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Guidance Document

Electrical layouts for EC Motors in Fan Convector units

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This document is intended to give a brief guide to the wiring and controls available from the new motors. It is not a comprehensive list of all control options but is intended to provide an understanding of the underlying concepts. The diagrams are for information only and intended to demonstrate the control logic; they must not be used as actual unit wiring diagrams. For any other further information contact the Technical Department

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Introduction

EC motors have been adopted by SPC for use in the full range of fan convectors due to their higher energy efficiency compared to the previous generation of AC motors. This means that they are able to deliver the same air volumes as the previous units while drawing less power from the mains. Building regulations and upcoming amendments to same place restrictions on the power draw of equipment for specific air volume flowrates; this is termed specific fan power (SFP) and measured in Watts per litre/s. The adoption of EC technology will allow SPC to comply with all foreseeable legislation.

As well as offering higher energy efficiency the EC motors also offer increased controllability. This document is intended to give a brief guide to the wiring and controls available from the new motors. It is not a comprehensive list of all control options but is intended to provide an understanding of the underlying concepts.

AC motors, as previously used, relied upon switching of mains voltage to control the units in on/off mode. Speed control was by auto-transformer with multiple tappings. These tappings reduced the voltage across the motor windings and reduced the rotational speed but in a very energy inefficient manner. EC motor control is electronic and does not share the above inefficiencies.

An EC motor is a brushless DC motor with built-in electronics which accepts a 230V AC power supply. Traditional DC motors, while more efficient than their AC counterparts, incur losses as a result of the 'brushes' used for commutation i.e. changing the polarity of the electro-magnetic field. An EC motor is 'electronically commutated' i.e. the built-in electronics reverse the polarity of the field rather than relying on mechanical brushes. EC motors differ from so-called brushless DC motors in that they accept a mains AC power supply, the rectification to DC is performed by the on-board electronics. The on board electronics also open up the possibility of enhanced low voltage control of the motor rotational speed.

The EC motor is supplied with two wiring cables; a standard 3 core 230V AC power supply loom and an additional control loom. The power supply to the motor is permanent and is not switched (unlike AC motors) and control of the speed is achieved by varying a low voltage control signal.

Whenever power is available at the unit the EC motor electronics generate a 10V DC signal. This 10V DC output is controlled (switched or reduced) by the fan convector wiring before being fed back to the EC motor as a DC signal which has a magnitude of between 0 and 10V. The electronics on board the EC motor interpret the magnitude of this signal and set the rotational speed of the motor to suit. If the signal is less than 1V then the motor will not rotate, between 1V and 10V the rotational speed varies between its minimum and maximum.

The various thermostats are wired into the control loop between the 10V DC output from the EC motor and the 0 to 10V DC input signal back to the EC motor.

Built-in speed control is achieved by using a standard set of three potentiometers. The 10V signal is fed to the potentiometer board which includes three potentiometers each with a different electrical resistance. The output from the potentiometers is less than 10V depending upon the voltage drop across the potentiometer. The use of three individual potentiometers allows the potential for the selection of up to three speeds on the fan convector, mimicking the old AC control.

Whenever remote thermostats or switches are employed on fan convectors they will now be rated as ‘safe low voltage’ as they are only switching a 10V signal. When used with AC motors the switches and thermostats were switching mains voltage and did not enjoy this classification.

The following gives an introduction to the wiring arrangements used with EC motors and includes a number of schematic diagrams. These diagrams are for information only and intended to demonstrate the control logic; they must not be used as actual unit wiring diagrams.

