Application Guide

Symbio™ 700 Controller

with Foundation™ Packaged Rooftop Units 15 to 25 Tons

⚠ 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.

September 2024 **ACC-APG004A-EN**

Introduction

Read this manual thoroughly before operating or servicing this unit.

Warnings, Cautions, and Notices

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

The three types of advisories are defined as follows:

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

Important Environmental Concerns

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

Important Responsible Refrigerant Practices

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

⚠ WARNING

Proper Field Wiring and Grounding Required!

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.**

⚠ WARNING

R-454B Flammable A2L Refrigerant!

Failure to use proper equipment or components as described below could result in equipment failure, and possibly fire, which could result in death, serious injury, or equipment damage. The equipment described in this manual uses R-454B refrigerant which is flammable (A2L). Use ONLY R-454B rated service equipment and components. For specific handling concerns with R-454B, contact your local representative.

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Introduction

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

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

- Conventional Thermostat Control (T-Stat) - Heating and cooling operation for space comfort managed by conventional thermostat inputs.
- Enhanced Thermostat Controls - cooling operation for space comfort managed by conventional thermostats and discharge air temperature.
- Constant Volume Zone Temperature Control (CVZT) - Multi-speed supply fan control to manage space comfort.
- Variable Volume Zone Temperature Control (VVZT) - The modulating supply fan speed modulates with heating or cooling capacity to maintain space comfort.

These configurations can be used with standard cooling systems.

Symbio 700 for Foundation provides Standard Controller functionality for advanced troubleshooting, secure remote connectivity via Trane Connect, and for access to the Symbio Service and Installation mobile app via a Bluetooth connection. The Symbio 700 configuration for Foundation equipment does not support:

- BACnet® MSTP/IP
- Modbus™ TCP/IP
- Air-Fi® communications
- Custom TGP2 programming
- XM30/XM332 expansion modules
- Upgrades to an advanced controller

This guide provides information about the configuration, control capabilities and troubleshooting of the Foundation 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*
- RT-PRC125*-EN: *Product Catalog, Foundation™ Packaged Rooftop Units Cooling and Gas/Electric 15 to 25 Tons, 60 Hz*
- RT-PRC127*-EN: *Quick Reference Guide, Foundation™ Packaged Rooftop Units Cooling and Gas/Electric 15 to 25 Tons, 60 Hz*
- RT-SVX095*-EN: *Installation, Operation, and Maintenance, Foundation™ Packaged Rooftop Units Cooling and Gas/Electric 15 to 25 Tons, 60 Hz*

Symbio 700 Overview

Field Connection

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

Figure 1. Symbio 700 field connections

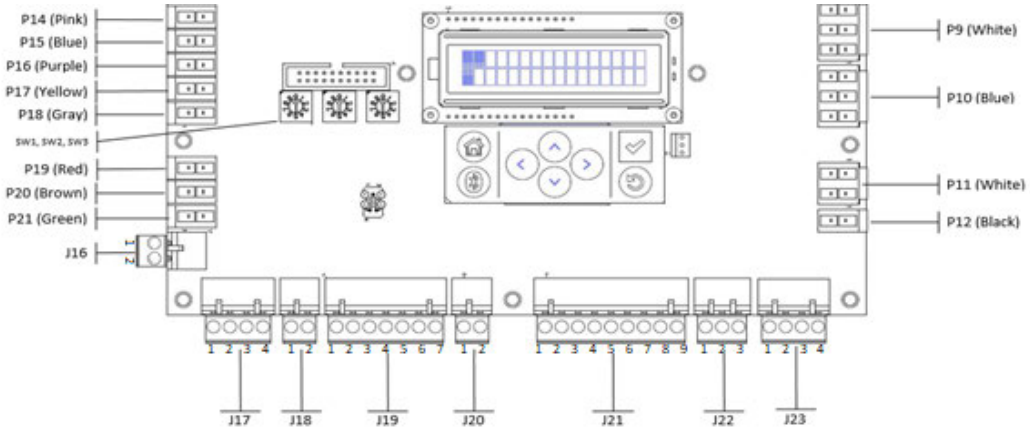


Table 1. Field connections

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

Table 1. Field connections (continued)

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

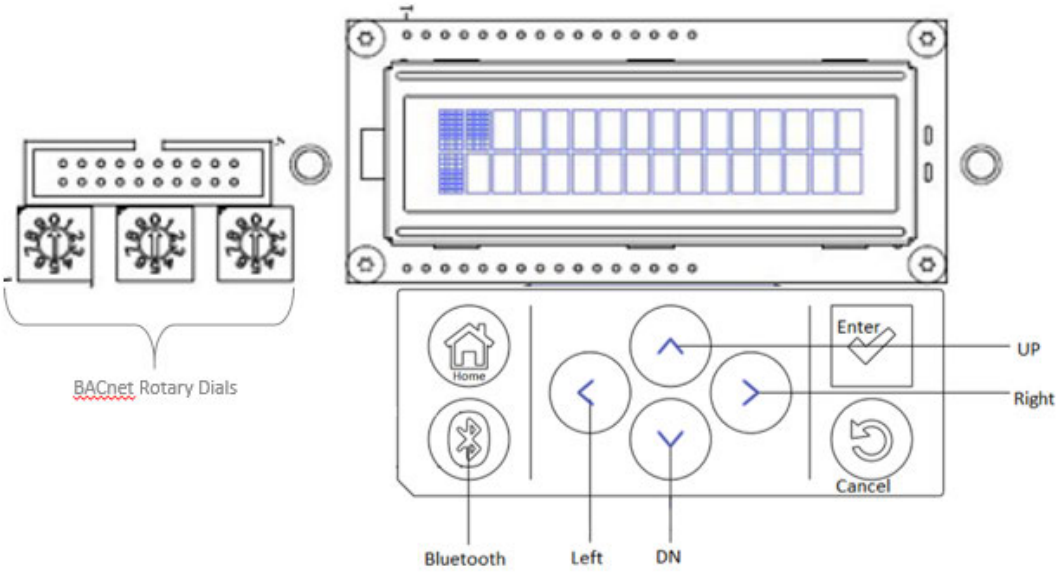
Unit Configuration

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

Onboard User Interface

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

Figure 2. Symbio 700 onboard user interface



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

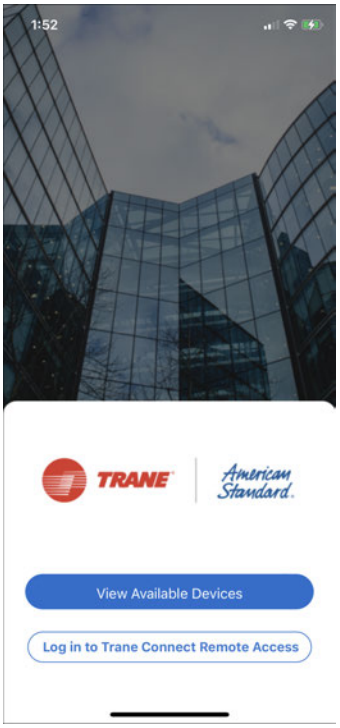
To configure the unit, navigate to the utilities menu and press **Enter**. Once in the utilities menu the user has additional submenu options. This allows the user to navigate and configure the appropriate setting quickly and easily.

Mobile App

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

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

Figure 3. Trane Symbio service and installation mobile app



Bluetooth Pairing

Quick Connection Instructions

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

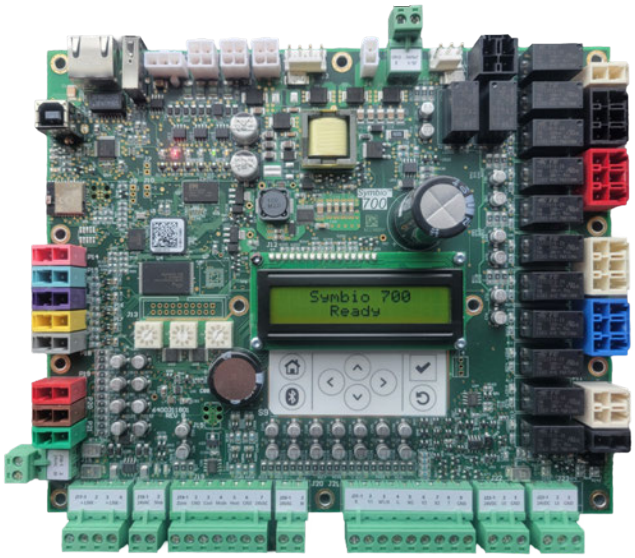
1. Turn on Bluetooth®[1].
2. Tap  .
3. Start the app. Tap **View Available Devices**.
4. Select the controller.
5. Tap **OK** to pair.
6. Tap  .

