MIXIT integration Guide

Application guide JAN2022

be
think
innovate

GRUNDFOS

Integration of MIXIT with BMS systems

1 INTRODUCTION

This document describes how to integrate MIXIT into an automation system via either the Modbus or the BACnet fieldbus protocols. Examples in this document and especially drawings mention specific control and status datapoints referring to BACnet objects. In those cases, tables are listed where the corresponding registers in the Modbus profile can be seen. The document is only concerned with the most relevant datapoints for start/stop, setpoints and sensors. The full list of datapoints are available in the functional profiles for the product at https://product-selection.grundfos.com/,or www.grundfos-eica.com search for MIXIT, click on a MIXIT product and browse to documentation.

The appropriate way of integrating MIXIT with the automation system depends on the use case. Three use cases are sketched in Figure 1

1. Interface to a controller that is programmable and has a Modbus RTU or BACnet MS/TP interface.
2. Interface to a dedicated controller that is not programmable to the extend it can interface to MIXIT's fieldbus profile.
3. Interface to a programmable controller that only supports analogue I/O.

Use case 1 is the common situation for large systems.

Use case 2 is sometimes used in smaller buildings.

Use case 3 can be encountered if the integration task you face is for retrofit with an older BMS system.

If facing use case 1, sections 3 and 4 are of relevance if integrating with an air handling unit or sections 3 and 5 are of relevance if integrating with a radiator system or a floor heating system. In addition to these sections, if facing use case 2, then section 1.1 is also of relevance. If use case 3 is faced please consult section 6.

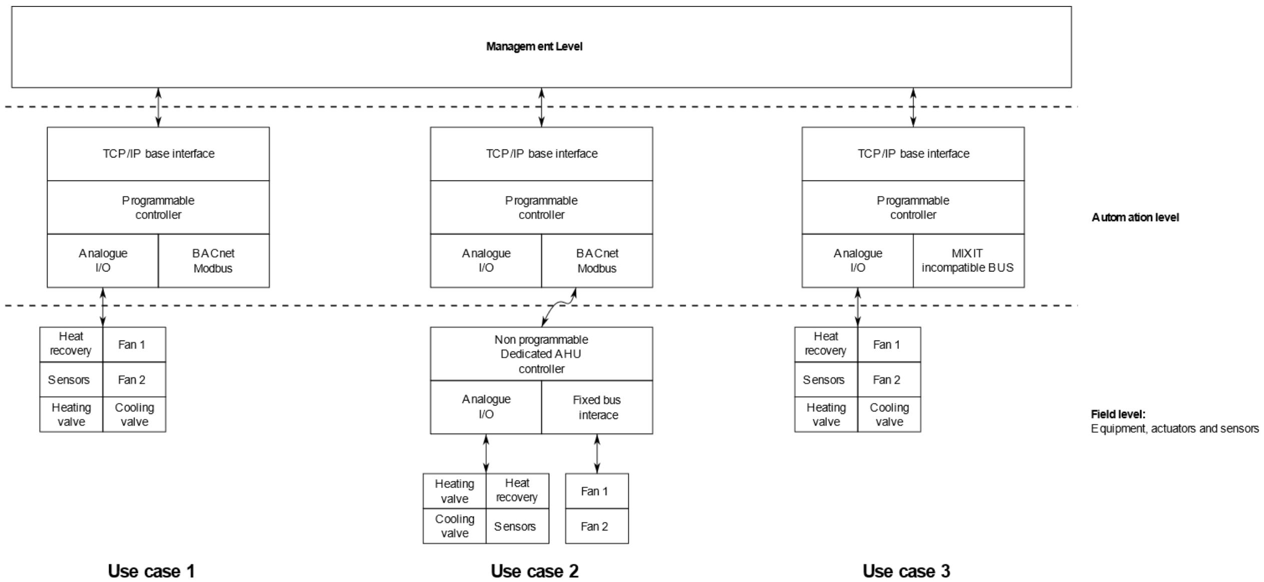

Figure 1: Use cases for BMS integration, the field level reflects the case for an air handling unit (AHU).

The corresponding use cases with MIXIT is shown in Figure 2. The difference between integrating MIXIT into a BMS system compared to a traditional valve is that MIXIT shall receive a start/stop signal and a temperature setpoint instead of a valve position, that many datapoints are available via the MIXIT fieldbus profile that relates to integrated sensors and the connected pump, and that the valve position of MIXIT cannot be controlled directly.

It is possible to send start/stop signal and the setpoint to MIXIT via the BACnet or Modbus or on an analogue interface. If the analogue interface is used for sending signals to MIXIT it is still possible to read datapoints from the BACnet or Modbus fieldbuses.

Use case 2 with the dedicated controller can be a problem as it is designed to control the valve position directly. However, sometimes the temperature setpoint and on/off signals are available in the bus profile of the dedicated controller. They should then be transferred to MIXIT via the programmable controller at the automation level.

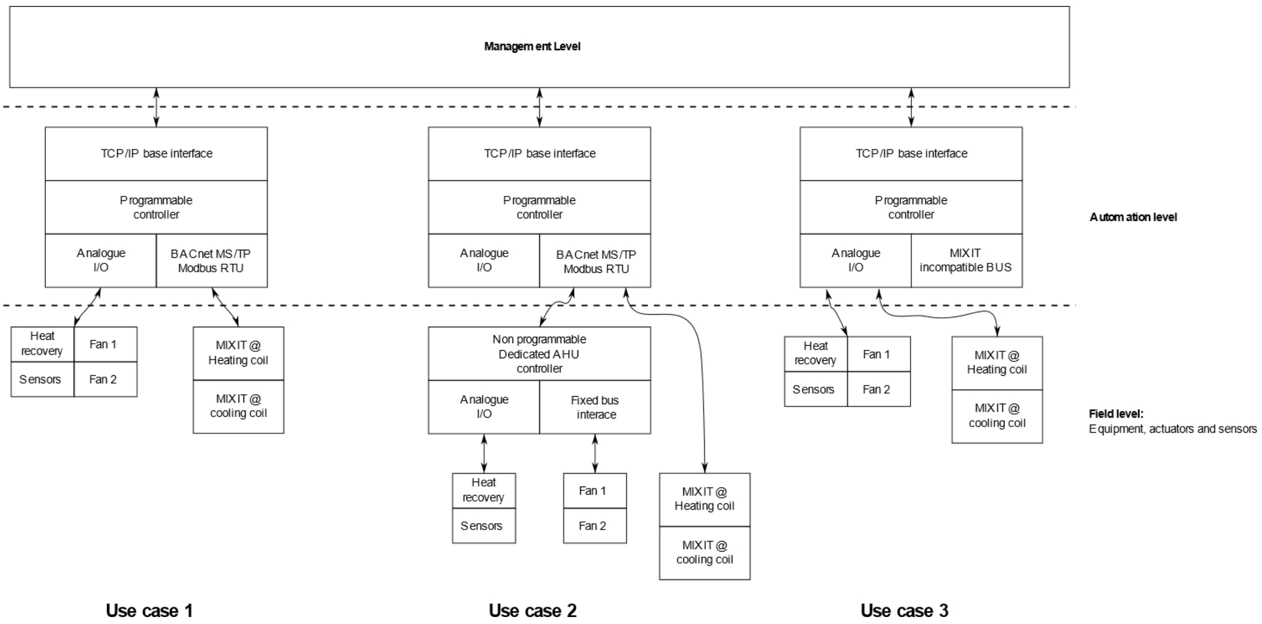

Figure 2: Use cases for BMS integration with MIXIT, the field level reflects the case for an air handling unit (AHU).

1.1 Alternative option for interfacing MIXIT to a dedicated controller

If MIXIT cannot be connected at the automation level in use case 2, for example because no spare analogue outputs are available or there is no BACnet MS/TP or Modbus RTU fieldbus master available at automation level, there is one additional way of interfacing MIXIT to the dedicated controller.

