



SAUTER ITALIA SPA
NRT407

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The functions described in this manual are handled using NRT tool version 1.4-1-00. The controllers are marked with revision number R02.

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Chapter 1 About the manual

This manual describes the NRT407 controllers.

Terms

Term used in the manual:

FS Factory setting

More information

More information about NRT can be found in:

- ***NRT tool Manual*** – Manual of how to configure the controllers
- ***NRT Room Controllers*** – Brochure for the NRT series

The information is available for download on SAUTER ITALIA SPA's homepage, www.sauteritalia.it.

NRT zone controllers

NRT is a wide series of room controllers which handle everything from heating, cooling and ventilation to lighting, humidity, CO₂ monitoring and blinds. NRT can be used for creating everything from stand-alone systems for managing the functions in one room, to large, integrated systems with a comprehensive SCADA-system.

NRT also offers web and Internet solutions. Temperature and other functions in a room can be individually controlled from a PC connected to the office network.

NRTs can be used either as stand-alone units or integrated into a system with communication. The controllers are connected to bus lines such as Modbus RTU or BACnet MS/TP (only models with display). They can also be configured for a specific application with software NRT tool.

Design

NRT has a modern design which enhances the indoor environment.

Applications

The NRTs controllers have an appealing design and functionality. They are suitable in buildings where you want optimal comfort and low energy consumption, for example offices, schools, shopping centres, airports, hotels and hospitals.

Mounting

The modular design with a separate bottom plate for wiring makes the whole series easy to install and commission. The controllers are mounted directly on the wall or on a wallbox.

NRT 407

Communication

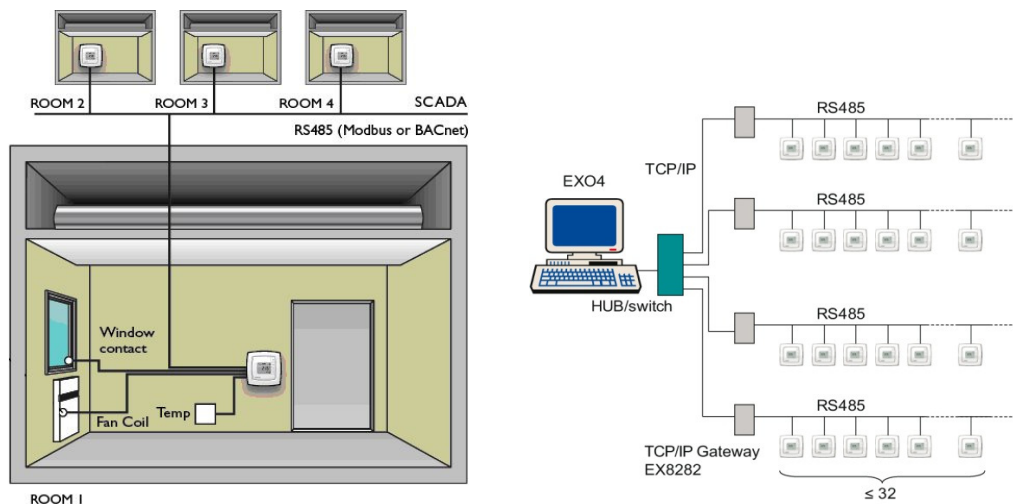
The controllers can be connected to a central SCADA-system via RS485 (BACnet MS/TP or Modbus RTU) and configured for a particular application using the configuration tool NRT tool,.

Control modes

The controllers can be configured for different control modes/control sequences:

- Heating
- Heating or cooling via the change-over function
- Heating/Heating
- Heating/Cooling
- Heating/ Cooling with VAV-control and forced supply air function
- Heating/Cooling with VAV-control
- Cooling
- Cooling/Cooling
- Heating/Cooling/VAV (except NRT407F902)
- Heating/Heating or Cooling via change-over (only available in NRT407F902)

Application examples



Chapter 3 Models

There are 2 different NRT407 room controllers. They can be divided according to type of control in basic models and models for fan control.

- F901-models

Basic models control analogue actuators, thermal actuators or On/Off actuators with spring return.
- F902-models

Like basic models, models for fan control control analogue, thermal and spring return actuators. They also have a button/fan switch for EC fan control on analogue output UO3.

Models		Display	Occupancy button	Fan control	3-point control	Setpoint knob	Hidden setpoint	CO ₂ input	EC fan control (AO) follow cooling/heating	Control of a third sequence (damper)
Basic models	NRT407F901	•	•					•	•	•
Models for fan control	NRT407F902	•	•	•				•	•	

Table 1. The NRT models and their functions

Design

NRT407F902



NRT407F901



Chapter 4 Technical data

Supply voltage	18...30 V AC, 50...60 Hz
Internal consumption	2.5 VA
Ambient temperature	0...50°C
Ambient humidity.....	Max 90 % RH
Storage temperature.....	-20...+70°C
Terminal blocks	Lift type for cable cross-section 2.1 mm ²
Protection class	IP20
Material casing	Polycarbonate, PC
Colour	
Cover	Polar white RAL9010
Bottom plate	Light gray
Weight	110 g

Dimensions

Models without setpoint knob	95 x 95 x 28 mm
Models with setpoint knob	95 x 95 x 31 mm

Communication

Type.....	RS485 (Modbus RTU or BACnet MS/TP)
Communication speed	9600, 19200, 38400 bps (Modbus and BACnet)
.....	or 76800 bps (BACnet only)
Functions as	
Modbus.....	RTU Slave
BACnet.....	MS/TP slave and master
Modbus.....	8 bits, 1 or 2 stop bits. Odd, even (FS) or no parity
Galvanically isolated port	No

Memory

Non-volatile (EEPROM)All settings and configurations are preserved
See also *Chapter 15, Memory function on power failure*.

Built-in temperature sensor

Type	NTC, linearised, 15 kOhm
Measuring range	0...50°C
Accuracy	+/-0.5°C at 15...30°C

Models with display

Display type.....	LCD with background illumination
-------------------	----------------------------------

LVD, Low Voltage Directive

This product conforms with the requirements of European LVD standard IEC 60 730-1.

EMC emission and immunity standard

This product conforms to the requirements of the EMC Directive 2004/108/EC through product standards EN 61000-6-1 and EN 61000-6-3.

RoHS

This product conforms to the Directive 2011/65/EU of the European Parliament and of the Council.

Inputs (see Table 2 below for number and function for different models)

AI1 PT1000-sensor, 0...50°C, accuracy +/- 0.1°C
UI AI: PT1000-sensor, 0...100°C, accuracy +/- 0.2°C
..... or AI2: 0...10 V
..... or DI: see DI below
CI Sauter condensation detector, EGH102
DI Closing potential-free contact connected to +C in one end

Outputs (see Table 2 below for number and function for different models)

DO 24 V AC, max 0.5 A
UO DO: 24 V AC, max 2.0 A or AO: 0...10 V DC, max 5 mA
+C, power output for DI only 24 V DC, max 10mA, short circuit protected

Terminals									
12	13	14	22	23	24	30	31	32	33
Model with input for CO ₂ control (NRT407F901)									
-	-	-	UO3* Forced vent. <i>alt.</i> EC fan <i>alt.</i> follow Heat/Cool in seq.	UO1* Heating actuator <i>alt.</i> Cooling actuator	UO2* Cooling actuator <i>alt.</i> Heating actuator	AI1 Ext. room sensor <i>alt.</i> Change-over	AI2 CO ₂ <i>alt.</i> Flow <i>alt.</i> 0...10 V	DI1 Occupancy sensor <i>alt.</i> Window contact <i>alt.</i> Change-over	DI2 CI Window contact <i>alt.</i> Condensation detector <i>alt.</i> Change-over
Model with input for CO ₂ control and Fan control (NRT407F902)									
DO1 -	DO2 -	DO3 -	UO3* EC fan	UO1* Heating actuator <i>alt.</i> Cooling actuator	UO2* Cooling actuator <i>alt.</i> Heating actuator	AI1 Ext. room sensor <i>alt.</i> Change-over	AI2 CO ₂ <i>alt.</i> Flow <i>alt.</i> 0...10 V	DI1 Occupancy sensor <i>alt.</i> Window contact <i>alt.</i> Change-over	DI2 CI Window contact <i>alt.</i> Condensation detector <i>alt.</i> Change-over

Table 2. Available connections and their functions for the NRT controllers.

*The function for these outputs depends on the control mode setting, see Chapter 7, Control modes.

For more information about inputs and outputs, see the chapter *Wiring*.

Accessories for NRT407

External temperature sensors EGT456F101
Condensation detector EGH102F001 / F101
CO₂ transmitter EGQ222F00

The accessories are available from SAUTER ITALIA SPA. For more information, see the product sheets and instructions for each product, search via www.sauteritalia.it.

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Chapter 5 Installation preparations

Different versions of terminals and pins

The old terminal type is dark grey and intended for 1.3 mm pins. The new terminal type is light grey and intended for 1.1 mm pins. Confusion between a new and old bottom plate may lead to deficient contact. Therefore, it is important to use an old electronics unit together with an old bottom plate and a new electronics unit together with a new bottom plate.

Figures 1 and 2 show an example of the difference between the old and new terminal types (the number of terminals depends on the NRTs model).

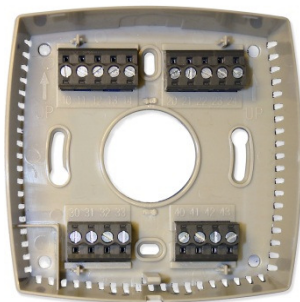


Figure 1. Old terminal type (1.3 mm pins)

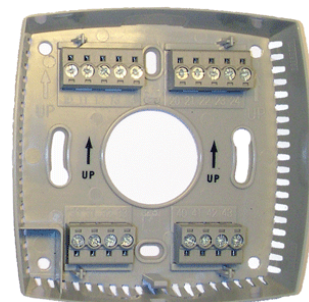
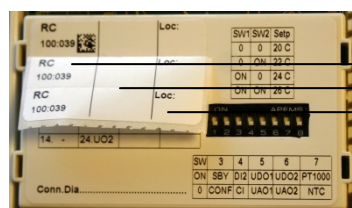


Figure 2. New terminal type (1.1 mm pins)

Using labels

On the back of the electronics cassette, there is a set of labels which makes it easier to install large numbers of NRT controllers. By using the labels as carriers of information for the installation engineer, much time will be saved and you can keep wiring errors at a minimum.



Model and address

Field for new address or reference to connection diagram

Field for room number

Figure 3. Label on the back of the controller

The three-piece label can be split and the parts can be fastened to the installation drawing and the bottom plate of the controller. The label carries information on the communication address etc., and has a note area where you can enter a reference number to the connection diagram.

The address on the sticker has a different meaning depending on what communication protocol is used.

Example 1

If the address on the sticker is 191:183 the following addresses are valid for the different communication protocols:

PLA=191, ELA=183

Modbus: address=183

BACnet: device ID=191183 (low 4 figures=1183, high 3 figures=19), MS/TP MAC address=83

Example 2

If the address on the sticker is 10:001 the following addresses are valid for the different communication protocols:

PLA=10, ELA=1

Modbus: address=1

BACnet: device ID=10001 (low 4 figures=1, high 3 figures=1), MS/TP MAC address=1

Configuration

The controllers are normally configured using NRT tool. The passwords for the various access levels are 1111 (log in as administrator) and 3333 (log in as operator). For more information, see the manual for NRT tool[®].

Models with a display can be configured via the parameter menu, but the easiest way to set parameters is via NRT tool.

Models without a display have DIP switches that should be set. See the section *DIP switches* below.

The computer running NRT tool is connected to the cassette with a USB-to-RS485 converter. The adapter is connected to terminals 42(A) and 43(B). Use a 24 V AC trafo for supply voltage of the electronics cassette on terminals 10 and 11.

If you want to configure the unit, it is normally better to do this before sending the cassette to the installation site. The bottom plates with location and wiring information can be sent separately to the installation site for electric installation. For more information about configuration, see Part III, *Configuration*, below.

Calibration

Calibration of a measured room temperature should be done under stable conditions.

Troubleshooting

The Manual/Auto function in NRT tool makes it possible to test outputs. The output itself is not affected; only the software object that controls the output. This means that the built-in safety functions will not be disregarded.

The controllers have different indications which can be used for troubleshooting. See the section *Indications*.

Chapter 6 Installation

Mounting

Place the controller in a location that has a temperature representative for the room. A suitable location is approx. 1.6 m above floor level in a place with unobstructed air circulation. Remove the frame by depressing the locking tab in the lower edge of the cover with a screwdriver. See figure 4.

Next, gently pry the electronics cassette out by using the four rectangular screwdriver slots to lever against the edge of the bottom plate. See figure 5.

Note: Take care not to damage the electronics when inserting the screwdriver into the slots!

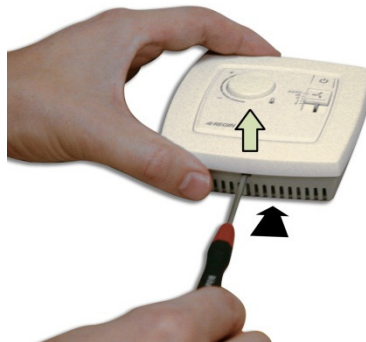


Figure 4.

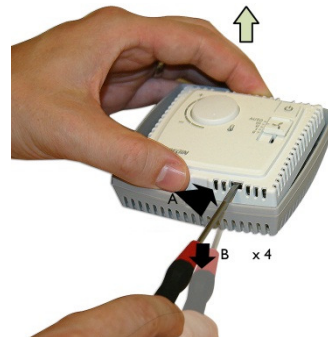


Figure 5.

The bottom plate with terminals has a number of fixing hole combinations. Select suitable holes and screw the bottom plate onto the wall or connection box, so that the arrows on the bottom plate point upwards. Do not tighten the screws too hard!

With surface-mounted cabling, break out suitable holes from the marks in the plastic.

Wiring

All units that share the same transformer and communication loop must use the same transformer-pole for G (terminal 10) and G0 (terminal 11). On the communication loop the A-terminal (terminal 42) should only be connected to another A-terminal and the B-terminal (terminal 43) to another B-terminal. Otherwise, the communication will not work.

The communication cable must be a screened twisted pair cable. The shield must be connected to G0 on one (and only one) NRT controller in each separate power supply loop with 24 V AC. If the length of the loop exceeds 300 m, a repeater is required. See figure 6.

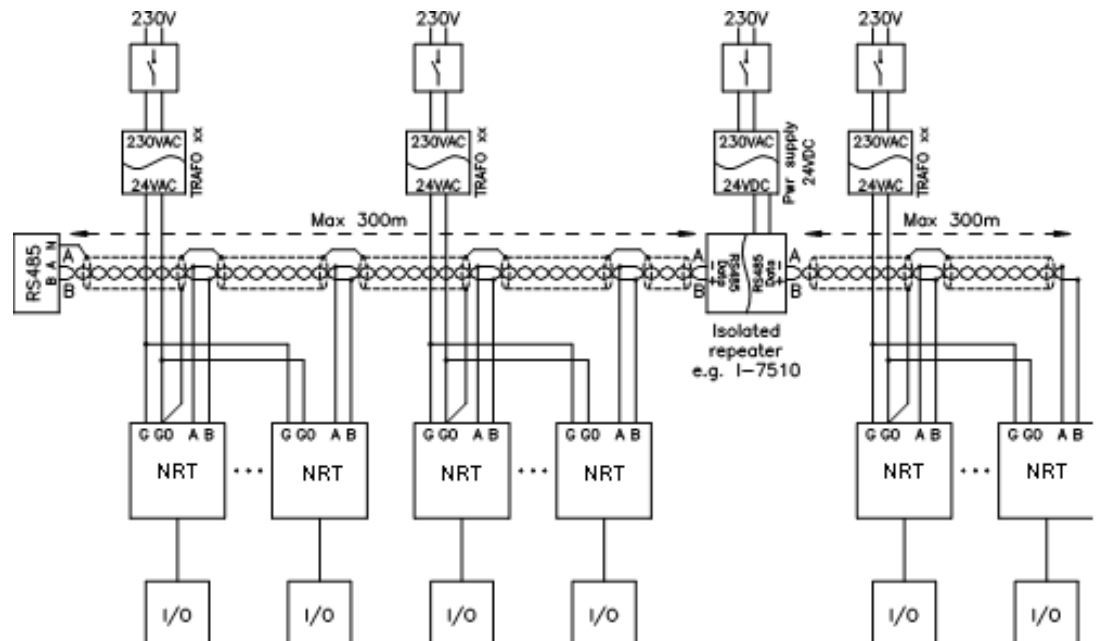


Figure 6.

The figure below shows the location of the terminals. The connection diagrams and tables on the following pages show the wiring for basic models and models for fan control.