Connecting to the Symbio™ 700 controller

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

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

Figure 4. Symbio 700 controller

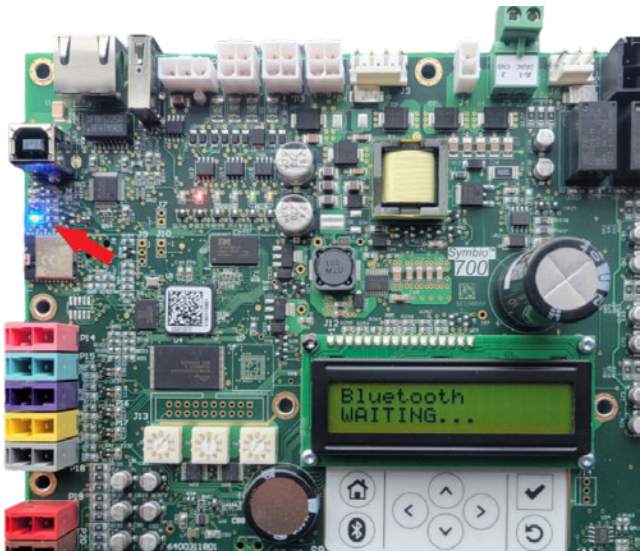


3. Tap  on Symbio 700 keyboard/display to turn on Bluetooth.
4. Confirm the status of Bluetooth communications. A solid blue LED indicates a successful pairing.

Table 2. Bluetooth communication status

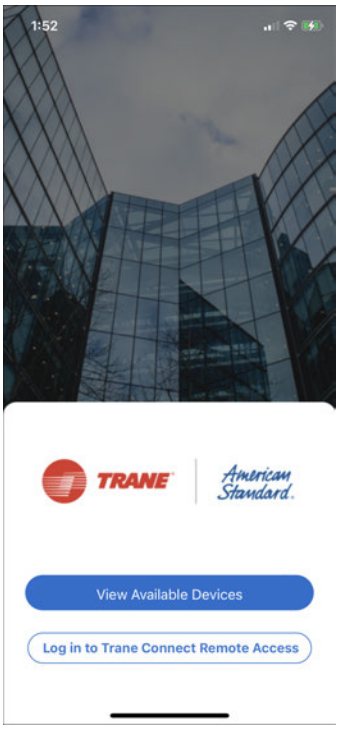
	Blue LED	Display	Description
Tap for On/Off	Off	NOT CONNECTED	Bluetooth Off
	Blinking	WAITING...	Bluetooth On — Not Paired
	On Solid	CONNECTED	Bluetooth On — Connected/ Paired

Figure 5. Symbio 700 bluetooth status



5. Start the mobile app on your smart device.

Figure 6. Login screen

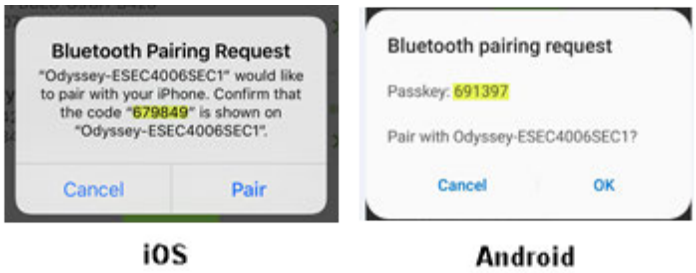


6. On the login screen, tap **View Available Devices** in the lower section of the screen. Or Trane personnel can login using their Trane Connect username and password.
7. On the Unit List page, select the Symbio 700 controller to which you want to pair. If the controller is not listed, tap the refresh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

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

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

Figure 7. Bluetooth pairing



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

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

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

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

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

- Historical Alarms
- Firmware Update (includes both the Symbio 700 Module and the Options Modules)
- Backing up and Restoring the database
- Transfer Settings from one controller to another
- Return the Symbio 700 to its Factory Default configuration by using the Factory Default Database (if available)

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

Option Modules

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

Table 3. Option modules

Function	Customer Connection Module	Indoor Options Module	Fresh Air Options Module	Stepper Motor Module
External Auto/Stop	X			
Ventilation Overrides	X			
Alarm Output	X			
Remote Minimum Position	X			
Condensate Overflow		X		
Electric Heat		X		
0 to 100% Economizer			X	
Relief Fan Control			X	

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

Figure 8. Customer connection options module

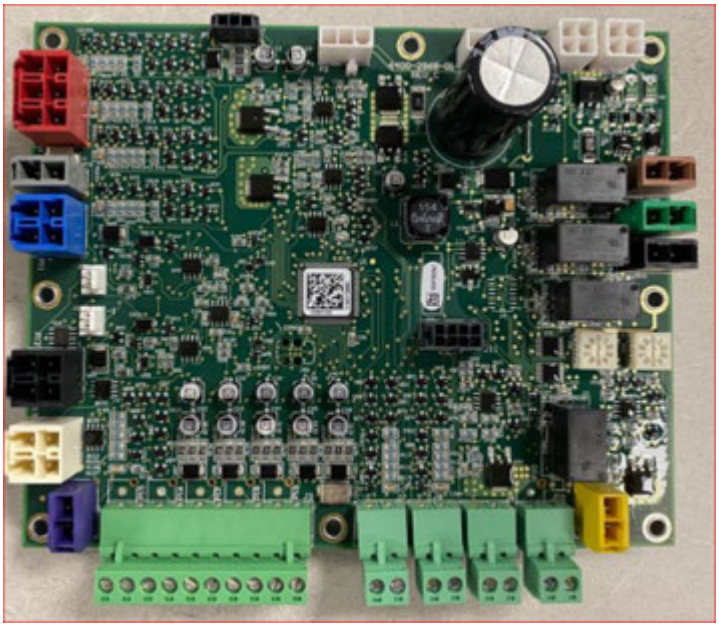


Table 4. Customer connection options module – Electrical connections

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

Option Module Address

All option modules are factory wired with an eight-position address plug, located toward the center of the module. Improperly addressed module creates a communication diagnostic. See Figure 8, p. 14 for a customer connection option module with address plug uninstalled (J11). When replacing any options module, it is important to remove the address plug from the replaced board and plugging into the replacement options module.

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

Table 5. Option module rotary switch address setting

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

Backing Up and Restoring the Database

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

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

Start-Up Sequence

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

Conventional Thermostat Sequence of Operation

When the Foundation 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 6. Cooling only, without outside air

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

Table 7. Cooling only, with outside air

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

Enhanced Thermostat Control

Enhanced Thermostat Control is a feature available for equipment with three or more stages of compressor cooling. This capability utilizes all available compressor stages in cooling modes of operation when the Symbio™ 700 is configured for Conventional Thermostat control.

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

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

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

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

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

Enhanced Thermostat Control is provided when the equipment meets the following criteria:

- Unit has 3 or more stages of compressor cooling.
- Thermostat Control Method Request is set to Enhanced.
- Discharge air temperature sensor is installed

If any of these criteria are not met, the control system will default to conventional 2-stage compressor cooling.

Table 8, p. 20 provides a summary of Enhanced Thermostat Control in cooling modes of operation. All heating modes of operation (not covered in the table), operate as defined by Conventional Thermostat control.

