Application Guide

Symbio™ 700 Controller

with Precedent™ Packaged Rooftop Air-Conditioners

⚠ SAFETY WARNING

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

October 2024

ACC-APG002D-EN

Introduction

Read this manual thoroughly before operating or servicing this unit.

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:

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

⚠ WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury.

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state/national electrical codes.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

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

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

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⚠ WARNING

Follow EHS Policies!

Failure to follow instructions below could result in death or serious injury.

- **All Trane personnel must follow the company's Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. Where local regulations are more stringent than these policies, those regulations supersede these policies.**
- **Non-Trane personnel should always follow local regulations.**

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Revision History

- Added Option Module Address chapter.
- Added Enhanced Thermostat Control chapter.
- Add Refrigerant detection and mitigation chapter.
- Added Symbio 700 Configuration chapter in Appendix B.
- Updated Dehumidification - Hot Gas Reheat.
- Updated Compressor Minimum Run Time.
- Updated Diagnostics and Alarm Indicator Status chapter.
- Added supply fan operation and temperature rise limit control to Modulating Gas Heat section.
- Added Variable Speed Compressor Operation chapter.
- Added Relief Damper Control - Powered Exhaust.
- Added Dual Fuel Operation.
- Added Heat Pump with Secondary Electric Heat.
- Added Modbus Device Service chapter.
- Updated Troubleshooting chapter.
- Updated Appendix A with compressor and supply fan staging information.

Table of Contents

Introduction

The Symbio™ 700 installed on Precedent™ rooftop units is a factory installed and programmed controller, providing digital control and protection of the equipment.

The Symbio 700 has two model options:

- **Standard Controller** — provides advanced troubleshooting and access to the Symbio Service and Installation mobile app via a Bluetooth connection. The Standard controller does not support remote communications of any type or custom TGP2 programming abilities. A Standard controller can be converted to an Advanced controller.
- **Advanced Controller** — supports Building Automation System interface via BACnet® (ANSI/ASHRAE Standard 135-2016), Modbus™, Air-Fi®, or LonTalk®. The Advanced Controller also allows optional (field applied) TGP2 programming utilizing optional XM30 and XM32 Expansion Module points. The advanced controller is a purchased feature.

The Symbio 700 offers multiple equipment configuration options regardless of controller model. The Precedent rooftop unit can be configured as the following system types:

- Conventional Thermostat Control (T-Stat) - Heating and cooling operation for space comfort managed by conventional thermostat inputs.
- Constant Volume Zone Temperature Control (CVZT) - Multi-speed supply fan control to manage space comfort.
- Variable Volume Zone Temperature Control (VVZT) - The modulating supply fan speed modulates with heating or cooling capacity to maintain space comfort.
- Variable Volume Discharge Air (VVDA) - The supply fan modulates air volume to maintain duct static pressure control. Also known as Multi-Zone VAV.

These configurations can be used with standard cooling systems.

This guide provides information about the configuration, control capabilities and troubleshooting of the Precedent system with Symbio 700 controller.

Additional Documentation

- *Symbio™ Service and Installation App Quick Start Guide* (BAS-SVN043*-EN)
- *Symbio™ 700 Controller User Guide* (BAS-SVU054*-EN)
- *BACnet and Modbus Integration Symbio™ 700 Integration Guide* (BAS-SVP085*-EN)
- *LonTalk Integration Symbio 700 Integration Guide* (BAS-SVP086*-EN)
- *Precedent Rooftop Air-Conditioners with Symbio™ 700 Controls Point List* (BAS-PTS001*-EN)
- *Symbio™ 700 Controller Installation Instructions* (BAS-SVN235*-EN)
- *Advanced License for Symbio™ 700 Controller Installation Instructions* (BAS-SVN288*-EN)
- *Precedent™ Packaged Rooftop Units Cooling and Gas/Electric Standard and High Efficiency 3 to 25 Tons - 60 Hz Installation, Operation, and Maintenance* (RT-SVX092*-EN)
- *Precedent™ Packaged Rooftop Units, Heat Pump, Standard and High Efficiency, 3 to 25 Tons — 60 Hz Installation, Operation, and Maintenance* (PKGP-SVX015*-EN)
- *Precedent™ Packaged Rooftop Units, Cooling and Electric Heat, Ultra High Efficiency 3 to 25 Tons — 60 Hz Installation, Operation, and Maintenance* (RT-SVX093*-EN)

Symbio 700 Overview

Field Connection

The Symbio™ 700 controller optimizes inputs and outputs (I/O) for multiple applications. For initial installation of a Precedent with Symbio™ 700, the field wired inputs are outlined below.

Figure 1. Symbio 700 field connections

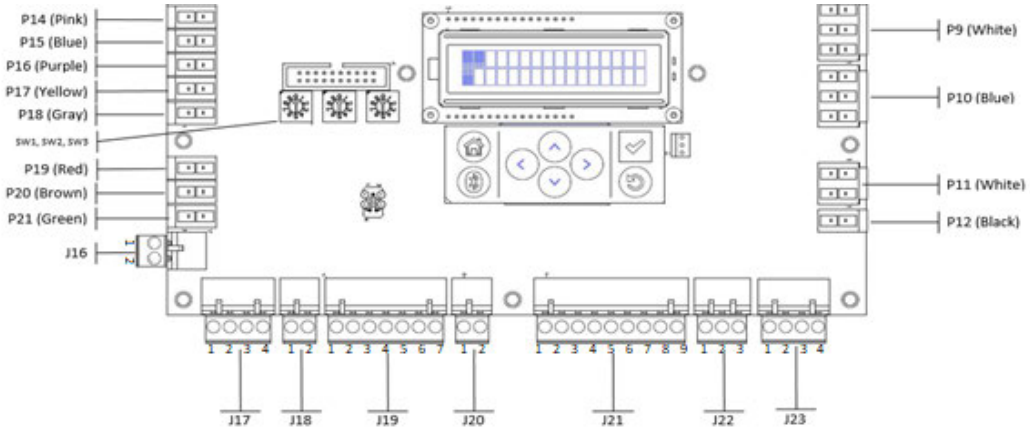


Table 1. Field connections

Connector	Function	Pin #	Signal
J16	Demand Shed/Demand Limit Connection	1	24VAC
		2	Demand Shed/Demand Limit Input
J17	BACnet MSTP or Modbus RTU Communication Connections	1	BACnet/Modbus +
		2	BACnet/Modbus -
		3	BACnet/Modbus +
		4	BACnet/Modbus -
J18	Equipment Shutdown Input Connections	1	24VAC
		2	Equipment Shutdown Input
J19	Zone Sensor Connections	1	Zone Temperature
		2	GND
		3	Cool Setpoint
		4	Mode
		5	Heat Setpoint
		6	GND
		7	24VAC
J20	Occupancy Connections	1	24VAC
		2	Occupancy Switch

Table 1. Field connections (continued)

Connector	Function	Pin #	Signal
J21	Thermostat Connections	1	24VAC
		2	Y1
		3	W1/O
		4	G (or VAV Changeover Input)
		5	W2
		6	Y2
		7	X2
		8	1.5K Ohms Pull-down
		9	GND
J22	Space CO_2	1	24VDC
		2	0-10 VDC input
		3	GND
J23	Space Relative Humidity	1	24VDC
		2	4-20 mA input
		3	GND

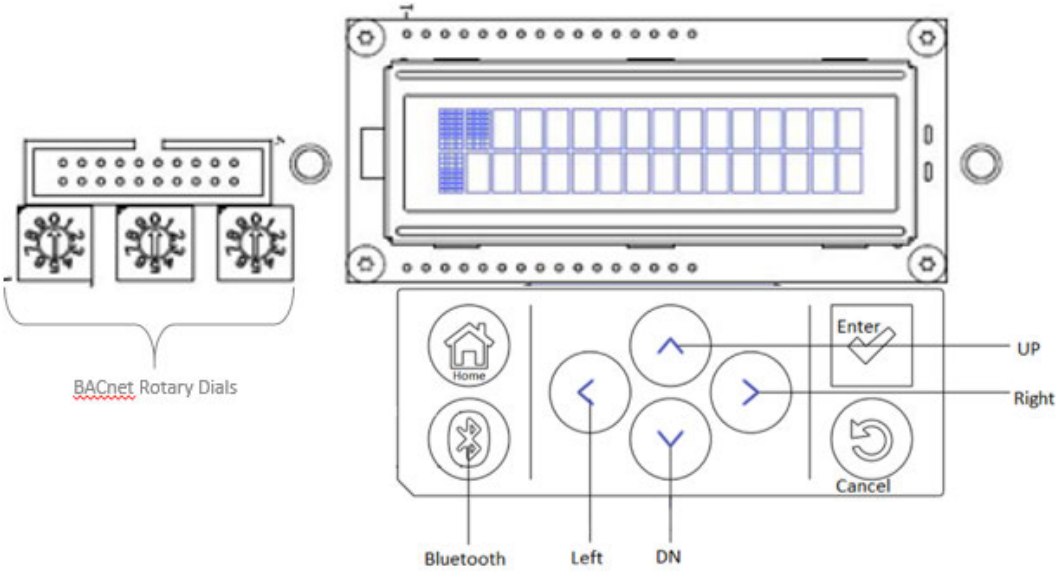
Unit Configuration

The Precedent unit can be configured via an onboard user interface or via the Symbio™ Service and Installation mobile app.

Onboard User Interface

The onboard user interface provides a 2 x 16 Backlit LCD display and navigational buttons. This allows the user to view status, configure, and troubleshoot the unit without additional tools.

Figure 2. Symbio 700 onboard user interface



The interface provides an intuitive menu structure: alarms, status, service, settings, and utilities. Configuration of the unit is accomplished under the utilities menu item. A complete list of functions is outlined in *User Guide, Symbio™ 700* (BAS-SVU054*-EN).

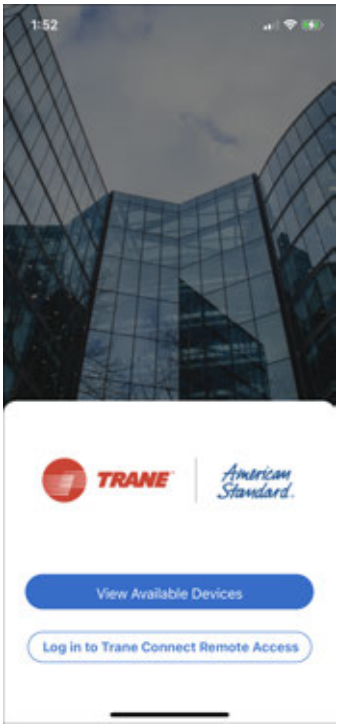
To configure the unit, navigate to the utilities menu and press **Enter**. Once in the utilities menu the user has additional submenu options. This allows the user to navigate and configure the appropriate setting quickly and easily.

Mobile App

The Trane Symbio™ Service and Installation mobile app is required to setup, edit, and confirm the communication protocol and associated settings.

The free download of Trane Symbio Service and Installation mobile app is available on the App Store® for iOS, and on Google Play® for Android™.

Figure 3. Trane Symbio service and installation mobile app



Bluetooth Pairing

Quick Connection Instructions

Follow these instructions to quickly connect the mobile app to the Symbio™ 700 controller:

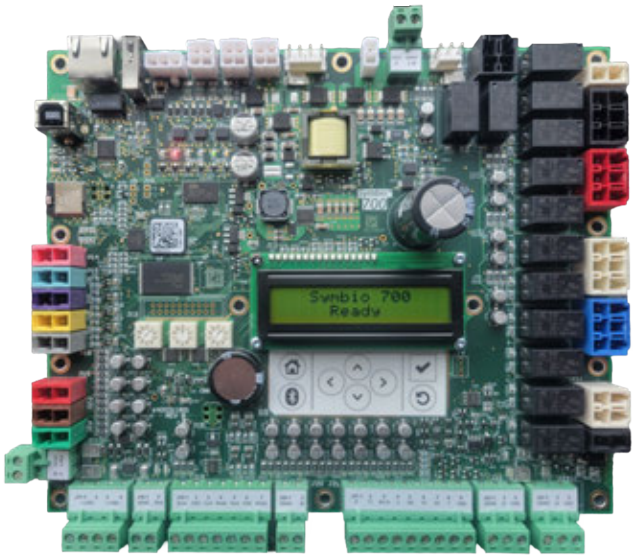
1. Turn on Bluetooth®[1].
2. Tap  .
3. Start the app. Tap **View Available Devices**.
4. Select the controller.
5. Tap **OK** to pair.
6. Tap  .

Connecting to the Symbio™ 700 controller

1. Enable Bluetooth®[1] on your smart device.
2. Access the Symbio 700 controller in the low voltage portion of the equipment.

1. *The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by the company is under license.*

Figure 4. Symbio 700 controller

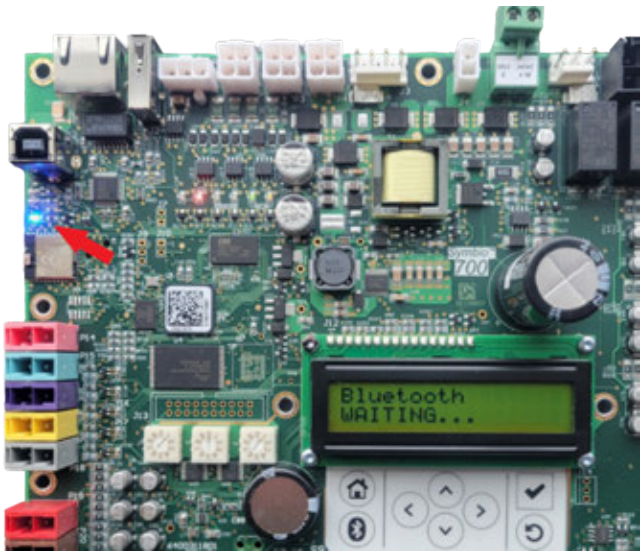


3. Tap  on Symbio 700 keyboard/display to turn on Bluetooth.
4. Confirm the status of Bluetooth communications. A solid blue LED indicates a successful pairing.

Table 2. Bluetooth communication status

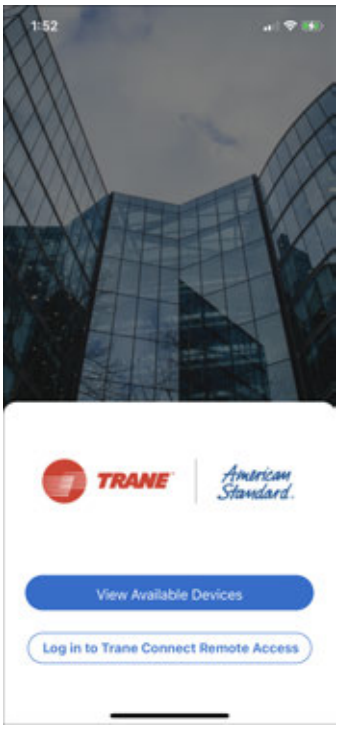
	Blue LED	Display	Description
Tap for On/Off	Off	NOT CONNECTED	Bluetooth Off
	Blinking	WAITING...	Bluetooth On — Not Paired
	On Solid	CONNECTED	Bluetooth On — Connected/ Paired

Figure 5. Symbio 700 bluetooth status



5. Start the mobile app on your smart device.

Figure 6. Login screen

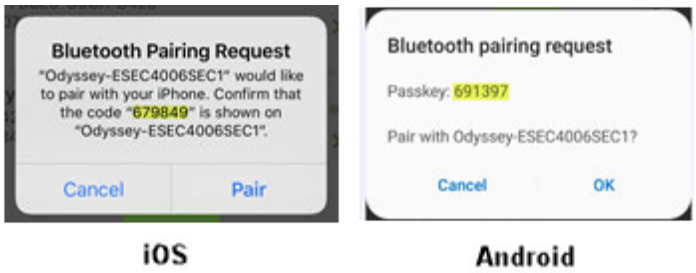


6. On the login screen, tap **View Available Devices** in the lower section of the screen. Or Trane personnel can login using their Trane Connect username and password.
7. On the Unit List page, select the Symbio 700 controller to which you want to pair. If the controller is not listed, tap the refresh arrow in the upper right-hand corner of the screen.

Note: *If a Symbio 700 is not the original Symbio controller as shipped with the equipment, the Bluetooth equipment list will list the controller serial number, instead of the equipment serial number.*

8. When prompted, pair the app to the Symbio 700 controller. A popup message displays a 6-digit random number. The same number is shown on the display of the Symbio™ 700 controller until the pairing is complete, allowing the user to confirm connection to the intended controller.

Figure 7. Bluetooth pairing



9. Tap  on the Symbio 700 on-board keyboard/display to complete the connection.

When the LED light is a solid blue and the display reads Bluetooth Connected, the Bluetooth pairing and connection is complete.

Important: *To keep the list of previously-connected devices manageable, the Bluetooth smart devices list is limited to 10 devices. When 10 or more Bluetooth devices are defined on the smart device, connection to the Symbio 700 controller is not allowed.*

- ***iOS devices*** *- delete any unused devices until there are less than 10 items.*
- ***Android devices*** *- the devices list is automatically limited to 10 items.*

The Symbio Installation and Service tool is required to view, manage, and configure the following:

- Building Automation System configuration (Advanced Controller Configuration)
  - BACnet® over Zigbee® (Air-Fi® Wireless)
  - BACnet IP (Internet Protocol)
  - BACnet MS/TP
  - LonTalk®
  - Modbus RTU
  - Modbus TCP
- Historical Alarms
- Firmware Update (includes both the Symbio 700 Module and the Options Modules)
- Backing up and Restoring the database
- Transfer Settings from one controller to another
- Return the Symbio 700 to its Factory Default configuration by using the Factory Default Database (if available)
- Update the license file

For more detailed information on the Symbio Service and Installation Mobile Application, refer to *Quick Start Guide, Symbio Service and Installation App* (BAS-SVN043*-EN).

Option Modules

The Symbio™ 700 extends its control capabilities through the use of additional hardware modules. These modules are installed, wired, and tested in the unit when ordered from the factory. The modules can be field installed. The following table summarizes the Symbio 700 functions that require an additional hardware module.

Table 3. Option modules – 6 to 25 ton units

Function	Customer Connection Module	Indoor Options Module	Fresh Air Options Module	Stepper Motor Module
Humidistat	X			
External Auto/Stop	X			
Ventilation Overrides	X			
Alarm Output	X			
Remote Minimum Position	X			
Condensate Overflow		X		
Supply Air Smoke Detector		X		
Electric Heat		X		
Duct Static Pressure Control		X		
0 to 100% Economizer			X	
Air Filter Status			X	
Return Air Smoke Detector			X	
Relief Fan Control			X	
Dehumidification	X	X		X

Table 3. Option modules – 6 to 25 ton units (continued)

Function	Customer Connection Module	Indoor Options Module	Fresh Air Options Module	Stepper Motor Module
Modulating Gas Heat		X		
Variable Speed Compressor	X	X		

Notes:
1. 6 to 25 ton.
2. 3 to 5 ton Ultra High Efficiency.
3. 3 to 5 ton High Efficiency Heat Pump.
4. 4 to 5 ton High Efficiency Cooling Only.

Table 4. Option modules — 3 to 5 ton standard efficiency and 3 ton high efficiency cooling only

Function	Customer Options Module	Indoor Options Module	Fresh Air Options Module	Stepper Motor Module
Humidistat	X			
External Auto/Stop	X			
Ventilation Override	X			
Alarm Output	X			
Remote Minimum Position	X			
Condensate Overflow	X			
Supply Air Smoke Detector				
Electric Heat				
Duct Static Pressure Control				
0 to 100% Economizer			X	
Air Filter Status			X	
Return Air Smoke Detector			X	
Relief Fan Control			X	
Dehumidification	X			X
Supply Fan Speed Command	X[(a)]			

[(a)] Customer Options Module sources the Supply Fan Speed Command in 3 tons high efficiency cooling only units via a PWM based speed control signal.

The figure below is the Customer Connection Module. Only the Customer Connection Module has screw type connectors for field installed options.

Figure 8. Customer connection options module

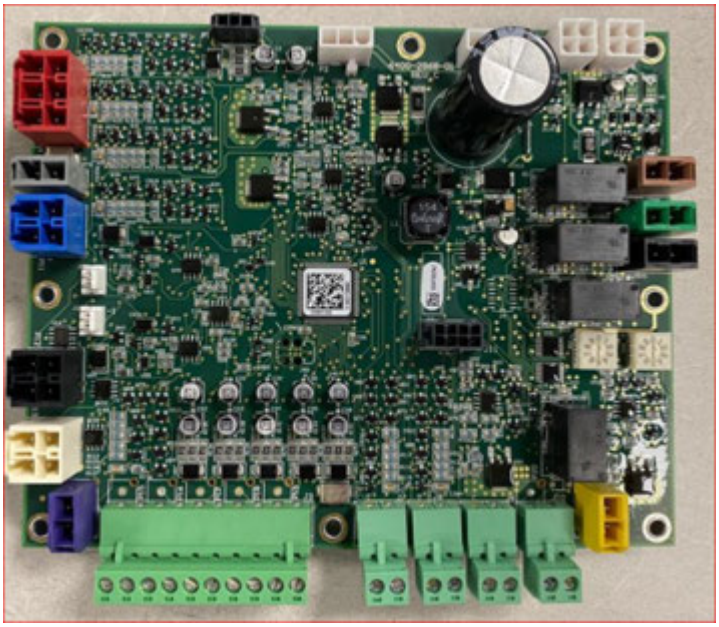


Table 5. Customer connection options module — Electrical connections

Connector	Function	Pin #	Signal
J7	Spare	1, 2	
J8	Remote Min Position	1 = Input 2 = Ground	0 – 270 Ohms
J9	Spare	1, 2	
J10	Alarm Indicator, Normally Open	1, 2	Dry Contact Binary Output
J3		1	24 Vac
J3	Reheat Humidistat	2	Binary Input #1
J3		3	24 Vac
J3	External Auto / Stop	4	Binary Input #2
J3		5	24 Vac
J3	Ventilation Override - Exhaust Status	6	Binary Input #3
J3		7	24 Vac
J3	Ventilation Override - Pressure Status	8	Binary Input #4
J3		9	24 Vac
J3	Ventilation Override - Purge Status	10	Binary Input #5

Option Module Address

All Option Modules are factory wired with an eight-position address plug, located toward the center of the module. In improperly addressed module will create a communication diagnostic. See Figure 8, p. 16 for a Customer Connection Option Module with address plug uninstalled (J11). When replacing any Options Module is it important to remove the address plug from the board being replaced and plugging into the replacement Options Module.

If the address plug is missing, two board-mounted rotary switches are required to be set properly for the board function. Note that the rotary dials are set to 0,0 from the factory. The following table provides rotary switch settings for each Symbio™ 700 option module.

Table 6. Option module rotary switch address setting

Option Module	Address Switch SW1, SW2	Address Plug
Indoor Option Module	7, 5	J11
Fresh Air Option Module	7, 6	J11
Customer Connection Module	7, 8	J11
Stepper Motor Module	7, 9	J9

Backing Up and Restoring the Database

Best practice is to backup the database after the unit is fully commissioned and set up. The database can be backed up to a technician-provided USB memory stick by using the Symbio Service and Installation Tool. The Symbio™ 700 controller has a USB port for this purpose. A backup file can be quickly restored into a service board in the event of board replacement. The backup file contains all Symbio 700 installation information, including configuration, setpoints and settings, communications setup, XM Module setup, TGP2 programs, and the Factory Default File.

Note: *Restoring a Backup file is best practice when making a service replacement of a Symbio 700 board.*

Start-Up Sequence

Under normal conditions, the Symbio™ 700 will start-up in approximately 60 seconds once power is applied to the system. During this process, the controller checks that a valid system configuration is present and proceeds to normal control operation. After start-up, the system will begin to respond to operational requests.

Conventional Thermostat Sequence of Operation

When the Precedent system is configured to operate with a conventional thermostat, the controller provides protection for the system (see General Support Sequence section) and continues to provide insight to operating conditions. A conventional thermostat can be applied with CVZT and single zone VAV configured systems. While not recommended, a conventional thermostat can be applied to single zone variable volume configured systems, but the system is limited to staged fan control instead of a fully variable sequence.

When under conventional thermostat control, the equipment responds directly to operating requests from the thermostat device. Each thermostat input corresponds to a specific unit function, as described in the following tables. Equipment protection functions and compressor minimum on/off timers remain in-control, even when under conventional thermostat control.

Table 7. Cooling only, without outside air

Inputs						Outputs				
X	**Y1**	**Y2**	**W1/O**	**W2**	**G**	**Supply Fan On/Off Request**	**Supply Fan Speed Request**	**Compressor Cool Stage Request**	**Auxiliary Heat Stage Request**	**Heat Cool Mode Status**
NA	OPEN	OPEN	OPEN	OPEN	CLOSED	ON	Min	None	None	Fan Only
NA	OPEN	OPEN	CLOSED	OPEN	X	ON	Min	None	Stage 1	Heat
NA	OPEN	OPEN	X	CLOSED	X	ON	Min	None	Full Stage	Heat
NA	CLOSED	OPEN	OPEN	OPEN	X	ON	Min	Stage 1	None	Cool
NA	OPEN	CLOSED	OPEN	OPEN	X	ON	Min	Stage 1	None	Cool
NA	CLOSED	CLOSED	OPEN	OPEN	X	ON	Max	Full Stage	None	Cool
NA	X	X	X	X	X	OFF	0	None	None	OFF

Table 8. Ultra high efficiency, without outside air

Inputs							Outputs				
X	**Y1**	**Y2**	**W1/O**	**W2**	**G**	**DH**	**Supply Fan On/Off Request**	**Supply Fan Speed Request**	**Compressor Cool Stage Request[a]**	**Auxiliary Heat Stage Request**	**Heat Cool Mode Status**
NA	OPEN	OPEN	OPEN	OPEN	CLOSED	Inactive	ON	Min	None	None	Fan Only
NA	OPEN	OPEN	OPEN	OPEN	CLOSED	Active	ON	Min[b]	Full Stage[c]	None	Cool
NA	OPEN	OPEN	CLOSED	OPEN	X	X	ON	Min	None	Stage 1	Heat
NA	OPEN	OPEN	X	CLOSED	X	X	ON	Min	None	Full Stage	Heat
NA	CLOSED	OPEN	OPEN	OPEN	X	Inactive	ON	Min	Stage 1[d]	None	Cool
NA	CLOSED	OPEN	OPEN	OPEN	X	Active	ON	Min[b]	Full Stage[c]	None	Cool
NA	OPEN	CLOSED	OPEN	OPEN	X	Inactive	ON	Min[e]	Stage 1[d]	None	Cool
NA	OPEN	CLOSED	OPEN	OPEN	X	Active	ON	Min[b]	Full Stage[c]	None	Cool
NA	CLOSED	CLOSED	OPEN	OPEN	X	X	ON	Max	Full Stage[c]	None	Cool
NA	X	X	X	X	X	Active	ON	Min[b]	Full Stage[c]	None	Cool
NA	X	X	X	X	X	Inactive	OFF	0	None	None	OFF

[a] All start-up and shutdown requirements will be followed for the VSPD compressor.

[b] The minimum Supply Fan Speed Request during Dehumid/HGRH will be 80%.

[c] For 12.5 to 15 ton UHE unit configurations Full Stage for TSTAT operation will run the VSPD compressor at Full Load RPM (12.5T = 4020 RPM; 15T = 5040 RPM). For 17.5 to 25 ton UHE unit configurations Full Stage for TSTAT operation will run the VSPD Compressor at Full Load RPM (17.5T = 3840 RPM; 15T = 5220 RPM; 25T = 4680 RPM) with the Fixed Speed Compressor ON.

[d] For 12.5 to 15 ton UHE unit configurations Stage 1 of TSTAT operation will run the VSPD compressor at 2700 RPM. For 17.5 to 20 ton UHE unit configurations Stage 1 of TSTAT operation will run the VSPD Compressor at 6000 RPM with the Fixed Speed Compressor OFF. For 25T UHE unit configurations Stage 1 of TSTAT operation will run the VSPD Compressor at 4500 RPM with the Fixed Speed Compressor OFF.

[e] The Supply Fan Speed will operate at 62% Fan Speed while only the VSPD compressor is operating.

Table 9. Ultra high efficiency, with outside air

Inputs									Outputs					
Economizer System Status	X	Y1	Y2	W1/O	W2	G	DCV Fan ON Request	DH	Supply Fan On/ Off Request	Supply Fan Speed Request	OA Damper Position Request	Compres-sor Cool Stage Request[a]	Auxiliary Heat Stage Request	Heat Cool Mode Status
X	NA	OPEN	OPEN	OPEN	OPEN	CLOSED	X	Inactive	ON	Min	Min	None	None	Fan Only
X	NA	OPEN	OPEN	OPEN	OPEN	CLOSED	X	Active	ON	Min[b]	Min	Full Stage [c]	None	Cool
X	NA	OPEN	OPEN	CLOSED	OPEN	X	X	X	ON	Min	Min	None	Stage 1	Heat
X	NA	OPEN	OPEN	X	CLOSED	X	X	X	ON	Min	Min	None	Full Stage	Heat
Disabled	NA	CLOSED	OPEN	OPEN	OPEN	X	X	Inactive	ON	Min[d]	Min	Stage 1[e]	None	Cool
Enabled	NA	CLOSED	OPEN	OPEN	OPEN	X	X	Inactive	ON	Min/Max	Econ	0	None	Cool
X	NA	CLOSED	OPEN	OPEN	OPEN	X	X	Active	ON	Min[b]	Min	Full Stage [c]	None	Cool
Disabled	NA	OPEN	CLOSED	OPEN	OPEN	X	X	Inactive	ON	Min[d]	Min	Stage 1[e]	None	Cool
Enabled	NA	OPEN	CLOSED	OPEN	OPEN	X	X	Inactive	ON	Min/Max	Econ	0	None	Cool
X	NA	OPEN	CLOSED	OPEN	OPEN	X	X	Active	ON	Min[b]	Min	Full Stage [c]	None	Cool
Disabled	NA	CLOSED	CLOSED	OPEN	OPEN	X	X	X	ON	Max	Min	Full Stage [c]	None	Cool
Enabled	NA	CLOSED	CLOSED	OPEN	OPEN	X	X	X	ON	Min[d]	Full	Stage 1[e]	None	Cool
X	NA	X	X	X	X	X	X	Active	ON	Min[b]	Min	Full Stage [c]	None	Cool
X	NA	X	X	X	X	X	ON	Inactive	ON	Min	Min	None	None	Fan Only
X	NA	X	X	X	X	X	X	Inactive	OFF	0	0	None	None	OFF

[a] All start-up and shutdown requirements will be followed for the VSPD compressor.

[b] The minimum Supply Fan Speed Request during Dehumid/HGRH will be 80%.

[c] For 12.5 to 15 ton UHE unit configurations Full Stage for TSTAT operation will run the VSPD compressor at Full Load RPM (12.5T = 4020 RPM; 15T = 5040 RPM). For 17.5 to 25 ton UHE unit configurations Full Stage for TSTAT operation will run the VSPD Compressor at Full Load RPM (17.5T = 3840 RPM; 15T = 5220 RPM; 25T = 4680 RPM) with the Fixed Speed Compressor ON.

