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USER GUIDE

C221 C222

Produal

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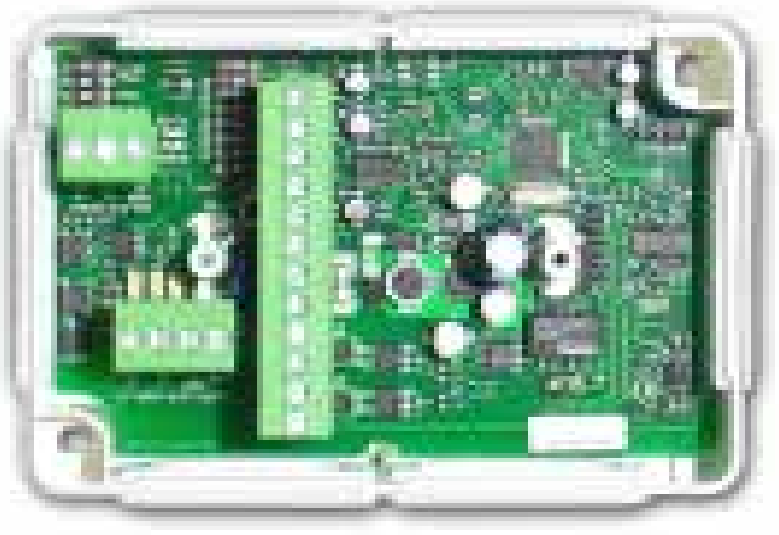
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1 Introduction

Information is subject to change without prior notice.

1.1 Presentation



This control unit delivers a stable and pleasant room temperature by effectively and accurately controlling and regulating different heat and cooling devices. The control unit has four outputs that may individually be adjusted to satisfy most needs. At delivery, the control unit is preset to control heating and cooling actuators with 24V and 0-10V.

The control unit may be connected with different types of sensors. A room unit with a built-in temperature sensor for monitoring and regulating temperature may also be connected:

G24 External room temperature sensor

E121 Room unit with knob

E122 Room unit with knob, for controlling fan with button and light emitting diode

E123 Room unit with knob, for forced ventilation with a button and light emitting diode

E201 Room unit with display

E202 Room unit with display, for controlling a fan coil with 3 fan speeds

With a room unit with display it is possible to reach all available measuring data and settings by using a menu system. Some settings may be blocked to prevent incorrect settings by mistake.

If settings need to be changed on a room unit with knob, a separate configuration unit with display (H203) is required. The configuration unit is temporarily connected to the room units modular contact. The modular contact is placed behind the cover. If no room unit is available, a room unit E201 may temporarily be connected to the 4-pole screw terminal block in the control unit.

To make the room temperature regulation work properly, a room temperature sensor is needed. In most cases the room units built-in sensor is used. If you wish to install an external sensor in the room or in, for example, an air duct, the sensor is connected to the screw terminal block in the control unit. The external sensor is then automatically active, also if there is a room unit connected.

It is possible to connect different kinds of sensors to the control unit, such as occupancy sensor, condensation sensor, extra temperature sensor or an external contact to change the operation mode. The external sensors functions can be set in the menus of the display units to influence the regulation in different ways.

The control unit has three operation modes (day, night, and save) which can activate different room temperatures. C221K (or C222K) is provided with a built-in real time clock with a week program. The clock and the week program will keep its functionality for three days also if the power supply is interrupted.

The control unit has a built-in communication port for connection to a communication bus (Modbus RS485). This makes it possible to read off values remotely from a PC (for example via the Internet).

1.2 Operation mode and selection of room temperature

The control unit has three operation modes. They are called DAY, NIGHT and SAVE. For each mode it is possible to set different temperature values, for energy saving functions etc.

The current operation mode can be influenced by different impulses, such as occupancy indication, a remote switch, a main control impulse via computer communication, a week program (if provided with built-in real time clock) or by the built-in timer function.
The current operation mode can be read with a room unit with display connected to the control unit. The following symbols indicate the current operation mode:

☼	sun	= DAY
☽	moon	= NIGHT
☼☽	sun + moon	= SAVE



Normally, the room unit shows the actual (measured) room temperature on the display in the initial view. If one of the INC/DEC buttons is pressed, the desired temperature for the current operation mode is shown instead. If the button is instantly pressed once more, the desired temperature increases or decreases in stages of a half degree. After a few seconds the display returns to the initial view and shows the measured room temperature.

With a room unit with knob, the temperature is set by turning the knob. Unlike the units with display, the knob influences the temperature for mode DAY, irrespective if any other current mode is active. It is not possible to see the current operation mode, but the light-emitting diode indicates if the controller is in heat or cooling position or in stand-by.



The scale of the knob is normally ungraded (that is, without numbers) to make it possible to change the knobs temperature range. At delivery the knobs range is 19-25°C with a set-point of 22°C in the center of the set-point scale. If the knob is turned up (clockwise) the temperature increases and vice-versa.

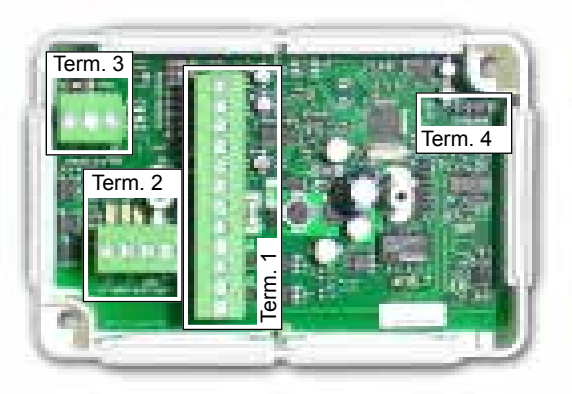
You can also choose not to have a room unit connected to the control unit. In this case an external temperature sensor is required instead. To be able to readjust the desired temperature a host computer is required to send the values via data communication. The preset desired temperature in the control unit is 22°C. If no host computer is available, a room unit E201 may temporarily be connected to make changes.

2 System structure and installation

Information is subject to change without prior notice.

2.1 System overview

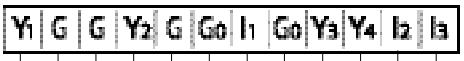
The control system can be configured in many different ways. The system is especially developed to simplify customer adaptations without making any changes to the hardware. The control unit can be directly connected to a variety of control systems without any changes of the controllers settings. This is described in this chapter.



2.2 Terminal block functions

The screw terminal blocks in the control unit are removable and have different markings and placements. The pictures below describe the screw terminal blocks in a factory preset control unit:

Terminal block 1:



I3. Input for condensation sensor
I2. Input for contact function / Energy save function
Y4. **Output A2** - Control signal 0-10V DC for heating actuator
Y3. **Output A1** - Control signal 0-10V DC for cooling actuator
G0. Common neutral point, 0V
I1. Input for remote room temperature sensor
* G0. Common neutral point, **0V from transformer**
* G. Phase, **24V AC from transformer**
Y2. **Output D2** - Control signal 0V for 24V heating actuator
G. Phase, 24V AC for heating actuator
G. Phase, 24V AC for cooling actuator
Y1. **Output D1** - Control signal 0V for 24V cooling actuator

*) To ensure safety, the transformer must always be connected to G och G0, dedicated for supply voltage.

Terminal block 2 for room unit and slave unit:



Connection E201	Connection E12x	Connection to slave unit
12V. K43, green	12V. Orange	12V Do NOT connect to slave unit!
C1. K43, red	C1. White-orange	C1. Connects to C2 on slave unit
B1. K43, yellow	B1. Blue	B1. Connects to B2 on slave unit
A1. K43, black	A1. White-blue	A1. Connects to A2 on slave unit

Terminal block 3 for ModBus communication or communication input from master unit.



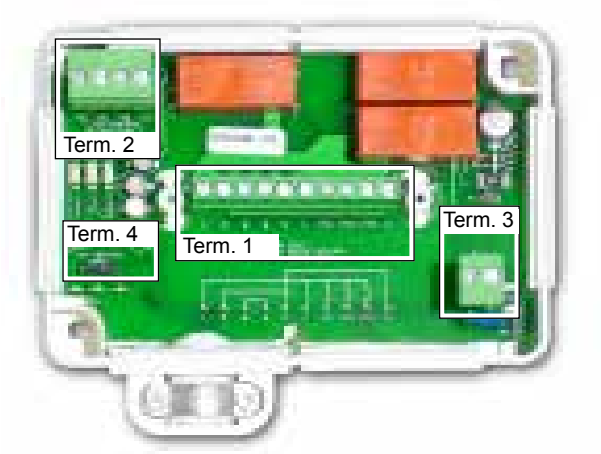
Connection to ModBus	Connection from master unit:
C2. GND2 (Ground)	C2. Connects to terminal block C1 on master unit
B2. ModBus B -	B2. Connects to terminal block B1 on master unit
A2. ModBus A+	A2. Connects to terminal block A1 on master unit

Terminal block 4 is used when relay unit RL203 is connected to the control unit, see next page.

2.3 Relay unit RL203

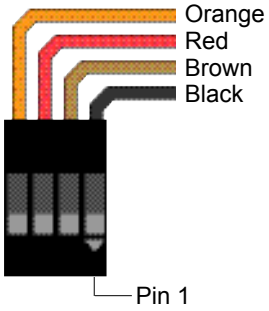
The control unit can be connected to a relay unit to extend the control functions.

If connected to control unit C221, the relay unit can control 24V dampers up to three stages in sequence.
If connected to control unit C222, the relay unit can control the fan speed in a fan coil in up to three stages in sequence.



2.3.1 Connecting a relay unit

To connect a relay unit to the control unit, cable K200 (60cm) or K201 (15cm) is used. The cable is connected to a special 4-pin connector on each circuit board (see terminal block 4 in picture).



The cable must always be connected with black cable on pin 1 on the control unit/relay unit. Pin 1 is marked ”1” on the circuit board, see picture.

The relay circuit board also has three screw terminal blocks. The functions of the screw terminal blocks differ depending on type of connected control unit. The tables below describe the functions of the blocks:

Terminal block 1:



Relay unit connected to **C221**	Relay unit connected to **C222**
N. 0V	N. 0V
RY3. Damper stage 3	RY3. Fan speed 3
RY2. Damper stage 2	RY2. Fan speed 2
RY1. Damper stage 1	RY1. Fan speed 1
L. Phase 24V / 240V	L. Phase 240V
N. 0V	N. 0V
PE. -	PE. Protective ground
PE. -	PE. Protective ground
N. 0V	N. 0V
L. Phase 24V / 240V	L. Phase 240V

Terminal block 2 for slave connection of multiple relays:



R3. Connect to R3 on next slave unit.
R2. Connect to R2 on next slave unit.
R1. Connect to R1 on next slave unit.
RC. Connect to RC on next slave unit.

Terminal block 3 for 24V AC transformer:



G0. 0V
G. 24V AC

Information is subject to change without prior notice.

2.4 Master/slave connection

The control and relay units can be connected as master and slave units if several control or relay units are to be controlled by a room unit, e.g. in larger rooms where the temperature is adjusted by multiple chilled ceilings or fan coils.

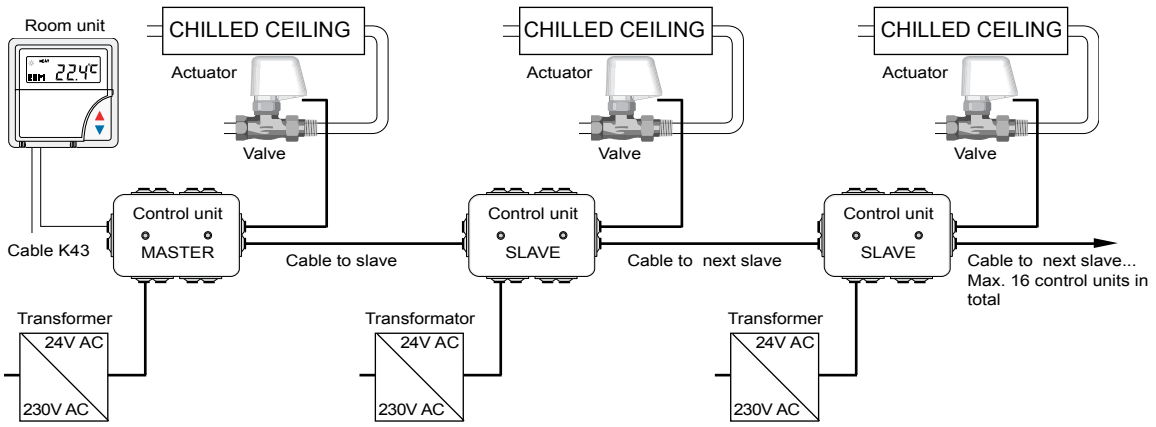
Master/slave connection can be combined and configured in many different ways. The examples below show two common master/slave systems.

2.4.1 Master/slave connection of control units

Below is an example of a master control unit and slaves. All control units read and controls the temperature via one single room unit.

For instructions of connections to terminal block, see pictures 2 and 3, section 2.2.

Example1. Master/slave connection of control units:

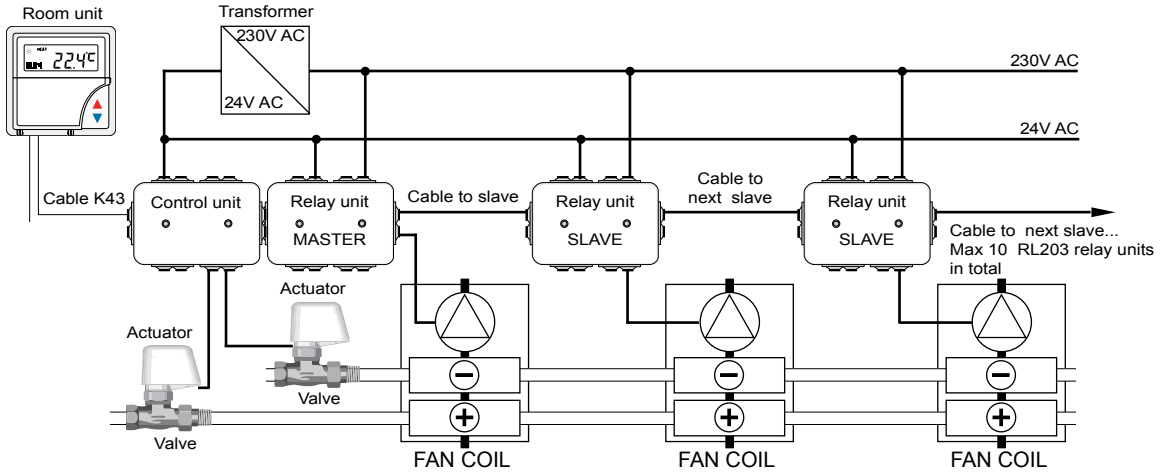


2.4.2 Master/slave connection of relay units

Below is an example of a master relay unit and slaves. All relay units are controlled by one single control unit.

For instructions on connections to terminal block, see pictures 2 and 3, section 2.3.1 Connecting a relay unit.

Example 2. Master/slave connection of relay units:



The master unit continuously sends information about the rooms heat or cooling requirements, along with fan/ damper stage status (auto-run or manual fan speed) to the slave units.

Each slave unit controls its output according to the power requirement from the master unit, but according to the slaves own settings for the outputs (according to the functions in menu 4, outputs).
The outputs can also be controlled by the slave units own inputs (if any) according to the settings in menu 5, Inputs.

The slave units stage/fan speed is controlled as follows:

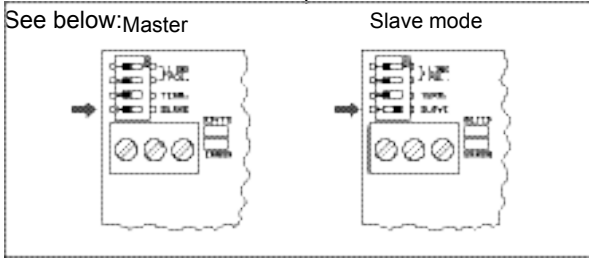
a) If the master units fan is controlled automatically, the slave units fan will also be controlled this way.. but according to its own settings in menu 12, stage/fan.

b) If the master units fan is controlled manually, the .. slave units fan will follow the master units fan ..... speed, but with its own limited values for speed/.... stage number which is set in menu 12, stage/fan.

A room unit E201 may be temporarily used to set the slave unit parameters.

2.4.2 Master/slave switch

If a control unit will be used as a slave unit it must be reset to slave mode with a dip-switch on its circuit card.
See below:



2.4.3 Master/slave cable between control units

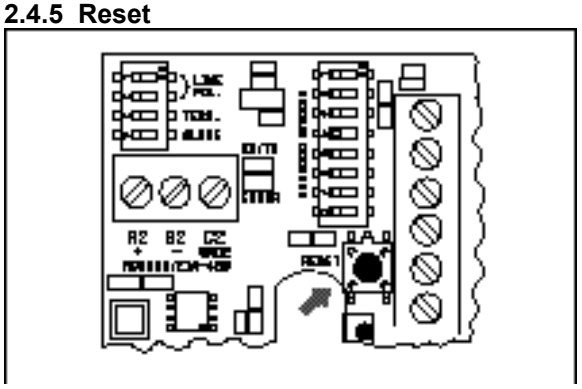
When several control units are connected in a master/ slave system, the communication to the slave units occurs from the ModBus-port. Therefore the cable must be of the same type as those used at computer communication, but with a 3 conductor cable.

For more information about cable types, see chapter 7, section 7.3.3 to 7.3.5.

2.4.4 Master/slave cable between relay units

When several relay units are connected in a master/slave system, the communication to the slave units occurs with 12V-signals. The cable must be four conductor cable and have at least 0,5m^2 cable area. The cable length should not exceed 20m between the relay units.

2.4.5 Reset



When the control unit is powered and the reset button is pressed for a short time, the program in the micro processor makes a restart, but no values are changed. If the reset button is held down for at least 4 seconds, all parameters are reset to the delivery values. Resetting can also be made with E201, E202 or H203, see page 69 and 70, item g.

2.5 Mounting instructions

2.5.1 Placing of room unit

Since the room unit contains a temperature sensor for measuring room temperature it must be placed protected from direct sunlight and sources of heating and cooling. This is necessary to ensure an accurate temperature measuring.

General placement recommendations:
· 170cm above the floor.
· 100cm from the closest heat radiator
· 30cm from the closest corner or window

2.5.2 Placing of external room temperature sensor

For room temperature sensor used for placement on walls see 2.5.1 above.

At duct mounting with duct temperature sensor it is important that the sensor is placed so that it can register the temperature of the air flow.

2.5.3 Placement of control and relay unit

Is mounted concealed above inner roof or mounted to chilled ceiling or fan coil

Note that the surrounding temperature must not exceed the temperature stated in the product data sheet.

3 Room units

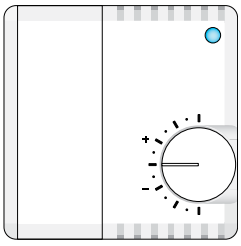
Information is subject to change without prior notice.

3.1 Room units with knob

E121 is a simple room unit with knob for adjustment of temperature. It has a built-in sensor which measures current room temperature. A light emitting diode indicates current function. Blue indicates cooling requirement and red indicates heating requirement.

E122 has an extra button for setting the fan speed, and is used together with control unit C222. The current fan speed is indicated with three light emitting diodes and another light emitting diode indicates whether the fan is controlled automatically or not.

E123 has an extra button for setting the time intervals of 1 to 5 hours. E123 is used together with control unit C221. The current time is displayed with four light emitting diodes indicating remaining time.



E121



E122



E123

3.1.1 Light emitting diode function

red: heating requirement
blue: cooling requirement
none: stand by / idle
blue flashing: indication of condense

3.1.2 Knob function

The knob settings determines which room temperature that the control system should strive to attain. The knob scale is normally 19 to 25°C (with 22°C in the middle), but can be re-calibrated with a configuration unit H203.

Turn CW (+): Increase heat temp.
Turn CCW (-) : Increase cooling temp.

3.1.3 Fan button and light emitting diodes (E122)

The ventilation can be controlled by a fan or damper in three speeds (or stages). The button next to the fan symbol increases the fan speed and indicates current level of the light emitting diodes above the button. The light emitting diode AUTO indicates that automatic control is selected. Each time the button is pressed the mode is changed according to the following sequence:

0 - 1 - 2 - 3 - AUTO - 0 - 1 - 2 - 3 - AUTO - etc.

With a C221 a 0-10V fan coil control can be used simultaneously with relay controlled ventilation. The button then controls the fan speed. The ventilation can not be affected manually.