Table 8. Enhanced thermostat control operation in cooling modes

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

Table 8. Enhanced thermostat control operation in cooling modes (continued)

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

[a] Discharge air temperature is controlled to the Economizer Discharge Air Setpoint (Default = 55°F).

Space Temperature Control

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

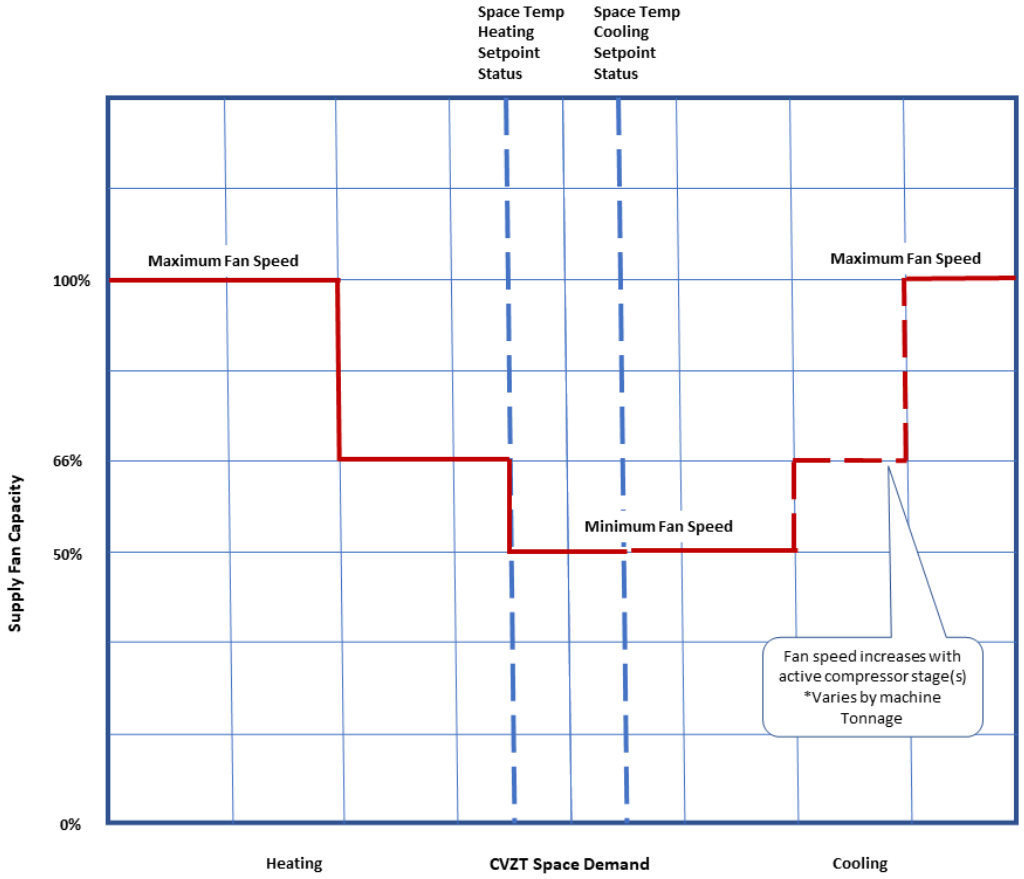
Symbio 700 supports two types of space temperature control: Single Loop Space Temperature Control and Single Zone Variable Air Volume.

Single Loop Space Temperature Control

Configured VVZT and CVZT System Types operate in Single Loop Space Temperature Control when only a space temperature input is provided to the Symbio™ 700 controller (no discharge air temperature sensor installed). In heating modes, staged gas heat, the supply fan will operate at a minimum speed (stage 1) and 100 percent (stage 2). Electric heat, the supply fan operates at 100 percent for all stages. In cooling modes, the supply fan will operate at the lowest speed allowed for the stage of cooling capacity and 100 percent when all compressor stages are on. When space temperature is between the heating and cooling setpoint, the supply fan operates at a minimum speed. See Table 24, p. 60 and Table 25, p. 60. Alternately, the supply fan can be setup to cycle off when there is no demand for heating or cooling via Supply Fan Configuration Command setting.

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

Figure 9. Multi-speed fan sequence of operation



Note: *Refer to supply fan speed tables in "Supply Fan," p. 60.*

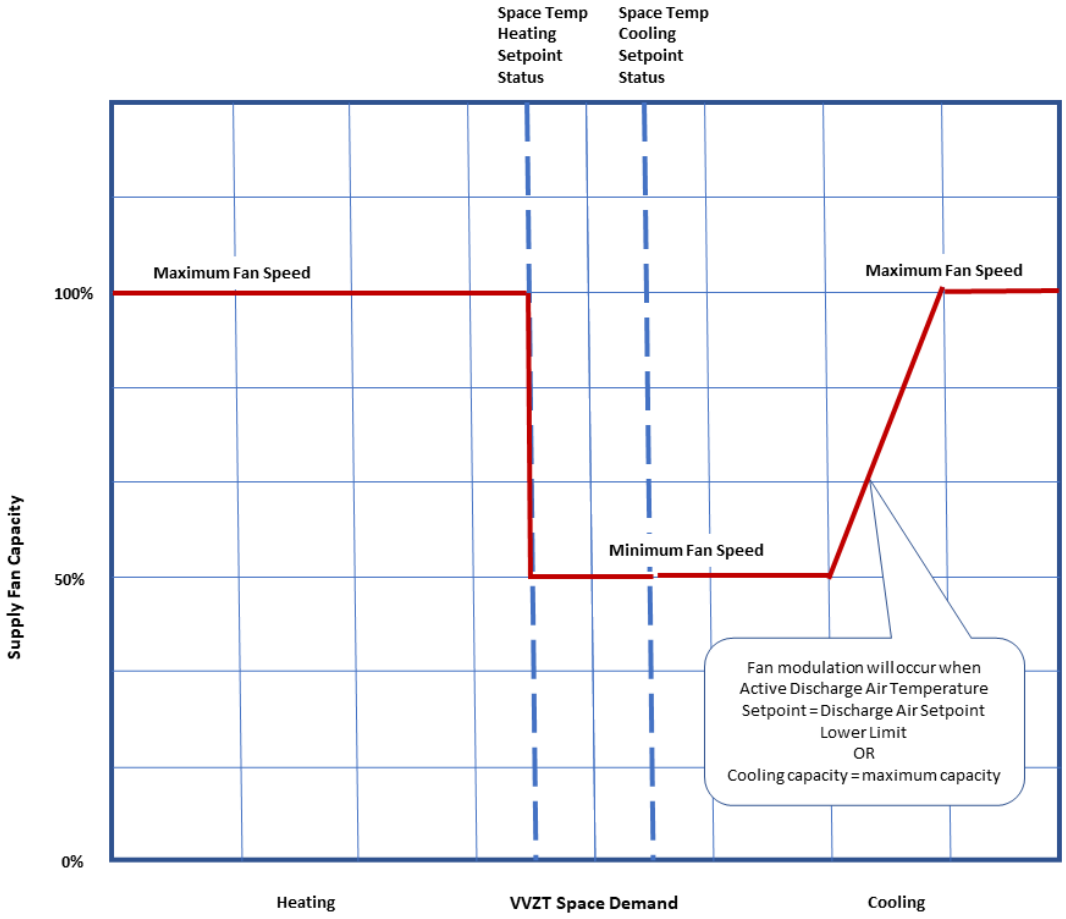
Single Zone Variable Air Volume

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

Single Zone VAV is a control method of space temperature control that operates the supply fan at the lowest speed allowed for the cooling capacity required to satisfy the load in the space. As cooling capacity increases, the supply fan speed will increase to a defined minimum speed for the operating cooling capacity and modulate accordingly until it reaches 100 percent of its allowed range of operation. See Table 26, p. 60 and Table 27, p. 61.

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

Figure 10. Supply fan 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 percent. See Table 26, p. 60 and Table 27, p. 61.

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

Cool — Economizer

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

Cool — Economizer + DX

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

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

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 Thermostat is configured.

