

Optimizing Mobile Power Delivery

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Agenda

- ❑ Overview
- ❑ Mobile Power System Review
- ❑ Optimizing Power Conversion Efficiency
 - Detailed View of Power Loss
 - VR Design w/ System Power Indicator
- ❑ Optimizing Battery Loading Characteristic
- ❑ Display Power Reduction
- ❑ Summary and Call to Action

Advancing The Mobile PC Platform

Intel
Developer
Forum
Fall 2001

□ Key attributes:

- Great performance
- Smaller and lighter weight
- Batteries charge lasts all day
- Ubiquitous wireless connectivity

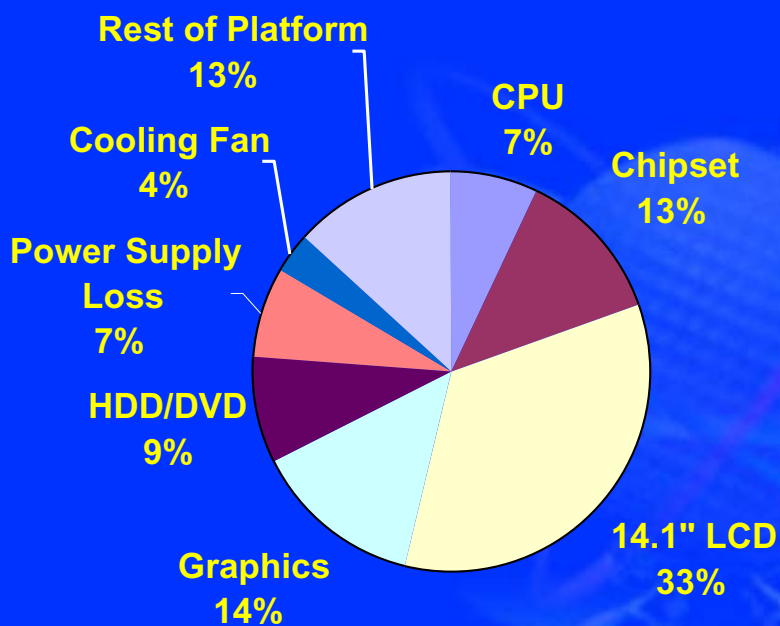
□ Enables new usage models and new form factors

- Anywhere, anytime mobile computing
- Tablet PC



Mobile PC Platform Challenges

Intel Developer Forum
Fall 2001



Average power consumption of an OEM T&L notebook during ZD-BL 4.01 Battery Mark

- ❑ Platform power reduction is the greatest challenge
- ❑ Idle power is about 85% of average power
- ❑ CPU and chipset are well power managed when idle
- ❑ Major opportunities to reduce power exist in LCD, GFX, Power delivery, HDD, DVD, and other subsystems

Battery Life is a Platform Issue

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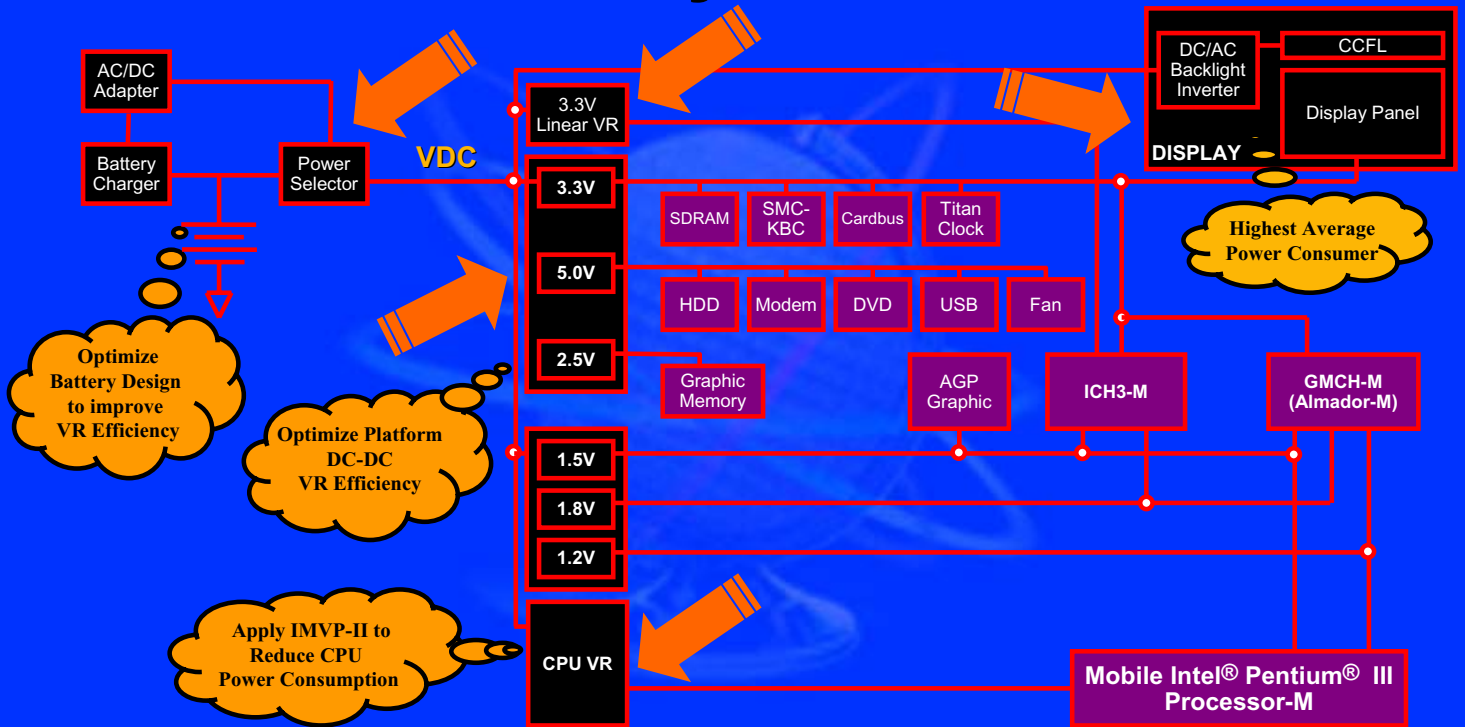
Platform Power Reduction

