NXP GreenChip iCFL and GreenChip iSSL smart lighting solutions

Make Internet-enabled, energy-efficient lighting networks a reality

This complete hardware/software solution enables IP connectivity, where every light bulb has its own IP address, so you can create advanced lighting systems that are easily controlled by IP-enabled devices like smartphones, tablets, and PCs.

Key features

- Flexible, small, cost-effective hardware and software solution
- IP-enabled smart lighting system with JenNet-IP software stack
- Future-proof development with "Over-Network-Download" capability
- Supports operation via IP-gateway as well as standalone network operation with simple, secure commissioning using a remote
- (Ultra-)low standby power when lamp is off
- Multiple control options

By bringing together wireless IP connectivity, energy-efficient lighting, and low-power standby operation, NXP's GreenChip smart lighting solution makes the Internet-enabled, energy-efficient lighting network now a reality – not only for consumers in the home but also for commercial applications. This provides clear proof-of-concept for the "Internet of Things" – a world in which every home appliance can be monitored and controlled via an IP address. Plus, wireless connectivity provides a simple way to implement a smart lighting network, so existing residences and offices can also take advantage of this new concept.

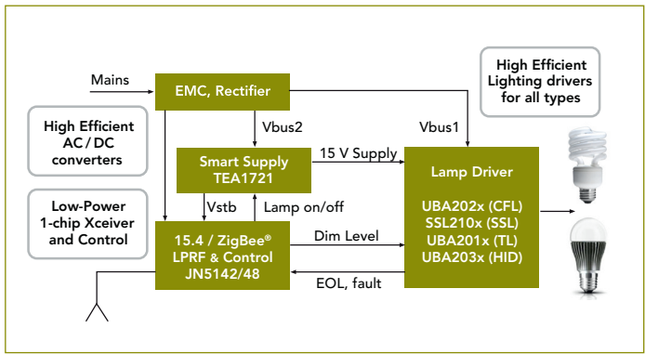
The GreenChip smart lighting solution comprises the GreenChip iCFL or the GreenChip iSSL module reference designs providing a low-cost, wireless solution for smart lighting networks that use CFL and SSL lamps respectively. The module enables high-efficiency luminary operation with (ultra-)low standby power (down to 50 mW). This can save up to 50% of an SSL lamp's daily energy usage. The hardware components are complemented by IEEE 802.15.4 software stacks such as ZigBee and NXP's JenNet-IP software stack, which provides true IP connectivity. Every light bulb has its own IP address, so the system can be controlled by smartphones, tablets, PCs, and other IP-enabled devices.

GreenChip smart lighting offers new ways to control lights and manage energy consumption. Individual lamps can now be used only when and where they are needed, and at the desired brightness level, thus saving power and electricity cost. And, by adding IP-enabled light level or occupancy sensors to the network, lights can even be configured to operate autonomously. Residential users can create highly personalized, intelligent lighting environments that use different lighting levels according to the task, such as when reading a book or watching

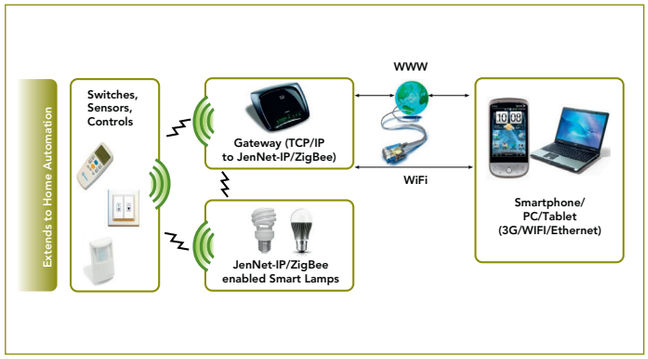
a movie. Travelers can use their smartphones to control lights remotely and thus ward off burglars and intruders. Professional users in hotels or other commercial and industrial buildings can use self-diagnostic information, including burning hours, switching cycles, and failure reporting, to optimize maintenance schedules and reduce costs. Also, IP-enabled lighting gives utility companies a way to help consumers control their energy consumption remotely. Consumers may choose, for example, to let the utility company dim their lights, during peak hours, by 10% (a change that is hardly noticeable), in return for lower rates.

