Keywords: LED Lighting, remote control lighting, street lighting, powerline communications IC, architectural lighting automation, wireless LED control

TUTORIAL 4687

Power Line Communication Circuit Guide

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Jun 27, 2011

Abstract: One benefit LEDs offer in general lighting applications is that they are easier to control remotely. This application note describes a remote-controlled architectural or street-lighting system and describes how to implement power-line or wireless communications control of a lighting system.

Remote-Controlled Applications in Street, Parking, and Indoor Lights

Click here for an overview of the wireless components used in a typical radio transceiver.

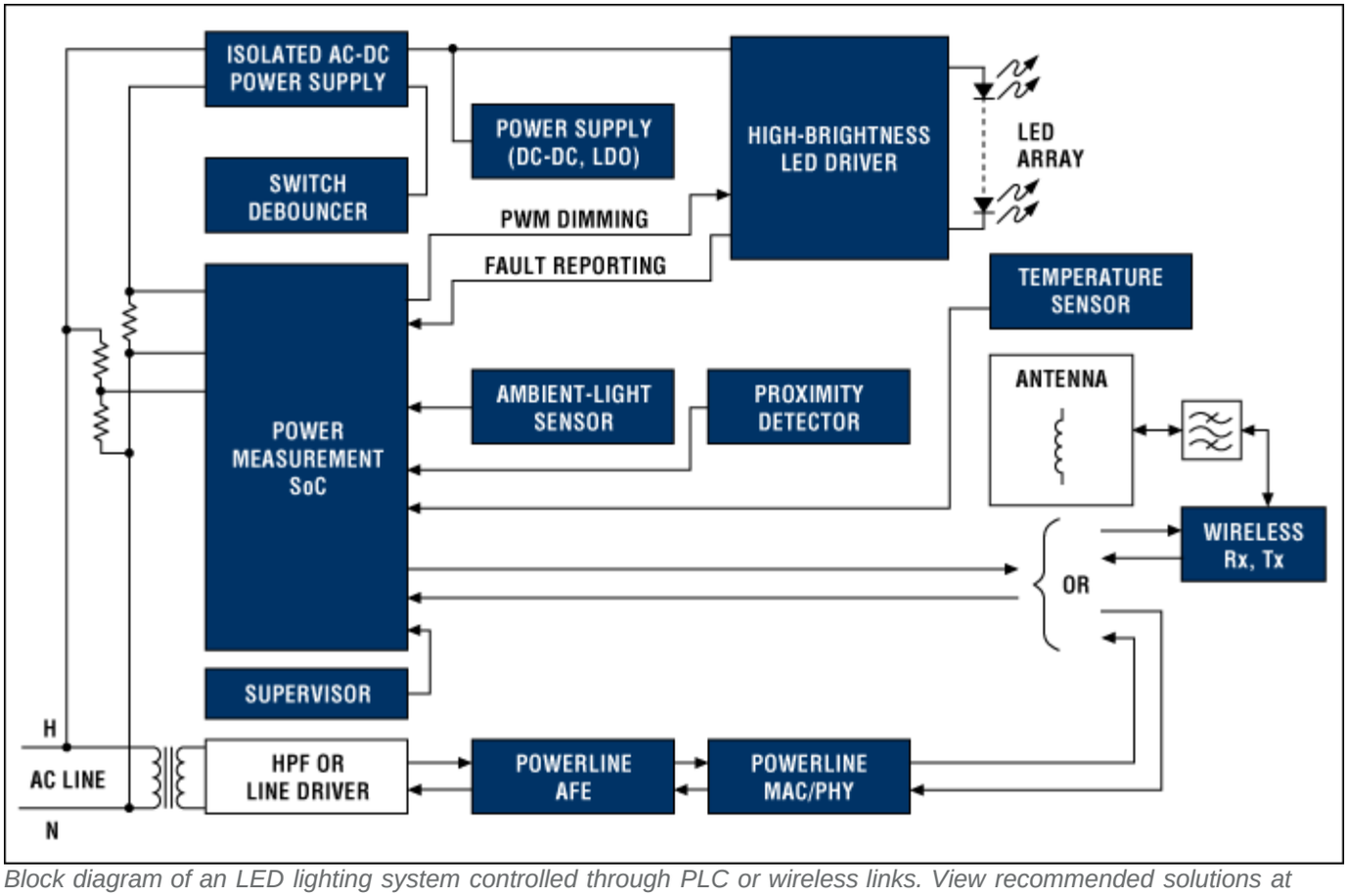
As stated in application note 4670, "LEDs for General Lighting: What They Offer and Their Design in Retrofit Lamps", LEDs offer more design flexibility for dimming and changing the light color. This versatility makes them ideal for applications like architectural lighting, indoor ambient lighting, and dimmable street and outdoor lighting. All these applications require a technology to control the LED light remotely. For the application to be successful in the marketplace, the cost of upgrading the lighting infrastructure to new LED technology must be minimized. Not surprising, solutions that can reuse the present infrastructure will likely be the first to penetrate the market.

