Features

- Incorporates the ARM7TDMI ® ARM® Thumb® Processor
  - High-performance 32-bit RISC Architecture
  - High-density 16-bit Instruction Set
  - Leader in MIPS/Watt
- Embedded ICE In-circuit Emulation, Debug Communication Channel Support
- 256 Kbytes of Internal High-speed Flash, Organized in 1024 Pages of 256 Bytes
  - Single Cycle Access at Up to 30 MHz in Worst Case Conditions
  - Prefetch Buffer Optimizing Thumb Instruction Execution at Maximum Speed
  - Page Programming Time: 4 ms, Including Page Auto-erase, Full Erase Time: 10 ms
  - 10,000 Write Cycles, 10-year Data Retention Capability, Sector Lock Capabilities
- 32K Bytes of Internal High-speed SRAM, Single-cycle Access at Maximum Speed
- Memory Controller (MC)
  - Embedded Flash Controller, Abort Status and Misalignment Detection
  - Memory Protection Unit
- Reset Controller (RSTC)
  - Based on Three Power-on Reset Cells
  - Provides External Reset Signal Shaping and Reset Sources Status
- Clock Generator (CKGR)
  - Low-power RC Oscillator, 3 to 20 MHz On-chip Oscillator and One PLL
- Power Management Controller (PMC)
  - Power Optimization Capabilities, including Slow Clock Mode (Down to 500 Hz), Idle Mode, Standby Mode and Backup Mode
  - Four Programmable External Clock Signals
- Advanced Interrupt Controller (AIC)
  - Individually Maskable, Eight-level Priority, Vectored Interrupt Sources
  - Four External Interrupt Sources and One Fast Interrupt Source, Spurious Interrupt Protected
- Debug Unit (DBGU)
  - 2-wire UART and Support for Debug Communication Channel interrupt, Programmable ICE Access Prevention
- Periodic Interval Timer (PIT)
  - 20-bit Programmable Counter plus 12-bit Interval Counter
- Windowed Watchdog (WDT)
  - 12-bit key-protected Programmable Counter
  - Provides Reset or Interrupt Signal to the System
  - Counter May Be Stopped While the Processor is in Debug Mode or in Idle State
- Real-time Timer (RTT)
  - 32-bit Free-running Counter with Alarm
  - Runs Off the Internal RC Oscillator
- Two Parallel Input/Output Controllers (PIO)
  - Sixty-two Programmable I/O Lines Multiplexed with up to Two Peripheral I/Os
  - Input Change Interrupt Capability on Each I/O Line
  - Individually Programmable Open-drain, Pull-up resistor and Synchronous Output
- Shutdown Controller (SHDWC)
  - Programmable Shutdown Pin and Wake-up Circuitry
- Four 32-bit Battery Backup Registers for a Total of 16 Bytes
- One 8-channel 20-bit PWM Controller (PMWC)
- One USB 2.0 Full Speed (12 Mbits per Second) Device Port
  - On-chip Transceiver, 2-Kbyte Configurable Integrated FIFOs
- Nineteen Peripheral Data Controller (PDC) Channels
- Two CAN 2.0B Active Controllers, Supporting 11-bit Standard and 29-bit Extended Identifiers
  - 16 Fully Programmable Message Object Mailboxes, 16-bit Time Stamp Counter
- Two 8-channel 10-bit Analog-to-Digital Converter

AT91 ARM® Thumb®-based Microcontrollers

AT91SAM7A3

Summary

Preliminary

6042AS–ATARM–23-Dec-04

Note: This is a summary document. A complete document is available on our Web site at www.atmel.com.

- **Three Universal Synchronous/Asynchronous Receiver Transmitters (USART)**
  - **Individual Baud Rate Generator, IrDA Infrared Modulation/Demodulation**
  - **Support for ISO7816 T0/T1 Smart Card, Hardware Handshaking, RS485 Support**
- **Two Master/Slave Serial Peripheral Interfaces (SPI)**
  - **8- to 16-bit Programmable Data Length, Four External Peripheral Chip Selects**
- **Three 3-channel 16-bit Timer/Counters (TC)**
  - **Three External Clock Inputs, Two Multi-purpose I/O Pins per Channel**
  - **Double PWM Generation, Capture/Waveform Mode, Up/Down Capability**
- **Two Synchronous Serial Controllers (SSC)**
  - **Independent Clock and Frame Sync Signals for Each Receiver and Transmitter**
  - **I²S Analog Interface Support, Time Division Multiplex Support**
  - **High-speed Continuous Data Stream Capabilities with 32-bit Data Transfer**
- **One Two-wire Interface (TWI)**
  - **Master Mode Support Only, All Two-wire Atmel EEPROM's Supported**
- **Multimedia Card Interface (MCI)**
  - **Compliant with Multimedia Cards and SD Cards**
  - **Automatic Protocol Control and Fast Automatic Data Transfers with PDC, MMC and SDCard Compliant**
- **IEEE 1149.1 JTAG Boundary Scan on All Digital Pins**
- **Required Power Supplies:**
  - **Embedded 1.8V Regulator, Drawing up to 100 mA for the Core and the External Components, Enables 3.3V Single Supply Mode**
  - **3.3 VDDIO I/O Lines and Flash Power Supply**
  - **1.8V VDDCORE Core Power Supply**
  - **3V to 3.6V VDDANA Analog Power Supply**
  - **3V to 3.6V VDDBU Backup Power Supply**
- **5V-tolerant I/Os**
- **Fully Static Operation: 0 Hz to 60 MHz at 1.65V and 85°C Worst Case Conditions**
- **Available in a 100-lead LQFP Package**

