



Lighting Application Guide for K-12 Classrooms

Lighting Controls for Today's Classroom

Commercial building energy codes contain detailed mandatory lighting control requirements related to buildings such as K-12 schools. The high-performance school design movement extends these requirements by demanding additional flexibility to support the contemporary learning experience in today's classroom.

This application guide by the Lighting Controls Association describes various control strategies that can be applied to classrooms to minimize operating costs, enact energy code compliance and support high-performance school design.

To learn more, talk to your building professional or manufacturers' representatives, or visit:

LightingControlsAssociation.org



Strategies

Manual control

Manual controls enable users to turn ON/OFF or reduce their lighting in response to visual needs. Incorporating flexibility provides a selection of light levels and can increase satisfaction while producing energy cost savings. The Lawrence Berkeley National Laboratory (LBNL) estimates average lighting energy savings of 31-36%.



Occupancy sensing

Occupancy sensing controls turn lighting OFF or reduce it in response to whether the space is occupied. LBNL estimates average lighting energy savings of 24%.



Daylight-responsive Control

Daylight harvesting controls turn lighting OFF or reduce it based on the contribution of daylight to task lighting needs. LBNL estimates average lighting energy savings of 28%.

High-Performance Classrooms

New teaching methods such as A/V systems, smart boards, tablets and web-based learning tools continue to transform the modern classroom. Today, teachers need conveniently accessible, easy-to-use and flexible lighting controls allowing them to establish optimal lighting conditions for various teaching tasks.

Founded in 1999, the Collaborative for High-Performance Schools (CHPS) developed a point-based rating and recognition system promoting construction of healthy, green schools. CHPS published updated national criteria (2014) allowing adoption across the United States beyond those states currently using customized CHPS criteria.



High-Performance Classrooms

The 2014 national CHPS criteria provides 4 points for achieving superior electric lighting performance via flexible lighting controls.

With the exception of specialty classrooms where not required, all classrooms should be designed with indirect/direct general lighting equipped with multiscene controls. These controls enable selection of two operating modes: General and AV. In General mode, the lights are ON at full output. In AV mode, lighting is reduced to accommodate AV-based learning methods.

Whiteboards should be illuminated by general lighting luminaires or a dedicated luminaire that is separately switched.

Teachers should be provided convenient access to a control device that permits selection of General/ AV mode, whiteboard lighting and a manual override of occupancy sensor time delays.



Energy Codes

The latest building energy codes are based on ASHRAE / IES 90.1-2010 or 2013 or the International Energy Conservation Code (IECC) 2012 or 2015.

These codes require that all interior lighting be turned OFF when it's not in use. Occupancy sensors are specifically required in the majority of classrooms.

The occupancy sensor must be either manual-ON or auto-ON to $\leq 50\%$ of lighting power, necessitating the addition of a manual switch. The switch must be readily accessible to occupants, which typically entails location at the classroom entrance.

Classrooms receiving ample daylight via sidelighting (e.g., windows) or toplighting (e.g., skylights) must designate lighting in daylight zones as being separately controllable from the rest of the room's general lighting.

If the energy code is based on IECC-2012, a separate manual switch or dimmer-switch is permitted. If 90.1, the lighting must be controlled by a daylight-responsive automatic controller. This controller must be capable of either continuous or step dimming.

This guide is based on compliance with ASHRAE / IES 90.1-2010 and IECC 2012.



