CONTROLS LITE SUPPLEMENT MANUAL

FOR VALENT VPR SERIES AND INNOVENT AIR HANDLING UNITS

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Controls Lite Supplement: For Valent VPR Series and Innovent Air Handling Units

This document is to be used in conjunction with the Valent VPR Series and Innovent Controls IOM, Part #482934. All safety information provided in that IOM pertains to all Controls Lite units also.

Please refer to the Valent VPR Series and Innovent Controls IOM, Part #482934 for additional information.

Controls Lite Overview

Controls Lite is designed to allow third-party control of a Valent or Innovent packaged DX, split DX, or Heat Pump unit while maintaining the safeties of the packaged refrigeration system. To achieve this, the Valent or Innovent controller is factory installed and factory commissioned. This controller is responsible for the operation of the refrigeration components installed in the unit. Valent and Innovent assures the safety of the refrigeration system by monitoring pressures and temperatures contained within the packaged refrigeration. Valent and Innovent requires control by others for the capabilities listed: supply air airflow, compressor control, hot gas reheat control, emergency shutdown, and heating or cooling operation selection, when the unit is configured as a heat pump.

Additionally, a third-party device that is field supplied and installed provides occupancy, temperature, and airflow. This third-party device interfaces to the Valent or Innovent unit via a terminal strip in the control cabinet, as represented in Figure 1.

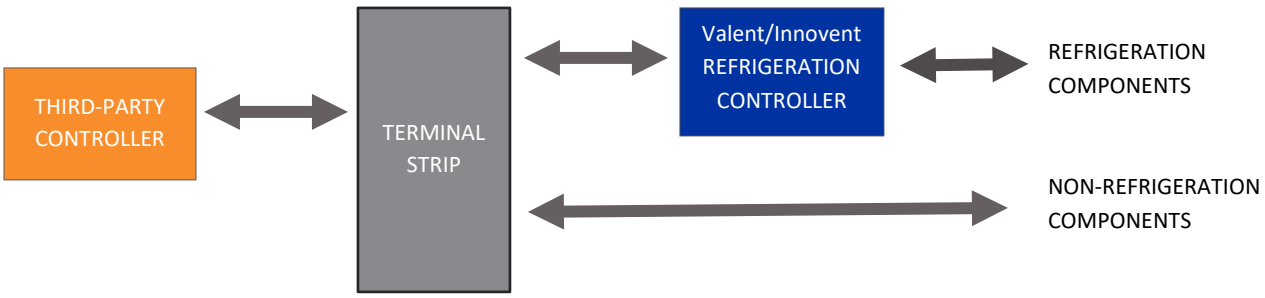


Figure 1: Third-party controller with Controls Lite

End Devices

End devices for *Controls Lite* that are provided and installed in the unit are for Valent or Innovent refrigeration control only. Other end devices that are needed for controlling non-refrigeration components will be provided and installed by the third party. Devices include, but is not limited to, sensors, VFDs, and actuators that are necessary for unit operation. Please refer to the unit's submittal information for the exact unit configuration and selected options.

Third-Party Control Responsibilities

Occupancy, temperature, airflow, and third-party device power with *Controls Lite* are the responsibility of the third party through a third-party device. This control not only includes the timing of each occupied mode, but logic for enabling and modulating all non-refrigeration components.

Third-Party Controller Power

Powering the third-party controller is the responsibility of the third party. The third party will supply and install a transformer to power the device. This power **cannot** be taken from the Valent or Innovent control panel. The third-party device **cannot** be mounted in the Valent or Innovent electrical control panel.

Occupancy

Scheduling and occupancy mode control are the responsibility of the third party.

Airflow

Maintaining the proper airflow through the unit is the responsibility of the third party. Enabling and modulating the fans and dampers is the responsibility of the third-party controller.

Damper Positioning

Confirmation of a closed damper end switch to ensure an open airflow path is the third party's responsibility. The end switch signal must be received prior to the start of any fans in the unit.

Fan Modulation

When modulating the fan speed, the enable and modulation signals are the responsibility of the third-party controller. The following are Valent and Innovent's guidelines for fan modulation. For Valent, the fan(s) would be for the supply airflow. For Innovent, the fan(s) could be any of the following: supply, return, or regeneration.

Cooling or Heat Pump Heating

When the unit is operating in cooling mode or heating with compressors, limit the fan turndown to 50% of the **designed airflow** to ensure the refrigeration system can adequately modulate to meet the desired temperature setpoints. Modulating below 50% of the **designed airflow** may result in loss of space temperature control and have a negative impact on the refrigeration system components.

Electric Heat

When the unit is heating with an electric heater, limit turndown to the minimum airflow requirements of the electric heater manufacturer. Please see *Appendix B – Controls Lite Heating Limitations* for more information for Valent electric heat.

Gas Furnace Heat

When the unit is heating with a gas furnace, limit turndown to the minimum airflow based on the unit size or 50.0% of **design airflow**, whichever value is greater. Please see *Appendix B – Controls Lite Heating Limitations* for minimum airflow specific to the unit size and furnace installed of Valent units.

Exhaust Fan

Exhaust fan airflow is also the responsibility of the third-party controller. The enable and modulation signals to the exhaust fans and any modulating dampers necessary to achieve the building requirements.

Energy Recovery

Control of energy recovery equipment installed in the unit is the responsibility of the third party. A heat wheel with or without a VFD for speed, or a face/bypass damper for a flat plate heat exchanger must be controlled to a third-party provided sensor. Both forms of energy recovery must have a defrost sequence provided via the third-party controller that controls to a third-party provided exhaust air temperature sensor when there is not pre-heat installed in the unit and the energy recovery device is located in the outside air stream. The exhaust air temperature **must** remain above 36.0°F.

Temperature

Controls Lite requires the third party to make decisions based on operating conditions and setpoints, in order to heat, cool, dehumidify, humidify, or economize.