[d] The Supply Fan Speed will operate at 62% Fan Speed while only the VSPD compressor is operating.

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Table 10. Cooling only, with outside air

Inputs								Outputs					
Economizer System Status	X	Y1	Y2	W1/O	W2	G	DCV Fan ON Request	Supply Fan On/Off Request	Supply Fan Speed Request	OA Damper Position Request	Compressor Cool Stage Request	Auxiliary Heat Stage Request	Heat Cool Mode Status
X	NA	OPEN	OPEN	OPEN	OPEN	CLOSED	X	ON	Min	Min	None	None	Fan Only
X	NA	OPEN	OPEN	CLOSED	OPEN	X	X	ON	Min	Min	None	Stage 1	Heat
X	NA	OPEN	OPEN	X	CLOSED	X	X	ON	Min	Min	None	Full Stage	Heat
Enabled	NA	CLOSED	OPEN	OPEN	OPEN	X	X	ON	Min/Max	Econ	0	None	Cool
Enabled	NA	OPEN	CLOSED	OPEN	OPEN	X	X	ON	Min/Max	Econ	0	None	Cool
Enabled	NA	CLOSED	CLOSED	OPEN	OPEN	X	X	ON	Max	Full	Stage 1	None	Cool
Disabled	NA	CLOSED	OPEN	OPEN	OPEN	X	X	ON	Min	Min	Stage 1	None	Cool
Disabled	NA	OPEN	CLOSED	OPEN	OPEN	X	X	ON	Min	Min	Stage 1	None	Cool
Disabled	NA	CLOSED	CLOSED	OPEN	OPEN	X	X	ON	Max	Min	Full Stage	None	Cool
X	NA	X	X	X	X	X	ON	ON	Min	Min	None	None	Fan Only
X	NA	X	X	X	X	X	X	OFF	0	0	None	None	OFF

Table 11. Heat pump with electric heat, without outside air

Inputs							Outputs					
X	Y1	Y2	W1/O	W2	G	DH	Supply Fan On/ Off Request	Supply Fan Speed Request	Compressor Cool Stage Request	Compressor Heat Stage Request	Electric Heat Stage Request	Heat Cool Mode Status
CLOSED	X	X	X	X	X	X	ON	Max	None	None	All Stages	Em Heat
OPEN	CLOSED	OPEN	OPEN	OPEN	X	X	ON	Max	None	Stage 2/3	None/1	Heat
OPEN	OPEN	CLOSED	OPEN	OPEN	X	X	ON	Max	None	Stage 2/3	None/1	Heat
OPEN	CLOSED	CLOSED	OPEN	OPEN	X	X	ON	Max	None	All Stages	None/1/2	Heat
OPEN	CLOSED	OPEN	OPEN	CLOSED	X	X	ON	Max	None	Stage 2/3	All Stages	Heat
OPEN	OPEN	CLOSED	OPEN	CLOSED	X	X	ON	Max	None	Stage 2/3	All Stages	Heat
OPEN	CLOSED	CLOSED	OPEN	CLOSED	X	X	ON	Max	None	All Stage	All Stages	Heat
OPEN	X	X	OPEN	CLOSED	X	X	ON	Max	None	None	All Stages	Heat
OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	Inactive	OFF	0	None	None	None	Cool
OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	Active	ON	Min	Full Stage	None	None	Cool
OPEN	CLOSED	OPEN	CLOSED	OPEN	X	Inactive	ON	Min	Stage 1	None	None	Cool
OPEN	CLOSED	OPEN	CLOSED	OPEN	X	Active	ON	Min	Full Stage	None	None	Cool
OPEN	OPEN	CLOSED	CLOSED	OPEN	X	Inactive	ON	Min	Stage 1	None	None	Cool
OPEN	OPEN	CLOSED	CLOSED	OPEN	X	Active	ON	Min	Full Stage	None	None	Cool
OPEN	CLOSED	CLOSED	CLOSED	OPEN	X	X	ON	Max	Full Stage	None	None	Cool
OPEN	OPEN	OPEN	X	OPEN	CLOSED	Inactive	ON	Min	None	None	None	Fan Only
OPEN	OPEN	OPEN	X	OPEN	CLOSED	Active	ON	Min	Full Stage	None	None	Cool
X	X	X	X	X	X	Inactive	OFF	0	None	None	None	OFF
X	X	X	X	X	X	Active	ON	Min	Full Stage	None	None	Cool

Table 12. Heat pump with gas heat, without outside air

Inputs							Outputs					
X	Y1	Y2	W1/O	W2	G	DH	Supply Fan On/ Off Request	Supply Fan Speed Request	Compressor Cool Stage Request	Compressor Heat Stage Request	Gas Heat Stage Request	Heat Cool Mode Status
CLOSED	X	X	X	X	X	X	ON	Max	None	None	All Stages	Em Heat
OPEN	CLOSED	OPEN	OPEN	OPEN	X	X	ON	Max	None	2/3	None/1	Heat
OPEN	OPEN	CLOSED	OPEN	OPEN	X	X	ON	Max	None	2/3	None/1	Heat
OPEN	CLOSED	CLOSED	OPEN	OPEN	X	X	ON	Max	None	All Stages/ None	None/1/2	Heat
OPEN	CLOSED	OPEN	OPEN	CLOSED	X	X	ON	Max	None	None	All Stages	Heat
OPEN	OPEN	CLOSED	OPEN	CLOSED	X	X	ON	Max	None	None	All Stages	Heat
OPEN	CLOSED	CLOSED	OPEN	CLOSED	X	X	ON	Max	None	None	All Stages	Heat
OPEN	X	X	OPEN	CLOSED	X	X	ON	Max	None	None	All Stages	Heat
OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	Inactive	OFF	0	None	None	None	Cool
OPEN	OPEN	OPEN	CLOSED	OPEN	OPEN	Active	ON	Min	Full Stage	None	None	Cool
OPEN	CLOSED	OPEN	CLOSED	OPEN	X	Inactive	ON	Min	Stage 1	None	None	Cool
OPEN	CLOSED	OPEN	CLOSED	OPEN	X	Active	ON	Min	Full Stage	None	None	Cool
OPEN	OPEN	CLOSED	CLOSED	OPEN	X	Inactive	ON	Min	Stage 1	None	None	Cool
OPEN	OPEN	CLOSED	CLOSED	OPEN	X	Active	ON	Min	Full Stage	None	None	Cool
OPEN	CLOSED	CLOSED	CLOSED	OPEN	X	Inactive	ON	Max	Full Stage	None	None	Cool
OPEN	OPEN	OPEN	X	OPEN	CLOSED	Inactive	ON	Min	None	None	None	Fan Only
OPEN	OPEN	OPEN	X	OPEN	CLOSED	Active	ON	Min	Full Stage	None	None	Cool
X	X	X	X	X	X	Inactive	OFF	0	None	None	None	OFF
X	X	X	X	X	X	Active	ON	Min	Full Stage	None	None	Cool

Table 13. Heat pump with electric heat, with outside air

Inputs									Outputs						
Economizer System Status	X	Y1	Y2	W1/O	W2	G	DCV Fan ON Request	DH	Supply Fan On/ Off Request	Supply Fan Speed Request	OA Damper Position Request	Compressor Cool Stage Request	Compressor Heat Stage Request	Electric Heat Stage Request	Heat Cool Mode Status
X	CLOSED	X	X	X	X	X	X	X	ON	Max	Min	None	None	Full Stage	Em Heat
X	OPEN	CLOSED	OPEN	OPEN	OPEN	X	X	X	ON	Max	Min	None	2/3	None/1	Heat
X	OPEN	OPEN	CLOSED	OPEN	OPEN	X	X	X	ON	Max	Min	None	2/3	None/1	Heat
X	OPEN	CLOSED	CLOSED	OPEN	OPEN	X	X	X	ON	Max	Min	None	All Stages	None/1/2	Heat
X	OPEN	CLOSED	OPEN	OPEN	CLOSED	X	X	X	ON	Max	Min	None	2/3	All Stages	Heat
X	OPEN	OPEN	CLOSED	OPEN	CLOSED	X	X	X	ON	Max	Min	None	2/3	All Stages	Heat
X	OPEN	CLOSED	CLOSED	OPEN	CLOSED	X	X	X	ON	Max	Min	None	All Stages	All Stages	Heat
X	OPEN	OPEN	OPEN	OPEN	CLOSED	X	X	X	ON	Max	Min	None	None	Full Stage	Heat
Disabled	OPEN	CLOSED	OPEN	CLOSED	OPEN	X	X	Inactive	ON	Min	Min	Stage 1	None	None	Cool
Enabled	OPEN	CLOSED	OPEN	CLOSED	OPEN	X	X	Inactive	ON	Min/Max	Econ	0	None	None	Cool
X	OPEN	CLOSED	OPEN	CLOSED	OPEN	X	X	Active	ON	Min	Min	Full Stage	None	None	Cool
Disabled	OPEN	OPEN	CLOSED	CLOSED	OPEN	X	X	Inactive	ON	Min	Min	Stage 1	None	None	Cool
Enabled	OPEN	OPEN	CLOSED	CLOSED	OPEN	X	X	Inactive	ON	Min/Max	Econ	0	None	None	Cool
X	OPEN	OPEN	CLOSED	CLOSED	OPEN	X	X	Active	ON	Min	Min	Full Stage	None	None	Cool
Disabled	OPEN	CLOSED	CLOSED	CLOSED	OPEN	X	X	X	ON	Max	Min	Full Stage	None	None	Cool
Enabled	OPEN	CLOSED	CLOSED	CLOSED	OPEN	X	X	X	ON	Max	Econ	Stage 1	None	None	Cool
X	OPEN	OPEN	OPEN	X	OPEN	CLOSED	X	Inactive	ON	Min	Min	None	None	None	Fan Only
X	OPEN	OPEN	OPEN	X	OPEN	CLOSED	X	Active	ON	Min	Min	Full Stage	None	None	Cool
X	X	X	X	X	X	X	ON	Active	ON	Min	Min	Full Stage	None	None	Cool
X	X	X	X	X	X	X	ON	Inactive	ON	Min	Min	None	None	None	Fan Only
X	X	X	X	X	X	X	X	Inactive	OFF	0	0	None	None	None	OFF

Table 14. Heat pump with gas heat, with outside air

Inputs									Outputs						
Economizer System Status	X	Y1	Y2	W1/O	W2	G	DCV Fan ON Request	DH	Supply Fan On/ Off Request	Supply Fan Speed Request	OA Damper Position Request	Compressor Cool Stage Request	Compressor Heat Stage Request	Gas Heat Stage Request	Heat Cool Mode Status
X	CLOSED	X	X	X	X	X	X	X	ON	Max	Min	None	None	Full Stage	Em Heat
X	OPEN	CLOSED	OPEN	OPEN	OPEN	X	X	X	ON	Max	Min	None	2/3	None/1	Heat
X	OPEN	OPEN	CLOSED	OPEN	OPEN	X	X	X	ON	Max	Min	None	2/3	None/1	Heat
X	OPEN	CLOSED	CLOSED	OPEN	OPEN	X	X	X	ON	Max	Min	None	All Stages	None/1/2	Heat
X	OPEN	CLOSED	OPEN	OPEN	CLOSED	X	X	X	ON	Max	Min	None	None	All Stages	Heat
X	OPEN	OPEN	CLOSED	OPEN	CLOSED	X	X	X	ON	Max	Min	None	None	All Stages	Heat
X	OPEN	CLOSED	CLOSED	OPEN	CLOSED	X	X	X	ON	Max	Min	None	None	All Stages	Heat
X	OPEN	OPEN	OPEN	OPEN	CLOSED	X	X	X	ON	Max	Min	None	None	All Stages	Heat
Disabled	OPEN	CLOSED	OPEN	CLOSED	OPEN	X	X	Inactive	ON	Min	Min	Stage 1	None	None	Cool
Enabled	OPEN	CLOSED	OPEN	CLOSED	OPEN	X	X	Inactive	ON	Min/Max	Econ	0	None	None	Cool
X	OPEN	CLOSED	OPEN	CLOSED	OPEN	X	X	Active	ON	Min	Min	Full Stage	None	None	Cool
Disabled	OPEN	OPEN	CLOSED	CLOSED	OPEN	X	X	Inactive	ON	Min	Min	Stage 1	None	None	Cool
Enabled	OPEN	OPEN	CLOSED	CLOSED	OPEN	X	X	Inactive	ON	Min/Max	Econ	0	None	None	Cool
Enabled	OPEN	OPEN	CLOSED	CLOSED	OPEN	X	X	Active	ON	Min	Min	Full Stage	None	None	Cool
Disabled	OPEN	CLOSED	CLOSED	CLOSED	OPEN	X	X	X	ON	Max	Min	Full Stage	None	None	Cool
Enabled	OPEN	CLOSED	CLOSED	CLOSED	OPEN	X	X	X	ON	Max	Econ	Stage 1	None	None	Cool
X	OPEN	OPEN	OPEN	X	OPEN	CLOSED	X	Inactive	ON	Min	Min	None	None	None	Fan Only
X	OPEN	OPEN	OPEN	X	OPEN	CLOSED	X	Active	ON	Min	Min	Full Stage	None	None	Cool
X	X	X	X	X	X	X	ON	Active	ON	Min	Min	Full Stage	None	None	Cool
X	X	X	X	X	X	X	ON	Inactive	ON	Min	Min	None	None	None	Fan Only
X	X	X	X	X	X	X	X	Inactive	OFF	0	0	None	None	None	OFF

Enhanced Thermostat Control

Enhanced Thermostat Control is a feature available for equipment with three or more stages of compressor cooling. This capability utilizes all available compressor stages in cooling modes of operation when the Symbio™ 700 is configured for Conventional Thermostat control. Heat pump heating modes of operation will stage compressors as defined for conventional thermostat control.

The Thermostat Control Method Request is set to Enhanced by default for units using R-454B refrigerant. However, if a discharge air temperature sensor is not installed or the unit is only capable of 2-stage cooling, then control will automatically revert to conventional 2-stage cooling Conventional Thermostat Control. If Enhanced Thermostat Control is not desired, Thermostat Control Method Request can be set to Conventional, and then Symbio 700 controller will revert operation to 2-stage Conventional Thermostat Control. The Thermostat Control Method Status point indicates the control method being utilized for compressor cooling, Enhanced or Conventional.

In the Enhanced Thermostat Control mode, when a Y1 call is received, the first stage of cooling is initiated, and the discharge air temperature is controlled to the setpoint specified by Discharge Air Cooling Setpoint Y1 (which can be adjusted). Additional stages of cooling are added as required to maintain the setpoint. The supply fan operates at a minimum speed necessary for the active compressor stage.

When a Y2 call is received, the discharge air temperature is controlled to the setpoint specified by Discharge Air Cooling Setpoint Y2 (which can also be adjusted). Additional stages of cooling are added as required to maintain the setpoint. The supply fan operates at a minimum speed necessary for the active compressor stage. If the Y2 call is closed for 15 minutes, the supply fan will increase to its maximum speed.

When the Y2 call is removed, the supply fan will continue to operate at maximum speed for 15 minutes before reverting to the minimum speed required for the compressor stage. When the Y1 call is opened, the compressors will stage down and eventually cycle off.

A Y1 call and economizer cooling is enabled, the economizer damper will modulate to provide discharge air temperature per the Economizer Discharge Air Setpoint. If a Y2 call is added, the economizer damper will open 100%, supply fan will operate at maximum speed, and compressors are staged per Discharge Air Cooling Setpoint Y2.

In summary, Enhanced Thermostat Control is provided when the equipment meets the following criteria: the unit has 3 or more stages of compressor cooling, the Thermostat Control Method Request is set to Enhanced, and a discharge air temperature sensor is installed. If any of these criteria are not met, the control system will default to conventional 2-stage compressor cooling.

Table 15, p. 27 provides a summary of Enhanced Thermostat Control is cooling modes of operation. All heating modes of operation, not covered in the table, operate as defined by Conventional Thermostat control.

Table 15. Enhanced thermostat control operation in cooling modes

Inputs								Outputs					
Economizer System Status	**X**	**Y1**	**Y2**	**W1/O[a]**	**W2**	**G**	**DH**	**Supply Fan On/Off Request**	**Supply Fan Speed Request**	**OA Damper Position Request**	**Compressor Cool Stage Request**	**Auxiliary Heat Stage Request**	**Heat Cool Mode Status**
Disabled	NA	CLOSED	OPEN	OPEN[a]	OPEN	X	Inactive	ON	Min/Max	Min	Stage compressors to maintain Discharge Air Cooling Setpoint Y1 Active[b]	None	Cool
Disabled	NA	X	CLOSED	OPEN[a]	OPEN	X	Inactive	ON	Min/Max	Min	Stage compressors to maintain Discharge Air Cooling Setpoint Y2 Active[b]	None	Cool
X	NA	CLOSED	OPEN	OPEN[a]	OPEN	X	Active	ON	Min	Min	Full Stage	None	Cool

Table 15. Enhanced thermostat control operation in cooling modes (continued)

Inputs								Outputs					
Economizer System Status	**X**	**Y1**	**Y2**	**W1/O[a]**	**W2**	**G**	**DH**	**Supply Fan On/Off Request**	**Supply Fan Speed Request**	**OA Damper Position Request**	**Compressor Cool Stage Request**	**Auxiliary Heat Stage Request**	**Heat Cool Mode Status**
X	NA	X	CLOSED	OPEN[a]	OPEN	X	Active	ON	Min	Min	Full Stage	None	Cool
Enabled	NA	CLOSED	OPEN	OPEN[a]	OPEN	X	Inactive	ON	Min/Max	Econ[c]	None	None	Cool
Enabled	NA	X	CLOSED	OPEN[a]	OPEN	X	Inactive	ON	Max	Full	Stage compressors to maintain Discharge Air Cooling Setpoint Y2 Active[b]	None	Cool

[a] Heat-pump units require W1 to be closed to enter cooling operation.
[b] Minimum of stage 1 On.
[c] Discharge air temperature is controlled to the Economizer Discharge Air Setpoint (Default = 55°F).

Space Temperature Control

System Types of VVZT and CVZT operate to provide space comfort heating and cooling. A system mode wired input or Heat Cool Mode Request input determines the heating or cooling mode of operation. If a heat cool system mode input is not provided, the Symbio™ 700 operates per Heat Cool Mode Request default value, Auto is the default setting. In Auto, the controller will automatically determine it is appropriate to heat or cool based on space temperature, setpoints, and heating/cooling configured for the unit. The space temperature and space temperature setpoints determine a space heating or cooling demand. If space temperature is above the cooling setpoint, this represents a space cooling demand.

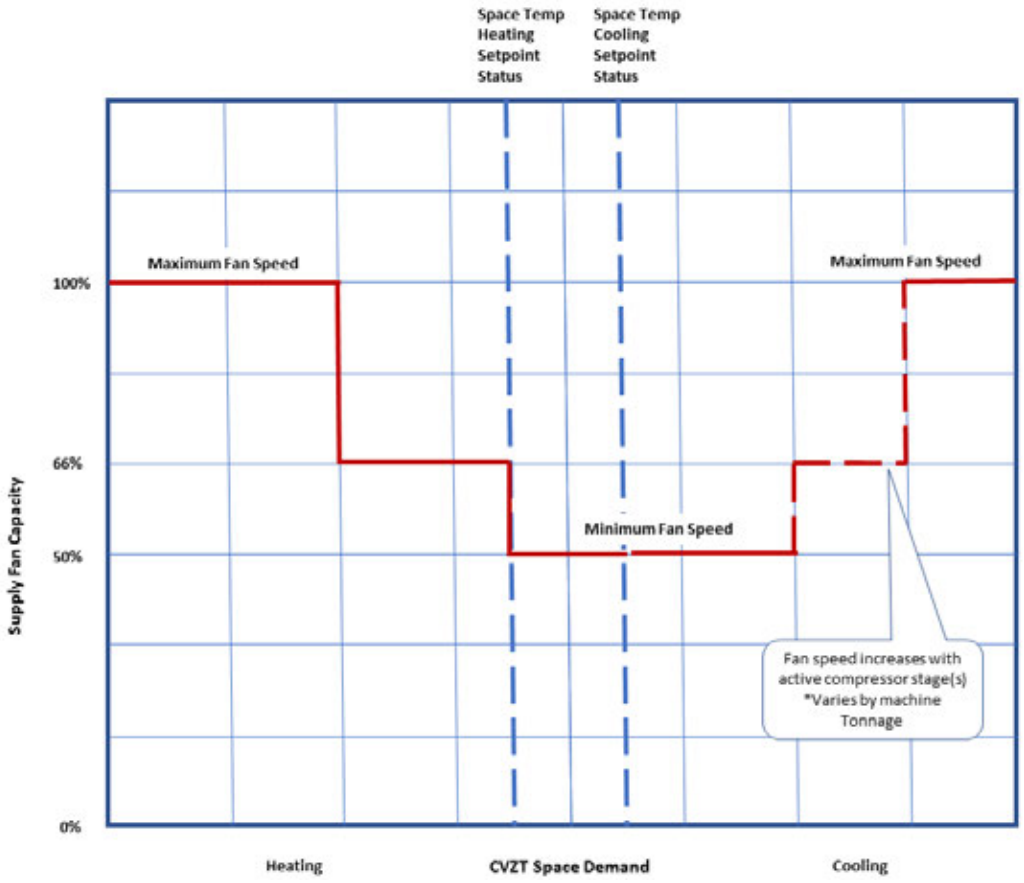
Symbio 700 supports two types of space temperature control: Single Loop Space Temperature Control and Single Zone Variable Air Volume.

Single Loop Space Temperature Control

Configured VVZT and CVZT System Types operate in Single Loop Space Temperature Control when only a space temperature input is provided to the Symbio™ 700 controller (no discharge air temperature sensor installed). In heating modes, staged gas heat, the supply fan will operate at a minimum speed (stage 1) and 100 percent (stage 2). Electric heat, the supply fan operates at 100 percent for all stages. In cooling modes, the supply fan will operate at the lowest speed allowed for the stage of cooling capacity and 100 percent when all compressor stages are on. When space temperature is between the heating and cooling setpoint, the supply fan operates at a minimum speed. See Appendix A and . Alternately, the supply fan can be setup to cycle off when there is no demand for heating or cooling via Supply Fan Configuration Command setting.

Cooling capacity increases as space temperature increases above the cooling setpoint. Heat capacity increases when space temperature decrease below the heating setpoint. Capacity decreases has space temperature approaches the desired space setpoint.

Figure 9. Multi-speed fan sequence of operation



Note: *Refer to supply fan speed tables in "Supply Fan," p. 94.*

Single Zone Variable Air Volume

Single Zone VAV operates in DX and economizer cooling modes of operation when configured for System Type: VVZT (variable speed indoor fan type) or CVZT (multi speed indoor fan type). A valid space temperature and discharge air temperature sensor are required input. If the discharge air temperature input becomes invalid, the control automatically reverts to Single Loop Space Temperature Control. Symbio™ 700 operates in Single Loop Space Temperature Control in heating modes when staged gas heat and staged electric heat are configured.

Single Zone VAV is a control method of space temperature control that operates the supply fan at the lowest speed allowed for the cooling capacity required to satisfy the load in the space. As cooling capacity increases, the supply fan speed will increase to a defined minimum speed for the operating cooling capacity and modulate accordingly until it reaches 100 percent of its allowed range of operation. See Appendix A , p. 94 and .

When there is no demand for heating or cooling the supply fan operates at the minimum speed setting while providing ventilation according to occupancy setpoints, see the following figure. Alternately, the supply fan can be setup to cycle off when there is no demand for heating or cooling via Supply Fan Configuration Command setting.

Figure 10. Supply fan operation - cooling only with staged gas or electric heat

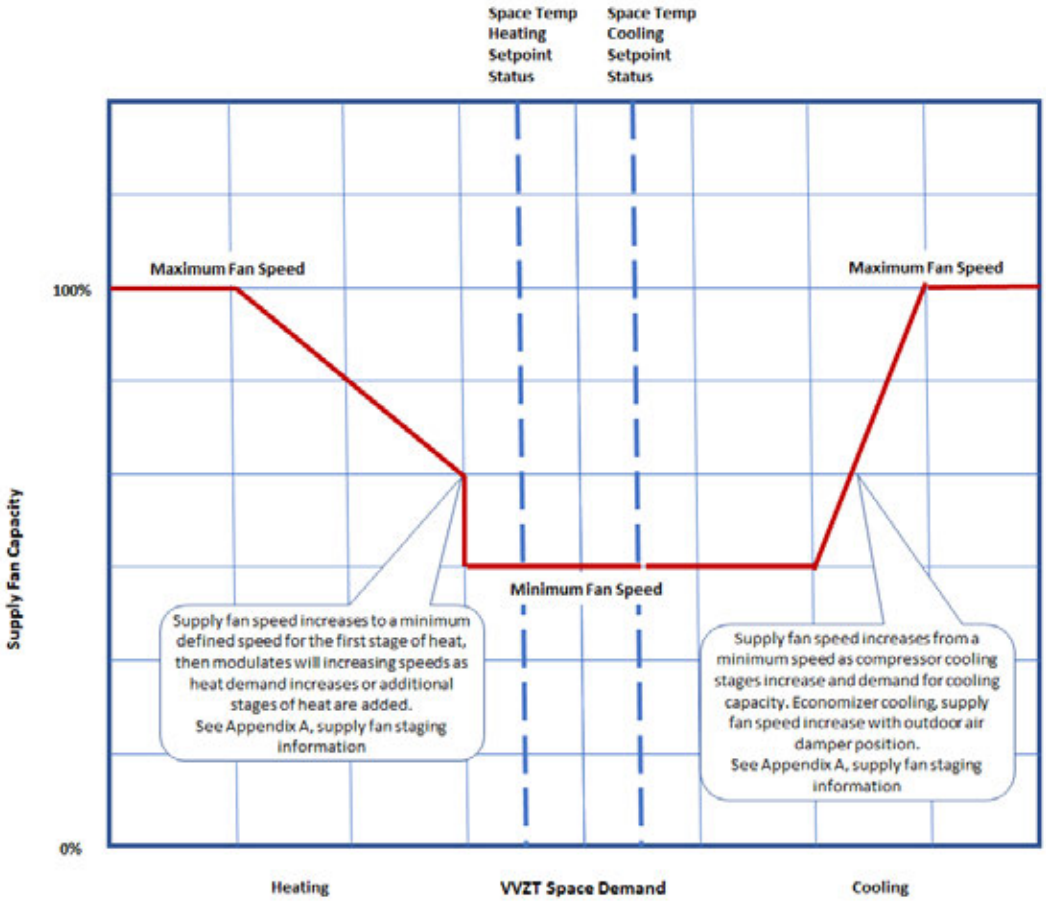
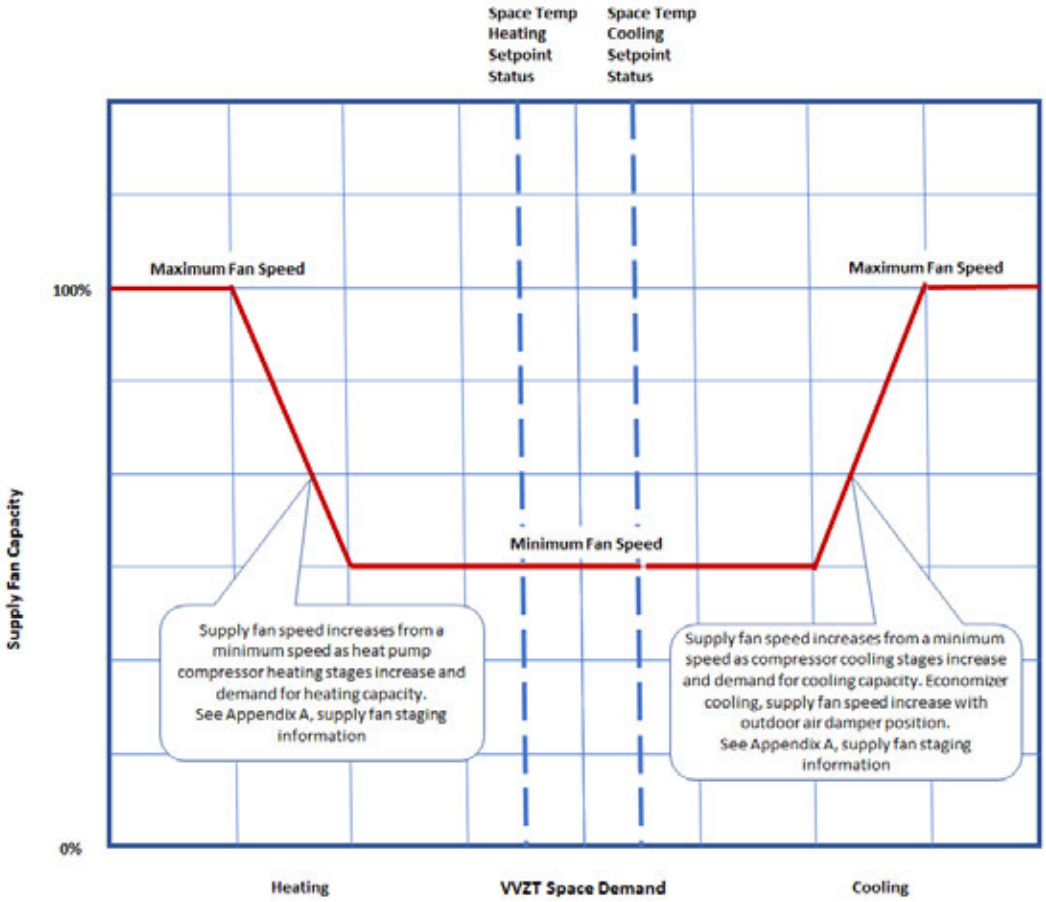


Figure 11. Supply fan operation - heat pump heating and cooling



Single Zone VAV — Cooling

Cool

When there is a space cooling demand, DX cooling will initialize and increase to satisfy space temperature. The supply fan will continue to operate at a low, fixed speed at low cooling capacities until the cooling capacity requires additional airflow to keep compressor operation optimal. The supply fan speed will increase as the demand for cooling capacity increases. The minimum supply fan speed is calculated by DX cooling capacity. As the space requires additional cooling capacity, Space Temperature Control will calculate a lower discharge air temperature setpoint increasing DX cooling which in turn increases the supply fan speed. Cooling capacity and supply fan speed both can increase to 100 percent. See Appendix A , p. 94 and .

If the unit discharge air temperature reduces to the Discharge Air Temperature Minimum Cool Limit setting or DX cooling reaches 100 percent capacity, cooling capacity increases will hold while the supply fan speed will continue to increase to 100 percent or modulate to manage space comfort cooling.

Cool — Economizer

If the unit is configured for a modulating outdoor air damper and conditions are suitable for economizer cooling, the supply fan will operate at minimum speed while the economizer damper modulates between the Outdoor Air Damper Minimum Position Setpoint and 100 percent to satisfy the discharge air temperature setpoint. If the economizer damper reaches 100 percent open and additional cooling capacity is required, the supply fan will increase toward 100 percent to provide additional cooling to the space.

Cool — Economizer + DX

Economizer Cooling + DX is a mode of operation when both economizer and DX cooling are active. If actively economizing, outdoor air damper is 100 percent and supply fan speed reaches 100 percent then DX cooling will be added if the unit is not satisfying space cooling requirements.

