Innovative semiconductor solutions for energy efficiency, mobility and security
Market segments with biggest growth potential: General Lighting + ATV

Consumption of LED chip area by application

- General Lighting: 39% CAGR (2012-20)
- Automotive: 19%
- Signs and displays: 4%
- LCD TV and Monitors: 7% (*)(2012-20)
- Consumer/Portables: 5% (*)

Source: Yole

* Actual growth rates likely to be lower, as OLED to displace LED in Consumer/Portables (>2013) and TV/Monitors (>2015)
Our Application Focus is mainly General Lighting

Professional Lighting
- COMMERCIAL: Luminaires, desk-lamps, high / low bay

Architectural & Entertainment
- Wall washer, stripe lights, accent lights, cove lighting, path lights, stage lighting

Outdoor area lighting
- Street, tunnel, parking lot

Replacement Lamps
- MR16
- Linear tubes

Others
- CONSUMER: Home appliances, projectors
- INDUSTRIAL: Channel letters, signs, signals, machines
- AUTOMOTIVE: Interior lighting, tail light

Architectural & Entertainment
- Street, tunnel, parking lot

Others
- CONSUMER: Home appliances, projectors
- INDUSTRIAL: Channel letters, signs, signals, machines
- AUTOMOTIVE: Interior lighting, tail light
Infineon as System Supplier for LED Lighting

AC/DC (primary side)
- EMI Filter / Rectifier
- PFC Converter
- LLC Converter
- FF/QR Flyback Converter
- PFC - Flyback Converter

DC/DC (secondary side)
- Buck LED driver
  - ILD 4035 (0.35A)
  - ILD 4120 (1.2A)
  - ILD 4180 (1.8A)
  - ILD 4001 (ext mosfet)
- Buck-Boost driver
  - ILD1151 (ext mosfet)
- Linear LED driver
  - BCR 450 (700mA)
  - BCR 32x (250mA)
  - BCR 420x (150mA)
  - BCR 40x (65mA)
- Discrete Power
  - CoolMOS™ C6/E6
  - OptiMOS™ New Bipolar transistors
- Microcontroller
  - DALI
  - DMX

Increasing power level

Copyright © Infineon Technologies 2011. All rights reserved.
AC / DC LED driver solutions vs. power range

1W to 60W
- Primary Side Current Control
- Benchmarking BOM
- Less design effort
- Less lifetime critical components

20W to 150W
- Secondary Side Feedback Control
- Integrated secondary side controller available
- Optocoupler required
- Precise regulation of higher currents

50W to 200W+
- Secondary voltage control plus current source
- Most powerful solution
- Easy way to drive many parallel strings
Our focus applications require a set of different power topologies and system partitioning concepts.

**Topology**

**Offline-LED Driver**
- (no sec. side Drivers)
- PFC/QR or FF flyback (PCC*)
- single-stage
- PFC/non-isolated buck
- single stage

**DC/DC LED Driver**
- MR16 (12VAC)
  - buck (<3W)
  - boost (>3W)

**Scope of ICLSx-Series NON Dimming**
- two-stage PFC/Flyback (SVC**)
- single-stage PFC/Flyback (SVC**)

**AC/DC Voltage Power Supply**
- (+ sec. side Drivers)
- two-stage PFC+LLC (SVC**)
- multi-string

**Application**

- **Consumer - Retrofit & Residential**
- **Indoor - Professional Downlight**
- **Indoor – Professional Office & Commercial (Luminaire)**
- **Indoor – Professional Industrial (high-bay)**
- **Outdoor – Park/Parking/Tunnel**
- **Outdoor – Tunnel/Street Lighting**

**Power Range**
- 5W
- 10W
- 20W
- 30W
- 40W
- 60W
- 80W
- 100W
- 200W

*Primary Current Control 
**Secondary Voltage Control
AC/DC primary side controller at a glance

Core competence

Retrofits
- One of the smallest bulb replacement approach currently in the market.
- Dedicated portfolio.

