.6	125.0	3.0	2	4.3	50.5	60
			2	18.6	125.0	5.0	2	6.2	54.3	70
	575/3/60	518/632	2	14.7	100.0	3.0	2	3.5	40.0	50
			2	14.7	100.0	5.0	2	4.5	42.1	50
34	208-230/3/60	197/253	2	55.8	340.0	5.0	2	13.5	152.6	200
	460/3/60	414/506	2	26.9	173.0	5.0	2	6.2	72.9	90

LEGEND

FLA — Full Load Amps
HP — Horsepower
LRA — Locked Rotor Amps
RLA — Rated Load Amps

Electrical Data — with Belt Drive Motor, Inverter Duty^a (50BVV,W,T)

50BVV,W,T SIZE	RATED VOLTAGE	VOLTAGE MIN/MAX	COMPRESSOR			INDOOR FAN MOTOR			POWER SUPPLY	
			QTY	RLA (EACH)	LRA (EACH)	MOTOR HP	MOTOR QTY	FLA (EACH)	MIN CIRCUIT AMPS	MAX FUSE/HACR
034	208-230/3/60	197/253	2	55.8	340	7.5	1	19.4	145.0	200
			2	55.8	340	10	1	25.2	150.8	200
			2	55.8	340	15	1	37.8	163.4	200
			2	55.8	340	20	1	49.0	174.6	225
	460/3/60	414/506	2	26.9	173	7.5	1	9.7	70.2	90
			2	26.9	173	10	1	12.6	73.1	100
			2	26.9	173	15	1	18.9	79.4	100
			2	26.9	173	20	1	24.5	85.0	110
	575/3/60	518/632	2	23.7	132	7.5	1	7.5	60.8	80
			2	23.7	132	10	1	10.3	63.6	80
			2	23.7	132	15	1	15.1	68.4	90
			2	23.7	132	20	1	19.6	72.9	90
044	208-230/3/60	197/253	4	33.3	239	7.5	2	19.4	180.3	200
			4	33.3	239	10	2	25.2	191.9	225
			4	33.3	239	15	2	37.8	218.3	250
			4	33.3	239	20	2	49.0	243.5	250
	460/3/60	414/506	4	17.9	125	7.5	2	9.7	95.5	110
			4	17.9	125	10	2	12.6	101.3	110
			4	17.9	125	15	2	18.9	114.1	125
			4	17.9	125	20	2	24.5	126.7	150
	575/3/60	518/632	4	12.8	80	7.5	2	7.5	69.4	80
			4	12.8	80	10	2	10.3	75.0	80
			4	12.8	80	15	2	15.1	85.2	100
			4	12.8	80	20	2	19.6	95.3	110
054	208-230/3/60	197/253	4	48.1	245	7.5	2	19.4	243.2	250
			4	48.1	245	10	2	25.2	254.8	300
			4	48.1	245	15	2	37.8	280.0	300
			4	48.1	245	20	2	49.0	302.7	350
	460/3/60	414/506	4	18.6	125	7.5	2	9.7	98.5	110
			4	18.6	125	10	2	12.6	104.3	110
			4	18.6	125	15	2	18.9	116.9	125
			4	18.6	125	20	2	24.5	129.5	150
	575/3/60	518/632	4	14.7	100	7.5	2	7.5	77.5	90
			4	14.7	100	10	2	10.3	83.1	90
			4	14.7	100	15	2	15.1	92.8	100
			4	14.7	100	20	2	19.6	102.9	110
064	208-230/3/60	197/253	4	55.8	340	7.5	2	19.4	276.0	300
			4	55.8	340	10	2	25.2	287.6	300
			4	55.8	340	15	2	37.8	312.8	350
			4	55.8	340	20	2	49.0	335.2	350
	460/3/60	414/506	4	26.9	173	7.5	2	9.7	133.7	150
			4	26.9	173	10.0	2	12.6	139.5	150
			4	26.9	173	15.0	2	18.9	152.1	175
			4	26.9	173	20.0	2	24.5	163.3	175
	575/3/60	518/632	4	23.7	132	7.5	2	7.5	115.7	125
			4	23.7	132	10.0	2	10.3	121.3	125
			4	23.7	132	15.0	2	15.1	130.9	150
			4	23.7	132	20.0	2	19.6	139.9	150

NOTE(S):

a. The presence of an inverter duty motor does not guarantee that the unit will be provided with a VFD; only 50BVW (VAV) units are provided with a VFD as standard.

LEGEND

FLA — Full Load Amps
VFD — Variable Frequency Drive
HP — Horsepower
LRA — Locked Rotor Amps
RLA — Rated Load Amps

Selection procedure



Please use Carrier's SCUBuilder performance and selection software to perform unit selections at a variety of actual operating conditions. All 50BV performance data can be found in Carrier's SCUBuilder selection software.

50BVC,Q,T,V 020-034 Constant Volume Wiring Schematic

TRANSFORMER PRIMARY LEAD CLR:	
120	- WHI
208	- RED
240	- ORG
277	- BRN
380	- PUR OR YEL
460	- BLK/RED
575	- GRN

STATUS LED/ALARM BLINK CODES	
1	HIGH PRESSURE FAULT - CKT 1
2	LOW PRESSURE FAULT - CKT 1
3	HIGH PRESSURE FAULT - CKT 2
4	LOW PRESSURE FAULT - CKT 2
5	FREEZE SENSOR FAULT
6	CONDENSATE FAULT
7	BROWN OUT FAULT

FACTORY WIRE ———
FIELD WIRE - - - - -

STANDARD COMPONENTS LEGEND:

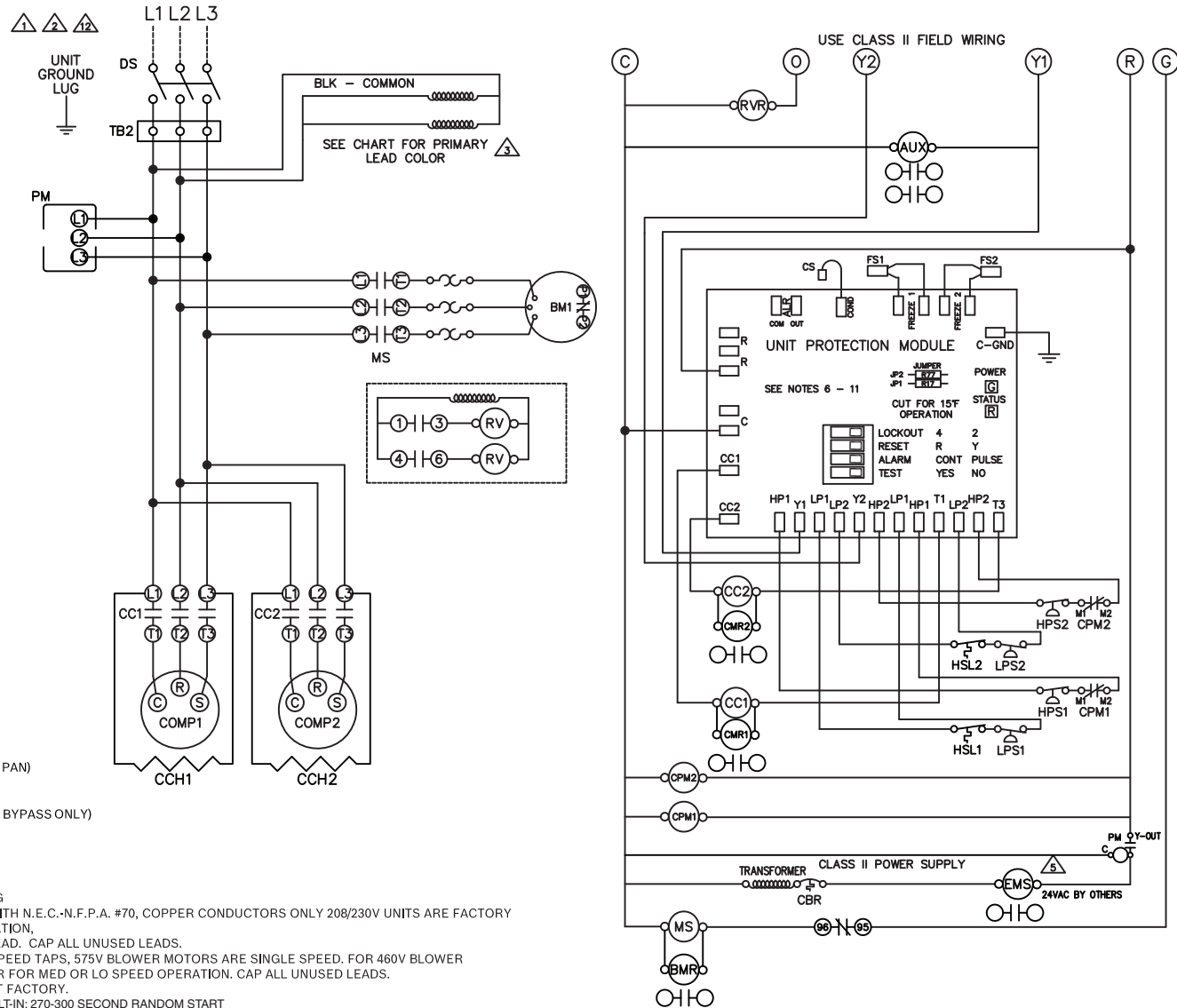
#1 - FIRST STAGE
#2 - SECOND STAGE
BM - BLOWER MOTOR (1 OR 2 PER UNIT)
CC - COMPRESSOR CONTACTOR
CBR - 24VAC CIRCUIT BREAKER
CPM - COMPRESSOR PROTECTION MODULE
(15 TON AND LARGER COMPRESSORS)
HPS - HIGH PRESSURE SWITCH
LPS - LOW PRESSURE SWITCH
MS - MOTOR STARTER
RV - REVERSING VALVE (HEAT PUMPS ONLY)
RVR - REVERSING VALVE RELAY
RVS - REVERSING VALVE SOLENOID

OPTIONAL COMPONENTS LEGEND:

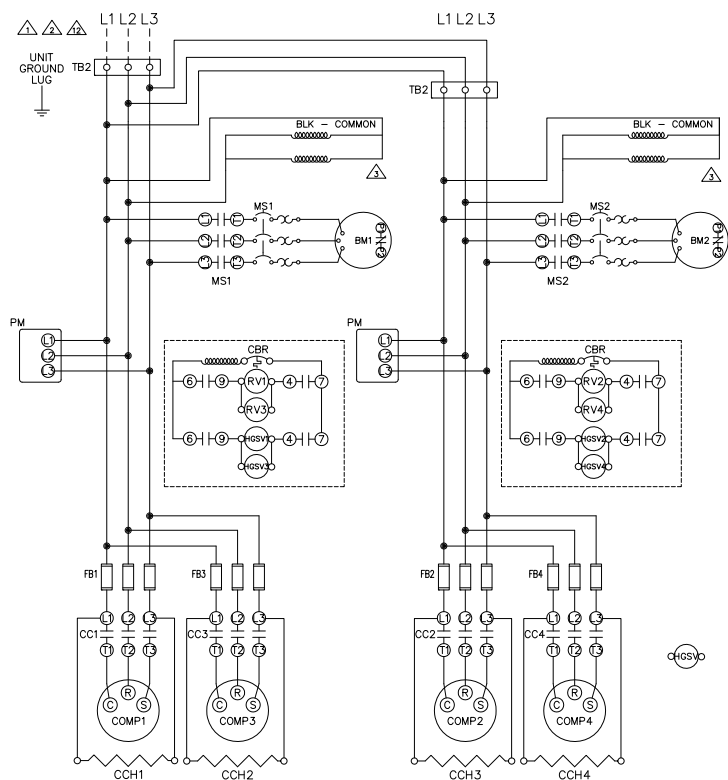
[] AUX - AUXILIARY RELAY
[] BMR - BLOWER MONITOR RELAY
[] CCH - CRANKCASE HTR (WHEN SUPPLIED)
[] CMR - COMPR. MONITOR RELAY
[] CS - CONDENSATE SENSOR (1 PER DRAIN PAN)
[] EMS - ENERGY MGMT SYSTEM RELAY
[] FS - FREEZE SENSOR
[] HSL - HIGH TEMP SUCTION LIMIT (WITH H.G. BYPASS ONLY)
[] PM - PHASE MONITOR

NOTES:

- SEE UNIT NAME PLATE FOR ELECTRICAL RATING.
- ALL FIELD WIRING MUST BE IN ACCORDANCE WITH N.E.C.-N.F.P.A. #70, COPPER CONDUCTORS ONLY 208/230V UNITS ARE FACTORY WIRED FOR 230V OPERATION. FOR 208V OPERATION, REMOVE ORG LEAD AND REPLACE WITH RED LEAD. CAP ALL UNUSED LEADS.
- 208/230V AND 460V BLOWER MOTORS HAVE 3 SPEED TAPS, 575V BLOWER MOTORS ARE SINGLE SPEED. FOR 460V BLOWER MOTORS, WIRE BLK AND ORG LEADS TOGETHER FOR MED OR LO SPEED OPERATION. CAP ALL UNUSED LEADS.
- FOR ALTERNATE EMS COIL VOLTAGES CONSULT FACTORY.
- UNIT PROTECTION MODULE (UPM-II) INCLUDES BUILT-IN: 270-300 SECOND RANDOM START
300 SECOND DELAY ON BREAK
120 SECOND LOW PRESSURE BYPASS
- "TEST" DIP SWITCH REDUCES DELAYS TO 10 SEC WHEN SET TO YES. MUST BE SET TO "NO" FOR NORMAL OPERATION. "FREEZE SENSOR" WILL OPERATE AT 30°F BY DEFAULT, IF 15°F OPERATION IS REQUIRED JUMPERS R77 & R17 MUST BE CUT IF FREEZE SENSOR IS NOT INSTALLED A JUMPER SHALL BE INSTALLED BETWEEN THE FREEZE SENSOR TERMINALS.
- "ALARM OUTPUT" DIP SWITCH MUST BE SET TO "PULSE" IF BLINKING T-STAT SERVICE LIGHT IS DESIRED.
- DEFAULT SETTINGS FOR UPM BOARD FROM FACTORY SHOWN. ALSO SEE INSTALLATION MANUAL.
- ALARM OUTPUT IS NORMALLY OPEN (NO) DRY CONTACT. IF 24 VAC IS NEEDED, CONNECT R TO ALR-COM TERMINAL, 24VAC WILL BE SENSED ON THE ALR-OUT WHEN THE UNIT IS IN ALARM CONDITION. OUTPUT WILL BE PULSED IF PULSE IS SELECTED.
- CHECK FOR PROPER PHASE ROTATION ON UNITS WITH SCROLL COMPRESSORS. REVERSE ROTATION WILL DAMAGE THE COMPRESSOR AND VOID UNIT WARRANTY.