GreenChip smart lighting solutions are complete and flexible solutions that consist of high-performance chipsets featuring highly efficient and dimmable smart lamp drivers such as the UBA2027 and the SSL21081. It also includes the TEA1721, an ultra-low power standby supply controller with a no-load capability of just 10 mW, and the JN514x, which integrates a low-power RF transceiver compatible with the IEEE 802.15.4 standard with a 32-bit microcontroller that has receive currents as low as 17 mA. The chipset is combined with the robust JenNet-IP network protocol stack, which offers small code size and supports a truly cost-effective design. The solution is complemented by a full set of reference designs and related Bill-Of-Materials (BOM) covering a wide range of applications. Other software stacks, including ZigBee, are available as options.

System architecture of the GreenChip smart lighting solution



Sample smart lighting network with lamps, switches, sensors, remote control, and optional IP-control via gateway by smartphone, tablet, or PC. The lamps can be IP enabled by a 6LoWPAN stack option used on top of JenNet (JenNet-IP)



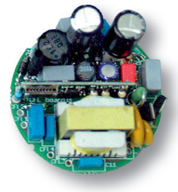
The GreenChip smart lighting solution allows for multiple control options including RF remote controls, sensors, and battery-powered switches for use in a standalone network. The very low-power performance of the JN514x enables battery lifetimes exceeding 10 years from a coin cell, and supports the use of battery-less, energy-harvesting switches.
Beyond these more conventional control options, the JenNet-IP SW stack allows the system to be controlled by IP devices such as smartphones, tablets, or PCs. This functionality is enabled via low-cost gateways, providing control either via the Internet or the Local Area Network (LAN). This makes GreenChip iCFL and GreenChip iSSL solutions for everyone from consumers in the home to professional users working with Building Management System (BMS) applications.

GreenChip (iSSL and iCFL) smart lighting solutions

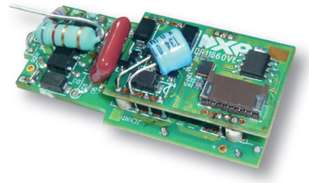
- IP-enabled smart lighting system with JenNet-IP SW stack, where every lamp has its own IP-address
  - Supporting operation via IP-gateway as well as standalone network operation with simple and secure commissioning using a remote
  - Future-proof with 'Over-Network-Download' capability of network and application SW updates
- (Ultra-)low standby power when lamp off
  - 150 mW with Zigbee and JenNet-IP SW stack
  - 50 mW with JenNet-IP low-power option (roadmap)
- Low cost option with linear instead of buck supply (roadmap)
- Low BOM cost (ICs, external components, PCBs)
  - Lowest cost with JenNet-based software stack and linear supply: ~ 20% cost reduction vs ZigBee software stack and buck converter supply
- Flexible solution due to full range of NXP lighting drivers, AC/DC converters, and high -performance, IEEE 802.15.4 single-chip transceivers and MCUs
  - UBA207x CFL-family, SSL21xx SSL-family, UBA201x TL-family, UBA203x HID-family, both standalone controllers as with integrated power FET
  - 100/120 and 230 V solutions
  - Various power ranges (5 to 150 W)
  - Isolated and non-isolated (flyback and buck topologies)
  - Deep dimmable down to 2% (iCFL) and <1% (iSSL) by RF remote control, switch, or IP device
  - Triac tolerant and on-off control by triac
  - JN5142 for JenNet(-IP) and JN5148 for ZigBee SW stacks
- Multiple control options
  - Battery-powered switches, dimmers, and (captouch) RF remote control with >10 years battery lifetime
  - Dual-boot option for remote (e.g. running both RF4CE and JenNet/ZigBee protocols)
  - Battery-less energy harvesting switches
  - Occupancy and light-level sensors
  - PCs, tablets, smartphones, etc. via gateway

