Digitally Controlled Electronic Lighting Ballast

Overview
A lighting system in a typical building, based on ballasts that use a simple inductor and starter, can consume up to 40 percent of the electricity required to power the building. This inefficiency is wasteful and costly. The introduction of new European and International legislation is mandating increased efficiencies and the elimination of the two most inefficient light ballasts from 2005. The deadline for this conversion is driving the development of efficient, cost-effective electronic light ballasts. Microcontrollers offer the ideal low-cost solution.

Key Benefits
> Electronic ballasts offer increased system efficiency over traditional magnetic ballasts.
> Improved ballast efficiency leads to extended life for fluorescent tubes.
> Electronic systems provide an increased level of control for variable light levels.
> Digital control allows large lighting networks to be controlled remotely.
> The DALI protocol provides intelligent building automation and cost-effective large lighting network control.
> Complete reference designs, based on Freescale Semiconductor MCUs, are available from Freescale Semiconductor free of charge.

![Electronic Light Ballast Block Diagram]

**Legend**
- HRP - Accurate 1/2 bridge control
- PWM Module - Boost topology PFC control
- ADC - Voltage and current measurements
- I/O - Zero crossing detection

**ELECTRONIC LIGHT BALLAST BLOCK DIAGRAM**

MC68HC908LB8

- Half Bridge Driver
- HRP
- PFC
- PWM
- LVI
- KBI
- COP
- I/O
- Flash
- CPU08
- RAM
- Timer
- Clock
- OpAmp/ACMP
- V/I
- PFC
- PWM
- COP
- KBI
- LVI
- I/O
Design Challenges
A lighting ballast that uses a simple inductor and starter consumes 40 percent of electricity required to power a building. The inefficiency is wasteful and costly.

Freescale Semiconductor Solutions
The MC68HC908LB8 from Freescale provides the ideal one chip solution for light ballast applications, offering reduced component count, significant cost-saving, and improvements in system efficiency. A complete reference design is available based on the MC68HC908LB8 demonstrating dimmable light ballast control with power factor correction. This device also supports the DALI protocol which provides intelligent building automation and cost-effective lighting network control. A complete DALI reference design based on the Freescale MC68HC908KX8 is also available. Many of our other standard microcontrollers, including the MC68HC908Q family detailed above, offer attractive low cost solutions as part of a multi-chip system.

Benefits Using MC68HC908LB8
> Reduces power loss and distortion by addressing power factor correction.
> Accurately controls signals using high resolution PWM.
> High integration reduces system size and cost.
> Complies with energy efficiency requirements for ballast in fluorescent lighting systems; directive IEC 555.

Development Tools

<table>
<thead>
<tr>
<th>Tool Type</th>
<th>Product Name</th>
<th>Vendor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo Board</td>
<td>DEMO908LB8</td>
<td>Freescale Semiconductor</td>
<td>Cost effective development board in a small form factor with serial port, switches, LEDs, potentiometer, and demo software including source code.</td>
</tr>
<tr>
<td>Emulation Module</td>
<td>M68EM08LB8</td>
<td>Freescale Semiconductor</td>
<td>Emulation module for FSICE system.</td>
</tr>
<tr>
<td>Emulation Kit</td>
<td>FSICEKITLB8</td>
<td>Freescale Semiconductor</td>
<td>Complete FSICE high-performance emulator kit; includes emulator module, cables, head adapters, and programming adapters.</td>
</tr>
<tr>
<td>Demo Board</td>
<td>M68DEMO908QT4</td>
<td>Freescale Semiconductor</td>
<td>Low-cost demo board for M68HC908Qx.</td>
</tr>
<tr>
<td>Emulation Module</td>
<td>M68EML08QBLTY</td>
<td>Freescale Semiconductor</td>
<td>Microcontroller emulation module for use with FSICE.</td>
</tr>
<tr>
<td>Emulation Kit</td>
<td>FSICEKITQBLTY</td>
<td>Freescale Semiconductor</td>
<td>Complete FSICE high-performance emulator kit; includes emulator module, cables, head adapters, and programming adapters.</td>
</tr>
<tr>
<td>Hardware</td>
<td>56F800DEMO</td>
<td>Freescale Semiconductor</td>
<td>56F800 Demonstration Kit</td>
</tr>
<tr>
<td>Hardware</td>
<td>DSP56F801EVM</td>
<td>Freescale Semiconductor</td>
<td>Evaluation module for 56F801 and 56F802 processors.</td>
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</table>
### Third Party Support

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Description</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metrowerks</td>
<td>CodeWarrior™ Development Studio for 56800/E Hybrid Controllers and HC(S)08.</td>
<td><a href="http://www.metrowerks.com">www.metrowerks.com</a></td>
</tr>
</tbody>
</table>

### Freescale Semiconductor Reference Designs

<table>
<thead>
<tr>
<th>Design Number</th>
<th>Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td>RDHC908LB8LIGHT</td>
<td>Dimmable Light Ballast with Power Factor Correction Reference Design</td>
<td><a href="http://www.freescale.com">www.freescale.com</a></td>
</tr>
</tbody>
</table>

The drive for energy conservation and the resulting legislation has led to a need for more efficient light ballast design. This reference design describes the design of a fully digital dimmable light ballast with power factor correction (PFC) control for two parallel connected fluorescent lamps.

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<tr>
<td>RDHC908KX8DALI</td>
<td>Digital Addressable Lighting Interface (DALI) for Lighting Networks Reference Design</td>
<td><a href="http://www.freescale.com">www.freescale.com</a></td>
</tr>
</tbody>
</table>

The drive for energy conservation and intelligent building automation has led to the development of the DALI standard for control of lighting networks, especially those involving fluorescent ballasts. Backed by the major lighting manufacturers in the world, the DALI interface allows for low-cost control of large networks.

This design demonstrates how to use the Freescale Semiconductor 68HC908KX8 in a master-slave configuration where the units are communicating with a simple protocol.

Note: Search on the listed design number.