If DX cooling is active and economizer cooling enables, the control will transition to increase economizer damper above minimum position to 100 percent to satisfy space cooling while decreasing DX cooling. DX cooling will steadily be removed as long as economizer cooling is able to satisfy the cooling load. The supply fan operates to the lowest speed possible during the transition.

Occupied Cooling with Variable Speed Compressor

For normal cooling operation, the total cooling capacity will be modulated based on a PI algorithm in order to meet the calculated Active Discharge Air Cooling Setpoint, as on standard fixed speed compressor units. If enabled, economizer cooling will be utilized prior to energizing the DX capacity, per the user configured Economizer Mode.

At cooling start, if the economizer is enabled, it will be utilized as the first stage of cooling and will be modulated to maintain the calculated Discharge Air Cooling setpoint as on standard fixed-speed compressor units.

Once all economizing requirements have been met, compressor operation will be enabled if the economizer alone cannot meet the demand. Once compressor operation is started, the variable speed compressor will be energized, following all startup requirements, and will then be modulated to maintain the discharge air temperature to the calculated discharge air cooling setpoint.

Once the active cooling demand has been satisfied, the variable speed compressor will begin to modulate down to its minimum speed and then will be de-energized, while adhering to all shutdown requirements. Once the VSPD compressor has de-energized, the economizer (if enabled) will be allowed to close back to minimum position if there is no longer a demand.

Unoccupied Cooling with Variable Speed Compressor

For unoccupied DX and economizer cooling control, the unit will operate as a standard fixed-speed compressor unit. During all requests for cooling operation during Unoccupied mode, the unit will operate the variable speed compressor at 100 percent of the available capacity. When compressor operation is requested, the variable speed compressor will be started first and its speed will be increased up to 100 percent, based on the unit configuration. The unit will follow all startup requirements.

Supply Air Tempering — Space Temperature Control

If the Supply Air Tempering function is configured and the Discharge Air Temperature local sensor is valid, this function prevents excessively cold discharge air from being supplied to the space. Supply Air Tempering is an option for VVZT and multi-speed supply fan units when auxiliary heat is installed.

Supply Air Tempering is not supported when a Conventional TStat is configured.

The following requirements must be met to allow Supply Air Tempering when heat is installed:

- The unit is in any heating mode, including Heat, Emergency Heat, Morning Warmup, Max Heat but is not actively heating OR
- The unit is in any cooling mode except night purge, but not actively cooling and cooling capacity has been OFF for 5 minutes.

If the discharge air temperature drops to the Discharge Air Temperature Minimum Cool Limit - Active and the Space Temperature is less than the Active Space Temp Cooling Setpoint Status – 0.5°F, the Supply Air Tempering function will bring ON one stage of auxiliary heat. The supply fan operates at the defined minimum speed for the active stage of heating. Modulating gas heat supply air tempering is limited to the first stage, main manifold (burner 1). See Appendix A , p. 94 and .

Supply Air Tempering terminates if the Discharge Air Temperature rises to 10°F above the Discharge Air Temperature Minimum Cool Limit - Active, or the Space Temperature rises to the Space Temp Cooling Setpoint Status. If the Space Heat Control function determines that one or more stages of Heat are required to meet the Space Temp Heating Setpoint Status, Supply Air Tempering will terminate and the unit will stage heating to meet the current space demand.

Unoccupied Cooling

Unoccupied mode is used when the building is unoccupied, and the space conditions are exceeding temperature limits. The unit is normally off in unoccupied mode, but unoccupied operation is allowed in any heat cool mode except OFF.

If a valid space temperature input rises above the Unoccupied Cooling Setpoint, unit operation starts unoccupied cooling to manage space temperature. The controller operates in Single Loop Space Temperature Control with ventilation disabled. DX or economizer cooling will steadily increase to 100 percent capacity. The supply fan will follow capacity control until it reaches 100 percent fan speed. Cooling continues until space temperature is 4°F less than the Unoccupied Cooling Setpoint, the unit will then cycle off.

Unoccupied Heating

When the unit is in unoccupied mode and the valid space temperature input falls below the Unoccupied Heating Setpoint, unit operation starts unoccupied heating to manage space temperature. The controller operates in Single Loop Space Temperature Control with ventilation disabled. The supply fan starts increases with heating capacity unit both reach 100 percent. Heating continues until space temperature is 4°F greater than the Unoccupied Heating Setpoint, the unit will then cycle off.

Variable Volume Discharge Air Control Sequence of Operation

Variable Volume Discharge Air (VVDA) control uses available heating and cooling capacity to deliver the required temperature at the discharge of the unit. A discharge air temperature sensor is required for operation.

In cooling modes, the control uses cooling sources to deliver air temperature as required by the Discharge Air Cooling Setpoint. In heating modes, the control uses heat sources to deliver air temperature as required by the Discharge Air Heating Setpoint. Primary heat is never used in conjunction with mechanical cooling.

Symbio™ 700 operates in Discharge Air Temperature Control in all heat, cool, and occupancy modes of operation. The typical operating mode is Cooling delivering conditioned air to multiple zones of a building. These units have duct work to supply VAV terminal units. The VAV units modulate to control space comfort.

VVDA units also change over to provide heat (when installed). A building automation system or the VAV Box Relay Output can be used when the heat source requires full airflow. See Heat Types for more information. A valid space temperature input must be provided to perform heating modes such as Daytime Warm Up and Morning Warm Up (when enabled).

Supply Air Tempering

Supply Air Tempering is disabled by default but can be enabled when modulating heating capacity is installed. Supply air tempering initiates if discharge air temperature falls 1°F below the Discharge Air Cooling Setpoint Status setpoint and cooling capacity is 0 percent for 5 minutes and heating capacity is required to maintain discharge air cooling control. Heat is controlled with a 2°F dead band to the discharge air cooling setpoint. The control will transition back to normal cooling when heat capacity is 0 percent for 5 minutes or there is a compressor demand to manage the discharge air cooling control. Supply air tempering will also terminate if dehumidification initiates or if the controller effective occupancy is unoccupied.

Changeover Input

Variable Volume Discharge Air units include a binary Changeover Input. An open input requests discharge air cooling operation. A closed input will request the unit to change to discharge air heating. This local input is arbitrated with building management Heat Cool Mode Request commands to determine the active mode of operation.

VAV Box Relay Output

This binary output is provided by the controller to be optionally wired to VAV units in a Multi Zone-VAV system to coordinate system changeover to full airflow heating. Reference VHR relay wired to Relay Board connection J2 and VHR wiring terminal block on unit schematics. The binary output is de-energized when the controller is operating in cooling modes. The binary output energizes when the heat type installed requires full airflow. See Maximum Heat for more details.

Discharge Air Reset

Discharge Air Reset is a method to save energy by resetting the discharge air temperature as heating and cooling building loads increase and decrease.

When enabled, the controller can independently reset the Discharge Air Heating Setpoint Active and/or Discharge Air Cooling Setpoint Active based on Zone (space temperature), Outdoor Air temperature or Return Air Temperature. The new target setpoints are reported as Discharge Air Setpoint Heating Status and Discharge Air Cooling Setpoint Status. The controller provides settings for the reset type (Outdoor Air, Zone, Return Air), temperature range to apply the reset, and reset amount. For example: the discharge air temperature cooling setpoint shall increase 5°F over an outdoor air temperature range of 90°F to 70°F. If Discharge Air Cooling Setpoint Active is 50°F and Outdoor Air Temperature is 80°F, the

reset function calculates and reports Discharge Air Cooling Setpoint Status = 52.5°F. The controller will provide discharge air at 52.5°F.

Duct Static Pressure Control

Multi Zone-VAV equipment have variable speed supply fans and are often used in Variable Air Volume (VAV) systems consisting of ductwork serving multiple building zones and VAV boxes that control space comfort independent of the rooftop air handler. VAV boxes modulate air volume by a damper that opens and closes to maintain space comfort. In response, duct static pressure increases and decreases. The controller will modulate supply fan speed to maintain Duct Static Pressure relative to the Duct Static Pressure Setpoint.

Duct Static Pressure High Limit

The controller operates the supply fan to maintain duct static pressure below the Duct Static Pressure High Limit setpoint. In the event that duct static pressure approaches the high limit setpoint, the controller will reduce and limit the supply fan speed.

Unoccupied Cooling

Unoccupied Cooling mode is used when the building is unoccupied and the space conditions are exceeding temperature limits. The unit is normally off in unoccupied mode. If a valid space temperature input rises above the Unoccupied Cooling Setpoint, unit operation starts unoccupied cooling to manage space temperature. The controller operates in Discharge Air Control with ventilation disabled while DX or economizer cooling capacity increases to satisfy the Discharge Air Cooling Setpoint. VVDA System Type operate the supply fan under duct static pressure control. Cooling continues until space temperature is 4°F less than the Unoccupied Cooling Setpoint, the unit will then cycle off.

Unoccupied Heating

When the unit is in unoccupied mode and the valid space temperature input falls below the Unoccupied Heating Setpoint, unit operation starts unoccupied heating to manage space temperature. The controller operates in Discharge Air Control with ventilation disabled while heating capacity increases to satisfy the Discharge Air Heating Setpoint. The supply fan operates according to heat type installed, see Heat Types for more information. Heating continues until space temperature is 4°F greater than the Unoccupied Heating Setpoint, the unit will then cycle off.

Occupied Cooling with Variable Speed Compressor

For normal cooling operation, the total cooling capacity will be modulated based on a PI algorithm in order to meet the Active Discharge Air Cooling Setpoint.

If enabled, economizer cooling will be utilized as the first stage of cooling prior to energizing the DX capacity. Economizer cooling will modulate the outdoor air damper to maintain the discharge air cooling setpoint - as on standard fixed speed compressor equipped units. Once all economizing requirements have been met, compressor operation will be enabled if the economizer alone cannot meet the demand. Once compressor operation is started, the variable speed compressor will startup, following all startup requirements, and will then be modulated to maintain the discharge air temperature to the discharge air cooling setpoint.

Once the active cooling demand has been satisfied, the variable speed compressor will begin to modulate down to its minimum speed and then will be de-energized, while adhering to all shutdown requirements. Once the variable speed compressor has de-energized, the economizer (if enabled) will be allowed to close back to minimum position if there is no longer a demand.

Unoccupied Cooling with Variable Speed Compressor

For Unoccupied DX and Economizer Cooling Control, the unit will operate as during normal Occupied mode – compressor capacity will be varied to maintain the discharge air temperature requirements and the supply fan will remain in-control based on the active compressor capacity and space demand. This operation is consistent with VVDA operation on standard Fixed-Speed Compressor units.

Heat Cool Modes

Heat Cool Mode Status reports the unit mode of operation. The Symbio™ 700 can receive mode inputs from different external and local input sources that are arbitrated; however, the control active operating mode represents the capacity being delivered to the building and reported via Heat Cool Mode Status. The following modes of operation are supported. All other, unsupported modes are managed as an Auto mode request.

Heat

In this mode, the controls provide heating capacity per heat type installed, heat setpoint, and occupancy. Application requirements such as full or modulating air flow are also considered in heating mode. All forms of cooling capacity are effectively disabled.

If Heat is the requested mode when the unit does not have heat capacity configured or heat is disabled, Heat is reported as Heat Cool Mode Status. If the unit cannot provide heat, the supply fan is enabled to operate (as configured) to provide ventilation during occupied modes of operation.

Cool

Cool mode is reported when the control objective is to provide cooling to maintain building comfort. Direct expansion cooling is the primary cooling source. Cool mode is also reported when Economizer and Dehumidification cooling modes of operation are active.

Fan Only

This mode disables all forms of heating and cooling capacity but operates the fan continuously at minimum speed or modulates to maintain duct static pressure. The outdoor air damper modulates to damper minimum position setpoint to provide ventilation.

Fan Only is also reported in Emergency Override and Ventilation Override Modes. Heat Cool Mode Request can also command the control into Fan Only mode.

Off

Off is the reported mode when unit operation is shutdown due to diagnostics, equipment protections, overrides or normal unit operation when the supply fan is cycled off.

Test

When Service Test is active, Heat Cool Mode Status reports Test.

Maximum Heat

Maximum Heat is a full airflow mode of heating operation with the supply fan operating at maximum speed. The controller does not provide maximum heat; instead, the controller provides heat capacity per the Operating Mode and unit type.

VVDA

Variable Volume Discharge Air control units will transition to Maximum Heat operation in heating modes (for example Occupied Heat, Morning Warm Up, Daytime Warm Up) when the installed heating capacity requires full air flow. Maximum Heat can also be a Heat Cool Mode Request command, which Symbio™ 700 will remain in the mode until the mode is released.

On the transition to Maximum Heat the Symbio 700 will reduce the supply fan to minimum speed, energize the VAV Box Relay and wait the duration of the VAV Box Stroke Time (adjustable). The VAV Box Stroke Time allows the VAV boxes in the system to open. The supply fan speed will then increase to 100 percent or the maximum speed subject to high duct static pressure limit. Once the supply fan reaches its allowed maximum speed, Symbio 700 will enable heating capacity control to Discharge Air Heating Setpoint Active. Ventilation is managed per the operating mode

The transition from Maximum Heat back to modulating air flow control modes is as follows:

1. Heat capacity terminates (if active), a 90 second post heat timer begins.
2. Supply fan speed slows to minimum speed, a 3 minute minimum speed timer begins.
3. VAV Box Relay de-energizes.
4. When the 90 second post heat and 3 minute minimum speed timer expire, modulating air flow control is enabled, operating mode transitions, and capacity control enables.

Space Temperature Control

Space Temperature control units will also accept a Maximum Heat command via Heat Cool Mode Request. On this command the Symbio™ 700 will transition to a heat mode while operating the supply fan at 100 percent capacity. Heat Cool Mode Status will report Maximum Heat to indicate the mode is active.

Morning Warm-up

Morning Warm-up is an optional feature when heat is configured and can be Enabled or Disabled. Morning Warm-up is a mode often used during building unoccupied periods and optimal start applications to rapidly increase the space temperature, as efficiently as possible, before building occupancy. The outdoor air damper minimum position setpoint will be overridden to 0 percent, ventilation air is not provided during Morning Warm-up

For Morning Warm-up to initiate on a transition from Unoccupied to Occupied, Space temperature control units must be in Heat, Max Heat, Emergency Heat or Auto. Discharge air control units can also initiate Morning Warm Up on an Off to Occupied transition.

For all equipment types: On a transition from Unoccupied to Occupied or Occupied-Standby, and with a valid space temperature 1.5° F below the Morning Warm-up Setpoint, morning warm-up operation initiates. Heat Cool Mode Status reports Maximum Heat if the heat type requires full airflow and VAV Box Relay binary output will energize (see Maximum Heat for details). Otherwise, heat types that allow modulating airflow will report Morning Warm Up via Heat Cool Mode Status.

VVDA

The Symbio™ 700 operates in a discharge air control mode delivering heating capacity per Discharge Air Heating Setpoint Active; this provides flexibility when 100 percent heat capacity in not desired. Variable air volume discharge air control units will operate the supply fan per Duct Static Pressure Setpoint if the installed heat type allows; otherwise, the supply fan operates in a full airflow mode and Maximum Heat is reported via Heat Cool Mode Status. When 60 minutes expires or when space temperature equals or exceeds the Morning Warmup Setpoint, Morning Warm Up mode will terminate.

Morning Warm-up mode can also be commanded via Heat Cool Mode Request from a building automation system or external control. In this case, the unit remains in Morning Warm-up mode indefinitely until the commanded mode is removed or changed. When the space temperature exceeds the Morning Warm-up Setpoint, heating capacity is disabled but the supply fan operation continues to circulate air until the Morning Warm-up command is removed. Heat capacity will re-enable if space temperature falls 1.5°F below Morning Warm-up Setpoint.

Space Temperature Control

The Symbio™ 700 operates in a space temperature control mode controlling heating capacity to manage space temperature at the Morning Warm-up Setpoint. The supply fan operates at maximum speed.

When 60 minutes expire or when space temperature equals or exceeds the Morning Warm-up Setpoint, Morning Warm-up mode will terminate.

Morning Warm-up mode can also be commanded via Heat Cool Mode Request from a building automation system or external control. The Symbio 700 controller will continuously control space temperature to the morning warm-up setpoint until the mode is released or changed.

Pre-Cool

Pre-Cool is a mode often used during building unoccupied periods and optimal start applications to rapidly decrease the space temperature, as efficiently as possible, before building occupancy. Pre-Cool

mode of operation can be enabled and disabled via Pre-Cool Enable Command. Pre-Cool is reported via Heat Cool Mode Status when active. Ventilation air is not provided during Pre-Cool operation.

VVDA

VVDA equipment types, a transition from Unoccupied to Occupied mode or Off/Shutdown to Occupied, if a valid space temperature input is above the Pre-Cool Setpoint + 1.5°F Pre-Cool Mode will initiate. Symbio™ 700 operates in a discharge air control mode providing discharge air per Discharge Air Cooling Setpoint Active until space temperature drops equal or below the Pre-Cool Setpoint. In this cooling mode the outdoor air damper minimum position is 0%, but the controller will use compressor and/or economizer cooling when suitable. VVDA units will modulate fan speed and manage to the duct static pressure setpoint.

Pre-Cool mode can also be commanded via Heat Cool Mode Request. In this case, the Symbio 700 remains in Pre-Cool indefinitely until the commanded mode is removed. When space temperature is equal or less than Pre-Cool Setpoint, cooling capacity is disabled but the supply fan continues to circulate air until the Pre-Cool command is removed. Cooling capacity control will enable if space temperature rises above Pre-Cool Setpoint + 1.5°F.

Space Temperature Control

Space temperature control units must be in Cool or Auto mode to allow Pre-Cool operation. A transition from Unoccupied to Occupied mode, the controls will initiate Pre-Cool if a valid space temperature input is above the Pre-Cool Setpoint + 1.5°F. The Symbio™ 700 operates in a space temperature control mode controlling space temperature to the Pre-Cool Setpoint. The supply fan operates at maximum speed. When 60 minutes expires or when space temperature is equal or below the Pre-Cool Setpoint, Pre-Cool mode will terminate.

Pre-Cool mode can also be commanded via Heat Cool Mode Request from a building automation system or external control. The Symbio 700 controller will continuously control space temperature to the Pre-Cool setpoint until the mode is released or changed.

Night Purge

Night Purge mode is typically applied in building unoccupied periods when conditions are suitable for economizer cooling; all other forms of cooling capacity are disabled. This mode is only supported via a commanded Heat Cool Mode Request. The controller will not use local inputs and assume outdoor air is suitable for economizing. The outdoor air damper minimum position setpoint will be overridden to 0 percent.

Night Purge operation is terminated when the Night Purge, Heat Cool Mode Request is removed.

VVDA

When active, the Symbio™ 700 operates in a discharge air control mode, modulating the outdoor air damper to provide cooling capacity per Discharge Air Cooling Setpoint Active.

Space Temperature Control

Space temperature control equipment modulates the outdoor air damper to control space temperature to the Space Temp Cooling Setpoint Status setpoint. If space temperature is greater than the space cooling setpoint + 1.5°F the outdoor air damper will be at 100 percent with supply fan at maximum speed. If space temperature is less than the space cooling setpoint -1.5°F the outdoor air damper will be closed with supply fan at minimum speed. Constant volume units, the supply fan operates at 100 percent while Night Purge is active.

Daytime Warm-up

Daytime Warm-up is a feature of VVDA units that can be Enabled, or Disabled. Daytime Warm-up is available with any heat type installed. Daytime Warm-up is a mode used during building occupied periods to recover a critical zone that is too cold. Ventilation air is provided while in Daytime Warm-up mode.

When the Heat Cool Mode Request is Cool (the unit is providing cooling), if a valid space temperature is 3°F below the adjustable Daytime Warm-up Setpoint, daytime Warm-up operation initiates. The unit will

operate in a discharge air control mode delivering heating capacity per Discharge Air Heating Setpoint Active. The supply fan operates at max speed on Constant Volume Units. Variable air volume discharge air control units will operate the supply fan to the duct static pressure setpoint and report Heat Cool Mode Status as Heat, if the installed heat type allows modulating air flow. Else if the heat type requires full air flow, Maximum Heat is reported. (See Heat Types and Maximum Heat section for more information).

When the space temperature is equal to or above the Daytime Warm-up Setpoint, daytime Warm-up operation terminates and the Symbio™ 700 will transition back to Cool mode. See Maximum Heat for details. If the requested operating mode is no longer Cool, Daytime Warm-up terminates.

Dehumidification — Hot Gas Reheat

Dehumidification control is a mode of Cooling when hot gas reheat is configured with a modulating reheat valve. Symbio™ 700 supports three configurable dehumidification methods: Dew Point (default), Relative Humidity, or Humidistat control for occupied and unoccupied operation. A discharge air temperature sensor, with Evaporator Entering Refrigerant Temperature sensor is required for humidistat dehumidification control. Relative Humidity control requires a valid space relative humidity, space temperature, discharge air temperature sensor and Evaporator Entering Refrigerant Temperature for dehumidification operation. Dew Point control additionally requires outdoor air temperature and outdoor air humidity.

Dehumidification is allowed when outdoor air temperature is between 40 and 100°F, but it is disabled outside this range. Dehumidification can be enabled and disabled directly via the Occupied Dehumidification Enable and Unoccupied Dehumidification Enable points.

Dehumidification Control

Dew Point — Initiation

Occupied dehumidification Dew Point control initiates when the follow conditions exist:

- Space Dew Point is greater than the Space Dew Point Setpoint and
- Outdoor Air Dew Point is greater than the Outdoor Air Dew Point Setpoint

Unoccupied dehumidification Dew Point control initiates when:

- Space Dew Point is greater than the Space Dew Point Unoccupied Setpoint and
- Outdoor Air Dew Point is greater than the Outdoor Air Dew Point Setpoint and
- Space has been unoccupied for less than Unoccupied Dehumidification Timer and relative humidity is greater than 65 percent or
- Space has been unoccupied for greater than or equal to Unoccupied Dehumidification Timer

The Unoccupied Dehumidification Timer is default to 12 hours. Setting the timer to 0 effectively disables the timer and, unoccupied dehumidification initiates only according to Space and Outdoor Dew Point.

Relative Humidity — Initiation

Occupied dehumidification control initiates when the Space Humidity is greater than the Space Dehumidification Setpoint. Unoccupied dehumidification control initiates when the Space Humidity is greater than the Space Dehumidification Unoccupied Setpoint.

Humidistat — Initiation

The Humidistat binary input on the Customer Options Module is active. If a Space Humidity sensor is installed, the Humidistat input will be ignored.

Operation – CVZT/VVZT

CVZT and VVZT units, the supply fan operates at the minimum speed defined for the compressor stage. When the dehumidification control mode becomes active Dehumidification Status reports Active and compressor operation will increase one stage. Additional compressor stages are added to achieve evaporator dew point.

Space temperature is managed by modulating the hot gas reheat valve. Dehumidification Control Status reports the position of the reheat valve. The reheat valve will not open until the space temperature is below the space cooling setpoint minus 1.5°F and modulates to the Discharge Air Temperature Setpoint - Active that is calculated by the Symbio™ 700 to maintain space temperature control. The reheat valve can also open if discharge air temperature decreases rapidly and drops below the Discharge Air Reheating Setpoint Low Limit – Active (default 50°F).

Unoccupied dehumidification, reheat initiate when space temperature is above 64°F and there is a dehumidification demand. If space temperature is greater than the Unoccupied Cooling Setpoint, the control will satisfy the sensible cooling demand first. If space has a dehumidification demand,

compressors will stage up to achieve a calculated evaporator dew point temperature. The reheat valve modulates to control discharge air temperature to the Discharge Air Cooling Setpoint Status setpoint.

During unoccupied dehumidification, the reheat valve modulates to hold the space temperature at a fixed 72.5°F. Dehumidification disables during unoccupied periods if space temperature falls below the Dehumidification Disable Space Temperature Setpoint (default = 68°F) and the reheat valve is at maximum position for more than 10 minutes or if space temperature falls below 60°F dehumidification mode will disable.

Operation – VVDA

Variable Volume Discharge Air units continue to modulate the supply fan to maintain duct static pressure control. Dehumidification is allowed if the space temperature is greater than 64°F. Compressors will stage to achieve a calculated evaporator dew point temperature. The reheat valve modulates to control discharge air temperature to the Discharge Air Cooling Setpoint Status setpoint. Dehumidification disables if the space temperature falls below 60°F and reheat valve status reaches a maximum position for more than 5 minutes.

Unoccupied dehumidification, if space temperature is greater than the unoccupied cooling setpoint, the control will satisfy the sensible cooling demand first. If the space has a dehumidification demand, compressors will stage to achieve a calculated evaporator dew point temperature and discharge air temperature will reheat to Discharge Air Cooling Setpoint Status setpoint until the dehumidification demand terminates.

Dew Point — Termination

Occupied dehumidification Dew Point control terminates when:

- Calculated Space Dew Point is less than the Space Dew Point Setpoint minus the Dew Point Setpoint Offset or
- Outdoor Air Dew Point is less than the Outdoor Air Dew Point Setpoint minus the Dew Point Setpoint Offset

Unoccupied dehumidification Dew Point control terminates when:

- Space Dew Point is less than the Space Dew Point Unoccupied Setpoint – Dew Point Setpoint Offset or
- Outdoor Air Dew Point is less than the Outdoor Air Dew Point Setpoint – Dew Point Setpoint Offset or
- [Space has been unoccupied for less than Unoccupied Dehumidification Timer and Space Relative Humidity is less than 65 percent minus Space Dehumidification Setpoint Offset]

Relative Humidity — Termination

Occupied modes of operation, Space Dehumidification control terminates when the Space Humidity is less than the Space Dehumidification Setpoint minus the Space Dehumidification Setpoint Offset. Unoccupied mode, Space Unoccupied Dehumidification control terminates when the Space Humidity is less than the Space Dehumidification Unoccupied Setpoint minus the Space Dehumidification Setpoint Offset.

Humidistat — Termination

The Humidistat binary input on the Customer Options Module is inactive.

Dehumidification Purge Cycle

During dehumidification, a 3 minute compressor cooling purge cycle initiates according to the Reheat Purge Interval (120 minutes adjustable). The modulating hot gas reheat valve moves to a fixed position and compressors go to full capacity.

Reheat Pumpout Solenoid

During cooling modes of operation (reheat valve closed), a reheat pumpout solenoid will energize to remove refrigerant from the reheat coil. For heat pump configurations the Reheat Pumpout Relay will be

energized during compressor heating operation and demand defrost. In all other modes, the reheat pumpout solenoid is de-energized.

Dehumidification — Thermostat Control

Dehumidification control can be activated utilizing a Space Humidity sensor or a Humidistat input. These options are available via Symbio™ 700 configuration. See Appendix B for details. If Space Humidity is used to space humidity levels, dehumidification activates when Space Humidity exceeds the Space Dehumidification Setpoint. If a Humidistat input is used, dehumidification initiates when the Humidistat input becomes active. A Y1 call is not required to initiate dehumidification.

When dehumidification activates, compressors stage to full capacity, and economizer cooling is disabled. The reheat valve will open and modulate to an adjustable Discharge Air Reheat Setpoint (70°F default).

Dehumidification terminates when Space Humidity is less than Space Dehumidification Setpoint minus the Space Dehumidification Setpoint Offset, or when utilizing a Humidistat, the Humidistat input becomes inactive. Dehumidification will also terminate with a Y1+Y2 call (reheat terminates) or with a call for heat.

Heat Types

The supported heat types are staged electrical heat, staged gas heat, and modulating gas heat. Space temperature control variable speed and multi-speed fan units will increase supply fan speed with increased heating capacity. Multi-Zone VAV units with staged heat will always operate the supply fan at full airflow. See “Maximum Heat,” p. 37 for details.

For all heat types, a post-heat timer is enforced when the control terminates heating capacity or a heating mode exists. The supply fan is kept **On** to remove heat from the unit before transitioning to a cooling mode or cycling the supply fan off.

Single Stage Low NOx Gas Heat

Symbio™ 700 supports a single stage Low NOx gas heat for dual fuel units as a secondary heating capacity. The Single Stage Heater is composed of a single manifold with a one-stage, single gas valve, single speed inducer, and a pre-mix blower. The Single Stage Low NOx Gas Heat Stage 1 provides 100 percent of the available gas heating capacity. During normal heating efforts, as demand for heat increases, the Symbio 700 evaluates space heating effectiveness and transitions from primary heat pump heating over to secondary gas heating when needed. The dual fuel heat pump and gas heat elements are not operated together in a concurrently active heating state, except when additional heating capacity is required during heat pump condenser coil defrosting efforts.

Single Stage Low NOx Gas Heat Sequence

1. When the ignition controller is not in a Low Ambient Temperature Limited state, a call for heat is initiated by the Symbio™ 700 via a digital Modbus™ communication signal to the ignition module (part number X136563002).
2. Pre-purge for 20 seconds. The draft inducer is energized at high speed for 20 seconds. The air pressure switch closes.
3. At end of pre-purge period, spark and the premix blower is energized and gas valve is opened.

Note: *Premix blower transitioning to energized state is sequenced together with gas valve opening transition.*

4. The burner ignites Stage 1 with the gas valve 100 percent open, pre-mix blower energized, and inducer fan at full speed. Trial for ignition is seven seconds, during which flame must be sensed.
5. Unit continues operation until the call for heat terminates or a Low Ambient Temperature Limit is reached.
6. The pre-mix blower is de-energized and the gas valve is closed as the unit enters its post-purge at low inducer fan speed for 20 seconds.
7. Draft inducer is shut off.
8. When the control terminates gas heating capacity or exits a heating mode, a post-heat fixed timer is enforced. The supply fan is kept on to remove heat from the unit before transitioning to a cooling mode or cycling the supply fan off.

During efforts to transition from a heating inactive state into a heating active state:

1. If ignition is not achieved within the trial period, the pre-mix blower de-energizes, gas valve closes, and the inducer continues to run for a 20 second post-purge period.
2. Additional ignition trials ‘retries’ follow the specified sequence.
3. A one-hour lockout is applied when three retries are accompanied with Gas Valve Closed (Off) when the valve is expected to be Open (ON).

Note: *See Appendix for a full list of gas heat diagnostics.*

During efforts to transition from previously disrupted active heating effort, back into a restored active heating state:

1. If ignition is not achieved within the trial period, the pre-mix blower de-energizes, gas valve closes, and the inducer continues to run for five seconds post-purge.
2. Additional ignition trial ‘recycles’ follow the specified sequence.

3. A one-hour lockout is applied when nine recycle attempts for ignition have occurred while the gas valve is detect OFF (Closed) when it should be On (Open).
4. The ignition control board will reset lockout diagnostic after one hour. Control lockout can be cleared by cycling the power off for a minimum of 10 seconds.
5. An ignition module heat lockout can also be cleared by removing the call for heat at the Thermostat, Zone Sensor, or BAS System for five seconds, and back to heat.

Two Stage Gas Heat

Symbio™ 700 supports two-stages of gas heat for primary heating capacity. Gas heat is composed of a single manifold with a two-stage, single gas valve. The burner is the inshot type with induced draft. As demand for heat increases, incremental stages of heat are added. Stage 1 provides approximately 70 percent of available heating capacity.

