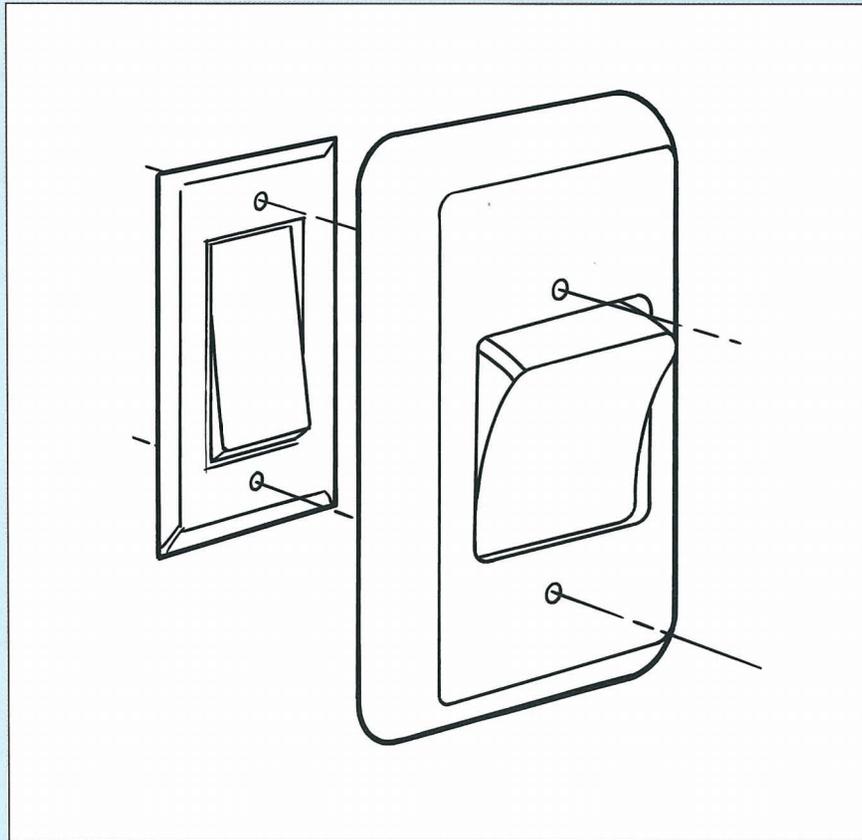


# Controls



**L**ighting controls include switches, dimmers, timers, motion detectors, photosensors, and central controls. Lighting controls operate the lamps within luminaires. In most applications, the greatest opportunity to avoid wasted lighting energy is the proper use of controls.

Lighting controls appropriate for use in homes can be operated manually or automatically. Manual controls include switches and dimmers. Switches turn the lamps on and off and dimmers vary the light output of some lamps. Automatic controls include timers, motion detectors, and photosensors. Timers can be used to turn lamps on either manually or automatically, but they always turn lamps off automatically after a designated time period. Motion detectors operate the lamps in response to motion, so they can be used to turn lamps off or dim lamps when no one is present. Photosensors switch or dim lamps in response to other sources of light, particularly daylight. Central controls can switch or dim lamps in many locations. They can be operated manually from a single location or automatically using timers, motion detectors, photosensors, or a programmable pattern of operation.

Controls vary in complexity and price. Use this chapter to identify controls that will be appropriate for your lighting needs. Typical price ranges for common controls are listed in Table 6 of the Economics chapter; however, the prices of these controls vary widely and depend upon the quality of construction, quantity purchased, and style. Controls can be purchased through retail or wholesale businesses. Purchase common controls at hardware, building supply, and discount department stores. For a wider variety, look in lighting stores. For more specialized controls, contact electrical suppliers. Due to variations in quality and price, consumers and contractors should check several sources before buying a control.

The following characteristics are described for each type of control.

### **Energy**

Energy can be saved by turning off or dimming lamps. Controls make this energy savings more convenient and predictable. All lighting designs have at least a single switch control. Consider a greater investment in controls for rooms with high-wattage lamps or rooms where the lamps are likely to be left on when not needed. Table 1 of the Economics chapter gives some estimates of the impact of dimmers on power and lamp life; Table 2 gives typical hours of lamp operation and motion detector factors for several rooms in the home.

### **Installation**

Controls must be appropriately located to make it convenient for residents to turn off lamps. Also, not all controls are appropriate for all rooms or lamps. Consider the accessibility of controls for people in wheelchairs and others who may have difficulty reaching a control. For residents with limited finger dexterity, choose controls that are large and easy to operate. Some manufacturers produce adaptive devices that attach to common switches to make them easier to grasp, or to operate without using hands. Some types of controls are not compatible with some compact fluorescent lamps; check the lamp and control manufacturers' recommendations for compatibility.