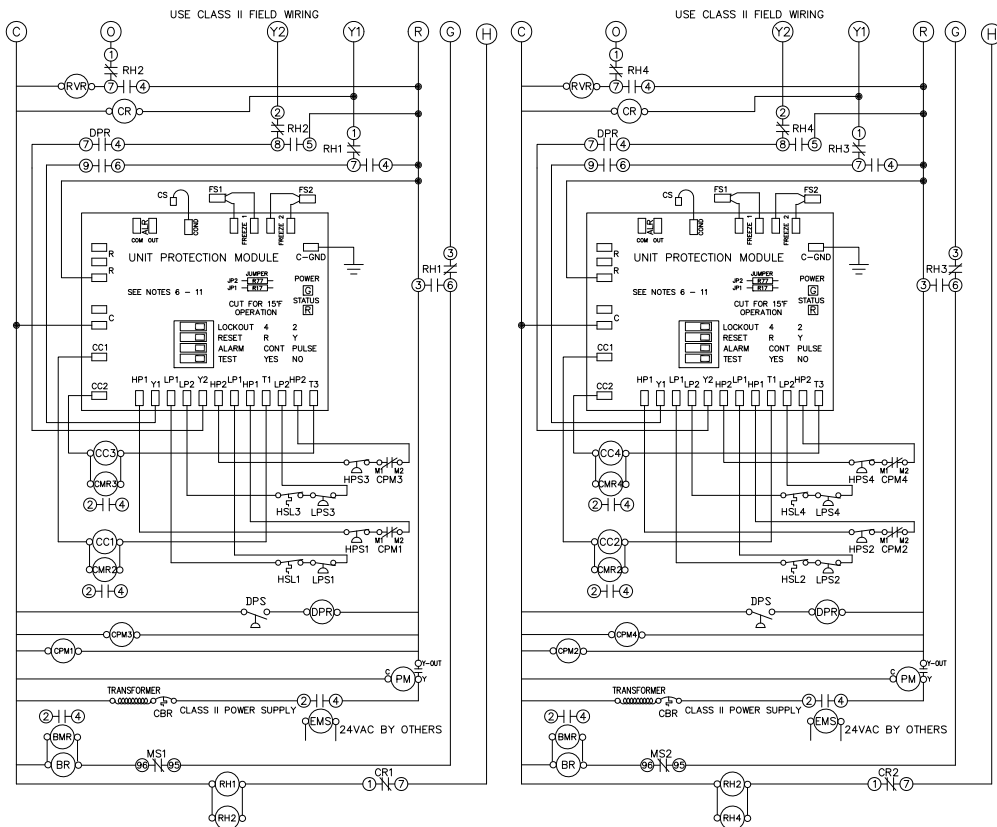


50BVT,V 044-064 Constant Volume Wiring Schematic



NOTES:

- SEE UNIT NAME PLATE FOR ELECTRICAL RATING.
- ALL FIELD WIRING MUST BE IN ACCORDANCE WITH N.E.C.-N.F.P.A. #70, COPPER CONDUCTORS ONLY.
- 208/230V UNITS ARE FACTORY WIRING FOR 230V OPERATION. FOR 208V OPERATION, REMOVE ORG LEAD AND REPLACE WITH RED LEAD. CAP ALL UNUSED LEADS.
- 208/230V AND 460V BLOWER MOTORS HAVE 3 SPEED TAPS. 575V BLOWER MOTORS ARE SINGLE SPEED. FOR 460V BLOWER MOTORS, WIRE BLK AND ORG LEADS TOGETHER FOR MED OR LO SPEED OPERATION. CAP ALL UNUSED LEADS.
- FOR ALTERNATE EMS COIL VOLTAGES CONSULT FACTORY.
- UNIT PROTECTION MODULE (UPM-II) INCLUDES BUILT-IN: 270-300 SECOND RANDOM START 300 SECOND DELAY ON BREAK 120 SECOND LOW PRESSURE BYPASS
- "TEST" DIP SWITCH REDUCES DELAYS TO 10 SEC WHEN SET TO YES. MUST BE SET TO "NO" FOR NORMAL OPERATION.
- "FREEZE SENSOR" WILL OPERATE AT 30° BY DEFAULT. IF 15° OPERATION IS REQUIRED JUMPER R42 MUST BE CUT. IF FREEZE SENSOR IS NOT INSTALLED A JUMPER SHALL BE INSTALLED BETWEEN THE FREEZE SENSOR TERMINALS.
- "ALARM OUTPUT" DIP SWITCH MUST BE SET TO "PULSE" IF BLINKING T-STAT SERVICE LIGHT IS DESIRED.
- DEFAULT SETTINGS FOR UPM BOARD FROM FACTORY SHOWN. ALSO SEE INSTALLATION MANUAL.
- ALARM OUTPUT IS NORMALLY OPEN (NO) DRY CONTACT. IF 24 VAC IS NEEDED, CONNECT R TO ALR-COM TERMINAL. 24VAC WILL BE SENSED ON THE ALR-OUT WHEN THE UNIT IS IN ALARM CONDITION. OUTPUT WILL BE PULSED IF PULSE IS SELECTED.
- CHECK FOR PROPER PHASE ROTATION ON UNITS WITH SCROLL COMPRESSORS. REVERSE ROTATION WILL DAMAGE THE COMPRESSOR AND VOID UNIT WARRANTY.



STANDARD COMPONENTS LEGEND:

- BM - BLOWER MOTOR (1 PER SECTION)
- BR - BLOWER RELAY
/>
- CC - COMPRESSOR CONTACTOR
- CR - COOLING RELAY (1 & 2)
- CBR - 24VAC CIRCUIT BREAKER
- CPM - COMPRESSOR PROTECTION MODULE (15 TON AND LARGER COMPRESSORS)
- CS - CONDENSATE SENSOR (1 PER DRAIN PAN)
- FS - FREEZE SENSOR
- HPS - HIGH PRESSURE SWITCH
- LPS - LOW PRESSURE SWITCH
- MS - MOTOR STARTER
- MS - MOTOR STARTER
- RVS - REVERSING VALVE SOLENOID (HEAT PUMPS ONLY)

OPTIONAL COMPONENTS LEGEND:

- [] AUX - AUXILIARY RELAY (FOR LOOP PUMP, ETC)
- [] BMR - BLOWER MONITOR RELAY
- [] CCH - CRANKCASE HEATER
- [] CCMR - COMPRESSOR MONITOR RELAY
- [] DPS - DIFFERENTIAL PRESSURE SWITCH RELAY (ENABLES CC1, CC2)
- [] EMS - ENERGY MOUNT SYSTEM RELAY (WITH H.G. BYPASS ONLY)
- [] HSL - HIGH TEMP SUCTION LIMIT (USED WITH DDC CONTROLLER ONLY)
- [] HGVS - HOT GAS VALVE SOLENOID (USED WITH DDC CONTROLLER ONLY)
- [] PM - PHASE MONITOR

TRANSFORMER PRIMARY LEAD CLR:

120	- WH1
208	- RED
240	- ORG
277	- BRN
380	- PUR OR YEL
460	- BLK/RED
575	- GRN

STATUS LED/ALARM BLINK CODES

1	HIGH PRESSURE FAULT - CKT 1
2	LOW PRESSURE FAULT - CKT 1
3	HIGH PRESSURE FAULT - CKT 2
4	LOW PRESSURE FAULT - CKT 2
5	FREEZE SENSOR FAULT
6	CONDENSATE FAULT
7	BROWN OUT FAULT

FACTORY WIRE ————

FIELD WIRE ————

Typical control wiring schematics (cont)



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50BVJ020-034 Variable Air Volume Wiring Diagram

USE CLASS II FIELD WIRING

STATUS	LED/ALARM BLINK CODES
1	HIGH PRESSURE FAULT - CKT 1
2	LOW PRESSURE FAULT - CKT 1
3	HIGH PRESSURE FAULT - CKT 2
4	LOW PRESSURE FAULT - CKT 2
5	FREEZE SENSOR FAULT
6	CONDENSATE FAULT
7	BROWN OUT FAULT

TRANSFORMER PRIMARY LEAD CLR:	
120	- WHI
208	- RED
240	- ORG
277	- BRN
380	- PUR OR YEL
460	- BLK/RED
575	- GRN

FACTORY WIRE ———
FIELD WIRE - - - -

STANDARD COMPONENTS LEGEND:

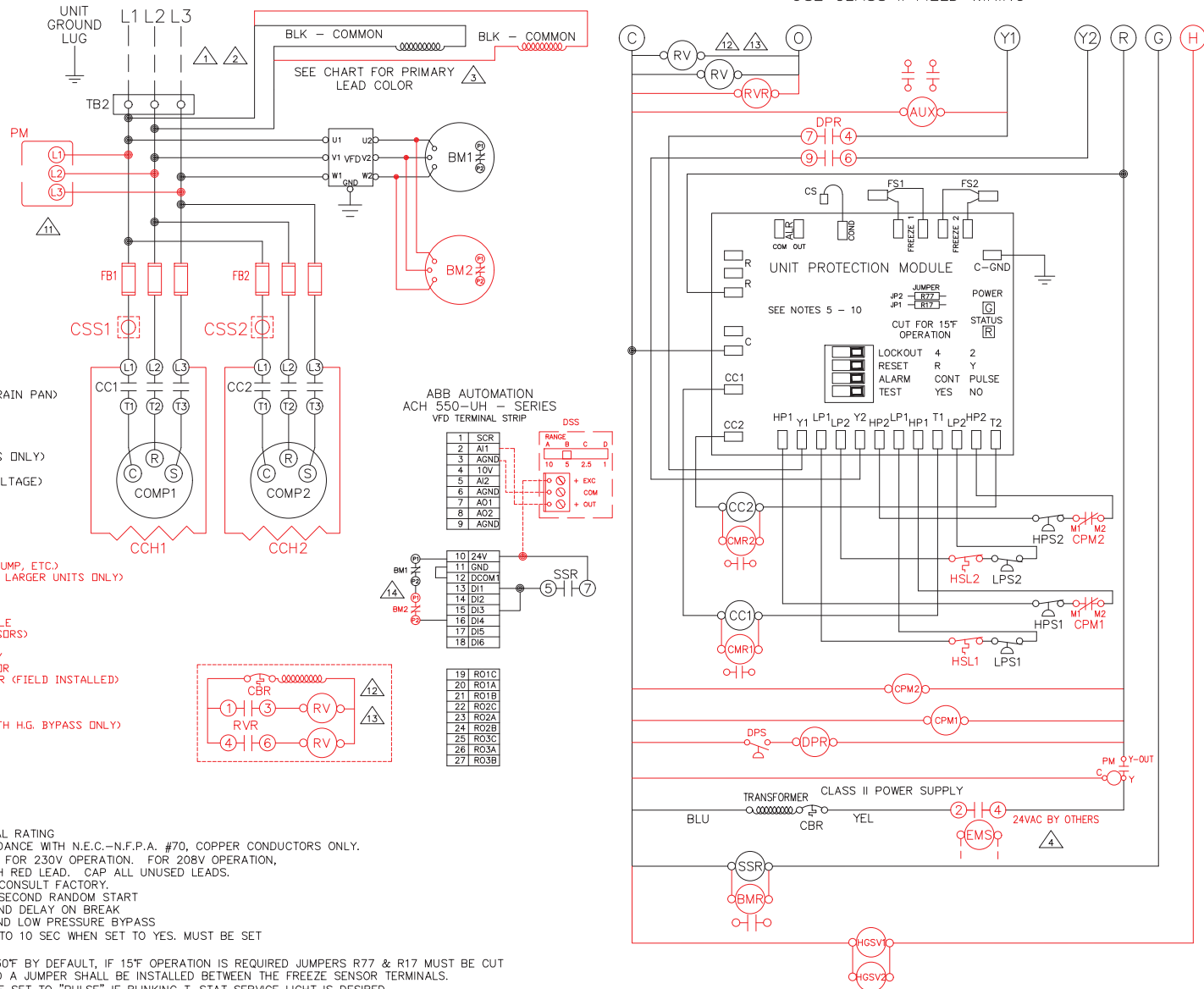
BM1 - BLOWER MOTOR 1
CBR - 24VAC CIRCUIT BREAKER
CC - COMPRESSOR CONTACTOR
CDMP - COMPRESSOR
CS - CONDENSATE SENSOR (1 PER DRAIN PAN)
FS - FREEZE SENSOR
HPS - HIGH PRESSURE SWITCH
LPS - LOW PRESSURE SWITCH
P1,P2- MOTOR THERMAL PROTECTOR
RV - REVERSING VALVE (HEAT PUMPS ONLY)
SSR - START/STOP RELAY
TB2 - MAIN TERMINAL BLOCK (HIGH VOLTAGE)
VFD - VARIABLE FREQUENCY DRIVE

OPTIONAL COMPONENTS LEGEND:

[] AUX - AUXILIARY RELAY (FOR LOOP PUMP, ETC.)
[] BM2 - BLOWER MOTOR 2 (15 TON AND LARGER UNITS ONLY)
[] BMR - BLOWER MONITOR RELAY
[] CH - CRANKCASE HEATER
[] CMR - COMPRESSOR MONITOR RELAY
[] CPM - COMPRESSOR PROTECTION MODULE (15 TON AND LARGER COMPRESSORS)
[] CSS - COMPRESSOR SENSOR SWITCH
[] DPR - DIFFERENTIAL PRESSURE RELAY
[] DPS - DIFFERENTIAL PRESSURE SENSOR
[] DSS - DUCT STATIC PRESSURE SENSOR (FIELD INSTALLED)
[] EMS - ENERGY MGMT SYSTEM RELAY
[] FB - FUSE BLOCK
[] HGS - HOT GAS SOLENOID VALVE
[] HSL - HIGH TEMP SUCTION LIMIT (WITH H.G. BYPASS ONLY)
[] PM - PHASE MONITOR
[] RVR - REVERSING VALVE RELAY

NOTES:

