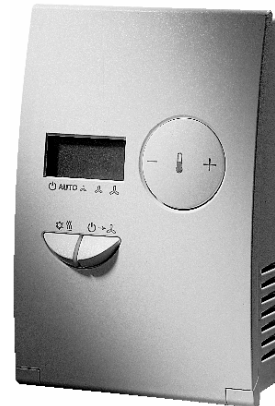




REF7090520
REF7090521



REF7090522
REF7090523

Fan-coil controller for wall mounting

REF709052x

Pulse width modulated (PWM) valve outputs for thermal actuators, AC 230 V

P or PI control behaviour selectable

3-speed fan control, automatic and manual

Manual switching between heating and cooling operation or automatic with changeover (C/O) sensor QAH11

Potential-free input for window contact or occupancy detector

Inbuilt room temperature sensor

Three operating modes: Comfort / Economy / Standby

The status of the operating mode switch (⏻ → 👤) and changeover switch (⚙️ ↔️) are memorised when the power is switched off.

The REF70902x types are customer specific types of the general types ACR12.4xx. The correlation of the types is shown in the type summary below.

Application

For controlling the room temperature in individual rooms and zones which are heated and cooled by fan-coils. The controllers are suitable for 2- or 4-pipe applications with manual and automatic fan control. They control:

- a 3-speed fan
- either two valve actuators for 4-pipe applications
- or one valve actuator and an electric heater for 2-pipe applications.

Functions

- Changeover between heating and cooling operation is either automatically, driven by the room temperature (4-pipe) or with the changeover sensor QAH11 (2-pipe) or manually.
- Selection of operating mode with a window contact, an occupancy detector or the standby button on the controller.
- Control of 3 fan speeds automatic or manual
- Outputs for one (REF7090521, REF7090523) or two (REF7090520, REF7090522) thermal valves with pulse duration modulation for heating and /or cooling, AC 230 V
- REF7090521, REF7090523 with relay output for an electric heater with up to 2 kW.

Type summary

Note that the type references which are in brackets in the table below are for comparison reasons only.

<i>Application</i>	<i>Operating panel</i>	<i>Type reference</i>
2-pipe fan-coil with or without electric heater	Analogue	REF7090521 (ACR12.420/ALG)
	With display	REF7090523 (ACR12.421/ALG)
4-pipe fan-coil	Analogue	REF7090520 (ACR12.440/ALG)
	With display	REF7090522 (ACR12.441/ALG)
Cable sensor for changeover or return air temperature		QAH11
Valve actuator for VD100 valve or V_P46 valve		STA21 *
Valve actuator for V_P47		STP21 *

* max. 1 actuator per output is allowed

Ordering

When ordering, please specify the type references as shown in the „Type summary“.

Technical design

Controller

The room temperature is measured by an inbuilt sensor and compared to the actual set-point. According to the resulting deviation, the processor calculates the pulse duration ratio for controlling the thermal valve actuators and, if necessary, for controlling the electric heater. In addition, if the selector switch for the fan speed on the controller is set to "Auto", the optimum fan speed is defined automatically.

The user can choose between P (proportional) and PI (proportional/integral) controlling behaviour. These and other settings can be made on the device by either using DIP switches or the parameter menu, depending on the type of controller.

The P (proportional) bands for the heating and cooling sequences can be defined separately between 2 K and 4 K (see switches P05 and P06).

The integral action time I (integral) is 5 minutes (only active if PI control is selected).

Display

The heating and cooling symbols on the display or the appropriate LEDs show in a **four pipe system** exactly what is done. The heating symbol is active when the fan-coil is heating and the cooling symbol when it is cooling. In neutral zone the symbols are switched off.

In a **two pipe system** these symbols show in general what the status of the fan-coil is (what it can do). This means, the symbols are also shown in the neutral zone. However there is an exception: If the changeover is on cooling and the electric heater is on, then the heating symbol is active. However as soon as the neutral zone is reached, the cooling symbol is shown again if this is still the actual status of the fan-coil.

