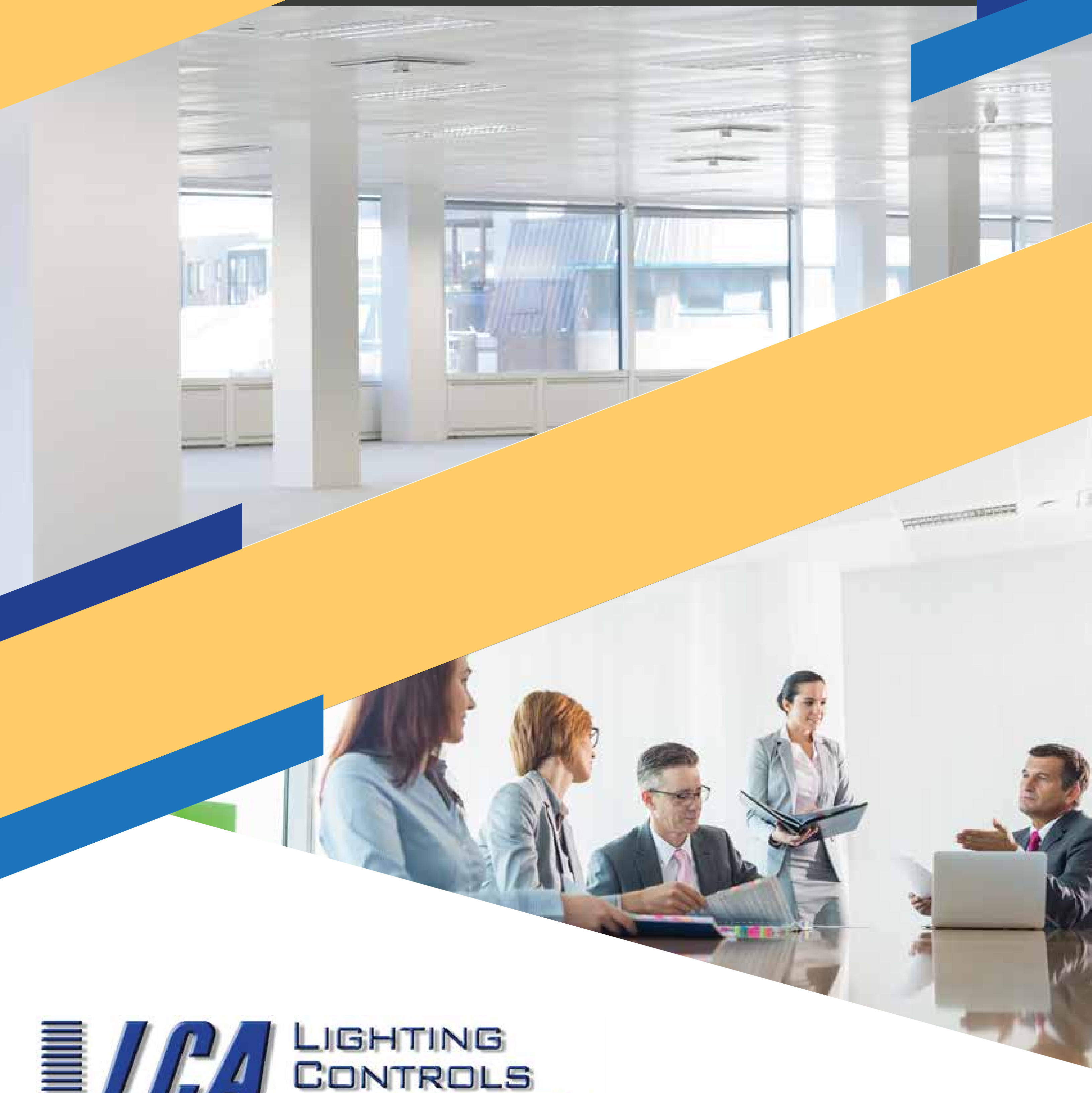


LCA Lighting Controls Association

LIGHTING CONTROL APPLICATION GUIDE FOR OPEN OFFICES

INTRODUCTION

Hoteling, hot-desking and other open office design trends are increasing demands for lighting flexibility. Meanwhile, commercial building energy codes are increasing demands for energy efficiency. A well-designed lighting and control system can maximize both of these objectives.

This application guide by the Lighting Controls Association describes various control strategies that can be applied to open office spaces. These strategies can minimize operating costs, achieve energy code compliance and support workspaces that are more productive.

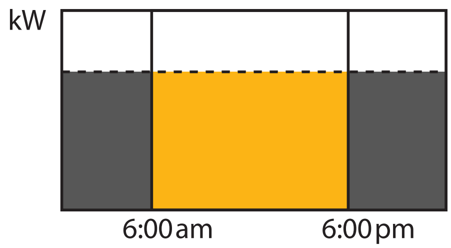
LIGHTING CONTROL STRATEGIES

Lighting controls are devices and systems that accept an input, make a decision about whether to reduce the lighting and by how much, and control the load as an output. The inputs may be manual (based on human initiative) or automatic (based on time, occupancy, ambient light level or instructions from a building management system). The outputs are switching, dimming or data.

The unique combinations of inputs and outputs provide a variety of strategies that, when properly matched to the application, can deliver average lighting energy cost savings up to 38+%. Below are lighting control strategies commonly deployed for new construction, renovation and retrofit in today's open office spaces:

Time-based control

Time-based control involves automatically turning the lights OFF at a certain time of day based on a predictable occupancy schedule. The Lawrence Berkeley National Laboratory estimates average lighting energy savings of 24%.



Manual control

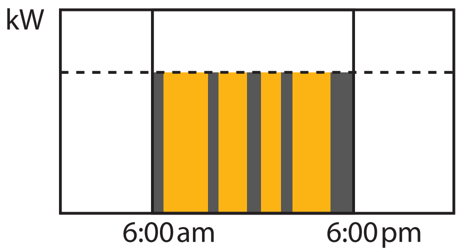
Manual controls enable occupants to turn lights ON/OFF or to dim the lights in response to visual needs. They can also override scheduled time-based controls.

Commercial building energy codes require light reduction capability. Options range from bilevel switching to dimming, which provides the greatest flexibility and is available as a standard capability of many LED luminaires. Dimmable luminaires combined with individually addressable luminaires also allow personal control strategies. In this scenario, each user can customize light output levels produced by the luminaire directly overhead.

