

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.

July 2022

**ACC-APG002A-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:



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



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.



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.**

**⚠ 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.

## Copyright

This document and the information in it are the property of Trane, and may not be used or reproduced in whole or in part without written permission. Trane reserves the right to revise this publication at any time, and to make changes to its content without obligation to notify any person of such revision or change.

## Trademarks

All trademarks referenced in this document are the trademarks of their respective owners.

# Table of Contents

Introduction.....	7
Additional Documentation.....	7
Symbio 700 Overview.....	8
Field Connection.....	8
Unit Configuration.....	9
Onboard User Interface.....	9
Mobile Application.....	9
Startup Sequence.....	13
Conventional Thermostat Sequence of Operation.....	14
Space Temperature Control.....	16
Single Loop Space Temperature Control.....	16
Single Zone Variable Air Volume.....	16
Single Zone VAV — Cooling.....	17
Cool.....	17
Cool — Economizer.....	18
Cool — Economizer + DX.....	18
Supply Air Tempering — Space Temperature Control.....	18
Unoccupied Cooling.....	18
Unoccupied Heating.....	18
Variable Volume Discharge Air Control Sequence of Operation.....	19
Supply Air Tempering.....	19
Changeover Input.....	19
VAV Box Relay Output.....	19
Discharge Air Reset.....	19
Duct Static Pressure Control.....	19
Duct Static Pressure High Limit.....	20
Unoccupied Cooling.....	20
Unoccupied Heating.....	20
Heat Cool Modes.....	21
Heat.....	21
Cool.....	21
Fan Only.....	21
Off.....	21
Test.....	21
Maximum Heat.....	21
VVDA.....	21
Space Temperature Control.....	22
Morning Warm-up.....	22
VVDA.....	22
Space Temperature Control.....	22
Pre-Cool.....	22
VVDA.....	23

Space Temperature Control . . . . .	23
Night Purge . . . . .	23
VVDA . . . . .	23
Space Temperature Control . . . . .	23
Daytime Warm-up . . . . .	23
Dehumidification — Hot Gas Reheat . . . . .	25
Dehumidification Control . . . . .	25
Dew Point — Initiation . . . . .	25
Relative Humidity — Initiation . . . . .	25
Operation . . . . .	25
Dew Point — Termination . . . . .	25
Relative Humidity — Termination . . . . .	26
Dehumidification Purge Cycle . . . . .	26
Dehumidification — Thermostat Control . . . . .	26
Heat Types . . . . .	27
Staged Gas Heat . . . . .	27
Electric Heat — Staged . . . . .	27
Outdoor Air Damper Control . . . . .	28
Economizer Cooling . . . . .	28
Ventilation Control . . . . .	29
Supply Fan Compensation . . . . .	29
Outdoor Air Minimum Position Control . . . . .	29
Remote Minimum Position Control . . . . .	30
Demand Controlled Ventilation (DCV) . . . . .	30
0 to 50% Motorized Damper . . . . .	32
General Support Sequences . . . . .	33
Fan Setpoints with ERM-driven Fan Types . . . . .	33
Compressor Minimum Runtime . . . . .	33
Compressor Proof of Operation . . . . .	33
Compressor Low Pressure Cutout Control . . . . .	34
Evaporator Defrost Control . . . . .	35
Building Automation System Support Sequences . . . . .	36
Occupancy Mode . . . . .	36
Timed Override . . . . .	36
Unit Stop . . . . .	36
Capacity Limit Control . . . . .	37
Remote Capacity Control . . . . .	37
Emergency and Ventilation Override . . . . .	38
Ventilation Override . . . . .	38
Emergency Override . . . . .	38
Service Test Mode . . . . .	39
Service Test Timeout . . . . .	39
Leaving Service Test Mode . . . . .	39

Service Test Mode — CVZT, VVZT, and VVDA .....	39
Diagnostics .....	42
Device Tracker .....	42
Compressor Proving Diagnostics .....	42
Diagnostic: Compressor X Proving Trip .....	42
Diagnostic: Compressor X Proving Lockout .....	42
Diagnostic: Compressor X Contactor Failure .....	43
Diagnostics — Low Pressure Cutout .....	43
Diagnostic: Circuit X LPC Trip .....	43
Diagnostic: Circuit X LPC Lockout .....	43
Diagnostics — Alarm Indicator Status .....	44
Reset Diagnostic .....	44
Power-Up Reset or Exception/Override Mode Transition .....	44
Reset Diagnostic Point .....	44
Heat Cool Mode Transition Reset .....	44
Reset Diagnostic Point — Active to Inactive Transition .....	44
Troubleshooting .....	45
Unit Communication Fault .....	45
Sensor Fault .....	46
Compressor Fault .....	46
Supply Fan Fault .....	47
Staged Gas Heat Fault .....	48
Economizer Fault .....	49
Outdoor Air Damper Fault Detection and Diagnostics (FDD) .....	49
Appendix A .....	51
Supply Fan .....	51
Multi-Speed/ERM .....	51
Variable Speed/ERM — Space Temperature Control .....	51
Variable Speed/ERM — Discharge Air Temperature Control .....	52
Compressor Staging .....	52
Thermostat Staging .....	52
Cooling Only (Electric Heat) — CVZT & VVZT .....	53
Condenser Fan Operation .....	53
Thermostat, CVZT, VVZT, and VVDA .....	53
Electric Heat .....	53
Gas Heat .....	54
Diagnostics and Alarm Indicator Status .....	54
Emergency and Ventilation Override .....	56
Space Setpoint Adjustment .....	56
Single Setpoint .....	56
Dual Setpoint .....	57

# 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 Configuration** — provides advanced troubleshooting and access to the Symbio Service and Installation mobile app.
- **Advanced Configuration** — Building Automation System interface via BACnet® (ANSI/ASHRAE Standard 135-2016), Modbus™, Air-Fi®, or LonTalk®.

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)
- Space Temperature Control Constant Volume (CVZT)
- Space Temperature Control Single Zone Variable Air Volume (VVZT)
- Variable Volume Discharge Air (VVDA)

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

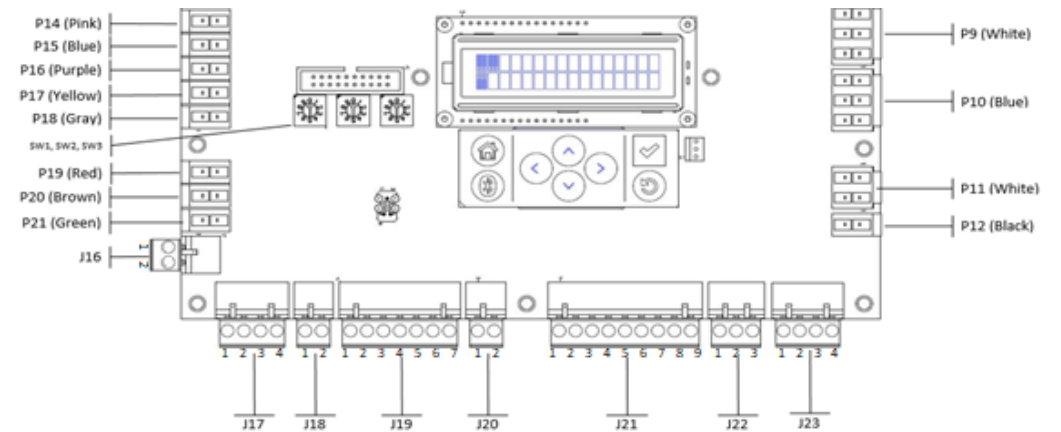
- BAS-SVN043\*-EN: *Quick Start Guide, Symbio™ Service and Installation App*
- BAS-SVU054\*-EN: *User Guide, Symbio™ 700*
- BAS-SVP062\*-EN: *Integration Guide, BACnet® and Modbus™ Integration to Precedent Packaged Rooftop Air-Conditioners with Symbio™ 700 Controls*
- BAS-SVP063\*-EN: *Integration Guide, LonTalk® Integration to Precedent Packaged Rooftop Air-Conditioners with Symbio™ 700 Controls*
- RT-SVX070\*-EN: *Installation, Operation, and Maintenance, Packaged Rooftop Air Conditioners, Precedent™ Cooling and Electric Heat, Standard Efficiency*
- RT-SVX071\*-EN: *Installation, Operation, and Maintenance, Packaged Rooftop Air Conditioners, Precedent™ Cooling and Gas/Electric, Standard Efficiency*

