SIEMENS

Using DXRs and Central Functions for Duct Static Pressure Reset

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Building Technologies

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Scope and Purpose

This document provides an overview of Duct Static Pressure Reset strategies and describes how to configure Central Functions to set up static pressure reset using DXR automation stations.

Duct Static Pressure Reset is a common method for optimizing pressure in the ducts so that all zones are satisfied and none are starved for air. It is addressed in a number of BAS (building automation system) standards and guidelines - see Appendix.

There are many ways to comply with the standards as they are intentionally vague. For example, California Title 24 explicitly states the option of using “other methods” to optimize duct pressure. This document provides guidance on using one method in particular – **saturation signals** – to manage Duct Static Pressure Reset in a simple and efficient way. This method can be used to satisfy any/all of the BAS standards and guidelines for Duct Static Pressure Reset.

This document describes how to

- Set up initial DXR application configuration parameters for pressure reset
- Set up a Central Function DXR in conjunction with the room controller
- Configure the use of saturation signals to control Duct Static Pressure Reset

DXR Templates and Central Functions

Templates from Hvac12 (VAV) and Hvac13 (FPB) DXR application types are used to configure Duct Static Pressure Reset. These applications come with datapoints that can be used in conjunction with AHU primary plant controllers to control and monitor the zone dampers for reset. In addition, a Central Function DXR can be used to easily bridge data between the zones and the AHU. The DXR template applications and Central Function DXR together allow for efficient collection of room data for use in Duct Static Pressure Reset.

Title 24 Fault Detection for VAV and FPB Templates

For compliance with Title 24, an FDD configured template must be used. FDD templates are located on StdApps under Apogee > Desigo_ABT > CustomApplications > FaultDetection.

Terminology

"ABT Inside" - new term that replaces ABT SSA (Setup & Service Assistant).

Duct Pressure Reset and VAV Saturation

Overview

When the pressure in the duct system is too low, VAV boxes may open to maximum or near maximum and still not get enough air. If pressure is too high, boxes could be nearly closed and the AHU could be forcing air through them, wasting energy. An efficient way to counteract these issues is to change the static pressure setpoint based on demand from the zone. Duct static pressure should be just low enough that **a single box** is almost fully open. At least one, and preferably only one, is ideal.

By using central functions it is possible to collect data from each VAV box and use it to automatically reset duct pressure if necessary. ASHRAE recommends choosing from available strategies such as flow setpoints, damper position data, and saturation signals. This document focuses on the simple and efficient **saturation signal method** to achieve duct pressure reset.

Each VAV (or FPB) application dynamically calculates the saturation level for the supply air damper. **StrtnLvl** (Saturation level) is the value used to determine if the damper is open more than a set amount. **DlyOnStrtn** (Switch-on delay saturation) is the time delay before a damper that is starving for air (i.e., open more than a set amount) initiates a signal change. Both parameters are configurable and are under “Supply air VAV” in the Default values task area in ABT Site.

If any box is starved of air, a signal (VavSuAflStrtn / **SU FLO SATUR**) is sent to the central function which then counts the total number of starved boxes. The central function shares the total number of starved boxes with the AHU, which can then use the data to reset static pressure to a level that is adequate for current demand.

SU FLO SATUR is a calculated binary object with two states: 0:Satisfied / 1:Starved. The value is true (Starved) when:

- Damper position is equal to or exceeds the value of StrtnLvl,
  AND
- Airflow error exceeds a configured error level,
  AND
- Both conditions stay true for longer than the value of DlyOnStrtn.

StrtnLvl (default 90%) can be adjusted to increase/decrease the terminal box application’s sensitivity to a saturation condition. It can be set higher if there is concern only with boxes being close to completely starved. Conversely, the level can be lowered if the goal is to collect data on boxes that are nearing saturation. 90% represents a balance between the two strategies. The configurable time delay (DlyOnStrtn) default is 60 seconds. This can be adjusted along with the saturation level to achieve desired results.

Group Master object

The Group Master object in the Central Function application for supply air coordination collects data from supply air Group Members to support duct pressure reset. When the VavSuAflStrtn signal = “Starved”, the collected information being shared with the AHU fan controller can be used to regulate an increase to the static setpoint.

Excluding a box from the pressure reset system
It is possible to configure a Saturation signal (in ABT Site or online) to stay permanently false (i.e., “Satisfied”). This allows a user to exclude a particular terminal from the pressure reset system. This may be useful in situations where, for example, a certain box is almost fully saturated but there is no actual need for pressure reset. See Excluding_a_terminal_box for more information.

VAV Saturation using Central Functions

The AHU control program should adjust the supply duct pressure to achieve the lowest pressure that fully satisfies the flow setpoint at each terminal. To accomplish this, the AHU control program collects values indicating a saturated control loop from each assigned terminal controller.

Each air terminal controller calculates a saturation signal that indicates whether the local airflow control loop is operating close to the limit. The program in the Central Function DXR counts the number of saturated airflow controllers among the terminals it serves.

VAV and FPB applications include a saturation function that calculates and determines whether a configured box is operating above the configured limit. The saturation function derives from the following objects and parameters:

Object and parameters for saturation

Name	Apogee Name	Description	Type	Default
VavSuAflStrtn	SU FLO SATUR	Supply air VAV airflow saturation (0:Satisfied; 1:Starved)	BCalcVal	Satisfied
EnStrtnCal	--	Enable saturation calculation (0:No; 1:Yes)	BCnfVal	Yes
StrtnLvl	--	Damper setting level indicating that the terminal is nearly fully open	ACnfVal	90%
DlyOnStrtn	--	Delay time before setting saturation signal	ACnfVal	60s

Object and parameters for airflow deviation calculation

Name	Apogee Name	Description	Type	Default
VavSuAirFlDvn	AIR VOL DIFF	Supply air VAV volume flow deviation	ACalcVal	0%
EnDvnCal	--	Enable deviation calculation (0:No; 1:Yes)	BCnfVal	Yes
AirFlErLm	--	Air volume flow error limit	ACnfVal	0%

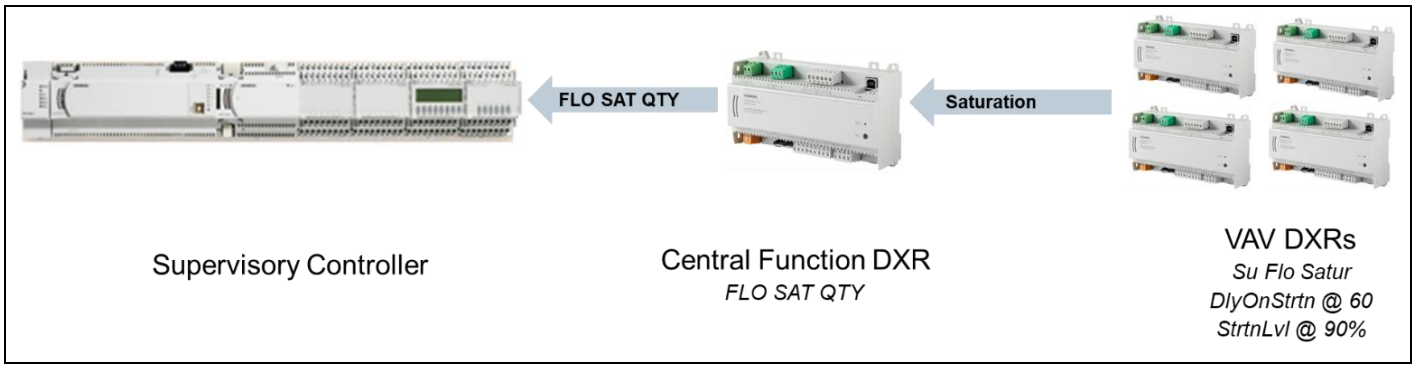
Each VAV controller sends both an airflow deviation signal (AIR VOL DIFF) and a saturation signal (SU FLO SATUR) to the Central Function application. SU FLO SATUR is a binary object that indicates whether the box is open more than the configured saturation level limit (StrtnLvl). AIR VOL DIFF is the VAV box airflow setpoint minus the actual VAV box airflow.

EnStrtnCal allows the box to send the saturation calculation to the Central Function. When set to No, the box will not be included in the collection of saturation levels but it will still be a member of the Group.

All of these parameters that are part of the **Supply air VAV** application function have counterparts that are unique to exhaust air as well. This means it is possible to configure reset based on exhaust settings if desired.

FLO SAT QTY

NumVavSuStrtn (FLO SAT QTY) is a Central Function calculated value object that reports the number of starved supply air VAV controllers to the PXC/PXCM and is used to control the AHU. When a Central Function is used to collect this information, the PXC/PXCM can be set to communicate with the AHU fan controller to increase the static setpoint if necessary.



