Code Compliance
Commercial Application Guide

ASHRAE 90.1-2010
IECC 2012
Title 24-2013

LUTRON®

save energy with Lutron™ ®

Summary of code requirements for lighting control

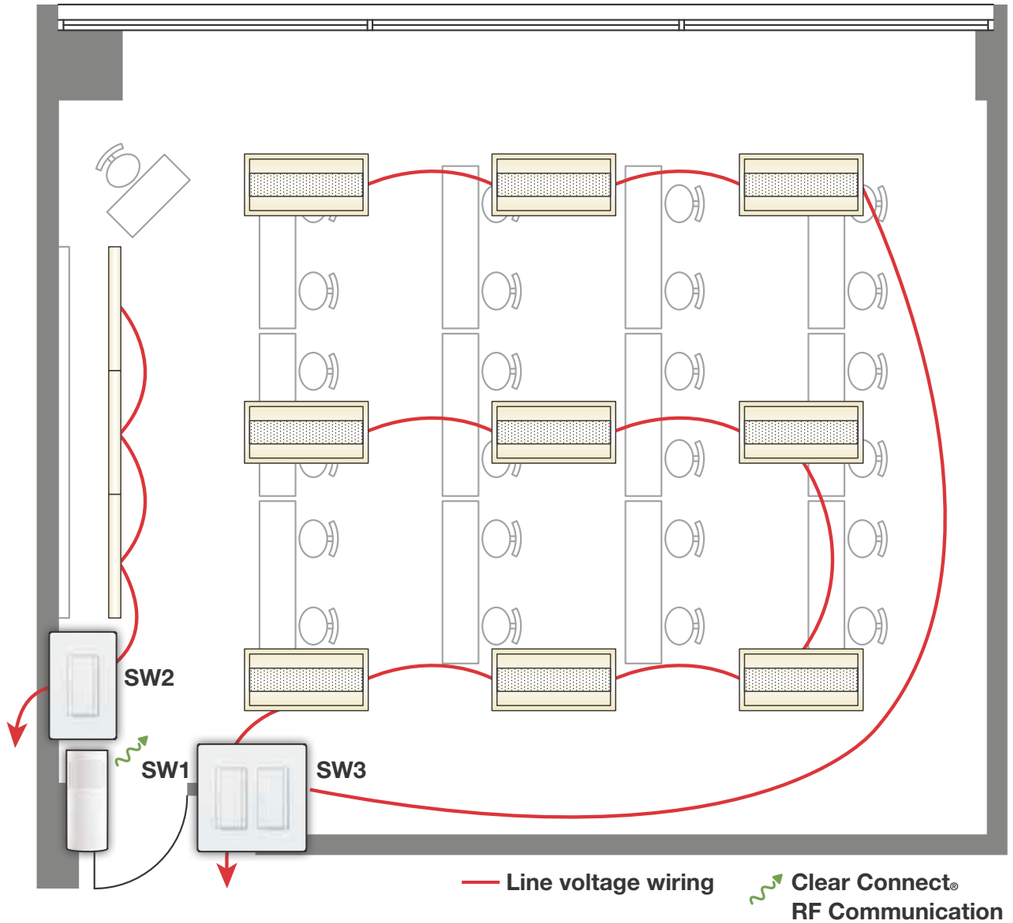
In the following pages, we've provided examples of how Lutron solutions save energy and help meet energy codes in commercial spaces such as classrooms, offices, restrooms, and more. The table below describes new construction and retrofit (lighting alterations[1]) code requirements for ASHRAE 90.1-2010, IECC 2012, and Title 24-2013[2].

For specific commercial building code lighting requirements in your state, please visit www.lutron.com/energycodes.

Code Provision (ASHRAE 90.1-2010; IECC 2012; T24-2013)	Description	Key exceptions or notes	Applications where needed							
			Classroom, Lecture Hall, Training Room	Conference, Meeting, Multi-purpose Room	Office (enclosed <250 ft²)	Office (open)	Corridor	Restroom	Stairwell	Storage Room
Area Control [9.4.1.2; C405.2.1.1; 130.1(a)]	Each space must have an accessible, manual control device (switch or dimmer) to control the general lighting.	• **ASHRAE 90.1:** Occupancy sensors comply. • **IECC:** Corridors and stairwells are exempt.	●	●	●	●	●	●	●	●
Automatic Lighting Shutoff [9.4.1.1; N/A; 130.1(c)]	All indoor lighting must have an automatic shut-off control, such as an occupancy sensor or time switch (i.e. timeclock).		●	●	●	●	●	●		●
Daylight Control [9.4.1.4; C405.2.2.3.1; 130.1(d)]	Daylight control is required for general lighting in daylight zones; some codes require this to be automatic and multi-level.	• **ASHRAE 90.1:** Only required in new construction. Requires automatic multi-level control. • **IECC:** Requires automatic multi-level control for skylighted zones and when the window-to-wall ratio is greater than 30%. Otherwise, a separate daylight zone with manual on/off complies. • **Title 24:** Requires automatic multi-level control.	●	●	●	●	●	●	●	●
Functional Testing [9.4.4; C408.3; 130.4(a)]	Lighting controls must be tested to ensure that they are working properly.	• **ASHRAE 90.1:** Only required in new construction.	●	●	●	●	●	●	●	●
Manual ON or Partial ON [9.4.1; N/A; N/A]	Automatic controls (e.g. occupancy sensors) must be manual-ON or auto-ON to not more than 50% lighting power.	• **Title 24:** Not required.	●	●	●	●				●
Multi-level Lighting Control [9.4.1.2a; C405.2.1.2; 130.1(b)]	Most spaces must allow the occupants to select a lighting level that is between 30% and 70% of full power (at least 50% or lower for IECC) in addition to OFF. This requirement does not apply to spaces with a lighting power density less than 0.5 W/sq. ft. or smaller than 100 sq. ft.	• **ASHRAE 90.1:** Only required in new construction. Not required in corridors, restrooms, or storage rooms. • **IECC:** Spaces with occupancy sensing are exempt. Not required in corridors, restrooms, or storage rooms. - A uniform level of illumination must be maintained. - Continuous dimming complies.	●	●	●	●	●	●	●	●
Occupancy Sensor Control [9.4.1.2b; C405.2.2.2; 130.1(c)5]	Occupancy sensors that turn off lighting within 30 minutes of vacancy are required in certain spaces.	• **ASHRAE 90.1:** Must be manual ON or partial ON. • **IECC:** Must be manual ON or partial ON.	●	●	●			●		●
Partial OFF Control [9.4.1.6g; N/A; 130.1(c)6C]	Lighting power must be automatically reduced by at least 50% within 30 minutes of vacancy.	• **ASHRAE 90.1:** Only required in new construction. • **ASHRAE 90.1:** Not required in corridors. • **IECC:** Not required.					●		●	

Disclaimer: This table is a summary only; other exceptions or details may apply. Jurisdictions may have requirements that differ from these standards.
See page 32 for notes/references.