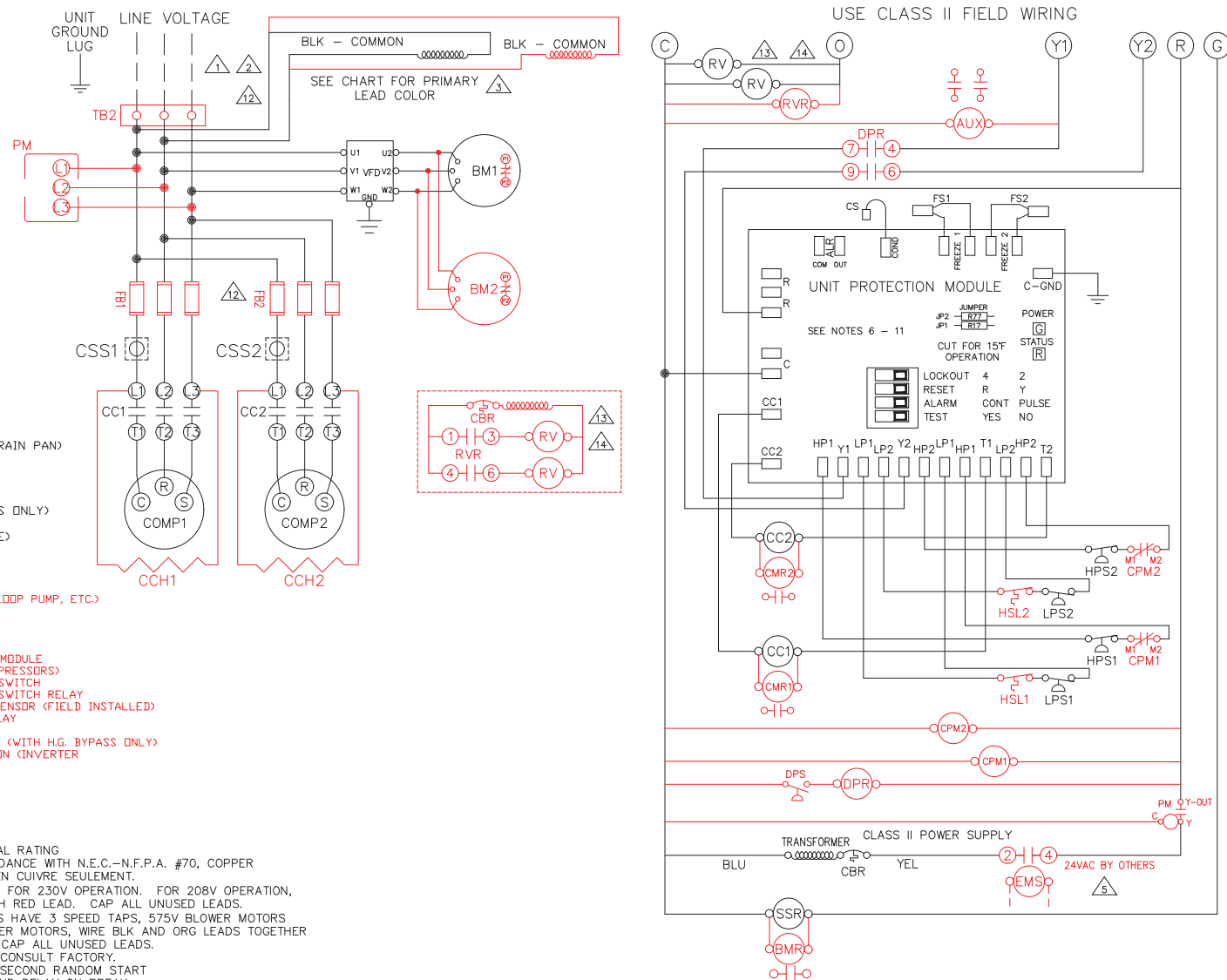
- SEE UNIT NAME PLATE FOR ELECTRICAL RATING
- ALL FIELD WIRING MUST BE IN ACCORDANCE WITH N.E.C.-N.F.P.A. #70, COPPER CONDUCTORS ONLY.
- 208/230V UNITS ARE FACTORY WIRED FOR 230V OPERATION. FOR 208V OPERATION, REMOVE ORG LEAD AND REPLACE WITH RED LEAD. CAP ALL UNUSED LEADS.
- FOR ALTERNATE EMS COIL VOLTAGES CONSULT FACTORY.
- UPM-1 INCLUDES BUILT IN: 270-300 SECOND RANDOM START
300 SECOND DELAY ON BREAK
120 SECOND LOW PRESSURE BYPASS
- "TEST" DIP SWITCH REDUCES DELAYS TO 10 SEC WHEN SET TO YES. MUST BE SET TO "NO" FOR NORMAL OPERATION.
- "FREEZE SENSOR" WILL OPERATE AT 30°F BY DEFAULT. IF 15°F OPERATION IS REQUIRED JUMPERS R77 & R17 MUST BE CUT IF FREEZE SENSOR IS NOT INSTALLED A JUMPER SHALL BE INSTALLED BETWEEN THE FREEZE SENSOR TERMINALS.
- "ALARM OUTPUT" DIP SWITCH MUST BE SET TO "PULSE" IF BLINKING T-STAT SERVICE LIGHT IS DESIRED.
- DEFAULT SETTINGS FOR UPM BOARD FROM FACTORY SHOWN. ALSO SEE INSTALLATION MANUAL.
- ALARM OUTPUT IS NORMALLY OPEN (NO) DRY CONTACT. IF 24 VAC IS NEEDED, CONNECT R TO ALR-COM TERMINAL, 24VAC WILL BE SENSED ON THE ALR-OUT WHEN THE UNIT IS IN ALARM CONDITION. OUTPUT WILL BE PULSED IF PULSE IS SELECTED.
- CHECK FOR PROPER PHASE ROTATION ON UNITS WITH SCROLL COMPRESSORS. REVERSE ROTATION WILL DAMAGE THE COMPRESSOR AND VOID UNIT WARRANTY.
- REVERSING VALVES ARE WIRED TO A SEPARATE TRANSFORMER ON 30 TON UNITS
- REVERSING VALVES AND REVERSING VALVES RELAYS ARE NOT PRESENT ON "STRAIGHT COOL" UNITS.
- P1 & P2 INTERLOCKS OF THE BLOWER MOTOR(S) MUST BE CONNECTED IN SERIES WITH TERMINALS 10 & 16 OF THE VFD TO ENABLE THE SAFETY INTERLOCK OF THE VFD AND TO PROTECT THE MOTOR(S) FROM THERMAL DAMAGE. TERMINALS 11 & 12 MUST ALSO BE CONNECTED TOGETHER.



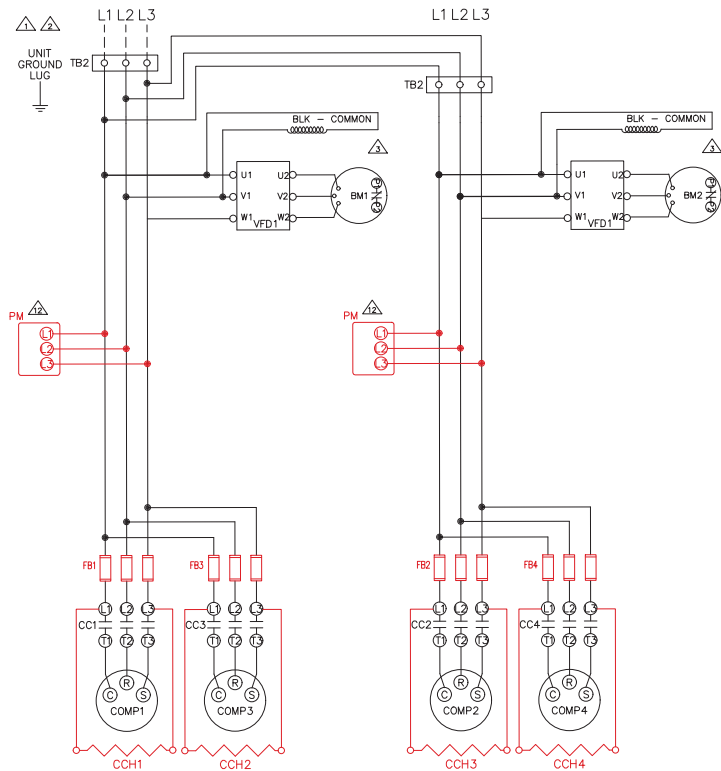
Typical control wiring schematics (cont)

NOTES:

1. SEE UNIT NAME PLATE FOR ELECTRICAL RATING
2. ALL FIELD WIRING MUST BE IN ACCORDANCE WITH N.E.C.—N.F.P.A. #70, COPPER CONDUCTORS ONLY, CONDUCTEURS EN CUIVRE SEULEMENT.
3. 208/230V UNITS ARE FACTORY WIRED FOR 230V OPERATION. FOR 208V OPERATION, REMOVE ORG LEAD AND REPLACE WITH RED LEAD. CAP ALL UNUSED LEADS.
4. 208/230V AND 460V BLOWER MOTORS HAVE 3 SPEED TAPS, 575V BLOWER MOTORS ARE SINGLE SPEED. FOR 460V BLOWER MOTORS, WIRE BLK AND ORG LEADS TOGETHER FOR MED OR LO SPEED OPERATION. CAP ALL UNUSED LEADS.
5. FOR ALTERNATE EMS COIL VOLTAGES CONSULT FACTORY.
6. UPM—I INCLUDES BUILT IN: 270—300 SECOND RANDOM START
300 SECOND DELAY ON BREAK
120 SECOND LOW PRESSURE BYPASS
7. "TEST" DIP SWITCH REDUCES DELAYS TO 10 SEC WHEN SET TO YES. MUST BE SET TO "NO" FOR NORMAL OPERATION.
8. "FREEZE SENSOR" WILL OPERATE AT 30°F BY DEFAULT, IF 15°F OPERATION IS REQUIRED JUMPERS R77 & R17 MUST BE CUT IF FREEZE SENSOR IS NOT INSTALLED A JUMPER SHALL BE INSTALLED BETWEEN THE FREEZE SENSOR TERMINALS.
9. "ALARM OUTPUT" DIP SWITCH MUST BE SET TO "PULSE" IF BLUNKING T—STAT SERVICE LIGHT IS DESIRED.
10. DEFAULT SETTINGS FOR UPM BOARD FOR FACTORY SHOWN, ALSO SEE INSTALLATION MANUAL.
11. ALARM OUTPUT IS NORMALLY OPEN (NO) DRY CONTACT. IF 24 VAC IS NEEDED, CONNECT R TO ALR—COM TERMINAL, 24VAC WILL BE SENSED ON THE ALR—OUT WHEN THE UNIT IS IN ALARM CONDITION. OUTPUT WILL BE PULSED IF PULSE IS SELECTED.
12. CHECK FOR PROPER PHASE ROTATION ON UNITS WITH SCROLL COMPRESSORS. REVERSE ROTATION WILL DAMAGE THE COMPRESSOR AND VOID UNIT WARRANTY.
13. REVERSING VALVES ARE WIRED TO A SEPARATE TRANSFORMER ON 30 TON UNITS.
14. (O) SIGNAL IS NOT WIRED FOR COOLING ONLY UNITS AND REVERSING VALVES/(RELAYS) ARE NOT PRESENT.

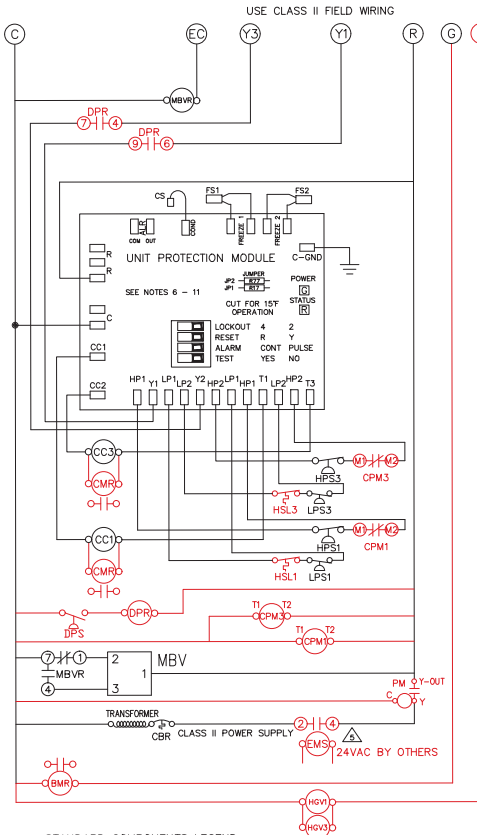


50BVJ020-034 Variable Air Volume Wiring Diagram



NOTES:

1. SEE UNIT NAME PLATE FOR ELECTRICAL RATING
2. ALL FIELD WIRING MUST BE IN ACCORDANCE WITH N.E.C. - N.E.P.A. #70, COPPER CONDUCTORS ONLY.
3. 208/230V UNITS ARE FACTORY WIRING FOR 230V OPERATION. FOR 208V OPERATION, REMOVE ORG LEAD AND REPLACE WITH RED LEAD. CAP ALL UNUSED LEADS.
4. 208/230V AND 460V BLOWER MOTORS HAVE 3 SPEED TAPS, 575V BLOWER MOTORS ARE SINGLE SPEED. FOR 460V BLOWER MOTORS, WIRE BLK AND ORG LEADS TOGETHER FOR MED OR LO SPEED OPERATION. CAP ALL UNUSED LEADS.
5. FOR ALTERNATE EMS COIL VOLTAGES CONSULT FACTORY.
6. UPM-I INCLUDES BUILT IN: 270-300 SECOND RANDOM START
300 SECOND DELAY ON BREAK
120 SECOND LOW PRESSURE BYPASS
7. "TEST" DIP SWITCH REDUCES DELAYS TO 10 SEC WHEN SET TO YES. MUST BE SET TO "NO" FOR NORMAL OPERATION.
8. "FREEZE SENSOR" WILL OPERATE AT 30°F BY DEFAULT. IF 15°F OPERATION IS REQUIRED JUMPER R42 MUST BE CUT. IF FREEZE SENSOR IS NOT INSTALLED A JUMPER SHALL BE INSTALLED BETWEEN THE FREEZE SENSOR TERMINALS.
9. "ALARM OUTPUT" DIP SWITCH MUST BE SET TO "PULSE" IF BLINKING T-STAT SERVICE LIGHT IS DESIRED.
10. DEFAULT SETTINGS FOR UPM BOARD FROM FACTORY SHOWN. ALSO SEE INSTALLATION MANUAL.
11. ALARM OUTPUT IS NORMALLY OPEN (NO) DRY CONTACT. IF 24 VAC IS NEEDED, CONNECT R TO ALR-COM TERMINAL, 24VAC WILL BE SENSED ON THE ALR-OUT WHEN THE UNIT IS IN ALARM CONDITION. OUTPUT WILL BE PULSED IF PULSE IS SELECTED.
12. CHECK FOR PROPER PHASE ROTATION ON UNITS WITH SCROLL COMPRESSORS. REVERSE ROTATION WILL DAMAGE THE COMPRESSOR AND VOID UNIT WARRANTY.
13. AQUASTAT IS CONNECTED BETWEEN Y1 AND C SIGNALS FOR STRAIGHT COOL UNITS AND NO REVERSING VALVES NOR REVERSING VALVE RELAYS WILL BE PRESENT.