Two Stage Gas Heat Sequence

1. A call for heat is initiated by the Symbio 700 via a digital Modbus™ communication signal to the Ignition Module (X13651763001 or X13651763002).
2. Pre-purge for 30 seconds. The draft inducer is energized at high speed for 25 seconds, the air pressure switch closes, the inducer fan reduces to low speed for 5 seconds.
3. At end of pre-purge period, spark and gas valve are energized.
4. The burner ignites Stage 1 with the gas valve at low fire and low inducer fan speed. Trial for ignition is seven seconds, in which time flame must be sensed.
5. The unit will add Stage 2 with the gas valve at high fire and high inducer fan speed, as required.
6. Unit continues in operation until the call for heat terminates.
7. The gas valve is de-energized and unit enters its post-purge at low inducer fan speed for 30 seconds.
8. Draft inducer is shut off.
9. When the control terminates gas heating capacity or exits a heating mode, a post heat fixed timer is enforced. The supply fan is kept on to remove heat from the unit before transitioning to a cooling mode or cycling the supply fan off.

During efforts to transition from a heating inactive state into a heating active state:

If ignition is not achieved within the trial period, the pre-mix blower de-energizes, gas valve closes, and the inducer continues to run for a 20 second post-purge period. Additional ignition trials ‘retries’ follow the specified sequence. A one-hour lockout is applied when three retries are accompanied with ‘Gas Valve Closed (Off) while the valve is expected to be Open (ON).

Note: *See Appendix for a full list of gas heat diagnostics.*

During efforts to transition from previously disrupted active heating effort, back into a restored active heating state:

If ignition is not achieved within the trial period, the pre-mix blower de-energizes, gas valve closes, and the inducer continues to run for five seconds post-purge. Additional ignition trial ‘recycles’ follow the specified sequence. A one-hour lockout is applied when nine recycle attempts for ignition have occurred while the gas valve is detected OFF (Closed) while it should be On (Open).

Note: *See “Diagnostics,” p. 77 for full list of gas heat diagnostics.*

The ignition control board will reset lockout diagnostic after one hour. Control lockout can be cleared by cycling the power off for a minimum of 10 seconds. An ignition module heat lockout can also be cleared by removing the call for Heat at the Thermostat, Zone Sensor or BAS System for five seconds and back to heat.

If flame sensor indicates presence of flame during purge period when no flame should be present, the inducer will remain energized but the gas valve will remain off until the cause of the "false flame" is removed. If the air pressure switch is closed when the inducer is de-energized, or does not close after the inducer is energized, the control will wait a predetermined time for the air switch to correct itself, if not then lock out. Control will go into lockout with all outputs off.

Modulating Gas Heat

Symbio 700 supports modulating gas heat for primary heat with a Modbus interface to a VB1285 modulating ignition controller. The Modbus interface provides operating details and diagnostics to the Symbio 700 controller. The gas furnace consists of a main gas valve, modulating gas valve (burner 1) and a single-stage gas valve (burner 2) on a single split manifold.

Modulating gas heat units include a Discharge Air Temperature sensor and a Supply Fan Entering Air Temperature sensor. The Symbio 700 controller uses the sensors to calculate and manage the gas heat furnace temperature rise. Status point Heating Output Operational Limit (active, inactive) is active when gas heat is limited due to the calculated temperature rise. If the Supply Fan Entering Air Temperature sensor or Discharge Air Temperature sensor fails, modulating gas heat disables.

Sequence of Operation

1. An initial call for heat the Symbio 700 creates a heat demand via Modbus to the gas heat ignition controller.
2. The draft inducer energizes; an air pressure switch closes for the initial pre-purge for 30 seconds. [Pur] is displayed on the gas ignition controller.
3. The modulating gas valve opens to approximately 35 percent, depending on gas heat size, during pre-purge.
4. At end of pre-purge period, the ignition source is activated, and the main gas valve opens for the trial for ignition period (up to 8 seconds). [Ign] is displayed on the gas ignition controller.
5. The modulating burner ignites, and flame is sensed.
6. During the 10 second warm-up period [HEA] is displayed.
7. At the end of the warm-up period, the primary burner enters the run state, and the gas valve is modulated under Symbio 700 control. [run] is displayed on the ignition controller.

As heat demand increases:

1. The Symbio 700 commands the modulating burner open with increasing heat demand until Heat Capacity Primary Status = 50 percent.
2. At this capacity, if there is a continued demand for heat, the staged gas valve opens on burner 2. Symbio 700 enforces a 3 minute period between adding or subtracting on the split manifold (burner 2).
3. When flame is sensed on burner 2, the modulating gas valve reverts to minimum fire and Heat Capacity Primary Status will report 60 percent (natural gas) or ≧67% (liquid propane). If flame is not sense on the split manifold burner 2, gas heat will continue on the primary burner and continue to call for heat on the split burner as required.
4. The modulating gas valve will again open with increasing heat demand.

As heat demand decreases:

1. The modulating burner will decrease capacity.
2. At Heat Capacity Primary Status = 60 percent (natural gas) or 67 percent, 70 percent (120 Mbh), 75 percent (80 Mbh) liquid propane, the second staged burner is turned off.
3. The modulating burner will increase to full capacity before decreasing with decreasing heat demand.
4. If there is no heat demand, gas heat is staged off.
5. The draft inducer will remain on for a post purge time of 60 seconds.

If ignition is not achieved within the trial period, the gas valve is shut off; the inducer continues to run for a 60 second post-purge period. Additional ignition trials follow the specified sequence. If four attempts for ignition have occurred without flame detection, the gas heat ignition controller will lock out.

Note: *See Appendix A for a full list of gas heat diagnostics.*

Supply fan operation VVZT/CVZT

The supply fan operates at a minimum speed of 58 percent when gas heat is less than 15 percent capacity. When gas heat capacity is 15 percent or greater the supply fan speed will increase with capacity on a defined supply fan curve. If Discharge air temperature reaches the heating maximum

setpoint before the supply fan is at 100 percent, the supply fan speed will increase to provide additional heating capacity.

VVDA

The supply fan operates under duct static pressure control.

Temperature Rise Limit Control

Precedent modulating gas heat units include a discharge air temperature sensor and a supply fan entering air temperature sensor. The Symbio™ 700 controller uses the sensors to calculate the gas heat furnace temperature rise. Gas heat capacity is controlled below maximum rise per the rating plate maximum rise specified. Heating output operational limit (active, inactive) is active when gas heat is limited due to the calculated temperature rise.

Dual Fuel Operation

Heat pump units with secondary gas heat will use gas heat to maintain building comfort when compressor heating is lockout or unavailable. Heat pump heating can be locked out/disabled due to low outdoor air temperature conditions. This occurs when outdoor air temperature is less than heat pump heating lockout setpoint, which disables compressor operation after minimum on-time expires. Gas heating initializes and modulates to maintain building comfort. Heat Pump Heating Lockout Setpoint Enable (default = Enable), enables, or disables the lockout setpoint. Heat pump heating will also lockout if operation is insufficient to fulfill the heating load.

VVZT/CVZT

If the following heat pump heating conditions are met, compressor operation terminates, and gas heat will begin to maintain building comfort:

- Heat pump heating operates at 100 percent capacity for nine minutes
- Space temperature is greater than 1°F below the space temperature setpoint
- Space temperature increases at less than 0.017°F in 10 seconds
- The heat pump operation restarts when the following is satisfied:
  - Modulating gas heat is off for more than 9 minutes
  - Space temperature decreases less than 0.017°F in 10 seconds
  - Space temperature is more than 1°F above the active space heating setpoint

VVDA

If the following conditions are met, compressor operation terminates and gas heat will startup to maintain building comfort.

- Heat pump heating operates at 100 percent capacity for nine minutes
- Discharge air temperature is less 1°F below the discharge air setpoint
- The control algorithm calculates a request for additional heat
- The heat pump operation restarts when following is satisfied:
  - Heat pump is available
  - The outdoor air temperature is greater than heat pump heating lockout setpoint + 5°F
  - Gas heat is not available, or there is no heat demand (all heat is off)
  - Discharge air temperature greater than the discharge air temperature setpoint + 1°F
  - The algorithm stage signal is less than -100 for 5 minutes

Electric Heat - Staged

When staged electric heat is configured in the unit, the controller manages two binary outputs to provide two-stages of heat control; depending on size of the electric heat installed. When two-stages of electric heat are installed on a cooling only unit, each stage of electric heat is 50 percent of available Heating

Capacity Primary Status. When one-stage of electric heat is installed on a cooling only unit, it is assumed to represent 100 percent of the Heating Capacity Primary Status.

When two-stages of electric heat are installed on a heat pump unit, each stage of electric heat is assumed to represent 50 percent of available Heat Secondary Capacity Status. When one-stage of electric heat is installed on a Heat Pump unit, it is assumed to represent 100 percent of the Heat Secondary Capacity Status. If the last stage of compressor heating is energized or compressor(s) lockout is active, electric heat is allowed to stage.

Heat Pump with Secondary Electric Heat

Electric heat provides secondary heating capacity, in the event heat pump heating is disabled, or as supplemental heat if heat pump alone is not able to meet the demand. If heat pump primary heat capacity is 100 percent for nine minutes, a secondary electric heat stage is added. Additional electric heat stage(s) are added as required for heating capacity demand.

If discharge air temperature is greater than or equal to 140°F, a stage of electric heat will be disabled. If discharge air temperature remains greater than 140°F for 60 seconds, a second stage of electric heat will disable. A disabled stage of electric heat will be allowed to stage up after 10 minutes if discharge air temperature is less than 120°F.

Outdoor Air Damper Control

Economizer Cooling

Symbio™ 700 supports a 0 to 100 percent economizer damper which requires a discharge air temperature sensor to be installed for economizer cooling. There are four configurable economizer types: fixed dry bulb, differential dry bulb, reference enthalpy, and comparative enthalpy. Each type, enable, and the high limit disable criteria are defined as follows.

Table 16. Economizer types

Type	Econo-mizer Status	Calculation
Fixed Dry Bulb	Enable	Outdoor Air Temperature < Economizer Outdoor Air Enable Setpoint – Economizer Dry Bulb Enable Offset
	Disable	Outdoor Air Temperature > Economizer Outdoor Air Enable Setpoint
Differential Dry Bulb	Enable	Outdoor Air Temperature < (Return Air Temperature - Economizer Dry Bulb Enable Offset - Economizer Dry Bulb Disable Return Air Offset)
	Disable	Outdoor Air Temperature < (Return Air Temperature - Economizer Dry Bulb Disable Return Air Offset)
Reference Enthalpy	Enable	Outdoor Air Enthalpy < (Economizer Outdoor Air Enthalpy Enable Setpoint – Economizer Cooling Reference Enthalpy Offset) AND Outdoor Air Temperature < (Economizer Outdoor Air Enable Setpoint – Economizer Dry Bulb Enable Offset)
	Disable	Outdoor Air Enthalpy > Economizer Outdoor Air Enthalpy Enable Setpoint OR Outdoor Air Temperature > Economizer Outdoor Air Enable Setpoint
Comparative Enthalpy	Enable	Outdoor Air Enthalpy < (Return Air Enthalpy – Economizer Cooling Reference Enthalpy Hysteresis Offset) AND Outdoor Air Temperature < (Economizer Outdoor Air Enable Setpoint - Economizer Dry Bulb Enable Offset)
	Disable	Outdoor Air Enthalpy > Return Air Enthalpy OR Outdoor Air Temperature > Economizer Outdoor Air Enable Setpoint

While the configuration parameters will be used to determine which method of economizer control will be utilized, the table below describes the needed sensor data for each control method.

Table 17. Sensor data

Economizer Enable Method	Required Sensor Data
Comparative Enthalpy	Outdoor Air Temperature
	Outdoor Air Humidity
	Return Air Temperature
	Return Air Humidity
Reference Enthalpy	Outdoor Air Temperature
	Outdoor Air Humidity

Table 17. Sensor data (continued)

Economizer Enable Method	Required Sensor Data
Dry Bulb	Outdoor Air Temperature
Differential Dry Bulb	Outdoor Air Temperature
	Return Air Temperature

When conditions are suitable for economizer operation, the outdoor air damper modulates between a calculated outdoor air damper minimum position (based on Supply Fan Compensation and Demand Controlled Ventilation) and 100 percent open. Economizing will not allow additional mechanical cooling until the damper position is 100 percent and supply fan has reached 100 percent capacity for 5 minutes. If economizer cooling becomes disabled, the damper will revert to minimum position control, and transition to mechanical cooling.

A building automation system can directly command economizer operation via Economizer Airside Enable (auto, enable, disable). If commanded Enable, the controller will start economizer cooling, regardless of outdoor air conditions. If commanded Disable, economizer cooling will be disabled (except if a mode of Night Purge is commanded to the controller). If commanded Auto, the controller will use the configured Economizer high limit method and input values to determine if economizer cooling is available.

Ventilation Control

On equipment installed with a 0 to 100 percent Economizer Damper, the Symbio™ 700 will control the outdoor air damper to provide minimum ventilation requirements based on the specific options installed, enabled features and mode of operation. During normal occupied periods of heating and cooling modes of operation, the outdoor air damper maintains ventilation requirements. However, the following modes of operation will override the damper minimum position setpoint to 0 percent.

- Morning Warm-up
- PreCool
- Night Purge
- Unoccupied Heat
- Unoccupied Cool
- Off

Supply Fan Compensation

The outdoor air damper minimum position is modulated to provide outdoor air based on supply fan speed. When the supply fan increases speed, the outdoor air damper minimum position is reduced to prevent over ventilation. When the supply fan decreases speed the outdoor air damper minimum position is increased to maintain design outdoor air requirements. There are three user editable design minimum settings to linearize damper position with the fan curve during Occupied and Occupied Bypass modes of operation.

- Design Minimum OA Damper Position at Min Fan Capacity (25 percent default)
- Design Minimum OA Damper Position at Mid Fan Capacity (15 percent default)
- Design Minimum OA Damper Position at Full Fan Capacity (10 percent default)

There are three additional user editable design minimum settings for Occupied-Standby mode of operation.

- Standby Minimum OA Damper Position at Min Fan Capacity (25 percent default)
- Standby Minimum OA Damper Position at Mid Fan Capacity (15 percent default)
- Standby Minimum OA Damper Position at Full Fan Capacity (10 percent default)

Outdoor Air Minimum Position Control

Available only when supply fan compensation is disabled, this function provides a fixed damper position for minimum outdoor air requirements. The damper is controlled to a position determined by Economizer Minimum Position Setpoint.

Remote Minimum Position Control

With an installed Customer Connection Module and Remote Minimum Position is configured in the Symbio™ 700, a wired potentiometer can be used to adjust the outdoor air damper minimum position setpoint in the range of 0 to 50 percent (0 to 270 ohms). The setting is reported via Remote Minimum Position. If Remote Minimum Position input and Demand Controlled Ventilation is installed, the Remote Minimum Position provides the minimum damper position setpoint at full fan capacity. Tables below provide details of when the Remote Minimum Position input is utilized in minimum ventilation control.

When Remote Minimum Position is installed with Demand Controlled Ventilation, the Remote Minimum Position input is used in place of Design Minimum OA Damper Position at Full Fan Capacity setpoint. See tables below for more details.

Demand Controlled Ventilation (DCV)

Demand controlled ventilation reduces energy consumption by reducing the outdoor air damper below design minimum ventilation based on space CO_2. When Demand Controlled Ventilation is configured and Supply Fan Compensation is enabled, DCV resets the outdoor air damper minimum position based on space CO_2 and supply fan speed. Decreasing CO_2 levels will decrease damper position below the Design Minimum toward the DCV minimum damper position setpoint. Increasing CO_2 level will increase damper position toward design minimum setpoint. DCV requires a valid space CO_2 value from a building management system or wired sensor. If Space CO_2 value is invalid or Supply Fan Compensation is disabled, the Symbio™ 700 will revert to Outdoor Air Minimum Position Control.

Demand controlled ventilation setpoints used in all methods.

- Space CO_2 High Limit
- Space CO_2 Low Limit

Occupied and Occupied-Bypass mode. If the supply fan is at 100 percent and CO_2 is at the Space CO_2 High Limit (1500 ppm default), the outdoor air damper will be positioned at Design Minimum OA Damper Position at Full Fan Capacity (10 percent default). As CO_2 in the space reduces below the high limit, the outdoor air damper will close. If CO_2 falls below the Space CO_2 Low Limit, the damper position will be at DCV Minimum OA Damper Position at Full Fan Capacity (5 percent default).

Occupied-Standby mode. The damper will reset, based on CO_2, between the Standby Minimum OA Damper Position at Full/Mid/Min Fan Capacity and DCV Minimum OA Damper Position at Full/Mid/Min Fan Capacity.

The following tables define the Symbio 700 setpoints for Demand Controlled Ventilation control, which depend on the features enabled and configuration options installed. Each table is based on the supply fan and damper type installed. Supply Fan Compensation is a feature that can be enabled or disabled. Demand Controlled Ventilation and Remote Minimum Position are Symbio 700 configurations.

Table 18. 0 to 100 percent economizer – variable speed supply fan

Supply Fan Compensa-tion	Demand Controlled Ventilation	Remote Minimum Position	Occupancy Status	Outdoor Air Damper Controlling Setpoints
Enabled	Installed	Installed	Occupied, Occupied Bypass	Remote Minimum Position (Full Fan Capacity) Design Minimum OA Damper Position at Mid Fan Capacity Design Minimum OA Damper Position at Min Fan Capacity DCV Minimum OA Damper Position at Full Fan Capacity DCV Minimum OA Damper Position at Mid Fan Capacity DCV Minimum OA Damper Position at Min Fan Capacity
Enabled	Installed	Not Installed	Occupied, Occupied Bypass	Design Minimum OA Damper Position at Full Fan Capacity Design Minimum OA Damper Position at Mid Fan Capacity Design Minimum OA Damper Position at Min Fan Capacity DCV Minimum OA Damper Position at Full Fan Capacity DCV Minimum OA Damper Position at Mid Fan Capacity DCV Minimum OA Damper Position at Min Fan Capacity
Enabled	Not Installed or Disabled	Installed	Occupied, Occupied Bypass	Remote Minimum Position (Full Fan Capacity) Design Minimum OA Damper Position at Mid Fan Capacity Design Minimum OA Damper Position at Min Fan Capacity
Enabled	Not Installed or Disabled	Not Installed	Occupied, Occupied Bypass	Design Minimum OA Damper Position at Full Fan Capacity Design Minimum OA Damper Position at Mid Fan Capacity Design Minimum OA Damper Position at Min Fan Capacity
Enabled	Installed	Installed or Not Installed	Occupied Standby	Design Minimum OA Damper Position at Full Fan Capacity Design Minimum OA Damper Position at Mid Fan Capacity Design Minimum OA Damper Position at Min Fan Capacity Standby Minimum OA Damper Position at Full Fan Capacity Standby Minimum OA Damper Position at Mid Fan Capacity Standby Minimum OA Damper Position at Min Fan Capacity
Disabled	Installed or Not Installed	Installed or Not Installed	Occupied, Occupied Bypass, Occupied Standby	Economizer Minimum Position Setpoint

Table 19. 0 to 100 percent economizer – multi-speed supply fan (2–speed)

Supply Fan Compensa-tion	Demand Controlled Ventilation	Remote Minimum Position	Occupancy Status	Outdoor Air Damper Controlling Setpoints
Enabled	Installed	Installed	Occupied, Occupied Bypass	**Supply Fan at 100%:** Remote Minimum Position DCV Minimum OA Damper Position at Full Fan Capacity **Supply Fan at minimum speed:** Design Minimum OA Damper Position at Min Fan Capacity DCV Minimum OA Damper Position at Min Fan Capacity
Enabled	Installed	Not Installed	Occupied, Occupied Bypass	**Supply Fan at 100%:** Design Minimum OA Damper Position at Full Fan Capacity DCV Minimum OA Damper Position at Full Fan Capacity **Supply Fan at minimum speed:** Design Minimum OA Damper Position at Min Fan Capacity DCV Minimum OA Damper Position at Min Fan Capacity
Enabled	Not Installed or Disabled	Installed	Occupied, Occupied Bypass	**Supply Fan at 100%:** Remote Minimum Position **Supply Fan at minimum speed:** Design Minimum OA Damper Position at Min Fan Capacity
Enabled	Not Installed or Disabled	Not Installed	Occupied, Occupied Bypass	**Supply Fan at 100%:** Design Minimum OA Damper Position at Full Fan Capacity **Supply Fan at minimum speed:** Design Minimum OA Damper Position at Min Fan Capacity
Enabled	Installed	Installed or Not Installed	Occupied Standby	**Supply Fan at 100%:** Standby Minimum OA Damper Position at Full Fan Capacity DCV Minimum OA Damper Position at Full Fan Capacity **Supply Fan at minimum speed:** Standby Minimum OA Damper Position at Min Fan Capacity DCV Minimum OA Damper Position at Min Fan Capacity
Enabled	Not Installed or Disabled	Installed or Not Installed	Occupied Standby	**Supply Fan at 100%:** Standby Minimum OA Damper Position at Full Fan Capacity **Supply Fan at minimum speed:** Standby Minimum OA Damper Position at Min Fan Capacity
Disabled	Installed or Not Installed	Installed or Not Installed	Occupied, Occupied Bypass, Occupied Standby	Economizer Minimum Position Setpoint BAS

0 to 50 percent Motorized Damper

When a 0 to 50 percent motorized damper is installed, with any supply fan type, the outdoor air damper is controlled to a setpoint from a Remote Minimum Position (wired input), Motorized Damper Position

Setpoint, or Economizer Minimum Position Setpoint BAS. The following table summarizes which setpoint is in control of the damper position based on options installed and enabled.

Table 20. 0 to 50 percent motorized damper

Supply Fan Compensation	Remote Minimum Position	Occupancy Status	Outdoor Air Damper Controlling Setpoints
Enabled	Installed	Any	Remote Minimum Position
Enabled	Not Installed	Any	Motorized Damper Position Setpoint
Disabled	Installed or Not Installed	Any	Economizer Minimum Position Setpoint BAS

Demand Controlled Ventilation (DCV) — Thermostat Control

When the Symbio™ 700 is configured for Conventional Thermostat Control, 0 to 100 percent Economizer Damper and Demand Controlled Ventilation (Installed), the controller provides an Occupancy binary input that can be used to control Occupied and Unoccupied modes of operation. In Unoccupied mode, DCV is disabled, and the outdoor air damper minimum position is effective 0 percent. In Occupied mode, DCV will control the outdoor air damper based on Space CO_2 while the supply fan is On, as described in the previous sections.

In Occupied mode, if the supply fan cycles Off, the controller will continue to monitor Space CO_2. If Space CO_2 exceeds the Space CO_2 High Limit setpoint for 15 minutes, the supply fan will turn On and operate at minimum speed and outdoor air damper at the Design Minimum OA Damper Position. If Space CO_2 falls below the Space CO_2 High Limit – 200 ppm, the supply fan will cycle Off. The supply fan will also cycle off if occupancy changes to Unoccupied.

Relief Damper Control – Powered Exhaust

Symbio™ 700 has a Space Pressure Control configuration options for Not Installed for Relief Fan Only. When configured for Relief Fan Only, the relief fan output energizes when the outdoor air damper position is greater than or equal to the Relief Enable Position Setpoint Status. Relief Fan Output Status point will report On.

The relief fan output de-energizes with the outdoor air damper is less than or equal to the Relief Enable Position Setpoint Status – 10 percent or when the outdoor air damper is closed. Relief Fan Output Status point will report Off.

General Support Sequences

Fan Setpoints with ERM - Driven Fan Types

When a system is equipped with an External Rotor Motor (ERM), the minimum and maximum ERM parameters can be adjusted to tune the airflow to meet the application requirements.

In addition to this, the Symbio™ 700 supports setpoints that can adjust airflow as needed:

- Supply Fan Maximum Speed Setpoint
  - Range: Determined by unit tonnage and cabinet size. See table below.

Unit Size (tons)	Cabinet	Range (%)	Default (%)
3	B	18-100	47
4	B	21-100	48
5	B	24-100	51
6	B	29-100	57
7.5	B	35-100	63
8.5	B	39-100	67
10	B	44-100	71
	C	43-100	66
12.5	C	50-100	77
	D	28-100	56
15	D	34-100	61
17.5	D	37-100	63
20	D	40-100	66
25	D	50-100	77

  - Operation: This setpoint **trims** the maximum fan speed, based on the configured maximum ERM rpm.
  - Example: rpm max = 1940 rpm
    - Supply Fan Maximum Speed Setpoint @ 75% yields a maximum of 1358 rpm ERM output.
    - Effective ERM Max (to be used in Supply Fan Minimum Speed Setpoint application) will be set to 1358 rpm.
- Supply Fan Maximum Speed Setpoint Heating

  High efficiency 3 to 5 tons heat pump units with staged gas heat are provided a Supply Fan Maximum Speed Setpoint Heating point to adjust airflow.

Unit Size (tons)	Cabinet	Range (%)	Default (%)
3	B	18-100	47
4	B	21-100	48
5	B	24-100	51

- Supply Fan Minimum Speed Setpoint
  - Range: 0-100%
  - Operation: 0-100% over minimum to effective maximum ERM configured fan speed
  - Example: ERM Min = 0 rpm, Effective ERM Max = 1940 rpm
    - Supply Fan Minimum Speed Setpoint @ 50% yields 970 rpm ERM output.

- Minimum and Maximum Speed Setpoints interact to ensure that the minimum defined fan speed at a given equipment operating condition is maintained.

Compressor Minimum Runtime

Cooling only units, a three minute minimum ON and OFF timer is maintained for each compressor. Heat Pump units, a five minute minimum ON timer and a three minute minimum OFF timer is maintained for each compressor. Once a compressor is turned ON, it remains on for a minimum of three or five minutes. Once a compressor is turned OFF, it remains off for a minimum of three minutes. System overrides that require immediate shutdown of the equipment, test modes, and compressor diagnostics/ protection functions can override these minimum run timers. For normal temperature and thermostat based control, these minimum ON/OFF timers are maintained.

Compressor Proof of Operation

For each compressor. a Compressor Proving binary input is used to monitor the state of the contactor auxiliary switch that is used to indicate compressor motor contactor status. Under normal operation, detected operation indicates that all safety devices within the compressor safety circuit are in their normal state. The switch is OPEN when the compressor motor is OFF and CLOSED when the compressor motor is ON.

Refer to the Diagnostics section for specific diagnostics generated based on the Compressor Proving signals.

Compressor Low Pressure Cutout Control

For each compressor/circuit, a normally CLOSED low pressure cutout input is monitored for equipment protection on the Symbio™ 700. When a low pressure event is active, the input becomes OPEN and diagnostics are generated as described below. Refer to the Diagnostics section below for specific diagnostics that are generated based on the circuit Low Pressure Cutout inputs.

Heat Pump Sequences

Heat Pump Switchover Valve

Heat pump units utilize a switchover valve to control the refrigeration system operation for compressor cooling and heating modes. When a heat pump unit is providing compressor heating, the Symbio™ 700 switchover valve output (P11-1) is OFF. When providing compressor cooling, in an active defrost mode, or when the unit Heat Cool Mode is Cool, the switchover valve output is ON.

When the unit enters defrost, the switchover valve output will be ON for the duration of defrost. When leaving active defrost, the switchover valve transition OFF is delayed 5 seconds.

Demand Defrost Control

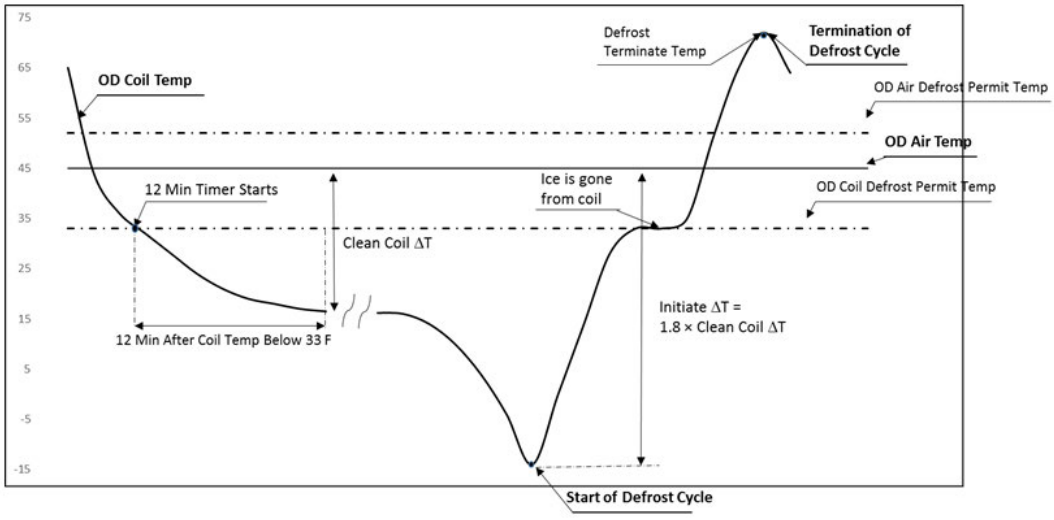
There are two schemes in common usage for heat pump outdoor coil defrosting: Demand Defrost and time temperature defrost. Demand Defrost is more efficient because defrost cycles are initiated only when necessary, compared with initiation based on operating time below the threshold temperature.

Outdoor coil defrosting occurs only when operating in heating mode with outdoor ambient temperature below 52° F and the outdoor coil temperature below 33° F. The first defrost cycle after power-up is initiated based on operating time at the required conditions. Shortly after completion of the defrost cycle, the temperature difference between the outdoor coil and outdoor air is calculated and is used as an indicator of unit performance at dry coil conditions.

Over time, as moisture and frost accumulate on the coil, the coil temperature will drop, increasing the temperature difference. When the temperature difference reaches 1.8 times the dry coil temperature differential (ΔT), a defrost cycle is initiated. While defrosting, the reversing valve is in the cooling position, outdoor fans are off, and the compressors continue to operate.

The defrost cycle is terminated when the coil temperature rises high enough to indicate that the frost has been eliminated. Termination of the defrost cycle includes a soft start delay. At the end of each defrost cycle, the outdoor fan comes on 5 seconds before the reversing valve is de-energized. This reduces stress on the compressor and makes for a quieter defrost.

Figure 12. Typical demand defrost cycle



During the defrost cycle, the Switchover Valve is turned ON, the Condenser Fan is turned OFF, and auxiliary heat is turned ON regardless of their prior operating status while maintaining compressor operation. The defrost cycle is terminated based on the defrost termination temperature calculation using the outdoor temperature (ODT) +47°F. The defrost termination temperature (DTT) will be limited between 57° F and 72° F.

Heat Pump Heating Lockout

The Heat pump heating lockout function provides the user the ability to disable compressor heating on heat pumps when the outdoor temperature falls below the Heat Pump Heating Lockout Setpoint. This feature can be used by setting the Heat Pump Heating Lockout Setpoint Enable to Enabled. When enabled, the Heat Pump Heating Lockout Setpoint can be adjusted between -18°F and 45°F (R-410A) or -8°F and 45°F (R-454B). The setpoint is set to 0° F as the Default for Precedent units.