# 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 landed 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 Communication Connections	1	BACnet +
		2	BACnet -
		3	BACnet +
		4	BACnet -
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
J21	Thermostat Connections	1	24VAC
		2	Y1
		3	W1/O
		4	G (or VAV Changeover Input)
		5	W2
		6	Y2
		7	X2



**Table 1. Field Connections (continued)**

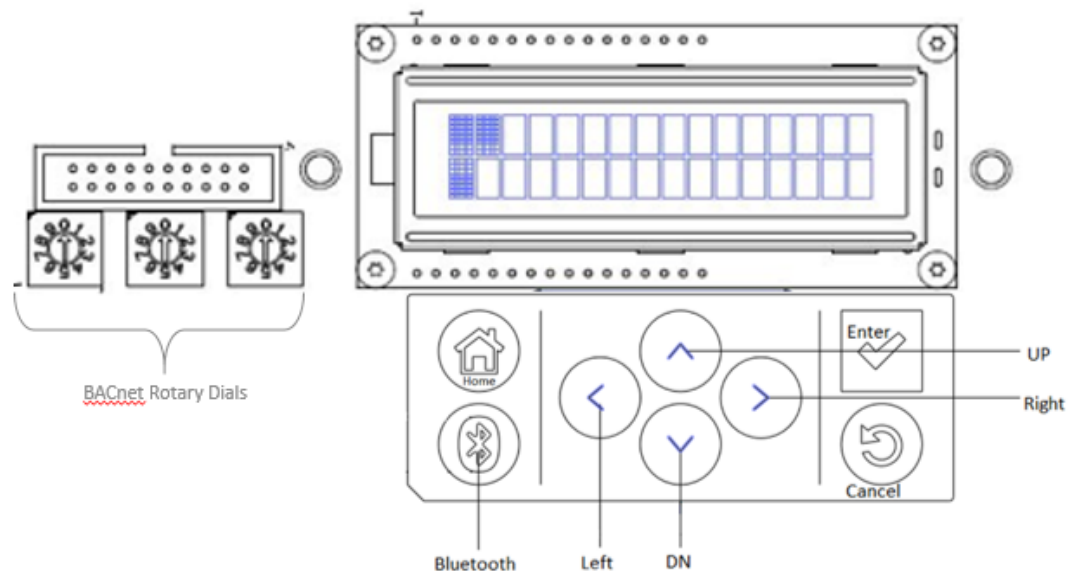
Connector	Function	Pin #	Signal
		8	1.5K Ohms Pull-down
		9	GND

## Unit Configuration

The Odyssey system 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 Application

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 .

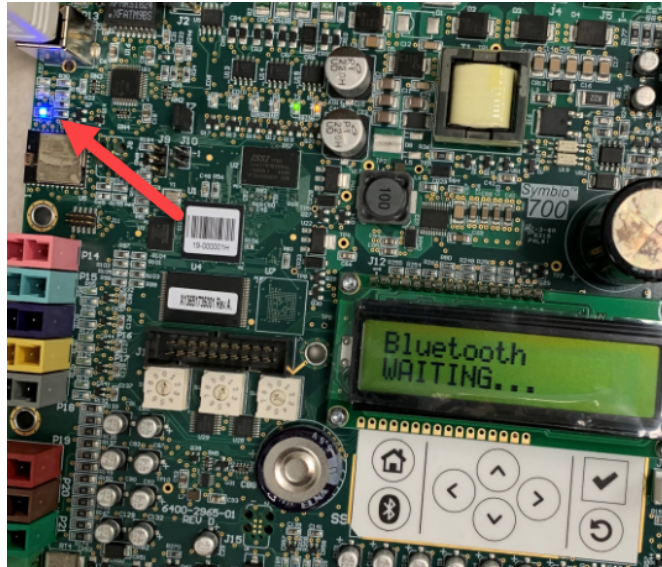
Connecting to the Symbio 700 controller

- 1. Enable Bluetooth® on your smart device.
- 2. Tap  on Symbio™ 700 keyboard/display to turn on Bluetooth.
- 3. Confirm the status of Bluetooth communications.

	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

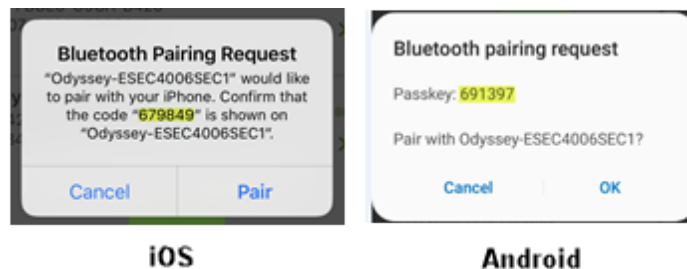
¹. The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. and any use of such marks by the company is under license.

Figure 4. Symbio 700 Bluetooth status



4. Start the mobile app on your smart device.
5. 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.
6. On the Unit List page, select the Symbio 700 controller that you want to pair with. If the controller is not listed, tap the refresh arrow in the upper right-hand corner of the screen.
7. 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 5. Bluetooth pairing



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

**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 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®
- Historical Alarms
- Firmware Updates
- Backup Restore

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).

# Startup Sequence

Under normal conditions, the Symbio 700 will startup over 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 startup, 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 2. 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 2	None	Cool
NA	OPEN	CLOSED	OPEN	OPEN	X	ON	Min	Stage 2	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 3. 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 2	None	Cool	
Disabled	NA	CLOSED	OPEN	OPEN	OPEN	X	X	ON	Min	Min	Stage 2	None	Cool	
Disabled	NA	OPEN	CLOSED	OPEN	OPEN	X	X	ON	Min	Min	Stage 2	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	