Lighting power supplies and street lighting
- Integrated solutions fully protected for AC/DC conversion
- Scalability of controller ICs
- Best in class power semiconductors

Full topologies availability

Single stage BULB & SPOT light replacement
- ICL8001 and ICLSxxxx PWM controllers

Medium power architectures for lighting power supplies
- ICE PFC controller ICs and QR/FF CoolSET™

High power for street and stage lighting
- ICE PFC controller ICs and ICE LLC
- CoolMOS™ and OptiMOS™ power mosfets
- New DALI/DMX 8Bit µControllers
### Primary side current control solutions

#### Low cost solution
- Best in class BOM (\(-30\%\) cmp to standard)
- No feedback required, integrated startup cell
- Smallest form factor
- With or without dimming support

#### Efficiency & Power Factor
- 90\% for ICL80x series
- 87\% for ICLS6x series
- CoolMOS integrated or ext. FET
- PFC stage integrated – PF > 98\%

#### Control Scheme
- Quasi Resonant Flyback in ICL80x series
- Fixed Frequency Flyback in ICLS6x series
- Constant Power control
- Isolated solution

#### Dimming
- ICL80x series: phase cut dimmable
- ICLS6x series: non-dimming
Single-stage isolated Flyback LED driver

**Dimmable**

<table>
<thead>
<tr>
<th>LEDSET</th>
<th>Typ</th>
<th>$V_{DS}$ (V)</th>
<th>$R_{DSON}$ (Ohm)</th>
<th>Nominal Power ($\pm 15%$) $230V_{VACIN}$</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICL8001G</td>
<td>PFC / QR-FB</td>
<td>Ext. FET</td>
<td>-</td>
<td>Ext. FET</td>
<td>PG-DSO-8</td>
</tr>
<tr>
<td>ICLS8082G</td>
<td>PFC / QR-FB</td>
<td>800V CoolMOS</td>
<td>2.26</td>
<td>26W</td>
<td>PG-DSO-12</td>
</tr>
</tbody>
</table>

**Non-Dimmable**

<table>
<thead>
<tr>
<th>LEDSET P/N</th>
<th>Typ</th>
<th>$V_{DS}$ (V)</th>
<th>$R_{DSON}$ (Ohm)</th>
<th>Nominal Power ($\pm 15%$) $230V_{VACIN}$</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICLS6021J</td>
<td>PFC+ FF-FB</td>
<td>650V</td>
<td>6.45</td>
<td>12W</td>
<td>DIP-8</td>
</tr>
<tr>
<td>ICLS6022J</td>
<td>PFC+ FF-FB</td>
<td>650V</td>
<td>4.70</td>
<td>17W</td>
<td>DIP-8</td>
</tr>
<tr>
<td>ICLS6022G</td>
<td>PFC+ FF-FB</td>
<td>650V</td>
<td>4.70</td>
<td>17W</td>
<td>DSO-12</td>
</tr>
<tr>
<td>ICLS6023J</td>
<td>PFC+ FF-FB</td>
<td>650V</td>
<td>1.70</td>
<td>26W</td>
<td>DIP-8</td>
</tr>
<tr>
<td>ICLS8023Z</td>
<td>PFC+ FF-FB</td>
<td>800V</td>
<td>2.26</td>
<td>24W</td>
<td>DIP-7</td>
</tr>
</tbody>
</table>

**Key Features:**
- Efficiencies 90% (ICL80xx) 89% (ICL6xxx)
- PF > 98%
- Best in Class BOM
- Smallest form factor
- Phase-cut dimmable (ICL80xx)
- Dimmer-safe (ICL60xx)
Single-stage isolated Flyback LED driver

Single-stage PFC/QR-Flyback Solution for Phase cut dimmable LED Retrofit Lamps

Features
- Efficiency up to 90%, Power Factor > 95%
- Good accuracy in Line Regulation < 5%
- For all phase cut dimmers
- Pass THD in ICE61000-3-2 in Class C

Benefits
- High lm/W and less heat generated
- Homogenous light output
- No changes in installation required
- In accordance with legal requirements

ICLx8000 series
Constant current vs. constant power

Constant Power Control allows Savings on Heat Sink Design

Variations in Vf classes do no longer require extra safety margins in heat sink design
- very good thermal management
- minimized LED bulb system cost
A good Compromise: Current \( \pm 4\% \) and Power Factor \( >90\% \)