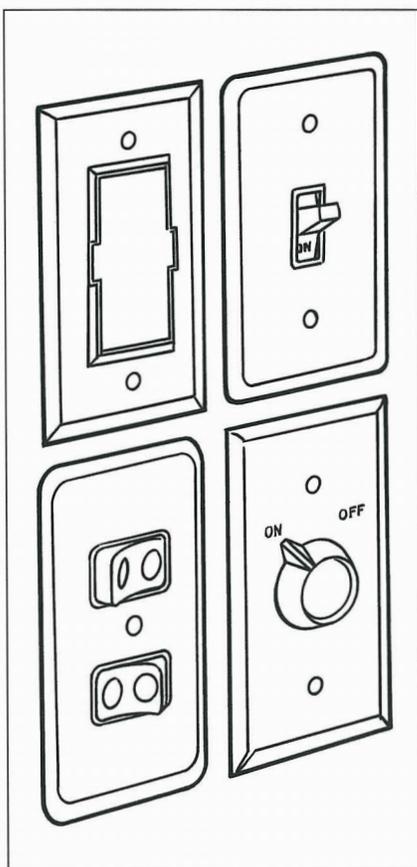
### **Cautions**

Some cautions are noted for controls, particularly for safety and for compatibility with lamps and luminaires. Always read the manufacturer's instructions concerning installation and maximum lamp wattage. A qualified electrician should install hard-wired lighting controls.

### **For more information refer to**

**Designs:** Most of the controls described in this chapter are used in the Designs chapter. Refer to the listed designs to see an application of the control.

# Switches



Switches are manual controls that turn lamps on and off. These controls are usually located on a wall or on the luminaire. Wall-mounted toggle switches, pull-cords, and luminaire-mounted switches are all examples of switches. These are the most inexpensive and popular means of operating lamps.

Wall switches are used widely in homes and are available in different types. The most common is called a single-pole switch, which operates one or more luminaires from a single location. To operate a luminaire from two locations, use three-way switches. To operate a luminaire from three locations, use four-way switches.

The operating handles of switches are available in toggle, push, rocker, rotary, and tap-plate types. Adaptive devices that are attached to wall switches facilitate operation by disabled persons and children. The cover plates for switches are usually available in white, ivory, brown, or black finishes. Some manufacturers offer special “designer” colors. To avoid wasting energy, people must use switches to turn off lamps when light is not needed. A “switch sticker” is a simple message affixed to a switch plate to remind residents to save energy. Switch stickers are an easy way to encourage children (and forgetful adults) to develop energy-conserving behavior.

Switches also can be located on the luminaire.

Fluorescent lamp strip luminaires and porcelain sockets located in basements, storage spaces, and garages often have pull-cord switches. Pull-cords are a length of rope or chain that switches the light on or off when pulled. They are an inexpensive method of lighting control because no additional electrical wiring to the switch is needed. Attach a card or decorative ball to the end of pull-cords so that they can be found in the dark and easily grasped.

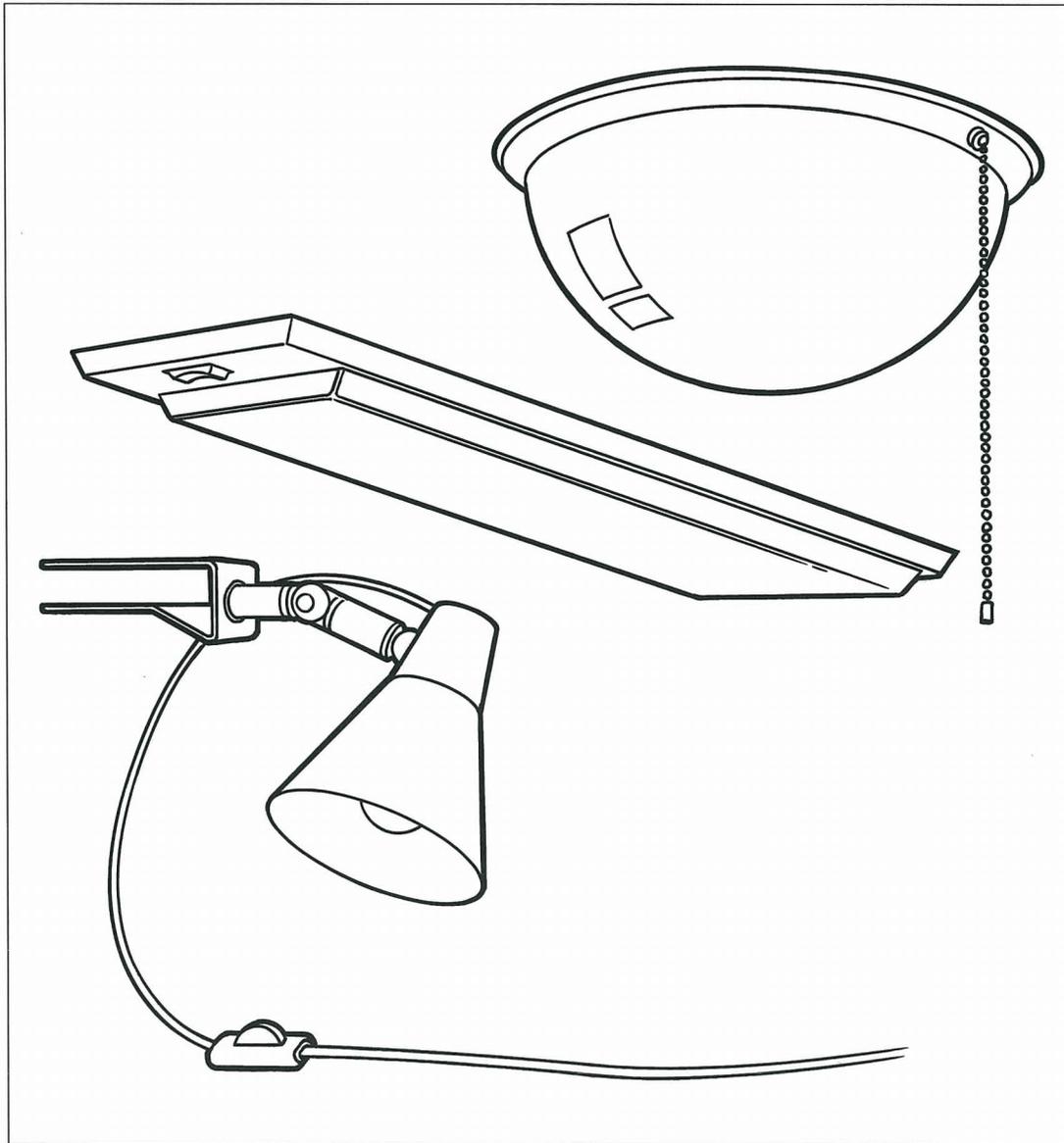
Door switches automatically turn lamps on when the door is opened. A small switch is mounted on the inside face of the door jamb and wired to the luminaire; it is similar to the switch on a refrigerator or car door. Use door switches in closets and pantries where supplemental lighting is needed, where luminaires are likely to be left on after use, or where the door is likely to be closed after use. Door switches can save energy and extend the service life of lamps.