# 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.

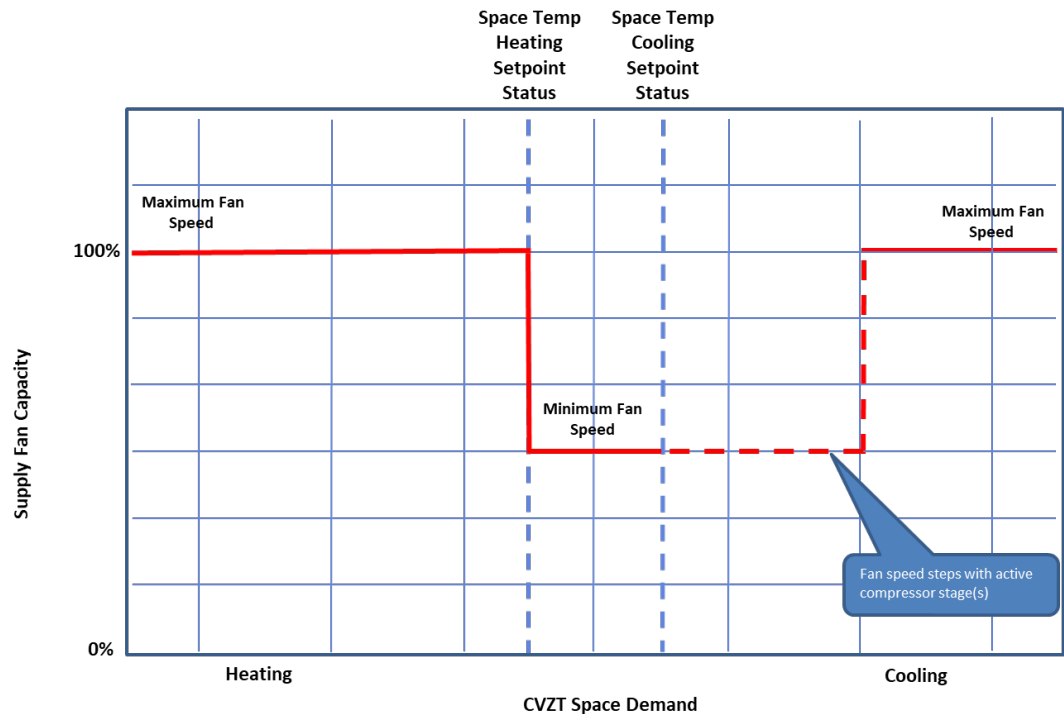
Symbio 700 supports two types of space temperature control: Single Loop Space Temperature Control and Single Zone Variable Air Volume.

## 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 the Symbio™ 700 control (no discharge air temperature sensor installed). In heating modes, with staged gas heat or staged electric heat installed, the supply fan will operate at maximum speed. In cooling modes, the supply fan will operate at the lowest speed allowed for the stage of cooling capacity and 100% when all compressor stages are on. When space temperature is between the heating and cooling setpoint, the supply fan operates at a minimum speed. 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 as space temperature approaches the desired space setpoint.

Figure 6. Multi-speed fan sequence of operation



## 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

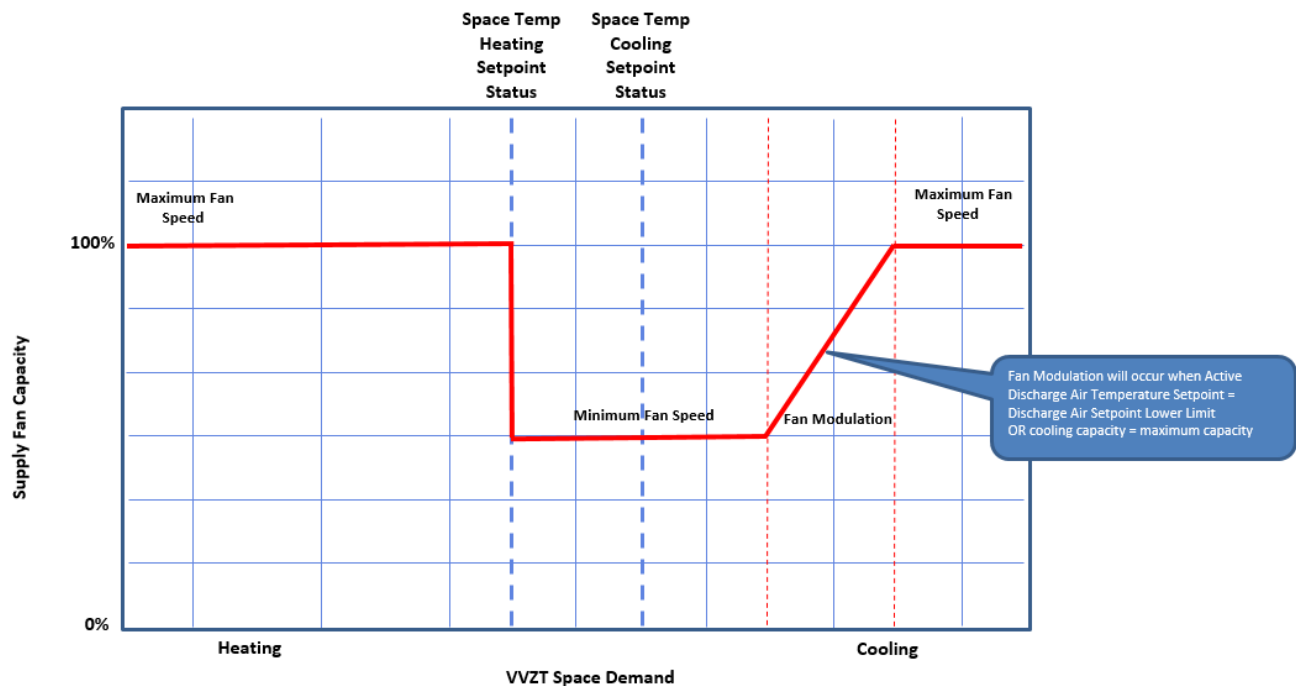


space temperature and discharge air temperature sensor are required input. If the discharge air temperature input becomes invalid, the control automatically reverts to Single Loop Space Temperature Control. Symbio™ 700 operates in Single Loop Space Temperature Control in heating modes when staged gas 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 allowed for the cooling capacity required to satisfy the load in the space. As cooling capacity increases, the supply fan speed will increase accordingly until it reaches 100% of its allowed range of operation.

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 7. Supply fan sequence of operation



## 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%.

If the unit discharge air temperature reduces to the Discharge Air Temperature Minimum Cool Limit setting or DX cooling reaches 100% capacity, cooling capacity increases will hold while the supply fan speed will continue to increase to 100% 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% to satisfy the discharge air temperature setpoint. If the economizer damper reaches 100% open and additional cooling capacity is required, the supply fan will increase toward 100% 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% and supply fan speed reaches 100% 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% 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.

## 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 on a Staged Heat unit:

- 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.

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. Additionally, 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% capacity. The supply fan will follow capacity control until it reaches 100% 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%. 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 not supported with staged heating capacity.

## 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. 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.

# 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% 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% 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%, 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% heat capacity is 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%.

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% 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% 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 two configurable dehumidification methods: Dew Point (default) or Relative Humidity control for occupied and unoccupied operation. All unit types require 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 relative 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% 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.

## Operation

Compressors are controlled to manage the humidity latent load by staging up as needed to achieve a Symbio™ 700 determined target evaporator coil dew point, based on space conditions.

Space temperature is managed by modulating the hot gas reheat valve. The valve will not open until the space temperature is below the space cooling setpoint minus 1.5°F and modulates to achieve the Reheat Discharge Air Temperature Setpoint to maintain space temperature control.

Anytime during occupied modes of operation, if the space temperature falls 3°F below the cooling setpoint or less than heating setpoint and the reheat valve is at maximum position for 5 minutes, dehumidification control terminates.

During unoccupied dehumidification, if space temperature falls below 60°F and the reheat valve is at maximum position for 5 minutes, dehumidification control 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% 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.

### 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.

### Dehumidification — Thermostat Control

Dehumidification control can be initiated utilizing a Space Humidity input or a Humidistat input. If Space Humidity input is used for control, dehumidification initiates when Space Humidity exceeds the Space Dehumidification Setpoint. Dehumidification terminates when Space Humidity is less than Space Dehumidification Setpoint minus the Space Dehumidification Setpoint Offset.

Utilizing a Humidistat, dehumidification becomes active when the Humidistat input is active. Dehumidification terminates when the Humidistat is no longer active.