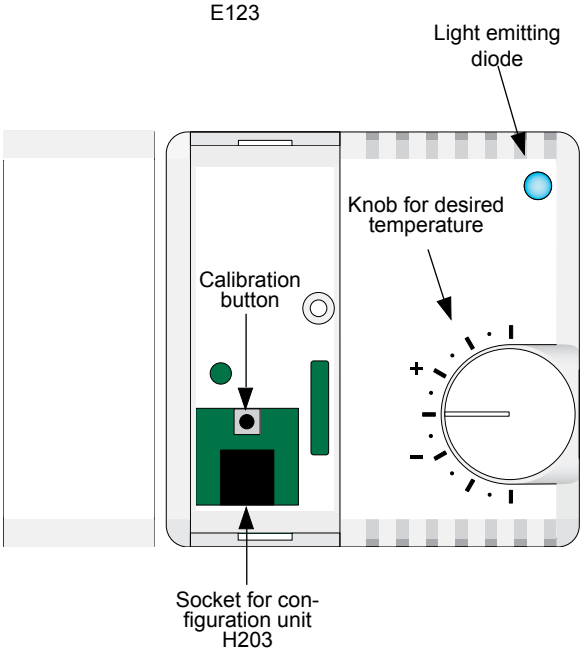
3.1.4 Timer button and light emitting diodes (E123)

The ventilation may be forced with a damper controlled by a timer. The timer activates the forcing
in stages of 1 to 5 hours. Each time the button is pressed the time is changed according to the following sequence (in hours):

0 - 1 - 2 - 3 - 5 - 0 - 1 - 2 - 3 - 5 - 0 - etc.

3.1.5 Configuration unit H203

A configuration unit with display, H203, can be connected to the modular contact under the cover. With H203 all values can be read off and set in the same way as with room unit E201 or E202, see further in this manual. The temperature sensor in H203 has no function.



3.1.6 Calibration button

It is possible to fine tune the temperature sensor by re-calibrating it. This is done with a button under the cover.

1. Measure the actual room temperature with a thermometer.
2. Adjust the knob to the corresponding temperature on the scale. Observe that the scale will span between 16 to 28°C (normally 19 to 25°C).
3. Push on the calibrating knob with a screwdriver. A short push, about half a second, is sufficient. The light emitting diode will flash in red to confirm the re-calibration.

Normally, small temperature differences within a degree are not apprehended. This means that a second re-calibration is almost never necessary.

3.1.7 Output inversion

The control units cooling and heating ouputs control with normally closed actuators. It is possible to invert the heating ouputs to enable functionality for normally open actuators. Here is how to do it:

1. Turn the setpoint knob to max. cooling demand.

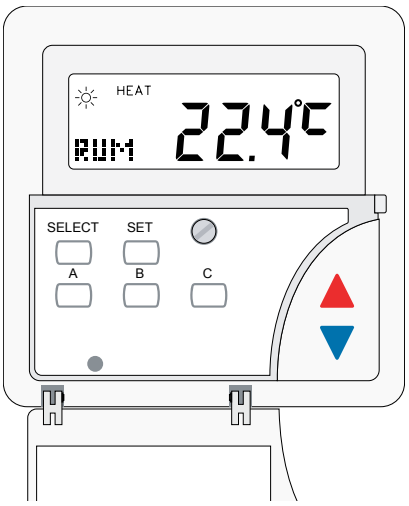
2. Press the calibration button for 3 seconds until the LED flashes purple. The controllers heating outputs is now inverted.

NOTE! If the inversion has been changed before with a configuration unit (e.g before delivery), the procedure above may have to be repeated.

3.2 Room units with display

E201 is a room unit with display and buttons for setting the desired room temperature. It has a built-in menu system for adjusting all functions of the room unit.
E202 also has an additional button to control fan speed (or control dampers in three stages).

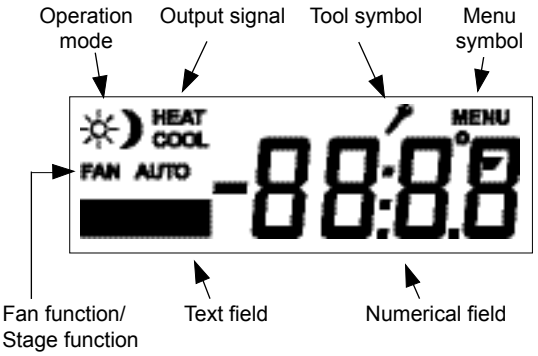
3.2.1 Button functions



SELECT:	selection in main menu
SET:	selection of value to be changed
A:	(no function)
B:	timer function (increased ventilation etc)
C:	damper stage (only E201/C221) fan speed (only E202/C222)
INC. (RED):	increase value, or go to menu, or previous function
DEC. (BLUE):	decrease value, or go to menu, or the next function

3.2.2 Display structure

The display consists of a text field and a numerical field, and various different symbols.



The text field displays short descriptions of current menu, or the function of the current value in the numerical field.

The different symbols have the following functions:

sun:	day mode
moon:	night mode
sun + moon:	saving mode
HEAT:	output signal active to heat output
COOL:	output signal active to cold output
Tool symbol:	indicates that the function value can be changed
MENU:	indicates that you're in menu mode
FAN:	indicates that the fan is running
FAN+AUTO:	indicates that the fan is set to auto mode
AUTO-flash:	indicates that automatic adjustment is disengaged.

3.2.3 Access protection

It is possible to activate access protection to the menu system by setting blocking parametres at menu 8.

Examples:
- An access code has to be entered before you are able to reach the menu system.
- Only the timer and setpoint temperature can be set.
- Read only access to the menu system.
- Only the setpoint temperature or current room temperature.

3.2.4 Changing the function parametres (values)

All function parametre values are organized in a menu system (see page 54 for overview). There are 14 submenus with several parametres under each menu. Under menu 13 ”Measure values” is a function, ”Main view”, (normally the current room temperature) to where the display view always returns.

At the ”Main view”, the MENU symbol is off. If INC/DEC button is pressed, the room temperature chosen for the operation mode ”Autoselect” will show on the display. The value can be changed easily with several presses on one of the INC or DEC buttons.
After 5 seconds the display view will return to show the ”Main view”.

When the SELECT button is pressed, the selected menu will be shown. The MENU symbol will show on the display and the menu mode is selected. With repeated presses on the SELECT button the next menu will show. With INC button you can go back to the previous menu, or you can select menu by pressing the SET button so the menu number flashes, select menu with INC/DEC button and then press SET again so the flashing stops.

When a menu has been selected, you can reach underlaying function parametres with the DEC button. Then you can go back to the previous function parametres with the INC button
After 3 minutes, or when the SELECT button is pressed for one second, the display will return to ”Main view”, and the MENU symbol turns off.

Change a value
In menu mode, if the function value is adjustable, the tool symbol will show on the display. When the SET button is pressed, the value that can be changed will start to flash. When the SET button is pressed again, the flashing ends or, if several adjustable values are shown, the next value will start to flash. If INC or DEC button is pressed the value will change continously.

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4 Control functions

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4. Control functions

The control unit controls the temperature in a room using heating radiators and/or chilled beams. The control unit compares the set temperature with the current measured temperature and controls room heating or cooling via its outputs.

4.1 Operation modes

The control unit has three operation modes, each with its own value setting for room temperature and ”dead-band”. Also some other functions can be connected to the different operation modes. The operation modes can be controlled by the following functions, listed by priority:

1. Timer
2. External contact
3. Occupancy function
4. Data communication
5. Week program (if the control unit has a real time clock)

4.2 Setting of room temperatures

With a room unit with a display the room temperature can be set individually for the three operation modes.

You can select that the ”DAY” temperature is reset to the middle value (between min and max) when the mode DAY is activated. The function ”RES SP” in menu 8 should then be set to value 1. This function is only valid for room units with a display.

When the display shows the basic view (i.e. when the current measured room temperature is shown and the MENU symbol is turned off) the temperature for the current operation mode can also be set directly with the arrow buttons.

If you have a room unit with a knob, only the room temperature for mode DAY can be set with the knob. With data communication all temperatures can be set for each operation mode.

The desired temperature is also called ”set point”. The measured room temperature is called ”current value”.

4.3 Deadband

The control unit has a neutral zone between the heating and cooling control called deadband. This function exists to prevent both heating and cooling outputs to be activated simultaneously and also to save energy. Thus, the control unit allows a deviation of the temperature of half a grade up or down, compared with the desired temperature, before any control signal goes to the heating radiators or chilled beams. This is valid in operation mode DAY.

In mode NIGHT and SAVE the deadband is wider to get a saving function when you are not in the room.

The deadbands can be adjusted in menu 3.

For mode DAY: function ”DB.D”
For mode NIGHT: function ”DB.N”
For mode SAVE: function ”DB.S”

When high climate comfort is desired the deadband should be relatively small. To save energy the deadband should be wider.

If the control unit is set to control only heating or only cooling, the deadband has no function but the room temperature is directly set to the temperature that is set for each operation mode.

4.4 The control process

Somewhat simplified the controlling works in the following way, stage by stage:

1. The control unit selects the correct temperature and deadband according to the current operation mode.
2. The unit calculates the controlling set points for cooling and heating, the same as the set set point ± half the deadband.
3. If the temperature has been higher than the controlling set point for cooling, the cooling mode is activated and the controlling set point is used for cooling when adjusting.
4. The deviation between the desired temperature and the measured temperature is calculated.
5. The effect value for the heating and cooling is calculated.
6. The control units i-function notices if the temperature deviation has not been corrected after a longer period of time and adds, if needed, an extra ”push” to the effect value.
7. The effect value is transformed into output signals.
8. If the controlling set-point value for the cooling output is set higher than 32°, the cooling function will be disabled.

4.5 P-function

The control units control type is called ”PI” which is an abbreviation of proportional and integrating. The proportional function (p-function) means that the controller calculates a power requirement which is in proportion to the temperature deviation.

Current power requirement for heating and cooling is calculated by comparing the temperature deviation with a p-range for heating and a p-range for cooling. If the temperature deviation is as high as (or higher than) the p-range the power requirement is changed with ± 100%.

Example:
The temperature for mode DAY is 22 °C and the deadband is 1 degree. The controlling set point for heating becomes 21,5°C. Current measured temperature is 20,3°C

which gives a deviation of 1,2 degrees. The P-range for the heating output is normally 1,5 degrees which gives a displacement of heating effect of 80% (1,2/1,5 = 80%). The P-ranges can be reset in menu 3.

P-range for heating: function ”P.H”
P-range for cooling: function ”P.C”

4.6 I-function

The integrated function (i-function) means that the control unit constantly supervises the power requirement from the p-function. It assists with correcting the deviation, with much more accuracy than sometimes the p-function itself, for example if the heating radiator or chilled beam needs a higher control signal to reach the correct temperature in the room.

Normally the speed of the i-function is set on 20 minutes for heating and cooling. This speed is called i-time and corresponds to the time that the i-function needs to change the power requirement up or down with as high percentage as the power requirement of the p-function.

The i-function can be reset in menu 3.

I-time for heating: function ”I.H”
I-time for cooling: function ”I.C”

Normally you set the sensitivity of the control unit by changing both p-range and i-time in different ways. However, the preset values in the control unit are suitable for most normal rooms.

4.7 Fan speed control

C221: Fan speed control with 0-10V signal: See page 59. Stage control of dampers: See chapter 4.8.

C222: Fan speed control with external relay unit RL203 is explained below. *The C222 control unit cannot control fan speed with a 0-10V signal.*

A fan can be controlled in 3 stages according to the rooms heating or cooling load. The fan motor winding of the fan is connected by relays in an external relay unit (RL203) which is connected to the control unit.

4.7.1 Manual and automatic fan control

Room unit with knob:
The lowest one of the small LEDs indicates stage 1, the next diode indicates stage 2, and the second highest indicates stage 3. The highest LED indicates that automatic control is engaged.

When the fan button is pressed the stage number is changed, and automatic control is engaged according to the following sequence: 0 - 1 - 2 - 3 - Auto - 0 - 1 - 2 - 3 - Auto - 0 - 1 - and so on...

Room unit with display:
To see current fan speed press the C button. The display shows the letter A if automatic control is engaged, and digit 0-3 indicates the current fan speed.
Each time the button C is pressed after this, the fan speed will change and automatic control is engaged according to the following sequence:
0 - 1 - 2 - 3 - Auto - 0 - 1 - 2 - 3 - Auto - 0 - 1 - and so on...

When the fan speed shows on the display you can change this with the INC/DEC buttons.

4.7.2 Minimum and maximum limitations

It is possible to limit the fan speeds for the manual and automatic control. You can also block or set the automatic mode constantly on.

The settings are made in menu 12.

Function ”MIN”:	selection of the lowest speed (auto)
Function ”MAX.H”:	selection of the highest speed in heating mode (auto)
Function ”MAX.C”:	selection of the highest speed in cooling mode (auto)
Function ”AUTO”:	select if the auto mode should be selectable or not (0 = no, 1 = yes , 2 = constant auto mode)
Function ”M.MIN”:	selection of the lowest speed allowed (manual)
Function ”M.MAX”:	selection of the highest speed allowed (manual)

4.7.3 Selected speed at startup

It’s possible to select the fan speed that the controller will start with after a voltage failure.

Go to the function ”INIT.” in menu 12 and select any of the following values:

- (line):	same speed as before the failure
1, 2, 3:	speed 1-3 in manual mode
A:	automatic mode

4.7.4 Fan control in automatic mode

At heating or cooling demand the fan speed will go up in speed automatically. If the power requirement for heating or cooling is changed directly from 0 to 100% the fan speed 1 is engaged after about 1 minute, speed 2 is engaged after 3 minutes, and speed 3 after 5 minutes.

When there is no heating or cooling demand the fan will go down in speed. The delay time can be changed by setting the time it should take to go from fan speed 1 to speed 3. The delay time for all three stages is then changed, correctly proportioned.

The delay time is set in menu 12.

Function ”IT.F”: 0-10 minutes

You can also change the relation between the different fan speeds and how they should stage over time. In menu 12 the following functions exist:

Function ”F.L%”: specify at which power requirement the lowest fan speed should start (that is, stage 1)
Function ”F.H%”: specify at which power requirement the highest fan speed should start (that is, stage 3)

The controller automatically calculates at which power requirement speed 2 should start between speed 1 and 3).

4.7.5 Turn-off delay

To prevent the fan from going to mode zero in automatic mode directly when there no longer is any heating or cooling demand, a turn-off delay can be activated. This can be used when you have an electric heater in a fan coil that needs to be ventilated for a short time after the heater disengages.

The setting is made in menu 12.

Function ”TIME-0”: 0-10 minutes

4.7.6 Filter alarm

Because the control unit automatically registers the delay time interval of the fan you can get an alarm on the room units display when a certain operating time is exceeded. The delay time interval is stored also at voltage failure. You can see current number of fan operating hours in the measurement value menu, function ”filter”.

A limit for the delay time interval can be set. When the time is reached an alarm is activated which means that the text ”change filter” is flashing on the display.
If you view other display views with the buttons this alarm text will come back automatically after a couple of minutes.

n menu 12 the alarm function can be set.

Function ”ALARM”: fan delay time interval is specified in hours (100-9900 hours). Value zero disengages the alarm function.

You can also connect an external power switch that is closed when the fan cover is opened, or the filter removed. This power switch should be connected to the control unit at the first available input I1 - I3. When the input is closed (towards G0) the alarm and operating time are set to zero.
If there is no available input, you can set the alarm and operating time to zero by pressing the SET button and INC or DEC button simultaneously when ”change filter” is flashing on the display.

4.8 Stage control of for example air damper (only C221)

An air damper or similar can be controlled in 3 stages according to the room heating and cooling load. The damper motors are connected by relays in an external relay unit which is connected to the control unit.

The stage control in C221 works in the same way as the fan speed control in C222, with two important differences:

- The relay control for damper in a C221 enables all three relays to be on simultaneously. In a C222 with fan speed control only one relay can be on simultaneously.
- C221 has no function for filter alarm.

To activate stage control, go to menu 12.

Function ”SEL.”. select 1 to activate

See item 4.7 - 4.7.5 above for a description of how the damper stage control works.

4.9 Cascade control

The integrated cascade control gives additional possibilities to control the room temperature with shunt valves, floor heating , exhaust and intake air, etc.
Since such controllers often have different reaction and control properties than the normal room control, an extra control process is needed.
With an extra control process you get control of, for example, the supply line temperature or room temperature, which the normal room sensor cannot manage fast or accurate enough. Since the normal room sensor needs to be placed in the middle of the room (or be integrated into a room unit) an additional sensor is needed, placed on for example the supply line tube or inside the floor or in the air exhaust duct etc.

I

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4.9.1 Activation of the cascade control

Cascade control can be activated on one of the outputs of the control unit. To get the cascade control started one of the outputs need to be activated, and input 2 needs to be set to be used for the extra (secondary) temperature sensor.

In menu 4 one of the outputs is activated:

Function ”OP.no” Select the output to be used as output for cascade control.

Function ”HC” Select between ”HEAT” or ”COOL”

Function ”CA.CO” Set value ”CASC.”

Activation of the sensor input is made in menu 5:

Function ”IN.no”: Select input 2

Function ”TYPE”: Select ”tEMP”

Function ”MODE”: Select for which operation mode(s) the cascade control should work:

d = DAY, n = NIGHT, s = SAVE

Function ”MISC.”: Select desired temperature area:

32°C gives area 0 to 32°C
128°C gives area -30 to +98°C

4.9.2 Control settings for cascade control

The additional control process can be set to fit different controllers and control areas. The preset settings can be used for floor heating etc. However, you may need to adjust the p-range and i-time to get a stable control together with each separate floor heating system.

Normally the extra media temperature, for example the floor or intake air, is adjusted to a temperature between the min- and max temperatures set for the cascade controller. To enable a blocking of the extra output if the normal room control is put into reverse cooling or heating mode, you can activate the cut off function. This function makes sure that unnecessary cooling or heating load is not supplied. For example during summer, at cooling load, it would be unnecessary to have the floor heating on and controlled to min. temperature. The floor heating is completely turned off if the cut off function is selected, to save energy.

In menu 3 the following selections is available:

Function ”MIN.2”: select the lowest temperature that the extra media (for example the floor) is allowed to be adjusted to

Function ”MAX.2”: select the highest temperature that the extra media (for example the floor) is allowed to be adjusted to

Function ”H-C-0”: select 1 to activate the cut off function

Function ”P.2”: specify the p-range, in number of degrees

Function ”I.2”: specify i-time, in number of minutes

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5 Inputs and sensors

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5. Inputs and sensors

The control unit has three inputs for external sensors. Depending on function selection a sensor can be of the type thermistor for temperature detection (resistive), condensation detection (resistive), 0-10V (active) or a contact.

A sensor is connected to one of the three blocks I1, I2 or I3 and to block G0 (-). An active sensor is sometimes connected to G (phase 24V).

In menu 5 you can select which type of sensor to be connected to each input I1-I3. Here also some settings for each sensor function are made.

There are 6 different sensor functions:

	Type	Input
1. Controlling temperature sensor	Thermistor or 0-10V	I1
2. Secondary temperature sensor	Thermistor or 0-10V	I2
3. Occupancy sensor	Contact	I1-3
4. Operation mode contact/output	Contact	I1-3
5. General 0-10V sensor	0-10V	I1-3
6. Condensation sensor	Resistive or 0-10V	I3

5.1 Controlling temp. sensor

The control unit can control the temperature with an integrated sensor in a connected room unit or with an external sensor, connected to block I1 (+) and G0 (-) in the control unit.

5.1.1 Sensor type

Three types of sensors can be used for controlling the temperature:

a) integrated sensor in room unit
b) external resistive sensor (NTC)
c) external active sensor (0-10V)

The integrated sensor in the room unit is always used automatically by the control unit if no sensor is connected to the block in the control unit. When an external, resistive sensor is connected the control unit automatically selects this sensor instead of the integrated one. When no room unit is connected an external sensor connected to the block is required.

When only the integrated sensor in a room unit should be used you can use the input for another sensor with other functions. Then go to the input menu (menu 5). Select input 1 by setting ”IN.no” to 1 and set ”TYPE” on desired function.

Selection of external resistive sensor (NTC) in menu 5:

Function ”IN.no”: select input 1
Function ”TYPE”: select ”ron”
Function ”0V”: select ”-”
Function ”10V”: select ”-”

Selection of external active sensor (0-10V) in menu 5:

Function ”IN.no”: select input 1
Function ”TYPE”: select ”ron”
Function ”0V”: specify temperature given by the sensor at voltage 0
Function ”10V”: specify temperature given by the sensor at voltage 10

5.1.2 Measurement of the mean value

To connect mean value measurement with both an external sensor and the integrated sensor in the room unit, make the following settings in menu 5:

Function ”IN.no”: select input 1
Function ”TYPE”: select ”ron”
Function ”INFL.”: select ”IE”

If there is no sensor connected on the block the control unit will only read off the sensor in the room unit. If there is no room unit connected, the control unit only reads off the external sensor.

5.1.3 Automatic sensor selection at different operation modes

You can specify that the external sensor is active only at different operation modes. In menu 5 the following selections are made:

Function ”IN.no”: select input 1
Function ”TYPE”: select ”ron”
Function ”MODE”: select which operation mode to influence the sensor.