Connection Terminals in EC motors

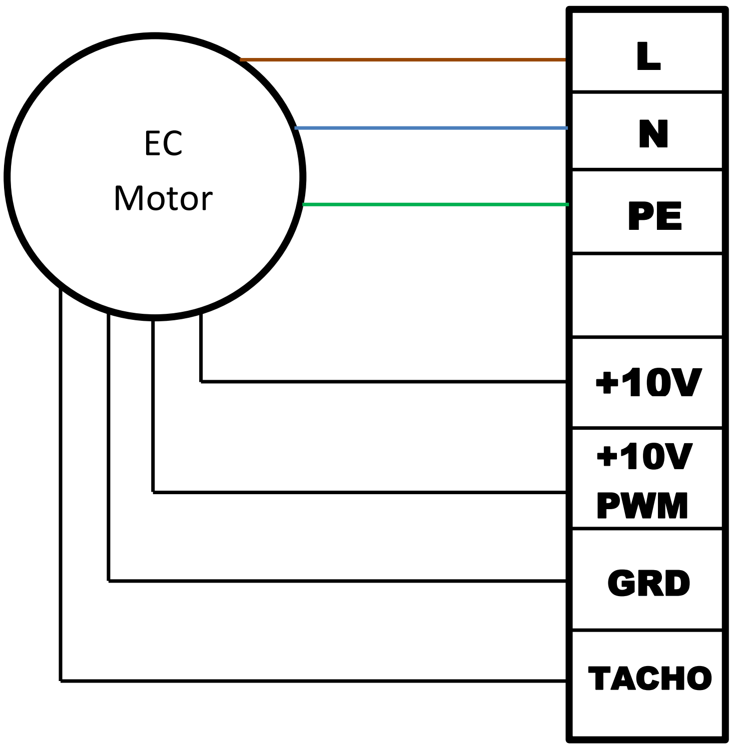


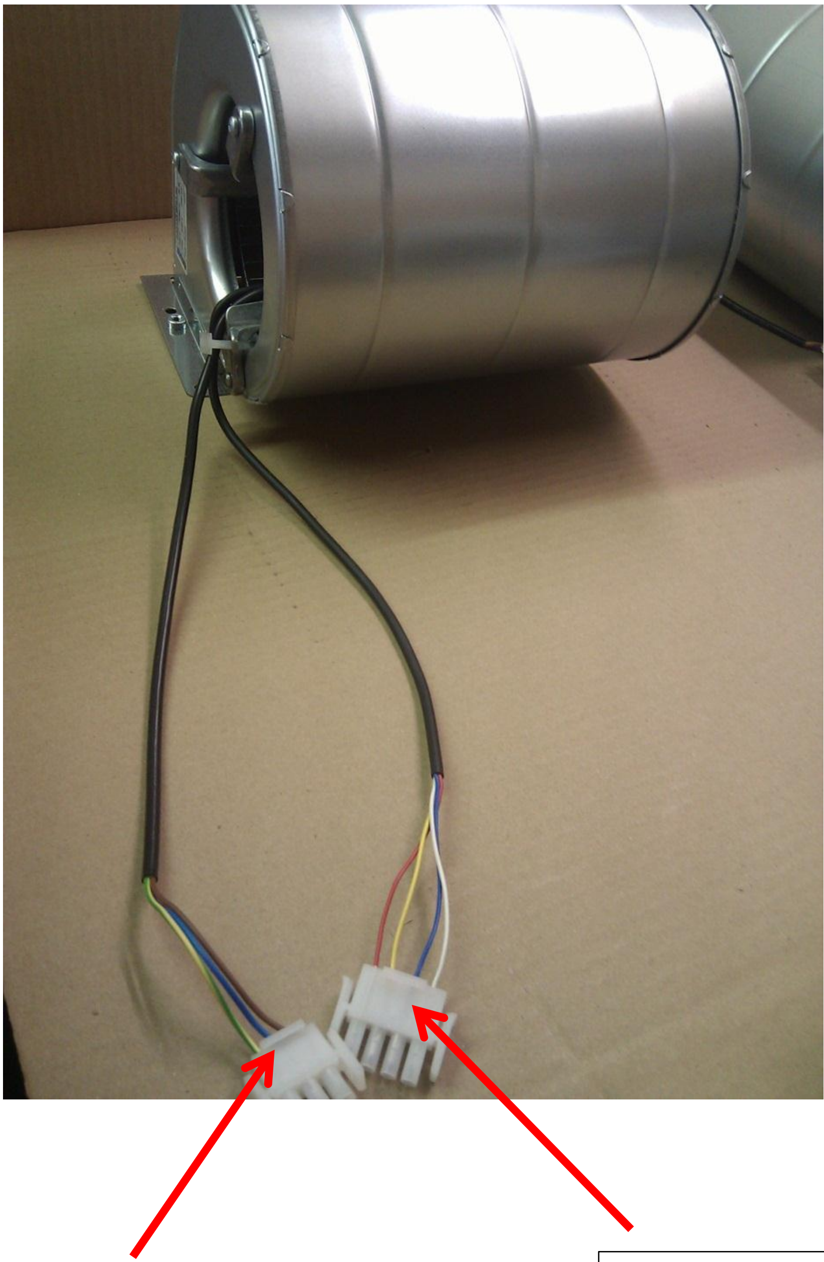
Figure shows the connection terminals available on EC motors.

- 'L' – Live
- 'N' – Neutral
- 'PE' – Protective Earth

The above terminals accept the 230V AC supply.

- '+10V' – A 10VDC output signal from the EC motor board.
- '+10V PWM' – A 0-10V DC input signal to the EC motor board. Depending on the input received at this terminal the desired fan speed is achieved. < 1V – 0 rpm, 1V-10V minimum to maximum speed. (Note: PWM refers to pulse width modulation and is an alternative means of control not used)
- 'GRD' – Ground connection (neutral or 0V)
- 'TACHO' – Output terminal that can linked to the BMS to measure fan rotational speed.

The figure below shows the EC motor used in Belgravia, Supreme & air curtain units with connection terminals



