



# Lighting with Embedded Controls

**Education**

# Embedded Controls

Lighting control solutions are in a continuous state of evolution. In the beginning, room control was typically centralized, which evolved into distributed digital devices, such as power packs and room controllers.

Today, lighting controls are moving to embedded controls within the luminaire. An embedded control is designed by the luminaire manufacturer to have the control device as part of the luminaire. The beauty of an embedded luminaire is that it is manufactured, tested, and shipped with the control already present in the luminaire, eliminating field installation of the control.



## The Changing Preference of Embedded Technology

Several factors have led to the emergence of luminaire embedded controls, and it began with the lighting industry's transition to LED and its advancements. This includes the availability of DC power, in-luminaire digital networks, shrinking component sizes, and the increased controllability of LEDs, all feeding into this transition to embedded controls.

The market has continued to demand luminaire embedded controls due to advanced configurability, complex designs, and increasingly strict energy codes, such as Luminaire Level Lighting Control (LLLC). Embedded controls promote an easier, yet effective design, reduce components and interoperability challenges, simplify installation, and improve user comfort. All of these benefits have led to the transition to embedded controls.

## Benefits

### Lower total installed cost

Luminaires with embedded controls not only feature less devices to install, but lower total project costs with the following benefits:

- Install the luminaire and you've installed the controls
- Wireless embedded luminaires eliminate all control wiring



### Easier lighting control designs

Designing a lighting controls system is easier with an embedded control in a luminaire as it eliminates the need for detailed design layouts with the placement of the occupancy sensors in the space. The sensor is in each luminaire eliminating the need for a design layout.

### Application Flexibility

Every project is unique. A lighting control system with embedded controls provides the flexibility needed to meet virtually any application for indoor and outdoor environments.

The nLight® platform of wired and wireless controls easily scale beyond the indoor environment, pulling outdoor site, area, and parking lighting under a single control platform.

### Application Efficiency

nLight AIR enabled luminaires with embedded sensors have shown a labor savings of over 23% compared to a traditional sensor/power pack installation for the most common applications.

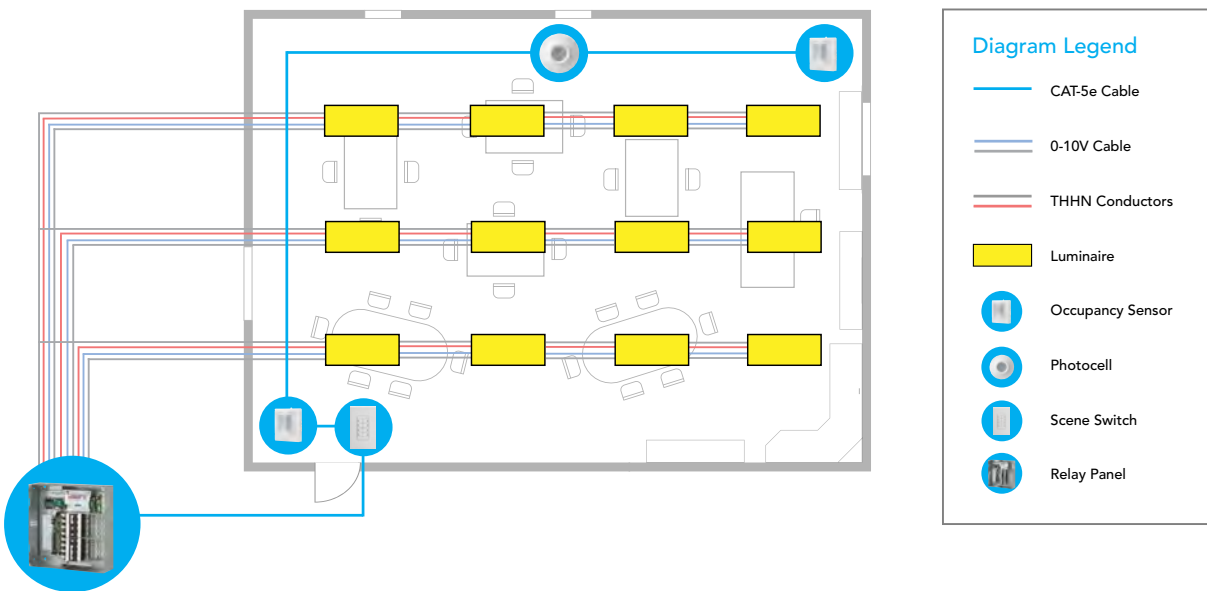
# Classroom Application Example

This is an example of a typical 1,000 - 1,400 square foot classroom with occupancy control, 3 zones of manual dimming control, and daylight harvesting.