Description

The AT91SAM7A3 is a member of a series of 32-bit ARM7® microcontrollers with an integrated CAN controller. It features a 256-Kbyte high-speed Flash and 32-Kbyte SRAM, a large set of peripherals, including two 2.0B full CAN controllers, and a complete set of system functions minimizing the number of external components. The device is an ideal migration path for 8-bit microcontroller users looking for additional performance and extended memory.

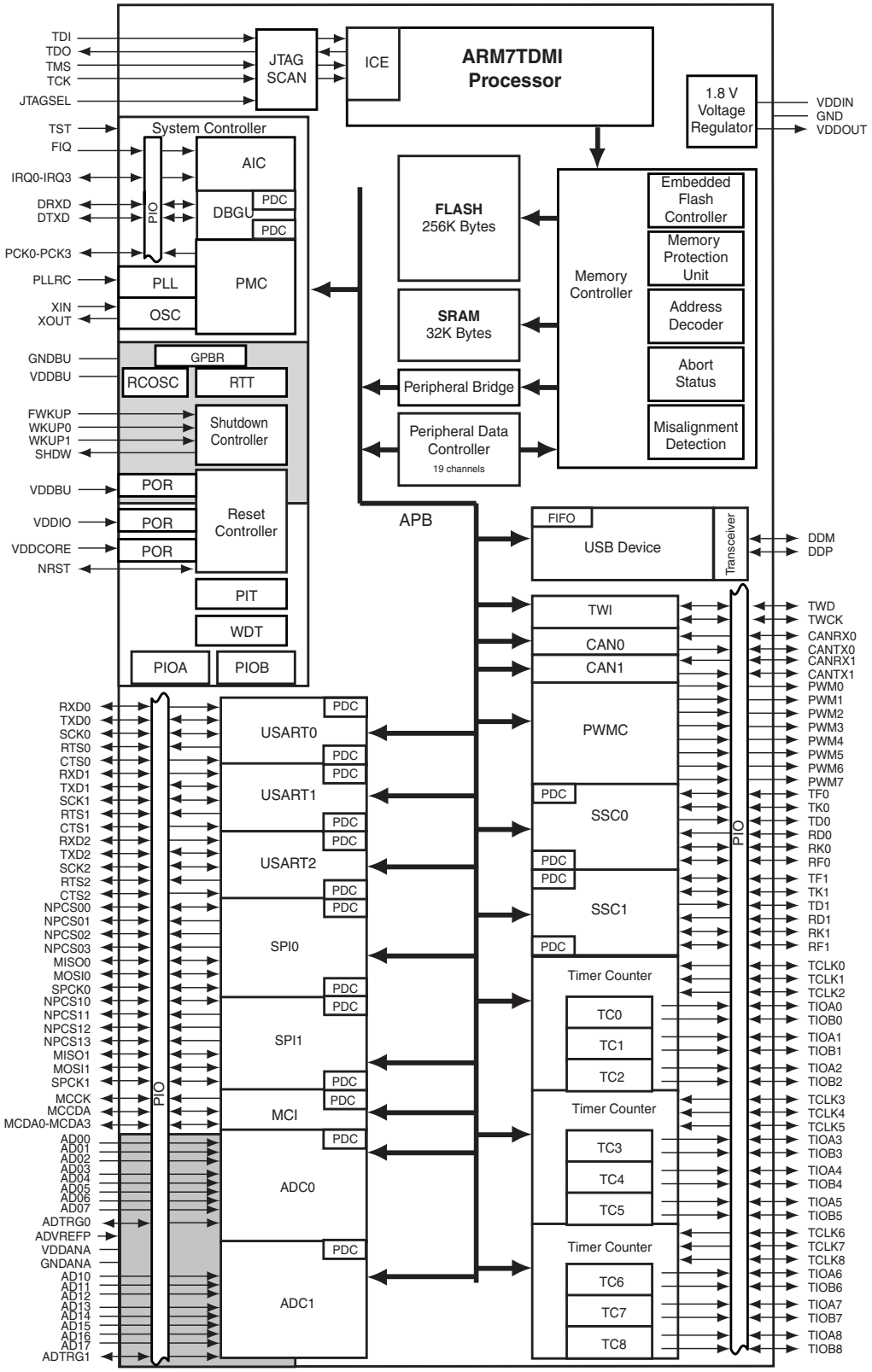
The embedded Flash memory can be programmed in-system via the JTAG-ICE interface. Built-in lock bits protect the firmware from accidental overwrite.