Classroom: Switching



Symbol	Model Number	Description	Qty	List Price/Unit
	MRF2-1S8A-1VK	Simple Retrofit Corner Vacancy Sensing Package	1	$198.00
	MRF2-8S-DV-WH	Maestro Wireless® Switch	2	$150.00
			Total Price	**$498.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010 Lighting Alterations[3]
- IECC 2012

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Manual
- Manual ON or Partial ON
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are switching only

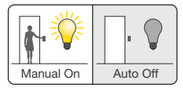
Occupancy

- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

Manual Wall Light Control

- SW1 provides ON/OFF control for the interior general lighting
- SW2 provides ON/OFF control for the whiteboard lighting
- SW3 provides ON/OFF control for the daylight row near the windows

Lighting Control Strategies



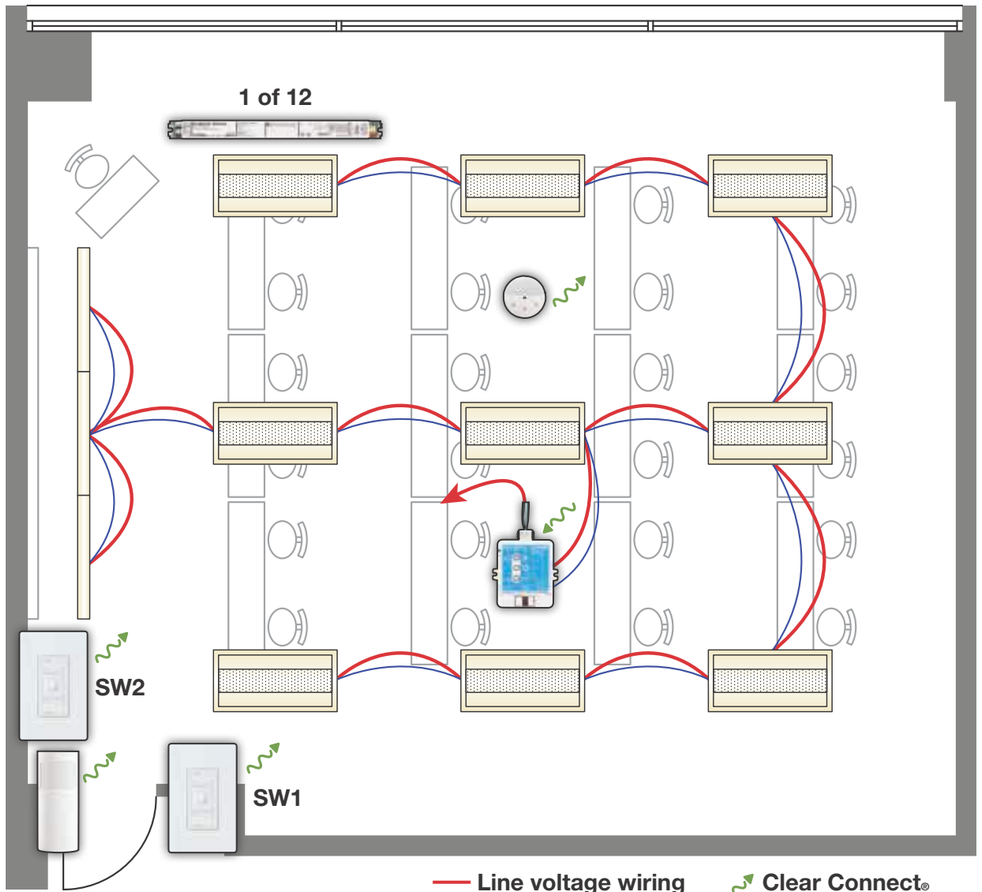
Occupancy/Vacancy Sensing

Total Savings

45%[4]

See page 32 for notes/references.

Classroom: Dimming



Symbol	Model Number	Description	Qty	List Price/Unit
	EHDT832MU210	EcoSystem® H-Series Ballast	12	$79.00
	RMJ-ECO32-DV-B	PowPak® EcoSystem Dimming Module	1	$170.00
	LRF2-VKLB-P-WH	Radio Powr Savr™ Wireless Corner Vacancy Sensor	1	$85.00
	LRF2-DCRB-WH	Radio Powr Savr Wireless Daylight Sensor	1	$120.00
	PJ-3BRL-GWH-I01	Pico® Wireless Control	2	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	2	$8.00
			Total Price	**$1,389.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Automatic
- Manual ON or Partial ON
- Multi-level Lighting Control
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are dimmable
- The maximum light level has been set to 80%

Occupancy

- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

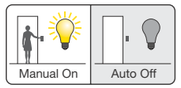
Daylight

- The general lighting is controlled by the daylight sensor and automatically brightens and dims to maintain the required light level in the space
- The daylight sensor can be manually overridden by wall switch SW1

Wall Light Switch

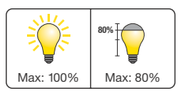
- SW1 is programmed to control all of the general lighting and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level
- SW2 is programmed to control the whiteboard lighting and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level

Lighting Control Strategies



Occupancy/Vacancy Sensing

Personal Dimming



High-End Trim/Tuning

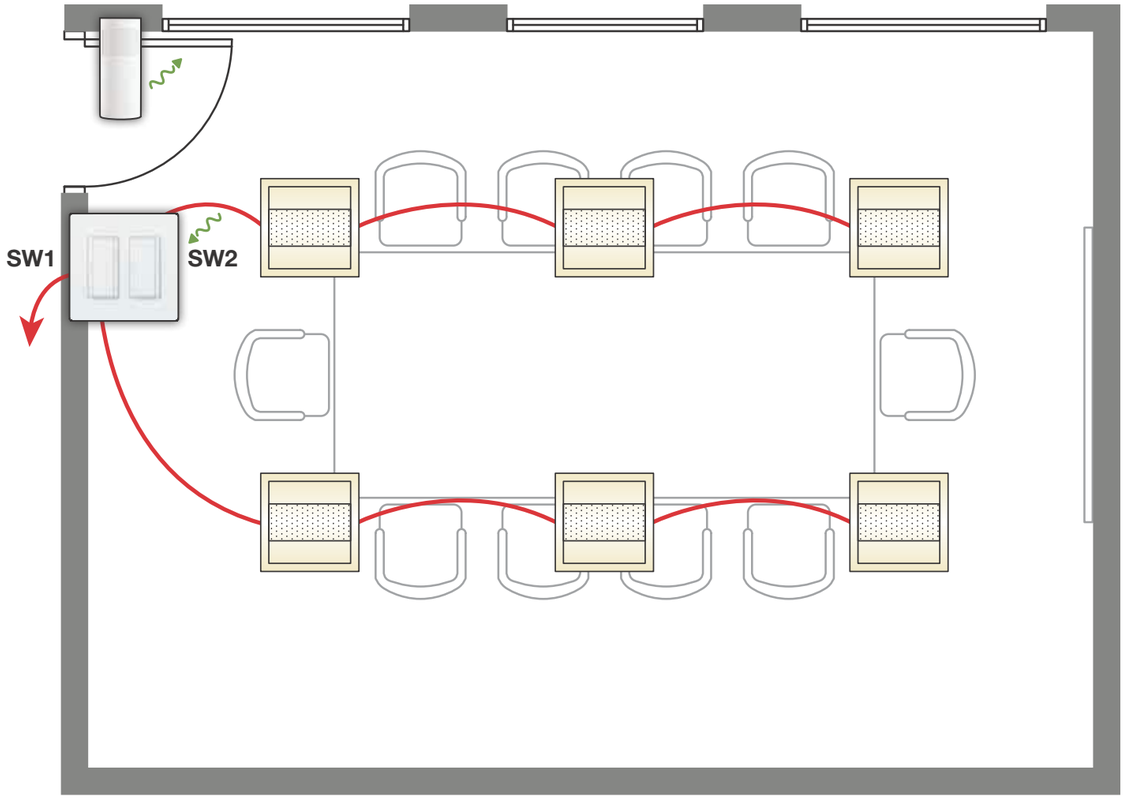
Daylight Harvesting

Total Savings

65%[4]

See page 32 for notes/references.