**LINE REGULATION**

LED Current versus AC Line Input Voltage @ nominal Load

- Config. 4 PF 95.8%
- Config. 7 PF 90.4%
- Config. 11 PF 81.1%

![Graph showing line regulation](image)
Overview of SMPS IC solutions

AC/DC for Secondary Side Regulated Solutions

- **PFC**
  - DCM PFC
  - CCM PFC
  - TDA4863
  - TDA4862
  - ICE2PCS0xx
  - ICE3PCS0xx

- **Flyback**
  - Fixed Frequency
  - Quasi Resonant
  - CoolSET ICE3-series
  - CoolSET ICE2Q-series

- **LLC Forward**
  - LLC
  - Forward
  - ICE1HS01
  - ICE2HS01 LLC+SyncRect
  - ICE1CS02

- **Combo**
  - PFC/FB single stage
  - ICL8000-series
  - ICLS6000-series
  - TDA4863

For all CoolSET types, visit www.infineon.com/coolset
120W reference design for wide area lighting
Highly efficient dimmable LED solution

Modular solution w/ adaptive voltage scheme to maximize efficiency

Vin: 90–270VAC  
Vbus: 37V-48V  
I_{LED}: 4 x 700mA  
DALI Interface Option  

Power Factor >0.95  
Efficiency >92%  
PWM Dimming  

TDA4863-2G (DCM-PFC) + ICE2HS01G (LLC)  

CoolMOS™ C6 + OptiMOS™  

BCR450+BDP947 (LED Driver+Booster)  
XC824 (MCU)  

Vin: 90–270VAC  
Power Factor >0.95

Vbus: 37V-48V  
Efficiency >92%

I_{LED}: 4 x 700mA  
PWM Dimming

DALI Interface Option

LED driver stage

TDA4863-2G (DCM-PFC) + ICE2HS01G (LLC)

CoolMOS™ C6 + OptiMOS™

BCR450+BDP947 (LED Driver+Booster)  
XC824 (MCU)
LED Driver ICs at a Glance

Core competence

**Linear LED drivers**
- The smallest available LED drivers with adjustable LED current on the market.
- The most cost effective LED drivers and the only dedicated 0.5W LED drivers on the market.

**Switch-mode LED drivers**
- Thermal protection to extend lifetime of the LED/System. PWM and DC voltage dimming.
- LED Controllers with external MOSFETs for great design flexibility.

LED drivers for all LED power classes

**Low power LED drivers - 0.1–0.2W LEDs**
- BCR40xW, BCR40xU, BCR205W

**Medium power LED drivers - 0.5W LEDs**
- BCR32xU, BCR42xU

**High power LED drivers - > 1W LEDs**
- BCR450, ILD4 family

More info: [www.infineon.com/lowcostleddriver](http://www.infineon.com/lowcostleddriver)

Market position
- We are #1 with linear LED drivers in channel letters and signage.
- We offer a fast growing portfolio of switch-mode LED drivers for high power LEDs.
Our Products for a wide Range of Applications

Max $I_{out}$ (A)  

- **0.02 A**: BCR401W, BCR402W, BCR402U, BCR405U
- **0.15 A**: BCR205W + Switch, BCR401W
- **0.35 A**: BCR450 + Switch, ILD4035
- **0.7 A > 2 A+**: ILD1151 + Switch, ILD4001 + Switch, ILD4120 / ILD4180

SELV Isolation

- **Buck/boost**
- **Buck**
- **Linear**

Max. $V_{out}$ (V): 12, 24, 36, 48, 60
Resistor biased LED Driving: No LED protection & inhomogenous light output

**Required driving current is 20mA @ 12.0V**

- **Test at Ta = -40°C**
- **Test at Ta = 25°C**
- **Test at Ta = 85°C**

**Disadvantages of resistor biased LED driving compared to linear drivers**

- Major driving current change if Vs changes slightly
  - → change in light output
- Higher Ta increases the LED current significantly
  - → thermal runaway
  - → no LED protection
Single Stage PFC with Fly-back combined with linear drivers on secondary side

Optimized System Solution:
Combination of single-stage PFC + Flyback AC/DC converter, constant current control and linear drivers allows

- high power factor,
- high efficiency (overall 87%),
- no EMI on secondary side
Demoboards for Design-In Support ctd.