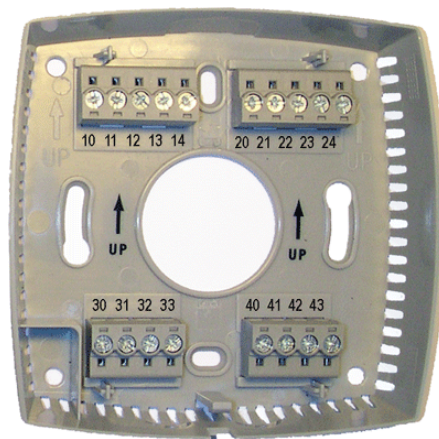


Figure 7. Bottom plate with terminals

Wiring for NRT407F901

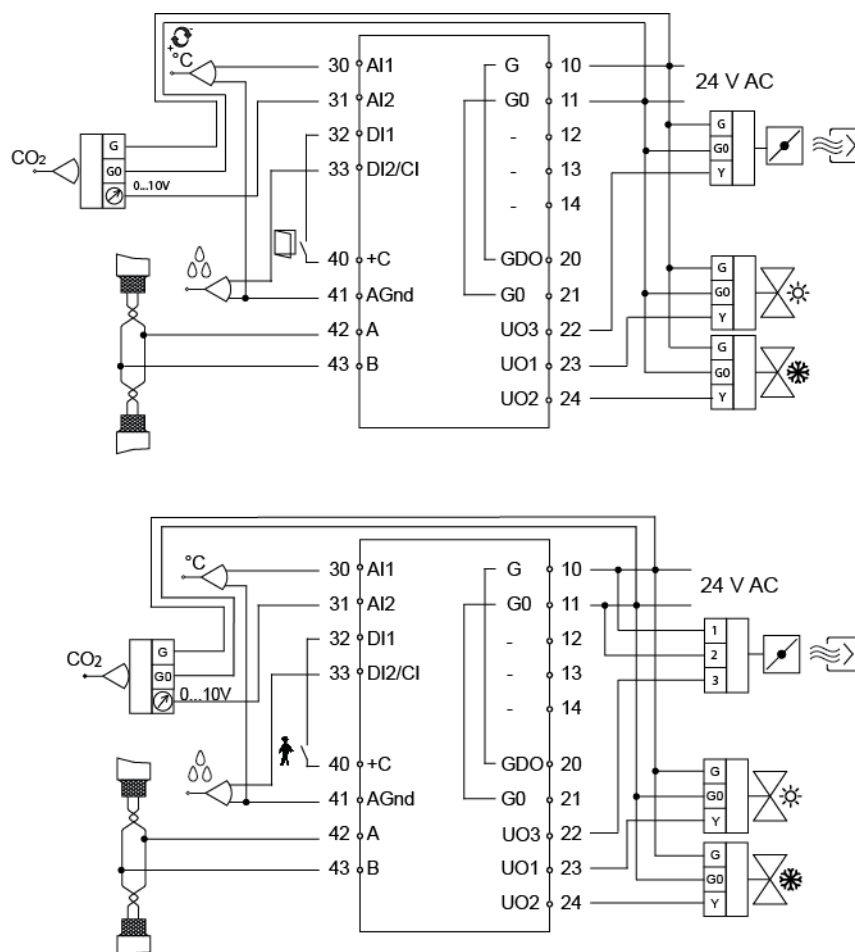


Figure 8. Connection diagrams for model for CO₂ control

Terminal	Designation	Operation
10	G	Supply voltage 24 V AC
11	G0	Supply voltage 0 V
12-14		No function.
20	GDO	24 V AC out common for DO. Internally connected to terminal 10, G.
21	G0	0 V common for UO. Internally connected to terminal 11, G0.
22	UO3	Output for VAV or EC-fan. For forced ventilation. 24 V AC output, max. 2.0 A. 24 V actuator is connected between terminal 22 and terminal 20, GDO. <i>alternatively</i> For 0...10 V DC damper control/EC-fan. The damper actuator/EC-fan 0...10 V control signal terminal is connected to terminal 22 and its supply terminals to terminals 10 and 11. Make sure that the reference pole G0 is connected to the correct terminal on the actuator.

Terminal	Designation	Operation
23	UO1	Control output heating (FS), cooling or heating or cooling via change-over. For a 0...10 V DC valve actuator, max 5 mA (FS). The valve actuator's 0...10 V control signal terminal is connected to terminal 23 and its supply terminals to terminals 10 and 11. Make sure that the reference pole G0 is connected to the correct terminal on the actuator. <i>alternatively</i> For a 24 V AC thermal actuator, max 2.0 A. The thermal actuator is connected between terminals 23 and 20, GDO. <i>alternatively</i> For a 24V AC actuator with spring return, max. 2.0 A. The actuator is connected between terminals 23 and 20. This can be configured either through the display or through NRT tool. The output signal for UO1 can be set to NC (normally closed) or NO (normally open).
24	UO2	Control output heating or cooling (FS). For a 0...10 V DC valve actuator, max 5 mA (FS). The valve actuator's 0...10 V control signal terminal is connected to terminal 24 and its supply terminals to terminals 10 and 11. Make sure that the reference pole G0 is connected to the correct terminal on the actuator. <i>alternatively</i> For a 24 V AC thermal actuator, max 2.0 A. The thermal actuator is connected between terminals 24 and 20, GDO. <i>alternatively</i> For a 24V AC actuator with spring return, max. 2.0 A. The actuator is connected between terminals 24 and 20. This can be configured either through the display or through NRT tool.
30	AI1	For an external room sensor, PT1000. Measuring range 0...50°C. The sensor is connected between terminals 30 and 41, AGnd.
31	AI2	For a 0...10 V CO ₂ sensor <i>alternatively</i> Flow input <i>alternatively</i> 0...10 V input
32	DI1	Occupancy detector. A potential-free contact is connected between terminals 32 and 40, +C. Closed contact corresponds to occupancy. <i>alternatively</i> Window contact (DI). A potential-free contact is connected between terminals 33 and 40, +C. Closed contact indicates closed window. <i>alternatively</i> Change-over.
33	DI2/CI	Sauter condensation detector, EGH102 (FS). The sensor is connected between terminals 33 and 41, AGnd. <i>alternatively</i> Window contact (DI). A potential-free contact is connected between terminals 33 and 40, +C. Closed contact indicates closed window. <i>alternatively</i> Change-over.
40	+C	24 V DC out common for DI and UI (with digital function)
41	AGnd	Analogue ground, reference for AI and UI (with analogue function)
42	A	RS485-communication A
43	B	RS485-communication B

Table 3. I/O connection terminals for model for CO₂ control

Wiring for NRT407F902

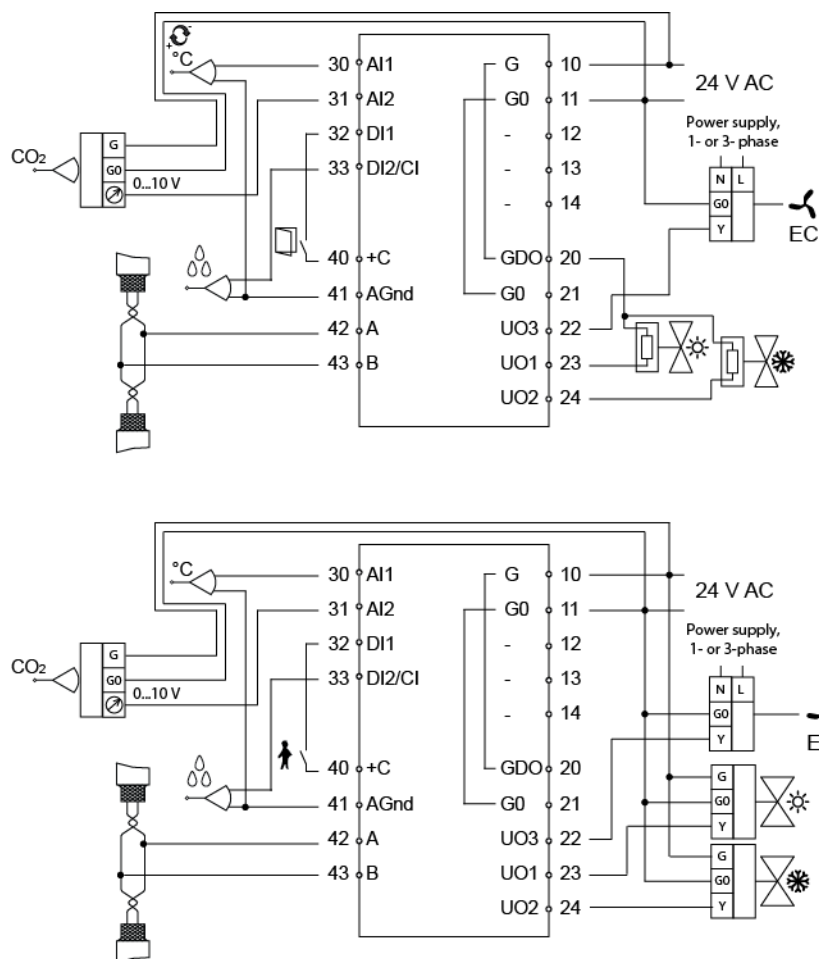


Figure 9. Connection diagrams for models for CO₂ control and fan control

Terminal	Designation	Operation
10	G	Supply voltage 24 V AC
11	G0	Supply voltage 0 V
12-14		No function.
20	GDO	24 V AC out common for DO. Internally connected to terminal 10, G.
21	G0	0 V common for UO. Internally connected to terminal 11, G0.
22	UO3	Control EC fan, 0...10 V DC.
23	UO1	<p>Control output heating (FS), cooling or heating or cooling via change-over.</p> <p>For a 0...10 V DC valve actuator, max 5 mA (FS). The valve actuator's 0...10 V control signal terminal is connected to terminal 23 and its supply terminals to terminals 10 and 11. Make sure that the reference pole G0 is connected to the correct terminal on the actuator.</p> <p><i>alternatively</i></p> <p>For a 24 V AC thermal actuator, max 2.0 A. The thermal actuator is connected between terminals 23 and 20, GDO.</p> <p><i>alternatively</i></p> <p>For a 24V AC actuator with spring return, max. 2.0 A. The actuator is connected between terminals 23 and 20. This can be configured either through the display or through NRT tool. The output signal for UO1 can be set to NC (normally closed) or NO (normally open).</p>

Terminal	Designation	Operation
24	UO2	<p>Control output heating, cooling (FS) or heating or cooling via change-over.</p> <p>For a 0...10 V DC valve actuator, max 5 mA (FS). The valve actuator's 0...10 V control signal terminal is connected to terminal 24 and its supply terminals to terminals 10 and 11. Make sure that the reference pole G0 is connected to the correct terminal on the actuator.</p> <p><i>alternatively</i></p> <p>For a 24 V AC thermal actuator, max 2.0 A. The thermal actuator is connected between terminals 24 and 20, GDO.</p> <p><i>alternatively</i></p> <p>For a 24V AC actuator with spring return, max. 2.0 A. The actuator is connected between terminals 24 and 20. This can be configured either through the display or through NRT tool.</p>
30	AI1	For an external room sensor, PT1000. Measuring range 0...50°C. The sensor is connected between terminals 30 and 41, AGnd.
31	AI2	<p>For a 0...10 V CO2 sensor</p> <p><i>alternatively</i></p> <p>Flow input</p> <p><i>alternatively</i></p> <p>0...10 V input</p>
32	DI1	<p>Occupancy detector. A potential-free contact is connected between terminals 32 and 40, +C. Closed contact corresponds to occupancy.</p> <p><i>alternatively</i></p> <p>Window contact (DI). A potential-free contact is connected between terminals 33 and 40, +C. Closed contact indicates closed window.</p> <p><i>alternatively</i></p> <p>Change-over.</p>
33	DI2/CI	<p>Sauter condensation detector, EGH102 (FS). The sensor is connected between terminals 33 and 41, AGnd.</p> <p><i>alternatively</i></p> <p>Window contact (DI). A potential-free contact is connected between terminals 33 and 40, +C. Closed contact indicates closed window.</p> <p><i>alternatively</i></p> <p>Change-over.</p>
40	+C	24 V DC out common for DI and UI (with digital function)
41	AGnd	Analogue ground, reference for AI and UI (with analogue function)
42	A	RS485-communication A
43	B	RS485-communication B

Table 4. I/O connection terminals for CO2 control and fan control

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Chapter 7 Control modes

Different control modes

The controllers can be configured for different control modes/control sequences. Depending on which control mode is active, one, both or all three of the universal outputs, UO1, UO2 and UO3, are used. See *Table 12* below for a summary.

Control mode	UO1*	UO2*	UO3**
Heating	Heating	-	VAV damper/EC fan
Heating/Heating (split output signal)	Heating	Heating	VAV damper/EC fan
Heating or cooling via change-over	Heating or cooling	-	VAV damper/EC fan
Heating/Cooling	Heating	Cooling	VAV damper/EC fan
Heating/Cooling with VAV-control and forced supply air function	Heating	Cooling	VAV damper/EC fan
Heating/Cooling with VAV-control	Heating	Cooling	VAV damper/EC fan
Cooling	Cooling	-	VAV damper/EC fan
Cooling/Cooling (split output signal)	Cooling	Cooling	VAV damper/EC fan
Heating/Cooling/VAV (except NRT407F902)	Heating	Cooling	VAV damper/EC fan
Heating/Heating or Cooling via change-over (only available in fan models)	Heating	Cooling	VAV damper/EC fan

Table 5. Control modes

* Not available in ...T-models.

** Only available in ...3-models.

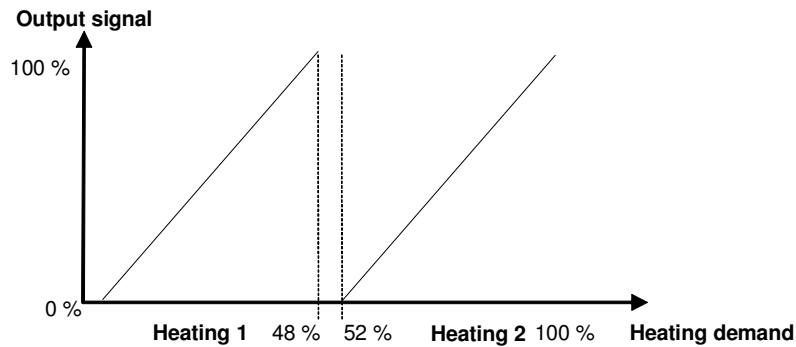
Heating

In control mode Heating, the unit is always a heating controller and controls according to the heating setpoint plus/minus the setpoint adjustment. The setpoint can be adjusted in the display or via the setpoint knob.

Heating/Heating

Split output signal

In control mode Heating/Heating, the controller is always a heating controller and controls according to the basic heating setpoint plus the setpoint adjustment. The control signal is divided between the two outputs with a deadband in between. The first output (UO1) works between 0...48 % of the control signal. When the control signal reaches 52 %, UO2 starts to operate and will be 10 V when the control signal is 100 %. See the figure below:

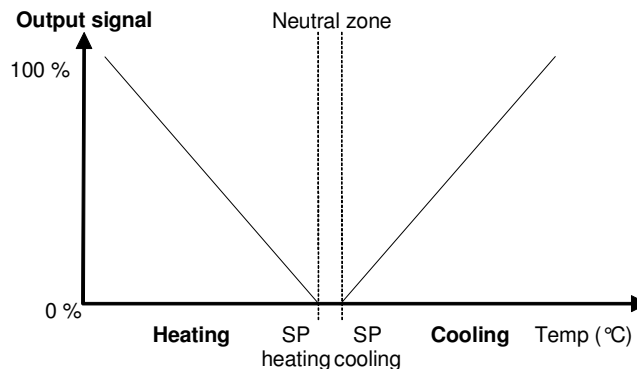


Heating or cooling via change-over

This control mode is used for installations with 2-pipe systems. It makes it possible to use the same pipe for both heating and cooling, depending on whether heating or cooling is required. Switching between heating and cooling mode can be performed either by using a digital or an analogue input. Only one output is used to control the actuator (UO1). See more in the chapter *Change-over function*.

Heating/Cooling

In control mode Heating/Cooling, the controller functions as a heating controller when the room temperature is lower than the basic heating setpoint plus half the neutral zone. The neutral zone is the difference in temperature between the heating setpoint and the cooling setpoint. When the room temperature exceeds this limit, the controller becomes a cooling controller. There is a hysteresis of 0.1°C when the controller changes from heating to cooling controller and vice versa. When the controller is heating, it regulates according to the basic heating setpoint plus the setpoint adjustment, and when it is cooling according to the basic cooling setpoint plus the setpoint adjustment.

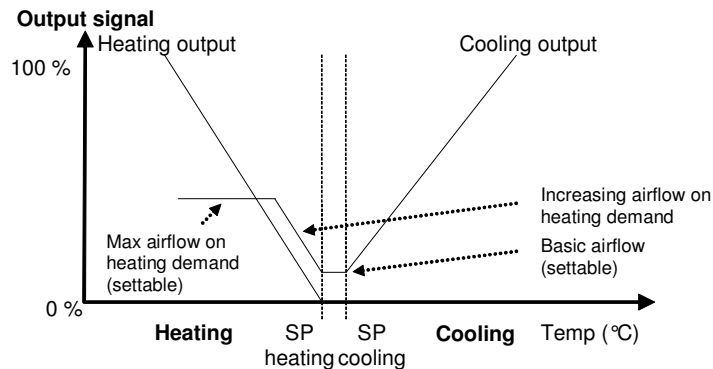


Heating/Cooling with VAV-control and forced supply air function

Like control mode Heating/Cooling but the cooling output is controlling a supply air damper (sub-tempered supply air). When the ventilation is forced (See *Chapter 12, Special functions*), the cooling output is set to full cooling (full supply air volume), regardless of what the controller output signal is.