Normally all operation modes are selected, both day (d), night (n), and save (S). To set the different modes, press SET until ”d” is flashing. Then press the arrow buttons to activate day mode. To go to night mode, press SET again, and so on.

At operation modes when the external sensor is disengaged, the control unit will read off the sensor in the room unit instead.

5.2 Secondary temp. sensor

There is a possibility to connect a secondary temperature sensor to have extended functions, such as min. limitation, protection against cold draught, cascade control and more.

When the temperature passes an adjustable limit, an optional output can be influenced. When the temperature passes another adjustable limit the influence can be disengaged. As a condition you can also select one or several operation modes. The sensor also must be activated and be used for cascade control. The secondary temperature is shown in the measurement value menu.

The secondary sensor is activated in menu 5 according to the following:

Function ”IN.no”: select input 2
Function ”TYPE”: select ”tEMP”

The secondary sensor should be connected between block I2 (+) and G0 (-).

5.2.1 Sensor type

Two types of sensors can be used for the secondary temperature sensor function:

a) resistive sensor (NTC)
b) active sensor (0-10V)

Selection of resistive sensor (NTC) is made in menu 5:

Function ”IN.no”: select input 2
Function ”TYPE”: select ”tEMP”
Function ”0V”: select ”-”
Function ”10V”: select ”-”

Selection of active sensor (0-10V) is made in menu 5:

Function ”IN.no”: select input 2
Function ”TYPE”: select ”tEMP”
Function ”0V”: specify temperature given by the sensor at 0V
Function ”10V”: specify temperature given by the sensor at 10V

5.2.2 Selection of temperature area

The area of the secondary temperature sensor can be selected in menu 5:

a) +0 to 32°C (with resolution 0,1 degree)

Function ”IN.no”: select input 2
Function ”TYPE”: select ”tEMP”
Function ”MISC.”: select ”32°C”

b) -30 to +98°C (with resolution 0,5 degree)

Function ”IN.no”: select input 2
Function ”TYPE”: select ”tEMP”
Function ”MISC.”: select ”128°C”

5.2.3 Selection influence of output

The secondary sensor can be set to override one of the outputs, by going to menu 5:

Function ”IN.no”: select input 2

Function ”TYPE”: select ”tEMP”

Function ”INFL.”: select the output to override, and if the output should be reset to high or low signal when the secondary sensor reaches a value below the limitation value set.

Function ”LIM-1”: specify the temperature limit that the sensor must be below in order to override the output.

Function ”LIM-0”: specify the temperature limit that the sensor must exceed to no longer override the output.

Function ”INV.”: select 1 to override the output with reverse effect, i.e. the measured sensor temperature should exceed the values specified on LIM-1 to override the output, and the temperature must be below the value specified on LIM-0 to turn the override off.

Function ”MODE”: select the operation modes to influence the output by the sensor:

d = DAY, n = NIGHT, S = SAVE

5.3 Occupancy sensor

You can connect an occupancy sensor which activates DAY mode when occupancy is indicated, and activates NIGHT mode when the occupancy indication stops. Turn-on and off delay of mode DAY can be selected.

The sensor should have a contact output (closing or switch) which is connected between block G0 and block I1 alt. I2 alt. I3 depending on for which of the three inputs this function is selected.

Connection of mode DAY at occupancy has higher priority than operation mode activation from a possible week program, data communication and external contact, but at the same time a lower priority than operation mode activation from timer.

The occupancy sensor is activated in menu 5:

Function ”IN.no”: select optional input
Function ”TYPE”: select ”OCC”

When the occupancy sensor has been selected according to above, mode NIGHT is activated instead of DAY when occupancy is not indicated. When occupancy is indicated, mode DAY is activated.

5.3.1 On delay

When occupancy has been indicated any time both during the first and second half of the selected delay time, mode DAY is activated when the time has passed. This mode keeps being activated as long as occupancy indication exists.

On delay for occupancy is selected in menu 5:

Function ”IN.no”: select the input for occupancy sensor
Function ”LIM-1”: select desired on-delay, in minutes (0-99 min)

5.3.2 Off delay

The off delay delays the disengagement of mode DAY when occupancy indication from the sensor stops. The time is adjustable between 0 - 990 minutes. Above 100 minutes the resolution is 10 minutes.

Occupancy off delay is selected in menu 5:

Function ”IN.no”: select input for occupancy
Function ”LIM-0”: select desired off delay, in minutes (0-990 min).

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5.3.3 Inversion of the occupancy signal

To be able to select both occupancy sensors with normally opened or closed contact at occupancy indication, the input function can be inverted.

In menu 5 the following selections are then made:

Function ”IN.no”: select occupancy input

Function ”INV.”: select desired contact function:

0 = (NO, normally open) closes when occupancy is detected

1 = (NC, normally closed) opens when occupancy is detected

5.4 Override the operation mode and influence an output with an external contact

You can connect an external contact to connect an optional operation mode and/or influence an optional output. Turn-off delay can be selected. The contact is connected between terminal blocks G0 and I1 alt. I2 alt. I3 depending on for which of the three inputs this function is selected.

In menu 5 the following selections are then made:

Function ”IN.no”: select current input, I1 - I3

Function ”TYPE” select ”SEtP”

This way of selecting operation mode has a higher priority than mode selection from the week program and from ModBus communication, but lower priority than operation mode activation from occupancy sensor and timer.

5.4.1 Selection influence of output

Direct influence of output is selected in menu 5:

Function ”INFL.” select output*: d1, d2, A1 or A2. Then select with 0 or 1 if the output should go on or off if the input is active.

**When an external relay unit is connected which is not used for controlling fan or stage output, also R1, R2 or R3 can be selected.*

5.4.2 Off delay

This function delays disengagement of the operation mode and output influence when the sensor indication stops. The time is adjustable between 0 - 990 minutes. Above 100 minutes the resolution is 10 minutes.

Off delay for ”SEtP” is selected in menu 5:

Function ”IN.no” Select input for ”SEtP”
Function ”LIM-0” Select desired turn-off delay, in minutes (0-990 min).

5.4.3 Selection of operation mode

You can select which operation mode that the contact function should activate in menu 5:

Function ”MODE” select ”d” for mode DAY
select ”n” for mode NIGHT
select ”S” for mode SAVE
select ”-” for no influence

5.4.4 Inversion of sensor signal

The normally open (NO) or normally closed (NC) contact function can be set in menu 5:

Function ”INV.” select 0 (inversion off)
select 1 (inversion on)

Inversion off: The selected operation mode is activated and the selected output is influenced when the contact is closed.

Inversion on: The selected operation mode is activated and the selected output is influenced when the contact is opened.

5.5 General 0-10V sensor

You can connect a 0-10V sensor to get extended functions, such as CO_2 control, limitation function and more.

When the voltage is higher or lower than the limit that is set, an optional output can be influenced.

When the voltage is higher or lower than another limit, the influence on the output can be disengaged. You can also choose one or several operation modes to be influenced.

It is also possible to select that the voltage from the sensor is directly routed to output A1 if the value is higher than the voltage from the control output to this output. The values are specified in % where 0-100% corresponds to 0-10V. The sensor values are shown in the measurement value menu if the input function ”tEMP” is not selected.

The sensor is connected between block G0 (-) and block I1 or I2 or I3 depending on for which of the three inputs this function is selected, see below.
Selection of general 0-10V sensor is made in menu 5:

Function ”IN.no” select current input, I1-I3

Function ”TYPE” select 0-10.

5.5.1 Selection influence of output

Direct influence of output is selected in menu 5:

Function ”INFL.” select output*: d1, d2, A1 or A2. Then select with 0 or 1 whether the output should be off or on if the input is active.

**When an external relay unit is connected, which is not used for controlling fan or stage output, also R1, R2 or R3 can be selected.*

5.5.2 Selection of %-limit for activation of output according to above

Selection of %-limit for activation of output is selected in menu 5:

Function ”LIM-1” select desired %-limit.

If the function ”INV” = 0 (inversion off), the selected output will be activated according to the selection above in chapter 5.5.1, if the sensor value exceeds the selected limit. If the function ”INV” = 1 (inversion on), the selected output will be activated according to the selection above in chapter 5.5.1, if the sensor value is below the selected limit.

If the function ”MISC.” = 1, according to below, the value for ”LIM-1” is the voltage on the 0-10V input (0-10V is interpreted as 0-100%) that will set output A1 to 10V. The value ”LIM-0” is the voltage that will set output A1 to 0V. The voltage changes proportional within that control area. When output A1 is also used as a control output for temperature control, the output that has the highest power demand will control the output voltage according to above.

5.5.3 Selection of %-limit for deactivation of output

Selection of %-limit for de-activation of output is selected in menu 5:

Function ”LIM-0” select temperature limit

If the function ”INV” = 0 (inversion off), the selected output will be deactivated according to the selection above in chapter 3.5.1, if the sensor value is below the selected limit.

If the function ”INV” = 1 (inversion on), the selected output will be deactivated according to the selection above in chapter 3.5.1, if the sensor value exceeds the selected limit.

If the function ”MISC.” = 1, the parametre ”LIM-0” is used as described under 5.5.2.

5.5.4 Selection inversion of %-condition

Inversion of %-conditions is set in menu 5:

Function ”INV.” select 0 (inversion off)
select 1 (inversion on)

Function: see 5.5.1 and 5.5.2.

5.5.5 Selection of operation mode conditions for activation of output according to above

The selected output is influenced according to above only then any of the selected operation modes is activated. Operation mode conditions for activation of output is set in menu 5:

Function ”MODE.” set which operation modes to influence the output*.

Normally all operation modes is day (d), except for night (n) or save (S).

**To set the different operation modes, press SET until ”d” is flashing. Then press the INC/DEC buttons to activate or deactivate the day mode. If you wish to go to night mode, press SET again, and so on.*

5.5.6 Selection direct influence of output A1

Here you can select that the voltage from the sensor should be fed to output A1 if the value is higher than the voltage from the control output to this output. This function can for example be used when the sensor indicates high Co2 value and by that will activate the ventilation when it is controlled by output A1. Direct influence of output is set in menu 5:

Function ”MISC.” select 0 (function off)
select 1 (function on).

5.6 Condensation sensor

You can connect a condensation sensor to control or to generate an alarm at high condensation. When the condensation value passes an adjustable limit an optional output can be influenced. When the condensation value passes another adjustable limit the influence on the output can be disengaged. The condensation sensor may be resistive or active(0-10V). At condensation indication you can also select that all cooling output is turned off.

The condensation sensor function is set in menu 5:

Function ”IN.no” select input 3
Function ”TYPE” select ”cond”.

5.6.1 Type of sensor

Two types of sensors can be used:

a) resistive sensor
b) active sensor (0-10V)

Selection of Resistive sensor (NTC) in menu 5:

Function ”0V” select ”-” or
Function ”10V” = select ”-”.

Selection Active sensor (0-10V) in menu 5:

Function ”0V” select 0 or
Function ”10V” select 100.

5.6.2 Selection influence of output

The condensation sensor input can directly influence an output for, for example, condensation alarm. Influence of condensation sensor input is set in menu 5:

Function ”INFL.” select output: d1,d2, A1 or A2.* Then select with 0 or 1 if the output should be off or on if the input is active, i.e. at high condensation: see 5.6.3.

**When an external relay unit is connected, which is not used for controlling fan or stage output, also R1, R2 or R3 can be selected.*

5.6.3 Selection of condensation limit for activation of output according to above

Condensation limit for activation of output is set in menu 5:

Function ”LIM-1” select condensation limit (0-100).

When a resistive sensor is used the value represents a resistance in the sensor, see table.

High condensation gives low resistance. When the measurement value (resistance) is below the limit value (=high condensation) the selected output will be activated according to selection in chapter 5.6.2.

When a 0-10V sensor is used the voltage represents a condensation value, where high condensation gives high voltage. A limit value between 0-100 % can be selected. The value represents 0-10V from the sensor. When the measurement value exceeds the limit value (=high condensation) the selected output will be activated according to above selection in 5.6.2.

5.6.4 Selection of condensation limit for de-activation of output according to above

Condensation limit for de-activation of output is set in menu 5:

Function ”LIM-0” select condensation limit (0-100).

When a resistive sensor is used the value represents a resistance in the sensor, see table. Low condensation gives high resistance. When the measurement value (resistance) exceeds the limit value (=low condensation) the selected output will be deactivated according to selection in 5.6.2.

When a 0-10V sensor is used the voltage represents a condensation value where low condensation gives low voltage. A limit value between 0-100 % can be selected. The value corresponds to 0-10V from the sensor. When the measurement value is below the limit value (low) condensation) the selected output will be deactivated according to selection in chapter 5.6.2.

5.6.5 Selection that the cooling output should not be disconnected:

All cooling outputs is normally turned off at condensation indication. This function can be deactivated.

Function ”MISC.” select 0 (for disconnection of all cooling outputs at condensation). select 1 (to not disconnect all cooling outputs at condensation).

Resistance in resistive condensation sensor at different limit values:

Limit value	Resistance kOhm
100	10000
99	4000
98	2000
97	1300
96	1000
95	800
94	600
92	500
90	400
86	300
82	200
74	150
62	100
47	60
19	40
0	30

6 Outputs and actuators

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6.Outputs and actuators

The control unit has two digital 24 V outputs (D1 and D2) plus two analog 0-10V outputs (A1 and A2).

Actuators are connected to the following blocks:

- D1: block Y1 and G.
- D2: block Y2 and G.
- A1: block Y3 (+) and G0 (-) and normally also to G (phase).
- A2: block Y4 (+) and G0 (-) and normally also to G (phase).

To the control unit also a separate relay unit with three relays can be connected.

An output can be influenced by the following functions (the uppermost has highest priority):

1. Output ”off” if function ”FAN-0” = 1 in menu 4 when fan or dampers are disconnected
2. Output influenced by condensation sensor
3. Output ”on” for valve exercise
4. Output influenced by secondary temperature sensor
5. Output influenced by general 0-10V sensor
6. Output influenced by input function ”SEtP”
7. Output ”on” if function ”FORC.”=1 in menu 4 when the timer is active
8. Output ”off” if function ”TYPE” = ”-” in menu 4 (controlling not selected)
9. Temperature control

influence of sensor according to item 2, 5, and 6 above:
See chapter 5.6, 5.2, 5,5 and 5.4.
Other influence: See below.

In menu 4 (”OUTP”) you can select type of control output and other settings for each output respectively.

Select output to be set:

Function ”OPno” select d1, d2, A1, or A2.

Settings of functions that follow ”OPno” is then only valid for the selected output.

When increase/decrease-output ”3P” is selected for output D1 the settings, however, are valid for both d1 and d2 since this output uses both digital outputs.

The control unit feeds the output logic with a heating or cooling effect value between 0-100%. based on this value (and depending on the settings below for each output) an effect value is calculated for each separate output.

6.1 Actuators

An actuator in this context is an electromechanical unit controlled by an electric signal from the controller and makes, for example, a valve or a damper close.

Also for example contactors can be seen as actuators since you with a weak electric signal from the con-troller can connect or disconnect electrical devices demanding high flows and voltage.

Below are the most common types of actuators possible to control from the controller.

Thermal actuator

Mounted directly on a certain type of valve, often on water radiators and consists of a wax body expanded by heat. When it is heated with a moderate amount of current from the controller, a ”metal rod” is pulled from the actuator, which in turn directly influences the valve. This type of actuator is normally controlled by a 24V voltage ”pulsating” from the controller.

Thermal actuators are slower and cannot control big valves for high flows. Despite this they are frequently used for controlling room temperature. They have a low price and small dimensions.

0-10V actuators

These are controlled by an analog 0-10V signal and has a built-in position sensor for opening the valve in proportion to the control voltage. There are several types of actuators with only one thing in common: the actuator changes position in proportion to the control voltage.

Increase/decrease-actuators

Also these actuators can be designed in different ways but they are controlled by an electric motor which opens or closes for example a valve or a damper depending on the rotation direction. They are controlled by two outputs from the controller: one for opening and one for closing. Position feedback in this case rarely exists. Normally they are controlled by 24V and can then often be controlled directly from the controller. Also 230V control signal exists. In this case intermediate relays are required for controlling the actuator.

Contactors or relays

Are used to control for example electric radiators or motors demanding high voltage and current, with a weak electric signal from the controller.

6.2 Output signals

Different actuators demand different output signals from the control unit.
The outputs are therefore possible to set for different types of actuators.

Pulsing control (time proportional control)

The output is activated during some of the adjustable period time. On/off relation = output effect. Example: At

Selectable types of outputs:	Normally used for:
-	The output is not influenced by
the	control output itself
Pulsing control	Thermal actuators or electric
heat control via e.g. contactors	
On-off-control	2-position actuator, e.g. motor
control, damper or electric	heating
3p (increase/decrease)	Increase/decrease-actuator
0-10V control	Control signal for 0-10V actuator

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25% power output and 20 minutes period time the output is ”on” during 25% of 20 minutes = 5 minutes, and ”off” during the remaining 15 minutes, whereupon the output is turned on again and the lapse is repeated. If pulsing control is used on output A1 or A2, selected min. alt. max. voltage is supplied.

On/off control

The output is activated when the effect value for the output is 100%, and is then on until the effect is 0%, when the output goes off. The output is off until the effect once again reaches 100%, whereupon the output goes back on again. If on/off control is used on output A1 or A2, selected min. alt. max. voltage is supplied.

3P (increase/decrease) control

This is valid for cooperating outputs D1 and D2. The actuator consists of an electric motor which, for example, opens or closes a valve depending on the rotation position. When output D1 is ”on” and D2 is ”off” a cooling actuator is opened (or inversely a heating actuator closed) until the opening degree corresponds to the output effect. If both D1 and D2 are ”off” the motor stops. The outputs D1 and D2 can never be simultaneously ”on”.

The actuator has no position feedback to the controller. It calculates the actuator position by registering the delay time interval compared to the total delay time interval. This interval therefore must be set. When the controller registers that the actuator is in an end position the open - or close-signal is continuously supplied. If the actuator was not in end position it will proceed there anyway. This acts as a position calibration.

0-10V control

This is valid for outputs A1 and A2. The voltage is modulated between set min. and max. voltage compared to the output effect to the output. Example: If the min. voltage is set to 2V, the max. voltage to 6V and the output effect is 25%, then the voltage is 2V + 25% x (6-2) = 3V.

Go to function ”TYPE” in menu 4. Set desired type of control (output) according to above.

6.3 Heating, cooling or direct temperature control of output

You can select whether an output should control a heating actuator, a cooling actuator or an actuator for both heating and cooling. You can also select that the output is directly controlled by the room temperature, regardless of other controlling.

A cooling actuator is only activated when the controller supplies an effect value for cooling. A heating actuator is only activated when the controller supplies an effect value for heating.

An actuator directly controlled by the room temperature is not influenced by the controller’s output effect, but only by selected limit values for the room temperature.

Go to function ”HC” in menu 4 and set the following options for the desired output:

COOL: for cooling control
HEAT: for heating control
HC: for both cooling and heating control
dIFF: for direct temperature control

In the ”HC” mode the output voltage will be 0-5V at cooling demand 100-0% and 5-10V at heatind demand 0-100% on output A1 and A2.

It is possible to adapt the controller so that the 0-10V output voltage on output A1 will supply 0-10V in both heating and cooling demand.

6.4 Timer forcing

You can select that an optional output should be ”on” when the built-in timer is activated. This function can be used, for example, if you during a limited period of time wish to force the air flow to a room. The timer cannot simultaneously influence the operation mode.

Go to function ”FORC.” in menu 4 and set the following options for desired output:

FORC.: 0 = deactivated and 1 = activated.

6.5 Cascade control

One of the four outputs can be cascade controlled. Cascade control is further described in chapter 4.9. When cascade control is selected for an output, possible earlier selections of cascade control for another output is deactivated.

Go to function ”CA.CO” in menu 4 and set the following options for desired output:

CA.CO: CASC = activated.

6.6 Change Over function

One of the four outputs can be reset to ”Change Over” function as an alternative to cascade control. When Change Over is selected for an output possible earlier selection of Change Over or cascade control for another output is deactivated. The output also must be selected as ”COOL” or ”HEAT”.

Go to function ”CA.CO” in menu 4 and set the following options for desired output:

CA.CO: C-O = activated

Also input function ”tEMP” in menu 5, ”IN.no” 2 must be selected. To this input a sensor should be connected, measuring the temperature in the cooling or heating device.

When the input is not active, which initially means that the temperature of the device is higher than the set value at ”LIM-0”, the output will act as a heating output.

When the input is active, which initially means that the temperature of the device is higher than the set value at ”LIM-0”, the output will act as a heating output.

By setting the function ”MISC.” = ”room °C” the temperature will instead be compared with the current, controlling room temperature. The values at ”LIM-0” and ”LIM-1” will then display a line.

The requirements for activation of the input can be inverted by setting ”INV.” = 1. To make the input active it is also required that the correct operation mode requirement is selected in function ”MODE”.

