Freescale Technology Forum
Design Innovation.

Nov. 5, 2008

SigmaTel Multimedia Products + i.MX - Strengthening Freescale's i.MX Multimedia Ecosystem

PC112

KW Ip

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Freescale Completes SigmaTel Acquisition 30 April 2008

"SigmaTel's analog and mixed-signal IC technologies complement our successful portfolio of i.MX multimedia applications processors and position our multimedia business as a key growth driver for Freescale. With this acquisition, Freescale enhances its technology and talent enabling us to provide our customers worldwide with one of the broadest, most feature rich multimedia portfolios on the market."

Rich Beyer
Chairman of the Board and Chief Executive Officer
Freescale Semiconductor

► SigmaTel operations have merged with Freescale's Multimedia Applications Division (MAD) creating the most comprehensive multimedia applications processors portfolio based on ARM® core technology in the industry targeting the mobile consumer devices market.

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SigmaTel Strengths

▶ Technology Innovation
- *CMOS mixed signal expertise*
- *Industry leading integrated power management and audio*
- *Optimized cost and performance*

▶ Market Heritage
- *150M+ PMP SoCs shipped into the market*
- *Fifth generation product family*

▶ Complimentary to MAD
- *Enhances product portfolio to cover all PMP market tiers*
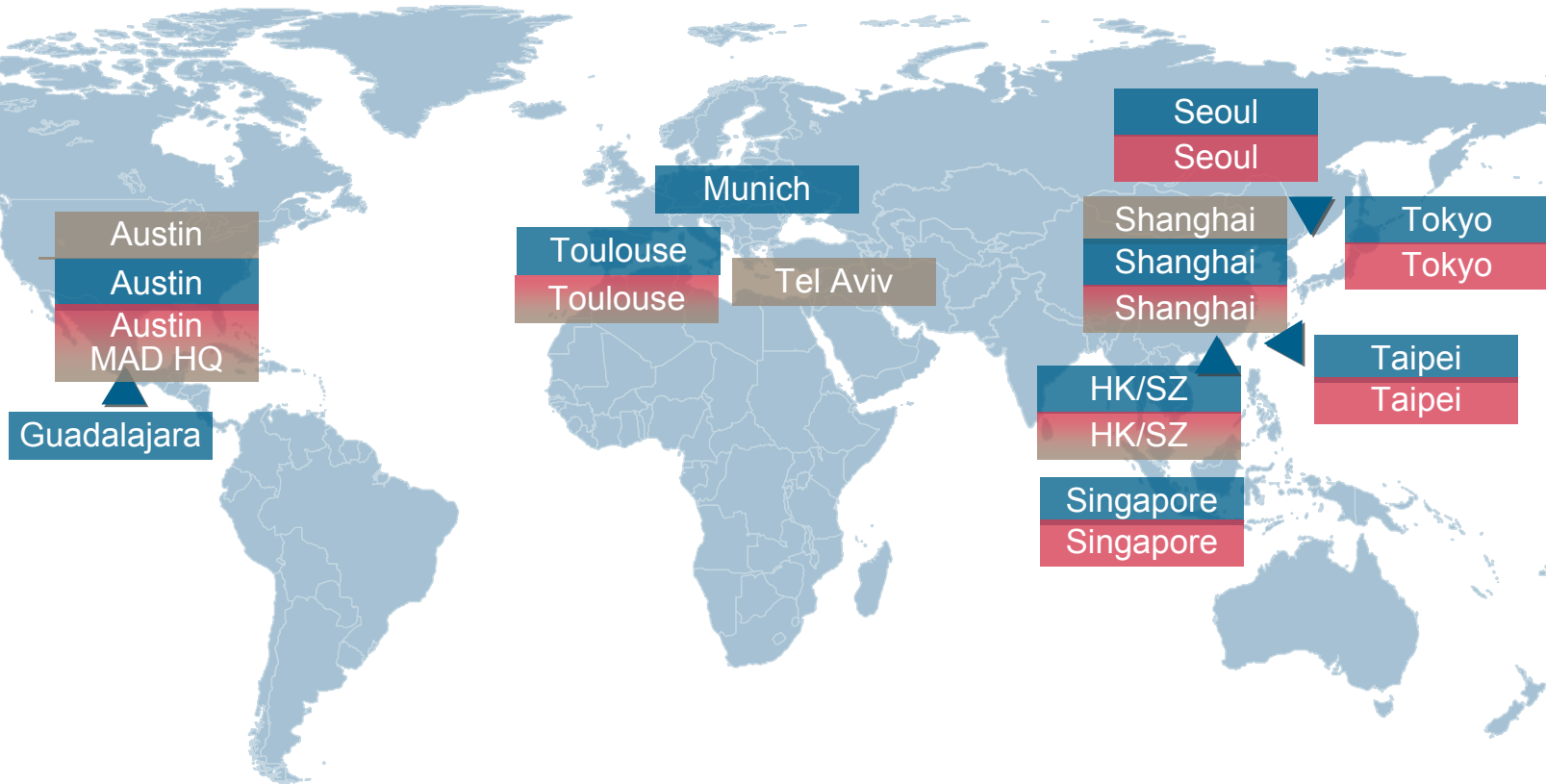- *Mixed signal expertise enables higher levels of integration*

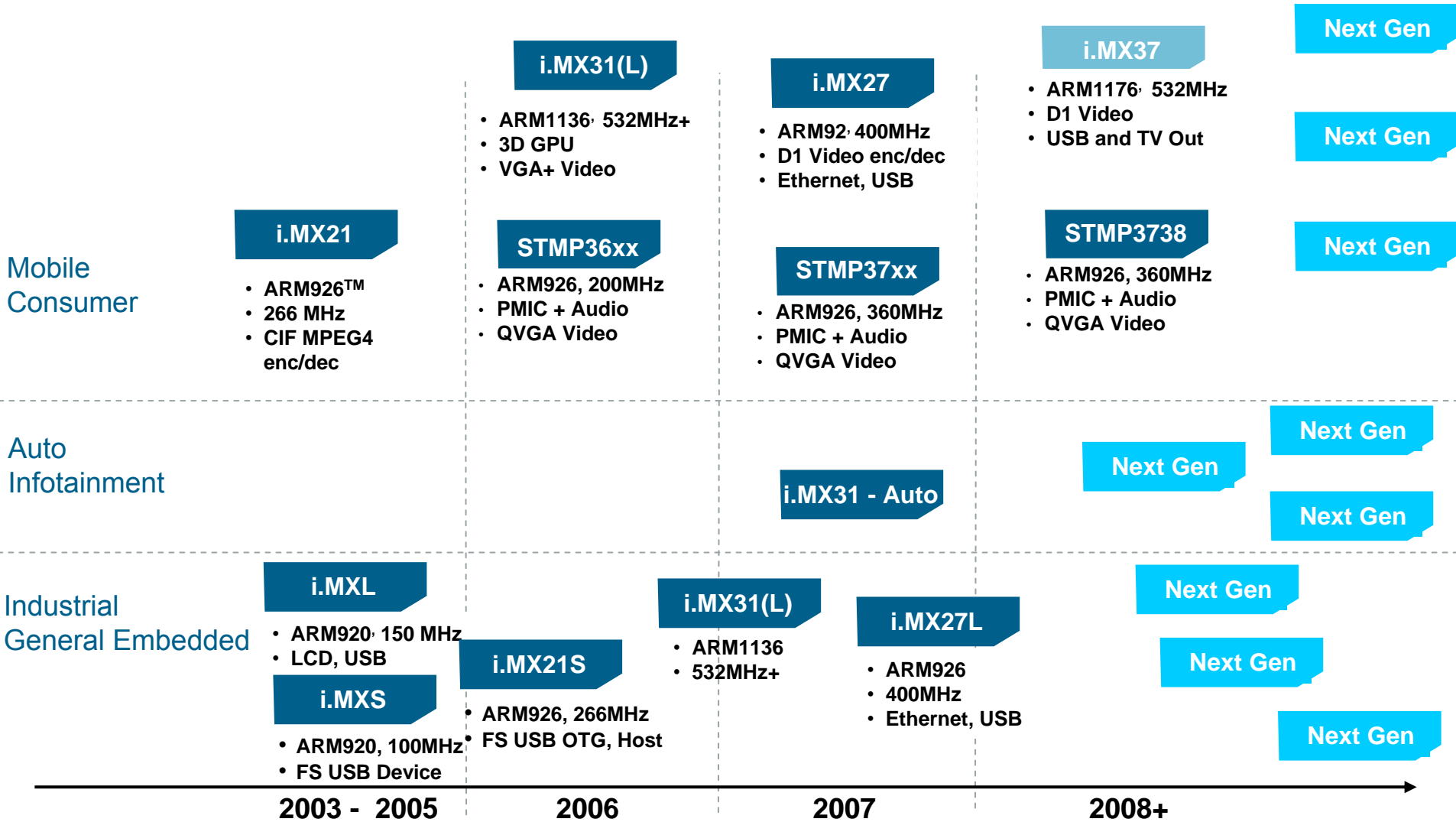# Expanded Global Footprint

Research & Development

Applications Engineering

Product Management/Marketing

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Multimedia Applications Processor Roadmap