Conference Room: Switching



— **Line voltage wiring**

Clear Connect® RF Communication

Symbol	Model Number	Description	Qty	List Price/Unit
	LRF2-VKLB-P-WH	Radio Powr Savr™ Wireless Corner Vacancy Sensor	1	$85.00
	MRF2-8S-DV-WH	Maestro Wireless® Switch	2	$150.00
			Total Price	**$385.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010 Lighting Alterations[3]
- IECC 2012

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Manual
- Manual ON or Partial ON
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are switching only

Occupancy

- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

Manual Wall Light Control

- SW1 provides ON/OFF control for the daylight row near the windows
- SW2 provides ON/OFF control for the interior general lighting

Lighting Control Strategies

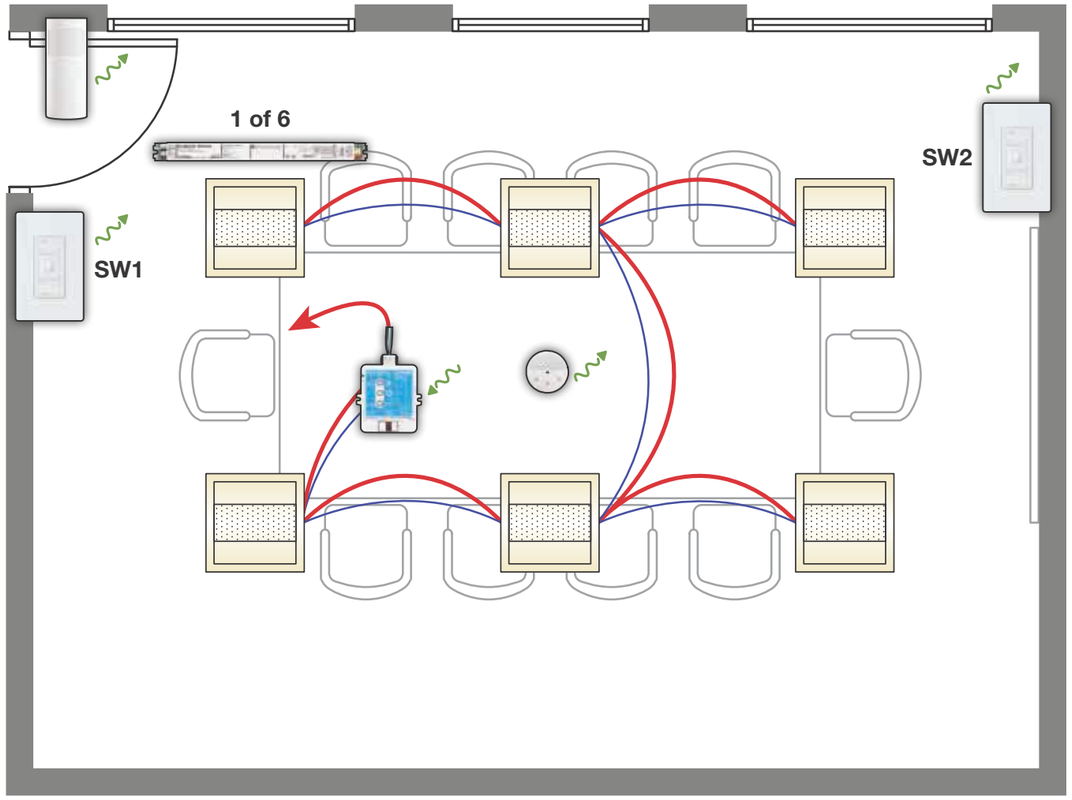
Occupancy/Vacancy Sensing

Total Savings

40%[4]

See page 32 for notes/references.

Conference Room: Dimming



Line voltage wiring
Low voltage wiring
Clear Connect® RF Communication

Symbol	Model Number	Description	Qty	List Price/Unit
	EHDT832MU210	EcoSystem® H-Series Ballast	6	$79.00
	RMJ-ECO32-DV-B	PowPak® EcoSystem Dimming Module	1	$170.00
	LRF2-VKLB-P-WH	Radio Powr Savr™ Wireless Corner Vacancy Sensor	1	$85.00
	LRF2-DCRB-WH	Radio Powr Savr Wireless Daylight Sensor	1	$120.00
	PJ-3BRL-GWH-I01	Pico® Wireless Control	2	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	2	$8.00
			Total Price	**$915.00**

Codes and Controls

Code (lighting control) Compliance:
- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:
- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Automatic
- Manual ON or Partial ON
- Multi-level Lighting Control
- Occupancy Sensor Control

Sequence of Operations

Lights
- All lights are dimmable
- The maximum light level has been set to 80%

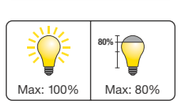
Occupancy
- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

Daylight
- All of the lights are controlled by the daylight sensor and automatically brighten and dim to maintain the required light level in the space
- The daylight sensor can be manually overridden by wall switches SW1 and SW2

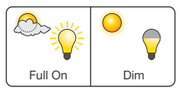
Wall Light Switch
- SW1 is programmed to control the four lights closest to the door and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level
- SW2 is programmed to control the whiteboard lighting and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level

See page 32 for notes/references.