The third-party controller will communicate setpoints, via hard-wired 2-10 volt signals, based on the operating mode:

- Heat Pump Heating – Supply Air Setpoint
- Cooling – Cooling Coil Setpoint
- Dehumidifying – Cooling Coil Setpoint and Supply Air Setpoint

The third-party controller needs to control the amount of heating, humidity, and energy recovery capacity necessary to meet the current requirements, depending on the equipment supplied with the unit. Analog output signals are to be sent to the terminal strip in the controls cabinet that interfaces with the Valent or Innovent controller or directly with equipment installed in the unit.

For Valent units, please refer to the unit wiring schematics or see *Appendix A – Terminal Strip Wiring* for further information regarding control input types and terminal strip wiring. For Innovent units, please refer to the unit wiring schematics.

When modulating the gas furnace heating capacity, Valent and Innovent recommends a maximum temperature rise and a minimum airflow for all units. The criteria must be met when controlling the staging and modulation of the gas furnaces in order to prevent improper combustion and damage to the unit. Please see *Appendix B – Controls Lite Heating Limitations* for minimum airflow specific to the unit size and furnace installed.

Please refer to the unit's submittal information for the exact gas furnace performance data.

Supply Air Temperature Control

When the unit configured with HGRH or as a Heat Pump, there will be a Supply Air Temperature Setpoint utilized by the third-party controller. This setpoint will range between 50 and 95°F in all modes of operation. The third-party controller will also have high and low temperature limits. These limits can be adjustable, but must follow the requirements below:

- Minimum Low Supply Temp Limit: 35°F
- Maximum High Supply Temp Limit: 120°F
  Note: A minimum setpoint of 60.0°F is advised in heating mode of a heat pump.

When the Low Supply Temp Limit is reached, all cooling in the unit must be turned off. When the High Supply Temp Limit is reached, all heating in the unit must be turned off.

Controls Lite Packaged Refrigeration

The Valent or Innovent integrated controller is programmed to safely start, stop, and operate the refrigeration system based on setpoints or request signals received from a third-party controller. Cycling of compressors is based on Valent and Innovent's algorithms. Add and subtract delays, minimum on and off timers, and alarm conditions that may be present in the unit could affect the availability of compressors.

Setpoint Control

Setpoint control allows the third party to send setpoints for the cooling coil and supply air to the controller via 2-10 vdc analog signals. Digital inputs are used to determine when the unit is dehumidifying vs cooling and, in a heat pump, to determine cooling vs heating.

Cooling Coil Setpoint

The cooling coil setpoint ranges from 50 to 75°F. The compressors are staged based on this setpoint when the unit is either cooling or dehumidifying.

Supply Air Setpoint

The supply setpoint ranges from 50 to 95°F. When dehumidifying, this setpoint is used for the hot gas reheat valve modulation. If the unit is a heat pump, the compressors are staged based on this setpoint in heating mode.

Note: Supply Air Setpoint is only necessary if the unit is configured as a heat pump or with hot gas reheat (HGRH).

Remote Start/Stop

This input is to remotely start or stop the refrigeration control of the unit. This input will be closed for the unit to provide cooling or heat pump heating.

Cooling/Dehumidification Control Mode

This input determines whether the unit is in cooling mode or dehumidification mode.

Cooling/Heating Control Mode

If the unit is a heat pump, this input determines whether the unit is in cooling or heating mode.

Demand Control

Demand control allows the third party to send separate request signals for the compressor capacity and modulation of the hot gas reheat valve. (Available upon request only and all legacy Valent units.)

Compressor Control Request

The compressor control request signal stages compressors on or off depending on the amount of cooling or heat pump heating that is requested from the third party. The controller requires at least a 5.0% request to enable the first compressor. When the request falls below 2.5%, all compressors will cycle off.

The Valent or Innovent controller will proportionally vary the amount of compressor capacity as the Compressor Control Request varies from the third-party controller in one of the following ways:

- Modulating the Inverter Scroll or Digital Scroll™ compressor
- Enabling/disabling fixed stage compressors

Refer to *Appendix C – Demand Compressor Staging* for more details on compressor staging and the Compressor Control Request.

HGRH Request

The HRGH request signal tells the controller when to enable dehumidification. The controller requires at least a 5.0% request to enable dehumidification. The Compressor Control Request must also be requesting a compressor for dehumidification to be enabled. When dehumidification is enabled, the HGRH valve will open to the percent requested by the third party. The valve follows the signal unless the compressor(s) in the HGRH circuit are off or a HGRH Purge cycle is active. If the unit is a heat pump, dehumidification is only available when the unit is in cooling mode. If the heat pump is in heating mode, the HGRH valve is 100.0% open. When the request falls below 2.5% for more than 90 seconds, dehumidification is disabled.

Cooling/Heating Control Mode

If the unit is a heat pump, this input determines whether the unit is in cooling or heating mode.

Remote Start/Stop

This input is to remotely start or stop the refrigeration control of the unit. This input will be closed for the unit to provide cooling or heat pump heating.

Cooling

The following conditions are required for the factory controller to enable a unit and start compressors in cooling mode:

- Remote Start Input: Closed
- Shutdown Input: Closed
- Unit Enable Screen: Enabled
- Damper Positioning: OAD/RAD End Switch Closed (proof of airflow)**
- Supply Fan Status: Closed
- Supply Fan Control: Not below 50.0% of the full-load airflow for the unit**
- Cooling/Dehumidification Control Input: Cooling mode (Open)
- Cooling/Heating Control Input: Cooling mode (Open) (Heat Pumps Only)
- Outside Air Temperature: > Cooling Ambient Lockout (55.0°F) (adj.)
- Cooling Coil Leaving Air Temp: > Coil Low Temp Limit (42.0°F) (adj.)
- Saturated Supply Temperature: < High SDT Setpoint (130.0°F) (adj.)(WSHP only)
- Refrigerant Pressure Switches: Closed (High and Low)
- Supply Air Temperature: > Minimum Low Supply Temp Limit (35.0°F)**
- Setpoint Control:
  - Cooling Coil Setpoint: 50 - 75°F scaled from 2-10vdc (Compressor staging)
- Demand Control:
  - Compressor Control Request: > 5.0% (compressor staging)

***NOTE: These safety checks are the responsibility of the third-party controller and do NOT input to the Valent or Innovent controller.*

Dehumidifying

The following conditions are required for the Valent or Innovent controller to enable a unit in dehumidification mode:

Note: Hot Gas Reheat must be installed in the unit to utilize this functionality.