External 230V AC power terminals

'L' – Brown

'N' – Blue

'PE' – Green/Yellow

Control Terminals

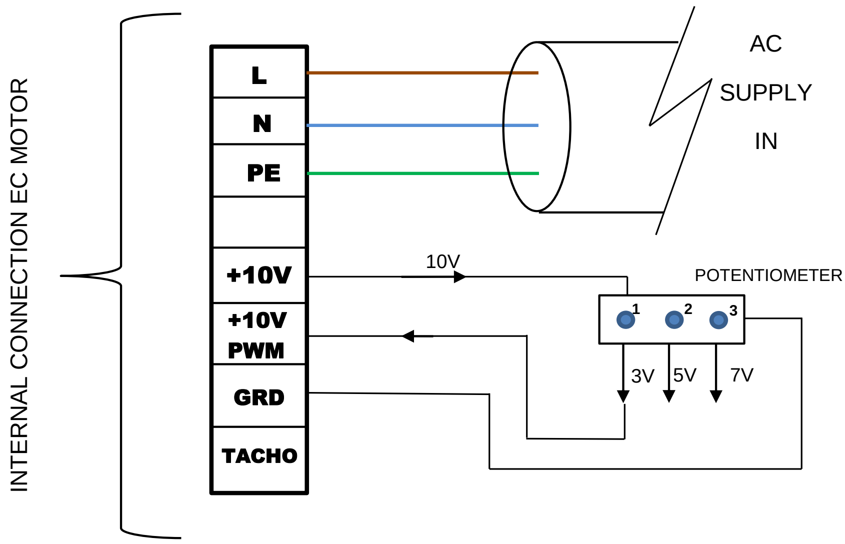
'+10V' – Red

'+10V PWM' – Yellow

'GRD' – Blue

'TACHO' - White

Fan Convector to achieve a specific motor speed and air flow rate



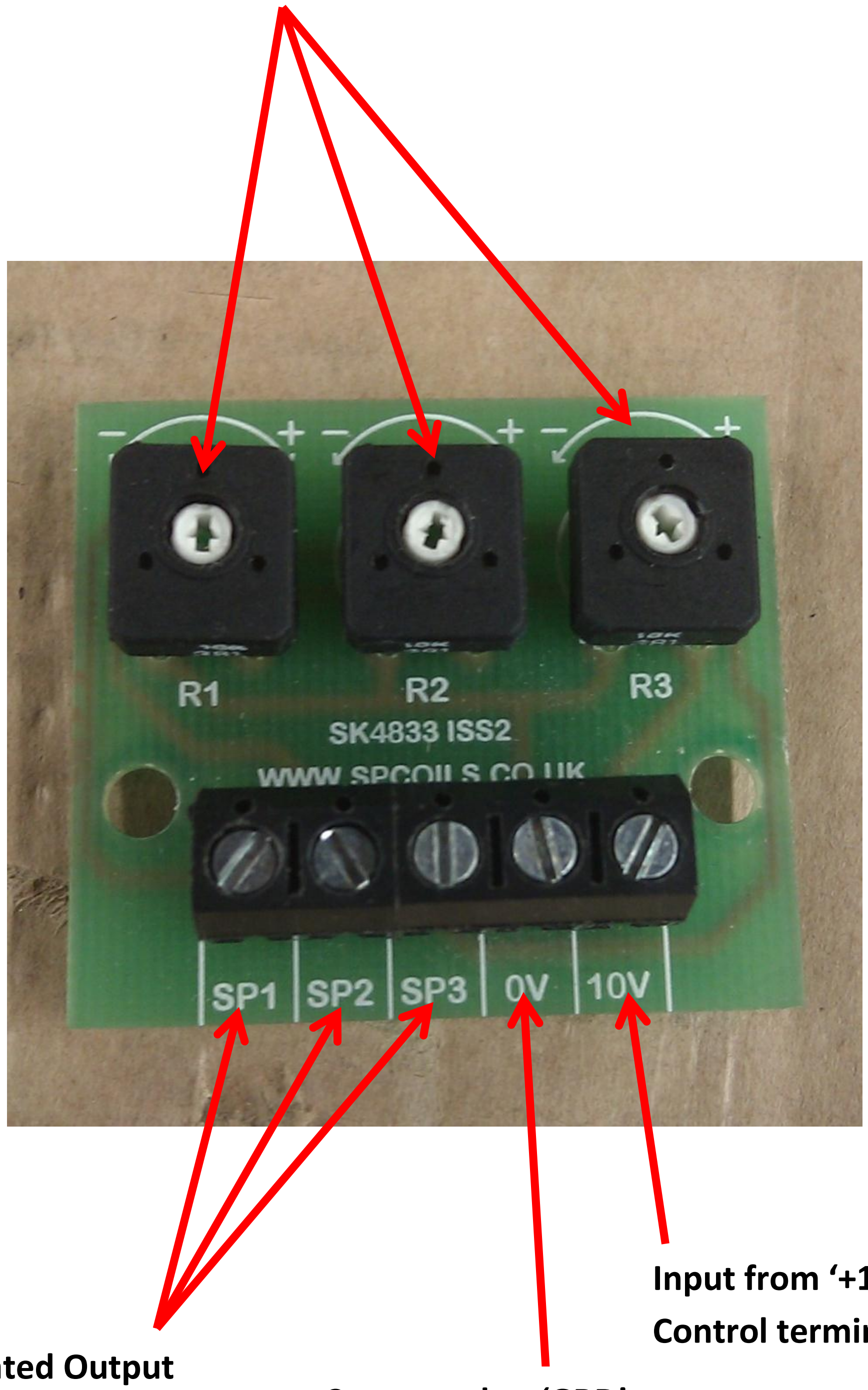
EC motors offer infinitely variable closed loop speed control via a 0-10V DC signal. In the figure shown above the aim is to achieve a constant fan speed which would then give a specific airflow. The electrical connections include mains supply (230V AC) to ‘L’, ‘N’ & ‘PE’ terminal.

