SIEMENS

3577

ACR12.481/ALG

Heat Pump controller for wall mounting

ACR12.481

ON / OFF outputs for controlling a compressor and a reversing valve

Modulating output for an electric heater (if available)

P or PI control behaviour selectable

3-speed fan control, automatic and manual

Configurable for single cooling mode or for manual or automatic switching between heating and cooling.

Potential-free input for window contact or occupancy detector

Inbuilt room temperature sensor or external return air sensor

Alarm input for heat pump alarms

Three operating modes: Comfort / Economy / Standby

The status of the operating mode switch (⏻ →) and the changeover switch (☼/♨) are memorised at power failure.

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Siemens Building Technologies
HVAC Products

Use

For controlling the room temperature in individual rooms and zones which are heated and cooled with standalone heat-pumps. The controllers are suited for single mode heat-pumps as well as for heat-pumps with a reversing valve or with an electric heater.

This is achieved by managing the following equipment:

- a 3-speed fan
- a compressor
- a reversing valve or an electric heater

Functions

- Changeover between heating and cooling operation automatically or manually.
- Changeover of operating mode with window contact, occupancy detector or standby button
- Control of 3 fan speeds automatically or manually.
- Output for an external relay for the compressor.
- Output for the reversing valve or for an external relay for the electric heater.

Type summary

Application	*Operating panel*	*Type reference*
Heat-pump with reversing valve or electric heater	With display	**ACR12.481/ALG**
Cable sensor for return air temperature		**QAH11.1**

Ordering

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

Technical design

The room temperature is measured by an in-built sensor (an external return air sensor is also possible) and compared to the actual set-point. According to the resulting deviation, the processor switches the compressor on or off and controls the reversing valve or the electric heater. At the same time, the optimum fan speed is automatically selected if the fan speed selector switch of the controller is set to “AUTO“.

The user can choose between P (proportional) and PI (proportional/integral) control. These and other settings can be made on the device by setting the corresponding parameters.

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

The integral action time I (integral) is 5 minutes (if parameter P07 = 1).

Temperature Sensors

There are two possible sensors for measuring the actual temperature:

- Sensor inside the controller for measuring the room temperature
- External return air sensor

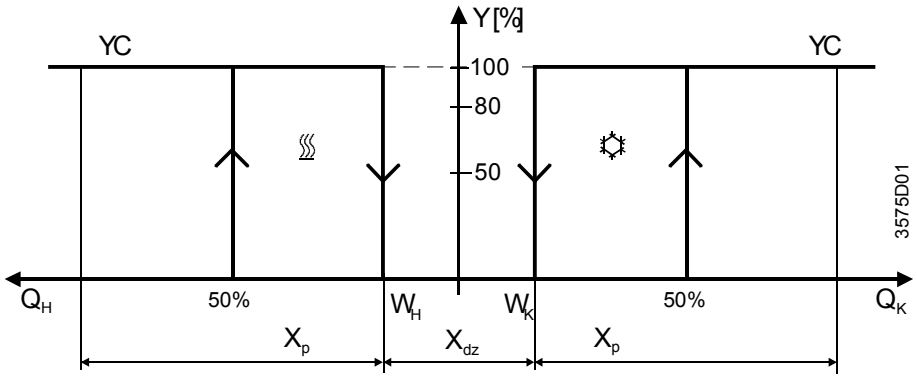
If no external sensor is connected and the terminals B2 and M are short-circuited, then the internal sensor is used automatically.

Setpoints

For **comfort operation,** the set-points can be defined in the parameter mode. The heating set-point is normally set to 21 °C and the cooling set-point to 23 °C. The room user can adjust the set-points within the limits defined by P13 (maximum ± 6 K). This produces a maximum set-point range of the default set-points of 15...27 °C in heating operation and 17...29 °C in cooling operation. The neutral zone remains constant at 2 K in this example (difference between cooling and heating set-point).
For **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) 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 with P13 set to 6K (the default). The neutral zone remains constant at 16K.
For **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