When dehumidification is initiated all compressor outputs energize. The reheat valve will open and modulate to the Discharge Air Reheat Setpoint (default 70°F). Dehumidification terminates with any Y1 or Y2 call.

# Heat Types

Two heating types are supported, staged electric and staged 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, in Heat Cool Modes section for details.

## Staged Gas Heat

Symbio™ 700 supports 2 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% of available heating capacity.

### Staged Gas Heat Sequence

1. A call for heat is initiated by the Symbio 700 via a digital Modbus™ communication signal to the White Rogers ignition module.
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.

If ignition is not achieved within the trial period, the gas valve is shut off; the inducer continues to run for a 30 second post-purge period. Additional ignition trials follow the specified sequence. If 3 attempts for ignition have occurred without flame detection, the gas heat ignition controller will lock out. Note, see Appendix for a 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 ten 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 5 seconds and back to heat.

## Electric Heat — Staged

When staged electric heat is configured, the controller manages two outputs to provide two stages of heat control.

# Outdoor Air Damper Control

## Economizer Cooling

Symbio™ 700 supports a 0 to 100% 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 4. Economizer types**

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 5. 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
Dry Bulb	Outdoor Air Temperature
Differential Dry Bulb	Outdoor Air Temperature

**Table 5. Sensor data (continued)**

Economizer Enable Method	Required Sensor Data
	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% open. Economizing will not allow additional mechanical cooling until the damper position is 100% and supply fan has reached 100% 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% 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%.

- 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% default)
- Design Minimum OA Damper Position at Mid Fan Capacity (15% default)
- Design Minimum OA Damper Position at Full Fan Capacity (10% 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% default)
- Standby Minimum OA Damper Position at Mid Fan Capacity (15% default)
- Standby Minimum OA Damper Position at Full Fan Capacity (10% default)

## Outdoor Air Minimum Position Control

If 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%. 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 CO2. When Demand Controlled Ventilation is configured and Supply Fan Compensation is enabled, DCV resets the outdoor air damper minimum position based on space CO2 and supply fan speed. Decreasing CO2 levels will decrease damper position below the Design Minimum toward the DCV minimum damper position setpoint. Increasing CO2 level will increase damper position toward design minimum setpoint. DCV requires a valid space CO2 value from a building management system or wired sensor. If Space CO2 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 CO2 High Limit
- Space CO2 Low Limit

Occupied and Occupied-Bypass mode. If the supply fan is at 100% and CO2 is at the Space CO2 High Limit (1500 ppm default), the outdoor air damper will be positioned at Design Minimum OA Damper Position at Full Fan Capacity (10% default). As CO2 in the space reduces below the high limit, the outdoor air damper will close. If CO2 falls below the Space CO2 Low Limit, the damper position will be at DCV Minimum OA Damper Position at Full Fan Capacity (5% default).

Occupied-Standby mode. The damper will reset, based on CO2, 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 6. 0 to 100% economizer – variable speed supply fan**

Supply Fan Compensation	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

**Table 6. 0 to 100% economizer – variable speed supply fan (continued)**

Supply Fan Compensation	Demand Controlled Ventilation	Remote Minimum Position	Occupancy Status	Outdoor Air Damper Controlling Setpoints
				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	Any	Economizer Minimum Position Setpoint

**Table 7. 0 to 100% economizer – multi-speed supply fan (2-speed)**

Supply Fan Compensation	Demand Controlled Ventilation	Remote Minimum Position	Occupancy Status	Outdoor Air Damper Controlling Setpoints
Enabled	Installed	Installed	Occupied, Occupied Bypass	<b>Supply Fan at 100%:</b> Remote Minimum Position DCV Minimum OA Damper Position at Full Fan Capacity <b>Supply Fan at minimum speed:</b> 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	<b>Supply Fan at 100%:</b> Design Minimum OA Damper Position at Full Fan Capacity DCV Minimum OA Damper Position at Full Fan Capacity <b>Supply Fan at minimum speed:</b> 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	<b>Supply Fan at 100%:</b> Remote Minimum Position <b>Supply Fan at minimum speed:</b> Design Minimum OA Damper Position at Min Fan Capacity

**Table 7. 0 to 100% economizer – multi-speed supply fan (2-speed) (continued)**

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

### 0 to 50% Motorized Damper

When a 0 to 50% 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 8. 0 to 100% economizer – 0 to 50% 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% 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%. In Occupied mode, DCV will control the outdoor air damper based on Space CO<sub>2</sub> 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<sub>2</sub>. If Space CO<sub>2</sub> exceeds the Space CO<sub>2</sub> 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<sub>2</sub> falls below the Space CO<sub>2</sub> High Limit – 200 ppm, the supply fan will cycle Off. The supply fan will also cycle off if occupancy changes to Unoccupied.



# 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. See table below.

Unit Size (tons)	Range (%)	Default (%)
6	38-100	71
7.5	42-100	75
8.5	44-100	75
10	51-100	83
12.5	50-100	77
15	41-100	75
17.5	44-100	74
20	48-100	78
25	51-100	79

- 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 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

Under all normal running conditions, a 3–minute minimum ON and OFF timer is maintained for each compressor. Once a compressor is turned ON, it remains on for a minimum of 3 minutes. Once a compressor is turned OFF, it remains off for a minimum of 3 minutes. System overrides that require immediate shutdown of the equipment, test modes, and compressor diagnostics/protection functions can override these 3–minute timers. However for normal temperature and thermostatic-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 an 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 operates as 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.

# 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.

# Building Automation System Support Sequences

## Occupancy Mode

During expected occupied periods, the system will control to the user selected cooling and heating setpoints.

- The unoccupied setpoint temperatures are often adjusted higher for cooling (setup) and lower for heating (setback) to reduce building operating cost.
- Regardless of how the (occupied) fan mode is set, the supply fan mode is forced to AUTO during unoccupied periods to reduce supply fan operating costs.

There are two mechanisms available to control when units should switch between occupied and unoccupied modes:

- Building controllers provide signals to the unit to request occupied or unoccupied operation. Time-of-day scheduling within building controllers typically determine when the switching should occur.
- Stand Alone Unoccupied control is initiated by a contact closure that causes the unit to begin unoccupied control. In this mode, the controller will use the Unoccupied Cooling and Heating setpoints to determine capacity control needs. Stand Alone Unoccupied control is only applicable when the unit is not being controlled by a conventional thermostat interface.

## 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 3 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
- Equipment Shutdown Input
- Emergency Override BAS
- Phase Monitor

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

There are three sources for capacity limitation provided by the Symbio™ 700:

- BAS Lockout Function
- BAS Capacity Enable function
- Demand Limit Function

Depending on how the controller application is configured, different portions of the capacity limit control can be active at any time. Because of this, a priority scheme is built into the capacity limitation function.

If cooling is allowed from “Cooling Lockout BAS – Active” and if Demand Management is configured for Demand Limit, “Cooling Demand Limit Capacity Enable Setpoint – Active” or “Heating Demand Limit Capacity Enable Setpoint – Active” will be used to limit the unit capacity if it is active and “Cooling Capacity Enable – Active” is not limiting capacity. If “Cooling Capacity Enable – Active” is set to a value less than 100, “Cooling Capacity Enable – Active” has priority.

For capacity limiting values for user selected values, refer to the Appendix section of this document.

## 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

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%, 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, 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 minute
- **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 — CVZT, 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 Ffan will be controlled as needed to ensure safe unit operation.