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

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

If the discharge air temperature drops to the Discharge Air Temperature Minimum Cool Limit - Active and the Space Temperature is less than the Active Space Temp Cooling Setpoint Status – 0.5°F, the Supply Air Tempering function will bring ON one stage of auxiliary heat. The supply fan operates at the defined minimum speed for the active stage of heating. Modulating gas heat supply air tempering is limited to the first stage, main manifold (burner 1). See Table 26, p. 60 and Table 27, p. 61.

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

Unoccupied Cooling

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

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

Unoccupied Heating

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

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.

Space Temperature Control

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

Morning Warm-up

Morning Warm-up is an optional feature when heat is configured and can be Enabled or Disabled. Morning Warm-up is a mode often used during building unoccupied periods and optimal start applications to rapidly increase the space temperature, as efficiently as possible, before building

occupancy. The outdoor air damper minimum position setpoint will be overridden to 0 percent, ventilation air is not provided during Morning Warm-up

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

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

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

Space Temperature Control

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

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

Night Purge

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

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

Space Temperature Control

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

Heat Types

The supported heat types are staged electrical heat and staged gas heat. Space temperature control variable speed and multi-speed fan units will increase supply fan speed with increased heating capacity.

Staged Gas Heat

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

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 10 seconds. An ignition module heat lockout can also be cleared by removing the call for Heat at the Thermostat, Zone Sensor or BAS System for 5 seconds and back to heat.

Electric Heat - Staged

When staged electric heat is configured in the unit, the controller manages two binary outputs to provide two-stages of heat control; depending on size of the electric heat installed. When two stages of electric heat are installed on a cooling only unit, each stage of electric heat is 50 percent of available Heating Capacity Primary Status. When one stage of electric heat is installed on a cooling only unit, it is 100 percent of the Heating Capacity Primary Status.

Outdoor Air Damper Control

Economizer Cooling

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

Table 9. Economizer types

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

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

Table 10. Sensor data

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

Table 10. Sensor data (continued)

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

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

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

Ventilation Control

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

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

Supply Fan Compensation

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

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

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

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

Outdoor Air Minimum Position Control

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

Remote Minimum Position Control

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

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

Demand Controlled Ventilation (DCV)

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

Demand controlled ventilation setpoints used in all methods.

- Space CO_2 High Limit
- Space CO_2 Low Limit

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

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

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

Table 11. 0 to 100 percent economizer – variable speed supply fan

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

Table 12. 0 to 100 percent economizer – multi-speed supply fan (2–speed)

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

0 to 50 percent Motorized Damper

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

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

Table 13. 0 to 50 percent motorized damper

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

Demand Controlled Ventilation (DCV) — Thermostat Control

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

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

General Support Sequences

Supply Fan Speed Setpoint Adjustment

The Symbio™ 700 provides a Supply Fan Maximum Speed Setpoint and a Supply Fan Minimum Speed Setpoint that adjusts the maximum and minimum settings provided from the VFD. The details of how the setpoints affect supply fan operation are provided as follows:

- Supply Fan Maximum Speed Setpoint
  - Range: 50%-100%
  - Operation: This setpoint **trims** the maximum fan speed, based on the configured maximum frequency within the VFD parameter.
  - Example: maximum frequency = 60Hz
    - Supply Fan Maximum Speed Setpoint at 75% yields a maximum allowed frequency of 45Hz VFD output.
- Supply Fan Minimum Speed Setpoint
  - Range: 0%-100%
  - Operation: This setpoint adjusts the minimum allowed frequency based on the maximum allowed frequency. This cannot drive the fan lower than the minimum frequency set within the VFD parameters.
  - Example: VFD Maximum Frequency = 60Hz; VFD Minimum Frequency = 22Hz
    - Supply Fan Maximum Speed Setpoint at 75% yields a maximum allowed frequency of 45Hz VFD output, then a Supply Fan Minimum Speed Setpoint at 75% yields a minimum allowed frequency of 34Hz VFD (75% of 45Hz = 34Hz).
- Minimum and Maximum Speed Setpoints interact to confirm that the minimum defined fan speed at a given equipment operating condition is maintained.

Compressor Minimum Runtime

Cooling only units, 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 minimum run timers. For normal temperature and thermostat based control, these minimum ON/OFF timers are maintained.

Compressor Proof of Operation

For each compressor. a Compressor Proving binary input is used to monitor the state of 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.

Refrigerant Detection System

⚠ WARNING

R-454B Flammable A2L Refrigerant!

Failure to use proper equipment or components as described below could result in equipment failure, and possibly fire, which could result in death, serious injury, or equipment damage.

The equipment described in this manual uses R-454B refrigerant which is flammable (A2L). Use ONLY R-454B rated service equipment and components. For specific handling concerns with R-454B, contact your local representative.

Foundation equipment with R454B refrigerant may require a refrigerant detection system based on the refrigerant charge.

The refrigerant detection system consists of a refrigerant detection sensor that communicates information to the Symbio 700™ controller.

When the refrigerant detection sensor is in a normal operating state, the equipment provides normal heating, cooling, and ventilation. The refrigerant sensor creates an alarm signal when the sensed refrigerant concentration has exceeded a predetermined threshold.

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

Mitigation actions

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

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

Table 14. Refrigerant Detection System Points

Point Reference	Detection Point
Refrigerant Leak Detection System Input	Active state maintained for the duration of the refrigerant detection system alarm state.
Refrigerant Mitigation Active	Active when the Symbio controller is in a refrigerant mitigation state. This point is also for coordination of building multi-zone VAV systems.
Refrigerant LFL Concentration Sensor A	Concentration reported by the refrigerant leak sensor, expressed in percent of LFL (Lower Flammability Limit).
Refrigerant LFL Concentration Alarm Threshold Sensor A	0-100% of LFL (Lower Flammability Limit), value represents the percent of refrigeration concentration level the refrigerant detection sensor will alarm.
Refrigerant Leak Sensor Communication Status Sensor A	Communication status of the Modbus communicating refrigerant detection system. Loss of communication shall initiate refrigerant mitigation actions.

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

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

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

System Support Sequences

Occupancy Mode

Occupancy is an input to equipment controls for energy management and ventilation. There can be communicated and hardwired input sources of occupancy that are arbitrated into an Occupancy Status result of Occupied, Occupied Standby, Occupied Bypass, or Unoccupied.

Sources of Occupancy

- **Occupancy Input**: a local input from the space served by the equipment. This input is typically an optional local time clocks or space occupancy sensors. The input is wired to Symbio™ 700, J20-2.
- **Bypass Timer**: a user-requested occupancy override (also known as Occupied Bypass). The occupant requests temporary occupied comfort heating or cooling during unoccupied scheduled time periods. For example: The Timed Override (TOV) button on the zone sensor.

Occupancy Status Definitions

- **Occupied**: The controller operates in an occupied mode providing temperature and ventilation control to the occupied heating and cooling setpoints.
- **Unoccupied**: The control is typically shut down and does not provide temperature control to the normal occupied setpoints. Ventilation is not provided. Temperature control is determined by energy conservation and building protection thresholds.
- **Occupied Bypass**: The control is temporarily in an Occupied state for a specified period and automatically returns to unoccupied operation when the bypass timer expires. The Occupied Bypass Timer is user-adjustable; setting the timer to 0 minutes effectively disables Timed Override function at the equipment controller.
- **Occupied Standby**: Space temperature control units in an Occupied-Standby state control to occupied heating and cooling standby temperature setpoints. Standby does not apply to controllers configured for discharge air control (such as VVDA), which translates Standby into an Occupied status.

Table 15. Occupancy status

Occupancy Input	Occupied Bypass Timer	Occupancy Status
Occupied	Zero or non-zero	Occupied
Unoccupied	Zero	Unoccupied
Unoccupied	Non-zero	Occupied Bypass

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

Timed Override

The Timed Override function provides a mechanism for an occupant to signal the system, override the time-of-day schedule, and to provide occupied control for a time period. It also provides a mechanism to return the system to unoccupied mode when the space is no longer occupied.

