

June 23, 2010

Power Management Design for Mobile Devices

FTF-CON-F0896

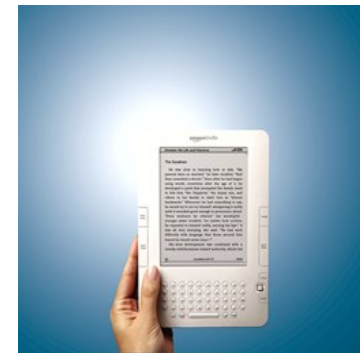
Daryl Bergstrom

Power Management System Architect



- ▶ Market summary
- ▶ Key considerations when selecting a PMIC
- ▶ SMOS10 technology advantages
- ▶ Features of the MC13892
- ▶ Next generation PMIC MC34708
- ▶ Key features of the MC34708
- ▶ Design considerations
- ▶ Examples of end-products using MC13892 PMIC
- ▶ Summary

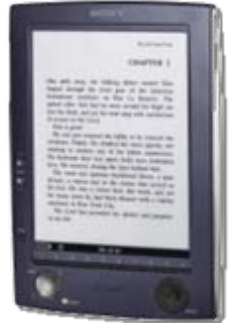
<u>Market</u>	<u>2012 SAM</u>	<u>CAGR</u>
▶ Smartphone	\$1.9B	33%
▶ MID	\$343M	225%
▶ Smartbook	\$247M	51%
▶ eReader	\$37M	126%



Power Management IC Focus Markets

Consumer

- ▶ Cell Phone
- ▶ Smartphone
- ▶ Mobile Internet Device
- ▶ Media Player
- ▶ Portable Navigation/GPS
- ▶ eReader



Key Considerations for Power Management IC's

- ▶ Maximize the efficiency and battery life of the application
 - Optimize switcher efficiency (targeting where the processor is used most of the time)
 - Use PFM, PWM-PS to improve efficiency in low power conditions

- ▶ Minimize bill of material (BOM) cost and area

- ▶ Battery technology (1, 2 or 3 Li-ion cells)

- ▶ Keep power dissipation within operation range of application

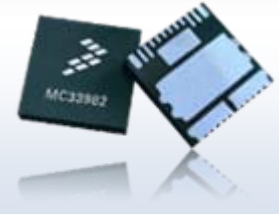
- ▶ Software driver support

- ▶ Flexible power up sequences/default voltages to support multiple processors and peripheral devices

- ▶ Audio internal or external to PMIC
 - Internal advantages
 - Decreases cost, saves board space
 - External advantages
 - Less noise
 - More flexible



Analog and Power Management



- ▶ 15 years of portable power management experience
- ▶ Industry-leading SMARTMOS™ technology enables system-on-chip integration of analog, power and logic functions
 - Down to 0.13µm
 - Up to 80V capability
- ▶ Extensive IP portfolio
 - Focus on efficiency, small size and low cost
- ▶ Compelling portfolio of analog and power management solutions for the consumer, industrial and automotive markets

▶ Power and Battery

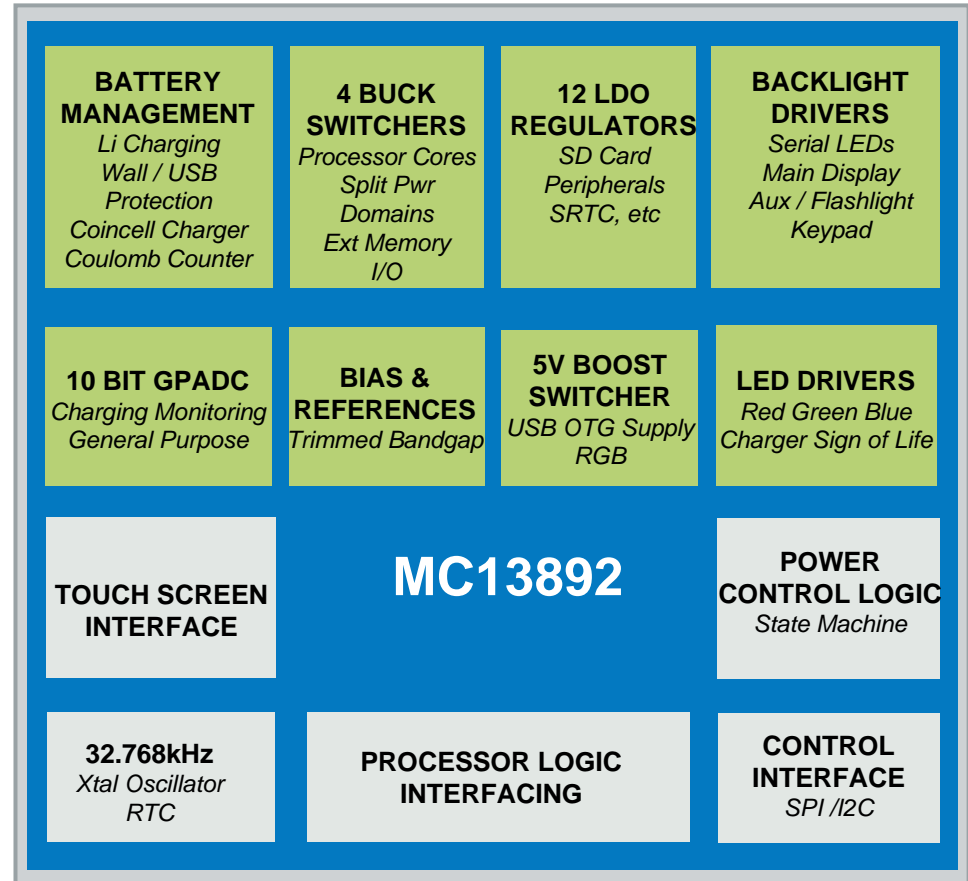
- ▶ Four multi-mode buck switchers – 1.05A, 3x800mA programmable outputs, 2 with DVS/DPTC interface
- ▶ One boost switcher – 5V
- ▶ 12 LDO regulators, 4 GPOs, power gating
- ▶ Main battery and coincell chargers, GP ADC
- ▶ Series WLED backlight drivers (main/aux, keypad)
- ▶ One bank RGB drivers, charger LED drive
- ▶ Standalone battery charging with auto disable if battery is out of temperature range
- ▶ Standby / user off configurations
- ▶ Coulomb counter