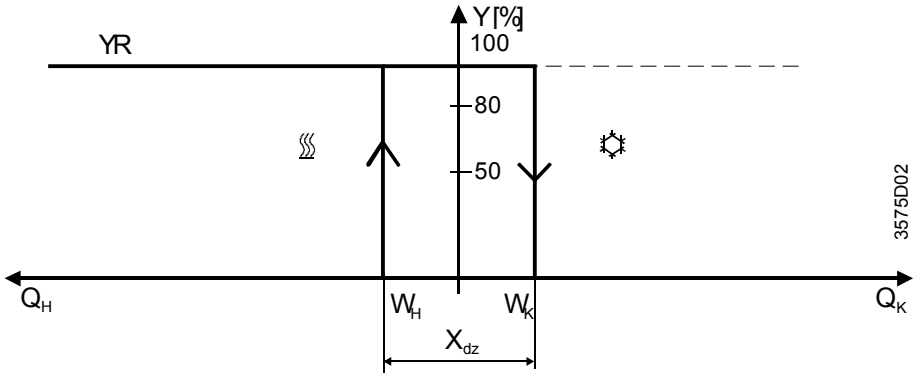
Compressor



This diagram shows how the compressor output (YC) is switched when the changeover between heating and cooling happens automatically. If only heating or only cooling is allowed, then only the left half of the curve (for heating) or the right half (for cooling) is valid.

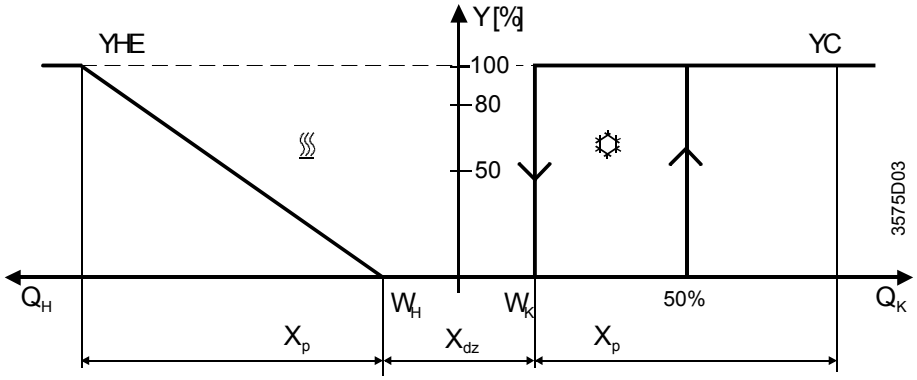
Note that that any time the compressor is switched off it stays off for at least 3 minutes.

Reversing valve



This diagram shows how the output for the reversing valve (YR) is switched when the change-over between heating and cooling happens automatically.

Cooling with compressor, heating with electric heater



Q_H	Heating demand	W_H	Heating set-point
Q_K	Cooling demand	W_K	Cooling set-point
X_p	P-band		
Y	Positioning variable		
YHE	Electric heater output		
YC	Compressor output		
YR	Reversing valve output		

Electric heater

If no reversing valve is available then the output of the controller can be used for switching an external relay for an electric heater.

The controlling of the heater depends on the control deviation (the output is pulse duration modulated).

The cycle time is 240 s. For safety reasons, max. 50 % of heating output is possible at manual fan speed I (relay 120 s “on” and 120 s “off”), at speed II max. 80 % and at speed III max. 100 %.

Note that if the electric heater is inside the fan coil and is active then the fan will not switch off immediately when for example the mode is changed from comfort to economy. The fan continues to run until the protection time of the heater has passed (1...4 min, depending on the situation).

Changeover between heating and cooling operation

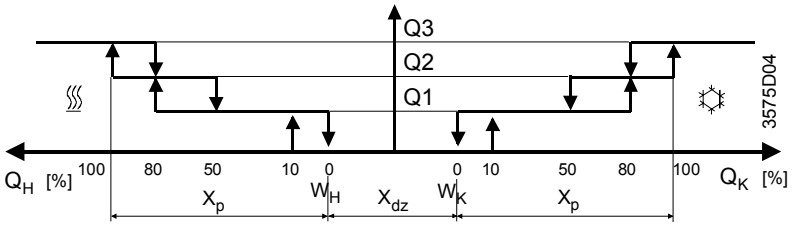
A changeover of the heat pump system between heating and cooling is only possible if a reversing valve is available (defined by parameter P09). Parameter P10 defines in this case whether the change-over happens automatically when the corresponding set-point is reached or whether the controller must be switched manually from one state to the other. There is a special key available on the controller for switching manually between heating and cooling ( )

Fan operation

In automatic mode (fan speed selector switch on the controller set to “Auto“) and the controller in neutral zone, the fan can be operated in two different modes (defined by P08). In one mode the ventilation remains constantly at speed 1, in the other mode it is switched off in the neutral zone.