The Change over-function also influences the fan speed control in the same way. If the output operates as a cooling output the fan speed control in automatic mode will not be active if there is heating demand. The function is reversed if the output operates as an heating output. The function is deactivated under menu 12, function ”C-O” = 0.

6.7 Limitation of the control area

(not valid if ”direct temperature control of output” is selected, in that case read chapter 6.7 instead)

The control unit calculates an effect value between 0-100% which is forwarded to the output logic. For each output you can select whether it should be controlled within the complete area or part of this area.

Example:
If you selected that an output should be controlled within the area 20-50% the power to the output itself will be controlled in the following way:

Power from controller	Power supply to output
0-20%	0%
20-50%	0-100%
50-100%	100%

This function can be used for example to control outputs in sequence. If you select that the first output should be controlled within the area 0-50%, and that the other output should be controlled within the area 50-100%, only the first output will be active at low power requirement. When the power requirement is increasing to more than 50% the other output will start to be controlled, while the first output is continuously on.

Go to menu 4 and set the following options for desired output:

LIML%: the lower power limit in %
LIMH%: the upper power limit in %
The limit values can also be set so that LIML% is greater than LIMH%. When an output should control both cooling and heating, ”HC”, the limit values can be set to between -100% and +100%. -100-0% refers to cooling and 0-100% to heating. If the output should control within the area from 50% cooling up to 75% heating, LIML% should be set to -50 and LIMH% to +75.

6.8 Setting of temperature limits at ”direct temp. control”

(see 6.3)

When ”dIFF” is selected in function ”HC” the output is not controlled by the effect value from the controller but directly by the selected room temperature limits.

Set a temperature area with the functions ”LIM.-1” and ”LIM.-0”. When the temperature is within this area, and ”PULS”-, ”3P” or ”0-10” control is selected , see 6.2, the effect is controlled to the output by the temperature value in comparison with these limit values.

When the temperature reaches ”LIM.-1” or is outside this value, 100% effect is supplied to the output.

When the temperature reaches ”LIM.-0” or is outside this value, 0% effect is supplied to the output.

When ”OnOF” is selected in function ”HC” the output is activated when the temperature reaches ”LIM.-1”, and is continuously on until the temperature reaches ”LIM.-0”. Then the output is inactivated and is off until the temperature again reaches ”LIM.-1”, whereupon the output is activated again.

Go to function LIM.-1 resp. LIM.-0 and set the temperature limits to between 2-30°C.

6.9 Setting of voltage limits for output A1 and A2

The voltage of output A1 and A2 is normally between 0-10V but the values can be limited up and down.

The voltage from output A1 and A2 respectively are not below the selected min. value in function ”LIML V” and is not over the selected max. value in function ”LIMH V”.

Exception: At condense indication, see 5.6, or when the output should be deactivated due to influence of a ”general 0-10V-sensor”, see 5.5, the voltage will be set to 0V regardless of the value in function ”LIML V”.
The voltage is modulated between set min. and max. voltage in comparison to the output effect.

Example:
If the min. voltage =2V, max. voltage =6V and the output effect =25% then the voltage is 2V+25% x (6-2) = 3V.

Go to function LIML V and LIMH V and set the voltage limits to between 0,0-11,0V.

6.10 Disconnection of output if fan is deactivated or dampers are closed

This function is only valid if fan control or damper control is activated. When all relays in an external unit are disconnected, i.e. when a possible fan is disconnected or all dampers are closed, the output will be deactivated. This function can, for example, be used to prevent overheating in a heating fan by turning the heating off when the fan is still.

Disconnection of output at inactive damper or fan is set in menu 4:

Function ”FAN-0” select 0 (function deactivated)
select 1 (function activated)

6.11 Selection period time at pulsing output or total delay time interval for an increase/decrease-actuator

At pulsing output different types of actuators requires different pulsing times, see 4.2. At control of thermal actuators 20 minutes is often a suitable period time. At control of electric heating 0,5-5 minutes is often a suitable period time. At pulsing output the period time is set in number of minutes.

At increase/decrease output the total delay time interval of the actuator must be set in number of seconds for the controller to be able to calculate its position.

Period time is set in menu 4:

Function ”PTIME” pulsing output: select number of minutes
increase/decrease: select number of seconds

6.12 Selection inversion of output

Inversion means that output D1 and D2 respectively is activated instead of inactivated, and the reverse.

At increase/decrease/-output the outputs will act inverted so that the actuator changes the rotation position.

Output A1 and A2 respectively gives 10-0V instead of 0-10V, for example 7V becomes 3V.
Inversion of output signal is reset in menu 4:

Function ”INV.” select 0 (function deactivated)
select 1 (function activated).

6.13 Valve exercise

Some valves needs to be ”exercised”, i.e. be opened and closed at regular intervals not to be stuck or get tougher to move.

Exercise is performed with selectable day intervals:
D1 and A1 open at between 01:00 - 01:03.
D2 and A2 open at 01:30 - 01:33.

Settings for exercise are made in menu 4:

Function ”EXERC” select number of days between the exercises. The alue 0 deactivates the exercise.

6.14 Relays in external relay unit

At control of fan or when stage control for, for example, a damper is selected: See chapter 4.8.

In other cases the relays are controlled in the following way (uppermost has highest priority):

1. Influence of condensation sensor
2. Influence of secondary temperature sensor
3. Influence of general 0-10V sensor
4. Influence of input function ”SET.P”
5. Relay 1: On if output A1 supplies >5V, otherwise off
   Relay 2: On if output A2 supplies >5V, otherwise off
   Relay 3: Only influenced according to item 1-3

Relay 1 and 2 are influenced by output A1 and A2.
By changing some settings for A1 and A2 in menu 4, you can make them act the same way as the digital control outputs D1 and D2, when several digital outputs are needed.

7 Data communication

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7. Data communication

The control unit has a built in communication port enabling connection to a RS485 network with modbus for monitoring and control via a superior system, for example a computer.

7.1 Modbus protocol

Modbus is a communication protocol (language)used to transfer information between a server and several client nodes.

All ”traffic” on the network is always initiated only by the server node. All other nodes on the network are only allowed to be quiet and wait until the server ”asks” them directly. Thereby the clients cannot send their own packages to another client node. A client node also cannot sent spontaneous messages to the server, such as alarms or similar. Instead you create a continuous reading from the server, so that it can detect alarms in the client nodes.

7.1.1 Protocol Modbus RTU

Modbus RTU, which is one of the different variants of the modbus protocol, is used to communicate with the control unit. Other ”dialects” available (not supported by the control unit) are Modbus ASCII and Modbus TCP.

7.1.2 Data bits and bytes

The information on the modbus network consists of a long row of ones and zeros. These are called bits and are grouped into bytes (= symbols). Each byte looks as follows:

a) start bit (1 bit)
b) data bits 0-7 (8 bits)
c) stop bit (1 bit)

Other byte-builds can be selected with a room unit with display (or configuration unit). 7 or 8 data bits can be selected, and 1 or 2 stop bits. One extra parity bit directly before the stop bit can also be selected to obtain extra error detection.

7.1.3 Data speed

The control unit is preset on the speed 9 600 bits/sec. Other speeds can be selected with a room unit with display (or configuration unit). If the data speed is changed to a higher level, the requirements of the network cable are higher. You may need to limit the cable length and sometimes also select a shielded cable. A termination at the cable ends may also be needed at higher speeds to eliminate so called reflection disturbances.

7.1.4 Modbus RTU package

Each ”package” (message) sent on the network contains the following information:

a) node address (1 byte)
b) command (1 byte)
c) data values(1-252 bytes)
d) check sum (2 bytes / CRC-16)

When a complete package with bytes has been sent from the server, the node being asked gets the opportunity to send its answer back to the server.

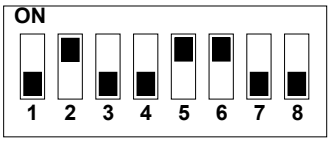
7.1.5 Modbus address

Each modbus device needs its own unique address to be able to communicate on the network. This is called node address and should be a number between 1 and 247. The node address is set on the control unit’s circuit card on a row with buttons or directly on a display unit.

Make sure that no other modbus device gets the same number as another on the same segment (bus). Due to this it is recommended to create a list with node numbers indicating in which room each device is installed.

If you select to set the address on the circuit card you need to calculate a binary code. Each button corresponds to a value twice as high as the previous button. The first button means 1, next button 2, next 4, next 8 and so on.

Example:



The button row above is called ”dip-switch” and has the buttons 2, 5 and 6 in position ”ON”. The buttons are worth, in turn, 1, 2, 4, 8, 16, 32, 64 and 128. If a button is in position ”ON” the value of the button should be calculated. The example above means that address 50 is selected.

(0+2+0+0+16+32+0+0 = 50)

To quickly calculate the correct binary code some calculators can be used (those who have a binary number system). The calculator coming with Microsoft Windows can be set to ”advanced mode” and can then be used to transform common decimal numbers into binary. Note that you then need to change the order of the ones and zeros. The number displayed to the right on the calculator should always be set on the button to the left on the control unit’s dip-switch. If the calculator displays less than eight numbers it means that the rest of the buttons to the right on the dip-switch should be set to off position (that is, not ”ON”).

If you reset the node address via a display unit the control unit ignores the dip-switch settings and instead uses the address set on the display. This is indicated by the letter ”F” on the display, meaning that the address shown is different from the address set on the dip-switch. The address is kept in the memory even if there is a voltage failure.

If you at a later occasion reset the address with the dip-switch again, the control unit ignores the old value earlier set from the display. The value shown on the display is always the valid address. If you have no display unit you can therefore not be sure that the correct address is displayed on the dip-switch. Therefore it is recommended to carefully document the installation.

7.1.6 Modbus register

All modbus products have several different registers which can be reached to read off or change values. In the control

unit the registers are organized in the following four register areas:

a) area 0x: 1-bit register, 11 (read/write)
b) area 1x: 1-bit status register, 9 (read)
c) area 3x: 16-bit status register, 18 (read)
d) area 4x: 16-bit register, 78 (read/write)

Each register has a number indicating partly the area to which it belongs and partly the serial number it has within the area. The first 4x register is called for example 40001 and the last one 40078. When the modbus packets are sent out on the network only the serial numbers of the registers are included since each packet is intended to read or write a register belonging to a certain area, depending on which command is included in the packet (se chapter 7.1.7 below). The first register in area 4x, i.e. register 40001, is sent as number zero, and register 40002 is called 1 and so on.

Example:

01 04 00 05 00 01 CL CH

The first byte indicates the destination address for the packet. The second byte is command 4, i.e. ”read 16 bit status register”. The following two bytes, i.e. ”00 05”, indicates that you want to read off register 30006. The following two bytes indicates how many registers you wish to read in sequence, and in this example only one register is asked for, i.e. ”00 01”. The last two bytes are a check sum (”CL CH”) which is a calculated value that the sender sends with the packet so that the receiver can control that the packet is received correctly and is intact.

A complete list of all registers can be found at the end of this chapter. There it is also stated how each data value is presented, for example that value 0 to 318 means 0 to 31.8°C. To display all data values correctly on a monitoring computer or a web page you need to add a transformation formula so that the value is displayed correctly.

7.1.7 Modbus commands

To read and write to the control unit’s register the following commands are used:

01. Read 1 bit register (area 0x)
02. Read 1 bit status register (area 1x)
03. Read 16 bit register (area 4x)
04. Read 16 bit status register (area 3x)
05. Write to 1 bit register (area 0x)
06. Write to 16 bit register (area 4x)
15. Write to several 1 bit registers (area 0x)
16. Write to several 16 bit registers (area 4x)

7.1.8 Modbus RTU over Ethernet

There are two different ways to connect a modbus network to the Internet or to a LAN network. One way is to select a converter that can transform Modbus TCP packets, coming from a monitoring program, to Modbus RTU packets, and vice versa. All traffic between the computer and the converter will then normally be lead via TCP-port 502.

The other way is to use a monitoring program that sends common Modbus RTU packets to a converter, which transparently forwards the packet to the Modbus network. The setting in the monitoring program is usually called ”Modbus RTU over Ethernet” or something similar. The traffic between the computer and the converter is then normally lead via another TCP-port, for example 4001.

7.1.9 Status LEDs

On the control unit’s circuit card there are two LEDs indicating the status of the modbus communication.

One of the LEDs is called ”RD/TD” and means ”receive data/transmit data”. This flashes in yellow when the control unit receives a packet from the server. It also flashes quickly when the control unit sends its answer (often as close to the received flashing that it only looks as one blink). The RD/TD LED is not flashing when a packet intended for other client nodes on the network is sent from the server.

The other LED is called ”ERROR” and is flashing it the received packet was incorrect, i.e. contains an incorrect reading or writing, for example a non-existing register number or similar. The LED is also flashing if the packet from the server had an incorrect check sum (CRC code).

An exception for the red LED is that it is not flashing if the server sent an incorrect reading or writing to all nodes (i.e. a broadcast to address zero).

7.1.10 Error messages

If an incorrect question is sent from the server, the client nodes answers with an error message back to the server and also the ERROR LED flashes in red.

The error messages that the control unit can send are the following:

a) not allowed command (error code 1)
b) not allowed data address (error code 2)
c) not allowed data value (error code 3)
d) incorrect CRC check sum (error code 9)

An error message can look like this:

01 81 02 CL CH

The first byte indicates the own node address. The second byte shows which command the server sent when the questions was put. This command number is added with 128 before it is sent out to inform that it is an error message (the example above is hexadecimal, where 81 corresponds to the decimal number 129). The third byte is the actual error code. Byte 4 and 5 is the CRC code (check sum) for this error message (CL and CH).

If the server sent the packet to all nodes (i.e. a broadcast to address zero) no error message is sent back to the server.

7.1.11 Delays and communication errors

If you communicate with modbus nodes via a LAN network or the Internet there are sometimes problems with timeouts and no answers. This may be due to the transmission via the TCP/IP communication and you then need to test to reset time delays and number of retries (repetitions).

You can also set the control unit (with a room unit with display or a configuration unit) so that the answer to the server is not sent immediately but after a small delay (indicated in number of milliseconds on the display). This may sometimes solve some errors, for example when the converter has no time to apprehend the answer since it continuously changes the direction of the communication flow (i.e. when it sends the server's questions and when it listens).

If you use a converter between RS485 and RS232 you should select one that has automatic flow control, i.e. that it redirects to listening position by itself and automatically changes the direction when the server is about to communicate, and then directly returns to listening afterwards.

To use for example the RTS signal on the RS232 port to switch between listening and sending is often not sufficiently fast which results in no answers to the server, despite that the nodes send the answer.

7.1.12 Monitoring programs

To monitor and control the nodes on the modbus network some type of program is needed on the server computer. There are both large and small scale programs suitable for different purposes.

A common program used in many cases is Citect Scada. This program also manages to communicate with other networks and manages alarms and so on. Many other well known programs also manages modbus and are sometimes available as plug-ins to the programs.

To test nodes on a network there are free programs to get on the Internet. These only communicates with separate nodes. See www.modbus.org and click "technical resources". Under the heading "offsite links" are some tips.

You can also quite simply create your own programs in for example Visual Basic or C++ if you have access to programming tools and have basic knowledge about programming.

7.1.13 Slave mode (not modbus)

There is a possibility to slave connect one or several control units for, for example, bigger rooms that requires many actuators. In this case the modbus port is used for receiving control signals from a master control unit and cannot be used for modbus communication.

A control unit is then selected as master and sends its output signals via the communication port. The master's screw terminal block "TO ROOM UNIT/SLAVES" should be used to connect to the slaves' block "MODBUS/EIA-485". Note that only three conductors should be connected to the master (A1, B1 and C1).

The protocol used at master/slave control is an internal protocol which cannot be connected to modbus networks. Therefore only the master may be connected to a modbus network.

See more about this in chapter 2.

7.2 RS485 network

On a RS485 network information is sent between two or several devices. The data speed can be up to 10 Mbit/sec and sometimes even higher. The control unit's maximum speed is however 38 400 bits/sec. RS485 is made to be able to send information over conductors with very long distances, up to about 1 km and sometimes longer. All depending on how well the network is built.

7.2.1 Nodes, server and clients

Each device connected to a data network is called ”node”. If you use modbus as protocol you may have several client nodes but only one server. The definition of server and client can sometimes differ. In this manual we call the central computer/unit as server and all other nodes as clients. The server sometimes is called master and the clients slaves.

On a RS485 network all nodes can communicate in both ways, i.e. both read and write. However, only one may talk at a time. This is controlled in some different ways depending on which protocol you select to use. With modbus as protocol it is decided that only the server node may initiate all traffic on the network.

7.2.2 Transceiver

Inside the control unit there is an electronic circuit called transceiver, which means ”combined transmitter and receiver”. It receives the signals from the network and transforms these to correct levels so that the internal processor may understand them. The transceiver also receives the processor's sending signals and makes sure these are sent on the correct level to the network.

7.2.3 Bits and signal levels

Each one and zero sent on the network is transformed into electrical signals. These can be measured with an oscilloscope or similar. If you measure the signals between channel A and B ”one” corresponds to about +5 volts and zero -5 volts.

The more nodes you connect to the network, the more the signal levels drop. Both the positive and negative signals may be close to zero. To make a node interpret a ”one”, a signal level higher than 0,2 volts is needed, and a zero is interpreted if the signal level is below 0 volts.

7.2.4 Converter

To connect the RS485 network to a computer or to the Internet some type of converter is needed. There are many different products on the market and these are transforming the signals in the following way:

a) RS485 to RS232 (transparent protocol)
b) RS485 to TCP/IP (transparent protocol)
c) Modbus RTU to Modbus TCP

Type c above means that the server computer should send Modbus TCP packets to the converter, and the converter will transform to and from Modbus RTU. The others (a and b) are made to talk directly with Modbus RTU .
Here follows some examples of converters that we find good:

- ICP CON 7520AR 1 segment *(type a above)*
- Moxa NPort 5430 4 segment *(type b above)*
- Moxa NPort 5430i 4 segment, and 2kV isolation *(type b above)*
- NetBiter RTU/TCP 1 segment *(type c above)*
- Procon TCP/485 1 segment *(type c above)*

7.2.5 Repeater

To divide a segment into several parts a repeater is needed. This is useful when you for example wish to isolate two parts of a segment from each other, or when a segment already contains the maximum number of nodes and you need to connect more nodes.

Another alternative is that already from the beginning divide the network into several segments and leave space for extra nodes on each segment.

A disadvantage with a repeater is a certain delay of the traffic. But in most cases this is of no importance.

7.2.6 Screw terminal block for network cable

The network cable should be connected to the control unit's 3-pole screw terminal block. It is important that the correct conductor is connected on the correct screw pole in the block. All nodes should be connected with the same polarity everywhere, i.e. all A conductors to A2, and all B conductors to B2. This also applies to the central server. On some other nodes the block marking is different, for example D+ and D-. The control unit's A2 is plus and B2 is minus.

Also a ground wire should be connected to all nodes to screw pole C2 (also called GND on some node blocks). The ground wire should also be connected to protective earth, normally close to the server.

7.2.7 Twisted pair cable

RS485 can communicate with most cable types but you should always use twisted pair cables to avoid disturbances and you can then use longer cables.

A twisted pair cable reduces radiating disturbances from the environment. Since both conductors in a twisted pair cable is exactly as close to all interference sources in all directions, each interference signal is stopped in the transceiver, since the conductor signals are measured differentially.

All data signals are sent positively in the A conductor and in the B conductor the signals are reversed. When both signals are read in a node, signals that differ between the

conductors gets amplified and all similar signals (such as all external interferences) gets leveled out.

Despite that RS485 is a two wire communication a third conductor is always needed, connected between all nodes. The fact is that all nodes needs a reference to earth to prevent overvoltage in those cases where the supply voltage on the different nodes comes from different fuse groups etc. This also requires that the nodes have a built-in galvanic isolation.

The cable should have a characteristic impedance of 120 ohm and in most cases do not need to be shielded. At higher speeds and in more difficult environments, such as industrial areas, a shielded cable may be needed. To get the third conductor to all nodes a 4-conductor can be selected with two separately twisted pairs. Alternatively a 2-conductor with an extra ground wire which is not twisted into the pair.

7.2.8 Galvanic isolation

The control unit is galvanic isolated from the network thanks to special opto components and dc/dc transformers. This gives the control unit a good protection against unprepared overvoltage and faulty connections.

7.2.9 Polarization

When all nodes on the network is ”silent” the signal level gets undefined since when a node goes into listening position it does not charge the network at all and adds no voltage. The complete network will, in principle, be completely without voltage and by that sensible to external disturbances. The signal level is then about 0 volts and risks going over 0,2 volts and below 0 volts, which would be interpreted as ones and zeros in the nodes.
With polarization connected the signal level goes up to a stable level and prevents the signal from reaching zero levels.

7.2.10 Termination

To remove reflection disturbances on the network end terminations can be connected. This is normally only needed at higher data speeds than 9 600 bits/sec.