The Lawrence Berkeley National Laboratory (LBNL) estimates average lighting energy savings of 31% for personal and 36% for group manual controls.

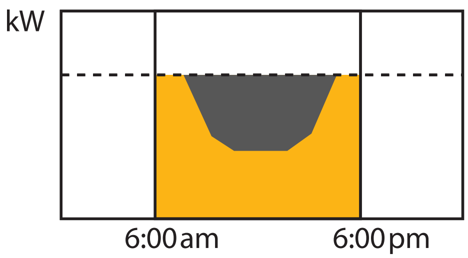
Vacancy sensing

Vacancy-sensing controls automatically turn OFF or reduce lighting when the space is vacant. Though ideally suited to smaller enclosed spaces such as private offices, these sensors can be deployed in large open office spaces, either as part of the luminaire or remotely mounted. With more precise luminaire control, higher energy savings can result. LBNL estimates average lighting energy savings of 24%.



Daylight-responsive control

Daylight harvesting controls turn OFF or reduce electric lighting in response to daylight falling on work surfaces. In open offices, dimming is preferred to avoid the visual disruption of lights turning ON / OFF. LBNL estimates average lighting energy savings of 28%.



Combining strategies

These and other lighting control strategies such as task tuning can be economically combined and layered within the same space; LBNL estimates average lighting energy savings of 38%.

GENERAL CONSIDERATIONS

Open workstations

Over the past few decades, open office areas have become predominantly populated with workstations—typically cubicle-based furniture systems featuring 5- or 6-ft. partitions. A recent trend is to eliminate the partitions. This significantly affects lighting system efficiency and lighting controls effectiveness. Inter-reflections of light increase, daylight penetration increases, and occupancy/vacancy sensing is afforded unobstructed views of workspaces.

Flexibility and personal control

Hoteling, hot-desking and a trend toward individual control of building systems have increased demand for lighting flexibility. Today's lighting control systems offer the ability to cap light output at custom design levels, separately zone small groups of luminaires, and provide occupants the ability to control local lighting.

Energy codes

Commercial building energy codes have become increasingly strict over the past decade. These codes impose both prescriptive requirements related to lighting power and mandatory requirements related to lighting controls. Today, lighting in most spaces must be turned OFF or dimmed when it is not needed based on occupancy (vacancy) or available daylight. The owner benefits from reduced operating costs. A majority of commercial building energy codes are based on the ASHRAE/IES 90.1 energy standard and the International Energy Conservation Code (IECC), which provide enforceable, code-ready language to jurisdictions. This guide is based on ASHRAE/IES 90.1-2013 and IECC 2015.

Retrofit options

Lighting control should be considered as part of every lighting upgrade as a means to increase energy savings and flexibility while gaining more control of lighting. Wireless control solutions, ideally paired with LED lighting, enable sophisticated lighting controls to be economically specified and installed in most buildings.

SAMPLE OPEN OFFICE SPACE

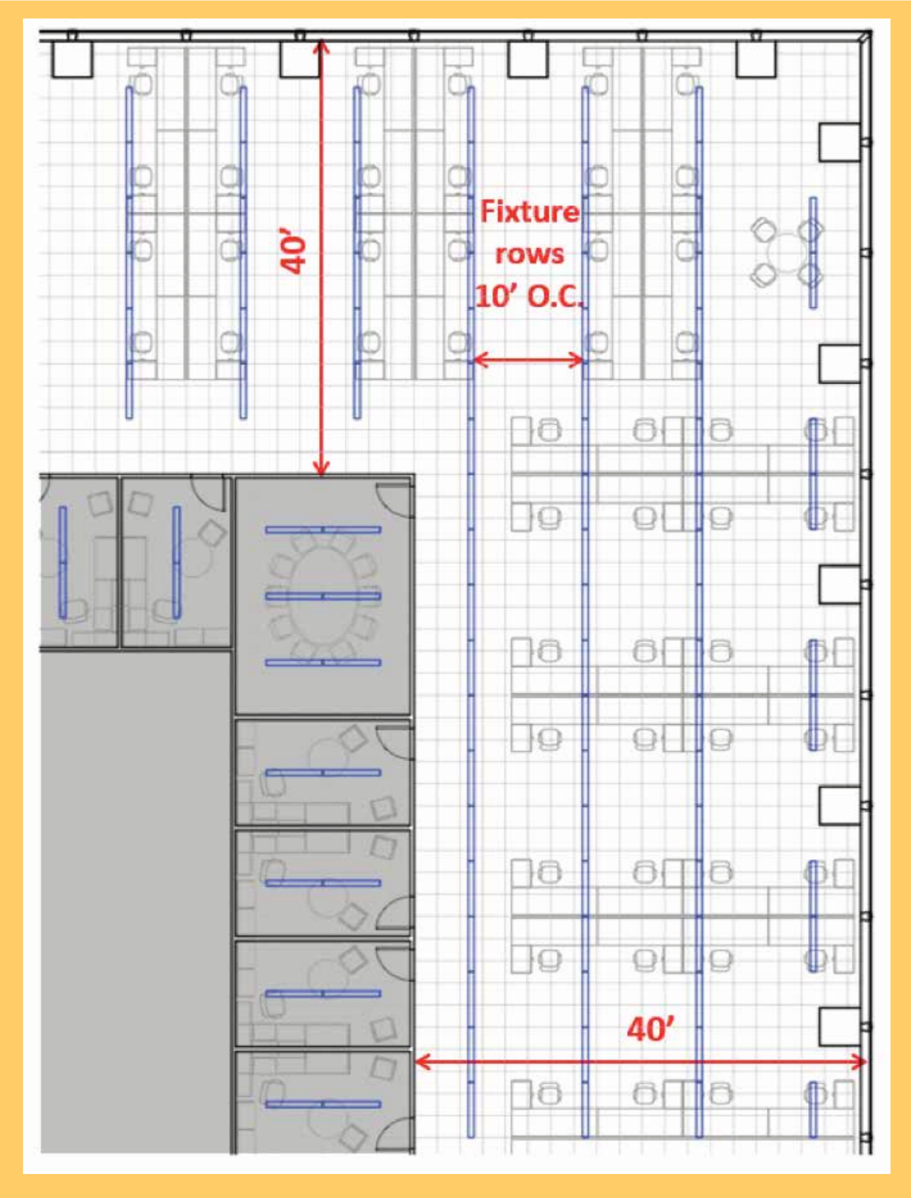
Space: Northeast corner of office building, 5,000 sq.ft. Open office bordered by glazing at the exterior and private offices and conference rooms in the core. It may be part of a larger floor plate, or a self-contained partitioned tenant office.