- ❑ **Goal: 30% reduction in typical mobile PC platform power through optimizations of:**
 - **Hardware subsystems**
 - **Software (OS and drivers)**
 - **Firmware**

- ❑ **Research results to be incorporated into future mobile reference platform and provided to all OEMs, IHVs, and IBVs**

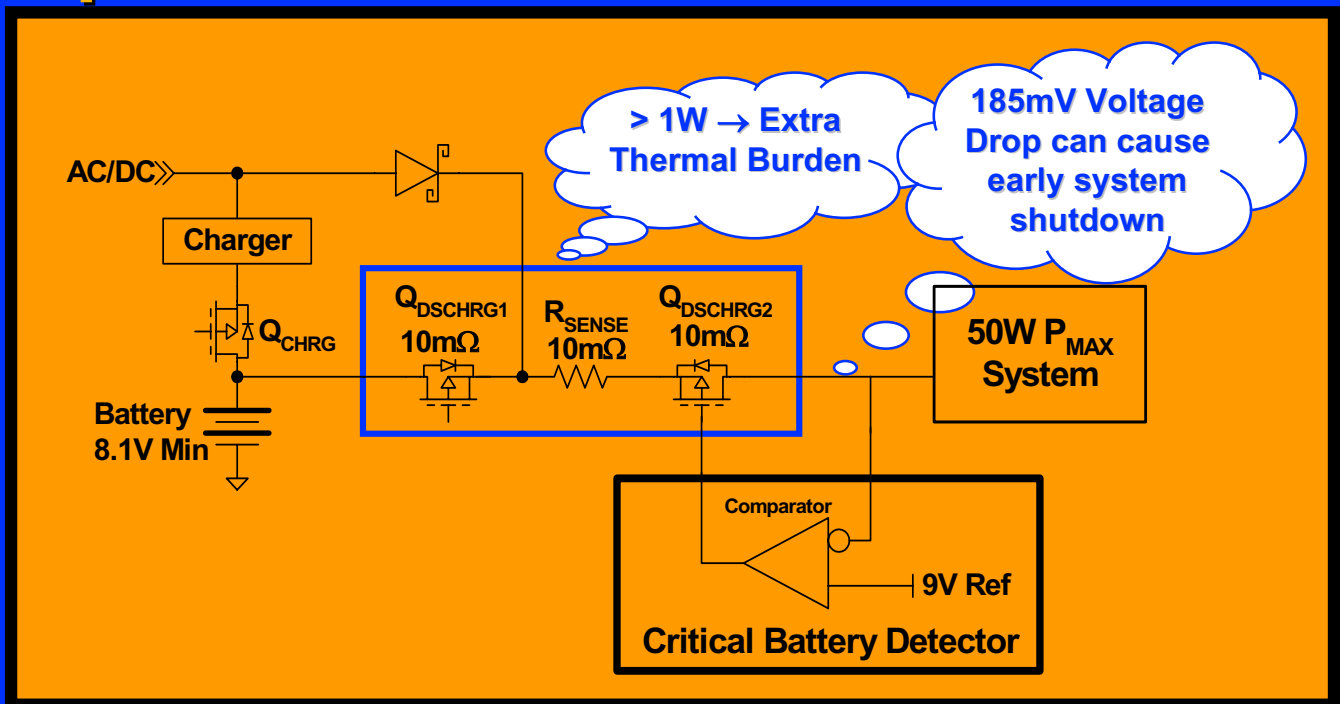
Optimizing Mobile Power Delivery

Mobile Power System Review



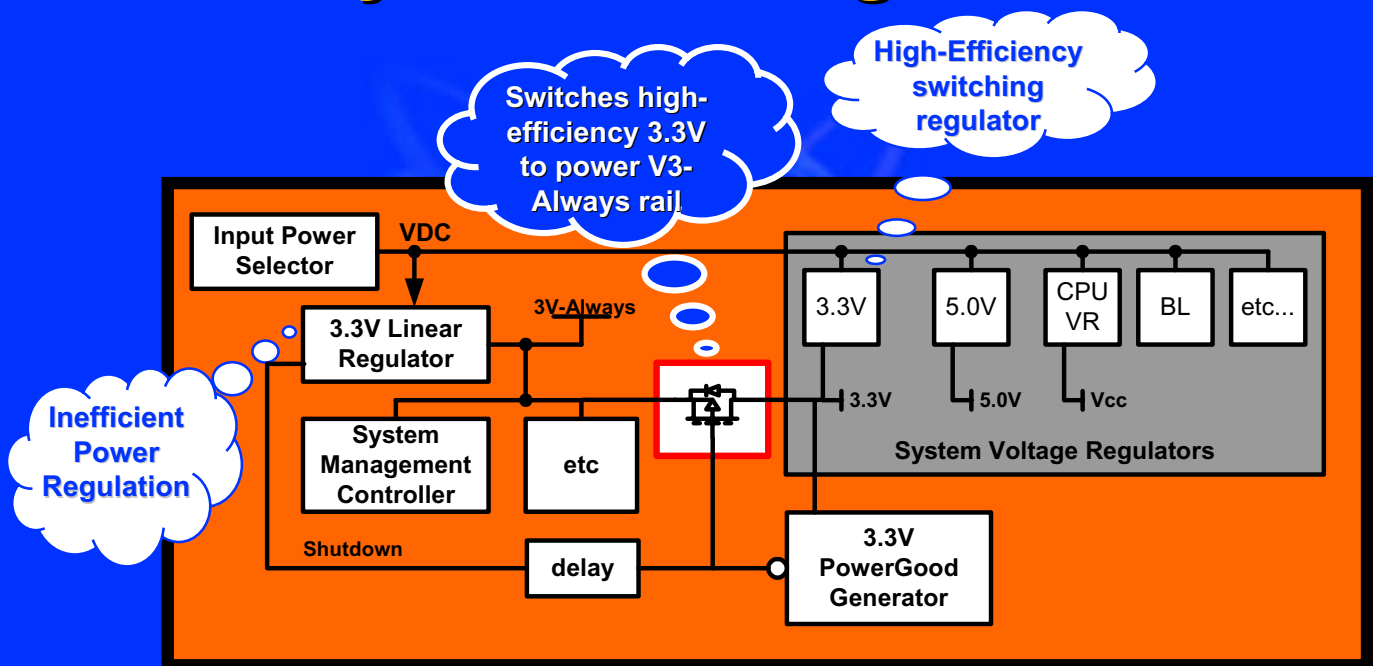
Complicated Power System Requires proper attention to optimize conversion efficiency