Classroom

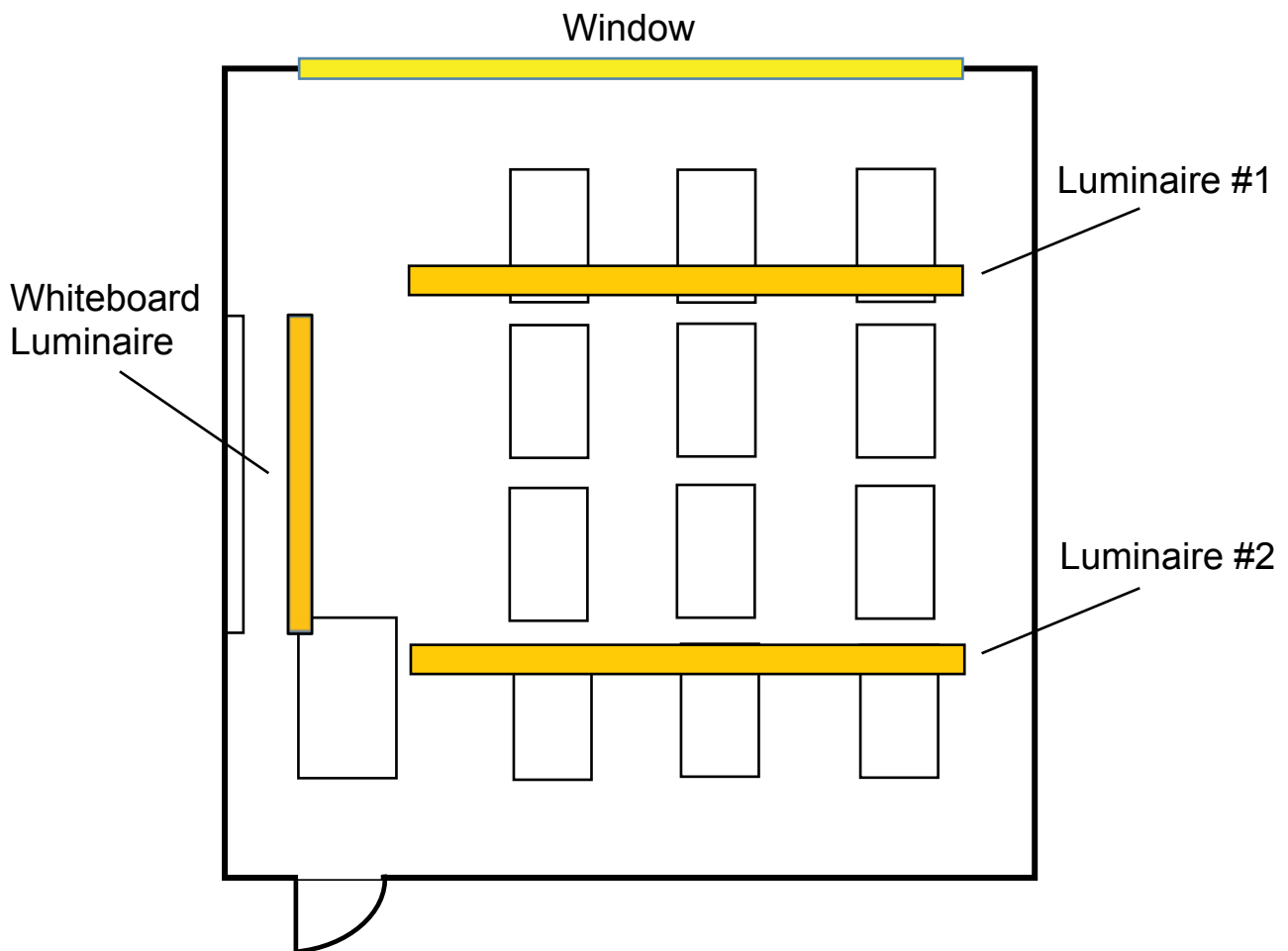
Space: 30 ft. x 30 ft.

Ceiling height: 10 ft.

Daylight: 20 ft. of windows along one wall, 8 ft. window height (floor to top of glazing)

Luminaires: Pendant indirect/direct luminaires and dedicated wall-washer whiteboard luminaire; similar strategies as in this guide, however, may be enacted with troffers/panels or no dedicated whiteboard luminaire.