The analogue valve opening setpoint u from the dedicated controller may be interpreted as a temperature setpoint because of the following steady state relation that is true for any mixing loop:

$$T_{mix} = T_{return} + f\left(T_{return}, T_{supply}, \Delta p, q_{mix}, u\right)$$

where

T_{mix}: The secondary supply temperature

T_{return}: The return temperature

T_{supply}: The primary supply temperature

Δp: The differential pressure across the valve

q_{mix}: The secondary flow

$f(.)$: A nonlinear function

By a closed valve $f\left(T_{return}, T_{supply}, \Delta p, q_{mix}, u = 0\right) = 0$ whereby $\boldsymbol{T_{mix}} = \boldsymbol{T_{return}}$, and when the valve is fully open for most mixing loops $f\left(T_{return}, T_{supply}, \Delta p, q_{mix}, u = 1\right) = T_{supply} - T_{return}$ whereby $\boldsymbol{T_{mix}} = \boldsymbol{T_{supply}}$

Therefore, setting up MIXIT to interpret the signal from the dedicated controller as a temperature setpoint may make sense. For example, if the analogue control signal from the dedicated controller is 0-10 Volts and the supply temperature is normally around 70 deg C and the minimum return temperature from the coil is 15 deg. C the configuration of MIXIT can be made via the Grundfos GO app as shown in Figure 3.

Some caution is to be made though. This solution cascades the control loop of the dedicated controller with the temperature control loop of MIXIT. The tuning of the dedicated control shall be slower than that of the MIXIT controller otherwise there is a risk that the overall control will oscillate and therefore the recommended option is to transfer the setpoints from the dedicated controller to MIXIT via the automation layer as shown in Figure 2.

The source for the start/stop signal that shall be given at a digital input on MIXIT depends on the dedicated controller model.

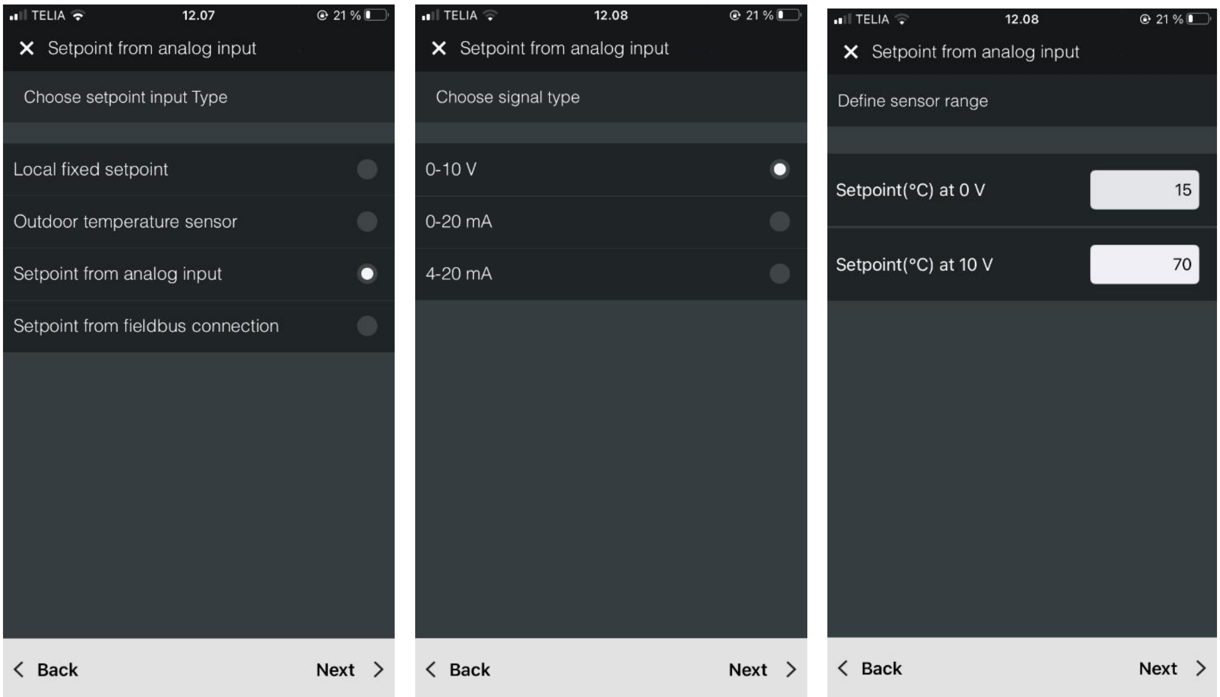

Figure 3: Configuration of analogue input as temperature setpoint.

2 APPLICATION SPECIFIC DEFAULTS

In this document there are reference to the build in application specific safety functions in MIXIT: Frost protection, coil preheat and floor overheat protection. When configuring MIXIT the first time these functions are enabled but they can be turned off via Grundfos GO. Table 1 gives an overview. The safety functions are described in detail in sections 4.3.1.1, 4.3.1.2 and 5.1.

Application	feature	Factory default status
Heating coil	Coil preheat Frost protection Default temperature setpoint	On On 40 deg. C
Floor heating	Floor overheat protection Default temperature setpoint	On 40 deg. C
Radiator heating	Default temperature setpoint	40 deg. C
Cooling applications	Frost protection Default setpoint	On 15 deg. C

Table 1: Application specific factory default values.

3 CONFIGURATION OF SETPOINTS AND BUS CONTROL

The field bus profile for MIXIT is made such that for the commands that can be given on an output object/register, there is a corresponding input object/register for reading back that the command was registered. The integration of MIXIT via the field bus protocols can only work if:

- MIXIT is set for bus control, otherwise it will not react on commands and setpoints. The bus control state is not persistent if the communication fails or MIXIT experience at power cycle. Therefore, there must be a cyclic checking and setting in case it has fallen back to local control.
- The correct setpoint chain is configured. For BUS control this is a persistent configuration and shall only be set once.

The configurations are described by Table 2.

Action	**BACnet**		**Modbus**		**Persistent setting**
	Object for setting	Object for status	Register for setting	Register for status	
Config. set-point from fieldbus	MV,0 = 3	MV,0	00117 = 2	00117	Yes
Set setpoint from fieldbus	AO,0	AI,0	00102	00311	No
Set bus control state	BO,0 = 1	BI,0	00101.0 = 1	00201.0	No
Config. default setpoint	AV,6	AV,6	00118	00118	Yes
Set start/stop	BO,1	BI,2	00101.1	00201.3	No

Table 2: Configuration and setting of remote state.

If MIXIT experience a communication failure, it will use the default setpoint which is factory configured at 40 deg. C for heating applications and 15 deg. C. for cooling applications. Therefore, it is a good idea to configure with a value meaningful for the application.

Notice! The default setpoint (BACnet: AV,6 / Modbus: 00118) is a persistent datapoint and shall not be used for regular/cyclic setpoint control. It is a fall back setpoint in case bus communication fails.

Notice! Single bits in Modbus register 00101 cannot be addressed even though the description of the register in the Modbus profile is bitwise. When writing the register all bits in the register must be written to their desired values.

4 MIXIT WITH AIR HANDLING UNITS

The objectives of using an air handling unit (AHU) are multiple:

- Supplying fresh air to a building zone.
- Discharging dirty air from a building zone.
- Pressurizing the building zone.
- Heating and cooling the fresh air supplied to the zone.
- Dehumidification and humidification of the fresh air supplied to the zone.

The heating and cooling of the fresh air happens by a combination of heat recovery and use of a heating coil or a cooling coil. The AHU controller manages the local setpoints, sequencing and safety functions of the AHU.

When MIXIT is used with AHUs it shall run a temperature control loop for either the discharge air temperature from the coil or the fluid temperature flowing towards the coil. It is up to the integrator to choose between these two options as follows:

- The selected MIXIT application is the **Heating coil** application: MIXIT controls the discharge **air temperature** leaving the coil.
- The selected MIXIT application is the **Radiator heating** application: MIXIT controls the **fluid temperature** flowing towards the coil.

The difference between the two are briefly described below. In either case local setpoints, sequencing and safety functions can be managed by the AHU controller.

The application selection is done via the Grundfos GO app.

4.1 MIXIT AHU control of discharge air temperature (heating coil application)

Figure 4 shows the simplified cascaded control loops associated with the AHU. The control loop for the air temperature which MIXIT runs when the heating coil application is selected is highlighted by the green box.

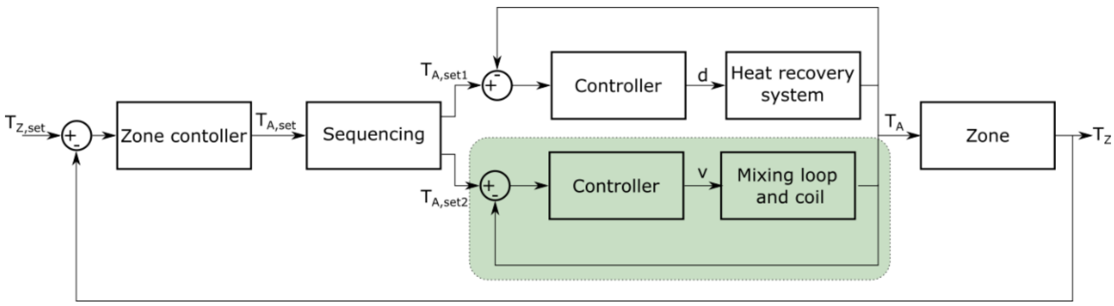

Figure 4: Simplified AHU control loops with MIXIT.