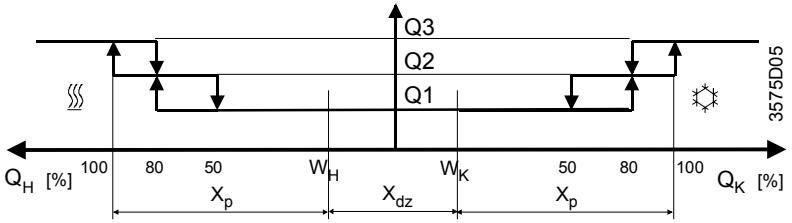
If the fan starts from standstill to stage 1, it starts with stage 3 for 1 second in order to start reliable.

With 10 % control of the heating or cooling valve, the fan switches to speed I, with 80 % to speed II and with 100 % to speed III. The switching hysteresis of the fan speeds are shown in the following diagram.



Ventilation in neutral zone OFF. (parameter P08 = 1).

If a return air sensor is used (B2, M) then the fan is switched ON for 2 min every 30 min. as long as the controller remains in the dead (neutral) zone.
Note that with an external electric heater the return air sensor cannot be used since the fan is not periodically switched when the controller is in heating mode.



Ventilation ON in neutral zone of comfort mode
Ventilation OFF in neutral zone of economy or frost protection.
(Parameter P08 = 0).

Legend to the drawings above:

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 demand	X_{dz}	Neutral zone
Q_K	Cooling demand		

There is a speed dwell time defined of 1 minute (minimum duration of one state). This dwell time is used in automatic operation and cannot be changed. It prevents the fan-speed from changing too often.

Alarm input

The input B2, M for the external sensor is also used as alarm input. If the external sensor and the alarm input are both used, then they have to be connected serially. The rules for the input at B2 and M are the following:

- If the resistance between B2 and M is > 10K Ohm or open circuited (< 0°C) then this means alarm.
- If the resistance is < 1.5K Ohm or short circuited (> 40.0°C) this means no sensor is connected and the internal sensor is used instead.
- If the resistance is according to a temperature of > 0°C and < 40°C then the external sensor is used.

If an alarm occurs then all outputs are switched off and the text “Err” is shown in the display. The operating mode is switched to standby and nothing can be done until the alarm disappears. When it disappears, the pointer to the standby sign (⏻) appears in the display in addition to “Err”. By pressing the Standby / AUTO /Fan-speed key, the alarm can now be reset and the operating mode is changed back to AUTO and the text “Err” disappears.

Note that with an electrical heater active the fan is only switched off when the protection time of the heater is over (1...4min). The heating symbol is blinking during the time the fan cannot be switched off because of the protection time.

Window Contact Input

Settings

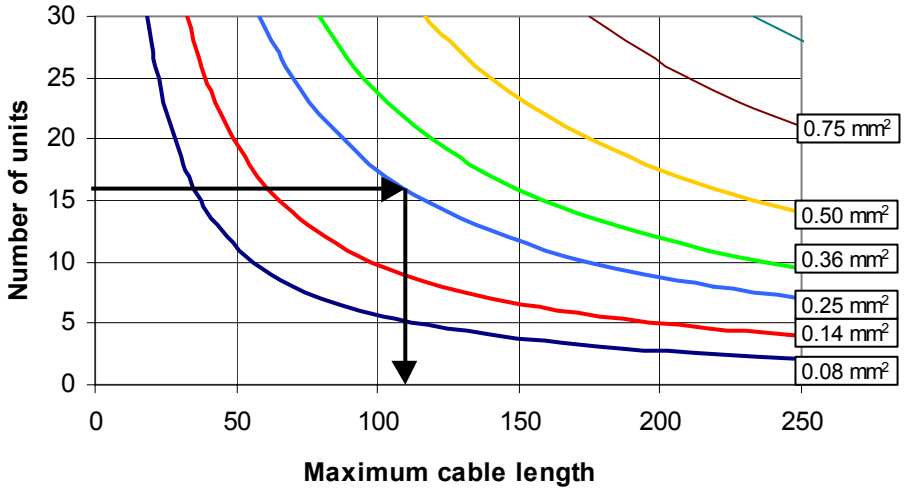
The window contact input (DU1, GND) is used to switch the operating mode from normal mode (defined by P01) to reduced mode (defined by P02). The idle position of the contact is defined by P03.