Purchase switches from lighting stores, electrical suppliers, building supply stores, and hardware stores. Switches are the least-expensive type of lighting control, but other controls may result in greater energy savings and thus have lower life-cycle costs.

## Energy

Manual switches only save energy if the lamps are turned off when the space is unoccupied or light is not needed. Locate switches in convenient locations so that people will be more likely to turn off lamps when they are not needed. Consider adding additional switches if people enter the space from multiple locations.

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In rooms where several luminaires are operated together, choose luminaires that are designed with pull-cords or other luminaire-mounted switches. For example, if a basement has four porcelain lamp holders that are controlled by the same switch, pull-cord lamp holders will allow three of these lamps to be left off when light is needed in only one area of the basement.

Switch accent and task luminaires separately from the luminaires that provide ambient light so that only the luminaires that are needed at a given time are operated. Many of these luminaires are available with luminaire-mounted switches.

If a luminaire contains more than one lamp, as in an architectural luminaire, use two or more switches wired to separate rows or sections of lamps to provide multiple levels of light output.

Consider using wall switches with dim, illuminated toggles for switch identification in the dark. These switches may replace the need for leaving other luminaires on at night. Also consider using switches with a pilot light, which is illuminated whenever the luminaires are on, in applications where the luminaire(s) that is operated by the switch cannot be seen from the switch location. For example, a pilot light on the switch to luminaires in the basement or on the porch may remind the resident that the luminaires have been left on inadvertently.

## Installation

Use three-way switches or four way-switches in spaces where it is desirable to control a luminaire from two or more locations in the room, such as hallways, stairs, garages, and any room entered from two or more locations. Special three-way or four-way switches and wiring configurations are required.

Switches are often located on the wall beside doors that are used to enter rooms and are usually mounted 4 feet above the floor to the center of the switch. This mounting height is the maximum acceptable height for people in wheelchairs. Lower mounting heights are also more easily reached by children and avoid interference with the 4-foot horizontal drywall seam that is common in new construction. The switch is mounted in a switch box that is recessed in the wall. When one switch is used, it is mounted in a “single-gang” box. A cover plate is used to conceal the wiring and provide a finished appearance to the switch. Where multiple switches are required to operate different luminaires from the same location, a “multi-gang” switch box and cover plate are required.