Lighting Control Strategies



Occupancy/Vacancy Sensing



Personal Dimming

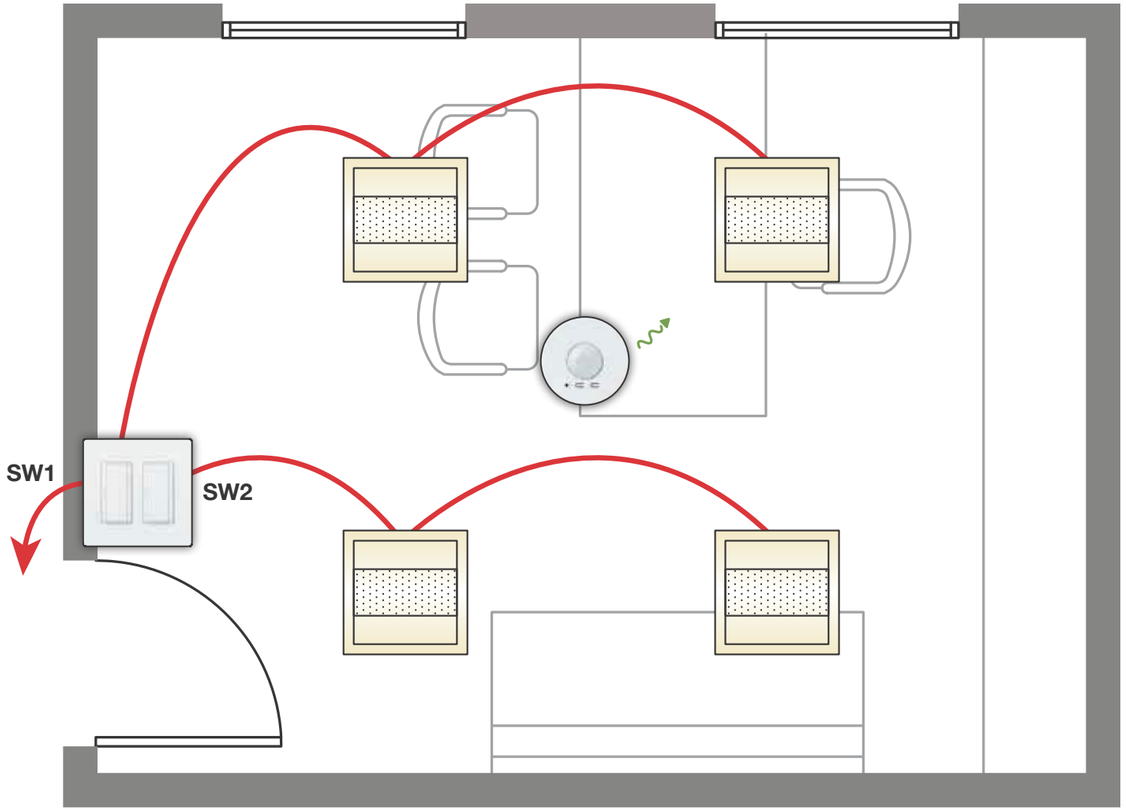
High-End Trim/Tuning

Daylight Harvesting

Total Savings

65%[4]

Private Office: Switching



— Line voltage wiring

Clear Connect® RF Communication

Symbol	Model Number	Description	Qty	List Price/Unit
	MRF2-1S8A-1VC	Simple Retrofit Ceiling Vacancy Sensing Package	1	$198.00
	MRF2-8S-DV-WH	Maestro Wireless® Switch	1	$150.00
			Total Price	**$348.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010 Lighting Alterations[3]
- IECC 2012

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Manual
- Manual ON or Partial ON
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are switching only

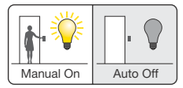
Occupancy

- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

Wall Light Switch

- SW1 provides ON/OFF control for the daylight row near the windows
- SW2 provides ON/OFF control for the interior general lighting

Lighting Control Strategies



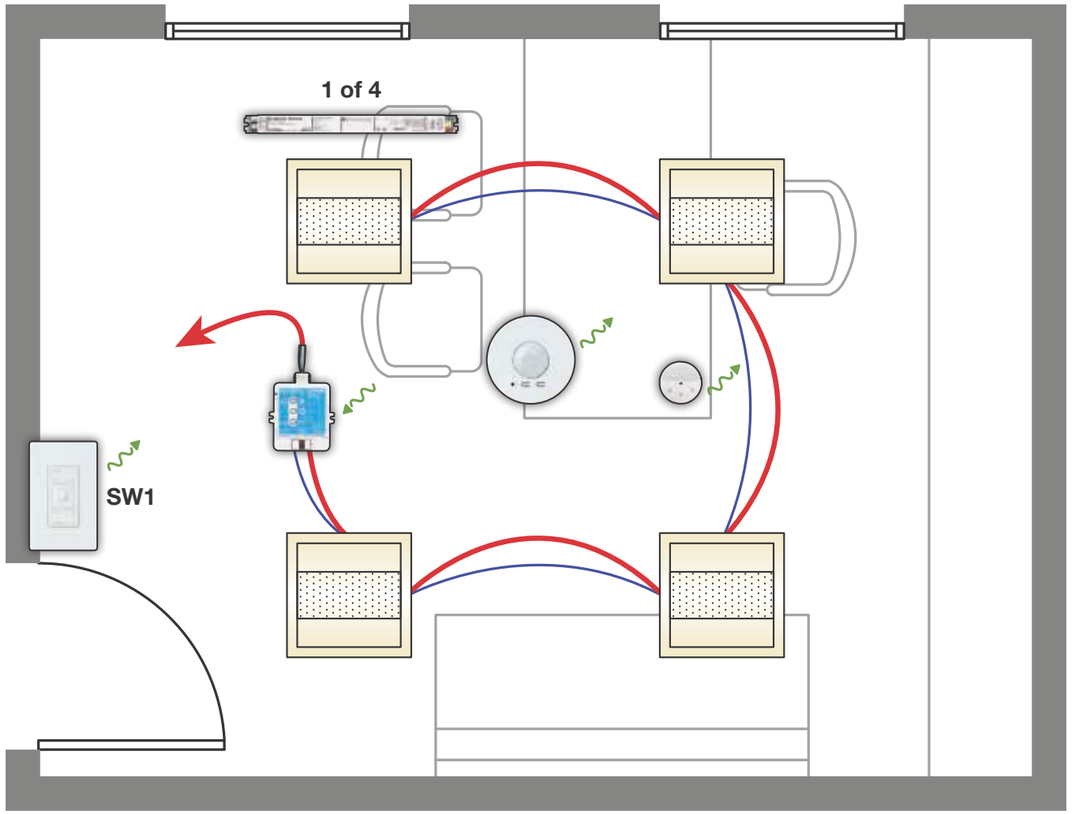
Occupancy/Vacancy Sensing

Total Savings

30%[4]

See page 32 for notes/references.

Private Office: Dimming



Line voltage wiring
Low voltage wiring
Clear Connect® RF Communication

Symbol	Model Number	Description	Qty	List Price/Unit
	EHDT832MU210	EcoSystem® H-Series Ballast	4	$79.00
	RMJ-ECO32-DV-B	PowPak® EcoSystem Dimming Module	1	$170.00
	LRF2-VCR2B-P-WH	Radio Powr Savr™ Wireless Ceiling Vacancy Sensor	1	$85.00
	LRF2-DCRB-WH	Radio Powr Savr Wireless Daylight Sensor	1	$120.00
	PJ-3BRL-GWH-I01	Pico® Wireless Control	1	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	1	$8.00
			Total Price	**$724.00**

Codes and Controls

Code (lighting control) Compliance:
- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:
- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Automatic
- Manual ON or Partial ON
- Multi-level Lighting Control
- Occupancy Sensor Control

Sequence of Operations

Lights
- All lights are dimmable
- The maximum light level has been set to 80%

Occupancy
- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

Daylight
- All of the lights are controlled by the daylight sensor and automatically brighten and dim to maintain the required light level in the space
- The daylight sensor can be manually overridden by wall switch SW1

Wall Light Switch
- SW1 is programmed to all of the lights and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level