Sequence of Operation

1. When the Outdoor Air Temperature Active ≤ Heat Pump Heating Lockout Setpoint – Active:
   - Compressor outputs for heating will be disabled after the minimum ON time has expired. Auxiliary Heating, if configured, will be used to satisfy a heating demand.
   - If compressors were not ON before this function became active, compressors will be prevented from operating for heating operation. Auxiliary Heating, if configured, will be used to satisfy a heating demand.
2. When the Outdoor Air Temperature Active point is in Alarm:
   - The Heat Pump Heating Lockout function will be disabled.
   - Compressor Outputs, if available, will be used to satisfy heating demands.
3. When the Outdoor Air Temperature Active point transitions from Alarm Active to an Alarm Inactive state:
   - The Heat Pump Heating Lockout function will be permitted.
4. When the Outdoor Air Temperature Active > “Heat Pump Heating Lockout Setpoint – Active” + 5° F, Or when the Outdoor Air Temperature Sensor Fails while one of each the following conditions is True:

Gas heat is Active/ON	Electrical heat is Active/ON	Aux heat is not Active/ON
During Active Heating Calls: When Gas Heat is Active, it will not be turned off regardless of OAT Sensor Failure, or the OAT Sensor value increasing by more than 5F above the Heat Pump Heating Lockout Setpoint. After the Active Heating Call is Satisfied, and Gas Heat has been staged Off -> condition(s) of OAT Sensor Failure, or the OAT Sensor value increasing by more than 5F above the Heat Pump Heating Lockout Setpoint will permit Heat Pump Compressor based heating to be staged up 1st during subsequent heating calls. ***Note:*** *Gas Heating Stages are only permitted to stage up concurrently with Compressor Heat Pump Heating Stages during Active Demand Defrost Cycles.*	During Active Heating Calls: When Electric Heat is Active, it will be permitted to remain active regardless of OAT Sensor Failure, or the OAT Sensor value increasing by more than 5F above the Heat Pump Heating Lockout Setpoint. However, the conditions of OAT Sensor Failure, or the OAT Sensor value increasing by more than 5F above the Heat Pump Heating Lockout Setpoint will enable the Compressor Heat Pump based heating stages to be made available to the Active Heating Call if and when the demand for heat increases. After the Active Heating Call is Satisfied, and Gas Heat has been staged Off -> condition(s) of OAT Sensor Failure, or the OAT Sensor value increasing by more than 5F above the Heat Pump Heating Lockout Setpoint will permit Heat Pump Compressor based heating to be staged up 1st during subsequent heating calls. ***Note:*** *Electric based heat stages and Compressor based heat stages are permitted to be Active/ energized at the same time.*	After the Active Heating Call is Satisfied, and Gas Heat has been staged Off -> condition(s) of OAT Sensor Failure, or the OAT Sensor value increasing by more than 5F above the Heat Pump Heating Lockout Setpoint will permit Heat Pump Compressor based heating to be staged up 1st during subsequent heating calls.

Variable Speed Compressor Operation

Ultra-high efficiency units are equipped with a variable speed compressor. The variable speed compressor will always be the first stage of cooling On and the last stage of cooling Off. The compressor acceleration and deceleration rate are controlled by the compressor variable speed drive. The variable speed compressor, and any fixed speed compressor in the system operate according to a three-minute minimum On time and three-minute minimum Off time. See Appendix A for variable speed compressor staging information.

Startup Sequence

The supply fan must be started and verified running. On compressor startup, the variable speed compressor increases to 2700 RPM for 120 seconds before transitioning to modulating control.

Single Compressor Operation

A unit with a single variable speed compressor will startup per the startup sequence. The compressor speed will modulate to satisfy the discharge air cooling setpoint defined for VVZT or VVDA cooling. The between defined minimum and maximum compressor speeds based on operating conditions. The variable speed compressor will cycle off according to the shutdown sequence defined below.

Dual Compressor Operation

Ultra-high efficiency, 17.5 to 25-ton units have an additional fixed speed compressor. The variable speed compressor follows the startup sequence. If the variable speed compressor reaches its maximum defined speed (stage 1) and the algorithm control identifies an additional cooling capacity demand, the fixed speed compressor will be energized (stage 2). The variable speed compressor will revert to its defined minimum speed and continue to increase speed with an increasing demand for cooling.

As the demand for cooling decreases, the variable speed compressor speed will reduce until it reaches its minimum defined speed. Algorithm control determines when to de-energize the fixed speed compressor and ramp the variable speed compressor to its maximum defined speed as an initial stage 1 state. As cooling demand continues to decrease the variable speed compressor speed will reduce until it reaches a minimum defined speed. The variable speed compressor will cycle off according to the shutdown sequence defined below.

Dehumidification Operation

During dehumidification mode of operation, with or without the reheat valve open, 3-to-10-ton units, the variable speed compressor operates at full capacity. Variable speed compressor, 12.5-to-25-ton units, operate at two fixed speeds: at a defined part-load capacity and full-capacity. The variable speed compressor is staged up, including the fixed speed compressor, to ensure the evaporator coil temperature is achieving dewpoint.

Oil Management

Oil management aids oil distribution in the refrigerant system. If the variable speed compressor operates less than 1800 RPM for 19 continuous minutes, the compressor speed will increase to 3600 RPM for 60 seconds. The compressor then returns to normal control. When the compressor speed exceeds 2000 RPM, the 19-minute timer resets.

Table 21. Variable speed compressor operation during oil recovery

Unit Tonnage	Cooling Capacity during Oil Recovery	Compressor RPM
3	100%	3300
4	92%	3600
5	92%	3600
6	81%	3600

Table 21. Variable speed compressor operation during oil recovery (continued)

Unit Tonnage	Cooling Capacity during Oil Recovery	Compressor RPM
7.5	97%	3600
8.5	85%	3600
10	71%	3600
12.5	89%	3600
15	71%	3600
17.5	40%	3600
20	35%	3600
25	43%	3600

Shutdown Sequence

When the variable speed compressor is no longer requested, the compressor speed is increased to 2700 RPM for 60 seconds before the speed is reduced to 0 percent, off. If the variable speed compressor was operating at or above 2700 RPM for a minimum of 60 seconds at time of off command, the compressor will immediately ramp down to 0 percent, off.

Evaporator Defrost Control

To prevent frost build-up on the indoor coil during low ambient conditions, compressor operation is monitored and controlled accordingly, relative to outdoor air temperature.

Evaporator Defrost Control can be initiated through two means, based on the FroStat input.

FroStat Installed (default):

- A FroStat input can also be used to directly request the Evaporator Defrost Control function
- When the unit is running in an effective **Cool** mode, the FroStat input will directly control the FroStat diagnostic. If the FroStat input CLOSES, the diagnostic will be annunciated.
- When the unit is running in an effective **Heat** mode, and the Refrigeration System = Heat Pump, the FroStat diagnostic will be controlled **Inactive** until the following are true:
  - FroStat input is CLOSED
  - One or More Compressors have been active for Heat Pump Heating for more than 30 seconds.

Once the above two conditions are met, the FroStat Diagnostic will become Active.

- The FroStat diagnostic is an Auto-Reset diagnostic such that it will be reset when the FroStat input is OPEN in either effecting unit mode.
- If the FroStat diagnostic becomes active, the Compressor Output(s) will de-energize until the FroStat diagnostic is cleared. The supply fan continues to operate during the FroStat diagnostic, so long as it is still requested by a heating or cooling function.

Refrigerant Detection System

Equipment with R-454B refrigerant may require a refrigerant detection system based on the refrigerant charge. The refrigerant detection system consists of a refrigerant detection sensor that communicates information to the Symbio™ 700 controller. When the refrigerant detection sensor is in a normal operating state, the equipment provides normal heating, cooling, and ventilation. The refrigerant sensor creates an alarm signal when the sensed refrigerant concentration has exceeded a predetermined threshold.

When the refrigerant detection system is in an alarm state, the Symbio 700 mitigates the refrigerant leak alarm condition for a minimum of 5 minutes after the refrigerant detection system has reset to a normal state.

Mitigation actions:

- All compressor operation is disabled.
- The supply fan operates continuously at or above a defined minimum speed.
- After the supply fan operation is proven; electric heat, gas heat, economizer cooling and ventilation operate normally.
- Alarm output energizes on the Customer Options Module (if installed).

The following Symbio 700 points are available on BACnet® or Modbus™; however, the points are not available on LonTalk®.

Table 22. Refrigerant detection system points

Point Reference	Description
Refrigerant Leak Detection System Input	The Active state maintained for the duration of the refrigerant detection system alarm state.
Refrigerant Mitigation Active	Active when the Symbio controller is in a refrigerant mitigation state. This point is also for coordination of building multi-zone VAV systems.
Diagnostic: Refrigerant Concentration Sensor A	Active when Refrigerant Leak Sensor is in the alarm state. Resets, inactive when the Refrigerant Leak Sensor alarm has reset; refrigerant concentration has reduced below the lower concentration threshold.
Diagnostic: Refrigerant Leak Sensor Failure Sensor A	Diagnostic point that shall be active when the refrigerant sensor reports a fault.
Refrigerant Leak Sensor Communication Status Sensor A	Communication status of the Modbus communicating refrigerant detection system. Loss of communication shall initiate refrigerant mitigation actions.

A Multi-Zone VAV application, the Symbio controller energizes the VAV Box Relay Output and the Refrigerant Mitigation Active point will be active to signal building systems to drive VAV boxes open. If the supply fan is off, the supply fan operation initiates within 15 seconds. When utilizing LON communications, wiring the VAV Box Relay Output to VAV boxes must be used to coordinate with building multi-zone VAV system.

In the event the control system detects the refrigerant sensor has failed, become disconnected or unpowered; the controls will respond with a Diagnostic: Refrigerant Leak Sensor Failure, Refrigerant Mitigation Active, and the Alarm Output are active. The Symbio controller provides all mitigation actions (outlined above) for the duration of the sensor failure mode.

Building fire and smoke systems utilizing Ventilation Override or Emergency Override will override the refrigerant detection system. Service Test mode and the Emergency Stop input will also override the refrigerant detection system.

After mitigation actions are completed and the condition triggering mitigation actions are no longer active, the unit will return back to normal operation.

Building Automation System Support Sequences

Occupancy Mode

Occupancy is an input used to aid energy management and ventilation.

Occupancy input can be communicated, or obtained from hardwired sources that are converted to status: Occupied, Occupied Standby, Occupied Bypass, or Unoccupied.

Sources for Occupancy:

- Occupancy Request is a communicated value from a Building Automation System (BAS) schedule.
- Occupancy Input is a local input from the space served by the equipment. This input is typically an optional local time clocks or space occupancy sensors, and is wired to Symbio 700™, J20-2.Bypass Timer a user-requested occupancy override (also known as Occupied Bypass). The occupant requests temporary occupied comfort heating or cooling during unoccupied scheduled time periods. An example of this would be the Timed Override (TOV) button on the zone sensor. See Timed Override for more information
- Bypass Timer a user-requested occupancy override (also known as Occupied Bypass). The occupant requests temporary occupied comfort heating or cooling during unoccupied scheduled time periods. An example of this would be the Timed Override (TOV) button on the zone sensor. See Timed Override for more information.

Occupancy Status Definitions

Occupied: The controller operates in an occupied mode providing temperature and ventilation control to the occupied heating and cooling setpoints.

Unoccupied: The control is typically shut down and does not provide temperature control to the normal occupied setpoints. No ventilation is provided. Temperature control is determined by energy conservation and building protection thresholds.

Occupied Bypass: The control is temporarily in an Occupied state for a specified period and will automatically return to unoccupied operation when the bypass timer expires. The Occupied Bypass Timer is user-adjustable; setting the timer to 0 minutes effectively disables Timed Override function at the equipment controller.

Occupied Standby: Space temperature control units in an Occupied Standby state control to occupied heating and cooling standby temperature setpoints. Standby does not apply to controllers configured for discharge air control (such as VVDA), which will translate Standby into an Occupied status.

Table 23. Occupancy status

Occupancy Request	Occupancy Input	Occupied Bypass Timer	Occupancy Status
Occupied	Occupied	Any Number	Occupied
Occupied	Unoccupied	Zero	Occupied Standby
Occupied	Unoccupied	Not Zero	Occupied Bypass
Unoccupied	Any State	Zero	Unoccupied
Unoccupied	Any State	Not Zero	Occupied Bypass
Occupied Bypass	Occupied	Any Number	Occupied
Occupied Bypass	Unoccupied	Zero	Occupied Standby
Occupied Bypass	Unoccupied	Not Zero	Occupied Bypass
Occupied Standby	Any State	Zero	Occupied Standby
Occupied Standby	Any State	Not Zero	Occupied Bypass
Auto	Occupied	Any Number	Occupied

Table 23. Occupancy status (continued)

Occupancy Request	Occupancy Input	Occupied Bypass Timer	Occupancy Status
Auto	Unoccupied	Zero	Unoccupied
Auto	Unoccupied	Not Zero	Occupied Bypass

By understanding and utilizing these occupancy modes and statuses, building managers and operators can effectively manage energy consumption and maintain optimal comfort levels within the building.

Timed Override

Exceptions to the time-of-day scheduling are required when unusual or difficult to schedule events cause a space to become occupied during a scheduled unoccupied period. The Timed Override function provides a mechanism for an occupant to signal the system that the space is actually occupied and override the time-of-day schedule to provide occupied control for some limited time period. It also provides a mechanism to return the system to unoccupied mode when the space is no longer occupied.

There are two methods of requesting or terminating timed override on a Symbio™ 700 control system:

- BAS
  - Timed Override Request value can be set to three discrete values:
    - **Idle [1]**— Controller will not override Unoccupied Mode.
    - **On [2]**— When the value is changed from Idle to On, the controller overrides Unoccupied Mode and the unit operates in Occupied Mode. The Occupied Bypass Timer and the Timed Override Timer is Active is set to ‘Active’. The controller remains in Timed Override for the duration of the Occupied Bypass Time.
    - **Cancel [3]**— When value is changed from On to Cancel, the unit’s unoccupied status is no longer overridden and the Occupied Bypass Timer will be set to 0.
- Zone Sensor Initiate/Terminate buttons – Some zone sensors have a Timed Override Initiate and Terminate buttons.

When Timed Override is initiated by any of the above methods, the controller starts a timer using the user selected Occupied Bypass Time to control the duration of the Timed Override event. The range for Occupied Bypass Time is 0-240 minutes with a default of 120 minutes.

When the unit is operating in Occupied Bypass mode, the Occupied Bypass Timer duration can be extended by initiating a Timed Override Request again. This extends the Occupied Bypass Timer duration by the value of the user selected Occupied Bypass Time.

When Timed Override is terminated by any of the above methods, the controller will exit Occupied Bypass and will again begin to use unoccupied control setpoints.

Unit Stop

The Unit Stop feature allows for immediate shutdown of all devices in the equipment when initiated. When a Unit Stop request is received, the following actions are taken:

- All equipment control binary outputs are de-energized
  - Indoor fan
  - Compressors
  - Condenser fans
  - Unloader solenoids
  - Heat stages
- All equipment control analog outputs are set to their minimum/off command values.
- All communicating devices, such as supply fans, are commanded to their off state.
- All control algorithms are initialized to their normal startup values and held until the stop request is released.

The Unit Stop request can be initiated from the following sources:

- Unit Stop Command (communicated input to Symbio 700)
- Equipment Shutdown Input (Symbio 700 binary input, J18)
- Emergency Override BAS (communicated input to Symbio 700)
- Phase Monitor (Symbio 700 binary input, J6-2)
- External Auto/Stop (Customer Connection Module), soft shutdown

If a Unit Stop is initiated, the source of the Unit Stop can be determined by the Unit Stop Source Point and other status/diagnostic points.

Capacity Limit Control

The Symbio™ 700 provides the following capabilities to lockout or limit heat and cool capacity installed in the equipment. These capabilities interact. Capacity Lockout points have highest priority. When Heat Lockout Command and Cooling Lockout BAS are false (not locked out); the control will limit capacity based on Cooling Capacity Enable and Primary Heat Enable BAS. Last in priority is Demand Limit Request BAS which enables independent limits on cooling and heating capacity. See the following sections for more details of each.

Priority	Cooling Limits	Heating Limits
1	Cooling Lockout BAS	Heat Lockout Command
2	Cooling Capacity Enable	Primary Heat Enable BAS
3	• Demand Limit Request BAS • Demand Limit Input (binary input) • Cooling Demand Limit Capacity Enable Setpoint	• Demand Limit Request BAS • Demand Limit Input (binary input) • Heating Demand Limit Capacity Enable Setpoint

Capacity Lockouts

Capacity Lockout points are available to the building automation to provide a method to override or lockout DX Cooling, Gas Heating and Electric Heating. Cooling Lockout BAS will disable all DX cooling capacity while economizer operation is allowed. Heat Lockout Command disables all forms of installed primary and secondary heating capacity.

Cooling Capacity Enable

Cooling Capacity Enable is a building automation interface point used to limit the DX cooling capacity of the equipment. It will not limit economizer cooling. The 0 to 100 percent value limits the amount of cooling capacity; default is 100 percent. The cooling stages allowed = (Limit % x number of stages), round down to the nearest integer.

Heat Primary Enable

Primary Heat Enable BAS is a building automation interface point used to limit all forms of primary and secondary (gas, electric, compressor) heat installed in the equipment. The 0 to 100 percent value limits the amount of heating capacity, default is 100 percent. Staged heating stages allowed = (Heat Primary Enable x number of stages), round down to the nearest integer.

Demand Limit

When Demand Management is configured for Demand Limit, demand limits can be applied via building management points or the Demand Limit Input (Symbio™ 700 J16-1 and J16-2). The primary purpose of this function is to limit power consumption of heating and cooling capacities installed in the equipment. Demand Limit does not apply to economizer cooling nor hot gas reheat.

If no building management is writing to the Demand Limit Request BAS point, demand limit can be enabled or disabled by the Demand Limit Input (hardware binary input). Otherwise, if Demand Limit Request BAS is being commanded, it will have priority over the hardware binary input. The result of the

arbitration between Demand Limit Request BAS and the Demand Limit Input is reported via Demand Limit Request BAS – Active point.

When Demand Limit Request BAS – Active point is Limit (true), Cooling Demand Limit Capacity Enable Setpoint (0 to 100 percent) and Heating Demand Limit Capacity Enable Setpoint (0 to 100 percent) apply limits to cooling and heating capacity, respectively. The power consumption result will depend on number of heating and cooling stages installed and how each map to the capacity calculation. Cooling Demand Limit Capacity Enable Setpoint limits compressor stages of operation however will not limit economizer cooling. Heating Demand Limit Capacity Enable Setpoint limits the stages of heat pump and electric; however, Heating Demand Limit Capacity Enable will not limit gas heat.
Calculation: Number of heating or cooling stages allowed = (Limit% x number of stages), round down to the nearest integer.

Example: 3-stage Cooling Only unit with 2-stage primary heat.

When Demand Limit Request BAS – Active is Limited and Heating Demand Limit Capacity Enable Setpoint is 60%, 2-stage primary heat installed, limits operation to 1-stage of heat.

(60% x 2) = 1.2, round down to nearest integer = 1.

When Demand Limit Request BAS – Active is Limited and Cooling Demand Limit Capacity Enable Setpoint is 90%, 3-stages cooling installed, limits operation to 2-stages of cooling.

(90% x 3) = 2.7, round down to nearest integer = 2.

Heat Pump Example: 2-stage Heat Pump unit with 2-stage electric heat.

When Demand Limit Request BAS – Active is Limited and Heating Demand Limit Capacity Enable Setpoint is 80%, 2-stages of primary heat and 2-stages of supplemental heat are installed (total of 4 stages). Operation is limited to 2-stages of compressor heat and 1 stage of electric heat. (80% x 4) = 3.2, round down to nearest integer = 3-stages of heat.

Remote Capacity Control

The Symbio™ 700 controls support the Remote Capacity Control function for all system types except VVDA. This function allows a user to directly control the unit capacity rather than allowing the internal algorithm to provide control.

The following features/functions can be requested directly via points, rather than relying on internal temperature or thermostat control sequences:

- Supply Fan Speed
- Cooling Capacity
- Heating Capacity
- Heating Capacity Control Type Override

For Thermostat Controlled equipment, the Thermostat Inputs must be **OPEN** i.e. requesting **OFF** mode before the Cooling or Heating Capacity requests will be honored.

For Space Temperature controlled equipment, the Heat Cool Mode Request must be set to **Fan Only** before the Cooling or Heating Capacity requests will be honored.

For each entity, there is an **Enable** point to enable or disable the remote capacity control, and an analog value point to allow the user to request an analog capacity value. The analog value is translated to the appropriate value per function.

Supply Fan Speed Command overrides will be honored in all non-Heat or Off modes. When Supply Fan Speed Command is enabled, and the Supply Fan Speed Command value is 0 percent, the system will interpret as an **OFF** mode request, and all active capacity will be set to **OFF**; fan, heating, and cooling.

All equipment safeties and limitations will be in-place while the Remote Capacity Control functions are being leveraged:

- Minimum fan speeds as defined per active capacity will be maintained
- Compressor Minimum ON/OFF times will be maintained
- All system diagnostics will be maintained.

Emergency and Ventilation Override

This feature has two options for initiating an override request, either through the optional hardwired Ventilation Override terminals via Customer Connection Module, or by initiating a request through the Emergency Override point. Ventilation Override via the hard-wired binary inputs has priority over Emergency Override.

Ventilation Override

When configured for the Ventilation Override option, applying 24 volts to one of the three Ventilation Override inputs manually activates Ventilation Override. Three inputs are provided on the Customer Option Module supporting Ventilation Override functionality:

- Pressurize mode
- Purge mode
- Exhaust mode

If more than one mode is requested at the same time, the Pressurize request will have priority followed by Purge, and then Exhaust. When Any Ventilation Override mode is active, all heating and cooling is turned off. For the case where the unit is required to turn Off via hardwired interface, the Equipment Shutdown binary input is used.

Emergency Override

All units with Symbio™ 700 support the remote Emergency Override command functionality. Within this point, there are addition enumerations versus the hardware Ventilation Override interface:

- 1 = EMERG_NORMAL
- 2 = EMERG_PRESSURIZE
- 3 = EMERG_DEPRESSURIZE
- 4 = EMERG_PURGE
- 5 = EMERG_SHUTDOWN
- 6 = EMERG_FIRE

Pressurize, Depressurize, and Purge map to their respective Ventilation Override Modes directly. , Emerg_Shutdown and Emerg_Fire are unique to Emergency Override. Both of those are treated as a remote shutdown request for the equipment.

Equipment Operation

Emergency and Ventilation Override requests/actions will take priority over normal equipment timing events, such as compressor minimum ON/OFF/Inter-stage timers.

During an Emergency or Ventilation Override sequence, all temperature control algorithms are initialized to an inactive state until the Emergency or Ventilation Override request is cleared. For each override request, the unit will operate in a pre-determined state until override requests are cleared.

For detailed unit operation during Emergency or Ventilation Override, refer to the Appendix section of this document.

Service Test Mode

Service Test Mode can be used to initiate certain operating modes of the equipment. Refer to the following sections for more details associated with this feature.

Service Test Timeout

Service Test Timeout (Minute) is a user selected time value. Once Service Test Mode has been initiated, and this timer expires, the controls are forced to leave Service Test Mode and return to normal unit operation.

- **Minimum value** - 1 minute
- **Maximum value** - 120 minutes
- **Default value** - 60 minutes

Timer Initiate: When any value for Service Test State Request is chosen other than Inactive, the controller sets the Service Test Timeout to the user selected value and the unit begins to operate as described in the tables below. It continues in operation until the Service Test Timeout Timer reaches 0 **OR** until the user chooses a different Service Test State Request.

Timer Terminate: if the Service Test Timeout timer has reached 0, the controls sets the Service Test Stage Request to Inactive and the unit returns to normal unit operation. If the Service Test Timeout Timer has not reached 0, the user can set the Service Test Stage Request to Inactive to exit the active Service Test State Request and return to normal unit operation.

Timer Reset: if the Service Test Timeout timer has not reached 0, the user can select the Service Test Stage Request to any value other than Inactive. The controller resets the Service Test Timeout Timer to the user selected value and the unit operates as describe in the tables below for the new request.

Leaving Service Test Mode

There are three ways to leave Service Test Mode:

- When the Service Test Timeout timer expires, the unit will leave Service Test Mode.
- Service Test State Request is set to **Inactive**.
- The controller goes through a power cycle or reset.

Service Test Mode — Multi-speed Zone Temperature, VVZT, and VVDA

The table below provides unit operation for each stage of service test depending on the unit configuration. The table describes the service test mode states and expected unit response. For all service test mode operations, **IN CONTROL** refers to Symbio™ 700 algorithms controlling the unit. For instance, in all service test mode states, the condenser fan will be controlled as needed for safe unit operation.

Table 24. Service test mode states — cooling only/heat pump

Service Test	Supply fan On/Off	Supply fan speed (VVZT, CVZT)	Supply fan speed (VVDA)[a]	VAV box relay request (VVDA)	Outdoor air damper position request	Compressor cool vfd request	Compressor cool stage request	Compressor heat stage request	Aux heat stage request[b]	Relief fan On/Off	Reheat pumpout solenoid On/Off request[c]	Reheat valve 1	Heat cool mode effective	Heat cool mode status (VVZT, CVZT)	Heat cool mode status (VVDA)[d]
Inactive	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control
Fan On	ON	Min	Min	Open	Min	0	0	0	0	In Control	OFF	0	Fan Only	Test	Maximum Heat
Fan On Econ Open	ON	Min	Min	Open	100	0	0	0	0	In Control	OFF	0	Cool	Test	Maximum Heat
Ventilation Low Fan Speed	ON	Min	Min	Open	Design Min [e]	0	0	0	0	In Control	OFF	0	Fan Only	Test	Maximum Heat
Ventilation Mid Fan Speed	ON	Effective Mid[f]	Effective Mid[f]	Open	Design Min [e]	0	0	0	0	In Control	OFF	0	Fan Only	Test	Maximum Heat
Ventilation High Fan Speed	ON	100	100	Open	Design Min [e]	0	0	0	0	In Control	OFF	0	Fan Only	Test	Maximum Heat
Cool 1	ON	Min for Capacity	100	Open	Min	Mid[g]	1	0	0	In Control	ON	0	Cool	Test	Maximum Heat
Cool 2	ON	Min for Capacity	100	Open	Min	Mid[g]	2	0	0	In Control	ON	0	Cool	Test	Maximum Heat
Cool 3	ON	Min for Capacity	100	Open	Min	Mid[g]	3	0	0	In Control	ON	0	Cool	Test	Maximum Heat
Cool 4	ON	Min for Capacity	100	Open	Min	Mid[g]	4	0	0	In Control	ON	0	Cool	Test	Maximum Heat
Cool 5	ON	Min for Capacity	100	Open	Min	Mid[g]	5	0	0	In Control	ON	0	Cool	Test	Maximum Heat
Reheat[h]	ON	Min for Capacity	100	Open	Min	Mid[g]	5	0	0	In Control	OFF	50	Cool	Test	Maximum Heat
Heat 1[i]	ON	Min for Capacity[i]	100	Open	Min	0	0	See[k]	See[l]	In Control	See[m]	0	Heat	Test	Maximum Heat
Heat 1[i]	ON	100	100	Open	Min	0	0	See[k]	See[l]	In Control	See[m]	0	Heat	Test	Maximum Heat
Heat 3	ON	100	100	Open	Min	0	0	See[k]	See[l]	In Control	See[m]	0	Heat	Test	Maximum Heat

Table 24. Service test mode states — cooling only/heat pump (continued)

Service Test	Supply fan On/Off	Supply fan speed (VVZT, CVZT)	Supply fan speed (VVDA)[a]	VAV box relay request (VVDA)	Outdoor air damper position request	Compressor cool vfd request	Compressor cool stage request	Compressor heat stage request	Aux heat stage request[b]	Relief fan On/Off	Reheat pumpout solenoid On/Off request[c]	Reheat valve 1	Heat cool mode effective	Heat cool mode status (VVZT, CVZT)	Heat cool mode status (VVDA)[d]
Heat 4	ON	100	100	Open	Min	0	0	See[k]	See[l]	In Control	See[m]	0	Heat	Test	Maximum Heat
Aux Heat 1	ON	Min for Capacity[j]	100	Open	Min	0	0	0	1	In Control	OFF	0	Heat	Test	Maximum Heat
Aux Heat 2	ON	100	100	Open	Min	0	0	0	2	In Control	OFF	0	Heat	Test	Maximum Heat
Defrost[n]	ON	100	100	Open	Min	0	0	4	In Control	In Control	ON	0	Heat	Test	Maximum Heat
Emergency Heat	ON	100	100	Open	Min	0	0	0	4	In Control	OFF	0	Heat	Test	Maximum Heat
Open Reheat Valve[i]	OFF	0	0	Open	0	0	0	0	0	OFF	OFF	70/85[o]	Cool	Test	Maximum Heat
Open Reheat Valve[i]	OFF	0	0	Open	0	0	0	0	0	OFF	OFF	0	Cool	Test	Maximum Heat

(a) For VVDA units, Supply Fan Speed Request shall not be 100 before VAV boxes full open. If VAV box stroke timer has not been expired, set fan speed to Min to avoid high duct static pressure trip.

(b) "Aux heat stage request" shall be mapped to "Gas heat request" if unit with Gas Heat installed, Stage 0 -> 0%, Stage 1 -> Min Fire + 1 Stage, Stage 2(+) -> 100%.

(c) Reheat Pumpout Solenoid On/Off Request shall be ON whenever compressor cool or heat stage request is greater than 0, except during the "Reheat" step.

(d) For VVDA units, Heat Cool Mode Status shall be set to Maximum Heat to coordinate VAV Box Relay, when any service test step activated.

(e) For Outdoor Air Damper Request designed Min/Mid/Max details , refer to the Supply Fan Compensation section of this document.

(f) Supply Fan Speed Request "Effective Mid" equals to (Effective Maximum Fan Speed + Effective Minimum Fan Speed) / 2.

(g) Service Test will send the Max (100%), Mid (50%) or 0 (0%) in RPM to the compressor.
For VSPD configurations the operating envelope will be enforced to maintain compressor operation within the appropriate operating bounds.

(h) This step cannot be started until the VSPD Compressor startup routine has completed.

(i) This step cannot be started until the VSPD Compressor Run Status = OFF.

(j) For Heat 1 and Aux Heat 1 steps, the supply fan speed shall run at min speed due to Staged Gas Heat. The min speed of other heating sources can be 100%.

(k) See Table Compressor heat stage request.

(l) See Table Auxiliary heat stage request.

(m) See Table Reheat pumpout solenoid On/Off request.

(n) Defrost step is supported by the demand defrost. One auxiliary heat stage is to be driven active when the defrost service test step drives the unit into an active demand defrost state. After defrost is completed, the unit will be running in heating mode.

(o) Reheat Valve 1 Request is set to 85 in Open Reheate Valve 1 step, because 85% is the max operating range during normal operation. Reheat Valve 1 Request is set to 70 in Open Reheate Valve 1 step, because 70% is the max operating range during normal operation for Precedent Heat Pump configurations.