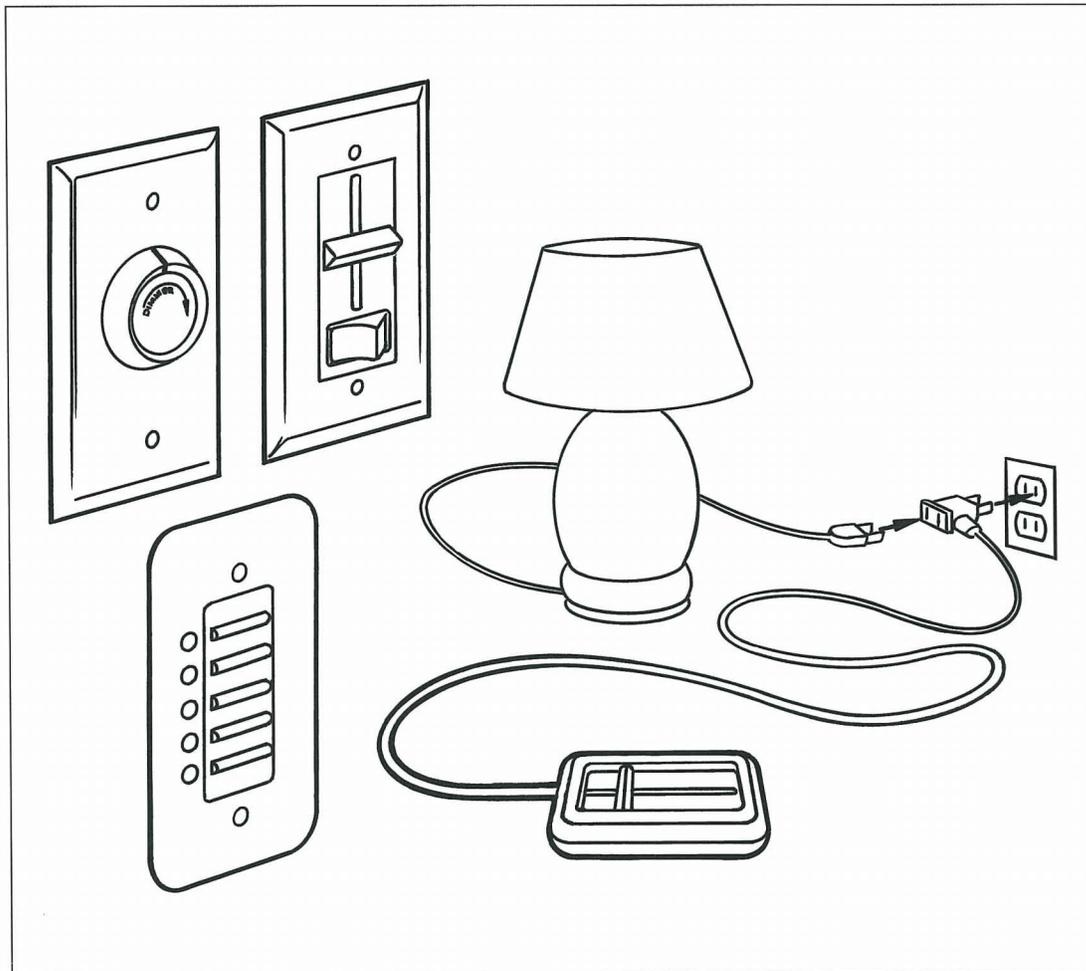
Recessed retrofit wall switch boxes are available that can be installed in existing plaster and drywall walls. Switches can also be added using surface-mounted switch boxes and wire raceways.

Recessed wall switches can be wired to operate a receptacle or receptacles instead of a luminaire. These “switched plugs” can be used for controlling plug-in luminaires. Receptacles can be split-wired so that only one receptacle in a duplex outlet is operated by the switch, leaving the other receptacle available for other electrical devices.

**Designs:** Switches are used throughout the Designs chapter.

For more  
information  
refer to

# Dimmers



Dimmers are used to vary the light output of the lamps that are used in a space. Use dimmers in rooms where a range of light outputs is desirable. Dimmers can be used to control incandescent lamps, including low-voltage halogen lamps, and many fluorescent lamps. Different lamp types may require different electronic circuitry for proper dimming.

Ideally, dimmers should have the capability of “full-range” dimming. Full-range dimming refers to the continuous variation of light output from a minimum to a maximum level. Efficient dimmers, commonly referred to as “solid-state” dimmers, incorporate electronic circuitry into their design. Purchase dimmers from lighting stores, electrical suppliers, building supply stores, and hardware stores.

Wall-mounted dimmers include four styles: toggle dimmers, rotary dimmers, linear slide dimmers, and touch dimmers. Most of these are available in single-pole and three-way models to allow dimming from two locations. The four styles differ in their appearance and operating complexity.

Toggle dimmers look like a toggle switch, except that they provide full-range dimming control. They can match standard toggle switches or toggle fan-speed controls in the same multi-gang switch box. Some are available with an illuminated toggle that serves as a switch locator in dark rooms.

Rotary dimmers use a knob to adjust light output. Some models are available with a push/on and push/off rotary knob. Pushing the knob turns the lamps on, turning the knob alters the light output, and pushing

the knob again turns the lamps off. Ivory or white knob finishes are the most common, although other colors can be ordered.

Linear slide dimmers provide full-range dimming using a slide element to adjust the lighting. These models range in complexity. The simplest type has a linear slide to control the lighting. Sliding up increases light output; sliding down decreases light output. Some linear slides are available with “preset” buttons and on/off switches. With these types, the linear slide is used to adjust the lighting to a desired level, then the “preset” button is pushed, programming the preset level in memory. The on/off switch is then used to turn the lamps on to this preset level.

Touch dimmers provide full-range dimming control using touch-sensitive solid-state circuitry. A person taps the touch-sensitive panel to turn the lamps on, continuously presses the panel to dim the lamps to the desired level, and taps again to turn off the lamps.

Some dimmers are combined with a motion detector to dim lamps to a preset level when no motion is detected in a space. See Motion Detectors for more information. Preset dimmers can control several luminaires. Multiple “scenes” can be programmed, so that several lamps are dimmed to preset levels by touching a single control button. A specific “scene” is switched on for a different atmosphere or set of tasks.

Socket and cord dimmers provide full-range dimming and are used for dimming incandescent table lamps, floor lamps, or other plug-in lamps that are not manufactured with a dimming switch. The system is made up of a plug-and-adaptor combination that is wired to a dimmer. The luminaire plugs into the adaptor which in turn plugs into the wall. The dimmer can then be used to dim the lamp.