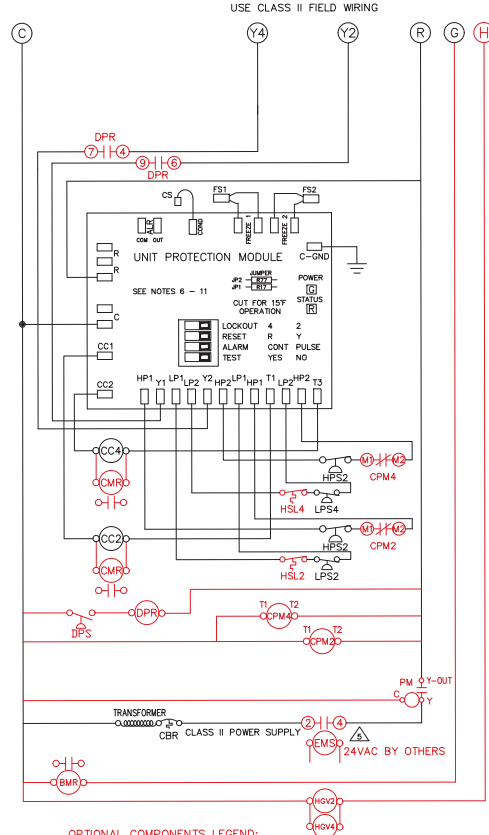


STANDARD COMPONENTS LEGEND:

- BM - BLOWER MOTORS (1 PER SECTION)
- BR - BLOWER RELAYS
- CC - COMPRESSOR CONTACTOR
- CBR - 24V CIRCUIT BREAKER
- CS - CONDENSATE SENSOR (1 PER DRAIN PAN)
- FS - FREEZE SENSORS
- HPS - HIGH PRESSURE SWITCHES
- LPS - LOW PRESSURE SWITCHES
- MBV - MOTORIZED BALL VALVE
- MBVR - MOTORIZED BALL VALVE RELAY
- MRV - MODULATING REHEAT VALVES
- TB2,3 - MAIN POWER TERMINAL BLOCKS

STATUS LED/ALARM BLINK CODES	
1	HIGH PRESSURE FAULT - CKT 1
2	LOW PRESSURE FAULT - CKT 1
3	HIGH PRESSURE FAULT - CKT 2
4	LOW PRESSURE FAULT - CKT 2
5	FREEZE SENSOR FAULT
6	CONDENSATE FAULT
7	BROWN OUT FAULT

TRANSFORMER PRIMARY LEAD CLR:	
120	- WHT
208	- RED
240	- ORG
277	- BRN
380	- PUR OR YEL
460	- BLK/RED
575	- GRY

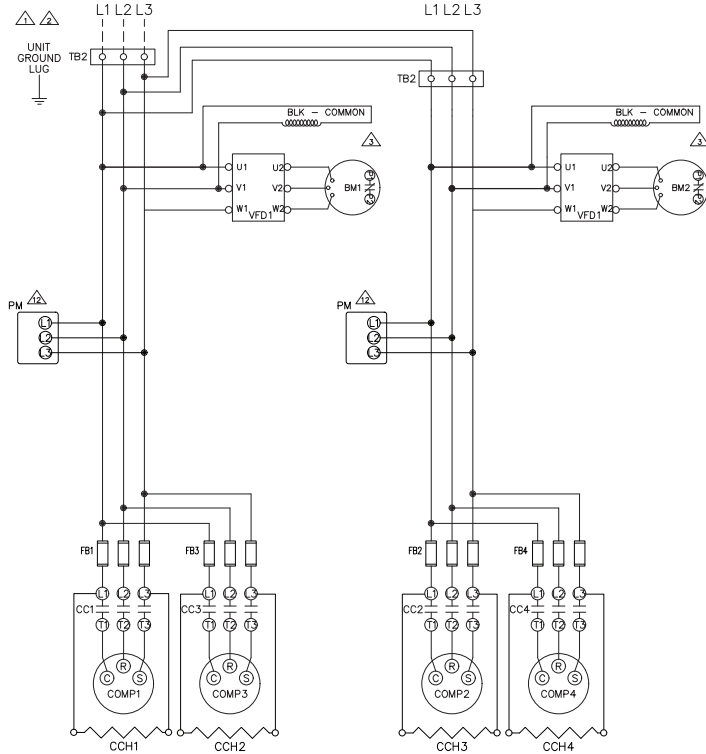


OPTIONAL COMPONENTS LEGEND:

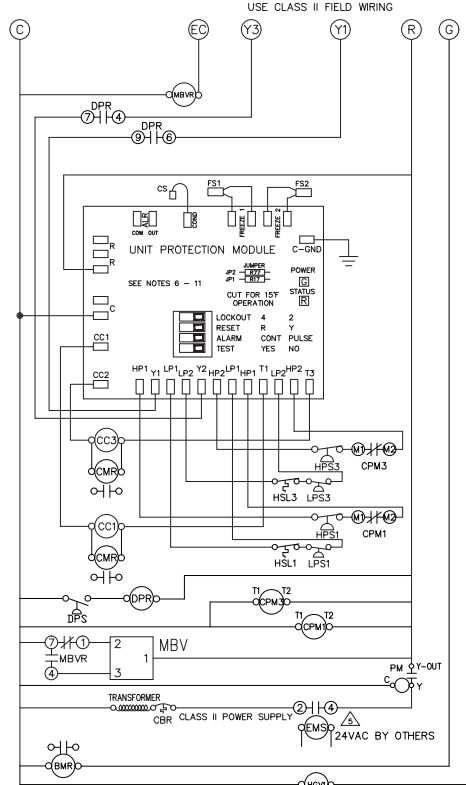
- [] AUX - AUXILIARY RELAY (FOR LOOP PUMP, ETC.)
- [] BMR - BLOWER MONITOR RELAY
- [] CCH - CRANKCASE HEATER
- [] CMR - COMPRESSOR MONITOR RELAY
- [] CPM - COMPRESSOR PROTECTION MODULE (15 TON AND LARGER COMPRESSORS)
- [] DPS - DIFFERENTIAL PRESSURE SWITCH
- [] DPR - DIFFERENTIAL PRESSURE RELAY
- [] EMS - ENERGY MGMT SYSTEM RELAY
- [] FB - FUSE BLOCK
- [] HSL - HIGH TEMP SUCTION LIMIT (WITH H.G. BYPASS ONLY)
- [] HGV - HOT GAS VALVE SOLENOID (UNITS WITH DDC AND HGRH ONLY)
- [] PM - PHASE MONITOR

FACTORY WIRE — — —
FIELD WIRE — — —

50BVW044-064 Variable Air Volume Control UPM and Economizer Wiring Diagram



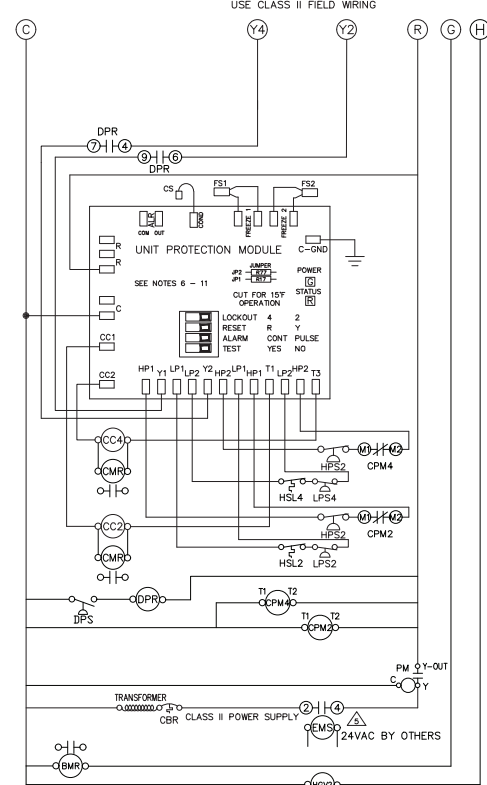
- NOTES:**
- SEE UNIT NAME PLATE FOR ELECTRICAL RATING
 - ALL FIELD WIRING MUST BE IN ACCORDANCE WITH N.E.C.-N.F.P.A. #70, COPPER CONDUCTORS ONLY.
 - 208/230V UNITS ARE FACTORY WIRED FOR 230V OPERATION. FOR 208V OPERATION, REMOVE ORG LEAD AND REPLACE WITH RED LEAD. CAP ALL UNUSED LEADS.
 - 208/230V AND 460V BLOWER MOTORS HAVE 3 SPEED TAPS. 575V BLOWER MOTORS ARE SINGLE SPEED. FOR 460V BLOWER MOTORS, WIRE BLK AND ORG LEADS TOGETHER FOR MED OR LO SPEED OPERATION. CAP ALL UNUSED LEADS.
 - FOR ALTERNATE EMS COIL VOLTAGES CONSULT FACTORY.
 - UPM-I INCLUDES BUILT IN: 270-300 SECOND RANDOM START
300 SECOND DELAY ON BREAK
120 SECOND LOW PRESSURE BYPASS
 - "TEST" DIP SWITCH REDUCES DELAYS TO 10 SEC WHEN SET TO YES. MUST BE SET TO "NO" FOR NORMAL OPERATION.
 - "FREEZE SENSOR" WILL OPERATE AT 30°F BY DEFAULT. IF 15°F OPERATION IS REQUIRED JUMPER R42 MUST BE CUT IF FREEZE SENSOR IS NOT INSTALLED A JUMPER SHALL BE INSTALLED BETWEEN THE FREEZE SENSOR TERMINALS.
 - "ALARM OUTPUT" DIP SWITCH MUST BE SET TO "PULSE" IF BLINKING T-STAT SERVICE LIGHT IS DESIRED.
 - DEFAULT SETTINGS FOR UPM BOARD FROM FACTORY SHOWN. ALSO SEE INSTALLATION MANUAL.
 - ALARM OUTPUT IS NORMALLY OPEN (NO) DRY CONTACT. IF 24 VAC IS NEEDED, CONNECT R TO ALR-COM TERMINAL. 24VAC WILL BE SENSED ON THE ALR-OUT WHEN THE UNIT IS IN ALARM CONDITION. OUTPUT WILL BE PULSED IF PULSE IS SELECTED.
 - CHECK FOR PROPER PHASE ROTATION ON UNITS WITH SCROLL COMPRESSORS. REVERSE ROTATION WILL DAMAGE THE COMPRESSOR AND VOID UNIT WARRANTY.
 - AQUASTAT IS CONNECTED BETWEEN Y1 AND C SIGNALS FOR STRAIGHT COOL UNITS AND NO REVERSING VALVES NOR REVERSING VALVE RELAYS WILL BE PRESENT.



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6	CONDENSATE FAULT
7	BROWN OUT FAULT

TRANSFORMER PRIMARY LEAD CLR:	
120	- WHI
208	- RED
240	- ORG
277	- BRN
380	- PUR OR YEL
460	- BLK/RED
575	- GRN



- OPTIONAL COMPONENTS LEGEND:**
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 - [] BMR - BLOWER MONITOR RELAY
 - [] CCH - CRANKCASE HEATER
 - [] CMR - COMPRESSOR MONITOR RELAY
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 - [] HGV - HOT GAS VALVE SOLENOID (UNITS WITH DDC AND HGRH ONLY)
 - [] PM - PHASE MONITOR

FACTORY WIRE ————
FIELD WIRE - - - - -

Location

The unit must be properly located and installed indoors. Selected location should not be adjacent to an acoustically sensitive location such as a conference room or office area. The best location is a mechanical room, next to elevators, restrooms, or stairways. The mechanical room should be constructed to help isolate the transmission of acoustical energy.

Unit isolation

Unit compressors are internally isolated and the compressor compartment is lined with acoustical insulation. If additional vibration isolation is desired, rubber shear pads are recommended under the four corners of the unit. Spring isolation is not recommended.

Ductwork

The supply duct should be properly supported and the aspect ratio as close to square as possible. The duct should be sized for a maximum of 2000 ft/min. velocity in areas outside the equipment room. The duct should be lined with acoustical insulation for a minimum of 10 ft beyond the equipment room. A flexible duct connection should be used on the connection to the unit to prevent transmission of any unit vibrations into the duct. Refer to the Carrier System Design Manual or ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Standards for recommended duct connection to unit with 2 fans.

NOTE: All 2 fan units require a "pair of pants" duct connection to ensure proper air distribution and prevent undue stress on the fan assembly.

A return duct may be attached to the unit, but is not necessary. The return to the unit should prevent line of sight visibility to the space. Insulated return duct is also recommended. The maximum velocity should not exceed 1000 ft/min. over occupied spaces. An adequate return area is essential for proper unit operation.

Piping

Recommended system piping configuration includes a reverse return system to minimize balancing. A strainer is recommended at the inlet to each unit to prevent sediments from plugging the condensers. Pressure gauges are also

recommended before the strainer and at the unit outlet to check any potential condenser fouling. Gate type isolation valves are also recommended at each unit to allow service without the need to drain the entire system.

Low entering water temperatures

In applications where the entering water temperature can drop below 55°F, consider equipping the unit with the extended range option to prevent condensation. The waterside economizer option is also recommended for free cooling and to raise the entering water temperature to allow for mechanical cooling.

In applications where mechanical cooling is required with low entering water temperatures, consider adding a tower bypass valve to raise the unit entering water temperature or a refrigerant or temperature activated water regulating valve to the first circuit of the unit.

Part load limits

50BVJ (20-30 tons) Minimum Cooling Airflow: 200 cfm/ton
50BVW (30-60 tons) Minimum Cooling Airflow: 17 cfm/ton

Multiple independent circuit operation

CV units have either two (size 034) or four (size 044-064) independent refrigerant circuits. Consider applying a thermostat or DDC controller that matches the unit staging capability for maximum performance. Otherwise, field wiring may be needed to match a higher number of available cooling or heating stages to a thermostat or DDC controller with a lower amount of cooling or heating stages.

Operation with dry cooler

The unit may be operated on a system that uses a dry cooler rather than a cooling tower. In this case, the saturated condensing temperature must be kept below 110°F for proper unit operation. If antifreeze is used in the system, the capacity must be adjusted for the solution concentration.