- Supported software stacks and size (excluding application)
  - JenNet standard ~ 50 kB
  - JenNet-IP ~ 120 kB
  - ZigBee Home Automation ~ 120 kB
  - ZigBee LightLink ~ 128 kB
  - ZigBee Green Power ~ 10 kB
- Full set of iCFL and iSSL reference designs

iCFL Smart Lighting solution



iSSL Smart Lighting solution



Overview of iCFL and iSSL reference designs

Reference design	Mains voltage	Lamp driver	Standby power supply	Wireless microcontroller	Power	Standby power	LED voltage	Efficiency @ 30/60 V LED voltage	Power factor	Optional features
CFL isolated analog dimming	110 V & 230 V	UBA20270	TEA1721	JN5142/48	20 W, scalable	140 mW	N.A.	CFL driver >90%	0.6 - >0.9	Triac compatibility, start-up time from mains <300 mS, meeting regional THD &EMI regulations, LED open string protection, standby power/cost optimization
SSL non-isolated PWM dimming	110 V & 230 V	SSL2108	TEA1721	JN5142/48	15 W	140 mW	12-80 V	88/91%	0.6 - 0.85	
SSL non-isolated analog dimming	110 V & 230 V	SSL2101	TEA1721	JN5142/48	15 W	160 mW	12-80 V	85/88%	0.6 - >0.9	
SSL isolated LEDs, non-isolated antenna, analog dimming	230 V	SSL2101	TEA1721	JN5142/48	15 W	160 mW	9-80 V	84/85%	0.6 - >0.9	
SSL isolated LEDs and antenna, analog dimming	Universal mains	TEA1731/33	TEA1721	JN5142/48	scalable	160 mW	9-80 V	84/85%	0.6 - >0.9	

iCFL chipset

Dimmable CFL lamp driver UBA2027

- Universal mains compatible
- Integrated bootstrap diode
- Triac dimmable, down to 1%
- Step dimming option
- Fast start-up adjustable down to 100 ms
- Boost function for faster light output run-up
- Longer lifetime with adjustable preheat, >15 k hours
- 5% higher energy efficiency
- Extensive protections
- SO16 package

5 W low-power SMPS regulator with ultra-low-power standby TEA1721

- No-load power consumption 10 mW
- Universal mains compatible
- Integrated 700 V powerFET
- High efficiency over full load range
- Primary sensing, eliminating need for opto-coupler
- Jitter for reduced EMI
- Minimizes audible noise
- Extensive protections
- SO7 package

Low-cost flyback controller for isolated analog dimmable LED lamps TEA1731/33

- Large input voltage range (12-30 V) allowing universal mains LED driver reference design
- Very low 10 uA supply current during (re-)start
- Low supply current during normal operation (0.5 mA without load)
- High efficiency at medium load and no-load
- Jitter for reduced EMI (TEA1733)
- Extensive protections
- TSOP6/SO8 package

iSSL chipset

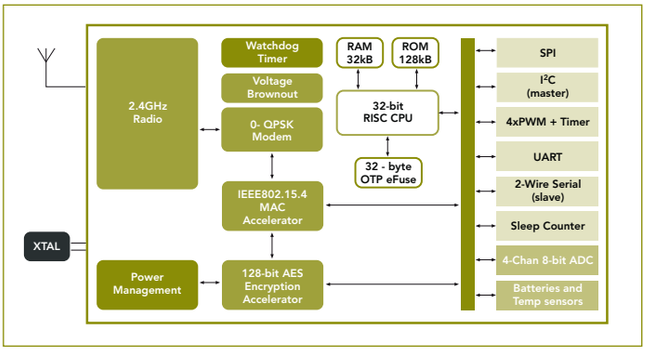
15 W dimmable SSL2108 LED lamp driver

- 100 to 120 V mains
- True constant-current source
- PWM dimmable
- Buck mode (non-isolated), efficiency >95%
- NTC temperature feedback
- No LED forward voltage binning required
- Low BOM cost and small size
- Extensive protections
- SO8 package