▶ Interface and Control

- ▶ SPI / I²C control and register interface
- ▶ Resistive touch screen
- ▶ 32 KHz crystal oscillator, real time clock / calendar alarms
- ▶ Package
 - 7x7mm BGA, 0.5mm pitch, 139 pins
 - 12X12mm BGA, 0.8mm pitch, 186 pins

▶ Applications

- ▶ Netbook, eReader, MID's, portable media players, portable navigational devices



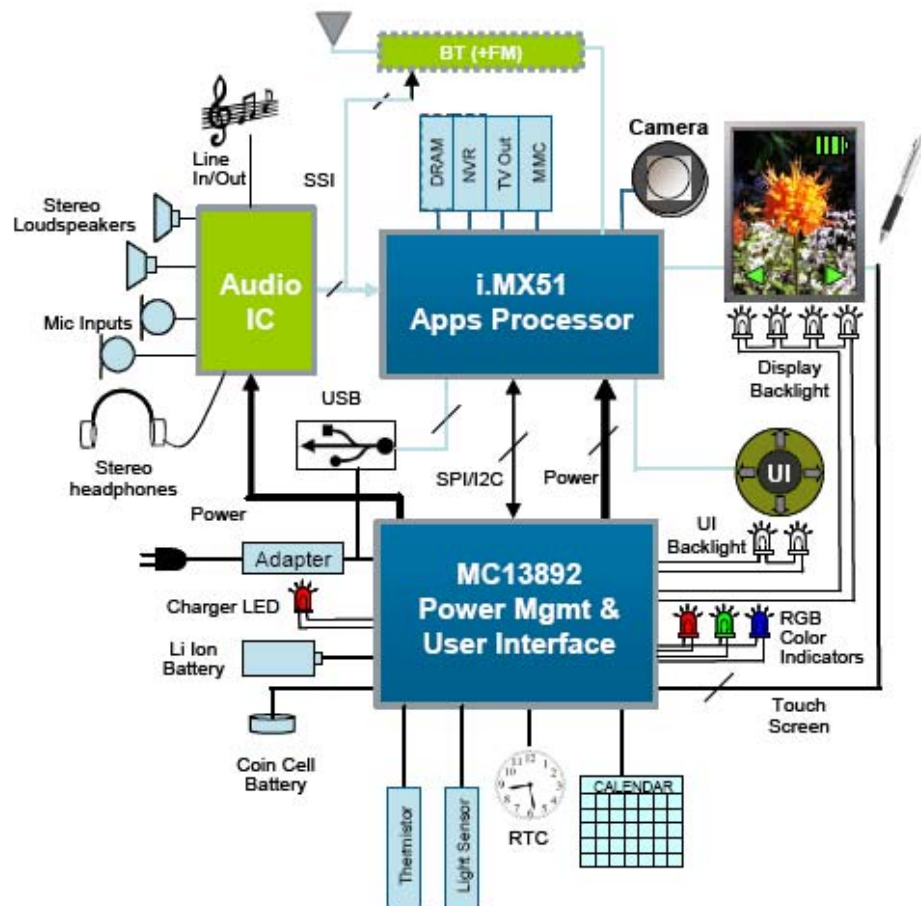
Complete system lineup with highly integrated

► **Power Management & User Interface features:**

- Switching and linear regulators with coordinated sequencing for system power tree
- Battery charging with backup cell
- Real time clock / calendar / alarm
- Serial WLED backlighting / flashlight
- Touch screen interface and GPADC

► **Key Benefits:**

- Optimized power management companion to i.MX51, i.MX37, i.MX35, i.MX27 applications processors
- EBOM efficiency, software simplicity and product scalability
- Audio in separate IC to allow greater flexibility



► Buck Switching Regulators

- High switching frequency of 3 MHz allows smaller components and board area
- Multi-mode (PWM, PWM-PS, PFM, Auto)
 - Configurable by SPI, standby, low power off modes, and adaptive with load current.