Mobile Consumer

i.MX31(L)
- ARM1136, 532MHz+
- 3D GPU
- VGA+ Video

i.MX27
- ARM92, 400MHz
- D1 Video enc/dec
- Ethernet, USB

i.MX37
- ARM1176, 532MHz
- D1 Video
- USB and TV Out

Next Gen

Next Gen

i.MX21
- ARM926™
- 266 MHz
- CIF MPEG4 enc/dec

STMP36xx
- ARM926, 200MHz
- PMIC + Audio
- QVGA Video

STMP37xx
- ARM926, 360MHz
- PMIC + Audio
- QVGA Video

STMP3738
- ARM926, 360MHz
- PMIC + Audio
- QVGA Video

Next Gen

Auto Infotainment

i.MX31 - Auto

Next Gen

Next Gen

Next Gen

Industrial General Embedded

i.MXL
- ARM920, 150 MHz
- LCD, USB

i.MXS
- ARM920, 100MHz
- FS USB Device

i.MX21S
- ARM926, 266MHz
- FS USB OTG, Host

i.MX31(L)
- ARM1136
- 532MHz+

i.MX27L
- ARM926
- 400MHz
- Ethernet, USB

Next Gen

Next Gen

Next Gen

2003 - 2005   **2006**   **2007**   **2008+**

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Portable Multimedia Solutions

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Value Proposition

► STMP SoC platforms leverage mixed-signal integration to deliver benefits applicable to many market segments

- Industry-leading power consumption

- Best-in-class audio quality

- Small form-factor designs

- High performance and advanced features

- Reduced system cost

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3700 Features

► High performance CPU
- ARM926-EJS up to 215MHz @ 1.08V and 360MHz @ 1.45V
- 16KB I-Cache and D-Cache

► Low power
- 90nm process geometry
- Optimized LCD backlight driver
- MP3@160kbps < 20mW
- 6Hrs MPEG-4 video playback with 400mAh battery

► Full QVGA resolution video
- Color space conversion and image scaling in HW
- Flexible LCD interface
- MPEG4, WMV & H.264 @ 30 fps

► Integrated PMU and battery charger

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► Best-in-class integrated audio quality
- -99 dB SNR
- 0.01% THD

► Broad NAND and SDRAM support
- 8-symbol RS ECC block
- 16-bit wide SDRAM, mSDRAM and mDDR up to 133MHz

► Wide array of peripherals
- USB 2.0, PWMs, SPI, SDIO, I2C, SPDIF, etc.

► Security features
- 128-bit AES HW decryption
- SHA-1 HW hashing
- Customer programmable OTP: AES key and read-only ID for DRM management

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Portable Multimedia Processor Roadmap

- ICs Available
- In Development
- In Concept
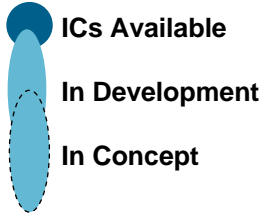
High Performance
D1 – HD Video
3D Graphics

Next Gen

- **i.MX31L + OGLES1.1 3D**

D1 Video
Open Applications
Advanced Connectivity

N

- **ARM1176, 532MHz**
- **D1 Decode**
- **TV-out**

- **ARM1136, 532MHz**
- **CIF-D1 Decode**
- **VGA Encode**

Next Gen

QVGA Video Playback

STMP375x

- **371x + QVGA Decode**

STMP377x

- **ARM926, 360MHz**
- **PMIC + Audio**
- **Rich UI**

Audio, Photo, MJPEG

STMP371x

- **ARM926, 360MHz**
- **PMIC + Audio**
- **Basic UI**

Left Edge = Samples

2008   **2009**

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STMP3710 Processor
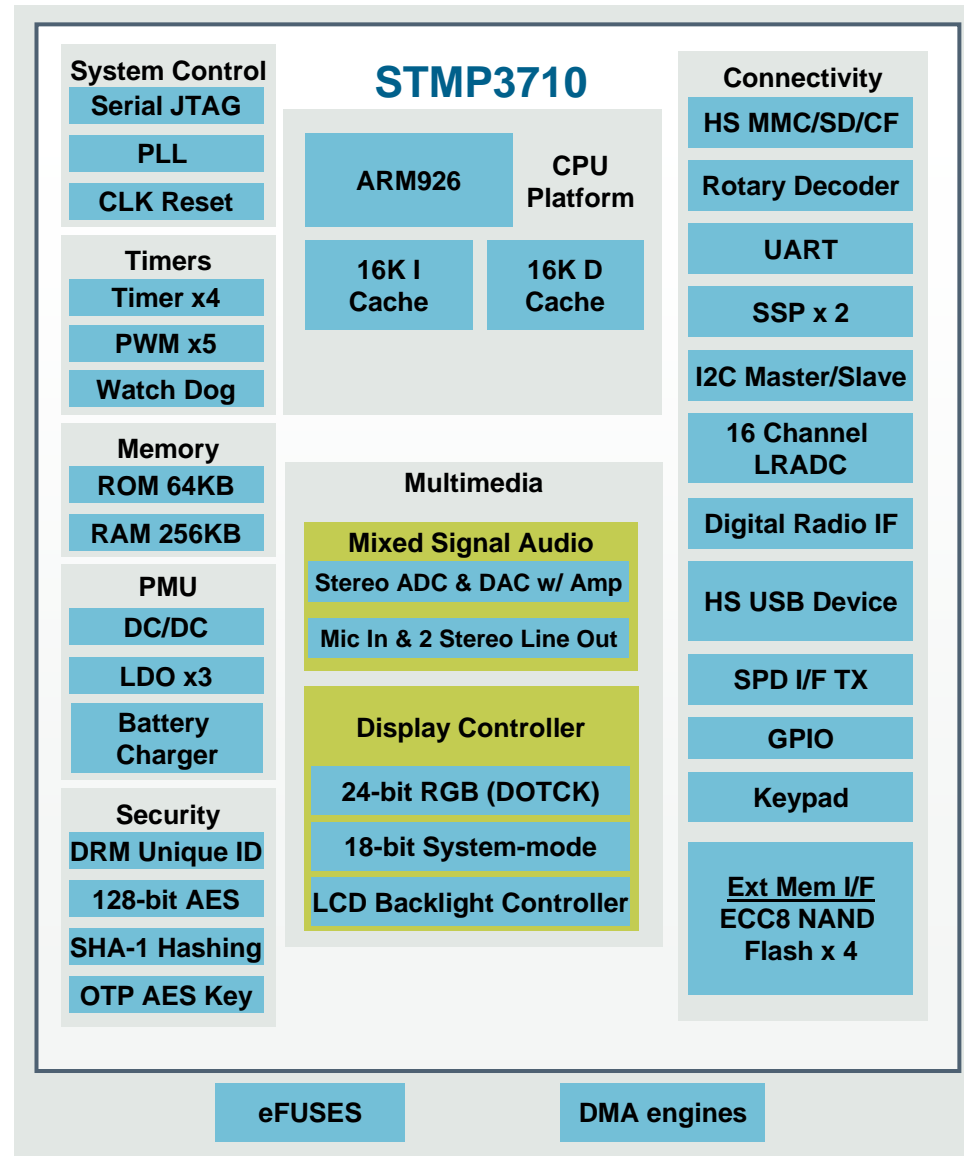
▶ **Specifications:**
- **CPU:** ARM926
- **Process:** TSMC 90LP
- **Core Voltage:** 1.05 – 1.45
- **Package:** 100fpBGA 6x6mm   .5mm
  - 100LQFP 16x16mm   .5mm
- **Temp Range:** -10 to 70C

▶ **Key STMP3710 Features and Advantages**
- ARM926 Core 320 MHz
- PMU with high efficiency on-chip DC/DC
- Targeting very low audio power consumption with MJPEG and limited UI
- Stereo headphone DAC w/ 99dB SNR & Stereo ADC w/ 85 dB SNR with integrated amplifiers
- Hardware 8 symbol Reed-Solomon Error Code Correction (ECC8) support for the latest MLC NANDs
- Power-Efficient Direct-Drive LCD Backlight Controller
- High speed USB with embedded Phy
- Does not require external RAM
- Supports WMDRM10 and DRM9
- No MP3 encode or Plays for Sure 2.x

▶ **Availability:**
- **Samples:** NOW
- **Production:** NOW

STMP3710

System Control
- Serial JTAG
- PLL
- CLK Reset

Timers
- Timer x4
- PWM x5
- Watch Dog

Memory
- ROM 64KB
- RAM 256KB

PMU
- DC/DC
- LDO x3
- Battery Charger

Security
- DRM Unique ID
- 128-bit AES
- SHA-1 Hashing
- OTP AES Key

CPU Platform
- ARM926
- 16K I Cache
- 16K D Cache

Multimedia

Mixed Signal Audio
- Stereo ADC & DAC w/ Amp
- Mic In & 2 Stereo Line Out

Display Controller
- 24-bit RGB (DOTCK)
- 18-bit System-mode
- LCD Backlight Controller

