

Clear Connect™ RF technology commercial overview

Lutron® pioneered the RF light control market more than a decade ago. The careful design considerations taken prior to launching our first product, and progressive design refinements since, have transformed a pioneering company into the recognized industry leader.

This document presents highlights of the technologies and topologies behind our highly successful RF products. For more in-depth coverage, please request the 16-page whitepaper (P/N 367-1234), which is also available online: www.lutron.com/technical_info/

Lutron requirements:

When Lutron set out to design the first RF light control System (LCS), several key specification points were non-negotiable:

- The system had to be “ultra-reliable” (working to specification in every application—at the time of installation and thereafter)
- Systems capable of 2-way RF communications to provide system feedback (an industry first)
- Simple installation: no special tools, methods or rewiring (requiring dimmers without neutral wires)
- Complete RF product offering (to include sensors, system interfaces, handheld devices load controllers and more)
- Elegant aesthetics would not be compromised

The investigation of communication technologies:

Several engineering man-years were spent in determining the best method for creating a “true RF retrofit” LCS. The following are a few of the items we considered in depth:

- Different frequency bands (400 MHz, 900 MHz, 2.4 GHz...)
- Different regulatory requirements—from a global perspective (FCC, NOM, IC, CE, R&TTE,...)

- Network and protocol designs (distributed vs. centralized intelligence, fixed vs. mesh network, group vs. directed commands)
- RF interference studies were conducted to determine the best frequency bands for operation and “real-world” RF activity levels

Our findings:

- Every RF system could be compromised by interference—regardless of sophisticated hopping or modulation techniques
- Higher RF power does not ensure reliable communications—the risk of interference in high power bands outweighs the benefits of higher power
- Frequency bands allowing “continuous” transmissions—such as those with phones, wireless routers and baby monitors—would be problematic
- Lower frequencies are attenuated and reflected less through construction materials than higher frequency signals (analogous to low-frequency “bass” audio signals)

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The Conclusion - FCC Part 15.231

Our investigations determined that the rules and other products operating under FCC Part 15.231 (similar operating regulations are used internationally—identified by different regulation numbers) were ideal for a robust LCS. Lutron® evaluated all devices operating in this band, and chose frequencies that did not line up with other popular devices. In brief, the rules and benefits of operation under 15.231 are as follows:

- Devices may not transmit continuously, and may not “poll” (making for an essentially silent band)
- Generally, activity is initiated by a button press or someone entering a room (“event driven” activity)
- Plenty of frequency bandwidth (~170 MHz) for products to share
- Long, stable history with no proposed rule changes
- Devices are relatively “low power” (fractions of a Watt)
- Great for high-density applications: schools, office buildings, industrial buildings, MDU
- Bands with similar definitions are available globally

Why not 900MHz or 2.4GHz?

- The FCC rules in these bands permit always-on, high-power transmissions from devices such as WiFi routers, Bluetooth devices and cordless phones. They require high data rates, encryption, and complicated radio techniques to mitigate interference from the potentially many competitive, co-located devices. These devices have high power draws and cannot operate for years on a battery.

- The higher operating frequency of these devices is attenuated and reflected by building materials more so than the lower frequency Clear Connect devices.
- Clear Connect devices have insignificant bandwidth competition and are designed to be densely co-located in a building without interference. The designs can operate for years on a battery allowing products that require no wiring and can be easily relocated during building reconfigurations.

Message Delivery – A “fixed network”:

Once the best operating rules and frequencies were selected, optimum network design was required. Fixed and mesh networks were analyzed. While both topologies have their strengths, we determined that fixed networks better served the unique needs of an LCS.

- Messages move quickly and consistently through the network
- Location of source and destination device do not affect performance
- Scales to larger systems without performance degradation
- Easier network troubleshooting

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Message Content – Group Commands:

LCS protocol must be efficient to achieve lights that react imperceptibly fast and simultaneously (not lights staging on one after the other – the “popcorn effect”). Directed commands that are used in other systems cannot achieve Lutron® performance in lighting actions involving numerous lights.

Some highlights of Group Commands:

- Commands are very short – “Preset 01” – propagated through the network very quickly
- System devices have distributed intelligence (memory) and have been preprogrammed with all the information required to react
- Scales from a few to many devices with no performance degradation
- Requires ownership, common hardware, and coordination of all system devices (not achievable when products are from different manufacturers)

Lutron RF Experience

- Pioneered RF LCS category
- Over 1 million devices sold
- More than a decade of production, sales and installation
- Diverse product lines: RadioRA® 2, HomeWorks® QS, Maestro Wireless®, GRAFIK Eye® QS, Stanza, Sivoia® QS, RadioTouch™ and Radio Powr Savr™

RF Technology

- Seven RF-specific patents
- Fixed network message delivery topology
- Fast group or preset commands (not directed commands)
- Unique device addresses and serial numbers (ensures that co-located systems will not cross-talk)
- Easy and reliable integration (Ethernet, RS232, IR, CCI and CCOs)

www.lutron.com

World Headquarters 1.610.282.3800

Technical Support Center 1.800.523.9466 (Available 24/7)

Customer Service/Quotes 1.888.LUTRON1 (1.888.588.7661)

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