Table 25. Compressor heat stage request

Compressor heat stage request	Heat Pump Compressor Stage for 3 Step Cooling Units	Heat Pump Stage for 4 Step Cooling Units
Heat 1	2	3
Heat 2	3	4
Heat 3	3	4
Heat 4	3	4

Table 26. Auxiliary heat stage request

Aux heat stage request	Cooling Only[a]	Cooling Only w/Aux Mod Gas Heat	Aux Gas Heat Stage for 3/4 Step Cooling Units[b]	Aux Electric Heat Stage for 3 Step Cooling Units	Aux Electric Heat Stage for 4 Step Cooling Units
Aux Heat 1	1	Min-Fire[c]	0	0	0
Aux Heat 2	2	Max-Fire[d]	0	0	0
Aux Heat 3	NA	NA	0	1	1
Aux Heat 4	NA	NA	0	2	2

[a] For cooling only units, Aux Heat concept is leveraged from that of Heat Pump units.
[b] For the units with Staged Gas Heat, they are not allowed to run together with Compressor Heating.
[c] All burners at mimimum fire. Modulating gas valve at min-fire, staged gas valve On or low-fire.
[d] All burners at maximum fire. Modulating gas valve at max-fire, staged gas valve at On or high-fire.

Table 27. Reheat pumpout solenoid On/Off request

Reheat pumpout solenoid On/Off request	Cooling Only[a]	Heat Pump
Heat 1	OFF	ON
Heat 2	OFF	ON
Heat 3	NA	ON
Heat 4	NA	ON

[a] For cooling only units, Heat 1 and Heat 2 steps will turn on Aux Heat without compressor operation, so the solenoid shall be OFF.

Troubleshooting

The Symbio™ 700 controller provides system shutdown, operational default operation, and communication error handling of the unit. The list of fault conditions below will stop normal operation or change the operation of the unit to a default condition. Diagnostics are indicated in the Active Alarm menu of the onboard user interface and the Symbio Service and Installation mobile app. The following sections provide diagnostic details valuable to troubleshooting.

Data Logs

Data logs are useful when servicing a unit. Many data logs for all core processes are created by default. The exact number depends on unit configuration. The Symbio Service and Installation App as well as Tracer® TU can be used to view, create, and manage data logs.

Data logs have 50,000 points trending at 10 second intervals, providing five days of data. Data logs can be exported to a USB memory stick via a .CSV format. Select property data, which has been configured for recording data over time, can be viewed graphically. Up to four sets of data can be viewed at one time using the Symbio Service and Installation App by using View Data Logs in the Tools menu.

Unit Stop Source

Symbio™ 700 provides a Unit Stop Source point that is valuable to understanding the source of a unit shutdown or what is preventing normal unit operation. Unit Stop Source is viewable from the local user interface, Symbio 700 Service and Installation App status screen, or Tracer® TU. One of the following values is reported:

- None
- Emergency Stop
- Drain Pan Overflow
- Local HI
- Remote HI
- External Auto Stop
- Phase Monitor
- Emergency Override
- Supply Fan Fault
- Equipment Shutdown Input
- Smoke Detector
- Equipment Limit
- Sensor Failure

Hardware

The following tables provide troubleshooting information for common sensors. The terminal voltage is measured at the Symbio™ 700 input while the sensor is connected.

Table 28. Temperature sensor (10K thermistor type)

Temp (°F)	Temp (°C)	Resistance (ohms)	Terminal Voltage
-10	-23.33	118070	2.30
-8	-22.22	110558	2.29
-6	-21.11	103574	2.28
-4	-20.00	97078	2.27
-2	-18.89	91032	2.25
0	-17.78	85403	2.24

Table 28. Temperature sensor (10K thermistor type) (continued)

Temp (°F)	Temp (°C)	Resistance (ohms)	Terminal Voltage
2	-16.67	80160	2.22
4	-15.56	75272	2.21
6	-14.44	70715	2.19
8	-13.33	66464	2.17
10	-12.22	62496	2.16
12	-11.11	58791	2.14
14	-10.00	55329	2.12
16	-8.89	52094	2.10
18	-7.78	49069	2.08
20	-6.67	46240	2.06
22	-5.56	43592	2.03
24	-4.44	41112	2.01
26	-3.33	38790	1.99
28	-2.22	36613	1.96
30	-1.11	34573	1.94
32	0.00	32659	1.91
34	1.11	30864	1.89
36	2.22	29178	1.86
38	3.33	27596	1.84
40	4.44	26109	1.81
42	5.56	24712	1.78
44	6.67	23398	1.75
46	7.78	22162	1.72
48	8.89	21000	1.69
50	10.00	19905	1.66
52	11.11	18875	1.63
54	12.22	17904	1.60
56	13.33	16989	1.57
58	14.44	16127	1.54
60	15.56	15314	1.51
62	16.67	14547	1.48
64	17.78	13823	1.45
66	18.89	13139	1.42
68	20.00	12494	1.39
70	21.11	11884	1.36
72	22.22	11307	1.33
74	23.33	10762	1.30
76	24.44	10247	1.27
78	25.56	9759	1.23
80	26.67	9298	1.20

Table 28. Temperature sensor (10K thermistor type) (continued)

Temp (°F)	Temp (°C)	Resistance (ohms)	Terminal Voltage
82	27.78	8861	1.17
84	28.89	8448	1.14
86	30.00	8056	1.12
88	31.11	7684	1.09
90	32.22	7332	1.06
92	33.33	6999	1.03
94	34.44	6682	1.00
96	35.56	6382	0.97
98	36.67	6097	0.95
100	37.78	5826	0.92
102	38.89	5569	0.89
104	40.00	5325	0.87
106	41.11	5093	0.84
108	42.22	4872	0.82
110	43.33	4662	0.79
112	44.44	4463	0.77
114	45.56	4273	0.75
116	46.67	4092	0.73
118	47.78	3921	0.70
120	48.89	3757	0.68
122	50.00	3601	0.66
124	51.11	3452	0.64
126	52.22	3311	0.62
128	53.33	3176	0.60

Table 29. Zone sensor - Setpoint input

Temperature (°F)	Resistance (ohms)	Terminal Voltage (V)
50	889.4	0.204
51	869.9	0.200
52	850.5	0.196
53	831.0	0.192
54	811.5	0.188
55	792.0	0.183
56	772.6	0.179
57	753.1	0.175
58	733.6	0.171
59	714.2	0.167
60	694.7	0.162
61	675.2	0.158
62	655.7	0.154

Table 29. Zone sensor - Setpoint input (continued)

Temperature (°F)	Resistance (ohms)	Terminal Voltage (V)
63	636.3	0.150
64	616.8	0.145
65	597.3	0.141
66	577.8	0.137
67	558.4	0.132
68	538.9	0.128
69	519.4	0.123
70	500.0	0.119
71	480.5	0.115
72	461.0	0.110
73	441.5	0.106
74	422.1	0.101
75	402.6	0.097
76	383.1	0.092
77	363.7	0.088
78	344.2	0.083
79	324.7	0.079
80	305.2	0.074
81	285.8	0.069
82	266.3	0.065
83	246.8	0.060
84	227.3	0.056
85	207.9	0.051

Table 30. Zone sensor – Mode input

System Mode	Fan Mode	Resistance (ohms nom.)	Terminal Voltage (V nom.)
Off	Auto	2.32K	0.47
Cool	Auto	4.87K	0.82
Auto	On	7.68K	1.09
Off	On	10.77K	1.30
Cool	On	13.32K	1.43
Auto	On	16.13K	1.54
Heat	Auto	19.48K	1.65
Heat	On	27.93K	1.84
Emergency Heat	Auto	35.0K	1.94
Emergency Heat	On	43.45K	2.03

Table 31. Relative humidity sensor

Relative Humidity	Current (mA)
0%	4
6%	5
13%	6
19%	7
25%	8
31%	9
38%	10
44%	11
50%	12
56%	13
63%	14
69%	15
75%	16
81%	17
88%	18
94%	19
100%	20

Table 32. CO_2 sensor

CO_2 (PPM)	Terminal Voltage (V)
200	1
300	1.5
400	2
500	2.5
600	3
700	3.5
800	4
900	4.5
1000	5
1100	5.5
1200	6
1300	6.5
1400	7
1500	7.5
1600	8
1700	8.5
1800	9
1900	9.5
2000	10

Diagnostic Reset

The following section describes how Diagnostics can be resets.

Power-Up Reset or Exception/Override Mode Transition

At power-up or after the unit exits an override mode, such as Service Test, the controller restarts and clears all diagnostics.

Reset Diagnostic Point

A Diagnostic Reset point is available to reset diagnostics by command a Reset. Diagnostic Reset default state is Normal but writing the Reset value to the point will command the controller to reset all diagnostics. The point value reverts to “Normal” after approximately 5 seconds.

Local User Interface Display

Using the Symbio™ 700 local user interface display, navigate to the Service menu, Diagnostics, then Reset Diagnostic. This operation will cause all diagnostics to reset.

Heat Cool Mode Transition Reset

When the unit is controlled by a zone sensor, a transition from System Mode Switch Local = OFF to System Mode Switch Local = Heat, Cool, Auto, or Emergency Heat triggers a Reset Diagnostic request.

Diagnostics

Table 33. Diagnostic descriptions

	Description
Diagnostics	The actual text displayed on the user interface display, Symbio Service and Installation App or Tracer TU alarm log.
Target	The system or component directly affected by the diagnostic. Either none, partial or total unit functionality is impaired.
Severity	Warnings may or may not affect unit operation. Normal Shutdown will provide an orderly termination of component control. Immediate Shutdown overrides all normal timers, components and outputs off. Components may have different responses based on the unit’s mode of operation.
Persistence	Latching diagnostics require a manual reset at a user interface, commanded reset or cycling power to the controller. See Diagnostic Reset section for all reset options. Non-Latching diagnostics automatically reset and can clear by normal unit operation.
Alarm Indicator Status	Symbio™ 700 supports an Alarm Indicator Status point that, if configured as Installed, drives a relay output on the Customer Connection Module (J10). This point is set to active when a failure occurs that functionally stops a critical component within the unit.
Condition / Response	This describes the conditions the system or component was experiencing at the time the alarm is generated. The response indicates what the unit, system or component will do during the alarm event.

Communication

If 15 seconds passes with no valid communications received from any of the Options modules, the Symbio™ 700 takes the following actions:

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: Unit Communications Failure	Unit	Warning	Non-Latching	YES	Active if any diagnostic listed in this table have a “not communicating” status.
Symbio 700 Onboard I/O	Unit	Immediate Shutdown	Non-Latching	YES	All Symbio 700 controller inputs and outputs are disabled.
Customer Options Module	Partial	Warning	Non-Latching	YES	Functions requiring a Customer Options Module are disabled. If Ventilation Override is inactive during communication loss event, unit will continue operation with component level disables.
	Unit	Immediate Shutdown	Non-Latching	YES	If Ventilation Override is active during communication loss event, unit perform an Immediate Shutdown.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Indoor Options Module	Partial	Warning	Non-Latching	YES	Single Zone VAV operation disables. Electric heat operation disables. Economizer cooling disables.
Fresh Air Options Module	Partial	Warning	Non-Latching	YES	All economizer outdoor air damper and power exhaust operation are disabled.

Sensor and Other Diagnostics

The following diagnostics are generated from sensor values out of range, or the diagnostic is generated by the Symbio™ 700 controller.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: Maintenance Required	None	Warning	Non-Latching	No	The supply fan run hours has exceeded Filter Runtime Hours Setpoint. To reset the diagnostic, set Filter Timer Reset. To disable this diagnostic, set Filter Runtime Hours Setpoint to zero.
Space Temperature Active	Unit	Immediate Shutdown	Non-Latching	YES	CVZT and VVZT space temperature control units will perform an immediate shutdown.
	Component	Warning	Non-Latching	No	VVDA (mulit-zone VAV) control units will disable the following modes of operation. Dehumidification Pre Cool Morning Warmup Daytime Warmup
Outdoor Air Temperature Active	Unit	Warning	Non-Latching	YES	Heat pump Demand Defrost disables, time based outdoor coil defrost will be utilized. Heat Pump Heating Lockout disables.
	Damper	Warning	Non-Latching	YES	Economizer cooling disabled. See Economizer failure modes and system response table.
	Reheat	Warning	Non-Latching	YES	Disable hot gas reheat.
Discharge Air Temperature Local	Component	Warning	Non-Latching	YES	Wired discharge air temperature input is out of range. The following capabilities are disabled: Dehumidification with hot gas reheat Modulating gas heat Single zone vav Economizer cooling Enhanced thermostat control Variable speed compressor
Outdoor Air Humidity Active	Damper	Warning	Non-Latching	YES	Comparative Enthalpy disables, Reference enthalpy disables, control reverts to dry bulb control. See Economizer failure modes and system response table.
Space Humidity Active	Dehumidification	Warning	Non-Latching	No	Dew Point and Space Relative Humidity dehumidification control disables.
Return Air Humidity Active	Damper	Warning	Non-Latching	No	Return air humidity greater than 90%, return air enthalpy calculations with be based on 90% return air humidity. Return air humidity less than 10%, return air enthalpy calculations with be based on 10% return air humidity. See Economizer failure modes and system response table.
Return Air Temperature Input	Damper	Warning	Non-Latching	No	Comparative Enthalpy disables, Reference enthalpy disables, control reverts to dry bulb control. See Economizer failure modes and system response table.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Space CO_2 Concentration Active	Damper	Warning	Non-Latching	No	Demand controlled ventilation disables. Control will revert to supply compensation, if enabled, or the outdoor air damper will revert to Economizer Minimum Position Setpoint.
Phase Monitor Status	Unit	Immediate Shutdown	Latching	YES	Phase Monitor binary input is in an active state.
Diagnostic: High Condensate Level Detected	None	Normal Shutdown	Non-Latching	No	Condensate overflow binary input is closed. If the condensate overflow input opens, the diagnostic will reset.
Diagnostic: Morning Warmup Mode Exceeded 120 Minutes	Heat	Warning	Non-Latching	No	Space conditions have not been satisfied to exit morning warmup mode for more than 120 minutes.
Diagnostic: Pre Cool Mode Exceeded 120 Minutes	Cool	Warning	Non-Latching	No	Space conditions have not been satisfied to exit pre cool mode for more than 120 minutes.
Diagnostic: Night Purge Mode Exceeded 120 Minutes	Cool	Warning	Non-Latching	No	Space conditions have not been satisfied to exit night purge mode for more than 120 minutes.
Diagnostic: Condensate Overflow Lockout	Unit	Immediate Shutdown	Latching	YES	Condensate Overflow Trip occurred three times within 72 hours. Inspect condensate pan and drain.
Diagnostic: Filter Change Required	None	Immediate Shutdown	Non-Latching	No	Clogged Filter Input (BI) is Closed for two continuous minutes while the Supply Fan is On.
Coil Temperature Sensor 1	None	Warning	Non-Latching	No	Heat pump units with a coil temperature sensor out of range. Symbio 700 P16-1. Demand defrost is disabled. Operation will revert to a time based defrost cycle.
Supply Fan Entering Air Temperature	Heat	Warning	Non-Latching	No	Precedent units, modulating gas heat disables.
Supply Air Smoke Detector	Unit	Immediate Shutdown	Non-Latching	YES	Indoor Options Module supply air smoke detector binary input (P1-2) is active.
Return Air Smoke Detector	Unit	Immediate Shutdown	Non-Latching	YES	Fresh Air Options Module return air smoke detector binary input (P1-2) is active.
Diagnostic: Outdoor Air Temperature Local	Component	Warning	Non-Latching	YES	Precedent 3 to 5 ton heat pump, high efficiency, units. Loss of Outdoor Air Temperature Local disables an additional compressor protection function to detect loss of charge, outdoor fan failure or outdoor coil blockage.
Diagnostic: Duct Static Pressure Local Trip	Unit	Warning	Non-Latching	No	Duct static pressure input has gone out of range. Inspect tubing, replace sensor as required.
Diagnostic: Duct Static Pressure Local Lockout	Unit	Immediate Shutdown	Latching	YES	Duct static pressure input has failed three times with one hour. Inspect tubing to the sensor, replace sensor as required.
Diagnostic: Duct Static Pressure Limit Trip	Unit	Immediate Shutdown	Non-Latching	No	Duct static pressure exceeded the Duct Air Static Pressure High Limit Setpoint. The unit will shutdown for 3 minutes before being allowing to restart.
Diagnostic: Duct Static Pressure Limit Lockout	Unit	Immediate Shutdown	Latching	YES	The supply air pressure has exceeded the Duct Static Pressure High Limit Setpoint for the 3rd consecutive time without the supply fan running for 3 continuous minutes.

Refrigerant Detection System

Equipment with R–454B refrigerant may require a refrigerant detection system based on the refrigerant charge. The refrigerant detection system consists of a refrigerant detection sensor that communicates the following diagnostics to the Symbio™ 700 controller via Modbus.

Diagnostic	Target	Severity	Persistence	Alarm Output	Condition / Response
Diagnostic: Refrigerant Concentration	Compressor	Immediate Shutdown	Non-Latching	YES	Refrigerant detection sensor detected a concentration above a limit, the following mitigation actions are taken for 5 minutes after the refrigerant sensor resets. Compressor operation disabled, supply fan operation at or above minimum speed, ventilation enabled, economizer cooling and non-compressor heating allowed.
Diagnostic: Refrigerant Sensor Failure	Compressor	Immediate Shutdown	Non-Latching	YES	Refrigerant detection sensor detected a failure, the following mitigation actions are taken until the refrigerant sensors is replaced or the failure is resolved. Compressor operation disabled, supply fan operation at or above minimum speed, ventilation enabled, economizer cooling and non-compressor heating allowed.
Refrigerant Detection System Communication Status	Compressor	Immediate Shutdown	Non-Latching	YES	Modbus communication has been lost with the refrigerant detection sensor, check wiring, ensure the sensor is receiving power, replace sensor as required. Compressor operation disabled, supply fan operation at or above minimum speed, ventilation enabled, economizer cooling and non-compressor heating allowed.

The refrigerant detection sensor has a green and red LED to indicate operating status as described in the following table.

Operating status	Green LED	Red LED	Symbio 700 Response
No power to the sensor or sensor failure.	OFF	OFF	Refrigerant Detection System Communication Status = 2, Not Communicating. Refrigerant Mitigation Active point in active state.
Power up initiate	ON	OFF	None
Power-up self-test failure	ON	ON	Diagnostic: Refrigerant Sensor Failure active. Refrigerant Mitigation Active point in active state.
Warm up delay	ON	OFF	None
Normal runtime mode	Heartbeat	OFF	None
LFL (Lower Flammability Limit) alarm, refrigerant concentration detected above setpoint limit.	OFF	ON	Diagnostic: Refrigerant Concentration active state. Refrigerant Mitigation Active point in active state.
Failure resulting in loss of function, sensor may need to be replaced.	OFF	Blinking	Diagnostic: Refrigerant Sensor Failure active state. Refrigerant Mitigation Active point in active state.
Sensor near end of life	Blinking	Heartbeat	None
Warning sensor is operating outside of its expected/ normal range due to excessive temperature or humidity. Sensor is not damaged and should return to a normal operating state when under normal conditions.	ON	Heartbeat	None

Supply Fan EBM-Papst drive

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: ERM Fault Supply Fan - 1	Unit	Immediate Shutdown	Non-Latching	YES	Supply fan drive 1 is reporting a fault condition causing a unit shutdown. Check CON2 connector, the alarm output contact between NC and COM, continuity check. Output contacts closed indicates no fault. Output contacts open indicates a fault condition.
Diagnostic: ERM Fault Supply Fan - 2	Unit	Immediate Shutdown	Non-Latching	YES	Supply fan drive 2 is reporting a fault condition causing a unit shutdown. Check CON2 connector, the alarm output contact between NC and COM, continuity check. Output contacts closed indicates no fault. Output contacts open indicates a fault condition.
Diagnostic: Supply Fan Proving Failure	Unit	Immediate Shutdown	Latching	YES	3-to-5 ton standard efficiency and 3 high efficiency. Symbio 700, supply fan binary input (P20-2) not proving supply fan operation for 40 seconds.
Diagnostic: ERM Supply Fan 1 Failure Diagnostic: ERM Supply Fan 2 Failure	Unit	Immediate Shutdown	Latching	YES	Supply fan 1/2 requested to run, supply fan drive speed is less than 30 RPM for 40 seconds.
Diagnostic: ERM Supply Fan Locked Motor – 1 Diagnostic: ERM Supply Fan Locked Motor – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a blocked motor condition. Drive will automatically restart after blockage is cleared. EBM Papst LED pulses: 8
Diagnostic: ERM Supply Fan Motor Overheated – 1 Diagnostic: ERM Supply Fan Motor Overheated – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a motor overheated condition. Drive power cycle required. EBM Papst LED pulses: 6
Diagnostic: ERM Supply Fan Power Mod Overheated – 1 Diagnostic: ERM Supply Fan Power Mod Overheated – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a rectifier thermocouple overheated condition. Drive power cycle required. EBM Papst LED pulses: 3
Diagnostic: ERM Supply Fan Phase Failure – 1 Diagnostic: ERM Supply Fan Phase Failure – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a phase failure condition. Drive will automatically restart after phase condition is corrected. Check mains voltage at each phase on the CON1 connector. Phases should be similar. Make sure voltage is within the acceptable range as listed on the motor nameplate. EBM Papst LED pulses: 1
Diagnostic: ERM Supply Fan Internal Comm Failure – 1 Diagnostic: ERM Supply Fan Internal Comm Failure – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting an internal communication failure between controllers. Check drive initiator-responder analog setpoint wiring. EBM Papst LED pulses: 4
Diagnostic: ERM Supply Fan Hall Sensor Error -1Diagnostic: ERM Supply Fan Hall Sensor Error - 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a hall sensor error condition. Drive will require a manual reset. EBM Papst LED pulses: 7
Diagnostic: ERM Supply Fan Speed Limit Exceeded – 1 Diagnostic: ERM Supply Fan Speed Limit Exceeded – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a speed has exceeded the maximum programmed speed. Drive will automatically restart. EBM Papst LED pulses: 9
Diagnostic: ERM Supply Fan Rotor Calibration – 1 Diagnostic: ERM Supply Fan Rotor Calibration – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a rotor position sensor calibration error. Drive will require a manual reset. EBM Papst LED pulses: 11
Diagnostic: ERM Supply Fan DC link Undervoltage – 1 Diagnostic: ERM Supply Fan DC link Undervoltage – 2	Unit	Immediate Shutdown	Non-Latching	YES	Modbus controlled supply fan 1/2 drive reporting a DC link undervoltage condition. Drive will automatically restart after undervoltage is cleared. Check CON2 connector “Vout” to GND, if motor is energized but there is no 10VDC output present, the motor is damaged. EBM LED pulses: 13

Compressor

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: FroStat Trip	Circuit	Immediate Shutdown	Non-Latching	No	Compressor circuit operating in the cooling mode when the FroStat input became active (closed). Supply fan continues to operate until the FroStat input is inactive (open).
Diagnostic: Comp 1 Proving Trip Diagnostic: Comp 2 Proving Trip	Circuit	Immediate Shutdown	Non-Latching	No	When a compressor output is commanded ON and it has been running for more than 5 seconds, if the associated proving input opens. Circuit is disabled for 15 minutes. ***Note:*** *Diagnostic: Compressor X Proving Trip is an indication of a HPC (high pressure cutout) or DTL (discharge temperature limit) opening the compressor contactor circuit.*
Diagnostic: Compressor 1 Proving Lockout Diagnostic: Compressor 2 Proving Lockout	Circuit	Immediate Shutdown	Latching	YES	Two scenarios can cause this diagnostic to be active: Scenario 1: If a refrigeration circuit accumulates 4 consecutive Diagnostic: Comp X Proving Trips during the same compressor call for heating or cooling, a Diagnostic: Compressor X Proving Lockout is generated. Note: If the call for the compressor operation terminates, the counter is set to zero. Scenario 2: If a compressor associated proving input does not CLOSE within 5 seconds of the compressor startup.
Diagnostic: Circuit 1 LPC Trip	Circuit	Immediate Shutdown	Non-Latching	No	Low pressure cutout binary input is open, circuit is disabled for 3 minutes.
Diagnostic: Circuit 1 LPC Lockout	Circuit	Immediate Shutdown	Latching	YES	If four LPC trip events occur within 3 minutes (R-410A) or 10 minutes (R-454B) of initial circuit operation. Requires a manual reset.
Diagnostic: Compressor 1 Contactor Failure Diagnostic: Compressor 2 Contactor Failure	Circuit	Immediate Shutdown	Latching	YES	If a compressor proving input becomes Active for 5 continuous seconds when the associated compressor output is Inactive.
Diagnostic: Reheat Valve 1 Fault	Compressor	Immediate Shutdown	Latching	YES	Hot gas reheat valve 1 motor fault associated with undervoltage, overcurrent, for thermal shutdown. All compressor operation is disabled.
Diagnostic: Low Saturated Suction Refrig Protection (Precedent 3-5T High Efficiency Heat Pump)	Compressor	Warning	Latching	YES	Temperature difference between Outdoor Air Temperature Local and Coil Temperature 1. Possible causes: outdoor fan failure, loss of refrigerant charge, outdoor coil blockage. Control will revert to Secondary heat when installed.
Diagnostic: Low Saturated Suction Protection Disabled (Precedent 3-5T High Efficiency Heat Pump)	Compressor	Warning	Non-Latching	YES	Low Suction Refrigerant Protection is disabled due to a sensor failure. Possible causes: Outdoor Air Temperature Local sensor is in a failed state or Coil Temperature 1 sensor is in a failed state.

Compressor Diagnostic Descriptions

Diagnostic: Compressor X Proving Trip

When a compressor output is commanded ON and it has been running for more than 5 seconds, if the associated proving input opens:

- Diagnostic: Comp X Proving Trip is active.
- Command the associated compressor output OFF immediately.
- Command any compressor output OFF that is on the same refrigeration circuit as the compressor which had the proving input trip.
- The Circuit is disabled for 15 minutes.

After a 15-minute compressor proving timeout has expired and Diagnostic: Compressor 1 Proving Lockout is not active:

- Diagnostic: Comp X Proving Trip diagnostic is reset.
- If the cooling stage is still requested ON, the circuit is allowed to stage again.

Diagnostic: Compressor X Proving Lockout

There are two cases that can cause a Diagnostic: Compressor X Proving Lockout:

- If a refrigeration circuit accumulates 4 consecutive Diagnostic: Comp X Proving Trips during the same compressor operating cycle, a Diagnostic: Compressor X Proving Lockout is generated.

  Note: *If the call for the compressor operation terminates, the counter is set to zero.*

- A compressor proving input does not close within 5 seconds of the compressor output commanded On.

If a Diagnostic: Compressor X Proving Lockout is active the following will occur:

- All compressors on the associated circuit are shut down immediately and locked out, a diagnostic reset action is required to clear the diagnostic.
- “Diagnostic: Compressor X Proving Lockout” diagnostic point is active.
- The alarm output is active.

Diagnostic: Compressor X Contactor Failure

If a compressor proving input becomes active for 5 continuous seconds when the associated compressor command output is commanded Off, Diagnostic: Compressor X Contactor Failure is active:

- All compressors on the associated circuit are de-energized immediately and they are locked out until a Reset Diagnostic is initiated.
- The Compressor X Contactor Failure diagnostic point is active
- The alarm output is active.

Diagnostics – Low Pressure Cutout

The following operation is enforced based on the state of the circuit LPC input:

Prior to Compressor Startup: If a compressor output is Off and compressor circuit LPC input is open, compressor operation is not inhibited, and the Diagnostic: Circuit X LPC Trip point is not active.

After Compressor Startup:

An LPC Bypass Delay function delays low-pressure cutout after compressor startup until a pre-determined amount of time passes in low ambient conditions. The length of the delay is determined based on ambient temperature:

- If the Outdoor Air Temperature Active is less than 40°F, the LPC Bypass Delay is set to 60 seconds.
- If the Outdoor Air Temperature Active is between 40°F and 50°F, the LPC Bypass Delay is set to 30 seconds.
- If the Outdoor Air Temperature Active is greater than 50°F, the LPC Bypass Delay is 0 seconds.

Diagnostic: Circuit X LPC Trip

- All compressor outputs on the effected circuit are commanded OFF.
- The Diagnostic: Circuit X LPC Trip point is active.
- The circuit is disabled for 3 minutes.
- The circuit LPC trip counter is incremented.

After the 3-minute circuit disable has expired, if the unit is not under a lockout event:

- The Diagnostic: Circuit X LPC Trip point is reset.
- If the compressor stage is still requested ON, the circuit is allowed to stage again.

LPC Trip Count reset:

- R–410A units, if the Circuit runs for 3 minutes without a low-pressure trip, its LPC Trip Count is reset to 0.
- R–454B units, If the circuit runs for 10 minutes without low pressure, the LPC timer resets to 0.

Heat pumps, if the Outdoor Air Temperature is less than 0°F or if the unit is in active defrost, the low-pressure cutout input state is ignored.

Diagnostic: Circuit X LPC Lockout

If a circuit LPC trip counter accumulates 4 low pressure events without the circuit running for the 3-minute or 10-minute reset time (counter is not reset), Diagnostic: Circuit X LPC Lockout is active.

- All compressors on the associated circuit are de-energized immediately and they are locked out until a Reset Diagnostic is initiated.
- Diagnostic: Circuit X LPC Lockout point is active.
- The alarm output is active.

Diagnostic: Low Suction Refrig Protection

An additional low suction protection is provided for 3 to 5 ton, high efficiency, heat pump units. The Symbio 700 utilizes the Outdoor Air Temperature Local and Coil Temperature 1 temperatures to determine if there is a potential low refrigerant charge, an outdoor fan failure, or an outdoor coil blockage. Diagnostic: Low Suction Refrig Protection is active when the temperature difference has exceeded a threshold.

Diagnostic: Low Suction Protection Disabled

An additional low suction refrigerant protection is provided for 3 to 5 ton, high efficiency, heat pump units. If the Outdoor Air Temperature Local or Coil Temperature 1 sensor is in an alarm state, the low suction refrigerant protection disables. Diagnostic: Low Suction Protection Disabled is active.

Demand Defrost

Demand Defrost Fault conditions will only be cleared when defrost mode is terminated by switching the mode to Emergency Heat or cycling power to the unit. All timers associated with Demand Defrost will be cleared and once the unit mode allows mechanical heating again, the unit will start up as normal and will begin defrost again as necessary.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: Demand Defrost Disabled	Circuit	Warning	Non-Latching	No	If any demand defrost fault in this table is active, Diagnostic: Demand Defrost Disabled is active, Demand Defrost is disabled and control will revert to time based defrost.
Diagnostic: Demand Defrost Fault A	Circuit	Warning	Non-Latching	No	Outdoor Air Temperature versus Outdoor Coil Temperature, at a minimum temperature than the Demand Defrost Initiate Delta Temperature 12 minutes after defrost is terminated. Defrost will be initiated. Diagnostic: Demand Defrost Disabled is active.
Diagnostic: Demand Defrost Fault B	Circuit	Warning	Non-Latching	No	Fault B is active if defrost is terminated by maximum allowed defrost time rather than normal termination with the condenser coil reaching termination temperature. Demand Defrost Fault B counter is incremented. If counter reaches 10, Diagnostic: Demand Defrost Disabled will be set active. Defrost will be initiated. Diagnostic: Demand Defrost Disabled is active.
Diagnostic: Demand Defrost Fault C	Circuit	Warning	Non-Latching	No	Outdoor Air Temperature versus Outdoor Coil Temperature, at a maximum temperature than the Demand Defrost Initiate Delta Temperature 12 minutes after defrost is terminated. Defrost will be initiated. Diagnostic: Demand Defrost Disabled is active.
Diagnostic: Demand Defrost Fault D	Circuit	Warning	Non-Latching	No	Defrost will be initiated. Diagnostic: Demand Defrost Disabled is active.