Zone sensors with Occupied and Unoccupied buttons initiate and terminate the Timed Override functionality respectfully.

When Timed Override is initiated by an Occupied request, 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, Occupied Request again. This extends the Occupied Bypass Timer duration by the value of the Occupied Bypass Time.

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

Unit Stop

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

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

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

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

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

Capacity Limit Control

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

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

Capacity Lockouts

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

Cooling Capacity Enable

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

Heat Primary Enable

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

Demand Limit

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

Demand limit can be enabled or disabled by the Demand Limit Input (hardware binary input).

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

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

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

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

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

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

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.

Service Test Mode

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

Service Test Timeout

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

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

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

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

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

Leaving Service Test Mode

There are three ways to leave Service Test Mode:

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

Service Test Mode — Multi-speed Zone Temperature, VVZT

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

Table 16. Service test mode states

Service Test	Supply fan On/Off	Supply fan speed (VVZT, CVZT) %	Outdoor air damper	Compressor cool stage request	Condensor fan (info only)	Aux heat stage request [a] %	Relief fan On/Off request	Relief damper position request	Heat cool mode status (VVZT, CVZT)
Inactive	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control	In Control
Fan On	ON	Min	Min	0	In Control	0	In Control	Min	Test
Fan On Econ Open	ON	Min	100	0	In Control	0	In Control	100	Test

Table 16. Service test mode states (continued)

Service Test	Supply fan On/Off	Supply fan speed (VVZT, CVZT) %	Outdoor air damper	Compressor cool stage request	Condensor fan (info only)	Aux heat stage request [a] %	Relief fan On/Off request	Relief damper position request	Heat cool mode status (VVZT, CVZT)
High Fan Speed Econ Open	ON	100	100	0	In Control	0	In Control	100	Test
Ventilation Low Fan Speed	ON	Min	Design Min [b]	0	In Control	0	In Control	Min	Test
Ventilation Mid Fan Speed	ON	Effective Mid [c]	Design Mid [b]	0	In Control	0	In Control	Min	Test
Ventilation High Fan Speed	ON	100	Design Max [b]	0	In Control	0	In Control	Min	Test
Cool 1	ON	Min for Capacity	Min	1	In Control	0	In Control	Min	Test
Cool 2	ON	Min for Capacity	Min	2	In Control	0	In Control	Min	Test
Cool 3	ON	Min for Capacity	Min	3	In Control	0	In Control	Min	Test
Cool 4	ON	Min for Capacity	Min	4	In Control	0	In Control	Min	Test
Cool 5	ON	Min for Capacity	Min	5	In Control	0	In Control	Min	Test
Heat 1	ON	Min for Capacity	Min	0	In Control	50	In Control	Min	Test
Heat 2	ON	100	Min	0	In Control	100	In Control	Min	Test

[a] Aux heat stage request is mapped to Gas heat request if unit with Gas Heat installed, Stage 0 -> 0%, Stage 1 -> Min Fire + 1 Stage, Stage 2 (+) -> 100%.

[b] For Outdoor Air Damper Request designed Min/Mid/Max details , refer to the Supply Fan Compensation section of this document.

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

Troubleshooting

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

Data Logs

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

Data logs have 50,000 points trending at 10 second intervals. This gives over 5 days of data. Data logs can be exported to a USB memory stick via a .CSV format. Select property data, that has been configured for recording data over time, can be viewed graphically. Up to 4 sets of data can be viewed at one time using the Symbio Service and Installation App by using View Data Logs in the Tools menu.

Unit Stop Source

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

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

Diagnostics

Diagnostics – Alarm Indicator Status

Symbio™ 700 supports 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 functionally stopping 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 confirms that the Reset Diagnostic point is set to the right value under normal application control. The below sections describe 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 restarts.

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 and 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.

Communication Status

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:

Diagnostic	Target	Severity	Persistence	Condition/Response
Diagnostic: Unit Communications Failure	Unit		Non-Latching	Active if any of these diagnostics listed in this table have a status of 'not communicating.
Symbio 700 Onboard I/O	Unit	Immediate Shutdown	Non-Latching	All Symbio 700 controller inputs and outputs are disabled.
Customer Options Module	Partial	Warning	Non-Latching	• Functions requiring a Customer Options Module are disabled. • If Ventilation Override is inactive during communication loss event, unit continues operation with component level disabled.
	Unit	Immediate Shutdown	Non-Latching	If Ventilation Override is active during communication loss event, unit performs an immediate shutdown.
Indoor Options Module	Partial	Warning	Non-Latching	• Single Zone VAV operation disables. • Electric heat operation disables. • Economizer cooling disables.
Fresh Air Options Module	Partial	Warning	Non-Latching	All economizer outdoor air damper and power exhaust operation are disabled.

Supply Fan

The following diagnostics are available through direct data monitoring from the Modbus™ controlled VFD or data monitoring.

Diagnostic	Target	Severity	Persistence	Condition/Response
Diagnostic: Supply Fan Failure	Unit	Immediate Shutdown	Latching	If the supply fan is requested to run, but the VFD Running Status is False (read via Modbus communication) for 40 continuous seconds.
Diagnostic: Supply Fan Proving Failure	Unit	Immediate Shutdown	Non-Latching	VFD drive is reporting via Modbus that the supply fan is not running.
Diagnostic: VFD Fault Supply Fan - 1	Unit	Immediate Shutdown	Non-Latching	VFD drive is reporting via Modbus that there is a fault.

Diagnostic	Target	Severity	Persistence	Condition/Response
Diagnostic: VFD Supply Fan Ground Fault - 1	Unit	Immediate Shutdown	Non-Latching	• VFD drive is reporting via Modbus that there is a ground fault. • There is a discharge from the output phases to ground, either in the cable between the frequency converter and the motor or in the motor itself. **Troubleshooting:** • Turn off the frequency converter and remove the ground fault. • Measure the resistance to ground the motor cables and the motor with a megohmmeter to check for ground faults in the motor.
Diagnostic: VFD Supply Fan Motor Current Overload - 1	Unit	Immediate Shutdown	Non-Latching	VFD drive is reporting via Modbus that there is a current overload condition. The fault is that the frequency converter is overloaded by more than 100% for too long.
Diagnostic: VFD Supply Fan Short Circuit - 1	Unit	Immediate Shutdown	Non-Latching	VFD drive is reporting via Modbus that there is a short circuit condition. There is short-circuiting in the motor or on the motor terminals.
Diagnostic: VFD Supply Fan Broken Belt - 1	Unit	Immediate Shutdown	Non-Latching	VFD drive motor torque is below the broken-belt torque (current) value. and the converter output frequency is above or equal to 15Hz.
Supply Fan VFD Communication Status	Unit	Immediate Shutdown	Non-Latching	Modbus communication to the supply fan VFD has exceeded 30 seconds. Check Modbus wiring.

Compressor

Compressor diagnostics are available through monitoring compressor contactor status and end devices.

Diagnostic	Target	Severity	Persistence	Condition/Response
Diagnostic: FroStat Trip	Circuit	Immediate Shutdown	Non-Latching	• Compressor circuit operatesin the cooling mode when the FroStat input became active (closed). • Supply fan continues to operate until the FroStat input is inactive (open).
Diagnostic: Circuit 1 LPC Trip	Circuit	Immediate Shutdown	Non-Latching	Low pressure cutout binary input is open; circuit is disabled for 3 minutes.
Diagnostic: Circuit 1 LPC Lockout	Circuit	Immediate Shutdown	Latching	If four LPC trip events occur within 3 minutes (R-410A) or 10 minutes (R-454B) of initial circuit operation - requires a manual reset.
Diagnostic: Compressor 1 Contactor Failure	Circuit	Immediate Shutdown	Latching	If a compressor proving input becomes Active for 5 continuous seconds when the associated compressor output is Inactive.
Diagnostic: Compressor 2 Contactor Failure				
Diagnostic: Comp 1 Proving Trip	Circuit	Immediate Shutdown	Non-Latching	When a compressor output is commanded ON and it has been running for more than 5 seconds, if the associated proving input opens. Circuit is disabled for 15 minutes.
Diagnostic: Comp 2 Proving Trip				

Diagnostic	Target	Severity	Persistence	Condition/Response
Diagnostic: Compressor 1 Proving Lockout	Circuit	Immediate Shutdown	Latching	Two scenarios can cause this diagnostic to be active: • Scenario 1: A refrigeration circuit accumulates four 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.* • Scenario 2: A compressor associated proving input does not CLOSE within 5 seconds of the compressor startup.
Diagnostic: Compressor 2 Proving Lockout				

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 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 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 10 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 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.