► LDO Regulators

- Mix of internal / external pass devices and dual configuration LDOs to optimize EBOM and balance power dissipation.
- Adaptive mode control (internal pass FETs) or programmable Low Power mode (low cost external PNPs)

► Power control

- Memory hold and user off modes allow application to retain state and turn on faster
 - Memory Hold – keeps the DDR memory supply active
 - User Off – All processor supplies are still active in low power mode
 - Power Gates – Isolate power rails from peripherals to prevent leakage

► Charger

- Linear with PMOS power FETs external
- Supports dead battery operation in serial path mode
- Standalone and software controlled charging
- Disables battery charging when battery is out of temp range

► POWER & BATTERY

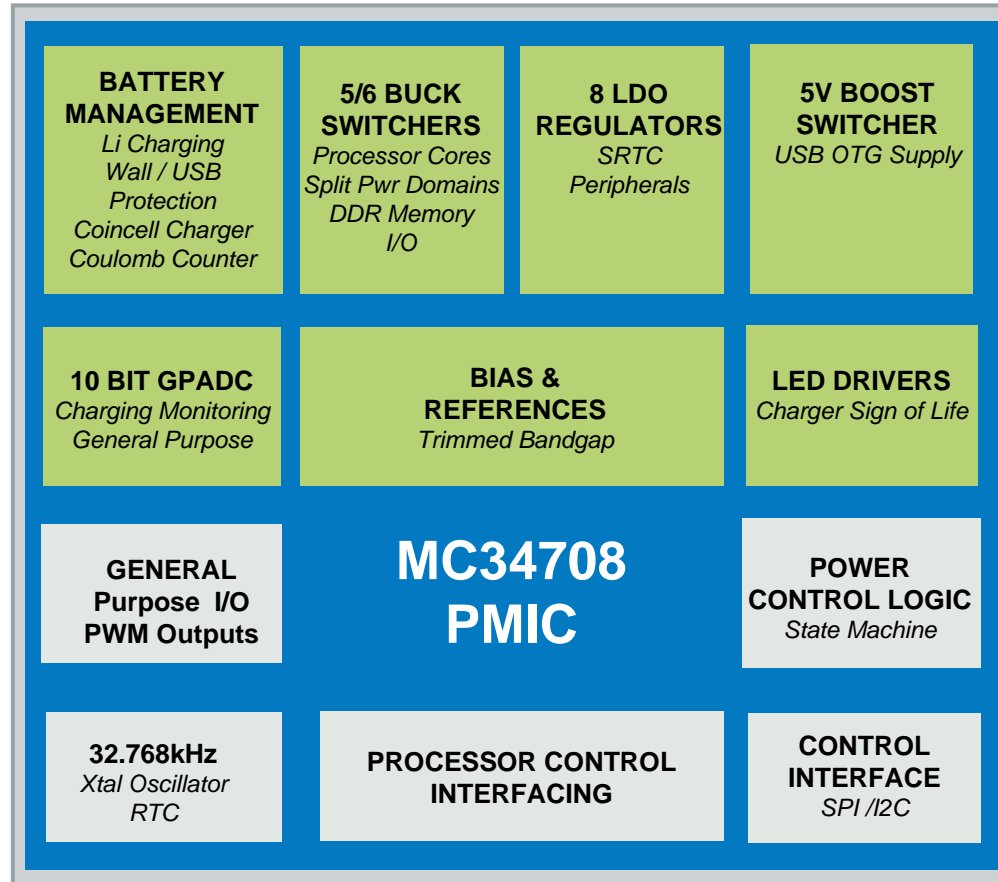
- 5/6 multi-mode buck switchers – 1 x 1.6A, 3 x 1A, 1x0.5A
 - Programmable outputs, DVS, PWRGDB
 - 2 Single/Dual phase switchers 1.6A, 1.0A
- 1 boost switcher – 5V, 380mA
- 8 LDO regulators, 4 GPIO's, 2 PWM's
- Switching Main Battery Charger, 1 Cell Li-Ion, with 2 LED status drivers, Aux Charger Input
- Coin cell charger
- Standalone battery charging with auto disable if battery is out of temperature range
- Programmable charge timer
- Auto charge detection of CEA936/Apple/USB/Host
- UART/Audio switching to USB D+/D- and ID pins
- 10 bit General Purpose ADC
- Coulomb counter
- 4 wire resistive touch screen

► INTERFACE & CONTROL

- SPI / I2C control & register interface
- 32KHz crystal oscillator, real time clock / calendar alarms
- Package
 - 8x8 mm BGA, 0.5mm pitch, 207 pins
 - In development 1st samples Aug 2010
 - Production 3rd Quarter 2011

► APPLICATIONS

- Netbooks, Ebooks, MID's, Smartphone's



► Buck Switching Regulators

- 4MHz Fs decreases size of inductors ~ 9% from MC13892
- Added single phase/dual phase capability
 - Dual phase
 - Improved ripple and output accuracy
 - Improved transient response
- Output FET scaling for higher efficiency at all loads
 - Lower RDS-on devices for improved efficiency
- Added 5th switcher to support LPDDR2 memory
 - Single/Dual phase or independent operation
 - Added wider output capability to 3.3V

► Buck Switching Regulators

- Increased capability to support i.MX53, i.MX51 (1GHz) load currents for Core supply rails

► LDO Regulators

- Optimized power tree to allow input from 1.8V switcher for VGEN1, and can use SW4 when configured at 3.15V for 2.5V LDO outputs
- VREFDDR support for DDR2 memories