Ceiling height: 9 ft.

Daylight: Fully glazed curtain wall with 9 ft. window height (floor to glazing top).

Luminaires: 5-ft.-length pendant-mounted direct/indirect LED luminaires mounted 10 ft. on center (solutions in this guide are also compatible with recessed troffers).

Lamping: LED with luminaire-integrated continuous-dimming drivers.



Control need: Provide occupant control of lighting via wallbox switches.

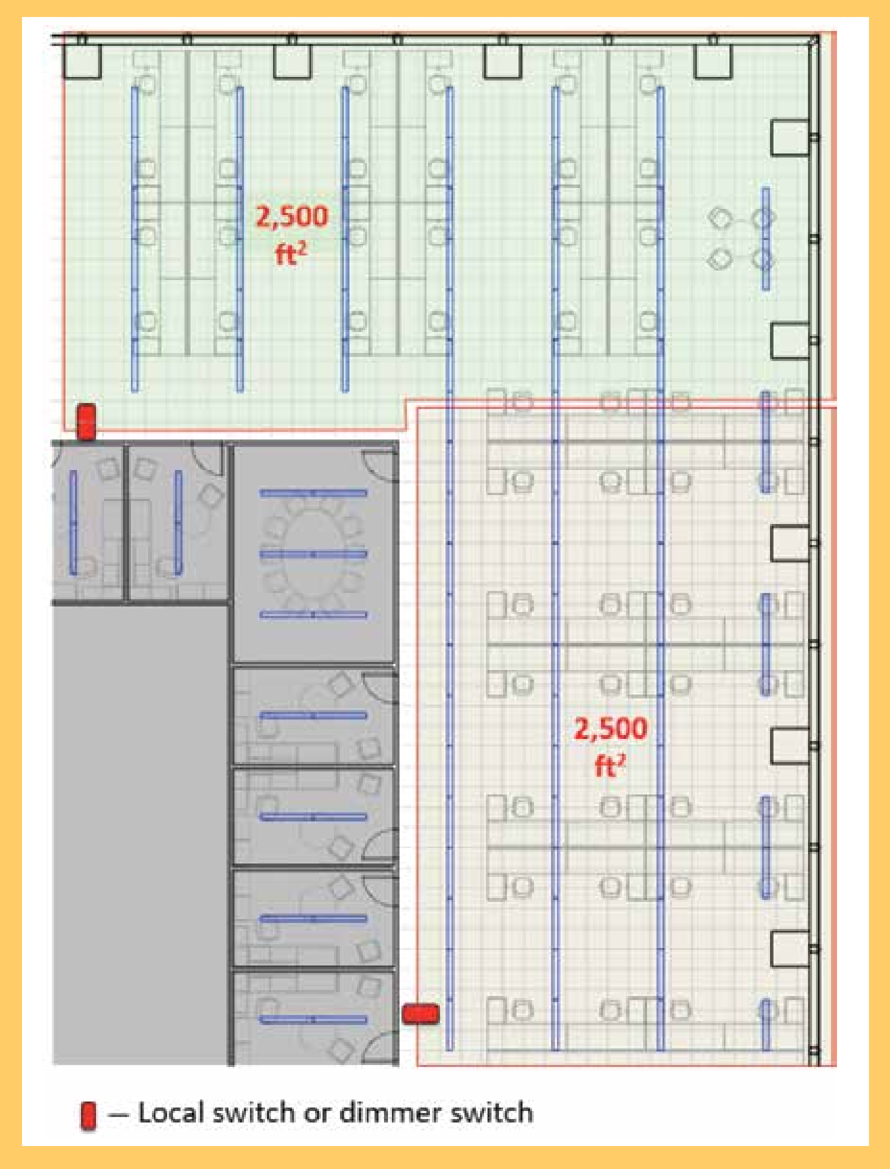
Occupant enters: Turns lights ON in work area using local switch.

Light reduction: Bilevel switching or continuous dimming.

Control zoning: Lighting in groups no larger than 2,500 sq.ft. (90.1) or 5,000 sq.ft. (IECC) must be independently controlled from other general lighting.

Personal control: As the luminaires are dimmable, users can be given the ability to control the downlight (task) component of overhead direct/indirect luminaires. This requires a compatible control system and lighting that aligns with workstations.

Other: Separately control any accent lighting.



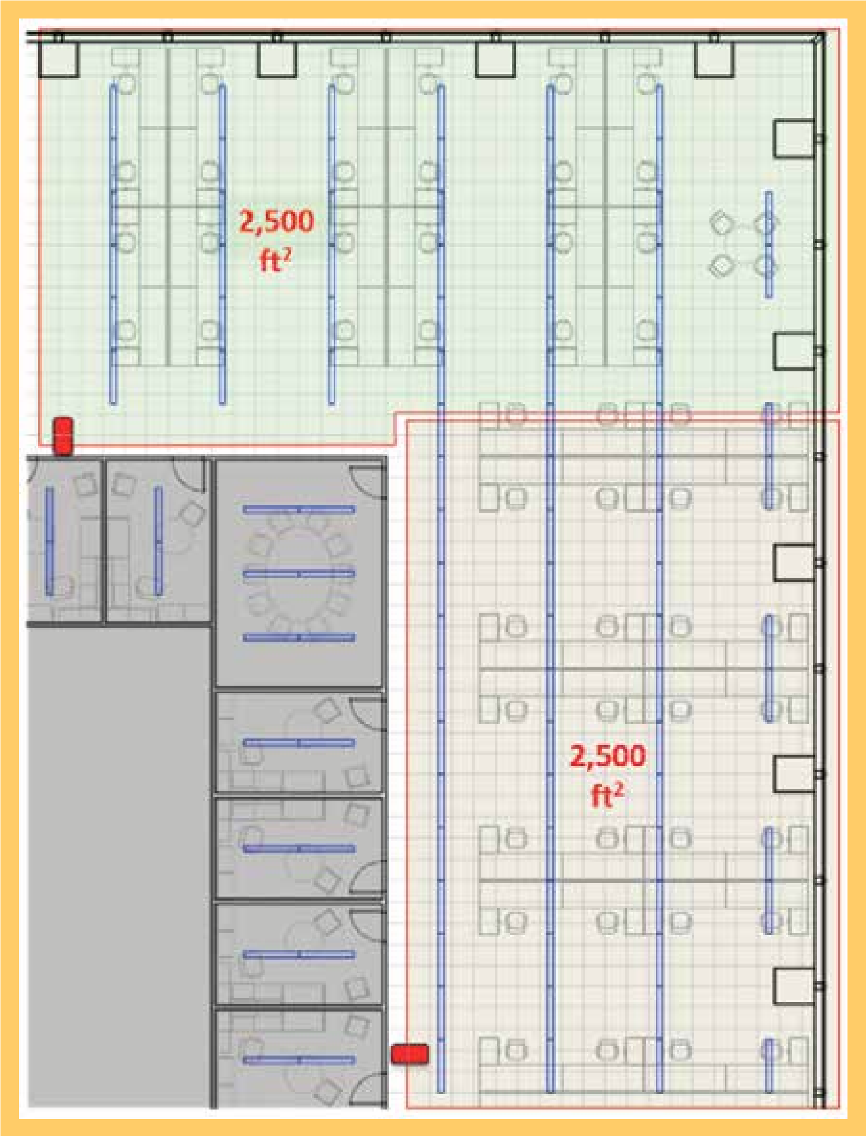
Control need: Automatically turn all lights OFF when not needed.

