CR24-.. Single room controllers

Table of contents

Single room controllers

CR24-B1   CR24-B2   CR24-B2E   CR24-B3

VAV applications   Compact   Universal

Water applications

Rotary actuators and
control ball valves

Air applications

Damper actuators

Brief description

The new developed CR24-.. controller generation provides the foundation for modern single room concepts.

The technology, functionality and handling of the new microprocessor-controlled room temperature controllers are perfectly adapted to the BELIMO actuators for motorized air and water final controlling elements.

The functional classification into three basic types with up to three output sequences and the large number of specific applications facilitate cost-effective system solutions for individually controlling the room climate and reducing energy consumption. The controllers can be used in both pure VAV and combined systems with 2 and 4-pipe water applications (radiators, air heaters/coolers, heated/chilled ceilings).

Device variants

Standard CR24-**B**.. type with operator panel (setpoint adjustment, mode switch and status indication). For operation, refer to page 15.

Type CR24-**A**..: same functionality as the CR24-**B**.. but without an operator panel.

Notes
Unless otherwise expressly mentioned, all references contained in this document to the CR24-**B**.. also apply to the CR24-**A**...

Accessories

Mechanical accessories

Type	Description
CRZA-A	Spare cover for A-types
CRZA-B	Spare cover for B-types (with operation panel)
CRZW	Spare baseplate, fitting to all types

Overview of CR24-B.. functions

	CR24-B1	CR24-B2	CR24-B2E	CR24-B3
Power supply AC 24 V / 50/60Hz	●	●	●	●
Application / Temperature range				
– Room temperature control in comfort zone	●	●	●	●
– Internal temperature sensor (Type NTC, sensing range 10...45°C)	●	●	●	●
– Setpoint (adjustment range 15...36°C)	●	●	●	●
Operation (CR24-B.. only)	●	●	●	●
– Mode selection Switch: AUTO – ECO – MAX	●	●	●	●
– Mode indication LEDs: AUTO – ECO – MAX	●	●	●	●
– Setpoint adjustm. Rotary knob: ±3 K	●	●	●	●
Inputs Number	4	5	5	5
– Energy hold off	●	●	●	●
– Stand-by	● [1]	●	●	●
– Change-over	● [1]			● [2]
– Chilled ceiling with dew point limiting and change-over				● [2]
– Air flush		●	●	
– Boost			●	● [2]
– External temperature sensor (Type NTC, sensing range 10...45°C)	●	●	●	●
– External setpoint shift 0...10 V	●	●	●	●
Outputs Number	1	2	3	3
– (0)2...10 V system output for Belimo VAV controller or change-over	● [3]			
– (0)2...10 V system output for Belimo VAV controller		●	●	●
– Heating output 3-point		●	●	●
– Electrical reheater 1 ... 3 stages or on/off radiator valve			●	
– Heating or cooling output, change-over 0...10 V				● [4]
Functions				
– Control characteristics	P	P	P	P / PI
– P-band switchable	●	●	●	●
– Boost function $\dot{V}_{max}$ or temperature-controlled, selectable				●
– Boost function temperature-controlled			●	
– Volume increase in heating mode, selectable		●	●	●
– Internal function test, including nominal voltage test	●	●	●	●
– Commissioning mode with output and sequence simulation	●	●	●	●
– VAV controller diagnosis via integrated PC-Tool connection	●	●	●	●
Mounting Surface mounting with flush-mounted or surface-mounted connection	●	●	●	●
Housing colors Baseplate NCS2005-R80B light gray (corresponds approx. to RAL 7035) Cover RAL 9003 signal white	●	●	●	●

[1] The stand-by input is not available in change-over (C/O) mode or in heating controller applications, as it is assigned to the change-over input function. CR24-B3 should be used if the stand-by function is needed in a change-over application.

[2] The boost function is not available in change-over mode or in chilled ceiling applications with dew point limiting. A combination of change-over and dew point limiting is possible.

[3] The output can either be used as a common cooling and heating output in change-over mode or exclusively as a cooling or heating output. The stand-by function is not available in change-over mode or in heating controller applications.

[4] The output can either be used as a common cooling and heating output in change-over mode or exclusively as a cooling or heating output.

Additional documentation

Comprehensive and regularly updated documentation with descriptions of specific applications is available for all controllers.

Temperature controllers for single room applications with one analog output:

• **The analog output ao1 can be used in VAV applications to contol one or more VAV controllers.**

• **In change-over applications, the analog output ao1 can be changed over from cooling to heating mode via an input.**

Device variants

Type CR24-A1, same functionality as the CR24-B1 but without an operator panel.

Technical data

Electrical data	Nominal voltage	AC 24 V 50/60 Hz
	For wire sizing	3 VA, without actuators
	Power supply range	AC 19.2...28.8 V
	Connections	Terminal block 1...3: 2.5 mm^2
		Terminal block 4...8: 1.5 mm^2
Functional data	Control characteristics	P
	– P-band heating / cooling	Selectable: 1.5 / 1.0 K or 3.0 / 2.0 K
	External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 10...45°C
		for example Belimo type TFK
	Heating setpoint	Range 15...36°C (default 21°C)
	– Energy hold off	Heating 15°C / cooling 40°C
	– Stand-by	Heating –2 K / cooling +3 K
	Dead band	1 K
	Frost limit temperature	10°C
	Operation (CR24-B.. only)	
	– Mode switch and status indication (LEDs)	AUTO (green) – ECO (orange) – MAX (red)
	– Rotary knob for setpoint adjustment	±3 K
	Communication port for field devices	2 x PP (for PC-Tool, MFT remote control etc.)
Inputs	2 x analog, 2 x digital	
	– External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 10...45°C
	– External setpoint shift (ai2)	0...10 V corresponds to 0...10 K
	– Digital inputs (di1, di2)	Contact rating 10 mA
Outputs	1 x analog	
	– VAV system output (ao1)	(0)2 ... 10 V, max. 5 mA
Norms und standards	Protection class	**III** Safety extra-low voltage
	Degree of protection	IP 30 to EN 60529
	Mode of operation	Type 1 to EN 60730-1
	Software class	A to EN 60730-1
	EMC	**CE** conformity to 89/336/EEC
	Ambient conditions	
	– Operation	0...+50°C / 20...90% rH (without condensation
	– Transport and storage	–25...+70°C / 20...90% rH (without condensation
Dimensions / Weight	Dimensions (H x W x D)	99 x 84 x 32 mm
	Weight	105 g
Housing colors	Baseplate	NCS2005-R80B light gray
		(corresponds approx. to RAL 7035)
	Cover	RAL 9003-Signalweiss

Safety notes

⚠️

• **The controller is not allowed to be used outside the specified field of application, especially in aircraft or in any other airborne means of transport.**

• **It may only be installed by suitably trained personnel.
All applicable legal or institutional installation regulations must be complied with.**

• **The device may only be opened at the manufacturer's site. It does not contain any parts that can be replaced or repaired by the user.**

• **The device contains electrical and electronic components and is not allowed to be disposed of as household refuse. All locally valid regulations and requirements must be observed.**

Product features

Energy hold off	In energy saving mode, the room temperature is reduced to building protection level, i.e. either the heating setpoint is significantly reduced or the cooling setpoint is significantly increased, for instance in a room with an open window.
Stand-by	The room temperature is reduced to stand-by level, i.e. either the heating setpoint is slightly reduced or the cooling setpoint is slightly increased, for instance in a room that is temporarily unoccupied.
Frost	The frost protection function is activated if the actual room temperature falls below 10°C.
Change-over	Change-over heating or heating/cooling.
External temperature sensor	An external temperature sensor can be connected to the analog input ai1, for instance in order to measure the average room temperature in the exhaust air duct.
External setpoint shift	An external DC 0...10 V signal at the analog input ai2 can be used to shift the basic setpoint 0...10 K, for instance for the summer/winter compensation.

These functions are described in detail on pages 17 to 24.

Configuration / Principal diagramm

Configuration

DIP	Default settings	▪
1	P-band **normal**	P-band **wide**
2	Input di2 **Stand-by**	Input di2 **Change-over**
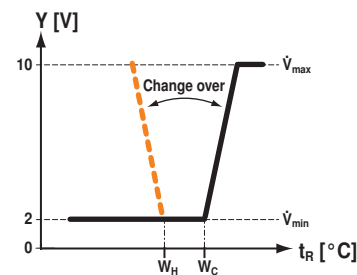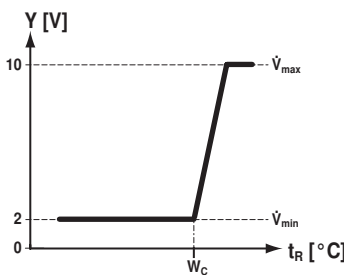
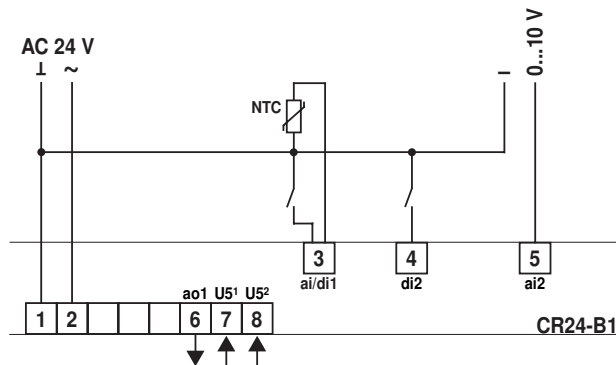| Key			
Y [V]	Output voltage in volt	$\dot{V}_{max}$	Maximum volume flow
t_R [°C]	Room temperature in degrees centigrade	$\dot{V}_{min}$	Minimum volume flow
W_H	Heating setpoint		
W_C	Cooling setpoint		

Electrical installation

Wiring diagram

Notes
- Connect via safety isolation transformer.
- Parallel connection of other actuators possible. Note the performance data.

Inputs			Outputs		
3	ai1	External temperature sensor	**6**	ao1	System output for Belimo VAV controller
	di1	Energy hold off	**Other connections**		
4	di2	Stand-by / Change-over	**7**	PP1	Diagnostics socket 1
5	ai2	External setpoint shift	**8**	PP2	Diagnostics socket 2

Temperature controllers for single room applications with two analog outputs:

- **The analog output ao1 can be used in VAV applications to contol one or more VAV controllers.**
- **The analog heating output ao3 supplies a 3-point signal.**

Device variants

Type CR24-A2, same functionality as the CR24-B2 but without an operator panel.