Operation with antifreeze

When units are operating in a system that will use antifreeze, use the following table to estimate system performance. Antifreeze concentrations above 35% are not recommended.

Antifreeze Correction Table

ANTIFREEZE TYPE	ANTIFREEZE %	COOLING			HEATING		WPD CORRECTION FACTOR
		EWT 90°F			EWT 30°F		
		Total Capacity	Sensible Capacity	kW	Heating Capacity	kW	EWT 30°F
Water	0	1.000	1.000	1.000	1.000	1.000	1.000
Propylene Glycol	5	0.997	0.997	1.004	0.989	0.997	1.060
	10	0.994	0.994	1.006	0.986	0.995	1.125
	15	0.990	0.990	1.009	0.978	0.988	1.190
	25	0.983	0.983	1.016	0.960	0.979	1.300
	30	0.979	0.979	1.020	0.950	0.974	1.736
	35	0.975	0.974	1.024	0.940	0.969	1.834
Methanol	5	0.997	0.997	1.003	0.990	0.997	1.060
	10	0.996	0.996	1.005	0.979	0.993	1.100
	15	0.994	0.994	1.008	0.970	0.990	1.140
	20	0.992	0.992	1.011	0.961	0.987	1.248
Ethanol	5	0.998	0.998	1.002	0.981	0.994	1.160
	10	0.996	0.996	1.004	0.960	0.988	1.230
	15	0.992	0.992	1.006	0.944	0.983	1.280
	25	0.986	0.986	1.009	0.917	0.974	1.400
Ethylene Glycol	5	0.997	0.997	1.003	0.993	0.998	1.060
	10	0.995	0.995	1.004	0.986	0.996	1.120
	15	0.992	0.992	1.005	0.980	0.993	1.190
	25	0.988	0.988	1.009	0.970	0.990	1.330
	30	0.985	0.985	1.012	0.965	0.987	1.400

LEGEND

EWT — Entering Water Temperature
WPD — Water Pressure Differential

Water Quality Guidelines

CONDITION	HX MATERIAL ^a	CLOSED RECIRCULATING ^b	OPEN LOOP AND RECIRCULATING WELL ^c		
Scaling Potential — Primary Measurement					
Above the given limits, scaling is likely to occur. Scaling indexes should be calculated using the limits below.					
pH/Calcium Hardness Method	All	N/A	pH < 7.5 and Ca Hardness, <100 ppm		
Index Limits for Probable Scaling Situations (Operation outside these limits is not recommended.)					
Scaling indexes should be calculated at 150°F for direct use and HWG applications, and at 90°F for indirect HX use. A monitoring plan should be implemented.					
Ryznar Stability Index	All	N/A	6.0 - 7.5 If >7.5 minimize steel pipe use.		
Langelier Saturation Index	All	N/A	-0.5 to +0.5 If <-0.5 minimize steel pipe use. Based upon 150°F HWG and direct well, 85°F indirect well HX.		
Iron Fouling					
Iron Fe ²⁺ (Ferrous) (Bacterial Iron Potential)	All	N/A	<0.2 ppm (Ferrous) If Fe ²⁺ (ferrous) >0.2 ppm with pH 6 - 8, O ₂ <5 ppm check for iron bacteria.		
Iron Fouling	All	N/A	<0.5 ppm of Oxygen Above this level deposition will occur.		
Corrosion Prevention^d					
pH	All	6 - 8.5 Monitor/treat as needed.	6 - 8.5 Minimize steel pipe below 7 and no open tanks with pH <8.		
Hydrogen Sulfide (H ₂ S)	All	N/A	<0.5 ppm At H ₂ S>0.2 ppm, avoid use of copper and cupronickel piping or HXs. Rotten egg smell appears at 0.5 ppm level. Copper alloy (bronze or brass) cast components are okay to <0.5 ppm.		
Ammonia Ion as Hydroxide, Chloride, Nitrate and Sulfate Compounds	All	N/A	<0.5 ppm		
Maximum Chloride Levels			Maximum allowable at maximum water temperature.		
			50°F (10°C)	75°F (24°C)	100°F (38°C)
	Copper	N/A	<20 ppm	NR	NR
	Cupronickel	N/A	<150 ppm	NR	NR
	304 SS	N/A	<400 ppm	<250 ppm	<150 ppm
	316 SS	N/A	<1000 ppm	<550 ppm	<375 ppm
	Titanium	N/A	>1000 ppm	>550 ppm	>375 ppm
Erosion and Clogging					
Particulate Size and Erosion	All	<10 ppm of particles and a maximum velocity of 6 fps. Filtered for maximum 800 micron size.	<10 ppm (<1 ppm “sandfree” for reinjection) of particles and a maximum velocity of 6 fps. Filtered for maximum 800 micron size. Any particulate that is not removed can potentially clog components.		
Brackish	All	N/A	Use cupronickel heat exchanger when concentrations of calcium or sodium chloride are greater than 125 ppm are present. (Seawater is approximately 25,000 ppm.)		

NOTE(S):

- Heat exchanger materials considered are copper, cupronickel, 304 SS (stainless steel), 316 SS, titanium.
- Closed recirculating system is identified by a closed pressurized piping system.
- Recirculating open wells should observe the open recirculating design considerations.
- If the concentration of these corrosives exceeds the maximum allowable level, then the potential for serious corrosion problems exists.
Sulfides in the water quickly oxidize when exposed to air, requiring that no agitation occur as the sample is taken. Unless tested immediately at the site, the sample will require stabilization with a few drops of one Molar zinc acetate solution, allowing accurate sulfide determination up to 24 hours after sampling. A low pH and high alkalinity cause system problems, even when both values are within ranges shown. The term pH refers to the acidity, basicity, or neutrality of the water supply. Below 7.0, the water is considered to be acidic. Above 7.0, water is considered to be basic. Neutral water contains a pH of 7.0.
To convert ppm to grains per gallon, divide by 17. Hardness in mg/l is equivalent to ppm.

LEGEND

- HWG** — Hot Water Generator
HX — Heat Exchanger
N/A — Design Limits Not Applicable Considering Recirculating Portable Water
NR — Application Not Recommended
SS — Stainless Steel

Unit Protection Module (UPM)

General description

All 50BV units (CV and VAV) include a factory installed unit protection module (UPM). The UPM is designed to protect the unit refrigerant circuit by monitoring the control inputs and unit safeties before enabling the compressors for operation. The UPM features thermostatic style inputs for use with a field installed thermostat or DDC controller for CV units. Below are some of the features and functions of the UPM.

Alarm relay

The UPM includes an alarm relay that can be used to indicate to an external source when the UPM is in alarm. The alarm relay can be configured as either a dry contact, a 24VAC output, or a pulse output.

Condensation overflow

The UPM controller continuously monitors the drain pan for high condensate water level by utilizing a sensor. It identifies an alarm condition when the sensor's impedance drops below 230,000 ohms $\pm$ 15%. Once the UPM senses this resistance value it enters into a hard lockout and reports the corresponding code via its status LED (6 flashes).

Random start-up delay

This feature prevents multiple units sharing the same electrical circuit or network from starting at the same time. It assures that units sharing the same electrical circuit do not

demand high inrush currents simultaneously when starting back up after a power failure.

If the controller has been completely powered down for more than 28 milliseconds, a random delay is initiated. If the controller is set to normal operation (test switch set to NO), then typically the unit will start within the time range of 270 and 300 seconds.

In order for the random sequence to initiate the unit power must be removed completely.

IMPORTANT: If the board is set to "TEST" mode through the "TEST" DIP switch, SW1 delay will be 10 seconds.

Anti-short cycle delay

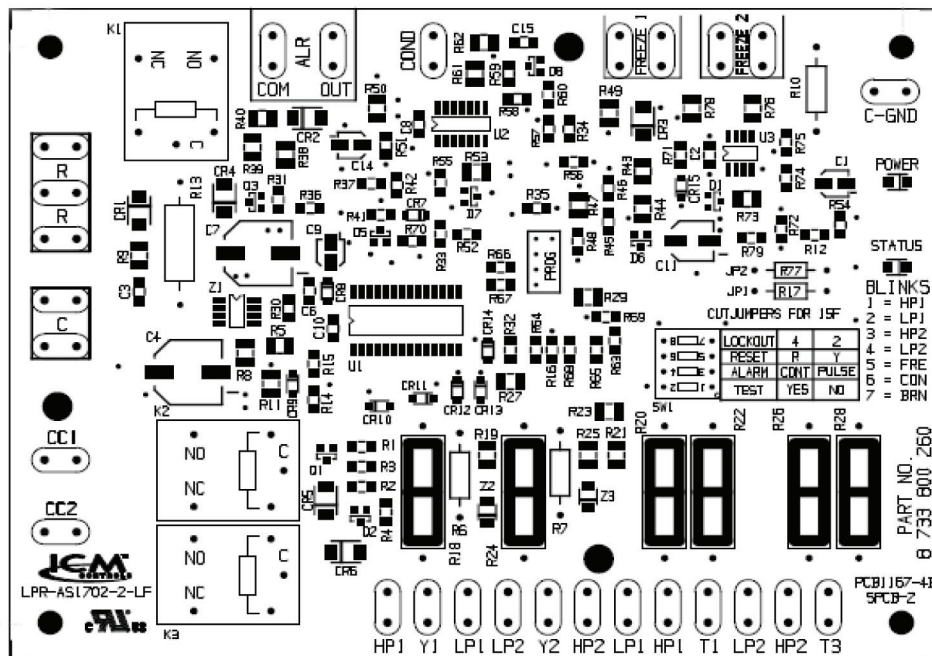
This feature protects the compressor short cycling if the Y call is set and removed. The anti-short cycle delay is 300 seconds on break during normal operation.

If the board is set to test mode through the "TEST" DIP switch, the delay will be 5 seconds.

High and low pressure protection

The UPM monitors the state of the High and Low pressure switch inputs of each refrigerant circuit, HP1, LP1, HP2, and LP2. These switches must be closed for the controller to energize the compressor output (CC1 and CC2). The CC output will only be energized when the switches are closed and the anti-short cycle (and/or random start-up when applicable) has expired.

Two-Stage Unit Protection Module



Brownout protection

The UPM controller will constantly monitor the power supply; if the nominal voltage drops below 25% of its value, (18 VAC approximately), the unit will enter brownout protection mode. The compressor output will be de-energized the unit will enter the soft lockout mode. The controller will not monitor the power supply during the first 500 milliseconds of compressor start up to avoid nuisance and false alarms.

Freeze protection

The water side freeze protection sensor, mounted close to coaxial coil, monitors refrigerant temperature between the water coil and thermal expansion valve (TXV). If temperature drops below or remains at freeze limit trip for 30 seconds, the UPM will shut down the compressor and enter into a soft lockout condition. The default freeze limit is 26°F, however this can be changed to 15°F by cutting the R30 or freeze 1 resistor located on top of DIP switch bank. The evaporator freeze protection sensor, mounted after the TXV, monitors the refrigerant temperature between the TXV and indoor air coil. If temperature drops below or remains at freeze limit trip for 30 seconds, the UPM will shut down the compressor and enter into a soft lockout condition. The default freeze limit trip is 26°F.

Intelligent reset

If a fault condition is initiated, the 5 minute delay on break time period is initiated. The unit will restart after the delays expire. If the fault has cleared, the unit will resume normal operation. If the fault condition still exists or occurs 2 or 4 times (depending on the UPM setting) before 60 minutes, the unit will go into a hard lockout and requires a manual lockout reset. A single condensate overflow fault will cause the unit to go into a hard lockout immediately, and will require a manual lockout reset. Hard lockout can be reset by power cycling the unit.

Service test mode

Allows service personnel to check the operation of the WSHF and control system efficiently. Upon entering Test mode, time delays speed up, and the Status LED flashes a code to indicate the last fault experienced.

LED power and fault indicator

The UPM module features a power and fault LED to assist with troubleshooting. The green power LED will be lit when the unit has a proper power feed. The red fault LED will be lit when there is a unit fault and will blink to indicate the type of fault, to simplify unit troubleshooting.

Sequence of operation, CV units

The following sequence of operation applies to constant volume units (50BVT,V).

Control of cooling, heating, dehumidification, and fan only is enabled by an external thermostat or DDC control when

interfacing with the unit thermostatic inputs and the UPM module. The unit sequence of operation is as follows:

Fan only mode

Contact closure at the G terminal will enable the supply fan for operation. For units with SAV™, the fan will operate at low fan speed if there is no additional call heating, cooling, or dehumidification.

Cooling mode

Cooling is engaged when there is contact closure at the Y1 input on cooling only units or the Y1 input and O reversing valve input for heat pump units. The UPM module will engage the compressor contact (CC) after the random start delay or short cycle relay has expired.

Subsequent contact closures at Y2, Y3 (044-064), and Y4 (044-064) units will engage further stages of cooling. For units with SAV, the supply fan will operate at high speed during any call for Y2-Y4.

For units with waterside economizer, if the entering water temperature drops below the Aquastat entering water temperature set point and there is a call for Y1 cooling, the waterside economizer is enabled. The three way valve will divert water to the economizer coil.

If there is a subsequent call for Y2 cooling, the UPM module will enable the Y1 compressor. A call for Y3 will enable the Y2 compressor.

If during economizer operation the entering water temperature rises above the Aquastat entering water temperature set point, the unit will exist economizer mode and enter regular cooling mode. The three way valve will direct water to the coaxial coil, only.

Heating mode (heat pump units only)

Heat pump heating is engaged where there is a contact closer at the Y1 input and no contact closure on the O reversing valve input. For units with SAV, the fan will operate at full fan speed.