At set time of day: System turns lights OFF automatically with a blink warning; program must account for weekends and holidays (90.1).

Override: Occupants can override time schedule for two hours using manual switches, after which the schedule attempts to sweep the lights OFF again.

Control zoning: Lighting in groups no larger than 2,500 sq.ft. (90.1) or 5,000 sq.ft. (IECC) must be independently controlled from other general lighting.

Other functionality: Minimum 7-day clock, automatic holiday shutoff feature (turns lighting OFF for at least 24 hours and then resumes normal schedule), and program backup (prevents loss of program and settings for at least 10 hours if power is interrupted) (IECC).



VACANCY SENSING #1

Control need: As an alternative to time-based control with potentially higher energy savings, groups of luminaires turn OFF when not needed using vacancy sensors.

Occupant enters: Lights must be turned ON manually or automatically to ≤50% of lighting power, requiring manual switches.

Occupant enters: Vacancy sensors turn lighting groups OFF automatically within 20 (90.1) or 30 minutes (IECC).

Suggested placement: Ceiling-mounted at center of control zone; vacancy sensor detection coverage should overlap 15-20%.

Suggested sensor type: Dual-technology or ultrasonic for reliable detection.

VACANCY SENSING #2

Description: Second scenario for vacancy sensing with control zoning that is more granular using more ceiling-mounted sensors.

Suggested placement: Ceiling-mounted with detection overlap of 15-20%.

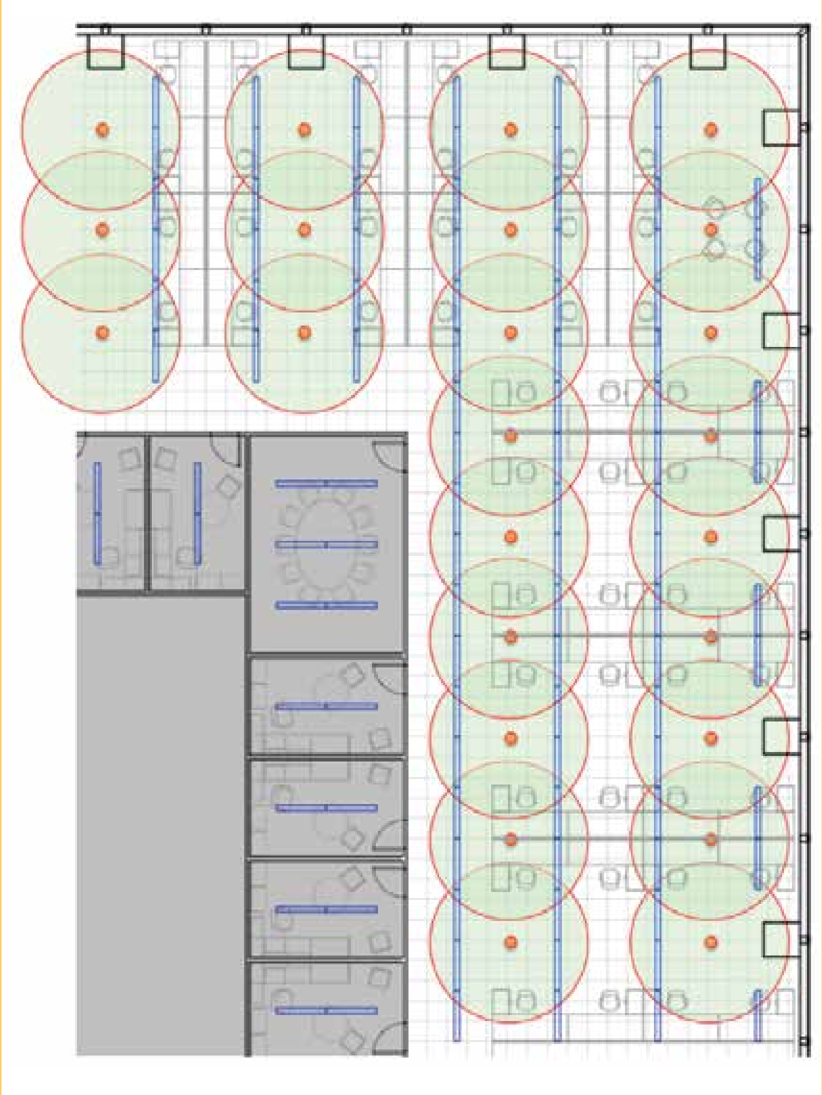
Suggested sensor type: Dual-technology or ultrasonic for reliable detection.

Uplight/Downlight: Luminaire uplight used for general ambient lighting may be separately controlled from downlight used for task lighting. Individual sensors control local downlight. Sensors can be networked for group control of uplight, dimming uplight to OFF when all networked sensors detect vacancy.

Fade to OFF: Sensors should dim to OFF to avoid visual disruption to other open office occupants.