## Energy

Operating lamps at less than full output saves energy. If lower light outputs are acceptable only some of the time, use dimming. If lower light outputs are consistently desired, consider using lower-wattage or fewer lamps.

Dimming incandescent lamps decreases the light output, decreases energy use, and extends the life of the lamp. See Table 1 in the Economics chapter for more information. Consider a simple replacement of a switch with a dimmer to save energy by dimming incandescent lamps. Replace switches with dimmers that control many lamps in an over-lit area for energy savings.

Dimming fluorescent lamps decreases light output and energy use, but does not extend lamp life. Both magnetic and electronic ballasts are available with dimming capabilities. Electronic ballasts offer quieter operation, dimming over a wider range, and greater energy savings. High-quality fluorescent lamp dimmers can dim to as low as 1 percent of full light output. Check manufacturers’ specifications for ballast dimming capabilities for fluorescent lamps. Only four-pin compact fluorescent lamps with special dimming ballasts and controls can be dimmed. Compact fluorescent lamp dimming systems are just being introduced to the market, but are not yet available for screwbase compact fluorescent lamps.

## Installation

Most residential-grade dimmers are designed to control up to 600 watts of lighting load. Loads greater than 600 watts require commercial-grade dimmers, which are significantly more expensive than residential-grade dimmers. Incandescent lamp dimmers are available for 120-volt applications. Fluorescent lamp dimmers are available for 120-volt (most common in homes) and 277-volt applications; thus it is important to

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order the appropriate voltage. Dimmers are usually recessed into the wall in a switch box in the same manner as switches. See Switches for more information.

An incandescent lamp dimmer has three wires: a hot, a common, and a ground. Rapid-start fluorescent lamps have a total of four pins on their bases and can be dimmed. Use a fluorescent lamp dimmer or dimming control to operate a dimming ballast located in the housing of the luminaire. The fluorescent lamp dimmer requires more wiring to send the dimming signal to the dimming ballast than does a dimmer for incandescent lamps.

## Cautions

Install dimmers according to the manufacturer's instructions. Verify the maximum load that the dimmer can accommodate with the manufacturer's instructions.

Occasionally operate halogen lamps at full output to retain the benefits of the halogen cycle.

Use dimmers that are designed for low-voltage lamps to control these lamps.

Do not install a compact fluorescent lamp in a luminaire that is controlled by a dimmer that is designed for incandescent lamps.

Dimmers should incorporate electromagnetic interference (EMI) and radio frequency interference (RFI) filters to prevent causing static on radios or on audio equipment.

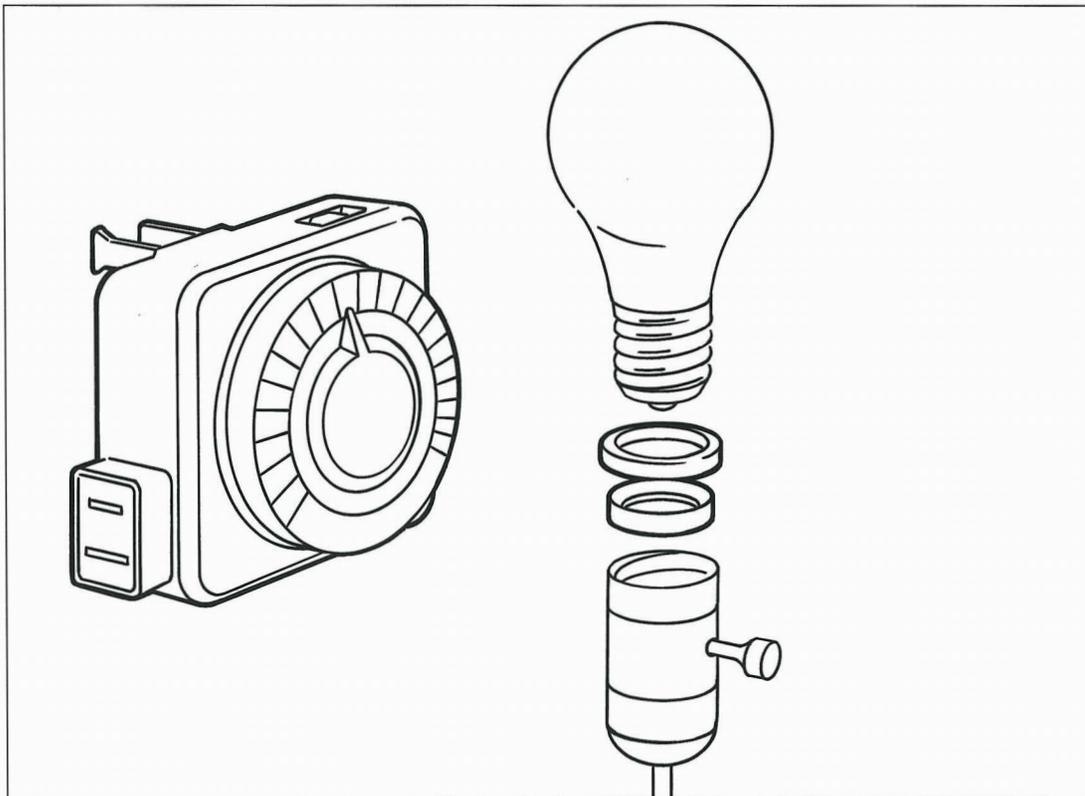
Do not use dimmers to control receptacles, fluorescent lamp luminaires, motor-operated appliances such as ceiling fans, or transformer-operated appliances, unless the dimmers are specifically designed for these applications. The dimmer could overheat and become damaged or cause a fire if used incorrectly.