Lamping: Pendant luminaires may be LED with continuous dimming, fluorescent luminaires with continuous dimming, or fluorescent luminaires with separately ballasted direct (1 lamp, inboard) and indirect (2 lamps, outboard) distribution



Occupancy Sensing

Control need: Automatically turn lights OFF when not needed

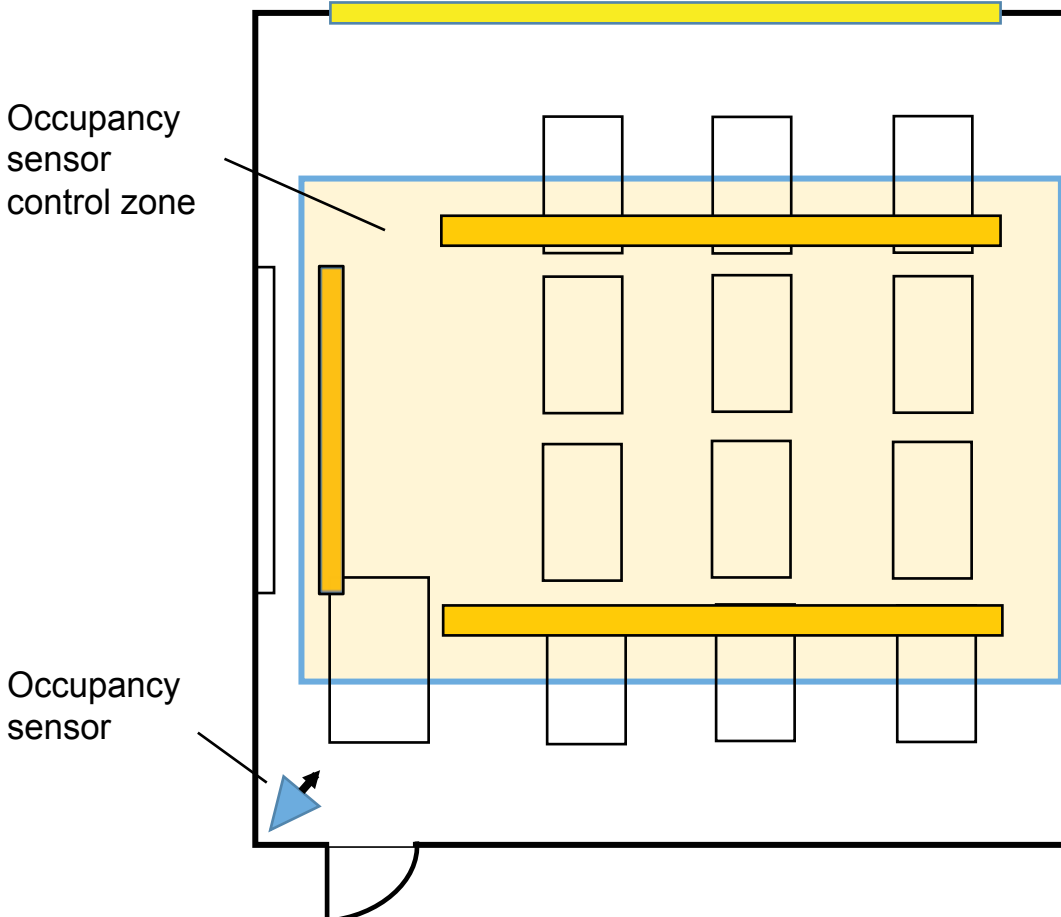
Occupant enters: Lights must be turned ON manually or automatically to $\leq 50\%$ of lighting power

Occupant exits: Lights are turned OFF automatically within 30 minutes

Suggested placement: Corner mounting facing opposite corner, near teacher's desk, at same height as luminaires (see blue icon)

Suggested sensor type: Dual-technology for reliable detection, passive-infrared when classroom features hanging objects such as mobiles

Other functionality: Manual override OFF, manual override of time delay via switch