Technical data

Electrical data	Nominal voltage	AC 24 V 50/60 Hz
	For wire sizing	3 VA, without actuators
	Power supply range	AC 19.2...28.8 V
	Connections	Terminal block 1...3: 2.5 mm^2
		Terminal block 4...8: 1.5 mm^2
Functional data	Control characteristics	P
	– P-band heating / cooling	Selectable: 1.5 / 1.0 K or 3.0 / 2.0 K
	External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 10...45°C
		for example Belimo type TFK
	Heating setpoint	Range 15...36°C (default 21°C)
	– Energy hold off	Heating 15°C / cooling 40°C
	– Stand-by	Heating –2 K / cooling +3 K
	Dead band	1 K
	Frost limit temperature	10°C
	Operation (CR24-B.. only)	
	– Mode switch and status indication (LEDs)	AUTO (green) – ECO (orange) – MAX (red)
	– Rotary knob for setpoint adjustment	±3 K
	Communication port for field devices	2 x PP (for PC-Tool, MFT remote control etc.)
Inputs	2 x analog, 3 x digital	
	– External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 10...45°C
	– External setpoint shift (ai2)	0...10 V corresponds to 0...10 K
	– Digital inputs (di1, di2, di3)	Contact rating 10 mA
Outputs	2 x analog	
	– VAV system output (ao1)	(0)2 ... 10 V, max. 5 mA
	– Heating output (ao3)	3-point, AC 24 V, max. source current 0.5 A / 10 VA (optimized for actuators with a running time of approx. 150 s)
Norms und standards	Protection class	**III** Safety extra-low voltage
	Degree of protection	IP 30 to EN 60529
	Mode of operation	Type 1 to EN 60730-1
	Software class	A to EN 60730-1
	EMC	**CE** conformity to 89/336/EEC
	Ambient conditions	
	– Operation	0...+50°C / 20...90% rH (without condensation
	– Transport and storage	–25...+70°C / 20...90% rH (without condensation
Dimensions / Weight	Dimensions (H x W x D)	99 x 84 x 32 mm
	Weight	105 g
Housing colors	Baseplate	NCS2005-R80B light gray (corresponds approx. to RAL 7035)
	Cover	RAL 9003-Signalweiss

Safety notes

⚠

- **The controller is not allowed to be used outside the specified field of application, especially in aircraft or in any other airborne means of transport.**
- **It may only be installed by suitably trained personnel. All applicable legal or institutional installation regulations must be complied with.**
- **The device may only be opened at the manufacturer's site. It does not contain any parts that can be replaced or repaired by the user.**
- **The device contains electrical and electronic components and is not allowed to be disposed of as household refuse. All locally valid regulations and requirements must be observed.**
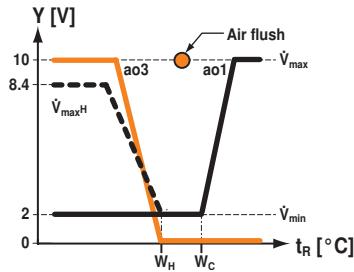
Product features

Energy hold off	In energy saving mode, the room temperature is reduced to building protection level, i.e. either the heating setpoint is significantly reduced or the cooling setpoint is significantly increased, for instance in a room with an open window.
Stand-by	The room temperature is reduced to stand-by level, i.e. either the heating setpoint is slightly reduced or the cooling setpoint is slightly increased, for instance in a room that is temporarily unoccupied.
Frost	The frost protection function is activated if the actual room temperature falls below 10°C.
Air flush	The room can be ventilated with the maximum volume flow ($\dot{V}$max), for instance in order to purge conference rooms, hotel rooms etc.
External temperature sensor	An external temperature sensor can be connected to the analog input ai1, for instance in order to measure the average room temperature in the exhaust air duct.
External setpoint shift	An external DC 0...10 V signal at the analog input ai2 can be used to shift the basic setpoint 0...10 K, for instance for the summer/winter compensation.
	These functions are described in detail on pages 17 to 24.

Configuration / Principal diagramm

Configuration

DIP	Default-settings	■
1	P-band **normal**	P-band **wide**
2	$\dot{V}_{max}$ heating **off**	$\dot{V}_{max}$ heating **80%**

Legende			
Y [V]	Output voltage in volt	**ao..**	Analog outputs
t$_R$ [°C]	Room temperature in degrees centigrade	**$\dot{V}_{max}$**	Maximum volume flow
W$_H$	Heating setpoint	**$\dot{V}_{maxH}$**	Maximum volume flow heating
W$_C$	Cooling setpoint	**$\dot{V}_{min}$**	Minimum volume flow

Electrical installation

Wiring diagram

Notes
- Connect via safety isolation transformer. ⚠
- Parallel connection of other actuators possible. Note the performance data.

Inputs			Outputs		
3	ai1	External temperature sensor	**6**	ao1	System output for Belimo VAV controller
	di1	Energy hold off	**9/10**	ao3	Heating (3-point)
4	di2	Stand-by	**Other connections**		
5	ai2	External setpoint shift	**7**	PP1	Diagnostics socket 1
12	di3	Air flush	**8**	PP2	Diagnostics socket 2

Temperature controllers for single room applications with one analog output and two digital outputs:

• The analog output ao1 for cooling, e.g. in VAV applications to contol one or more VAV controllers.
• The digital heating output do3 for
  – electrical reheater with one or two stages, in binary mode with three stages
  – on/off radiator valve

Device variants

Type CR24-A2E, same functionality as the CR24-B2E but without an operator panel.

Technical data

Electrical data	Nominal voltage	AC 24 V 50/60 Hz
	For wire sizing	3 VA, without actuators
	Power supply range	AC 19.2...28.8 V
	Connections	Terminal block 1...3: 2.5 mm^2
		Terminal block 4...8: 1.5 mm^2
Functional data	Control characteristics	P
	– P-band heating / cooling	2 K with 2 resp. 3 stages / 2.0 K
	External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 10...45°C for example Belimo type TFK
	Heating setpoint	Range 15...36°C (default 21°C)
	– Energy hold off	Heating 15°C / cooling 40°C
	– Stand-by	Heating –2 K / cooling +3 K
	Dead band	1 K
	Frost limit temperature	10°C
	Operation (CR24-B.. only)	
	– Mode switch and status indication (LEDs)	AUTO (green) – ECO (orange) – MAX (red)
	– Rotary knob for setpoint adjustment	±3 K
	Communication port for field devices	2 x PP (for PC-Tool, MFT remote control etc.)
Inputs	2 x analog, 3 x digital	
	– External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 30...50°C
	– External setpoint shift (ai2)	0...10 V corresponds to 0...10 K
	– Digital inputs (di1, di2, di3)	Contact rating 10 mA
Outputs	1 x analog, 2 x digital	
	– VAV system output (ao1)	(0)2 ... 10 V, max. 5 mA
	– Heating output (do3), 2 stages	Triac, AC 24 V, max. source current 0.5 A / 10 VA
Norms und standards	Protection class	**III** Safety extra-low voltage
	Degree of protection	IP 30 to EN 60529
	Mode of operation	Type 1 to EN 60730-1
	Software class	A to EN 60730-1
	EMC	**CE** conformity to 89/336/EEC
	Ambient conditions	
	– Operation	0...+50°C / 20...90% rH (without condensation
	– Transport and storage	–25...+70°C / 20...90% rH (without condensation
Dimensions / Weight	Dimensions (H x W x D)	99 x 84 x 32 mm
	Weight	105 g
Housing colors	Baseplate	NCS2005-R80B light gray (corresponds approx. to RAL 7035)
	Cover	RAL 9003-Signalweiss

Safety notes

⚠

• The controller is not allowed to be used outside the specified field of application, especially in aircraft or in any other airborne means of transport.
• It may only be installed by suitably trained personnel.
  All applicable legal or institutional installation regulations must be complied with.
• The device may only be opened at the manufacturer's site. It does not contain any parts that can be replaced or repaired by the user.
• The device contains electrical and electronic components and is not allowed to be disposed of as household refuse. All locally valid regulations and requirements must be observed.

Product features

Energy hold off	In energy saving mode, the room temperature is reduced to building protection level, i.e. either the heating setpoint is significantly reduced or the cooling setpoint is significantly increased, for instance in a room with an open window.
Stand-by	The room temperature is reduced to stand-by level, i.e. either the heating setpoint is slightly reduced or the cooling setpoint is slightly increased, for instance in a room that is temporarily unoccupied.
Frost	The frost protection function is activated if the actual room temperature falls below 10°C.
Boost	The room can be ventilated with the maximum volume flow ($\dot{V}_{max}$) or heated up with the maximum capacity.
Supply air temperature limiter	An optional mounted sensor allows to control the supply air temperature to a maximum of 50°C.
$\dot{V}_{max}$ at heating	For electrical reheaters the air volume at the heating condition can optionally be increased.
Output mode	The do3 output mode can be set accordingly to the application to – **stage** for one-stage electrical reheater or on/off radiator valve – **binary** for two-stage electrical reheaters (stage I: $^1/_3$, stage II: $^2/_3$) which will be $^1/_3$, $^2/_3$, $^3/_3$
Soft start (Roll-out feature)	The build-in start-up and roll-out of the stage control provides temperature excess protection. This helps to avoid service calls due to switched-off safety chains and reduces the electrical load after a power-fail.
External setpoint shift	An external DC 0...10 V signal at the analog input ai2 can be used to shift the basic setpoint 0...10 K, for instance for the summer/winter compensation.

Configuration / Prinzipal diagram

Configuration

DIP	Default-settings	
1	1 or 2 stage	Binary mode
2	$\dot{V}_{max}$ heating **off**	$\dot{V}_{max}$ heating **on**
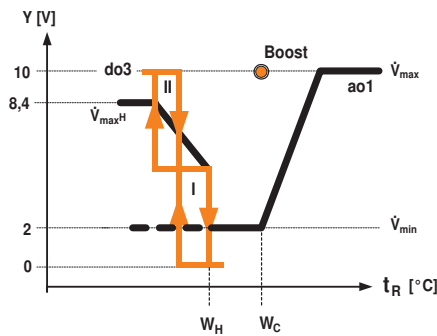
Key			
Y [V]	Output voltage in volt	**ao1**	Cooling output
t$_R$ [°C]	Room temperature in degrees centigrade		System output for Belimo VAV controller
W$_H$	Heating setpoint	**do3**	Heating stage I
W$_C$	Cooling setpoint		Heating stage II
▼ ▲	Output on/off	$\dot{V}_{max}$	Maximum volume flow
		$\dot{V}_{maxH}$	Maximum volume flow heating
		$\dot{V}_{min}$	Minimum volume flow

Electrical installation

Wiring diagram

Note
- Connect via safety isolation transformer.
- Parallel connection of other actuators possible. Note the performance data.
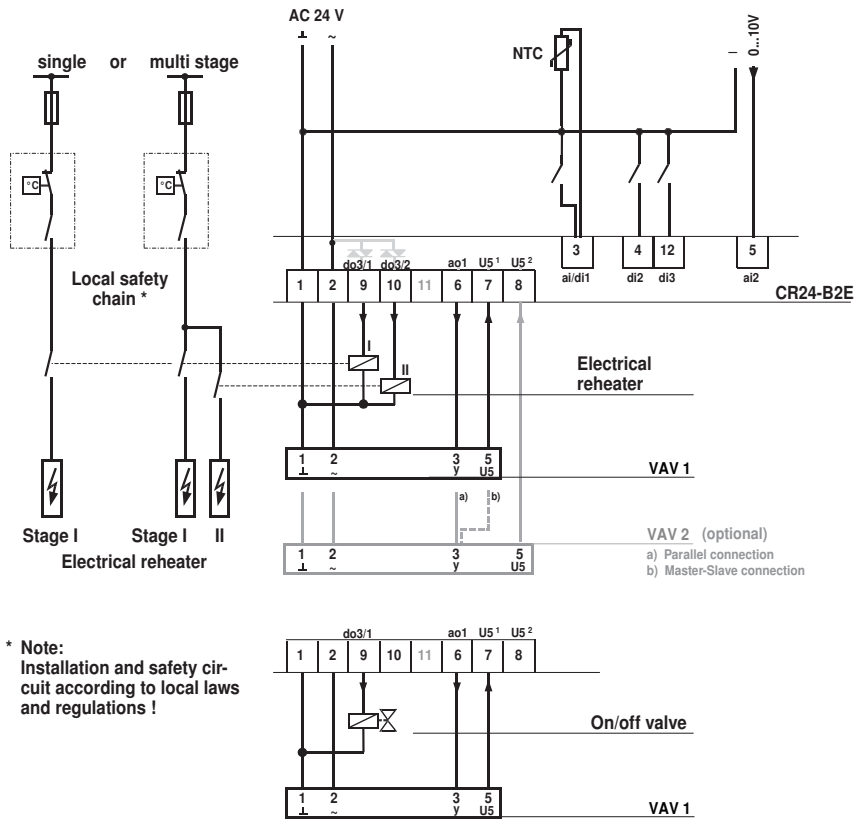
* **Note:**
Installation and safety circuit according to local laws and regulations !