To set the fan to rotate at a specific speed, the 10V DC signal obtained from the EC motor board is used in conjunction with the potentiometer. The potentiometer accepts the 10V signal and gives out a lower voltage signal according to the position of the rotary dial. The ‘+10V’ signal from the EC motor is connected to all three pots in parallel and one of the three is chosen to provide the output signal. This lower DC signal from the pot is connected back to the ‘+10v PWM’ terminal.

The speed of the fan varies proportionally to the voltage supplied back to the ‘+10V PWM’ terminal. Tests previously conducted identify rotational speeds that are achieved for a given voltage. The voltages have been determined and are set to match the rotational speeds that were used on the previous AC motor sets. The DC signal coming out of the potentiometer is measured using a voltmeter on all production units and the potentiometer tweaked to give the required speeds

The figure below shows the potentiometer used in a fan convector unit

Dials

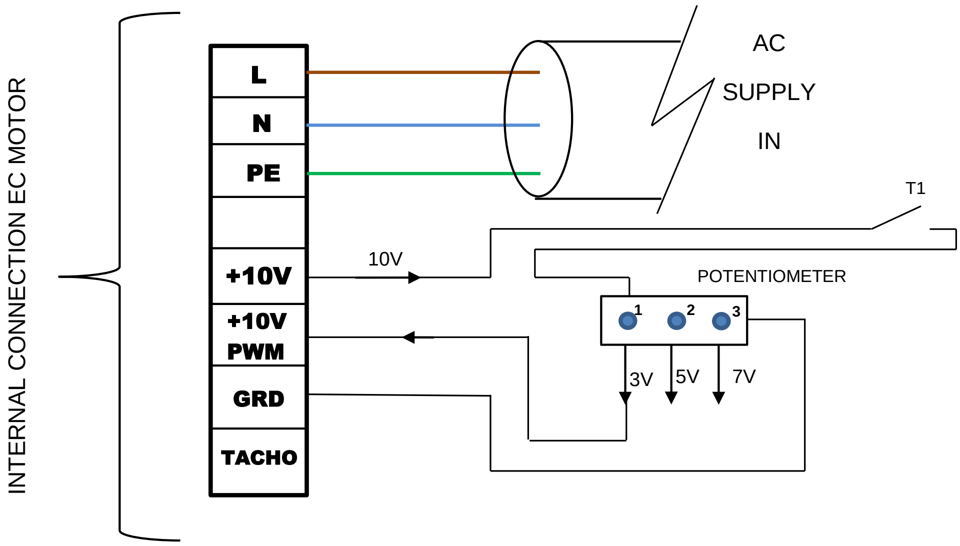


Input from '+10V' Control terminal

Modulated Output Voltage from Potentiometer

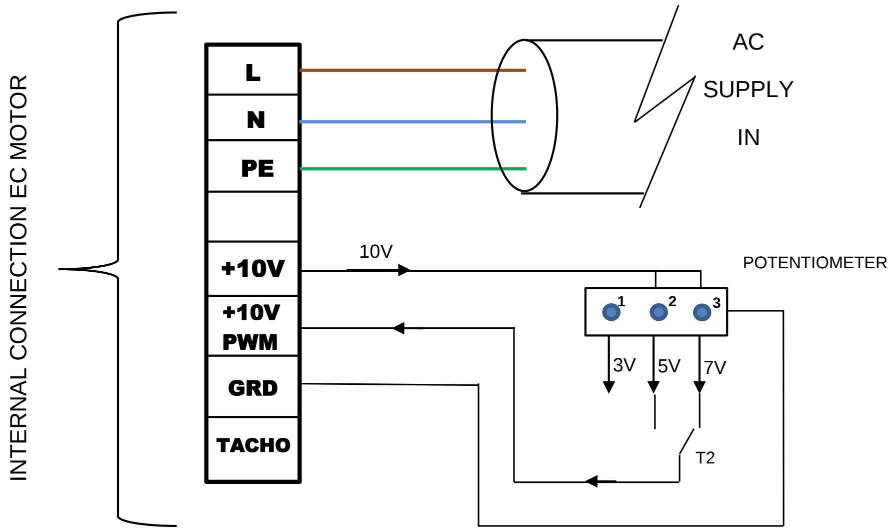
Connected to 'GRD' Terminal

Fan Convector with integral On/Off thermostat (T1)



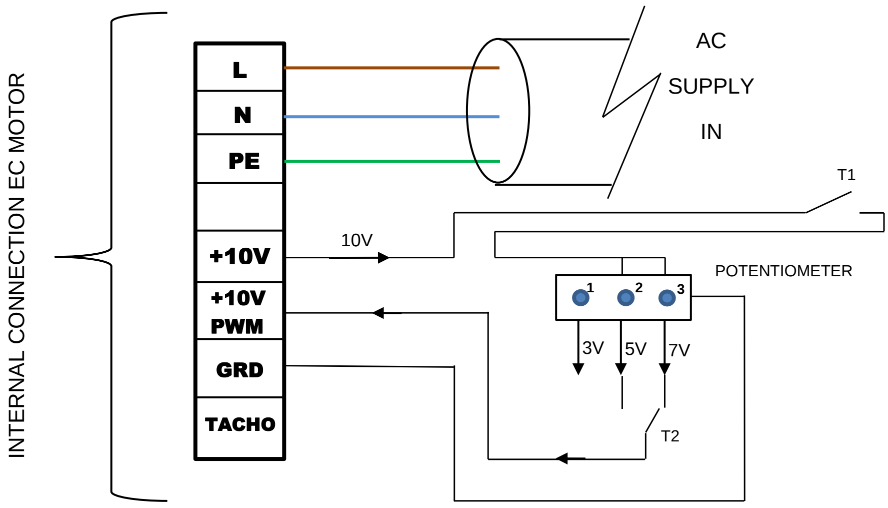
The addition of the On-Off thermostat (T1) is shown in figure above. The thermostat is set to a temperature, set point (T_{sp1}), at which the room condition needs to be maintained. If the room temperature is above the set point the switch T1 opens and the fan stops running as it receives a 0V signal. As the room temperature falls below the set point temperature the thermostat 'T1'closes and the fan starts again at the speed associated with the voltage from the potentiometer.