## Centralized Lighting Controls

The centralized solution has been a traditional design method that has become more costly and restrictive with the addition of dimming and multiple zones within the space. Distributed and embedded design options now deliver better user experiences while providing energy efficiency and aiding in code compliance.

In the example below, it is necessary to have 0-10V and CAT 5e control wiring, ceiling or wall-mounted sensors, and multiple switch legs from the centralized control panel that increase the project cost and restrict the user experience to zone-based control.



### Sequence of Operations

#### Luminaires

- 0-10V fully dimmable 2x4 lay-in

#### Occupancy

- Manual-On (\*Auto-On up to 50%)
- 20-minute timeout

#### Daylight Harvesting

- Full-range dimming

#### Switching

- Master On-Off & Raise/Lower
- 4-Scene Control

Group	Product	Cost
Luminaires	2BLT4 Series	\$
Relay Panel	ARP Series	\$ \$
Wall Switch	nPODMA 4S DX Series	\$
Occupancy Sensors	nWV PDT 16 Series	\$
Photocell	nCM ADC Series	\$
Wiring	THHN, CAT5, 0-10V	\$ \$ \$
Labor		\$ \$ \$
<b>TOTAL</b>		\$ \$ \$ \$

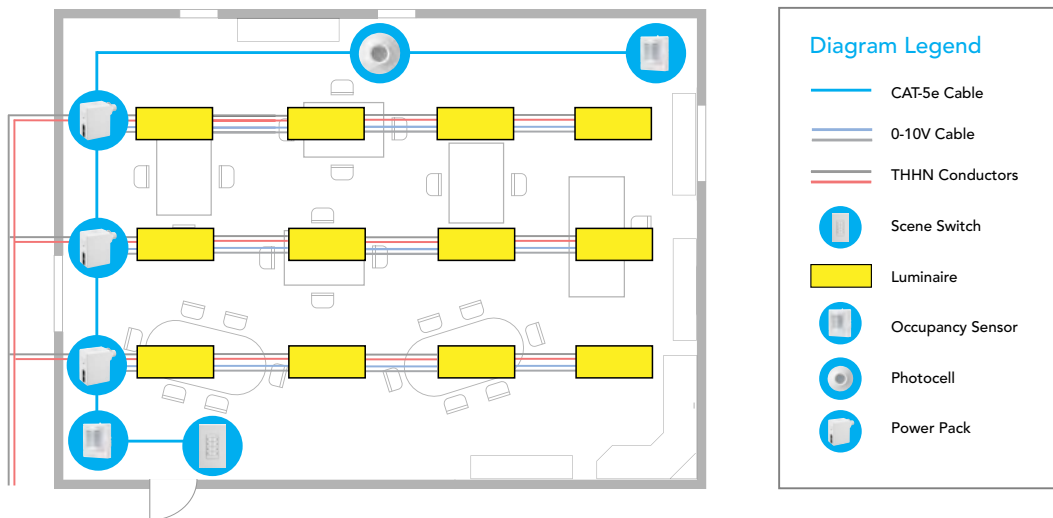
# Classroom Application Example

This is an example of a typical 1,000 - 1,400 square foot classroom with occupancy control, 3 zones of manual dimming control, and daylight harvesting.

## Distributed Lighting Controls

The digital distributed lighting control strategy moves the control points, such as relays or power packs into the space they are controlling. This reduces the wiring complexity and installation cost by keeping switch-legs and low-voltage control wiring (i.e., 0-10V, CAT 5e) to a minimum compared to a centralized control strategy. Distributed control is generally used for zone-based control, where multiple luminaires are controlled together by a single power pack. Each unique control zone will require its own power pack.

In this example, a dedicated power pack controls each row of luminaires. The power pack provides switch-legs and 0-10V dimming wires to the respective row of luminaires. CAT 5e cabling connects each digital lighting control device in a daisy-chain fashion.



- ✔ More Cost-Effective than Centralized Lighting Control
- ✔ More Flexible
- ✔ Reduces Overall Wiring and Total Cost
- ✔ Simplify Installation

### Sequence of Operations

**Luminaires**

- 0-10V fully dimmable 2x4 lay-in

**Occupancy**

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- 20-minute timeout

**Daylight Harvesting**

- Full-range dimming

**Switching**

- Master On-Off & Raise/Lower
- 4-Scene Control

Group	Product	Cost
Luminaires	2BLT4 Series	\$
Power Packs	nPP16 D Series	\$
Wall Switch	nPODMA 4S DX Series	\$
Occupancy Sensors	nWV PDT 16 Series	\$
Photocell	nCM ADC Series	\$
Wiring	THHN, CAT5, 0-10V	\$ \$
Labor		\$ \$ \$
TOTAL		\$ \$ \$

# Classroom Application Example

This is an example of a typical 1,000 - 1,400 square foot classroom with occupancy control, 3 zones of manual dimming control, and daylight harvesting.