Inputs			Outputs		
3	ai1	Supply air temperature limiter	**6**	ao1	System output for Belimo VAV controller
	di1	Energy hold off	**9**	do3/1	Heating stage I	On/off radiator valve
4	di2	Stand-by	**10**	do3/2	Heating stage II
5	ai2	External setpoint shift	**Other connections**		
12	di3	Boost	**7**	PP1	Diagnostics socket 1
			8	PP2	Diagnostics socket 2

BELIMO
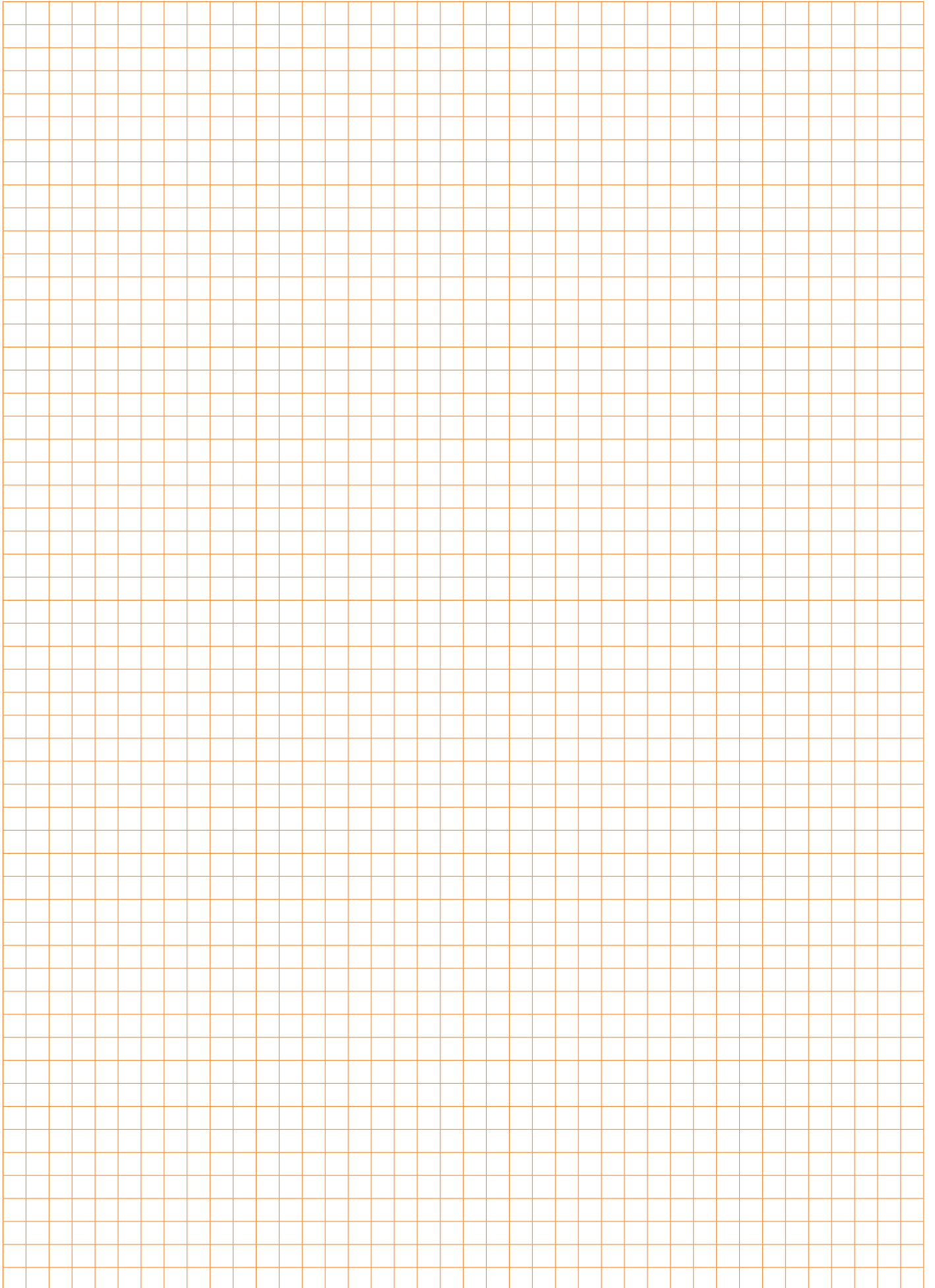
Temperature controllers for single room applications with three analog outputs:

- **The analog output ao1 can be used in VAV applications to contol one or more VAV controllers.**
- **The analog output ao2 can be used to control a heating or cooling sequence (change-over).**
- **The analog heating output ao3 supplies a 3-point signal.**

Application chilled ceiling certified by eu.bac Control Accurancy according to EN15500 = CA 0.7

eu.bac Cert 020718

Device variants

Type CR24-A3, same functionality as the CR24-B3 but without an operator panel.

Technical data

Electrical data	Nominal voltage	AC 24 V 50/60 Hz
	For wire sizing	3 VA, without actuators
	Power supply range	AC 19.2...28.8 V
	Connections	Terminal block 1...3: 2.5 mm^2
		Terminal block 4...8: 1.5 mm^2
Functional data	Control characteristics	P / PI
	– P-band heating / cooling	Selectable: 1.5 / 1.0 K or 3.0 / 2.0 K
	External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 10...45°C for example Belimo type TFK
	Heating setpoint	Range 15...36°C (default 21°C)
	– Energy hold off	Heating 15°C / cooling 40°C
	– Stand-by	Heating –2 K / cooling +3 K
	Dead band	1 K
	Frost limit temperature	10°C
	Operation (CR24-B.. only)	
	– Mode switch and status indication (LEDs)	AUTO (green) – ECO (orange) – MAX (red)
	– Rotary knob for setpoint adjustment	±3 K
	Communication port for field devices	2 x PP (for PC-Tool, MFT remote control etc.)
Inputs	2 x analog, 3 x digital	
	– External temperature sensor (ai1)	Type NTC, 5 kΩ, sensing range 10...45°C
	– External setpoint shift (ai2)	0...10 V corresponds to 0...10 K
	– Digital inputs (di1, di2, di3)	Contact rating 10 mA
Outputs	3 x analog	
	– VAV system output (ao1)	(0)2 ... 10 V, max. 5 mA
	– Heating / cooling output (ao2)	0...10 V, max. 5 mA
	– Heating output (ao3)	3-point, AC 24 V, max. source current 0.5 A / 10 VA (optimized for actuators with a running time of approx. 150 s)
Norms und standards	Protection class	**III** Safety extra-low voltage
	Degree of protection	IP 30 to EN 60529
	Mode of operation	Type 1 to EN 60730-1
	Software class	A to EN 60730-1
	EMC	**CE** conformity to 89/336/EEC
	Ambient conditions	
	– Operation	0...+50°C / 20...90% rH (without condensation
	– Transport and storage	–25...+70°C / 20...90% rH (without condensation
Dimensions / Weight	Dimensions (H x W x D)	99 x 84 x 32 mm
	Weight	105 g
Housing colors	Baseplate	NCS2005-R80B light gray (corresponds approx. to RAL 7035)
	Cover	RAL 9003-Signalweiss

Safety notes

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- **The controller is not allowed to be used outside the specified field of application, especially in aircraft or in any other airborne means of transport.**
- **It may only be installed by suitably trained personnel. All applicable legal or institutional installation regulations must be complied with.**
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- **The device contains electrical and electronic components and is not allowed to be disposed of as household refuse. All locally valid regulations and requirements must be observed.**
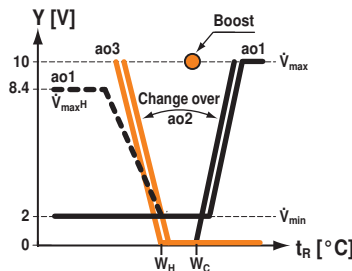
Product features

Energy hold off	In energy saving mode, the room temperature is reduced to building protection level, i.e. either the heating setpoint is significantly reduced or the cooling setpoint is significantly increased, for instance in a room with an open window.
Stand-by	The room temperature is reduced to stand-by level, i.e. either the heating setpoint is slightly reduced or the cooling setpoint is slightly increased, for instance in a room that is temporarily unoccupied.
Frost	The frost protection function is activated if the actual room temperature falls below 10°C.
Change-over	Change-over heating or heating/cooling.
Chilled ceiling with dew point limiting	If the temperature falls below the dew point, the corresponding output is set to 0.
Boost	The room can be ventilated with the maximum volume flow ($\dot{V}_{max}$) or heated or cooled with the maximum capacity.
External temperature sensor	An external temperature sensor can be connected to the analog input ai1, for instance in order to measure the average room temperature in the exhaust air duct.
External setpoint shift	An external DC 0...10 V signal at the analog input ai2 can be used to shift the basic setpoint 0...10 K, for instance for the summer/winter compensation.
	These functions are described in detail on pages 17 to 24.

Configuration / Prinzipal diagram

Configuration

DIP	**Default-settings**	
1	P-band **normal**	P-band **wide**
2	$\dot{V}_{max}$ heating **off**	$\dot{V}_{max}$ heating **80%**
3	Output ao2 **Heating**	Output ao2 **Change-over Cooling**
4	Input di3 **Boost**	Input di3 **Change-over Dew point**
5	Boost **Temperature controlled**	Boost $\dot{V}_{max}$
6	Control characteristic **PI**	Control characteristic **P**

Key			
Y [V]	Output voltage in volt	**ao..**	Analog outputs
t_R [°C]	Room temperature in degrees centigrade	$\dot{V}_{max}$	Maximum volume flow
W_H	Heating setpoint	$\dot{V}_{maxH}$	Maximum volume flow heating
W_C	Cooling setpoint	$\dot{V}_{min}$	Minimum volume flow

Electrical installation

Wiring diagram

Note
- Connect via safety isolation transformer.
- Parallel connection of other actuators possible. Note the performance data.

Inputs			**Outputs**		
3	ai1	External temperature sensor	**6**	ao1	System output for Belimo VAV controller
	di1	Energy hold off	**9/10**	ao3	Heating (3-point)
4	di2	Stand-by	**11**	ao2	Heating / Cooling
5	ai2	External setpoint shift	**Other connections**		
12	di3	Boost / Change-over / Dew point	**7**	PP1	Diagnostics socket 1
			8	PP2	Diagnostics socket 2

Operator level 1 – Operation

Operating mode / Setpoint   **CR24-B.. only**
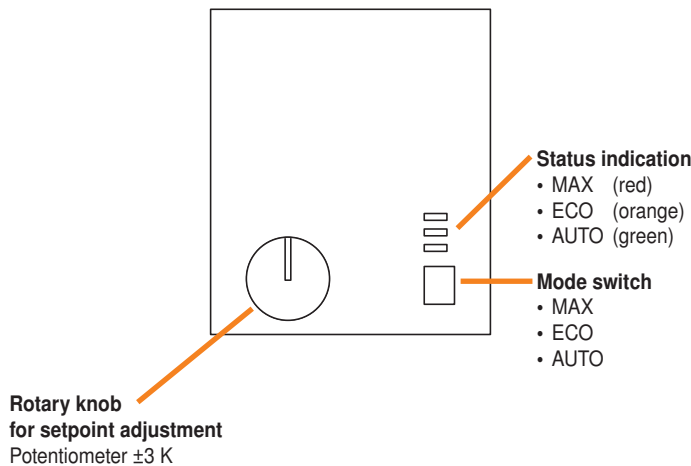
Mode switch and status indication

There are three possible operating modes:

- **AUTO – optimum comfort mode**
  The room is heated, cooled or ventilated with the highest level of comfort, providing this is permitted by the external control signals. All the control functions (sequence control, boost function) are enabled.

- **ECO – optimum energy mode**
  The room is heated, cooled or ventilated with the stand-by settings, providing this is permitted by the external control signals. The heating setpoint is reduced in this mode (–2 K) and the cooling setpoint is increased (+3 K). The room can be changed from "optimum energy" to "optimum comfort" in a very short time. Sequence control and the boost function are enabled. ECO mode is intended for rooms that are only irregularly occupied resp. at reduced demand.