Automatic Daylight-Responsive Control (Sidelighting)

Control need: Reduce lighting in sidelighted (e.g., windowed) daylight zones when ample daylight available

Operation: Lighting in daylight zone automatically raises or lowers based on degree to which daylight increases light levels

Input: Manual (allowed by IECC 2012) or automatic (allowed by IECC 2012 and required by 90.1-2010)

Output:

- Bi-level switching or step dimming with outboard lamps (uplight) controlled by the light sensor (step between $\leq 35\%$ of lighting power which may include OFF, a step between 50-70% of lighting power, and full ON)
- Continuous dimming to $\leq 35\%$ of lighting power, recommended for automatic control as the space will normally be occupied during light reduction

Recommended threshold:

- Daylight contribution is 150-200% of design light level for switching; threshold should also allow “dead band” with high and low set-points to avoid overly frequent switching
- Daylight contribution is 150% of design light level for continuous dimming

Suggested placement:

- A single light sensor per 30 linear ft. of glazing; in this classroom, one sensor controls the luminaire row in closer proximity to the windows

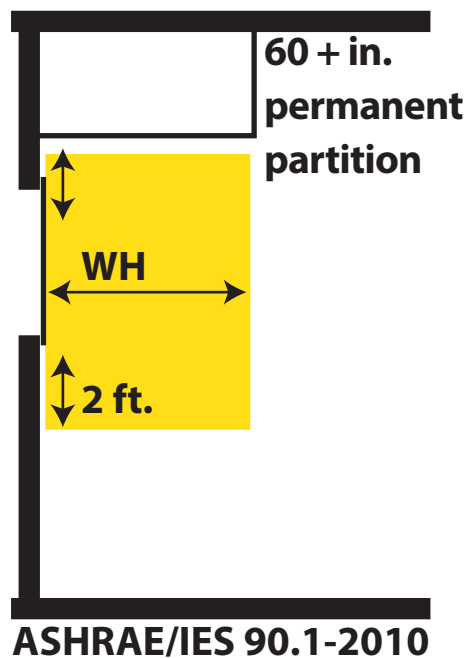
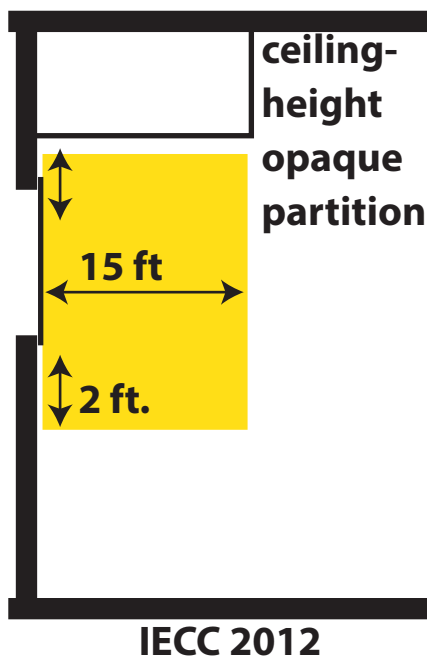
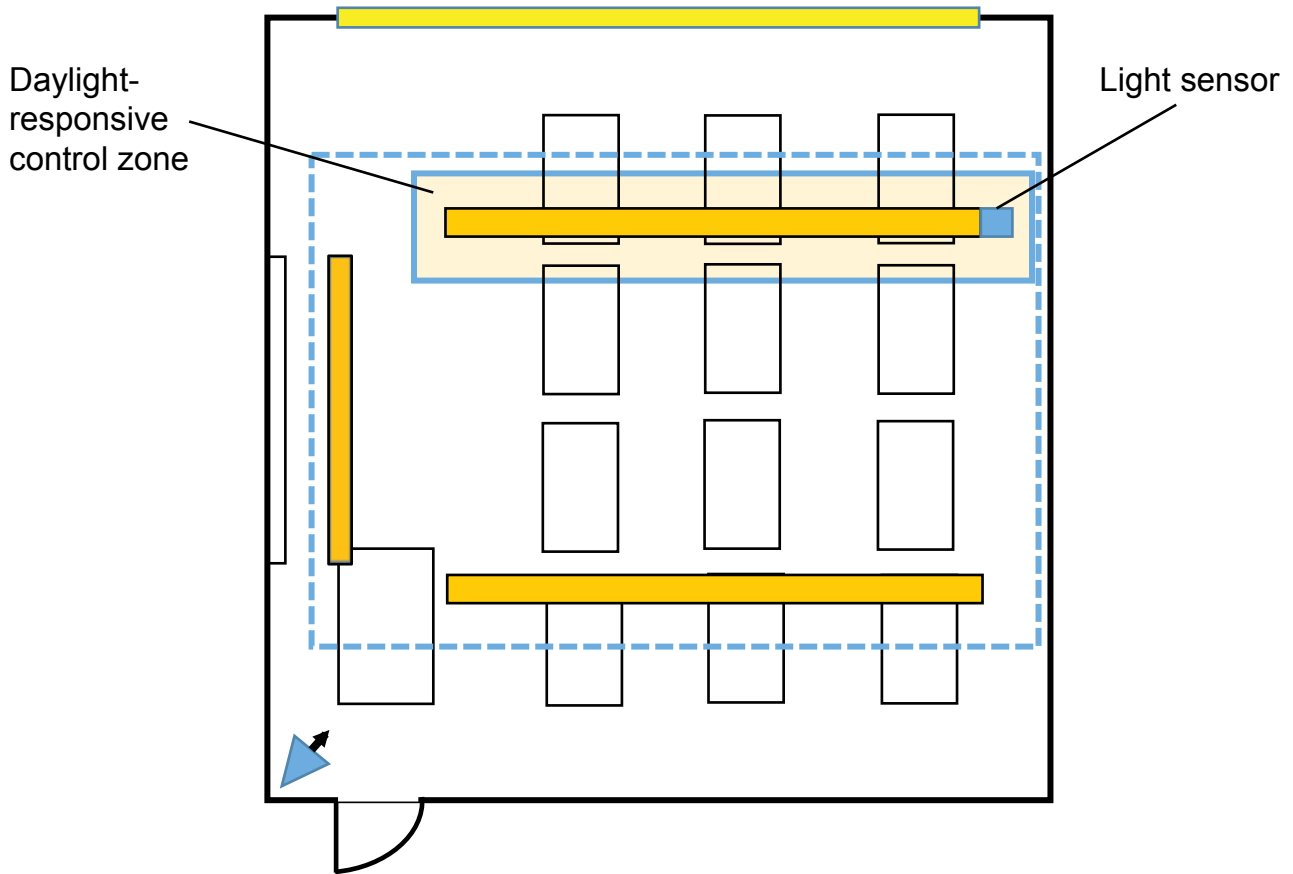
- Luminaire should be mounted at a distance from window of 1-2 times effective window height (sill or 3 ft. off floor to top of window)
- Sensor should be aimed so its view does not receive direct electric light or sunlight or is otherwise blocked by a luminaire or fan
- Sensor should not be aimed directly over a desk
- Sensor can be mounted on a luminaire

Suggested sensor type: As the windows feature blinds that can be closed, closed-loop or dual-loop sensor is recommended, with appropriate range of light level response

Other: Light sensor takes precedence for upper light level limit over manual dimming



Automatic Daylight-Responsive Control (Sidelighting)



Daylight zones as required by major energy standards. WH = window height.