► General Purpose I/O's

- Added 2 PWM outputs to allow control of LED's
- 4 General purpose input and output pins
 - Inputs can be configured as interrupts
 - Configurable Pull-up/Down resistors
 - Output level CMOS or Open Drain

▶ Power Control

- Power up sequence to support i.MX50 and i.Mx53 processors
- Backwards compatibly to support i.MX51/37 and i.M35 processors

▶ Charger

- Switching charger operating at 2 MHz
- Supports USB charge and Auxiliary charge path
 - USB has priority over Aux path
 - Charge input current limited at 950mA
 - Programmable charge current and charger termination
 - Programmable charge timer from 1 to 16 Hrs
 - Configurable pre charge timer up to 6.5 Hrs

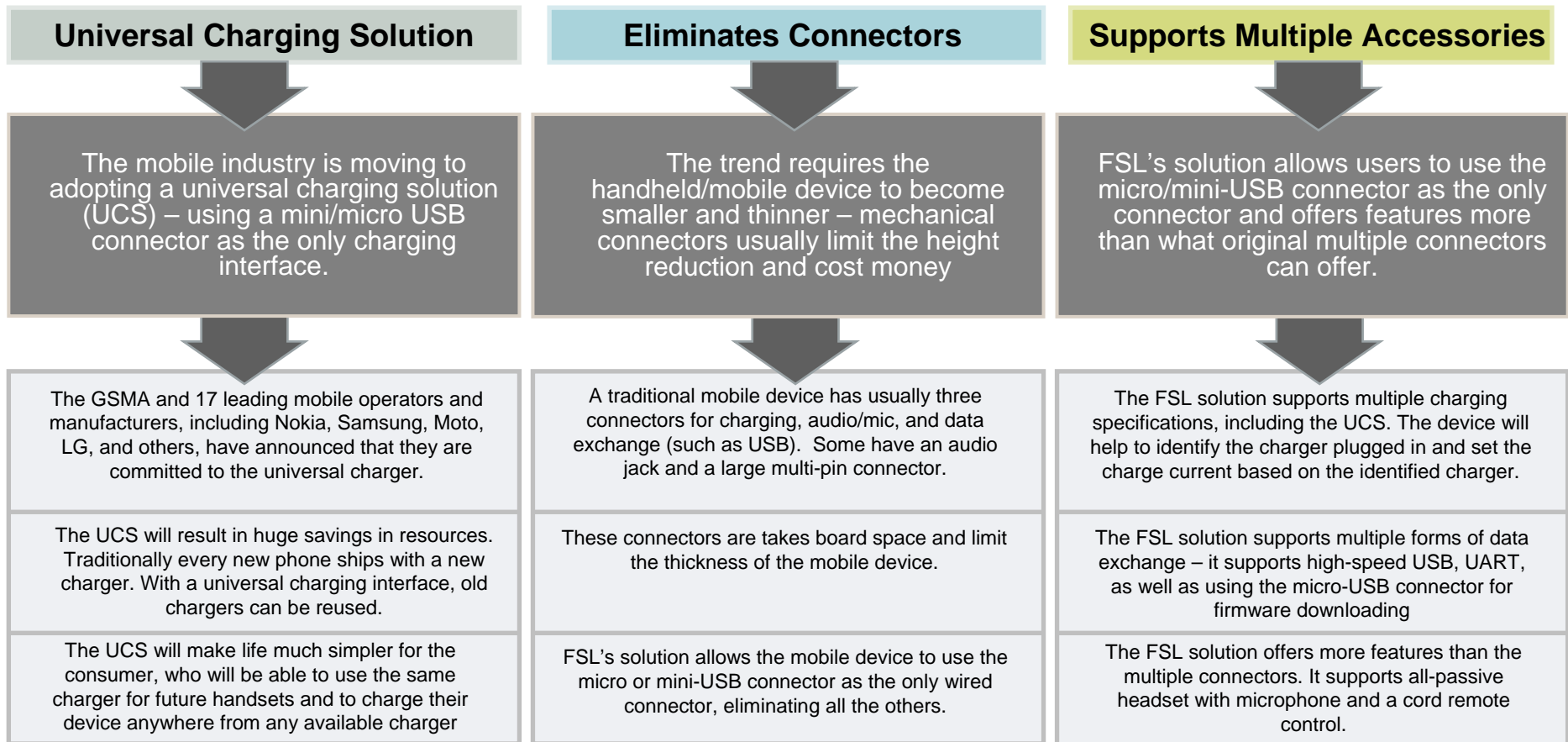
► Charger

- Support for weak input supply on USB and Aux input
- Selectable trickle charge current 70mA, 325mA, 550mA
- Standalone and software controlled charging
- Disables battery charging when battery is out of temp range
- 2 Charge LED's to indicate charge mode

► Mini/Micro USB

- Auto detects Charger and configures the charger input current limit

The MC34708 manages the Universal Charging Solution and other wired accessories with a single micro-USB connector



MC34708 Mini/Micro-USB Supported Accessories



Various chargers:

- ▶ USB port/hub
- ▶ Dedicated chargers
- ▶ USB charger
- ▶ Carkit chargers
- ▶ Other customized chargers



PASSIVE headsets with any of the following functions:

- ▶ Stereo/mono audio
- ▶ Microphone
- ▶ Remote control w/ up to 12 push buttons (play/stop/FF/FB.....)