Table 9. Service test mode states — cooling only

Service Test Step	Supply fan On/Off	Supply fan speed (VVZT, CVZT)	Supply fan speed (VVDA) <sup>(a)</sup>	VAV box relay request (VVDA)	Outdoor air damper position	Compr cool stage	Aux heat stage	Relief fan On/Off	Reheat pumpout solenoid On/Off <sup>(b)</sup>	Reheat valve 1	Heat cool mode status (VVZT, CVZT)	Heat cool mode status (VVDA) <sup>(c)</sup>
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
Fan On	ON	Min	Min	Open	Min	0	0	In Control	OFF	0	Test	Maximum Heat
Fan On Econ Open	ON	Min	Min	Open	100	0	0	In Control	OFF	0	Test	Maximum Heat
Ventilation Low Fan Speed	ON	Min	Min	Open	Design Min	0	0	In Control	OFF	0	Test	Maximum Heat
Ventilation Mid Fan Speed	ON	Effective Mid <sup>(d)</sup>	Effective Mid <sup>(d)</sup>	Open	Design Mid	0	0	In Control	OFF	0	Test	Maximum Heat
Ventilation High Fan Speed	ON	100	100	Open	Design Max	0	0	In Control	OFF	0	Test	Maximum Heat
Cool 1	ON	Min for Capacity	100	Open	Min	1	0	In Control	ON	0	Test	Maximum Heat
Cool 2	ON	Min for Capacity	100	Open	Min	2	0	In Control	ON	0	Test	Maximum Heat
Cool 3	ON	Min for Capacity	100	Open	Min	3	0	In Control	ON	0	Test	Maximum Heat
Cool 4	ON	Min for Capacity	100	Open	Min	4	0	In Control	ON	0	Test	Maximum Heat
Reheat	ON	Min for Capacity	100	Open	Min	5	0	In Control	OFF	50	Test	Maximum Heat
Heat 1	ON	Min for Capacity <sup>(e)</sup>	100	Open	Min	0	1	In Control	OFF	0	Test	Maximum Heat
Heat 2	ON	100	100	Open	Min	0	2	In Control	OFF	0	Test	Maximum Heat
Open Reheat Valve	OFF	0	0	Open	0	0	0	In Control	OFF	85 <sup>(f)</sup>	Test	Maximum Heat
Close Reheat Valve	OFF	0	0	Open	0	0	0	In Control	OFF	0	Test	Maximum Heat



Table 9. Service test mode states — cooling only (continued)

- (a) For VVDA units, Supply Fan Speed Request shall not be 100 before VAV boxes full open. If VAV box stroke timer has not expired, set fan speed to Min to avoid high duct static pressure trip.
- (b) 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.
- (c) For VVDA units, Heat Cool Mode Status shall be set to Maximum Heat to coordinate VAV Box Relay, when any service test step activated
- (d) Supply Fan Speed Request "Effective Mid" equals to  $(\text{Effective Maximum Fan Speed} + \text{Effective Minimum Fan Speed}) / 2$ .
- (e) For "Heat 1", the supply fan speed shall run at min speed due to Staged Gas Heat supply fan requirements.
- (f) Reheat Valve 1 Request is set to 85% in "Open Reheat Valve 1" step, because 85% is the max operating range during normal operation. Refer to the step motor reference docs for more detail information.

# Diagnostics

## 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
- Condenser Fan 1
- Condenser Fan 2
- Supply Fan
- Electric Heat Stage 1
- Electric Heat Stage 2
- Filter (Runtime only)
- Gas Heat Stage 1
- Gas Heat Stage 2

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 for any reason it is required 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.

## Compressor Proving Diagnostics

Three diagnostics can be generated based on the compressor proving input.

### 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, the controls generate the Diagnostic: Comp X Proving Trip and the following will occur:

- 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 the 15 minute compressor proving timeout has expired, if the unit is not under a “Diagnostic: Compressor 1 Proving Lockout” event

- The 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.*

- If a compressor's associated proving input does not CLOSE within 5 seconds of the compressor startup.

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

- All compressors on the associated circuit are de-energized immediately and they are locked out until a Reset Diagnostic action is initiated.
- The “Diagnostic: Compressor X Proving Lockout” diagnostic point is activated and the alarm output is activated.

### Diagnostic: Compressor X Contactor Failure

If a compressor proving input becomes Active for 5 continuous seconds when the associated compressor command output is Inactive, a Diagnostic: Compressor X Contactor Failure is generated and the following occurs:

- 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 activated and the alarm output is activated.

## Diagnostics – Low Pressure Cutout

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

#### Prior to Compressor Startup:

- If a compressor output is Off and its circuit’s LPC input is open, compressor operation is not inhibited, and the **Diagnostic: Circuit X LPC Trip** point will not be annunciated.

#### After Compressor Startup:

An LPC Bypass Delay function delays the setting of a low pressure cutout after compressor startup on a circuit 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

There are two diagnostics that can be generated based on the Compressor Low Pressure Cutout input:

### Diagnostic: Circuit X LPC Trip

- All Compressors Outputs on the effected circuit are commanded OFF
- The Diagnostic: Circuit X LPC Trip point is annunciated
- The circuit is disabled for 3 minutes
- The circuit’s LPC trip counter is incremented

After the 3 minute low pressure event timeout has expired, if the unit is not under a lockout event,

- The Diagnostic: Circuit X LPC Trip point is reset
- If the stage is still requested ON, the circuit is allowed to stage again
- If the Circuit runs for 3 minutes, its LPC Trip Count is reset to 0.

On 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’s LPC trip counter accumulates 4 low pressure events without the circuit running for the 3 minute minimum on time (counter is not reset), a Diagnostic: Circuit X LPC Lockout” is generated.

Once a Diagnostic: Circuit X LPC Lockout has been generated, the following occurs:

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

### Diagnostics – Alarm Indicator Status

Symbio™ 700 will support an Alarm Indicator Status point that if configured, drives the state of a relay output on the Customer Connection Module. This point is set to active when a failure occurs that functionally stops a critical component within the HVAC system.

For a list of all supported Symbio 700 Diagnostics and if it sets the Alarm Indicator, refer to the Appendix section of this document.

### Reset Diagnostic

A Reset Diagnostic function is responsible for ensuring that the Reset Diagnostic point is set to the right value under normal application control. The below sections describes how the Reset Diagnostic point is set to Active and Inactive.

#### Power-Up Reset or Exception/Override Mode Transition

At power-up or after the unit leaves an Exception or Override mode, all diagnostics are cleared, and the application starts over.

#### Reset Diagnostic Point

Diagnostic Resets throughout the controller application are triggered by the state of the Reset Diagnostic Point. The Reset Diagnostic point is setup as a last-write-wins point type, so it can be controlled by the local UI on the Symbio™ 700 or can be communicated.

#### 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 ≠ OFF triggers a Reset Diagnostic request.

#### Reset Diagnostic Point – Active to Inactive Transition

When the diagnostic reset function detects the state of the Reset Diagnostic point is Active, after 5 seconds, the Diagnostic Reset function sets the Reset Diagnostic point to Inactive.