When converting to remote-controlled LED lighting, the most costly infrastructure upgrade to anticipate is the wiring to control the LED lights. Fortunately, LED lamps can be controlled through existing power lines using PLC technology.

PLC technology allows communication over a long range. New OFDM-based PLC technology, including emerging standards such as G3-PLC™, is simplifying integration of lighting control applications by providing noise immunity and interoperability.

The main design requirements for remote-controlled LED lighting solutions are:

- **The communication range**, which is dictated by the application. For an indoor residential application, something in the range of 30m is sufficient. Street lighting can require a range of several kilometers.
- **Low power consumption**. An important selling point of LEDs is their high energy efficiency. It is important that an LED lamp consume the least power possible when the light is off and only the communication circuit is active.
- **The communication rate**. Some lighting applications require only a low communication bit rate (i.e., a few kbps) to control light dimming and perhaps read possible faults. Large networks of lamps and architectural lighting, however, can sometimes require data rates up to 100kbps. An example would be a run of several hundred street lamps on a single PLC-controlled network.



Block diagram of an LED lighting system controlled through PLC or wireless links. View recommended solutions at www.maximintegrated.com/lighting.

A remote-controlled lamp often includes a microcontroller, either as a discrete component or integrated in another IC. Unless a complex communication protocol is adopted with a complex stack, a basic microcontroller is typically sufficient. The microcontroller's duties will typically include decoding of the communication protocol, generation of dimming signals for the LED driver, reading faults, and controlling the lighting effects of the lamp (e.g., theater dimming).

For wireless communication for indoor lighting applications, Maxim offers the MAX1473 receiver and the MAX1472 transmitter. These products allow communication in the 300MHz to 450MHz free bands, over a range of 30m to 50m

in an indoor environment.

For PLC, Maxim's solution includes the G3-PLC compliant MAX2992 baseband and MAX2991 analog front-end (AFE). These devices form a complete powerline transmitter/receiver chipset that can transmit data at distances from hundreds of meters to 10km or more, and at data rates up to 300kbps. This range makes the parts ideal for street-lighting applications. The MAX2992 uses OFDM and adaptive tone mapping to provide robust communications over power lines. It conforms to the IEEE® P1901.2 prestandard.

Energy Measurement

Energy demand around the world is predicted to increase at a rate that will likely outstrip our ability to generate power. The International Energy Agency (IEA) calculates that lighting accounts for about 17.5% of global electricity use. That equates to over 2,200 terawatt-hours (TWh), more than all the world's nuclear plants generate in a single year. As an energy-efficiency advisor to the G8, IEA has stated that electricity consumption for lighting could increase dramatically by 2030 unless concerted action is taken to implement new technologies. Increased energy efficiency and improved energy management are critical to averting this potential energy crisis.

Traditional open-loop strategies for managing power usage are crude and inefficient, resulting in lower reliability and reduced distribution stability. Engineers are working to improve power efficiency in all electronic applications; however, increasing efficiency is only part of the equation.

Better energy management and, consequently, comprehensive measurement systems are essential. Incorporating feedback about how power is consumed yields the benefits of a closed-loop system and reduces waste. Additionally, giving energy users greater visibility into their power consumption can help overcome consumer indifference to energy concerns.

Accurate measurement provides the feedback necessary to understand, confirm, and modify power consumption behavior. It is critical to implementing an energy-management control loop and providing insight for maintenance and failure diagnostics.

For outdoor lighting, accurate measurement provides the opportunity for municipalities to reduce electricity cost by dimming lights and by being billed on actual power consumption. In relay control panels, accurate measurement provides the energy management monitoring and verification feedback to qualify for LEED credits, ISO 50001, and time-of-use billing adjustments.

Related Parts		
MAX1472	300MHz-to-450MHz Low-Power, Crystal-Based ASK Transmitter	Free Samples
MAX1473	315MHz/433MHz ASK Superheterodyne Receiver with Extended Dynamic Range	Free Samples
MAX16819	2MHz High-Brightness LED Drivers with High-Side Current Sense and 5000:1 Dimming	Free Samples

MAX16820	2MHz High-Brightness LED Drivers with High-Side Current Sense and 5000:1 Dimming	Free Samples
MAX16822	2MHz, High-Brightness LED Drivers with Integrated MOSFET and High-Side Current Sense	Free Samples
MAX16832	2MHz, High-Brightness LED Drivers with Integrated MOSFET and High-Side Current Sense	Free Samples
MAX16834	High-Power LED Driver with Integrated High-Side LED Current Sense and PWM Dimming MOSFET Driver	Free Samples
MAX2990	10kHz to 490kHz OFDM-Based Power Line Communications Modem	Free Samples
MAX2991	Power-Line Communications (PLC) Integrated Analog Front-End Transceiver	Free Samples
MAXQ610	16-Bit Microcontroller with Infrared Module	Free Samples

More Information
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