Set-points

In **comfort operation**, the set-points are either defined at the factory (for controllers without a display) or are defined in the parameter mode. The heating set-point is normally set to 20 °C and the cooling set-point to 23 °C. The room user can adjust the set-points by maximum ± 6 K (Kelvin) or what is defined by P15. This produces a maximum set-point range for the default set-points of 14...26 °C in heating operation and 17...29 °C in cooling operation. The neutral zone remains constant at 3 K in this example. The minimum possible neutral zone is 2K.

In **economy operation**, the set-points are fixed at 14 °C for heating and 30 °C for cooling and cannot be changed with the room units.

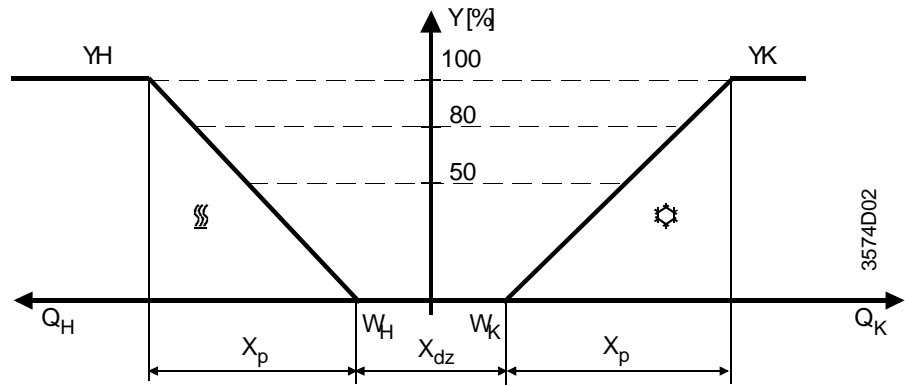
However if the economy operation is defined as the normal mode and not as the reduced mode (P01 = 1 or ON) then the offset shift is active for the economy set-points. This produces a set-point range of 8...20°C for heating and 24...36°C for cooling operation. The neutral zone remains constant at 16K.

In **standby operation**, the set-point of the controller is permanently set to 8°C heating. Adjustments are prohibited, due to the regulations of some countries. Cooling operation is not possible.

Control Sequences

4-pipe fan-coil

P09 = OFF or 0



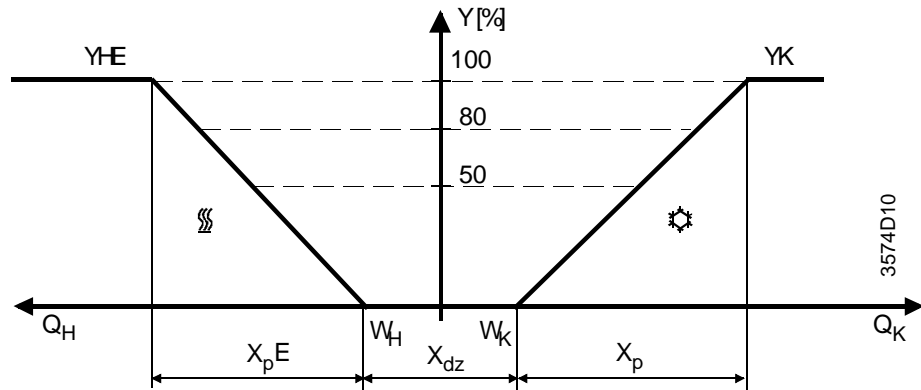
Note that if P04 = ON or 1, then the heating output YH can be used to control a radiator heater which is external of the fan coil. In this case the fan stops in the heating sequence.

Return air sensor

If the controller is set to a 4-pipe system (P09 = OFF or 0) then an external sensor (return air sensor) can be connected to the terminals B2, M. The sensor must be of the type QAH11.1. The sensor inside the controller is disconnected automatically as soon as an external sensor is connected.