- Remote Start Input: Closed
- Shutdown Input: Closed
- Unit Enable Screen: Enabled
- Damper Positioning: OAD/RAD End Switch Closed (proof of airflow)**
- Supply Fan Status: Closed
- Supply Fan Control: Not below 50.0% of the full-load airflow for the unit**
- Cooling/Dehumidification Control Input: Dehumidification mode (Closed)
- Cooling/Heating Control Input: Cooling mode (Open) (Heat Pumps Only)
- Outside Air Temperature: > Cooling Ambient Lockout (55.0°F) (adj.)

Dehumidifying (cont'd)

- Cooling Coil Leaving Air Temp: > Coil Low Temp Limit (42.0°F) (adj.)
- Saturated Supply Temperature: < High SDT Setpoint (130.0°F) (adj.)(WSHP only)
- Refrigerant Pressure Switches: Closed (High and Low)
- Supply Air Temperature: > Minimum Low Supply Temp Limit (35.0°F)**
- Setpoint Control:
  - Supply Air Setpoint: 50 - 95°F scaled from 2-10vdc (HGRH valve modulation)
  - Cooling Coil Setpoint: 50 - 75°F scaled from 2-10vdc (Compressor staging)
- Demand Control:
  - HGRH Request: > 5.0% scaled from 2-10vdc (HGRH valve modulation)
  - Compressor Control Request: > 5.0% scaled from 2-10vdc (Compressor staging)

***NOTE: These safety checks are the responsibility of the third-party controller and do NOT input to the Valent or Innovent controller.*

Heating - Heat Pump

The following conditions are required for the factory controller to enable a unit and start compressors in heating mode:

- Remote Start Input: Closed
- Shutdown Input: Closed
- Unit Enable Screen: Enabled
- Damper Positioning: OAD/RAD End Switch Closed (proof of airflow)**
- Supply Fan Status: Closed
- Supply Fan Control: Not below the minimum CFM recommendation for the unit**
- Heating/Cooling Control Mode: Heating mode (Closed)
- Outside Air Temperature: < Heating Ambient Lockout (80.0°F) (adj.)
- Outside Air Temperature: > ASHP Low Ambient Lockout (17.0°F ASHP, adj.)
- Saturated Suction Temperature: > WSHP Saturated Suction Lockout (-15.0°F WSHP, adj.)
- Refrigerant Pressure Switches: Closed (High and Low)
- Supply Air Temperature: < Maximum High Supply Temp Limit (120.0°F)**
- Setpoint Control:
  - Supply Air Setpoint Request: 50 - 95°F scaled from 2-10vdc (Compressor staging)
- Demand Control:
  - Compressor Control Request: > 5.0% scaled from 2-10vdc (Compressor staging)

***NOTE: These safety checks are the responsibility of the third-party controller and do NOT input to the Valent or Innovent controller.*

Heating

The following conditions are required prior to enabling heating mode that is not heating with compressors in a heat pump unit. **All steps** are the responsibility of the third-party controller:

- Remote Start Input: Open (this will stop the use of the refrigeration system)
- Damper Positioning: OAD/RAD End Switch Closed (proof of airflow) **
- Supply Fan Status: Closed **
- Supply Fan Control: Not below the minimum CFM recommendation for the unit **
- Supply Air Temperature: < Maximum High Supply Temp Limit (120.0°F)**

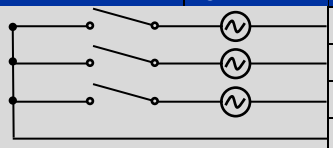
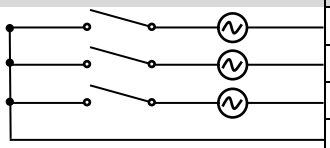
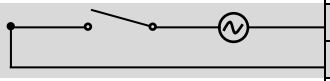
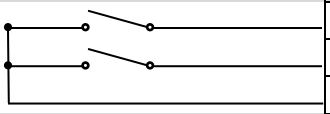
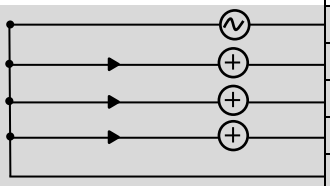
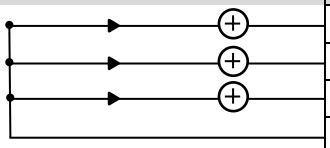
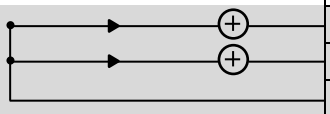
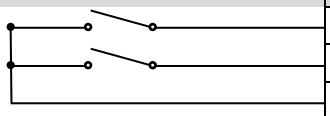
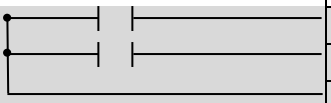
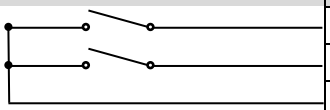
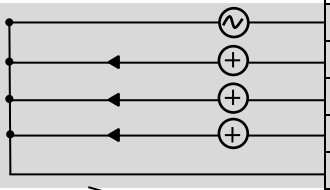
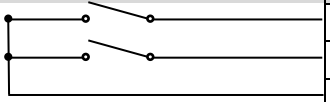
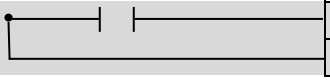
***NOTE: These safety checks are the responsibility of the third-party controller and do NOT input to the Valent or Innovent controller.*

IOM Appendices

Appendix A – Valent Unit Terminal Strip Wiring

Valent TB5 Third-Party Wiring

The following table/diagram is the terminal strip wiring of TB5 for Controls Lite. This terminal board is the wiring point for the third-party device. For wiring of an Innovent unit, please refer to the unit wiring schematics.