Automatic Daylight-Responsive Control (Toplighting)

Control need: Reduce lighting in toplighted (e.g., skylighted) daylight zones when ample daylight available

Operation: Lighting in daylight zone automatically raises or lowers based on degree to which daylight increases light levels

Input: Manual (allowed by IECC 2012) or automatic (allowed by IECC 2012 and required by 90.1-2010)

Output:

- Bi-level switching or step dimming with outboard lamps (uplight) controlled by the light sensor (step between $\leq 35\%$ of lighting power which may include OFF, a step between 50-70% of lighting power, and full ON)
- Continuous dimming to $\leq 35\%$ of lighting power, recommended for automatic control as the space will normally be occupied during light reduction

Recommended threshold:

- Daylight contribution is 150-200% of design light level for switching; threshold should also allow “dead band” with high and low set-points to avoid overly frequent switching
- Daylight contribution is 150% of design light level for continuous dimming

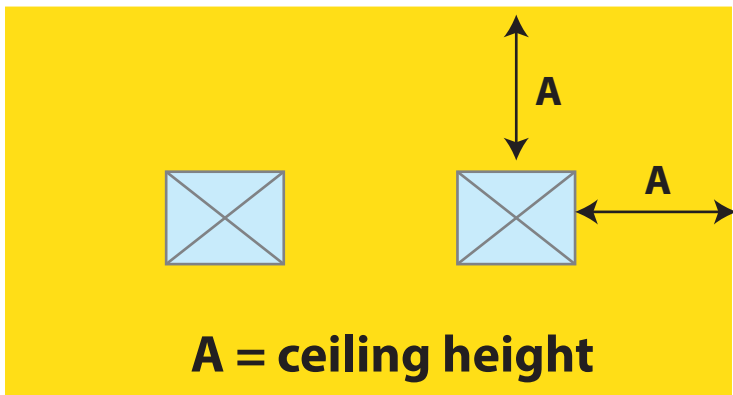
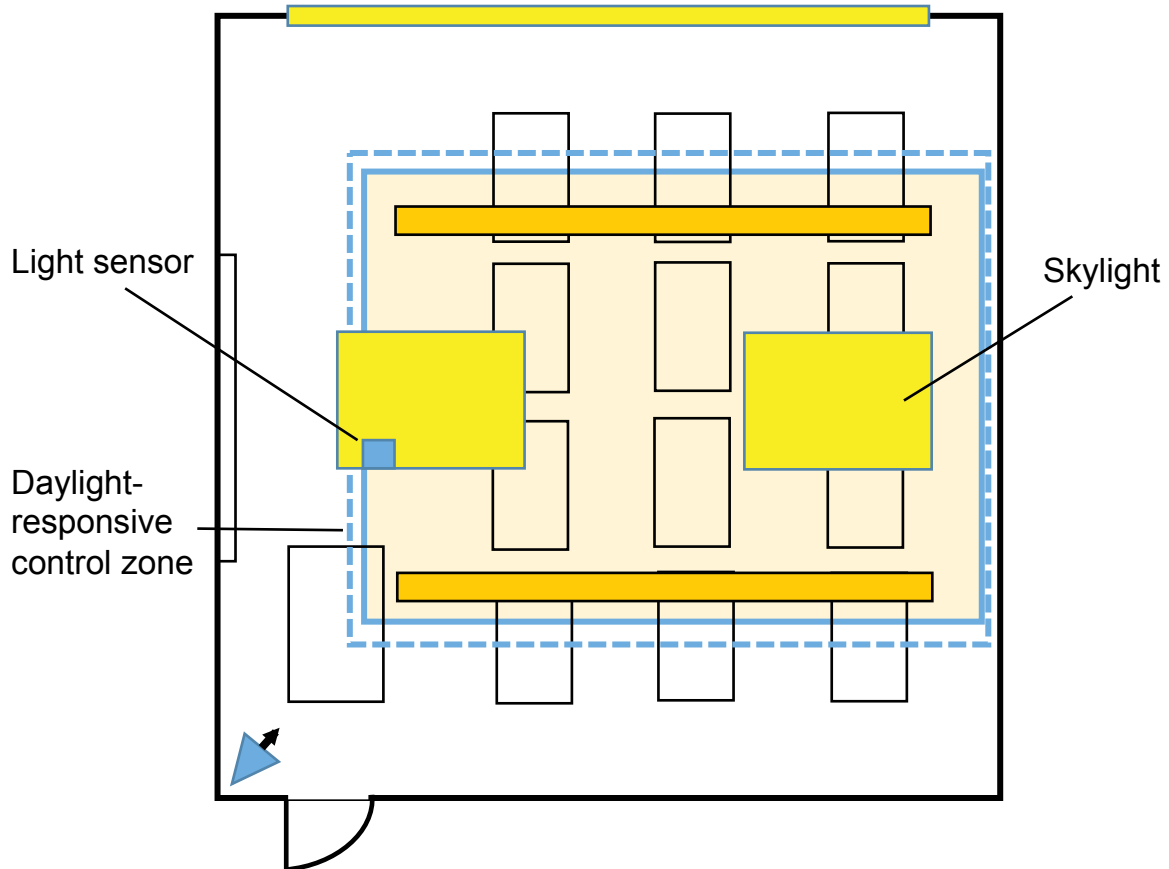
Suggested placement:

- A single light sensor mounted in a skylight well, aimed outside
- A sensor should not receive direct sunlight

Suggested sensor type: Open-loop, with appropriate range of light level response

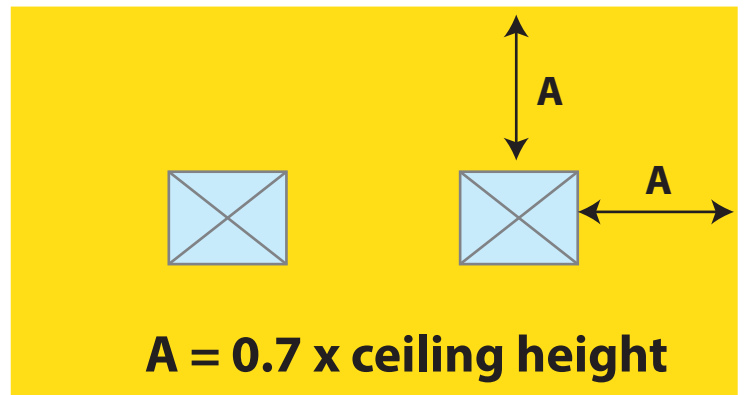
Other: Light sensor takes precedence for upper light level limit over manual dimming

Automatic Daylight-Responsive Control (Toplighting)



$A = \text{ceiling height}$

IECC 2012



$A = 0.7 \times \text{ceiling height}$

ASHRAE/IES 90.1-2010

Daylight zones as required by major energy standards. WH = window height.