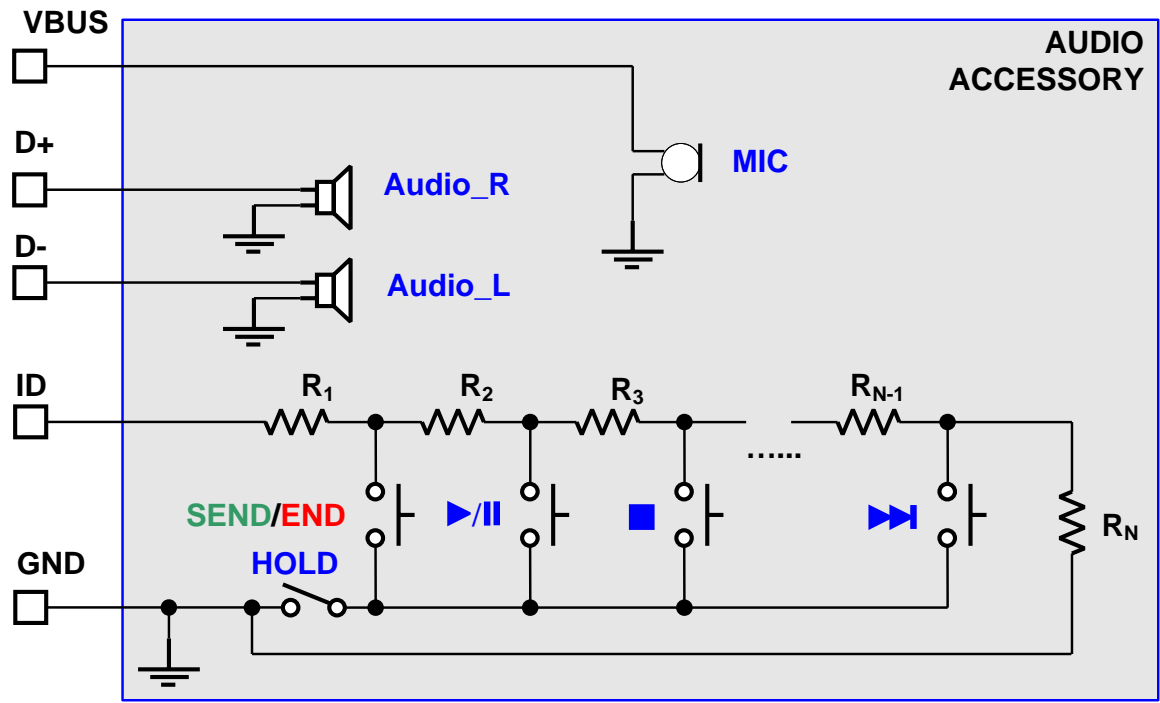
Phone-powered devices

- ▶ Active headset
- ▶ Smart accessory
- ▶ USBOTG



MC34708 Mini/Micro-USB Audio Accessory

Freescale's architecture is unique in the industry because it enables the headphone to have a microphone, stereo audio and remote control with no special active components inside.



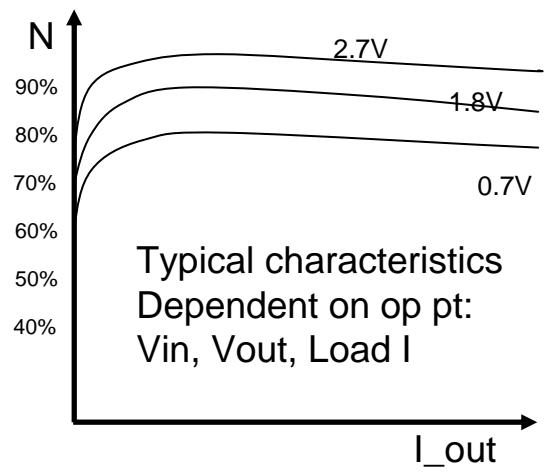
► Switcher Losses:

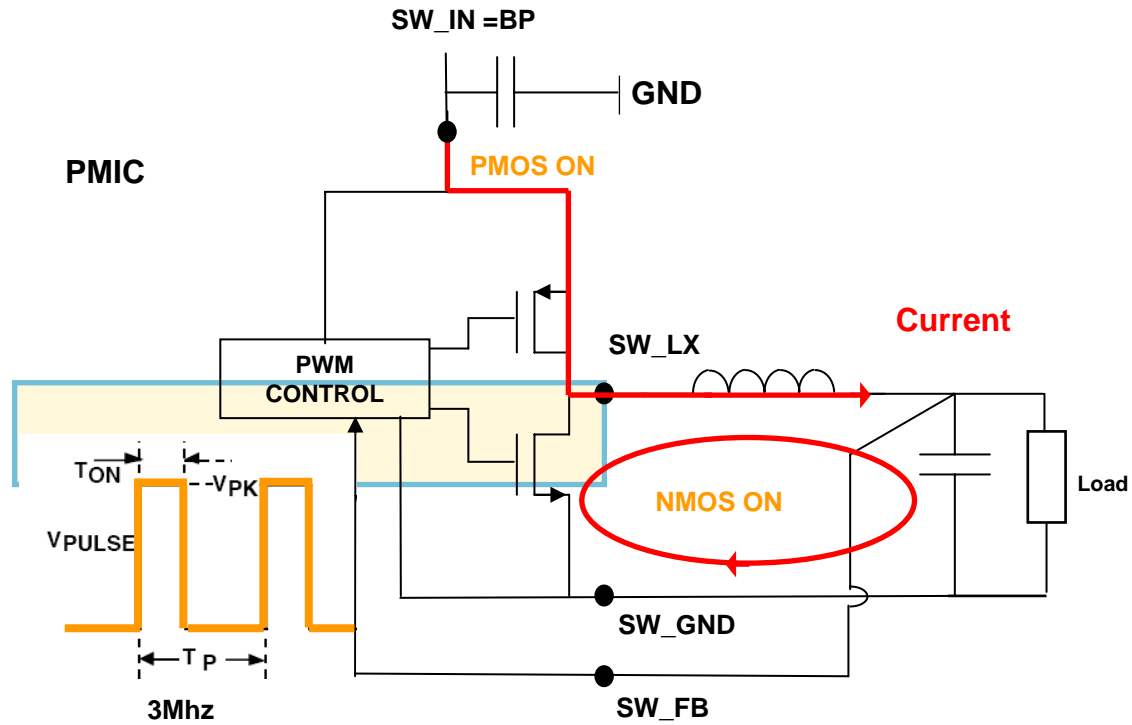
- IR in switches, bond wires, substrate & board level routing
- DCR of inductor
- Dynamic losses: parasitic reactance's, switch synchronization

$$\text{Efficiency} = \frac{P_{\text{out}}}{P_{\text{in}}} = \frac{P_{\text{out}}}{P_{\text{out}} + \text{Losses}}$$

$$P_{\text{out}} = V_{\text{out}} * I_{\text{out}}$$

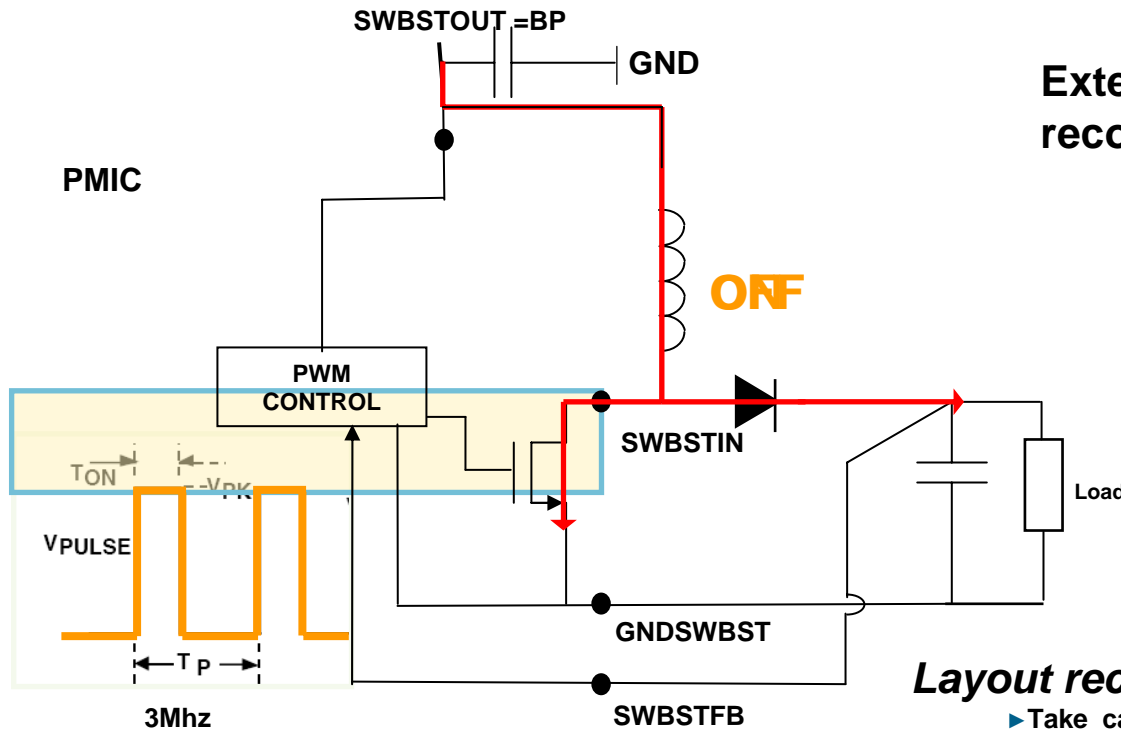
At a given I_{out} , if V_{out} is reduced, efficiency drops (losses ~ constant)





Layout recommendation :

- ▶ Take care of layout resistivity WRT to the efficiency
- ▶ SWFB is a sense but acts as a brake during overshoot
- ▶ Vin cap recommended, very near of the pin