Heating/Cooling with VAV-control

Heating and cooling are controlled in the same way as in the VAV-control above. The damper cannot be forced like above. There is also a function that opens the supply air damper on heating demand. This is normally always required if the heater is placed in the supply air duct, to carry the heat to the room. A maximum limit is set for the opening of the damper on heating demand. The factory setting is zero, which means that the function to open the damper on heating demand is not active. The basic flow can also be set separately.



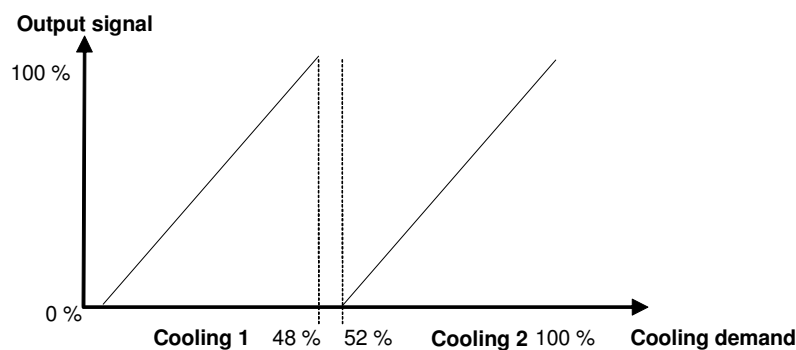
Cooling

In control mode Cooling, the unit is always a cooling controller and controls according to the basic cooling setpoint plus the setpoint adjustment.

Cooling/Cooling

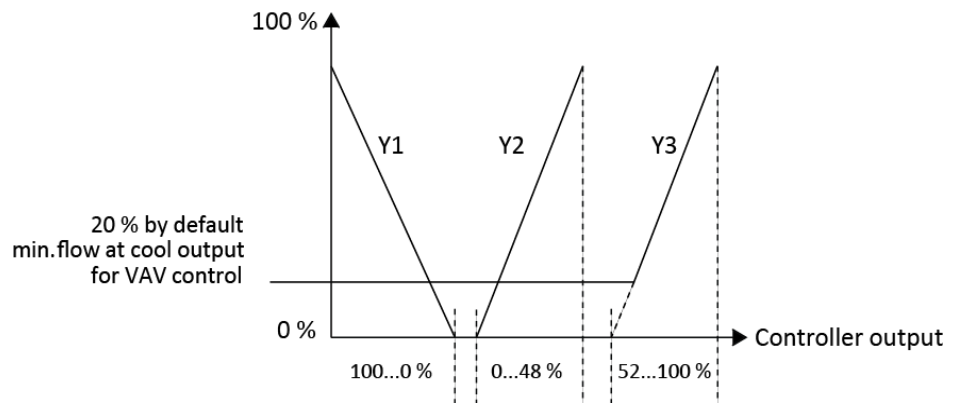
Split output signal

In control mode Cooling/Cooling, the controller always functions as a cooling controller and controls according to the basic cooling setpoint plus the setpoint adjustment. The control signal is divided between the two outputs with a deadband in between. The first output (UO1) works between 0...48 % of the control signal. When the control signal reaches 52 %, UO2 starts to operate and will be 10 V when the control signal is 100 %. See the figure below:



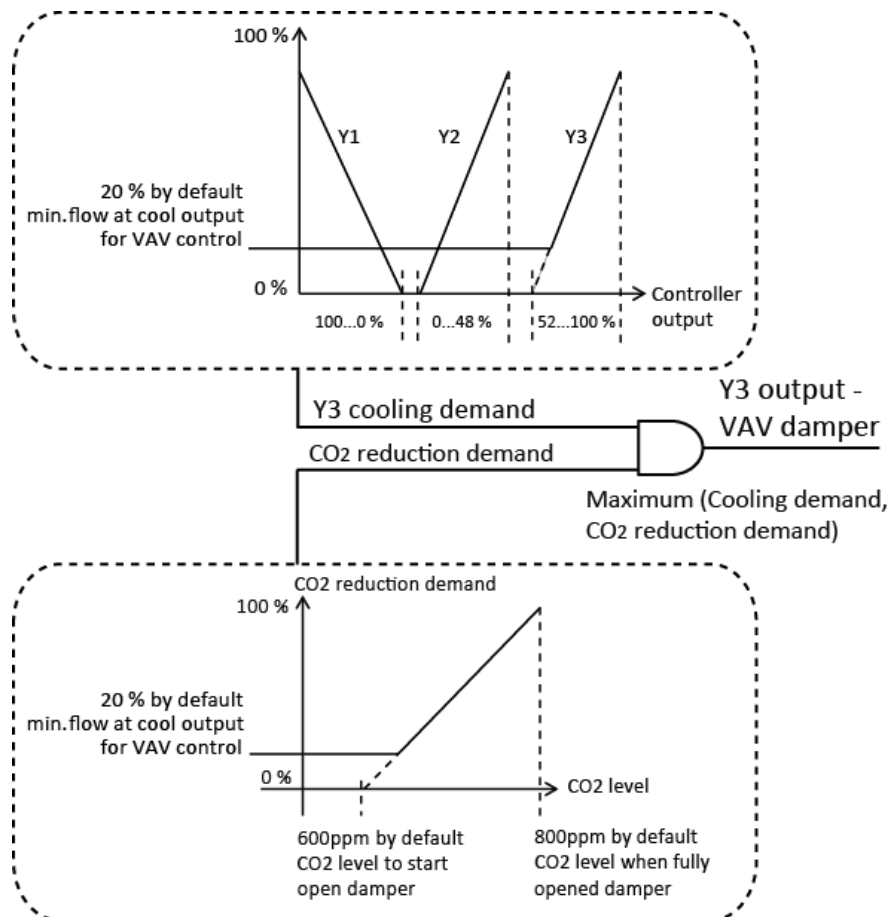
Heating/Cooling/VAV

This control mode offers the possibility to control three analogue outputs: heating, cooling and VAV. When the controller is in cooling mode, the control signal is split between cooling and VAV (this control mode is only available in ...C3 models, except RC-C3DFOC), see figure below:



To avoid Y2 and Y3 opening and closing frequently during switch-over, a saddle point is implemented. Y2 will output 0...10 V (linear) when the controller output is 0...48 % and Y3 will output 0...10 V (linear) when the controller output is 52...100 %. In the saddle point, the outputs will always be 100 % for Y2 and 0 % for Y3.

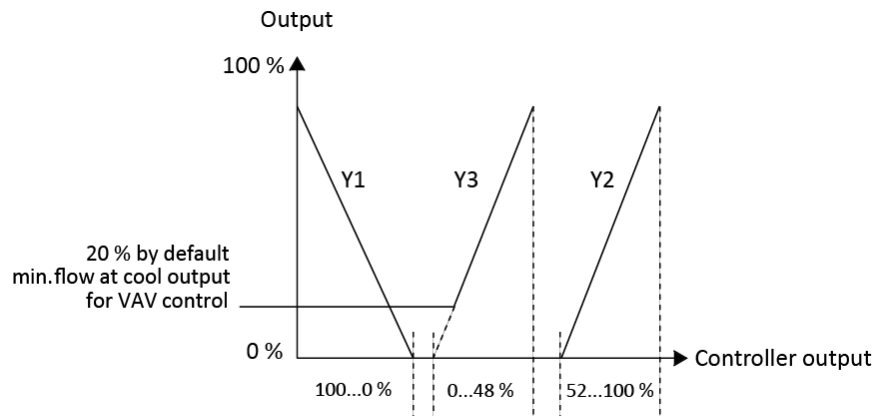
As an addition to the function described above, it is possible to connect a CO₂ sensor to RC-C3DOC. The output on Y3 will then be affected by either cooling demand or by the CO₂ level rising too high. The output from the CO₂ function is linear between two user-defined setpoints (see figure below).



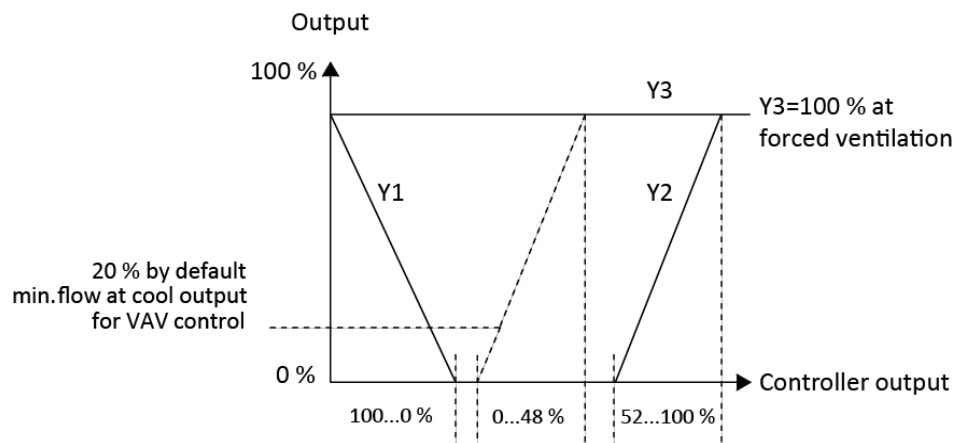
The variable for the min. limit of the VAV-damper is the same as for the VAV-damper in the VAV control applications on Y2. Default is 20 % min. limit.

Reversed sequence

In some applications, e.g. free cooling, it may be desirable to reverse the sequence of Y2 and Y3 (i.e., to open Y3 before Y2). This function is a configuration of the control mode Heating/Cooling/VAV. When the function is active, the sequence of Y2 and Y3 will be reversed, i.e. Y3 will open 0...100 % when controller output is in the range of 0...48 % and Y2 will open 0...100 % when the controller output is 52...100 %. See the figure below:



At forced ventilation, Y3 will open fully as before, and Y2 will control depending on temperature. However, Y2 will not give any output unless the controller output is above 52 %.



This function is only valid for models with Y3 output.

Heating/heating or cooling via change-over

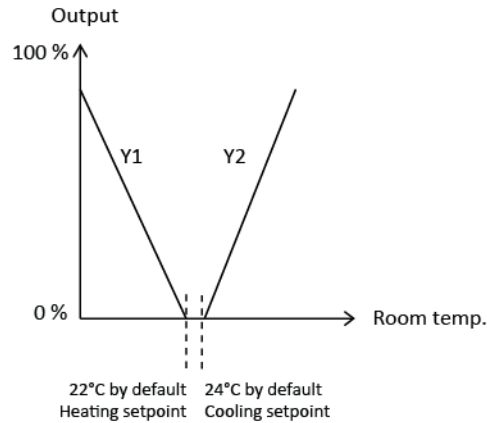
For models offering fan functionality, a function for control of a heating battery on UO1 in sequence with change-over on UO2 is available. When this has been performed, the start sequence of UO1/UO2 is changed along with the limits for fan start.

The change-over function will be used to switch between summer and winter mode. UO2 will be used as a cooling actuator in summer mode and as a heating actuator in winter mode.

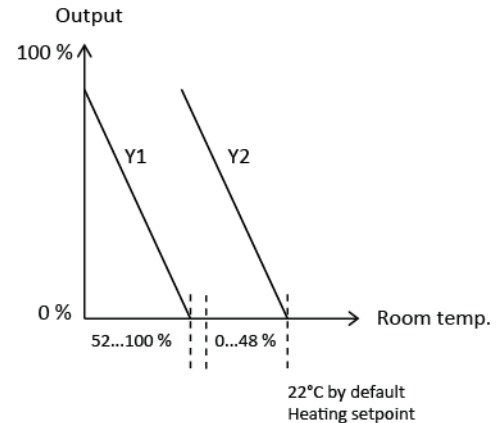
In summer mode, NRT will function as a regular heating/cooling controller.

In winter mode, NRT will function as a heating/heating controller. UO2 will initiate first and UO1 second. The electrical heating battery connected to UO1 will start only if the ordinary heat battery on UO2 cannot meet the heating demand. When a heating demand exists, the output of UO2 is 0...100 % linear to the heating demand 0...48 % and UO1 0...100 % to the heating demand 52...100 %. When the heating demand is 48...52 % UO2 will always output 100 % and UO1 0 %.

Summer mode activated
by change-over input



Winter mode activated
by change-over input



As the electrical heater is connected to UO1, and since an electrical heater may become very hot, a fan stop delay has been implemented into the system. The fan stop delay will only be activated in heating mode, and then only if the fan has been running prior to the stop. When the heat output has been set to 0 %, the fan will continue to run for an additional 120 s, at the same speed it had prior to stopping.

It is very important to note that NRT does not have any built-in function for monitoring when the fan is running or if the heat battery is overheating. This function must instead be provided by a supervisory system.

Additional features

CO₂ sensor and VAV control

NRTs can be set to all of the above control modes. When they are set to VAV control, the control mode is combined with a CO₂ control function.

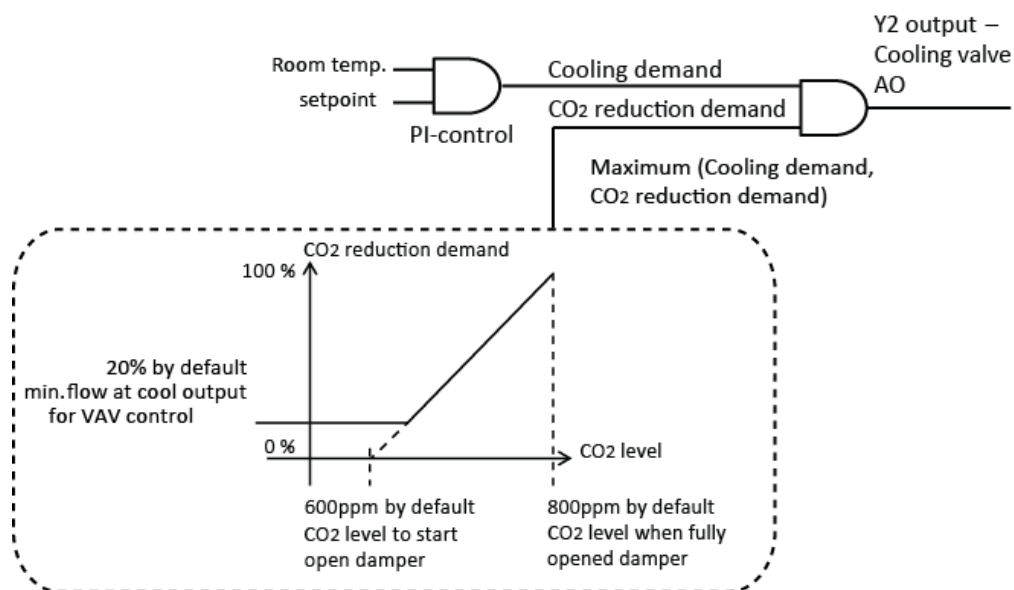
In control mode Heating/Cooling with VAV-control, the CO₂ concentration in the room will make the VAV damper, cooling output UO2, open. The function is linear and the damper works between the configured min. flow (FS=20 %) and 100 %, depending on the CO₂ concentration in the room. If the CO₂ concentration drops below the configured min. limit, the damper will stay on the minimum allowed air flow. When the CO₂ concentration rises, the damper will open linearly until reaching the configured CO₂ max. value, at which point it will be 100 % open.

Minimum limit on analogue 0...10 V actuators

The minimum limitation on the analogue output is only active in Bypass, Occupied and Standby. If the operating mode is Unoccupied or Off, the damper will be closed (0 V on the analogue output). See table below:

Operating mode	Min. limit	VAV output (Y2)
Bypass	20 %	2 V
Occupied	20 %	2 V
Standby	20 %	2 V
Unoccupied	20 %	0 V
Off	20 %	0 V

Many damper actuators have a working range of 2...10 V. This means that to set a minimum limitation of 20 %, the min. limitation in the NRT will have to be set to 36 % .



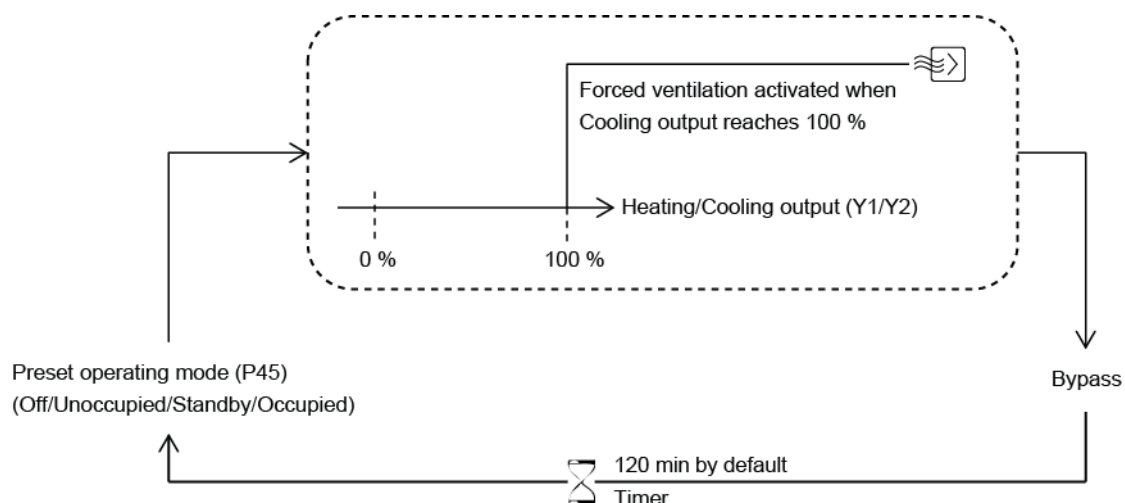
Forced ventilation depending on the heating/cooling output

At 100 % heating or cooling output, forced ventilation can be activated. The function is intended to be used when the heater or cooler is located in the ventilation duct and the system is struggling to reach the setpoint. When the cooling or heating output reaches 100 %, the controller will switch to control mode Bypass.

