



## Wireless Lighting Control Made Easy



## Wireless Lighting Control Made Easy

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## Learning Objectives

- Become aware of the wireless communication protocols available to manufacturers of controls and how they differ
- Understand the energy code requirements adopted by each state and the compliance path associated with each
- Review and analyse the newest energy code for lighting controls released in the United States: ASHRAE 90.1 2016, chapter 8 and 9
- Discuss ways wireless lighting control can aid in the compliance of ASHRAE 90.1 2016



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## Basics of Wireless Technology

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## Radio Frequency Summary 418 MHz / 900 MHz / 2.4 GHz

- Three main frequencies of communication for “smart” devices
  - 418 MHz
    - Low power, high range
    - Old technology
  - 900 MHz
    - Small antennae
    - Domestic usage only
  - 2.4 GHz
    - Secure and most popular
    - Crowded band
- Lighting control manufacturers utilize all three frequencies
- Take into consideration pros and cons before selecting a system for a commercial project
  - Utilize a factory technician for setup and channel mapping

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## 418 MHz

- Pros
  - Uncrowded
    - Not many devices communicate over this band anymore
    - Restrictive measures put forth from FCC
  - Low-power / High-range
    - Requires less power to transmit further
  - Low-cost of components
  - International acceptance
- Cons
  - Out-dated technology
  - High restrictions from FCC
  - Limited to no security protocols
    - Outdated technology doesn't provide same security measures
  - Large antennae



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## 900 MHz

- Cons

- Out-dated technology
- Limited security protocols
- Not allowed outside of USA
  - No international standard developed for 900 MHz



- Pros

- Low restrictions from the FCC
  - Any digital or analog signal can be sent without restriction to duration or content
- Higher power is allowed to increase range
- Low-power / High-range
- Smaller antennae than 418 Mhz

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## 2.4 GHz

- Pros

- Wide signal coverage
- Most accepted frequency band
  - Low restrictions by FCC
  - Two popular protocols for communication
    - 802.11 (WiFi)
    - 802.15.4 (ZigBee)
- Very secure
  - 128 bit AES
    - NIST standard for encryption of electronic data
    - Used at the NSA for top secret information
- Newer technology

- Cons

- Crowded frequency band
  - Most accepted and secure band results in many communication mediums
- Higher power required for longer distances when compared to lower frequencies



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## WiFi vs. Zigbee

- Battery life
  - WiFi 1-2 Days
  - Zigbee 3-5 years
- Data Rate
  - WiFi 54 MB/s
  - Zigbee 250 KB/s
- Range <sup>(1)</sup>
  - WiFi 100 Meters
  - Zigbee 1000Meters

(1) Line of sight

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## WiFi Network



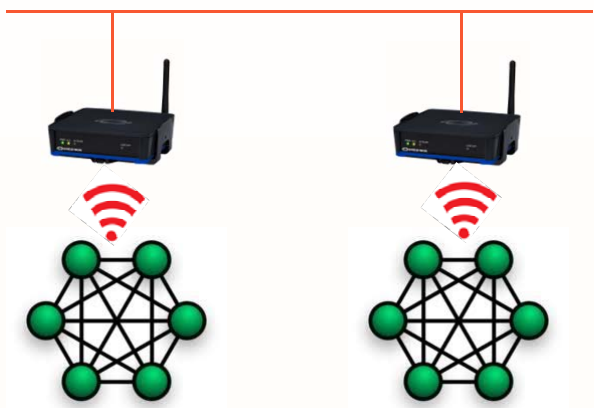
- Wireless connectivity is created through access points
- Data is not routed through wireless devices
- Distance is increased by adding additional access points

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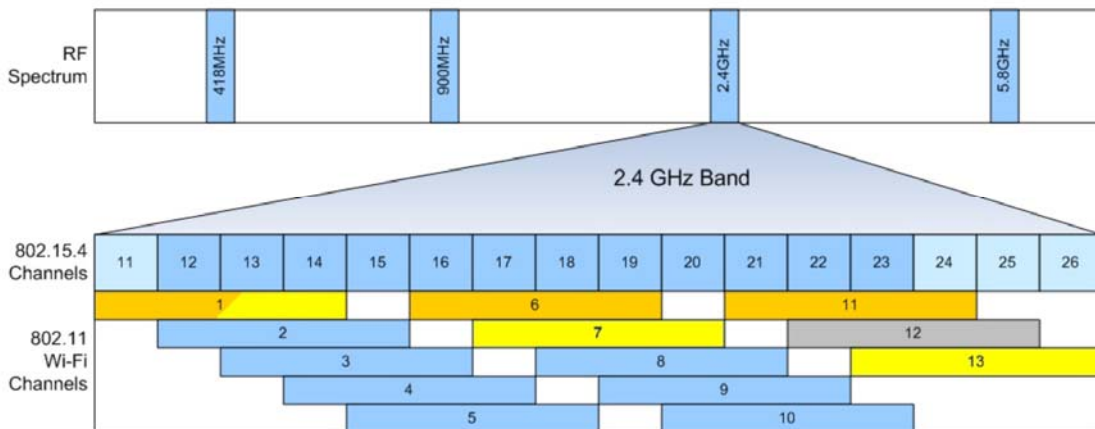
## Mesh Network