7.2.11 Electromagnetic disturbances

At the data speed 9 600 bits/sec ones and zeros are pulsing out on the network cable with a frequency of 4,8 kHz. Since data signals do not consists of plain sinus waves also some higher frequencies occur on the signal. This is due to that a good communication demands as plain ”square wave” as possible, i.e. with fast signal increase and decrease.

To limit electromagnetic disturbances (EMI) there is a built-in ”slewrate” limitation in the transceiver, which somewhat rounds off too fast signal increase and decrease.

7.2.12 Shielded cable

Shielded cable is used in environments where strong electromagnetic disturbances exists, such as in industrial areas. The shielding also removes radiating disturbances

coming from the modbus network.

7.3 Network build-up

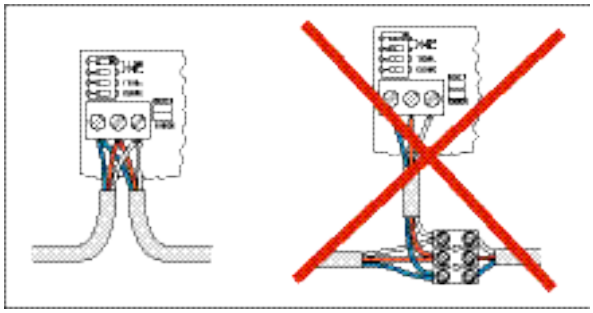
To build up a stable and working network with several nodes you need to take some important aspects into consideration. Otherwise there is a risk that communication problems may occur. An incorrect connection can even damage the nodes or the central converter.

We therefore recommend that you read the following chapter thoroughly, and also take part of available standards, for example the Modbus standard, the EIA-485 standard, ESD protection etc.

7.3.1 Segments

A network can be built with one or several segments depending on how the installation location physically looks like. A segment is also called ”loop” and is the physical connection between the nodes on the network.

Each segment should be built as a bus, which means that the connection forms a long straight line with the nodes connected directly on the segment. This means that you cannot connect long cut-offs on the segment to drag to the nodes. You should therefore drag both incoming and outgoing network cables all the way to the screw terminal block of the node.



If you connect the nodes via long cut-offs anyway there may be reflection disturbances since each cut-off acts like new small segments.

7.3.2 Number of nodes

Each segment has a maximum limit of how many nodes you may connect. If the maximum limit is exceeded you risk overloading the segment, which may lead to communication errors or that nodes are damaged.

The RS485 standard tells that each segment should manage 32 UL (unit loads). Depending on how big unit load each node has you can calculate how many nodes the segment manages. The control unit has a lower unit load than many other products, which allows for a higher number of control units per segment.
In many cases you need to install different types of nodes, also from different manufacturers, on the same segment. If the nodes have different unit loads you need to calculate the total unit load according to the following example:

15	R221	á 1 UL	=	15 UL
60	C221	á 0,1 UL	=	6 UL
1	RS485-converter	á 1 UL	=	1 UL
Total UL on the segment: *(remaining capacity: 10 UL)*				22 UL

Another important thing to consider is not to exaggerate the number of nodes per segment since it in many cases is good to divide the network into different segments. Since all nodes on the segment share the same electric conductor pair all can be exposed to disturbances if one single node is damaged. One single incorrect connection with for example 24V in on the segment would, in the worst case scenario, damage all nodes on the segment.

7.3.3 Network cable

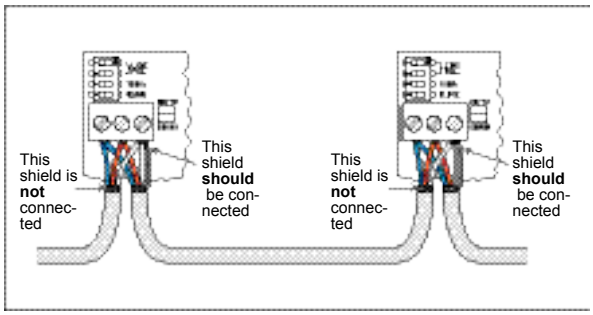
The cable should be of the type twisted pair cable. The cable should also have a third conductor for ground. If you have a shielded cable the shield should not be used as ground connection. Normally a 4-pole twisted pair cable is used where one pair is used for data communication and one of the conductors in the other pair as ground connection.

Note that if the cable has a shield this should always be connected (see chapter 7.3.4 below about shielded cable).

7.3.4 Shielded cable

Shielded cable is only needed in some cases, where the environment has a lot of radio interference, such as in industrial areas. The data signals sent on the network can also to some extent send radio interference that needs to be shielded, but this usually applies to much higher data speeds.

If you select a shielded cable this should always be connected. Otherwise you risk that the shield receives radio interference which then radiates the cables with these disturbances.



The shield must only be connected in one end between two nodes. Otherwise there is a risk of ground current interference. If a shield is used, both the ground wire and the shield must be connected to one of the nodes on screw terminal block C2. On the other node, only the ground wire should be connected.

7.3.5 Ground wire

All nodes must be connected to protective ground, to avoid level differences between different nodes' potentials (voltages). Screw terminal block C2 must therefore be connected between all nodes, and must at one point in the network be connected to protective ground.

Note that the protective shield in a shielded cable cannot be used as a ground wire but a separate conductor must be used. A 4-pole pair twisted cable should be used, where one of the conductors in the pair that is not used may be used as a ground wire. Do not use conductors without plastic insulation for the protective ground; as this might come in contact with a critical spot and damage or ruin the control unit's printed circuit board.

Note that nodes without a galvanic isolation must not be connected to protective ground. Their earthed neutral must instead be connected to the 24V side. If the same transformer is used on several nodes, it is very impor-tant that phase and earthed neutral on the 24V-supply are connected to the same block number on every node. Otherwise the nodes might be damaged or ruined.

7.3.6 Polarisation

To have a stable level on the network when the nodes are "silent", a clear signal level that exceeds 0,2 volts is needed. This is achieved by activating the built-in polarisation resistors in the control-unit by setting the switches 1 and 2 to "ON", on the 4-pole dip-switch on the printed circuit board. Both switches should always be in the same position ("ON") when polarisation is desired.

The voltage level should be about +5 volts if the segment is unloaded. Depending on the number of nodes on the segment, the polarity voltage is reduced. The signal must be over at least 0,2 volts to give a safe level.

The polarisation should only be activated on a single node on each segment. If there are several segments on the network divided with a converter or repeater, there should be one polarisation on each segment.

The placement of the polarisation is not important, but is usually placed in a cabinet device or similar where the converter is placed. Since the control unit has built-in polarisation you can choose any node. As a suggestion the node closest to the converter so that it can be easily found at fault tracing or examination of the system.

7.3.7 End termination

To deal with interference or other problems that might occur in the communication, you can activate end termination on the segment. Termination is a built-in function in the control unit and is activated by setting switch 3 to "ON" position on the 4-pole dip-switch on the printed circuit board.

End termination must always be activated on the first and last node in the segment. Termination must never be activated on more than two nodes per segment, since this can interfere with the communication or in the worst case overload and even brake the nodes on the segment.

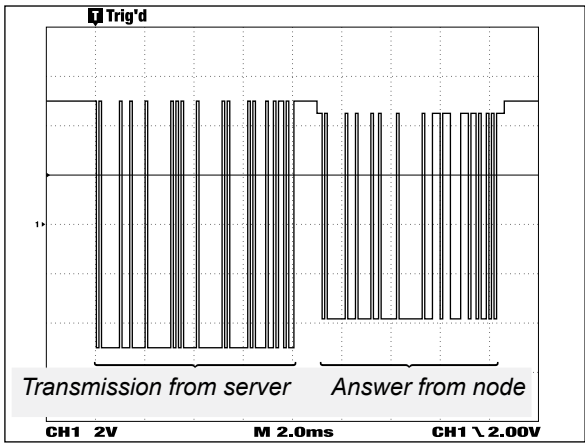
The built-in termination in the control unit is a RC-bridge with 120 ohm/1nF, which gives an improved elimination of reflection interference. Termination is normally not necessary at as low data speeds as 9 600 bits/sec.

7.4 Fault tracing of network

To verify that the network is operating correctly, it should be measured with a oscilloscope. Even if all communication seems to function correctly, it should be checked that no signal interference is present on the network. These can vary in strength and should be traced.

An isolated oscilloscope is needed to make accurate measurements. For example a hand held, battery operated oscilloscope can be used. A 230V oscilloscope can also be used, but it requires a connected transformer with insulator for 230V (230V in and out). This might however be heavy and clumsy to operate.

The probe's positive pole should be connected to the

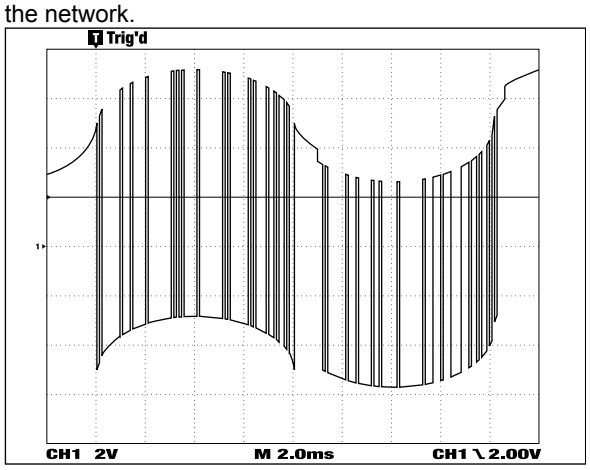


network's positive channel, conductor A. The probe's ground wire should be connected to the network's negative channel, conductor B.
Set the amplitude to 2 volts/grid and set the time to 2 ms/grid. Set the trigger level to 2 volts and set the timer point in lateral one grid from the left edge of the screen. A complete modbus packet from the server should be visible and also the receiving node's answer.

Check that the signals are square shaped, by temporarily zooming time. If the pulses are too rounded off at the edges at up-and down, there is a too vast capacitance on the network.

This might suggest that the network cable is of the wrong type, or that one of the nodes on the network is faulty and provides a capacity load on the network. Also make sure that both the server and the node's signal levels are strong enough. The levels should ideally reach up to +5 volts respectively down to -5 volts, but should be sufficient even if the levels are from +1 volts to -1 volts.

It is important that the positive level exceeds 0,2 volts (with a margin) and fall below 0 volts at the negative pulse.
Depending on where the measurements are taken at the network, the server's and the nodes' signal levels will vary because of potential drop in the wires. If measurements are taken at the server, the nodes' signal is generally weaker. However, if the measurements are taken at a node, the server's signal might be weaker than the node's. Commence with each node's condition on its place on the network when checking the traffic on the network.



It is important to scan for strong signal interference. If it should, for example, occur a 50 Hz-signal that makes the signals flutter up and down (see picture above), this suggests that there is an error with the connection on the network.

If interference occurs on the network, it is a good idea to check each node one by one to pinpoint where the error is. Make sure that the server continuously sends modbus packets to one node at a time and check if the node responds or not.

If possible, connect a laptop to the segment. By using a RS232-converter (or USB) you can eliminate tcp/ip-problems and make it possible to communicate with the nodes directly. This also makes it easy to choose which node to test.
Note! Always disconnect the ordinary converter first.

It is also possible to disconnect parts of the segment to pinpoint where the error occurs. Start with the first node on the segment. Disconnect the others. Perform tests on the node. If the node works correctly, connect the next node on the segment and check that both are functional in the segment and so on.

Also monitor the oscilloscope's signals gradually after each node is connected. One faulty node might disturb all the others.

Note that some monitor programs might alert for errors due to incorrect set timeout parameters. Some monitor programs abort the reading of a segment if they miss an answer from one single node. To make sure that you read the actual status on the segment, it might help to restart the program.

7.5 Deviation from the Modbus-standard

The control unit's construction is based on the demands and norms specified in the document "Modbus over serial line, specification and implementation guide v1.01" (below called the "standard"), published by the organisation Modbus-IDA (web page www.modbus.org). In order to meet the conditions of the market, Zone Controls has chosen to perform some things different from this specification, as follows:

7.5.1 RTU communication format

The control unit is at delivery set for communication with 8/N/1 (8 databits, no parity and 1 stopbit).

The standard prescribes that odd parity should be used (by the standards paragraph 2.5.1). The control unit can be reset to odd parity or to 2 stopbits if desired (with a room unit with display or a configuration unit).

Reason: Our customers wish to use 8/N/1, being the standard set for most converters and such.

7.5.2 Data speed

At delivery the control unit is set for communication with 9 600 bits/sec.

The standards prescribes that the speed should be 19 200 bits/sec. The control unit can be reset to 19 200 bits/sec if desired (with a room unit with display or a configuration unit).

Reason: The most common data speed for modbus is, according to our customers, 9 600 bits/sec, and will in most cases make end terminations and a shielded cable unnecessary.

7.5.3 Block marking

The control unit is marked A2 (+) for non-negative data channel, and B2 (-) for negative data channel. The ground connection is marked C2 (GND).

The standard prescribes that blocks should be marked D0 for a non-negative data channel and D1 for a negative data channel, and "Common" for the ground connection.

Reason: Usually the two connections on RS485 are called "A" and "B", or also in many cases (+) and (-). This you will find on most converters for RS485, and this is why we chose this way of marking the screw terminal blocks.

7.5.4 Polarisation

The control unit has a built-in function for giving the network a distinct level when all nodes are "silent". This is called "polarisation" (also called "bias-voltage" or "fail-safe"). On the circuit card there are two transformers for connecting polarisation voltage on the network, where the A channel is connected via 620 ohm to +5 volts and the B channel via 620 ohm to 0 volts.

The standard prescribes a reverse connection, i.e. that the A channel is connected via resistance to 0 volts and the B channel to +5 volts. If this connection is needed, the control unit's two polarisation voltage transformers should be set to mode OFF, and an external polarisation circuit may then be connected.

Reason: We tested both connections and found that the communication port of the microprocessor works best if the A channel is raised up to +5 volts, since it is expecting that each sent sign also starts with a "start bit", and it is always low (i.e. -5 volts). This means that the level should be high (+5 volts) before the start bit. We also tested several different RS485 converters and these works well, and some also demands this type of connection.

7.5.5 Termination

The control unit normally does not demand any end termination for working properly. If higher speeds over 9 600 bits/sec is used it is, however, recommended that termination is used.

The standard prescribes that you should always connect terminations regardless of speed.

Reason: At 9 600 bits/sec, which is the delivery setting on the control unit, not as strong reflections are created at the ends of the network cable as is the case at higher speeds. If you connect end terminations on the network the total voltage is lowered on all signals, and it has turned out that sometimes the performance can even be worse.

7.5.6 Shielded cable

The control unit normally does not demand any shielded cable to work properly. If the network is installed in environments such as heavy industry, where strong radio disturbances or such often is present, shielding may be necessary.

The standard prescribes that you should always use a shielded cable, regardless of speed and environment.

Reason: Since the control unit most often is used with the speed 9 600 bits/sec shielded cable is normally not needed.

7.6 Modbus register

Here are all available registers in the control unit.

Area 0x

1-bit register (read/write)
Command 01 for reading (Read coil status),
command 05 (Force single coil) or 15 (Force multiple coils) for writing.

Register name	Reg. no.	Function	Description	Min	Max	Unit
00001	0	**Invert output D1**	Inverting means that output D1 goes on instead of off and the reverse. 0 = Not inverted, 1 = Inverted.	0	1	0=off 1=on
00002	1	**Invert output D2**	Inverting means that output D2 goes on instead of off and the reverse. 0 = Not inverted, 1 = Inverted.	0	1	0=off 1=on
00003	2	**Invert output A1**	Inverting means that output A1 gives 10 - 0V instead of 0 - 10V. 0 = Not inverted, 1 = Inverted.	0	1	0=off 1=on
00004	3	**Invert output A2**	Inverting means that output A2 gives 10 - 0V instead of 0 - 10V. 0 = Not inverted, 1 = Inverted.	0	1	0=off 1=on
00005	4	**Invert the function of the secondary temperature sensor input**	Inverting means that the input is activated when the temperature exceeds the selected limit and is deacti-vated when the temperature is below another selected limit.	0	1	0=off 1=on
00006	5	**Invert occupancy sensor input**	Inverting means that occupancy is indicated when the contact to the input is open instead of closed.	0	1	0=off 1=on
00007	6	**Invert operation mode input**	Inverting means that the selected operation mode is activated when the contact to the input is open instead of closed.	0	1	0=off 1=on
00008	7	**Invert the function of the general 0-10V input**	Inverting means that the input is activated when the value of the input is below the selected limit and is deactivated when the value exceeds another selected limit.	0	1	0=off 1=on
00009	8	**Selection ”Cut-Off” at cascade control**	The ”Cut-Off” funtion makes a cascade controlled heating actuator always close fully in cooling mode or alternatively make a cooling actuator always close fully in heating mode.	0	1	0=off 1=on
00010	9	**Confirm the fan filter alarm**	Only applicable to control units with fan speed control. 0=Confirm the alarm. 1=Alarm signal on (for testing)	0	1	
00011	10	**Selection store force via data communication**	1= Force is stored at voltage failure. **NOTE!** If store is selected, do not force more often than once/hour !!!	0	1	

Area 1x

1-bit status register (read)
Command 02 (Read input status) for reading.

Register name	Reg. No.	Function	Description	Unit
10001	0	**Status on output D1**	0 = D1 off, terminal Y1 is not active 1 = D1 on, terminal Y1 is active	0=off 1=on
10002	1	**Status on output D2r**	0 = D2 off, teminal Y2 is not active 1 = D2 on, teminal Y2 is active	0=off 1=on
10003	2	**Influence from the secon-dary temperature sensor**	1 = All conditions for the input are fulfilled. The selected output can be influenced	0=off 1=on
10004	3	**Influence from the ope-ration**	1 = Conditions fulfilled for activation of the selected operation mode However, operation mode connection has higher priority due to Mod-Bus force and occupancy	0=off 1=on

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Register name.	Reg. no.	Function	Description	Unit
10005	4	Occupancy from sensor	0 = No occupancy, 1= Occupancy. The value refers only to the sensor and possible selected inversion, not if occupancy is or isn't 1=on connected. Occupancy connection is also controlled by time delays.	0=off
10006	5	Occupancy status	0 = Occupancy disconnected, 1= Occupancy connected	0=off 1=on
10007	6	Influence from general 0-10V input	1 = All conditions for the input are fulfilled. The selected output can be influenced.	0=off 1=on
10008	7	Influence from condensation sensor	1 = All conditions for the input are fulfilled. The selected output can be influenced.	0=off 1=on
10009	8	Manual or automatic fan speed control	0 = manual fan speed control, 1 = automatic fan speed control	

Area 3x

16-bit status register (read)
Command 04 (Read input registers) for reading.

Register name	Reg. No.	Function	Description	Unit
30001	0	**Measured room temperature**	0 - 319 = 0 - 31,9°C in stages of 0,1°.	°C
30002	1	**External temperature sensor**	0 - 319 = 0 - 31,9°C in stages of 0,1°.	°C
30003	2	**Secondary temperature sensor**	0 - 319 = 0 - 31,9°C in stages of 0,1°. *alternatively:* -300 - +975 = -30,0 - +97,5°C in stages of 0,5°.	°C
30004	3	**General sensor: 0-10V on input I2**	0-100% = 0-10V	%
30005	4	**0-10V on input I3 or a measured value of resistive condensation sensor on input I3**	0-100% = 0-10V. 0-100% = high - low resistance = low - high condensation value. (applies to resistive condensation sensor)	%
30006	5	**Current selected room temperature**	Selected room temperature for the current operation mode. 20 - 300 = 2,0 - 30,0°C in stages of 0,5°.	°C
30007	6	**Current operation mode**	1 = DAY, 2 = NIGHT, 3 = SAVE.	
30008	7	**Heating effect**	The control units current heating effect in %.	%
30009	8	**Cooling effect**	The control units current cooling effect in %.	%
30010	9	**Effect to output D1**	The control units current effect to output D1 in %.	%
30011	10	**Effect to output D2**	The control units current effect to output D2 in %.	%
30012	11	**Effect to output A1**	The control units current effect to output A1 in %.	%
30013	12	**Effect to output A2**	The control units current effect to output A2 in %.	%
30014	13	**Fan operating time**	0 - 99 = 0 - 9900 hours. The value is reset at alarm confirmation.	hours
30015	14	**Serial no. 1 (two last numbers)**	0-99	
30016	15	**Serial no. 1 (two first numbers)**	0-99	
30017	16	**Serial no. 2 (two last numbers)**	0-99	
30018	17	**Serial no. 2 (two first numbers)**	0-99	
30019	18	**Voltage output, output A1**	0-110 = 0-11,0 Volts	volts
30020	19	**Voltage output, output A2**	0-110 = 0-11,0 Volts	volts

Area 4x

16-bit register (read/write)
Command 03 (Read holding register) for reading,
command 06 (Preset single register) or
command 16 (Preset multiple registers) for writing.