Compressor – Variable Speed

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: Diagnostic: VFD Cprsr Current Overload – Cprsr1	Compressor	Immediate Shutdown	Non-latching	YES	The inverter peak current of approximately 120% of rated current was exceeded for 1.5 seconds. All compressor function will be shutdown. Variable speed drive will try to reset these diagnostics in 1 minute, there will be max 11 tries.
Diagnostic: VFD Compressor Ground Fault – Cprsr1	Compressor	Immediate Shutdown	Non-latching	YES	An earth ground fault has resulted in a discharge from the output phases to ground, either in the cable between the adjustable frequency drive and the motor or in the motor itself. Further compressor operation is not recommended until measurements to ground can be taken from the motor leads and the ground fault removed. Variable speed drive will try to reset these diagnostics in 1 minute, there will be max 11 tries.
Diagnostic: VFD Compressor Short Circuit – Cprsr1	Compressor	Immediate Shutdown	Non-latching	YES	A short circuit in the motor windings or the motor terminals was detected. Compressor operation is not recommended until the short circuit is removed. Variable speed drive will try to reset these diagnostics in 1 minute, there will be max 11 tries.
Diagnostic: VFD Compressor In Hand Mode – Cprsr1	Compressor	Immediate Shutdown	Non-latching	YES	The drive has been put into hand mode at the drive interface. This will cause issues for normal sequences and operation. All compressor functions will be shut down, including condenser fans. The Supply Fan will be allowed to operate normally.
Diagnostic: VFD Compressor Fault – Cprsr1	Compressor	Immediate Shutdown	Non-latching	YES	Becomes active any time a drive fault is active (including faults listed above). All compressor functions will be shut down, including condenser fans. The Supply Fan will be allowed to operate normally.
Compressor 1 VFD Communication Status	Compressor	Immediate Shutdown	Non-latching	YES	Continual loss of communication between the Symbio 700 and the VFD has occurred for a 30 second period. All compressor functions will be shut down, including condenser fans. The Supply Fan will be allowed to operate as normal. 1 = Not Configured 2 = Not Communicating 3 = Communicating 4 = Communicating - Not Configured

Outdoor Air Damper

Symbio™ 700 provides Economizer fault detection and diagnostics which can impact or alter the controller's ability to provide economizer cooling.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition/Response
FDD: Excessive Outdoor Air	Economizer cooling	Warning	Non-Latching	YES	Economizer cooling disabled (Economizer Airside Status = Inactive), and outdoor air damper command is less than the outdoor air damper position feedback – 10% for five minutes. Economizer operation is disabled.
FDD: Outdoor Air Damper Not Modulating	Economizer cooling	Warning	Non-Latching	YES	Economizer cooling disabled (Economizer Airside Status = Inactive), and outdoor air damper command is less than the outdoor air damper position feedback + 10% for five minutes. Economizer operation is disabled.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition/Response
FDD: Unit Economizing When It Should Be	Economizer cooling	Warning	Non-Latching	YES	Economizer cooling enabled (Economizer Airside Status = Active), and outdoor air damper command is less than the outdoor air damper position feedback – 10% for five minutes. Economizer operation is disabled.
FDD: Unit Not Economizing When It Should	Economizer cooling	Warning	Non-Latching	YES	Economizer cooling enabled (Economizer Airside Status = Active), and outdoor air damper command is less than the outdoor air damper position feedback + 10% for five minutes. Economizer operation is disabled.

Table 34. Economizer failure modes and system response

Economizer Control	Failure Mode	Economizer Cooling Response
Comparative Enthalpy	Return Air Humidity Sensor	- Absolute (Reference) Enthalpy
	Return Air Temperature Sensor	- Absolute (Reference) Enthalpy
	Outdoor Air Temperature Sensor	- Economizer Cooling Disabled- OA Damper Closes to Economizer Minimum Position Setpoint Active
	Outdoor Air Humidity Sensor	- Absolute Temperature (Reference Dry Bulb)
Reference Enthalpy	Outdoor Air Temperature Sensor	- Economizer Cooling Disabled- OA Damper Closes to Economizer Minimum Position Setpoint Active
	Outdoor Air Humidity Sensor	- Absolute Temperature (Reference Dry Bulb)
Reference Dry Bulb	Outdoor Air Temperature Sensor	- Economizer Cooling Disabled- OA Damper Closes to Economizer Minimum Position Setpoint Active
Differential Dry Bulb	Outdoor Air Temperature Sensor	- Economizer Cooling Disabled- OA Damper Closes to Economizer Minimum Position Setpoint Active
	Return Air Temperature Sensor	- Absolute Temperature (Reference Dry Bulb)
Fresh Air Options Module	Communications Failure	All economizing operation is discontinued

Staged Gas Heat

The following diagnostics are available through direct data monitoring from the Modbus controlled gas heat ignition module or through data monitoring.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: Heat Failure	Heat	Immediate Shutdown	Non-Latching	Yes	Active when any gas heat lockout condition exists, communication to the ignition module is lost, or “IGN1 Hardware Configuration Error” is active.
Diagnostic: IGN1 Module Lockout	Heat	Immediate Shutdown	Non-Latching	No	Call for heat is removed to the gas heat ignition controller. This diagnostic is active when a gas heat ignition module lockout condition exists following a ‘retries exceeded’ startup sequence or ‘recycles exceeded’ gas heat restart sequence. Retries occur during initial call for heat. Three retries and are limited to three when the retry is accompanied with detection of gas valve low (Off) when it should be On. Recycles occur during attempts to re-establish active calls for heat are limited to nine when the recycle is accompanied with the with detection of gas valve low (Off) when it should be On. Ignition controller LED: 2 flashes
Diagnostic: IGN1 Heating High Temp Limit Open	Heat	Immediate Shutdown	Non-Latching	No	Ignition controller High Limit switch protection device open. If high limit switch is open upon a call for first stage of heat, the inducer is energized on low speed. If high limit switch is open upon a call for second stage of heat, the inducer is energized on high speed. Ignition controller LED: 4 flashes

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: IGN1 Flame Rollout Switch Open	Heat	Immediate Shutdown	Non-Latching	No	Spark igniter and gas valve de-energize. Inducer will be energized on low speed if first stage heat call is present and high speed if second stage heat call is present. Rollout switch requires a manual reset. Diagnostic resets after rollout switch resets or call for gas heat is removed. Ignition controller LED: 6 flashes
Diagnostic: IGN1 Inducer Proving Switch Fail Closed	Heat	Immediate Shutdown	Non-Latching	No	If the inducer pressure switch is closed within the 8 seconds upon a call for heat, the ignition controller will not energize the inducer and will wait for the pressure switch to open before proceeding. Ignition controller LED: 3 flashes
Diagnostic: IGN1 Inducer Proving Switch Fail Open	Heat	Immediate Shutdown	Non-Latching	No	The pressure switch should be detected closed within 2 seconds after the inducer is energized. If the pressure switch is detected open 2 seconds after the inducer is energized, the control will display a 3-flash diagnostic code and will wait for the pressure switch to close before proceeding. The inducer pressure switch opens for 0.5 seconds during 40 second inter-purge time with a call for heat, the ignition controller will hold the inter-purge time, energize the inducer on high speed, and wait for the inducer pressure switch to close. If the inducer pressure switch opens for 0.5 seconds any time after pre-purge, the gas valve will immediately de-energize, the inducer will be on high speed. Ignition controller LED: 3 flashes
Diagnostic: IGN1 No Flame Sensed on Ignition	Heat	Immediate Shutdown	Non-Latching	No	Ignition failed to sense flame. Gas heat ignition module will retry initial calls for heat or recycle active calls for heat. When retries/recycles are accompanied with detection of gas valve low (Off) when it should be On… retries are limited to three and recycles are limited to nine before the controller enters the active ‘Diagnostic: IGN1 Module Lockout’ state. Possible cause: Low stage gas valve did not open due to faulty gas valve relay. Pressure switch did not close during 40 second inter-purge time. Ignition controller LED: 2-flashes after three consecutive failed ignition attempts.
Diagnostic: IGN1 Flame Sensed w/Gas Valve Off	Heat	Immediate Shutdown	Non-Latching	No	Flame sensed while gas valve output not energized, or flame sensed with no call for heat. The inducer fan will be energized on high speed. Ignition controller LED: 5 flashes
Diagnostic: IGN1 Hardware Configuration Error	Heat	Warning	Non-Latching	No	Not supported, reserved for future use.
Diagnostic: IGN1 Weak Flame	Heat	Warning	Non-Latching	No	If a weak flame condition, the ignition controller continues to serve call for heat. Ignition controller LED: 7 flashes
Diagnostic: IGN1 Gas Valve Error	Heat	Immediate Shutdown	Non-Latching	No	Gas valve is detected On when gas valve should be Off. Inducer fan energized to high speed. If call for heat is removed, inducer maintains at high speed for post-purge time. Potential cause: Gas valve mis wired. Ignition controller LED: 9 flashes
Diagnostic: IGN1 Module Failure	Heat	Immediate Shutdown	Non-Latching	No	Gas heat ignition module reported an internal error via Modbus. Ignition controller LED: 8 flashes
Diagnostic: IGN1 Low Ambient Lockout (Low NOx Staged Gas Heat only)	Heat	Normal Shutdown	Non-Latching	No	Ignition controller low ambient lockout input is active (~32°F). Symbio 700 will disable gas heat until the low ambient lockout input reports inactive and revert to primary heat, if available. Ignition controller LED: 10 flashes
Gas Heat Ignition Module 1 Communication Status	Heat	Warning	Non-Latching	No	Gas heat operation on ignition module 1 disabled. Check Modbus wiring. Check gas heat ignition module for fault codes. Ignition controller LED: 1 flash

Table 35. White-Rogers staged ignition controller LED indicator codes

LED State	Description
Steady OFF	No Power/Failure/ Internal Failure:
Steady ON	Normal
Slow Flash Rate	Normal, call for heat (¾ second on, ¼ second off)
Fast Flash Rate	Used for error indication (¼ second off, ¼ second on), see Error Code Table.

Table 36. Fast flash rate – error code

Error Code	Error Description
1 Flash	Modbus not communicating
2 Flashes	System Lockout: Failed to detect or sustain flame.
3 Flashes	Pressure switch problem detected.
4 Flashes	High Limit switch protection device open.
5 Flashes	Flame sensed while gas valve not energized, or flame sensed and no call for heat.
6 Flashes	Flame Rollout Switch open.
7 Flashes	Weak Flame
8 Flashes	Internal Error
9 Flashes	Gas valve detected On when gas valve should be Off.
10 Flashes	Low NOx gas heat temperature limit lockout.

Modulating Gas Heat

The following diagnostics are available through direct data monitoring from the Modbus controlled gas heat ignition module (VB1285) or through data monitoring.

Diagnostic	Target	Severity	Persistence	Alarm Output	Condition / Response
Diagnostic: Gas Heat Lockout Manifold 1	Heat	Immediate Shutdown	Non-Latching	YES	Call for heat is removed to the VB1285 ignition controller. This diagnostic is active anytime a gas heat ignition module lockout condition exists (if the diagnostic is or is not listed in this table).
Diagnostic: Gas Heat Unexpected Flame Manif 1 Burner 1	Heat	Immediate Shutdown	Non-Latching	YES	Call for heat is removed to the VB1285 ignition controller and supply fan operation stays On continuous. Unexpected flame on manifold 1, burner 1. VB1285 ignition controller lockout duration will remain in effect for 10 to 300 seconds after error condition is cleared or the power is cycled. VB1287 LED Display [E08] Possible causes: Gas valve may be stuck open or malfunctioning. Flame rod maybe malfunctioning.
Diagnostic: Gas Heat Unexpected Flame Manif 1 Burner 2	Heat	Immediate Shutdown	Non-Latching	YES	Call for heat is removed to the VB1285 ignition controller and supply fan operation stays On continuous. Unexpected flame on manifold 1, burner 2. VB1285 ignition controller lockout duration will remain in effect for 10 to 300 seconds after error condition is cleared or the power is cycled. VB1287 LED Display [E18] Possible causes: Gas valve may be stuck open or malfunctioning. Flame rod maybe malfunctioning.
Diagnostic: Modulating Gas Invalid ID Plug Manifold 1	Heat	Immediate Shutdown	Non-Latching	No	Call for heat is removed to the VB1285 ignition controller. VB1285 ignition controller ID Plug contains invalid data. Possible cause: Corrupt ID Plug. Plug not connected properly.

Diagnostic	Target	Severity	Persistence	Alarm Output	Condition / Response
Diagnostic: Modulating Gas Heat Configuration Invalid	Heat	Immediate Shutdown	Non-Latching	No	The Symbio 700 configuration does not match the VB1285 ignition controller ID Plug heat configuration. All burners on the manifold are unavailable until the condition is corrected. Diagnostic also occurs when communication fails to the gas heat ignition module; Symbio 700 is unable to read the ignition module ID Plug heat configuration. VB1285 ignition controller functioning properly. LED Display [normal activity] Possible causes: Wrong ID Plug installed on VB1287 ignition controller. Symbio 700 mis-configured.
Diagnostic: Gas Heat Weak Flame Manif 1 Burner 1	Heat	Warning	Non-Latching	No	The Symbio 700 will continue call for heat. VB1285 ignition controller has detected a weak flame on manifold 1, burner 1. LED Display [A05] This diagnostic is an indication that the signal from the flame sensor is weak. Possible causes: Dirty flame rod. Improper flame rod installation/position. Improper gas valve pressure.
Diagnostic: Gas Heat Weak Flame Manif 1 Burner 2	Heat	Warning	Non-Latching	No	The Symbio 700 will continue call for heat. VB1285 ignition controller has detected a weak flame on manifold 1, burner 2. This diagnostic is an indication that the signal from the flame sensor is weak. LED Display [A15] Possible causes: Dirty or weak flame rod. Improper flame rod installation/position. Improper gas valve pressure.
Diagnostic: Gas Heat Insufficient Combustion Air	Heat	Warning	Non-Latching	No	The Symbio 700 will continue call for heat. VB1285 ignition controller has detected insufficient combustion air and will reduce heat capacity while the condition exists. LED Display [A03] Possible causes: Blocked vent, high vent temperatures, high elevation or the inducer fan is not able to run at the required speed. Note: At extreme elevations, an A03 code may be normal operation.
Diagnostic: Modulating Gas Primary Limit Open Manifold 1	Heat	Immediate Shutdown	Non-Latching	YES	Symbio 700 call for heat is removed to the VB1285 ignition controller. VB1285 ignition controller has detected the roll out switch open, an open fuse, or the thermal cut out. All burners on the manifold are temporarily unavailable. Lockout duration will remain in effect for 10 to 300 seconds after error condition is cleared or the power is cycled. LED Display [E02] Possible causes: Roll out switch, open fuse, or the TCO (thermal cut out).
Diagnostic: Modulating Gas Heat Open Fuse Manifold 1	Heat	Immediate Shutdown	Non-Latching	YES	Symbio 700 call for heat is removed to the VB1285 ignition controller. LED Display [E13] VB1285 ignition controller has detected a fuse is open. All burners on the manifold are unavailable.
Diagnostic: Gas Heat Failed Ignition Manifold 1	Heat	Immediate Shutdown	Non-Latching	YES	Symbio 700 call for heat is removed to the VB1285 ignition controller. VB1285 ignition controller has four failed ignition attempts on the primary burner and retries have been exhausted. Heat is locked out for 1-hour. The ignition controller will attempt to restart after the 1-hour lockout period. Power may be cycled to reset. LED Display [E01] Possible causes: Plugged vent on gas pressure regulator. Spark ignitor is bad. The high voltage wire is bad.

Diagnostic	Target	Severity	Persistence	Alarm Output	Condition / Response
Diagnostic: Gas Heat Failed Ignition Manifold 1 Burner 2	Heat	Warning	Non-Latching	No	The Symbio 700 will continue call for heat on the primary burner and operate at limited 50% capacity. VB1285 ignition controller, manifold 1 split burner has four failed ignition attempts and retries have been exhausted. Split burner is locked out for 1-hour. The ignition controller will attempt to restart the split burner after the 1-hour lockout period. Power may be cycled to reset. LED Display [A11] Possible causes: Plugged vent on gas pressure regulator, failed flame rod. The high voltage wire is bad.
Diagnostic: Modulating Gas Valve Failure Manifold 1	Heat	Immediate Shutdown	Non-Latching	YES	Symbio 700 call for heat is removed to the VB1285 ignition controller. The VB1285 modulating gas valve actuator did not reach a Park or Full-On position. Lockout duration will remain in effect for 10 to 300 seconds after error condition is cleared or the power is cycled. LED Display [E03] Possible cause: Bad gas valve.
Diagnostic: Modulating Gas Control Board Failure Manifold 1	Heat	Immediate Shutdown	Non-Latching	YES	Symbio 700 call for heat is removed to the VB1285 ignition controller. VB1285 Board Failure. Lockout duration will remain in effect for 10 to 300 seconds after error condition is cleared. LED Display [888] Possible cause: Bad wiring. Board failure.
Diagnostic: Gas Heat Air Pressure Sensor Reading Low	Heat	Immediate Shutdown	Non-Latching	YES	Symbio 700 call for heat is removed to the VB1285 ignition controller. Air pressure switch failed to open during pre-purge calibration process. The inducer fan increases until the air pressure switch closes, then the inducer fan decreases until the air pressure switch opens (the switch failed to open). Display Code [E04] Possible cause: Incorrect ID Plug or incorrect air pressure switch installed. Insufficient air due to blocked vent, pneumatic tube between inducer fan static tap and the air pressure switch has an obstruction.
Diagnostic: Gas Heat Air Pressure Sensor Reading High	Heat	Immediate Shutdown	Non-Latching	YES	Symbio 700 call for heat is removed to the VB1285 ignition controller. Air pressure switch failed to close during pre-purge calibration process. VB1285 Display Code [E05] Possible cause: Pneumatic tubing connections or tubing is damaged. Verify pneumatic tubing is connected to VB1285 negative connection. Defective air pressure switch.
Diagnostic: Gas Heat Loss of Inducer Motor Control	Heat	Warning	Non-Latching	No	The Symbio 700 will continue call for heat. VB1285 ignition controller, the air pressure is not modulating down at minimum inducer drive. Display Code [A07] Possible cause: Pneumatic tubing. Connect a manometer and verify the pressure on the VB1285 display matches the manometer. If pressures do not match cycle control power on the VB1285. If problem still exists, the VB1285 ignition module and/or the inducer fan may need replacing.
Diagnostic: Gas Heat Air Sensor Null Pressure Check	Heat	Warning	Non-Latching	No	The Symbio 700 will continue call for heat. VB1285 ignition controller air sensor pressure check out of tolerance. Display Code [A08] Possible cause: The VB1285 air pressure on-board sensor is out of tolerance. Cycle control power to the VB1285. If problem still exists, the VB1285 ignition module may need replacing.
Diagnostic: Gas Heat Limited Low Fire	Heat	Warning	Non-Latching	No	The Symbio 700 will continue call for heat. Flame loss at low fire results in an auto-adjustment that limits the burner turn down during the rest of the current call for heat. VB1285 Display Code [A04] Possible cause: Wind caused loss of flame at low fire.
Gas Heat Ignition Module 1 Communication Status	Heat	Warning	Non-Latching	YES	Gas heat operation on ignition module 1 disabled. Check Modbus wiring.

VB1285 Ignition Module Display Code Callout

On power up:

H-A	Heatco Model Series
600	Gas Heating Input (600 MBH)
-10, -5	10:1 modulation turndown, 5:1 modulation turndown
nat, LP	Natural Gas, Propane Gas
001	Version of ID Chip
OFF	Standby Mode – awaiting call for heat or increase in firing rate demand
Pur	Purge – 30 second purge period
IGn	Ignition sequence – 6 second trial for ignition and flame signal proving
HEA	Warm up – 10 second warm up period (ignores firing rate demand)
Run	Normal run operation

During normal run operation the display will cycle through multiple codes:

Run	Normal run operation
Fr=	Firing rate percentage
100	Numerical value of firing rate percentage (numerical values will change)
AIr	Inducer fan pressure
1.80	Numerical value of inducer pressure (numerical values will change)

During abnormal operation the display will cycle through multiple codes:

A01	Alert Code (There are nine different alert functions)
Fr=	Firing rate percentage
100	Numerical value of firing rate percentage (numerical values will change)
AIr	Inducer fan pressure
1.80	Numerical value of inducer pressure (numerical values will change)

Device Tracker

Symbio™ 700 will keep statistical data of the unit for component starts and component run times (in hours) for the following unit components:

- Compressor 1
- Compressor 2
- Compressor 3
- Circuit 1 Condenser Coil Defrost
- Circuit 2 Condenser Coil Defrost
- Condenser Fan 1
- Condenser Fan 2
- Condenser Fan 3
- Supply Fan
- Electric Heat Stage 1
- Electric Heat Stage 2

- Filter (Runtime only)
- Gas Heat Stage 1
- Gas Heat Stage 2
- Modulating Gas Heat
- Relief Fan
- Filter

If the Filter Runtime hours exceed the value set by the user for the Filter Runtime Hours Setpoint, the Symbio 700 controller activates the Diagnostic: Maintenance Required point. If there is a requirement to reset the component statistical data, the Run Time Reset or Starts Reset points can be accessed through the Symbio Service and Installation mobile app. If the reset points are set to Reset, the Component Run Time and Starts are reset to 0 and the associated reset points are set back to inactive. In the case of the Diagnostic: Maintenance Required point, it will also be reset to Inactive if Filter Timer Reset point is set.

Modbus Device Service

Symbio™ 700 provides the ability to apply a Modbus address to an end-device which is useful for field replacement of Modbus-controlled end devices. The service is available via the onboard display Service menu, Symbio 700 Service and Installation app and Tracer TU.

Important: *Changing factory Modbus device address must only be performed by experienced service personnel. Re-addressing factory Modbus devices can result in unit malfunctioning.*

Procedure for local user interface:

1. Power Down the Equipment

   Remove power from the equipment.

2. Connect Symbio 700 to Replacement End Device
   - Connect Symbio 700 to the replacement end device which requires a Modbus address change. All other Modbus devices required to be disconnected from the Modbus communication bus.
   - Technician must trip the Symbio 700 Equipment Shutdown input (J18) prior to applying power.

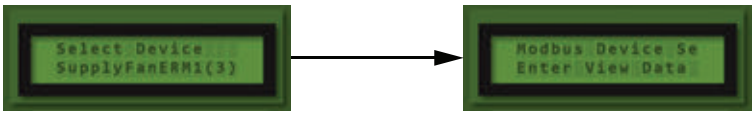
3. Power Up the Equipment

   After checking connections, apply power to the equipment. The replacement end device should be powered and communicating with the Symbio 700.

4. Symbio 700 onboard display, Service Menu

   Using the Symbio 700 local user interface, navigate to the Service Menu and then to Modbus Device Service screen. Press ENTER to begin the Modbus address change process.

Figure 13. Modbus device service menu



5. Select the Replacement Device
   - The *Select Device* screen will display a list of discovered Modbus devices communicating the Symbio 700 at power up.
   - Example, when replacing Precedent supply fan 2 drive, the replacement drive is programmed as “SupplyFanERM1 (3)”.

     If no Modbus devices are detected, “No Communicating Devices” is displayed. Restart the process at step 1 and check that the end device power and Modbus link connections.

Figure 14. Selecting device to be re-addressed

6. Assign new Modbus Address
   - The screen will prompt you to *Select New Device*. Use the Up and Down buttons to select the device with the desired Modbus address and press Enter.
   - Only valid addresses are allowed to be selected.
   - When replacing Precedent supply fan 2 drive, at this step, select “SupplyFanERM2 (4)”. Press Enter to apply the setting to the replacement device.

Figure 15. Selecting new device

7. On board display confirmation Messages
   - “Updated” is displayed if the device was successfully addressed.
   - “Unsupported Target Device” is displayed if the device is unsupported.
   - “Not Changed” is displayed if selected device address is the same the address being written.
8. Cycle power to the Symbio 700
9. Verify end-device communication status
   - Navigate to Service menu, Modbus Devices, Supply Fan 2 Communication Status
   - Verify communication status is “Communicating”, if not communicating repeat steps 1-9.

Figure 16. Verifying communication status

10. Power Down the Equipment
    - Remove power from the equipment.
    - Reconnect all Modbus Devices
    - Reconnect all previously disconnected Modbus devices from Step 2.
    - Return Symbio 700 Equipment Shutdown input (J18) to a normal state.
11. Verify communication status of all Modbus end-devices
    - Navigate to Service menu, Modbus Devices
    - Verify communication status is “Communicating” for applicable devices, if not communicating check Modbus connections.
      1. Supply Fan 1 Communication Status
      2. Supply Fan 2 Communication Status
      3. Gas Heat Ignition Module 1 Communication Status
      4. Compressor 1 VFD Communication Status
      5. Refrigerant Leak Sensor Communication Status Sensor A

Appendix A

Supply Fan

Multi-Speed

Table 37. Multi-speed supply fan (%)

Unit Operation	3 to 5 ton High Efficiency	6 to 17.5 ton	20 to 25 ton
Off	0	0	0
Fan Only	66	66	66
DX Cooling Stage 1	66	66	66
DX Cooling Stage 2	100	66	66
DX Cooling Stage 3	—	100	66
DX Cooling Stage 4	—	—	100
DX Heating Stage 1	66	66	—
DX Heating Stage 2	100	66	66
DX Heating Stage 3	—	100	66
DX Heating Stage 4	—	—	100
Electric Heat Stage 1 of 1	100	100	100
Electric Heat Stage 1 of 2	66	66	66
Electric Heat Stage 2 of 2	100	100	100
Gas Heat Startup	0[(a)] or 25	25	25
Staged Gas Stage 1	66	66	66
Staged Gas Stage 2	100	100	100
Modulating Gas	—	66	66

[(a)] Cooling only, 3 ton unit gas heat startup with supply fan off.

Variable Speed — Space Temperature Control

Table 38. Standard and high efficiency, space temperature control, variable speed minimum supply fan (%)

Unit Operation	3 to 5 ton	6 to 17.5 ton	20 to 25 ton
Off	0	0	0
Fan Only	50	50	50
DX Cooling Stage 1	66	50	50
DX Cooling Stage 2	80	50	50
DX Cooling Stage 3	—	100	65
DX Cooling Stage 4	—	—	100
DX Heating Stage 1	66	—	—
DX Heating Stage 2	80	50	50
DX Heating Stage 3	—	80	65
DX Heating Stage 4	—	—	80
Electric Heat Stage 1 of 1	100	100	100

Table 38. Standard and high efficiency, space temperature control, variable speed minimum supply fan (%) (continued)

Unit Operation	3 to 5 ton	6 to 17.5 ton	20 to 25 ton
Electric Heat Stage 1 of 2	66 or 100[a]	66 or 100[a]	66 or 100[a]
Electric Heat Stage 2 of 2	100	100	100
Gas Heat Startup	0[b] or 25	25	25
Staged Gas Stage 1	100	66	66
Staged Gas Stage 2	100	100	100
Modulating Gas	—	50	50

[a] Cooling only units with primary, 2-stage electric heat operate the supply fan at a minimum of 66%. Heat pump units with auxiliary electric heat, supply fan will operate at 100%.

[b] Cooling only, 3 ton unit gas heat startup with supply fan off.

Variable Speed – Discharge air control (MZ-VAV)

Table 39. Variable volume discharge air control (MZ-VAV), high efficiency, minimum supply fan (%)

Unit Operation	3 to 5 ton	6 to 12.5 ton	15 to 25 ton
Off	0	0	0
Fan Only	50	50	50
DX Cooling Stage 1	66	50	50
DX Cooling Stage 2	66	50	50
DX Cooling Stage 3	—	50	50
DX Cooling Stage 4	—	—	50
DX Heating Stage 1	100	—	—
DX Heating Stage 2	100	100	—
DX Heating Stage 3	—	100	100
DX Heating Stage 4	—	—	100
Electric Heat Stage 1 of 1	—	100	100
Electric Heat Stage 1 of 2	100	100	100
Electric Heat Stage 2 of 2	100	100	100
Gas Heat Startup	25	25	25
Staged Gas Stage 1	100	100	100
Staged Gas Stage 2	100	100	100
Modulating Gas	—	50	50

Variable Speed – Ultra-high efficiency

Table 40. Ultra-high efficiency unit, minimum supply fan (%)

Unit Operation	4 ton	3, 5 to 10 ton	12.5 to 25 ton
Off	0	0	0
Fan Only	50	50	50
DX Cooling Stage 1	66	50	50
DX Cooling Stage 2	—	—	50

Table 40. Ultra-high efficiency unit, minimum supply fan (%) (continued)

Unit Operation	4 ton	3, 5 to 10 ton	12.5 to 25 ton
Electric Heat Stage 1 of 1	100	100	100
Electric Heat Stage 1 of 2	66	66	66
Electric Heat Stage 2 of 2	100	100	100
Gas Heat Startup	25	25	25
Staged Gas Stage 1	66	66	66
Staged Gas Stage 2	100	100	100
Modulating Gas	50	50	50

Compressor Staging

Compressor Staging – Cooling

The following tables apply to cooling only units and heat pump units operating in cooling mode.

Table 41. 3 to 5 ton standard efficiency compressor cooling stages

Compressor Stage	Conventional Thermostat (Y1, Y2)	Cooling Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
			BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	0%	OFF	OFF	OFF	OFF	ON or OFF[a]	OFF	NA
1	Y1 or Y2	100%	**ON**	OFF	OFF	OFF	**ON**	**ON**	NA

[a] Heat Pump units, the switchover will be Off for heating modes, or if the unit mode is Off. Switchover valve is On in cooling and defrost modes of operation.

Table 42. 3 to 5 ton high efficiency compressor cooling stages

Compressor Stage	Conventional Thermostat Control		Cooling Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	ON or OFF[a]	OFF	NA
1	Y1 or Y2	Closed	67%	**ON**	OFF	OFF	OFF	**ON**	**ON**	NA
2	Y1+Y2	Closed	100%	**ON**	OFF	**ON**	OFF	**ON**	**ON**	NA

[a] Heat Pump units, the switchover will be Off for heating modes, or if the unit mode is Off. Switchover valve is On in cooling and defrost modes of operation.