- **MAX – boost function**
  The room is ventilated with the maximum air volume or heated or cooled with the maximum capacity, providing this is permitted by the external control signals. Sequence control is disabled, but the boost and ventilation functions are active.
  The boost function gets deactiveded:
  – timer elapsed
  – setpoint reached (VAV fix 15 minutes)
  – change to another mode (AUTO or ECO)

Status indication
- MAX   (red)
- ECO   (orange)
- AUTO (green)

Mode switch
- MAX
- ECO
- AUTO

Rotary knob for setpoint adjustment
Potentiometer ±3 K

Operator level 2 – Configuration

Application / Parameters   **all CR24-..**
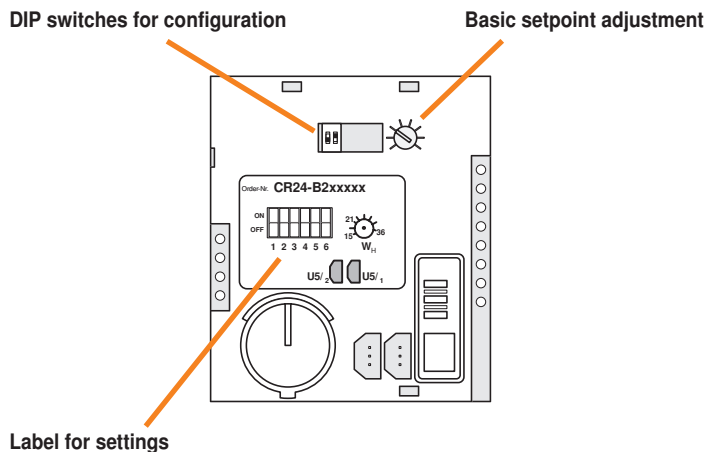
DIP switches for configuration

DIP switches 1 and 2 (CR24-B1, BR24-B2 and CR24-B2E) or 1 to 6 (CR24-B3)

Basic setpoint adjustment

Potentiometer 15...36°C (default 21°C)

Label for settings

Used to record the selected settings (DIP switches and basic setpoint).

DIP switches for configuration

Basic setpoint adjustment

Order-Nr. CR24-B2xxxxx

Label for settings

Operator level 3 – Service

Test / Simulation   **all CR24-..**
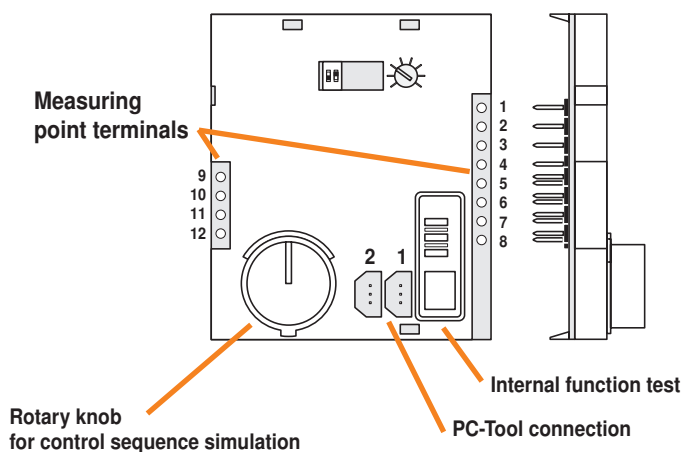
Measuring point terminals

Measuring points for all terminals (also during operation).

Internal function test

A comprehensive internal function test, including a nominal voltage test (AC 24 V), can be started for the controller with the mode switch. The three LEDs (status indication) indicate the voltage level and the states.

Control sequence simulation

The connected actuators, and thus also the heating and cooling control sequences, can be simulated independently of the room temperature with the rotary knob for adjusting the setpoint.

PC-Tool connection

Diagnostics sockets 1 and 2 are used for PP communication with the connected Belimo MFT actuators or VAV controllers. As a result, physical access to the field devices can be dispensed with.

Measuring point terminals

Rotary knob for control sequence simulation

Internal function test

PC-Tool connection
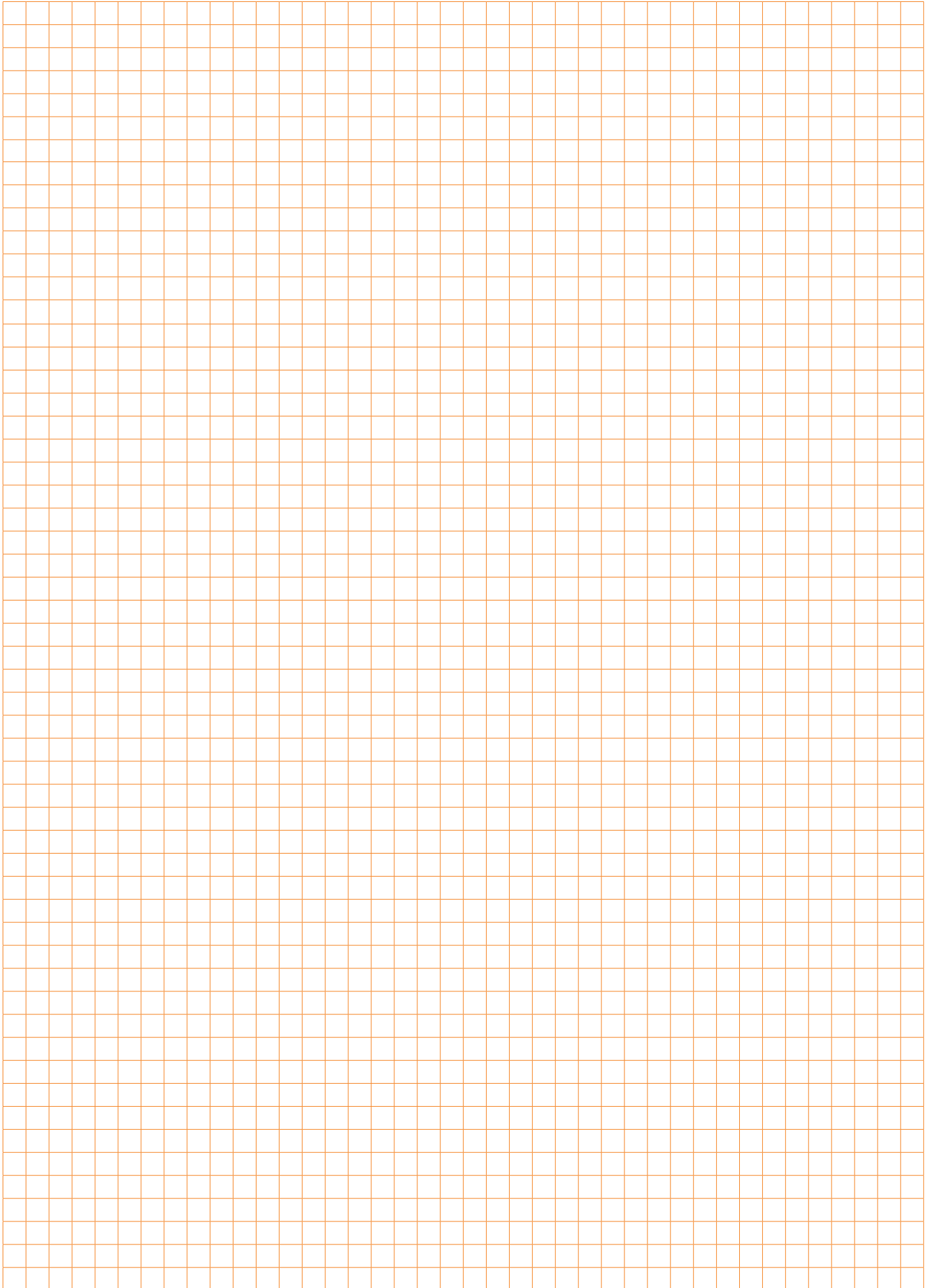
Introduction

The control functions define the behavior of the controller outputs and influence the current setpoint.

Both the level of comfort and the energy saving potential can be significantly enhanced by installing suitable sensors on the input side.
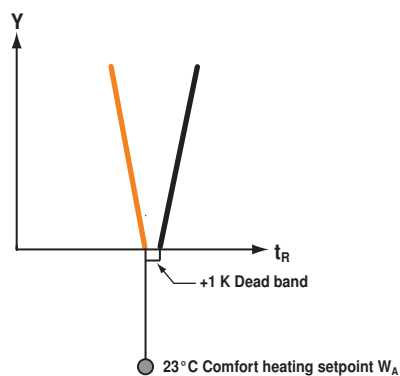
Please refer to the table on page 3 for an overview of the functions of the three basic CR24-B.. types. These functions are described in detail below.

Setpoint calculation
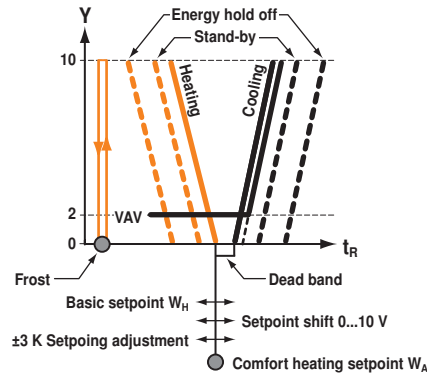
Operating status	Heating setpoint	Cooling setpoint
Comfort	Basic setpoint W_H ± 3 K Setpoint adjustment + Setpoint shift 0...10 V	Comfort heating setpoint W_A + 1 K Dead band
Stand-by	Comfort heating setpoint W_A − 2 K Stand-by offset heating	Comfort heating setpoint W_A + 1 K Dead band + 3 K Stand-by offset cooling
Energy hold off	Fixed 15°C (building protection)	Fixed 40°C (building protection)
Frost	Fixed 10°C	Not relevant

Examples **Comfort** **Stand-by**

Energy hold off

AC 24 V

CR24-B..

Key
Y	Output signal
t_R	Room temperature
W_A	Current setpoint
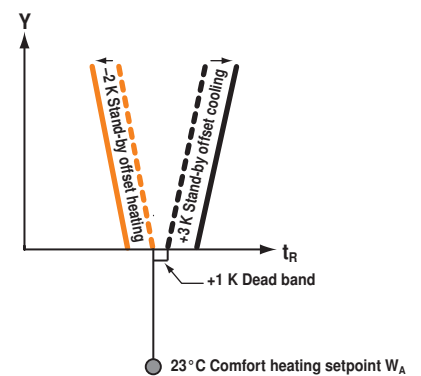
Digital input di1   all CR24-..
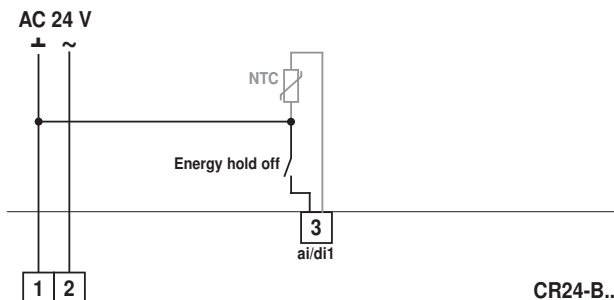
If a local detector (e.g. a window switch) acts on the digital input di1 and closes the corresponding contact, the room is adjusted to the building protection settings in energy saving mode, in other words the heating setpoint is significantly reduced (15°C) or the cooling setpoint significantly increased (40°C), though not sufficiently to cause damage to sensitive objects (plants, paintings etc.).

Typical applications

– A window switch at di1 stops all energy consumption from the moment the window is opened until the lower or upper building protection limit is reached.
– Higher-level override command, e.g. building management system.

Notes

– The minimum VAV output is set to 0 V instead of 2 V while energy hold off is active (forced closing in 2...10 V)
– The mode switch (operator level 1) is deactivated while energy hold off is active (input di1 takes priority).
– If an external temperature sensor is used, the frost limit is monitored by the internal sensor while energy hold off is active.
– Due to the automatic sensor detection the change into energy hold off takes about 40 seconds.