The air temperature needs to be feed to MIXIT via an analogue signal. The air temperature is also used by the AHU and the signal can be shared as shown in figure 3.

By method 1 the signal is shared via a signal splitter, all signals are analogue. By method 2 the analogue signal is fed to MIXIT and the AHU controller reads the air temperature value from MIXIT's fieldbus profile. By method 3 the sensor is connected to the AHU controller which feeds the signal to MIXIT via the field bus. In the current release of MIXIT there is no datapoint for this in the fieldbus profile it will be available in a future release.

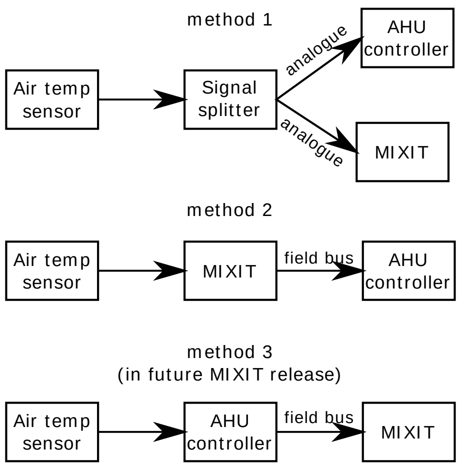

Figure 5: Ways of sharing the air temperature signal with MIXIT.

Integrating MIXIT where it controls the air temperature has the following benefits for heating coil control:

- MIXIT has a build in algorithm that can detect a frost risk at the coil and protect against coil damage.
- MIXIT can run a coil preheat routine when the AHU is started op.

This way of integrating is described in section 4.3 together with the setpoint configuration in section 3.

4.2 MIXIT AHU control of hot water temperature (radiator heating application)

Figure 6 shows an alternative way of cascading the control loops when MIXIT is integrated with the AHU. In that figure, the AHU controller gives the setpoint for the water temperature that is supplied to the coil. MIXIT controls therefore the water temperature (T_F) out of the mixing loop according to the setpoint. The AHU controller is responsible for setting the appropriate water temperature setpoint, such that the air temperature leaving the coil is at its appropriate setpoint for T_A.

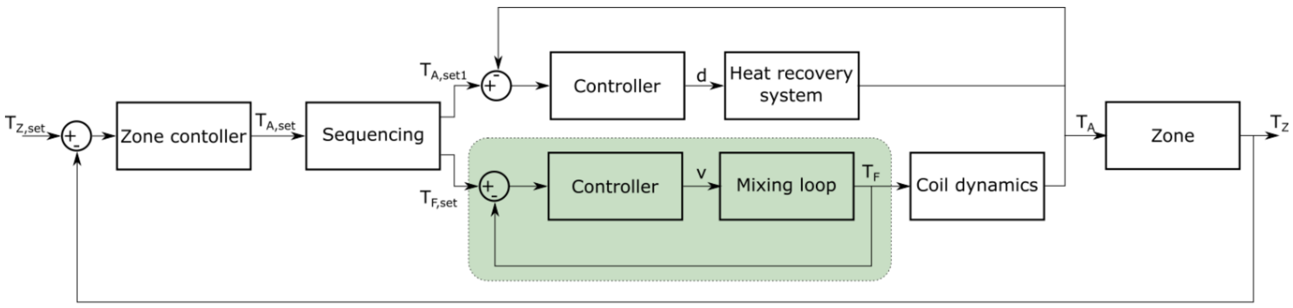

Figure 6: Alternative AHU control loops with MIXIT.

The drawbacks of this way of integration are, since MIXIT does not have access to the air temperature at the coil:

- AHU controller needs to handle frost protection of the coil via the water temperature setpoint for MIXIT.
- AHU controller needs to control coil preheat via the water temperature setpoint for MIXIT.

The advantage is that MIXIT does not need connection of additional sensor signals. This way of integrating is described in section 4.4 together with the setpoint configuration in section 3.

4.3 Integration of MIXIT in AHU control with MIXIT configured for the heating coil application

Here some basic topics of interfacing MIXIT with AHU control are covered. It is a prerequisite that MIXIT is configured for heating coil application to follow the below guides.

Notice! When MIXIT is configured with the heating coil application, it will assume control of the air temperature leaving the heating coil, and it needs an air temperature sensor connected, e.g. see Figure 5 in section 4.1.

4.3.1 AHU sequencing with safety functions for heating coil

This section describes the start and control sequence when MIXIT is integrated with the AHU controller.

Figure 7 shows the state diagram of MIXIT with the integrated coil preheat and frost protection functions enabled. The shown states are as follows:

READY: If a start signal is not given MIXIT is in the READY state. The pump is stopped, and the valve is closed.

PREHEAT: When a start signal is given the PREHEAT state is entered, e.g. see section 4.3.1.2.

TEMPERATURE CONTROL: When the coil has been preheated the air temperature after the coil is controlled according to the setpoint. MIXIT signals this at the fieldbus by setting BI,1=1.

FROST: The frost state is entered if a frost risk at the coil is signaled or it is detected by the integrated frost protection function. Both conditions have to be false for MIXIT to enter the TEMPERATURE CONTROL state again, e.g. see section 4.3.1.1.

STOP: When the start signal is removed MIXIT initializes for next start via the STOP state. After the STOP state MIXIT always enters READY.

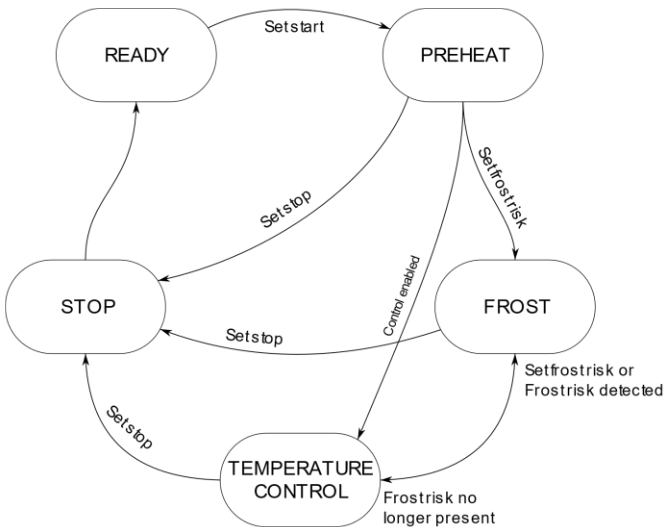

Figure 7: State machine for MIXIT heating coil application.

The data points associated with the state transitions are listed in Table 3.

Action	BACnet		Modbus		Persistent setting?
	Object for setting	Object for status	Register for setting	Register for status	
Set bus control state	BO,0 = 1	BI,0	00101.0 = 1	00201.0	No
Set start	BO,1 = 1	BI,2	00101.1 = 1	00201.3	No
Set stop	BO,1 = 0	BI,2	00101.1 = 0	00201.3	No
Set frost risk/ Frost risk detected	BO,4 = 1	BI,7	00101.7	00204.4	No
Temperature control Enabled		BI,1		00201.4	

Table 3: Data points associated with the state machines in Figure 7 and Figure 8.

In situations where the coil preheat function is not needed and has been disabled, the state diagram is as in Figure 8. The data points associated with the state transitions are the same as above.

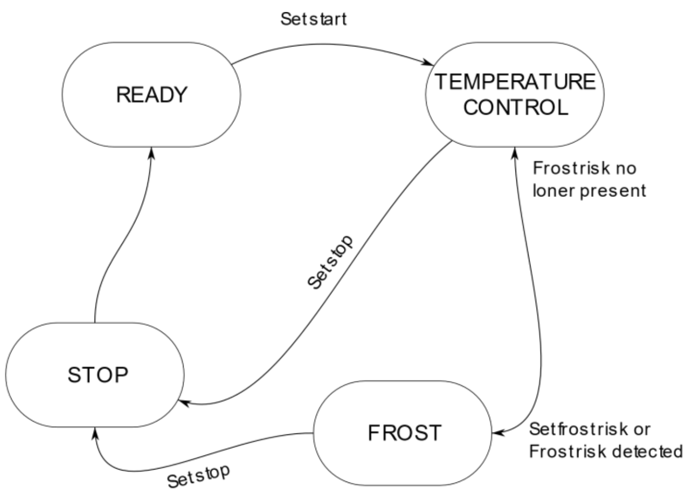

Figure 8: State machine for MIXIT with the preheat function disabled.

