Low Power System Design Using Atmel ARM® Cortex®-based Products
Low Power System

• What’s driving low power system?
  • System power budget constrain
  • Long battery life
  • Specification of application mandatory
  • Green power law/rule

• Low power System key Consideration
  • Low power consumption in running status
  • Low power consumption in sleep status
  • Stay on the sleep status as much time as it can
  • Fast wake up to avoid data or event handle miss
Atmel ARM-based Cortex-M Flash MCU Roadmap

CM3/4 Available Now  CM4 Development  CM0+ Development

16KB  32KB  64KB  128KB  256KB  512KB  1MB  2MB

- SAM D20 Q4 2013
- SAM D21 Q4 2013
- SAM3N
- SAM3S Q4 2013
- SAM4S
- SAM4N
- SAM3U
- SAM3X
- SAM3A
- SAM4E
- SAM4L Q3 2013

Atmel picoPower
General Purpose
Connectivity
Atmel picoPower

12-Year Lifetime Commitment
Introducing Atmel SAM D20 & SAM D21 Series
Powerful and Efficient Products

- Atmel SAM D20 and D21 Product Series
  - 48MHz operation
  - Up to 2.14 CoreMark®
  - ±2% int RC oscillator
  - 1.62V-3.63V
  - 16KB to 256KB Flash
  - 32-, 48- and 64-pin versions
Series Features

- Atmel SAM D20 Differentiating Features
  - Event system
  - SERCOM modules configurable as I2C, USART or SPI
  - Capacitive Touch HW engine
  - 12-bit 350ksps ADC with gain stage
  - 10-bit 350ksps DAC

- Atmel SAM D21 Additional Features
  - Full speed USB from internal RC
  - DMA
  - I2S
  - Fractional PLL
  - Enhanced Timer/Counters
    - Complimentary outputs
    - Dead time insertion
    - High resolution PWM
Target Applications

- Atmel SAM D20 and SAM D21
  - Toys
  - Board controllers
  - Wireless applications
  - Sensor interfaces
  - Gaming
  - Medical
  - White goods
  - Set-top boxes
  - Electric tools

- Atmel SAM D21
  - PC peripherals
  - Motor control
  - Lighting
  - Communication bridges
  - Audio
# SAM4L Family Overview

Two series for maximum flexibility

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SAM4L Device Details

The world’s most efficient Cortex-M4

• picoPower® Technology
  • Industry’s lowest power consumption
    • Active mode: down to 90µA/MHz
    • Full RAM retention: 1.5µA
  • 1.68 – 3.6V operation
    • No degraded performance
  • Fast wake-up
    • 1.5µs
  • Peripheral Event System
    • SleepWalking™

• Integrated Hardware QTouch®
  • Wake up from a touch of a button or proximity

• Segment LCD Controller
  • 4x40 segments

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SAM4L Target applications

• Industrial
  • Process transmitters
  • Sensors & detectors
  • Sub-meters
  • Sensor hub

• Healthcare
  • Glucose meters
  • Pulse oximetry
  • Human fall detection
  • Blood pressure

• Consumer
  • Sport watches
  • Remote control
  • Toys
  • Sensor hub
picoPower

Advanced power saving techniques for designing low power Cortex-M applications
picoPower™ Technology

- Ultra low active power consumption
  - Down to 90 µA/MHz

- Dynamic Frequency Scaling
  - Change CPU speed in real time

- Ultra fast wake-up
  - 1.5 µs

- SleepWalking™
  - Qualify event before waking system

- Sleeping BOD
  - No BOD power consumption in sleep and Idle

- Low Leakage Process
  - Down to 1.5 µA with full RAM Retention

- True 1.6V operation
  - All modules including Flash and analog working
Superior CPU Performance

- SAM offers superior CPU performance
  - Architecture designed with compiler experts
  - Designed to run from Flash
  - Up to 3.39 CoreMark™ / MHz running from Flash

- DSP instruction set in Cortex-M4
  - Single cycle multiply and accumulate
  - Optimized DSP library by Atmel experts

- High Code Density
  - Increased performance
Dynamic Power Management

- Multiple clock domains
  - Tune domain clocks for performance vs. power consumption

- Dynamic Frequency Scaling (DFS)
  - Reduce power consumption when maximum speed is not required
  - Change CPU speed in real time
  - Adapt to changes in workload

- Individual peripheral clock control
  - Tune clock speed to match required performance
  - Stop unused peripherals
Peripheral Event System

Overview

- Event Routing Network
  - Message passing
  - No CPU
  - Event qualification

- Saves power
  - Main clock turned off while waiting for event
  - Peripheral clocks are enabled when needed
Peripheral Event System

Overview

• Event Routing Network
  • Message passing
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  • Event qualification

• Saves power
  • Main clock turned off while waiting for event
  • Peripheral clocks are enabled when needed
Peripheral Event System

• Direct routing of signals between peripherals
  • 2 cycle latency
  • Predictable
  • No lost events

• Eliminates CPU wakeups

• Examples
  • RTC event → ADC start conversion
  • Analog Comparator → adjust PWM period
SleepWalking and EventSystem Real Case

Reduces the overall power consumption

Reduces power consumption by 57%

1. RTC wakes AC to measure temperature
2. Temperature below threshold: Return to sleep back to sleep
3. RTC wakes AC to measure temperature
4. Temperature above threshold: Wakes-up CPU
5. Write message on LCD
picoPower in Action