POWER BY 3RD PARTY	TERMINAL #	TERMINAL TYPE	DESCRIPTION	3RD PARTY
	101	24 VAC	Supply Fan Start	DO
	102	24 VAC	Exhaust Fan Start	DO
	103	24 VAC	Pre-Heater Enable	DO
	103C		Common	
	104	24 VAC	Gas Furnace Htg Stage 1 Enable	DO
	105	24 VAC	Gas Furnace Htg Stage 2 Enable	DO
	106	24 VAC	Gas Furnace Htg Stage 3 Enable	DO
	106C		Common	
	107		Energy Recovery Wheel Start	DO
	107C		Common	
	201		Energy Recovery Status	DI
	202		OA/RA Damper End Switch	DI
	202C		Common	
	301		24 VAC Power (Field Supplied by Others)	
	302	0.0-10.0 VDC	OA/RA Damper Position Input	AO
	303	0.0-10.0 VDC	Supply Fan Speed Input	AO
	304	0.0-10.0 VDC	Exhaust Fan Speed Input	AO
	304C		Common	
	305	0.0-10.0 VDC	Heating Capacity Input	AO
	306	0.0-10.0 VDC	Aux Electric Heat Capacity Input	AO
	307	0.0-10.0 VDC	Energy Recovery Capacity Input	AO
	307C		Common	
	308	2.0-10.0 VDC	Cooling Coil Setpoint	AO
	309	2.0-10.0 VDC	Supply Air Setpoint (HGHR or HP Heating)	AO
	309C		Common	
	401	24 VAC	Shutdown(0) Input	DO
	402	24 VAC	Cooling(0)/Heating(1) Control Mode	DO
	402P		24 VAC Power (from Valent)	
	403	24 VAC	Global Alarm Output (Refrigeration Alarms Only)	DI
	404	24 VAC	ASHP Defrost Active or WSHP Heating Not Available	DI
	404C		Common	
	901		Filter Pressure Switch	DI
	902		Low Temperature Protection Output	DI
	902C		Common	
	903		24 VAC Power (Field Supplied by Others)	
	904	0.0-10.0 VDC	Supply Airflow Measuring Station	AI
	905	0.0-10.0 VDC	Exhaust Airflow Measuring Station	AI
	906	0.0-10.0 VDC	Outside Airflow Measuring Station	AI
	906C		Common	
	907	24 VAC	Cooling(0)/Dehumidification(1) Control Mode	DO
	908	24 VAC	Remote Start Input	DO
	908P		24 VAC Power from Valent	
	909		WSHP Pump Enable	DI
	909C		Common	

Appendix B – Heating Limitations

Gas Furnace Limitations – Valent Units

Supply fan modulation must be limited to the minimum airflow based on the unit size or 50% of **design airflow**, whichever value is greater. When modulating the gas furnace heating capacity, Valent recommends a maximum temperature rise and a minimum airflow for all units.

The following criteria **must** be met when controlling the staging and modulation of the gas furnaces to prevent improper combustion and damage to the unit. The airflow reduction is **only** allowed if the supply air temperature does not exceed the max temp rise listed below. The supply air temp must be monitored and the furnace must be modulated to prevent over-firing of the furnace at low airflows.

1. In the table below, locate the unit casing size, the correct furnace MBH, and the airflow supply direction for the minimum airflow in CFM.
2. All gas furnaces must be limited to the **greater** of the following:
    a. minimum airflow in CFM; OR
    b. 50% of **design airflow**.
3. The third-party controls must monitor the supply air temperature and control to a supply air temperature setpoint between 50.0°F (10.0°C) and 95.0°F (35.0°C) during all modes of operation.
4. The third-party controls must have a high supply temperature limit of 120.0°F (48.8°C) that shuts down all heating sources within the unit when the supply air temperature is greater than or equal to this high supply temp limit.

UNIT	FURNACE	BOTTOM DISCHARGE		SIDE DISCHARGE	
CASING SIZE	MBH	MAX TEMP RISE	MIN AIRFLOW CFM	MAX TEMP RISE	MIN AIRFLOW CFM
110	100	100.0°F	741	60.0°F	1,235
	150	100.0°F	1,111	60.0°F	1,852
	200	100.0°F	1,481	60.0°F	2,469
210	200	100.0°F	1,481	60.0°F	2,469
	250	100.0°F	1,852	60.0°F	3,086
	300	100.0°F	2,222	60.0°F	3,704
	350	100.0°F	2,593	60.0°F	4,321
	400	100.0°F	2,963	60.0°F	4,938
310	400	100.0°F	2,963	60.0°F	4,938
	500	100.0°F	3,704	60.0°F	6,173
	600	100.0°F	4,444	60.0°F	7,407
	700	100.0°F	5,186	60.0°F	8,642
	800	100.0°F	5,926	60.0°F	9,877
350	600	100.0°F	4,444	60.0°F	7,407
	750	100.0°F	5,556	60.0°F	9,259
	900	100.0°F	6,667	60.0°F	11,111
	1050	100.0°F	7,778	60.0°F	12,963
	1200	100.0°F	8,889	60.0°F	14,814
352	600	100.0°F	4,444	80.0°F	5,556
	800	100.0°F	5,926	80.0°F	7,407
	1000	100.0°F	7,407	80.0°F	9,259
	1200	100.0°F	8,889	80.0°F	11,111

Please refer to the unit's submittal information for the exact gas furnace performance data.

Electric Heat Limitations – Valent Units

Supply fan modulation must be limited to the minimum airflow requirements of the electric heater manufacturer. The minimum air flow required through a duct heater depends on the KW per square foot of face area for the highest capacity ON-OFF stage. In general 500 FPM is adequate in most applications.

Please contact Valent or Innovent technical support to get more information regarding specific products.