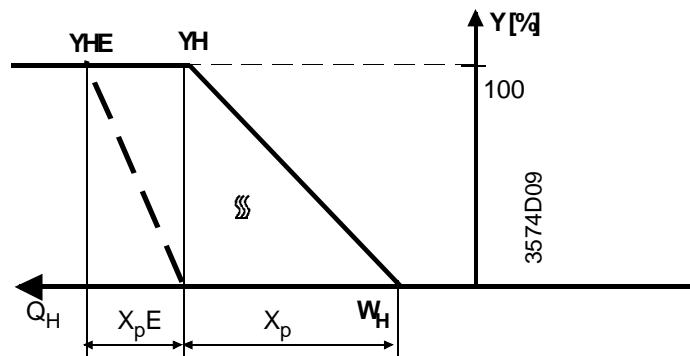
2-pipe fan-coil

P09 = ON or 1
with electric heater
C/O (changeover)
set to **cooling**



2-pipe fan-coil

P09 = ON or 1
with electric heater
C/O (changeover)
set to **heating**



Q_H	Heating load	W_H	Heating set-point
Q_K	Cooling load	W_K	Cooling set-point
X_p	P-band	X_{pE}	P-band electric heater
Y	Positioning variable		
YH	Heating output with 2 pipe systems and c/o on heating or with 4 pipe systems		
YHE	Electric heater output with REF7090521, REF7090523		
YK	Cooling output with 2 pipe systems and c/o on cooling or with 4 pipe systems		

Changeover between heating and cooling operation

Controllers for 4 pipe fan-coils change automatically between heating and cooling. Controllers for 2 pipe fan-coils need information about the water temperature. They receive this information either from a water temperature sensor (changeover sensor) or from a remote central station or from the operator through the C/O (changeover) key.

Manual changeover

If no C/O sensor is connected and the terminals B2-M are open and P18 = 1 (if available) then the C/O key on the controller is active and is used for switching between heating and cooling. Pressing the key once switches the mode immediately and the new active mode is shown by the heating or cooling symbol or by the LEDs.

Remote changeover

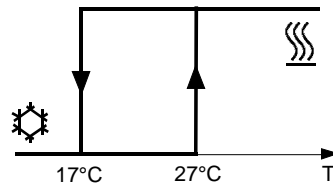
With a remote switch connected to the terminals B2-M then the controller is in cooling operation when the switch is open or in heating when the switch is closed. Since an open input also enables manual switching, a resistor of 10 K Ohm must be connected to B2-M (in parallel to the contact) or the manual switching must be inhibited by P18 = 0 (if parameter entry is available). Note that if P18 = 0 then the 10 K Ohm resistor is not used to inhibit the manual switching.

Local changeover

If a C/O sensor type QAH11 is connected to the terminals B2-M for measuring the water temperature then the diagrams below show the switching between heating and cooling (note that the behaviour depends on P11):

P11 = ON or 1

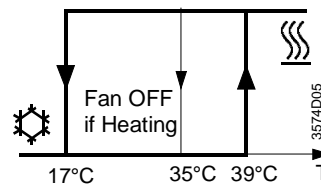
Hysteresis between 17°C and 27 °C





P11 = OFF or 0

Hysteresis between 17°C and 39 °C

Fan is switched OFF if the water temperature falls below 35 °C in heating mode



	heating	T	water temperature
	cooling		

Window Contact Input

Settings

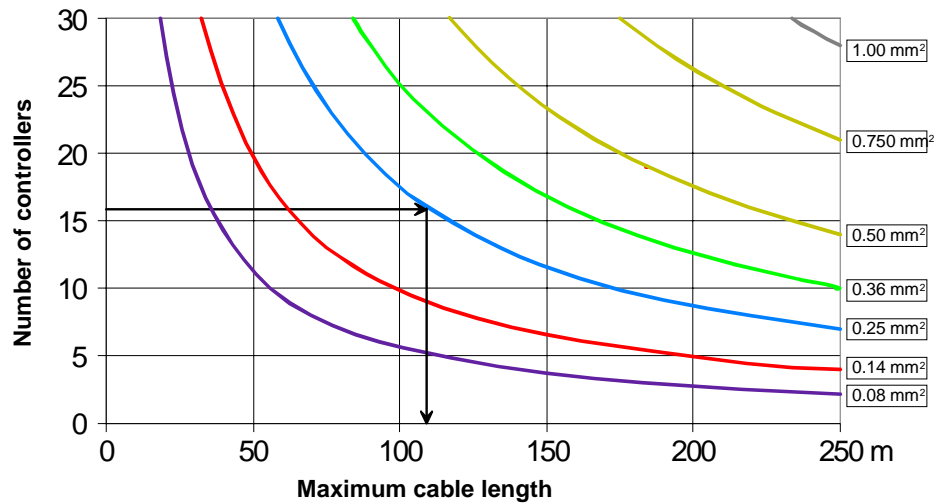
The window contact input (DU1, GND) is used to switch the operating mode from normal mode (defined by P01) to reduced mode (defined by P02). The idle position of the contact is defined by P03.