Make sure dimmers click when turned off; otherwise, the lamps will still draw current which wastes energy and may shorten lamp life.

**For more  
information  
refer to**

**Designs:** Large Kitchen, Small Living Room 2, Large Living Rooms 2 and 3, Multi-Family Lobby

# Timers



Timers turn lamps on either manually or automatically, but turn lamps off automatically after a designated time period. Three types of timers for lighting are interval timers, plug-located timers, and socket-located timers.

Interval timers often are used in place of wall switches in areas that are used for short or predictable amounts of time, such as bathrooms, utility areas, and storage closets. These devices are equipped with a mechanical spring-winding system that turns the lamps off automatically as soon as the set time interval has elapsed. Various time intervals are available, including 5, 15, or 30 minutes, to 4, 6, or 12 hours. Interval timers are a low-cost alternative to motion detectors. Interval timers also are available in solid-state models that fit directly into a standard switch box. Some interval timers are designed for use in multi-level stairwells.

Plug-located timers are used to turn table or floor lamps off and on at various times of the day or night, often while a house is empty. The system is made up of a plug and a timer. The table or floor lamp plugs into the timer which in turn plugs into the receptacle. The timer is set for the desired time to turn on the lamps. These devices are available with spring-wound or electronic components. The electronic versions can be programmed to turn the lamps on and off at different times and on different days. Lights controlled by these timers give the impression of occupancy for an unoccupied home. Hard-wired timers, which often are used for exterior luminaires, can be used to switch lights automatically.

A socket-located timer is a small button that fits in a medium-base socket before an incandescent lamp is inserted. The timer has a fixed duration, usually of ten to thirty minutes. When the switch is turned on, the lamp comes on, but the socket-located timer will turn the lamp off automatically after the designated time has elapsed. These are inexpensive and easy to install.

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Purchase timers from lighting, building supply, and hardware stores, electrical suppliers, and catalogs featuring energy-saving products.

### Energy

Interval timers save energy and may extend the service life of lamps by turning lamps off when light is no longer needed. Use plug-located timers for security when the home will not be occupied for an extended period of time. Operate low-wattage and/or fluorescent lamps to save energy. Use socket-located timers on luminaires that have incandescent lamps and are in spaces occupied for short periods of time such as closets or pantries where the lamps are likely to be left on.

### Installation

Use interval timers in rooms that are occupied infrequently or on luminaires that are operated for short periods of time, including vanity lights, bathroom heat lamps, or closet or pantry lamps. Mount interval timers in standard switch boxes. An electrician should install hard-wired interval timers. Plug- or socket-located timers do not require an electrician's services.

### Cautions

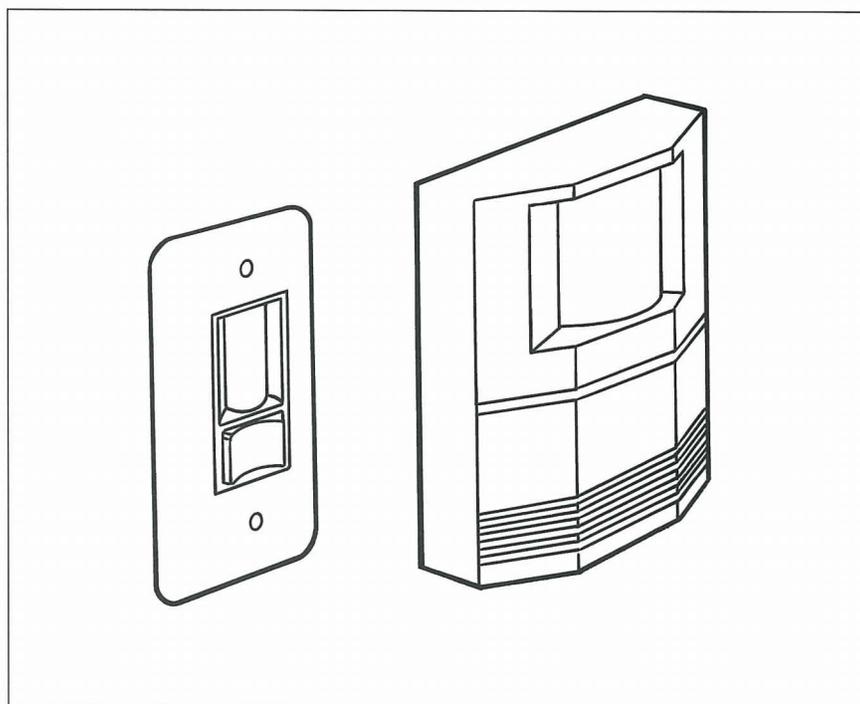
Install interval timers according to manufacturers' recommendations. Avoid using timers in rooms where the resident could be stranded away from the switch when the lamps turn off. Spring-wound interval timers may produce noise, so use a solid-state electronic interval timer if quiet operation is preferred. Some screwbase compact fluorescent lamps are not compatible with timing devices. Follow the lamp manufacturer's directions for use.