The controller will remain in forced ventilation throughout the set Bypass time (FS=2h).

Three different alternatives can be selected for setting the function forced ventilation:

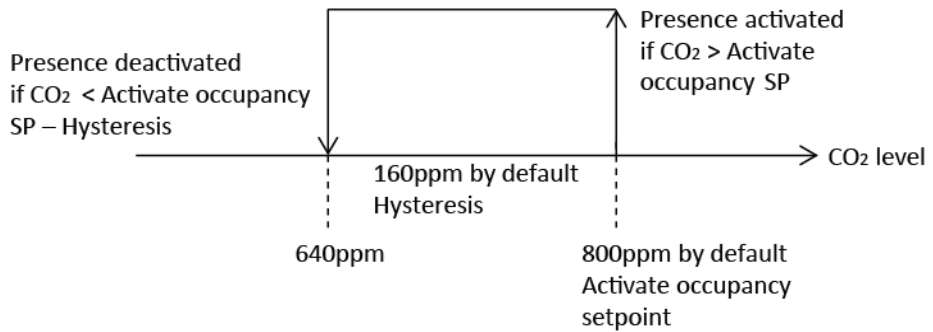
- Not active (FS)
- Forced ventilation at 100% heating or cooling output
- Forced ventilation at 100% cooling output



Presence detection depending on the CO₂ concentration

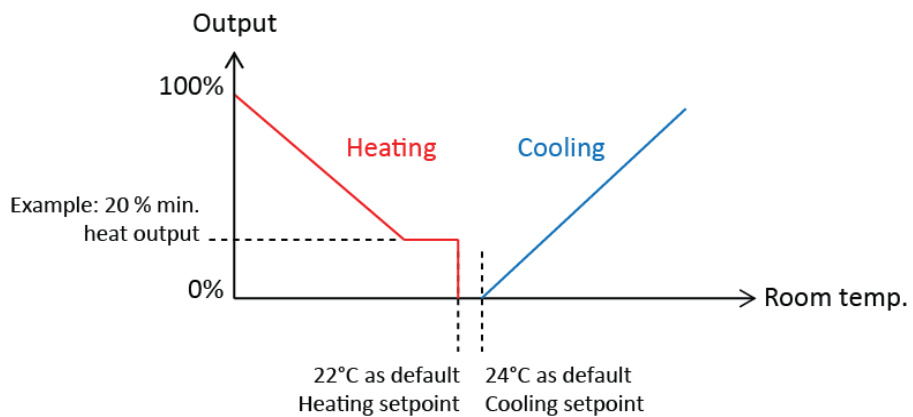
This function is not active when the controller is configured for Heating/Cooling with VAV-control.

When the CO₂ concentration exceeds the set value for activation of presence, UO3 will switch to forced ventilation if the presence operating mode is set to Bypass. It will stay there until the concentration drops below the set value (FS=800ppm) minus the hysteresis (FS=160ppm). When the concentration drops below this value, the controller will remain in presence mode for the duration of the configured occupancy off-delay (FS=10min).



Minimum limit for the heating output

In some applications, it is desirable to set a minimum limit for the heating output in order to prevent, for instance, downdraughts under windows. In general, this function works in a way similar to the minimum limit for the cooling output. However, there is a difference between the minimum limit for the heating and cooling output as the minimum limit for the latter still remains active after the controller enters heating mode. In addition, the minimum limitation for the heating output functions in all control modes.



Features for NRT

0...10 V input

The 0...10 V input used as a CO₂ input supports a general 0...10 V signal. This input is not connected to any function but only acts as a read-out for the signal. To configure this option, parameter 81 is set to option 7, "0...10 V".

Flow input

AI2 may be configured as a flow calculation input. A flow corresponding to 0 V and one corresponding to 10 V is set, and the flow is then calculated linearly between these two end points. To configure the flow calculation, Parameter 81 has the additional option 8, "Flow calculation".

The calculated flow value may be shown in the display by setting parameter 42 to option 9.

Different operating modes

NRT controllers have the following operating modes:

- 0 = Off
- 1 = Unoccupied
- 2 = Stand-by
- 3 = Occupied (FS)
- 4 = Bypass

Off

Operating mode Off means that the controller is not heating or cooling, and the fans are stopped. However, the temperature must not drop below the set minimum temperature (FS=8°C). If it does, the controller will start heating, and (if a fan is used) start the fan whether it has been manually stopped or not.

For controllers with display the background lighting is not lit, and only OFF is shown in the display.

Unoccupied

Operating mode Unoccupied means that the room where the controller is placed is not used for an extended period of time, for example during holidays or long weekends. Both heating and cooling are disconnected and the fans are stopped within a temperature interval with configurable min/max temperatures (FS min=15°C, max=30°C).

For controllers with display the background lighting is not lit, but the current room temperature (or setpoint depending on the configuration) is shown in the display. OFF is also shown in the display.

Stand-by

Operating mode Stand-by means that the room is in an energy save mode and is not used at the moment. This can be during nights, weekends, evenings etc. The controller is prepared to change operating mode to Occupied (comfort) if someone enters the room (presence). The room temperature is controlled around the applicable heating and cooling setpoints, with an extended temperature interval (FS=+/-3°C). For example, if the heating setpoint=22°C and the cooling setpoint=24°C, the controller will allow the temperature in the room to be between 19°C and 27°C. The setpoints can also be adjusted +/- 3°C via the setpoint knob or the display.

For controllers with display the background lighting is lit (dimmed). STANDBY and the current room temperature (or setpoint depending on the configuration) are shown in the display.

Occupied

Operating mode Occupied means that the room is in use and is therefore in a comfort mode. The controller regulates the room temperature around a heating setpoint and a cooling setpoint (FS heating setpoint=22°C, cooling setpoint=24°C). The setpoints can also be adjusted +/- 3°C locally via the setpoint knob or in the display, or via a central command.

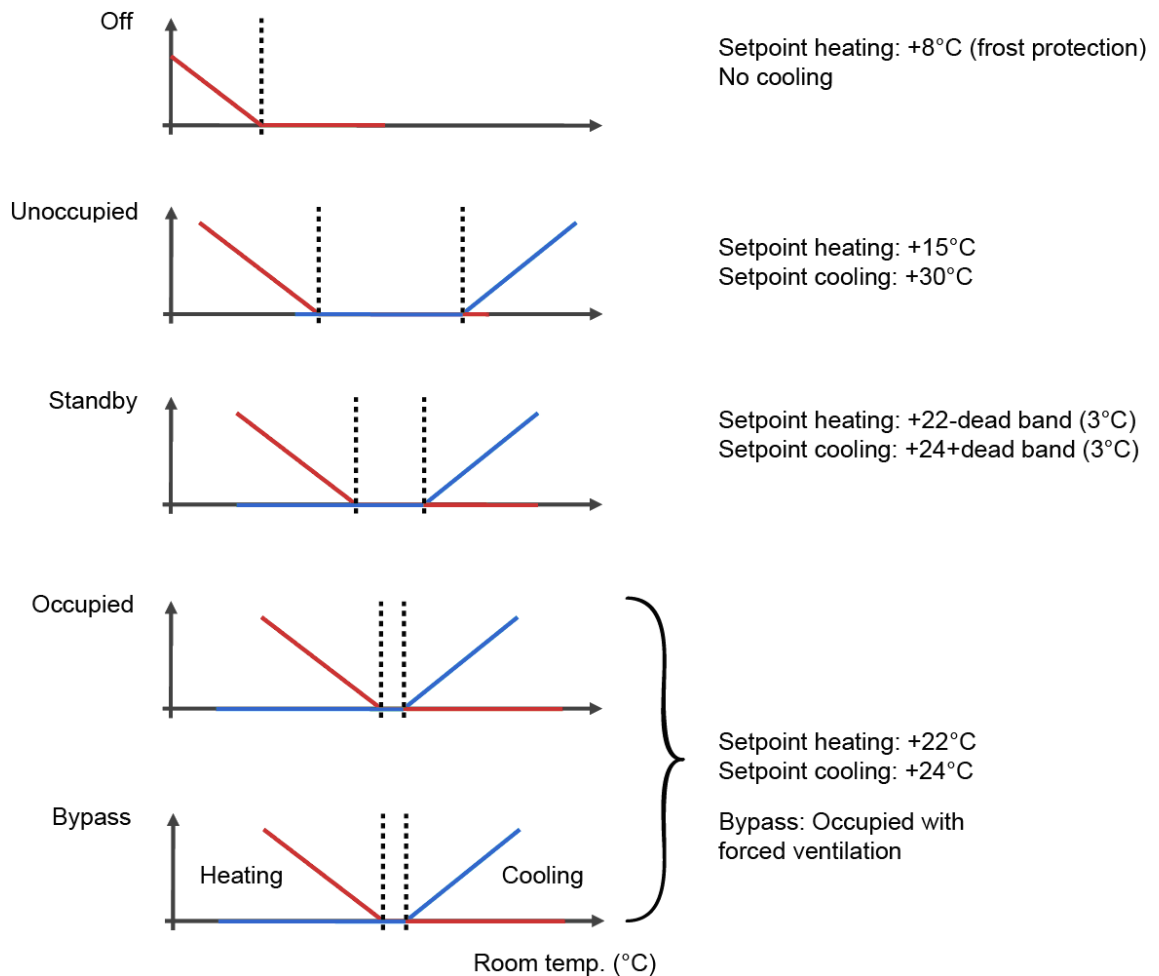
For controllers with display the background lighting is lit (dimmed), and the occupancy indication is shown (see the chapter *Display handling*). The current room temperature (or setpoint depending on the configuration) is also shown in the display.

Bypass

Operating mode Bypass means that the controller controls the room temperature in the same way as in operating mode Occupied. The output for forced ventilation is also active. After a configurable time (FS=2 hours) in Bypass, the controller automatically returns to the preset operating mode. Bypass is normally activated when the Occupancy button is pressed, via an occupancy detector, a central command or the CO₂ level. The operating mode is useful for example in conference rooms, where many people are present at the same time for a certain period of time.

For controllers with display the background lighting is lit (dimmed). The occupancy indication and the symbol for forced ventilation are shown (see the chapter *Display handling*). The current room temperature (or setpoint depending on the configuration) is shown in the display.

Depending on the settings and input values, the controller will be set to different control modes using different setpoint values:



Activation of the different operating modes

Preset operating mode The preset operating mode is configured to Occupied by default. On models without display the preset mode can be changed to Stand-by using DIP switch SW3. OFF (FS): Occupied, ON: Stand-by. On models with display, this is configured in the parameter menu in the display, parameter 45.

The operating mode is changed at the following events:

- When the Occupancy button is pressed (if the controller has an Occupancy button).
- Activation/deactivation of an occupancy detector on the digital input.
- Activation/deactivation of presence by CO₂ level (for model with CO₂ detection)
- Via central control, for example central time control, central booking system etc.

Occupancy button

For models without fan control, the occupancy button push time for Shutdown is 5 s as a default. It is configurable via NRT tool.

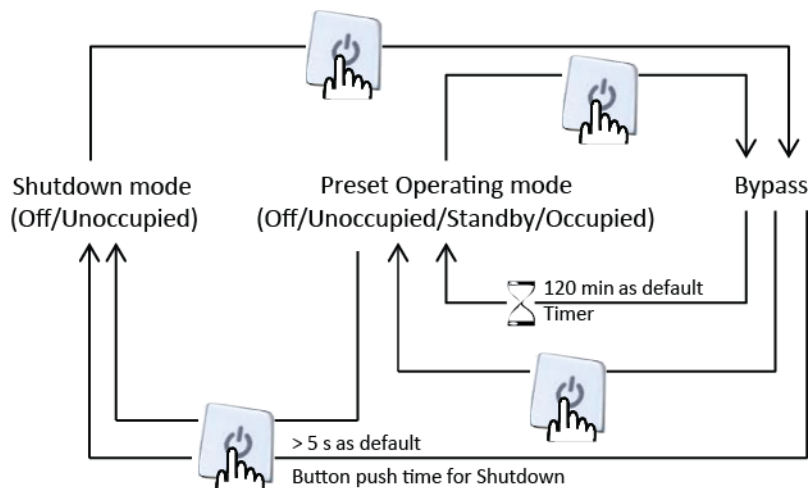
When pressing the occupancy button, the controller is set to forced ventilation. If the button is pressed again when forced ventilation is active, the controller will switch to the default running mode which can be configured either to Off, Unoccupied, Standby or Occupied.

When the Occupancy button is held depressed for more than 5 seconds, the controller will change its operating mode to Shutdown (Off/Unoccupied), regardless of the present operating mode. Via the display or NRT tool, it is possible to configure which operating mode (Off or Unoccupied) should be activated upon Shutdown (FS=Unoccupied).

Shutdown

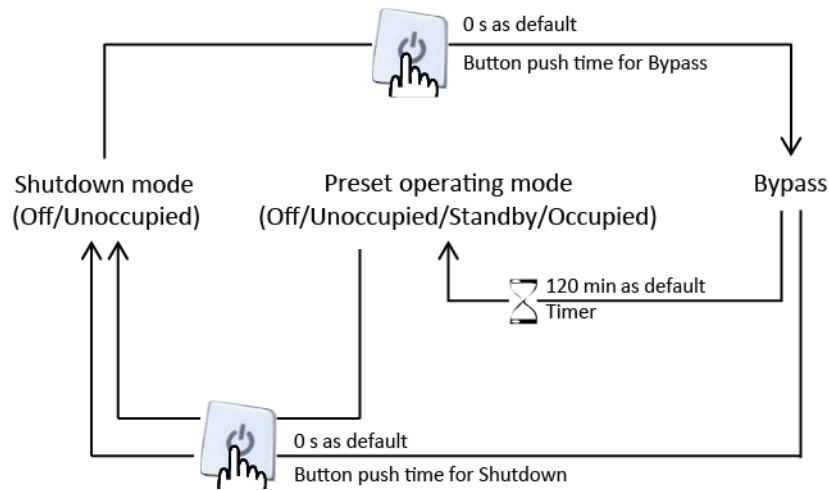
If the Occupancy button is pressed for less than 5 seconds when the controller is in its preset operating mode or in Shutdown, the controller will change to Bypass. If the button is then depressed for less than 5 seconds, the controller will return to the preset operating mode.

After a configurable period of time in Bypass (FS=2 hours), the controller will return to the preset operating mode.



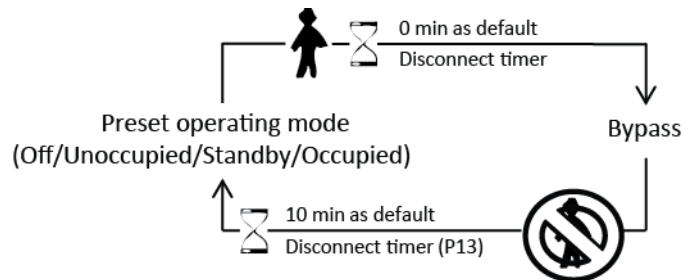
For models with fan control, the Occupancy button Shutdown push time is 0 s as a default. This value is configurable via NRT tool®.

Because of the default 0 s setting, switching operating modes by depressing the Occupancy button functions differently: If the Occupancy button is pressed when the controller is in the preset operating mode or in Bypass mode, the controller will change to Shutdown. If the Occupancy button is pressed in Shutdown mode, the controller will switch to Bypass. After a configurable period of time in Bypass (FS=2 hours), the controller will return to the preset operating mode.



For handling of the Occupancy button in combination with central control, please see the section entitled *Central control*, below.

Occupancy detector



For local control of the operating mode between the preset operating mode and Bypass, an occupancy detector is connected.

When occupancy is indicated, the controller changes operating mode to Bypass. If you want to be able to enter the room temporarily without activating Presence (to, for example, pick something up) it is possible to configure a power-up delay. This means that Presence is not activated until the power-up delay has expired. The Presence delay can be set to a value between 0 and 60 minutes (FS=0 min).

In Bypass on presence, there is a switch-off timer, which means that if there is no occupancy indication during this time (FS=10 min), the controller will return to the preset operating mode.