Security

The window contact input is separated from 230V and is SELV (Secure Electric Low Voltage). No additional power supply is needed for detecting the position of the external contact (the current necessary is delivered by the controller).

Wiring Controllers

Several contacts can be wired serially and up to 30 controllers can be connected to these contacts. **Make sure that GND is connected with GND and DU1 with DU1** of the different controllers. The maximum cable length should not exceed 250m. Since the currents of the individual inputs sum up, the diameter of the wires must carefully be chosen. If the diameter of the wires in the cable is below 1 mm², then the following graph shows the relationship between cable length, number of units connected in parallel and the wire diameter.

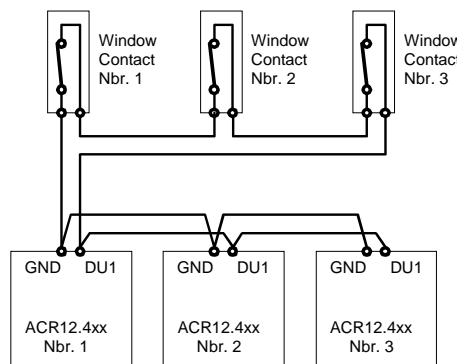


Example of wiring

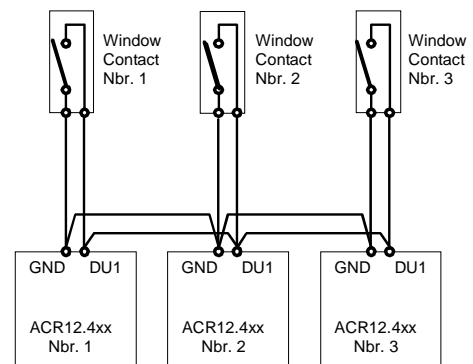
16 controllers are switched in parallel and the wire diameter is 0.25 mm², then the maximum cable length must not exceed 110 m. However with wire diameters of 0.75 mm² 250 m are possible with up to 21 controllers.

Wiring diagrams

Circuit with normally closed contacts.
(Parameter P03 = ON or 1)



Circuit with normally open contacts.
(Parameter P03 = OFF or 0)



Fan Operation

Neutral zone

When the fan is automatically controlled (manual fan speed selector switch on the controller set to "Auto") then in the neutral zone (control-free zone) of the normal operating mode the fan remains either constantly on or is switched off after 2 to 3 minutes. The actual behaviour is defined by P08.

In the reduced mode the fan is always switched off in the neutral zone.

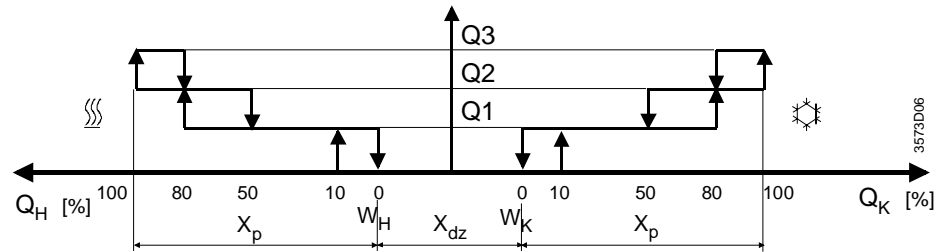
Start

When the fan starts from zero, then it starts with speed 3 for 1 second in order to guarantee a safe start (to overcome inertia and friction).

AUTO mode

In automatic mode the fan is switched to speed 1 (if not already there) when the controller output crosses 10 %. At 80 % speed II is switched on and at 100 % speed III. The switching hysteresis of the fan speeds are shown in the following diagram.