The AT91SAM7A3 integrates a complete set of features facilitating debug, including a JTAG In-Circuit-Emulation interface, misalignment detector, interrupt driven debug communication channel for user configurable trace on a console, and JTAG boundary scan for board level debug and test.

By combining a high-performance 32-bit RISC processor with a high-density 16-bit instruction set, Flash and SRAM memory, a wide range of peripherals including CAN controllers, 10-bit ADC, Timers and serial communication channels, on a monolithic chip, the AT91SAM7A3 is ideal for many compute-intensive embedded control applications in the automotive, medical and industrial world.

Block Diagram

Figure 1. AT91SAM7A3 Block Diagram



Signal Description

Table 1. Signal Description

Signal Name	Function	Type	Active Level	Comments
Power				
VDDIN	1.8V Voltage Regulator Power Supply	Power		2.7V to 3.6V
VDDIO	I/O Lines and Flash Power Supply	Power		3V to 3.6V
VDDBU	Backup I/O Lines Power Supply	Power		3V to 3.6V
VDDANA	Analog Power Supply	Power		3V to 3.6V
VDDOUT	1.8V Voltage Regulator Output	Power		1.85V typical
VDDCORE	1.8V Core Power Supply	Power		1.65V to 1.95V
VDDPLL	1.8V PLL Power Supply	Power		1.65V to 1.95V
GND	Ground	Ground		
GNDANA	Analog Ground	Ground		
GNDBU	Backup Ground	Ground		
GNDPLL	PLL Ground	Ground		
Clocks, Oscillators and PLLs				
XIN	Main Oscillator Input	Input		
XOUT	Main Oscillator Output	Output		
PLLRC	PLL Filter	Input		
PCK0 - PCK3	Programmable Clock Output	Output		
SHDW	Shut-Down Control	Output		Driven at 0V only. Do not tie over VDDBU
WKUP0 - WKUP1	Wake-Up Inputs	Input		Accept between 0V and VDDBU
FWKUP	Force Wake Up	Input		Accept between 0V and VDDBU
ICE and JTAG				
TCK	Test Clock	Input		No pull-up resistor
TDI	Test Data In	Input		No pull-up resistor
TDO	Test Data Out	Output		
TMS	Test Mode Select	Input		No pull-up resistor
JTAGSEL	JTAG Selection	Input		Pull-down resistor
Reset/Test				
NRST	Microcontroller Reset	I/O	Low	
TST	Test Mode Select	Input		Pull-down resistor
Debug Unit				
DRXD	Debug Receive Data	Input		
DTXD	Debug Transmit Data	Output		

Table 1. Signal Description (Continued)

Signal Name	Function	Type	Active Level	Comments
AIC				
IRQ0 - IRQ3	External Interrupt Inputs	Input		
FIQ	Fast Interrupt Input	Input		
PIO				
PA0 - PA31	Parallel IO Controller A	I/O		Pulled-up input at reset
PB0 - PB29	Parallel IO Controller B	I/O		Pulled-up input at reset
Multimedia Card Interface				
MCCK	Multimedia Card Clock	Output		
MCCDA	Multimedia Card A Command	I/O		
MCDA0 - MCDA3	Multimedia Card A Data	I/O		
USB Device Port				
DDM	USB Device Port Data -	Analog		
DDP	USB Device Port Data +	Analog		
USART				
SCK0 - SCK1 - SCK2	Serial Clock	I/O		
TXD0 - TXD1 - TXD2	Transmit Data	I/O		
RXD0 - RXD1 - RXD2	Receive Data	Input		
RTS0 - RTS1 - RTS2	Request To Send	Output		
CTS0 - CTS1 - CTS2	Clear To Send	Input		
Synchronous Serial Controller				
TD0 - TD1	Transmit Data	Output		
RD0 - RD1	Receive Data	Input		
TK0 - TK1	Transmit Clock	I/O		
RK0 - RK1	Receive Clock	I/O		
TF0 - TF1	Transmit Frame Sync	I/O		
RF0 - RF1	Receive Frame Sync	I/O		
Timer/Counter				
TCLK0 - TCLK8	External Clock Input	Input		
TIOA0 - TIOA8	I/O Line A	I/O		
TIOB0 - TIOB8	I/O Line B	I/O		
PWM Controller				
PWM0 - PWM7	PWM Channels	Output		

Table 1. Signal Description (Continued)