Other functionality: Manual override OFF, manual override of time delay via local control. Override period not to exceed 2 hours before system returns to normal functionality (sensors automatically turn lights OFF based on vacancy).

Centralized networked control: If these sensors are deployed within a centralized networked lighting control system, they can control small groups of luminaires for certain functions (such as automatic shutoff) while also responding to input from other devices (e.g., wall-mounted dimmer-switch for manual override control of each luminaire in a 2,500-sq.ft. control zone). The control zone hierarchy is created in the system's software during startup.

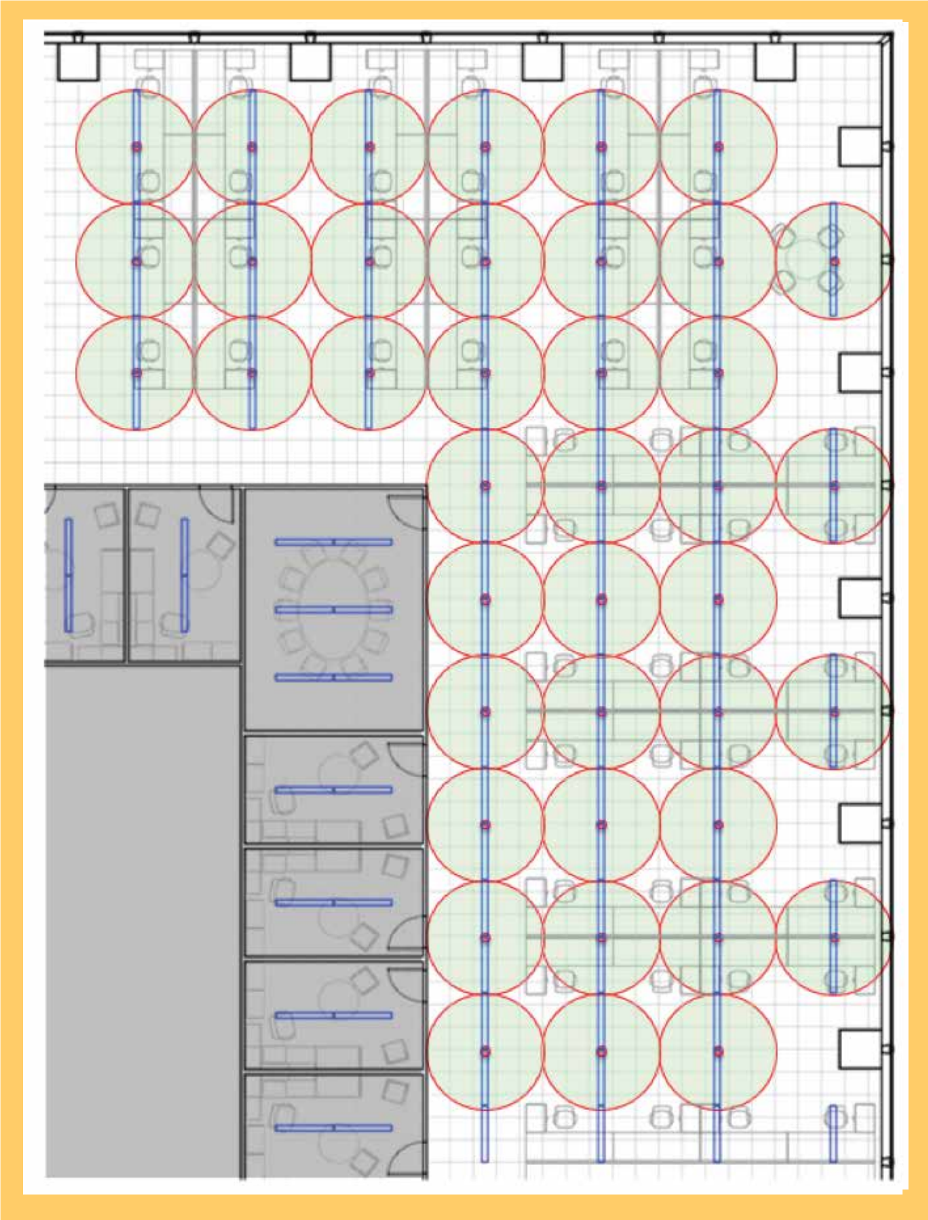


VACANCY SENSING #3

Description: Third scenario for vacancy sensing with control zoning that is more granular using luminaire-integrated sensors. This option offers the potential for maximum energy savings without compromising occupant comfort levels.

Suggested placement: One sensor per 10-ft tandem strip of luminaires.

Other: See Vacancy Sensing #2. Note if the luminaires are direct luminaires, the sensors can dim to a lower level instead of OFF to avoid dark spots on the ceiling.

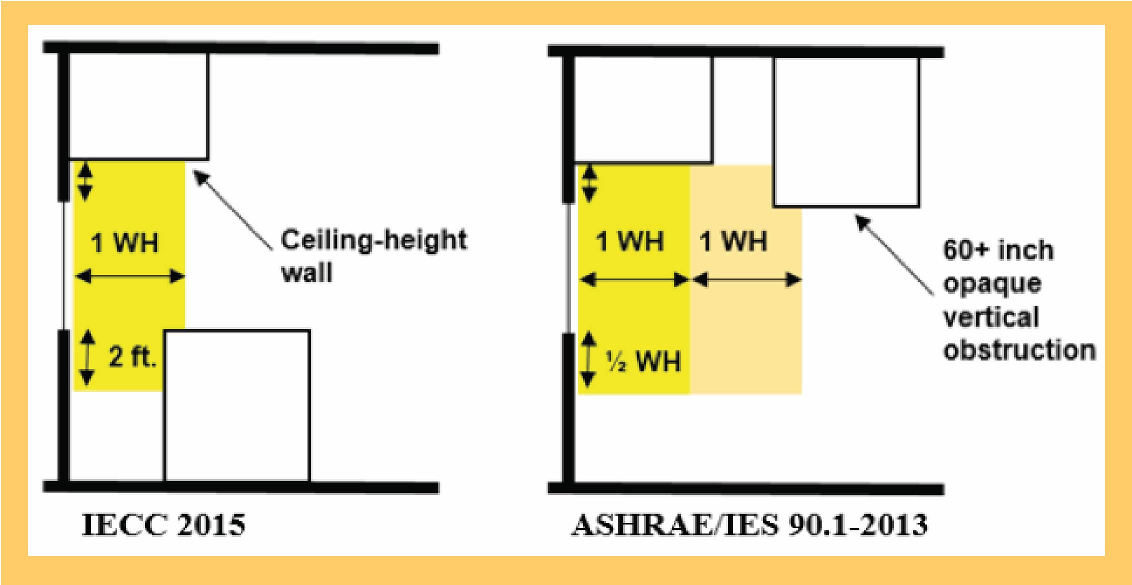


Control need: Reduce lighting in sidelighted (e.g., windowed) daylight zones when ample daylight available, using light sensors (aka, daylight sensors, photosensors).