Input Power Selector Loss



Review Battery Discharge Profile for signs of premature system shutdown

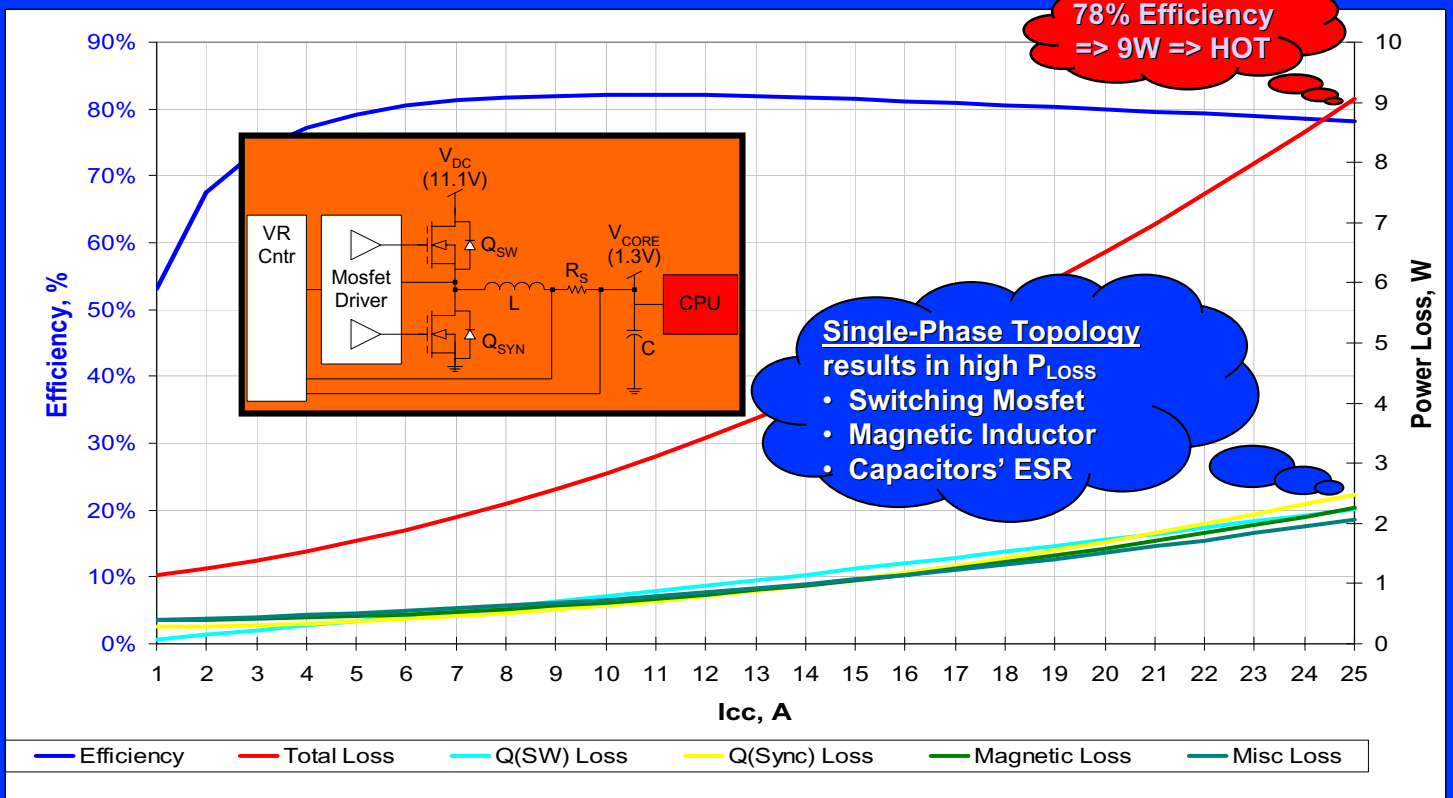
3V-Always Linear Regulator



Optimize Regulator Design to Reduce Power Consumption

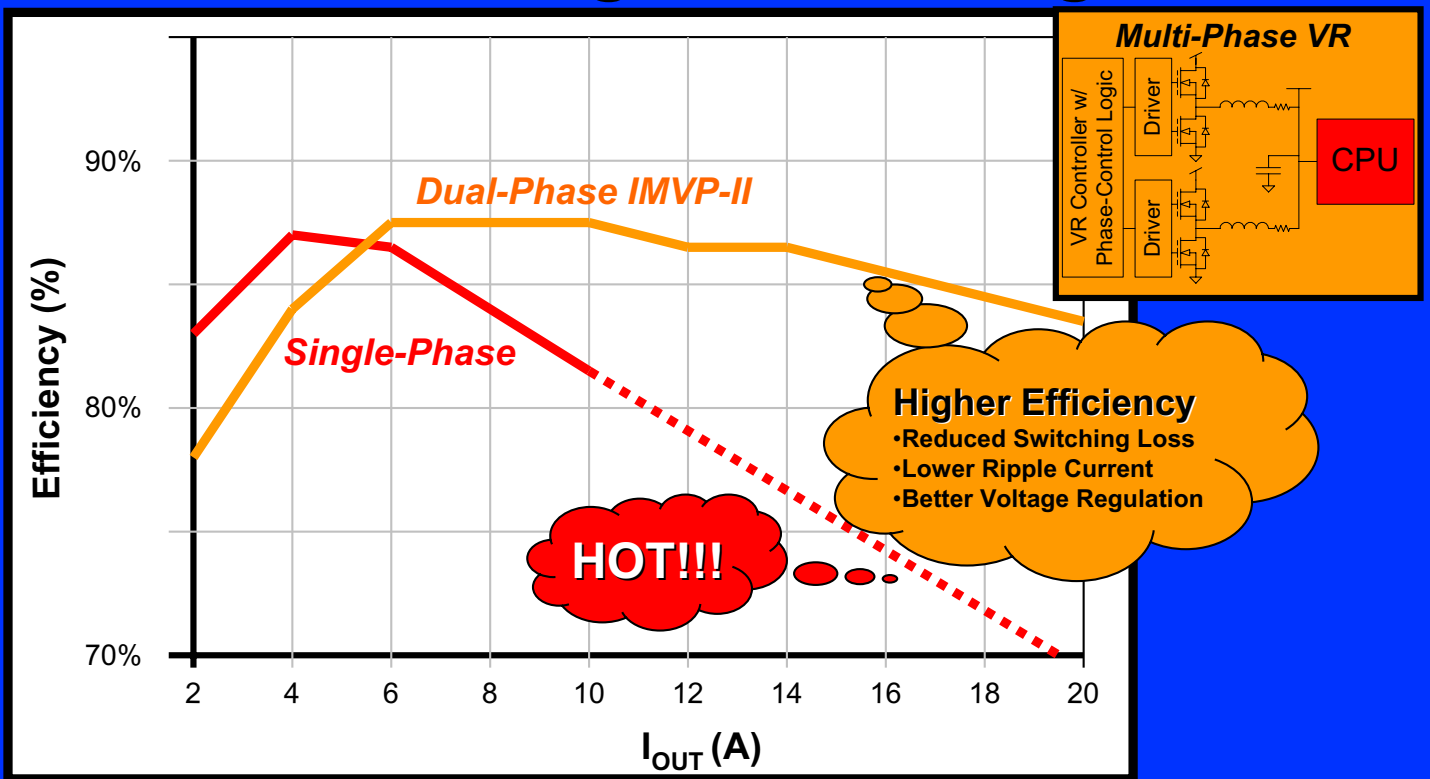
Optimizing Power Conversion Efficiency

Voltage Regulator Power Loss



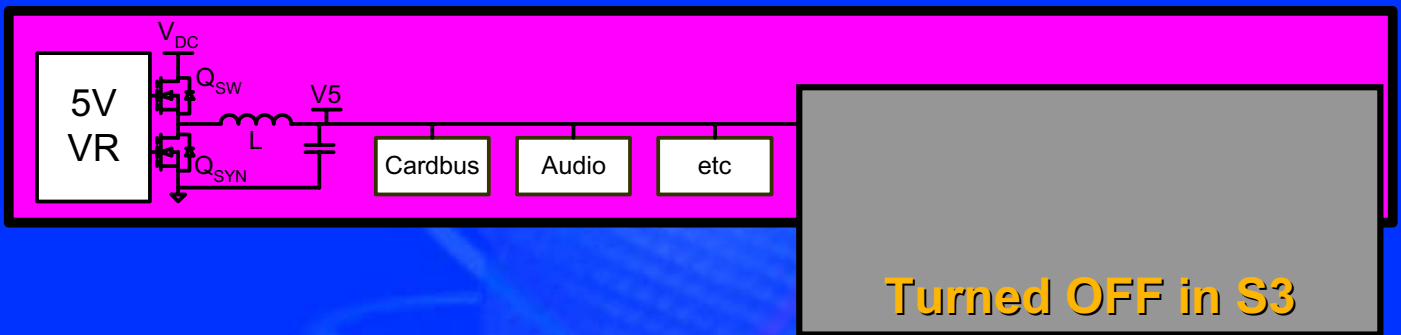
Optimize High-Load Efficiency to Minimize Thermal Impact

Intel Mobile Voltage Positioning - II