- Wireless connectivity is created through Gateways points
- Data is routed through other wireless devices
- Distance is increased by adding additional gateways

## 2.4 GHz: WiFi vs. ZigBee

2.4 GHz Wireless Network



# Energy Codes

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## 9.1.2 Lighting Alterations Retrofits

- Alterations of any lighting system must comply with new LPD requirements and controls
  - Exception: If you are altering less than 20% of the lighting in the space
- Repairs and 1-for-1 replacements of fixtures do not need to update their controls to newest energy code

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## 9.4.1.1a Local Control – Manual Override

- Code

- Manual control over the lighting must be installed in each space
  - Each device cannot control an area larger than 2500sqft
- Device should be readily accessible
- Occupant using device must be able to see the lighting they are controlling
  - Override device can be remote mounted if there is an indicator light showing status of lights and the device is properly labeled

- Compliance

- Keypad control
  - Battery powered



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## 9.4.1.1b,c,g,h Motion Sensors

- Code

- Best practice options:
  - Manual On, Automatic Off
  - 50% Automatic On, Automatic Off
  - Auto/Manual On, 50%/100% Off (corridors, labs, lobbies, theatres, stairwell, storage, warehouse)
- Code allows for removal of motion sensors if:
  - Space's LPD is less than 0.8W/sqft
    - Must use time clock then
  - Lighting required for 24/7 operation
  - Safety and security concerns
  - Shop or lab space

- Compliance

- Occupancy and/or vacancy sensor
  - Battery powered



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## 9.4.1.1d Bi-level Lighting Control

- Code

- Lights are required to have scene and/or dimming control
  - Scene: Between 30% and 70%
  - Dimming: Continuous dimming control



- Compliance

- J-Box zone controller
  - Easy install and commissioning
- Wall-Box zone controller
  - Retrofit option



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## 9.4.1.1e,f Automatic Daylight Responsive Control