Central control

Central control of the operating mode is also possible. By changing the variable *NRTRemoteState*, you can control the operating mode centrally according to the following table (there is a variable list for central control in Part IV of this manual):

NRTRemoteState	Description
0	Central operating mode Off
1	Central operating mode Unoccupied
2	Central operating mode Standby
3	Central operating mode Occupied
4	(Not used)
5 (FS)	No central control

Table 6. The variable *NRTRemoteState*

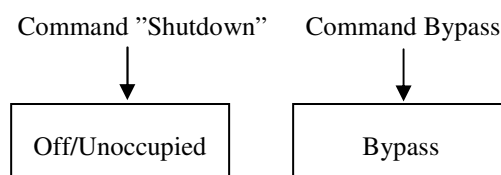
The occupancy button When using central control (i. e. *NRTRemoteState* \neq 5) and you press the Occupancy button, the controller will change to Bypass and stay in this mode for as long time as you have configured. If you press the Occupancy button again when the controller is in Bypass, the controller will change to Stand-by, regardless of what has been set in the central control (*NRTRemoteState*).

When the controller is in Bypass and the Bypass time has run out, the controller will change to the operating mode given by *NRTRemoteState*. If *NRTRemoteState* equals 5 it will change to the preset operating mode.

If the controller is in Stand-by and the central control is changed, the controller will change to this new operating mode.

Occupancy detector When central control is used and the occupancy detector is activated, the controller will go to Bypass for a configurable time, and thereafter return to the central operating mode.

Central command Via central commands from a comprehensive system, for example nPOpen, you can handle the controller in the same way as you handle it locally via the Occupancy button, i. e. you can change its operating mode to Off/Unoccupied (Shutdown) or Bypass.



Central commands should be regarded as events and can be changed locally via the Occupancy button.

Chapter 9 Setpoint calculation

Basic setpoint

There are two basic setpoints, one basic heating setpoint (FS=22°C) and one basic cooling setpoint (FS=24°C). The basic cooling setpoint is automatically changed at the same time. Therefore, the difference between the basic heating setpoint and the basic cooling setpoint is always the same.

On models with display, the basic setpoint is set in the display.

On all models, you can also configure the setpoints via a central system or NRT tool. When the model has DIP switches, the latest setpoint change will be valid.

Setpoint offset

On all models, setpoint value can be adjusted up and down from the basic setpoint value, via the display. How much the value can be adjusted can be configured in NRT tool or in the parameter menu in the display (FS=+/-3°C).

In models with display, you use the INCREASE button to increase the current setpoint in steps of 0.5°C to the max. limit, and the DECREASE button to decrease the current setpoint in steps of 0.5°C to the min. limit.

Calculation of the active setpoint

What setpoint value the controller should control according to depends on the operating mode, the control mode and the current setpoint offset.

Off	In operating mode Off or on open window the controller is a heating controller, and controls according to the frost protection setpoint (FS=8°C), regardless of the setpoint adjustment.
Unoccupied	In operating mode Unoccupied, it controls according to the heating setpoint (FS=15°C) if a control mode with heating has been set and the room temperature is lower than this setpoint. If the room temperature is higher than the cooling setpoint (FS=30°C) and a control mode with cooling has been set, the unit is a cooling controller and controls according to the cooling setpoint. The active setpoint changes in the middle of the neutral zone with a hysteresis of 0.1°C. A setpoint adjustment is not active in this operating mode.
Stand-by	In operating mode Stand-by the controller controls according to the basic heating setpoint or the basic cooling setpoint plus/minus a settable neutral zone (FS=3°C). The setpoint can also be adjusted via the setpoint knob or display. This means that the factory setting for the heating setpoint is 19°C +/- 3°C (local adjustment) and the cooling setpoint is 27°C +/- 3°C (local adjustment). On heating demand the unit will control according to the heating setpoint, and on cooling demand it will control according to the cooling setpoint. The setpoint change takes place halfway between the setpoints with a hysteresis of 0.1°C.
Occupied/Bypass	In operating modes Occupied and Bypass the unit controls according to the basic heating setpoint or the basic cooling setpoint. The setpoint can also be adjusted via the setpoint knob or display. The setpoint change takes place halfway between the setpoints with a hysteresis of 0.1°C.

Setpoint display at setpoint adjustment

Parameter 74 is used to set what is shown in the display when the setpoint is adjusted.

- 0 = The added adjustment is shown in the display. Example: +1.5°C. The adjustment is added to both the heating and cooling setpoints.
- 1 = The sum of the control setpoint and the adjustment is shown in the display. Example: The control setpoint is 22°C and the added adjustment is +1.5°C. This means that the value 23.5°C will be shown in the display. "HEAT" or "COOL" will flash depending on which of the setpoint values is the control setpoint when you enter the setpoint menu, i.e. depending on which setpoint you are changing. The adjustment is added to both the heating and cooling setpoints.
- 2 = The sum of the heating setpoint and the adjustment is shown in the display. The adjustment is added to both the heating and cooling setpoints.
- 3 = The sum of the cooling setpoint and the adjustment is shown in the display. The adjustment is added to both the heating and cooling setpoints.

Chapter 10 Actuators

NRT can be used with four types of actuators:

- Analogue 0...10 V actuators
- Thermal actuators
- 3-point actuators (Increase/Decrease actuators)
- On/Off spring return actuators

On units without display, it is possible to select if thermal or analogue actuators will be used via the DIP switches. For other actuators and NRT models, the actuator type is set via NRT tool or, for controllers with a display, in the parameter menu.

Analogue actuators

The following output signals can be set for analogue actuators:

- 0...10 V (FS)
- 2...10 V
- 10...2 V
- 10...0 V

Thermal actuators

When thermal actuator control has been selected, it is controlled digitally with time proportional pulses via output UO1 and UO2. By pulsing, the opening degree of the actuator (and its valve) is varied. The period time (in seconds) is the sum of the on and off output times on the output. The period time is FS=60s. The controller varies the on and off output times proportionally depending on the output signal demand to the actuator.

3-point actuators

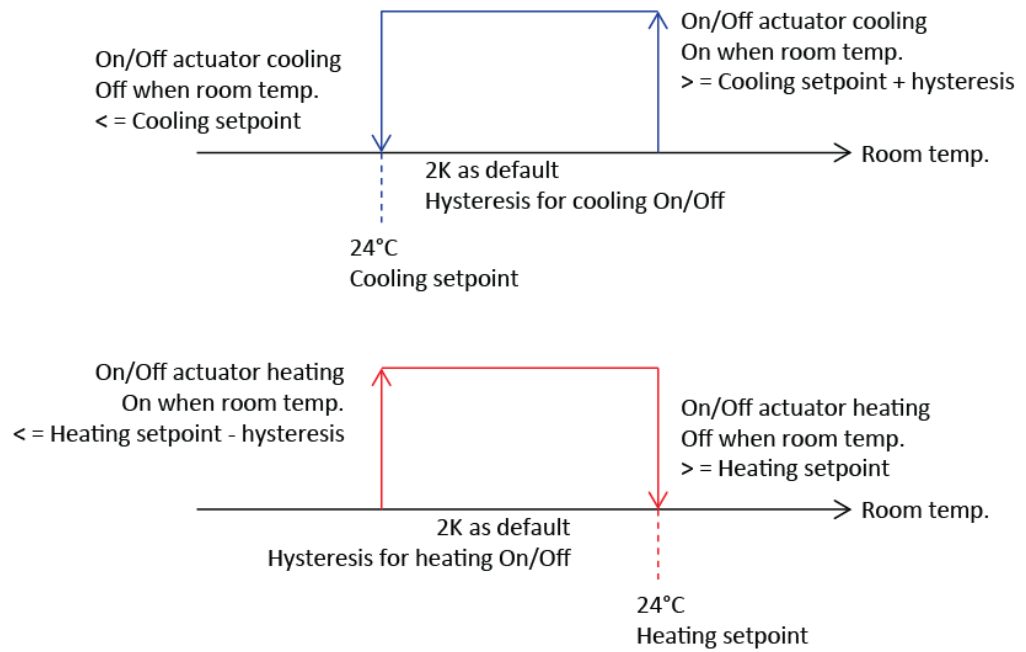
For 3-point actuators (increase/decrease actuators, -T-models), two digital outputs are used for controlling one actuator, one output to open the actuator and one to close it. You can configure the run time (in seconds) for the different actuators (FS=120 s). The program calculates the position of the actuator (0...100 %) and sends an increase or decrease signal when the controller output signal deviates more than the set neutral zone (FS=2 %) from the calculated position.

On/Off spring return actuators

When On/Off spring return actuator has been selected, the functionality is similar to a thermostat function. This will be relevant only in control modes Heating, Heating/Cooling via change-over, Heating/Cooling and Cooling. Selecting this function will not be possible if any other control mode has been selected.

A hysteresis is used when the outputs are On or Off.

In heating mode, the temperature will be permitted to fall below the setpoint, minus the hysteresis, before the actuator opens. The actuator will then remain open until the temperature rises above the setpoint.



Actuator exercise

All actuators are exercised. The exercise takes place at set intervals in hours (FS=23 hours interval). An opening signal is sent to the actuator for as long as the configured run time. Then a closing signal corresponding to the length of the run time is sent and the exercise is finished.

On units with a display, the exercise can be inactivated by setting parameters 36 and 37 to zero (0).

Chapter 11 Fan control

In controllers for fan control it is possible to control a fan at the following speeds: Off, Low speed, Medium speed, High speed, Auto. The fan speed in the Auto position depends on the controller output signal and the settings for each speed.

Fan speed control

Manual control

The fan can be manually controlled to work at any speed. On models with display, you press the fan button once and a fan symbol is lit for 5 seconds in the display. As long as the symbol is lit, you can change the fan speed by repeatedly pressing the fan button. Models without display have a fan switch.

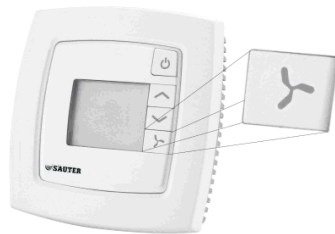


Figure 10. Fan button on models with display

The controller has the following positions:

- Auto** = Automatic control of the fan speed to maintain desired room temperature
- 0** = Manual off
- I** = Manual position with low speed
- II** = Manual position with medium speed
- III** = Manual position with high speed

Manual setting of speed I-III means that the speed of the fan in operating modes Stand-by, Occupied and Bypass is always the set speed. In the other operating modes, the fan is demand controlled.

Auto control

In auto mode, you can configure if the fan should be controlled by the heating output, the cooling output, or both the heating and cooling outputs. When the selected output exceeds the start value that has been set for each speed (FS speed 1=20 %, speed 2=60 %, speed 3=100 %), the fan is activated. It stops when the controller output signal drops below the set value minus the set hysteresis (FS=5 %).

When the fan speed changes, there is always a minimum delay (2-3 s) between the inactivation of the output for the current speed and the activation of the output for the new speed. Only one fan speed output is defined at a time.

Fan stopped

In operating modes Off and Unoccupied, the fan is stopped, regardless of the position of the fan switch or the setting in the display, on condition that the temperature is within the set temperature limits. If the temperature is not within the set temperature limits, the fan will be started in the corresponding Auto position, regardless of the settings.

No fan stop

NRT contain an option in which the fan will never stop in operating modes Bypass, Occupied and Standby but instead continue to run at fan speed 1. This function uses parameter number 41. The factory setting for this option is 0, meaning that the function is disabled. This function will only work if the fan is in Auto mode; if the fan is set to manual mode, the manual setting will instead be applied.

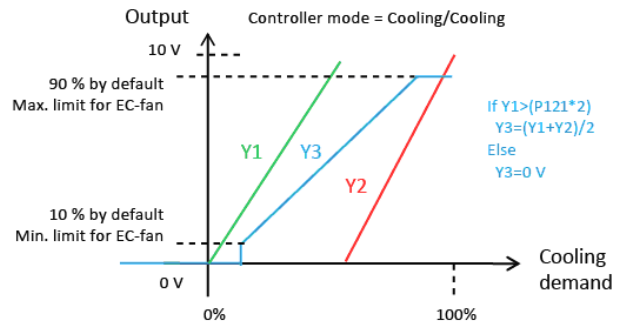
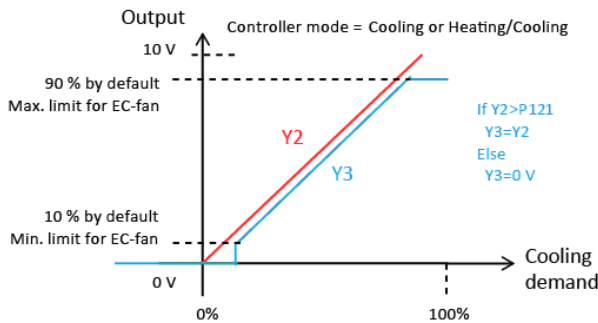
EC fan control

NRT407 offer an added function for the control of EC fans. When this function is active, Y3 will follow Y1 and Y2, respectively. As for ...F models with fan control, it is possible to select whether the fan will run in Heating or Cooling, or in both Heating and Cooling. This setting is made using the same parameter (P50) as for other fan models.

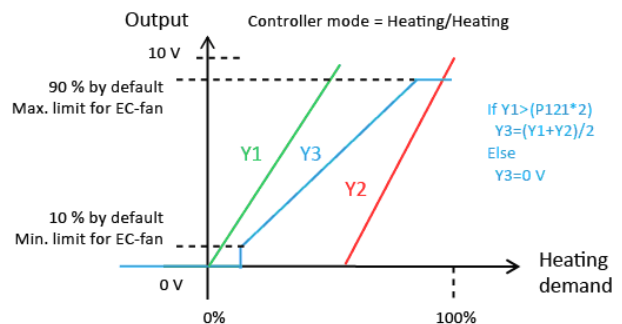
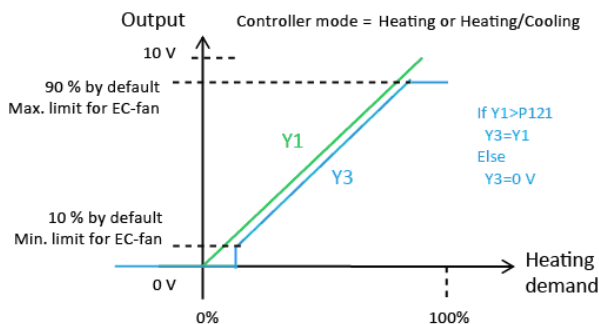
The function is activated by setting UO3 to Control of EC fan (P22). It may be activated in control modes Heating, Heating/Heating, Heating or Cooling via change-over, Heating/Heating or Cooling via change-over, Heating/Cooling, Cooling/Cooling and Cooling.

The function will add a minimum limit to UO3, so that the fan will have sufficient supply voltage.

Cooling mode

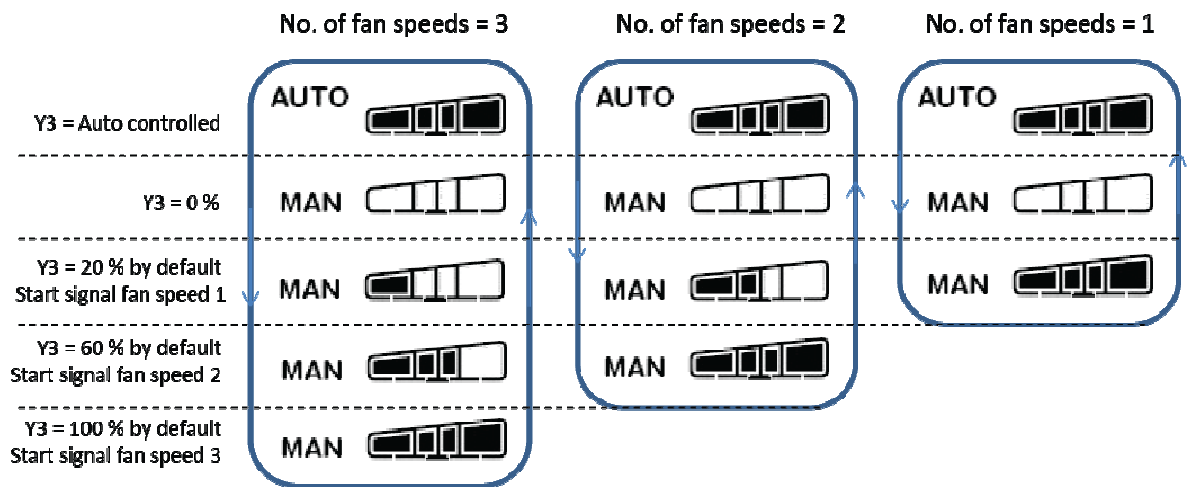


Heating mode



For model NRT407F902, the fan button will control the EC fan output to preset speeds and then offer feedback to the user through the fan segment displayed. This takes place in the same way as for other ...F models.

When the fan button is depressed, it will step through the configured fan levels:



Chapter 12 Special functions

Change-over function

Change-over is a function for installations with 2-pipe systems. It makes it possible to use the same pipe for both heating and cooling, depending on requirements during for example the summer (cooling output) and the winter (heating output).

Control modes To activate the change-over function, control modes "Heating or Cooling via change-over" or "Heating/Heating or Cooling via change over" needs to be configured.

The input can be either of the type analogue PT1000-sensor or a closing contact connected to a digital input (FS=PT1000-input).

Change-over digital When using a digital signal input (potential-free contact), closing the contact will activate the change-over function and set the heating output, UO1 alt. DO2/DO3, to cooling. On open contact, the change-over function will set the heating output to heating.