Lighting Control Strategies

Occupancy/Vacancy Sensing

Personal Dimming

High-End Trim/Tuning

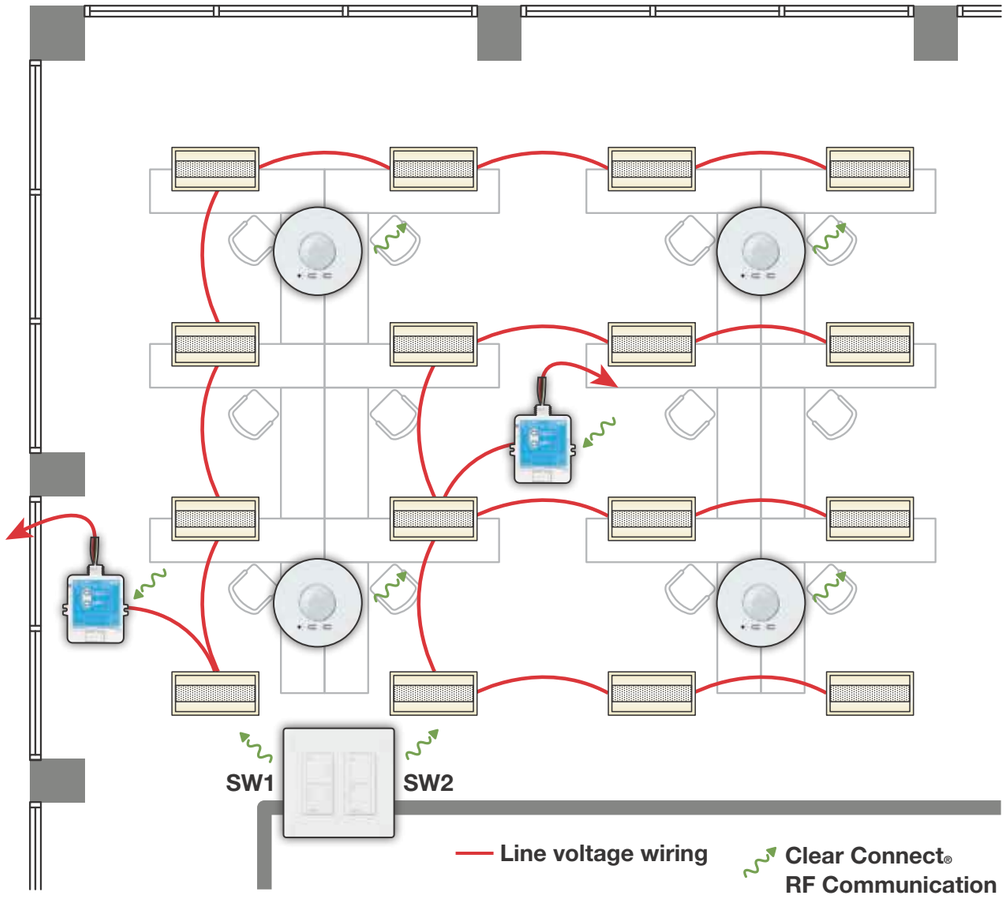
Daylight Harvesting

Total Savings

60%[4]

See page 32 for notes/references.

Open Office: Switching



Symbol	Model Number	Description	Qty	List Price/Unit
	RMJ-16R-DV-B	PowPak® Relay Module (16A)	2	$109.00
	LRF2-VCR2B-P-WH	Radio Powr Savr™ Wireless Ceiling Vacancy Sensor	4	$85.00
	PJ-2B-GWH-I01	Pico® Wireless Control	2	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	2	$8.00
			Total Price	**$644.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010 Lighting Alterations[3]
- IECC 2012

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Manual
- Manual ON or Partial ON
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are switching only

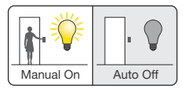
Occupancy

- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

Wall Light Switch

- SW1 provides ON/OFF control for the daylight rows near the window
- SW2 provides ON/OFF control for the interior general lighting

Lighting Control Strategies



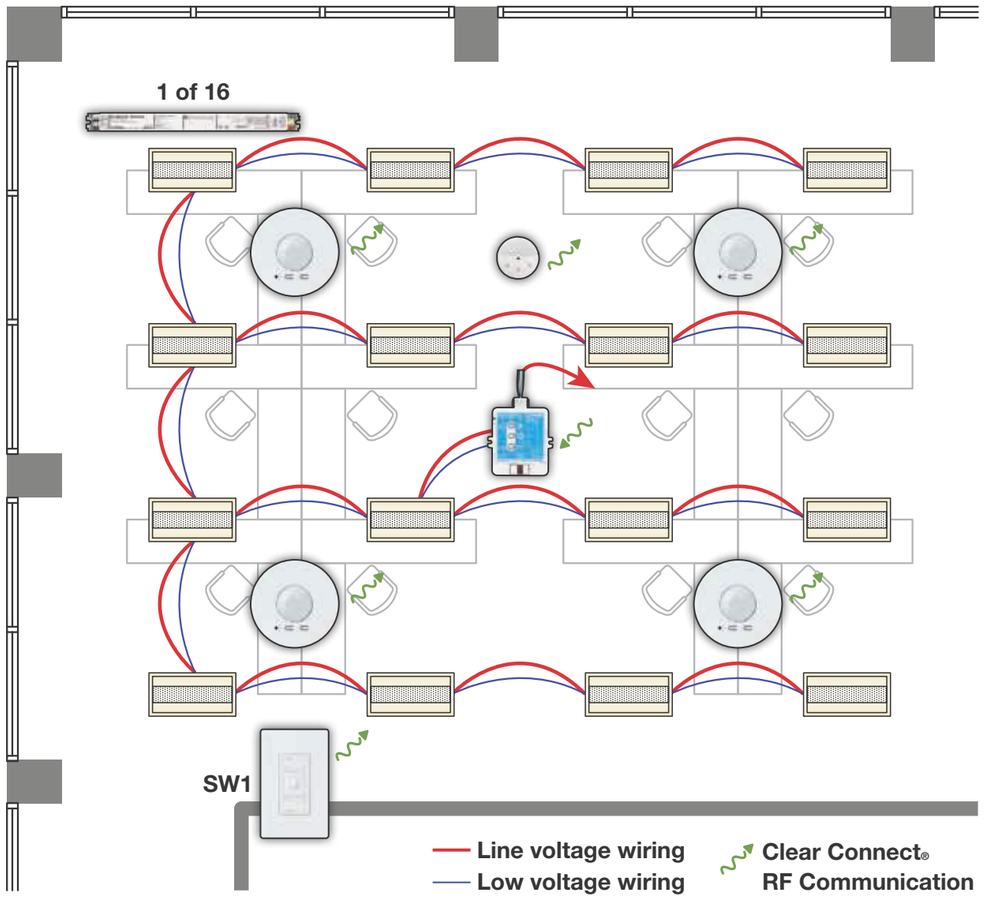
Occupancy/Vacancy Sensing

Total Savings

35%[4]

See page 32 for notes/references.