Connectivity
- HS MMC/SD/CF
- Rotary Decoder
- UART
- SSP x 2
- I2C Master/Slave
- 16 Channel LRADC
- Digital Radio IF
- HS USB Device
- SPD I/F TX
- GPIO
- Keypad
- **Ext Mem I/F** ECC8 NAND Flash x 4

eFUSES

DMA engines

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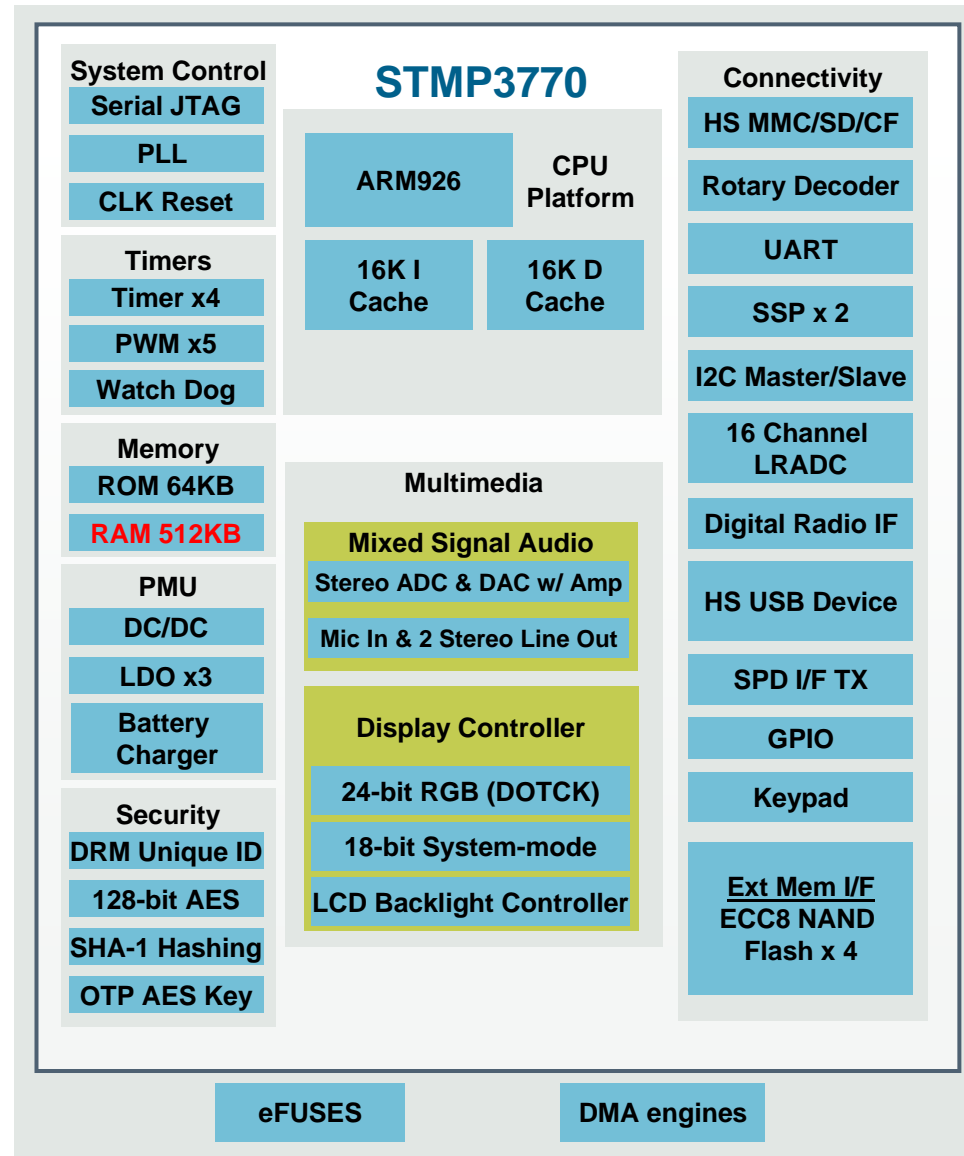semiconductor

STMP3770 Processor

► Specifications:

- **CPU:** ARM926
- **Process:** TSMC 90LP
- **Core Voltage:** 1.05 – 1.45
- **Package:** 100fpBGA 6x6mm .5mm
  100LQFP 16x16mm .5mm
- **Temp Range:** -10 to 70C

► Key STMP3770 Features and Advantages

- ARM926 Core 320 MHz
- PMU with high efficiency on-chip DC/DC
- Targeting very low audio power consumption with MJPEG and elaborate UI
- Stereo headphone DAC w/ 99dB SNR & Stereo ADC w/ 85 dB SNR with integrated amplifiers
- Hardware 8 symbol Reed-Solomon Error Code Correction (ECC8) support for the latest MLC NANDs
- Power-Efficient Direct-Drive LCD Backlight Controller
- High speed USB with embedded Phy
- 512KByte on chip RAM
- Supports WMDRM10, DRM9, and Plays for Sure 2.x
- Support MP3 & WMA encode

► Availability:

- **Samples:** NOW
- **Production:** NOW

STMP3770

System Control
- Serial JTAG
- PLL
- CLK Reset

Timers
- Timer x4
- PWM x5
- Watch Dog

Memory
- ROM 64KB
- RAM 512KB

PMU
- DC/DC
- LDO x3
- Battery Charger

Security
- DRM Unique ID
- 128-bit AES
- SHA-1 Hashing
- OTP AES Key

- ARM926
- CPU Platform
- 16K I Cache
- 16K D Cache

Multimedia

Mixed Signal Audio
- Stereo ADC & DAC w/ Amp
- Mic In & 2 Stereo Line Out

Display Controller
- 24-bit RGB (DOTCK)
- 18-bit System-mode
- LCD Backlight Controller

Connectivity
- HS MMC/SD/CF
- Rotary Decoder
- UART
- SSP x 2
- I2C Master/Slave
- 16 Channel LRADC
- Digital Radio IF
- HS USB Device
- SPD I/F TX
- GPIO
- Keypad
- **Ext Mem I/F** ECC8 NAND Flash x 4

- eFUSES
- DMA engines

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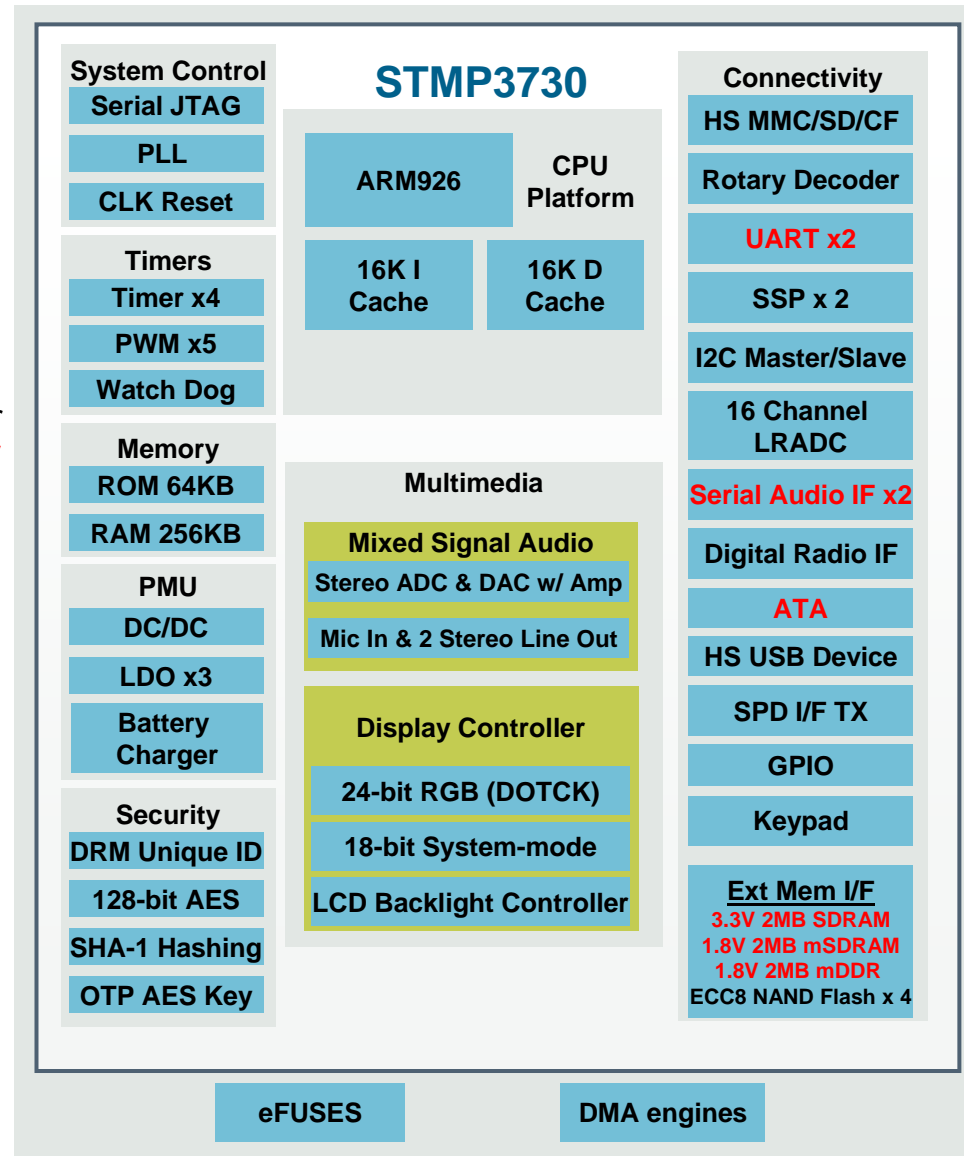semiconductor