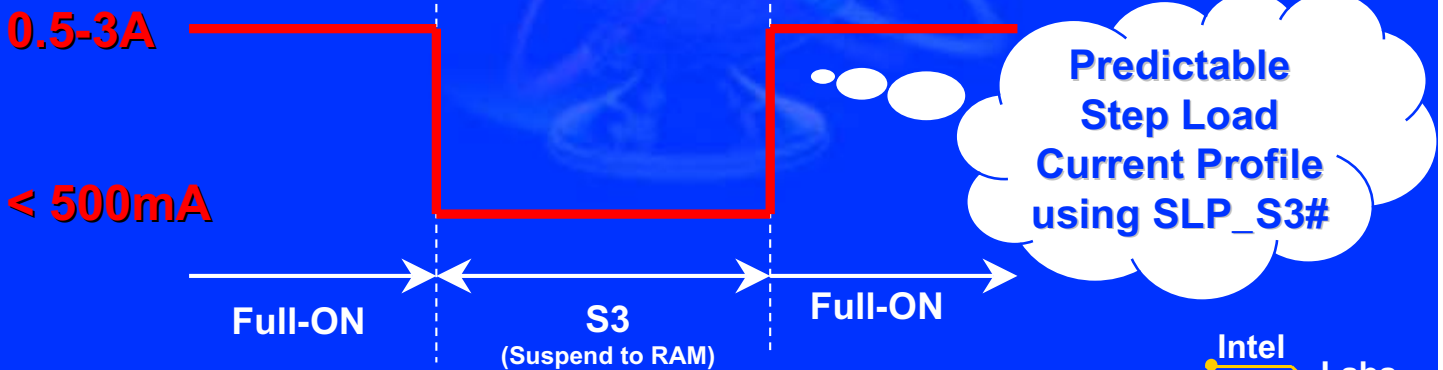


Use Multiphase IMVP-II design to increase efficiency

System Status Improves VR Design



5.0V Output Load Current Profile



Optimizing Power Conversion Efficiency

System Status Improves VR Design

Continuous Mode

- Lower Efficiency @ Light Load

Discontinuous Mode

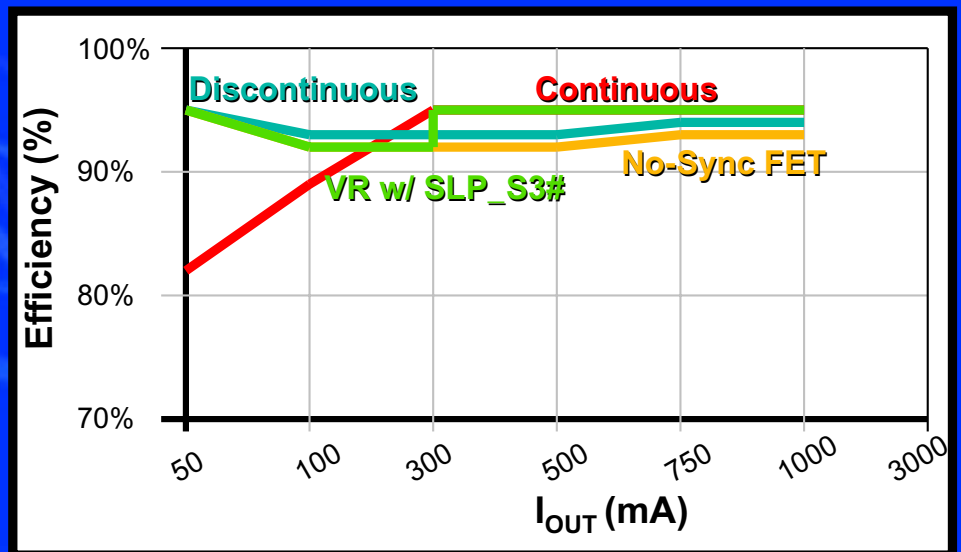
- Lower Efficiency @ Heavy Load
- Increased DC Output Voltage causing increased output power