Change-over analogue In this mode, the change-over function will measure the difference between the room and media temperature. As long as the heat valve is more than 20 % open, or every time a valve exercise is performed, the difference between the media and room temperature will be calculated. If the temperature difference is lower than the configured value (differs for Heating and Cooling mode), the control mode will change. The factory settings for the difference between Heating and Cooling change-over are:

- Change from Heating to Cooling = 4K
- Change from Cooling to Heating = 3K

This setting may be changed using parameters number 9 and 10.

Forced ventilation

All NRT controllers have functionality for forced ventilation. All controllers except NRT407F902 have a digital output for controlling a forcing damper to increase the airflow to the room. This output is always activated in operating mode Bypass.

When control mode "Heating/Cooling with VAV-control and forced supply air function" is active, the cooling output is used to control the forcing damper. When forced ventilation is active, the cooling output is set to full cooling, regardless of what the controller output signal is.

NRT407F901 can select whether the forced ventilation output should be a 0...10 V analogue output or a 24 V digital output (parameter 22).

Condensation detector

Special input CI There is a special input (CI) on all NRT controllers. This input is intended for Sauter condensation detector, EGH102, and functions internally as a digital input, i. e. condensation or no condensation.

When the condensation detector is activated, the cooling control is blocked and the controller is set in neutral position. When condensation ceases, the controller will start controlling from the neutral position.

Window contact When window contact has been configured, the controller is set to normal mode on closed window. On open window, the controller is set to off mode, the heating and cooling outputs are set to 0 V and the frost protection function is activated.

Frost protection

NRT has built-in frost protection, which is activated when the controller is not in use. The frost protection prevents the temperature from dropping below 8°C. Return to normal fan speed and control occurs automatically when the room temperature exceeds 8°C.

High/low room temperature alarm

High/low temperature alarm is a function to indicate if the room temperature is too high or too low.

The high room temperature alarm will trigger when the room temperature exceeds the configured high temp limit (FS=40°C).

The low room temperature alarm will trigger when the room temperature falls below the configured low temp limit (FS=15°C).

The alarms are implemented as points that trigger when the temperature either exceeds or falls below the limits, and return as soon as the temperature returns. There is no advanced alarm handling, incorporating blocking or acknowledging or so forth. There is only an indication for faulty temperatures. All other alarm and alarm handling functions must be handled by a supervisory system.

Chapter 13 **Indications**

Chapter 14 Display handling

The NRT models have a display.

These models also have an Occupancy button, as well as an INCREASE button and a DECREASE button to increase and decrease the setpoint.

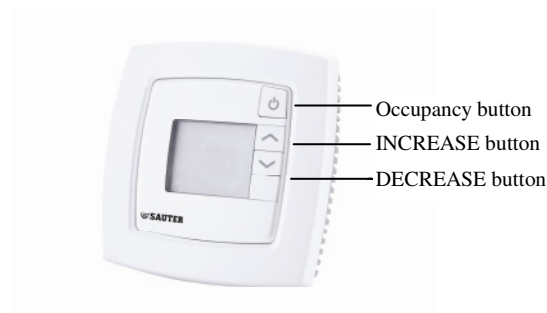


Figure 11. Buttons for display handling

Display indications

The display has the following indications (indications marked with an asterisk (*) are only available on NRT407F902):

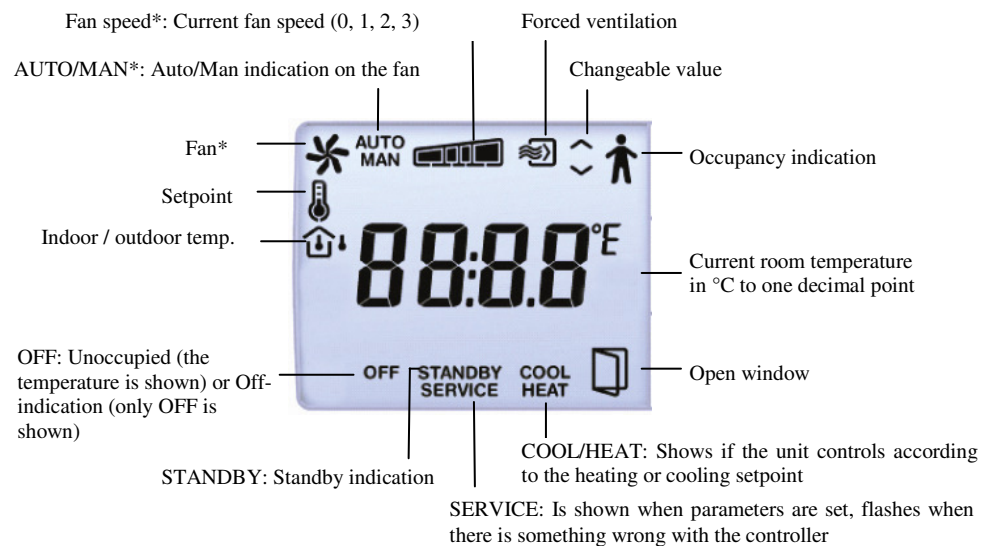


Figure 12. Indications in the display

Parameter menu

It is possible to set different parameter values in a parameter menu. The parameter menu is accessed by simultaneously holding the INCREASE and DECREASE buttons depressed for about 5 seconds and then pressing the INCREASE button twice. The Service indication will be displayed.

The display will initially show the parameter number “1”. Use the INCREASE and DECREASE buttons to scroll between parameters.

Press the Occupancy button to select the desired parameter. The parameter number will be replaced by the parameter value. The value can be changed using the INCREASE and DECREASE buttons. If a button is held depressed the value will start scrolling, first slowly and then with increasing speed in 3 – 4 steps with 2 – 3 seconds between steps.

Acknowledge/Regret

To acknowledge and store a set parameter value, press the Occupancy button again, the display then returns to showing the parameter number. To retrieve the original value, i.e. the value before change, press the INCREASE and DECREASE buttons at the same time. The original value is shown on the display.

Return

After a certain time, about 1 minute, or when the INCREASE and DECREASE buttons are pressed at the same time while in the menu, the display returns to the normal view. Exit is shown on the display after the last parameter. The parameter menu is exited by pressing the Occupancy button while in Exit. Pressing on INCREASE goes to the first parameter and pressing on DECREASE goes to the last parameter.

Parameters

The following parameters can be changed in the parameter menu (FS = Factory setting):

Parameter number	Description	FS
1	Basic heating setpoint	22°C
2	Basic cooling setpoint	24°C
3	Neutral zone at standby, Heating setpoint = Basic sp. heating-3 by default Cooling setpoint = Basic sp.cooling+3 by default	3°C
4	Heating setpoint at Unoccupied	15°C
5	Cooling setpoint at Unoccupied	30°C
6	Frost protection setpoint	8°C
7	P-band for room controller	10°C
8	I-time for room controller	300 s
9	The difference between the temperature in the room and the media temperature for change-over to cooling	3K
10	The difference between the temperature in the room and the media temperature for change-over to heating	4K
11	Control mode: 0=Heating 1= Heating / Heating 2= Heating or Cooling via change-over 3= Heating / Cooling 4= Heating / Cooling with VAV-control and forced ventilation 5= Heating / Cooling with VAV-control 6= Cooling 7= Cooling / Cooling 8= Heating / Cooling/VAV (C3-models, except NRT407F902) 9=Heating / Heating or Cooling via change-over (only available on models with fan control)	3
12	Time in Bypass mode	120 min
13	Disconnect timer with Occupancy/Unoccupancy	10 min
14	Switch-on delay for Occupancy	0 min
15	State connected sensor on AII: 0=Internal sensor 1=External room sensor 2=Change-over sensor (NRT407F901 / F902)	0

Parameter number	Description	FS
16	State connected sensor on UI1: (except NRT407F901 / F902) 0=None 1=Change-over digital 2=Change-over analogue	2
17	State connected sensor on DI1: 1=Window contact 2= No function 3= Presence detector 4=Change-over sensor (NRT407F901 / F902)	1
18	State connected sensor on DI2: 1=Window contact 2=Condensation detection 3=No function 4=Change-over sensor (NRT407F901 / F902)	2
20	State connected function on UO1: 0=None 1=Thermal actuator heat 2= None 3=Heating actuator 0...10 V 4= None 5=On/off actuator heat 6= None	3
21	State connected function on UO2: 0= None 1= None 2=Thermal actuator cool 3= None 4=Cooling actuator 0...10 V 5= None 6=On/off actuator cool	4
22	State connected function on UO3: 0= None 1=Forced vent. digital 2=Analogue output (OEM) 3=None 4=Ordinary analogue output 5=None 6=Control of EC fan	1
24	Y3 output in manual mode (only if Y3 is configured as an analogue output; not available for NRT407F902)	0 %
28	State output signal range for Y3-actuators: 0=0...10 V 1=2...10 V 2=10...2 V 3=10...0 V	0
29	State output signal range for heating actuators: 0=0...10 V 1=2...10 V 2=10...2 V 3=10...0 V	0
30	State output signal range for cooling actuators: 0=0...10 V 1=2...10 V 2=10...2 V 3=10...0 V	0
31	Period time for heating actuators with thermal actuator	60 s
32	Period time for cooling actuators with thermal actuator	60 s
33	Run time for heating actuators with increase/decrease actuators	120 s
34	Run time for cooling actuators with increase/decrease actuators	120 s
35	Neutral zone for increase/decrease actuators	2%
36	Time in hours between exercise of heating actuators	23h
37	Time in hours between exercise of cooling actuators	23h
38	Hysteresis for on/off actuators and heating	2K
39	Hysteresis for on/off actuators and cooling	2K
40	Minimum limit for the heat output	20 %

Parameter number	Description	FS
41	The fan will never stop 0=OFF 1=ON	0
42	Select if setpoint or actual value is to be shown in the display. 0=Actual value 1=Heat setpoint 2=Cool setpoint 3=Average value of heating and cooling setpoint 4=Only setpoint offset 5= CO ₂ concentration in the room in ppm (NRT407F901 / F902) 6=Heating setpoint +setpoint offset 7=cooling setpoint+setpoint offset 8=Average of heating and cooling setpoint+setpoint offset 9=The calculated flow in the duct in l/s (NRT407F901 / F902)	0
43	Highest permitted setpoint adjustment upwards	3°C
44	Highest permitted setpoint adjustment downwards	3°C
45	Preset operating mode: 0=Off 1=Unoccupied 2=Stand-by 3=Occupied. Forced ventilation is not set in Occupied mode.	3
46	State operating mode by pressing the occupancy button for 5 s: 0=Off 1=Unoccupied.	1
47	Select operating mode for central control: 0=Off 1=Unoccupied 2=Stand-by 3=Occupied 5=No central control	5
48	Min flow at cool output when control mode Heating/Cooling with VAV-control is selected Min flow at Y3 output when control mode Heating/Cooling/VAV is selected	20 %
49	Max flow on Y3 output when control mode Heating/Cooling/VAV is selected and in heating mode	0 %
50	Configuration of fan control: 0=No control 1=Fan is controlled by heating demand 2=Fan is controlled by cooling demand 3=Fan is controlled by both heating and cooling demand	3
51	Start signal in % for fan speed 1 on heating or cooling control	5%
52	Start signal in % for fan speed 2	60%
53	Start signal in % for fan speed 3	100%
54	Hysteresis for start/stop of fans	5%
55	State number of speeds for the fan (1, 2 or 3)	3
56	Temperature compensation on AI1	0°C
57	Temperature compensation on UI1	0°C
58	Temperature compensation on internal room sensor	0°C
59	Filter factor for analogue temperature inputs	0,2
60	State NO/NC digital input 1: 0=NO (Normally open) 1=NC (Normally closed)	0
61	State NO/NC digital input 2: 0=NO (Normally open) 1=NC (Normally closed)	1
62	State NO/NC universal input 1: 0=NO (Normally open) 1=NC (Normally closed)	0
63	Manual/Auto Heating output: 0=Off 1=Manual 2=Auto	2

Parameter number	Description	FS
64	Manual/Auto cooling output: 0=Off 1=Manual 2=Auto	2
65	Manual/Auto Y3 forced ventilation output: 0=Off 1=Manual 2=Auto For C3 models (except NRT407F902), manual mode means that Y3 puts out what is stated in parameter 24 if Y3 is configured as an analogue output. When Y3 is configured as a Digital output or does not exist, this parameter constitutes the Manual/Auto mode for the forced ventilation.	2
66	Manual/Auto control of change over mode: 0=Heat control 1=Cool control 2=Automatic change over depending on analogue sensor input or digital input	2
67	Heating output in manual mode	0 %
68	Cooling output in manual mode	0 %
69	Controller Modbus address	Factory set
70	Parity but Modbus communication: 0=No parity 1=Odd parity 2=Even parity	2
71	Modbus time out for character (t1.5), in ms. Should be 1,5 times a character, i.e. at least 2 ms.	3 ms
72	Answer delay in Modbus (t3.5), in ms. Should be 3,5 times a character, i.e. at least 5 ms.	5 ms
73	Selection of heating output function (NO/NC): 0=NC (Normally closed) 1=NO (Normally opened)	0
74	Setpoint display at setpoint adjustment.: 0=The offset is shown in the display 1=The active setpoint + offset is shown in the display. Heat or Cool is shown depending on whether heat or cool is active when entering the menu 2=Heat setpoint + offset is shown in the display 3=Cooling setpoint + offset is shown in the display	0
75	Sequence order for Y2 and Y3: 0=Y2 activates before Y3 1=Y3 activates before Y2	0
76	Forced ventilation, control function: 0=Not active 1=Forced ventiaction at 100% output of heat or cool 2=Forced ventilation at 100% Cool output	0
77	Operating mode at presence detection (DI1): 3=Occupied 4=Bypass	4
78	PLA-address	Factory set
79	ELA-address	Factory set
80	Selection of cooling output functions (NO/NC): 0=NC 1=NO	0
81	State the connected sensor at AI2: (Only NRT407F901 / F902) 0=None 1- 4=No function 5= CO ₂ -sensor 6=No function 7=0...100% (OEM-function) 8=Flow calculation 9=0...10 V	5
82	Flow at 0 V input in AI2	0 l/s
83	Flow at 10 V input in AI2	100 l/s
84	Minimum runtime when calculating for change over	600s
86	Alarm limit for high room temperature	40°C
87	Alarm limit for low room temperature	15°C

Parameter number	Description	FS
97	Activate presence if CO ₂ level is higher (NRT407F901 / F902)	800ppm
98	Deactivate presence if the CO ₂ level is lower than the limit minus this hysteresis (NRT407F901 / F902)	160ppm
100	Filter factor for CO ₂ -input (NRT407F901 / F902)	0.2
104	CO ₂ -level at 0 V (NRT407F901 / F902)	0ppm
105	CO ₂ -level at 10 V (NRT407F901 / F902)	2000ppm
112	Min limit for VAV-damper at CO ₂ -control (NRT407F901 / F902)	600ppm
113	Max limit for VAV-damper at CO ₂ -control (NRT407F901 / F902)	800ppm
114	This parameter defines the protocol to be used: 0=Modbus 1=BACnet MS/TP	0
115	BACnet MS/TP MAC address: 0-127=master address 128-254=slave address	Factory set (00-99)
116	Low 4 figures of the BACnet device ID. 0-9999	Factory set
117	High 3 figures of the device ID.	Factory set
118	BACnet MS/TP Max master.	127
119	COMbus speed: 0=9600 1=19200 2=38400 3=76800 (only BACnet)	0
120	COMbus reset. When activated (1) it resets the communication to default settings	0 (deactivated)
121	Min limit for EC fan (%)	10 %
122	Max limit for EC fan (%)	100 %
125	Model	Factory set (read only)
126	Version Major	Factory set (read only)
127	Version Minor	Factory set (read only)
128	Version Branch	Factory set (read only)
129	Revision	Factory set (read only)

Table 7. Parameter list

Chapter 15 Memory function on power failure

On power failure, settings and configurations are preserved in the controller in a so-called non-volatile memory (EEPROM). All changes made to the settings and configuration is saved in the memory, which means that the latest values are always stored. Measured values, as well as other variables that change often, are not stored.

Values can be saved up to approximately 100 000 times in the non-volatile memory. Therefore, changed values should not systematically and very often be sent to the controller via network communication. Normal changes may still be sent via the network; for example if the operating mode is changed a few times per day.

Example

Activation of Bypass is not stored in the memory. Instead, the controller will return to the preset operating mode after power failure. However, the set operating mode will be saved if central control is being used (parameter 47).

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Chapter 16 Modbus signal types

Modbus Type

The Modbus types of the signals (types in the list below):

- 1 = Coil Status Register (Modbus function = 1, 5 and 15)
- 2 = Discrete Input (Modbus function = 2)
- 3 = Holding Register (Modbus function = 3, 6 and 16)
- 4 = Input Register (Modbus function = 4)

Supported Modbus functions:

- 1 = Read Coils
- 2 = Read Discrete Input
- 3 = Read Holding Register
- 4 = Read Input Register
- 5 = Write Single Coil
- 6 = Write Single Register
- 15 = Write Multiple Coils
- 16 = Write Multiple Registers

Scale factor Modbus

Integer, Index and Logic always have scale factor 1.

Modbus wiring etc.