Even simpler, if the internal frost protection function has also been disabled, the only thing that can bring MIXIT to the frost state is either a signal on the fieldbus (BACnet: BO,4/Modbus 00101.7) or a signal at a digital input from a frost thermostat.

Figure 9 shows how to interface to MIXIT, when the coil preheat function in MIXIT is enabled. The example in the figure is based on BACnet objects but the corresponding Modbus registers are listed in Table 2 and Table 3. For example, as shown in Figure 9, BI,2 is read back to check that the start command BO,1 was received by MIXIT. It is good practice always to do this, because if a command was for example not registered, it shall be resent.

Notice! The control loop in MIXIT runs each 1 second asynchronous with the fieldbus communication. Therefore, up to 1 second may elapse before a command takes effect.

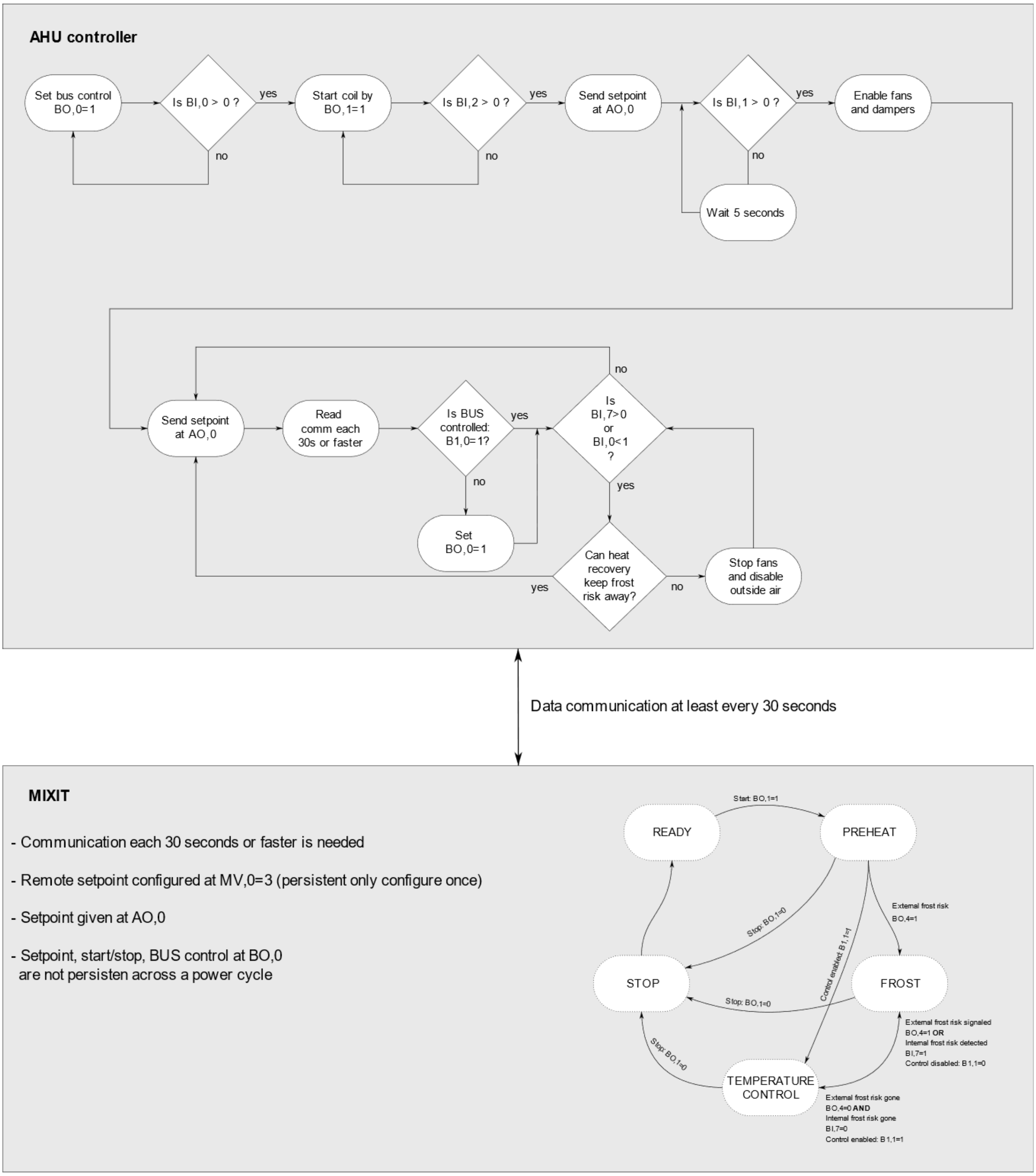

Figure 9: Example of AHU controller interaction with MIXIT when configured with the heating coil application.

4.3.1.1 The build in frost protection function

In Figure 9 MIXIT detects frost by the build in frost detection function. It could also be signaled from the AHU control to MIXIT to go into FROST state. This is done by setting frost risk (BACnet: BO,4/Modbus 00101.7). In that case MIXIT sets frost risk detected (BACnet: BI,7=1/Modbus 00204.4=1) as would happen when frost was detected by the build in frost detection function.

MIXIT may be set into frost protection state via the following methods:

1. Via external digital input at DI4
2. Via BACnet/Modbus at BO,4/00101.7
3. Via internal detection

The options 1 to 3 for setting MIXIT into frost protection state can be used in any combination. They have equal priority.

4.3.1.1.1 When is a frost risk detected by the build in function?

When the internal frost protection is enabled (this is the default for MIXIT's heating coil application), a frost risk is registered if the supply air temperature or the return temperature, or both drops below their respective threshold values. The configuration of the threshold values needs to be done by Grundfos GO. It cannot be done by fieldbus, e.g. see Figure 10.

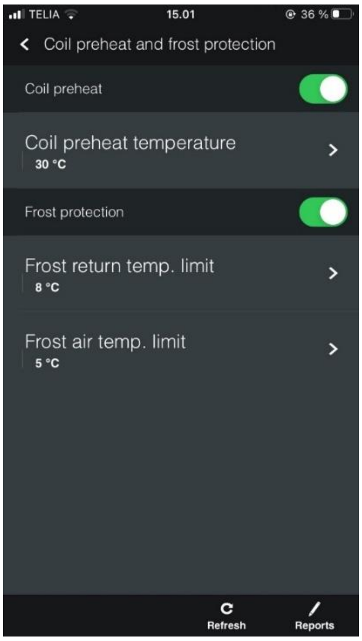

Figure 10: Configuration of frost protection by Grundfos GO.

4.3.1.2 The build in preheat function

The preheat function will warm up the coil until the water return temperature is above a certain threshold. The threshold can only be set from Grundfos GO, e.g. see Figure 10.

The preheat function makes sure there is a flow in the shunt, such that the return temperature sensor can be trusted. That is, it exists into the "TEMPERATURE CONTROL" state shown in Figure 9 when the mixed water temperature is 85% or less of the water supply temperature, while the return temperature is above the preheat threshold.

Preheating will be done at every start after MIXIT has been stopped e.g. again see Figure 9.

The preheat function cannot be disabled from the fieldbus, disabling the feature must be done from Grundfos GO. The default setting in MIXIT's heating coil application is "enabled".

4.3.1.2.1 Exit of preheat by time out

If the coil could not be preheated inside a predefined time limit MIXIT will switch to TEMPERATURE CONTROL anyway by one of the two conditions:

1. The water supply temperature from the boiler to MIXIT is above 50 degrees C.
2. If there is a sensor error whereby the appropriate preheating cannot be determined by sensor values.

The time out value is 1200 seconds. If this value shall be changed Grundfos service needs to be contacted.

If the supply temperature is below the 50 degrees C and the coil could not be preheated inside the predefined time limit, MIXIT will remain in the preheat state as this could be a sign of a missing heat supply, and frost damage could occur at the coil if the fans and dampers are released anyway.

4.3.2 Signal diagram of AHU

Depending on local geographical requirements, the topology of the AHU may be of a different design from case to case. For example, heat recovery may happen using regenerator wheels if there are not large requirements for keeping clean and dirty air streams separated. If there is a nearly constant requirement for dehumidification and economizer loop may be fitted to the AHU etc.

