Smart LED Lighting Solutions
Complete LED Lighting Solutions from Marvell Semiconductor

There is a bright future for LED lighting products. A growing awareness of energy conservation and resource management, efforts to abate greenhouse emissions, and government-mandated phase out of incandescent bulbs are the leading factors spurring the demand for LED lighting products in homes, offices and outdoors. LED lights consume 80% less energy than traditional lighting and an LED light can have a life span from 25,000 to 50,000 hours, a 25 times improvement over incandescent lights.

With the addition of lighting control, such as occupancy sensors and daylighting controls, a further 40% energy can be saved. Given these facts, the evolution to LED lighting in homes and offices promises a significant positive environmental impact towards reducing carbon footprint.
Furthermore, the lighting industry is starting to deploy standards such as DALI (Digital Addressable Lighting Interface) and ZigBee® to install smart lighting controls in building systems. These standards deliver new ease-of-control capabilities for commercial lighting including two-way communication and the ability to regulate lighting remotely through cloud-based applications and mobile devices. Lighting can be manipulated in ground breaking ways to create never before seen safety, display and mood lighting effects.

Existing lighting manufacturers are looking to transition their core business into developing LED lights and with this technology disrupt, new players are emerging in this exciting market.

Regardless of the level of experience in the industry, there are challenges to developers of both residential and commercial products. Retrofit bulbs (A19, GU10, PAR, and BR) for the home market need to be efficient and produce high quality light. More importantly, as there is a large installed-base of dimmers, it is crucial to have a product that is compatible with these dimmers.

Since the actual installation can account for 80% of the cost of commercial lighting control systems, a quick payback can justify the expense of putting LED lighting in buildings. Commercial lighting manufacturers need to find a complete solution that reduces energy consumption, is much simpler to install and maintain, and integrates control technology with driver electronics to fully exploit the promise of LEDs.

As one of the world’s largest fabless semiconductor companies with a proven track record of semiconductor innovations, Marvell is uniquely positioned to address some of the world’s greatest environmental challenges through technology. Marvell has established a commitment to developing and delivering solutions that positively impact the environment.

With a portfolio of LED solutions featuring innovative lighting architecture and networking technology, Marvell enables superior, green LED lighting applications. These complete LED lighting solutions are designed to provide highly cost-effective, fully-integrated, end-to-end silicon and software solutions that enable original equipment manufacturers (OEMs) to develop best-in-class LED lighting and lighting control solutions.

Marvell has optimized LED lighting architecture to service two key LED lighting applications, the residential or retrofit bulb market and commercial lighting controls.

**Marvell Delivers**

*Combining dedication to green technology and LED lighting products with its world-class engineering and mixed-signal design expertise, Marvell delivers critical building blocks to its customers, giving them the competitive edge to succeed in today’s dynamic LED lighting market. Using Marvell LED lighting ICs, software and reference designs, OEMs and ODMs can introduce high-performing, energy efficient LED lighting for the residential market and easy-to-install smart commercial lighting systems that provide quick return on investment.*
Innovative LED Driver Electronics

Innovative mixed-signal LED driver architecture delivers high efficiency, high power factor, and low harmonics to LED lighting applications while advanced dimming technology ensures deep dimming and compatibility with existing lighting infrastructures. The high level of integration of the integrated circuits (ICs) reduces the cost of the bill of materials and allows for a small form factor printed circuit board (PCB).

88EM8183/88EM8182
The Marvell solution for the retrofit residential market is based on Marvell 88EM8183, a deep dimming single stage AC/DC LED driver integrated circuit (IC). The 88EM8183 delivers full range dimming with programmable deep dimming down to 1% and the highest compatibility with all types of phase-cut dimmers including leading-edge (TRIAC), trailing-edge and special (smart) dimmers worldwide. It significantly reduces external components hence needs less board space than other dimmable LED drivers on the market allowing lighting OEMs and ODMs to bring LED lighting to most lighting form factors. The IC also delivers high power factor, high efficiency and low total harmonic distortion.

Delivering the same high performance metrics as the 88EM8183, the 88EM8182 supports non-dimming applications.

88EM8801
The highly-integrated, highly-efficient, 88EM8801, is the industry’s first intelligent LED driver to independently control two strings of LEDs with digital interfaces. Intelligent digital control allows for 0-10V and deep dimming capability. The incorporated OTP memory block further allows the calibration of each string to its respective target LED current, during the final light fixture manufacturing. As a result, the 88EM8801 device enables the mass production of consistent light output, without using tight, hence expensive, binning LEDs. Moreover, the 88EM8801 device enables high quality light output in terms of warm correlated color temperature (CCT) and high CRI (color rendering index) by mixing red LEDs with cool white LEDs or bluish green LEDs. These applications may be controlled with the addition of DALI or ZigBee communication modules which allows networked lighting control enabling further energy efficiency through networked lighting control.

88MZ100
The Marvell 88MZ100 ZigBee® microcontroller system-on-chip (SoC) offers unparalleled advantages for home automation LED lighting control. Delivering the industry’s highest level of integration, the 88MZ100 significantly improves performance, lowers power consumption, and reduces the total bill of materials. This enables OEMs and ODMs to easily, quickly, and cost-effectively reach the market with new and innovative products in this rapidly growing space.
Software Solutions

To make design-in easier, Marvell also provides software in its complete LED Lighting Reference Platform.