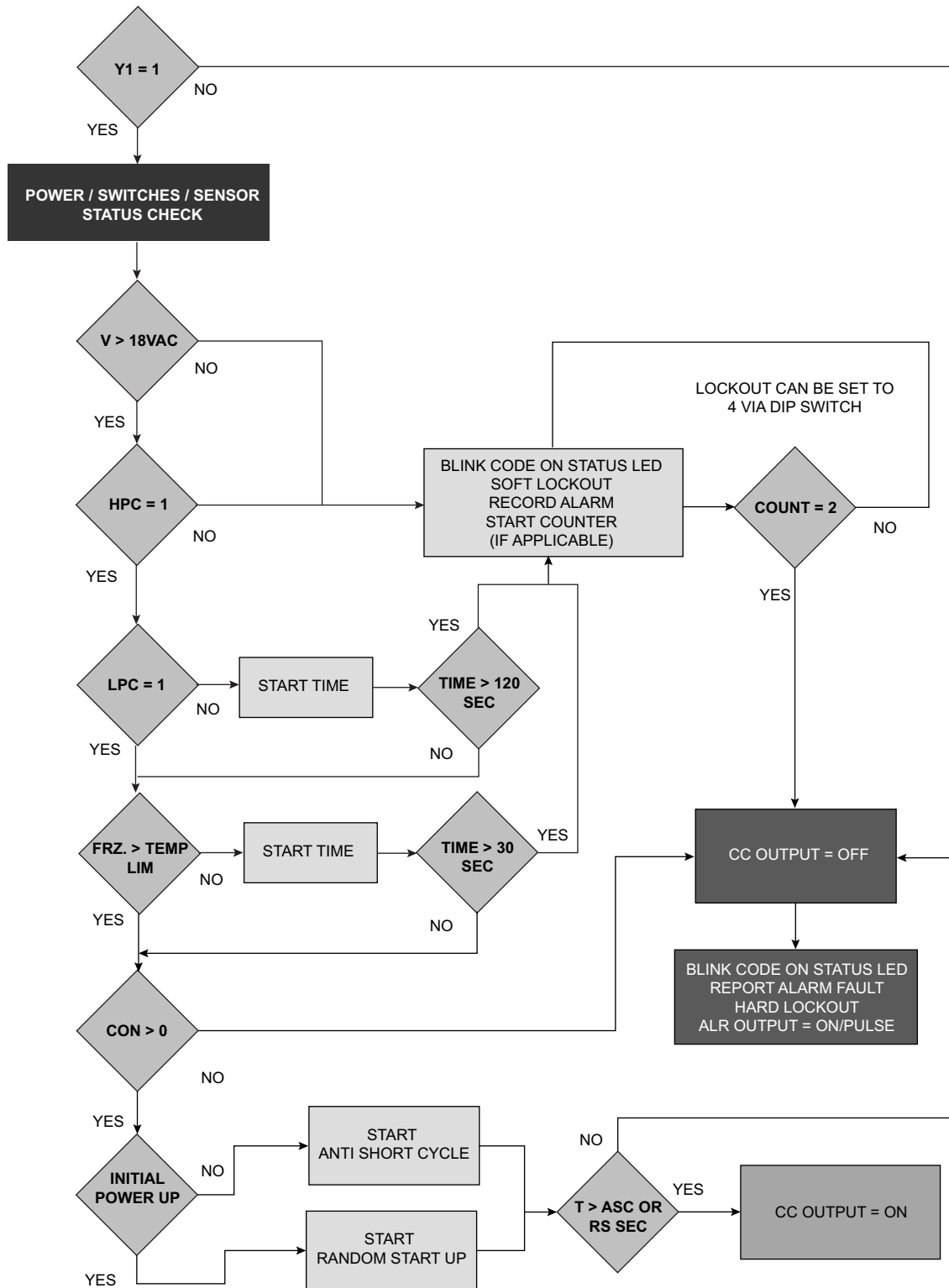
Subsequent contact closures at Y2, Y3 (044-064), and Y4 (044-064) units will engage further stages of heat pump heating.

Dehumidification mode

For units with the optional on/off HGRH, a contact closure at the H dehumidification input will enable dehumidification mode. The reversing valve, all unit compressors, and the reheat valves will be enabled for operation. For units with SAV, the fan will operate at high fan speed. Any call for cooling or heating at the Y1 input will override a call for dehumidification and put the unit into cooling or heating mode.

For units with modulating HGRH, an input is provided at the reheat valve that accepts a 0-10V signal from an external controller. When the compressor is operating and a 1-10V signal is applied at the reheat valve, the reheat valve will release refrigerant into the HGRH coil to reheat the air leaving the evaporator coil.

UPM Sequence of Operation Flowchart



General description

All 50BVJ and W VAV units include a factory mounted, wired, and programmed ALC I/O Flex 6126 DDC controller with expander module. The controller is factory programmed for multi-zone VAV control with a water cooled unit.

The DDC controller can operate stand alone or integrate with a building automation system using BACnet (ARCnet and MS/TP), Modbus, or Lonworks (with optional Lon card). Local interface to the DDC control is accomplished through the Virtual BACview PC based software with USB Link cable.

Key features and benefits

- Point count: 6 digital outputs, 12 universal inputs, and 6 analog outputs.
- Point count: 8 digital outputs, 8 digital inputs and 8 analog inputs
- Built-in protocol support: BACnet (ARCNET and MS/TP) and Modbus.
- Built-in local access support: BACview⁶ keyboard/display.
- On-board lithium battery holds controller time clock settings
- Program archived in non-volatile memory allows unit to be ready after long periods of power outages.
- Parameter settings archived in nonvolatile memory allows unit configuration to be available after long periods of power outages.

Control and status parameters and alarms

Control

- BACview occupancy schedule
- System control: Schedule, Manual ON, BAS command, or DI Enable
- Unit blower control
- Compressor 1 control
- Compressor 2 control
- Compressor 3 control
- Compressor 4 control
- Unit enable manual control (optional)
- Discharge air control with modulating HGRH
- Condenser water valve control (flex required)
- Economizer control
- Damper control

Status

- Cooling control status
- Cooling demand percentage (0-100%)
- Discharge air temperature
- Return air temperature
- Leaving water temperature
- Entering water temperature
- Unit filter status (optional)
- Fan-hours runtime counter (filter replacement indicator)
- Fan starts counter

- Compressor 1 starts counter
- Compressor 2 starts counter
- Compressor 3 starts counter
- Compressor 4 starts counter

Alarms

- Leaving water temperature high/low trip
- Discharge air temperature high/low trip
- Entering water temperature high/low trip
- Sensor failure alarm
- Unit filter runtime trip (optional)
- Comp 1 runtime trip
- Comp 2 runtime trip
- Comp 3 runtime trip
- Comp 4 runtime trip
- Freeze stat sensor UPM alarm (optional)
- Low pressure sensor UPM alarm
- High pressure sensor UPM alarm
- Low pressure sensor UPM alarm
- High pressure sensor UPM alarm
- Condensate overflow UPM alarm
- High/low voltage UPM alarm

Sequence of operation, VAV units

Control source (run conditions)

The unit may have external or internal control sources to initiate heating or cooling operation.

External control source

The unit may be controlled from the following external sources:

- Digital Input
- BAS – Building Automation System
- Manual On

Digital input

Provides a method of running the unit by providing a contact closure (On/Off) to UI-12. Digital input provides a simple interface for enabling unit operation. Once enabled, the unit will run until the occupied set point has been satisfied.

BAS

Provides a network interface to the heat pump. The I/O Flex 6126 controller supports the following building automation protocols:

COMMUNICATION PROTOCOL	
BACnet	Building Automation and Control network
Modbus	Common open industrial protocol standard
LonWorks	LonWorks Automation and control network (Card required)

Manual On

Places the unit in manual run mode; the unit will operate until the set point is satisfied.

Internal control source (keypad)

All controllers are provided with a battery backup real time clock. When configured for Keypad, the internal scheduler uses the local time and user schedule to initiate unit operation. Occupied schedule: 56°F supply air set point (adjustable).

Unit mode

The unit mode is used to configure the unit per its specific design configuration and application. A unit mode may be selected from the following:

- Cooling only
- Cooling only with hot gas reheat

Cooling only

The unit is configured for mechanical cooling.

Cooling only with hot gas reheat

The unit is configured for cooling only with active humidity control. Please see Discharge Air Control with Modulating Reheat on page 55 for additional details.

Fan modes

The Fan mode option is used to select the type of fan hardware being used with the unit. Fan hardware is application specific and will determine the behavior for the specific application for which it is being applied.

The Fan option may be configured with one of the following options:

- Supply Air Fan (SAF) Start/Stop (also known as On/Off signaling)
- Variable Frequency Drive (or Variable Fan used in VAV applications)
- Return Fan interlock with Supply Fan (if SAF runs RAF runs)

Start/stop fans

The fan enable signal is provided on BO-1 of the I/O Flex 6126 controller; operation is interlocked with cooling and reheat operations. The return air fan can be enabled via the BACview tool, and it will be commanded 5 seconds after the supply fan has been engaged at all times.

The supply fan can also be set to stop if the return fan is in alarm via the BACview tool.

Variable frequency drive (VFD) fan

The VFD uses an analog signal (0-10V) to control the speed of the blower. This signal is output from Analog Output 1 (AO-1) of the I/O Flex 6126 controller.

The supply and return air fan speeds are modulated by independent proportional integral derivative loops (PID) to maintain independent static pressure set points; the factory-provided duct static pressure sensor is required as input (connected to UI-11 for supply and IN-10 for return) on the I/O Flex 6126 controller and I/O Flex EX8160 expander, for the VFD blower option. Units do not allow for mounting of the return fan VFD inside the equipment and require the VFD equipment to be mounted close to the unit. An inside wall in the mechanical room close to the unit is typically used for mounting an external VFD. Return fans are not included inside the 50BV units.

Supply and return fan operation

When the unit control is set for occupied operation the fan will run continuously as the default behavior. If the return

fan is enabled, it will follow the operation of the supply fan mode which may be modified to cycle only during mechanical operation. During unoccupied operation the fan will only cycle during a call to maintain a cooling set point. Return fans are not included inside the 50BV units.

Fan operation during discharge (supply air temperature) air control (DAC)

For DAC applications, the fan speed is calculated as a demand percent calculated based on the PID static pressure sensor value and the static pressure set point.

If static pressure reset strategies are utilized, the minimum fan speed recommended is 40% of nominal cfm. If the fan demand is less than 40% of nominal cfm (20% for the return fan) the PID loop will be disregarded and the fan will run at the minimum value.

Units configured for discharge air control will run only when the controller is in occupancy mode.

VFD control

The following applies for VFD control:

- Variable frequency drive fan control requires a static pressure measurement. A duct static pressure sensor is factory supplied to be installed in the field.
- The static pressure sensor uses inches of water column as the unit of measure.
- The static pressure sensor is configured for UI-11 port of the I/O Flex 6126 controller for the supply duct and IN-10 for the return air duct.
- The static pressure set point is user configurable and is used by the static pressure PID control.
- The minimum VFD fan speed is user configurable and is set during the test and balance phase of the commissioning phase.
- A high static pressure alarm will be generated for a static pressure exceeding the maximum static pressure trip point for a minimum of 10 minutes.
- The static pressure sensor will be range-validated and a sensor failure alarm will be generated for a missing sensor.
- The VFD output may be switched to a constant value for a smoke event if enabled.
- For VFD factory-installed parameters, please see latest 50BV Installation, Start-Up, Service and Controls Operation and Troubleshooting manual.

Fan operation during smoke event

The speed of the fan during a smoke event is user configurable for VFD enabled units (defaults to 100%).

Fan history statistics

The controller will collect fan history statistics and sum the total number of fan start events that occurred in the preceding 1-hour period. The fan history may be reset by the user. Fan history reset may be performed locally at the unit with a BACview terminal.

Digital inputs for monitoring

The controller software may be configured to provide digital inputs for monitoring unit faults and alarms. The equipment integrator must configure the input for the appropriate installed option and desired function. The functional options may be configured via a local terminal or building automation system.

Filter status (DFS)

The I/O Flex 6126 controller has the option of providing a filter alarm for indicating that the filter needs servicing. The filter-status service option may be implemented with hardware or with fan run time. The filter switch hardware is field provided and installed, and is connected directly to IN-4 on the I/O Flex EX8160 expander with a contact closure indicating a service event.

The following applies to the filter status:

- The filter status (replacement) may be configured for accumulated running time.
- The total fan run time prior to filter service is user configurable, factory default 2000 hrs.
- The filter timer may be reset upon the filter being serviced.

Water differential pressure switch (DPS)

A field supplied and installed differential pressure/flow proving switch can be provided to prove flow before the unit compressors will operate. The differential pressure switch hardware is connected directly to IN-6.

In addition, the following applies to the DPS option:

- An alarm notification is set if the DPS is asserted True (No flow condition).
- A DPS alarm will terminate compressor operation.
- Three DPS events will hard lockout the unit.
- The DPS hard lockout condition which will keep the unit off can be cleared by a reset via the BACview tool.
- A sum of all DPS events will be logged for a 1-hour period.

Smoke detector status (SDS)

The unit may be set up to receive a smoke event via a contact closure. The smoke detector input is available for field wiring on IN-1 of the I/O Flex EX8160 expander.

The response to a smoke event must be determined by safety regulations and jurisdiction of the local governing body. The smoke detector response must be enabled and set up upon system start-up. The default behavior for a smoke event will terminate the operation of the unit (fan and compressor).

The unit may be configured for operation during a smoke event for specific safety applications. Variable frequency drive configured units can be configured for a specific fan speed during a smoke event.

A smoke detector contact closure on IN-1 will produce a Smoke Alert.

Compressor status

The unit is equipped with compressor status current transducers and Input Expansion Modules (IEMs) and will verify that the compressor stages are running by monitoring the status of the current switches. If the compressor fails (no current flow) an individual alarm per compressor stage will occur.

The controller will identify the compressor operating in the following three modes:

- Auto (No alarm)
- Hand Mode
- Failed

Cooling operation

The controller will maintain the supply air temperature and set point by staging the compressor(s). To prevent short-cycling, there is a 10-minute delay between compressor stages. Additionally, there will be a 3-minute delay (adj.) to prove water flow prior to Compressor 1 operation when the unit is first powered on. The compressor will run subject to internal safeties and controls provided by the UPM board. For discharge air control applications, the following minimum on-times and off-times are applicable:

Discharge Air Control

COMPRESSOR							
1		2		3		4	
Min ON	Min OFF	Min ON	Min OFF	Min ON	Min OFF	Min ON	Min OFF
10	5	10	5	10	5	7	5

If for any reason the compressor alarms reset, the unit compressors will start within 10 seconds of each other.

Cooling

Cooling will be enabled whenever:

- Unit is in occupied mode
- The fan output is on
- The loop valve is open

Cooling mode

When commanded into cooling mode, the unit will energize the condenser water valve and wait for its valve end switch to be made prior to energizing the compressors.

Once the valve has been proved open the unit will command the compressor to stage according to the cooling percentage required. This value is provided via a reverse acting PID loop which compares the supply air temperature (SAT) value and the SAT cooling set point.

The unit monitors return air temperature to assure air entering the unit is greater than 60°F (adj.) prior to running in the cooling with modulating hot gas reheat, when the controller is set to operate with multiple reset points. If the controller is set to operate with single return temperature reset the factory default value will be the free cooling value 50°F (adj.)