Common for all is that heat recovery is needed and there are coils to control the temperature leaving the AHU. It is for this temperature control MIXIT can be used.

In Europe air handling units often have a structure like the one shown in Figure 11. In the figure sensors and control loops relevant for control of the air temperature leaving the AHU are shown, and sensors and control loops relevant for controlling the pressure have been omitted.

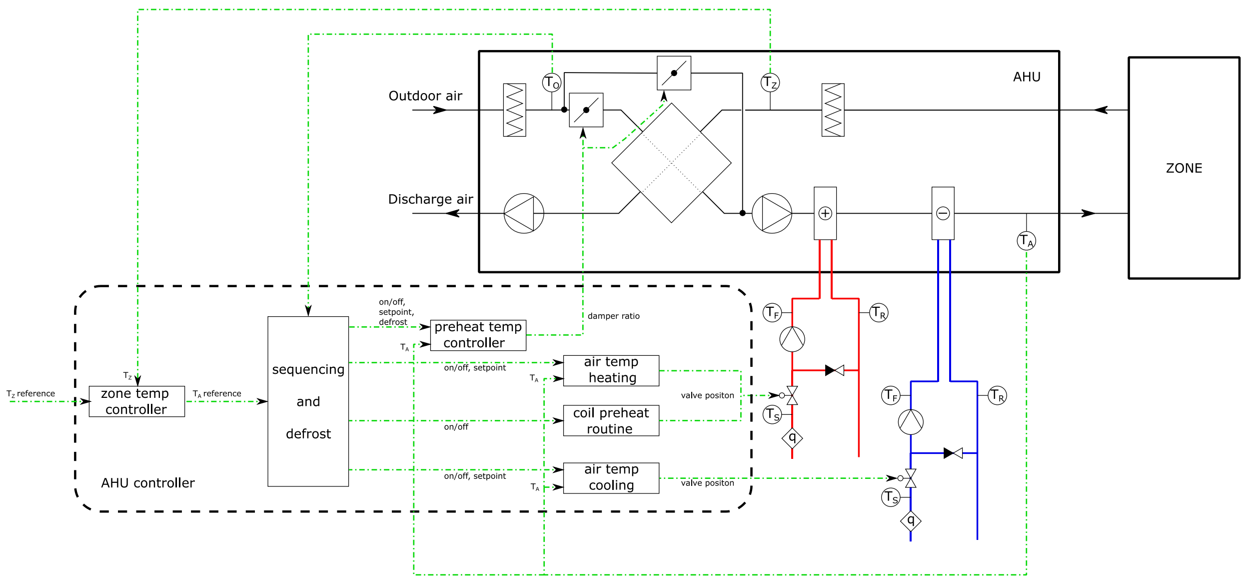

Figure 11: Air handling unit with control blocks.

The air handling unit in Figure 11 is of a type where heat recovery happens in a crossflow heat exchanger with separated air streams. Thus, the air supply from the AHU into the zone is entirely fresh air that is preheated in a crossflow heat exchanger. The amount of preheat is controlled by operating the bypass dampers by which the amount of outdoor air though the heat exchanger is controlled.

In scenarios where the heat recovery cannot deliver sufficient heat, the heating coil of the AHU is operated to deliver additional heat to the outdoor air stream. Likewise, heating via the heating coil is needed if the crossflow heat exchanger needs defrosting. In that case, the outdoor air is bypassed around the crossflow exchanger and the heating coil takes over the entire heat load. In that case, the heating coil may be exposed to frosty air why a coil frost protection routine is needed.

Finally, in periods where the outdoor air is hotter than the discharge air, and cooling is needed in the zone, the crossflow heat exchanger cools the supplied outdoor air and any additional needed cooling happens by a cooling coil.

4.3.2.1 The air handling unit controller

An example of the structure of an AHU controller is also shown in Figure 11. The nomenclature of the sensor and control signals are the following.

Signal name	Description
T_A	Supply air temperature
T_O	Outdoor air temperature
T_Z	Zone air temperature
T_S	Water supply temperature to mixing loop
T_R	Water return temperature from coil
T_F	Water supply temperature to coil
T_Z reference	Reference for zone temperature
T_A reference	Reference for supply air temperature
damper ratio	Control signal for amount of heat exchanger bypass
valve position	The position or rotation of a valve depending on settings in the valve motor, the signal may be proportional to the opening degree
setpoint	The temperature setpoint of a control loop
on/off	On/off signal for a particular control loop

Table 4: Nomenclature for AHU controller (in figure 1).

The blocks of the AHU controller have the following functions:

- **zone temp controller:** Calculates the reference for supply air temperature bases on the discharged air stream temperature and the outdoor temperature.
- **sequencing and defrost:** Decides which control loop runs and by which setpoint. Priority for air heating is via the heat recovery system if such is present. It also controls defrosting of the heat recovery system.
- **preheat temp controller:** Controls the air temperature leaving the heat recovery by setting the damper ratio for the fresh air stream passing through the heat recovery system. For AHUs where the heat recovery happens via a heat wheel, it sets the speed of the heat wheel.
- **coil preheat routine:** Purges the heating coil with warm water at startup before the fans are turned on and the dampers towards outside air are opened. This is done for comfort reasons and to prevent coil from freezing in cold conditions.
- **air temp heating:** Controls the air temperature leaving the heating coil by setting the position/rotation of the valve of the mixing loop. Heating via the coil has second priority when a heat recovery system is present in the AHU.
- **air temp cooling:** Controls the air temperature leaving the cooling coil by setting the position/rotation of the valve of the mixing loop. Cooling via the coil has second priority when a heat recovery system is present in the AHU.

4.3.2.2 Summary of control functions

In headlines the controller of the AHU does the following task (Air pressure and CO2 control excluded).

- Outer room temperature control loop
- Air inlet temperature control loops via heat recovery
- Setpoint for air inlet temperature control with coil
- Coordinating balance between heat regeneration and heat injection with mixing loop
- Defrosting of heat recovery system
- Local coil control loops (controls valve position)
- Safety functions:
    - Coil preheat in cold conditions
    - Coil frost protection
    - Valve anti stick functionality
    - Valve position monitoring

4.3.3 Signal diagram of AHU with MIXIT configured with the heating coil application

Integration of MIXIT with an AHU controller can be done with a few or more datapoints, depending on the level of required reliability around the control and the number of features in MIXIT that are used.

Figure 12 shows an integration corresponding to the one in Figure 11, where only start/stop signals and setpoints are sent to the MIXIT unit. There is no read back of the set datapoints. The object numbers are for BACnet but the corresponding Modbus register are listed in Table 5.

If MIXIT is in the coil preheat state or the in frost protection state the "Temperature control enabled " at BI,1 and which is also a physical relay signal is not set, indicating that MIXIT is in a different state than normal temperature control. Hence, appropriate action may be taken regarding the fans and dampers setting, for example to help mitigate frost damage of the coil. The frost protection in the figure happens by a temperature switch with manual reset. This can be used exclusively or alongside the build in frost protection function in MIXIT.

Figure 13 shows the same system, but where setpoints and on/off signals are read back, and the flags for finished preheating of the coil (BI,1) and frost risk detected (BI,7) are used for appropriate sequencing with the rest of the AHU control, e.g. Figure 9 see about a possible implementation.

The read back of the set datapoints has the advantage that the AHU controller can check that the set datapoints were registered by MIXIT. An alternative is to send all datapoints with a fixed interval as it is unlikely a transfer will fail continuously, but this gives no assurance that integration has happened correctly.

In the figure shows the use of BO,4 as a way of signaling frost risk to MIXIT via BACnet. Again the Mobus registers corresponding to the BACnet example in the figure are listed in Table 5.

4.3.3.1 Use of air temperature sensor

In both Figure 12 and Figure 13 a signal splitter at the air temperature is shown. This may be avoided by connecting the air temperature sensor only to MIXIT and reading the air temperature for the AHU controller via MIXIT, e.g. see Figure 5. In a future software release it will be possible to send the air temperature to MIXIT via the fieldbus, hereby avoiding physically to connect an air temperature sensor to MIXIT.

For the current software version MIXIT can be integrated with the AHU controller without the air temperature sensor by using the radiator heating application as sketched in section 4.4.