Non-Synchronous Mode

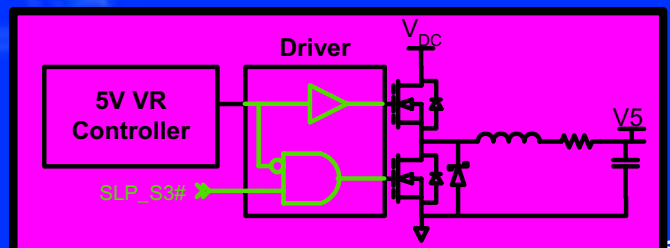
- Similar to Discontinuous Mode

Status Indicator Mode

- Higher overall efficiency
- Increased DC output voltage can be compensated using SLP_S3# in feedback loop

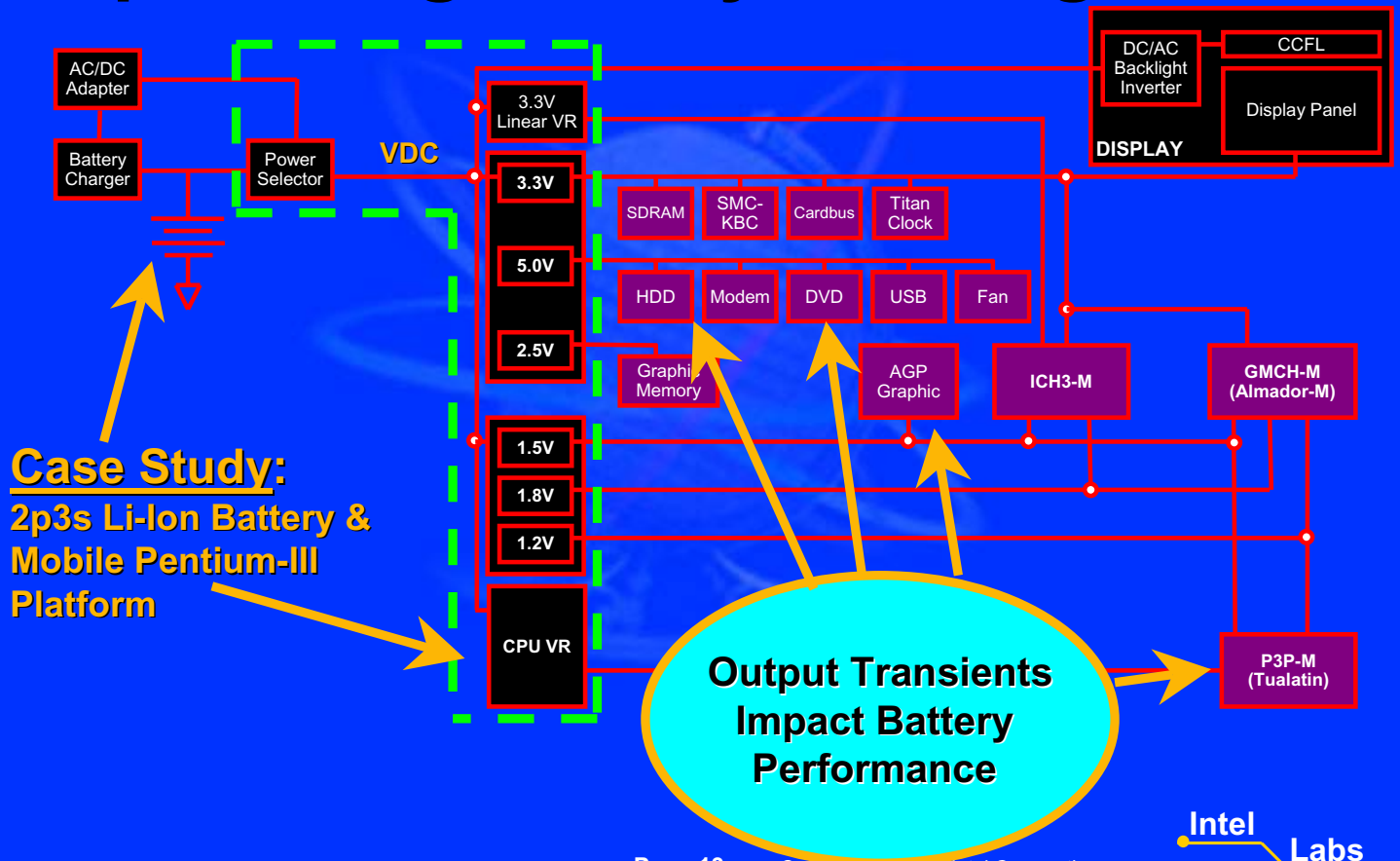


Use SLP_S3# to
INCREASE efficiency of
system VR



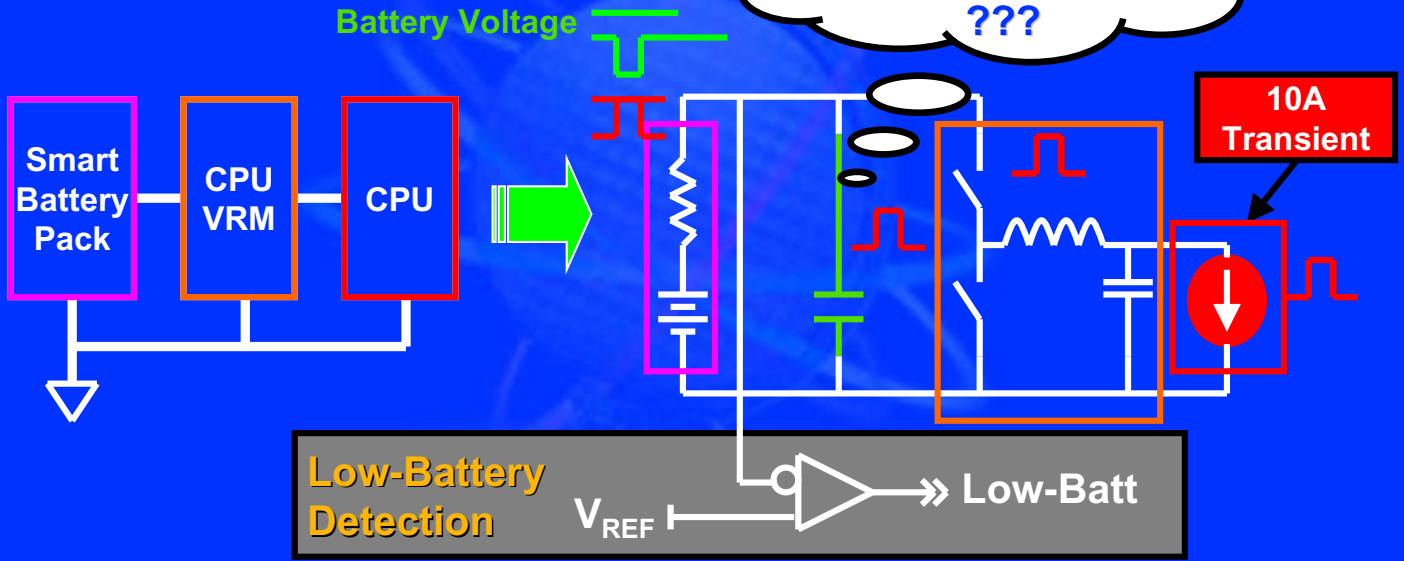
Optimizing Mobile Power Delivery

Optimizing Battery Loading



Battery Transient Analysis