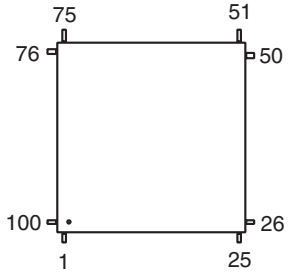
Signal Name	Function	Type	Active Level	Comments
SPI				
MISO0-MISO1	Master In Slave Out	I/O		
MOSI0-MOSI1	Master Out Slave In	I/O		
SPCK0-SPCK1	SPI Serial Clock	I/O		
NPCS00-NPCS10	SPI Peripheral Chip Select 0	I/O	Low	
NPCS01 - NPCS03 NPCS11 - NPCS13	SPI Peripheral Chip Select	Output	Low	
Two-wire Interface				
TWD	Two-wire Serial Data	I/O		
TWCK	Two-wire Serial Clock	I/O		
Analog-to-Digital Converter				
AD00-AD07 AD10-AD17	Analog Inputs	Analog		Digital pulled-up inputs at reset
ADVREFP	Analog Positive Reference	Analog		
ADTRG0 - ADTRG1	ADC Trigger	Input		
CAN Controller				
CANRX0-CANRX1	CAN Inputs	Input		
CANTX0-CANTX1	CAN Outputs	Output		

Package and Pinout

100-lead LQFP Mechanical Overview

Figure 2 shows the orientation of the 100-lead LQFP package. A detailed mechanical description is given in the section Mechanical Characteristics of the product datasheet.

Figure 2. 100-lead LQFP Pinout (Top View)



Pinout

Table 2. Pinout in 100-lead LQFP Package

1	GND	26	VDDBU	51	PA20	76	PLLRC
2	NRST	27	FWKUP	52	PA21	77	VDDANA
3	TST	28	WKUP0	53	PA22	78	ADVREFP
4	PB13	29	WKUP1	54	PA23	79	GNDANA
5	PB12	30	SHDW	55	PA24	80	PB14/AD00
6	PB11	31	GNDBU	56	PA25	81	PB15/AD01
7	PB10	32	PA4	57	PA26	82	PB16/AD02
8	PB9	33	PA5	58	PA27	83	PB17/AD03
9	PB8	34	PA6	59	VDDCORE	84	PB18/AD04
10	PB7	35	PA7	60	GND	85	PB19/AD05
11	PB6	36	PA8	61	VDDIO	86	PB20/AD06
12	PB5	37	PA9	62	PA28	87	PB21/AD07
13	PB4	38	VDDIO	63	PA29	88	VDDIO
14	PB3	39	GND	64	PA30	89	PB22/AD10
15	VDDIO	40	VDDCORE	65	PA31	90	PB23/AD11
16	GND	41	PA10	66	JTAGSEL	91	PB24/AD12
17	VDDCORE	42	PA11	67	TDI	92	PB25/AD13
18	PB2	43	PA12	68	TMS	93	PB26/AD14
19	PB1	44	PA13	69	TCK	94	PB27/AD15
20	PB0	45	PA14	70	TDO	95	PB28/AD16
21	PA0	46	PA15	71	GND	96	PB29/AD17
22	PA1	47	PA16	72	VDDPLL	97	DDM
23	PA2	48	PA17	73	XOUT	98	DDP
24	PA3	49	PA18	74	XIN	99	VDDOUT
25	GND	50	PA19	75	GNDPLL	100	VDDIN

Power Considerations

Power Supplies

The AT91SAM7A3 has seven types of power supply pins:

- VDDIN pin. It powers the voltage regulator; voltage ranges from 2.7V to 3.6V, 3.3V nominal. If the voltage regulator is not used, VDDIN should be connected to GND.
- VDDIO pin. It powers the I/O lines, the Flash and the USB transceivers; voltage ranges from 3.0V to 3.6V, 3.3V nominal.
- VDDOUT pin. It is the output of the 1.8V voltage regulator.
- VDDCORE pins. They power the logic of the device; voltage ranges from 1.65V to 1.95V, 1.8V typical. It might be connected to the VDDOUT pin with decoupling capacitor. VDDCORE is required for the device, including its embedded Flash, to operate correctly.
- VDDPLL pins. They power the PLL; voltage ranges from 1.65V to 1.95V, 1.8V typical. They can be connected to the VDDOUT pin with decoupling capacitor.
- VDDBU pin. It powers the Slow Clock oscillator and the Real Time Clock, as well as a part of the System Controller; ranges from 3.0V and 3.6V, 3.3V nominal.
- VDDANA pin. It powers the ADC; ranges from 3.0V and 3.6V, 3.3V nominal.

Separated ground pins are provided for VDDPLL, VDDIO, VDDBU and VDDANA. The ground pins are respectively GNDPLL, GND, GNDBU and GNDANA.

Voltage Regulator

The AT91SAM7A3 embeds a voltage regulator that consumes less than 120 µA static current and draws up to 100 mA of output current.

Adequate output supply decoupling is mandatory for VDDOUT to reduce ripple and avoid oscillations. The best way to achieve this is to use two capacitors in parallel: one external 470 pF (or 1 nF) NPO capacitor must be connected between VDDOUT and GND as close to the chip as possible. One external 3.3 µF (or 4.7 µF) X7R capacitor must be connected between VDDOUT and GND.