A protocol such as Modbus consists of several layers (OSI-model). The bottom layer is always the physical layer, number of wires and signal levels. The next layer describes the communication digits (number of data bits, stop-bits, parity etc). Then come the layers describing the Modbus specific functions (number of digits per message, the meaning of different messages etc).

For Modbus, the bottom layer can be RS485, RS422 or RS232.

RS485 contra RS422

RS485 and RS422 are the electric part of the protocol, i. e. the physical layer.

RS485 has two connections, A and B. Often there is also a protective earth. RS485 units are connected $A \rightarrow A$ and $B \rightarrow B$. You may have to shift A and B in order for Modbus to work. RS485 is so called half duplex communication: Communication can only go in one direction at a time; i. e. the master will first send an enquiry and will thereafter listen for the reply. A and B are used for both transmission and reception.

RS422 is a full duplex communication which means you need 4 wires, 2 for transmit (Tx+ and Tx-) and 2 for receive (Rx+ and Rx-). Tx is used to transmit and Rx to receive, which means that Tx in one unit must be connected to Rx in the other and vice versa. As for signal levels, etc., RS422 and RS485 are identical.

To interconnect RS485 and RS422: On the RS422 unit connect Tx+ with Rx+ and Tx- with Rx-. We have now changed a 4-wire system to a 2-wire system and can connect them to A and B on the RS485 unit. Which goes where is something you most often need to find out by trial and error. Incorrect polarity will just give nonfunction but cannot harm either unit.

```
Tx+ ----|----- A (or B)
          |
Rx+ ----|-----
          |
Tx- ----|----- B (or A)
```


|
Rx- ----|

Bitrate, two stop bits, parity is the next layer

These settings must correspond to the settings in the master unit. Find out how the master is set and then give the Controller the same settings.

Parity can be set to odd, even (FS) or none. If none is chosen, two stop bits will automatically be used. If odd or even is chosen, only one stop-bit is used, or there will be too many bits altogether: 1 start-bit, 8 data-bits, 1 parity-bit and 1 stop-bit give a total of 11 bits which is the maximum amount.

Chapter 17 Modbus signals

Discrete inputs

Signal name	Type	Modbus address	Description
RC_Actual_L.NRTDigIn(0)	L,2	1	Not used
RC_Actual_L.NRTDigIn1	L,2	2	Value of digital input 1
RC_Actual_L.NRTDigIn2	L,2	3	Value of digital input 2
RC_Actual_L.NRTUDigIn1	L,2	4	Value of universal digital input 1
RC_Actual_L.NRTDigOut(0)	L,2	5	Not used
RC_Actual_L.NRTDigOut1	L,2	6	Value of digital output 1
RC_Actual_L.NRTDigOut2	L,2	7	Value of digital output 2
RC_Actual_L.NRTDigOut3	L,2	8	Value of digital output 3
RC_Actual_L.NRTDigOut4	L,2	9	Value of digital output 4
RC_Actual_L.NRTDigOut5	L,2	10	Value of digital output 5
RC_Actual_L.NRTUDigOut1	L,2	11	Value of universal digital output 1
RC_Actual_L.NRTUDigOut2	L,2	12	Value of universal digital output 2
RC_Actual_L.NRTDIOpenWindow	L,2	13	Indicate open window
RC_Actual_L.NRTDICondenseAlarm	L,2	14	Indicate condense alarm from digital input
RC_Actual_L.NRTDIPresences	L,2	15	Indicate presence from digital input
RC_Actual_L.NRTDIChangeOver	L,2	16	Indicate change over from digital input
RC_Actual_L.NRTFanSpeed1	L,2	17	Indicate fan speed 1
RC_Actual_L.NRTFanSpeed2	L,2	18	Indicate fan speed 2
RC_Actual_L.NRTFanSpeed3	L,2	19	Indicate fan speed 3
RC_Actual_L.NRTForcedventilation	L,2	20	Indicate forced ventilation
RC_Actual_L.NRTCHeatPulsProp	L,2	21	Indicate pulse prop heating
RC_Actual_L.NRTCVCoolPulsProp	L,2	22	Indicate pulse prop cooling
RC_Actual_L.NRTCHeatInc	L,2	23	Indicate increase heating
RC_Actual_L.NRTCHeatDec	L,2	24	Indicate decrease heating
RC_Actual_L.NRTCVCoolInc	L,2	25	Indicate increase cooling
RC_Actual_L.NRTCVCoolDec	L,2	26	Indicate decrease cooling
RC_Actual_L.NRTAIChangeOverState	L,2	27	Indicate change-over state from analogue input
RC_Actual_L.NRTChangeOverState	L,2	28	Indicate change-over state from both digital and analogue input
Not used in this model	L,2	29	
RC_Actual_L.NRTDigOut3	L,2	30	Value of universal digital output 3
RC_Actual_L.NRTPresence	L,2	31	Indicate presence
RC_Actual_L.NRTRoomTempHighTempAlarm	L,2	32	Indicate high room temperature alarm
RC_Actual_L.NRTRoomTempLowTempAlarm	L,2	33	Indicate low room temperature alarm
RC_Actual_L.NRTDICO2	L,2	34	Indicate high CO ₂ level

Coil status register

Signal name	Type	Modbus address	Default value	Description
RC_Setp_L.NRTBypass	L,1	1	0	Force the unit in Bypass mode. Is automatically returned after Bypass time. 0=No bypass 1=Bypass
RC_Setp_L.NRTShutDown	L,1	2	0	Force the unit in Shutdown state. 0=No Shutdown 1=Shutdown
RC_Setp_L.NRTNotUsed	L,1	3		Not used
RC_Setp_L.NRTDiNC(0)	L,1	4		Not used
RC_Setp_L.NRTDi1NC	L,1	5	0	State NO/NC digital input 1: 0=NO (Normally open) 1=NC (Normally closed)
RC_Setp_L.NRTDi2NC	L,1	6	1	State NO/NC digital input 2: 0=NO (Normally open) 1=NC (Normally closed)
RC_Setp_L.NRTUDi1NC	L,1	7	0	State NO/NC universal input 1: 0=NO (Normally open) 1=NC (Normally closed)
RC_Setp_L.NRTCVCoolPulsPropNC	L,1	8	0	Selection of heating output function (NO/NC): 0=NO (Normally open) 1=NC (Normally closed)
Not used in this model	L,1	9-13	0	
RC_Setp_L.NRTMinFanSpeed	L,1	14	0	The fan will never stop: 0=Off 1=On
RC_Setp_L.NRTCVCoolPulsPropNC	L,1	15	0	Selection of cooling output functions (NO/NC): 0=NO (Normally open) 1=NC (Normally closed)
RC_Setp_L.NRTComFactoryDefault	L,1	16	0	Resets communication to default values: 1=Reset (returns to 0)

Input register

Signal name	Type	Modbus address	Description
RC_Actual_X.NRTSoftware	X, 4	1	Model
RC_Actual_X.NRTVerMajor	X, 4	2	Version Major
RC_Actual_X.NRTVerMinor	X, 4	3	Version Minor
RC_Actual_X.NRTVerBranch	X, 4	4	Version Branch
RC_Actual_X.NRTRevision	X, 4	5	Revision

Signal name	Type	Modbus address	Description
RC_Actual_X.NRTFanSwitch	X, 4	6	Indicates the position of the fan switch: 0=Fan switched off 1=Fan speed 1 2=Fan speed 2 3=Fan speed 3 4=Auto
RC_Actual_X.NRTUnitState	X, 4	7	Indicate current unit state: 0=Off 1=Unoccupied 2=Stand-by 3=Occupied 4=Bypass
RC_Actual_X.NRTControllerState	X, 4	8	Indicate current controller state: 0=Off 1=Heating 2=Cooling
RC_Actual_X.NRTFanSpeed	X, 4	9	Indicate current fan speed: 0=Off 1=Fan speed 1 is on 2=Fan speed 2 is on 3=Fan speed 3 is on
RC_Actual_R.NRTNotUsedX	X, 4	10	Not used
RC_Actual_R.NRTRoomTemp	R, 4	11	Room temperature
RC_Actual_R.NRTRoomTempExt	R, 4	12	Room temperature from external sensor
RC_Actual_R.NRTRoomTempInt	R, 4	13	Room temperature from internal sensor
RC_Actual_R.NRTAIChangeOver	R, 4	14	Change-over temperature
RC_Actual_R.NRTAnaIn1	R, 4	15	Value of analogue input 1
RC_Actual_R.NRTUAnaIn1	R, 4	16	Value of universal analogue input 1
RC_Actual_R.NRTUAnaOut1	R, 4	17	Value of universal analogue output 1
RC_Actual_R.NRTUAnaOut2	R, 4	18	Value of universal analogue output 2
RC_Actual_R.NRTSetPAdjustment	R, 4	19	Setpoint adjustment from internal device
RC_Actual_R.NRTPIDSetP	R, 4	20	The controller setpoint
RC_Actual_R.NRTPIDOutput	R, 4	21	The controller output (0...100 %)
RC_Actual_R.NRTHeatOutput	R, 4	22	Heat output (0...100 %)
RC_Actual_R.NRTCoolOutput	R, 4	23	Cool output (0...100 %)
RC_Actual_R.NRTAI1Raw	R, 4	24	The raw value on analogue input 1
RC_Actual_R.NRTUI1Raw	R, 4	25	The raw value on universal input 1
RC_Actual_R.NRTUO3Output	R, 4	26	Value of universal output 3
RC_Actual_R.NRTUAnaOut3	R, 4	27	Value of universal analogue output 3
RC_Actual_R.NRTRoomCO2	R, 4	32	CO ₂ input value (ppm)
Not used in this model	R, 4	44	
RC_Actual_R.NRTVoltInput	R, 4	45	Value of 0...10 V DC input at AI2
RC_Actual_R.NRTRoomFlow	R, 4	46	Value of Room Air Flow at AI2

Holding register

Signal name	Type	Modbus address	Default value	Description
RC_Setp_X.AlaModStat	X, 3	1	-	Not used
RC_SetP_X.NRTFreeCoolAvailable	X, 3	2	0	Sequence order for Y2 and Y3: 0=Y2 activates before Y3 1=Y3 activates before Y2
RC_Setp_X.NRTHeatOutputSelect	X, 3	3	2	Manual/Auto Heating output: 0=Off 1=Manual 2=Auto
RC_Setp_X.NRTCoolOutputSelect	X, 3	4	2	Manual/Auto Cooling output: 0=Off 1=Manual 2=Auto
RC_Setp_X.NRTFanSelect	X, 3	5	4	Select fan mode: 0 = Off 1 = Manual speed 1 2 = Manual speed 2 3 = Manual speed 3 4 = Auto
RC_Setp_X.NRTFanControlMode	X, 3	6	3	Configuration of fan control: 0=No control 1=Fan is controlled by heating demand 2=Fan is controlled by cooling demand 3=Fan is controlled by both heating and cooling demand
RC_Setp_X.NRTFanSpeed1Start	X, 3	7	5 %	Start signal in % for fan speed 1 on heating or cooling control
RC_Setp_X.NRTFanSpeed2Start	X, 3	8	60 %	Start signal in % for fan speed 2
RC_Setp_X.NRTFanSpeed3Start	X, 3	9	100 %	Start signal in % for fan speed 3
RC_Setp_X.NRTFanSpeedHyst	X, 3	10	5 %	Hysteresis for start/stop of fans
RC_Setp_X.NRTFanSpeedMax	X, 3	11	3	State number of speeds for the fan
RC_Setp_X.NRTForcedVentSelec	X, 3	12	2	Manual/Auto Y3 forced ventilation output: 0=Off 1=Manual 2=Auto
RC_Setp_X.NRTChangeOverSelect	X, 3	13	2	Manual/Auto control of change-over mode: 0=Heat control 1=Cool control 2=Automatic change over depending on analogue sensor input or digital input
RC_Setp_X.NRTRemoteState	X, 3	14	5	Select operating mode for central control: 0=Off 1=Unoccupied 2=Stand-by 3=Occupied 5=No central control

Signal name	Type	Modbus address	Default value	Description
RC_Setp_X.NRTUnitReturnState	X, 3	15	3	Preset operating mode: 0=Off 1=Unoccupied 2=Stand-by 3=Occupied. Forced ventilation is not set in Occupied mode.
RC_Setp_X.NRTUnitShutDownState	X, 3	16	1	State operating mode by pressing the occupancy button for 5 s: 0=Off 1=Unoccupied.
RC_Setp_X.NRTBtnOnOffTime	X, 3	17	5 s (0 s for F902 models)	Time to keep the occupancy button depressed before switching to Shutdown state.
RC_Setp_X.NRTControllerMode	X, 3	18	3	Control mode: 0=Heating 1= Heating / Heating 2= Heating or Cooling via change over 3= Heating /Cooling 4= Heating /Cooling with VAV-control and forced supply air function 5= Heating /Cooling with VAV-control 6= Cooling 7= Cooling/Cooling 8= Heating /Cooling/VAV (except NRT407F902) 9=Heating/Heating or Cooling via change-over (only available in models with fan control)
RC_Setp_X.NRTCHeatType	X, 3	19	0	State output signal range for Heating-actuators: 0=0...10 V 1=2...10 V 2=10...2 V 3=10...0 V
RC_Setp_X.NRTCVCoolType	X, 3	20	0	State output signal range for Cooling actuators: 0=0...10 V 1=2...10 V 2=10...2 V 3=10...0 V
RC_Setp_X.NRTCHeatExerciseInterval	X, 3	21	23h	Time in hours between exercise of heating actuators
RC_Setp_X.NRTCVCoolExerciseInterval	X, 3	22	23h	Time in hours between exercise of cooling actuators
Not used in this model	X, 3	23	-	
RC_Setp_X.NRTAi1	X, 3	24	0	State connected sensor on AI1: 0=Internal sensor 1=External room sensor 2=Change over sensor (NRT407F901 / F902)

Signal name	Type	Modbus address	Default value	Description
RC_Setp_X.NRTAi2 (NRT407F901 / F902)	X, 3	25	5	State the connected sensor at AI2: (Only NRT407F901 / F902) 0=None 1– 4=No function 5=CO ₂ -sensor 6=No function 7=0...100 % (OEM-function) 8=Flow calculation 9=0...10 V
Not used in this model	X, 3	26	-	
RC_Setp_X.NRTDi1	X, 3	27	3	State connected sensor on DI1: 1=Window contact 2= No function 3=Presence detector 4=Change over sensor (NRT407F901 / F902)
RC_Setp_X.NRTDi2	X, 3	28	2	State connected sensor on DI2: 1=Window contact 2=Condensation detection 3=No function 4=Change over sensor (NRT407F901 / F902)
Not used in this model	X, 3	29	0	
RC_Setp_X.NRTUi1	X, 3	30	2	State connected sensor on UI1: (All models except NRT407F901 / F902) 0=None 1=Change-over digital 2=Change-over analogue
Not used in this model	X, 3	31-34	-	
RC_Setp_X.NRTDo1	X, 3	35	1 (-F902 models), 4 (other models)	1=Fan speed 1 4=Forced ventilation
RC_Setp_X.NRTDo2 (only used for F902)	X, 3	36	2 (-F902 models), 7 (-T-models)	2=Fan speed 2 7= Heat valve increase
RC_Setp_X.NRTDo3 (only used for F902)	X, 3	37	3 (-F902 models), 8 (-T-models)	3=Fan speed 3 8=Heat valve decrease
RC_Setp_X.NRTDo4 (only used for F902)	X, 3	38	4 (-F902 models), 9 (-T-models)	4=Forced ventilation 9= Cool valve increase
RC_Setp_X.NRTDo5 (only used for -T- models)	X, 3	39	10 (-T-models)	10=Cool valve decrease
Not used in this model	X, 3	40-41	-	

Signal name	Type	Modbus address	Default value	Description
RC_Setp_X.NRTUo1	X, 3	42	3	State connected function on UO1: 0=None 1=Thermal actuator heat 2=None 3=Heating actuator 0...10 V 4=None 5=On/off actuator heat 6=None
RC_Setp_X.NRTUo2	X, 3	43	4	State connected function on UO2: 0=None 1=None 2=Thermal actuator Cool 3=None 4=Cooling actuator 0...10 V 5=None 6=On/off actuator cool
RC_Setp_X.NRTModbusSlaveAddr	X, 3	44	Factory set	Controller Modbus address
RC_Setp_X.NRTModbusParity	X, 3	45	2	Parity of Modbus communication: 0=No parity 1=Odd parity 2=Even parity
RC_Setp_X.NRTModbusCharTimeout	X, 3	46	3 ms	Modbus timeout for character (t1.5), in ms. Should be 1.5 times a character, i.e. at least 2 ms.
RC_Setp_X.NRTModbusAnswerDelay	X, 3	47	5 ms	Answer delay in Modbus (t3.5), in ms. Should be 3.5 times a character, i.e. at least 5 ms.
RC_Setp_X.NRTDispBacklightLO	X, 3	48	10	10=Backlight low
RC_Setp_X.NRTDispBacklightHi	X, 3	49	30	30=Backlight high
RC_Setp_X.NRTDispContrast	X, 3	50	15	15=Display contrast
RC_Setp_X.NRTDisplayViewMode	X, 3	51	0	Select if setpoint or actual value is to be shown in the display. 0=Actual value 1=Heat setpoint 2=Cool setpoint 3=Average value of heating and cooling setpoint 4=Only setpoint offset 5=CO ₂ -concentration in the room in ppm (NRT407F901 / F902) 6=Heating setpoint +setpoint offset 7=Cooling setpoint+setpoint offset 8=Average of heating and cooling setpoint+setpoint offset 9=The calculated flow in the duct in l/s (NRT407F901 / F902)