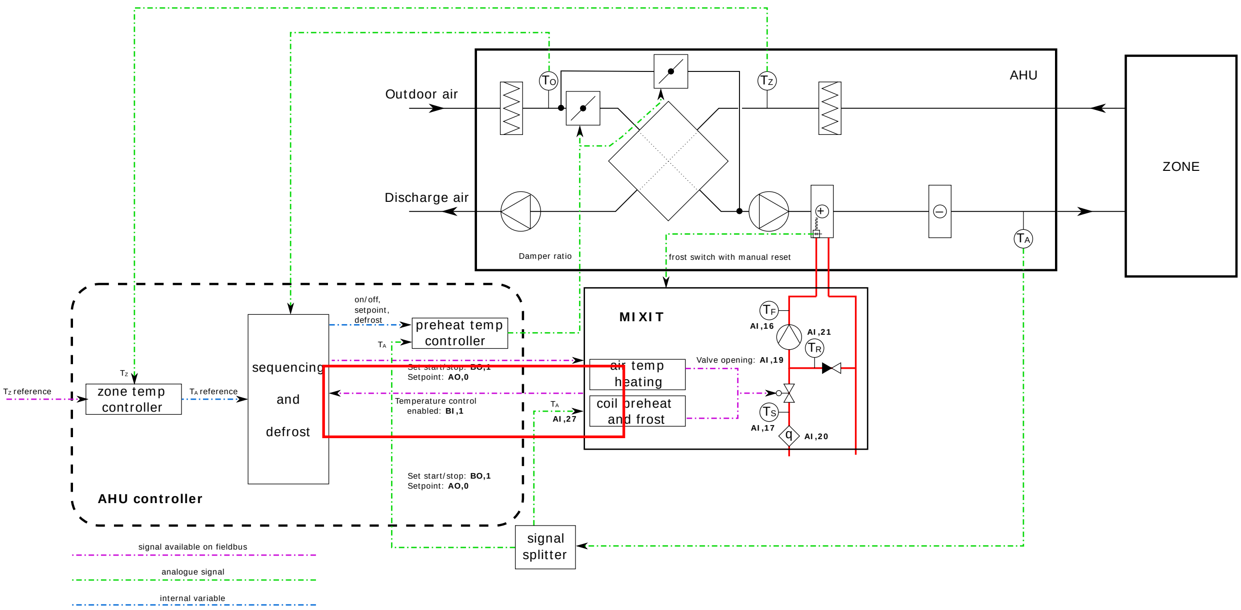

Figure 12: Air handling unit with MIXIT integration using few datapoints.

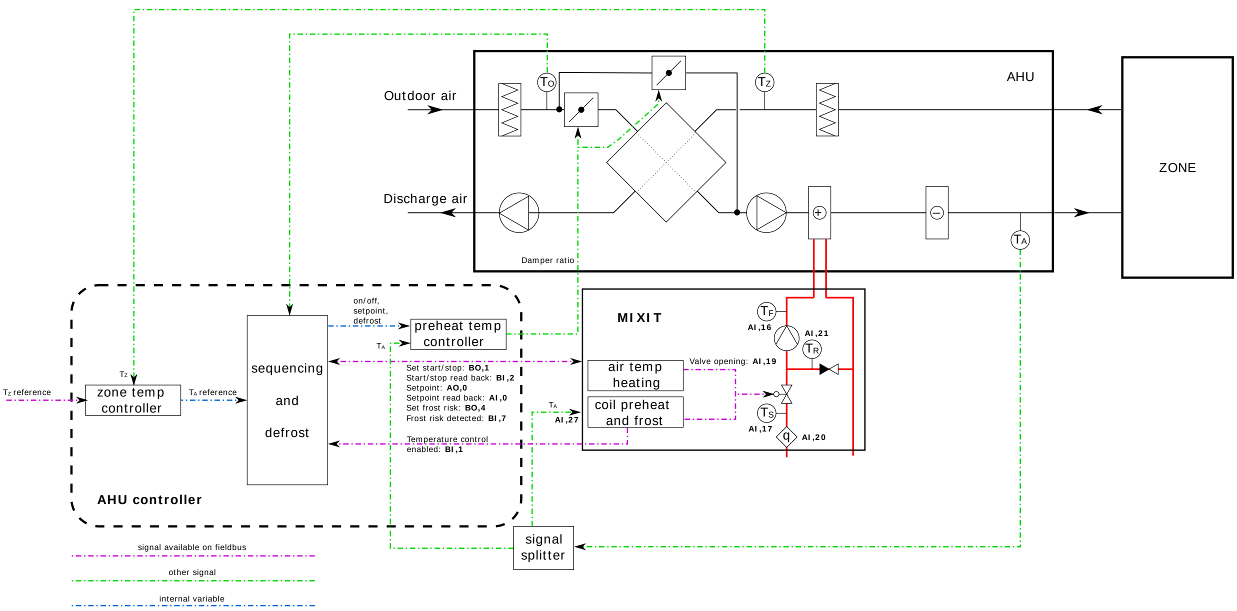

Figure 13: Air handling unit with MIXIT integration using more datapoints and read back for improved reliability and sequencing.

Action	BACnet		Modbus		Persistent setting?
	Object for setting	Object for status	Register for setting	Register for status	
Set start	BO,1 = 1	BI,2	00101.1 = 1	00201.3	No
Set stop	BO,1 = 0	BI,2	00101.1 = 0	00201.3	No
Set frost risk/ Frost risk detected	BO,4 = 1	BI,7	00101.7	00204.4	No
Set setpoint from fieldbus	AO,0	AI,0	00102	00311	No
Temperature control enabled		BI,1		00201.4	
T_A, air temp.		AI,27		00316	
T_S, supply temp.		AI,17		00314	
T_F, flow temp.		AI,16		00313	
T_R, return temp		AI,21		00322	
Valve opening		AI,19		00319	

Table 5: Data points associated with the signal diagram in Figure 12 and Figure 13.

4.3.3.2 AHU control functions when MIXIT is configured with the heating coil application

Controlled by AHU controller:

- Outer room temperature control loop
- Air inlet temperature control loops via heat recovery
- Setpoint for air inlet temperature control with coil
- Coordinating balance between heat regeneration and heat injection with mixing loop
- Defrosting of heat recovery system

Controlled by MIXIT:

- Direct control of the air temperature at the coils according to setpoint from AHU controller.
- Safety functions:
  - Heating coil preheat
  - Heating coil frost protection (may be activated from AHU controller)
  - Valve anti stick functionality

4.4 Integration of MIXIT in AHU control with MIXIT configured for the radiator heating application

It is a prerequisite that MIXIT is configured for the radiator heating application to follow the below guide.

When configured by the radiator application the PREHEAT and FROST states are not part of the state machine, e.g. compare Figure 14 and Figure 7. It is up to the integrator to program these features if required.

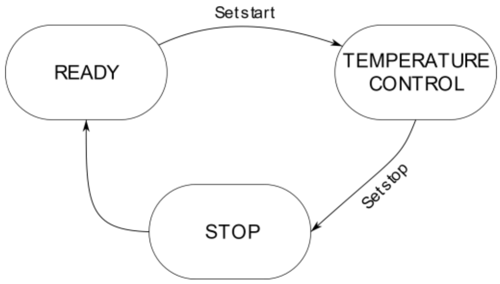

Figure 14: State machine for radiator heating application.

An integration with the AHU controller when MIXIT is configured with the radiator heating application is shown in Figure 15. In comparison to the heating coil application the flags in the field bus profile signaling frost, and the build in preheat and frost detection functions cannot be used. BACnet objects are used in the example but the corresponding Modbus registers are listed in Table 6.

It is up to the BMS integrator to figure out when preheat is sufficient. Please remember that the return temperature sensor is integrated in the shunt, so if using this datapoint from MIXIT to detect the preheat, the water temperature towards the coil must be less than the water supply temperature to MIXIT, otherwise there is no shunt flow, and the instantaneous return temperature measured at the sensor in shunt is not correct in this case. If using the heating coil application with the build in preheat function this problem is taken care of by MIXIT.

Action	**BACnet**		**Modbus**		**Persistent setting?**
	Object for setting	Object for setting	Register for setting	Register for status	
Set bus control state	BO,0 = 1	BI,0	00101.0 = 1	00201.0	No
Set start	BO,1 = 1	BI,2	00101.1 = 1	00201.3	No
Set stop	BO,1 = 0	BI,2	00101.1 = 0	00201.3	No
Temperature control Enabled		BI,1		00201.4	

Table 6: Data points associated with Figure 15.

