How to implement automatic lighting controls

Introduction

Automatic lighting controls have been developed to minimise energy waste by turning off artificial lighting when it is not required. Whilst their use is not appropriate for all lighting applications, when suitably applied (for example in intermittently occupied areas or those with high levels of natural daylight), savings of around 30% of lighting energy use are typically achieved with payback periods of less than five years.

In addition to possible financial and carbon savings there can be further benefits:

- reduced lighting maintenance costs
- an improved working environment
- a highly visible demonstration of an organisation's carbon commitment.

The technology

Automatic lighting controls can be categorised as follows:

- whether they sense occupancy or daylight levels (or both)
- whether they switch (on/off) or dim the lighting
- whether they are stand alone devices or integrated (either within light fittings or in to a building-wide lighting control system).

This implementation guidance deals solely with **retro-fitting** lighting controls to existing installations. As such, it only considers stand alone devices that switch (rather than dim). In general, integrated lighting controls and those that dim cannot easily be retro-fitted and are best considered as part of major refurbishment or new lighting installations.

Types of occupancy sensors

There are two principal technologies used for occupancy detection namely:

- passive infra red (PIR)
- ultrasonic/microwave

PIR sensors detect the movement of warm objects within their field of view. They are “line of sight” devices and so can be shielded (for example by furniture or partition screens).

In contrast, ultrasonic/microwave sensors transmit an inaudible wave form, into the workplace and monitor the reflections that come back from the walls and objects within the room. Any movement of solid objects will cause the pattern of the reflections to change (the ‘Doppler Effect’) and this is what is detected. Because the waves are reflected off hard surfaces, ultrasonic/microwave detectors do not need “line of sight” to detect movement.

Daylight sensors

Daylight sensors (also called photocells), can be used to measure internal or external ambient light levels and hence switch artificial lighting accordingly.

Combined Sensors

In some applications (for example an intermittently occupied corridor, with large quantities of external glazing), the optimum control strategy will require the use of both occupancy and daylight sensing.

Combined (dual technology) detectors are widely available and provide both of these capabilities within a single unit, but these are inevitably more expensive.

Format

Surface mounted

Recessed

As a wall switch replacement

Mode of operation

Many lighting controls can be configured to provide either ‘automatic’ or ‘semi-automatic’ operation.

Under ‘automatic’ operation, the control switches the lighting both on and off automatically.

Under ‘semi-automatic’ operation the detector only turns the lighting off automatically – switching the lighting on requires manual intervention, via a wall switch or hand held remote.

Multi-circuit switching

Some sensors can provide dual circuit switching to allow different control strategies to be applied to two separate lighting circuits. For example, one circuit can be set to fully automatic operation, whilst the other can be set to semi-automatic operation.

Application

Automatic lighting controls can potentially be applied to any area where lights are being left on unnecessarily. In practice; the economics of retro-fitting automatic lighting controls is influenced by a number of factors including:

- the complexity of the controls installation
- the annual hours of operation saved
- the lighting load being switched.

As a general rule, automatic lighting controls should be considered for applications where at least 500 kWh/year of electricity can be saved. For example, this could be achieved with a 500 W lighting load, being turned off for 1,000 hours per year (approximately 4 hours per day).

In addition, the use of automatic lighting controls may be also be constrained by health and safety issues, which should always be considered. Extreme caution should be exercised when considering the use of automatic lighting controls in high risk areas such as those containing moving machinery or other hazards. In many cases, health and safety concerns can be satisfied by leaving a small number of light fittings uncontrolled.

Probably the most significant decision that will need to be taken when considering the applicability of automatic lighting controls is the choice between PIR and ultrasonic/microwave occupancy detection.

The following table lists the key distinguishing characteristics of the two types.