Open Office: Dimming



Symbol	Model Number	Description	Qty	List Price/Unit
	EHDT832MU210	EcoSystem® H-Series Ballast	16	$79.00
	RMJ-ECO32-DV-B	PowPak® EcoSystem Dimming Module	1	$170.00
	LRF2-VCR2B-P-WH	Radio Powr Savr™ Wireless Ceiling Vacancy Sensor	4	$85.00
	LRF2-DCRB-WH	Radio Powr Savr Wireless Daylight Sensor	1	$120.00
	PJ-3BRL-GWH-I01	Pico® Wireless Control	1	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	1	$8.00
			Total Price	**$1,927.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Daylight Control—Automatic
- Manual ON or Partial ON
- Multi-level Lighting Control
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are dimmable
- The maximum light level has been set to 80%

Occupancy

- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

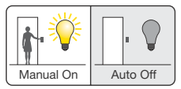
Daylight

- The two perimeter rows of lights are controlled by the daylight sensor and automatically brighten and dim to maintain the required light level in the space
- The daylight sensor can be manually overridden by wall switch SW1

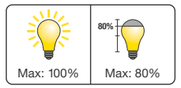
Wall Light Switch

- SW1 is programmed to all of the lights and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level

Lighting Control Strategies



Occupancy/Vacancy Sensing



High-End Trim/Tuning

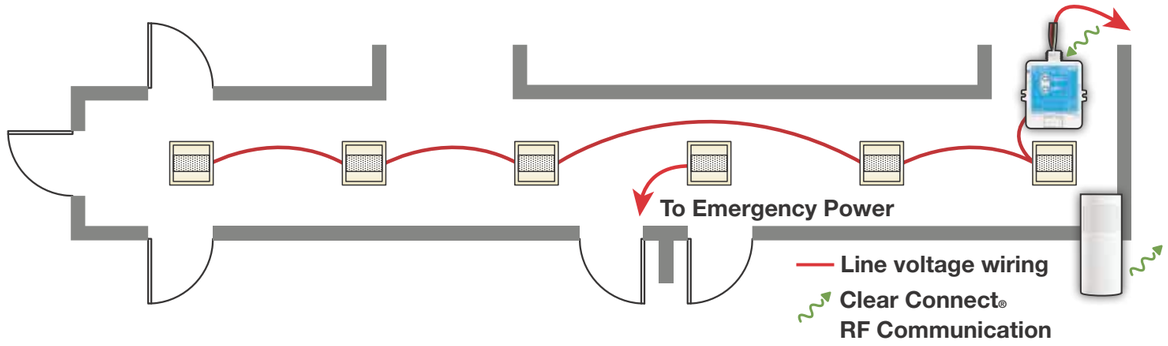
Daylight Harvesting

Total Savings

60%[4]

See page 32 for notes/references.

Corridor/Hallway: Switching



Symbol	Model Number	Description	Qty	List Price/Unit
	RMJ-5R-DV-B	PowPak® Relay Module (5A)	1	$89.00
	LRF2-OHLB-P-WH	Radio Powr Savr™ Wireless Hallway Occupancy Sensor	1	$85.00
			Total Price	**$174.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010
- IECC 2012

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Occupancy Sensor Control

Sequence of Operations

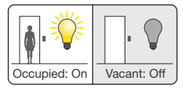
Lights

- The emergency light is not controlled
- All controlled lights are switching only

Occupancy

- Lights automatically turn on when an occupant enters the space
- Lights automatically turn off 15 minutes after all occupants leave the space

Lighting Control Strategies



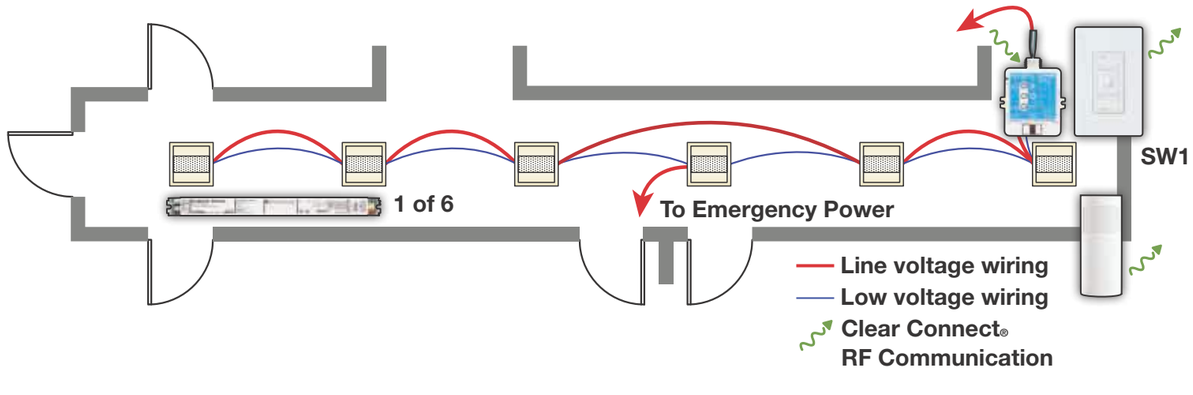
Occupancy/Vacancy Sensing

Total Savings

50%[4]

See page 32 for notes/references.

Corridor/Hallway: Dimming



Symbol	Model Number	Description	Qty	List Price/Unit
	EHDT832MU210	EcoSystem® H-Series Ballast	6	$79.00
	RMJ-ECO32-DV-B	PowPak® EcoSystem Dimming Module	1	$170.00
	LRF2-OHLB-P-WH	Radio Powr Savr™ Wireless Hallway Occupancy Sensor	1	$85.00
	PJ-3BRL-GWH-I01	Pico® Wireless Control	1	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	1	$8.00
			Total Price	**$762.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Multi-level Lighting Control
- Occupancy Sensor Control
- Partial OFF

Sequence of Operations

Lights

- All lights are dimmable
- The maximum light level has been set to 80%

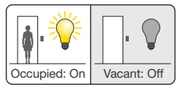
Occupancy

- Lights automatically turn on to 80% when an occupant enters the space
- Lights automatically turn off 15 minutes after all occupants leave the space
- Instead of turning off, lights can be programmed to dim to a low light level if desired

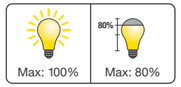
Wall Light Switch

- SW1 is programmed to all of the lights and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level

Lighting Control Strategies



Occupancy/Vacancy Sensing



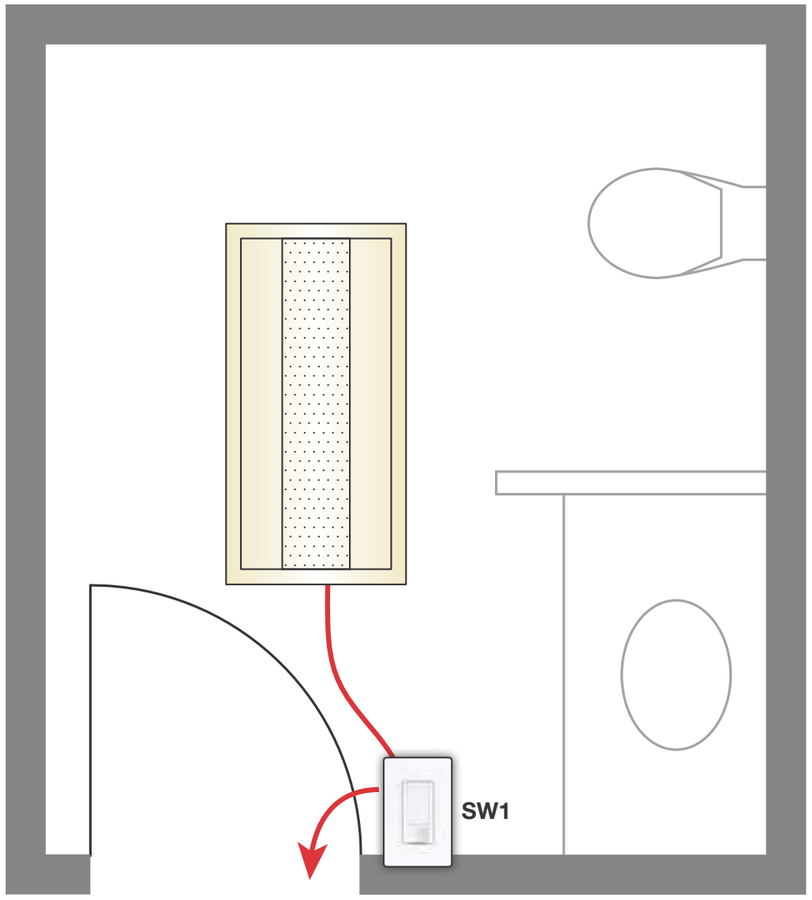
High-End Trim/Tuning

Total Savings

60%[4]

See page 32 for notes/references.