- Code - part 1

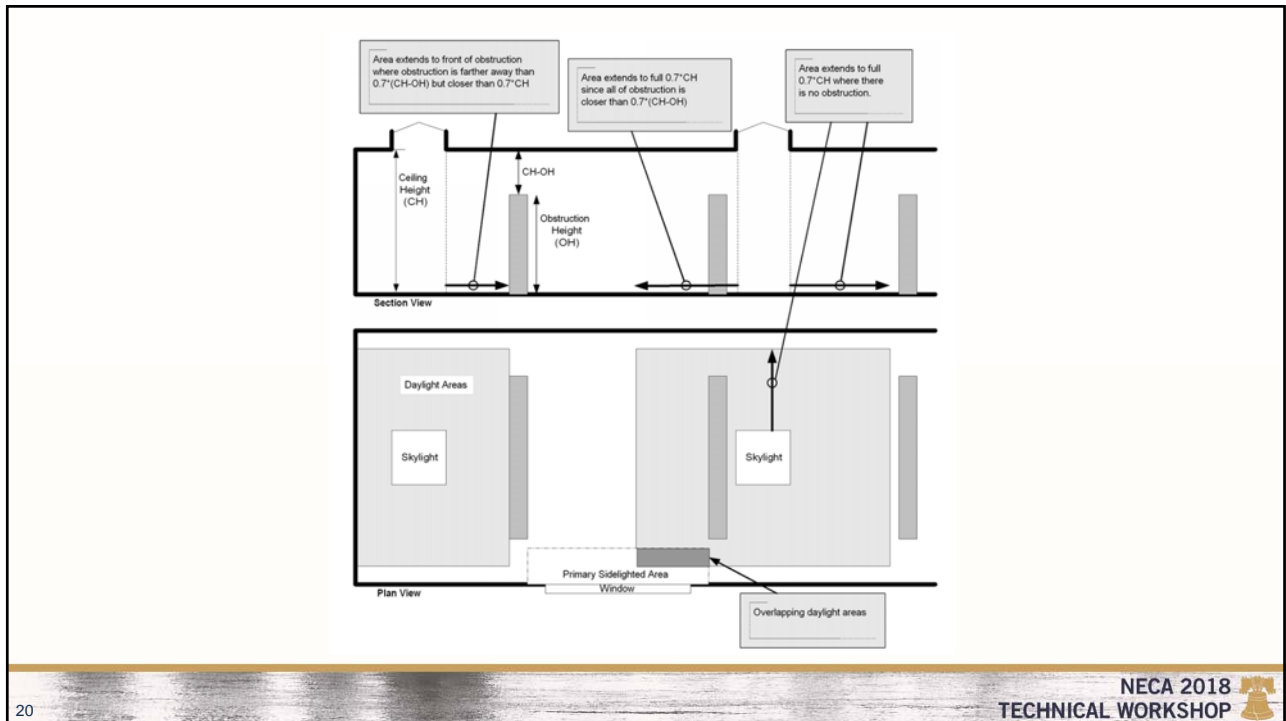
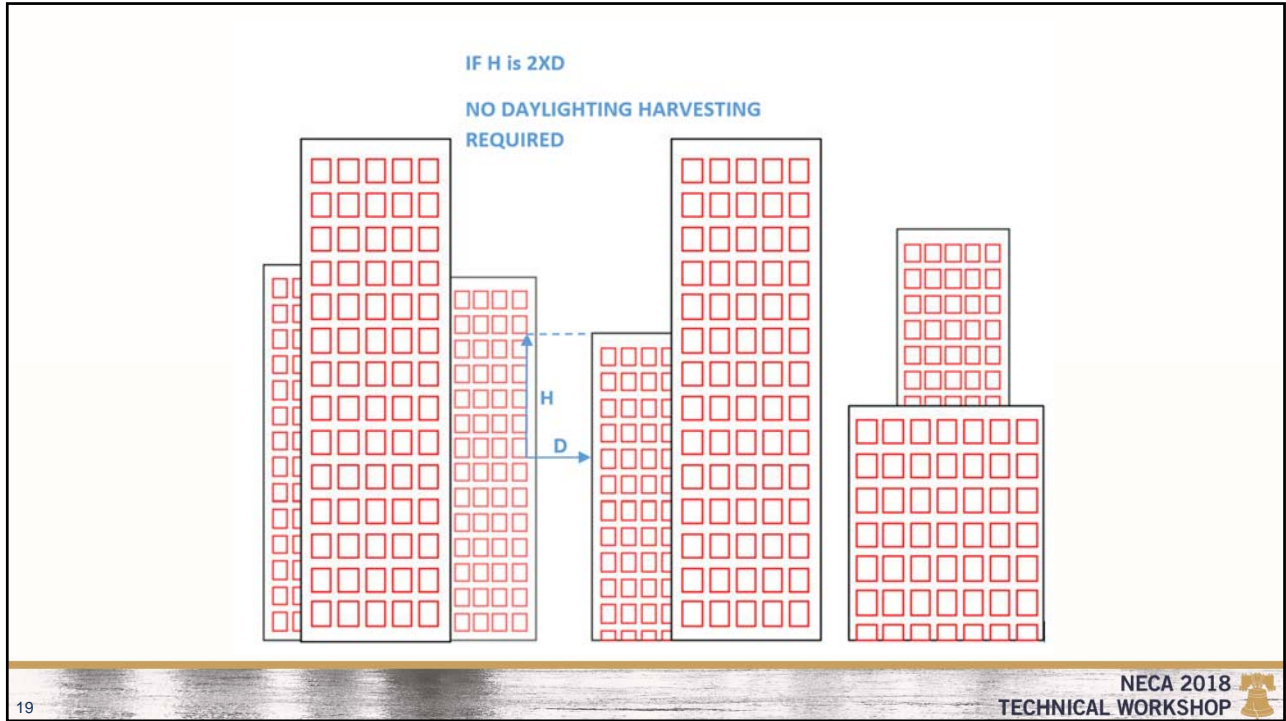
- Daylight harvesting is required for all lighting sufficiently affected by natural daylight
- Two separate photo controls if:
  - Primary zone: 150W or greater
  - Primary + secondary zone: 300W or greater
    - Independent control
- Calibration controls must be readily accessible and mounted no higher than 11' above the floor
  - Physical presence at sensor must not be required for calibration process to complete
- System must reduce artificial lighting automatically using continuous dimming

- Code - part 2

- Exceptions to daylight harvesting (window):
  - Primary zone: less than 150W
  - Adjacent obstruction to window is twice as high above the window as its distance away from the window
  - Window is less than 20sqft
  - Retail spaces
- Exceptions to daylight harvesting (skylight):
  - Zone: less than 150W
  - Obstruction blocks direct sunlight for more than 1500 hours throughout the year 8am-4pm

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## 9.4.1.1e,f Automatic Daylight Responsive Control

- Compliance
  - Photo sensor w/ automatic calibration
    - Battery powered



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## 9.4.1.1i Scheduled Shutoff – Time Clock