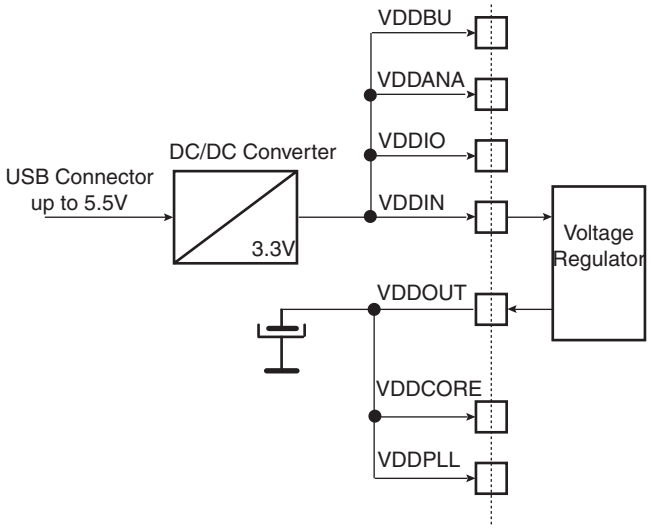
Adequate input supply decoupling is mandatory for VDDIN in order to improve startup stability and reduce source voltage drop. The input decoupling capacitor should be placed close to the chip. For example, two capacitors can be used in parallel: 100 nF NPO and 4.7 µF X7R.

Typical Powering Schematics

3.3V Single Supply

The AT91SAM7A3 supports a 3.3V single supply mode. The internal regulator is connected to the 3.3V source and its output feeds VDDCORE and VDDPLL. Figure 3 shows the power schematics to be used for USB bus-powered systems.

Figure 3. 3.3V System Single Power Supply Schematics



I/O Lines Considerations

JTAG Port Pins

TMS, TDI and TCK are schmitt trigger inputs. TMS and TCK are 5V-tolerant, TDI is not. TMS, TDI and TCK do not integrate any resistors and have to be pulled-up externally.

TDO is an output, driven at up to VDDIO.

The JTAGSEL pin is used to select the JTAG boundary scan when asserted at a high level.

The JTAGSEL pin integrates a permanent pull-down resistor so that it can be left unconnected for normal operations.

Test Pin

The TST pin is used for manufacturing tests and integrates a pull-down resistor so that it can be left unconnected for normal operations. Driving this line at a high level leads to unpredictable results.

Reset Pin

The NRST pin is bidirectional. It is handled by the on-chip reset controller and can be driven low to provide a reset signal to the external components or asserted low externally to reset the microcontroller. There is no constraint on the length of the reset pulse, and the reset controller can guarantee a minimum pulse length. This allows connection of a simple push-button on the NRST pin as system user reset, and the use of the NRST signal to reset all the components of the system.

PIO Controller A and B Lines

All the I/O lines PA0 to PA31 and PB0 to PB29 are 5V-tolerant and all integrate a programmable pull-up resistor. Programming of this pull-up resistor is performed independently for each I/O line through the PIO Controllers.

5V-tolerant means that the I/O lines can drive voltage level according to VDDIO, but can be driven with a voltage at up to 5.5V. However, driving an I/O line with a voltage over VDDIO while the programmable pull-up resistor is enabled can lead to unpredictable results. Care should be taken, especially at reset, as all the I/O lines default as inputs with pull-up resistor enabled at reset.

Shutdown Logic Pins

The SHDW pin is an open drain output. It can be tied to VDDBU with an external pull-up resistor.

The FWUP, WKUP0 and WKUP1 pins are input-only. They can accept voltages only between 0V and VDDBU. It is recommended to tie these pins either to GND or to VDDBU with an external resistor.

I/O Line Drive Levels

All the I/O lines can draw up to 2 mA.

Processor and Architecture

ARM7TDMI Processor

- RISC Processor Based on ARMv4T Von Neumann Architecture
  - Runs at up to 60 MHz, providing 0.9 MIPS/MHz
- Two instruction sets
  - ARM high-performance 32-bit Instruction Set
  - Thumb high code density 16-bit Instruction Set
- Three-stage pipeline architecture
  - Instruction Fetch (F)
  - Instruction Decode (D)
  - Execute (E)

Debug and Test Features

- Integrated embedded in-circuit emulator
  - Two watchpoint units
  - Test access port accessible through a JTAG protocol
  - Debug communication channel
- Debug Unit
  - Two-pin UART
  - Debug communication channel interrupt handling
  - Chip ID Register
- IEEE1149.1 JTAG Boundary-scan on all digital pins

Memory Controller

- Bus Arbiter
  - Handles requests from the ARM7TDMI and the Peripheral Data Controller
- Address Decoder Provides Selection Signals for
  - Three internal 1Mbyte memory areas
  - One 256 Mbyte embedded peripheral area
- Abort Status Registers
  - Source, Type and all parameters of the access leading to an abort are saved
  - Facilitates debug by detection of bad pointers
- Misalignment Detector
  - Alignment checking of all data accesses
  - Abort generation in case of misalignment
- Remap Command
  - Remaps the Internal SRAM in place of the embedded non-volatile memory
  - Allows handling of dynamic exception vectors
- 16-area Memory Protection Unit
  - Individually programmable size between 1K Bytes and 1M Bytes
  - Individually programmable protection against write and/or user access
  - Peripheral protection against write and/or user access
- Embedded Flash Controller
  - Embedded Flash interface, up to three programmable wait states