STMP3731 Processor

▶ **Specifications:**
- **CPU:** ARM926
- **Process:** TSMC 90LP
- **Core Voltage:** 1.05 – 1.45
- **Package:** 169fpBGA 11x11mm .8mm
  128LQFP 16x16mm .4mm
- **Temp Range:** -10 to 70C

▶ **Key STMP3730 Features and Advantages**
- ARM926 Core 320 MHz
- PMU with high efficiency on-chip DC/DC
- Targeting applications with very low audio power consumption, MJPEG, and custom algorithms or connectivity
- Stereo headphone DAC w/ 99dB SNR & Stereo ADC w/ 85 dB SNR with integrated amplifiers
- Hardware 8 symbol Reed-Solomon Error Code Correction (ECC8) support for the latest MLC NANDs
- Power-Efficient Direct-Drive LCD Backlight Controller
- High speed USB with embedded Phy
- External memory support for 2MB RAM
- WMDRM10, DRM9 and Plays for Sure 2.x
- Supports MP3 & WMA encode

▶ **Availability:**
- **Samples:** NOW
- **Production:** NOW

STMP3730

System Control
- Serial JTAG
- PLL
- CLK Reset

Timers
- Timer x4
- PWM x5
- Watch Dog

Memory
- ROM 64KB
- RAM 256KB

PMU
- DC/DC
- LDO x3
- Battery Charger

Security
- DRM Unique ID
- 128-bit AES
- SHA-1 Hashing
- OTP AES Key

CPU Platform
- ARM926
- 16K I Cache
- 16K D Cache

Multimedia
- Mixed Signal Audio
  - Stereo ADC & DAC w/ Amp
  - Mic In & 2 Stereo Line Out
- Display Controller
  - 24-bit RGB (DOTCK)
  - 18-bit System-mode
  - LCD Backlight Controller

Connectivity
- HS MMC/SD/CF
- Rotary Decoder
- UART x2
- SSP x 2
- I2C Master/Slave
- 16 Channel LRADC
- Serial Audio IF x2
- Digital Radio IF
- ATA
- HS USB Device
- SPD I/F TX
- GPIO
- Keypad
- **Ext Mem I/F**
  - 3.3V 2MB SDRAM
  - 1.8V 2MB mSDRAM
  - 1.8V 2MB mDDR
  - ECC8 NAND Flash x 4

eFUSES

DMA engines

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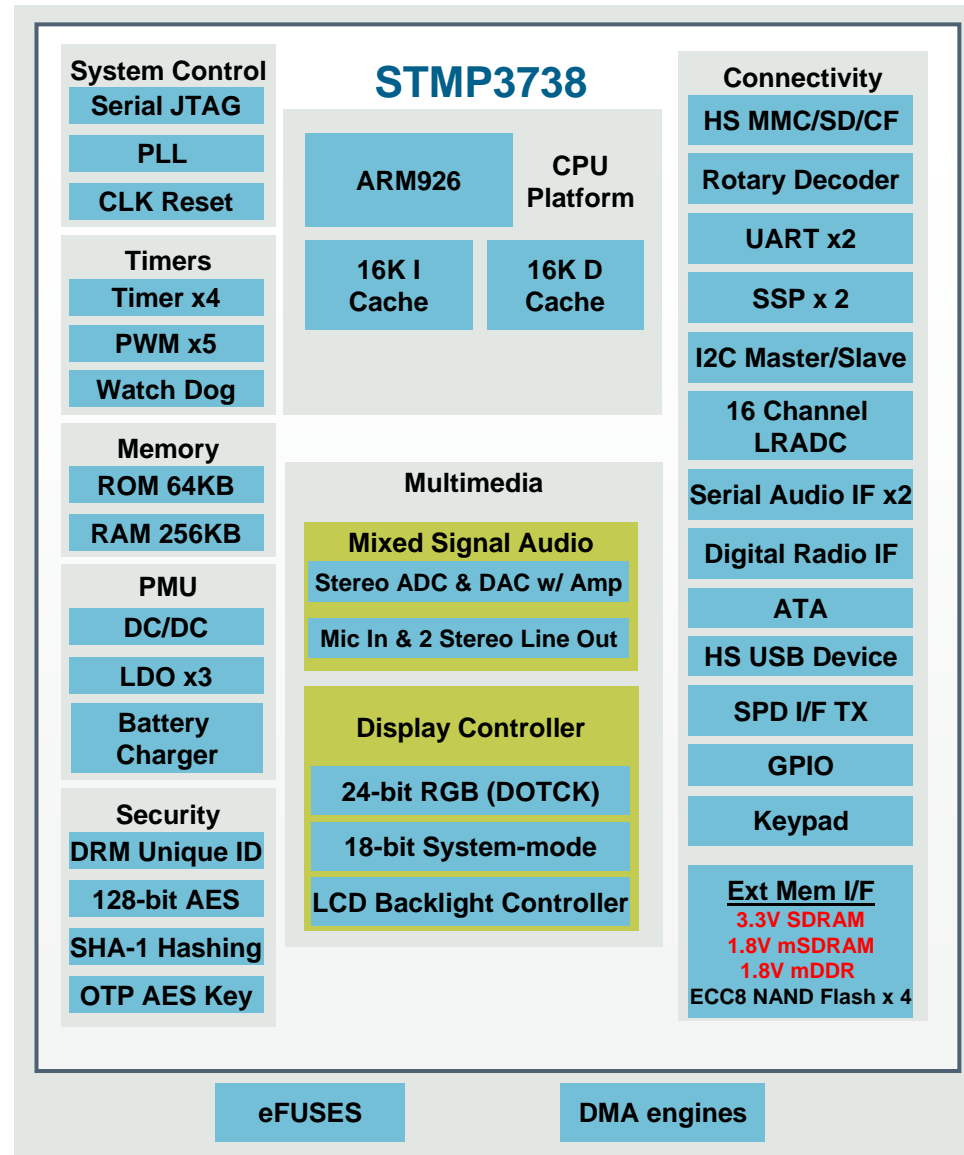
STMP3738 Processor

► **Specifications:**
- **CPU:** ARM926
- **Process:** TSMC 90LP
- **Core Voltage:** 1.05 – 1.45
- **Package:** 169fpBGA 11x11mm   .8mm
  128LQFP 16x16mm   .4mm
- **Temp Range:** -10 to 70C

► **Key STMP3738 Features and Advantages**
- ARM926 Core 360 MHz
- PMU with high efficiency on-chip DC/DC
- Targeting very low video and audio power consumption applications without MP3 encode or DRM
- Stereo headphone DAC w/ 99dB SNR & Stereo ADC w/ 85 dB SNR with integrated amplifiers
- Hardware 8 symbol Reed-Solomon Error Code Correction (ECC8) support for the latest MLC NANDs
- Power-Efficient Direct-Drive LCD Backlight Controller with Voltage or Current Feedback
- High speed USB with embedded Phy
- No WMDRM10 or DRM9
- Support MP3 & WMA encode

► **Availability:**
- **Samples:** NOW
- **Production:** NOW

Block Diagram

STMP3738

System Control
- Serial JTAG
- PLL
- CLK Reset

Timers
- Timer x4
- PWM x5
- Watch Dog

Memory
- ROM 64KB
- RAM 256KB

PMU
- DC/DC
- LDO x3
- Battery Charger

Security
- DRM Unique ID
- 128-bit AES
- SHA-1 Hashing
- OTP AES Key

CPU Platform
- ARM926
- 16K I Cache
- 16K D Cache

Multimedia
- Mixed Signal Audio
  - Stereo ADC & DAC w/ Amp
  - Mic In & 2 Stereo Line Out
- Display Controller
  - 24-bit RGB (DOTCK)
  - 18-bit System-mode
  - LCD Backlight Controller