Staged Gas Heat

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

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: Heat Failure	Heat	Immediate Shutdown	Non-Latching	YES	Active when any gas heat lockout condition exists, communication to the ignition module is lost, or “IGN1 Hardware Configuration Error” is active.
Diagnostic: IGN1 Module Lockout	Heat	Immediate Shutdown	Non-Latching	No	• Call for heat is removed to the gas heat ignition controller. This diagnostic is active when a gas heat ignition module lockout condition exists. • Ignition controller LED: two flashes.
Diagnostic: IGN1 Heating High Temp Limit Open	Heat	Immediate Shutdown	Non-Latching	No	Ignition controller High Limit switch protection device open. • If high limit switch is open upon a call for first stage of heat, the inducer is energized on low speed. • If high limit switch is open upon a call for second stage of heat, the inducer is energized on high speed. • Ignition controller LED: four flashes.
Diagnostic: IGN1 Flame Rollout Switch Open	Heat	Immediate Shutdown	Non-Latching	No	• Spark igniter and gas valve de-energize. Inducer will be energized on low speed if first stage heat call is present and high speed if second stage heat call is present. • Rollout switch requires a manual reset. Diagnostic resets after rollout switch resets or call for gas heat is removed. • Ignition controller LED: six flashes.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: IGN1 Inducer Proving Switch Fail Closed	Heat	Immediate Shutdown	Non-Latching	No	• If the inducer pressure switch is closed within the 8 seconds upon a call for heat, the ignition controller will not energize the inducer and will wait for the pressure switch to open before proceeding. • Ignition controller LED: three flashes.
Diagnostic: IGN1 Inducer Proving Switch Fail Open	Heat	Immediate Shutdown	Non-Latching	No	• The pressure switch should be detected closed within 2 seconds after the inducer is energized. If the pressure switch is detected open 2 seconds after the inducer is energized, the control will display a 3-flash diagnostic code and will wait for the pressure switch to close before proceeding. • The inducer pressure switch opens for 0.5 seconds during 40 second inter-purge time with a call for heat, the ignition controller will hold the inter-purge time, energize the inducer on high speed, and wait for the inducer pressure switch to close. • If the inducer pressure switch opens for 0.5 seconds any time after pre-purge, the gas valve will immediately de-energize, the inducer will be on high speed. • Ignition controller LED: three flashes.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: IGN1 No Flame Sensed on Ignition	Heat	Immediate Shutdown	Non-Latching	No	Ignition failed to sense flame. • Gas heat ignition module will lockout after three consecutive failed ignition attempts. Lockout will reset after 1-hour and reattempt ignition if a call for heat is present. • Possible cause: Low stage gas valve did not open due to faulty gas valve relay. Pressure switch did not close during 40 second inter-purge time. • Ignition controller LED: two flashes after three consecutive failed ignition attempts.
Diagnostic: IGN1 Flame Sensed w/Gas Valve Off	Heat	Immediate Shutdown	Non-Latching	No	• Flame sensed while gas valve output not energized, or flame sensed with no call for heat. The inducer fan will be energized on high speed. • Ignition controller LED: five flashes.
Diagnostic: IGN1 Hardware Configuration Error	Heat	Warning	Non-Latching	No	Not supported — for future use.
Diagnostic: IGN1 Weak Flame	Heat	Warning	Non-Latching	No	• If a weak flame condition, the ignition controller continues to serve call for heat. • Ignition controller LED: seven flashes.
Diagnostic: IGN1 Gas Valve Error	Heat	Immediate Shutdown	Non-Latching	No	• Gas valve is detected ON when gas valve should be OFF. Inducer fan energized to high speed. If call for heat is removed, inducer maintains at high speed for post-purge time. • Potential cause: Gas valve mis wired. • Ignition controller LED: nine flashes.

Diagnostic	Target	Severity	Persistence	Alarm Indicator	Condition / Response
Diagnostic: IGN1 Module Failure	Heat	Immediate Shutdown	Non-Latching	No	• Gas heat ignition module reported an internal error via Modbus. • Ignition controller LED: eight flashes.
Gas Heat Ignition Module 1 Communication Status	Heat	Warning	Non-Latching	No	• Gas heat operation on ignition module 1 disabled. Check Modbus wiring. Check gas heat ignition module for fault codes. • Ignition controller LED: one flash.

Table 17. White-Rogers staged ignition controller LED indicator code

Code	Description
Steady OFF	No Power/failure/internal failure
Steady ON	Normal
Slow Flash Rate	Normal, call for heat (¾ second on, ¼ second off)
Fast Flash Rate	Used for error indication (¼ second off, ¼ second on). See the error code flash rate table below.

Table 18. Error code flash rate

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

Outdoor Air Damper

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

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

Economizer Failure Modes and System Response

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

Refrigerant Detection System

Equipment with R454B refrigerant may require a refrigerant detection system based on the refrigerant charge. The refrigerant detection system consists of a refrigerant detection sensor that communicates the following diagnostics to the Symbio 700™ controller via Modbus™.

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

Sensor and Other Diagnostics

The following diagnostics are generated from sensor values or the Symbio 700.

Diagnostic	Target	Severity	Persistence	Condition / Response
Diagnostic: Maintenance Required	None	Warning	Non-Latching	The supply fan run hours has exceeded Filter Runtime Hours Setpoint. • To reset the diagnostic, set Filter Timer Reset. • To disable this diagnostic, set Filter Runtime Hours Setpoint to zero.
Diagnostic: High Condensate Level Detected	None	Normal shutdown	Non-Latching	Condensate overflow binary input is closed. If the condensate overflow input opens, the diagnostic will reset.
Diagnostic: Condensate Overflow Lockout	Unit	Immediate Shutdown	Latching	Condensate Overflow Trip occurred three times within 72 hours – inspect condensate pan and drain.
Diagnostic: Morning Warmup Mode Exceeded 120 Minutes	Heat	Warning	Non-Latching	Space conditions not met to exit morning warmup mode for more than 120 minutes.
Diagnostic: Pre Cool Mode Exceeded 120 Minutes	Cool	Warning	Non-Latching	Space conditions not met to exit pre cool mode for more than 120 minutes.
Diagnostic: Night Purge Mode Exceeded 120 Minutes	Cool	Warning	Non-Latching	Space conditions not met to exit night purge mode for more than 120 minutes.
Space CO2 Concentration Active	Damper	Warning	Non-Latching	Demand controlled ventilation disables.
Phase Monitor Status	Unit	Immediate Shutdown	Latching	Phase Monitor binary input is went into an active state.
Discharge Air Temperature Local	Component	Immediate Shutdown	Non-Latching	Wired discharge air temperature input is out of range. The following capabilities are disabled: • Dehumidification with hot gas reheat • Modulating gas heat • Single zone vav • Economizer cooling • Enhanced thermostat control • Variable speed compressor • Variable Volume Discharge Air Control (VVDA)
Outdoor Air Humidity Active	Damper	Immediate Shutdown	Non-Latching	Comparative enthalpy disables, reference enthalpy disables, and control reverts to dry bulb control. See Economizer failure modes and system response table.
Return Air Temperature Input	Damper	Immediate Shutdown	Non-Latching	Comparative Enthalpy disables, Reference enthalpy disables, control reverts to dry bulb control. See Economizer failure modes and system response table.

