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Networked Lighting Control

Introduction

Electrical engineers must consider important design features when designing networked lightening controls. These include its key topologies, components, configurations, and operational protocols. In addition to the distribution layout/configuration, a designer must evaluate the lighting control sensors, types of controllers, computer programs specific to lighting controls, and continuous dimming features.

Types of Layouts

Networked lighting is comprised of permanently connected electrical equipment supplied from a generating source. Distribution mediums can include power cables, low-voltage wiring, or Ethernet cables. Networked distribution layouts depend on a variety of factors such as hardware, devices, levels and types of communications, database, facility (occupancy types), and location of the service. The most common types of networked lighting layouts are radial, star, ring, and interconnected layouts:

1. Radial layout includes bus and branching (tree) layouts:
   a. Bus refers to nodes connected linearly, with communication following a direct pathway between nodes.
   b. Branching (tree) refers to multiple nodes that aren't connected linearly, requiring reconfiguration of the distribution.
2. Star layout refers to all nodes linked directly to a central hub, enabling communication between any two nodes through the hub. While a central hub is necessary for this layout, the addition of a new node to a star network usually has minimal impact on existing communication, as each node connects directly to the hub.
3. Ring layout refers to a closed loop of nodes that communicate in a circular fashion. Data is passed from one node to the next until it reaches its intended destination. The addition of nodes to a ring network can disrupt communication flow, potentially necessitating reconfiguration to ensure continued efficiency and reliability.
4. Interconnected (mesh) layout involves nodes which are interconnected through multiple redundant connections, creating robust communication pathways. This redundancy ensures that if one connection fails, alternative routes are available, enhancing reliability and fault tolerance. The addition of a new node to a mesh network expands its coverage and potentially enhances its resilience. However, the impact of adding nodes varies depending on the network's architecture and scalability.

Network Components and Protocols

The most common types of networked lighting components include:

1. Sensor technologies:
   a. Motion sensors enable lights to adjust brightness or switch on/off in response to detected motion. Sensors can either be integrated within the luminaire or installed separately.
   b. Lighting intensity sensors enable lights to adjust brightness or switch on/off based on the presence of artificial light or daylight. Sensors may be integrated into fixtures or mounted on walls/ceilings.
2. Wall controllers offer autonomous lighting control within the space, integrating occupancy sensors, timeclocks, and photocells.
3. Scene-controllers integrate lighting devices to enable the operation of multiple lights across various spaces based on pre-set schedules.
4. Individual controllers allow personal lighting control, giving users the ability to individually set lighting levels.
5. Continuous dimming refers to the ability to adjust the lighting intensity seamlessly and smoothly using 0-10V control to scale its output. For example, at 10 V, the controlled light should be at 100% of its potential output, and at 0 V it should at 0% output.

Wireless lighting control systems consist of relay modules or power packs, typically installed on a luminaire or a junction box within the space. They also include input devices such as sensors and switches as well as management devices such as gateways, which function similarly to wireless routers. These input devices interact with a power controller. Wall-mounted switches typically send signals directly to the luminaire controller and can be integrated with an occupancy sensor. These wireless lighting control fixtures are typically designed with PC software which communicates with the lighting control panel for user-defined settings and adjustments.

Protocols entail a set of rules governing device design to ensure interoperability. Lighting control protocols can be open, allowing devices from different manufacturers to communicate, or proprietary, restricting communication to devices from a single manufacturer.

Conclusion

Networked lighting control requires the correct hardware design, software and operating system to allow a range of user-adjustable lighting functions and controls. Designers must consider the most appropriate layout and the necessary fixtures and components in order for a lighting system to meet the needs of a facility and its users.

Further Reading

1. IES, Illuminating Engineering Society