Stand-by

AC 24 V

CR24-B..

Key
Y	Output signal
t_R	Room temperature
W_A	Current setpoint
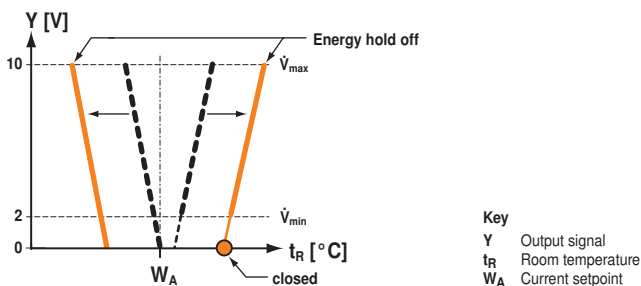
Digital input di2   all CR24-..
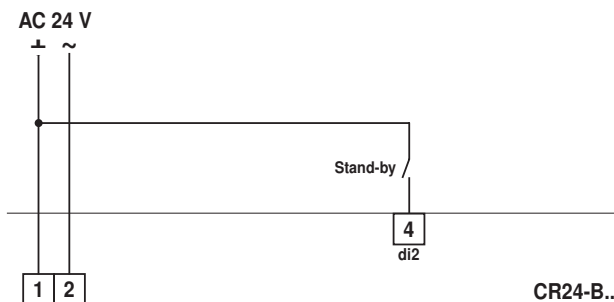
If a local detector (e.g. a motion detector) acts on the digital input di2 and closes the corresponding contact, the room is adjusted to the stand-by settings, in other words the heating setpoint is reduced by 2 K or the cooling setpoint is increased by 3 K.

Typical applications

– A motion detector, a light switch or another detector at di2 reduces the energy consumption of unoccupied rooms.
– Higher-level override command, e.g. building management system.
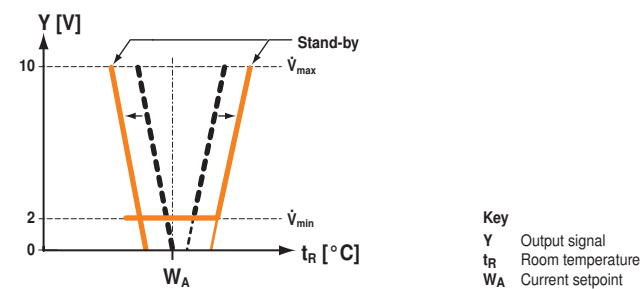
VAV function: air volume in heating mode (Reheater)   CR24-B2 und CR24-B3 only

Key
Y	Output signal
t_R	Room temperature
W_A	Current setpoint
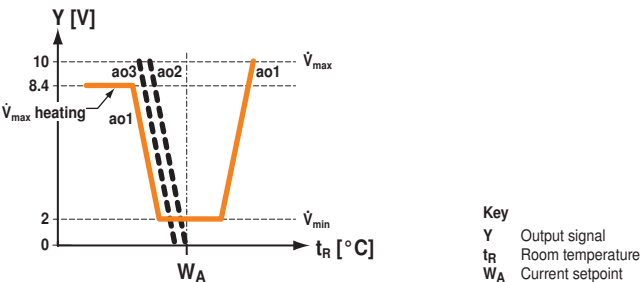
If the selected application requires an increased air volume for heating, e.g. for:
– Providing or assisting heating with air.
– Improving the air quality during heating.

CR24-B2 configuration
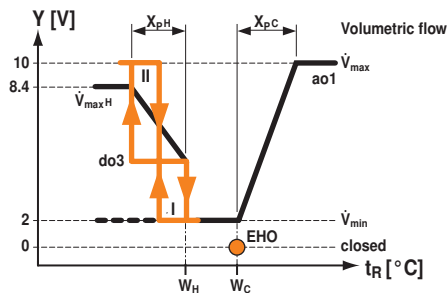
The VAV function is configured using DIP switch 2.

CR24-B3 configuration

The VAV function is configured using DIP switch 2.

Electric air heater   CR24-B2E only

Key
- Y — Output signal
- t_R — Room temperature
- W_H — Setpoint Heating
- W_C — Setpoint Cooling
- X_{PH} — P-band Heating
- X_{PC} — P-band Cooling
- $\dot{V}_{max\,H}$ — $\dot{V}_{max}$ Heating

If the selected application requires an increased air volume for heating, e.g. for:
- Provision without assisting heating with air
- Improving the air quality during heating

CR24-B2E configuration

This function is activated using DIP switch 2.

External temperature sensor   Analog input ai1   CR24-B1, CR24-B2, CR24-B3
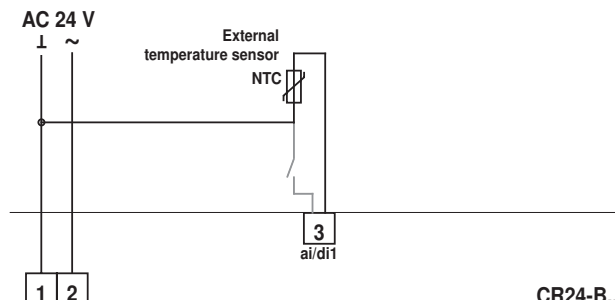
An external NTC temperature sensor can be connected to the analog input ai1.

Typical application

A temperature sensor measures the average room temperature in the exhaust air duct.

Notes

- The internal sensor automatically detects the presence of an external sensor.
- It is possible to install an energy hold off switch simultaneously at di1, in which case the system changes over to the internal sensor (see also "Energy hold off"). This permits the actual room temperature to be monitored in order to protect the building.

Supply air temperature limitation   Analog input ai1   CR24-B2E only
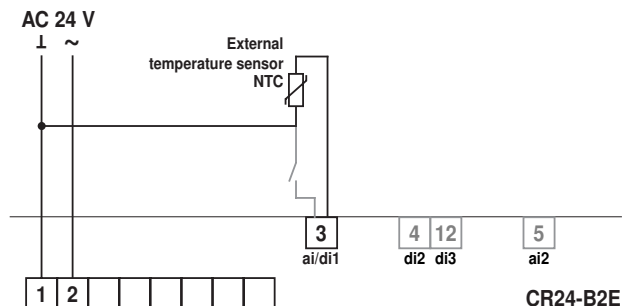
An external NTC temperature sensor can be connected to the analog input ai1. Sensor type: NTC 5k (5 kΩ)
Function: The temperature of the supply air is limited by shedding individual load increments if the maximum temperature is exceeded. This results in an almost modulating control characteristic.
Benefits: Increased comfort and economical energy consumption

Notes

- The controller automatically detects the presence of a supply air limitation sensor.
- Combined application with EHO switch:
  EHO active = supply air temperature limitation not active
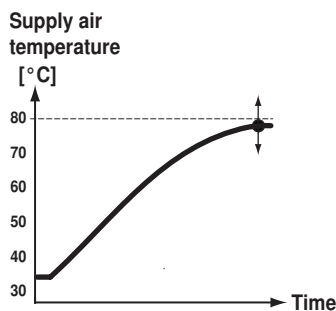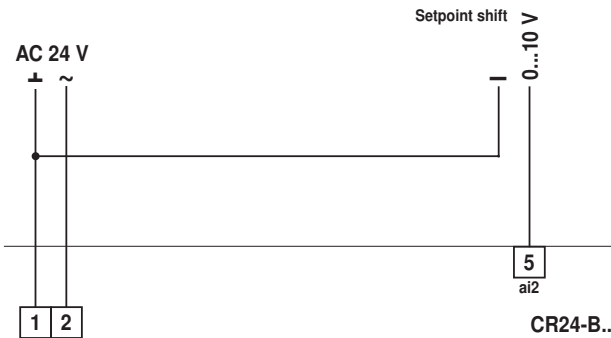

Without supply air limitation
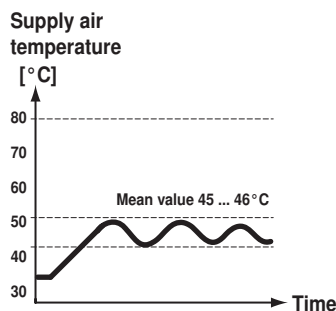
With supply air limitation

External setpoint shift

Setpoint shift

AC 24 V

0...10 V

| 5 |
| ai2 |

| 1 | 2 | **CR24-B..**

Key
W Setpoint
S Shift signal

Analog input ai2   all CR24-..

An external DC 0...10 V signal at the analog input ai2 can be used to shift the basic setpoint 0...10 K (corresponds to 0...10 V).
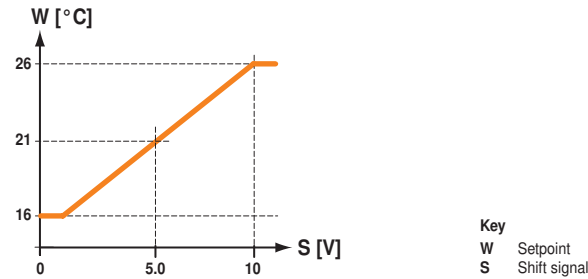
Typical application

– Summer/winter compensation

Notes

A negative shift can be achieved by adjusting the basic setpoint to the required final setpoint, e.g. from 21°C (default value) to 16°C. In this case:
– 0... 5 V corresponds to 16...21°C and
– 5...10 V corresponds to 21...26°C (see diagram opposite).

Air flush

AC 24 V

Auto

Air flush

Air flush

| 12 |
| di3 |

| 1 | 2 | **CR24-B2**

Air flush

Key
Y Output signal
t$_R$ Room temperature
W$_A$ Current setpoint

Digital input di3   CR24-B2 only
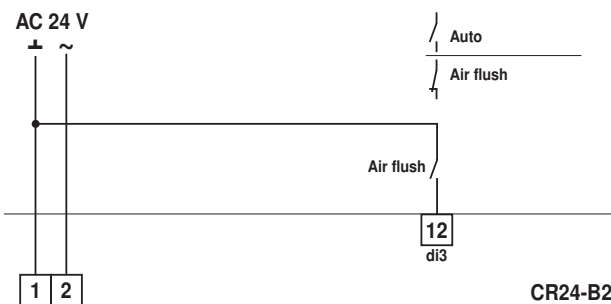
The CR24-B2 controller allows override control at the digital input di3, to enable the room to be flushed with the maximum volume flow ($\dot{V}$max).

Typical applications

– Purging conference rooms, hotel rooms etc.
  (e.g. time switch-controlled)
– Assisting smoke extraction
– Controlling air quality (2-point signal)

Notes

– The VAV output ao1 is set to a fixed value of $\dot{V}_{max}$ (10 V).
– The heating output ao3 remains in the normal control mode and continues to be controlled by means of the heating sequence.