Ventilation OFF in neutral zone

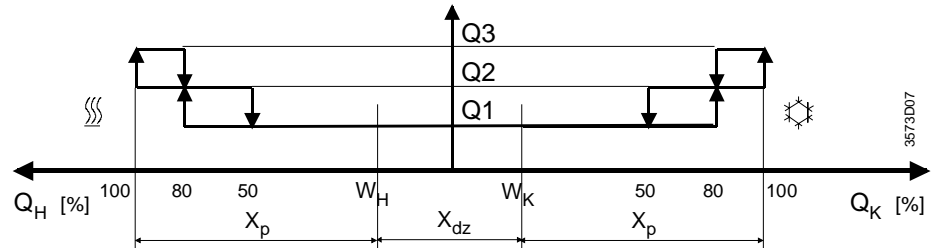


This behaviour is selected with P08 = ON or 1

Periodical Fan

If an external temperature sensor (e.g. return air sensor) is connected (only possible with 4 pipe fan-coil mode), then the fan is periodically switched on for 2 min. every 30 min. as long as the controller is in the neutral zone.

Ventilation always ON



This behaviour is selected with P08 = OFF or 0.

Freeze time

In automatic mode a freeze (or hold time) of 1 minute is active. This means that the fan remains at least for one minute at one speed until it is switched to the next.

Legend

Q1	Fan speed 1	W_H	Heating set-point
Q2	Fan speed 2	W_K	Cooling set-point
Q3	Fan speed 3	X_p	P-band
Q_H	Heating load	X_{dz}	Neutral zone
Q_K	Cooling load		

Valve Actuators

⚠ Important note

Thermal valve actuators for AC 230 V voltage must be used.
The control algorithm is optimised for STA21 and STP21 actuators.

Motor on/off valves must not be used.

Electric heater

The REF7090521, REF7090523 controllers have a relay built in for directly controlling an electric heater. The REF7090520, REF7090522 controllers need an external relay with a 230V coil for this purpose. Note that this relay is not included in the delivery.

The controller must be configured as a 2 pipe controller (P09 = ON or 1).

The controlling of the heater depends on the control deviation (pulse duration modulated). The P-band of the electric heater is as following:

- 2 K if P05 = ON or 1 and the change-over on cooling
- 4 K if P05 = OFF or 0 and the change-over on cooling
- 0.4 K if P05 = ON or 1 and the change-over on heating
- 0.8 K if P05 = OFF or 0 and the change-over on heating

The cycle time for the pulse duration modulation is fixed at 240 s. If an external relay is used, then it must be dimensioned for being switched every 240 s.

For safety reasons, the heating output is limited to max. 50 % at manual fan speed I (relay 120 s "on" and 120 s "off"), to max. 80 % at speed II and unlimited at speed III.

Parameters

Various parameters define the behaviour of the controller. These parameters are defined by 12 DIP switches (in controllers without display) or by entering the values in the parameter mode (in controllers with display).

The first 12 parameters (P01...P12) are identical in both types of controllers.

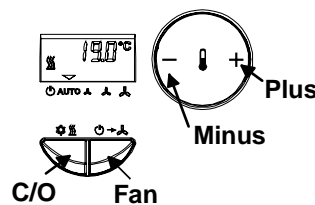
E.g. P01 corresponds to DIP switch 01 and "P01 = 1" in the text of this document refers then actually to "DIP switch 01 = ON".



Important note

For safety reasons, always switch off the controller before opening the housing and before manipulating the DIP switches. Changes of the DIP-switches are only valid after a power-on reset.

Entering the parameter mode of controllers with an LCD display and setting the parameters is achieved in the following way:





- Press simultaneously the keys <C/O><FAN><MINUS> until the display gets dark (after about 2 to 4 seconds).
- Press <MINUS> 2 times at an interval of about 1 second.
- Press <C/O> until P01 appears in the LCD display.
- With the <PLUS> or <MINUS> key, select the parameter you want to see or to modify.
- Press the <C/O> key to see the actual value of the parameter.
- Change the value by using the <PLUS> or <MINUS> keys.
- Press the <C/O> key to enter a modification or the <FAN> key to cancel the modification.
- Incrementing Parameter numbers and values is accelerated when the + or - key is depressed for more than 2 seconds.
- To return to normal operation, press the <FAN> key.