Diagnostic	Target	Severity	Persistence	Condition / Response
Return Air Humidity Active	Damper	Immediate Shutdown	Non-Latching	• Return air humidity greater than 90%, return air enthalpy calculations with be based on 90% return air humidity. • Return air humidity less than 10%, return air enthalpy calculations with be based on 10% return air humidity. See Economizer failure modes and system response table.
Outdoor Air Temperature Active	Damper	Immediate Shutdown	Non-Latching	Economizer cooling disabled. See Economizer failure modes and system response table.

Device Tracker

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

Hardware

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

Table 19. Temperature sensor (10K thermistor type)

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

Table 19. Temperature sensor (10K thermistor type) (continued)

Temp (°F)	Temp (°C)	Resistance (ohms)	Terminal Voltage
0	-17.78	85403	2.24
2	-16.67	80160	2.22
4	-15.56	75272	2.21
6	-14.44	70715	2.19
8	-13.33	66464	2.17
10	-12.22	62496	2.16
12	-11.11	58791	2.14
14	-10.00	55329	2.12
16	-8.89	52094	2.10
18	-7.78	49069	2.08
20	-6.67	46240	2.06
22	-5.56	43592	2.03
24	-4.44	41112	2.01
26	-3.33	38790	1.99
28	-2.22	36613	1.96
30	-1.11	34573	1.94
32	0.00	32659	1.91
34	1.11	30864	1.89
36	2.22	29178	1.86
38	3.33	27596	1.84
40	4.44	26109	1.81
42	5.56	24712	1.78
44	6.67	23398	1.75
46	7.78	22162	1.72
48	8.89	21000	1.69
50	10.00	19905	1.66
52	11.11	18875	1.63
54	12.22	17904	1.60
56	13.33	16989	1.57
58	14.44	16127	1.54
60	15.56	15314	1.51
62	16.67	14547	1.48
64	17.78	13823	1.45
66	18.89	13139	1.42
68	20.00	12494	1.39
70	21.11	11884	1.36
72	22.22	11307	1.33
74	23.33	10762	1.30
76	24.44	10247	1.27
78	25.56	9759	1.23

Table 19. Temperature sensor (10K thermistor type) (continued)

Temp (°F)	Temp (°C)	Resistance (ohms)	Terminal Voltage
80	26.67	9298	1.20
82	27.78	8861	1.17
84	28.89	8448	1.14
86	30.00	8056	1.12
88	31.11	7684	1.09
90	32.22	7332	1.06
92	33.33	6999	1.03
94	34.44	6682	1.00
96	35.56	6382	0.97
98	36.67	6097	0.95
100	37.78	5826	0.92
102	38.89	5569	0.89
104	40.00	5325	0.87
106	41.11	5093	0.84
108	42.22	4872	0.82
110	43.33	4662	0.79
112	44.44	4463	0.77
114	45.56	4273	0.75
116	46.67	4092	0.73
118	47.78	3921	0.70
120	48.89	3757	0.68
122	50.00	3601	0.66
124	51.11	3452	0.64
126	52.22	3311	0.62
128	53.33	3176	0.60

Table 20. Zone sensor - Setpoint input

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

Table 20. Zone sensor - Setpoint input (continued)

Temperature (°F)	Resistance (ohms)	Terminal Voltage (V)
62	655.7	0.154
63	636.3	0.150
64	616.8	0.145
65	597.3	0.141
66	577.8	0.137
67	558.4	0.132
68	538.9	0.128
69	519.4	0.123
70	500.0	0.119
71	480.5	0.115
72	461.0	0.110
73	441.5	0.106
74	422.1	0.101
75	402.6	0.097
76	383.1	0.092
77	363.7	0.088
78	344.2	0.083
79	324.7	0.079
80	305.2	0.074
81	285.8	0.069
82	266.3	0.065
83	246.8	0.060
84	227.3	0.056
85	207.9	0.051

Table 21. Zone sensor – Mode input

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

Table 22. Relative humidity sensor

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

Table 23. CO_2 sensor

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

Appendix A

Supply Fan

Table 24. 15 to 17.5 tons standard efficiency, multi-speed supply fan

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

Table 25. 20 to 25 tons standard efficiency, multi-speed supply fan

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 Heat Stage 1	100
Electric Heat Stage 2	100
Staged Gas Heat Stage 1	100
Staged Gas Heat Stage 2	100

Table 26. 15 to 17.5 tons standard efficiency, variable speed supply fan

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

Table 27. 20 to 25 tons standard efficiency, variable speed supply fan

Unit Operation	Supply Fan Speed (%)
Off	0
Fan Only	50
Cooling Stage 1	50
Cooling Stage 2	50
Cooling Stage 3	65
Cooling Stage 4	100
Electric Heat 1	100
Electric Heat 2	100
Staged Gas Heat Stage 1	100
Staged Gas Heat Stage 2	100

Compressor Staging

Table 28. 15 to 17.5 tons standard efficiency compressor cooling stages

Cooling Stage	Cooling Capacity %	Compressor Output		Unloader Solenoid		Compressor	
		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	CPR1	CPR2
0	0	OFF	OFF	OFF	OFF	OFF	OFF
1	33	OFF	ON	OFF	OFF	OFF	ON
2	66	ON	OFF	OFF	OFF	ON	OFF
3	100	ON	ON	OFF	OFF	ON	ON

Table 29. 20 to 25 tons standard efficiency compressor cooling stages

Cooling Stage	Cooling Capacity %	Compressor Output		Unloader Solenoid		Compressor	
		BO-4 (P8-5)	BO-6 (P9-5)	BO-5 (P8-6)	BO-7 (P9-6)	CPR1	CPR2
0	0	OFF	OFF	OFF	OFF	OFF	OFF
1	24	OFF	ON	OFF	OFF	NA	ON
2	36	OFF	ON	OFF	ON	OFF	ON
3	64	ON	Off	OFF	OFF	ON	OFF
4	100	ON	ON	OFF	ON	ON	ON

Thermostat Staging

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

Condenser Fan Operation

Table 30. 15 to 17.5 tons standard efficiency condenser fan staging

Cooling Stage	Outdoor Air Temperature	Condenser Fan Output	
		Fan 1 (P8-5)	Fan 2 (P9-5)
0	NA	Off	Off
1	<95°F	ON	Off
	>=95°F	ON	ON
2	<65°F	ON	Off
	>=65°F	ON	ON
3	<45°F	ON	Off
	>=45°F	ON	ON

Notes:

- *Condenser Fan 1 energizes with any compressor stage.*
- *Condenser Fan 2 de-energizes 5°F below the specified outdoor air temperature.*

Table 31. 20 to 25 tons standard efficiency condenser fan staging

Cooling Stage	Outdoor Air Temperature	Condenser Fan Output	
		Fan 1 (P8-5)	Fan 2 (P9-5)
0	NA	Off	Off
1	<95°F	ON	Off
	>=95°F	ON	ON
2	<95°F	ON	Off
	>=95°F	ON	ON
3	<65°F	ON	Off
	>=65°F	ON	ON
4	<45°F	ON	Off
	>=45°F	ON	ON

Notes:

- *Condenser Fan 1 energizes with any compressor stage.*
- *Condenser Fan 2 de-energizes 5°F below the specified outdoor air temperature.*

Electric Heat

Table 32. 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 33. 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 34. Supported diagnostics and alarm relay functionality

Name	Alarm Output
Communication	
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
Fresh Air Options Module Communication Status	Y
Gas Heat Ignition Module 1 Communication Status	Y
Supply Fan VFD Communication Status	Y
VFD Supply Fan	
Diagnostic: Supply Fan Failure	Y
Diagnostic: Supply Fan Proving Failure	Y
Diagnostic: VFD Fault Supply Fan - 1	Y
Diagnostic: VFD Supply Fan Ground Fault - 1	Y
Diagnostic: VFD Supply Fan Motor Current Overload - 1	Y
Diagnostic: VFD Supply Fan Short Circuit - 1	Y
Diagnostic: VFD Supply Fan Broken Belt – 1	Y
IGN1: White Rogers Gas Heat Ignition Controller	
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