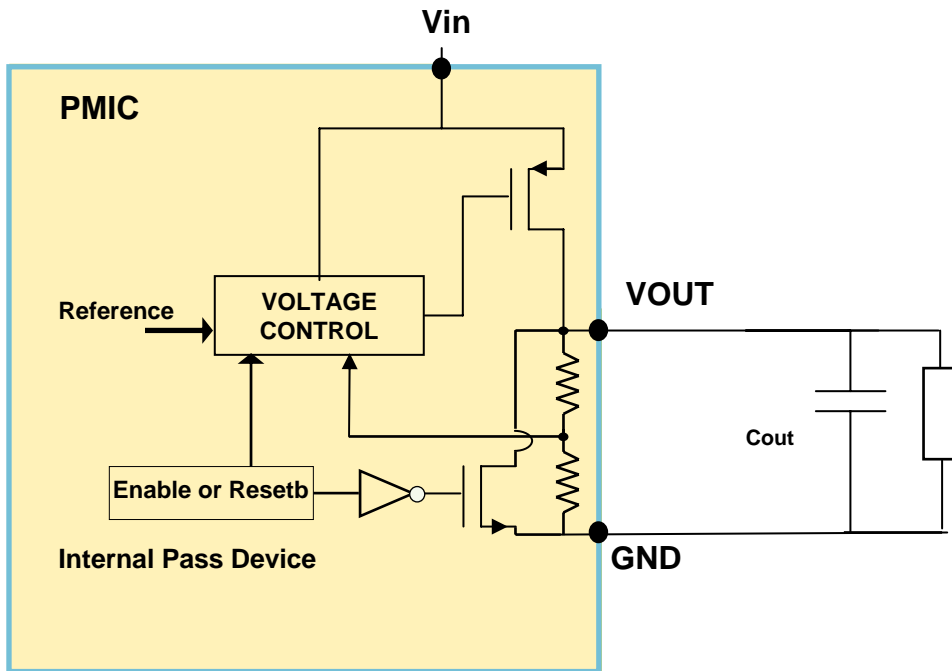


External components design recommendation :

- ▶ Coil 2.2 μ H
- ▶ Capacitor 10 μ F (Cout)
- ▶ Capacitor 4.7 μ F (Cin)
- ▶ Schottky Diode

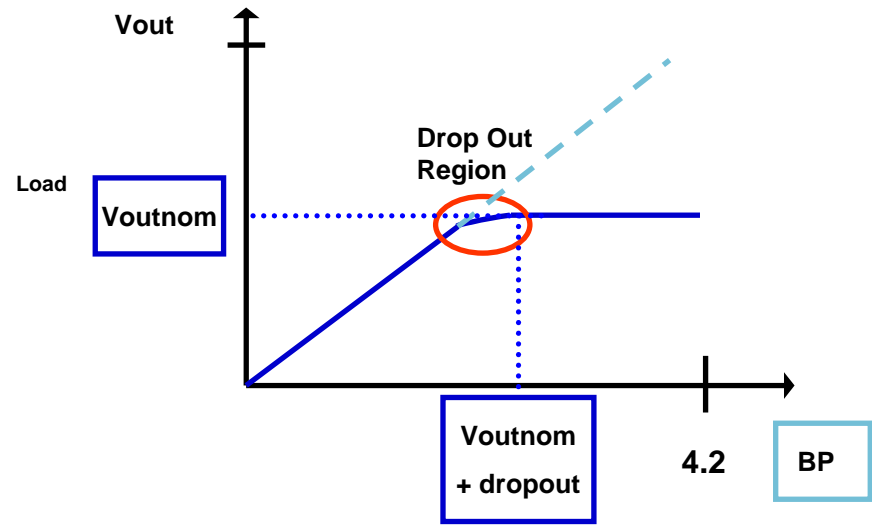
Layout recommendation :

- ▶ Take care of layout resistivity WRT to the efficiency
- ▶ SWFB is a sense but acts as a brake during overshoot
- ▶ SWIN will drive Iload max up to Ilimit max.
- ▶ Vin cap recommended very near of the pin



External components design recommendation :