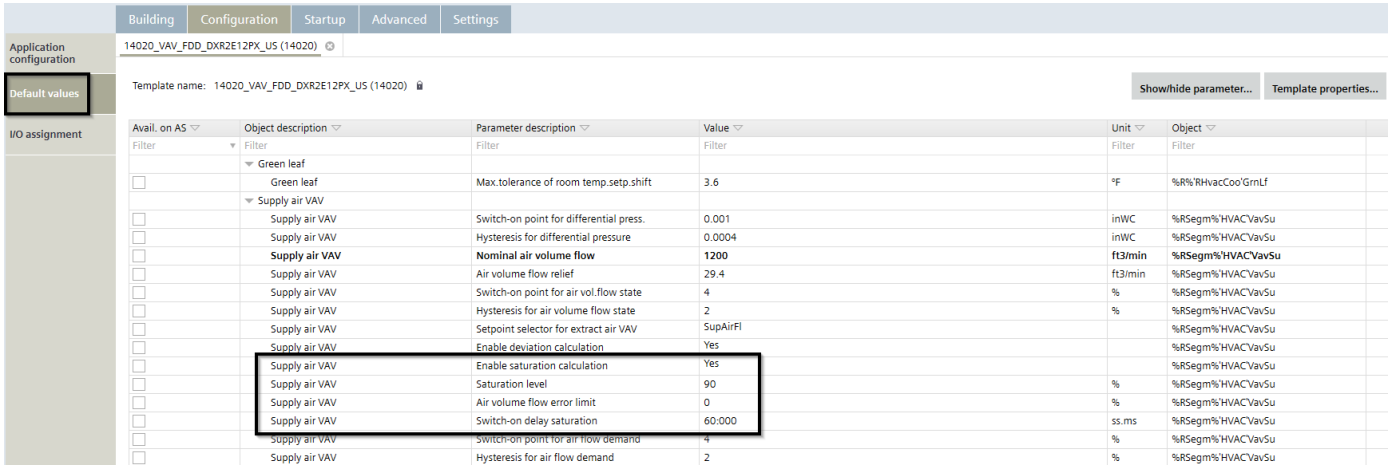
The above graphic illustrates the communication of parameters between a Room level DXR, Central Function DXR, and Primary Plant controller. This type of communication is common across all Central Functions. The Central Function DXR can act as a bridge between data from the room and data at the primary plant. By configuring the Room DXR(s) and Central Function DXR as needed, the saturation function is a very efficient way to control Static Duct Pressure Reset at the AHU level.

Using Saturation Level in ABT Site and ABT Inside

Title 24 Fault Detection for VAV and FPB Templates

For compliance with Title 24, an FDD configured template must be used. FDD templates are located on StdApps under Apogee > Desigo_ABT > CustomApplications > FaultDetection.

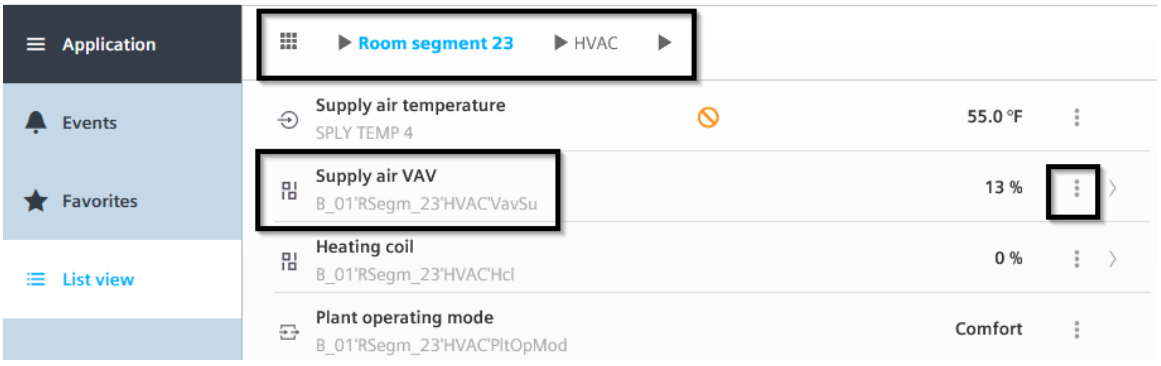
VAV and FPB templates include Saturation level parameters by default. To find and edit them in ABT Site, go to the Default values task and locate them under Supply air VAV. They can be edited here before the application is loaded into the controller:



If a controller was already loaded, and these values need to be edited, they can be changed online using ABT Inside:

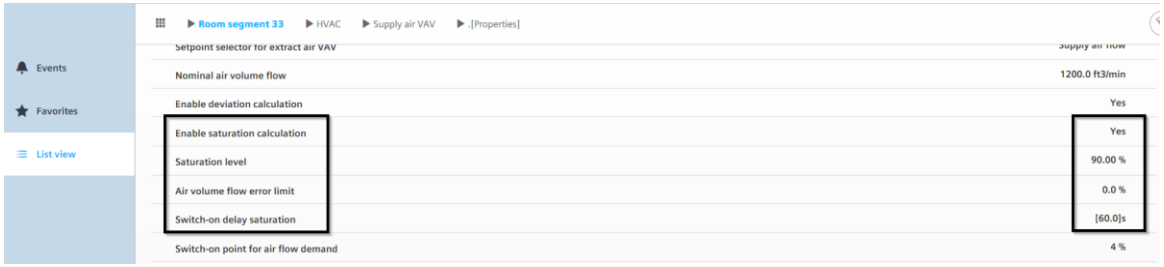
1 Go Online with the device.

2 Navigate to **Room segment - HVAC**



3 Click the three dots next to Supply air VAV.

4 Locate the parameters and edit / configure as needed:



Configuring VAV Terminal with Default Values (Optional)

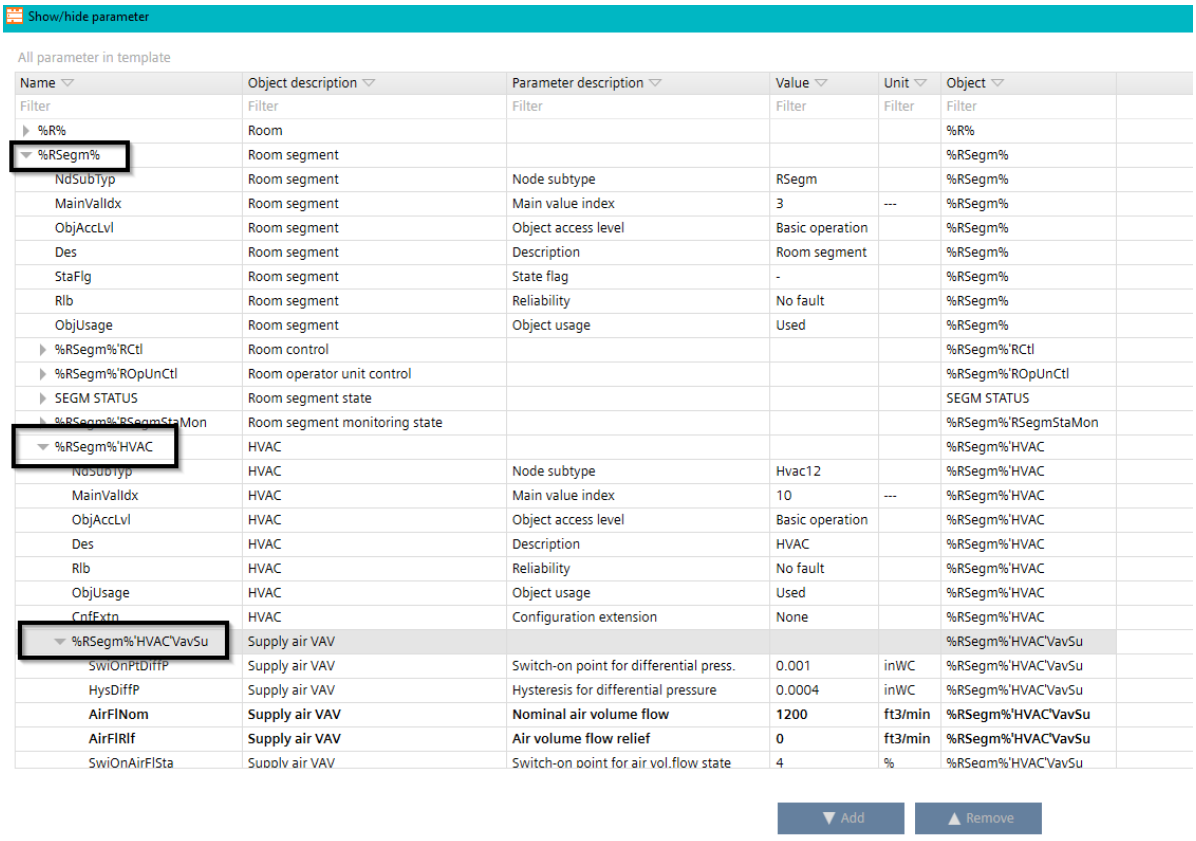
Although this configuration example is the suggested way of setting up Duct Static Pressure Reset, it is not the only correct method. There are other ways to achieve the same result, for example by using the VavSu11 AF (instead of VavSu12) and Central Functions. VavSu11 uses an external air flow controller / actuator.

