White Paper **WP144001EN** Effective December 2013

Meeting evolving energy codes with proven technology

Using remote control circuit breakers for receptacle control

Executive summary

Energy codes set minimum requirements for the energy-efficient design and construction of new and renovated buildings. These codes are often focused on the implementation of proven technologies for reducing energy consumption. Due to the continually rising need to decrease waste, automatic control of electric receptacles has already become law in some areas and will be in even more areas over the next few years as energy codes are updated across the United States.

Meeting this new code requirement could present a challenge because the automatic control must be built-in and hard-wired. However, by unifying power distribution and control equipment into one compact, intelligent panel, remote control circuit breaker systems provide a convenient, safe, and simple solution to control receptacles.

This white paper will explain the controlled receptacle requirement that is appearing in non-residential energy codes and discuss some modern solutions available for compliance.

Energy waste by miscellaneous electrical loads

With many efficiency improvements to lighting and heating, ventilation, and air conditioning (HVAC) already in place, electrical loads such as task lights, printers, and computer monitors are the next target for additional energy savings. These non-essential loads are almost always left connected to receptacles when building occupants are not present.

The standby power consumed by these loads can represent a significant portion of total energy use and their relative consumption will continue to rise as the efficiency of other systems continues to improve (**Figure 1**). Further, the electrical consumption by miscellaneous loads and office equipment continues to increase per square foot while consumption by all other load types decreases (**Figure 2**).

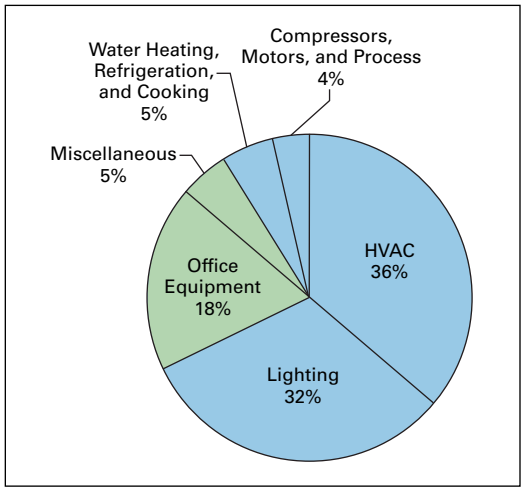

Figure 1. Office Electricity Consumption Research Findings on Consumer and Office Electronics, prepared for the California Energy Commission, April 2011

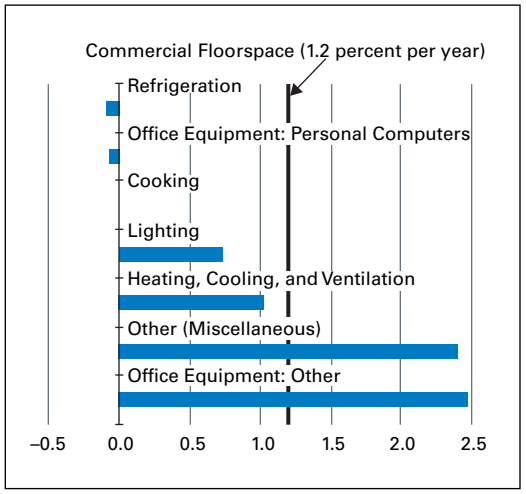

Figure 2. Average Annual Growth Rates for Electricity in the Commercial Sector, 2009–2035 in %/Yr "U.S. Energy Information Administration Annual Energy Outlook 2011"

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Automatic control of receptacles

To address these areas of waste, energy codes are beginning to require automatic control of electric receptacles. These codes mandate that controlled receptacles must be provided in environments such as private offices, open office areas, computer classrooms, reception lobbies, conference rooms, and office kitchenettes. Under the requirement, at least one switched receptacle must be provided within six feet of each uncontrolled receptacle. Split-wired duplex receptacles, with one outlet controlled and one outlet uncontrolled, are another viable option. The occupant ultimately decides which plug-in loads are suitable for automatic shutoff.

Open space areas intended for cubicle workstations present a unique challenge. If the cubicles are already installed at the time of inspection, it becomes possible to verify if the cubicles are equipped with local devices to control the receptacles. However, many buildings are constructed for future lease and without a specific cubicle layout plan. In these situations, controlled circuits must be provided for the open space areas. Both the controlled and uncontrolled circuits will have to be clearly marked to allow for inspection and future connection. When eventually connected, the controlled receptacles will be automatically switched off using the preferred method.