*) Depending of the configuration of the superior system, the value FFFFH may sometimes need to be written in a numeric value = 65535.

Register name	Reg. no.	Function	Description	Min	Max	Units
40001	0	Force measured room temperature	Applies to the controlling room temperature. The ModBus value replaces the value from connected sensors. Value 0-318 = 0-31,8°C. Force off: write FFFFH. Reading shows FFFFH when force is off. *)	0	318	°C
40002	1	Force desired temperature	The ModBus value replaces the temperature for the current operation mode. Value 20-300 = 2,0 - 30,0°C in stages of 0,5°. Force off: write FFFFH. Reading shows FFFFH. *)	20	300	°C
40003	2	Force operation mode	The values 1-3 from ModBus, activates the DAY (1), NIGHT (2), or SAVE (3) operation mode with higher priority than the week program but with lower than the timer, occupancy and external contact. Force off: write FFFFH. Reading shows FFFFH. *)	0	3	
40004	3	Force heating outputs	The ModBus value replaces the heating set point in the controller to the output logic. Forcing of cooling outputs has to be off. Force off: write FFFFH. Reading shows FFFFH when force is off. *)	0	100	%
40005	4	Force cooling outputs	The ModBus value replaces the cooling set point in the controller to the output logic. Forcing of heating outputs has to be off. Force off: write FFFFH. Reading shows FFFFH when force is off. *)	0	100	%
40006	5	Force power to output D1	The ModBus value replaces the calculated effect value of the controller to output D1. Force off: write FFFFH Reading shows FFFFH when force is off. *)	0	100	%
40007	6	Force power to output D2	The ModBus value replaces the calculated effect value of the controller to output D2. Force off: write FFFFH Reading shows FFFFH when force is off. *)	0	100	%
40008	7	Force power to output A1	The ModBus value replaces the calculated effect value of the controller to output A1. Force off: write FFFFH Reading shows FFFFH when force is off. *)	0	100	%
40009	8	Force power to output A2	The ModBus value replaces the calculated effect value of the controller to output A2. Force off: write FFFFH Reading shows FFFFH when force is off. *)	0	100	%
40010	9	Set room temperature for DAY mode	The ModBus value changes the selected room temperature for the DAY operation mode in the control unit. Value 20-300 = 2,0 - 30,0°C in 1/2°-stages.	20	300	°C
40011	10	Set room temperature for NIGHT mode	The ModBus value changes the selected room temperature for the NIGHT operation mode in the control unit. Value 20-300 = 2,0 - 30,0°C in 1/2°-stages.	20	300	°C
40012	11	Set room temperature for SAVE mode	The ModBus value changes the selected room temperature for the SAVE operation mode in the control unit. Value 20-300 = 2,0 - 30,0°C in 1/2°-stages.	20	300	°C
40013	12	Min. adjustable room temperature for DAY mode	The ModBus value changes the selected minimum room temperature for the DAY operation mode in the control unit. Value 20-300 = 2,0 - 30,0°C in 1/2°-stages.	20	300	°C
40014	13	Max. adjustable room temperature for DAY mode	The ModBus value changes the selected maximum room temperature for the DAY operation mode in the control unit. Value 20-300 = 2,0 - 30,0°C in 1/2°-stages.	20	300	°C
40015	14	Room temperature sensor calibration	The ModBus value changes the selected calibration value for the room units built-in sensor. Value -99 - +99 = -9,9° - +9,9°K.	-99	99	°K
40016	15	External room temperature sensor calibration	The ModBus value changes the selected calibration value for the external sensor. Value -99 - +99 = -9,9° - +9,9°K.	-99	99	°K

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Register name	Reg. no.	Function	Description	Min	Max	Unit
40017	16	Calibration of the clock	The ModBus value changes the selected calibration value for the clock. Value -99 - +99 = -9,9 - +9,9 sec. / day.	-99	99	sec.
40018	17	Dead band for the DAY operation mode	The ModBus value replaces the selected dead band value for the DAY operation mode. Value 5-300 = 0,5 - 30°K in 1/2°-stages.	5	300	°K
40019	18	Dead band for the NIGHT operation mode	The ModBus value replaces the selected dead band value for the NIGHT operation mode. Value 5-300 = 0,5 - 30°K in 1/2°-stages.	5	300	°K
40020	19	Dead band for the SAVE operation mode	The ModBus value replaces the selected dead band value for the SAVE operation mode. Value 5-300 = 0,5 - 30°K in 1/2°-stages.	5	300	°K
40021	20	P-range for heating	The ModBus value replaces the selected P-range value for heating. Value 5-995 = 0,5 - 99,5°K in 1/2°-stages.	5	995	°K
40022	21	P-range for cooling	The ModBus value replaces the selected P-range value for cooling. Value 5-995 = 0,5 - 99,5°K in 1/2°-stages.	5	995	°K
40023	22	I-time for heating	The ModBus value replaces the selected I-time for heating. Value 0-995 = 0-99,5 minutes in 1/2-min.stages.	0	995	min.
40024	23	I-time for cooling	The ModBus value replaces the selected I-time for cooling. Value 0-995 = 0-99,5 minutes in 1/2-min.stages.	0	995	min.
40025	24	Min. temp. at cascade control	The ModBus value replaces the selected minimum value at casc. control. Value 20-950 = 2,0-95,0°C in 1/2°-stages.	20	950	°C
40026	25	Max. temp. at cascade control	The ModBus value replaces the selected maximum value at casc. control. Value 20-950 = 2,0-95,0°C in 1/2°-stages.	20	950	°C
40027	26	cascade control P-range	The ModBus value replaces the selected P-range for the casc. control. Value 5-995 = 0,5 - 99,5°K in 1/2°-stages.	5	995	°K
40028	27	Cascade control I-time	The ModBus value replaces the selected I-time for the casc. control. Value 0-995 = 0-99,5 minutes in 1/2-min. stages.	0	995	min.
40029	28	Lowest limit of the control range, output D1	The ModBus value changes the selected lowest limit value for the effect range for output D1, ”LIML %”.	0	100	%
40030	29	Lowest limit of the control range, output D2	The ModBus value changes the selected lowest limit value for the effect range for output D2, ”LIML %”.	0	100	%
40031	30	Lowest limit of the control range, output A1	The ModBus value changes the selected lowest limit value for the effect range for output A1, ”LIML %”.	0	100	%
40032	31	Lowest limit of the control range, output A2	The ModBus value changes the selected lowest limit value for the effect range for output A2, ”LIML %”.	0	100	%
40033	32	Highest limit of the control range, output D1	The ModBus value changes the selected highest limit value for the effect range for output D1, ”LIMH %”.	0	100	%
40034	33	Highest limit of the control range, output D2	The ModBus value changes the selected highest limit value for the effect range for output D2, ”LIMH %”.	0	100	%
40035	34	Highest limit of the control range, output A1	The ModBus value changes the selected highest limit value for the effect range for output A1, ”LIMH %”.	0	100	%
40036	35	Highest limit of the control range, output A2	The ModBus value changes the selected highest limit value for the effect range for output A2, ”LIMH %”.	0	100	%
40037	36	Temp. limit to set D1 on at diff-output	The ModBus value changes the selected temp. limit value at DIFF-output for output D1 on. 20-300 = 2,0-30,0°C.	20	300	°C
40038	37	Temp. limit to set D2 on at diff-output	The ModBus value changes the selected temp. limit value at DIFF-output for output D2 on. 20-300 = 2,0-30,0°C.	20	300	°C
40039	38	Temp. limit to set A1 on at diff-output	The ModBus value changes the selected temp. limit value at DIFF-output for output A1 on. 20-300 = 2,0-30,0°C.	20	300	°C
40040	39	Temp. limit to set A2 on at diff-output	The ModBus value changes the selected temp. limit value at DIFF-output for output A2 on. 20-300 = 2,0-30,0°C.	20	300	°C
40041	40	Temp. limit to set D1 off at diff-output	The ModBus value changes the selected temp. limit value at DIFF-output for output D1 off. 20-300 = 2,0-30,0°C.	20	300	°C

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Register name	Reg. no.	Function	Description	Min	Max	Unit
40042	41	**Temp. limit to set D2 off at diff-output**	The ModBus value changes the selected temp. limit value at DIFF-output for output D2 off. 20-300 = 2,0-30,0°C.	20	300	°C
40043	42	**Temp. limit to set A1 off at diff-output**	The ModBus value changes the selected temp. limit value at DIFF-output for output A1 off. 20-300 = 2,0-30,0°C.	20	300	°C
40044	43	**Temp. limit to set A2 off at diff-output**	The ModBus value changes the selected temp. limit value at DIFF-output for output A2 off. 20-300 = 2,0-30,0°C.	20	300	°C
40045	44	**Minimum voltage for output A1**	The ModBus value changes the selected minimum voltage level for output A1. 0-110 = 0,0-11,0 Volts	0	110	Volts
40046	45	**Maximum voltage for output A1**	The ModBus value changes the selected maximum voltage level for output A1. 0-110 = 0,0-11,0 Volts	0	110	Volts
40047	46	**Minimum voltage for output A2**	The ModBus value changes the selected minimum voltage level for output A2. 0-110 = 0,0-11,0 Volts	0	110	Volts
40048	47	**Maximum voltage for output A2**	The ModBus value changes the selected maximum voltage level for output A2. 0-110 = 0,0-11,0 Volts	0	110	Volts
40049	48	**Period time for D1 at pulse output**	The ModBus value changes the selected period time for the D1 output pulse. 5-995 = 0,5-99,5 minutes.	5	995	min.
40050	49	**Period time for D2 at pulse output**	The ModBus value changes the selected period time for the D2 output pulse. 5-995 = 0,5-99,5 minutes.	5	995	min.
40051	50	**Period time for A1 at pulse output**	The ModBus value changes the selected period time for the A1 output pulse. 5-995 = 0,5-99,5 minutes.	5	995	min.
40052	51	**Period time for A2 at pulse output**	The ModBus value changes the selected period time for the A2 output pulse. 5-995 = 0,5-99,5 minutes.	5	995	min.
40053	52	**Runtime for increase/ decrease actuator**	The ModBus value changes the selected total runtime for increase/decrease actuator in even 2-second intervals	20	510	sec.
40054	53	**Valve exercise on output D1**	The ModBus value changes the selected day interval for valve exercise on output D1. 0=Exercise off.	0	30	days
40055	54	**Valve exercise on output D2**	The ModBus value changes the selected day interval for valve exercise on output D2. 0=Exercise off.	0	30	days
40056	55	**Valve exercise on output A1**	The ModBus value changes the selected day interval for valve exercise on output A1. 0=Exercise off.	0	30	days
40057	56	**Valve exercise on output A2**	The ModBus value changes the selected day interval for valve exercise on output A2. 0=Exercise off.	0	30	days
40058	57	**Temp. limit for activating the output of the secondary temperature sensor**	The ModBus value changes the selected temp. limit for activating the output of the secondary temperature sensor.	-25	+95	°C
40059	58	**Temp. limit for deactivating temperature sensor**	The ModBus value changes the selected temp. limit for sensor.	-25	+95	
40060	59	**Turn-on delay of the occupancy**	The ModBus value changes the turn-on delay of the DAY operation mode at occupancy indication.	0	255	min.
40061	60	**Turn-off delay of the occupancy**	The ModBus value changes the turn-off delay of the DAY operation mode at occupancy indication. 0-100 = 0-100 min. in one minute stages. 101-189 = 110- 990 min. in 10-minute stages.	0	255	min.
40062	61	**Activation limit of general 0-10V sensor**	The ModBus value changes the selected limit for activating an output etc. of a general 0-10V sensor.	0	100	%
40063	62	**Dectivation limit of general 0-10V sensor**	The ModBus value changes the selected limit for deactivating an output etc. of a general 0-10V sensor. 0 - 100% = 0,0 - 10,0 Volts	0	100	%
40064	63	**Activation limit of condensation sensor**	The ModBus value changes the selected limit for activating an output etc. of a condensation sensor. Resistive sensor: 0 - 100 = resistance, see table. 0-10V sensor: 0 - 100 = 0,0 - 10,0 Volts	0	100	

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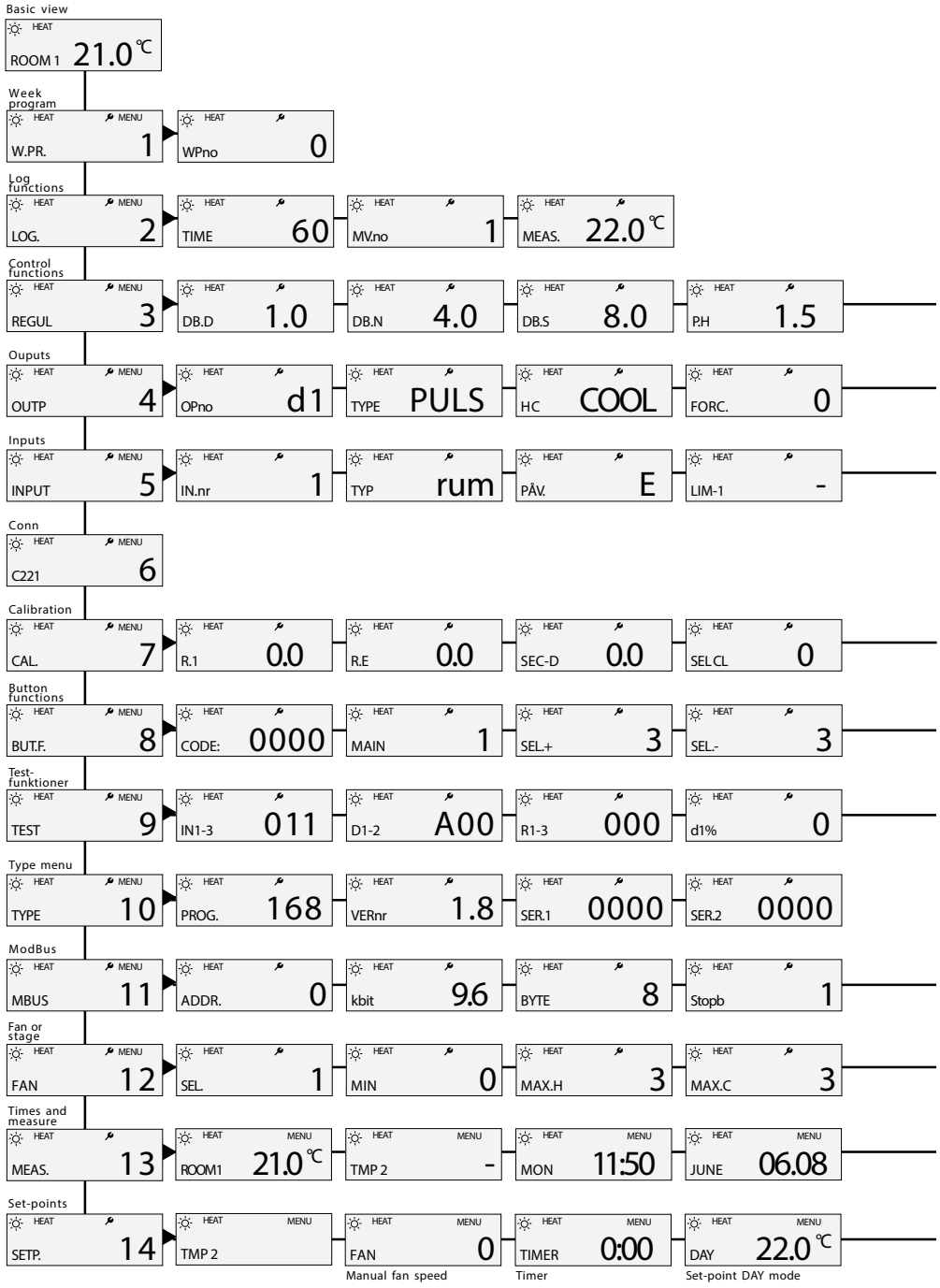
Register name	Reg. no.	Function	Description	Min	Max	Unit
40065	64	**Deactivation limit for the condensation sensor**	The ModBus value changes the selected limit for deactivating an output etc. of a condensation sensor. Resistive sensor: 0 - 100 = resistance, see table. 0-10V sensor: 0 - 100 = 0,0 - 10,0 Volts	0	100	
40066	65	**Clock, seconds**	The ModBus value changes seconds in the clock.	0	59	sec.
40067	66	**Clock, minutes**	The ModBus value changes minutes in the clock	0	59	minutes
40068	67	**Clock, hours**	The ModBus value changes hours in the clock	0	23	hours
40069	68	**Clock, days**	The ModBus value changes days in the clock.	1	7	days
40070	69	**Calendar, dates**	The ModBus value changes the date in the calendar.	1	31	dates
40071	70	**Calendar, months**	The ModBus value changes the month in the calendar. 1 - 12 = jan. - dec.	1	12	months
40072	71	**Calendar, years**	The ModBus value changes the year in the calendar. 0-99 = 2000 - 2099	0	99	years
40073	72	**Week program number**	The ModBus value changes the week program number. Only applicable to units with clock. 0 = week program not selected.	0	2	no.
40074	73	**Select fan speed or stage number, alternatively automatic control**	The ModBus value activates fan speed / damper stage number, alt. automatic control. 0-3 = manual selection of speed/stage 0-3. 4 = automatic control. 4 (=auto) can only be written. Reading shows 0-3 (=speed/stage no.)	0	4	
40075	74	**Power limit to activate fan speed 1 / stage 1**	Cooling or heating power limit in % to activate fan speed 1 or stage 1	10	100	%
40076	75	**Power limit to activate fan speed 3 / stage 3**	Cooling or heating power limit in % to activate fan speed 3 or stage 3	10	100	%
40077	76	**Time delay for activation or deactivation of fan speed / stage number**	The ModBus value changes the time delay for activation of fan speed 3 / stage 3 and deactivation of fan speed 1 / stage 1.	0	10	minutes
40078	77	**Filter alarm at fan speed control**	The ModBus value changes the fan operating time for the filter alarm or disables the alarm function. 0=alarm disabled. 1 - 99 = 100 - 9900 hours of operating time for the alarm.	0	99	hours
40079	78	**Turn-off delay of the MODE function**	The ModBus value changes the turn-off delay of the MODE function 0-100 = 0-100 min. in one minute stages. 101 - 189 = 110 - 990 min. in 10 minute stages.	0	189	minutes
40080	79	**0-10V Fan speed**	Read or write manual fan speed 0-3 or write 4=Automatic fan speec control	0	4	
40081	80	**Preselected time for timer**	Read or write preselected time for the timer function	0	255	hours
40082	81	**Time for timer**	Read or write time for the timer function	0	255	hours

8 Menu functions

Information is subject to change without prior notice.

8. Display overview

The display view may look different depending on the configuration of the control unit

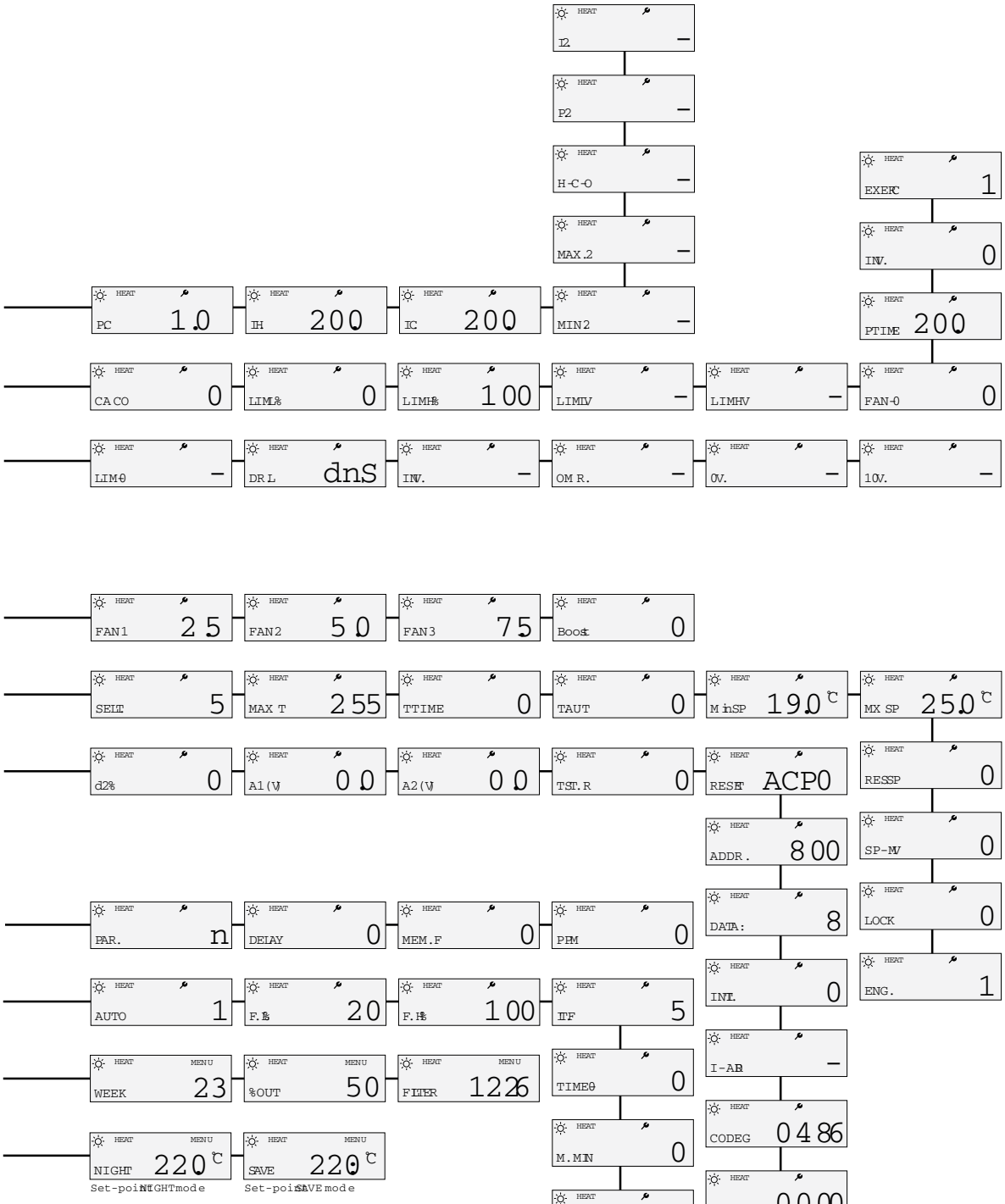


All function values is organized in a menu system shown above. There are 14 main menus and several sub-menus.