Operation: Lighting in daylight zone automatically raises or lowers based on degree to which daylight increases light levels. The system may be calibrated manually or automatically, with automatic calibration recommended for optimal effectiveness.

Daylight zoning: Lighting adjacent to windows constitutes the primary daylight zone. ASHRAE/IES 90.1-2013 requires lighting adjacent to the primary zone also be controlled as a secondary daylight zone. See graphic for sizing.

Sidelighting daylight zones as required by ASHRAE/IES 90.1-2013 and IECC 2015. WH = window height.



Control zoning: Control zones can then be placed within the daylight zones; in our example (see next page), four control zones are established, two (primary and secondary) for the north- and two (primary and secondary) for the east-facing glazing

Output: Continuous dimming recommended as the space will normally be occupied during light reduction:

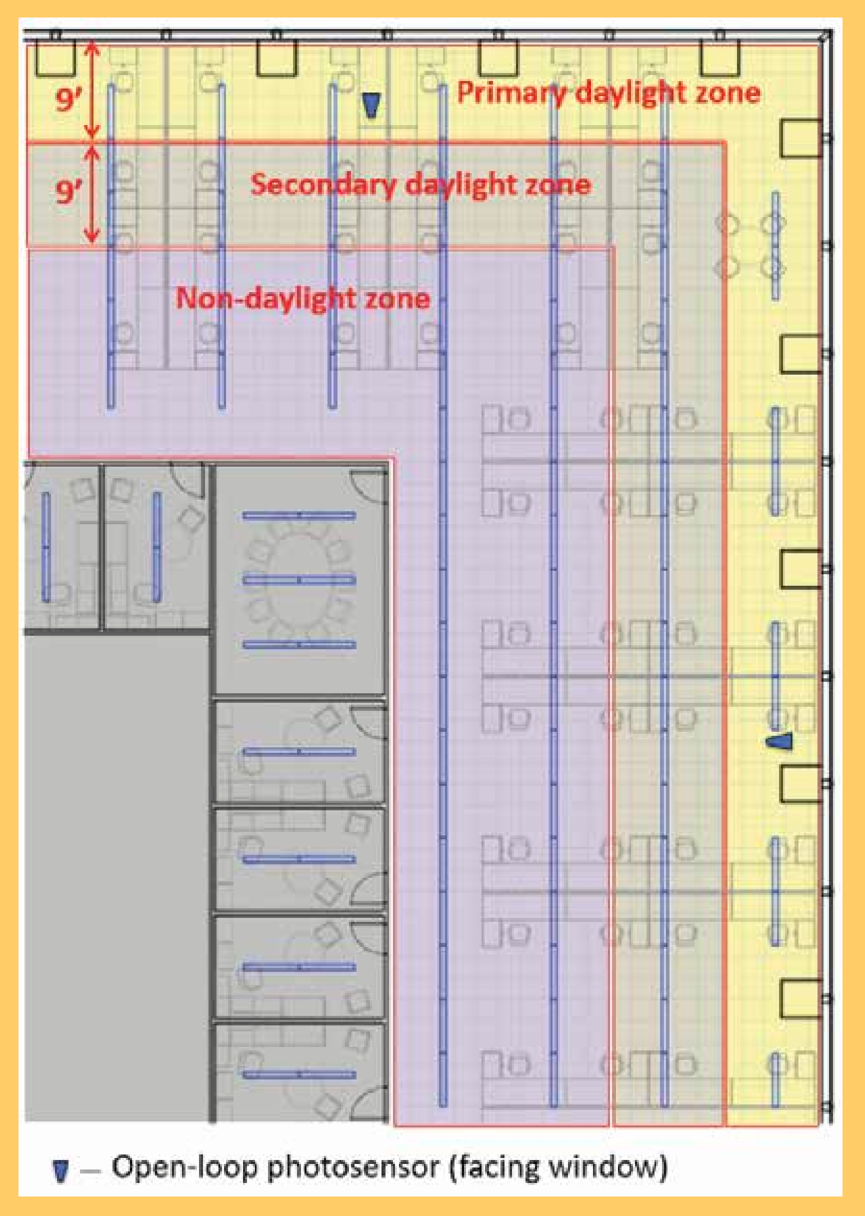
- Dimming to at least three control inputs: 50-70% of lighting power, 20-40% of lighting power, and OFF (90.1)
- Dimming to at least 15% of lighting power and capable of full OFF (IECC)

Recommended threshold for dimming: Daylight contribution is 150% of design light level.

Suggested sensor type: Open loop for simplicity and reduced cost. However, if there are blinds or window obstructions, or if this is a ground floor where reflections from parked cars can significantly affect performance, consider closed loop.

Suggested placement: Open-loop sensors must be placed with an obstructed view of the daylight source (at the windows or on the roof).

Other: Photosensor takes precedence for upper light level limit over manual dimming.



OTHER CONTROL OPPORTUNITIES

Institutional task tuning:

This option primarily applies to programmable networked lighting controls. Because the luminaires are dimmable, they can be programmed with a high-end trim point—that is, a maximum light output setting. This allows light levels to be customized by application, potentially resulting in higher energy savings.

Demand response:

Because the luminaires are dimmable, they can be triggered to temporarily reduce output and power in response to a utility emergency event.

Integration with building management and other systems:

The lighting control system can be integrated with other building systems for various benefits. For example, additional sensors can be integrated to generate data. As another example, the building's security department can be notified that lights are ON, indicating the presence of people.

CONTROL SYSTEM EXAMPLE #1: ROOM-BASED SOLUTION

In this “room-based” solution, central controllers switch and dim luminaires. The controllers contain relays for switching. They also make the luminaires dim—typically by sending 0-10V analog signals over low-voltage wires to a dimmable driver in each luminaire.