Furthermore, job requirements might necessitate changes in this configuration. This example is meant to be used as a guideline and not an all-use case.

Note, in your application these object parameters should already be exposed if you are using standard VAV / FPB templates. Adding them again here will not alter the application but you do not need to add objects or parameters if they are already exposed.

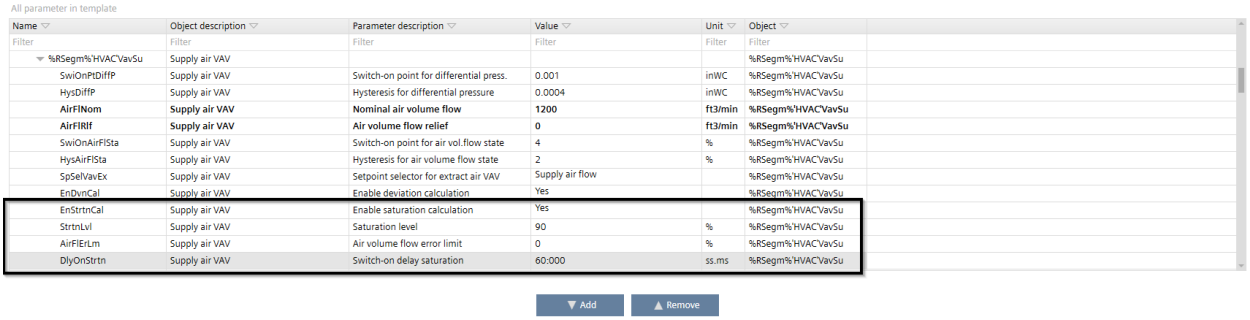
Skip this section as appropriate.

1 Choose the Configuration component, then choose the Application selection task
2 . Open the VAV application template and choose the Default values task.
3 Choose the Show/hide parameters button.
4 Expand the selections to see the parameters under %RSegm%'HVAC'VavSu

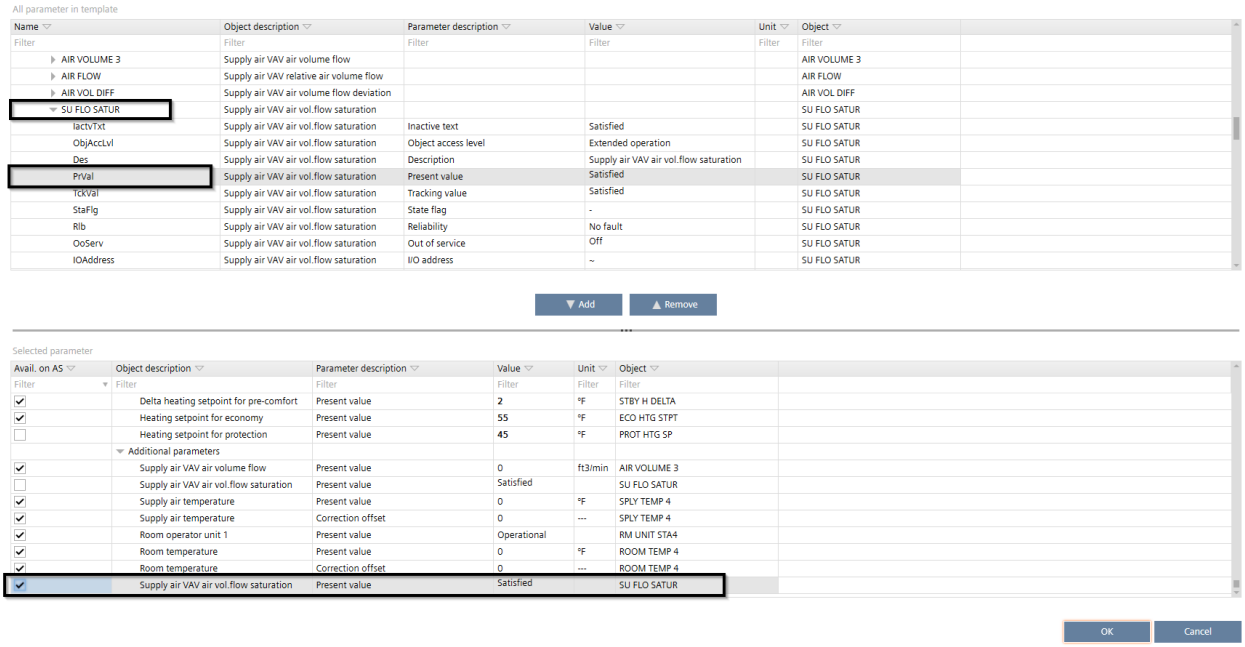


5 Select the object parameters for **EnStrtnCal**, **StrtnLvl**, and **DlyOnStrtn**.

6 Click the Add button.

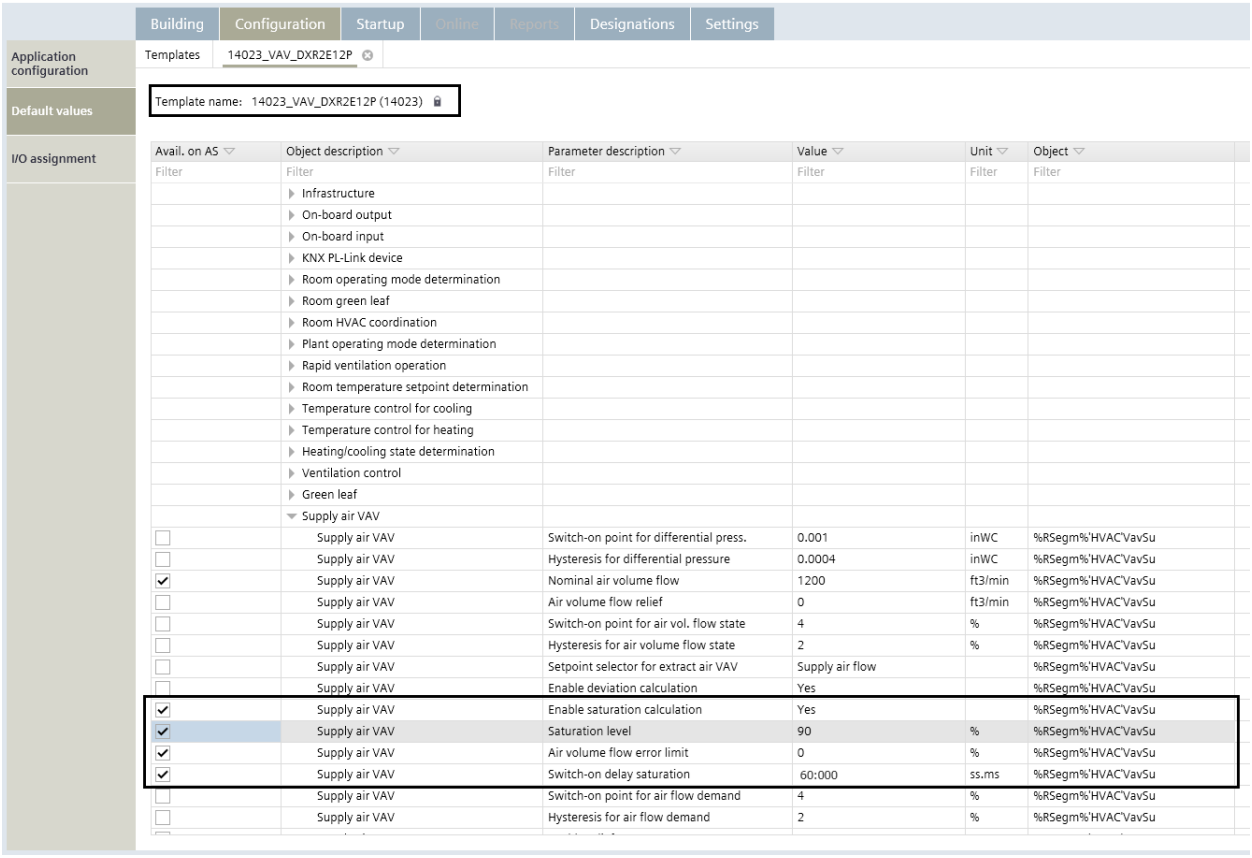


7 If SU FLO SATUR (Supply air VAV airflow saturation) is required by the commissioning agent, expand the list under SU FLO SATUR and select **PrVal** and click the Add button.



8 The **NumVavSuStrtn** (Number of supply air VAV air volume flow starved) parameter may be added to Additional parameters (or may be already exposed). Note that this object does not need to be pulled out from Show/Hide Parameters; it will be visible / shown while online even if not selected here.