When displaying the basic view the MENU-symbol will be off. If INC or DEC button is pressed, the display will normally show the selected room temperature for the current operation mode (”Autoselect”).

The value can be changed directly with the INC/DEC buttons, The display will automatically return to show the main view after 5 seconds.

When the SELECT button is pressed, the selected function menu and the MENU symbol will flash. If the SELECT button is pressed, the display will show the next function menu. With the INC button you can go back to the previous menus. It is also possible to select menus by pressing the SET-button, and when the menu number is flashing you can change menu number with the INC/DEC buttons and the press SET again so the flashing stops.
When the right menu has been selected, the sub-functions is reached by pressing the DEC button. The INC button can be used to go back to the previous menu. After 3 minutes, or if the SELECT button is pressed for 1 sec. the display view will return to show the basic view, and the menu symbol will be off.



Changing configuration values

If a function value can be changed i MENU mode, the tool symbol will show on the display. When the SET button is pressed the value that can be changed under that menu will start to flash. The value can be changed with the INC/DEC buttons. When the SET button is pressed the value will stop flashing, or if several values are available, the next one will start flashing.

Information is subject to change without prior notice.

8.1 Week program

This settings menu is used for activating and setting the desired week program for control units with a built-in clock. The week program is used to automatically switch between mode NIGHT and DAY at selected times during the week.

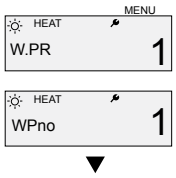
The control unit has two week programs, from which one can be active. The week program function only exists in control units of the type C222K-01.000. To activate a week program go to the display ”WPno” and set the desired program number (0-2) by pressing the SET button, and then on the INC/DEC buttons. Program zero means that no program is active.

Each program contains of six different program items, three for day and three for night mode. The week programs are preset; however, it is possible to set other times and week days.

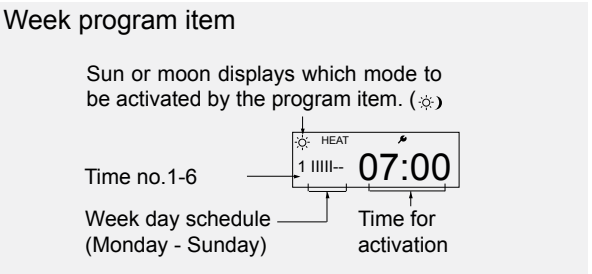
The week program to the right means that mode DAY is activated at 7-17 o’clock Mon - Fri. For the rest of the day mode NIGHT is active.

When you go to one of the displays for time no.1-6, the number of the program item is displayed, and seven items or lines valid for each week day. When a line is displayed for a week day it means that the program item becomes activated on this week day. A dot means that it does not become active on this week day.

To change the values of the program items you press the SET button one or several times until the value is flashing, and you then make adjustments with the INC/DEC buttons.







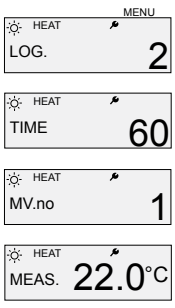
8.2 Log function

The control unit has a built-in log function where current room temperature with preset interval is saved. As default the log interval is set to once/hour.

The control unit can hold 220 log values.

The log interval can be set in the display ”TIME”, and is defined in minutes in area 0-255. Value zero deactivates the log function.

To read logged values the desired log item 1-220 is set in the display ”MV.no” where item 1 is the latest saved log. The log value itself is read off in the display ”MEAS.”.

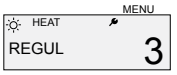


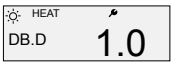
8.3 Control settings

In this menu you find the controllers adjustable control parameters for temperature control.

The following parameters exists:

a)	Dead band, day mode	”DB.D”	0.5 - 30.0 K
b)	Dead band, night mode	”DB.N”	0.5 - 30.0 K
c)	Dead band, save mode	”DB.S”	0.5 - 30.0 K
d)	P-range, heating	”P.H”	0.5 - 99.5 K
e)	P-range, cooling	”P.C”	0.5 - 99.5 K
f)	I-time, heating	”I.H”	0 - 99.5 min
g)	I-time, cooling	”I.C”	0 - 99.5 min





a)



b)



c)



d)



e)



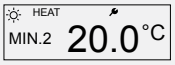
e)



f)

The following parameters are for the cascade controller:

h)	Lower temp. limit	”MIN.2”	2.0 - 30.0 °C or 2.0 - 95.0 °C
j)	Upper temp. limit	”MAX.2”	2.0 - 30.0 °C or 2.0 - 95.0 °C
k)	Closing at heating or cooling	”H-C-O”	0 - 1
l)	P-range	”P.2”	0.5 - 99.5 K
m)	I-Time	”I.2”	0 - 99,5 min



h)



j)



k)



l)



m)

Information is subject to change without prior notice.

8.4 Outputs, settings

In this menu you can select the functions of all the outputs of the control unit. There are two 24V outputs and two 0-10V outputs. These are called ”d1”, ”d2”, ”A1”, and ”A2”, where ”d” stands for digital, i.e. two levels, and ”A” means analog.

To choose which output to see or change in the menu you select this in the display ”OPno”. Press the SET button, until ”d1” starts to flash, and then select with the INC/DEC buttons. Press SET again to confirm the selection. The displays in this view, i.e. ”TYPE” to ”EXERC.”, is now displaying current settings for the selected output.

a) Type of output (”TYPE”)

Here you can select between the following types:

- Increase/decrease	”3p”
- On/off	”OnOF”
- Time proportional on/off (PWM)	”PULS”
- 0-10V	”0-10”
- No signal	”-”

Depending on which output is selected, only the applied signal types are displayed for each output.

Output A1 in control unit C221 the functions ”OnOF” and”-” are replaced with ”FAn3” and ”FAnC”, which is 0-10V fan speed control in threee steps or stepless control. See page 60.

b) Selection of heating and/or cooling output signal (”HC”)

Here you set whether the output should function as a cooling output or a heating output. You also have the possibility to let the output control both heating and cooling, for example for mixing valves or such.

Additionally, you can let the output be controlled directly by the room temperature. You then set the desired limit values in ”LIML” and ”LIMH” (see item c below).

- Cooling output signal	”COOL”
- Heating output signal	”HEAT”
- Heating/Cooling signal	”HC”
- Absolute temperature	”dIFF”

The controller automatically detects, on all outputs, whether there are only cooling outputs or heating outputs, or if there are both. This determines how the set point values of the controller work. If there, for example, are no outputs set as cooling outputs, the controller is controlling without dead band, i.e. directly on preset set point value. As soon as the controller detects that both heating and cooling outputs exists, the dead bands are used.

c) Selection forcing of output

Forcing means that the output is activated by the timer in the main menu.
0= Forcing deactivated







a)



b)



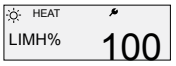
c)



d)



e)



e)



f)



f)



g)



h)



j)



k)

Information is subject to change without prior notice.

1= Forcing activated

d) Selection of cascade control (”CASC.”)

(Control settings, see menu 3 ”REGUL”) or selection Change Over ”C-O” (see page 33).

e) Setting of the control area (”LiML%” / ”LIMH%”)

The controller has a PI-function calculating the ef fect requirement of the room. This signal is then connected with different outputs. Normally for example outputs ”d1” and ”A1” are set to controlling between 0 to 100% of the cooling power requirement, i.e. the complete cooling output signal.

If you wish to reset the outputs to get for example two stage cooling in sequence, you can set that for example output ”d1” should act between 0-50% of the cooling power requirement, and output ”d2” is then reset for cooling control and set to area 50-100%. These outputs are then acting in sequence.

In the above example the outputs ”d1” and ”d2” are set on the following values:

”d1”	HC	=	COOL
”d1”	LiML%	=	0%
”d1”	LiMH%	=	50%
”d2”	HC	=	COOL
”d2”	LiML%	=	50%
”d2”	LiMH%	=	100%

If the output type is set to ”dIFF”, these displays are changed to ”LIM.-1” resp. ”LIM.-0”. In the display ”LIM.-1” the room temperature to give full output signal on the output is set, and on ”LIM.-0” the temperature to give zero signal on the output is set.

f) Setting of voltage limits for analog outputs AN1 Wresp. AN2.

Example: ”LiML V” is set to 2,0 Volts and ”LiMH V” is set to 7,4 Volts. The output value to the control output is ”re-scaled” so that it is modulated between 2,0 - 7,4 Volts for the complete selected control area.

At forcing or exercising the voltage is set to the value in ”LIMH V”, and at the signal ”Output off” the voltage is set to the value in ”LIML V”. ”LIML V” and ”LIMH V” an also be used for calibrating the output voltage.

The minimum voltage limit does not apply at the operation mode SAVE or if the output is deactivated because of the condensation function.

g) Selection if output should be off when the fan is off (”FL-O”)

0 = Output can control even if the fan is off
1 = Output cannot control if the fan is off

h) Setting of time proportional period or operating time to increase/decrease actuator (”PTIME”)

Here the period time is set if the output has the type ”PULS”, i.e. time proportional on/off. The period time is set to 20.0 minutes as default. The time pro portional function is sometimes called ”PWM”, i.e. pulse width modulating.
This means that the controller transforms an output signal between 0-100% to pulses with varying times.If the output signal for example is 50%, the output gives 24V in 50% of the period time (i.e. 10 minutes), and is then closed for the rest of the period (i.e. 10 minutes).
If the outputs d1 (and d2) are set as increase/decrease outputs, you here set the actuator’s total operating time between the end positions, in number of seconds. The initiation value is 120.

j) Inversion of output signal (”INV.”)

Here you can select that the output signal should be inverted on the output. This applies to all output types. It is for example common that electro thermal actuators are used with normally open function, which requires the output signal to be inverted.

k) Automatic valve exercise (”EXERC”)

A normally activated function is the automatic valve exercise. It makes the actuator reach open position during 3 minutes once/day, regardless of normal output signal. This to prevent valves to get stuck when they sometimes are closed during long periods, for example during summer.

Here you set in which interval the actuator should exercise the valve, from 0 to 30 days. If the value 0 is set, the function is deactivated.

The exercise is activated with desired interval in the nights between 01.00-01.03 o’clock for output d1 and a1, and at 01.30-01.33 for outputs d2 and a2.

8.4b Output A1, if controlling fan

This page is only valid if output A1 is used to control the fan speed.

Initial values at start-up is not adapted for 0-10V fan speed control. The values shown in the display views below are only examples of values that could be suitable for fan speed control in 3 steps.

a) Output type (”TYPE”)

FAN3 = Fan speed control in 3 steps
FANC = Stepless control at automatic operation

b) Select heating and/or cooling function (”HC”)

HEAT = Fan active only for heating
COOL = Fan active only for cooling
HC = Fan active for cooling and heating
DIFF = Do NOT use

c) Forcing the fan (”FORC”)

Forcing function is activated by the timer function under the main menu. During this selected time the fan will operate at the highest speed.

0 = No forcing
1 = Forcing activated

d) Setting the lower control area (”LIML%”)

3 stage control: The upper limit for fan speed 1. The limit for fanspeed 2 is always between LIML and LIMH. When using stageless control LIML is used for setting the lower control area of the fan.

e) Setting the higher control area (”LIMH%”)

3 stage control: The upper limit for fan speed 3. The limit for fanspeed 2 is always between LIML and LIMH. When using stageless control LIMH is used for setting the upper control area of the fan.

f) Minimum and maximum voltage on the output ”LIML V” for lowest and ”LIMH V” for highest allowed voltage. Applies at operation mode DAY and NIGHT, not SAVE.

g) No function when in fan speed control.

h) 3-stage control: The time delay in minutes before changing fan speed to the next lower stage. The speed for increasing the fan speed is always 10 seconds, but if ”P.TIME” is set to a lower value than 1 minute, the speed for increasing the fan speed will be without any delay at all.

Stepless control: Delay time for changing the fan speed. Value = Number of minutes for 100% speed change.







a)



b) Initialized to: COOL *(Change to HC if the fan also controls heating).*



c)



d) Initialized to: 0 *(Change to 1 if the fan needs to be at speed 0, off).*



e)



f)



f)



g)



h) Initialized to: 20 *(Change to 1-2 for a more rapid reaction of the automatic fan speed change).*



i)



j) Initialized to: 1 *(Change to 0 to allow manual fan speed control).*

i) Fan cut-off (”HC-0”)

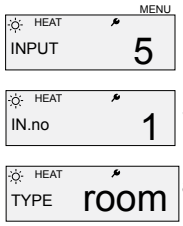
1 = ”Cut-off” when the voltage on output A1 has a minimum limitation. Output A1 = 0V in heating mode at ”COOL” and in cooling mode at ”HEAT” even if ”LIML V” is not set to 0.

j) Lock functions for button influence of fan (”LockF”)

0 = Not locked, all functions are available.
1 = In heating mode & ”COOL” alt. cooling mode & ”HEAT”: Button influence locked and the fan is disengaged.
2 = As ”1” but stage 0 cannot be selected manually.
3 = As ”1” but stage 3 cannot be selected manually.
4 = As ”1” but stage 0&3 cannot be selected manually.
5 = Automatic fan speed control is enabled and button influence is locked. The fan speed can however be read.

Voltage settings for the output A1 stage 1-3 and voltage ”BOOST” functions: See menu 7 ”CAL” on page 66.

8.5 Inputs, settings



Selection of input

a)

In this menu you can select the functions of the control unit's three inputs. They are called "IN1", "IN2" and "IN3". To select which input to see or change in the menu, use the display "IN. no". Press the SET button,
until the number starts to flash, and then select the input with the INC/DEC buttons. Press SET again to confirm the selection. The displays in this display, i.e. from "TYPE" to "10V", now shows the current settings for the selected input.

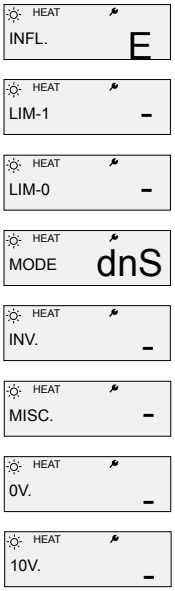
a) Type of input ("TYPE")

Here you can select between the following types:

-	No function
room	Selection external room sensor for control *Only applies to IN1*
tEMP	Selection external temp. sensor for control of output and for cascade control *Only applies to IN2*
OCC	Selection occupancy function
SEtP	Selection external connection of the operation mode and control of output
0-10V	Selection 0-10V sensor for control of output
cond	Selection condensation function. *Only applies to IN3.*

You cannot select the same input type for several inputs.

The following functions, **b)** to **j)**, may have different functions and initiation values for different input types. These are therefore described separately on the following pages.



b)
c)
d)
e)
f)
g)
h)
j)

"room": Selection external room sensor for control

If no sensor is connected the controller uses the room unit's built-in sensor.

b) Selection average value between external sensor and sensor in room unit.
E = Selection of temp. (only from external sensor).
IE = Selection of temp. (average value between external sensor and sensor in room unit).

c) No function.

d) No function.

e) Selection at which operation modes the external sensor will apply.
d = DAY, n = NIGHT och S = SAVE.

f) No function.

g) No function.

h) Selection 0-10V sensor and selection of temperature at 0 Volts.

j) Selection 0-10V sensor and selection of temperature at 10 Volts.

”tEMP”: Selection external temp. sensor for control of output and cascade control

This function can only be selected on input 2, ”IN2”. The temp. value is shown in the measurement value menu, if input ”0-10V” is not selected.

b) Selection which output to be influenced when the function condition is fulfilled.
Output d1, d2, A1 or A2. Also R1-R3 (relay 1-3) when fan or damper control is not selected.
Selection influence: 1 = output on, 0 = output off.

c) Temp. limit for influencing an output.
When temp. value < selected value the output is influenced.
If inversion is selected below, the output is influeced when the temp. > the selected value.

d) Temp.limit for disconnecting influence of output.
When temp. value > selected value the influence is disconnected.
If inversion is selected below, influence is disconnected when temp. < selected value.

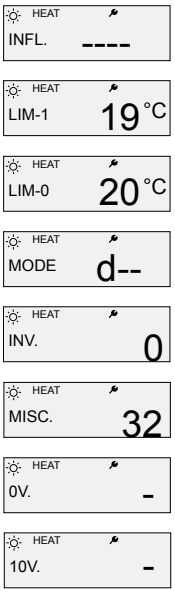
e) Selection at which operation modes influence from this sensor will apply.
d = DAY, n = NIGHT och S = SAVE.

f) 1 = Selection of inversion of the function conditions.
See c) and d) above.

g) Selection of temperature area:

h) Selection 0-10V sensor and selection of temperature at 0 Volts.

j) Selection 0-10V sensor and selection of temperature at 10 Volts.



32 = 0-32°C with the resolution 0,1°.
128 = -30 - +98°C with the resolution 0,5°
run°C = Comparison with the current room temperature occurs instead of the values ”LIM-1” and ”LIM-0”, whose data is then displayed as lines.

”OCC”: Selection occupancy function with switch input

When the occupancy function is selected but occupancy not indicated, mode NIGHT will usually be activated instead of DAY. At occupancy indication DAY is activated.

b) No function.

c) Turn-on delay in minutes.
Occupancy indication must have happened sometime during the first and second half of the time period to make the occupancy activate the day operation mode. This to avoid unintentional activation.

d) Turn-off delay in minutes.

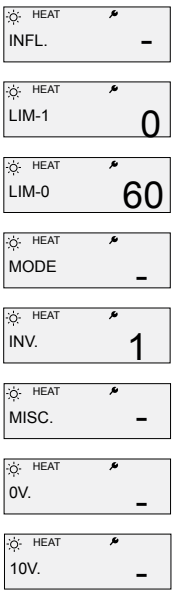
e) No function.

f) 1 = Selection inversion of input.
Occupancy is connected when the contact is open.

g) No function.

h) No function.

j) No function.



”MODE”: Selection activation of operation mode and/or influence of output with an extenal contact



b)



c)



d)



e)



f)



g)



h)



j)

b) Selection which output to be influenced when the function condition is fulfilled.
Output d1, d2, A1 or A2. Also R1-R3 (relay 1-3) when fan or damper control is not selected.
Selection of influence: 1 = output on, 0 = output off.

c) No function.

d) Turn-off delay in minutes.

e) Selection which operation mode to be activated when the contact is closed.
d = DAY, n = NIGHT, S = SAVE and - = No influence.

f) 1 = Selection inversion of input.
The operation mode is activated when the contact is open.

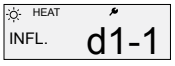
g) No function.

h) No function.

j) No function.

”0-10”: Selection external 0-10V sensor for control of output

E.g. 0-10V condensation sensor can be connected to this input for condensation function. The % value from the sensor (0-100% corresponds to 0-10V) is displayed in the measurement value menu.



b)



c)



d)



e)



f)



g)



h)



j)

b) Selection which output to be influenced when the function condition is fulfilled.
Output d1, d2, A1 or A2. Also R1-R3 (relay 1-3) when fan or damper control is not selected.
Selection influence: 1 = output on, 0 = output off.

c) % limit for influence of output (0-10V corresponds to 0-100%).
When the sensor value in % > the selected limit value, the output is influenced. If inversion is selected the output is influenced when the sensor value in % is < the selected limit value.

d) % limit for disconnection of influence of output. (0-10V corresponds to 0-100%).
When the sensor value in % < the selected limit value the influence is disconnected. If inversion is selected the influence is disconnected when the sensor value in % is > the selected limit value.

e) Selection at which operation modes the influence from this sensor will apply.
d = DAY, n = NIGHT och S = SAVE.

f) 1 = Selection inversion of input.
See c) and d) above.

g) 1 = Selection that the voltage from the sensor is transformed within the area selected in the functions ”LIM-1” and ”LIM-0” (”P-range”) and is supplied to output A1 if this voltage is higher than the one from the control supply to this output

h) No function

j) No function

Information is subject to change without prior notice.