**Gateway Software**

The Marvell gateway software includes embedded Linux OS and Marvell EZ-Connect Software features. The embedded Linux OS software support includes basic embedded Linux OS, DHCP client-over-Ethernet and Wi-Fi interface, WPS provisioning to connect to Application Protocol (AP), ZigBee PRO coordinator and Wi-Fi AP and Wi-Fi Direct support. Marvell EZ-Connect software features service discovery, web-services framework and firmware upgrades over the air, for an easy-to-use end user solution.

**DALI Software**

Marvell DALI software supports the latest version of the DALI standard, which was developed for the digital control of commercial lighting systems. The DALI end point stack provides provisioning, group scheduling, scene management, and integrates with the Marvell 88EM8801 to supply lighting control functions including off/on control, deep digital dimming, CCT control, temperature compensation, calibration, fixture monitoring and energy estimations. Additionally, DALI control stack architecture enables access to web management user interfaces including HTTPD, 802.3 switch driver, 802.11 access points and RESTful APIs.

Marvell works closely with leading DALI controller providers to ensure compatibility of its DALI end-point software stack.

**ZigBee Software**

Marvell ZigBee PRO software supports the ZigBee standard for wireless low-energy consumption communication. The ZigBee PRO software stack supplies mesh networking which interconnects nodes. It is the intelligence in the Marvell ZigBee Wi-Fi architecture, interfacing with the Marvell 88AP166 application processor which controls the 88W8782 Wi-Fi processor.

Marvell is working in partnership with multiple 3rd party ZigBee application software and system providers to enable turn-key wireless lighting control systems for its OEM customers.

**Kinoma User Interface**

For the client user interface, the Marvell Kinoma LED lighting software offers a software user interface for smartphones and tablets. By providing the software interfaces, Marvell makes it simpler to design an LED lighting solution where the user can control dimming, CCT control, zoning and scheduling, all from the convenience of a PC, tablet or smartphone.
Evaluation Kit and Reference Designs
Speed Product Development

To help customers rapidly introduce products into the marketplace, Marvell supplies turn-key manufacturing ready reference designs for OEMs/ODMs looking to develop residential and commercial lighting solutions. These kits include Marvell LED driver boards, design files, test files, optional network communication modules and fixtures.

88EM8183 Reference Designs
Marvell has a series of isolated and non-isolated reference designs that range from 5W, 10W and up developed for evaluating the performance of the Marvell® 88EM8183, a deep dimming, single-stage AC/DC constant current controller for replacement of offline LED lamps and luminaires. The kit’s lamp can be used to quickly verify the driver’s high level of dimmer compatibility. Further performance and evaluation tests can be conducted on the LED driver board, which can also provide the basis for product development. As these designs target the global LED market, it can be ordered as either a high-voltage 220VAC input version or as a low-voltage 110VAC input version.

External LED Drivers Reference Designs
Marvell offers a family of external LED driver solutions for low cost, high quality commercial LED lighting that include options to integrate smart lighting control. These external LED drivers have deep dimming capability that is compatible with wall box dimmers available in North American, European and Asian markets (Class 1 and Class 2). The driver and dimming circuit is designed for Class 1 isolation and UL compliance.

Applications that require Smart LED lighting control, including on/off switching, dimming, color mixing or CCT tuning, can also be developed with the addition of DALI or ZigBee communication modules which allow networked lighting control. The Marvell external LED driver boards include an interface to accept these smart communication modules making it easy to integrate this functionality into lighting designs.

Marvell turn-key reference designs for commercial lighting applications are ready for certification for EMI/EMC and CE/UL safety requirements, allowing quick time to market for LED lighting OEMs/ODMs.

- 20 Watt, 2-Stage, 2-Channel LED Driver for Downlight Applications
  - Supports CCT, Color Mixing
  - DALI, ZigBee
- 40 Watt, 2-Stage, 4-Channel LED Driver for Panel Light Applications
  - Supports DALI, ZigBee
ZIGBEE SMART LIGHTING REFERENCE PLATFORM

- **Wi-Fi Thermostat**
- **Kinoma UI Control SW**
  - Dimming
  - CCT Control
  - Zoning
  - Scheduling
- **Gateway**
  - Coordinator
  - Commissioning
  - Wi-Fi/ZB GW
- **Sensors**
  - (OCC and Photo)
- **LED Down Light**
  - (12W/20W Driver)
  - Dimming
  - CCT Control
- **Smart Outlet**
- **Switch/Dimmer**
- **LED Panel Light**
  - (40W Driver)

MARVELL SMART LED LIGHTING SOLUTIONS
THE MARVELL ADVANTAGE: Marvell chipsets come with complete reference designs which include board layout designs, software, manufacturing diagnostic tools, documentation, and other items to assist customers with product evaluation and production. Marvell’s worldwide field application engineers collaborate closely with end customers to develop and deliver new leading-edge products for quick time-to-market. Marvell utilizes world-leading semiconductor foundry and packaging services to reliably deliver high-volume and low-cost total solutions.

ABOUT MARVELL: Marvell is a leader in storage, communications, and consumer silicon solutions. Marvell’s diverse product portfolio includes switching, transceiver, communications controller, processor, wireless, power management, and storage solutions that power the entire communications infrastructure, including enterprise, metro, home, storage, and digital entertainment solutions. For more information, visit our Web site at www.marvell.com.

No representation or warranties are made concerning third party patents with regard to the use of Marvell products. The mixing of red LEDs with phosphor-converted LEDs may be protected by certain third party patents.