Parameter table

<i>Nbr.</i>	<i>Designation</i>	<i>Values</i>	<i>DIP</i>	<i>Entry</i>
P01	Normal Operating Mode (1)	Comfort Economy	<u>ON</u> OFF	<u>1</u> 0
P02	Reduced Operating Mode (2)	Frost Protection Economy	<u>ON</u> OFF	<u>1</u> 0
P03	Idle Position of Contact at Input DU1	Normally closed Normally open	<u>ON</u> OFF	<u>1</u> 0
P04	Place of heating system (only applicable to 4 pipe fan-coils)	Outside fan-coil Inside fan-coil	ON <u>OFF</u>	1 <u>0</u>
P05	P-Band Heating	2 k 4 K	<u>ON</u> OFF	<u>1</u> 0
P06	P-Band Cooling	2 k 4 K	<u>ON</u> OFF	<u>1</u> 0
P07	Controlling algorithm	PI P	<u>ON</u> OFF	<u>1</u> 0
P08	Ventilation in neural zone of normal mode	OFF ON	<u>ON</u> OFF	<u>1</u> 0
P09	Type of fan-coil (3)	2 Pipe 4 Pipe	ON OFF(3)	1 0(3)
P10	Electric Heater (only if P09 =2 Pipe)	YES NO	ON OFF(3)	1 0(3)
P11	Change Over Switching Points	17°C...27°C 17°C...39°C (4)	<u>ON</u> OFF	<u>1</u> 0
P12	Valve Actuator controlling	Modulating (5) ON / OFF	<u>ON</u> OFF	<u>1</u> 0
P13	Set-point Heating Comfort	16°C...26°C	-	<u>20</u>
P14	Set-point Cooling Comfort	18°C...28°C	-	<u>23</u>
P15	Maximum Offset for set-points	0K...6K	-	<u>6</u>
P16	Correction of Temp. Measurement	-10K...+10K	-	<u>0</u>
P17	Units of Temperature Display	°C °F	-	<u>1</u> 0
P18	Manual Change Over Switch	active inhibited		<u>1</u> 0

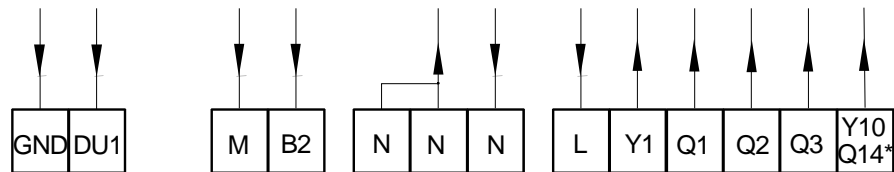
The factory settings are underlined and in bold print in the table above (**ON**)

Remarks

- (1) The operating mode can be changed with the  button on the controller, by means of a window contact, occupancy detector or otherwise (terminals DU1-GND). Input DU1-GND has a higher priority than the  button.
- (2) In case the controller is in the reduced operating mode, any operation carried out on the front of the controller changes the mode immediately to the normal operating mode. Note that the set-point offset is not active in the reduced operating mode.

- (3) All controllers can be set to either 2 or 4 pipe controllers. The difference between the REF7090521 or REF7090523 and the REF7090520 or REF7090522 is the relay instead of the second valve output. The default setting of P09 and P10 for REF7090521 or REF7090523 is "ON" or 1 and for REF7090520 or REF7090522 "OFF" or 0. If the REF7090520 or REF7090522 controllers are used to control an electric heater, then an external relay must be used and P09 and P10 must be set accordingly.
- (4) This setting defines that the C/O is set to heating only when the water temperature goes above 39 °C and that the fan-coil is completely switched off if the water temperature falls below 35 °C (in heating mode).
- (5) The modulating action on valve actuators is optimised for STA21 or STP21 actuators only.