If at any time the cooling set point is greater than the return air temperature (RAT) the unit will enter into economizer assist mode.

Compressors will be staged as follows.

Compressor 1 will run:

- When the fan is running
- AND the condenser valve is proved.
- AND the cooling demand is greater than 25%

Compressor 2 will run:

- When compressor 1 has run for 10 min
- AND the cooling demand is greater than 50%

Compressor 3 will run:

- When compressor 2 has run for 10 min
- AND the cooling demand is greater than 75%

Compressor 4 will run:

- When compressor 3 has run for 10 min
- AND the cooling demand is greater than 90%

When the unit runs in cooling mode the hot gas reheat valve will be enabled and modulated to maintain supply air temperature set point; factory default is 55°F ± 4°F.

Discharge air control with modulating reheat

When in cooling mode, if the unit is equipped with modulating hot gas reheat, the hot gas reheat will be enabled and modulated to maintain supply air temperature set point; factory default is 55°F (adj.) ± 4°F.

The cooling stages can be reset based on a single point or multiple return air temperature (RAT) values as follows:

Single:	
Free Cooling	50°F < RAT
Mechanical Cooling	RAT > 50°F (enabled)
Multiple:	
Free Cooling	50°F < RAT < 59°F
Mechanical Cooling	
(Comp 1)	60°F < RAT < 69°F (adj.)
Mechanical Cooling	
(Comp 2)	70°F < RAT < 77°F (adj.)
Mechanical Cooling	
(Comp 3)	78°F < RAT < 83°F (adj.)
Mechanical Cooling	
(Comp 4)	RAT > 83°F (adj.)

All values have a hysteresis of 2.0°F.

If discharge air set point reset is required, when the value of the discharge air set point is greater than the value of the return air reset for a particular compressor, the return limit will have to be adjusted via BACnet to compensate for the demand changes and release. The particular compressor stage or the unit must be set to a single reset point and the discharge set point reset can be adjusted as needed.

Any of the following alarms will immediately shut down all compressor stages. Refer to the sensor section or the integration points list in the Installation, Start-Up, Service and Controls Operation and Troubleshooting manual for default values:

- Leaving water high
- Leaving water low
- Entering later low
- Fan alarms
- Low static pressure
- Water differential pressure switch (DPS)
- Smoke

Discharge (supply) air temperature (DAT) sensor

The DAT sensor is shipped loose in the electrical controls box compartment and is to be field installed in the supply duct work and terminated on UI-6 of the I/O Flex 6126 controller.

The sensor should be installed where the air flow pattern is laminar to avoid temperature stratification. If supplemental heating is to be installed then the DAT sensor should be mounted downstream of the discharge side of the heating

coil. High discharge (supply) air temperature condition (cooling) DAT measurements are tested for a high limit trip above 70°F. An alarm is asserted for high discharge air temperature under the following conditions:

- DAT is above the high limit for 5 minutes
- Fan operation asserted
- Cooling mode
- Valid DAT sensor measurement

High static lock

The controller will monitor the static pressure high limit switch (if installed) and will increment a counter every time the static pressure switch trips. A High Static Alarm will be generated, and will reset automatically. Upon receiving the alarm 3 times, the unit will lock out to protect the ductwork and prevent cycling of major unit components.

Waterside economizer mode

If the entering water temperature is less than the set point 55°F (adj.) the unit will transition to economizer mode:

- Disable mechanical cooling stage 1 operation for minimum of 12 minutes.
- Enable economizer valve.
- Waterside economizer will operate until the entering water temperature reset value is reached; default is 58°F (adj.).

When in economizer mode, if the entering water temperature reaches the reset value in less than 5 minutes, the first stage of mechanical cooling operation will be disabled for at least 5 minutes.

In economizer operation, if the unit requires additional stages of mechanical cooling the controller will command them according to the unit demand percentage calculated by the Cooling PID. If additional stages of cooling were running those will be maintained.

The fan will continue to modulate to meet the static pressure set point and the economizer valve will be commanded to open and the economizer will be treated as the first stage of cooling.

Leaving water temperature

The controller will monitor the leaving water temperature. Refer to the Factory-Provided Sensors table. Alarms will be provided as follows:

- High Leaving Water Temp: If compressor(s) is running and the leaving water temperature is greater than 135°F (adj.).
- Low Leaving Water Temp: If compressor(s) is running and the leaving water temperature is less than 33°F (adj.).
- Leaving Water Sensor Failure: If leaving water sensor outside of normal operating limits. Should a High or Low Leaving Water Temperature Alarm occur, the call for cooling will be removed.

UPM fault monitor

The controller will monitor both Unit Protection Modules (UPM1 and UPM2) fault inputs.

Upon hard lockout alarm, compressors are disabled by the UPM board.

Alarms will be provided through BACnet point current alarm as follows:

- HP1: High Pressure Alarm (circuit 1)
- HP2: High Pressure Alarm (circuit 2)
- LP1: Low Pressure Alarm (circuit 1)
- LP2: Low Pressure Alarm (circuit 2)
- HP3: High Pressure Alarm (circuit 3)
- HP4: High Pressure Alarm (circuit 4)
- LP3: Low Pressure Alarm (circuit 3)
- LP4: Low Pressure Alarm (circuit 4)
- FRE: Freeze Alarm
- FRE2: Freeze Alarm
- CON: Condensate Alarm B
- RN: Brownout Alarm

Factory-Provided Sensors for VAV Units 50BVJ,W

UNIT	DESCRIPTION	QTY	SHIPPING LOCATION	INSTALLATION LOCATION
50BVJ 020-034	Supply Air Temperature Sensor	1	Loose For Field Installation	Supply Air Stream
	Return Air Temperature Sensor	1	Loose For Field Installation	Return Air Stream
	Entering Water Temperature	1	Installed	Condenser Entering Water
	Leaving Water Temperature	1	Installed	Condenser Leaving Water
	Duct Static Pressure Sensor	1	Loose For Field Installation	Supply Air Stream
	Compressor Current Transducer	a	Installed	Unit Electrical Box
50BVW 034-064	Supply Air Temperature Sensor	1	Loose For Field Installation	Supply Air Stream
	Return Air Temperature Sensor	4	Loose For Field Installation	Return Air Stream
	Entering Water Temperature	1	Installed	Condenser Entering Water
	Leaving Water Temperature	1	Installed	Condenser Leaving Water
	Duct Static Pressure Sensor	1	Loose For Field Installation	Supply Air Stream
	Compressor Current Transducer	a	Installed	Unit Electrical Box

NOTE(S):

a. 1 per compressor.

Indoor Packaged Unit Variable Air Volume Application

HVAC Guide Specifications

Size Range: **18 to 30 Tons**

Carrier Model Number:

50BVJ — Water Source, Cooling Only Unit

Part 1 — General

1.01 SYSTEM DESCRIPTION

- A. Units shall be water source, cooling only self-contained packaged air-conditioning units. Capacities, models, and unit arrangement shall be as shown on the unit schedule and the contract drawings.

1.02 QUALITY ASSURANCE

- A. Units shall be listed for UL (Underwriters Laboratories) and UL, Canada. Units shall conform to ANSI (American National Standards Institute)/UL standard 1995.
- B. Each unit shall be completely factory assembled, piped, wired, and tested. Water-cooled units shall be leak tested and charged with a full operating charge of R-410A refrigerant.
- C. Factory test shall include, but not be limited to: run check of all electrical components and safeties, pressure test of refrigerant coils and condensers; leak check of completed refrigerant circuits; compressor run check.

Part 2 — Products

2.01 EQUIPMENT

A. General:

The unit shall be factory assembled. Water source units shall be built for an entering-water temperature range from 50 to 110°F. Contained within the unit enclosure shall be all factory wiring, piping, controls, refrigerant charge (R-410A), and special features required prior to field start-up.

B. Cabinet:

- 1. Unit shall be post and panel construction. Unit exterior panels shall be 18 gauge G90 galvanized steel for corrosion protection (unpainted).
- 2. Interior of the unit shall be insulated with 1/2 in. thick, dual density, coated fiberglass.
- 3. Two blower and two compressor compartment access panels shall be removable with supply and return ductwork in place. A duct collar shall be provided on the supply-air opening of all units.
- 4. Units shall have an insulated divider panel between the air-handling section and the compressor section to minimize the transmission of compressor noise, and to permit operational service testing without air bypass.
- 5. Units shall have a stainless steel condensate drain pan.

C. Evaporator Coil:

- 1. The direct expansion coil shall be a minimum of 3 rows and be fabricated from 3/8 in. or 1/2 in.

OD seamless copper tubing, mechanically bonded to rippled and corrugated aluminum fins.

- 2. Each individual evaporator coil shall be removable for replacement without disturbing the remaining refrigerant circuits.
- 3. Each evaporator coil circuit shall be fed by an adjustable thermostatic expansion valve, with external equalizer, sized to provide efficient operation at full and part load operating points in the cooling mode.

D. Supply Fan:

- 1. Supply fans shall be double-width double-inlet (DWDI) forward-curved type with dynamically balanced wheels.
- 2. The housings and wheels shall be designed for quiet low velocity operation.
- 3. Fan motors shall be 1725 or 3450 rpm, 56 frame sealed ball bearing type. Motors shall be permanently lubricated and have thermal overload protection. Motors shall be compatible with variable frequency drive (VFD).
- 4. The drive shall include a fixed pitch blower sheave and variable pitch motor sheave with multiple matched belts, sized for 115% of the fan brake horsepower, and provide maximum static capability in stable fan operation and when applied with variable frequency drive (VFD).
- 5. Units shall be available with factory-installed optional blower orientation. See unit certified drawings for details.

E. Supply Fan Capacity Control/Variable Frequency:

Variable frequency drive (VFD) shall include:

- 1. Factory-installed VFD motor control device, factory-mounted, wired and tested. The VFD shall control motor speed to maintain set point static pressure at the supply duct sensor location.
- 2. A duct differential pressure transmitter (DPT) shall be factory supplied (ships in control enclosure) for field installation. Field supplied wiring, pneumatic tubing, and pressure pick up port are required.
- 3. Low pressure reference tube factory installed.

F. Refrigeration Circuit:

- 1. Each unit shall contain multiple independent refrigeration circuits.
- 2. Each circuit shall include a high-efficiency heavy-duty scroll compressor.
- 3. Each circuit shall have high and low pressure cutouts.
- 4. Each circuit shall be dehydrated and factory charged with R-410A.
- 5. Suction and discharge Schrader valves shall be provided for manifold gage connections to facilitate servicing.

6. Hot gas bypass shall be provided to allow unit operation under extended operating conditions to avoid coil freeze-up.
 7. Modulating hot gas reheat shall be provided to help control discharge air conditions.
- G. Compressors:
1. Each unit shall have multiple high-efficiency scroll compressors with internal or external motor protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure.
 2. Each compressor shall be on an independent refrigerant circuit.
 3. The compressors shall be mounted on rubber isolators.
- H. Water Source Condensers:
1. All condensers shall be coaxial tube-in-tube for maximum heat transfer efficiency and performance.
 2. Inner water tubes shall be either standard copper or optional cupronickel with large internal diameters for reduced waterside pressure drops.
 3. Outer tubes shall be steel, painted for corrosion protection.
 4. All condensers shall be rated at 600 psig operating refrigerant pressures and 400 psig waterside pressures.
- I. Filter Section:
1. The unit shall be supplied with 1 in. thick, 30% efficiency filters.
- J. Electrical:
1. Each unit shall be wired and tested at the factory prior to shipment.
 2. Wiring shall comply with NEC requirements and shall conform with all applicable UL standards.
 3. The units shall have a single point power connection. Control power shall be supplied through a factory-installed, low voltage control circuit transformer with an integral resettable circuit breaker.
 4. A terminal block shall be provided for the main power connection.
 5. Unit shall have a short circuit current (SCCR) rating of 5 kA.
- K. Controls, Safeties, and Diagnostics:
1. The Unit Protection Module (UPM) is a printed circuit board (PCB) that interfaces with the thermostat or the digital direct controller. The main purpose of this device is to protect the compressors by monitoring the different states of switches and sensors of each refrigerant circuit. This device provides time delays and protects the unit against freezing of the water and refrigerant heat exchangers as well as condensate overflow.
2. Controls shall be capable of performing the following functions:
 - a. Random power start-up. This feature prevents multiple units sharing same electrical circuit or network from starting at the same time.
 - b. Anti-short cycle delay. This feature protects the compressor short cycling if the Y call is set and removed.
 - c. High pressure protection.
 - d. Selectable Alarm Mode. The UPM controller can be configured to have either a constant signal or a pulse.
 - e. Freeze protection.
 - f. Condensation overflow.
 - g. Brownout protection. The UPM controller will constantly monitor the power supply. If the nominal voltage drops below 25% of its value (18 vac approximately), the unit will enter brownout protection mode.
 3. Variable air volume (VAV) controls shall be capable of performing the following monitoring and alarm functions:
 - a. High static lock
 - b. Supply fan status
 - c. Return fan status
 - d. Filter status
 - e. Smoke detector
 - f. Low leaving water temperature
 - g. Leaving water temp sensor failure
 - h. Supply air sensor failure
 - i. High and low supply air temperature
 4. Condensate overflow switch shall provide protection against condensate overflow. The safety switch shall be located in the unit's evaporator drain pan. Float switches are not allowed.
- L. Special Features:
1. Waterside Economizer:
 - a. Shall function as first stage of cooling when free cooling is available. Economizer coil valve can be modulated to control discharge-air temperature when the economizer can meet or exceed cooling needs.
 - b. Consists of the economizer coil, one 3-way valve, vent and drain fittings and the required piping. Economizer coils are 2 or 4-row coils. The unit controller controls all required control logic and changeover.
 2. Cupronickel condenser shall provide higher corrosion protection.
 3. Insulated basepan shall provide additional sound deadening characteristics and corrosion protection in the compressor compartment.

4. Extended range option shall provide condensate protection on the condenser waterside for humid applications.
5. Freeze protection switch shall provide evaporator coil protection against freezing.

M. Accessories:

1. Virtual BACview¹:

The main unit control interface shall be Virtual BACview or similar PC based interface program. Connection between the PC and unit controller shall be accomplished using the unit Rnet port and a USB to Rnet link cable.

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1. BACview is a registered trademark of Automated Logic Corporation.

Indoor Packaged Unit Constant Volume Application

HVAC Guide Specifications

Size Range: **30 to 60 Tons**

Carrier Model Number:

50BVT — Water-Cooled Packaged Cooling Unit

50BVV — Water-Cooled Vertical Heat Pump

Part 1 — General

1.01 SYSTEM DESCRIPTION

- A. Units shall be water-cooled, cooling only or water-cooled heat pump self-contained packaged air-conditioning units. Capacities, models, and unit arrangement shall be as shown on the unit schedule and the contract drawings.