- Read-optimized interface, buffering and anticipating the 16-bit requests, reducing the required wait states
- Password-protected program, erase and lock/unlock sequencer
- Automatic consecutive programming, erasing and locking operations
- Interrupt generation in case of forbidden operation

Peripheral Data Controller

- Handles data transfer between peripherals and memories
- Nineteen Channels
  - Two for each USART
  - Two for the Debug Unit
  - Two for each Serial Synchronous Controller
  - Two for each Serial Peripheral Interface
  - One for the Multimedia Card Interface
  - One for each Analog-to-Digital Converter
- Low bus arbitration overhead
  - One Master Clock cycle needed for a transfer from memory to peripheral
  - Two Master Clock cycles needed for a transfer from peripheral to memory
- Next Pointer management for reducing interrupt latency requirements

Memory

Embedded Memories

- 256 Kbytes of Flash Memory
  - 1024 pages of 256 bytes.
  - Fast access time, 30 MHz single cycle access in worst case conditions.
  - Page programming time: 4 ms, including page auto-erase
  - Full erase time: 10 ms
  - 10,000 write cycles, 10-year data retention capability
  - 16 lock bits, each protecting 64 pages
- 32 Kbytes of Fast SRAM
  - Single-cycle access at full speed

Memory Mapping

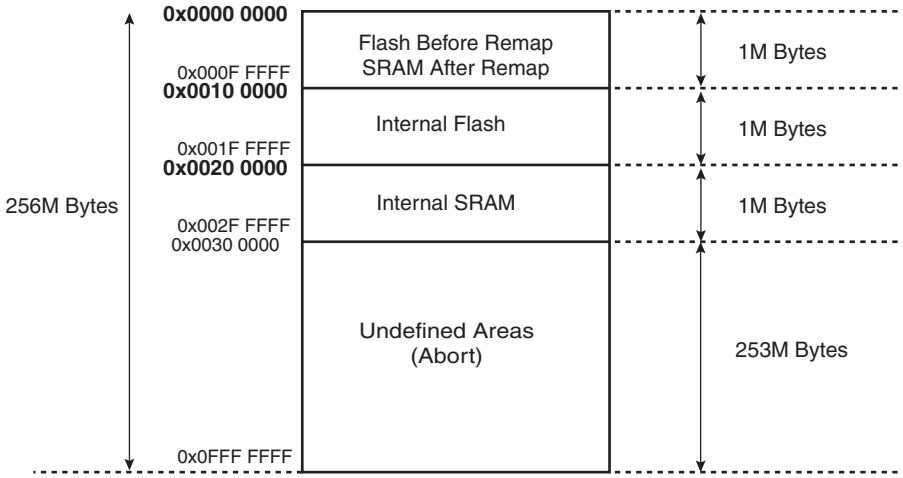
Internal RAM

The AT91SAM7A3 embeds a high-speed 32-Kbyte SRAM bank. After reset and until the Remap Command is performed, the SRAM is only accessible at address 0x0020 0000. After Remap, the SRAM also becomes available at address 0x0.

Internal Flash

The AT91SAM7A3 features one bank of 256 Kbytes of Flash. The Flash is mapped to address 0x0010 0000. It is also accessible at address 0x0 after the reset and before the Remap Command.

Figure 4. Internal Memory Mapping



Embedded Flash

Flash Organization

The Flash block of the AT91SAM7A3 is organized in 1024 pages of 256 bytes. It reads as 65,536 32-bit words.

The Flash block contains a 256-byte write buffer, accessible through a 32-bit interface.

Embedded Flash Controller

The Embedded Flash Controller (EFC) manages accesses performed by the masters of the system. It enables reading the Flash and writing the write buffer. It also contains a User Interface mapped within the Memory Controller on the APB. The User Interface allows:

- programming of the access parameters of the Flash (number of wait states, timings, etc.)
- starting commands such as full erase, page erase, page program, NVM bit set, NVM bit clear, etc.
- getting the end status of the last command
- getting error status
- programming interrupts on the end of the last commands or on errors

The Embedded Flash Controller also provides a dual 32-bit Prefetch Buffer that optimizes 16-bit access to the Flash. This is particularly efficient when the processor is running in Thumb mode.

Lock Regions

The Embedded Flash Controller manages 16 lock bits to protect 16 regions of the Flash against inadvertent Flash erasing or programming commands.

The AT91SAM7A3 has 16 lock regions. Each lock region contains 64 pages of 256 bytes.