# Troubleshooting

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

## Unit Communication Fault

The maximum time for the inter-module communications (IMC) bus is 15 seconds. If 15 seconds passes with no valid communications received from any of the Options modules, the Symbio™ 700 takes the following actions:

Module	Symbio 700 Response	Response Type
Symbio 700 Onboard I/O	<ul style="list-style-type: none"><li>Set Diagnostic: Unit Communications Failure</li><li>On-Board I/O Communication Status = Not Communicating</li><li>All unit functions will be shut down and I/O will go to their comm. loss state</li></ul>	Auto Reset
Customer Options Module	<ul style="list-style-type: none"><li>Set Diagnostic: Unit Communications Failure</li><li>Customer Options Module Communication Status = Not Communicating</li><li>All unit functions that have dependencies on data from other modules will be discontinued<ul style="list-style-type: none"><li>Ventilation Override functionality is discontinued</li><li>Alarm Indicator function is discontinued after seven seconds</li></ul></li></ul>	Auto Reset
Indoor Options Module	<ul style="list-style-type: none"><li>Set Diagnostic: Unit Communications Failure</li><li>Indoor Options Module Communication Status = Not Communicating</li><li>All unit functions that have dependencies on data from other modules will be discontinued<ul style="list-style-type: none"><li>All Electric Heat operation is discontinued</li><li>Discharge Air Temperature dependent control discontinued (SZVAV)</li><li>HGRH/Dehumidification control will be discontinued</li></ul></li></ul>	Auto Reset
Fresh Air Options Module	<ul style="list-style-type: none"><li>Set Diagnostic: Unit Communications Failure</li><li>Fresh Air Options Module Communication Status = Not Communicating</li><li>All unit functions that have dependencies on data from other modules will be discontinued<ul style="list-style-type: none"><li>All economizing operation is discontinued</li></ul></li></ul>	Auto Reset
Stepper Motor Module	<ul style="list-style-type: none"><li>Set Diagnostic: Unit Communications Failure</li><li>Stepper Motor Module Communication Status = Not Communicating</li><li>All unit functions that have dependencies on data from other modules will be discontinued<ul style="list-style-type: none"><li>All HGRH functionality will be discontinued</li><li>All Compressor related functionality will be discontinued</li></ul></li></ul>	Auto Reset

### Sensor Fault

On Symbio™ 700, if a sensor value goes outside of its minimum or maximum range, the point goes into an Alarm State. If the point in the Alarm State, we consider the sensor failed and take the following actions:

Fault	Symbio 700 Response	Response Type
Space Temperature Active	<ul style="list-style-type: none"> <li>Annunciated in the Active Alarm list.</li> <li>For specific unit operational response, see Space Temperature Control (CVZT/VVZT) section of this document.</li> <li>(VVDA) Loss of Space Temperature Active does not shutdown unit operation; rather, disables specific operating modes that require valid space temperature.</li> </ul>	Auto Reset
Discharge Air Temperature Local	<ul style="list-style-type: none"> <li>Annunciated in the Active Alarm list.</li> <li>For specific unit operational response, see Space Temperature Control (CVZT/VVZT) section of this document.</li> <li>(VVDA) Loss of Discharge Air Temperature Sensor results in a loss of heating and cooling capacity.</li> </ul>	Auto Reset
Outdoor Air Temperature Active	<ul style="list-style-type: none"> <li>Annunciated in the Active Alarm list.</li> <li>Economizer cooling disabled.</li> </ul>	Auto Reset
Coil Temperature Sensor 1	<ul style="list-style-type: none"> <li>Annunciated in the Active Alarm list.</li> <li>If Outdoor Air Temperature &lt; 52° F, Demand Defrost will be disabled and timed defrost will be used.</li> </ul>	Auto Reset
Coil Temperature Sensor 2	<ul style="list-style-type: none"> <li>Annunciated in the Active Alarm list.</li> <li>If Outdoor Air Temperature &lt; 52°F, Demand Defrost will be disabled and timed defrost will be used.</li> </ul>	Auto Reset
Space Humidity Sensor	<ul style="list-style-type: none"> <li>Annunciated in the Active Alarm list.</li> <li>Space Dehumidification disabled.</li> <li>Comparative Enthalpy disabled.</li> </ul>	Auto Reset
Space CO2 Sensor	<ul style="list-style-type: none"> <li>Annunciated in the Active Alarm list.</li> <li>Demand Controlled Ventilation disabled.</li> </ul>	Auto Reset
Duct Static Pressure Local	VVDA: Loss of Duct Static Pressure Sensor shall result in a unit shutdown.	Auto Reset
Duct Static Pressure Local Lockout	VVDA: Loss of Duct Static Pressure Sensor three times within 1-hour shall result in a unit shutdown.	Manual Reset
Duct Static Pressure Limit Trip	VVDA: The supply air static pressure exceeded the Supply Air Static Pressure High Limit Setpoint. Supply fan shall turn off (immediate shutdown) for 3 minutes before being allowed to start.	Auto Reset
Duct Static Pressure Limit Lockout	VVDA: 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. (If the fan runs for 3 continuous minutes the counter will be reset.)	Manual Reset

### Compressor Fault

Symbio™ 700 supports compressor safety functionality to keep the compressors from operating in an undesirable condition. If a compressor safety failure occurs, the following actions occur:

Fault	Symbio 700 Response	Response Type
LPC Lockout	For specific operation associated with the LPC diagnostics, refer to the Compressor Protection section of this document.	Manual Reset
Proving Lockout	For specific operation associated with the proving diagnostics, refer to the Compressor Protection section of this document.	Manual Reset
Contactor Failure	For specific operation associated with the proving diagnostics, refer to the Compressor Protection section of this document.	Manual Reset

## Supply Fan Fault

The following failures are derived either through direct data monitoring from the Modbus™ device, or through a combination of data monitoring and additional failure criteria.

Failure	Failure Detection	Symbio 700 Response	Response Type
Diagnostic: ERM Supply Fan 1 Failure	If while the Supply Fan 1 ERM is requested to run, the ERM Actual Speed from the drive is set to < 30 RPM for 40 continuous seconds, this failure will be detected	<ul style="list-style-type: none"> <li>Diagnostic: Supply Fan 1 Failure will be set to "Active"</li> <li>All unit functions will be shut down immediately</li> </ul>	Manual Reset
Diagnostic: ERM Supply Fan 2 Failure	If while the Supply Fan 2 ERM is requested to run, the ERM Actual Speed from the drive is set to < 30 RPM for 40 continuous seconds, this failure will be detected	<ul style="list-style-type: none"> <li>Diagnostic: Supply Fan 2 Failure will be set to "Active"</li> <li>All unit functions will be shut down immediately</li> </ul>	Manual Reset
Diagnostic: ERM Supply Fan Locked Motor - 1	Something has blocked the rotor from turning. (Motor Auto Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Supply Fan Locked Motor – 1 will be set to "Active"</li> <li>All unit functions will be shut down immediately</li> </ul>	Auto Reset
Diagnostic: ERM Supply Fan Locked Motor - 2	Something has blocked the rotor from turning. (Motor Auto Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Supply Fan Locked Motor – 2 will be set to "Active"</li> <li>All unit functions will be shut down immediately</li> </ul>	Auto Reset
Diagnostic: ERM Supply Fan Motor Overheated - 1	The motor thermocouples have reached a too-high temperature. (Motor Manual Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Supply Fan Motor Overheated - 1 will be set to "Active"</li> <li>All unit functions will be shut down immediately</li> </ul>	Auto Reset
Diagnostic: ERM Supply Fan Motor Overheated - 2	The motor thermocouples have reached a too-high temperature. (Motor Manual Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Supply Fan Motor Overheated – 2 will be set to "Active"</li> <li>All unit functions will be shut down immediately</li> </ul>	Auto Reset
Diagnostic: ERM Supply Fan Power Mod Overheated - 1	The Rectifier thermocouple has reached a too-high temperature. (Motor Manual Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Supply Fan Power Mod Overheated - 1 will be set to "Active"</li> <li>All unit functions will be shut down immediately</li> </ul>	Auto Reset