Signal name	Type	Modbus address	Default value	Description
RC_Setp_X.NRTDispSetpMode	X, 3	52	0	Setpoint display at setpoint adjustment: 0=The offset is shown in the display 1=The active setpoint + offset is shown in the display. Heat or Cool is shown depending on whether heat or cool is active when entering the menu 2=Heat setpoint + offset is shown in the display 3=Cooling setpoint + offset is shown in the display 4=Heating occupied setpoint + offset is shown in the display 5=Cooling occupied setpoint + offset is shown in the display 6=Average of heating and cooling setpoints + offset is shown in the display
RC_Setp_X.NRTUo3	X, 3	53	6 (NRT407 F902) or 1 (other models)	State connected function on UO3: 0=None 1=Forced vent. digital 2=Analogue output (OEM) 3=None 4=Ordinary analogue output 5=None 6=Control of a EC fan
RC_Setp_X.NRTForcedVentControlMode	X, 3	54	0	Forced ventilation, control function: 0=Not active 1=Forced ventilation at 100 % output of heat or cool 2=Forced ventilation at 100 % cool output
RC_Setp_X.NRTUnitDIPresenceState	I, 3	55	4	Operating mode at presence detection (DI1): 3=Occupied 4=Bypass
RC_Setp_I.NRTBypassTime	I, 3	56	120 min	Time in Bypass mode
RC_Setp_I.NRTPresenceOffTime	I, 3	57	10 min	Disconnect timer with Occupancy/Unoccupancy
RC_Setp_I.NRTPresenceOnTime	I, 3	58	0 min	Switch-on delay for Occupancy
RC_Setp_I.NRTCVCoolPeriodTime	I, 3	59	60s	Period time for heating actuators with thermal actuator
RC_Setp_I.NRTCVCoolPeriodTime	I, 3	60	60s	Period time for cooling actuators with thermal actuator
RC_Setp_I.NRTCVCoolRunTime	I, 3	61	120 s	Run time for heating actuators with increase/decrease actuators
RC_Setp_I.NRTCVCoolRunTim	I, 3	62	120 s	Run time for cooling actuators with increase/decrease actuators
Not used in this model	X, 3	63-67	-	
RC_Setp_R.NRTOccSetPHeat	R, 3	68	22°C	Basic Heating setpoint
RC_Setp_R.NRTOccSetPCool	R, 3	69	24°C	Basic Cooling setpoint

Signal name	Type	Modbus address	Default value	Description
RC_Setp_R.NRTStandbySetPDeadBand	R, 3	70	3°C	Neutral zone at Stand-by, Heating sp=basic sp .heating-3 by default, Coolsp=Basic sp.cool+3 by default
RC_Setp_R.NRTUnOccSetPHeat	R, 3	71	15°C	Heating setpoint at Unoccupied
RC_Setp_R.NRTUnOccSetPCool	R, 3	72	30°C	Cooling setpoint at Unoccupied
RC_Setp_R.NRTFrostSetP	R, 3	73	8°C	Frost protection setpoint
RC_Setp_R.NRTSetpointOffsetPos	R, 3	74	3°C	Highest permitted setpoint adjustment upwards
RC_Setp_R.NRTSetpointOffsetNeg	R, 3	75	3°C	Highest permitted setpoint adjustment downwards
RC_Setp_R.NRTSetPOffset	R, 3	76	0 °C	The setpoint adjustment
RC_Setp_R.NRTPIDPGain	R, 3	77	10°C	P-band for room controller
RC_Setp_R.NRTPIDTime	R, 3	78	300 s	I-time (s) for room controller
RC_Setp_R.NRTCVDDeadband	R, 3	79	2%	Deadband for increase/decrease actuators (%)
RC_Setp_R.NRTAiChangeOverDiffHeat	R, 3	80	3K	The difference between the temperature in the room and the media temperature for change over to cooling
RC_Setp_R.NRTAiChangeOverDiffCool	R, 3	81	4K	The difference between the temperature in the room and the media temperature for change over to heating
RC_Setp_R.NRTAi1Comp	R, 3	82	0°C	Temperature compensation on AI1
RC_Setp_R.NRTUi1Comp	R, 3	83	0°C	Temperature compensation on UI1
RC_Setp_R.NRTInternalTempComp	R, 3	84	0°C	Temperature compensation on internal room sensor
RC_Setp_R.NRTTempFilterFactor	R, 3	85	0,2	Filter factor for analogue temperature inputs
RC_Setp_R.NRTMinFlow	R, 3	86	20	Min flow at cool output when control mode Heating/Cooling with VAV-control is selected Min flow at Y3 output when control mode Heating/Cooling/VAV is selected
RC_Setp_R.NRTMaxFlowHeat	R, 3	87	0%	Max flow on cool output when control mode Heating/Cooling with VAV-control is selected and heating is applied.
RC_SetP_R.NRTRoomTempHighLimit	R, 3	88	40°C	Alarm limit for high room temperature
RC_SetP_R.NRTRoomTempLowLimit	R, 3	89	15°C	Alarm limit for low room temperature
Not used in this model	R, 3	90-92	-	
RC_Setp_R.NRTUo3OutputManual	R, 3	93	0%	Y3 Output in manual mode
RC_Setp_R.NRTHeatOutputManual	R, 3	94	0%	Heating output in manual mode
RC_Setp_R.NRTCoolOutputManual	R, 3	95	0%	Cooling output in manual mode
RC_Setp_R.NRTRoomTempRemote	R, 3	96	-255	Room temp set by remote control if external room sensor is configured (-255 = disabled)

Signal name	Type	Modbus address	Default value	Description
RC_Setp_R.NRTCO2_0V (NRT407F901 / F902)	R, 3	120	0ppm	CO ₂ -level at 0 V (NRT407F901 / F902)
RC_Setp_R.NRTCO2_10V (NRT407F901 / F902)	R, 3	121	2000ppm	CO ₂ -level at 10 V (NRT407F901 / F902)
RC_Setp_R.NRTCO2FilterFactor (NRT407F901 / F902)	R, 3	125	0,2	Filter factor for CO ₂ -input (NRT407F901 / F902)
RC_Setp_R.NRTCO2PresenceLimit (NRT407F901 / F902)	R, 3	133	800ppm	Activate presence if CO ₂ level is higher (NRT407F901 / F902)
RC_Setp_R.NRTCO2PresenceHyst (NRT407F901 / F902)	R, 3	134	160ppm	Deactivate presence if the CO ₂ level is lower than the limit minus this hysteresis (NRT407F901 / F902)
RC_Setp_R.NRTCO2LimitLow (NRT407F901 / F902)	R, 3	147	600ppm	Min limit for VAV-damper at CO ₂ -control (NRT407F901 / F902)
RC_Setp_R.NRTCO2LimitHigh (NRT407F901 / F902)	R, 3	148	800ppm	Max limit for VAV-damper at CO ₂ -control (NRT407F901 / F902)
RC_SetpExt_R.NRTFlowFilterFactor	R, 3	149	0	Flow filter factor
RC_SetpExt_R.NRTFlow_0V (NRT407F901 / F902)	R, 3	277	0 l/s	Flow at 0 V input in AI2 (l/s)
RC_SetpExt_R.NRTFlow_10V (NRT407F901 / F902)	R, 3	278	100 l/s	Flow at 10 V input in AI2 (l/s)
RC_SetpExt_R.NRTThermostatHystHeat	R, 3	279	2K	Hysteresis for On/Off actuators and heating
RC_SetpExt_R.NRTThermostatHystCool	R, 3	280	2K	Hysteresis for on/off actuators and cooling
RC_SetpExt_R.NRTMinHeat	R, 3	281	0 %	Min. limit for the heat output
RC_SetpExt_R.NRTMinECFanSpeed (NRT407F901 / F902)	R, 3	282	10 %	Min. limit for EC fan (%)
RC_SetpExt_R.NRTMaxECFanSpeed (NRT407F901 / F902)	R, 3	283	100 %	Max. limit for EC fan (%)

Chapter 18 BACnet signal types

BACnet	In order to communicate via BACnet, the protocol has to be changed either via NRT tool [®] or via the parameter list in the display. Once the protocol has been set to BACnet it can only be switched back to Modbus via the display.
MS/TP mode	Both MS/TP master and slave are supported. The mode is controlled by setting the MAC address. If < 127, master mode is selected. A MAC address of > 127 enables slave.
Object Type	<p>The BACnet types of the signals (types in the list below):</p> <ul style="list-style-type: none">• Analogue inputs• Analogue values• Binary inputs• Binary values• Loop• Multistate inputs• Multistate values• Device
Out_of_service	The property out_of_service is not writable for all Object Types.
Commandable	The value objects are not commandable (i.e. does not use a priority array).

Chapter 19 BACnet signals

Analogue inputs

Object name	Object-ID	Description	Unit	Writable
RC_Actual_R.NRTRoomTemp	Analog input, 0	Room temperature	°C	No
RC_Actual_R.NRTAIChangeOver	Analog input, 1	Change over temperature	°C	No
RC_Actual_R.NRTAnaIn1	Analog input, 2	Value of analogue input 1	°C	No
RC_Actual_R.NRTUAnaIn1	Analog input, 3	Value of universal analogue input 1	V	No
RC_Actual_R.NRTRoomCO2	Analog input, 4	CO ₂ input value	ppm	No

Analogue values

Object name	Object-ID	Description	Unit	Writable
RC_Actual_R.NRTUAnaOut1	Analog value, 0	Value of universal analogue output 1	V	No
RC_Actual_R.NRTUAnaOut2	Analog value, 1	Value of universal analogue output 2	V	No
RC_Actual_R.NRTSetPAdjustment	Analog value, 2	Setpoint adjustment from internal device	°C	No
RC_Actual_R.NRTPIDSetP	Analog value, 3	Controller setpoint	°C	No
RC_Actual_R.NRTPIDOutput	Analog value, 4	Controller output	%	No
RC_Actual_R.NRTHeatOutput	Analog value, 5	Heat output	%	No
RC_Actual_R.NRTCoolOutput	Analog value, 6	Cool output	%	No
RC_Setp_R.NRTOccSetPHeat	Analog value, 7	Room base setpoint heating	°C	Yes
RC_Setp_R.NRTOccSetPCool	Analog value, 8	Room base setpoint cooling	°C	Yes
RC_Setp_R.NRTUnOccSetPHeat	Analog value, 9	Room heat setpoint in unoccupied mode	°C	Yes
RC_Setp_R.NRTUnOccSetPCool	Analog value, 10	Room cool setpoint in unoccupied mode	°C	Yes
RC_Setp_R.NRTFrostSetP	Analog value, 11	Frost protection setpoint	°C	Yes
RC_Setp_R.NRTSetPOffset	Analog value, 12	Setpoint adjustment	°C	Yes
RC_Setp_R.NRTHeatOutputManual	Analog value, 13	Manual value heating output	%	Yes
RC_Setp_R.NRTCoolOutputManual	Analog value, 14	Manual value cooling output	%	Yes

Object name	Object-ID	Description	Unit	Writable
RC_Setp_R.NRTRoomTempRemote	Analog value, 15	Remote control of room temperature	°C	Yes
RC_Setp_R.NRTStandbySetPDeadBand	Analog value, 16	Deadband in Standby mode	°C	Yes
RC_Setp_R.NRTCVDDeadband	Analog value, 17	Deadband control valve	%	Yes
RC_Setp_R.NRTAIChangeOverDiffHeat	Analog value, 18	If lower change-over temp it is cooling	K	Yes
RC_Setp_R.NRTAIChangeOverDiffCool	Analog value, 19	If higher change-over temp it is heating	K	Yes
RC_Setp_R.NRTRoomTempHighLimit	Analog value, 20	Alarm limit for high room temperature	°C	Yes
RC_Setp_R.NRTRoomTempLowLimit	Analog value, 21	Alarm limit for low room temperature	°C	Yes
RC_Setp_R.NRTFlow_0V	Analog value, 22	Flow at 0 V input signal at AI2	l/s	Yes
RC_Setp_R.NRTFlow_10V	Analog value, 23	Flow at 0 V input signal at AI2	l/s	Yes
RC_Setp_R.NRTThermostatHystHeat	Analog value, 24	Hysteresis when On/Off control and Heat control	K	Yes
RC_Setp_R.NRTThermostatHystCool	Analog value, 25	Hysteresis when On/Off control and Cool control	K	Yes
RC_Setp_R.NRTMinHeat	Analog value, 26	Minimum heat output at Heat control	%	Yes
RC_Setp_R.NRTMinECFanSpeed	Analog value, 27	Minimum speed for the EC fan	%	Yes
RC_Setp_R.NRTMaxECFanSpeed	Analog value, 28	Maximum speed for the EC fan	%	Yes
Not used in this model	Analog value, 29-33			

Binary inputs

Object name	Object-ID	Description	Values	Writable
RC_Actual_L.NRTDIOpenWindow	Binary input, 0	Indicate open window	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTDICCondenseAlarm	Binary input, 1	Indicate condense alarm from digital input	YES/ NO	No
RC_Actual_L.NRTDIPresences	Binary input, 2	Indicate presence from digital input	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTDICHangeOver	Binary input, 3	Indicate change over from digital input	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTRoomTempHighTempAlarm	Binary input, 4	Room high temperature alarm	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTRoomTempLowTempAlarm	Binary input, 5	Room low temperature alarm	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTDICO2	Binary input, 6	Indicates high CO ₂ level	ACTIVE/ INACTIVE	No

All binary inputs have normal polarity.

Binary values

Object name	Object-ID	Description	Values	Writable
RC_Actual_L.NRTForcedVentilation	Binary value, 0	Indicate forced ventilation	ON/OFF	No
RC_Actual_L.NRTCHeatPulsProp	Binary value, 1	Indicate pulse prop heating	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTCVCoolPulsProp	Binary value, 2	Indicate pulse prop cooling	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTCHeatInc	Binary value, 3	Indicate increase heating	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTCHeatDec	Binary value, 4	Indicate decrease heating	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTCVCoolInc	Binary value, 5	Indicate increase cooling	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTCVCoolDec	Binary value, 6	Indicate decrease cooling	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTChangeOverState	Binary value, 7	Indicate change over state from both digital and analogue input	ACTIVE/ INACTIVE	No
RC_Actual_L.NRTRoomTempSensorAlarm	Binary value, 8	Indicate sensor alarm on room sensor	ACTIVE/ INACTIVE	No
RC_Setp_L.NRTBypass	Binary value, 9	Force the unit in Bypass mode. Is automatically returned after Bypass time (default=120 min)	ACTIVE/ INACTIVE	Yes
RC_Setp_L.NRTShutDown	Binary value, 10	Force the unit in ShutDown state	ACTIVE/ INACTIVE	Yes

All binary values have normal polarity.

Loop

Object name	Object-ID	Description
Regulator	Loop, 0	The NRT Regulator

Multistate inputs

Object name	Object-ID	Description	Values	Writable
RC_Actual_X.NRTFanSwitch	Multistate input, 0	Fan switch state	1=OFF 2=LOW 3=MEDIUM 4=HIGH 5=AUTO	No
RC_Actual_X.NRTUnitState	Multistate input, 1	Current unit state	1=Off 2=Unoccupied 3=Stand-by 4=Occupied 5=Bypass	No

Object name	Object-ID	Description	Values	Writable
RC_Actual_X.NRTControllerState	Multistate input, 2	Current controller state	1=Off 2=Heating 3=Cooling	No
RC_Actual_X.NRTFanSpeed	Multistate input, 3	Current fan speed	1=Off 2=Fan speed 1 3=Fan speed 2 4=Fan speed 3	No

Multistate values

Object name	Object-ID	Description	Values	Writable
RC_Setp_X.NRTHeatOutputSelect	Multistate value, 0	Manual/Auto heat output	1=Off 2=Manual output 3=Automatic output	Yes
RC_Setp_X.NRTCoolOutputSelect	Multistate value, 1	Manual/Auto cool output	1=Off 2=Manual output 3=Automatic output	Yes
RC_Setp_X.NRTFanSelect	Multistate value, 2	Fan mode select	1=Off 2=Manual speed 1 3=Manual speed 2 4=Manual speed 3 5=Auto 6=Auto 2 7=Auto 1	Yes
RC_Setp_X.NRTForcedVentSelect	Multistate value, 3	Manual/Auto forced ventilation	1=Off 2=Manual On 3=Auto	Yes
RC_Setp_X.NRTChangeOverSelect	Multistate value, 4	Manual/Auto change-over	1=Heating 2=Cooling 3=Auto	Yes
RC_Setp_X.NRTRemoteState	Multistate value, 5	Remote control unit state	1=Off 2=Unoccupied 3=Stand-by 4=Occupied 6=No remote control	Yes

Device

The device object contains two writable properties; Description and Location. Description can be 17 characters long, and Location can be 33 characters long, if using single byte character encoding.

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