Change-over ao1

AC 24 V

Cooling

Heating

Change-over | Fixed heating mode

4
di2

ao1 U5¹

| 1 | 2 | | 6 | 7 | | **CR24-B1** |

| 1 | 2 | | 3 | 5 |
| ± | ~ | | Y | U5 | | **Belimo actuator** |

Y [V]

Heating   Cooling

Change-over

10

2

0

W$_A$ t$_R$ [°C]

Key
Y   Output signal
t$_R$ Room temperature
W$_A$ Current setpoint
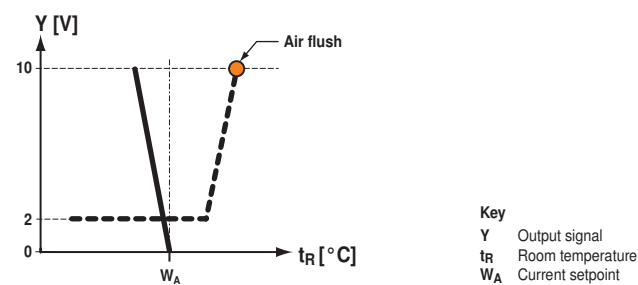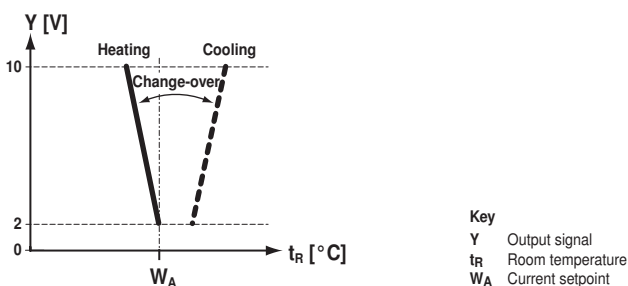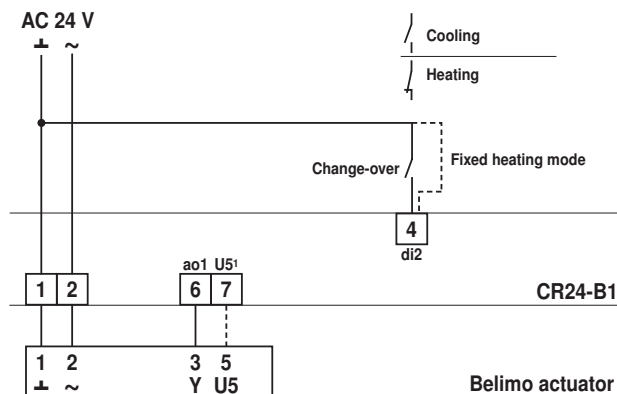
Digital input di2 — CR24-B1 only

In change-over applications, the digital input di2 controls the VAV system output ao1 of the CR24-B1 controller.

Typical applications

Change-over heating or heating/cooling.

Note

The CR24-B3 controller is suitable for applications that require both a stand-by function and a change-over function.

Configuration

The change-over function is configured using DIP switch 2

Change-over ao2

AC 24 V

Cooling

Heating

Change-over

12
di3

ao2 U5¹

| 1 | 2 | | 11 | 7 | | **CR24-B3** |

| 1 | 2 | | 3 | 5 |
| ± | ~ | | Y | U5 | | **Belimo actuator** |

Y [V]

Heating   Cooling

Change-over

10

0

W$_A$ t$_R$ [°C]

Key
Y   Output signal
t$_R$ Room temperature
W$_A$ Current setpoint
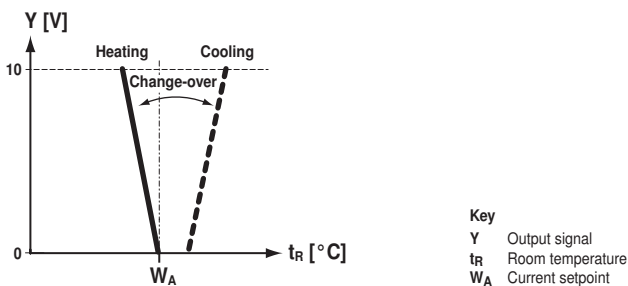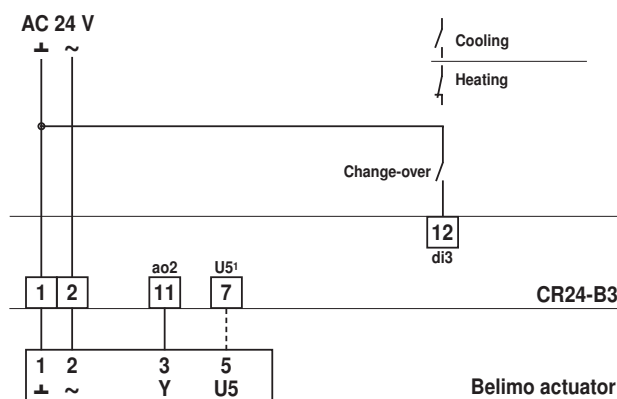
Digital input di3 — CR24-B3 only

In change-over applications, the digital input di3 controls the common heating/cooling output ao2 of the CR24-B3 controller.

Typical applications

Change-over heating or heating/cooling.

Note

– For chilled ceiling applications, refer to page 23.
– The CR24-B1 controller is suitable for applications that only require a change-over function.
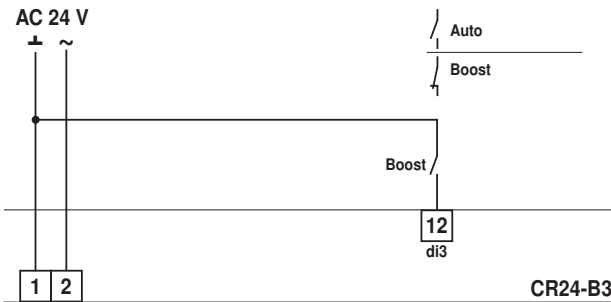
Configuration

The change-over function is configured using DIP switches 3 and 4.

Boost – $\dot{V}_{max}$

AC 24 V

CR24-B3

Key
Y	Output signal
t_R	Room temperature
W_A	Current setpoint

Digital input di3   CR24-B3 only

The CR24-B3 controller allows override control at the digital input di3, to enable the room to be ventilated with the maximum air flow ($\dot{V}_{max}$). This function acts on all three analog outputs (see "Notes"). Room temperature control is deactivated in this mode (exception: frost protection function).

Typical applications

– Purging conference rooms, hotel rooms etc.
– Assisting smoke extraction
– Free- or night cooling

Notes

The boost function acts on the outputs as follows:
– ao1 (VAV)   100% > 10 V ($\dot{V}_{max}$)
– ao2 (heating/cooling)   0% > 0 V
– ao3 (heating)   0% > closed (3-point)

The boost function is deactivated by the following events:
– Boost signal (di3) not active
– Frost limit temperature (10°C) undershot

Configuration

This boost function is configured using DIP switches 4 (boost on) and 5 (boost $\dot{V}_{max}$).

Boost – Temperature-controlled

AC 24 V

CR24-B3

Key
Y	Output signal
t_R	Room temperature
W_A	Current setpoint
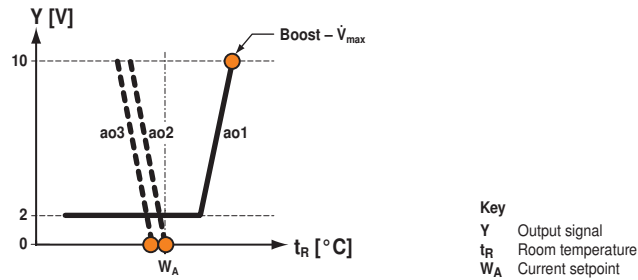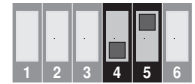
Digital input di3   CR24-B3, CR24-B2E
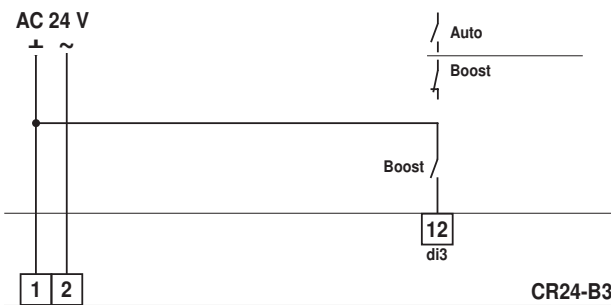
The CR24-B3 resp. CR24-B2E controller allows override control at the digital input di3, to enable the room to be heated or cooled with the maximum capacity. This function acts on all three analog outputs (see "Notes").

Typical applications

– Rapid heating, rapid cooling
– Cooling, morning boost etc.

Notes

The boost function acts temperature-sensitive on the outputs as follows
CR24-B3:
– ao1 (VAV)   100% > 10 V ($\dot{V}_{max}$)
– ao2 (heating/cooling) 100% > 10 V
– ao3 (heating)   100% > open (3-point)
CR24-B2E:
– ao1 (VAV)   100% > 10 V ($\dot{V}_{max}$)
– do3 / 1   ON
– do3 / 2   ON

To support reheater applications the VAV system output (ao1) gets activated at the heating condition too.

The boost function is deactivated by the following events:
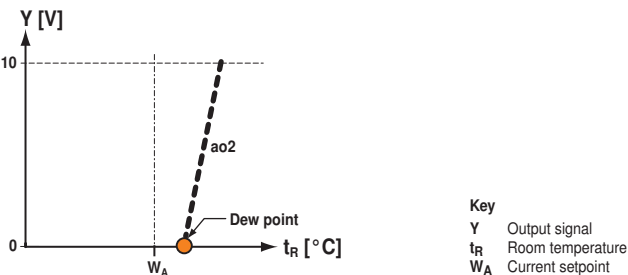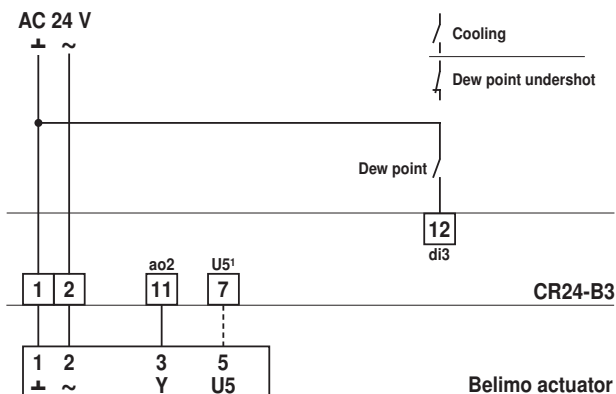– Boost signal (di3) not active
– Comfort setpoint (W) reached

The air is always conditioned to the comfort setpoint W, even if stand-by (d1) is active, in order to facilitate room preconditioning.

Configuration (CR24-B3 only)

This boost function is configured using DIP switches 4 (boost on) and 5 (boost temperature-controlled).
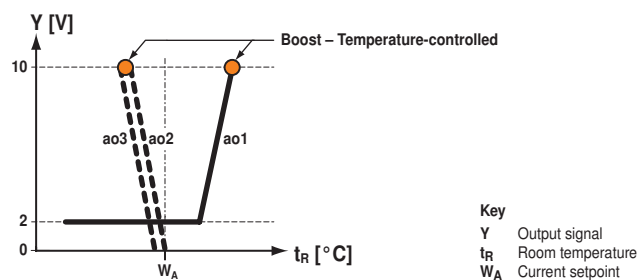
Chilled ceiling with dew point limiting

Digital input di3 — CR24-B3 only

If the temperature at the external dew point monitor (input di3) falls below the dew point, output ao2 is set to 0 V.
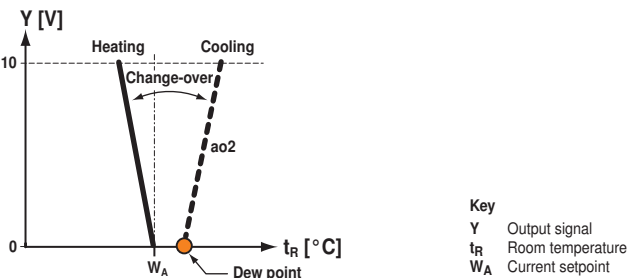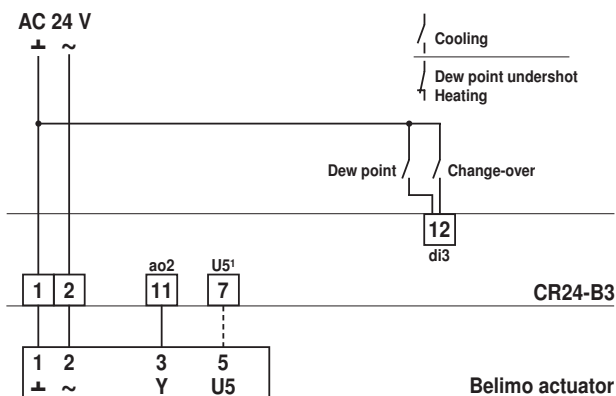
Typical applications

Chilled ceiling systems that require dew point limiting.