”cond”: Selection condensation function with resistive or 0-10V sensor.

This function can only be selected on input 3, ”IN3”.

b) Selection which output to be influenced when the function condition is fulfilled.
Output d1, d2, A1 or A2. Also R1-R3 (relay 1-3) when fan or damper control is not selected.
Selection influence: 1 = output on, 0 = output off.

c) If resistive sensor is used:
The limit value corresponds to a resistance value on the sensor. Higher value = higher resistance = less condensation. ***See table below!***
If the resistance is < than the selected limit value (more condensation), the output is influenced.

If 0-10V sensor is used:
% limit for influence of output. (0-10V corresponds to 0-100%). When the sensor value in % > the selected limit value, the output is influenced.

d) If resistive sensor is used:
The limit value corresponds to a resistance value on the sensor. Higher value = higher resistance = less condensation. ***See table below!***
If the resistance is > than the selected limit value, i.e. less condensation, the influence of the output is disconnected.

If 0-10V sensor is used:
% limit for disconnection of influence of output (0-10V corresponds to 0-100%). When the sensor value in % < the selected limit value, the influence of the output is disconnected.

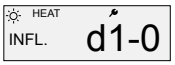
e) No function.

f) No function.

g) 1 = Selection that the cooling set point value from the room controller should not be set to zero when the function is active.

h) Selection 0-10V sensor.

j) Selection 0-10V sensor.



b)



c)



d)



e)



f)



g)



h)



j)

Table showing which resistance on the resistive sensor the limit values corresponds to:

Limit value	Resistance kOhm
100	10000
99	4000
98	2000
97	1300
96	1000
95	800
94	600
92	500
90	400
86	300
82	200
74	150
62	100
47	60
19	40
0	30

8.6 Displays type of controller



This display shows which type of controller the room unit is connected to.

8.7 Calibration

Here you can recalibrate the built-in temperature sensor in the room unit (R.I) and the external sensor (R.E). You can also adjust the clock in number of 1/10 seconds per day (SEC-D), select whether the clock should be displayed or not, and if it should be automatically adjusted according to daylight-saving time (SEL.CL).



SEL.CL 0 : Clock and calendar is not displayed. Only a line is displayed.

1 : Clock and calendar is displayed, but no adjustment according to daylight-saving time.

2 : Clock and calendar is displayed, and automatic adjustment according to daylight-saving time.









The values are valid if the voltage is 0-10V and is not limited from any voltage settings in the output menu. These values can also be considered as percentage values within the selected limitation values under menu 4 (the output menu).

Example:
If the voltage limit is set to 0,0-5,0 Volts, the values under this menu, function ”FAN 3” can be seen as 75% of 5,0 Volt (3,75 Volt).



Voltage (Volt) at fan speed 1



Voltage (Volt) at fan speed 2



Voltage (Volt) at fan speed 3



Boost function at activation
Temporarily boosts the voltage output for the fan output signal at 3 stage controlling. Shows number of seconds that the output signal will be forced to 10 Volts at startup.

8.8 Button functions

In this menu you can set how the basic view should work, add access protection and set limits for day set point value, and more.



a) Code for access protection (”CODE:”)



Here you can define a system code preventing unauthorized users to enter the settings menu from the main menu. At delivery the system code is always set to ”0000”, meaning that the protection is not active. If a code for access protection is selected it can also be configured how to function by setting the values for functions ”MAIN” and ”SEL.+”:

If ”MAIN” =0 and ”SEL.+” =0
Only the measurement value is shown, but can be selected with the arrow buttons.



b)

If ”MAIN”=0 and ”SEL.+” is not =0
Function according to ”SEL.+” is continuously shown. The value can be changed with the INC/DEC buttons.



c)



c)

If ”MAIN” is not =0 and ”SEL.+” =0 and ”SEL.-” =0
Measurement value according to ”MAIN” is continuously shown. The value cannot be changed with the INC/DEC buttons.



d)



e)

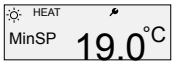


f)



g)

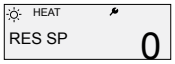
If ”MAIN”is not =0 and ”SEL.+” is not =0
The SELECT button shows measurement value according to ”MAIN”. This measurement value is also shown auto-matically after 5 sec. Function according to ”SEL.+” and ”SEL.-” is shown/changed with the INC/DEC buttons.



h)



j)



k)



l)



m)



n)

b) Selection of display in basic view (”MAIN”)

Here you select which value to be shown in the basic view. As default the room temperature is shown.

Value 0 ”Autoselect”	=	No value is shown. If the function is active (see ”d” on next page), this is shown instead; otherwise the basic view is removed completely and you will then always be in the main menu or in a sub-menu.
Value 1	=	Room temperature
Value 2	=	Value from secondary sensor or general 0-10V sensor.
Value 3	=	Week day and time
Value 4	=	Month and date
Value 5	=	Year and week number
Value 6	=	Output signal in percentage to outputs

c) Selection of Autoselect function (”SEL.+”) and (”SEL.-”)

The Autoselect function makes you reach a certain display view when you press one of the INC/DEC buttons from the basic view. As default the temperature value is selected. ”+” indicates the red and ”-” the blue DEC button.

Value 0 = No Autoselect active
Value 1 = Timer function
Value 2 = Possible fan or damper function
Value 3 = Set point value (for the current operation mode)

d) Return time from Autoselect (”SEL.T”)

When you have pressed the INC/DEC buttons in the basic view, the control unit automatically goes to the predefined display. When you are ready and do not press anymore, the control unit returns to the basic view again, after this return time, which normally is 5 seconds. A value between 3 to 99 seconds can be selected.

After 3 minutes (or if SELECT-button is pressed 1 second) the display will return to show the main view.

e) Maximum timer time (”MAX T”)

Here you can limit how many hours you wish to allow making settings for in the timer function. A value between 0 to 255 can be set. If the value zero is set, you cannot activate the timer function from the main menu at all. The default value is 255.

f) Predefined timer time for button B and possibly C (TTIME)

If any value between 1-255 is selected, the B button (and also the C button if this is not used for fan or damper control) will activate the timer during the selected time. The operation mode for the timer that can be selected with the SELECT button is activated during this time. The timer time can be changed with the INC/DEC buttons.

g) Automatic timer (”T.AUT”)

Value 0 = Function deactivated

Value 1-3 = Selection of automatic connection of the timer during selected time when the INC/DEC button is pressed to change the room temperature. The selected operation mode for the timer is then activated. The room temperature is changed by repeatedly pressing the INC/DEC button. The timer time is pre-selected with the function ”TTIME” that is initiated to 1 hour.

Value 1 = main operation mode = DAY
Value 2 = main operation mode = NIGHT
Value 3 = main operation mode = SAVE

h) Min. limitation of day set point value (”MinSP”)

Here the lowest set point value to be allowed in the control unit’s day mode is set. If this value is the same as or higher than the max limitation (”MX SP”), the set point value setting is locked.

i) Max limitation of day set point value (”MX SP”)

Here the highest day set point value to be allowed in the control units day mode is set. If this value is the same as or lower than the min. limitation (”MinSP”), the set point value setting is locked.

k) ”RES.SP”: Reset DAY temperature and activation of the automatic fan speed control.

By setting this value to 1, the controller will reset the DAY mode temperature to a mean value between the ”MIN B” and ”MAXB” (initially 22°C) when the operation mode is set back to DAY. The fan speed control will also be reset to auto when the operation mode is changed to NIGHT or SAVE.

l) Display of desired temperature (”SP-MV”)

You can select that the set temperature for the current operation mode is shown to the left on the display, together with the measurement value ”ROOM1”. This value should then be set to 1.

m) Lock function for set point values, clock etc. (”LOCK”)

When LOCK = 1 you cannot change any values except for the following which can be limited separately:

- Day set point value
- Timer time
- Fan speed / stage number

n) Menu language selection

Value 0 = Swedish text
Value 1 = English text

8.9 Test functions

In this menu you can, for example, monitor inputs and outputs, perform temperature simulations, reset the software etc.



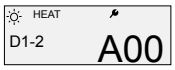
a) Status for inputs (”IN1-3”)



a)

The display shows status of input 1-3 when they are used as contact inputs. 0 = Open contact and 1 = closed contact.

b) Status for outputs (”d1-2”)



b)

Here you can see the status of the two 24V outputs in the control unit. The first number from the right shows the status of output ”d2”. Next number shows the status of output ”d1” (cooling).

The letter A at the left you can reset to an ”n”, if you wish to force any of the outputs, by pressing the SET button and then the arrow up button. Then press the SET button again to jump to the next number, the value can then be adjusted to 1 or 0, to force each output.

When manual operation is selected the AUTO symbol is flashing on the display. The forcing is automatically deactivated after 2 hours.

c) Status for relays (”R1-3”).



c)

Here you can see the status of a possible connected relay unit. At manual operation the relays can be adjusted with the SET and INC/DEC buttons.

d) Reading of supplied effect value in % to output d1 resp. d2. The value is flashing when it is forced via data communication.



d)



d)

e) Voltage on analog output A1 or A2.
When manual operation is selected with the above function this voltage can be set with the SET and INC/DEC buttons. The value is flashing when it is forced via data communication.



e)



e)

f) Override of room temperature (”TST.R”)

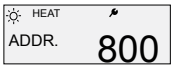


f)

To enable simulation and test of the control functions in the control unit, you can inactivate the reading of input 1 and 2, and instead set desired (simulated) room temperature in the basic view, by firstly activating the override ”TST.R” with value 1, and then return to the basic view and pressing the SET button. You can then set the desired room temperature. When the simulation is active, the symbol AUTO is flashing on the room unit’s display. This function is automatically deactivated after 2 hours. At forcing via data communication ”F” is shown.



g)



h)



h)



j)



k)



l)



l)



Production test program.
Can only be connected by staff from Zone Controls AB.

Information is subject to change without prior notice.

g) Resetting software (”RESET”)

If you wish to restart the software in the control unit or reset all values to the status at delivery, the reset function can be used. The following reset functions are available:

A = Reset all (i.e. all values are reset to the fixed delivery values from the ROM memory) NOTE! This can only be done by Zone Controls, with a special code.
C = Reset all but clock time. Functions having a certain customer initiation value are reset to this value. Other functions are reset to the fixed delivery values from the ROM memory.
P = ”Common” restart
0 = Not used. Must be zero!

Press the SET button to switch between the different reset functions, and confirm your selection by pressing the red INC button.

h) Reading of values in RAM memory (”ADDR.”) and (”DATA”)

To make certain fault tracing or other analysis, reading of the controller’s RAM memory may be needed. In the display ”ADDR.” the address is given and the value can be read off on the display ”DATA”.

j) Optional function ”INIT”. This value can only be changed by staff at Zone Controls AB, or when a temporary code has been given. When the value is set to 1, all function values are registered, whereby they are changed in a customer related memory.

At customer reset (see item e) the changed parameters are reset to these values instead of the factory set values. The function is set to zero with the SET and INC/DEC buttons at voltage failure, or automatically after two hours.

k) With the function ”I-ADR” you can read off which functions that:

1. Have been changed in a common way with the SET and INC/DEC buttons, and thereby are different from the original values.
2. Have gotten a certain customer initiation according to item j.

When SET and INC/DEC up are pressed the next function address with a different value according to above is shown. When INC is pressed again the next address is shown. When all addresses have been shown a line is displayed. When DEC is pressed the set value is shown if it is different from the original value. Otherwise a line is displayed. When DEC is pressed again the customer related original value is shown if it is different from the factory set value. Otherwise a line is displayed. When DEC is pressed again, the address is displayed once again.

The displayed address and data values are to be interpreted by staff from Zone Controls AB.

l) Special code for protected system functions (”cODEG”) and (”CODES”).

Some functions in the control unit are protected to prevent making incorrect hardware settings. In some cases some settings may be needed anyway, and they are then available with the special code.

Go to the display ”cODEG” and read off the number there. Contact Zone Controls to get a temporary special code, to be entered in the display ”CODES”.

8.10 Type designations



This menu helps you identity the software and its version in the product. You can also read the products serial number.



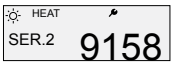
a) Software number (”PROG.”)



b) Version number (”VER.n”)



c) Serial number (”SER.1”) and (”SER.2”)



To read off the correct serial number the numbers in ”SER.1” should be interpreted from right to left as a unit, in ten, in hundreds, and in thousands.

The numbers in ”SER.2” are interpreted from right to left in ten thousands, hundred thousands, millions, and ten millions.

8.11 Communication menu - ModBus



In this menu you can make settings that may be needed for ModBus communication.



a) Address. Each unit should have its own address within the area 1 - 247.
The address is first of all set with a dip switch on the control unit’s circuit card. The selected address is shown here. The address can also be selected here with the SET and INC/DEC buttons. Then an ”F” is displayed in front of the address.



b) Transmission speed kbit/s.



c) Number of data bits per byte.



d) Number of stop bits



e) Parity, ┌┐ = None, ┌ = Odd, E = Even.



f) Extra time delay before sending answer in ms.



g) Selection, store of forcing data from data communication at voltage failure.
NOTE! The memory has a limited life time.
If storing of forcing data is selected:
Do not write forcing data more than once/hour during a long period of time.



h) Reading PPM (0-2000) via ModBus 0-2000 instead of 0,0-10,0 Volt. Applies only to ModBus register 30004.

8.12 Damper stage or fan functions



In the program version with fan control the functions below are valid. The function ”SEL.” =1 cannot be reset.



In the program version without fan control the menu text ”STAGEr 12” is shown. The function ”SEL.” is initiated to 0, and all function values in this menu displays lines. ”SEL.” can be reset to 1, whereby control of relays in a connected relay unit are connected for, for example, control of dampers in sequence. The control is performed in the same way as for a fan according to the functions in this menu, except for that filter alarm cannot be activated, and that the relays can be activated simultaneously. Functions for relay control under the SELECT and C buttons are also activated, as well as at fan control, but the text on the display shows ”STAGE” instead of ”FAN”.



	Relay 1	Relay 2	Relay 3
Stage 0	0	0	0
Stage 1	1	0	0
Stage 2	1	1	0
Stage 3	1	1	1

In this menu you can set the way you want the fan speeds to be able to be controlled manually and in auto mode.



a) Min. limitation of fan speed, auto mode (”MIN”)



b) Max. limitation of fan speed, auto mode with influence of heat requirement (”MAX.H”)



c) Max. limitation of fan speed, auto mode with influence of cooling requirement (”MAX.C”)



d) Selection whether or not auto mode should be possible to set.
0 = Auto cannot be connected
1 = Auto can be connected
2 = Auto cannot be disconnected



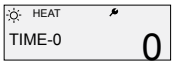
e) Selection of fan sequence stage 1 in percentage of the cooling and heating output signal, auto mode (”F.L%”)



f) Selection of fan sequence stage 3 in percentage of the cooling and heating output signal, auto mode (”F.H%”)



g) I-time for automatic fan control (”IT.F”)
Here you set the time in minutes that the controller may use to stage from speed 0 to 3, at a change from 0 to 100% cooling or heating requirement.



h) Selection of fan turn-off delay in minutes.



j) Min. limitation of fan speed, manual mode (”M.MIN”)



k) Max. limitation of fan speed, manual mode (”M.MAX”)



l) Selection of fan mode at start of the controller, at for example a voltage failure (”INIT.”)

- = *Fan mode according to below, valid at the voltage failure.*
- *0* = *Fan speed 0*
- *1* = *Fan speed 1*
- *2* = *Fan speed 2*
- *3* = *Fan speed 3*
- *A* = *Auto mode*



m) Fan operating time in hours for filter alarm. The value zero deactivates the alarm function.

Information is subject to change without prior notice.

8.13 Times and measurement values

To switch between different views, press the INC/DEC buttons. The changeable values are week day, time, month, date and year, given that the control unit has a built-in real time clock (or if you activate clock view in menu 7). To change a value, press the SET button and one of the values starts to flash and you can then change the value with the INC/DEC buttons. To go to the next value, press the SET button again.



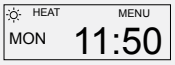
menu ”Times and measurement”



current room temperature



secondary temperature
(or value in % for 0-10V sensor)



week day and time

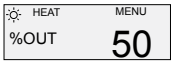


month, date and year



week number

These values are shown only if the control unit has a real time clock (C221K/ C222K), or if clock view is activated in menu 7 ”CAL” (funktion ”SEL.CL”).



Output signal in percentage to outputs
If a symbol is shown before the % value a function is forcing the operation mode, as follows:

= week program
= data communication
= external signal
= occupancy
= timer



operating time, in hours
If filter alarm is activated the text ”change” is flashing when the time reaches the alarm limit.
(read more in chapter 4.7)

8.14 Set points menu

To switch between views, press the INC/DEC buttons.

a) Fan speed / stage(step) (”FAN / STEP”):

This view is only shown if the function is activated under menu 12.

To change the current fan speed or stage number, press the SET button first, and the the INC/DEC buttons. If you press the DEC button, the fan speed/ step is lowered. If you press the INC button, the fan speed/step is increased from 0-1-2-3-Auto. ”Auto”, the automatic fan speed control / step control is controlled by the heat or cooling demand. An active function is indicated with the letter ”A” in the numerical field of the display.

The fan speed / step control function is also indicated on the display by showing the ”FAN” symbol on the room units display. If automatic control is activated, the display will also show the ”AUTO” symbol

Quick button for fan speed / step:
The C button can be used for showing or changing the current fan speed / step. If pressed repeatedly, the the fan speed / step will increase or the automatic mode will be activated the same way as when the INC button is pressed.
If you press the C button while in automatic mode, the automatic mode will deactivate and the fan speed / stage will go to zero (stop) or to the lowest minimum value that is set, see chapter 4.7.2.

If none of the functions ”FAN” or ”STEP” is activated, the C button has the same function as the B button (quick button for the timer, explained below).

b) Timer function, (”TIMER”):

The timer function can temporarily, during a selected period of time, change the operation mode or force an output.

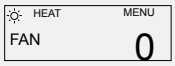
The display shows hours and days. If the timer is activated to change operation mode, the sun and moon symbols shows which operation mode the timer function will activate during the selected time. To change the timers operation mode, press the SET button twice, and then the INC/DEC buttons.

To set the timer, press the SET button and the INC/ DEC buttons. If the time 0:00 is set, the timer fuction is deactivated.
When activated, the sun and moon symbols will flash on the display (in all display views except the timer view).

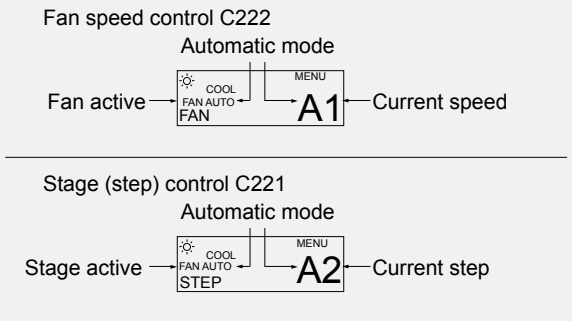
If the forcing function is selected for any of the outputs the timer is used to force the output to be active during the selected period of time, see chapter 6.4.



Set points menu

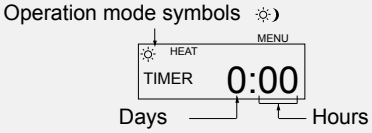


a) fan speed /stage
(only shown if the function is active)





b) timer function

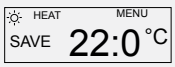




c) set point temperature, day



c) set point temperature, night



c) set point temperature, save

Quick button for timer function:
When the B button is pressed, the timer will be active for 1 hour and the operation mode DAY will be activated. There is a function under menu 8 ”T TIME” that has to be set to the desired timer value in number of hours.
If the B button is pressed during an active timer, the timer will restart. It is also possible to change the timer temporarily after pressing the B button with the INC/DEC buttons. The operation mode that is activated by pressing the B button cannot be changed.

If none of the functions ”FAN” or ”STEP” is activated the C button has the same function as the B button.

c) Set point (desired) temperature, (”DAY / NIGHT / SAVE”):

There are 3 different levels for a desired temperatures that the control unit can select depending the operation mode, that is day, night and save.
The operation modes can be controlled by a timer, occupancy detection, data communication or a week program. As default, the operation mode DAY is always active. The temperatures for the operation modes can be changed by selecting each display view and change the values with the SET buttons and then the INC/DEC buttons.

Information is subject to change without prior notice.