Table 34. Supported diagnostics and alarm relay functionality (continued)

Name	Alarm Output
Compressor	
Diagnostic: FroStat Trip	N
Diagnostic: Comp 1 Proving Trip	N
Diagnostic: Comp 2 Proving Trip	N
Diagnostic: Circuit 1 LPC Trip	N
Diagnostic: Compressor 1 Contactor Failure	Y
Diagnostic: Circuit 1 LPC Lockout	Y
Diagnostic: Compressor 1 Proving Lockout	Y
Diagnostic: Compressor 2 Contactor Failure	Y
Diagnostic: Compressor 2 Proving Lockout	Y
Outdoor Air Damper	
FDD: Excessive Outdoor Air	Y
FDD: Outdoor Air Damper Not Modulating	Y
FDD: Unit Economizing When It Should Be	Y
FDD: Unit Not Economizing When It Should	Y
Refrigerant Detection System	
Diagnostic: Refrigerant Concentration Sensor A	Y
Diagnostic: Refrigerant Leak Sensor Failure Sensor A	Y
Refrigerant Leak Sensor Communication Status Sensor A	Y
Sensor and Other	
Diagnostic: Maintenance Required	N
Diagnostic: Filter Change Required	N
Diagnostic: High Condensate Level Detected	N
Diagnostic: Condensate Overflow Lockout	Y
Diagnostic: Morning Warmup Mode Exceeded 120 Minutes	N
Diagnostic: Pre Cool Mode Exceeded 120 Minutes	N
Diagnostic: Night Purge Mode Exceeded 120 Minutes	N
Discharge Air Temperature Local	Y
Outdoor Air Temperature Active	Y
Outdoor Air Humidity Active	Y
Phase Monitor Status	Y
Space CO2 Concentration Active	N
Space Humidity Active	N
Space Temperature Active	Y

Emergency and Ventilation Override

Table 35. Emergency and ventilation override

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

[a] Variable Volume Discharge Air units.

Space Setpoint Adjustment

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

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

Single Setpoint

Heat mode:

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

Cool mode:

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

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

- Heating setpoint high limit

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

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

Dual Setpoint

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

Appendix B

Symbio 700 Configuration

The following table describes the Symbio™ 700 configuration (in order) and options available with reference to the Foundation 15-25 ton model number.

Symbio 700 Configuration Item	Symbio 700 Configuration Option	Model Number (reference)	Description
Equipment Type	Foundation	Digit 1 = E, G	DX Cooling (E).
			DX Cooling, Gas Heat (G).
System Type	CVZT	Digit 15 = 7, 9	Multi-speed motor.
	VVZT	Digit 15 = A, B	Single Zone Variable Air Volume.
Space Controller	Conventional TStat	Not applicable	Equipment is being controlled from a thermostat in the space.
	Dual Setpoint Zone Sensor	Not applicable	Heating and Cooling setpoint zone sensor installed. Applicable to CVZT and VVZT System Type.
	Single Setpoint Zone Sensor	Not applicable	Single setpoint zone sensor installed. Applicable to CVZT and VVZT System Type.
Indoor Fan Type	Multi Speed	Digit 15 = 7, 9	Multi-speed motor.
	Variable Speed	Digit 15 = A, B	Single Zone Variable Air Volume.
Refrigeration System	Cooling Only	Digit 1 = E, G	Direct expansion cooling unit with or without primary heating capacity.
Refrigerant	R454B	Digit 3 = K	Equipment designed for R454B.
Tonnage (60 Hz)	15	Digit 4, 5, 6 = 180	Designates the equipment capacity in tons of cooling.
	17.5	Digit 4, 5, 6 = 210	
	20	Digit 4, 5, 6 = 240	
	25	Digit 4, 5, 6 = 300	
Refrigeration Circuit	Single Manifold	Not applicable	
Voltage (60 Hz)	208/230/60	Digit 8 = 3	208VAC or 230VAC, 60Hz.
	460/60	Digit 8 = 4	460VAC, 60Hz.
	575/60	Digit 8 = W	575VAC, 60Hz.
Efficiency	Standard	Digit 2 = D	Standard Efficiency.
Primary Heating Source	Not Installed	Digit 10 = 0	No primary heating installed.
	Electric	Digit 1 = E	Cooling only unit with primary electric heat installed.
		Digit 10 = G, N, P, R	
	Gas	Digit 1 = G	Cooling only unit with primary staged gas heat installed.
		Digit 10 = H, L, M, X, Y, Z	
Primary Heating Type	Not Installed	Digit 10 = 0	No primary heat installed.
	Staged	Digit 10 = G, N, P, R, H, L, M, X, Y, Z	Staged electric heat or staged gas heat installed.

Symbio 700 Configuration Item	Symbio 700 Configuration Option	Model Number (reference)	Description
Primary Heating Stages	1	Digit 10 = G	1-stage electric heat installed (18 kW).
	2	Digit 10 = N, P, R, H, L, M, X, Y, Z	2-stage electric heat or staged gas heat installed.
Outside Air	Not Installed	Digit 14 = 0, A	No fresh air (0) installed or manual outside air (A) option.
	0 to 50% Motorized Damper	Digit 14 = B	Motorized outside air (B) option installed.
	0 to 100% Economizer	Digit 14 = C, D, E, F, G, H, J, L, N, S	100% Economizer damper installed.
Economizer Type	Dry Bulb	Digit 14 = C, D, J	Economizer cooling operation enables based on outdoor air temperature (dry bulb).
	Differential Dry Bulb	Digit 14 = S	Economizer cooling operation enables based on outdoor air temperature and space temperature difference.
	Reference Enthalpy	Digit 14 = E, F, L	Economizer cooling operation enables based on outdoor air temperature and outdoor air humidity.
	Comparative Enthalpy	Digit 14 = G, H, N	Economizer cooling operation enables based on outdoor air temperature and outdoor air humidity (enthalpy) vs. return air temperature and return air humidity (enthalpy).
Demand Controlled Ventilation	Enabled	Not applicable	Demand Controlled Ventilation is a 0 to 100% economizer damper option when a Space CO2 sensor is installed.
	Disabled	Not applicable	Demand Controlled Ventilation is disabled.
Remote Minimum Position	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	0 to 100% Economizer damper installed or 0 to 50% motorized damper installed and field-installed remote minimum position potentiometer installed.
Space Pressure Control	Not installed	Digit 14 = 0, A, B, C, E, G, J, L, N, S	No Barometric Relief installed.
	Relief Fan Only	Digit 14 = D, F, H	Economizer with Barometric Relief.
FroStat	Installed	Not applicable	FroStat is standard.
Condensate Overflow Switch	Not Installed	Digit 25 = 0	Not installed.
	Installed	Digit 25 = A	Condensate Overflow Switch (COS) installed.
CO2 Sensor	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Space CO2 Sensor installed, required for demand controlled ventilation.

Symbio 700 Configuration Item	Symbio 700 Configuration Option	Model Number (reference)	Description
Discharge Temperature Sensor	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Discharge Air Sensing (DAS) installed.
External Auto/Stop	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	External Auto/Stop binary input installed, requires a Customer Options Module.
Ventilation Override	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Ventilation Override installed, requires a Customer Options Module.
Alarm Indicator	Not Installed	Not applicable	Not installed.
	Installed	Not applicable	Alarm Indicator requires a Customer Options Module binary output.
Demand Management	None	Not applicable	Symbio 700 Demand Shed/ Demand Limit binary input (J16) is disabled.
	Demand Limit	Not applicable	Symbio 700 binary input (J16) enables and disables energy Demand Limit function. See Demand Limit is this document.
	Demand Shed	Not applicable	Symbio 700 binary input (J16) enables and disables energy Demand Shed function. The Demand Shed is enabled and space heating and cooling setpoints will be offset 4°F (default setting).

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ACC-APG004A-EN 14 Sep 2024
Supersedes (New)