But ... How **BIG** is an IDEAL capacitor ???

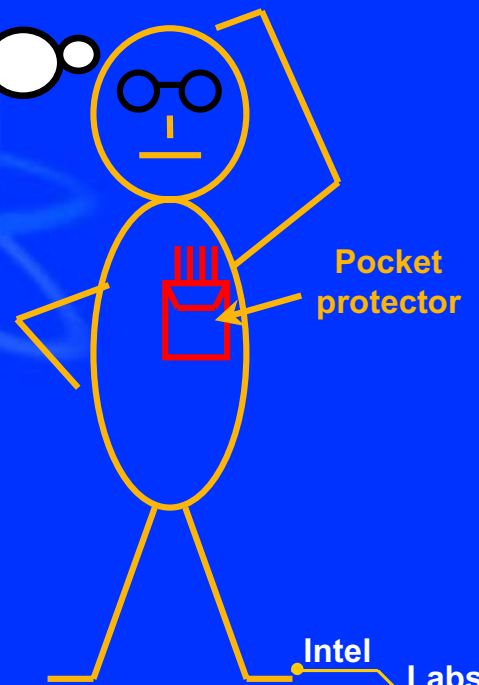


Ideal capacitor isolates system transient from battery

Battery Transient Analysis



So ... How
BIG is an
IDEAL
capacitor ???



Pocket
protector

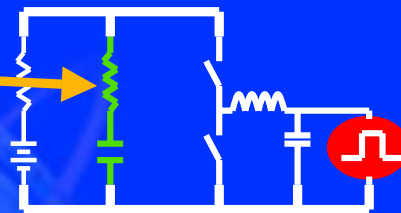
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Optimizing Battery Loading

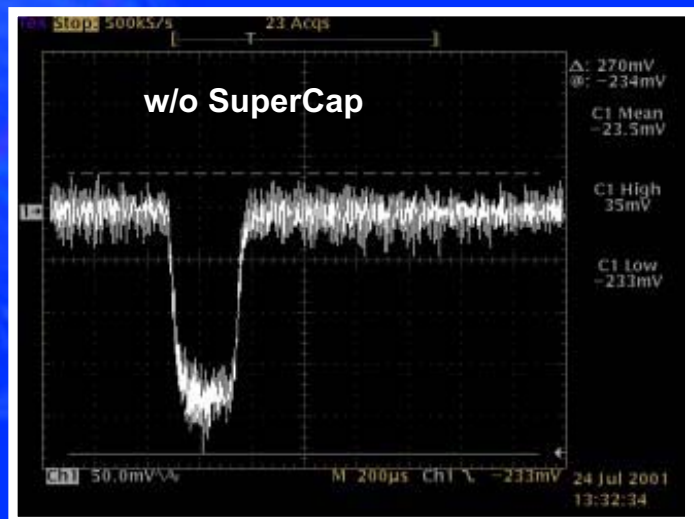
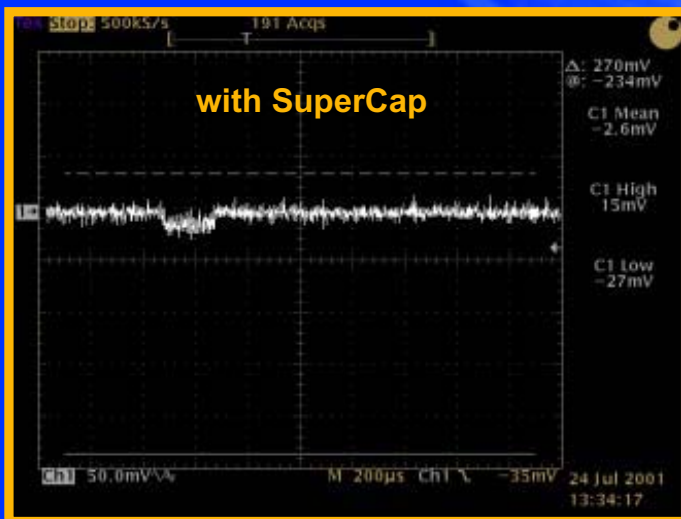
SuperCap (Transient Suppressor)