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 mm^2, then the following graph shows the relationship between cable length, number of units connected in parallel and the wire diameter.

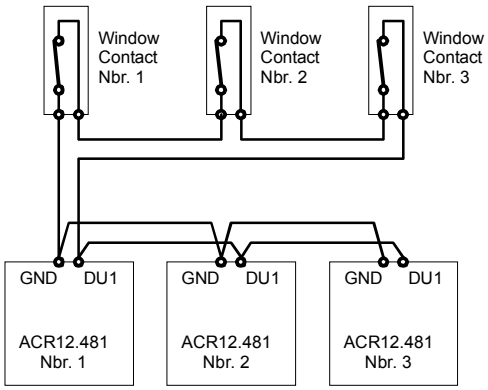


Example of wiring

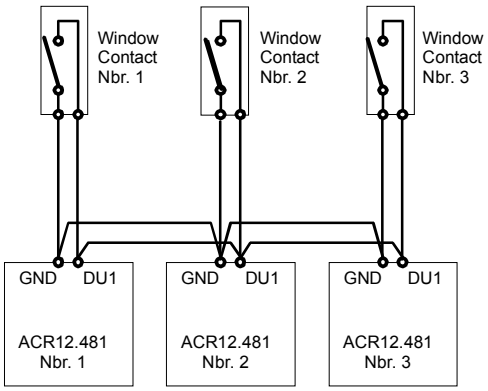
16 controllers are switched in parallel and the wire diameter is 0.25 mm^2, then the maximum cable length must not exceed 110 m. However with wire diameters of 0.75 mm^2 250 m are possible with up to 21 controllers.

Wiring diagrams

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



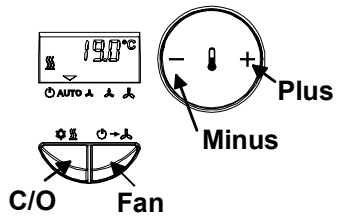
Circuit with normally open contacts.
(Parameter P03 = 0)



Parameters

15 parameters (P01...P15) define the behaviour of the controller. These parameters can be changed in the parameter mode.

Entering the parameter mode and changing the parameters is achieved in the following way:



- Press simultaneously the keys **<C/O><FAN><MINUS>** until the display is dark (about 2 seconds).
- Press **<MINUS>** 2 times at an interval of about 0.5 seconds.
- 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 accept a modification or the **<FAN>** key to cancel the modification.
- Incrementing the parameter numbers or the values is accelerated when the + or – key is being kept depressed for more than 2 seconds.
- To return to normal operation, press the **<FAN>** key.

Nbr.	*Designation*	*Values*	*Entry*
P01	Normal Operating Mode (1)	Comfort Economy	**1** 0
P02	Reduced Operating Mode (2)	Frost Protection Economy	**1** 0
P03	Idle position of contact at input DU1	Normally closed Normally open	1 **0**
P04	Place of heating system (only applicable if P09 = P10 = 1)	Outside heat pump Inside heat pump	1 **0**
P05	P-band heating	2 k 4 K	**1** 0
P06	P-band cooling	2 k 4 K	**1** 0
P07	Controlling algorithm	PI P	**1** 0
P08	Ventilation in neural zone of normal mode	OFF ON	**1** 0
P09	Type of heat pump	Cooling only Reversing valve	**1** 0(3)
P10	Electric heater or change over (3)	EH Yes or C/O Auto EH No or C/O Manual	1 **0**
P11	Set-point heating comfort	16°C…26°C	**21**
P12	Set-point cooling comfort	18°C…28°C	**23**
P13	Maximum offset for set-points	0K…6K	**6**
P14	Correction of temp. measurement	-10K…+10K	**0**
P15	Units of temperature display	°C °F	**1** 0