Configuration

This function is configured using DIP switches 3 and 4.

Chilled ceiling with dew point limiting and change-over

Digital input di3 — CR24-B3 only

If the temperature at the external dew point monitor (input di3) falls below the dew point, output ao2 is set to 0 V. Dew point limiting can be combined with the change-over function.

Typical applications

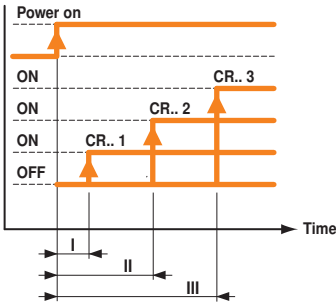Switchable heated/chilled ceiling systems that also require dew point limiting.

Configuration

This function is configured using DIP switches 3 and 4.

## Rolling start   CR24-B2E only

An ingenious startup function prevents overload situations when the power is switched on and stops fuses from being tripped if several air heaters are operated with the same voltage supply.

Power-on behavior

– Power on
– Delay I   Electric air heater of the first CR24-B2E enabled
– Delay II   Electric air heater of the second CR24-B2E enabled
– Delay III   Electric air heater of the third CR24-B2E enabled
– etc.

Excess temperature protection   CR24-B2E only
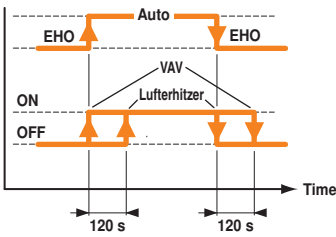
This function prevents the local safety interlock (STh) from responding unless absolutely necessary and relieves the load on devices and installations.
When the system is started up after a power on or EHO off, or when EHO active is switched off, the air heater output is switched on after a delay and the VAV output is switched off after a delay.

Step control   CR24-B2E only

Single steps
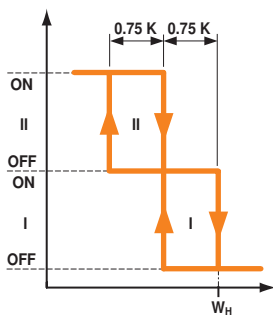
The B2E supports two AH control modes:
– Single steps: Simple electric air heaters or
                 open/close radiator/zone valves
– Binary steps: 2-step electric air heaters in 3-step mode,
                 e.g. 1/3 – 2/3 – 3/3

CR24-B2E configuration
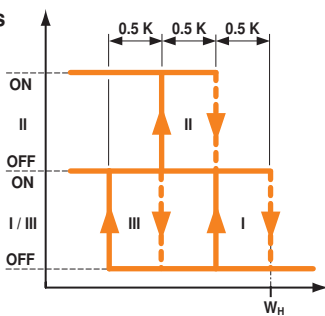
This function is configured using DIP switch 1.

– Einzelstufen: Simple electric air heaters or
                 open/close radiator/zone valves   (Factory setting)
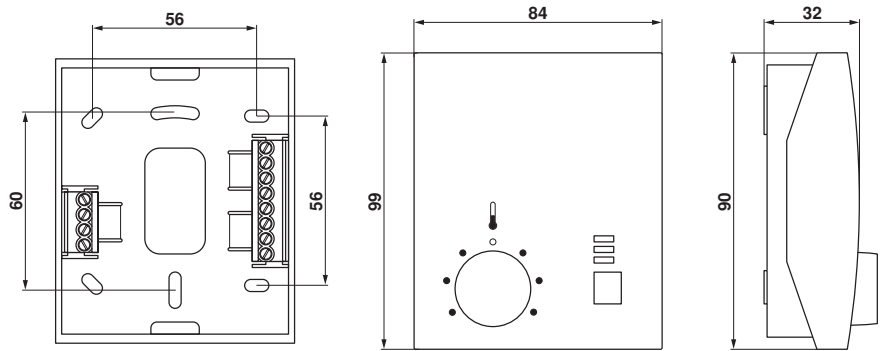
Binary steps

– Binärstufen: 2-step electric air heaters in 3-step mode,
   e.g. 1/3 – 2/3 – 3/3

Dimensions [mm]

Mechanical installation

1. Remove the housing cover.
2. Pull out slightly the wall of the housing to release the pcb.
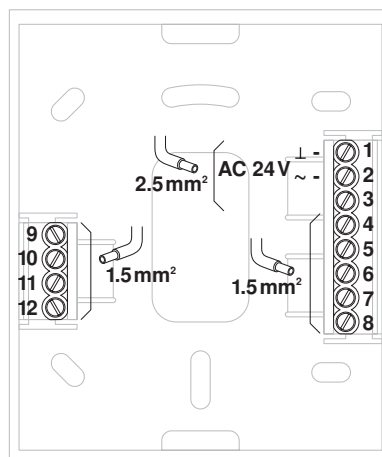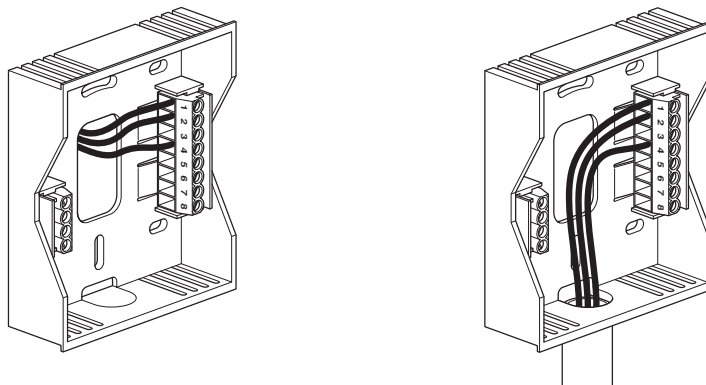3. Remove the printed circuit board.

Rotary knob for setpoint adjustment

If the rotary knob has been removed proceed as follows:

a. Insert the rotary knob approximately half way and turn it clockwise as far as the stop.
b. Remove the knob and align it so that the cam is flush with the left stop.
c. Insert the knob fully.

Left stop

Cam
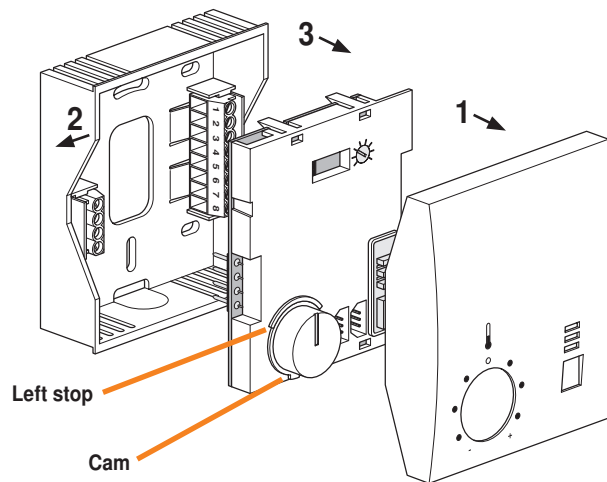
Electrical installation

Power supply design / wire sizing

In addition to the actual wire sizing, attention must also be paid to the surrounding area and the cable routing. Signal cables must not be laid in the vicinity of load cables, objects liable to cause EMC interference etc. Paired or layer stranded cables improve immunity to interference.

24 V supply
Wire sizing and cabling

The wire sizing and installation of the AC 24 V supply, the fuse protection, and the cables are dependent on the total operated load and local regulations.
Account must be taken of the following performance data, including starting currents:
– Wire sizing values for room temperature controllers: 3 VA per CR24-...
– Wire sizing values for control devices, VAV controllers, damper actuators, valves etc. can be found in the latest data sheets and product information (www.belimo.com)
– Other devices to be operated with the AC 24 V supply
– Reserve capacity for subsequent expansion (if planned)

Digital input connections di1 / di2 / di3

The digital inputs of the CR24 controllers are connections with a low electrical load that can be controlled by a common switching contact if necessary.
Example: Common thermostat for changeover function.
The maximum cable length depends on the number of CR24 controllers and the cross section of the cable used or the maximum resistance of the cable and switching contact as well as the quality of the environment.

No. of CR24-...	Cable cross section	Cable length
10	0.75 mm^2	max. 250 m
20	0.75 mm^2	max. 200 m
20	1.00 mm^2	max. 250 m
25	0.75 mm^2	max. 170 m
25	1.00 mm^2	max. 220 m
25	1.50 mm^2	max. 250 m
30	0.75 mm^2	max. 140 m
30	1.00 mm^2	max. 190 m
30	1.50 mm^2	max. 250 m
40	0.75 mm^2	max. 100 m
40	1.0 mm^2	max. 140 m
40	1.50 mm^2	max. 210 m
50	0.75 mm^2	max. 80 m
50	1.00 mm^2	max. 110 m
50	1.50 mm^2	max. 170 m

If the number of CR24-.. controllers exceeds that indicated in the table, the next higher number of CR24-.. controllers should be taken instead.
Example of a system with 13 CR24-B1 controllers and a common C/O contact:
Use the table data for 20 CR24.. controllers to design the cable:
20 x CR24-.. → 0.75 mm^2 → 200 m.

Note
This table does not apply to the design of the AC 24 V power supply cable.
The supply cable is determined by the total power of all loads (see above).

Analog input connection ai1

The analog input ai1 is used to connect an external NTC 5 kΩ temperature sensor. The sensor value is 5969 Ω at 21°C. A change of 50 Ω corresponds to approximately 0.2 K in this range.
The sensor cable constitutes a series resistance that must be added to the actual sensor value.
Assuming a cable length of 15 m (2 x 15 = 30 m), the resistance of one 0.75 mm2 Cu cable is approximately 0.7 Ω, in other words negligible.
To prevent interference, however, the sensor cable should be a maximum of 20 m long.

Analog input connection ai2

The 0...10 V input (with the 10 kΩ pulldown resistor) can be used to connect an external 0...10 V signal for a setpoint shift.
The current is calculated according to Ohm's Law: I = U / R: 10 V / 10 kΩ = 1 mA.
Calculation: Maximum permissible voltage drop across the cable (V) divided by the current (1 mA) = cable impedance in Ω.

Commissioning / Power on behaviour

Commissioning
1. Assemble the baseplate of the housing and connect the cables (see page 15).
2. Configure the DIP switches on the printed circuit board according to the required application.
3. Assemble the printed circuit board on the baseplate of the housing and then mount the housing cover (see page 15).
4. Switch on the nominal voltage (AC 24 V).
5. Optional: start the test and simulation mode (see below).

When the voltage is applied, the system starts operating normally in AUTO mode (unless the test and simulation mode is selected). The
active operating status is determined primarily by the configuration of the DIP switches and the status of the inputs

Power on behaviour
After power on of the voltage supply the output gets initialized as follows:
– ao1 = 0 V
– ao2 = 0 V
– ao3 = closed (200 s)
Subsequently the controller switches automatically to the control mode.

Test and simulation mode

All controllers are supplied with two auxiliary programs for commissioning and servicing:
– Internal function test
– Control sequence simulation

Activating test and simulation mode
The test and simulation mode of CR24-B.. controllers can be activated easily with the mode switch on the operator panel. With CR24-A.. controllers, the housing cover must be removed first.

To activate test mode

1. Set the mode switch to MAX
   – The red LED (MAX status indication) lights up
2. Keep the mode switch pressed for ten seconds
   – The internal function test is activated (see below)

To activate simulation mode

3. Press the mode switch again briefly (for approximately one second)
   – The green LED (AUTO status indication) flashes
   – Control sequence simulation is activated (see below)

Deactivating test and simulation mode
The test and simulation mode can be deactivated either by pressing the mode switch again for ten seconds or by interrupting the power supply. It is also deactivated automatically 15 minutes after the last user action (auto-reset).