Fan Convector with integral change speed thermostat (T2)



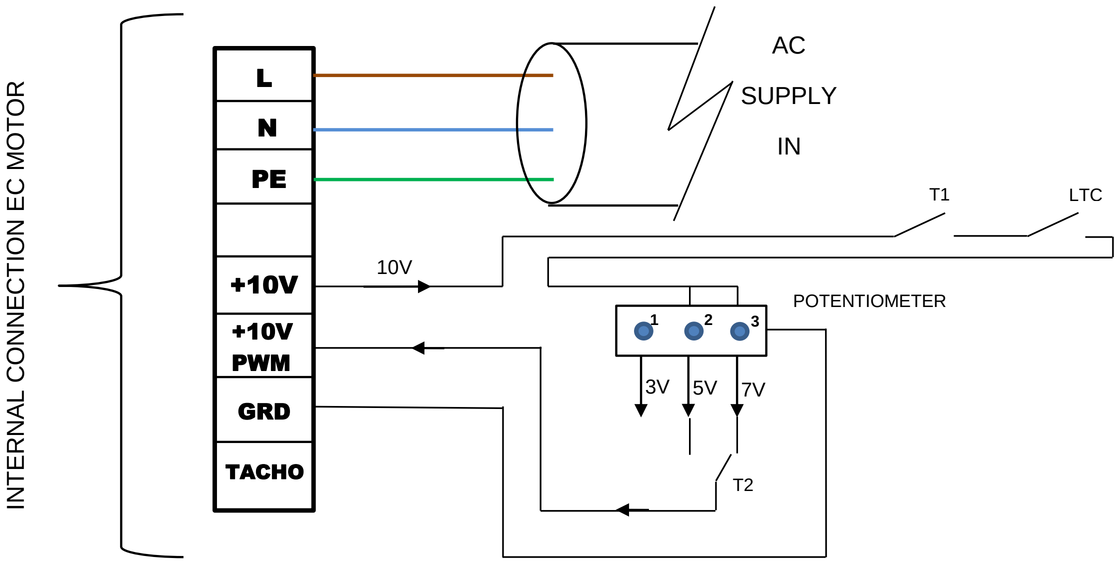
With the addition of a change speed thermostat the EC motor can run at two different speeds. The '+10V' terminal is connected to two terminals of the potentiometer, say 2 & 3 for medium and high speed. The thermostat 'T2' is set to a temperature (T_{sp2}) such that if the room temperature is below T_{sp2} 'T2' switches to terminal '3' of the potentiometer (high speed). If the room temperature is above T_{sp2}, 'T2' switches to terminal '2' of the potentiometer (medium speed).

Fan Convector with integral On/Off thermostat (T1) & Change speed thermostat (T2)



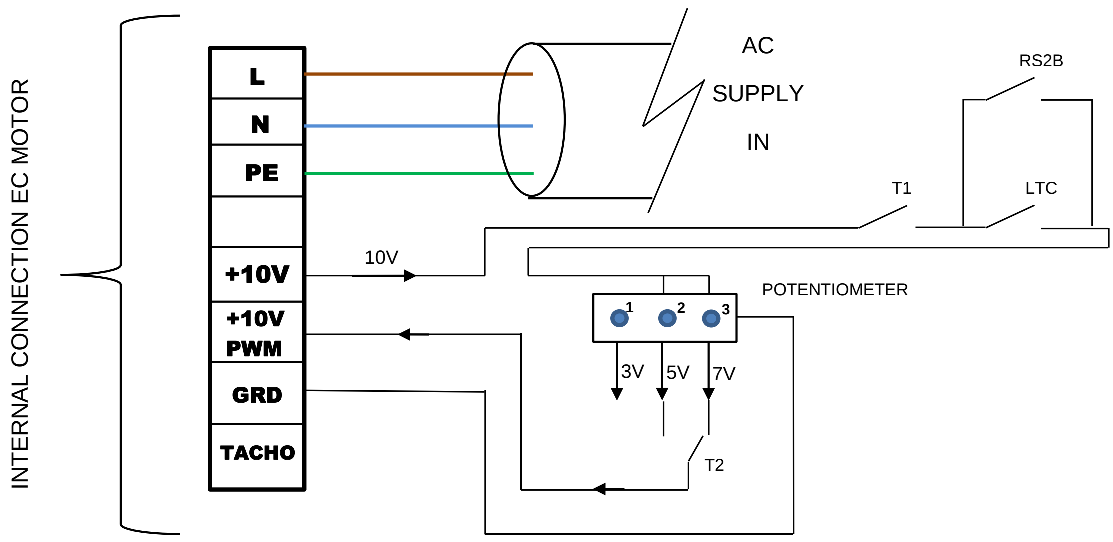
A combination of both 'T1' and 'T2' is used to switch the fan on/off as well as control its speed. The set point temperatures are fixed such that $T_{sp1} > T_{sp2}$. If the room temperature is above T_{sp1} then the fan will not run as it receives a 0 V signal. If 'T1' is closed then the rotational speed will be selected by 'T2' as described in the previous section.