9 If necessary, select the Avail on AS option for the parameters. (Note that doing this will increase network traffic.)



10 Click OK.

11 Close the application.

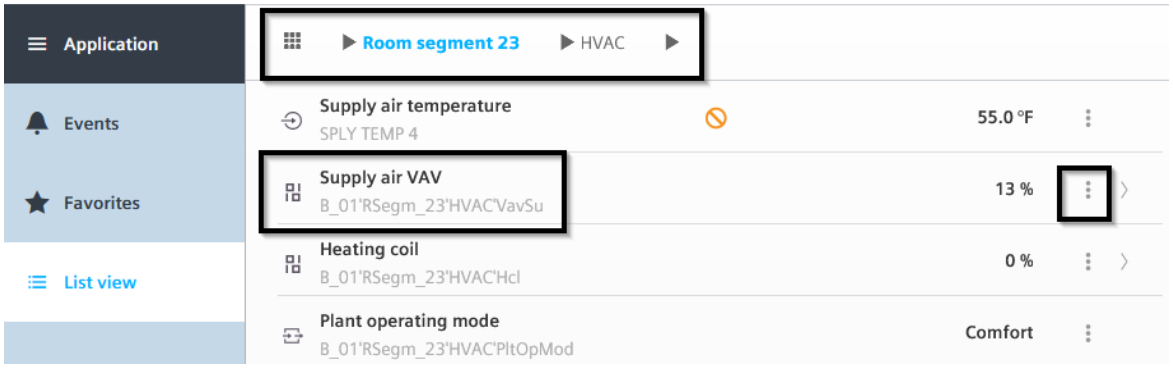
12 Add the VAV Automation Stations to the Building Hierarchy.

If any changes are made to the application configuration (for example, changes to the I/O) the application must be unlocked with a custom application number. However, simply changing or adding default values (such as changing StrtnLvl) does not require a change in the application template number.

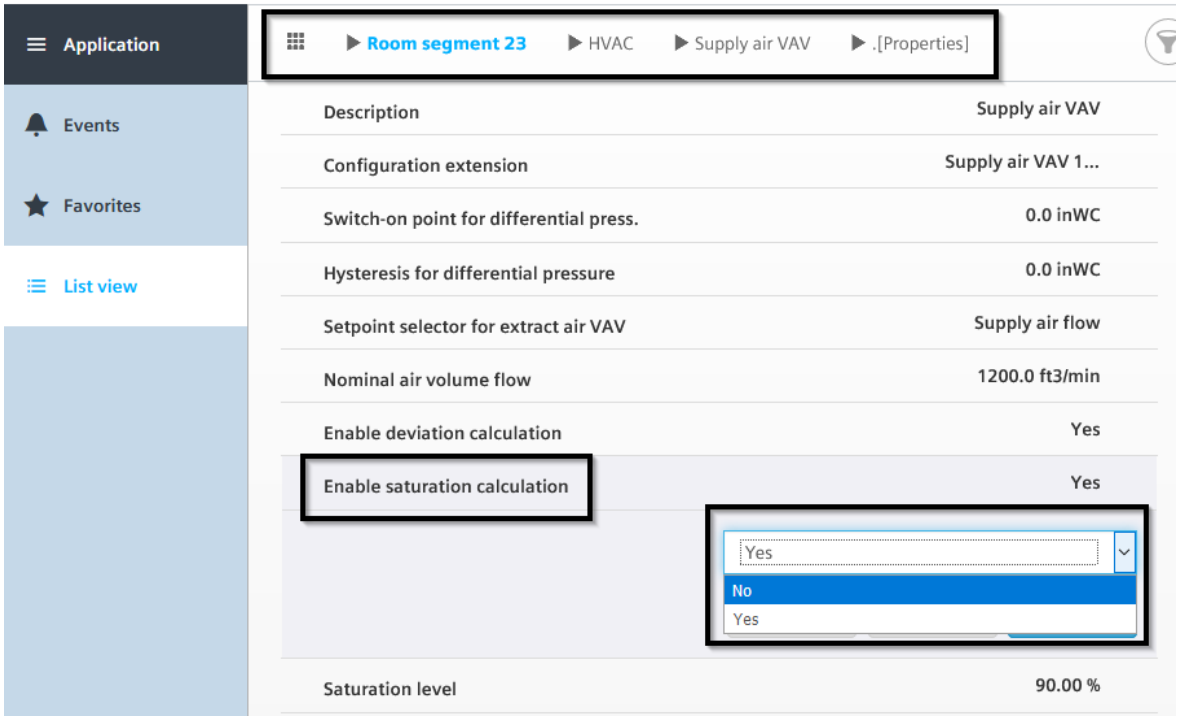
Excluding VAV Terminal from Saturation Calculation

When the Enable Saturation Calculation parameter is set to false, the VAV box is not included in the Duct Pressure Reset calculation, but it still remains part of the group. The following example shows how to exclude a box while online in the controller. It can also be done by changing the same setting in the Default values area in ABT Site.

1 Go Online with the device.
2 Navigate to **Room segment - HVAC**
3 Click the three dots next to Supply air VAV.



4 Change **Enable saturation calculation** to “No”.



5 Click OK.

Central Functions

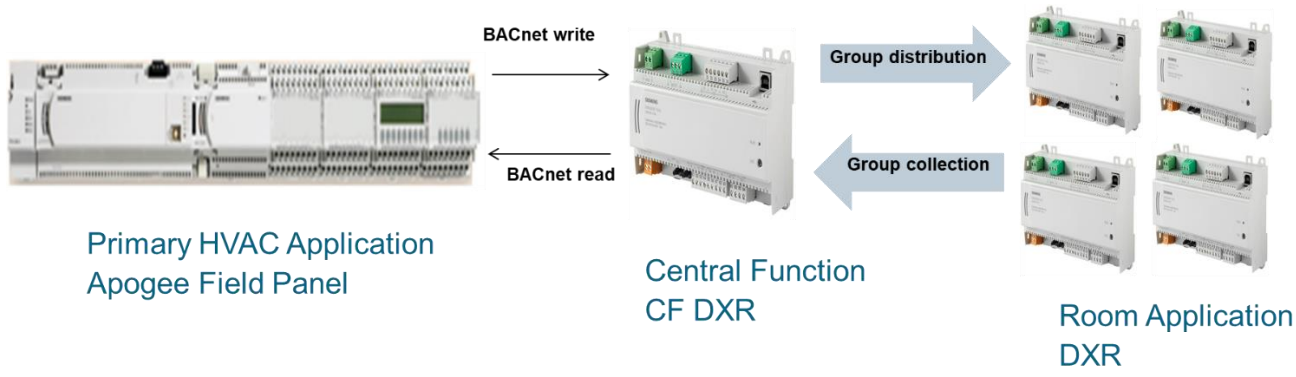
Central Functions Basics

The Central Function Application or Coordinator is implemented through the use of a DXR2E/M.18 controller. Central Functions coordinate the actions of the room controller to the primary plant. A DXR running the Central Function Application facilitates group data exchange between room applications or DXRs and the primary plant controller or Field Panel. It does this by using group member and group master objects to communicate with RA Applications and by using ordinary BACnet objects to communicate with the primary application. This avoids the need to field-configure BACnet object references in the Field Panel.

Central Functions and Group Data Exchange are not mandatory because the controllers support the read/write of standard BACnet Objects as we currently use them.

One Central Function DXR can collect up to 255 Group Member objects. It can read and write to those objects, as well as read and write using BACnet objects from the Field Panel.

More than one group may be required depending on the size of the application, as only one central function DXR should be used per AHU.



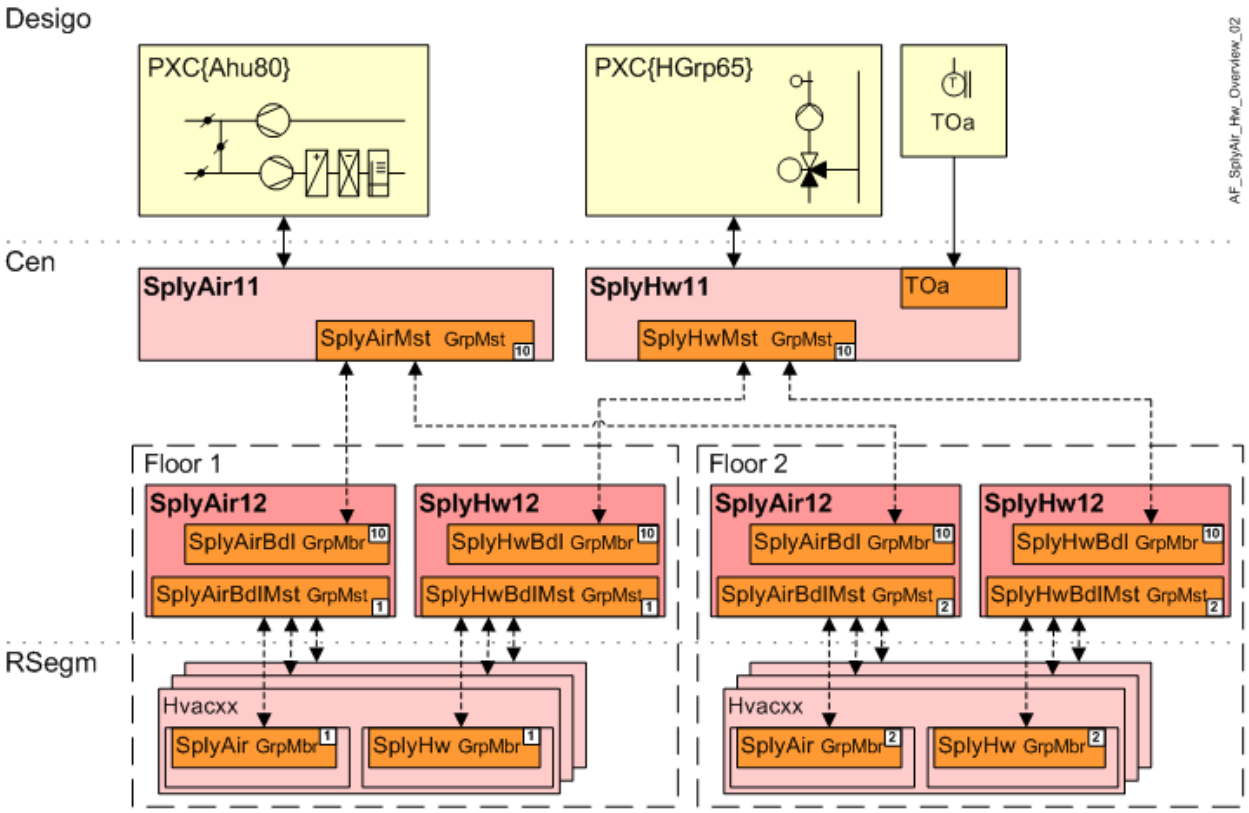
If there is more than one group, the group number can be changed in ABT Site under the Central Functions task. The first group will have a default Group Number of 1, and subsequent Group Numbers can be changed as necessary. See Configuring Group Members and Masters for a detailed look at Group Member assignment.