cap-XX SuperCap

- C = 7 Farads
- ESR = 5 mΩ



CPU Transient

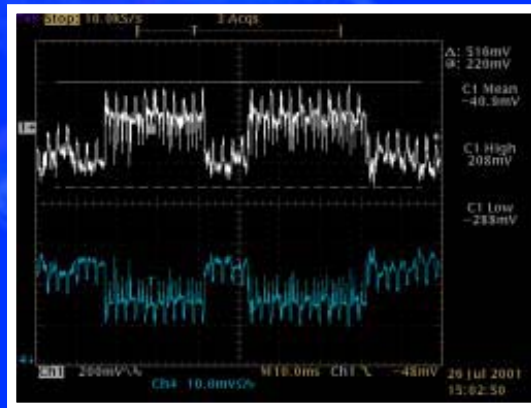
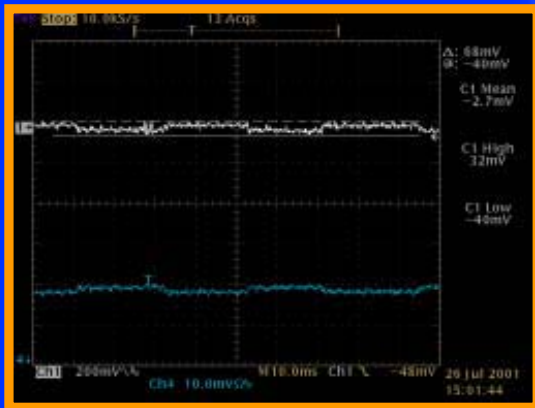
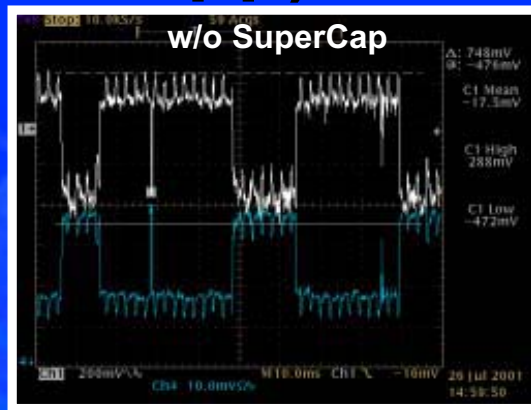
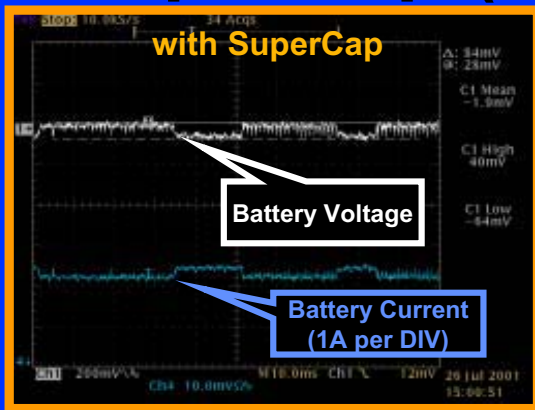


SuperCap Reduces Battery Transient by 7x

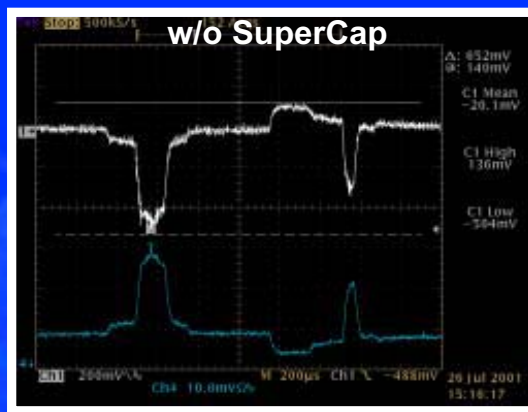
Optimizing Battery Loading SuperCap (DVD App)

POM
9x Ripple
Reduction

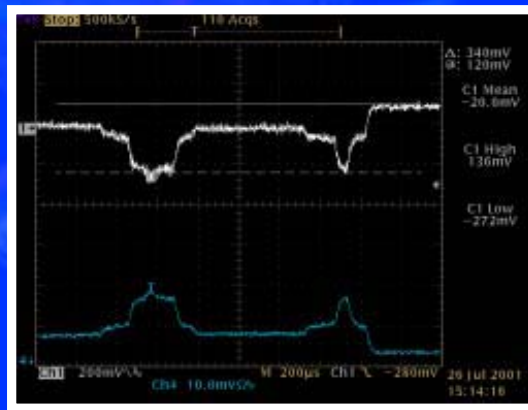
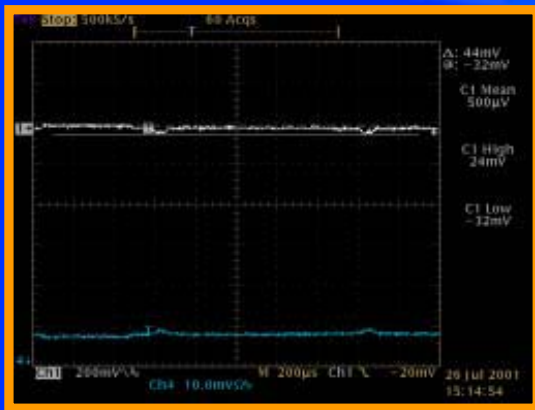
BOM
7x Ripple
Reduction



Optimizing Battery Loading SuperCap (Win-Idle App)