Fan Convector with T1, T2 & Low temperature cut-out switch (LTC)



The LTC switch opens and closes based on the hot water temperature measured on the coil pipes. If the water temperature falls below 45°C, the switch opens and stops the fan from running. This prevents cold air being blown out from the fan convector unit. The LTC switch closes when the water temperature increases. Including the LTC option in a fan convector means that the unit operates only in winter or when hot water is being circulated. The adjustable LTC works on the same principle but the cut off temperature can be set between 30°C to 90°C. Note that the adjustable version (ALTC) is supplied loose and needs to be clipped to the water pipework; it does not attach directly to the coil. If the effect of the LTC needs to be overridden in order to circulate cool air in summer then a 'Summer/Winter' switch must be specified.

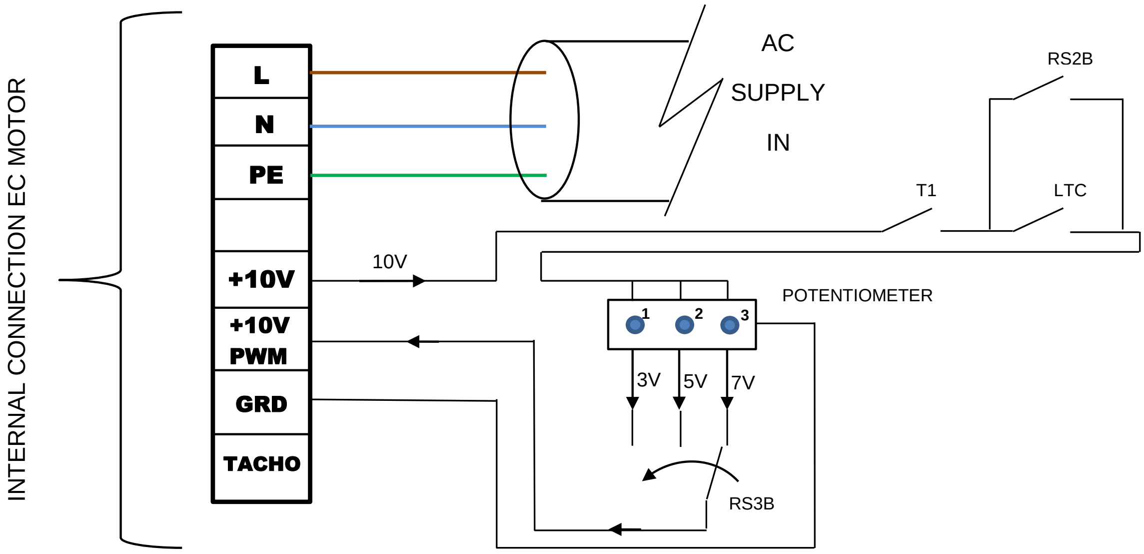
Fan Convector with T1, T2, LTC & Rocker switch summer-winter built in (RS2B)



RS2B option is added if both winter and summer operations are required. In winter the RS2B is always kept open and the LTC switches on/off based on the water temperature. During summer when there is no hot water circulating the LTC switch will open. Hence for summer operation, to allow cool air circulation, the RS2B, which is connected in parallel to the LTC, is switched to summer, closing the contact. This ensures fan rotation even though the LTC is open.

Note that the suffix B on the rocker switches refers to 'built-in' i.e. the switch is mounted on the motorplate. The switch will only be accessible after removing the unit access panel. Options C & R are also available with rocker switches; C refers to 'case mounted' whereby the switch is fitted externally on the case and R refers to remote mounted where the switch is mounted on a switch plate on the wall and wired back to the unit via a customer connection box. All the three rocker switch mounting options provide the same functionality.

Fan Convector with T1, T2, LTC, RS2B & Rocker switch 3-speed (RS3B)