Lighting control application extended

The California Energy Commission sponsored a study to investigate the feasibility and cost-effectiveness of automatically shutting off plug-in loads via controlled receptacles. The study team used research data on power consumption and status of plug-in load devices to estimate the potential energy savings, focusing only on the loads that could be switched off without disruption when the occupant is away or when the office is closed.

The study team discovered that receptacle circuits could be easily controlled using the same equipment commonly installed to control lighting. This discovery provided a lower-cost approach to obtaining energy savings, as automatic lighting controls are readily available and this proven technology is widely understood. But it was noted that plug-in controllable power strips should not be allowed because they could be easily removed.

Control methods

Both time schedule and occupancy sensor lighting control methods are appropriate for receptacle control because both are designed to reduce energy consumption when occupants are not present. But selecting the method requires consideration. For example, using a time schedule to control a receptacle is universally applicable to plug loads in all areas. Using occupancy sensors to control receptacles can provide incremental energy savings beyond time schedules by responding to unoccupied periods that may randomly occur during the day. For this reason, occupancy sensors are very well suited to small spaces such as private offices or conference rooms, but will only provide energy savings equal to time schedules in larger areas that are continuously occupied during normal hours.

It is important to note that occupancy sensors would not be appropriate for equipment that should not be turned off during business hours, such as a shared printer or a water cooler. For these reasons, a combined approach using time schedule control in general and optionally using occupancy control in appropriate locations can yield higher energy savings at the lowest cost.

It is also worth noting that, similar to lighting systems, energy codes will allow the use of a signal from another system to control receptacles. This signal may come from a building automation system or may use something as simple as the "armed away" status of the security alarm in a small office situation.

Power switching options

Figure 3 shows a simplified representation of three power switching methods using technology commonly used for lighting control. Controlled receptacle circuits can be switched by either a remote controlled circuit breaker panelboard (A), a lighting relay panel (B), or by a relay (C) driven by an occupancy sensor. Control panels typically contain an internal time clock for time-of-day control and are also capable of responding to external signals via simple connection. Network connections allow remote monitoring via software or Web page. While they are typically standalone, some occupancy sensors offer system connectivity options as well.