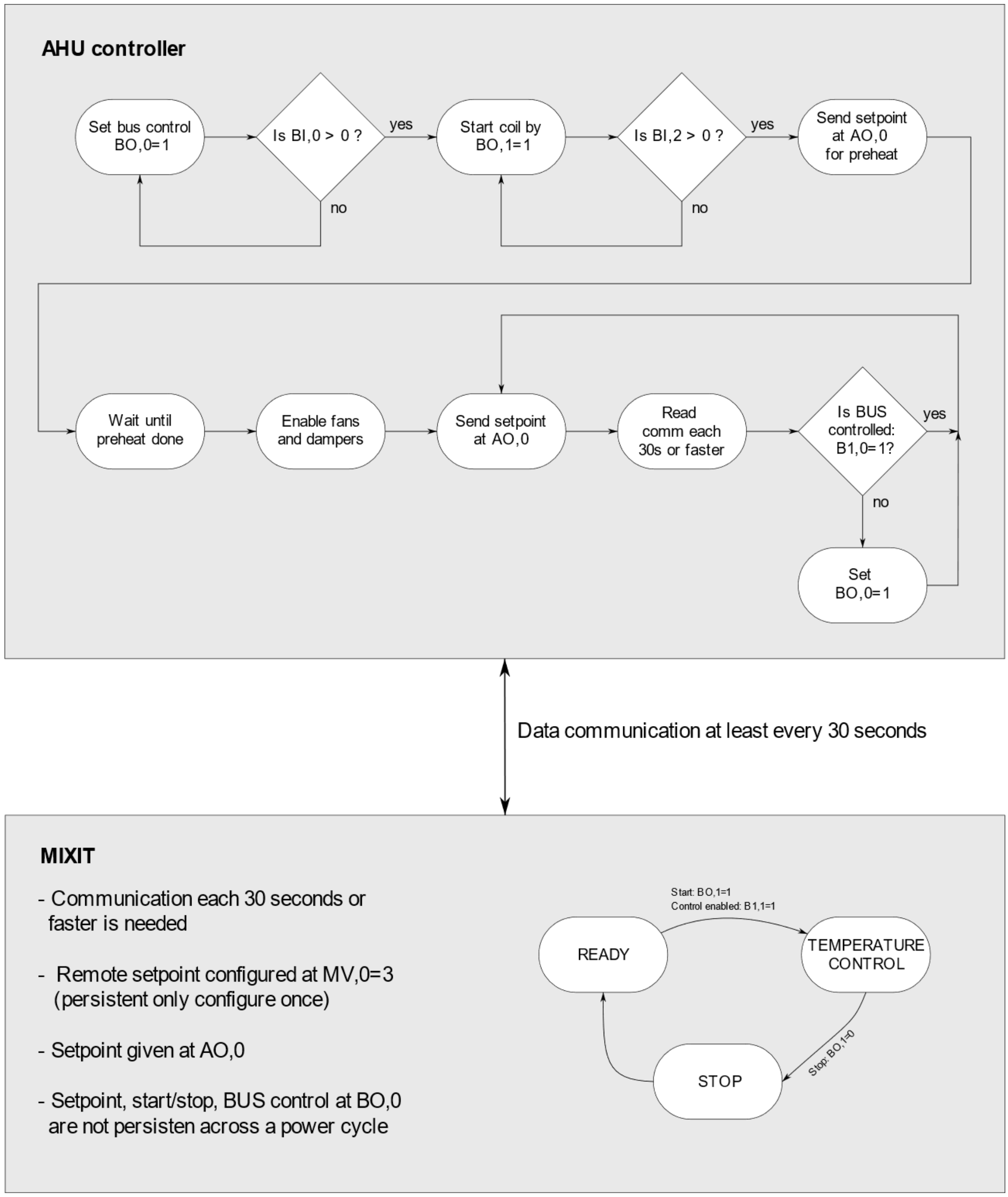

Figure 15: Example of AHU controller interaction with MIXIT when configured with the radiator heating application.

Figure 16 shows a signal diagram of MIXIT configured for the radiator heating application Table 5 list the associated control and status registers.

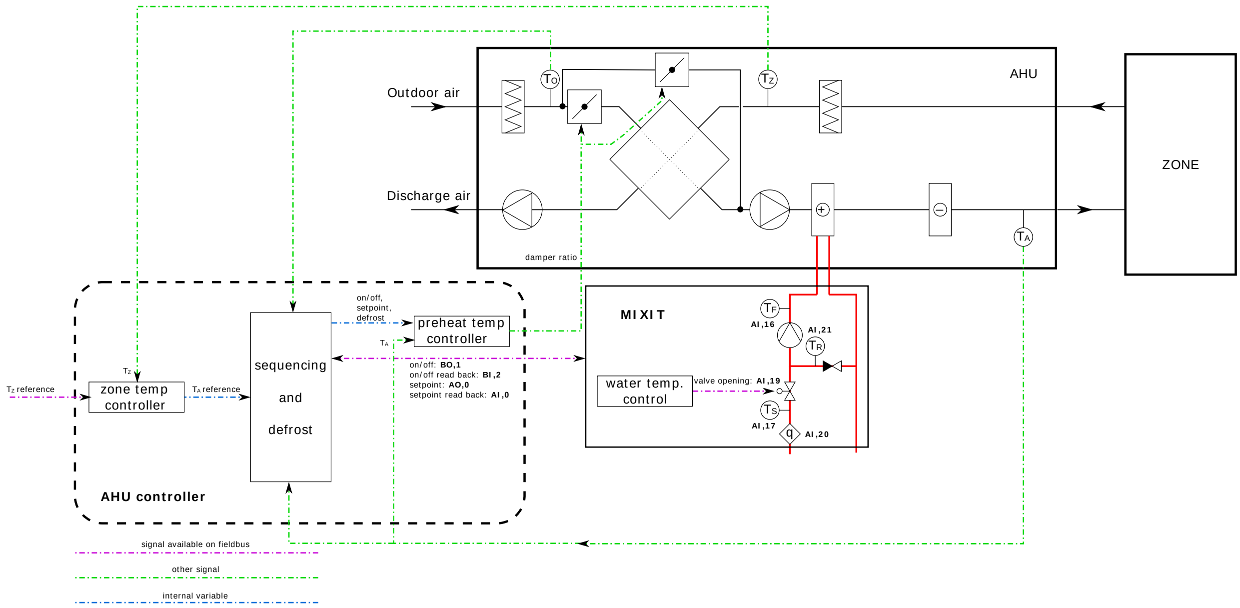

Figure 16: AHU integration of MIXIT when using the radiator heating application.

If MIXIT is used with afterheat coils where another controller sets the flow to the coils via valves, it is also possible to use the radiator heating application for controlling the temperature of the water to the coils, e.g. see Figure 17.