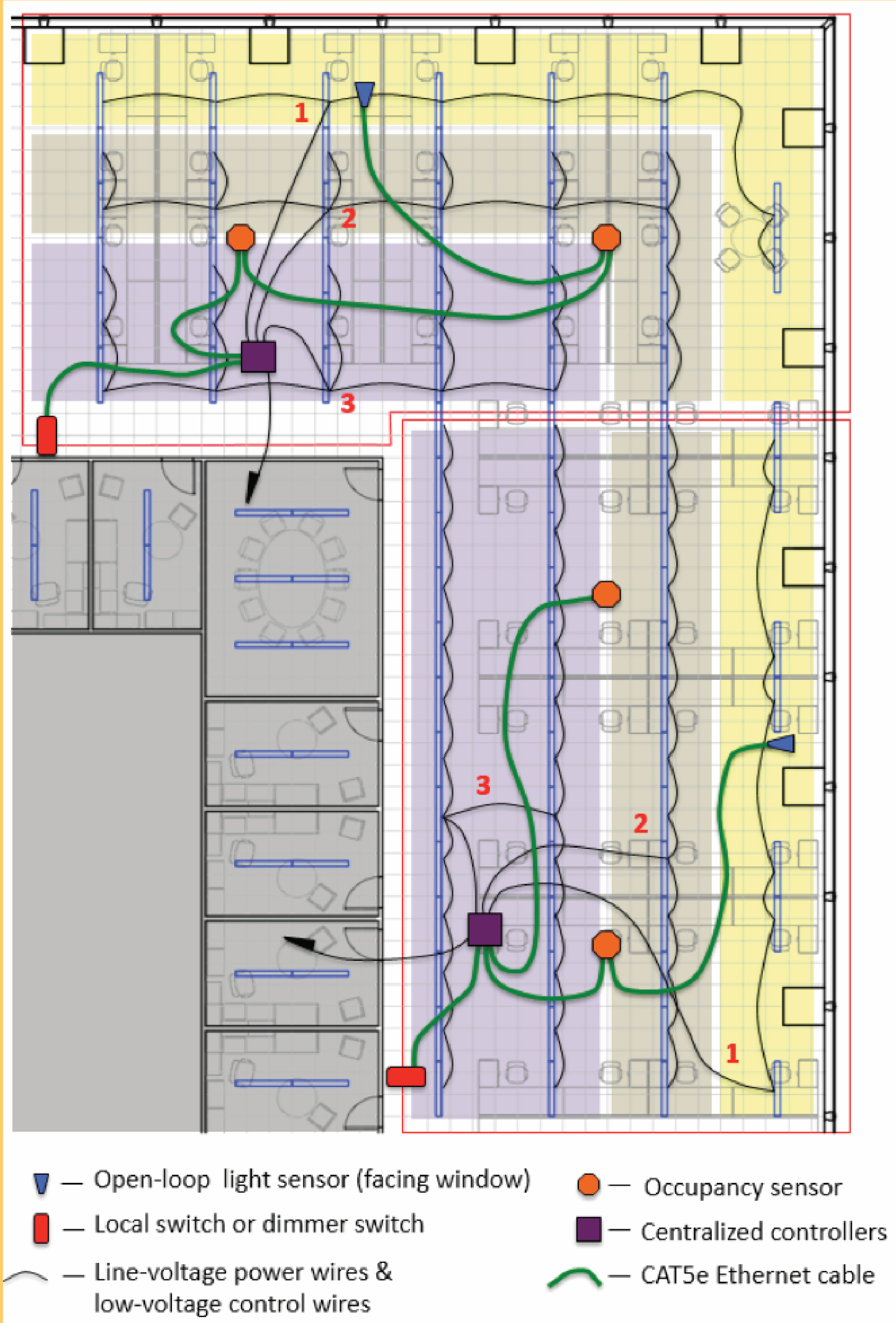
Instead of 0-10V analog signals, some systems use digital signals (e.g., DALI). Most LED luminaires are now sold with integral dimming drivers that communicate using 0-10V. As such, many vendors have developed “room-based” equipment to control these luminaires.

Note that in this example, the luminaires do not have individual (discrete) addresses. Therefore, zoning (grouping) of luminaires is restricted based on how the line-voltage power wires as well as low-voltage control wires are routed. If there is no expectation that the open office area will have to be reconfigured at some future date, this may be acceptable.

Additionally, note that these centralized controllers may be limited based on maximum current (e.g., 20A for a typical lighting branch circuit), number of luminaires connected, number of relays in the controller, or some other restriction.

If there is any expectation that the open office area may have to be reconfigured at some future date, consider using a system that relies on individual (discrete) addresses for every luminaire.

On a final note, most spaces require some code-compliant method of providing emergency lighting for paths of emergency egress. It’s essential to discuss options that a prospective vendor has for providing code-compliant emergency egress lighting. Methods vary based on the source of emergency power and the type of lighting control equipment being considered. It’s preferable to have these discussions as early as possible in the process since emergency lighting requirements typically affect the required equipment and/or wiring topology.


1
2
3
3
2
1
Open-loop light sensor (facing window)
Local switch or dimmer switch
Line-voltage power wires & low-voltage control wires
Occupancy sensor
Centralized controllers
CAT5e Ethernet cable

CONTROL SYSTEM EXAMPLE #2: DIGITAL NETWORK WITH NO CENTRAL SERVER

In this example, every luminaire contains an integral controller for switching and dimming. Just as with the central controllers in the previous example, these controllers contain relays for switching luminaires ON and OFF. They also make the luminaires dim—typically by sending 0-10V analog signals or digital signals over low-voltage wires to the integral dimming ballast or dimming driver.

Therefore, these luminaires have individual (discrete) addresses. Consequently, zoning (grouping) of luminaires is not restricted based on how the line-voltage power wires are routed.

These luminaire-integrated controllers are restricted based on maximum current (e.g., 2A per controller). Check with the vendor for maximum current ratings of each type of controller offered.

In this type of system, zoning of luminaires as required by code may be achieved by pushing a hidden button on each device, or by some other method. Consult with the vendor to determine how this is accomplished subsequent to equipment installation.

Note that instead of using one controller integrated into every luminaire, a controller may be used for a small group of luminaires as long as this doesn't exceed the maximum current rating of the controllers being used. Doing so will reduce the equipment cost for a given project, but it will also reduce the flexibility for possible future rezoning, if required.