Failure	Failure Detection	Symbio 700 Response	Response Type
Diagnostic: ERM Supply Fan Power Mod Overheated - 2	The Rectifier thermocouple has reached a too-high temperature. (Motor Manual Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Supply Fan Power Mod Overheated – 2 will be set to “Active”</li> <li>All unit functions will be shut down immediately</li> </ul>	Auto Reset
Supply Fan 1 Communication Status is “Not Communicating”	If continual loss of communication between the controller and the Supply Fan 1 ERM has occurred for a 30-second period, this failure will be detected and the controller will take action.	All unit functions will be shut down	Auto Reset
Supply Fan 1 Communication Status is “Not Communicating”	If continual loss of communication between the controller and the Supply Fan 2 ERM has occurred for a 30-second period, this failure will be detected and the controller will take action.	All unit functions will be shut down	Auto Reset
Diagnostic: ERM Fault Supply Fan - 1	ERM Fault. Numerous drive faults can cause this general fault. Reference the EBM-PAPST Installation and Operating manual for a list of fault codes and descriptions. (Clears on Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Fault Supply Fan – 1 will be set to “Active”</li> <li>All unit functions will be shut down</li> </ul>	Auto Reset
Diagnostic: ERM Fault Supply Fan - 2	ERM Fault. Numerous drive faults can cause this general fault. Reference the EBM-PAPST Installation and Operating manual for a list of fault codes and descriptions. (Clears on Reset)	<ul style="list-style-type: none"> <li>Diagnostic: ERM Fault Supply Fan – 1 will be set to “Active”</li> <li>All unit functions will be shut down</li> </ul>	Auto Reset

## Staged Gas Heat Fault

The following diagnostics are derived from data monitoring via Modbus™ ignition controller, or through a combination of data monitoring and additional failure criteria.

Fault	Fault Detection	Symbio 700 Response	Response Type
Diagnostic: Heat Failure	Active when certain diagnostics below.	Status Only	Auto Reset
Diagnostic: IGN1 Module Lockout	<ul style="list-style-type: none"> <li>Monitored directly from Modbus.</li> <li>Active when any lockout is active on the IGN 1 controller</li> </ul>	<ul style="list-style-type: none"> <li>All heating operation is terminated/ disabled</li> <li>Diagnostic: Heat Failure set to Active</li> </ul>	Auto Reset
Diagnostic: IGN1 Heating High Temp Limit Open	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset
Diagnostic: IGN1 Flame Rollout Switch Open	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset
Diagnostic: IGN1 Inducer Proving Switch Fail Closed	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset
Diagnostic: IGN1 Inducer Proving Switch Fail Open	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset
Diagnostic: IGN1 No Flame Sensed on Ignition	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset



Fault	Fault Detection	Symbio 700 Response	Response Type
Diagnostic: IGN1 Flame Sensed w/Gas Valve Off	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset
Diagnostic: IGN1 Hardware Configuration Error	Gas Heat Ignition Module via Modbus	<ul style="list-style-type: none"> <li>All heating operation is terminated/disabled</li> <li>Diagnostic: Heat Failure set to Active</li> </ul>	Auto Reset
Diagnostic: IGN1 Weak Flame	Gas Heat Ignition Module via Modbus	Status Only	Auto Reset
Diagnostic: IGN1 Gas Valve Error	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset
Diagnostic: IGN1 Module Failure	Gas Heat Ignition Module via Modbus	Status Only (Ignition Module Lockout)	Auto Reset
Gas Heat Ignition Module 1 Communication Status is "Not Communicating"	When Gas Heat Ignition Module 1 Communication Status is "Not Communicating" for 30 continuous seconds.	<ul style="list-style-type: none"> <li>All heating operation is terminated/disabled</li> <li>Diagnostic: Heat Failure set to Active</li> </ul>	Auto Reset

## Economizer Fault

Table 10. Economizer cooling 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	<ul style="list-style-type: none"> <li>Economizer Cooling Disabled</li> <li>OA Damper Closes to Economizer Minimum Position Setpoint Control</li> </ul>
	Outdoor Air Humidity Sensor	Absolute Temperature (Reference Dry Bulb)
Reference Enthalpy	Outdoor Air Temperature Sensor	<ul style="list-style-type: none"> <li>Economizer Cooling Disabled</li> <li>OA Damper Closes to Economizer Minimum Position Setpoint Control</li> </ul>
	Outdoor Air Humidity Sensor	Absolute Temperature (Reference Dry Bulb)
Dry Bulb	Outdoor Air Temperature Sensor	<ul style="list-style-type: none"> <li>Economizer Cooling Disabled</li> <li>OA Damper Closes to Economizer Minimum Position Setpoint Control</li> </ul>
Differential Dry Bulb	Outdoor Air Temperature Sensor	<ul style="list-style-type: none"> <li>Economizer Cooling Disabled</li> <li>OA Damper Closes to Economizer Minimum Position Setpoint Control</li> </ul>
	Return Air Temperature Sensor	Absolute Temperature (Reference Dry Bulb)
Fresh Air Options Module	Communications Failure	All economizing operation is discontinued

## Outdoor Air Damper Fault Detection and Diagnostics (FDD)

The outdoor air damper fault will have two fault detection components, faults that are generated when operating in minimum ventilation mode and another set when the damper is being controlled by the economizer:

- **FDD: Excessive Outdoor Air**

In minimum ventilation mode and the damper feedback position is >10% of the damper commanded value for 5 continuous minutes.

- **FDD: Outdoor Air Damper Not Modulating**

In minimum ventilation mode and the damper feedback is <10% of the damper commanded value for 5 continuous minutes.

- **FDD: Unit Economizing When It Should Not**

In economizer cooling mode and the damper feedback is >10% of the damper commanded value for 5 continuous minutes.

- **FDD: Unit Not Economizing When It Should**

In economizer cooling mode and the damper feedback is <10% of the damper commanded value for 5 continuous minutes.

# Appendix A

## Supply Fan

### Multi-Speed/ERM

**Table 11. Multi-speed supply fan speeds (three stages of cooling)**

Unit Operation	Supply Fan Speed (%)
Off	0
Fan Only	66
Cooling Stage 1	66
Cooling Stage 2	66
Cooling Stage 3	100
Electric/Gas Heat 1	66
Electric/Gas Heat 2	100

**Table 12. Multi-speed supply fan speeds (four stages of cooling)**

Unit Operation	Supply Fan Speed (%)
Off	0
Fan Only	66
Cooling Stage 1	66
Cooling Stage 2	66
Cooling Stage 3	66
Cooling Stage 4	100
Electric/Gas Heat 1	66
Electric/Gas Heat 2	100

### Variable Speed/ERM — Space Temperature Control

**Table 13. Variable speed space temperature control supply fan speeds (three stages of cooling)**

Unit Operation	Minimum Supply Fan Speed (%)
Off	0
Fan Only	50
Cooling Stage 1	50
Cooling Stage 2	50
Cooling Stage 3	100
Electric/Gas Heat 1	66
Electric/Gas Heat 2	100

**Table 14. Variable speed space temperature control supply fan speeds (four stages of cooling)**

Unit Operation	Minimum Supply Fan Speed (%)
Off	0
Fan Only	50

**Table 14. Variable speed space temperature control supply fan speeds (four stages of cooling) (continued)**

Unit Operation	Minimum Supply Fan Speed (%)
Cooling Stage 1	50
Cooling Stage 2	50
Cooling Stage 3	65
Cooling Stage 4	100
Electric/Gas Heat 1	66
Electric/Gas Heat 2	100%

### Variable Speed/ERM — Discharge Air Temperature Control

**Table 15. Variable speed discharge temperature control supply fan speeds (three stages of cooling)**

Unit Operation	Minimum Supply Fan Speed (%)
Off	0
Fan Only	50
Cooling Stage 1	50
Cooling Stage 2	50
Cooling Stage 3	50
Electric/Gas Heat 1	100
Electric/Gas Heat 2	100

**Table 16. Variable speed discharge temperature control supply fan speeds (four stages of cooling)**

Unit Operation	Minimum Supply Fan Speed (%)
Off	0
Fan Only	50
Cooling Stage 1	50
Cooling Stage 2	50
Cooling Stage 3	50
Cooling Stage 4	50
Electric/Gas Heat 1	100
Electric/Gas Heat 2	100

## Compressor Staging

### Thermostat Staging

For equipment staging response to a conventional thermostat signals, refer to the Conventional Thermostat sequence of operation above.