Characteristic	PIR	Ultrasonic / Microwave
Coverage	Line of sight. Field of view can be adjusted by user through sensitivity adjustments or masking.	Covers entire space (volumetric). Field of view can be slightly adjusted by user through sensitivity adjustment, but cannot be masked.
Detection range	Up to 12 metres	Up to 60 metres
Highest sensitivity	Motion lateral to the sensor	Motion to and from the sensor
Mounting	Wall switch, wall, ceiling	Wall switch, wall, ceiling
Indoor/outdoor use	Indoor, outdoor	Indoor only
Typical applications	Small self-contained areas, for example: • offices • canteens • meeting rooms Areas that require selective coverage, for example: • zones within open plan offices • individual warehouse • aisles External lighting	Areas with visual obstructions, for example: • toilets • corridors with intrusive columns Larger spaces, for example: • assembly halls • long corridors
Incompatible applications	Low motion levels by occupants on the extreme edge of the coverage pattern. Obstacles blocking sense of view. Within 2 metres of HVAC air diffusers and other heat sources.	Ceiling heights above 6 metres. High levels of vibration or airflow. Open spaces that require selective coverage (such as control of individual warehouse aisles).

Specification checklist

The following table lists the key parameters that you should define through discussion with your supplier when carrying out a lighting control project.

Item No	Parameter	Comments
1	Occupancy, daylight or combined sensing	
2	Lighting current to be switched	The switching capability of lighting controls is normally expressed in Amps. For single phase lighting circuits, each Amp will support around 220 Watts of lighting load.
3	PIR or ultrasonic/microwave occupancy detection	See previous characterisation table.
4	Format	Surface, recessed or wall switch mounted.
5	Detection range	Expressed in metres.
6	Automatic or semi-automatic operation	See earlier explanation
7	Single or dual circuit switching	See earlier explanation
8	User adjustable settings for: range/sensitivity delay time prior to switch-off angle of field of view daylight switching level/lux (on daylight sensing controls)	Essential for effective commissioning.

Commissioning procedures

The optimum values for control settings will depend upon individual applications, but as a general rule the following should be observed:

- The delay time to switch off should not be less than ten minutes (to avoid excessive switching).
- On internal daylight sensing controls, the switch off lux level should be at least three times that of the required workplace illumination. For example, in an office where the required minimum level of illumination is 400 lux, then the daylight sensing controls should be set to switch off the artificial lighting when the internal illumination levels are over 1200 lux.

A useful commissioning feature (which should be specified for all occupancy detecting controls), is the ability to turn off the time delay. This allows the response of the detector to be seen immediately during the commissioning process. The detector should be reset to normal time delay operation however, once the commissioning is complete.

Common problems

The most common problems associated with automatic lighting controls are:

- lights are switched off prematurely (for example when staff are sitting still at their desks)
- lights are switched on prematurely (for example by staff walking past an empty office).

There are a number of potential solutions to these problems including:

- The use of dual sensitivity ultrasonic detectors: These operate in a low sensitivity mode in the “unoccupied” state, switching to high sensitivity once occupancy has been detected.
- Dual technology detectors: Utilising PIR to switch the lights on and ultrasonic/microwave to turn them off.
- The use of semi automatic operation (see earlier), to overcome the problem of premature switch on.

Many lighting control manufacturers will offer a free site-specific advice service, allowing the correct control solution to be selected for each application.

Finding a supplier

Automatic lighting controls are one of the technologies supported by the Government's Enhanced Capital Allowances Scheme and a list of ECA approved lighting controls can be found at www.eca.gov.uk.

For simple installations, it should be possible for any competent electrician to install the selected lighting control in accordance with the manufacturer's recommendations. For larger or more complicated installations, consideration should be given to using the design, installation and commissioning services offered by many automatic lighting control manufacturers.

The business case

The cost of installing automatic lighting controls is heavily influenced by the specification of the detector and the complexity that is associated with its installation.

As a rule of thumb; an occupancy detector (with built in daylight sensor), would typically cost around £200 (plus VAT) to install using a contractor.

A five year payback on this investment would be achieved providing at least 500 kWh/year of electricity is saved (based on 7.9p/kWh, including CCL).

For example, this could be achieved by switching off 500 W of lighting load for 1,000h/year (equivalent to approximately 4 hours per day).

Lower costs and payback may be achieved through the use of in house electricians or buying in bulk.

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