Connectivity
- HS MMC/SD/CF
- Rotary Decoder
- UART x2
- SSP x 2
- I2C Master/Slave
- 16 Channel LRADC
- Serial Audio IF x2
- Digital Radio IF
- ATA
- HS USB Device
- SPD I/F TX
- GPIO
- Keypad
- **Ext Mem I/F**
  - 3.3V SDRAM
  - 1.8V mSDRAM
  - 1.8V mDDR
  - ECC8 NAND Flash x 4

eFUSES   **DMA engines**

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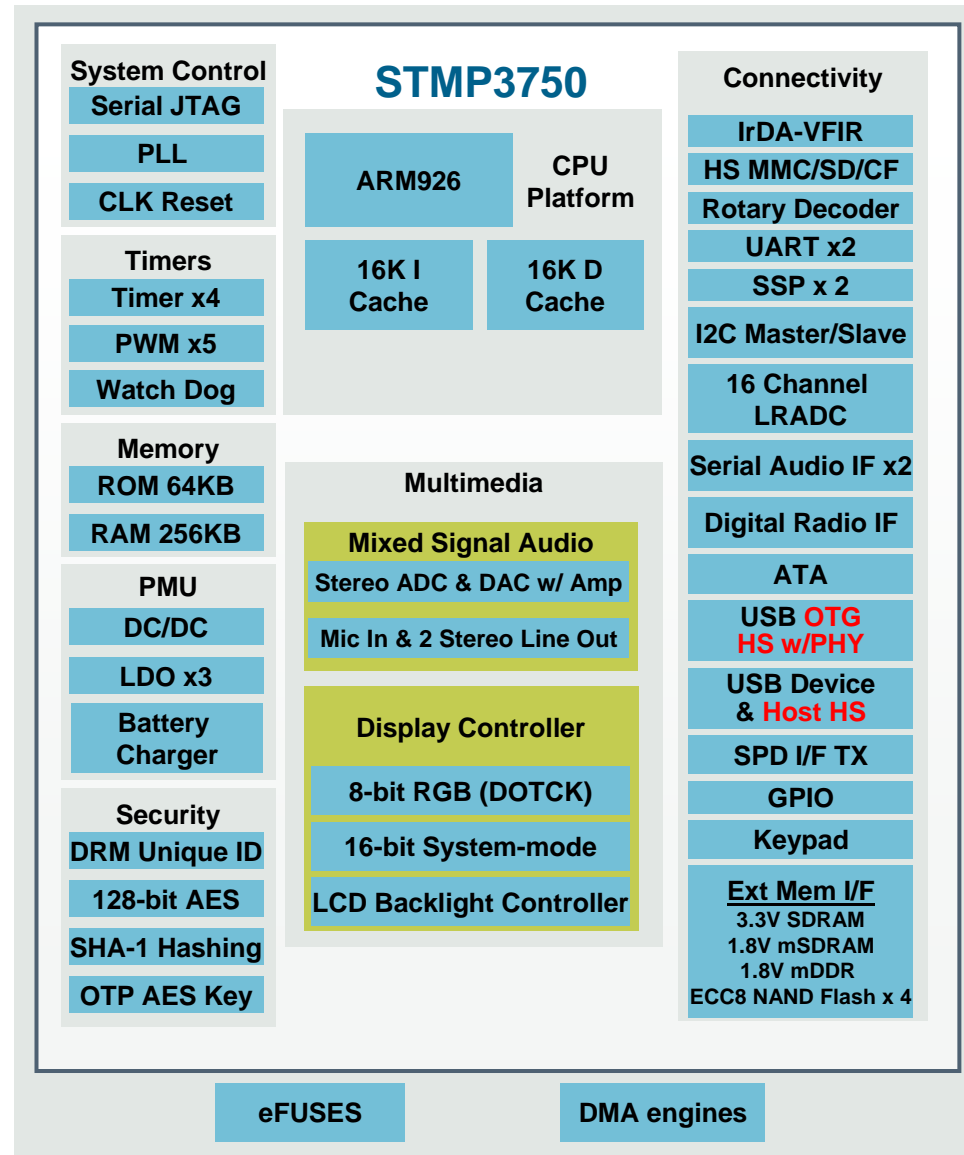
STMP3750 Processor

► Specifications:

- **CPU:** ARM926
- **Process:** TSMC 90LP
- **Core Voltage:** 1.05 – 1.45
- **Package:** 169fpBGA 11x11mm .8mm
  - 128LQFP 16x16mm .4mm
- **Temp Range:** -10 to 70C

► Key STMP3750 Features and Advantages

- ARM926 Core 360 MHz
- PMU with high efficiency on-chip DC/DC
- Targeting very low video and audio power consumption applications that require MP3 encode and/or DRM
- Stereo headphone DAC w/ 99dB SNR & Stereo ADC w/ 85 dB SNR with integrated amplifiers
- Hardware 8 symbol Reed-Solomon Error Code Correction (ECC8) support for the latest MLC NANDs
- Power-Efficient Direct-Drive LCD Backlight Controller with Voltage or Current Feedback
- High speed USB with embedded Phy
- WMDRM10, DRM9 and Plays for Sure 2.x
- Support MP3 & WMA encode

► Availability:

- **Samples:** NOW
- **Production:** NOW

STMP3750

System Control
- Serial JTAG
- PLL
- CLK Reset

Timers
- Timer x4
- PWM x5
- Watch Dog

Memory
- ROM 64KB
- RAM 256KB

PMU
- DC/DC
- LDO x3
- Battery Charger

Security
- DRM Unique ID
- 128-bit AES
- SHA-1 Hashing
- OTP AES Key

CPU Platform
- ARM926
- 16K I Cache
- 16K D Cache

Multimedia
- Mixed Signal Audio
  - Stereo ADC & DAC w/ Amp
  - Mic In & 2 Stereo Line Out
- Display Controller
  - 8-bit RGB (DOTCK)
  - 16-bit System-mode
  - LCD Backlight Controller

Connectivity
- IrDA-VFIR
- HS MMC/SD/CF
- Rotary Decoder
- UART x2
- SSP x 2
- I2C Master/Slave
- 16 Channel LRADC
- Serial Audio IF x2
- Digital Radio IF
- ATA
- USB OTG HS w/PHY
- USB Device & Host HS
- SPD I/F TX
- GPIO
- Keypad
- **Ext Mem I/F**
  - 3.3V SDRAM
  - 1.8V mSDRAM
  - 1.8V mDDR
  - ECC8 NAND Flash x 4

eFUSES   DMA engines

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Benefits Summary
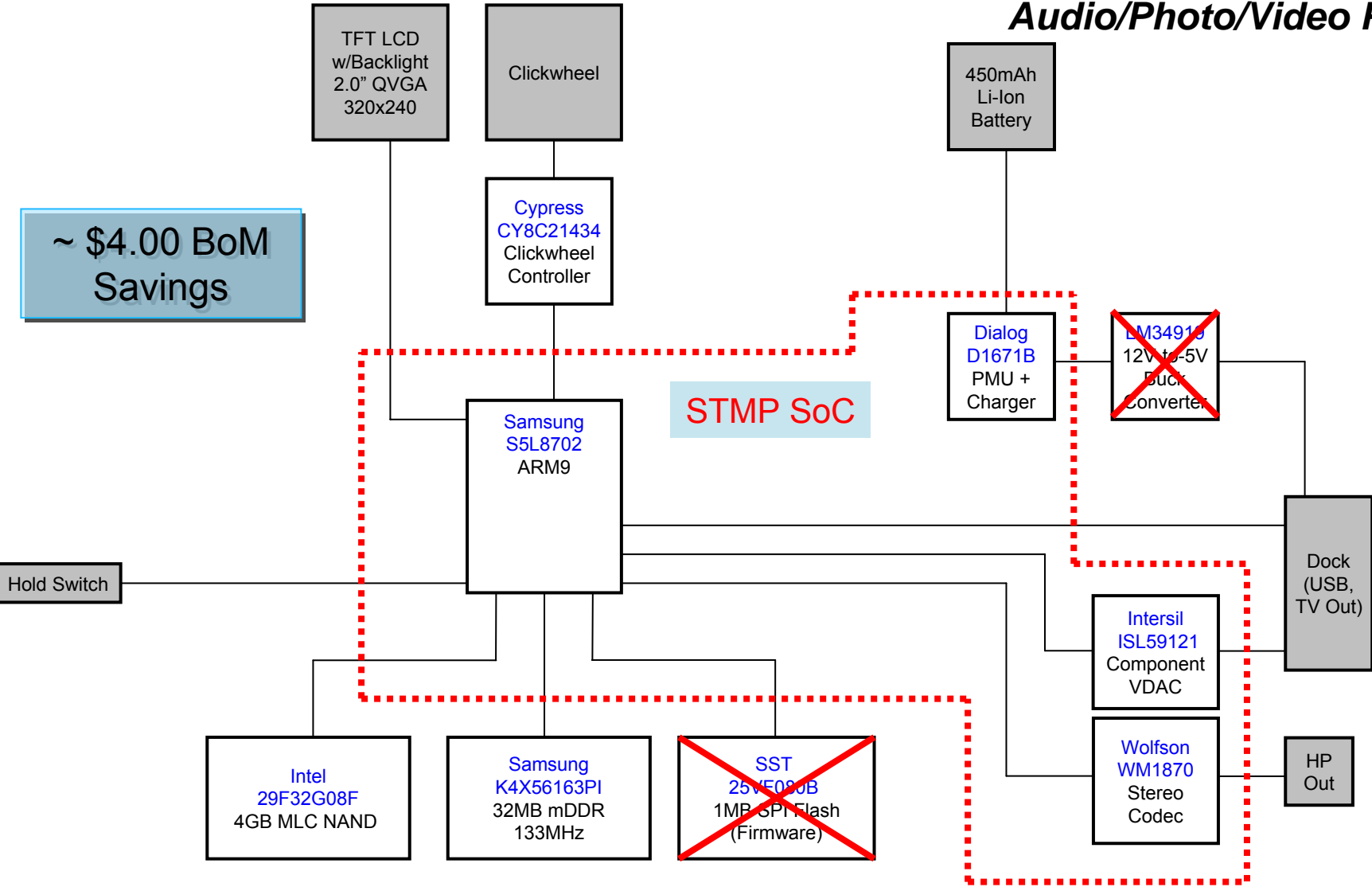
► Highly integrated SoC platforms