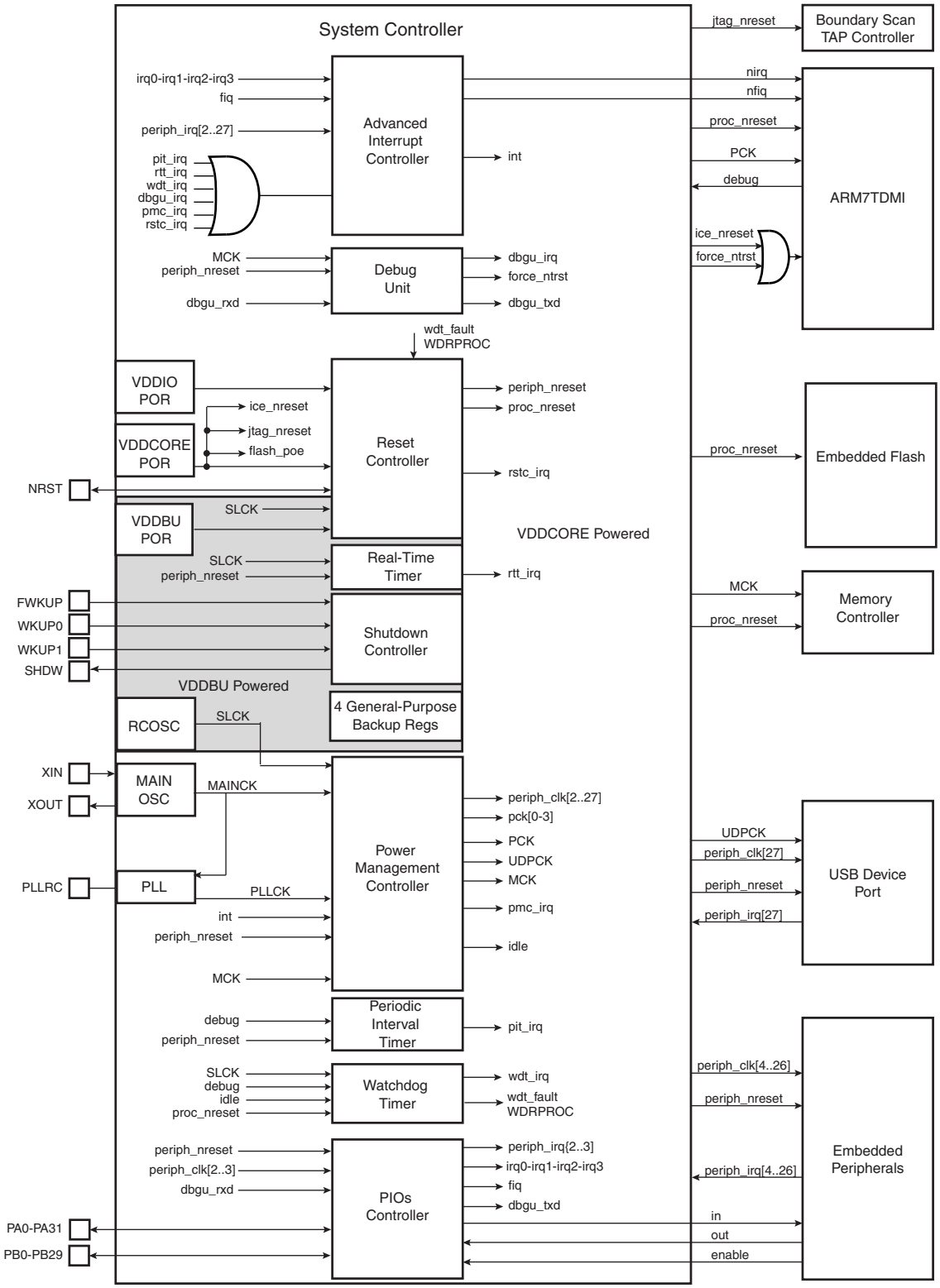
Each lock region has a size of 16 kbytes.

The 16 NVM bits are software programmable through the EFC User Interface. The command “Set Lock Bit” enables the protection. The command “Clear Lock Bit” unlocks the lock region.

System Controller

The System Controller manages all vital blocks of the microcontroller: interrupts, clocks, power, time, debug and reset.