Appendix C – Demand Control Compressor Staging

Valent Unit Compressor Staging with Demand Signal

Listed below is a sample of the analog input values where each compressor stages on or off based on the Compressor Control Request in units operating controls lite in Demand Control. In a heat pump, the cooling and heating requests for compressor operation utilize the same Compressor Control Request analog input.

Unit with One Modulating Compressor					
COMP #	STAGE	ON/OFF	REQUEST %	0.0-10.0 VDC	2.0-10.0 VDC
1	1 (MOD/HGRH)	On	5.0%	0.50 VDC	2.40 VDC
		Off	2.5%	0.25 VDC	2.20 VDC

Unit with Two Modulating Compressors					
COMP #	STAGE	ON/OFF	REQUEST %	0.0-10.0 VDC	2.0-10.0 VDC
2	1 (MOD)	On	5.0%	0.50 VDC	2.40 VDC
		Off	2.5%	0.25 VDC	2.20 VDC
1	2 (HGRH)	On	55.0%	5.50 VDC	6.40 VDC
		Off	45.0%	4.50 VDC	5.60 VDC

Unit with Two Modulating Compressors (when Dehumidifying)					
COMP #	STAGE	ON/OFF	REQUEST %	0.0-10.0 VDC	2.0-10.0 VDC
1	1 (HGRH)	On	5.0%	0.50 VDC	2.40 VDC
		Off	2.5%	0.25 VDC	2.20 VDC
2	2 (MOD)	On	55.0%	5.50 VDC	6.40 VDC
		Off	45.0%	4.50 VDC	5.60 VDC

Unit with Four Modulating Compressors					
COMP #	STAGE	ON/OFF	REQUEST %	0.0-10.0 VDC	2.0-10.0 VDC
3	1 (MOD)	On	5.0%	0.50 VDC	2.40 VDC
		Off	2.5%	0.25 VDC	2.20 VDC
1	2 (HGRH)	On	30.0%	3.00 VDC	4.40 VDC
		Off	20.0%	2.00 VDC	3.60 VDC
2	3 (HGRH)	On	55.0%	5.50 VDC	6.40 VDC
		Off	45.0%	4.50 VDC	5.60 VDC
4	4	On	80.0%	8.00 VDC	8.40 VDC
		Off	70.0%	7.00 VDC	7.60 VDC

Unit with Four Modulating Compressors (when Dehumidifying)					
COMP #	STAGE	ON/OFF	REQUEST %	0.0-10.0 VDC	2.0-10.0 VDC
1	1 (HGRH)	On	5.0%	0.50 VDC	2.40 VDC
		Off	2.5%	0.25 VDC	2.20 VDC
2	2 (HGRH)	On	30.0%	3.00 VDC	4.40 VDC
		Off	20.0%	2.00 VDC	3.60 VDC
3	3 (MOD)	On	55.0%	5.50 VDC	6.40 VDC
		Off	45.0%	4.50 VDC	5.60 VDC
4	4	On	80.0%	8.00 VDC	8.40 VDC
		Off	70.0%	7.00 VDC	7.60 VDC

NOTE: HGRH indicates that the compressor is part of the circuit that is responsible for dehumidification.

Appendix D – Airflow Calculations

The Valent or Innovent units may have optional airflow monitoring stations (AFMS) available for the third-party controller to determine the amount of airflow at various positions in the unit. The following tables and formulas will assist the third party in calculating the airflow from the 0.0 to 10.0 VDC signal to the CFM for the airflow monitoring station. The 0.0 to 10.0 signal(s) is available from the terminal strip for the supply fan, the exhaust fan, or the outside air damper. See the unit submittal and wiring schematic for availability and specific locations of the signals.

Valent Supply and Exhaust Fan Models

The following table shows the available models for the supply and exhaust fan blades installed in a Valent unit and the corresponding K Factor for the fan blade. The third party needs to know the model number of the fan, how many fans are installed, and whether the airflow monitoring station was purchased with the supply and/or exhaust fans.

Valent Supply and Exhaust Fan Models				
Manufacturer	Model Number	Fan Blade Material	Fan Blade Diameter	K Factor
Comefri	TE280/ATE11	Blue Plastic	280mm/11”	706.6
Comefri	TE315/ATE12	Blue Plastic	315mm/12”	898.3
Comefri	TE355/ATE14	Blue Plastic	355mm/14”	1137.7
Comefri	TE400/ATE16	Blue Plastic	400mm/16”	1473
Comefri	TE450/ATE18	Blue Plastic	450mm/18”	1892
Greenheck	QEP/APM15	Aluminum	15”	1296
Greenheck	QEP/APM16	Aluminum	16”	1537
Greenheck	QEP/APM 18	Aluminum	18”	1888
Greenheck	QEP/APM 20	Aluminum	20”	2253
Greenheck	QEP/APM 24	Aluminum	24”	3334
Greenheck	APD280	Aluminum	280mm/11”	739
Greenheck	APD315	Aluminum	315mm/12.5”	936
Greenheck	APD355	Aluminum	355mm/14”	1198
Greenheck	APD400	Aluminum	400mm/16”	1479
Greenheck	APD450	Aluminum	450mm/18”	1956
Greenheck	APD500	Aluminum	500mm/20”	2377
Greenheck	APD560	Aluminum	560mm/22”	3089
Greenheck	APD630	Aluminum	630mm/25”	3838

Valent Supply and Exhaust Fan Airflow Measurement

The third-party controller can use the transducer’s signal from the supply fan and/or from the exhaust fan and the airflow formula to determine the amount of current airflow.

- ***Formula: $CFM = k * \sqrt{(\Delta P)}$***
  - *ΔP = Differential Pressure (0.0-30.0 in. wc scaled from 0.0 to 10.0 VDC reading from transducer)*
  - *k = K Factor (from table) * # of Fans*
  - *$\sqrt{}$= Square Root*

NOTE: The supply and exhaust airflow will be calculated separately. Only include the fans of the same type in the calculation.