Although socket-located timers can be installed without an electrician, care must be taken to avoid electric shock. Some socket-located timers have an insulating ring to reduce risk of shock. Follow manufacturers' recommendations.

### For more information refer to

**Designs:** Large Bath, Children's Bedroom, Closed Stair, Multi-Family Fire Stairs, Entry 2

# Motion Detectors



Motion detectors, often called occupancy sensors, automatically turn lamps on when motion is detected and off when no motion is detected. They are used for interior and exterior applications. There are two primary types of motion detectors, infrared and ultrasonic. Infrared sensors respond to a change in infrared heat motion in a space, and ultrasonic sensors respond to a change in ultrasonic frequencies caused by motion in the space.

In homes, motion detectors are used in place of a standard wall switch. They are mounted and wired in a manner similar to standard switches. Options include dimming, manual on and/or manual off switching, and three-way switching. A manual on/automatic off motion detector does not turn the lamps on unless someone touches the switch, but will turn the lamps off automatically when no motion is sensed.

Combination motion detector and dimmer units are available that dim lamps instead of turning lamps off when no motion is detected. Also available are motion detector and photosensor combinations, which only turn lamps on when motion is detected and the surrounding light levels are below a preset level.

Purchase motion detectors from lighting stores, electrical suppliers, or electric utility promotions. Some luminaires with built-in motion detectors for exterior applications are available at building supply and hardware stores. Conversion kits containing a photosensor and a motion detector are available for luminaires that contain incandescent lamps but are not manufactured with an automatic control.

Motion detectors save energy and can extend the service life of lamps by turning lamps off when a room is unoccupied. Frequent switching of fluorescent lamps will shorten lamp burning life, but may increase actual lamp service life since the lamps are turned off during periods when they might have been left on. See the Economics chapter for a procedure to estimate the economic impact of switching fluorescent lamps.

**Energy**

CONTINUED

## Installation

Use motion detectors in rooms where occupancy is infrequent or of short duration and the lamps are likely to be left on, such as basements, bathrooms, bedrooms, and exterior applications. Use manual on/automatic off motion detectors for rooms with windows, so the lamps will not operate when daylight is sufficient for the resident's needs. Manual on/automatic off motion detectors also decrease the likelihood of lamps being activated by motion caused by pets or moving objects. Use motion detectors with a manual off override in any space where the resident may want the lamps off during occupancy, such as bedrooms.

Use either infrared or ultrasonic sensors for detecting large body motions such as walking. Use ultrasonic sensors for detecting small body movements in a room such as writing, typing, or turning pages in a book. Follow manufacturers' instructions for mounting sensors.

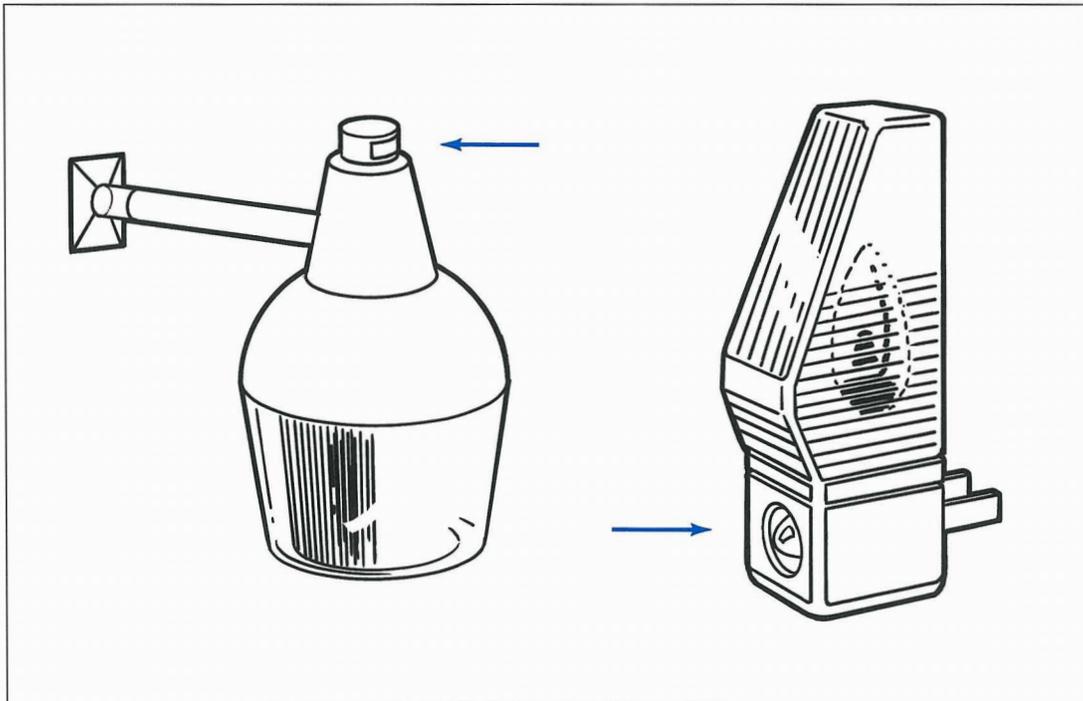
## Cautions

Do not switch high-intensity discharge lamps with motion detectors because these lamps have a delay before they will relight. If a motion detector switches a fluorescent lamp frequently, the life of the lamp will be reduced. Some compact fluorescent lamps are not compatible with motion detectors; check the lamp manufacturer's recommendations for compatibility.