► Full-featured and robust software

► Industry-leading power consumption

► Best-in-class audio quality

► Small form-factor designs

► High performance and advanced features

► Reduced system cost

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PMP
Application Example

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iPod nano (gen 3)
Audio/Photo/Video Player

~ $4.00 BoM Savings

TFT LCD w/Backlight 2.0" QVGA 320x240

Clickwheel

450mAh Li-Ion Battery

Cypress CY8C21434 Clickwheel Controller

STMP SoC

Dialog D1671B PMU + Charger

LM34919 12V to-5V Buck Converter

Samsung S5L8702 ARM9

Hold Switch

Dock (USB, TV Out)

Intersil ISL59121 Component VDAC

Intel 29F32G08F 4GB MLC NAND

Samsung K4X56163PI 32MB mDDR 133MHz

SST 25VF080B 1MB SPI Flash (Firmware)

Wolfson WM1870 Stereo Codec

HP Out

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Mobile Internet Device (MID) Application Example

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iPod touch

~ $3.00 BoM Savings

TFT LCD w/Backlight 3.5" HVGA 320x480	Multi-touch Touch Panel		800mAh Li-Ion Battery

STMP SoC

- Taos TSL256 Ambient Light Sensor
- National LM2512 LCD Serializer (crossed out)
- Broadcom BCM5937A Multi-touch Controller
- ST Micro LIS302DL Accelerometer
- TI TMP106 Temp Sensor
- LTC4066 Li-Ion Charger

- Wi-Fi Module — Marvell 86W8686B 802.11b/g

- Samsung S5L8900 ARM11 400MHz — Mac OS X Mobile

- NXP PMU
- National 12V to 5V Buck Converter (crossed out)
- TI SN65C3238 RS-232 Line Driver (crossed out)

- Buttons

- Dock (USB, TV Out)

- TI THS7318 Component VDAC

- Samsung K9LBG08U1M (x2) 8GB MLC NAND
- Samsung K4X1GA53PE 128MB mDDR
- SST 39WF800A 1MB NOR Flash (Firmware) (crossed out)
- Wolfson WM8758BG Stereo Codec
- HP Out

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GPS PND
Application Example

Personal Navigation Device Block Diagram

~ $4.00 BoM Savings

SDRAM

NAND

SD MMC

GPS Module

SAMSUNG
S3C2412
ARM926EJS/203MHz/.13um
272pinFBGA 14x14

FM Tuner

Audio Codec

Speaker Amp.

Display
TFT-LCD 2.8/3.5 w/ Touch

Buttons

STMP SoC

DCDC Converter

Battery Charger

Battery
Li-ion Polymer
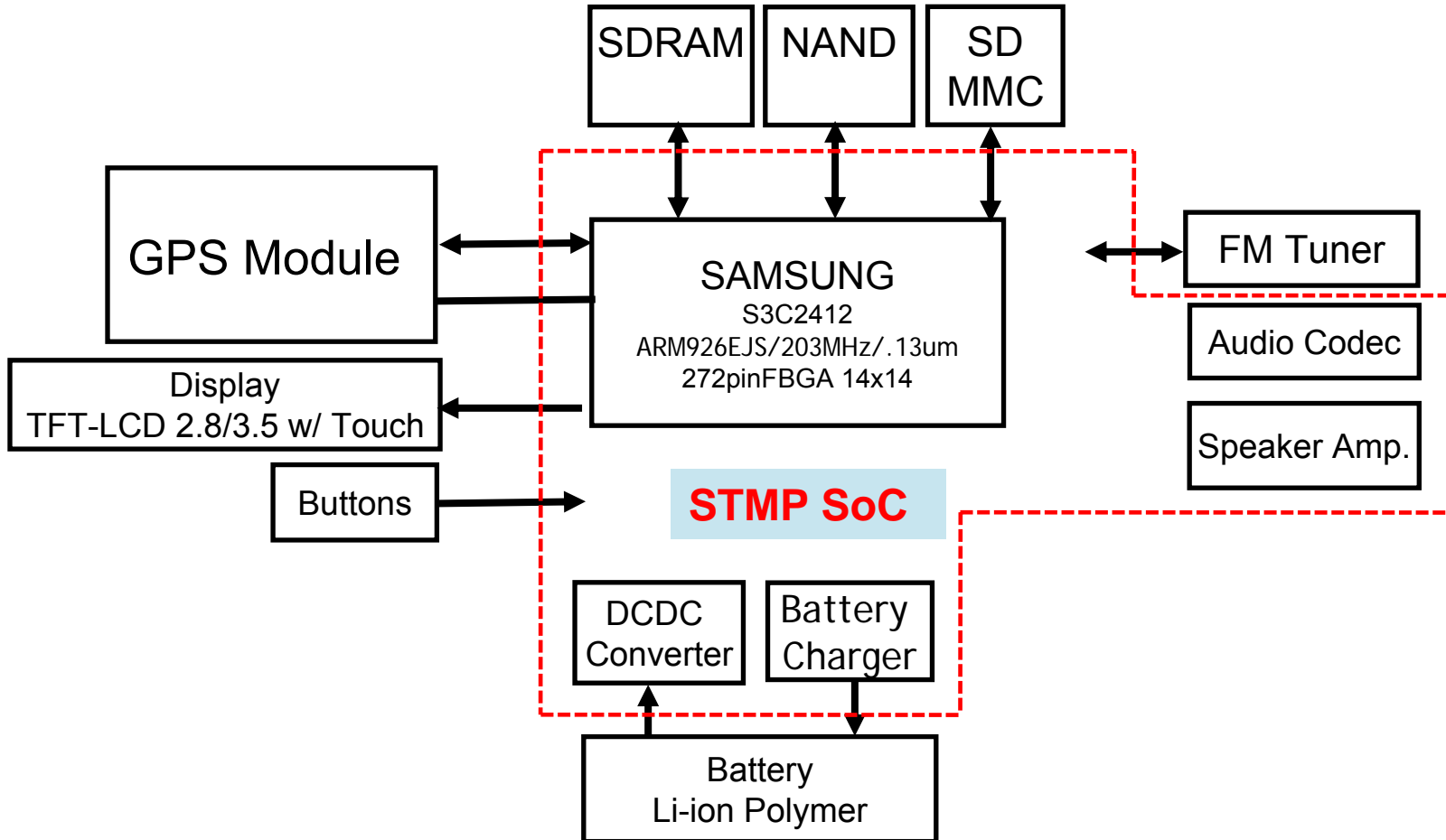
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High Performance, Low Power Audio Codecs

Agenda

▶ Roadmap

▶ Low Power Audio Codecs
- • Product Overview
- • Competitive Advantages

▶ Summary

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Consumer Audio Codec Roadmap

Legend:
- ICs Available
- In Development
- Conceptual
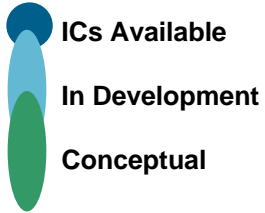
IPA:Portable Power & Audio

SGTL5000
Stereo CODEC w/ HP amp
- Line In, Mic In, I2S in
- HP out, Line out

SGTL5001
Stereo CODEC w/ HP Speaker Output
- Line In, Mic In, I2S in
- HP out, Line out
- 2 x 1W Speaker Out

SGTL5002
- Stereo CODEC w/ HP amp & Speaker Output + SRC
- Line In, Mic In, 2*I2S in w/ SRC
- HP out, Line out
- 2 x 1W Speaker Out

SGTL5010
SGTL5000+GND Ref Headphone

SGTL5012
SGTL5002+GND Ref Headphone

IPA+
- PMIC + audio
- Touch Screen
- USB + Charger
- Clock Generator
- FMTX

IPA
- PMIC + audio
- For Portables
- --PMP, PND etc

TV/Multichannel Audio

SGTV5910
TV Audio Processor
- Broadcast Audio Demodulator
- 10 Stereo Inputs
- 3 Stereo Outputs w/ Headphone Amp

SGTL5901
Audio CODEC
- 8 Stereo Inputs
- 6 Channel 2Vrms Outputs
- w/ Headphone Amp
- 1 synchronous I2S and 1 asynchronous I2S

Class D
- 15Watt Class D
- DDX Technology
- Controller proven in SGTV5910

Right Edge = Samples

| 3Q08 | 4Q08 | 1Q09 | 2Q09 | 2H09 |

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Why Codecs?
Takes advantage of our SoC Development

► MP3 SoCs: Over 100M sold
  - Each unit has an audio codec
  - Currently on 5th generation platform
  - Best-in-class integrated codec performance

► Audio architecture optimizes
  - Power consumption
  - Audio performance
  - Cost

