Power over Ethernet (PoE) Enabled Smart LED Lighting System

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Power over Ethernet (PoE) Enabled Smart LED Lighting System

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Differentiated LED lighting systems improve energy efficiency, simplify installations, facilitate data gathering and monitoring have become requirements in domestic, office and industrial environments. The global acceptance of LED lighting also makes the LED system ideal for adding intelligence by using sensors as part of the Internet of Things (IoT). In such a system, power conversion efficiency and circuit complexity will benefit from low voltage (below 60V SELV) operation. Power over Ethernet (POE) is an integral part of telecom infrastructure and the same Ethernet cable can be used for smart lighting applications. Thus it mitigates the AC power processing complexity as well as safety threats. This article presents the STEVAL-POEL45W1, a constant current smart LED driver, capable of working with the latest PoE standard on Ethernet RJ-45cable and wirelessly controlled through BLE.

The power supply for the LED driver developed is capable of operating from 37–57V input DC voltage with a maximum power output of 48W. The evaluation board is also featured with digital/PWM dimming. The depth of PWM dimming is close to 1%. The smart dimming and ON/OFF of LEDs is controlled through an Android application. The standby power (no load) consumption meets the energy targets set by Energy Star and EU Eco-design standards. The converter efficiency reaches 95% for most of the input voltage range. All protection features like LED open and short are present in the developed solution. The STEVAL-POEL45W1 evaluation board is compact in size to fit into existing commercially available LED extrusions.

SYSTEM OVERVIEW

The indoor lighting market constitutes 13% of the total available market for lighting applications. Presently it is being served by AC infrastructure of 90-265VACuniversal input supply and 47-63Hz line frequency. The PoE standard evolution as shown in Figure 1 is now capable of handling power ratings up to 71.3W on the powered device (PD) side. Thus, PoE infrastructure creates a big boost for LED lighting applications. Figure 2 shows the block diagram of the PoE enabled smart lighting system.

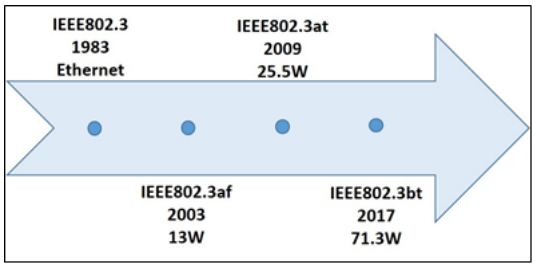


Figure 1. Evolution of Power over Ethernet Standard for PD

The power conversion controller from STMicroelectronics, the *LED6000*, is used for driving LEDs in constant current mode. Thanks to the

The *SPBTLE-1S* is a radio frequency (RF) certified Bluetooth low energy (BLE) module used for wireless communication from any android phone having Bluetooth connectivity. The BLE module has been programmed to generate a PWM signal for adjusting the brightness level of the LED Lights connected to the LED6000. Each evaluation board has a different MAC address for point to point communication. The *PM8805* is used as a Power over Ethernet interface. It embeds two active bridges and their driving circuitry, a charge pump to drive high-side MOSFETs, the hot-swap MOSFET, and the standard single-signature interface IEEE 802.3bt-compliant, including detection, classification, UVLO and inrush current limitation. The housekeeping power supply for BLE module is based on the *VIPer012XS*, and manages the auxiliary SMPS in buck topology.

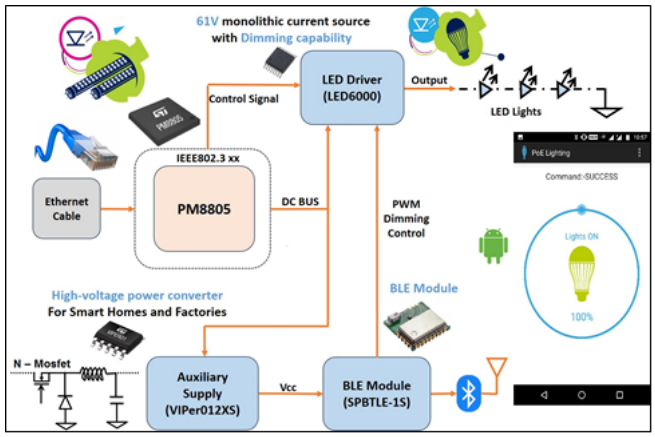


Figure 2. STEVAL-POEL45W1 Block Diagram

The STEVAL-POEL45W1 LED driver evaluation board developed is shown in Figure 3. It is capable enough to handle power upto 48W output with high efficiency, good current regulation (CR), low standby consumption, and low current ripple.