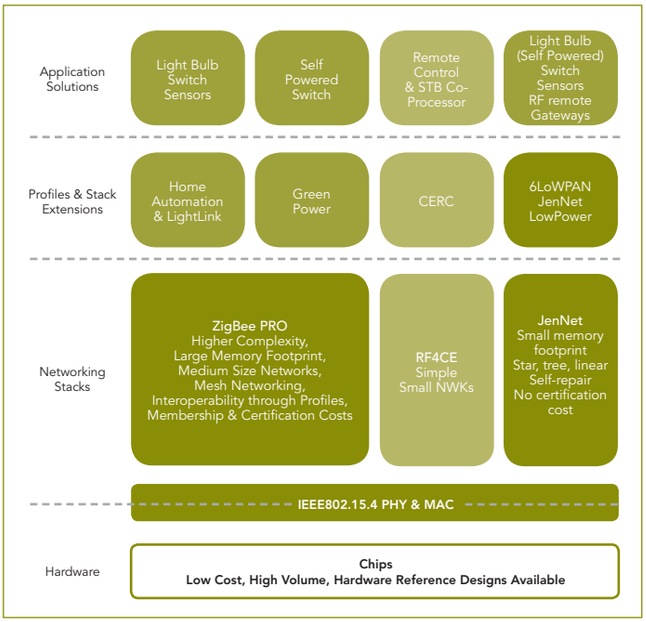
IEEE 802.15.4 wireless microcontroller JN5142/48

- 2.4 GHz IEEE 802.15.4 compliant
- Low operating power: 15/17 mA Tx/Rx
- Low sleep current: 0.1 µA deep sleep with IO-wake-up, 0.5 µA with timer running
- 98 dB link budget
- 128-bit AES encryption security processor
- Various MAC accelerator functions
- High-performance 32-bit, 32 MHz RISC CPU
- 128 kB ROM, 32/128 kB RAM
- Extensive set of peripherals, including I^2C, SPI, UART, ADC, DAC, PWM, timers, GPIO
- Capacitive touch-sensing capability
- On-chip temperature sensor
- QFN40/56 package

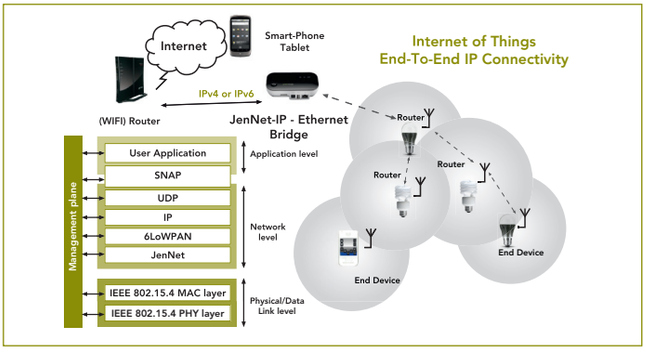
Block diagram of JN5142 IEEE 802.15.4 wireless microcontroller



Overview iCFL and iSSL hardware, networking and application software



JenNet-IP software and system architecture



JenNet-IP low power wireless network protocol stack

This stack is used to manage the following: network formation, the execution of join and repair functions, and packet transmission between nodes.

- Based on IEEE 802.15.4 MAC and PHY and 6LoWPAN IPv6 IETF standard, backwards compatible with IPv4
- Highly robust, easily scalable, self-healing and re-shaping star, tree, or linear network topology proven at over 500 nodes
- 'Mesh-under' approach minimizes power consumption, number of packet buffers, and latencies
- Gateway and non-gateway options for connecting to the internet (via low cost ethernet-15.4 IP-bridge) or standalone operation
- Automatic route formation and self-repair to prevent single-points-of failure and network re-shaping functionality to reduce network 'depth' and latencies
- IP / ICMP / UDP Internet Protocol stack
- Easy-to-use MIB- and SNMP-model based (GET/SET/TRAP commands) SNAP application API tuned for extensible sensing/control
- Provides real end-to-end communication between nodes, eliminating all issues associated with intermediate expensive and power-hungry Home Automation gateways like increased latencies, security issues, limited feature visibility & expandability and state integrity
- Highly secure authentication & device joining and secure communication with 128-bit AES encryption, simple commissioning of standalone networks with a remote with reduced radio performance during key exchange
- Future proof with "Over-the-Network" download functionality for application or network firmware updates
- Sleeping end-devices for extended battery life
- Co-existence with Bluetooth and Wi-Fi
- Low-power option for applications requiring low standby power
- Low cost of ownership: small memory footprint ~ 120 kB, low development cost, low complexity, license-free, compliance-free

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Date of release: November 2011
Document order number: 9397 750 17204
Printed in the Netherlands