Restroom: Single Stall



Line voltage wiring

Symbol	Model Number	Description	Qty	List Price/Unit
	MS-OPS6M2-DV-WH	Maestro® Occupancy Sensing Switch	1	$49.00
			Total Price	**$49.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are switching only

Occupancy

- Lights automatically turn on when an occupant enters the space
- Lights automatically turn off 15 minutes after all occupants leave the space

Wall Light Switch

- SW1 provides ON/OFF control for all the lights in the space

Lighting Control Strategies

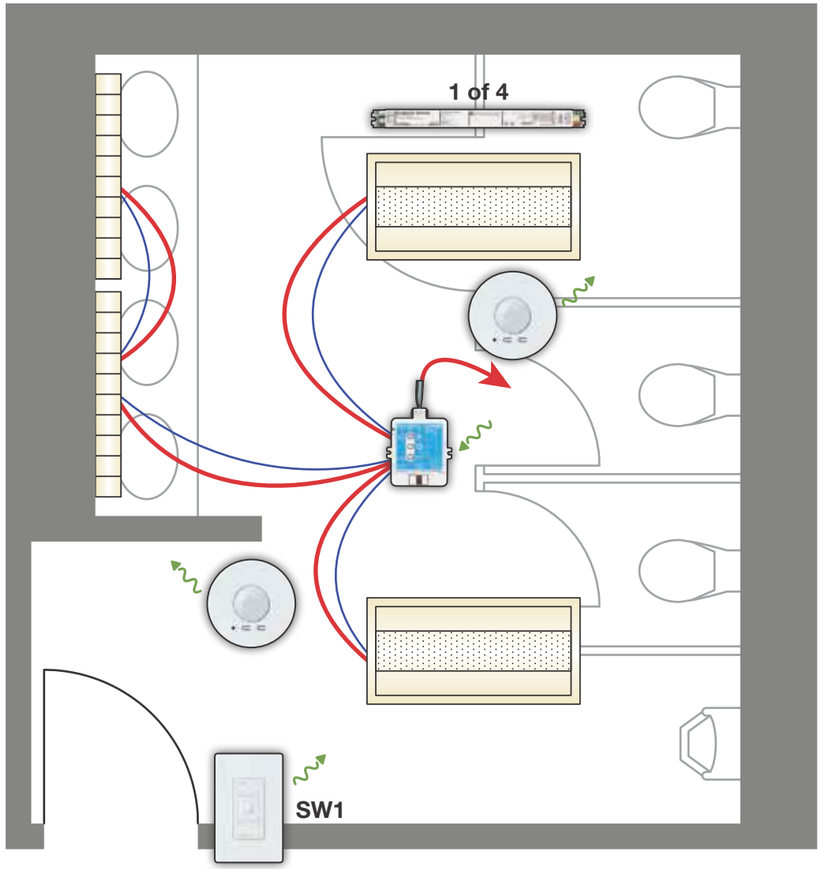
Occupancy/Vacancy Sensing

Total Savings

50%[4]

See page 32 for notes/references.

Restroom: Multiple Stalls



Line voltage wiring **Low voltage wiring** **Clear Connect® RF Communication**

Symbol	Model Number	Description	Qty	List Price/Unit
	EHDT832MU210	EcoSystem® H-Series Ballast	4	$79.00
	RMJ-ECO32-DV-B	PowPak® EcoSystem Dimming Module	1	$170.00
	LRF2-OCR2B-P-WH	Radio Powr Savr™ Wireless Ceiling Occupancy Sensor	2	$85.00
	PJ-3BRL-GWH-I01	Pico® Wireless Control	1	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	1	$8.00
			Total Price	**$689.00**

Codes and Controls

Code (lighting control) Compliance:
- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:
- Area Control
- Automatic Lighting Shutoff
- Multi-level Lighting Control
- Occupancy Sensor Control

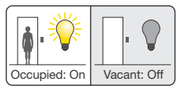
Sequence of Operations

Lights
- All lights are dimmable
- The maximum light level has been set to 80%

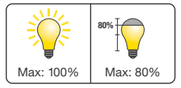
Occupancy
- Lights automatically turn on to 80% when an occupant enters the space
- Lights automatically turn off 15 minutes after all occupants leave the space
- Instead of turning off, lights can be programmed to dim to a low light level if desired

Wall Light Switch
- SW1 is programmed to all of the lights and provides ON/OFF control, BRIGHTEN/DIM control, and allows for one preset light level