There are multiple applications for Central Functions that can be used in a variety of ways including:

- Start/stop coordination
- Minimizing Duct Pressure
- Optimizing Supply Air Temperature
- Controlling scheduling modes (Warm-up, Cool Down, etc.)
- Optimizing hot and/or chilled water parameters (supply temperature, start/stop modes)

Central Functions can also be bundled together in order to collect and distribute Group Member data to / from multiple other Central Function DXRs. All central functions have “bundled” variants that are used as subordinate central functions to one master. If one central function may not be enough to control all of the data from the room controllers, a higher-level Central Function DXR can be used to communicate between the lower level central functions to the AHU/primary plant.

The following diagram shows the hierarchy of bundled functions, and how the Group Members and Masters communicate with one another. The bundled Central Functions collect data from each floor, while the corresponding Master Central Function collects the data from the subordinate bundled members. For more information on bundling, see ABT Site Help.



The following section provides an overview on the ability and limitations of SplyAir11, the main Central Function used for Duct Pressure Reset. For information on other central functions, see ABT Site Help.

Supply Chain Air 11

The application function “Supply chain air 11” (SplyAir11) collects the demand signals of the different rooms via group mechanism and provides the setpoint and demand for the central air handling unit. SplyAir11 contains multiple lower level application functions, all of which can be used to control the air demand in different ways depending on the application. The complete list of outputs can be found in the ABT Site Application help.

Commonly Used Outputs of SplyAir11

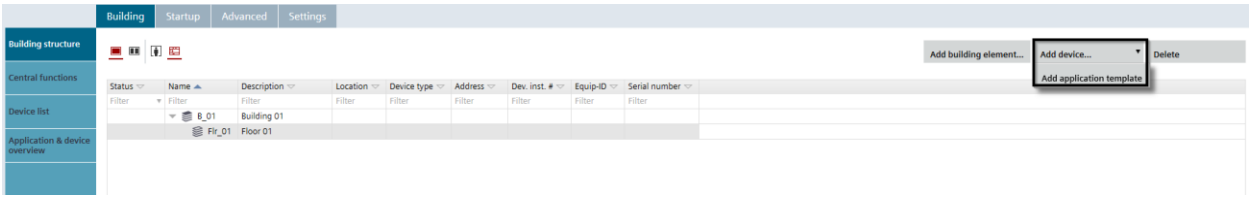
BACnet Point Database

Description	BACnet Name (Abbreviated name)	Type	Comment	Direction of Data Flow
Condition Value of air handling unit mode	AhuModCndVal	BCalcVal	Used with Fault Detection: faults will not activate, when the AHU serving the Zones is not turnedon, and this parameter signals the AHU operational state (On/Off).	To Terminals
Command for changeover mode air NOTE: Must select "Changeover condition determ.for air" = ACTIVE in ABTSite Central Function config.	ChoAirModCmd	MPrcVal	Multistate value that determines the changeover condition (Heating, Cooling, Neither, Neutral). This acts as a global command to command Vav Supply dampers for warmup from DesigoCC. If Vav supply dampers ONLY provide Cooling, make sure this BacNet point Is Overridden to always be set for Cooling.	To Terminals
Changeover function for supply chain air number of cooling demand	ChoAirNumCDmd	ACalcVal	The evaluated number of segments requiring cooling.	From Terminals
Changeover function for supply chain air number of heating demand	ChoAirNumHDmd	ACalcVal	The evaluated number of segments requiring heating.	From Terminals
Number of supply air VAV air volume flow starved	NumVavSuStrtn (FLO SAT QTY)	ACalcVal	Collects the number of supply VAVs that are above the Saturation Level for that box. This BACnet point is used by the AHU supply duct static pressure reset logic.	From Terminals
Number of exhaust air VAV air volume flow starved	NumVavExStrtn (EX SAT QTY)	ACalcVal	Collects number of exhaust VAVs that are above Saturation. This BACnet point is used by the AHU extract duct static pressure reset logic.	From Terminals

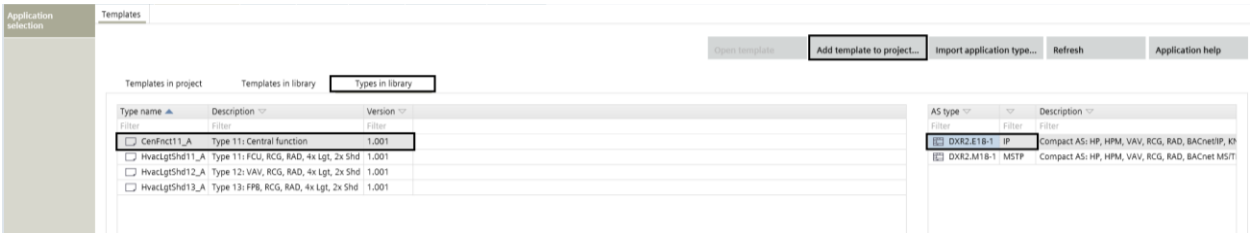
There are many other BACnet outputs of SplyAir11 (see ABT Site Application Help). The above objects are commonly used in conjunction with Fault Detection and can be used along with Duct Pressure Reset. The other objects can be accessed from the "Show/hide parameter" list in ABT Site depending on which functions were activated in the Application Configuration.

The next sections provide a guide on how to set up and configure a Central Function DXR for Duct Pressure Reset.

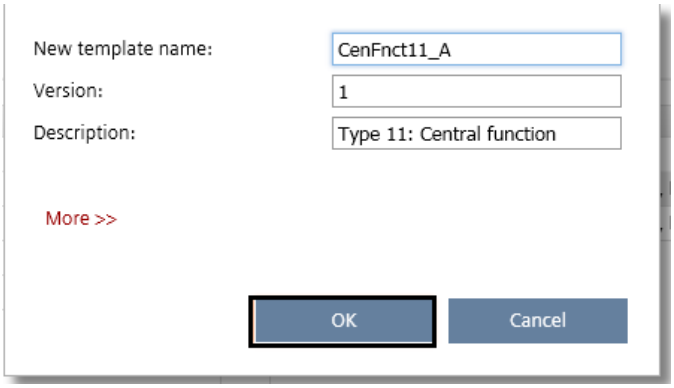
Adding a Central Function



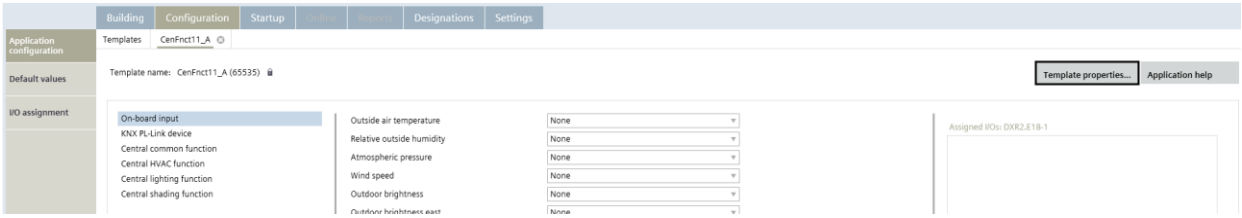
1. Choose the **Building** component.
2. Choose the **Building Structure** task.
3. Choose the **Add application template** button from the **Add Device** drop-down.