1.02 QUALITY ASSURANCE

- A. Units shall be listed for UL (Underwriters Laboratories) and UL, Canada. Units shall conform to ANSI (American National Standards Institute)/UL standard 1995. Unit shall be accepted for use in the City of New York by the Department of Buildings (MEA).
- B. Each unit shall be completely factory assembled, piped, wired, and tested. Units shall be leak tested and charged with a full operating charge of refrigerant.
- C. Units shall then be disassembled into their individual modules for shipping and assembly on site.
- D. Factory test shall include, but not be limited to: complete run check of all electrical components and safeties, including proper control sequencing; pressure test of refrigerant coils and condensers; leak check of completed refrigerant circuits; leak check of completed water circuit (water-cooled units only); compressor run check.

Part 2 — Products

2.01 EQUIPMENT

A. General:

The unit shall be comprised of two distinct modules: the main air-conditioning section and the filter/pre-cooling coil section. Water-cooled units shall be built for an entering water temperature range from 50 to 110°F. The unit shall be designed for easy assembly. The refrigeration circuit shall remain intact during disassembly and reassembly. All high-boy modules shall be able to pass through a 36 in. steel framed door.

B. Cabinet:

- 1. The frame shall be fabricated of an angle iron framework. Unit exterior panels shall be 18 gauge G90 galvanized steel for corrosion protection.
- 2. Each section shall incorporate removable access panels. The complete cabinet frame and access panels shall be insulated with 1/2 in., dual density, coated fiberglass insulation.

- 3. The main air conditioning section and the filter/pre-cooling coil section shall contain a stainless steel drain pan.
- 4. Low-boy cabinet shall be available on all models. Blower shall be dropped into main coil section, reducing the overall height of the unit. This is for those applications where there is a restriction in the height of the unit.

C. Evaporator:

- 1. The direct expansion coil shall be a minimum of 3 rows and be fabricated from 3/8 in. or 3/4 in. OD seamless copper tubing, mechanically bonded to rippled and corrugated aluminum fins.
- 2. Each individual evaporator coil shall be removable for replacement without disturbing the remaining refrigerant circuits.
- 3. Each evaporator coil circuit shall be fed by an adjustable thermostatic expansion valve, with external equalizer, sized to provide efficient operation at full and at part load operating points in the cooling modes.

D. Supply Fan:

- 1. Supply fans shall be double-width double-inlet (DWDI) forward curved type of Class II construction.
- 2. All fans shall be statically and dynamically balanced.
- 3. Fan shafts shall be mounted in heavy-duty 150,000-hour greasable pillow-block bearings.
- 4. The fan motor shall be open drip-proof (ODP), three-phase, NEMA T-frame E high-efficiency EPACT rated, 1800 rpm, with grease lubricated ball bearings.
- 5. The drive shall include a fixed pitch blower sheave and variable pitch motor sheave with multiple V-belts sized for 115% of the fan brake horsepower.
- 6. Airflow configurations shall include rear return, front supply; and rear return, rear supply.
- 7. Units shall be available with factory-installed optional blower orientation. See unit certified drawings for details.

E. Reverse Cycle Operation (Heat Pump Only):

- 1. Heat pump units shall be equipped with reversing valves to allow operation in the reverse cycle heating mode.

F. Refrigeration Circuit:

- 1. Each unit shall contain multiple independent refrigeration circuits.
- 2. Each circuit shall include a high-efficiency heavy-duty scroll compressor.
- 3. Each circuit shall have high and low pressure cutouts.
- 4. Each circuit shall be dehydrated and factory charged with R-410A (water-cooled units).

5. Suction and discharge Schrader valves shall be provided for manifold gauge connections to facilitate servicing.
- G. Compressors:
 1. Each unit shall have multiple high-efficiency scroll compressors with internal or external motor protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure.
 2. Each compressor shall be on an independent refrigerant circuit.
 3. The compressors shall be mounted on rubber isolators.
- H. Water-Cooled Condensers:
 1. All condensers shall be coaxial tube-in-tube for maximum heat transfer efficiency and performance.
 2. Inner water tubes shall be either standard copper or optional cupronickel with large internal diameters for reduced waterside pressure drops.
 3. Outer tubes shall be steel, painted for corrosion protection.
 4. All condensers shall be rated at 600 psig operating refrigerant pressures and 400 psig waterside pressures.
 5. Units shall be rated down to 50°F without the use of water regulating valves.
- I. Filter Section:
 1. The unit shall be supplied with 4 in. deep pleated, 30% high-efficiency filters. The filters shall have side access capability through an access panel.
- J. Electrical:
 1. Each unit shall be wired and tested at the factory prior to shipment.
 2. Wiring shall comply with NEC requirements and shall conform with all applicable UL standards.
 3. The units shall have a single point power connection. Control power shall be supplied through a factory-installed, low voltage control circuit transformer with an integral resettable circuit breaker.
 4. The fan motor starter shall have a magnetic three-line, ambient compensated overload protector with a manual reset.
 5. A terminal block shall be provided for the main power connection.
- K. Controls, Safeties, and Diagnostics:
 1. The Unit Protection Module (UPM) is a printed circuit board (PCB) that interfaces with the thermostat or the digital direct controller. The main purpose of this device is to protect the compressors by monitoring the different states of switches and sensors of each refrigerant circuit. This device provides time delays and protects the unit against freezing of the water and refrigerant heat exchangers as well as condensate overflow.
2. Controls shall be capable of performing the following functions:
 - a. Random power start-up. This feature prevents multiple units sharing same electrical circuit or network from starting at the same time.
 - b. Anti-short cycle delay. This feature protects the compressor short cycling if the Y call is set and removed.
 - c. High pressure protection.
 - d. Selectable Alarm Mode. The UPM controller can be configured to have either a constant signal or a pulse.
 - e. Freeze protection.
 - f. Condensation overflow.
 - g. Brownout protection. The UPM controller will constantly monitor the power supply. If the nominal voltage drops below 25% of its value (18 vac approximately), the unit will enter brownout protection mode.
3. Condensate overflow switch shall provide protection against condensate overflow. The safety switch shall be located in the unit's evaporator drain pan. Float switches are not allowed.
- L. Special Features:
 1. Waterside Economizer:
 - a. Shall function as first stage of cooling when free cooling is available. Economizer coil valve can be modulated to control discharge-air temperature when the economizer can meet or exceed cooling needs.
 - b. Consists of the economizer coil, one 3-way valve, vent and drain fittings and the required piping. Economizer coils are 2 or 4-row coils. The unit controller controls all required control logic and changeover.
 2. Hot water coil shall be factory-installed on the inlet side of the direct expansion cooling coils with field piping connections on the side of the unit.
 3. Optional cycling or modulating hot gas reheat (HGRH) shall be provided for dehumidification operation.
 4. Energy management and alarm 24-vac relay package shall be provided to remotely enable/disable units with constant volume configuration. An additional relay is provided to close when a compressor malfunction is detected, providing remote signaling to a building automation system.
 5. Cupronickel condenser shall provide higher corrosion protection.

6. Hot gas bypass shall provide extended capacity operation and prevent coil freezing at low load conditions.
7. Insulated basepan shall provide additional sound deadening characteristics and corrosion protection in the compressor compartment.
8. Extended range option shall provide condensate protection on the condenser waterside for humid applications.

Indoor Packaged Unit Variable Air Volume Application

HVAC Guide Specifications

Size Range: **30 to 60 Tons**

Carrier Model Number:

50BVW — Water-Cooled Packaged Cooling Unit

Part 1 — General

1.01 SYSTEM DESCRIPTION

- A. Units shall be water-cooled, cooling only self-contained packaged air conditioning units. Capacities, models, and unit arrangement shall be as shown on the unit schedule and the contract drawings.

1.02 QUALITY ASSURANCE

- A. Units shall be listed for UL (Underwriters Laboratories) and UL, Canada. Units shall conform to ANSI (American National Standards Institute)/UL standard 1995. Unit shall be accepted for use in the City of New York by the Department of Buildings (MEA).
- B. Each unit shall be completely factory assembled, piped, wired, and tested. Units shall be leak tested and charged with a full operating charge of refrigerant (water-cooled only).
- C. Units shall then be disassembled into their individual modules for shipping and assembly on site.
- D. Factory test shall include, but not be limited to: complete run check of all electrical components and safeties, including proper control sequencing; pressure test of refrigerant coils and condensers; leak check of completed refrigerant circuits; leak check of completed water circuit (water-cooled units only); compressor run check.

Part 2 — Products

2.01 EQUIPMENT

A. General:

The unit shall be comprised of two distinct modules: the main air-conditioning section and the filter/pre-cooling coil section. The unit shall be designed for easy assembly. Water-cooled units shall be built for an entering water temperature range from 55 to 105°F. The refrigeration circuit shall remain intact during disassembly and reassembly. All high-boy modules shall be able to pass through a 36 in. steel framed door.

B. Cabinet:

1. The frame shall be fabricated of an angle iron framework. Unit exterior panels shall be 18 gauge G90 galvanized steel for corrosion protection.
2. Each section shall incorporate removable access panels. The complete cabinet frame and access panels shall be insulated with 1/2 in., dual density, coated fiberglass insulation.
3. The main air conditioning section and the filter/pre-cooling coil section shall contain a stainless steel drain pan.

4. Low-boy cabinet shall be available on all models. Blower shall be dropped into main coil section reducing the overall height of the unit. This is for those applications where there is a restriction in the height of the unit.

C. Evaporator:

1. The direct expansion coil shall be a minimum of 3 rows and be fabricated from 3/8 in. or 3/4 in. OD seamless copper tubing, mechanically bonded to rippled and corrugated aluminum fins.
2. Each individual evaporator coil shall be removable for replacement without disturbing the remaining refrigerant circuits.
3. Each evaporator coil circuit shall be fed by an adjustable thermostatic expansion valve, with external equalizer, sized to provide efficient operation at full and at part load operating points in the cooling mode.

D. Supply Fan:

1. Supply fans shall be double-width double-inlet (DWDI) forward curved type of Class II construction.
2. All fans shall be statically and dynamically balanced.
3. Fan shafts shall be mounted in heavy-duty 150,000-hour greasable pillow-block bearings.
4. The fan motor shall be open drip-proof (ODP), three-phase, NEMA T-frame E high-efficiency EPACT rated, 1800 rpm, with grease lubricated ball bearings. Motor shall be compatible with variable frequency drive (VFD).
5. Fan shall be belt driven with fixed-pitch motor and fan pulley, with multiple matched belts; drive shall be selected for 110% of motor horsepower and to provide maximum static capability in stable fan operation and when applied with variable frequency drive (VFD).
6. Units shall be available with factory-installed optional blower orientation. See unit certified drawings for details.

E. Supply Fan Capacity Control/Variable Frequency:

Variable frequency drive (VFD) shall include:

1. Factory-installed VFD motor control device, provided with a NEMA Type 1 enclosure, and factory-mounted, wired and tested. The VFD shall control motor speed to maintain set point static pressure at the supply duct sensor location.
2. A duct differential pressure transmitter (DPT) shall be factory supplied (ships in control enclosure) for field installation. Field supplied wiring, pneumatic tubing, and pressure pick up port are required.

F. Refrigeration Circuit:

1. Each unit shall contain multiple independent refrigeration circuits.

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2. Each circuit shall include a high-efficiency heavy-duty scroll compressor.
3. Each circuit shall have high and low pressure cutouts.
4. Suction and discharge Schrader valves shall be provided for manifold gauge connections to facilitate servicing.
5. Hot gas bypass shall be provided to allow unit operation under extended operating conditions to avoid coil freeze-up.
6. Modulating hot gas reheat shall be provided to help control discharge air conditions.

G. Compressors:

1. Each unit shall have multiple high-efficiency scroll compressors with internal or external motor protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure.
2. Each compressor shall be on an independent refrigerant circuit.
3. The compressors shall be mounted on rubber isolators.

H. Water Source Condensers:

1. All condensers shall be coaxial tube-in-tube for maximum heat transfer efficiency and performance.
2. Inner water tubes shall be either standard copper or optional cupronickel with large internal diameters for reduced waterside pressure drops.
3. Outer tubes shall be painted steel.
4. All condensers shall be rated at 600 psig operating refrigerant pressures and 400 psig waterside pressures.

I. Filter Section:

1. The unit shall be supplied with 4 in. deep pleated, 30% high-efficiency filters. The filters shall have side access capability through an access panel.

J. Electrical:

1. Each unit shall be wired and tested at the factory prior to shipment.
2. Wiring shall comply with NEC requirements and shall conform with all applicable UL standards.
3. The units shall have a single point power connection. Control power shall be supplied through a factory-installed, low voltage control circuit transformer with an integral resettable circuit breaker.

4. The fan motor starter shall have a magnetic three-line, ambient compensated overload protector with a manual reset.
5. A terminal block shall be provided for the main power connection.
6. Unit shall have a short circuit current (SCCR) rating of 5kA.

K. Controls, Safeties, and Diagnostics:

1. Control shall be accomplished through the use of a factory-installed, microprocessor-based control system and associated electronic and electrical hardware. Control system shall determine control sequences through monitoring the following operational variables:
 - a. Day and time.
 - b. Schedule (Unoccupied/Occupied).
 - c. Set points (Unoccupied/Occupied, Duct Pressure, others).
 - d. Return-air, Mixed-air, or Outdoor-air temperature.
 - e. Unit supply-air temperature.
 - f. Supply-air fan status.
 - g. Accessory and/or field-supplied sensors, function switches and/or signals.
2. Controls shall be capable of performing the following functions:
 - a. Capacity control based on discharge-air temperature and compensated by rate of change of return-air temperature (VAV [variable air volume]). Capacity control shall be accomplished through the use of compressor staging and modulating hot gas reheat.
 - b. Perform a quick test to check the status of all input and output signals to the control system using diagnostic display module.
 - c. Supply fan volume control shall control output from a variable frequency drive to maintain duct static pressure at user-configured set point.

3. Alerts and Alarms:

Control shall continuously monitor all sensor inputs and control outputs to ensure safe and proper system operation. Alerts shall be generated whenever sensor conditions have gone outside user-configured criteria for acceptability. Alarms shall be initiated when unit control detects that a sensor input value is outside its valid range (indicating a defective device or connection that prevents full unit operation), that an output has not functioned as expected, or that a safety device has tripped.