Internal function test

The internal function test tests the nominal voltage that is connected to the controller (AC 24 V), in other words the complete electrical wiring system from the control cabinet to the controller. The three LEDs (status indication) indicate the voltage level (see below) and states during the test.

Nominal voltage (AC 24 V)

Note
Case B and C do not need further attention. In case A (<20 V) attation must be paid to the following points:
– Quality of the wiring and connections
– Cable length/diameter and the transformer sizing.

LED (status indication)		Scenario A	Scenario B	Scenario C
MAX	red	**flash**	**flash**	**permanently on**
ECO	orange	**flash**	**flash**	**permanently on**
AUTO	green	**permanently off**	**flash**	**permanently on**
		<20 V	**20...22 V**	**>22 V**

| Control sequence simulation	(CR24-B1, CR24-B2, CR24-B3)

CR24-B1, CR24-B2, CR24-B3

The connected actuators, and thus also the heating and cooling control sequences, can be simulated independently of the room temperature in simulation mode.

This permits the air volume ($\dot{V}_{min}$ and $\dot{V}_{max}$) to be tested in air systems or the maximum heating and cooling capacity in water systems.

Notes

– The external control signals (di1, di2 and di3) are suppressed while the simulation is active.

– The potentiometer changes during simulation mode should be done slowly to avoid over-shooting of the output values due to the system depending adjuster damping.

– A-types (controllers without operation panel): please do reset the potentiometer to the 0-position after simulation to avoid setpoint deviations.

– Simulation mode is automatically deactivated 15 minutes after the last user action (auto-reset).

Potentiometer (setpoint adjustment) for simulating the room temperature
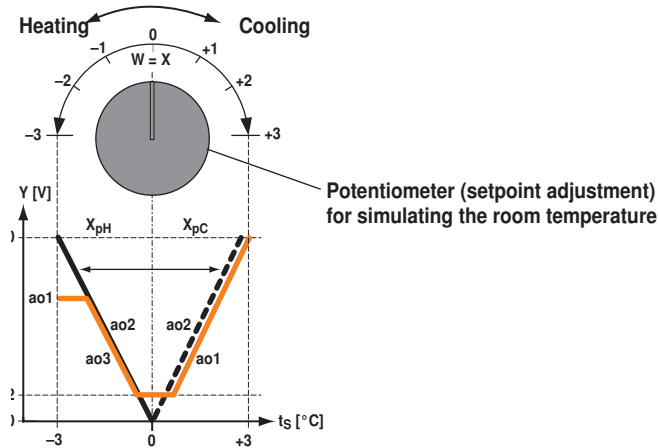
CR24-B2E

The simulation mode for the CR24-B2E is basically as described above.

Unlike water operated air heaters, electric air heaters are not allowed to be operated without a flow. Simulations can be carried out on the CR24-.. at any time, even if the ventilation system is not operating.

The two triac outputs are activated for a maximum of 15 seconds in simulation mode to prevent overheating due to operation without ventilation. To activate these outputs again, the potentiometer must be reset via the "0" position to the heating range.

Potentiometer (setpoint adjustment) for simulating the room temperature

max. 15 s
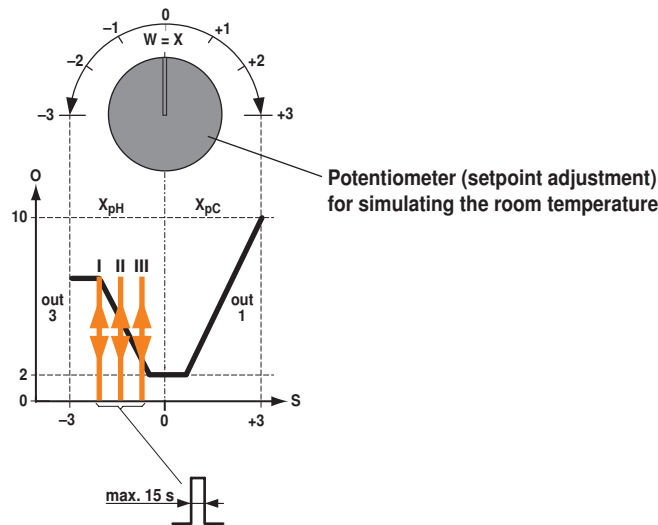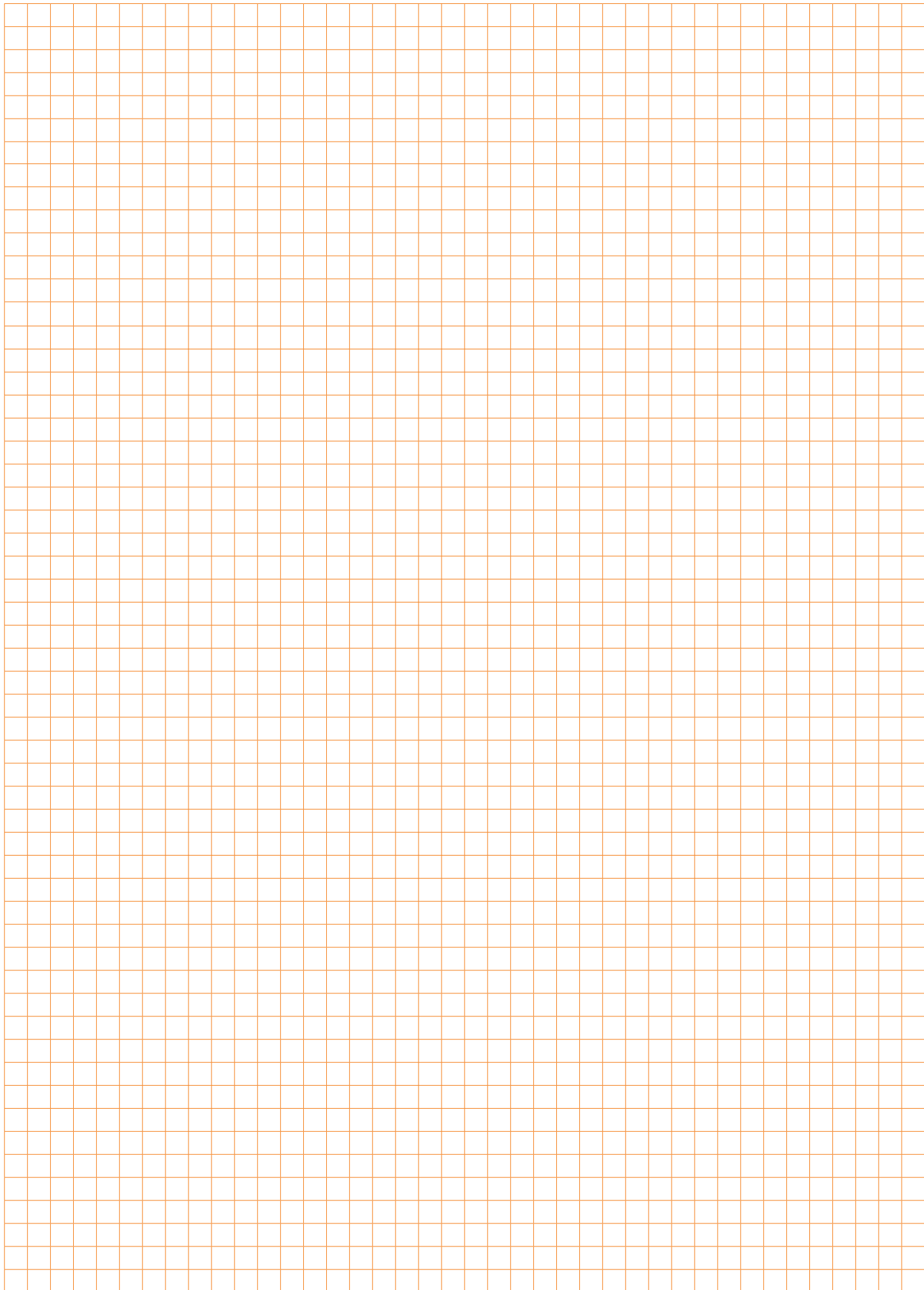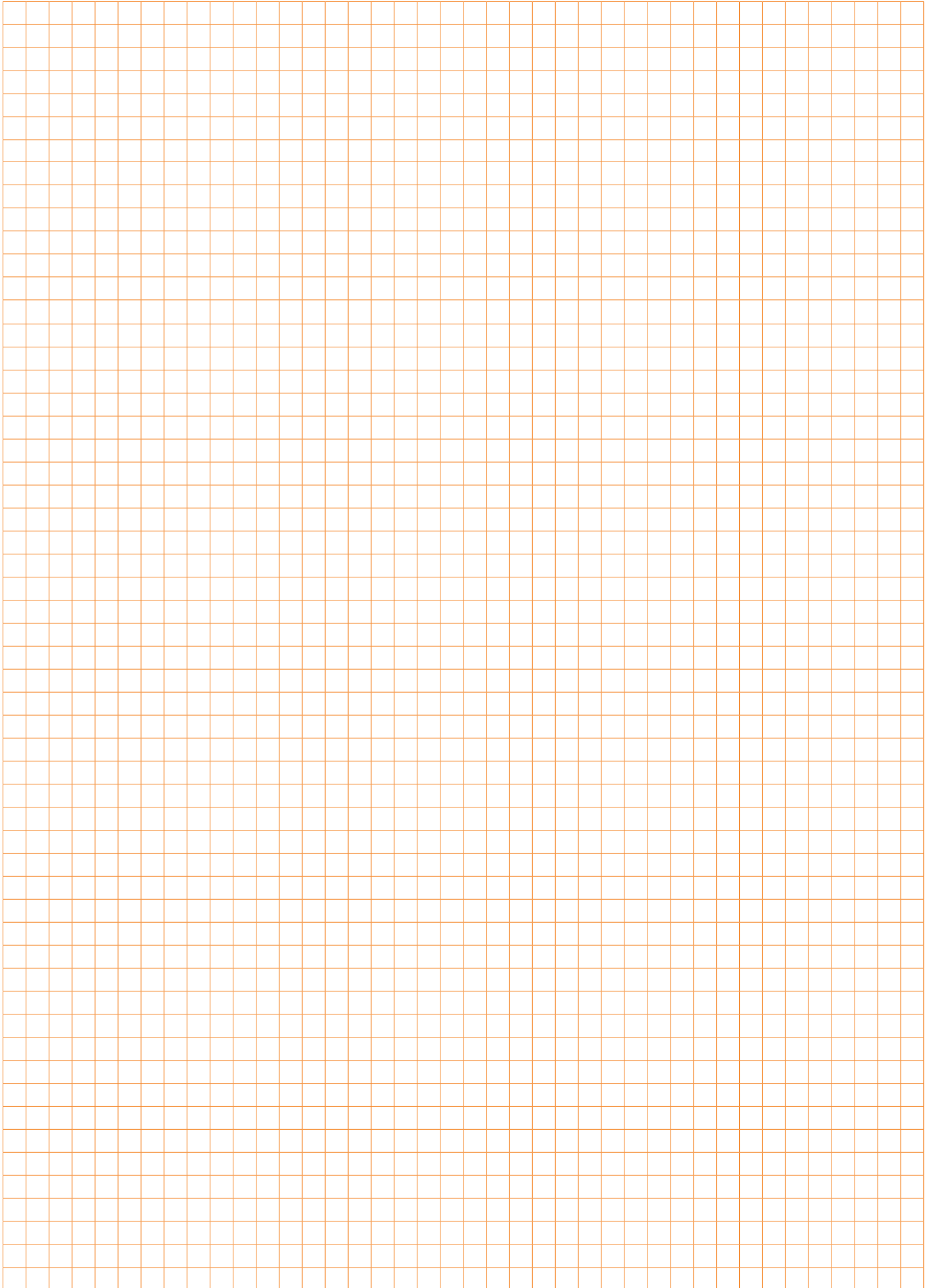
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