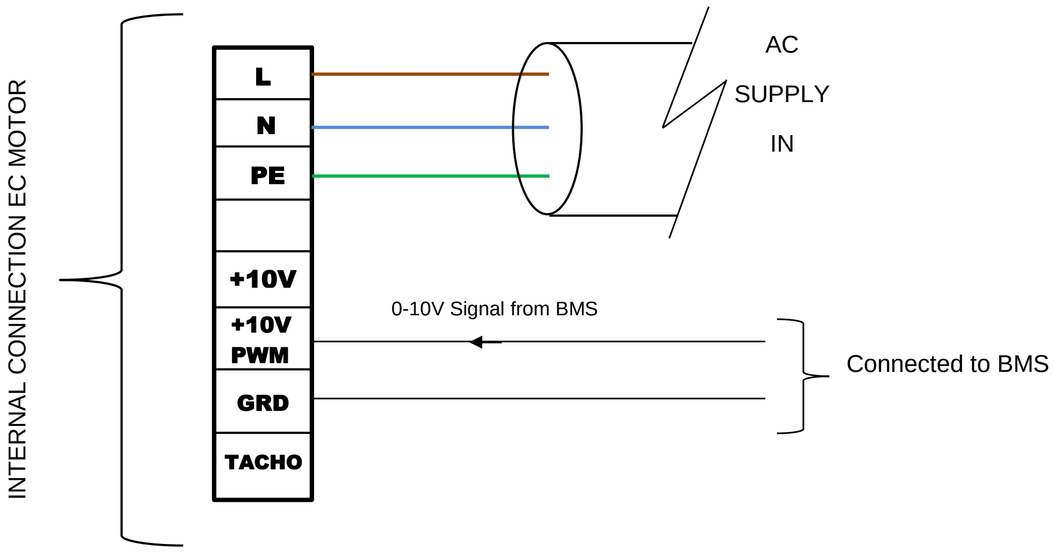
RS3B is added to allow the fan to run at three different user selected speeds. The user can set the fan manually between the three speeds available by using the RS3B switch which is a three position rocker switch which can alternatively be case or remote mounted.

Fan convector integrated with BMS

A Building Management System (BMS) is a computer-based control system installed in buildings that controls and monitors the building’s mechanical and electrical equipment such as heating, cooling, ventilation, lighting, power systems, fire systems, and security systems. The BMS controls the system by sending voltage signals to the equipment it is controlling.

Depending on the type of voltage signal sent by the BMS; the integration of a fan convector is explained on the following pages.

Fan speed control via BMS – Analogue Signal

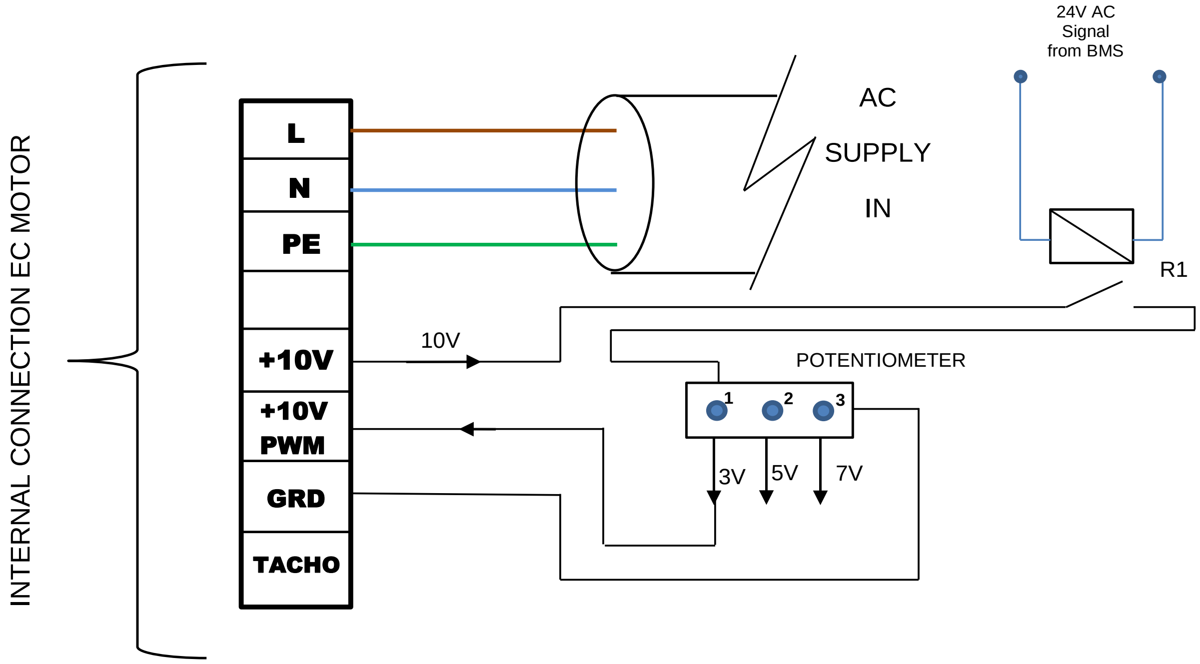


In order to control the fan convector directly the BMS should send a 0-10V DC signal to the unit as shown in the figure above. Using the BMS to control the fan speed directly bypasses the internal potentiometers and any other controls. The '+10V' output signal from the EC motor board is not used.

The BMS is programmed such that it senses the room temperature and modulates the DC signal to the Fan convector. The BMS is programmed by a third party and will generate its 'analogue' 0-10V DC signal based upon a number of sensors from which it receives data. These can be temperature sensors, occupancy sensors and time clocks.

The BMS can directly control the speed of the fan only if it capable of sending a 0-10V DC signal.