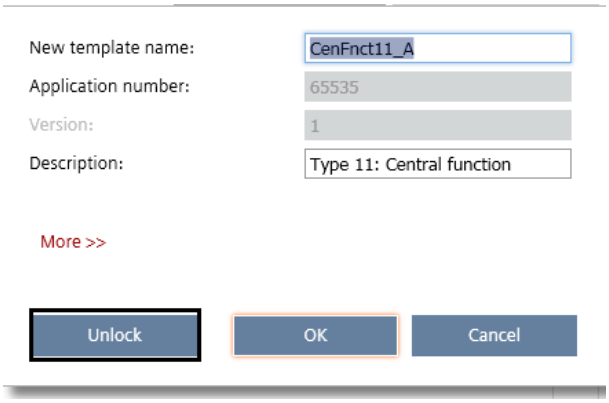
4. Choose the **Types in Library** tab.
5. Choose the **CentFnct11_A** type.
6. Select the **AS Type** required.
7. Choose the **Add template to project** button.
8. Use the default name, version, and description and click **OK**.



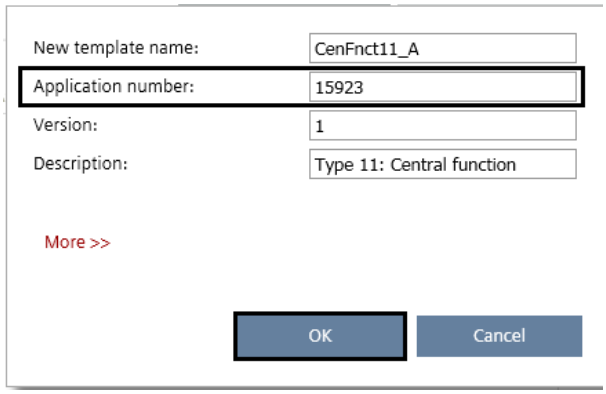
9. Click the **Template Properties** button.



10.Click the **Unlock** button.

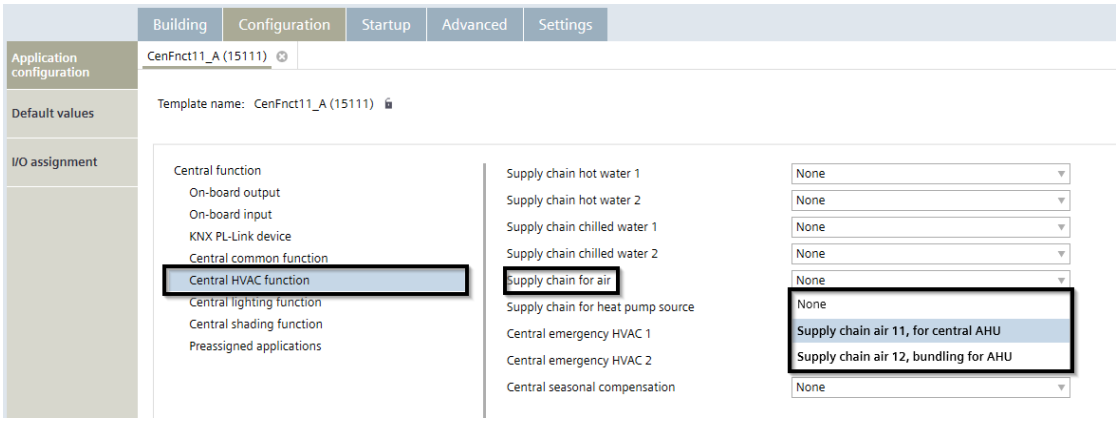


11. Enter an Application Number.
12. Click **OK**.

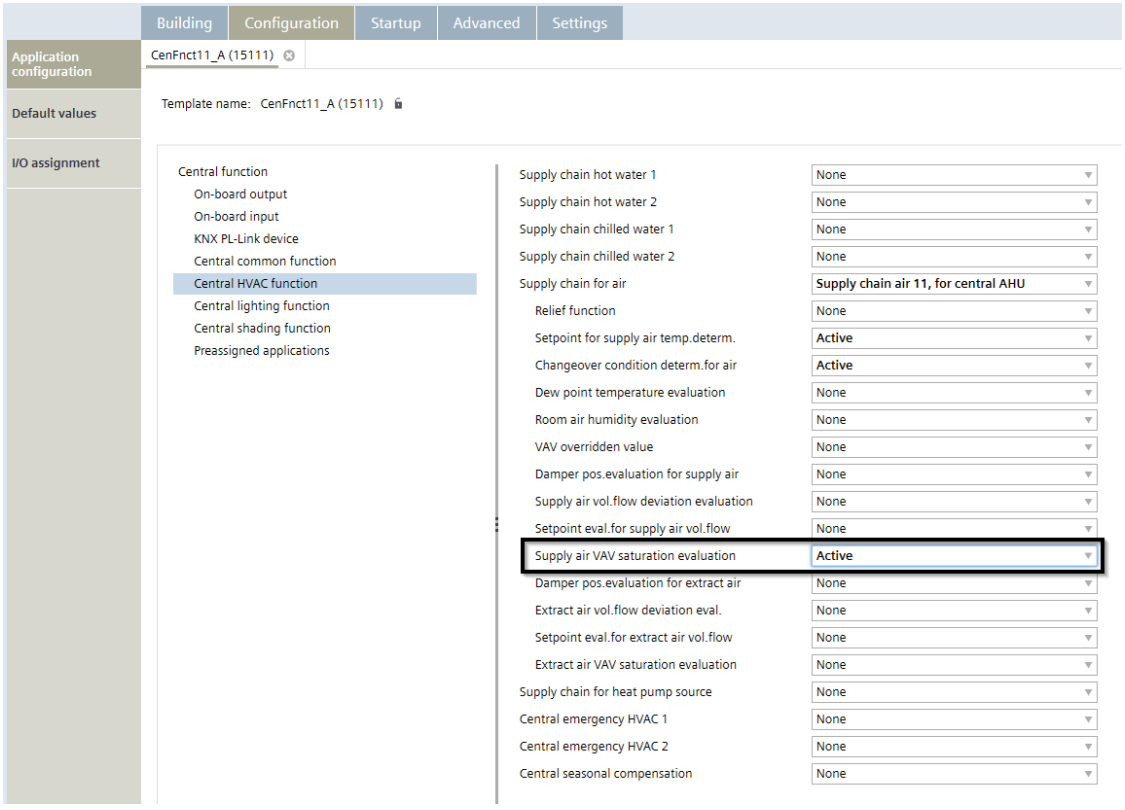


Configure Central Function for Supply Air VAV Saturation Evaluation

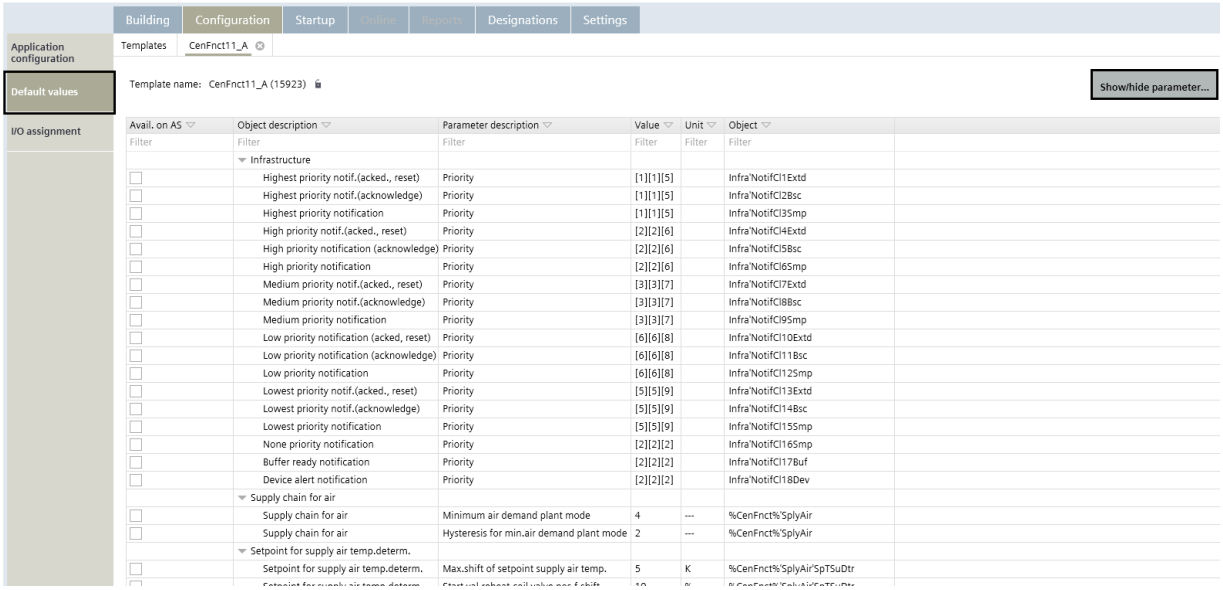
1. Choose the **Central HVAC Function**.
2. Choose **Supply chain for air**.
3. Click the drop down and change **None** to **Supply chain air 11**.