## Wired Embedded Lighting Control

An embedded lighting control strategy simplifies the design and installation while reducing the cost compared to centralized and distributed control systems. Intelligent luminaires equipped with onboard occupancy sensors, photocells, and dimming controllers eliminate the need for any other non-manual control devices and control wiring. This strategy aids in meeting Luminaire Level Lighting Control (LLLC) energy code compliance without the need for any external lighting control devices.

This example shows intelligent luminaires with embedded lighting controls eliminating power packs, independent occupancy sensors and photocells, plus all 0-10V dimming wiring and switch-legs. An unswitched circuit connects to each luminaire, and CAT 5e is daisy-chained between the digital switch and each luminaire. This allows any fixture to be controlled in any fashion to meet any Sequence of Operations.

Luminaires equipped with on-board occupancy sensor, photocell & dimmer.



- ✓ More Cost-Effective than Distributed Lighting Control
- ✓ More Flexible
- ✓ Eliminates 0-10V, Switch Legs & Reduces Total Cost
- ✓ Simplify Installation
- ✓ Simple Reconfiguration
- ✓ LLLC Compliant
- ✓ Tunable Control Optional

### Sequence of Operations

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#### Switching

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Group	Product	Cost
Luminaires	2BLT4 Series	\$ \$
Power Packs	N/A	
Wall Switch	nPODMA 4S DX Series	\$
Occupancy Sensors	N/A	
Photocell	N/A	
Wiring	THHN, CAT5	\$ \$
Labor		\$ \$
<b>TOTAL</b>		\$ \$

# Classroom Application Example

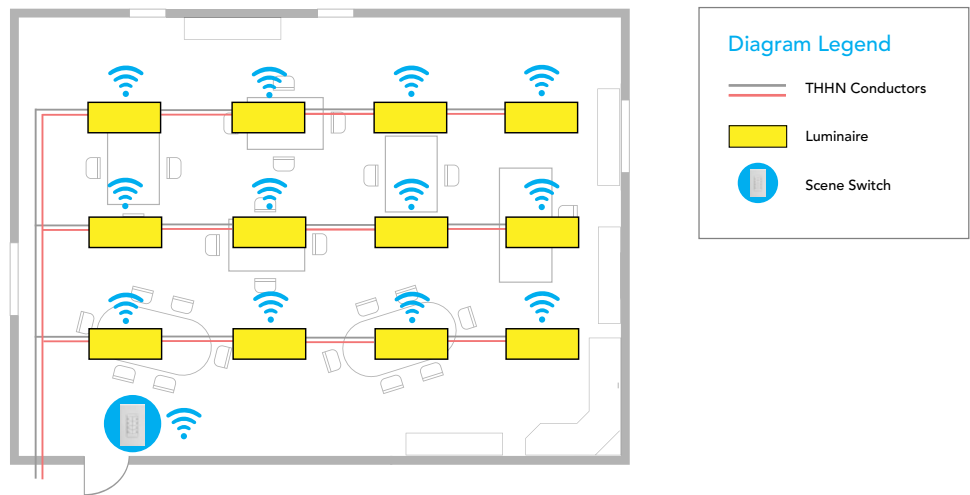
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## Wireless Embedded Lighting Control

Wireless embedded lighting control further simplifies design and installation by eliminating the need for CAT 5e cable. Every intelligent luminaire is equipped with wireless technology that allows for the most flexible, reconfigurable, and cost-effective solution available. This strategy also meets energy code LLLC requirements and is perfect for retrofit or new construction!

This example shows the simplicity of wireless embedded lighting control. Simply connect each fixture to an unswitched circuit, install the switch and configure the room to meet the Sequence of Operations through a mobile application.

Luminaires equipped with on-board wireless radios, occupancy sensor, photocell & dimmer.



- ✔ More Cost-Effective than Distributed Lighting Control
- ✔ More Flexible
- ✔ Eliminates All Control Wires, Switch Legs & Reduces Total Cost
- ✔ Simplify Installation
- ✔ Simple Reconfiguration
- ✔ LLLC Compliant

### Sequence of Operations

#### Luminaires

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Group	Product	Cost
Luminaires	2BLT4 Series	\$ \$
Power Packs	N/A	
Wall Switch	rPODBA 4S DX Series	\$
Occupancy Sensors	N/A	
Photocell	N/A	
Wiring	THHN	\$
Labor		\$
TOTAL		\$ \$



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