## Cooling Only (Electric Heat) – CVZT & VVZT

**Table 17. Dual compressor cooling staging (manifold)**

Unit Operation	Unit Response
Cool Stage 1	Compressor 1 Output ON
Cool Stage 2	Compressor 2 Output ON
Cool Stage 3	Compressor 1 Output ON + Compressor 2 Output ON

**Table 18. Dual unloading compressor cooling staging**

Unit Operation	Unit Response
Cool Stage 1	Compressor 1 Output ON
Cool Stage 2	Compressor 1 Output ON + Compressor 2 Unloader Solenoid ON
Cool Stage 3	Compressor 2 Output ON
Cool Stage 4	Compressor 1 Output ON + Compressor 1 Unloader Solenoid ON + Compressor 2 Output ON

## Condenser Fan Operation

### Thermostat, CVZT, VVZT, and VVDA

**Table 19. Single condenser fan systems (cooling only)**

Unit Operation	Unit Response
Compressor 1 Output ON	Condenser Fan Output 1 ON
Compressor 2 Output ON	Condenser Fan Output 1 ON
Compressor 1 Output ON + Compressor 2 Output ON	Condenser Fan Output 1 ON

**Table 20. Dual condenser fan (cooling only)**

Unit Operation	Unit Response
Compressor 1 Output ON	Condenser Fan Output 1 ON + Condenser Fan Output 2 ON
Compressor 2 Output ON	Condenser Fan Output 1 ON + Condenser Fan Output 2 ON
Compressor 1 Output ON + Compressor 2 Output ON	Condenser Fan Output 1 ON + Condenser Fan Output 2 ON

**Table 21. Dual condenser fan - independent airstream (cooling only and heat pump)**

Unit Operation	Unit Response
Compressor 1 Output ON	Condenser Fan Output 1 ON
Compressor 2 Output ON	Condenser Fan Output 2 ON
Compressor 1 Output ON + Compressor 2 Output ON	Condenser Fan Output 1 ON + Condenser Fan Output 2 ON

## Electric Heat

**Table 22. 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 23. 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

## Diagnostics and Alarm Indicator Status

**Table 24. Supported diagnostics and alarm relay functionality**

Diagnostic/Alarm	Alarm Indicator
Diagnostic: Unit Communications Failure	Y
On-Board I/O Communication Status	Y
Customer Options Module Communication Status	Y
Indoor Options Module Communication Status	Y
Heat Options Module Communication Status	Y
Stepper Motor Module Communication Status	Y
Diagnostic: Excessive Outdoor Air	Y
Diagnostic: Outdoor Air Damper Not Modulating	Y
Diagnostic: Unit Economizing When It Should Be	Y
Diagnostic: Unit Not Economizing When It Should	Y
Diagnostic: Gas Heat Supply Airflow Limit Trip	Y
Diagnostic: Heat Failure	Y
Diagnostic: IGN1 Module Lockout	N
Diagnostic: IGN1 Heating High Temp Limit Open	N
Diagnostic: IGN1 Flame Rollout Switch Open	N
Diagnostic: IGN1 Inducer Proving Switch Fail Closed	N
Diagnostic: IGN1 Inducer Proving Switch Fail Open	N
Diagnostic: IGN1 No Flame Sensed on Ignition	N
Diagnostic: IGN1 Flame Sensed w/Gas Valve Off	N
Diagnostic: IGN1 Hardware Configuration Error	N
Diagnostic: IGN1 Weak Flame	N
Diagnostic: IGN1 Gas Valve Error	N
Diagnostic: IGN1 Module Failure	N
Diagnostic: Circuit 1 LPC Lockout	Y
Diagnostic: Circuit 2 LPC Lockout	Y
Diagnostic: Compressor 1 Proving Lockout	Y
Diagnostic: Compressor 2 Proving Lockout	Y
Diagnostic: Compressor 1 Contactor Failure	Y
Diagnostic: Compressor 2 Contactor Failure	Y
Diagnostic: Circuit 1 LPC Trip	N

**Table 24. Supported diagnostics and alarm relay functionality (continued)**

Diagnostic/Alarm	Alarm Indicator
Diagnostic: Circuit 2 LPC Trip	N
Diagnostic: Comp 1 Proving Trip	N
Diagnostic: Comp 2 Proving Trip	N
Diagnostic: Maintenance Required	N
Discharge Air Temperature Local	Y
Outdoor Air Temperature Active	Y
Outdoor Air Humidity Active	Y
Space CO2 Concentration Active	N
Space Humidity Active	N
Space Temperature Active	Y
Diagnostic: Condensate Overflow Lockout	Y
Diagnostic: Supply Fan Proving Failure	Y
Diagnostic: ERM Supply Fan 1 Failure	Y
Diagnostic: ERM Supply Fan 2 Failure	Y
Diagnostic: ERM Supply Fan Locked Motor - 1	Y
Diagnostic: ERM Supply Fan Locked Motor - 2	Y
Diagnostic: ERM Supply Fan Motor Overheated - 1	Y
Diagnostic: ERM Supply Fan Motor Overheated - 2	Y
Diagnostic: ERM Supply Fan Power Mod Overheated - 1	Y
Diagnostic: ERM Supply Fan Power Mod Overheated - 2	Y
Supply Fan 1 Communication Status	Y
Supply Fan 2 Communication Status	Y
Diagnostic: ERM Fault Supply Fan - 1	Y
Diagnostic: ERM Fault Supply Fan - 2	Y
Phase Monitor Status	Y
Diagnostic: Duct Static Pressure Local Trip	N
Diagnostic: Duct Static Pressure Local Lockout	Y
Diagnostic: Duct Static Pressure Limit Trip	N
Diagnostic: Duct Static Pressure Limit Lockout	Y

## Emergency and Ventilation Override

Table 25. Emergency and ventilation override

Inputs	Outputs					
Emergency Override BAS	EOM Supply Fan On/Off Request	EOM Supply Fan Speed Request	EOM Compres- sor Cool Stage Request	EOM Compres- sor Heat Stage Request	EOM Auxiliary Heat Stage Request	Heat Cool Mode Status
Point	State	%	Value	Value	Value	Point
2 = EMERG_PRESSURIZE	ON	100	0	0	0	Fan Only
3 = EMERG_DEPRESSURIZE	OFF	0	0	0	0	Fan Only
4 = EMERG_PURGE	ON	100	0	0	0	Fan Only
5 = EMERG_SHUTDOWN	OFF	0	0	0	0	OFF
6 = EMERG_FIRE	OFF	0	0	0	0	OFF
1 = EMERG_NORMAL	Auto	Auto	Auto	Auto	Auto	Auto

## 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.





Trane and American Standard create comfortable, energy efficient indoor environments for commercial and residential applications. For more information, please visit [trane.com](http://trane.com) or [americanstandardair.com](http://americanstandardair.com).

Trane and American Standard have a policy of continuous product and product data improvement and reserve the right to change design and specifications without notice. We are committed to using environmentally conscious print practices.