Manual Control

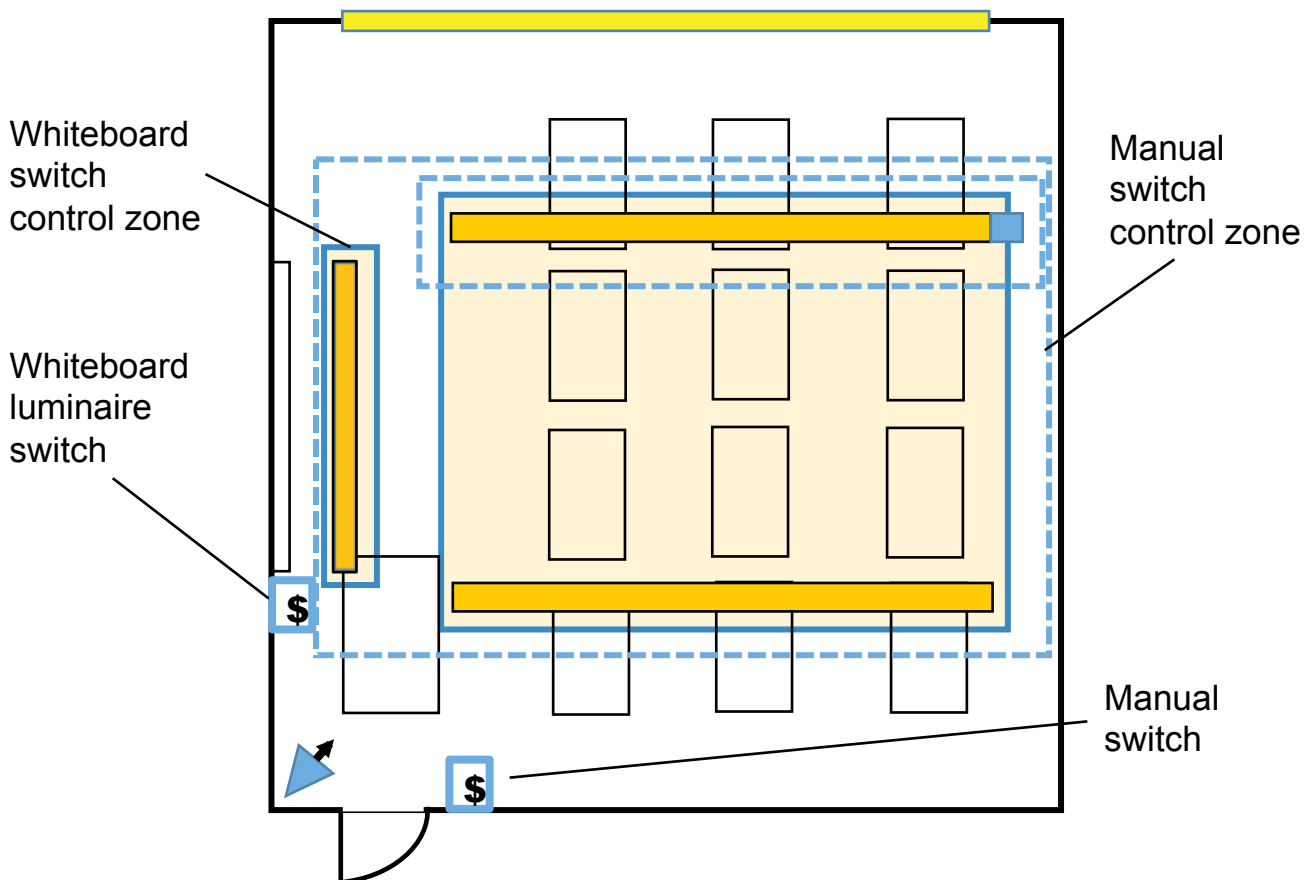
Control need: Manually control lights for visual needs and to override automatic operation

Operation: ON/OFF switching (whiteboard luminaire) and bi-level switching, stepped dimming or continuous dimming (general lighting)

Sequence of operations:

- Occupant enters the room and, using a wall switch by the door:
 - 1) leaves lights at stepped level or turns lights ON to full output if occupancy sensor set to auto-ON-to- $\leq 50\%$ operation, or
 - 2) turns lights ON to stepped level or full output if manual-ON sensor

- During instruction, using a teacher wall control station adjacent to the main teaching board, teacher can select:
 - 1) turn the whiteboard luminaire ON/OFF, if present
 - 2) select General or AV mode for the general lighting or otherwise dim the lights for AV presentation, and
 - 3) override the time delay of the occupancy sensor for up to 3 hours during written examinations



Get Control of Your Classroom Lighting

Reducing energy costs and complying with energy codes is only part of the equation for good lighting control for K-12 classrooms. The lighting system should also be flexible so as to support the array of visual needs in today's dynamic learning environment. With the right lighting control solution, the modern classroom can support learning 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:

www.LightingControlsAssociation.org



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