POM
11x Ripple Reduction

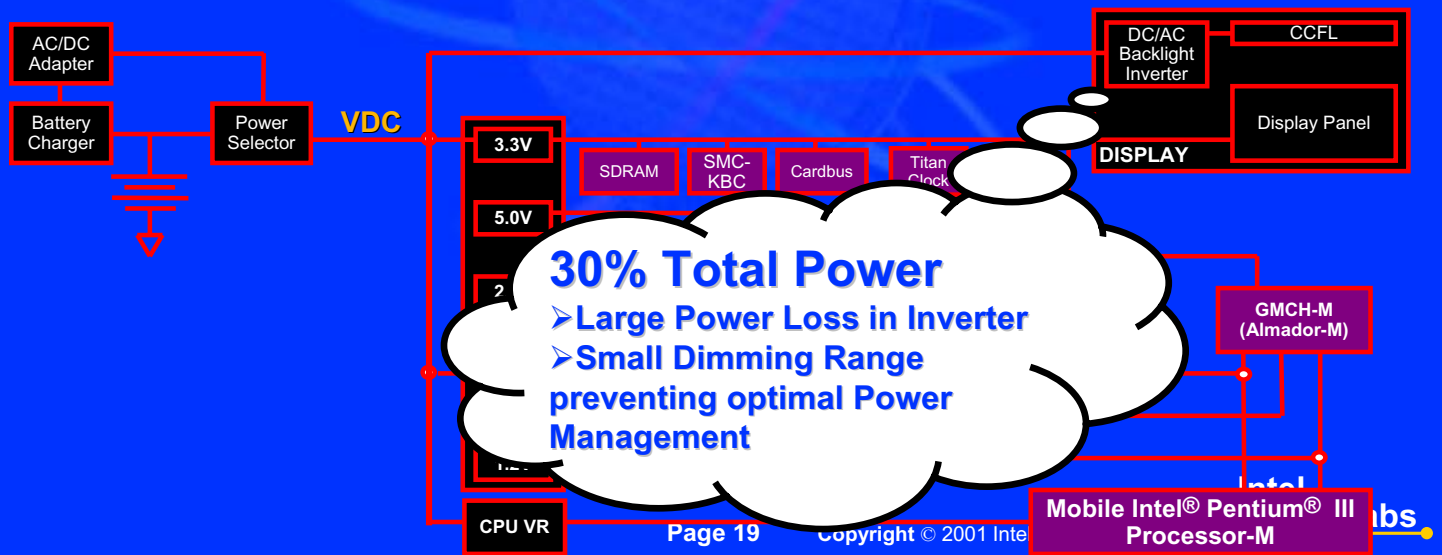


BOM
7x Ripple Reduction

Use SuperCap to utilize Battery Discharge completely

Display Power Reduction

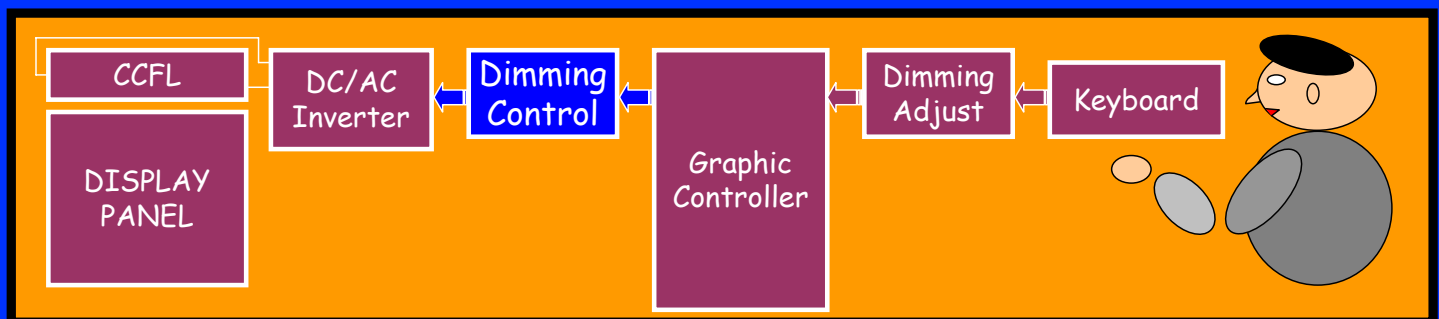
- ❑ Recommended “Digital” or “Low-Frequency” Dimming Control to extend dimming range (Spring '01 IDF)
- ❑ Proposal for Common Dimming Control Interface between Inverter & Graphic Controller



Display Power Reduction

Dimming Control Interface

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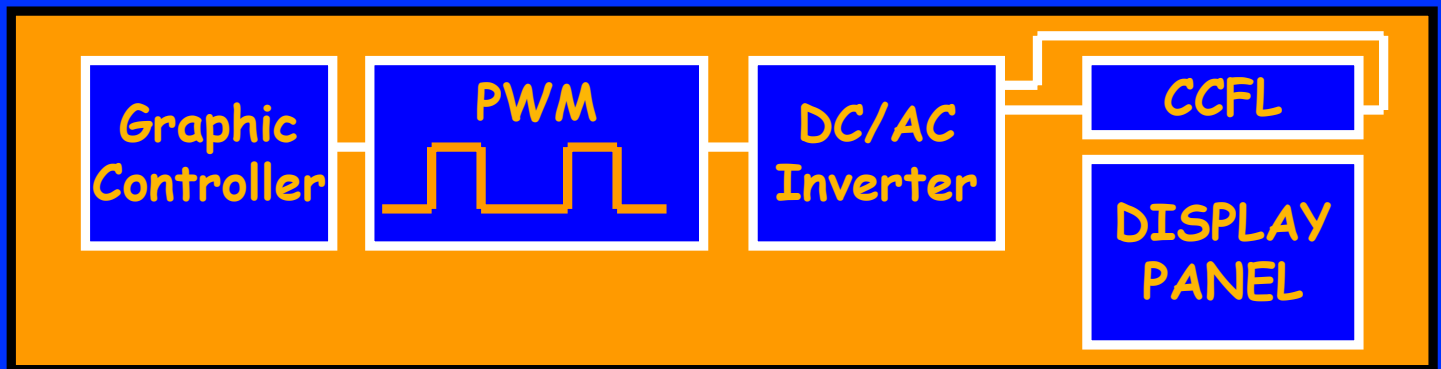


Key Parameters

- ❑ Supported by OEMs & Suppliers
- ❑ Low Cost
- ❑ Memory (ability to retain last setting)
- ❑ High Resolution Capability

Display Power Reduction

Dimming Control Interface



Key Specifications

- ❑ 3.3V CMOS signal level
- ❑ Adjustable Frequency 10-10kHz

“Standardized” Backlight Control Interface Optimizes Power Reduction

Summary

- ❑ **Mobile power system greatly impacts battery life**
- ❑ **Premature System Shutdown inhibits full battery utilization**
- ❑ **Low VR efficiency at heavy load carries heavy thermal burden**
- ❑ **Lack of Backlight Dimming Control “standards” hinders optimal power management for LCD**

Call to Action

- ❑ Use IMVP-II for CPU to increase efficiency at heavy load condition
- ❑ Use System Status to increase system VR efficiency at light load condition
- ❑ Switch linearly regulated rails to high-efficiency regulator when possible
- ❑ Use SuperCap to reduce battery transient & prevent premature system shutdown
- ❑ Adopt PWM-control method to optimize LCD Dimming Control