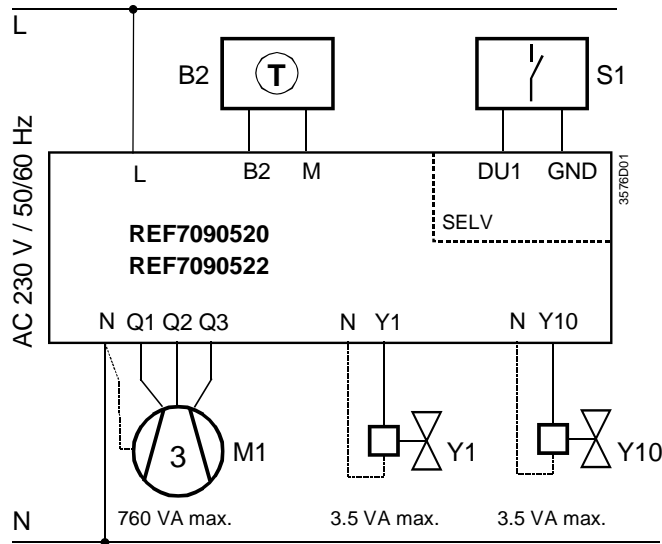
Terminal assignment



REF7090520 and REF7090522 // * REF7090521 and * REF7090523

GND	Measuring neutral for control input	
DU1	Operating mode control input, SELV	
L, N	Power supply AC 230 V	
M	Measuring neutral for sensor	
B2	Changeover- or return air sensor QAH11	
Y1	4-pipe application / control output for valve (heating)	/ AC 230 V
	2-pipe application / control output for valve (heating or cooling)	/ AC 230 V
Q1	Control output for fan speed 1	/ AC 230 V
Q2	Control output for fan speed 2	/ AC 230 V
Q3	Control output for fan speed 3	/ AC 230 V
Y10	4-pipe application / control output for valve (cooling)	/ AC 230 V
	2-pipe application / control output for external heater relay	/ AC 230 V
Q14	Control output for electric heater	/ AC 230 V

4-pipe fan-coil

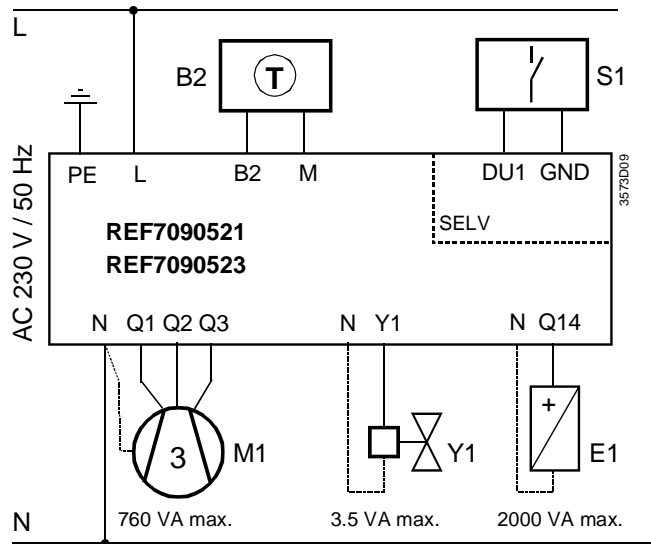


With 4-pipe applications (P09 = OFF or 0), a return air sensor QAH11 can be connected to terminals B2-M. In this case, the inbuilt sensor is automatically deactivated.

⚠ Important:

The c/o or return air sensor input (B2, M) is internally in the controller connected to the mains supply voltage of AC 230 V. Make sure that the isolation of the electric wiring is according to the requirements for 230V lines!

2-pipe fan-coil



- B2 Changeover sensor (REF7090521, REF7090523) or return air sensor (REF7090520, REF7090522)
- S1 Window contact or occupancy detector
- E1 Electric heater
- Y1 4 pipe applications: heating valve
2 pipe applications: cooling or heating valve (depending on changeover)
- M1 3-speed fan
- Y10 4 pipe applications: cooling valve
2 pipe applications: control output for external relay for electric heater
- Q14 Control output for electric heater