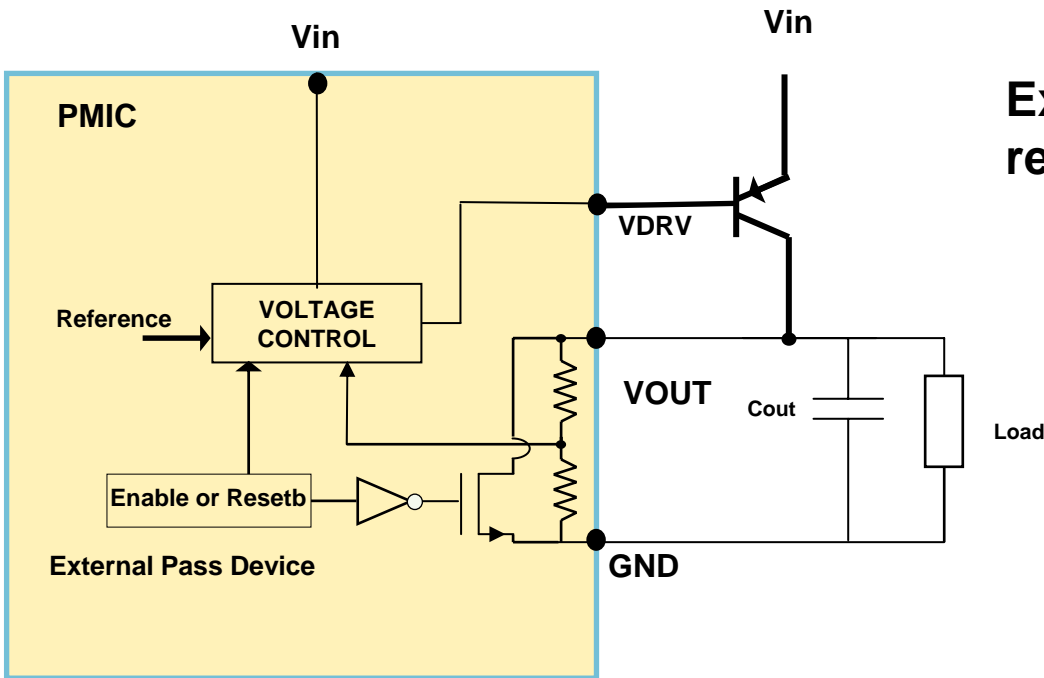
Low Esr Capacitor 2.2 μ F



Layout recommendation :

- ▶ Cout should be as close as possible of Vout pin.
- ▶ Trace from BP should have very low resistivity.

External PNP LDO Design Considerations



External components design recommendation :

Low ESR Capacitor 2.2 μ F (Cout)

External bipolar transistor:

NSS12100XV6T1G for

\leq 250mW

NSS12100UW3TCG for

250-500mW

Layout recommendation for regulator with external Pass Device:

- ▶ Cout ESR should be **> 20mOhm** (Cout esr or layout or additional resistor)
- ▶ Trace from BP to the emitter should have very low resistivity.

- ▶ Single Cell Lion battery applications (eReaders, MIDs, Smartphone's)
 - Support for dead battery operation
 - Allows for system optimization of battery charging where dead battery support is not required (single path charging mode)

- ▶ Capability to support multi cell battery packs using a pre regulated buck supply for applications such as Netbooks, Smartbooks, Auto infotainment

- ▶ Several end products are using the MC13892 PMIC have been launched to market(e.x. Kindle, Sharp Netwalker, Acer Monitor)

Examples of End-Products Using MC13892/SGTL5000

- ▶ The MC13892 PMIC and SGTL5000 CODEC are used in Acer's Display Plus D241H

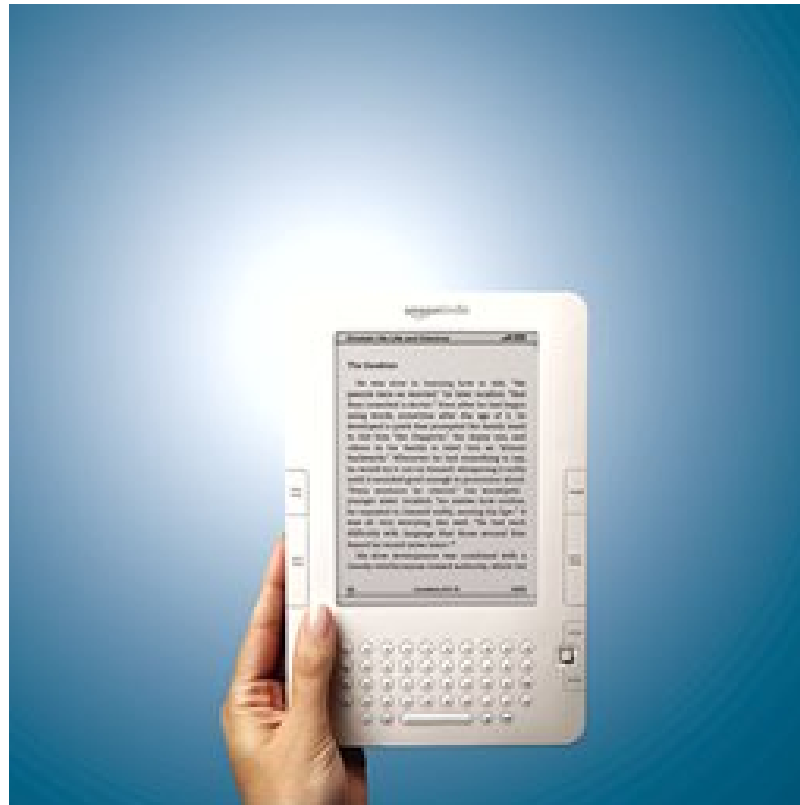


Examples of End-Products Using MC13892/SGTL5000

- ▶ The MC13892 PMIC and SGTL5000 CODEC are used in Freescale's Smartbook/Tablet reference design



- ▶ The MC13892 PMIC is used in Kindle



- ▶ Freescale is focused on providing power management solutions for the i.MX series of processors for eReaders, Netbooks, Smartbooks, MIDs, personal navigational devices, as well as auto infotainment applications
- ▶ Several generations of PMIC design and system level expertise. Freescale SMOS10 technology provides for differentiated and optimized solutions to the customer
- ▶ MC34708 will address i.MX50 series and i.MX53 series and be backwards compatible to support the i.MX51/37 and i.MX35 series of processors
- ▶ Coupled with i.MX, and SGTL5000 codec, offers a complete Freescale platform for eReaders, Netbooks, PMP, PND's, Smartphone applications