Fan convector control via BMS – Digital Signal

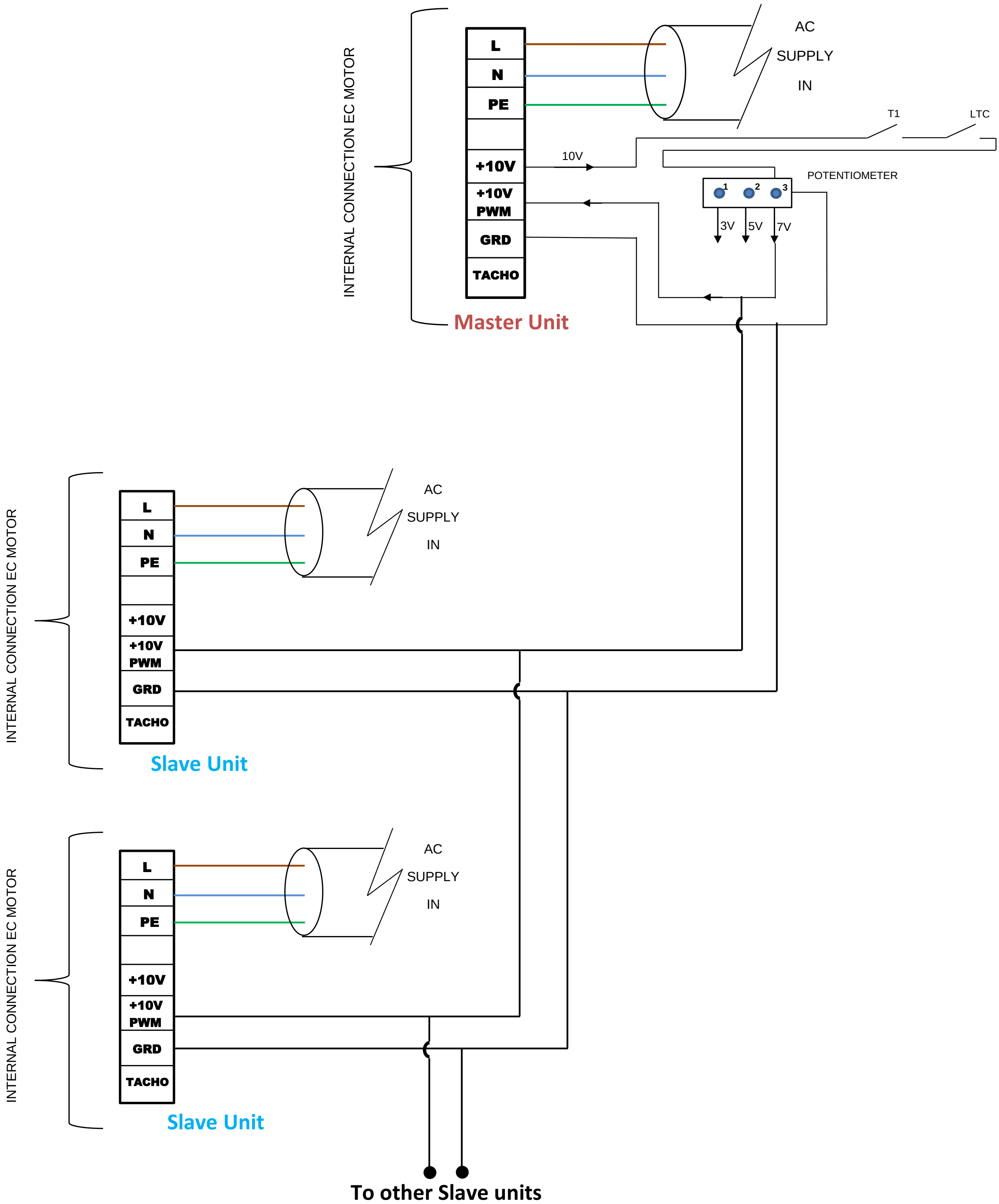


The BMS can control the fan convector in on/off mode if it sends a digital signal to the unit. The signal from the BMS is described as being digital in as much as it controls the unit on or off. The analogue signal described in the previous section provides continuous speed control depending on the magnitude of the signal. In the figure above a 24V AC signal from the BMS is used to switch the fan convector On/Off. A relay, which is an electrically operated switch, is used for this purpose. The AC signal from the BMS energizes the coil in the relay closing the switch and allows the fan to run at the speed set by the potentiometer.

Additional controllability can be added to the fan convector by using a T2 option.

The control requires SPC to fit a relay within the unit. The relay coil terminals will be made available to the BMS via a customer connection box. 24V AC is the most common input from the BMS but other voltages may be used and the input may also be DC. The correctly rated relay must be used and agreed with the customer.

Master and Slave Units



A typical master/slave electrical schematic is shown in the above figure. The benefit of the master/slave configuration is that only one set of thermostats control all the fan convector units in a single zone. Each unit will have its own AC mains supply but the additional control features for controllability are only wired to the master unit. The 0-10VDC signal to the slave units is supplied from the master unit so that all the units within the zone operate together and run at the same speed.

As the only signal being passed between units is a low voltage control signal the number of units that can belinked is almost limitless. Previous generation AC motor master/slave arrangements were limited to groups of 3 or 5 units. This is because speed control was via auto-transformer and the transformer, fitted in the master, needed to be rated against the entire current draw of the all the units in the master/slave grouping.