4. Choose **Supply air VAV saturation evaluation**.
5. Click the drop down and change the setting from **None** to **Active.**



6. Choose the **Default Values** task.



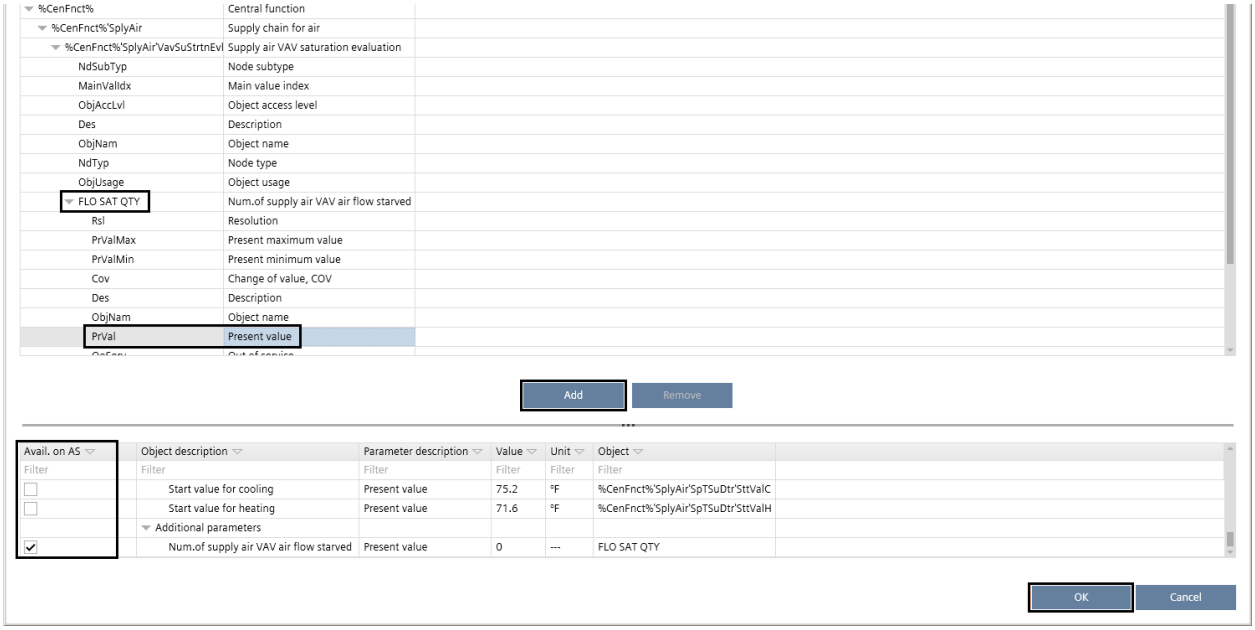
7. Change Infrastructure Priority Objects

IMPORTANT: When configuring a Central Function app type for the first time, the Infrastructure Objects must be changed. If they are kept as defaults, they can cause alarms to come in at a Life Safety priority, regardless of whether they are high priority. They should be as shown here:

Infrastructure				
Highest priority notif.(acked., reset)	Priority	[64][64][64]		Infra'NotifCl1Extd
Highest priority notif.(acknowledge)	Priority	[64][64][64]		Infra'NotifCl2Bsc
Highest priority notification	Priority	[64][64][64]		Infra'NotifCl3Smp
High priority notif.(acked., reset)	Priority	[128][128][128]		Infra'NotifCl4Extd
High priority notification (acknowledge)	Priority	[128][128][128]		Infra'NotifCl5Bsc
High priority notification	Priority	[128][128][128]		Infra'NotifCl6Smp
Medium priority notif.(acked., reset)	Priority	[160][160][160]		Infra'NotifCl7Extd
Medium priority notif.(acknowledge)	Priority	[160][160][160]		Infra'NotifCl8Bsc
Medium priority notification	Priority	[160][160][160]		Infra'NotifCl9Smp
Low priority notification (acked, reset)	Priority	[192][192][192]		Infra'NotifCl10Extd
Low priority notification (acknowledge)	Priority	[192][192][192]		Infra'NotifCl11Bsc
Low priority notification	Priority	[192][192][192]		Infra'NotifCl12Smp
Lowest priority notif.(acked., reset)	Priority	[254][254][254]		Infra'NotifCl13Extd
Lowest priority notif.(acknowledge)	Priority	[254][254][254]		Infra'NotifCl14Bsc
Lowest priority notification	Priority	[254][254][254]		Infra'NotifCl15Smp
None priority notification	Priority	[255][255][255]		Infra'NotifCl16Smp
Buffer ready notification	Priority	[255][255][255]		Infra'NotifCl17Buf
Device alert notification	Priority	[255][255][255]		Infra'NotifCl18Dev

8. Choose the **Show/hide parameters** button.
9. Under %**CenFnct**%, expand %CenFnct%'**SplyAir**, and then select %CenFnct%'SplyAir'**VavSuStrtnEvl**

10. Expand the displayed list to show the object parameters for **FLO SAT QTY**.
11. Select **PrVal** and click the Add button.

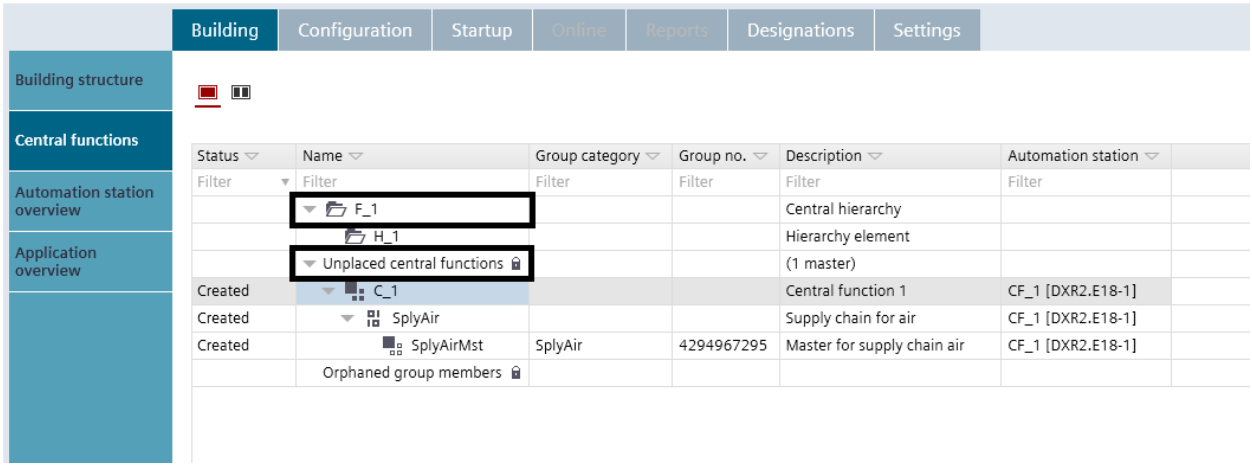


12. The parameter **Num of supply air VAV airflow starved** is added to Additional Parameters.
13. En able the **Avail on AS** option for **FLO SAT QTY**.
14. Click OK.
15. Close the application.
16. Add the Central Function Automation Station to the Building Hierarchy.

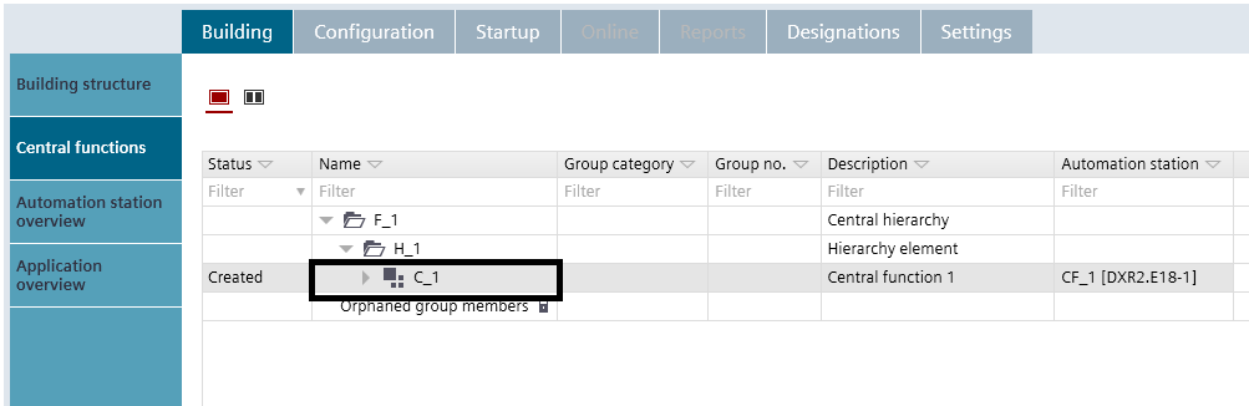
Configuring Group Members and Masters

Group master/member communication is how all central functions read and write to other applications. The high-level central function controls a single Group Master object. This Master object is then what writes to the Group Member objects in the lower level application functions. Because of this, it is extremely important to make sure to set up the member/master connection for each central function, as otherwise there will be no communication between the member and master, or the Central Function DXR and the VAV Terminal DXR. It is also possible here to simply not select any subordinate Automation Stations that are not involved with this central function application.