## For more information refer to

**Designs:** Medium Kitchen 1, Medium Living Room 1, Large Living Room 1, Small Bath, Children's Bedroom, Multi-Family Lobby, Multi-Family Corridor, Entry 2, Floodlight 2

# Photosensors



A photosensor is a light-detecting device that operates a luminaire when the surrounding light level drops below a specified level. Typically, photosensors operate exterior luminaires that are on all night and are off in the daytime. Photosensors can also operate interior luminaires that are intended to operate all night, such as security lighting in a daylight lobby or a night light.

Luminaires with photosensors are available at lighting stores and electrical suppliers. Conversion kits containing a photosensor and a motion detector are available for luminaires that contain incandescent lamps but are not manufactured with an automatic control.

## Energy

Use photosensors only for luminaires that are operated all night, but do not need to be on in the daytime. Consider timers or motion detectors instead of photocells if the luminaire does not need to be operated all night long. Use a photosensor integrated into a night light to automatically switch off the night light in the morning or when other luminaires are used.

## Installation

Position luminaires with photosensors so that the photosensor is not obstructed.

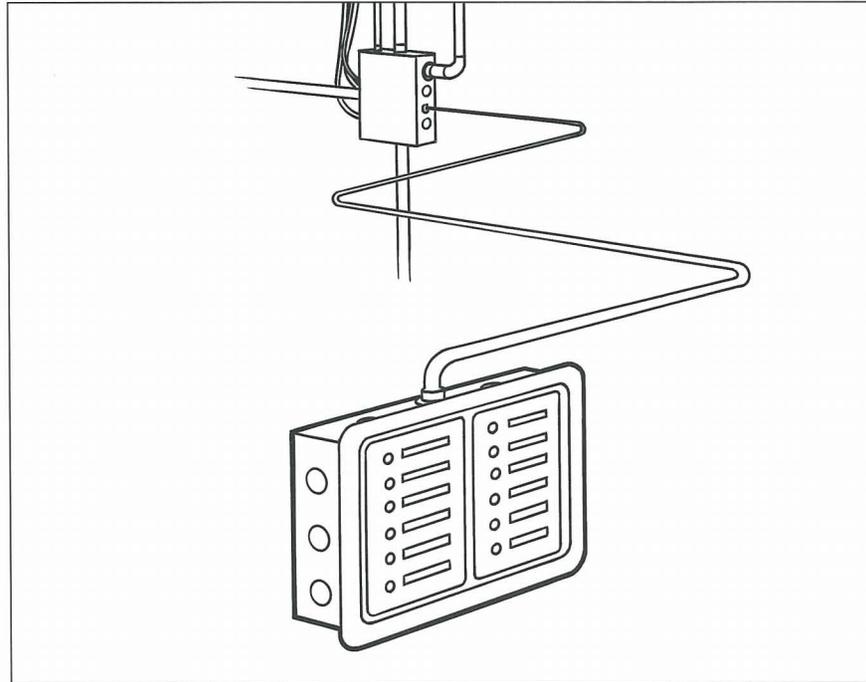
## Cautions

Some compact fluorescent lamps are not compatible with photosensors; check the lamp manufacturer's recommendations for compatibility.

For more information refer to

**Designs:** Children's Bedroom, Floodlight 2

# Central Controls



Central lighting controls allow a person to control switches and dimmers located throughout a home from a central location. These systems can be used to monitor the lighting in a house, turn lamps off that have been left on unnecessarily, and turn lamps on remotely as needed for security. Light-emitting diode (LED) indicator lamps sometimes are used to indicate that certain elements in the lighting system are on or off. Central systems can be used to create a path of light through the house, or can be used as a security measure to monitor outdoor lighting. Security systems, receptacles, telephone jacks, and cable television jacks also can interface with these types of controls. Some of these systems are expensive, especially the sophisticated systems that allow for programmable switching and the switching of groups of lamps for pre-defined functions or scenes.

Power-line carrier control systems are a type of central control system that controls luminaires by transmitting signals over existing household wiring. This type of control system allows switching and dimming from multiple locations without the added cost of running control wiring. A transmitter sends coded signals through the house wiring to receivers located at strategic points throughout the home. The receivers then send an on, off, or dim signal to the luminaires. The receivers are used in place of standard wall switches or dimmers. Luminaires can be wired to one or more receivers. Any number of transmitters can control one receiver.

Purchase central controls at lighting stores and electrical suppliers.

## Energy

Central controls may save energy because the master control can monitor the status of lighting in each room of the house and detect lamps that have been left on unnecessarily.

## Installation

Use central controls when master control of multiple areas in the home is desired. Use power-line carrier control systems when dimming and switching from multiple locations is desired and/or the added costs of new wiring are prohibitive. Install central controls according to the manufacturer's recommendations.