Valent Outside Air Damper and AFMS

The following table shows the Valent unit casing and tonnage along with the model of the AMD-23 that would be used with the optional purchase of airflow monitoring of OAD. Select the proper Supply CFM Range to determine the values to use in the calculation. The values are also available on the AMD.

NOTE: The operating range for the AMD damper is 300 to 2000 fpm (feet per minute). Airflows outside of the operating range may not properly register.

Valent Outside Air Dampers								
Unit Casing	110	110	210	210	310	310	350/352	350/352
Supply CFM Range	< 2700	> 2700	< 5100	> 5100	< 8300	> 8300	< 13700	> 13700
AMD-23	G-5904	G-5905	G-5902	G-5903	G-5908	G-5909	G-6081	G-5906
Area	1.75 ft^2	2.33 ft^2	3.33 ft^2	4.72 ft^2	5.43 ft^2	7.67 ft^2	9.17 ft^2	12.22 ft^2
K Factor	1963	2031	2060	2120	2115	2093	2139	2105
M Value	0.5030	0.4910	0.4910	0.4910	0.4910	0.4910	0.4910	0.4910
Transducer Range	0 – 1”wc	0 – 1”wc	0 – 1”wc	0 – 1”wc	0 – 0.5”wc	0 – 1”wc	0 – 0.5”wc	0 – 1”wc

Valent Outside Air Damper Airflow Measurement

The third-party controller can use the transducer’s signal from the AMD for the airflow formula to determine the amount of current airflow through the OAD.

- ***Formula:*** $CFM = A * K * (P)^M$
  - *A = Area*
  - *K = K Value*
  - *P = Pressure (transducer range in.wc scaled from 0.0 to 10.0 VDC reading from transducer)*
  - *M = M Value*

Innovent Supply and Exhaust Fan Models

The following table shows the available models for the supply, return, exhaust, or regen fan blades installed in an Innovent unit and the corresponding K Factor for the fan blade. The third party needs to know the model number of the fan, how many fans are installed, and whether the airflow monitoring station was purchased for a specific fan type.

Innovent Fan Models		
Manufacturer	Model	K Factor
Greenheck (Sure-Aire)	QEP 12	354.7
Greenheck (Sure-Aire)	QEP 15	354.7
Greenheck (Sure-Aire)	QEP 16	420.9
Greenheck (Sure-Aire)	QEP 18	515.4
Greenheck (Sure-Aire)	QEP 20	616.9
Greenheck (Sure-Aire)	QEP 22	759.4
Greenheck (Sure-Aire)	QEP 24	912.9
Greenheck (Sure-Aire)	QEP 27	1104.9
Greenheck (Sure-Aire)	QEP 30	1355
Greenheck (Sure-Aire)	QEP 33	1625.4
Greenheck (Sure-Aire)	QEP 36	1966.5
Greenheck (Sure-Aire)	QEP 40	2361.1
Greenheck (Sure-Aire)	QEP 44	2853.9
Greenheck (Sure-Aire)	QEP 49	3411

Innovent Fan Models		
Manufacturer	Model	K Factor
Greenheck (Sure-Aire)	QEP 54	4121
Greenheck (Sure-Aire)	QEP 60	4972.3
Greenheck (Sure-Aire)	QEP 66	5959.9
Greenheck (Sure-Aire)	QEP 73	7275.8
Greenheck (Sure-Aire)	PLG 7	259.1
Greenheck (Sure-Aire)	PLG 8	251.6
Greenheck (Sure-Aire)	PLG 9	247.6
Greenheck (Sure-Aire)	PLG 10	202.3
Greenheck (Sure-Aire)	PLG 12	295.9
Greenheck (Sure-Aire)	PLG 13	350.5
Greenheck (Sure-Aire)	PLG 15	361
Greenheck (Sure-Aire)	PLG 16	440.3
Greenheck (Sure-Aire)	PLG 18	541.7
Greenheck (Sure-Aire)	PLG 20	650.3

Innovent Fan Models		
Manufacturer	Model	K Factor
Greenheck (Sure-Aire)	PLG 22	804
Greenheck (Sure-Aire)	PLG 24	971.4
Greenheck (Sure-Aire)	PLG 27	1184
Greenheck (Sure-Aire)	PLG 30	1463
Greenheck (Sure-Aire)	PLG 33	1770
Greenheck (Sure-Aire)	PLG 36	2167
Greenheck (Sure-Aire)	PLG 40	2628
Greenheck (Sure-Aire)	PLG 44	3218
Greenheck (Sure-Aire)	PLG 49	3901
Greenheck (Sure-Aire)	PLG 54	4783
Greenheck (Sure-Aire)	PLG 60	5880
Greenheck (Sure-Aire)	PLG 66	7078
Greenheck (Sure-Aire)	PLG 73	8660
Greenheck (Sure-Aire)	APD315	936
Greenheck (Sure-Aire)	APD355	1198
Greenheck (Sure-Aire)	APD400	1479
Greenheck (Sure-Aire)	APD450	1956
Greenheck (Sure-Aire)	APD500	2377
Greenheck (Sure-Aire)	APD560	3089
Greenheck (Sure-Aire)	APD630	3838
Comefri	ATZAF 12-12 T1	2337.5
Comefri	ATZAF 12-12 T2	2237.3
Comefri	ATZAF 15-15 T1	3873.6
Comefri	ATZAF 15-15 T2	3873.6
Comefri	ATZAF 18-18 T1	4675
Comefri	ATZAF 18-18 T2	4675
Comefri	ATZAF 20-20 T1	5843.7
Comefri	ATZAF 20-20 T2	5119.9
Comefri	ATZAF 22-22 T1	7513.4
Comefri	ATZAF 22-22 T2	6624.1
Comefri	ATZAF 25-25 T1	9683.9
Comefri	ATZAF 25-25 T2	8891.1
Comefri	ATZAF 28-28 T1	12856.2