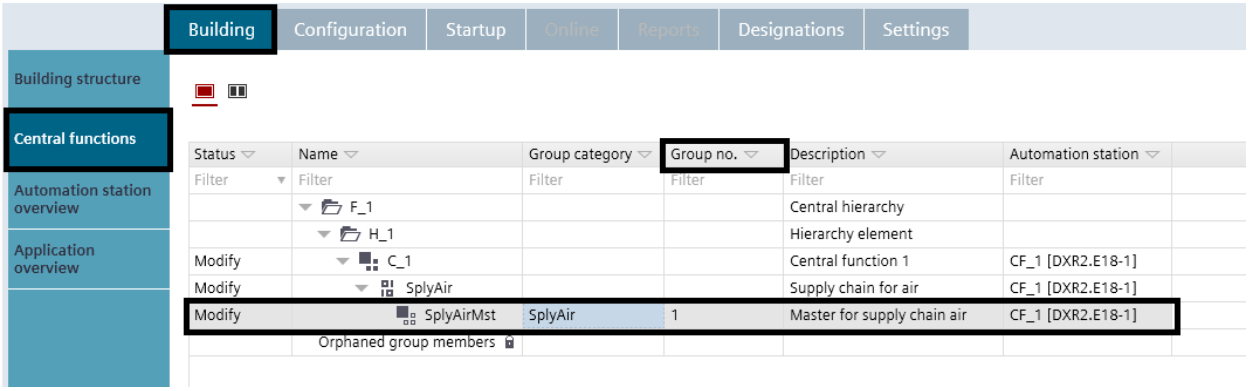
1. Select the **Building** component.
2. Select the **Add device** button and add the Central Function to the building structure.
3. Select the **Central Functions** task.
4. Add a Central Function hierarchy. Expand the **Unplaced central functions** hierarchy to expose the **SplyAirMst Group Master**.



5. Drag the unplaced Central function to the Hierarchy element



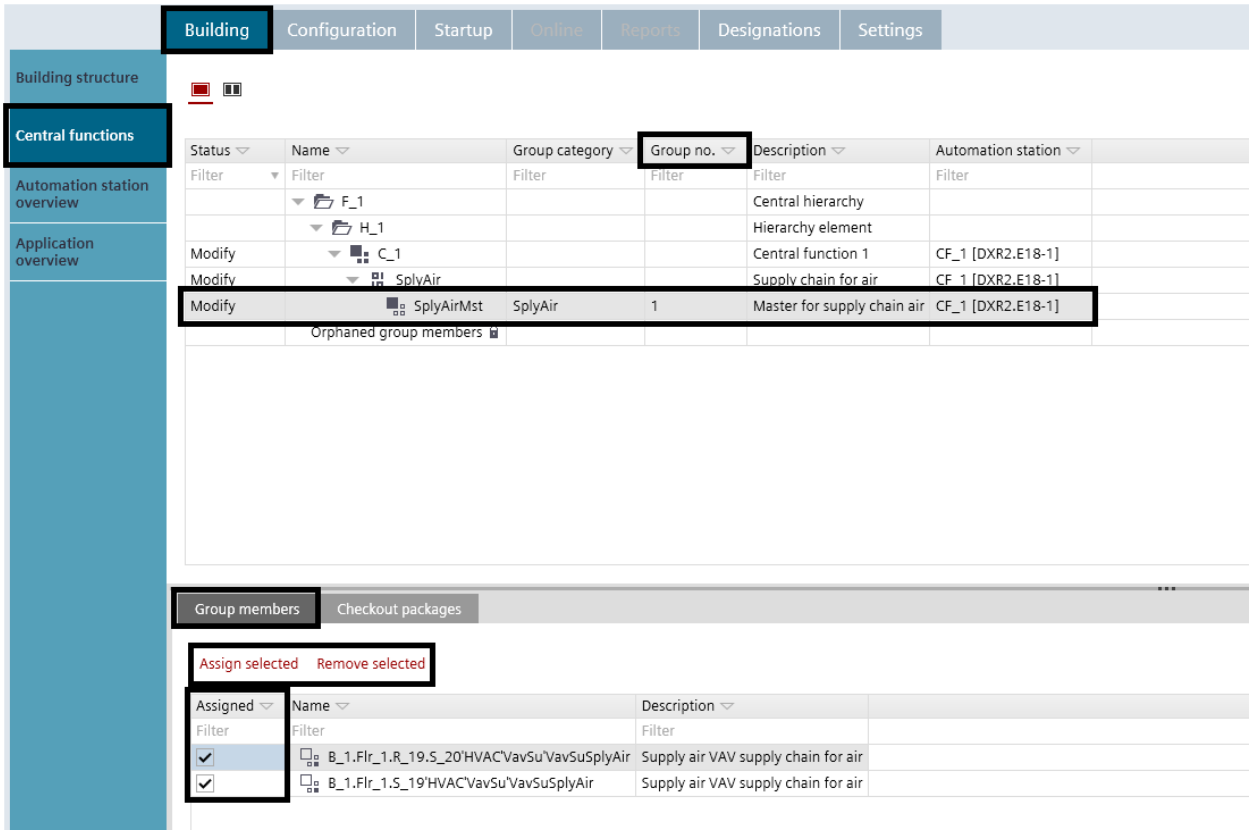
6. Expand the Central function. Modify the **Group Number** to 1. (It may already be set to 1)



7. With the Group Master selected, the VAV Automation Stations should be displayed in the **Group Members** tab. <u>All Automation Stations used in the Duct Pressure Reset calculations must have an **Assigned** selection in this tab.</u>

All Central Functions can be grouped hierarchically, which is used for separating Group Member and Master functions. Multiple Central Functions can be grouped like this to simplify floors, or to split number of members. One group member can only have 255 objects for supply functions, so it may be necessary to use two central functions depending on the number of objects.

8. Use Assign Selected or Remove Selected buttons may be used to assign or remove the VAV Automation Stations from the group.



Once the Terminal application is connected as shown, the data from the VAV box should be collected and read by the Central Function. This will allow the Central Function DXR to communicate with the AHU and perform Duct Pressure Reset correctly.

While online in the Central Function DXR, FLO SAT QTY will show how many VAV boxes are starved from the group members that were assigned to this DXR:

Appendix

Duct Static Pressure Reset – Standards and Guidelines

ASHRAE 90.1-2018	6.5.3.2.3 VAV Setpoint Reset	"For multiple-zone VAV systems having a total fan system motor nameplate horsepower exceeding 5 hp with DDC of individual zones reporting to the central control panel, static pressure set point shall be reset based on the zone requiring the most pressure; i.e., the set point is reset lower **until one damper is nearly wide open**. Controls shall provide the following: a. Monitor zone damper positions or other indicator of need for static pressure. b. Automatically detect those zones that may be excessively driving the reset logic and generate an alarm to the system operator. c. Readily allow operator removal of zones from the reset algorithm."
IECC - 2017	C403.6.8 Setpoints for direct digital control	"For systems with direct digital control of individual zones reporting to the central control panel, the static pressure setpoint shall be reset based on the zone requiring the most pressure. In such case, the setpoint is reset lower **until one zone damper is nearly wide open**. The direct digital controls shall be capable of monitoring zone damper positions or shall have an alternative method of indicating the need for static pressure that is configured to provide all of the following: 1. Automatic detection of any zone that excessively drives the reset logic. 2. Generation of an alarm to the system operational location. 3. Allowance for an operator to readily remove one or more zones from the reset algorithm."
California Title24 - 2019	Energy Standard: 140.4(c)2B	"For systems with direct digital control of individual zone boxes reporting to the central control panel, static pressure setpoints shall be reset based on the zone requiring the most pressure; i.e., the set point is reset lower **until one zone damper is nearly wide open**."
	Compliance Manual: 4.5.2.3 VAV Supply Fan Controls	"For systems with DDC to the zone level the sensor(s) may be anywhere in the distribution system and the duct static pressure set point must be reset by the zone demand. Typically, this is done by one of the following methods: 1. Controlling so that the most open VAV box dampers are 95 percent open. 2. A trim and respond algorithm to continually reduce the pressure until one or more zones indicate that they are unable to maintain airflow rate set points. 3. Other methods that dynamically reduce duct static pressure setpoint as low as possible while maintaining adequate pressure at the VAV box zone(s) of greatest demand."
	Compliance Documents: 2019 NRCA-MCH-07-A Supply Fan Variable Flow Controls (A.2.d.i.)	"IF the system includes a direct digital control of individual zone boxes reporting to the central control panel, THEN static pressure setpoints will be reset based on the zone requiring the most pressure (i.e., the set point is reset lower **until one zone damper is nearly wide open**)"

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