► Provides more complete system solution for i.Mx processors

3xxx Simplified Block Diagram

| Peripherals | ARM 9 Core | Audio CODEC |
| | | Power Management |

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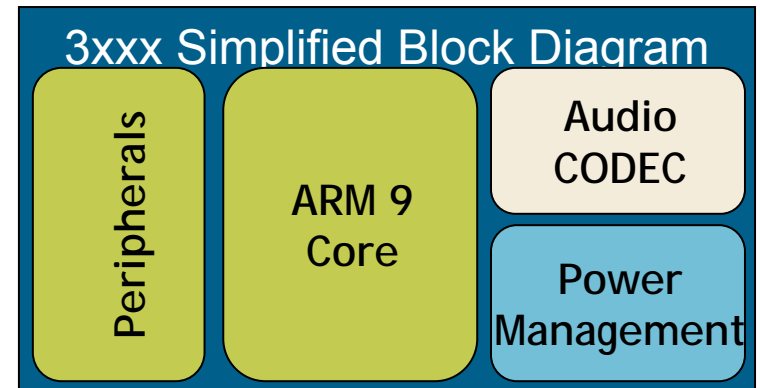
SGTL5000: Stereo Codec w/ Headphone Amp
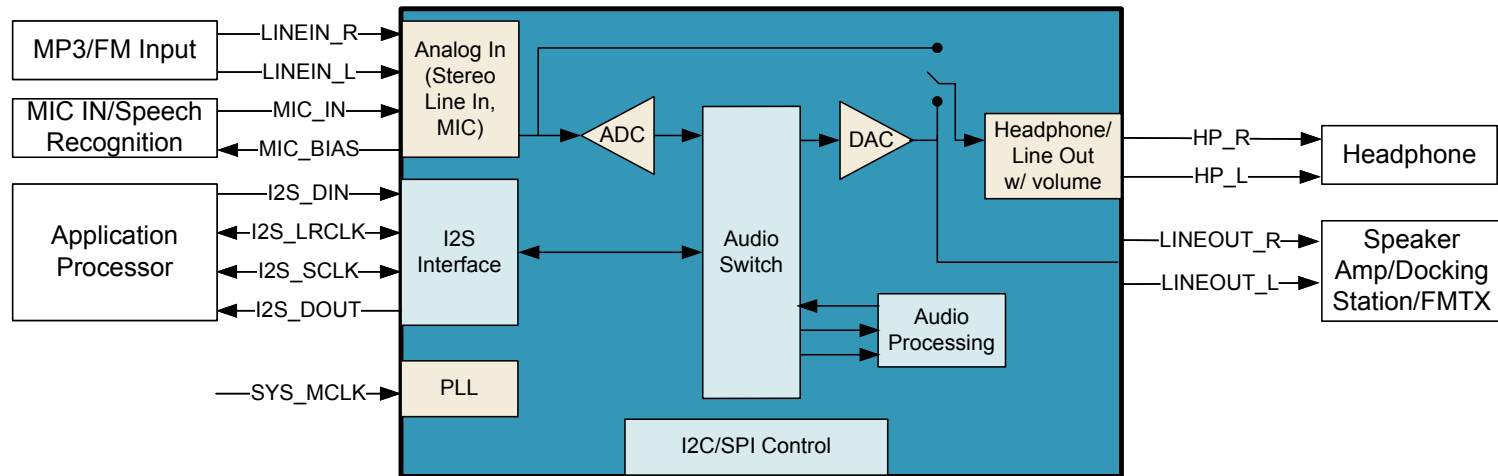
► Playback performance:
  - 98dB Dynamic Range (AWtd) @ < 4mW power, < -80dB THD+N
  - Quiesent power, I2S->DAC->HP, VDDA = 1.8V

► ADC performance:
  - 85dB Dynamic Range (AWtd), -70dB THD+N, VDDA=1.8V
  - 92dB Dynamic Range (AWtd), -78dB THD+N, VDDA=3.3V

► Headphone output: 9mW (32ohm, 1.8V) to 45mW (16ohm, 3.3V)
  - -80dB THD+N at full scale output

► PSRR > 80dB (1kHz)

► Footprint: 20QFN, 3mm x 3mm (32QFN 5mm x 5mm available)

SGTL5001: Stereo Codec with HP AMP & 1W+1W Class D Stereo Speaker Amp
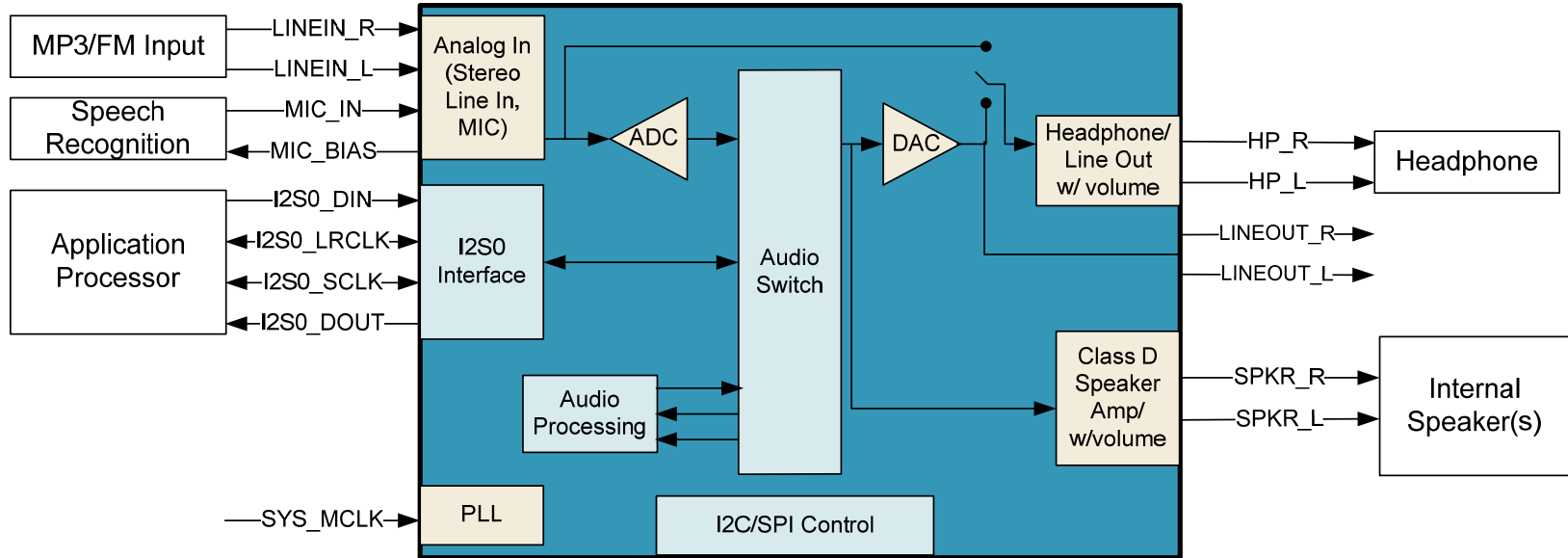
▶ **DDX Class-D stereo speaker output**
- 90% efficient
- < -70dB THD+N, 1W into 8 ohms at 4.2V

▶ **Small footprint: 28QFN, 4mm x 4mm**

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SGTL5002: Stereo Codec with HP AMP & Stereo Class D Speaker Amp & Dual I2S
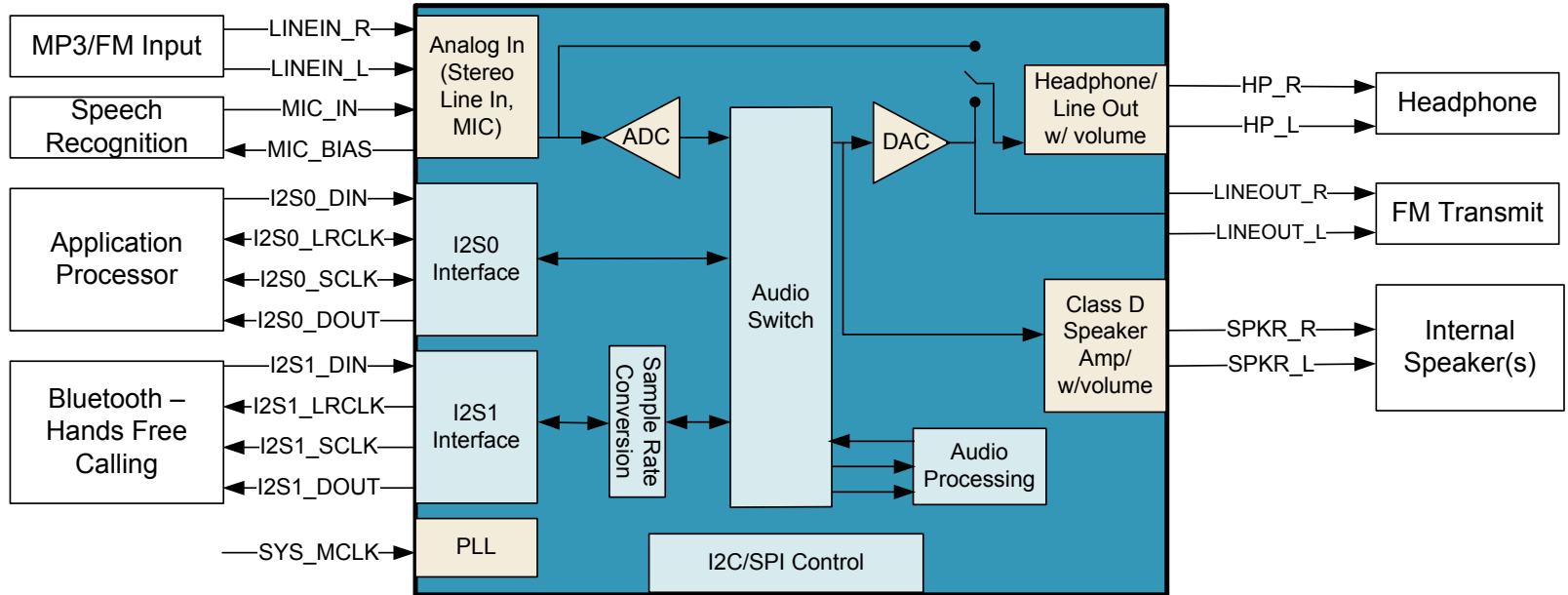
▶ Second digital input port supports synchronous or asynchronous operation

