Meeting Energy Efficiency Standards

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Power Integrations

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The Leader in High Voltage AC-DC Power Conversion ICs

- Revolutionary products
  - TOPSwitch®, TinySwitch®, LinkSwitch®
- Pioneer in energy efficiency (EcoSmart®)
  - $2.7 billion saved in energy waste to date
- Products address 70% of all AC-DC power supplies
- Shipping > 650 million ICs per year
Cost-Effective Integration

36-watt discrete adapter:
75 discrete components
Cost-Effective Integration

36-watt adapter with a PI chip: 25 components
Power Integrations - India

• Established in 1995
  – 600+ customers
  – 2 distributors (Spectra Innovations, SM Electronics & Components)
    • 1 more to be added in 2008

• Applications design lab in Bangalore
  – Conducted EMI test capability

• Localized design support
  – Customized designs for India mains
  – Design seminars
Reducing Standby Power – Two Components

- Each area can contribute to significant energy savings
- Many products need attention to both areas for maximum savings
  - Power supply to improve standby efficiency
  - Power management to reduce consumption in standby

AC Mains → Standby Power

Power Conversion
Improve power supply efficiency in standby

Internal or external

Power Management
Reduce power consumption in standby

Usable DC Power

Set-top box, TV, DVD… etc
### Importance of Power Supply Standby Efficiency

<table>
<thead>
<tr>
<th>Power supply standby efficiency</th>
<th>Total input power</th>
<th>Loss in Power supply</th>
<th>Power used by the product</th>
</tr>
</thead>
<tbody>
<tr>
<td>33%</td>
<td>1.5 W</td>
<td>1.0 W</td>
<td>0.5 W</td>
</tr>
<tr>
<td>67%</td>
<td>0.75 W</td>
<td>0.25 W</td>
<td>0.5 W</td>
</tr>
</tbody>
</table>

- Doubling Standby Efficiency Saves: 0.75 W
A Good Example of Power Management

- Inexpensive phone (free with contract)
- Transmits and receives constantly
- Consumes only 20 mW in standby (180 hours)
- Consumes 1.15 W during calls (3 hours)
- On:Standby consumption ratio is 60:1

Demonstrates what can be achieved through cost-effective power management
Switchers Offer High Efficiency

Switchers offer much higher efficiency at cost-parity with linears
EcoSmart Cost Effectively Improves Stand-by and Active Mode Efficiency
# Two Control Methods Cover All Power Ranges

<table>
<thead>
<tr>
<th>Power Range</th>
<th>Architecture</th>
<th>Control Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 30 W</td>
<td>Single supply</td>
<td>Digital ON/OFF control</td>
</tr>
<tr>
<td>20 – 200 W</td>
<td>Single supply</td>
<td>Multi-Mode PWM control</td>
</tr>
<tr>
<td>&gt;150 W</td>
<td>Dual supply</td>
<td>Digital ON/OFF control (for 0 - 50 W standby supply)</td>
</tr>
</tbody>
</table>
Digital ON/OFF Control
Digital ON/OFF Control

- Each ON cycle delivers full power
  - Cycles are disabled (OFF cycles) as needed to maintain regulation
- Provides virtually constant efficiency over entire load range
  - Effective switching frequency proportional to load
- Much simpler than PWM control
- Meets 300mW no-load without bias winding
Less Than 30mW No-load With Bias Winding

- Three parts reduce no-load consumption from ~300 mW to 30 mW
  - Energy saving is 27 cents per year
  - Component cost is 1 cent - about 5 cents at retail
  - Payback period only 2.2 months
32 W (85 W Peak) Printer Power Supply

Greater than 70% efficiency at 1 W input
Constant Efficiency Over a Wide Power Range

- Average frequency automatically adjusted for line/load condition
  - Constant efficiency operation over entire line and load range
Multi-Mode PWM Control
Optimizing Operating Mode vs. Load

- Standby/Sleep Mode
- Active-on load range
- Low Fixed Frequency PWM
- Variable Frequency PWM
- Full Frequency PWM
- Multi-Cycle Modulation

Efficiency vs. Pout normalized to 46 W

- 115 VAC
- 230 VAC
Multi-Mode PWM Control Example
46 W LCD Monitor Supply
Standby Power Supply
(Digital ON/OFF Control)
20 W PC Standby Supply

67% efficiency at 1 W input
Usable Output Power

PC Standby Supply

<table>
<thead>
<tr>
<th>INPUT POWER</th>
<th>AVAILABLE OUTPUT POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 W</td>
<td>2.3 W (eff 77%)</td>
</tr>
<tr>
<td>2 W</td>
<td>1.48 W (eff 74%)</td>
</tr>
<tr>
<td>1 W</td>
<td>0.67 W (eff 67%)</td>
</tr>
</tbody>
</table>

AC Input Voltage (V)
Industry Begins Driving Energy Efficiency Specs

- **Proposed Energy Efficiency Index for Mobile Phones**
  - Driven by major OEMs
  - Suppliers commit by 2008 with updates every 3 years

- **Self certification**
  - Uses ENERGY STAR test method

- **Star rating to be shown on product or user guide**

- **Tighter than current standards**

<table>
<thead>
<tr>
<th>Scoring</th>
<th>No-load power consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>🌟🌟🌟🌟🌟</td>
<td>≤ 0.03 W</td>
</tr>
<tr>
<td>🌟🌟🌟🌟</td>
<td>&gt; 0.03 W to 0.1 W</td>
</tr>
<tr>
<td>🌟🌟🌟</td>
<td>&gt; 0.1 W to 0.2 W</td>
</tr>
<tr>
<td>🌟🌟</td>
<td>&gt; 0.2 W to 0.3 W</td>
</tr>
<tr>
<td>🌟</td>
<td>&gt; 0.3 W to 0.5 W</td>
</tr>
<tr>
<td>No stars</td>
<td>&gt; 0.5 W</td>
</tr>
</tbody>
</table>
Conclusions

• Increasing trend towards mandatory standards
  – Energy efficiency: quick & painless way to slow down global warming

• Some OEMs demanding even tighter requirements
  – Proactively exploiting available technology

• Two components to reducing standby consumption
  – Power supply efficiency in standby
  – Product power management

• Power supply standby efficiency is essentially free
  – Design objective, not necessarily a cost issue