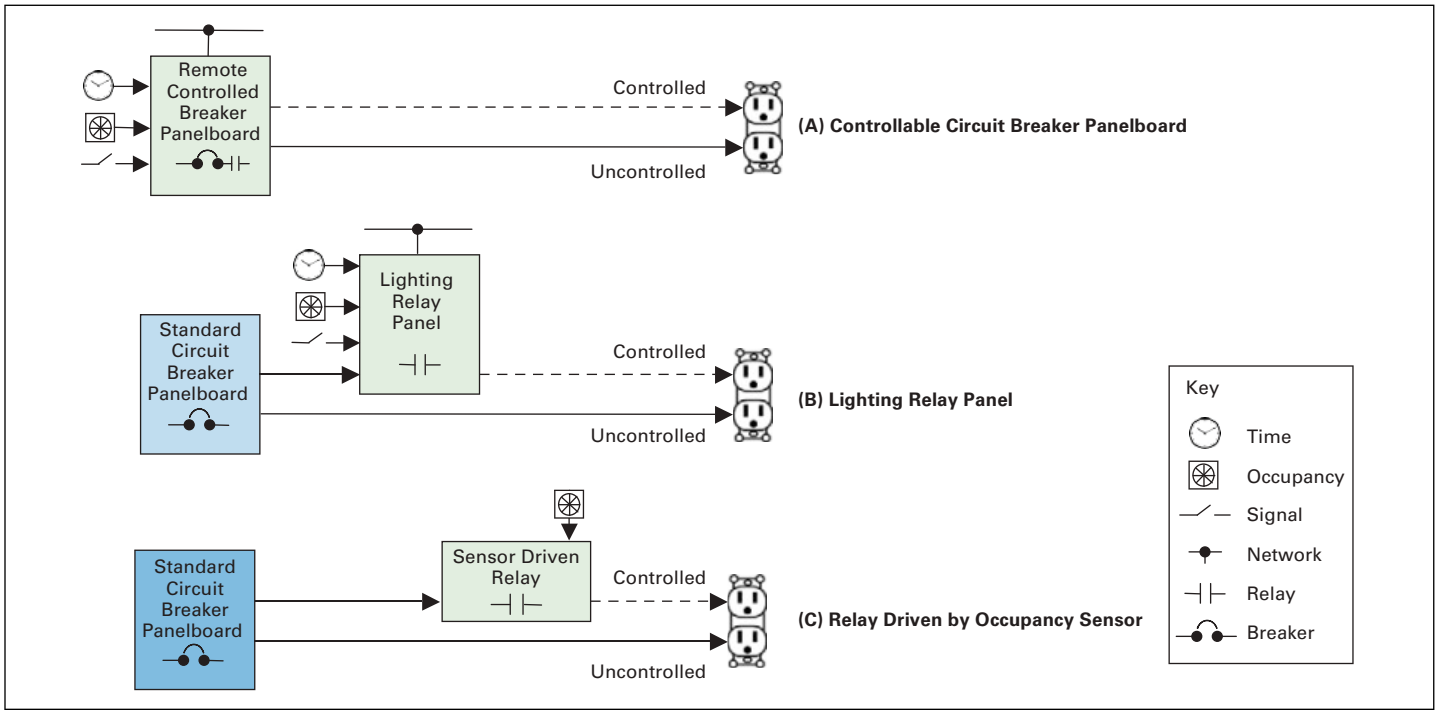

Figure 3. Receptacle Power Switching Options

Advantages of controllable circuit breakers

Controllable circuit breakers offer many advantages when they are used to switch receptacles. A circuit breaker is always required to protect the connected circuit. A remote-controlled circuit breaker provides the required circuit protection but eliminates the need to provide an additional device for switching. There is no additional labor for installation and no additional connections to establish and troubleshoot (**Figure 4**).

Further, having receptacle control embedded inside the distribution panelboard reduces the amount of material required and saves space in the electric closet. All of the equipment is concentrated in one place for simple verification, and the panelboard directory can be marked to indicate the controlled circuits that correspond to the designated switched receptacles.

A controllable circuit breaker solution also offers several advantages for building occupants. Because circuit breakers are designed to interrupt and survive a short-circuit condition, a circuit breaker would only need to be reset if a short circuit were to occur when a load is plugged into a receptacle. Other types of switching devices could be damaged, requiring service by a qualified electrician. Another advantage is the mechanical override feature typically found on controllable circuit breakers. This easy-to-access mechanism allows power to be restored to a load in the event of a control failure. If the override type is temporary, the energy-saving operation will be automatically restored along with the control function.

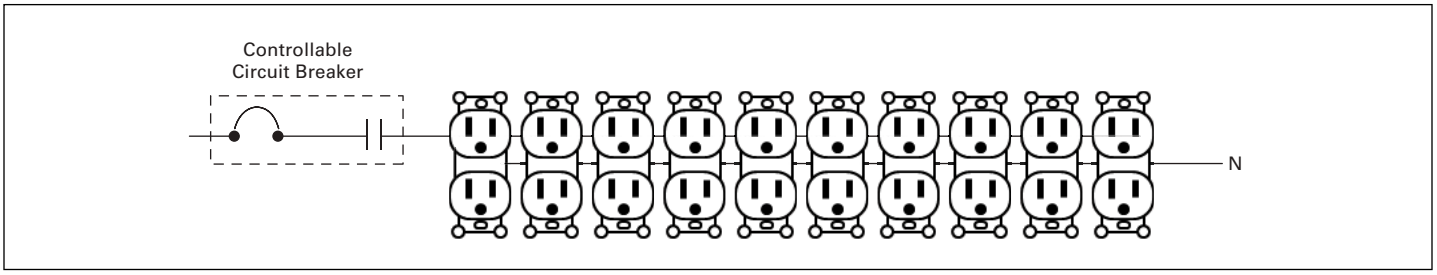

Figure 4. Receptacle Control Using Controllable Circuit Breaker

Controlling receptacles located in the same wall box

While code requirements will allow controlled and uncontrolled receptacles to be as much as six feet apart, it is likely that they will be located in the same wall box to save material and labor costs. When two circuits are located in the same wall box, a method to simultaneously disconnect both circuits may be desired or even required.

Circuit breakers can be easily and simultaneously disconnected by joining their handles together with a handle tie (**Figure 5**).

Handle-tied circuits are inherently on different phases, which can have additional advantages.

Circuits that are fed from different phases are allowed to share the same neutral conductor because the neutral currents from each circuit will partially cancel each other. Not only will sharing a neutral conductor eliminate a wire and the space that it takes up in a conduit, some additional energy is saved because the cancellation reduces voltage loss and heat.