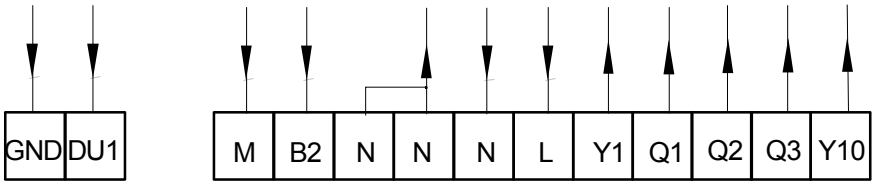
In the table above the factory settings are underlined and in bold print (**1**).

(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) P9=1, P10=1, Compressor for cooling only, heating with electric heater
P9=1, P10=0, Compressor for cooling only, no heating possible
P9=0, P10=1, Reversing valve, change-over automatically
P9=0, P10=0, Reversing valve, change-over manually

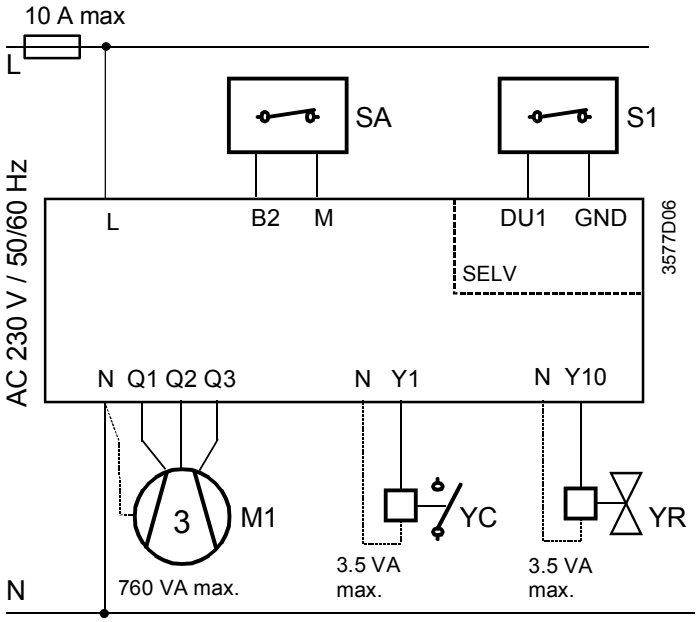
Terminal assignment



DU1 GND	Operating mode control input, SELV Measuring neutral for control input	
M	Measuring neutral for sensor	
B2	Return air sensor QAH11.1 or alarm input	
N, L	Power supply AC 230 V	
Y1	Output for external relay for compressor	/ 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	Control output for reversing valve or for electric heater relay	/ AC 230 V

Connection diagrams

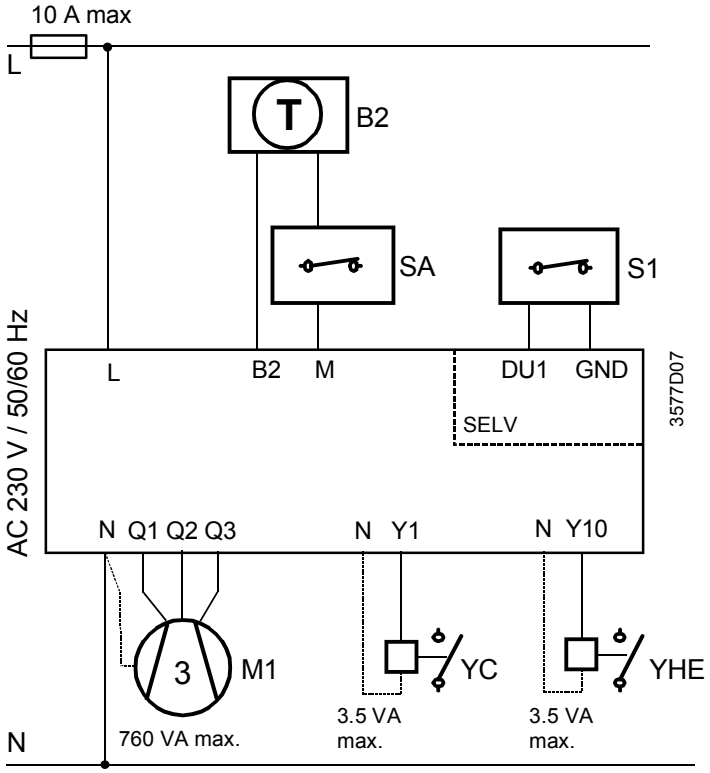
Heat pump
with reversing valve
and alarm input.