Table 43. 6 to 12.5 ton standard and high efficiency compressor cooling stages

Compressor Stage	Conventional Thermostat Control[a]		Cooling Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	ON or OFF[b]	OFF	OFF
1[c] [d]	Y1 or Y2	Closed	33%	OFF	**ON**	OFF	OFF	**ON**	OFF	**ON**

Table 43. 6 to 12.5 ton standard and high efficiency compressor cooling stages (continued)

Compressor Stage	Conventional Thermostat Control[a]		Cooling Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
2[e]	Note	Closed	66%	**ON**	OFF	OFF	OFF	**ON**	**ON**	OFF
3	Y1+Y2	Closed	100%	**ON**	**ON**	OFF	OFF	**ON**	**ON**	**ON**

[a] Thermostat Control Method Status set to Enhanced, compressors will stage according to Cooling Capacity column, providing 3 stages of cooling.
[b] Heat Pump units, the switchover will be Off for heating modes, or if the unit mode is Off. Switchover valve is On in cooling and defrost modes of operation.
[c] Oil management. If operation is at compressor stage-1 for 19 accumulated minutes, control will go to full capacity for 60 seconds before reverting to cool stage 1.
[d] Oil management. Compressor stage 1 is disabled when outdoor air temperature is less than 50°F. Stage 1 is allowed when outdoor air temperature rises above 55°F.
[e] Heat Pump units (6 to 12.5 ton), whenever the switchover valve is Off, compressor cooling operation will start at stage 2 for 5 minutes.

Table 44. 15 to 17.5 ton standard and high efficiency compressor cooling stages

Compressor Stage	Conventional Thermostat Control[a]		Cooling Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	ON or OFF[b]	OFF	OFF
1[c] [d]	Y1 or Y2	Closed	33%	OFF	**ON**	OFF	OFF	**ON**	OFF	**ON**
2	N/A	Closed	66%	**ON**	OFF	OFF	OFF	**ON**	**ON**	OFF
3	Y1+Y2	Closed	100%	**ON**	**ON**	OFF	OFF	**ON**	**ON**	**ON**

[a] Thermostat Control Method status set to Enhanced, compressors will stage according to Cooling Capacity column, providing 3 stages of cooling.
[b] Heat Pump units, the switchover will be Off for heating modes, or if the unit mode is Off. Switchover valve is On in cooling and defrost modes of operation.
[c] Oil management. If operation is at compressor stage-1 for 19 accumulated minutes, control will go to full capacity for 60 seconds before reverting to cool stage 1.
[d] Oil management. Compressor stage 1 is disabled when outdoor air temperature is less than 50°F. Stage 1 is allowed when outdoor air temperature rises above 55°F.Oil management. Compressor stage 1 is disabled when outdoor air temperature is less than 50°F. Stage 1 is allowed when outdoor air temperature rises above 55°F.

Table 45. 20 to 25 ton standard and high efficiency compressor cooling stages – cooling only

Compressor Stage	Conventional Thermostat Control[a]		Cooling Capacity	Compressor Output		Unloader Solenoid		Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	OFF	OFF
1[b] [c]	Y1 or Y2	Closed	24%	OFF	**ON**	OFF	OFF	OFF	**ON**
2	N/A	Closed	36%	**ON**	OFF	OFF	OFF	**ON**	OFF
3	N/A	Closed	64%	**ON**	**ON**	OFF	OFF	**ON**	**ON**
4	Y1+Y2	Closed	100%	**ON**	**ON**	OFF	OFF	**ON**	**ON**

Note: Heat Pump units, the switchover will be Off for heating modes, or if the unit mode is Off. Switchover valve is On in cooling and defrost modes of operation.

Table 45. 20 to 25 ton standard and high efficiency compressor cooling stages – cooling only (continued)

(a) Thermostat Control Method Status set to Enhanced, compressors will stage according to Cooling Capacity column, providing 4 stages of cooling.
(b) Oil management. If operation is at compressor stage-1 for 19 accumulated minutes, control will go to full capacity for 60 seconds before reverting to stage 1.
(c) Oil management. Compressor stage 1 is disabled when outdoor air temperature is less than 50°F. Stage 1 is allowed when outdoor air temperature rises above 55°F.

Table 46. 20 to 25 ton standard and high efficiency compressor cooling stages – heat pump

Compressor Stage	Conventional Thermostat Control(a)		Cooling Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	ON or OFF(b)	OFF	N/A
1(c) (d)	Y1 or Y2	Closed	24%	OFF	**ON**	OFF	OFF	**ON**	N/A	**ON**
2(c)(d)(a)	N/A(c)(d)(a)	Closed	36%	OFF	**ON**	OFF	**ON**	**ON**	OFF	**ON**
3	N/A	Closed	64%	**ON**	OFF	OFF	OFF	**ON**	**ON**	OFF
4	Y1+Y2	Closed	100%	**ON**	**ON**	OFF	**ON**	**ON**	**ON**	**ON**

(a) Thermostat Control Method Status set to Enhanced, compressors will stage according to Cooling Capacity column, providing 4 stages of cooling.
(b) Heat Pump units, the switchover will be Off for heating modes, or if the unit mode is Off. Switchover valve is On in cooling and defrost modes of operation.
(c) Oil management. If operation is at compressor stage-1 or stage-2 for 19 accumulated minutes, control will go to full capacity for 60 seconds before reverting to compressor stage 1 or stage-2.
(d) Oil management. Compressor stage 1 is disabled when outdoor air temperature is less than 60°F. Stage 1 is allowed when outdoor air temperature rises above 65°F.

Oil Management – Fixed Speed Compressor Units

Oil management is a function that aids oil distribution in the refrigerant system. Noted in the compressor staging tables above for cooling only and heat pump cooling modes of operation, if cooling is operating at compressor stage-1 (or compressor stage-2 for some tonnages) for 19 continuous minutes, oil management is enforced. Cooling will transition to full capacity for 60 seconds before reverting to compressor stage-1 or stage-2.

Oil management actions are also enforced based on outdoor air temperature. For 6 to 25 ton cooling only and 6 to 17.5 ton heat pump units, compressor stage 1 is disabled when outdoor air temperature is less than 50°F. Stage-1 is allowed when outdoor air temperature rises above 55°F.

For 20 to 25 ton Heat Pump units, compressor stage-1 is disabled when outdoor air temperature is less than 60°F. Stage 1 is allowed when outdoor air temperature rises above 65°F.

Compressor Staging – Heat Pump Heating

The following tables apply to heat pump units operating in a compressor heating mode.

Table 47. 3 to 5 ton standard efficiency compressor heating stages

Compressor Stage	Conventional Thermostat Control		Primary Heating Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	OFF	OFF	NA
1	Y1 or Y2	Open	100%	**ON**	OFF	OFF	OFF	OFF	**ON**	NA

Table 48. 3 to 5 ton high efficiency compressor heating stages

Compressor Stage	Conventional Thermostat Control		Primary Heating Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	Y1 or Y2	Open	0%	OFF	OFF	OFF	OFF	OFF	OFF	OFF
2	Y1+Y2	Open	100%	**ON**	OFF	**ON**	OFF	OFF	**ON**	OFF

Table 49. 6 to 17.5 ton standard and high efficiency compressor heating stages

Compressor Stage	Conventional Thermostat Control		Primary Heating Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	N/A	Open	0%	OFF	OFF	OFF	OFF	OFF	OFF	OFF
2	Y1 or Y2	Open	66%	**ON**	OFF	OFF	OFF	OFF	**ON**	OFF
3	Y1+Y2	Open	100%	**ON**	**ON**	OFF	OFF	OFF	**ON**	**ON**

Note: When outdoor air temperature drops below 20°F compressor stage 2 disables, operation will be 0% or 100% until outdoor air temperature rises above 25°F.

Table 50. 20 to 25 ton standard and high efficiency compressor heating stages

Compressor Stage	Conventional Thermostat Control		Primary Heating Capacity	Compressor Output		Unloader Solenoid		Switchover Valve	Compressor	
	Y1, Y2	O		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	BO-10 (P11-1)	CPR1	CPR2
0	Open	Open	0%	OFF	OFF	OFF	OFF	OFF	OFF	OFF
1	N/A	Open	24%	OFF	OFF	OFF	OFF	OFF	OFF	OFF
2	N/A	Open	36%	OFF	OFF	OFF	OFF	OFF	OFF	OFF
3[(a)]	Y1 or Y2	Open	64%	ON	OFF	OFF	OFF	OFF	ON	OFF
4	Y1+Y2	Open	100%	ON	ON	OFF	**ON**	OFF	ON	ON

[(a)] When outdoor air temperature drops below 20°F compressor stage 3 disables, operation will be 0% or 100% until outdoor air temperature rises above 25°F.

Variable Speed Compressor Staging

For more information, see Variable Speed Compressor Operation section.

Table 51. 3 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	36%	100%	**ON**	N/A	**ON**	N/A

Table 52. 4 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	27%	100%	**ON**	N/A	**ON**	N/A

Table 53. 5 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	31%	100%	**ON**	N/A	**ON**	N/A

Table 54. 6 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	27%	100%	**ON**	N/A	**ON**	N/A

Table 55. 7.5 ton Ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	32%	100%	**ON**	N/A	**ON**	N/A

Table 56. 8.5 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	28%	100%	**ON**	N/A	**ON**	N/A

Table 57. 10 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	24%	100%	**ON**	N/A	**ON**	N/A

Table 58. 12.5 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	27%	100%	**ON**	N/A	**ON**	N/A

Table 59. 15 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	N/A	OFF	N/A
1	22%	100%	**ON**	N/A	**ON**	N/A

Table 60. 17.5 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	OFF	OFF	OFF
1	12%	68%	**ON**	OFF	**ON**	OFF
2	69%	100%	**ON**	**ON**	**ON**	**ON**

Table 61. 20 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	OFF	OFF	OFF
1	11%	54%	**ON**	OFF	**ON**	OFF
2	55%	100%	**ON**	**ON**	**ON**	**ON**

Table 62. 25 ton ultra-high efficiency compressor cooling stages

Compressor Stage	Cooling Capacity		Compressor 1 Command Status	Fixed Compressor Output	Compressor	
			(BI-11100)	BO-6 (P9-5)	VSPD	CPR2
0	0%	0%	OFF	OFF	OFF	OFF
1	14%	58%	**ON**	OFF	**ON**	OFF
2	59%	100%	**ON**	**ON**	**ON**	**ON**

Condenser Fan Operation

Condenser fan operation is dependent on several factors including outdoor air temperature, operating compressor stage, and hot gas reheat status. If compressors are operating at stage-1, the condenser fan output will be On. Additional condenser fan stages are added as cooling capacity increases or outdoor air temperature increases.

Electric Heat

Table 63. Electric heat staging

Unit Operation	Unit Response
Electric Heat Stage 1	Electric Heat Stage 1 Output ON
Electric Heat Stage 2	Electric Heat Stage 1 and 2 Outputs ON

Gas Heat

Table 64. Gas heat staging

Unit Operation	Unit Response
Gas Heat Stage 1	Gas Valve Stage 1 ON
Gas Heat Stage 2	Gas Valve Stage 2 ON

Emergency and Ventilation Override

Table 65. Emergency and ventilation override

Inputs	Outputs					
Emergency Override BAS	Supply Fan On/Off Request	Supply Fan Speed Request	Outdoor Air Damper	Relief Fan	VAV Box Relay Output[a]	Heat Cool Mode Status
Point	State	%	State	State	State	Point
2 = EMERG_PRESSURIZE	ON	100	100%	Off	Energized	Fan Only
3 = EMERG_ DEPRESSURIZE	OFF	0	0%	On/100%	De-energized	Fan Only
4 = EMERG_PURGE	ON	100	100%	On/100%	Energized	Fan Only
5 = EMERG_SHUTDOWN	OFF	0	0%	Off/0%	De-energized	OFF
6 = EMERG_FIRE	OFF	0	0%	Off/0%	De-energized	OFF
1 = EMERG_NORMAL	Auto	Auto	Auto	Auto	Auto	Auto

[a] Variable Volume Discharge Air units.

Space Setpoint Adjustment

Zone sensors with an internal or external setpoint adjustment provide the controller with a local setpoint (50 to 85°F or 10 to 29.4°C). The internal setpoint adjustment is concealed under the zone sensor cover. To access the setpoint adjustment, remove the zone sensor cover. Some external setpoints (when present) are displayed on the digital display zone sensor front cover. When the local setpoint adjustment is used to determine the setpoints, all unit setpoints are calculated based on the local setpoint value, the configured setpoints, and the active mode of the controller. The controller determines the effective space setpoint based on the following:

- Local wired setpoint input
- Occupancy mode
- Heating or cooling mode (space demand)
- Space setpoint high and low limits (configured)

Single Setpoint

Heat mode:

- Occupied mode: Space Temperature Setpoint Active = Space Temperature Setpoint (arbitrated) - Occupied Offset

- Occupied standby mode: Space Temperature Setpoint Active = Space Temperature Setpoint (arbitrated) - Standby Offset
- Unoccupied mode: Space Temperature Setpoint Active = Unoccupied Heating Setpoint Cool mode

Cool mode:

- Occupied mode: Space Temperature Setpoint Active = Space Temperature Setpoint (arbitrated) + Occupied Offset
- Occupied standby mode: Space Temperature Setpoint Active = Space Temperature Setpoint (arbitrated) + Standby Offset
- Unoccupied mode: Space Temperature Setpoint Active = Unoccupied Cooling setpoint

When a building automation system or other controller communicates a setpoint to the controller, the controller ignores the local setpoint input and uses the communicated value (default operation). The exception is when the system is in unoccupied mode and the controller always uses the unoccupied setpoints. After the controller completes all setpoint calculations, the calculated occupied setpoint is validated against the following configured space setpoint limits:

- Heating setpoint high limit
- Heating setpoint low limit
- Cooling setpoint high limit
- Cooling setpoint low limit

These setpoint limits apply only to the occupied and occupied standby, heating, and cooling setpoints. They do not apply to the unoccupied heating and cooling setpoints. When the controller is in the unoccupied mode, it always uses the unoccupied heating and cooling setpoints.

Dual Setpoint

When Symbio™ 700 is configured for system types CVZT or VVZT, the controls can be configured for Dual Setpoint control. Dual Setpoint provides independent space cooling setpoint and space heating setpoint inputs to the controller. It also allows an external source to write to independent the space cooling and heating setpoints.

Appendix B

Precedent and Axiom Rooftop WSHP Configuration

The following table describes the Symbio™ 700 configuration and options available with reference to the Precedent and Axiom Rooftop Water Source Heat Pump model number.

Symbio 700		Model Number (reference)	Description
Configuration Item	**Configuration Option**		
Equipment Type	Precedent	Digit 1 = T, W, Y, D	Precedent:
			Cooling only (T)
			Heat Pump (W)
			Gas Heat (Y)
			Dual Fuel (D)
		Digit 1 = G	Axiom Rooftop Water Source Heat Pump. Equipment Type shall be set to “Precedent” for Rooftop WSHP products.
	Odyssey	Not applicable	
	Voyager 3	Not applicable	
	Foundation	Not applicable	
System Type	CVZT	Digit 15 = 0, 1	Supply fan operation at 2-speed, zone temperature control.
	VVZT	Digit 15 = 2, 3	Variable speed supply fan zone temperature control (single zone vav).
	VVDA	Digit 15 = 4, 5	Variable volume discharge air control for multi-zone VAV systems.
Space Controller	Conventional TStat	Not applicable	Equipment is being controlled from a thermostat in the space.
	Dual Setpoint Zone Sensor	Not applicable	Heat and Cool dual setpoint zone sensor installed. Applicable to CVZT, VVZT, and VVDA System Type.
	Single Setpoint Zone Sensor	Not applicable	Heat/Cool single setpoint zone sensor installed. Applicable to CVZT, VVZT, and VVDA System Type.
Indoor Fan Type	Multi Speed	Digit 2 = H, Z	High or Ultra-High efficiency, 3 to 5 ton unit with a standard or oversized supply fan motor.
		Digit 4, 5, 6 = 036, 048, 060	
		Digit 15 = 0, 1	
		Digit 4, 5, 6 = 072-300	6-25 ton unit with a standard or oversized supply fan motor.
		Digit 15 = 0, 1	
	Single Speed	Digit 2 = S	Standard Efficiency, 3to 5 Ton unit.
		Digit 4, 5, 6 = 036, 048, 060	
	Variable Speed	Digit 15 = 2, 3, 4, 5	Single zone variable air volume supply fan (VVZT) or True VAV supply fan (VVDA).
Indoor Fan Vfd (Precedent only)	Ebm Papst	Digit 4, 5, 6 = 072-300	Tonnage is 6 to 10 ton.
		Digit 1, 2 = WH, DH	High efficiency, heat pump, dual fuel, 3-ton unit.
		Digit 4, 5, 6 = 036	
		Digit 2 = Z	Ultra-High efficiency, 3-ton unit.
		Digit 4, 5, 6 = 036	
		Digit 2 = H, Z	High or Ultra-High efficiency, 4-ton or 5-ton unit.
		Digit 4, 5, 6 = 048, 060	
	Mitsubishi	Digit 4, 5, 6 = 072, 090, 102, 120	Tonnage is 6, 7.5, 8.5, 10 and Voltage is 208/230/60 or 460/60.
		Digit 8 = 3, 4	

Symbio 700		Model Number (reference)	Description
Configuration Item	**Configuration Option**		
Refrigeration System	Cooling Only	Digit 1 =	Direct expansion cooling unit with or without primary heating capacity.
		T – DX Cooling	
		Y – DX Cooling, Gas Heat	
	Heat Pump	Digit 1 = W, D, G	Heat Pump (W), Dual Fuel (D) or Axiom Rooftop Water Source Heat Pump (G).
Heat Pump Type	Air Source	Digit 1 = W, D	Air cooled condenser (Precedent Heat Pump)
	Water Source	Digit 1 = G	Water cooled condenser (Axiom Rooftop Water Source Heat Pump).
Refrigerant	R–410A	Digit 3 = J	Equipment designed for R-410A.
	R–454B	Digit 7 = K	Equipment designed for R-454B.
Tonnage (60 Hz)	3	Digit 4, 5, 6 = 036	Designates the equipment capacity in tons of cooling.
	4	Digit 4, 5, 6 = 048	
	5	Digit 4, 5, 6 = 060	
	6	Digit 4, 5, 6 = 072	
	7.5	Digit 4, 5, 6 = 090	
	8.5	Digit 4, 5, 6 = 102	
	10	Digit 4, 5, 6 = 120	
	12.5	Digit 4, 5, 6 = 150	
	15	Digit 4, 5, 6 = 180	
	17.5	Digit 4, 5, 6 = 210	
	20	Digit 4, 5, 6 = 240	
	25	Digit 4, 5, 6 = 300	
Refrigeration Circuit	Single	Digit 2 = S, H	Standard or high efficiency, 3 to 5 ton units.
		Digit 4, 5, 6 = 036, 048, 060	
	Single Manifold	Digit 2 = S, H	Standard or high efficiency, 6 to 25 ton units.
		Digit 4, 5, 6 = 072-300	
		Digit 2 = Z	Ultra-high efficiency, 3 to 25 ton units.
		Digit 4, 5, 6 = 036-300	
Voltage (60 Hz)	208/230/60	Digit 8 = 3	208VAC or 230VAC, 60Hz.
	460/60	Digit 8 = 4	460VAC, 60Hz.
	575/60	Digit 8 = W	575VAC, 60Hz.
Efficiency	Standard	Digit 2 = S	Standard Efficiency.
	High	Digit 2 = H	High Efficiency.
	Ultra High	Digit 2 = Z	Ultra-High Efficiency.
Hot Gas Reheat	Not Installed	Digit 22 = 0	Standard refrigeration system.
	Modulating	Digit 22 = A	Modulating hot gas reheat installed.
Dehumidification Control	Humidistat	Not applicable	Dehumidification will be initiated based on a Humidistat binary input when modulating hot gas reheat is installed.
	Relative Humidity	Not applicable	Dehumidification will be initiated based on a Space Relative Humidity when modulating hot gas reheat is installed.
	Dew Point	Not applicable	Default setting when modulating hot gas reheat is installed. Dehumidification will be initiated based on a Space Dew Point and Outdoor Air Dew Point.

Symbio 700		Model Number (reference)	Description
Configuration Item	**Configuration Option**		
Primary Heating Source	Not Installed	Digit 1 = T Digit 11 = 0	No primary heating installed.
	Electric	Digit 11 = B, C, E, G, J, K, N, P, R	Cooling only unit with primary electric heat installed.
	Gas	Digit 1 = Y	Cooling only unit with primary staged or modulating gas heat installed.
	Heat Pump	Digit 1 = W, D, G	
Primary Heating Type	Staged	Digit 10 = A, C	Staged electric heat or staged gas heat installed.
	Modulating	Digit 10 = B	Modulating gas heat installed.
Primary Heating Capacity (Primary Heating Type = Modulating	80 MBH Low Heat	Digit 4, 5, 6 = 072 (6 ton) Digit 10 = B (modulating gas heat) Digit 11 = L (low gas heat)	Low heat modulating gas option for 6-ton units.
	150 MBH High Heat	Digit 4, 5, 6 = 072 (6 ton) Digit 10 = B (modulating gas heat) Digit 11 = H (high gas heat)	High heat modulating gas option for 6-ton units.
	120 MBH Low Heat	Digit 4, 5, 6 = 90, 102 (7.5, 8.5 ton) Digit 10 = B (modulating gas heat) Digit 11 = L (low gas heat)	Low heat modulating gas option for 7.5-ton or 8.5-ton units.
	200 MBH High Heat	Digit 4, 5, 6 = 90, 102 (7.5, 8.5 ton) Digit 10 = B (modulating gas heat) Digit 11 = H (high gas heat)	High heat modulating gas option for 7.5-ton or 8.5-ton units.
	240 MBH High Heat	Digit 2 = S, H (standard, high) Digit 4, 5, 6 = 120 (10 ton) Digit 10 = B (modulating gas heat) Digit 11 = H (high heat)	High heat modulating gas option for standard or high efficiency, 10-ton units.
	150 MBH Low Heat	Digit 2 = Z (ultra-high efficiency) Digit 4, 5, 6 = 120 (10 ton) Digit 10 = B (modulating gas heat) Digit 11 = L (low gas heat)	Low heat modulating gas option for ultra-high efficiency, 10-ton units.
		Digit 2 = S (standard) Digit 4, 5, 6 = 150 (12.5 ton) Digit 7 = K (R-454B) Digit 10 = B (modulating gas heat) Digit 11 = L (low gas heat)	Low heat modulating gas option for standard efficiency, 12.5-ton units with R-454B refrigerant.
		Digit 2 = S, H (standard, high) Digit 4, 5, 6 = 150 (12.5 ton) Digit 7 = J (R-410A) Digit 10 = B (modulating gas heat) Digit 11 = L (low gas heat)	Low heat modulating gas option for standard or high efficiency, 12.5-ton units with R-410A refrigerant.

Symbio 700		Model Number (reference)	Description
Configuration Item	**Configuration Option**		
Primary Heating Capacity (Primary Heating Type = Modulating)	250 MBH High Heat	Digit 2 = Z (ultra-high efficiency)	High heat modulating gas option for ultra-high efficiency, 10-ton units with R-454B refrigerant.
		Digit 4, 5, 6 = 120 (10 ton)	
		Digit 7 = K (R-454B)	
		Digit 10 = B (modulating gas heat)	
		Digit 11 = H (high gas heat)	
		Digit 4, 5, 6 = 150 (12.5 ton)	High heat modulating gas option for standard, high, ultra-high efficiency, 12.5-ton units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = H (high gas heat)	
	250 MBH Low Heat	Digit 4, 5, 6 = 180, 210, 240, 300	Low heat modulating gas option for standard, high, ultra-high efficiency, 15, 17.5, 20, 25-ton units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = L (low gas heat)	
	400 MBH High Heat	Digit 4, 5, 6 = 180, 210, 240, 300	High heat modulating gas option for standard, high, ultra-high efficiency, 15, 17.5, 20, 25-ton units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = H (high heat)	
Primary Heating Stages	1	Digit 9 = A, B	1-stage electric heat installed.
	2	Digit 9 = C, D, E (electric heat)	2-stage electric heat or staged gas heat installed.
		Digit 9 = L, H, J, K (staged gas heat)	
	Full	Digit 1 = W, D	Heat Pump (W) or Dual Fuel (D) units will set Primary Heating Stages = Full.
Secondary Heating Source	Electric	Digit 1 = W	Heat Pump (W) units.
		Digit 11 = B, C, E, G, J, K, N, P, R	
	Gas	Digit 1 = D	Dual Fuel (D) units.
	Not Installed	Digit 1 = W	Heat Pump (W) units with no secondary/auxiliary heat.
Secondary Heat Type	Modulating	Digit 1 = D	Dual Fuel (D), 6-25 ton units with modulating gas heat.
	Staged	Digit 1 = W, D	Heat Pump (W) units with staged electric heat. Dual Fuel (D) units with staged gas heat.
Secondary Heating Capacity	80 MBH Low Heat	Digit 4, 5, 6 = 072 (6 ton)	Low heat modulating gas option for 6-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = L (low gas heat)	
	150 MBH High Heat	Digit 4, 5, 6 = 072 (6 ton)	High heat modulating gas option for 6-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = H (high gas heat)	
	120 MBH Low Heat	Digit 4, 5, 6 = 90, 102 (7.5, 8.5 ton)	Low heat modulating gas option for 7.5, 8.5-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = L (low gas heat)	

Symbio 700		Model Number (reference)	Description
Configuration Item	**Configuration Option**		
Secondary Heating Capacity	200 MBH High Heat	Digit 4, 5, 6 = 90, 102 (7.5, 8.5 ton)	High heat modulating gas option for 7.5, 8.5-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = H (high gas heat)	
	150 MBH Low Heat	Digit 4, 5, 6 = 120 (10 ton)	Low heat modulating gas option for 10-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = L (low gas heat)	
	250 MBH High Heat	Digit 4, 5, 6 = 120, 150 (10, 12.5 ton)	High heat modulating gas option for ultra-high efficiency, 10, 12.5-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = H (high gas heat)	
	250 MBH Low Heat	Digit 4, 5, 6 = 180, 210, 240, 300	Low heat modulating gas option for 15, 17.5, 20, 25-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = L (low gas heat)	
	400 MBH High Heat	Digit 4, 5, 6 = 180, 210, 240, 300	High heat modulating gas option for 15, 17.5, 20, 25-ton dual fuel units.
		Digit 10 = B (modulating gas heat)	
		Digit 11 = H (high heat)	
Secondary Heating Stages	1	Digit 1 = W	Heat pump, 3-15 Ton units, with 1-stage electric heat.
		Digit 4, 5, 6 = 036 to 180	
		Digit 11 = B, C, E, G, J, K, N, P, R	
		Digit 1 = D	Dual Fuel, high efficiency, 3-5 Ton units, with Low NOx Gas Heat.
		Digit 2 = H	
		Digit 4, 5, 6 = 036 to 060	
		Digit 10 = C	
		Digit 11 = L	
	2	Digit 1 = W, D	Heat pump and dual fuel units with 2-stage electric heat or 2-stage gas heat.
Outside Air	Not Installed	Digit 14 = 0, A	No fresh air (0) installed or manual outside air (A) option.
	0 to 50% Motorized Damper	Digit 14 = B	Motorized outside air (B) option installed.
	0 to 100% Economizer	Digit 14 = C, D, E, F, G, H, J, K, L, M, N, P, Q, R	100% Economizer damper installed.
Economizer Type	Dry Bulb	Digit 14 = C, D, J, K	Economizer cooling operation enables based on outdoor air temperature (dry bulb).
	Differential Dry Bulb	Not applicable	Economizer cooling operation enables based on outdoor air temperature and space temperature difference.
	Reference Enthalpy	Digit 15 = E, F, L, M	Economizer cooling operation enables based on outdoor air temperature and outdoor air humidity.
	Comparative Enthalpy	Digit 15 = G, H, Q, R	Economizer cooling operation enables based on outdoor air temperature and outdoor air humidity (enthalpy) vs. return air temperature and return air humidity (enthalpy).
Demand Controlled Ventilation	Enabled	Not applicable	Demand Controlled Ventilation is a 0 to 100% economizer damper option when a Space CO_2 sensor is installed.
	Disabled	Not applicable	Demand Controlled Ventilation is disabled.
Remote Minimum Position	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	0 to 100% Economizer damper installed, or 0 to 50% motorized damper installed, and field installed remote minimum position potentiometer installed

Symbio 700		Model Number (reference)	Description
Configuration Item	**Configuration Option**		
Space Pressure Control	Not installed	Digit 30 = 0	None, not installed.
	Relief Fan Only	Digit 30 = A	Modulating Power Exhaust installed.
Clogged Filter	Not Installed	Digit 25 = 0, 2, 3, 6	Not installed.
	Installed	Digit 25 = 1, 4, 5, 7	Clogged Filter Switch (CFS) installed.
FroStat	Installed	Not applicable	FroStat is standard.
Condensate Overflow Switch	Not Installed	Digit 25 = 0, 1, 3, 5	Not installed.
	Installed	Digit 25 = 2, 4, 6, 7	Condensate Overflow Switch (COS) installed.
Supply Air Smoke Detector	Not Installed	Digit 24 = 0, A	Without smoke detector (0) or Return air smoke detector installed (A).
	Installed	Digit 24 = B, C	Supply air smoke detector installed (B) or Supply and Return air smoke detector installed (C).
Return Air Smoke Detector	Not Installed	Digit 24 = 0, B	Without smoke detector (0) or Supply air smoke detector installed (B).
	Installed	Digit 24 = A, C	Return air smoke detector installed (A) or Supply and Return air smoke detector installed (C).
Humidistat	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Field installed Humidistat installed.
Humidity Sensor	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Space Humidity Sensor installed.
CO_2 Sensor	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Space CO_2 Sensor installed.
Discharge Temperature Sensor	Not Installed	Digit 25 = 0, 1, 2, 4	Not installed.
	Installed	Digit 25 = 3, 5, 6, 7	Discharge Air Sensing (DAS) installed.
External Auto/Stop	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	External Auto/Stop binary input installed, requires a Customer Options Module.
Ventilation Override	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Ventilation Override installed, requires a Customer Options Module.
Alarm Indicator	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	An installed Alarm Indicator requires a Customer Options Module.
Demand Management	None	Not applicable	Symbio 700 Demand Shed/Demand Limit binary input (J16) is disabled.
	Demand Limit	Not applicable	Symbio 700 binary input (J16) enables and disables energy Demand Limit function. See Demand Limit is this document.
	Demand Shed	Not applicable	Symbio 700 binary input (J16) enables and disables energy Demand Shed function. The Demand Shed is enabled, space heating and cooling setpoints will be offset 4°F (default setting).
Supply Air Tempering	Disabled	Not applicable	Disabled, Supply Air Tempering functional is disabled.
	Enabled	Not applicable	Enabled, Supply Air Tempering function is allowed on units that are not controlled from a thermostat. Requires a discharge air sensing to be installed.

Symbio 700		Model Number (reference)	Description
Configuration Item	**Configuration Option**		
Low Ambient Cool	Not Installed	Digit 29 = 0	Not Installed. Low Ambient cooling is disabled.
	Installed	Digit 2 = Z	Installed, Low Ambient cooling function is enabled on units with a variable speed condenser fan(s).
		Digit 29 = A	
		Digit 1 = W, D	
		Digit 2 = S, H	
		Digit 4, 5, 6 = 102, 120	
		Digit 1 = T, Y	
		Digit 2 = H	
		Digit 3 = K	
		Digit 4, 5, 6 = 120	

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