As with the previous example, remember that some form of code-compliant emergency egress lighting will be required in most spaces. Consult with each vendor regarding options for achieving code-compliant emergency egress lighting.

CONTROL SYSTEM EXAMPLE #2: DIGITAL NETWORK WITH NO CENTRAL SERVER

CONTROL SYSTEM EXAMPLE #3: WIRELESS SOLUTION

In a wireless networked system with a central server, every luminaire contains an integral controller for switching and dimming as well as a radio for communicating with the server via a wireless gateway(s). As in the previous examples, these controllers contain relays for switching luminaires and dim typically by sending 0-10V analog signals or digital signals over low-voltage wires to the driver.

Therefore, these luminaires have individual (discrete) addresses. Consequently, zoning (grouping) of luminaires is not restricted based on how the line-voltage power wires are routed. Zoning is created by grouping luminaires in the software during the setup process.

These luminaire-integrated controllers will be also limited based on maximum current (e.g., 2A). Check with the vendor for maximum current ratings of each type of controller offered.

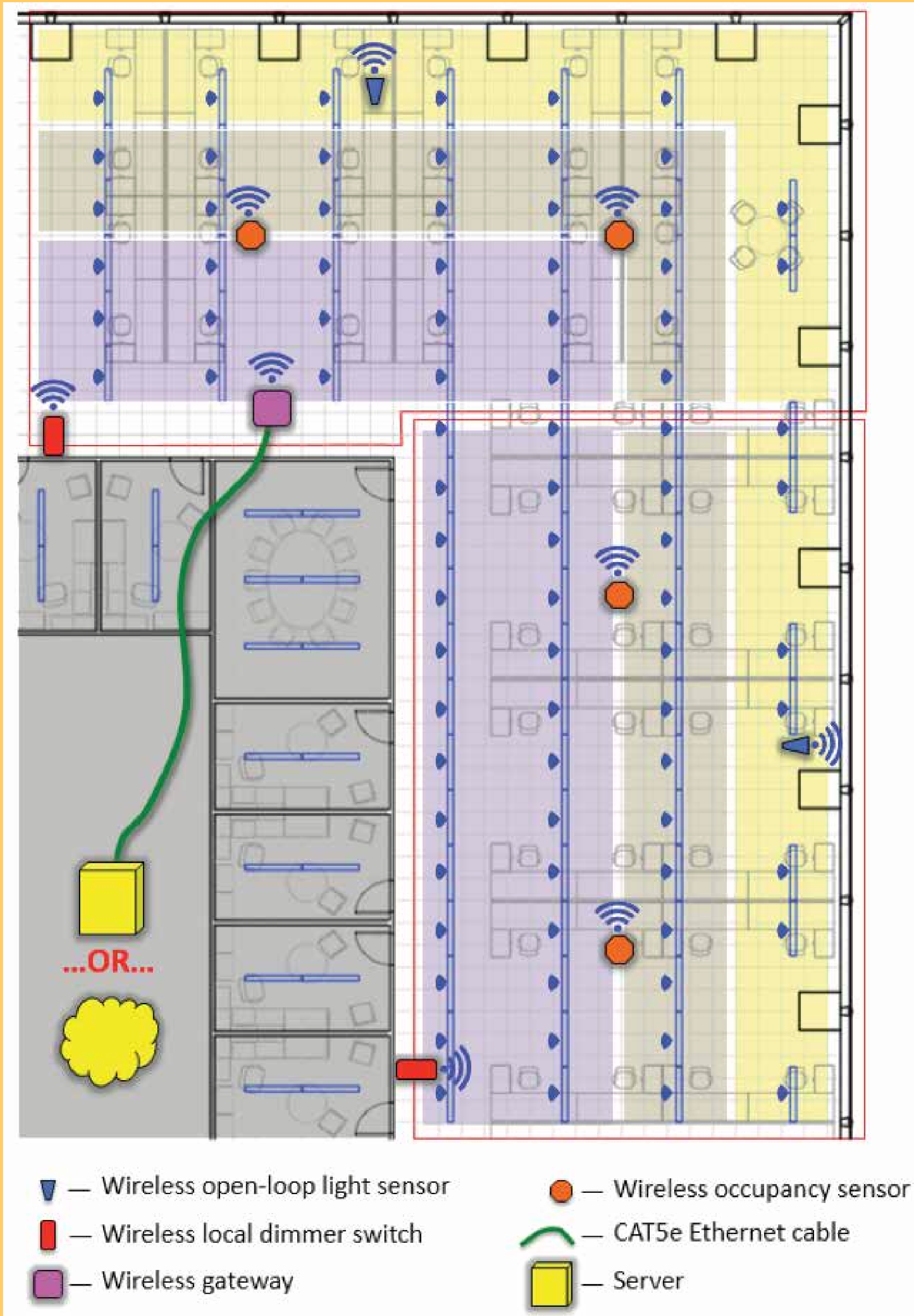
Note that instead of using one controller integrated into every luminaire, a controller may be used for a small group of luminaires as long as this doesn't exceed the maximum current rating of the controllers being used. This will reduce the equipment cost for a given project, but it will also reduce the flexibility for possible future rezoning, if required.

When using a networked system with a central server, the server typically provides additional functionality beyond what "room-based" solutions contain, for example:

- provides a GUI (graphic user interface)
- monitors all luminaires, and/or other information such as occupied areas, etc.
- records energy usage data, and/or other data (e.g., occupancy vs. vacancy)
- sends messages about alerts or alarms to designated staff via text, phone, e-mail, etc. (when the system isn't functioning properly or requires attention for any other reason)

As with the previous examples, remember that some form of code-compliant emergency egress lighting will be required in most spaces. Consult with each vendor regarding options for achieving code-compliant emergency egress lighting.

CONTROL SYSTEM EXAMPLE #3: WIRELESS SOLUTION



GET CONTROL OF YOUR LIGHTING

Reducing energy costs and complying with energy codes is only part of the equation for good lighting control for open offices. The lighting system should also be flexible so as to support the array of visual needs in today's dynamic office environment. With the right lighting control solution, the modern office can support productivity while minimizing operating costs.

The Lighting Controls Association offers numerous resources to facilitate selection and design, including online education courses, articles and access to products and news from member companies. To learn more, visit:

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