Innovent Fan Models		
Manufacturer	Model	K Factor
Comefri	ATZAF 28-28 T2	11795
Comefri	ATZAF 32-32 T1	16295.6
Comefri	ATZAF 32-32 T2	16295.6
Comefri	ATZAF 36-36 T1	19701.7
Comefri	ATZAF 36-36 T2	19367.8
Comefri	ATZAF 40-40 T1	25378.4
Comefri	ATZAF 40-40 T2	25044.5
Comefri	ATLI T2 7-7	3675.2
Comefri	ATLI T2 9-9	5510.6
Comefri	ATLI T2 9-6	3919
Comefri	ATLI T2 10-10	5556.2
Comefri	ATLI T2 10-7	5556.2
Comefri	ATLI T2 9-4	3919
Comefri	ATLI T2 12-12	8190.1
Comefri	ATLI T2 12-9	6789.7
Comefri	ATLI T2 15-15	11065
Comefri	ATLI T2 15-11	11065
Comefri	ATLI T2 18-18	13101.8
Comefri	ATLI T2 18-13	11670
Ziehl Abegg	RH22C	437
Ziehl Abegg	RH25C	558
Ziehl Abegg	RH28C	697
Ziehl Abegg	RH31C	883
Ziehl Abegg	RH35C	1124
Ziehl Abegg	RH40C	1431
Ziehl Abegg	RH45C	1830
Ziehl Abegg	RH50C	2413
Ziehl Abegg	RH56C	2861
Ziehl Abegg	RH63C	3540
Ziehl Abegg	RH71C	4552
Ziehl Abegg	RH80C	5760
Ziehl Abegg	RH90C	7330
Ziehl Abegg	RH10C	9281

Innovent Supply and Exhaust Fan Airflow Measurement

The third-party controller can use the transducer's signal from a fan type and the airflow formula for the fan manufacturer to determine the amount of current airflow.

- ***Formula 1: Greenheck QEP & PLG, and Comefri fans***
  - ***CFM = CFM = k * √(ΔP/0.0745)***
    - *ΔP = Differential Pressure*
    - *k = K Factor (from table) * # of Fans*
    - *√= Square Root*
- ***Formula: Greenheck APD and Ziehl Abegg***
  - ***CFM = k * √(ΔP)***

NOTE: The all airflows will be calculated separately. Only include the fans of the same type in the calculation.

Appendix E – Controls Lite Sequence of Operation

1. Third-Party Controls Responsibilities and Limitations

The following information in this section are guidelines for the third-party controls contractor to follow when controlling the Valent unit:

1.1 Airflow

Maintaining the proper airflow through the unit is the responsibility of the third party.

A. Dampers
Ensure damper end switch proves the damper position for airflow through the unit.
   i. Outside Air Damper
   ii. Return Air Damper

B. Fan Modulation *(Note: Valent = supply; Innovent = supply, return, or regen)*
Proper fan modulation is the responsibility of the third party. The guidelines below must be followed:
   i. Cooling or Heat Pump Heating (Compressor Operation)
      - Fan turndown limited to 50% of the **designed airflow**.
   ii. Electric Heat
      - Fan turndown limited to the requirements from the electric heater manufacturer.
   iii. Gas Furnace Heat
      - All gas furnaces must be limited to the **greater** of the following:
        - minimum airflow in CFM; OR
        - 50% of **design airflow**.
   iv. Exhaust Fan
      - Enable and modulation of the exhaust fan and any modulating dampers necessary to achieve the building requirements.

1.2 Energy Recovery

Controlling the energy recovery equipment to maintain the desired temperature in the unit is the responsibility of the third party.

A. Enable of energy recovery device and modulation signal.
B. Defrost of device if no pre-heat installed and located in the outside air stream.
All units with energy recovery options **must** provide a defrost sequence for the energy recovery section.
   i. Provide an exhaust air temperature sensor; AND
   ii. Maintain the exhaust air temperature >= 36.0°F.

1.3 Supply Air Temperature Control

Supply Air Temperature **must** be monitored and maintained by the third party.

A. Supply Air Temperature Setpoint
   i. A setpoint must be utilized by the third party regardless of control method; setpoint or demand.
   ii. Setpoint range between 50.0°F and 95.0°F for **all** modes of operation.
   Note: A minimum setpoint of 60.0°F is advised in heating mode of a heat pump.

B. Supply Air Temperature Limits
   i. Minimum Low Supply Temp Limit
      - Supply Air Temperature < 35.0°F
      - All cooling in the unit **must** be turned off.
   ii. Maximum High Supply Temp Limit
      - Supply Air Temperature > 120.0°F
      - All heating in the unit **must** be turned off.

1.4 Compressor and Dehumidification Control

Compressor control is requested by the third party in one of the following methods:

A. Setpoint Control:
   i. Dehumidification Mode
      a. Cooling/Dehumidification Input: Closed
      b. Cooling/Heating Input: Open (Heat Pumps Only)
      c. Supply Air Setpoint Request: 50 - 95°F scaled from 2-10vdc (HGRH Valve Modulation)
      d. Cooling Coil Setpoint Request: 50 - 75°F scaled from 2-10vdc (Compressor Staging)

ii. Cooling Mode
   a. Cooling/Dehumidification Input: Open
   b. Cooling/Heating Input: Open (Heat Pumps Only)
   c. Cooling Coil Setpoint Request: 50 - 75°F scaled from 2-10vdc (Compressor Staging)
iii. Heat Pump Heating Mode
   a. Cooling/Dehumidification Input: Open
   b. Cooling/Heating Input: Closed (Heat Pumps Only)
   c. Supply Air Setpoint Request: 50 - 95°F scaled from 2-10vdc (Compressor Staging)

Note: A minimum setpoint of 60.0°F is advised in heating mode of a heat pump.