- Code
  - Only required if not using motion sensors
  - Automatically shut off lights when space is scheduled to be unoccupied
    - Zones must be smaller than 25,000sqft per time clock
    - 1 floor per time clock
    - Incorporate holidays and weekends
  - Manual overrides
    - Less than two hours of activation
    - Zone must be less than 5000sqft
- Compliance
  - Central processor
    - Integration hub



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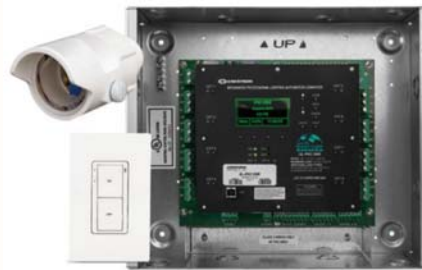
## 9.4.1.2 Parking Garages

- Code

- Time clock is required as per 9.4.1.1i
  - Entrances and exits to be reduced by 50% from sunset to sunrise
- Lighting to be automatically reduced by 30% after 20m of vacancy
  - Zone smaller than 3600sqft
- If net opening-to-wall ratio is greater than 40%, daylight harvesting is required
  - Reduce by 50% any fixture 20' into the space
  - Not required if an obstruction is located 20' from opening
  - Not required in transition zones and ramps w/out parking

- Compliance

- Integrated Switching System
  - Contractor panel



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## 9.4.1.3b Guest Rooms

- Code

- Hotels, motels, boarding houses, etc.
- All lighting and switched receptacles in each enclosed space to be turned off 20m after all occupants leave
  - Captive key systems are allowed
- Bathrooms to have separate control to turn off 30m after occupants leave bathroom
  - Allowed 5W nightlight in bathroom

- Compliance

- Wireless residential lighting control system
  - iPad based lighting control



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## 9.4.1.4 Exterior Lighting Control

- Code

- Lighting must be turned off when there is sufficient daylight
- Building façade and landscape lighting shut off between:
  - Midnight or business closing (later one)
  - 6am or business opening (earlier one)
- Signage (not all) and other exterior lighting needs only 50% reduction during above time periods OR vacancy for 15m

And

- Compliance

- Integrated Dimming System
  - Distributed room controller



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## 9.4.3 Functional Testing

- Code

- All control devices and control systems shall be tested for proper calibration, program, etc.
  - Motion sensors
  - Time clocks
  - Manual overrides
  - Daylight harvesting controls
- Responsible party for testing shall NOT be involved in design or construction of project
  - Must document everything

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## 9.6.3 Additional Lighting Power Densities

- Lighting Power Under Control  $\times$  Control Factor = Additional Lighting Power Allowance
  - Manual dimming provided (control factors)
    - Open office = 0.05
    - Private office = 0.05
    - Conf/Class room = 0.10
    - Retail = 0.10
  - Programmable dimming from time clock (control factors)
    - Open office = 0.05
    - Private office = 0.05
    - Conf/class room = 0.10
    - Retail = 0.10
    - Lobby/atrium/corridors/gym/parking garage = 0.10
- Lighting Power Under Control  $\times$  Control Factor = Additional Lighting Power Allowance
  - Automatic continuous daylight dimming in secondary zone (control factors)
    - Open office = 0.10
    - Private office = 0.10
    - Conf/class room = 0.10
    - Retail = 0.10
    - Lobby/atrium/corridors/gym/parking garage = 0.10
  - Motion sensors and personal devices allowing for dimming control of the downlight component at the workstation (control factors)
    - Open office = 0.30 (workstation specific luminaires)

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## 8.4.2 Automatic Receptacle Control

- Code
  - 50% of receptacles must be automatically controlled:
    - Private offices, conf rooms, print/copy rooms, break rooms, classrooms, workstations
    - Time clock or motion sensor (20m timeout)
  - All controlled receptacles must be permanently marked to differentiate them from uncontrolled ones
  - Plug-in devices not allowed
- Compliance
  - Plug load controller
    - J-box mountable power-pack relay



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## 8.4.3 Energy Monitoring

- **Code**
  - New buildings over 25,000sqft and individual tenant spaces over 10,000sqft require energy monitoring of:
    - Electrical energy
      - Interior and exterior lighting separately
    - Receptacles
    - HVAC systems
  - Recorded every 15m
  - Reported hourly, daily, monthly annually
    - Available to tenants
    - Graphically displayed
  - Stored for 3 years
- **Compliance**
  - Energy meter
    - Mains and pulse metering for water/gas
  - Enterprise Dashboard
    - BMS system



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## Code Wrap-Up

- Majority of spaces will require the following:
  - Dimming
  - Vacancy sensing
  - Daylight harvesting
  - Manual override
  - Time clock control
- Remember to always check exceptions
  - Great opportunities for initial hardware savings
- Always research the full code set for details
  - Use ASHRAE table of REQ/ADD
- Reach out to manufacturers and/or agents for questions and clarifications on your design



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# Questions?

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