  - Supports 8kHz sample rate conversion for Bluetooth applications
  - All audio can be routed through codec to minimize processor overhead

▶ Small footprint: 32QFN, 5mm x 5mm

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Audio Processing Detail
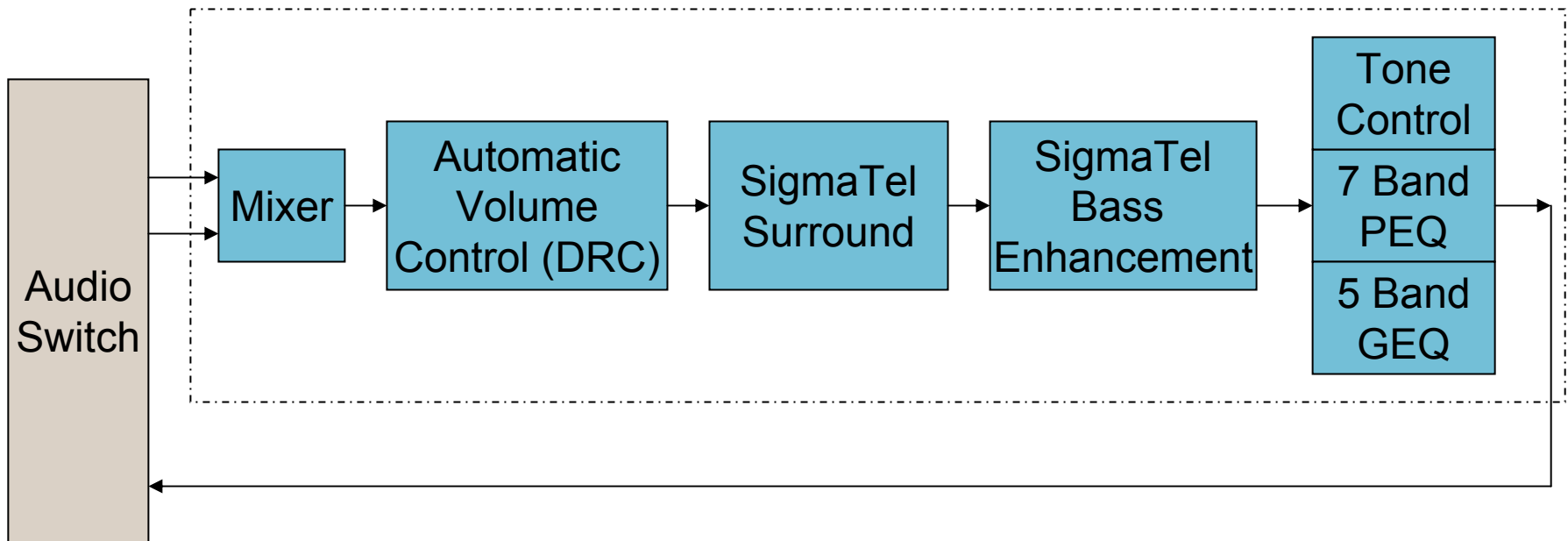
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Competitive Analysis

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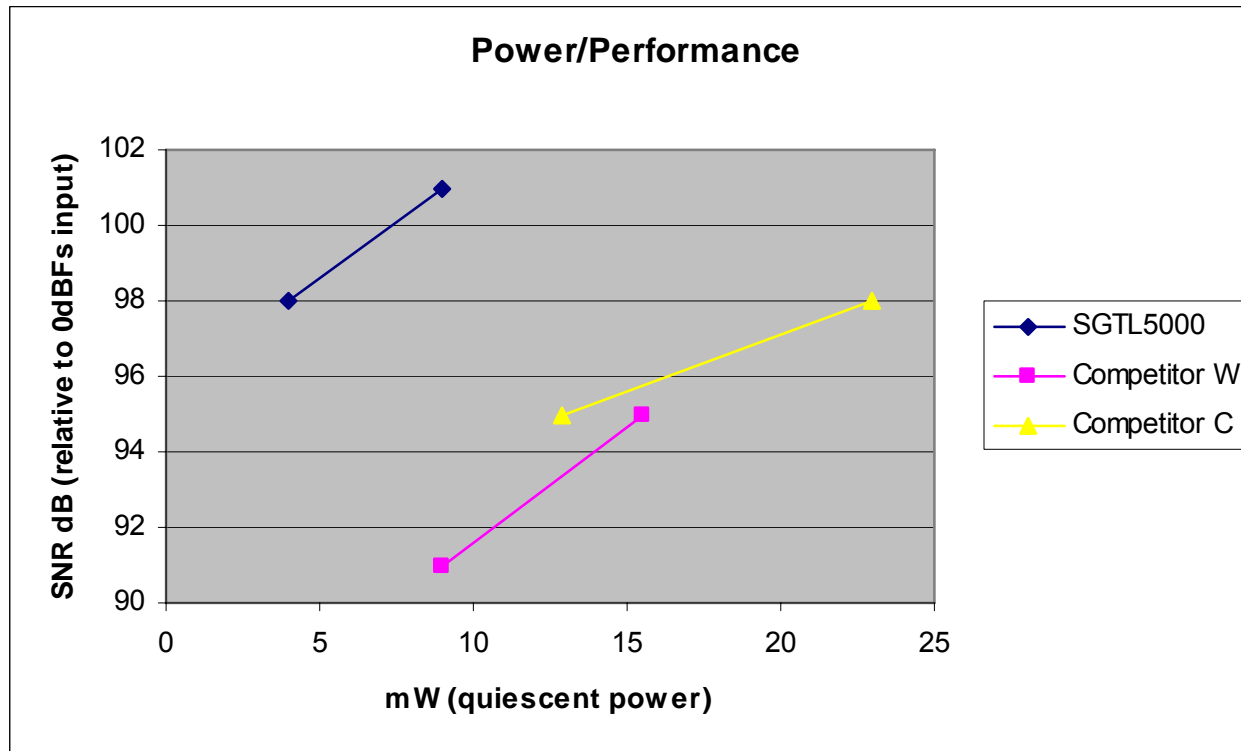
Headphone Power & Performance (AVDD = 1.8V, 16 ohm load)			
	Dynamic Range A-Wtd (dB)	THD+N (dB)	Headphone Output (mW)
SigmaTel CODEC	98	-80	18
Competitor W	95	-40**	18
Competitor C	95	-75	23
** (32 ohm load @ -2dBFs)			

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Detailed Competitive Analysis: System Cost

	External Component Count
SGTL5000	8 Caps
Competitor W	18 Caps + 3 resistors
Competitor C	19 Caps + 8 resistors

Notes:
1. Comparing Parts assuming single MIC, One Line In, One Line Out and Headphone.
2. Following typical connection diagrams from datasheets
3. SGTL5000 32QFN low cost configuration shown.

SGTL5000 BOM (32QFN low cost configuration)	
Count	Component
2	.1uF Capacitor
6	1uF Capacitor

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Detailed Competitive Analysis - Size

5mmx5mm QFN

SGTL5000
3mmx3mm
QFN

- SGTL 3mmx3mm package is ~3x smaller than the size 5mmx5mm
- These are strictly package sizes and do not take into account area required by additional external components

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Target Markets

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▶ Primary:

- PMP
- GPS
- Cell Phone/Smart Phone

▶ Secondary

- Gaming
- Docking Stations
- Portable Electronics
- Non Portable Electronics

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Summary

► Advantages
  - Best audio quality at lowest power
  - Excellent headphone performance across volume range
  - High PSRR – can reuse existing supplies without additional linear regulator
  - Audio Processing
  - Functionality
  - Smallest PCB footprint

► Price: Highly competitive

► Schedule:
  - SGTL5000: Low Power Codec w/ Headphone:
    - Sampling Q208
    - Production Q308
  - SGTL5001 & SGTL5002: Low power Codec w/ HP & Speaker Amp
    - Sampling Q408
    - Production Q109

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Related Session Resources

Session Location – Online Literature Library

http://www.freescale.com/webapp/sps/site/homepage.jsp?nodeId=052577903644CB

Sessions

Session ID	Title

Demos

Pedestal ID	Demo Title

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