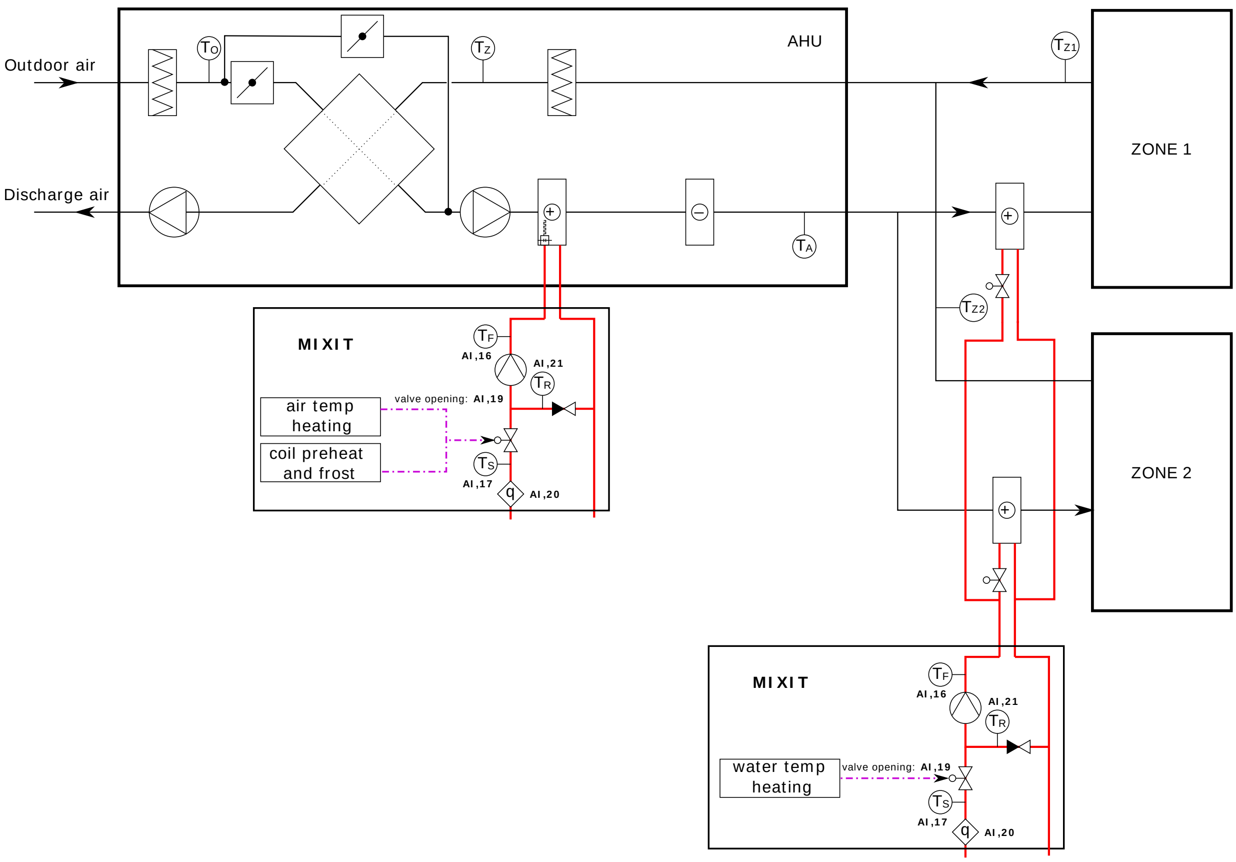

Figure 17: MIXIT used with afterheat coils.

5 MIXIT WITH RADIATORS AND UNDERFLOOR HEATING

The underfloor heating and radiator heating applications of MIXIT controls the water temperature out of the mixing loop. The two application settings only differ by the underfloor heating setting having an overheat protection function that will close the valve and stop the pump in case the water temperature out of the mixing loop increases above a set maximum level. If the underfloor overheat protection function is disabled, the two application settings functions 100% the same, both are therefore treated in this section.

5.1 The build in underfloor overheat protection function

When the underfloor overheat protection is enabled the setpoint is limited 5 deg. C below the set maximum level. This is to avoid triggering the overheat protection function in case of a small overshoot. The control loop carried out by MIXIT is shown simplified in Figure 18.

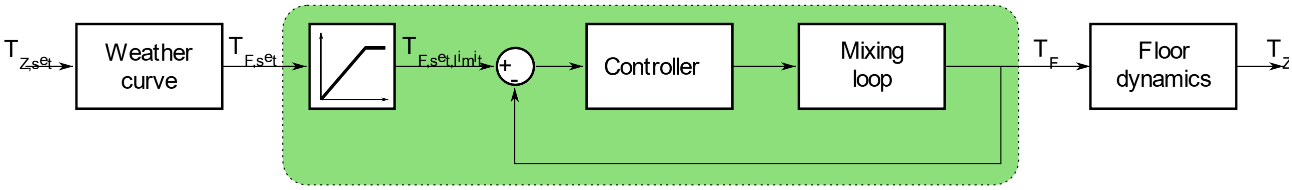

Figure 18: MIXIT control loop with setpoint limitation, due to overheat protection function.

For example, if the overheat protection function is set with a maximum level of 50 deg. C and the given setpoint is above the 45 deg. C. MIXIT will automatically limit the setpoint at 45 deg. C. if. The screen for setting up or disabling the function in Grundfos GO is shown in Figure 19. Settings -> Application settings -> Underfloor overheat protection.

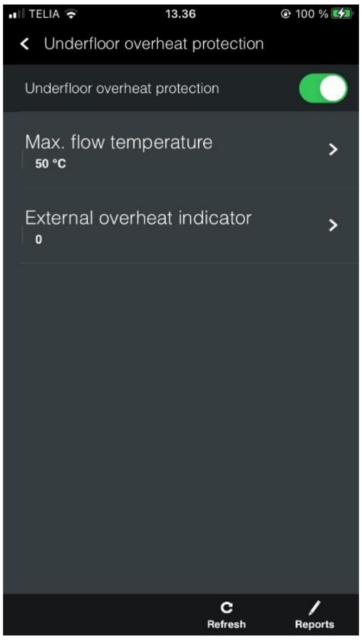

Figure 19: Setup of the overheat protection function by Grundfos GO.

If the temperature increases above the set maximum limit the valve will close and the pump stop until the temperature has decreased below the set maximum limit. This may take some time as the water standing in the pump needs to cool down by natural convection.

MIXIT may be set into overheat protection state via the following methods having equal priority:

1. Via external digital input at DI4
2. Via BACnet/Modbus at BO,3/00101.4
3. Via internal detection

The digital input may for example be used with an electrical bimetal switch as an extra layer of safety.

5.2 Signal flow diagram for the radiator and underfloor heating applications

The signal diagram for the underfloor heating application is shown in Figure 20 with the most relevant BACnet object numbers. Their description and corresponding Modbus registers are listed in Table 7.

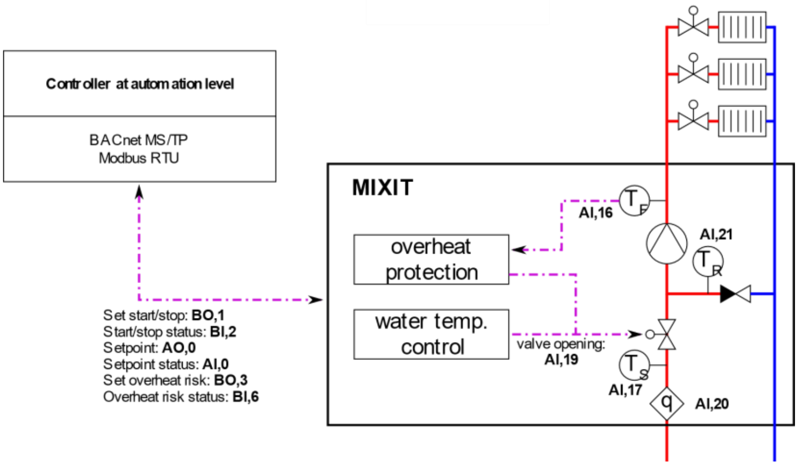

Figure 20: MIXIT used with floor heating application.

Action	BACnet		Modbus		Persistent setting?
	Object for setting	Object for status	Register for setting	Register for status	
Set start	BO,1 = 1	BI,2	00101.1 = 1	00201.3	No
Set stop	BO,1 = 0	BI,2	00101.1 = 0	00201.3	No
Set overheat risk/ Overheat risk detected	BO,3 = 1	BI,6	00101.4	00212 = 6	No
Set setpoint from fieldbus	AO,0	AI,0	00102	00311	No
Temperature control enabled		BI,1		00201.4	
T_S, supply temp.		AI,17		00314	
T_F, flow temp.		AI,16		00313	
T_R, return temp		AI,21		00322	
Valve opening		AI,19		00319	

Table 7: Most relevant datapoints associated with the underfloor and radiator heating applications.

The data points associated with the overheat protection are only relevant for the underfloor heating application.

6 INTERFACING MIXIT TO THE BMS USING ANALOGUE SIGNALS

In the case of retrofit where no BACnet or Modbus interfaces are available MIXIT can be controlled via analogue signals. The complete terminal overview is given in the MIXIT installation and operating instructions that can be downloaded at https://product-selection.grundfos.com/, search for MIXIT, click on a MIXIT product and browse to documentation. The most relevant are listed in Table 8.

Action	Input	Notes	Relevant MIXIT application
Set start	Pull DI5 low	Input has internal pull up	all applications
Set stop	Pull DI5 up	Input has internal pull up	all applications
Set setpoint	CI01	Configure range and type in Grundfos GO	all applications
Temperature control enabled	Relay 2		all applications
Fault	Relay 1		all applications
Boiler setpoint	CIO3	Voltage 0-10 corresponds to 0-100 deg. C.	all applications
Set overheat risk	Pull DI4 up	Input has internal pull down	underfloor heating
Remove overheat risk	Pull DI4 down	Input has internal pull down	underfloor heating
Set frost risk	Pull DI4 up	Input has internal pull down	heating coil
Remove frost risk	Pull DI4 down	Input has internal pull down	heating coil
Air sensor input	CI02	Configure range and type in Grundfos GO	heating coil

Table 8: Most relevant datapoints associated with the underfloor and radiator heating applications.