Lighting Control Strategies



Occupancy/Vacancy Sensing



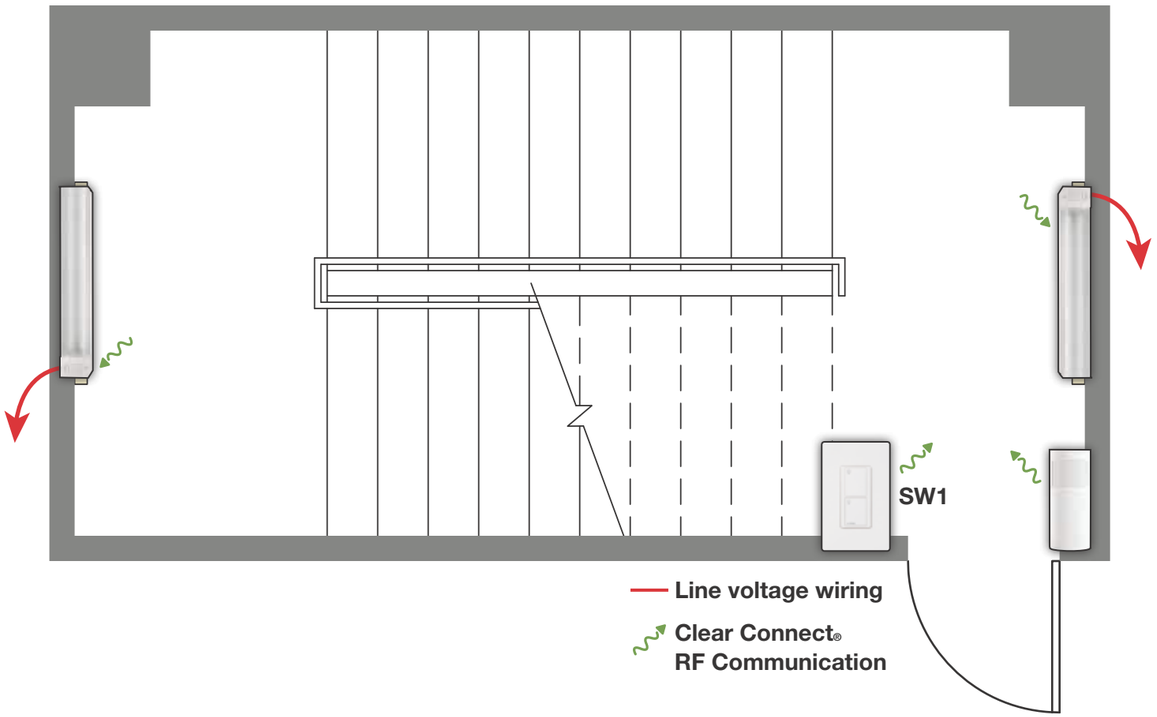
High-End Trim/Tuning

Total Savings

60%[4]

See page 32 for notes/references.

Stairwell



Symbol	Model Number	Description	Qty	List Price/Unit
	FX-SW-XX-14-2-28-U-82-SM-XX-WH	Lutron 4' Two-Lamp T8 Fluorescent Stairwell Fixture	2	$390.00
	LRF2-OKLB-P-WH	Radio Powr Savr™ Wireless Corner Occupancy Sensor	1	$85.00
	PJ-2B-GWH-I01	Pico® Wireless Control	1	$25.00
	PICO-FP-ADAPT	Pico Faceplate Adapter	1	$8.00
			Total Price	**$898.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:

- Area Control
- Occupancy Sensor Control
- Partial OFF

Sequence of Operations

Lights

- All lights are dimmable
- The maximum light level has been set to 80%

Occupancy

- Lights automatically turn on to 80% when an occupant enters the space
- Lights automatically dim to 20% 15 minutes after all occupants leave the space

Wall Light Switch

- SW1 is programmed to all of the lights and provides ON/OFF control

Lighting Control Strategies

Occupancy/Vacancy Sensing

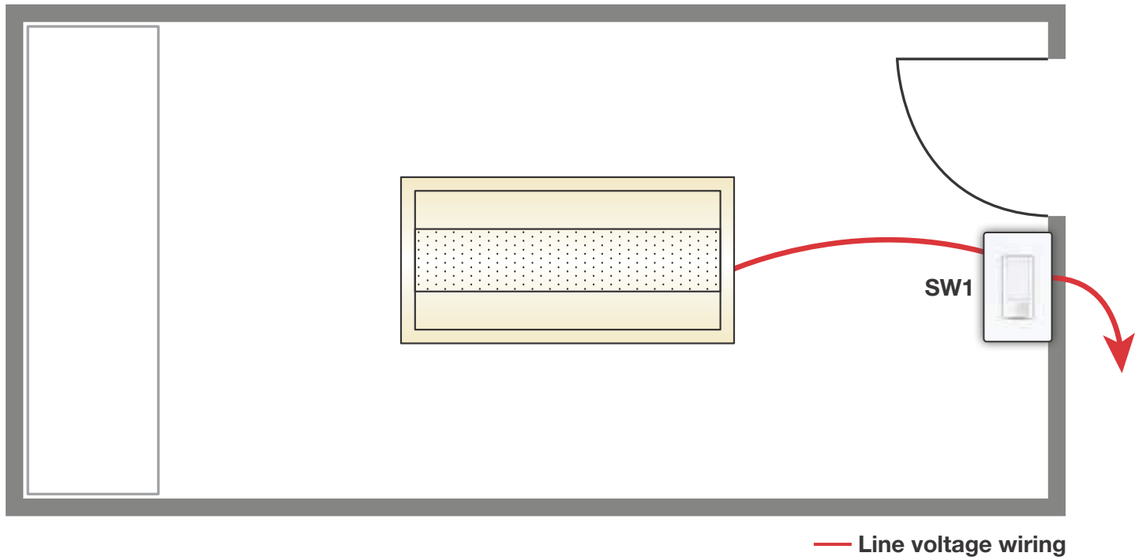
High-End Trim/Tuning

Total Savings

70%[4]

See page 32 for notes/references.

Storage Room



Symbol	Model Number	Description	Qty	List Price/Unit
	MS-VPS6M2-DV-WH	Maestro® Vacancy Sensing Switch	1	$49.00
		Total Price		**$49.00**

Codes and Controls

Code (lighting control) Compliance:

- ASHRAE 90.1-2010
- IECC 2012
- Title 24-2013[2]

Meets Lighting Control Requirements:

- Area Control
- Automatic Lighting Shutoff
- Manual ON or Partial ON
- Occupancy Sensor Control

Sequence of Operations

Lights

- All lights are switching only

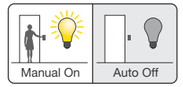
Occupancy

- Lights do not automatically turn on when an occupant enters the space; lights must be turned on manually
- Lights automatically turn off 15 minutes after all occupants leave the space

Wall Light Switch

- SW1 provides ON/OFF control for all of the lights in the space

Lighting Control Strategies



Occupancy/Vacancy Sensing

Total Savings

30%[4]

See page 32 for notes/references.

Notes/References

1. Lighting alterations and control requirements
   - ASHRAE 90.1-2010: Lighting alterations that involve more than 10% of the lighting load in a space must meet the Automatic Lighting Shutoff provision (9.4.1.1). A lighting alteration includes the addition or removal of luminaires, or the replacement of lamps plus ballasts in a space.
   - IECC 2012: Lighting alterations require compliance with all of the lighting control requirements. A lighting alteration is defined as a replacement of 50% or more of the luminaires in a space. The replacement of only the lamps plus ballasts within an existing luminaire is exempt from meeting the control requirements in the space as long as the alteration doesn't increase the lighting power density (W/ft^2).
   - Title 24-2013: Replacement of more than 10% of the luminaires, or modifying 40 or more existing luminaires, requires compliance with all the control requirements for the altered space (daylight control and demand responsive control are not always required; see the Table 141.0E and 141.0F in the Standard for details).

2. Demand response is required in Title 24-2013 for buildings larger than 10,000 sq. ft.

3. Separate daylight zone and switch (manual daylight control) not required in ASHRAE 90.1-2010 for lighting alterations.

4. All savings numbers based on data collected from Lutron projects and the following journal articles:
   - VonNieda B, Maniccia D, & Tweed A. 2000. An analysis of the energy and cost savings potential of occupancy sensors for commercial lighting systems. Proceedings of the Illuminating Engineering Society. Paper #43.
   - Williams A, et al. 2012. Lighting Controls in Commercial Buildings. Leukos. 8(3) pg 161-180.
   - Reinhart CF. 2002. Effects of interior design on the daylight availability in open plan offices. Study of the American Commission for an Energy Efficient Environment (ACE) Conference Proceedings. To achieve maximum lighting savings, automated shades are utilized.
   - Galasiu AD, et al. 2007. Energy saving lighting control systems for open-plan offices: A field study. Leukos. 4(1) pg 7-29.