<table>
<thead>
<tr>
<th>Demoboard</th>
<th>Ordering Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILD 4035 board</td>
<td>SP00085844 12V</td>
<td>- Drive 1W LEDs with the buck LED driver ILD 4035</td>
</tr>
</tbody>
</table>
|                  | version SP00085845 24V version | - 24V and 12V supply voltage version available  
- 350mA preset LED current  
- Analog voltage and PWM pin for dimming  
- Can be connectec to a string of 1W LEDs |
| ILD 4120 board   | SP000858454         | - Drive 3W LEDs with the buck LED driver ILD 4120  
- 12/24V supply voltage  
- 700mA preset LED current  
- Analog voltage and PWM pin for dimming  
- To be connected to a string of 3W LEDs |
| ILD 4180 demoboard | SP000848474     | - Drive ultra-high power LEDs with the buck LED driver ILD4180  
- Up to 45V supply voltage  
- LED current adjustable up to 1.8A  
- Demoboard can be operated in either constant current or constant output voltage mode |
Infineon LED Drivers and LED Lighting solutions
Support tools and collaterals

**Dedicated**
Demo boards for each LED driver
Ask for your demo board today!

**Ready-to-copy Reference Designs**
(BoM, Gerbers available on request)
Visit
www.infineon.com/led-bulb
www.infineon.com/led.appnotes

**Online LED Driver Selection Tool**
for General Lighting Applications
Visit
www.infineon.com/ledcircuitdesigner

**LED Driver Sample Kit**
(Contains a selection of LED driver product samples for instant designing)
Ask for your personal sample kit today!

**Increasing number of Application Notes**
Visit
www.infineon.com/led.appnotes

**Up-to-date collaterals: Lighting brochures/flyers**
Visit
www.infineon.com/lightingbrochure
www.infineon.com/lightingflyer

Copyright © Infineon Technologies 2011. All rights reserved.
LED driver selection tool for General Lighting applications

1. Register
2. Enter design parameters
3. Application schematic & Simulation
4. Overview of BOM

Infineon.com/ledcircuitdesigner
Infineon LED Drivers
LED Lighting solution examples

15W E27 LED Bulb (equivalent to 60W)
Features:
- Single Stage, incl. PFC
- Power factor > 0.98
- Efficiency: 90%
- Wide dimmer support

Benefits:
- 30% BoM cost reduction vs. competition
- Smallest form factor (also suitable for GU10)
- Ready to meet future regulatory requirements

visit www.infineon.com/led-bulb

40W Public LED Lighting solution
Features:
- Power factor > 0.95
- Efficiency (AC to LED): ~90%
- Supports PWM control for dimming

Benefits:
- Cost competitive due to low part count & cost efficient ICs
- Easy to scale due to modular concept

Appnote AN186 on www.infineon.com/led.appnotes

120W Street Lighting solution
Features:
- 2-stage power supply with feedback control
- Power factor > 0.95
- Efficiency (AC to LED): 92%
- Supports PWM and DALI control

Benefits:
- No EMI on secondary side
- Very cost competitive
- Modular concept allows 1-8 channels

Appnote soon available on www.infineon.com/led.appnotes

LED Lighting Control Kits for PWM / DALI
Features:
- Based on XC822
- USB I/F for power supply and programming access
- Software included

Benefits:
- Ready-to-use
- Free tool chain
- Code examples included for faster time to market

visit www.infineon.com/inlight
Leaders in linear LED drivers

We will ship more than 100 million pcs linear LED Drivers in FY2011 Worldwide!

Main application: Channel letters

Automotive LED Lighting

Tier 1 through Tier 3 customers use Infineon LED drivers

Major design wins with Offline LED Drivers

Major LED bulb designs made in EMEA already have Infineon inside!

This could be your success story!

Make the LED Applications the next success story
ENERGY EFFICIENCY
MOBILITY
SECURITY

Innovative semiconductor solutions for energy efficiency, mobility and security.