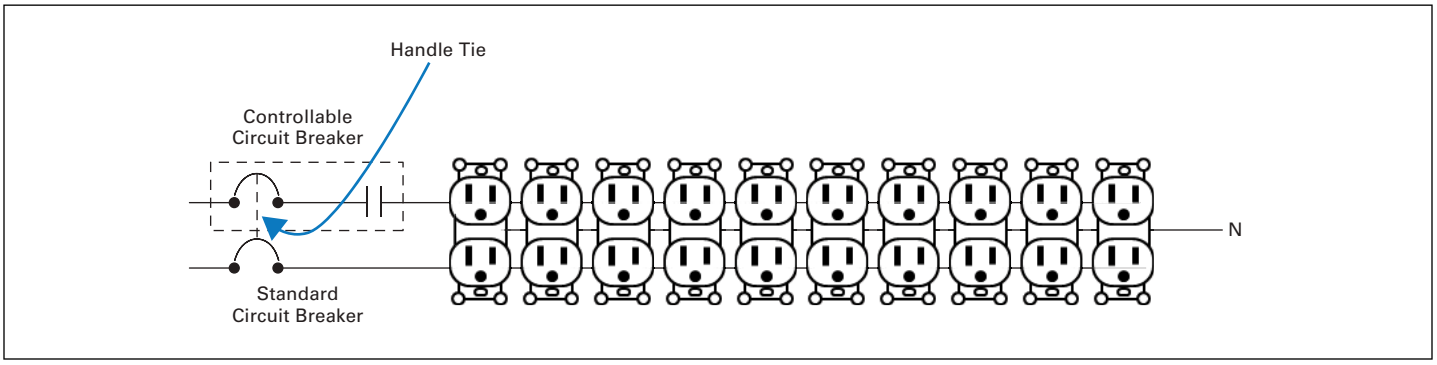

Figure 5. Split Receptacle Control Using Controllable Circuit Breakers

Receptacle breaker

It should be noted that installing a handle tie across adjacent circuit breakers does not provide a common trip function. If common trip is desired, an internal trip bar must be present to ensure that an overload on one pole will trip the other pole. Internal trip bars are not an accessory but must be installed in the breaker at the time of manufacture. Remote-control circuit breakers designed for receptacle applications combine controlled and uncontrolled poles with common trip and a handle tie (**Figure 6**).

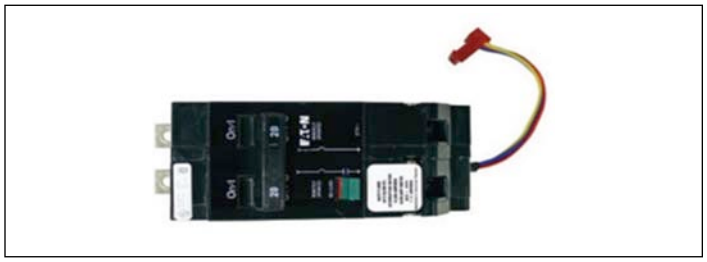

Figure 6. Receptacle Breaker

Conclusion

When selecting products for energy savings and code compliance, it is important to consider the advantages and the flexibility of remote-controlled circuit breakers. These systems bring power distribution and control together into one compact, intelligent panel while reducing the need for additional equipment and complex wiring.

For many years, remote-control circuit breaker systems have been an obvious choice for managing electrical power and lighting, widely used from small facilities to the world's largest buildings. Applying these solutions for receptacle control is simply a new application for this versatile type of system.

About Eaton

Eaton's electrical business is a global leader with expertise in power distribution and circuit protection, backup power protection, control and automation, lighting and security, structural solutions and wiring devices, solutions for harsh and hazardous environments, and engineering services. Eaton is positioned through its global solutions to answer today's most critical electrical power management challenges.

Eaton is a power management company providing energy-efficient solutions that help our customers effectively manage electrical, hydraulic, and mechanical power. A global technology leader, Eaton acquired Cooper Industries plc in November 2012. The 2012 revenue of the combined companies was $21.8 billion on a pro forma basis. Eaton has approximately 102,000 employees and sells products to customers in more than 175 countries. For more information, visit www.eaton.com.

About the author

Drew Reid is the Product Line Manager for Eaton's Lighting Control and Building Management business, featuring the innovative Pow-R-Command™ system for lighting and building control. He is a Certified Energy Manager and Certified Energy Auditor with more than 30 years of experience in the marketing and engineering of control systems, software, and communication networks. He has 17 U.S. patents with additional patents pending. He can be reached at DrewAReid@eaton.com.

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

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