- 90µA/MHz
- 1.5µs Wake-up
- Cortex-M4 with DSP Instructions
- High Code Density Flash & System performance
- Event System SleepWalking™
- DMA
- Efficient Power Management
- Digital Frequency Locked Loop (DFLL)
- 500nA

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Peripheral Touch Controller (PTC)
Built-in Hardware Support for Touch

• Supports Buttons, Sliders, Wheels and Proximity
• Superb Sensitivity and Noise Tolerance
• Supports Mutual and Self Capacitive Touch
  • Self-calibrating, no tuning needed
  • No external components needed
• Wake-up from Power Down on Touch Detection
  • 250ms scan @ 10µA
Atmel Well Address Low Power System Design

• Atmel is a Market Leader in Low Power
  • Industry leading 8-bit picoPower devices
  • Worlds lowest power Cortex-M with picoPower SAM4L and SAMD20

• High performance CPU
  • Enable low power in complex applicaiton
  • Quick finish software runing then back to sleep mode
  • Lower power consumption at CoreMark™ benchmark

• PicoPower™
  • True 1.6V operation. All modules including Flash and analog working
  • Ultra fast wake-up
  • SleepWalking peripherals
Atmel Well Address Low Power System Design

• Built-in Hardware Support for Touch (PTC)
  • Touch Detection while CPU in sleep with lower power consumption

• High Integration. Reduce bom cost
  • Built-in lots peripherals for low power applications
    • RTC, DAC, Timers, ADC, Serial coms, USB, LCD, and so on
  • Ultra-low power oscillators
  • Clock failure protection
  • Windowed watchdog timer
  • Capacitors on power lines

• PicoPower™
  • True 1.6V operation. All modules including Flash and analog working
Atmel Embedded MPU Portfolio

400MHz ARM926
- SAM9N12
- SAM9CN12
- Security
- FS USB

SAM9G15
- LCD

SAM9G25
- EMAC

SAM9X25
- 2xEMAC
- 2xCAN
- LCD

SAM9G45
- EMAC
- LCD
- 2xEBI
- Security

SAM9M10
- +Video
- +Security

200+MHz ARM926
- SAM9R64
- SAM9RL64
- LCD
- HS USB
- Device

SAM9G10
- LCD

SAM9G20
- EMAC

SAM9263
- EMAC
- CAN
- LCD
- 2xEBI
Introducing SAMA5D3 Series

Offers high performance, low power and ease of use

- Up to 536MHz ARM® Cortex-A5 Core
  - VFPU
- <0.5mW in Low-power Mode
- <200mW in RUN @ 536MHz
- 32-bit DDR2, LPDDR2, LPDDR Memory Support
- MLC NAND with 24-bit ECC
- Gigabit EMAC with IEEE1588
- Up to 3 HS USB Ports
- Soft modem support
- LCD with Overlays
- Encryption Engine and Secure Boot
- BGA324 15x15mm
- 12-year Lifetime Commitment
# Target Applications and Benefits

SAM5D3 is ideal for a wide range of industrial and consumer applications

| HMI and Control Panels | • High-resolution screen and/or complex animation achieved through superior bandwidth  
| |   • 32-bit DDR controller, up to 1328MB/s  
| |   • 24-bit LCD with overlays for HW accelerated image composition  
| |   • FPU for accelerated graphics processing  
| Networking and Gateways | • Superior peripheral set  
| |   • Gigabit Ethernet with real-time time stamping (IEEE1588)  
| |   • 10/100 EMAC, 2x CAN, 7x UARTS, 2x SPI, 2x I2C  
| |   • High-bandwidth architecture  
| |   • Encryption engine for secure communication  
| Imaging and Terminals | • CMOS sensor interface (ISI)  
| |   • ARM Cortex-A5 and FPU for state-of-the-art image processing  
| |   • Low power consumption in active (RUN) and static (low-power) modes  
| Battery-Operated Applications | • <200mW typical in RUN mode @ 536MHz with all peripherals activated  
| | • < 0.5mW typical in low-power mode with instant wake-up capability  
| | • <2uA typical in backup mode  
| | • LPDDR and LPDDR2 memory support  
| | • Market-leading ARM Cortex-A5 core  

Target Applications and Benefits
Application: Portable Fitness and Outdoor Equipment

• What:
  • Portable electronic equipment used to measure performance or provide navigation for fitness or outdoor activities such as running, cycling, hiking or golf

• Key Design Considerations of the Product:
  • Low active and standby power consumption
    • Reduce battery size and extend time between charges
    • Fast wake up to respond to user commands
  • Small footprint design
    • Minimize PCB and housing size for portability
  • Consumer-grade user interface
    • Direct support for TFT displays, capacitive touch, camera sensors, and audio
Application: Portable Fitness and Outdoor Equipment

• The Atmel SAMA5D3 series offers high processing power and high integration to address today’s portable fitness and outdoor design trends:
  
  • Low Active and Standby Power Consumption
    • Lowest active power consumption (<200mW at max speed)
    • Ultra-low power and standby mode with instant wake-up (<0.5mW)
  
  • Small Footprint Design
    • High integration includes up to 3 USB HS hosts with PHYs, ADC for battery monitoring and resistive touchscreens, I2S audio support and multiple SDIO interfaces
  
  • Consumer-grade user interface
    • Support for 24-bit TFT LCD with overlays for HW accelerated image composition
    • Floating point unit accelerates graphics processing
    • Image sensor interface to directly connect to CMOS / imaging sensors
    • Android and other popular GUIs available