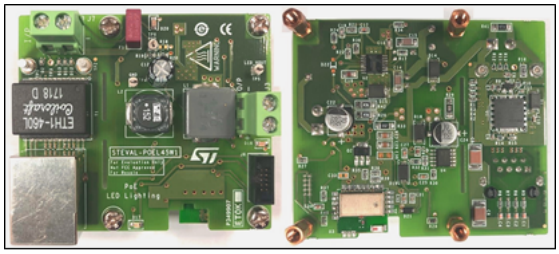
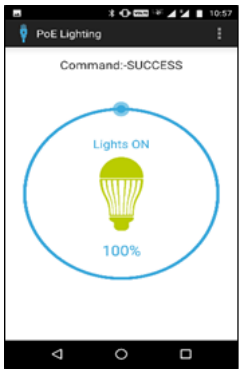


Figure 3. STEVAL-POEL45W1 Evaluation Board

DIMMING CONTROL

On powering up the evaluation board through PoE, the LEDs turn ON with maximum brightness. The dimming and ON/OFF of the LEDs can be controlled by using the *PoE Lighting* Android application from STMicroelectronics. The Android application is available for free on the Google Play store. The Android application communicates with the SPBTLE-1S over Bluetooth. On successfully pairing of the evaluation board with the Android application, the Android device will display the screen as shown in Figure 4. The ON/OFF of the LEDs is controlled by clicking on the bulb icon and the brightness of the LEDs can be changed by adjusting the bar around the bulb icon. Based on the selected dimming level, the BLE module SPBTLE-1S adjusts the duty cycle signal going to the LED driver LED6000. The frequency of the PWM to the LED driver is 500Hz.



Experimental RESULTS

The overall efficiency, current regulation (CR) and dimming behavior of the STEVAL-POEL45W1 has been evaluated at different loads. With 100% load at 48V DC, the efficiency is above 95%. Figures 5, 6, and 7 show the LED driver performance in terms of dimming behavior, current regulation, and efficiency. The standby power consumption is less than 100mW.

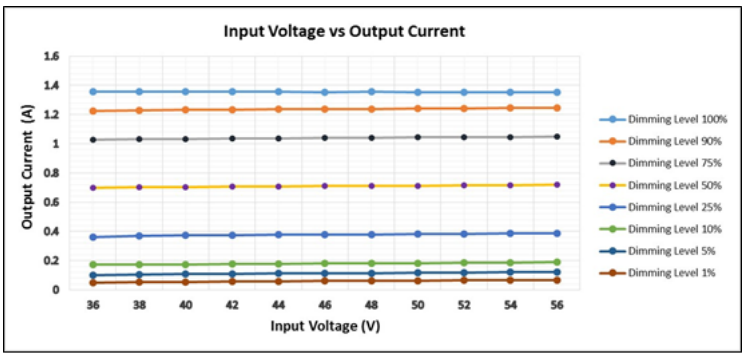


Figure 5. Output current vs Input Voltage at Different Brightness Levels

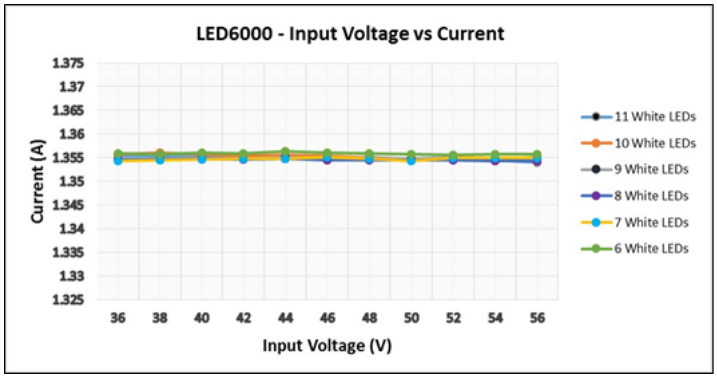


Figure 6. Current Regulation vs Input Voltage at Different Loads

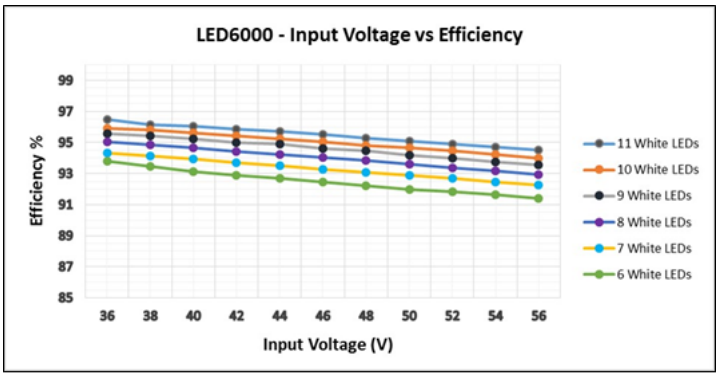


Figure 7. Efficiency vs Input Voltage at Different Loads

Conclusion

The digitally controlled PoE LED driver presented in the current work can deliver the output power of 48W.The system can dim the LEDs up to 1% of the maximum brightness level without any flicker. The experimental results show high efficiency and good current regulation under wide input voltage and load conditions thanks to the performance of the ST power products.