B. Demand Control:
   i. HGRH Request: > 5.0% scaled from 2-10vdc (HGRH Valve Modulation)
   ii. Compressor Control Request: > 5.0% scaled from 2-10vdc (Compressor Staging)
   iii. Cooling/Heating Input: Open for Cooling; Closed for Heating (Heat Pumps Only)

2. Controls Availability

2.1 Unit Availability

The unit is available for operation when the following conditions are met:

A. 5 second initial delay on power up for the controller to be ready.
B. Shutdown Input is closed.
C. Remote Start Input is closed.
D. Unit is enabled at the handheld display.
E. Fan Status indicates that a fan is running.
F. Outside Air Temperature sensor is reading a normal temperature.
G. Coil Leaving Air Temperature sensor is reading a normal temperature.
H. Supply Air Temperature sensor is reading a normal temperature.

2.2 Cooling Availability

The unit compressors are available to operate in cooling mode when all of the Unit Availability conditions and the following conditions are met:

A. Coil Leaving Air Temp must be greater than the Cold Coil Low Limit Setpoint (42.0°F) (adj.)
   i. If the coil leaving temp falls below 42.0°F, the compressors are not available to stage on until the cooling coil temp reaches 46.0°F.
B. Outside Air Temp must be greater than the Cooling Amb Lockout (55.0°F) (adj.)
C. If the unit is a Heat Pump, the following must also be true:
   i. Cooling/Heating Control Mode is open for cooling mode (third-party input).
   ii. Mode Switch Delay (120 secs) (adj.) timer has expired.

2.3 Heat Pump Heating Availability

The unit compressors are available to operate in heating mode when the unit is configured as a WSHP or ASHP, the Unit Availability conditions, and the following conditions are met:

A. Outside Air Temp must be less than the Heating Amb. Lockout (80.0°F) (adj.)
B. Outside Air Temp must be greater than the ASHP Low Ambient Lockout (17.0°F) (adj.) for ASHP; OR
   - Saturated Suction Temp > WSHP Low Saturated Suction Lockout (-15.0°F) (adj.) for WSHP.
C. Cooling/Heating Control Mode is closed for Heating Mode (third-party input).
D. Mode Switch Delay (120 secs) (adj.) timer has expired.

3. Refrigeration Sequence

3.1 Compressor Availability

The unit compressors are available based on conditions of the refrigerant circuit and the conditions listed under Unit Availability, Cooling Availability, and Heat Pump Heating Availability in this document.

A. Refrigeration alarms are not active.

3.2 Compressor Control

The main controller performs the following functions for compressor control.

A. Stages and modulates compressors to maintain the requested capacity.
B. Coil Staging Safety Setpoint – Compressor Ramp Limit

The Coil Staging Safety Setpoint limits the compressor ramp and prevents the cooling ramp from bringing on any additional compressors. Compressors may still stage off during the safety, but will not stage back on until the safety has reset.

i. Coil Leaving Air Temp must be greater than the Coil Staging Safety Setpoint (46.0°F) (adj.)
ii. If the coil leaving temp falls below 46.0°F, the modulating compressor is limited and the standard compressors are not available to stage on until the coil leaving temp reaches above safety plus 4°F for five minutes.

C. Envelope Control – Modulating Inverter Scroll Compressor
If the unit is equipped with an inverter modulating compressor, the main controller will monitor temperatures and pressures in the circuit and compare them to the compressor's operating envelope to ensure that the compressor is within safe operating conditions.

D. Superheat Control – Modulating Inverter Scroll Compressor
If the unit is equipped with an inverter modulating compressor, an Electronic Expansion Valve (ExV) and Electronic Valve Driver (EVD) will be utilized in the modulating circuit where the inverter compressor is installed.

i. The EVD will control the position of the ExV based on the Suction Superheat to maintain a Superheat Setpoint (15.0°F) (adj.).
ii. Loss of power to the EVD will result in the ExV staying at its current position.

3.3 Heat Pump – Switching Modes of Operation

The Heat Pump Unit switches modes of operation based on an external input from a third-party device.

A. Switch from Cooling to Heating

When the Cooling/Heating contact is closed heating mode will initiate and the following will occur:

i. All currently operating compressors are shut down.
ii. The reversing valve moves to the heating position.

B. Switch from Heating to Cooling

When the Cooling/Heating contact is open cooling mode will initiate and the following will occur:

i. All currently operating compressors are shut down.
ii. The reversing valve moves to the cooling position.

3.4 Dehumidification

Dehumidification mode is possible on units equipped with Hot Gas Reheat. Cooling Availability and Compressor Availability are prerequisites for operating in dehumidification mode.

A. Enable Dehumidification
The Cooling/Dehumidification contract is closed to initiate dehumidification mode, the following will occur:

i. The hot gas reheat valve modulates to maintain the supply air temperature setpoint.
ii. The compressors stage and modulate to maintain the cooling coil temperature setpoint.
iii. Lag compressor staging takes over during dehumidification to maximize reheat capacity based on unit configuration.

B. Disable Dehumidification

The Cooling/Dehumidification contract is open to initiate cooling mode, the following will occur:

i. The HGRH valve modulates to the closed position when a compressor in the HGRH circuit is operating.
ii. The compressors stage and modulate to maintain the cooling coil temperature setpoint.
iii. Lead compressor staging takes over allowing the modulating compressor to be the first compressor on and the last off.

3.5 Condenser Pressure Control

Condenser pressure control maintains a consistent condensing temperature in cooling, dehumidification, and heating modes by modulating condenser fans or water valves to meet the pressure control setpoint(s) configured in the Valent or Innovent controller.

3.6 Outside Coil Defrost - ASHP

An Air-Source Heat Pump (ASHP) periodically needs to initiate a defrost cycle of the outside coil to remove the accumulation of frost build-up when operating in heating mode. An output to the third party will energize when the unit is in defrost indicating the need for auxiliary heat.

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More Information

Unit Schematics

For configuration and connection questions, see the schematics that shipped with your unit. They can typically be found attached to the main control panel door.

Mechanical and Controls Manuals

Go to the literature section of your air handler's web site to find current mechanical and controls manuals:

Valent units: www.valentair.com
Innovent units: www.innoventair.com

Continuous product improvement is a policy of Valent and Innovent; therefore, product functionality and specifications are subject to change without notice. For the most recent product information visit our product web sites.

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