- Wiring, fuses and earthing must be installed in compliance with local regulations. It must be made certain that safety extra low voltage lines (SELV circuits) are clearly separated from AC 230 V mains voltage cables (also refer to Installation Instructions G3573X)
- The cables to the controller, external sensor, fan, valves and to the electric heater carry AC 230 V and must be appropriately dimensioned.
- Only sensors and valves rated for AC 230 V may be used
- The 230V mains power supply line must have an external fuse or circuit breaker with a rated current of not more than 10 A. This means that the total load connected to the controller (e.g. fan, electric heater) must be below 10 A.
- The controller is designed for withstanding overload currents which can occur in connection with defective loads or wiring and which can be quite high before the fuse in the 230V supply line (max. 10 A) interrupts the current.
- The connecting wires inside the controller must be placed so that no pressure is exerted on components when the cover of the controller is closed (also refer to Installation Instructions G3573X).
- The outputs to the fan motor are micro interruptions only. This means, that in error cases more than one output can be switched on the same time. If this happens, the short circuit current between two windings of the fan motor (and therefore two outputs) can be essentially greater than the maximum allowed 10 A, due to the special build of the fan motors. This short circuit current of two (or even three) windings is not protected by the fuse in the supply line of the controller. Therefore it must be either clear (verified through tests) that the erroneous currents are below 10 A or an (external) over-current protection must be installed in the connection lines of the fan motor.
- If an electric heater is used, it must be protected against overheating by an independent thermal switch or thermal fuse installed directly into the supply lines to the heater (see also EN 60 335-2-73)
- The switching contacts for signal inputs must be suited for low power.
- The changeover inputs of different controllers must not be connected in parallel. This means, one switching contact must be used per input. Remember that this input is not isolated from 230V.

 **Important**

The controller is not approved for mounting on metallic surfaces unless the surface is permanently connected to a protective conductor.

Safety instructions:

 **Important**


If an electric heating element is connected to the controller then the installation must comply with the safety regulations EN 60 335-2-73.

 **Safety check**

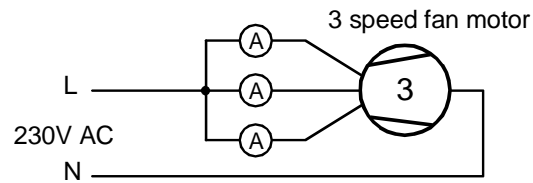
If any safety device of the installation activates an interrupt, then **the installation must be thoroughly checked** before the system is reset and put back into operation.

 **Important**

The controller may be opened only when isolated from the mains supply.



 **Important application instruction:**

Check the currents on the motor side when all 3 fan steps are supplied with 230 V (maximum failure current). These currents must not be higher than the max. 10 A the controller is designed for.



The currents of all three connections to the fan motor (measured with the current meters A) must be below 10 A when they are connected to 230V simultaneously.

Technical data

 Power supply	Operating voltage L, N	AC 230 V $\pm 10\%$
	Frequency	50 /60 Hz
	Power consumption	3VA (without field devices)
	Fuse or circuit breaker in supply lines max.	10 A
	Over-voltage category	III
Electrical connections	Max. cross-sectional area per terminal	2 wires each with 1.5 mm ² or 1 wire with 2.5 mm ²
Outputs	Fan control Q1, Q2, Q3	AC 230 V
	Max. load, $\cos \varphi > 0.9$	AC 3.3 A (note 1)
	Type of automatic action according to EN60730	1.B
	Electric heater Q14	AC 230 V
	Max. load (purely resistive)	2000 VA (230V, 8.7 A) (note 1)
	Type of automatic action according to EN60730	1.B
	Triac outputs Y1, Y10 for valve actuators	AC 230 V
	Steady state load	3.5 VA (one thermal actuator)
	Inrush current per output (<1 sec) (Suited for STA21 valve actuators)	max. 290mA
	Type of automatic action according to EN60730	1.C
Inputs	Changeover- or return air sensor B2 - M	
	Voltage against earth	AC 230 V
	Cable length max.	10 m
	Temperature sensor	QAH11 (NTC Element 3K)
	Signal input DU1- GND	
	Voltage (SELV), terminals open	9 V peak of a halfway rectified sinusoidal voltage.
Short circuit current	Effective value 5 mA	
Cable length max.	250 m	
Protection class	Insulation class	II (if correctly installed)
Housing protection	Degree of protection	IP 30 (note 2)
	Pollution degree	2 according to EN60730. (Representative of normal household air circulation)
Environmental conditions	Operation	Class 3K5 to IEC 721
	Temperature	0...50 °C
	Humidity	< 85 % rH
	Maximum height	2000 m above sea level
	Transport	Class 2K3 to IEC 721
	Temperature	-25...65 °C
Humidity	< 95 % rH	
Norms and standards	 - Conformity according to	
	EMV - directive	89/336/EWG