An open input at B2, M means alarm. The compressor is operated through an external relay YC. The reversing valve can be connected directly to Y10 if the power of the coil is within the limits of 3.5VA. Note that the external wiring of the compressor is not shown here.

⚠ **Important:** **The alarm input has the same potential as the supply voltage of AC 230 V.**

Heat pump
with electric heater
and return air sensor
and alarm input.



The alarm contact is wired serially with the return air sensor. An open input at B2, M means alarm. The compressor is operated through an external relay YC. The electric heater is also operated through an external relay YHE. Note that the external wiring of the compressor and the electric heater is not shown here.

⚠ **Important:**

The alarm input and the return air sensor have the same potential as the supply voltage of AC 230 V.

Legend to the connecti-
on diagrams:

S1	Window contact, occupancy detector	YC	Relay for Compressor
SA	Alarm contact (normally closed)	YR	Reversing valve
B2	Return air sensor	YHE	Relay for electric heater
M1	3-speed fan		

Project engineering and wiring notes

⚠ **Important:**

- 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 G3577)
- 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
- 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 such that no pressure will be exerted on components when the cover of the controller is closed (also refer to Installation Instructions G3577).
- The outputs to the fan motor are micro interruptions only. This means, that in error cases more than one output can be switched on at 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 design 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.

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

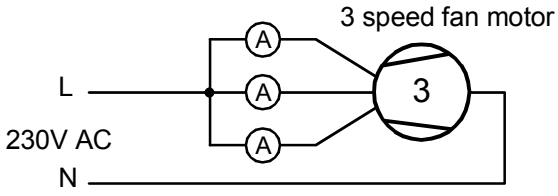
Safety instructions

⚠ **Important:** **The controller must be installed by the customer according to the safety regulations VDE 0700 / EN 60 335-2-73.**

⚠ **Safety check** If any safety device of the system is activated, **the installation must be thoroughly checked** before the system is reset.

⚠ **Important** **The controller may be opened only when separated 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 simultaneously to 230V.

Technical data

⚠ **Power supply**	Operating voltage L, N	AC 230 V ±10 %
	Frequency	50 / 60Hz
	Power consumption	3 VA (without field devices)
	Max. fuse in supply line	10 A
	Overvoltage 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 φ > 0.9	3.3 A
	Type of automatic action according to EN60730	1.B
	Triac controlled outputs Y1, Y10 for valve actuators or external relays	AC 230 V
	Steady state load	3.5 VA (one thermal actuator)
	Inrush current per output (<1 sec)	max. 290mA
	Type of automatic action according to EN60730	1.C
Inputs	Return air sensor or alarm input B2 - M	
	Voltage against earth	230 V AC
	Temperature sensor	QAH11.1 (NTC Element 3K)
	Signal input DU1- GND 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 1)
	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	CE - Conformity according to	
	EMC- directive	89/336/EWG
	Low voltage directive	73/23/EWG
	Electromagnetic compatibility	
	Immunity to interference	EN 50082-1
	Emissions	EN 50081-1
	Product safety	
	Automatic control devices for use in the home and similar applications	EN 60730-1
	Special requirements for energy controllers	EN60730-2-11
Housing	Colour	RAL 9010

Note 1: In oder to have IP30 protection the controller must be mounted on a flat surface such that all openings on the back side of the housing are completely covered.

Dimensions