Figure 5. System Controller Block Diagram

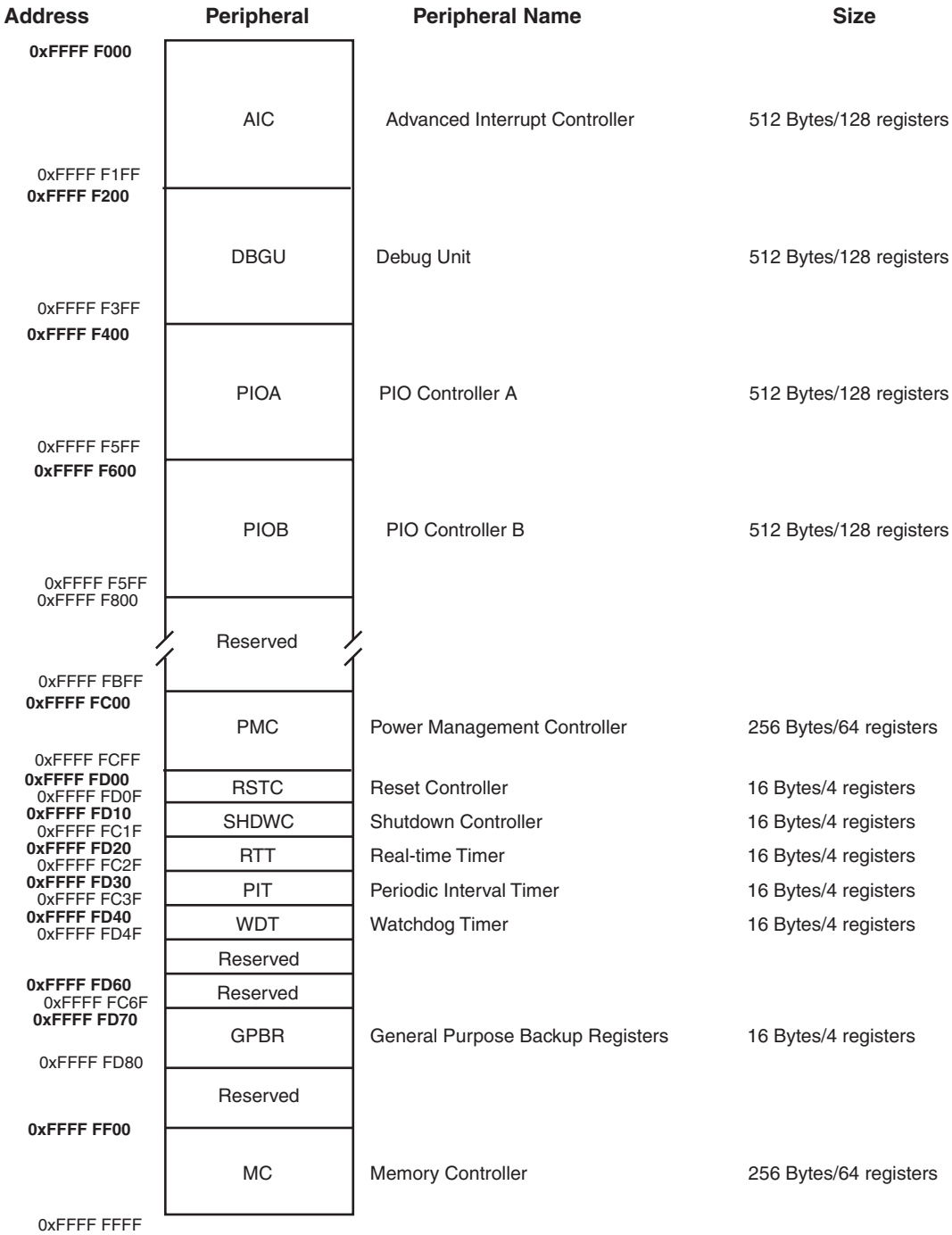


System Controller Mapping

The System Controller peripherals are all mapped to the highest 4K bytes of address space, between addresses 0xFFFF F000 and 0xFFFF FFFF. Each peripheral has an address space of 256 or 512 Bytes, representing 64 or 128 registers.

Figure 6 shows the mapping of the System Controller and of the Memory Controller

Figure 6. System Controller Mapping



Reset Controller

The Reset Controller is based on three power-on reset cells. It gives the status of the last reset, indicating whether it is a general reset, a wake-up reset, a software reset, a user reset or a watchdog reset. In addition, it controls the internal resets and the NRST pin output. It shapes a signal on the NRST line, guaranteeing that the length of the pulse meets any requirement.

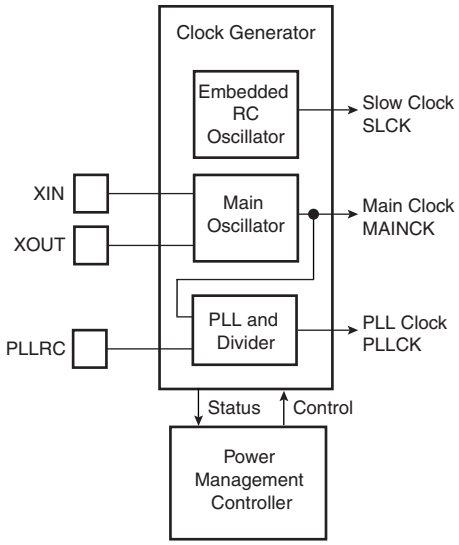
Clock Generator

The Clock Generator embeds one low-power RC Oscillator, one Main Oscillator and one PLL with the following characteristics:

- RC Oscillator ranges between 22 KHz and 42 KHz
- Main Oscillator frequency ranges between 3 and 20 MHz
- Main Oscillator can be bypassed
- PLL output ranges between 80 and 220 MHz

It provides SLCK, MAINCK and PLLCK.

Figure 7. Clock Generator Block Diagram



Power Management Controller

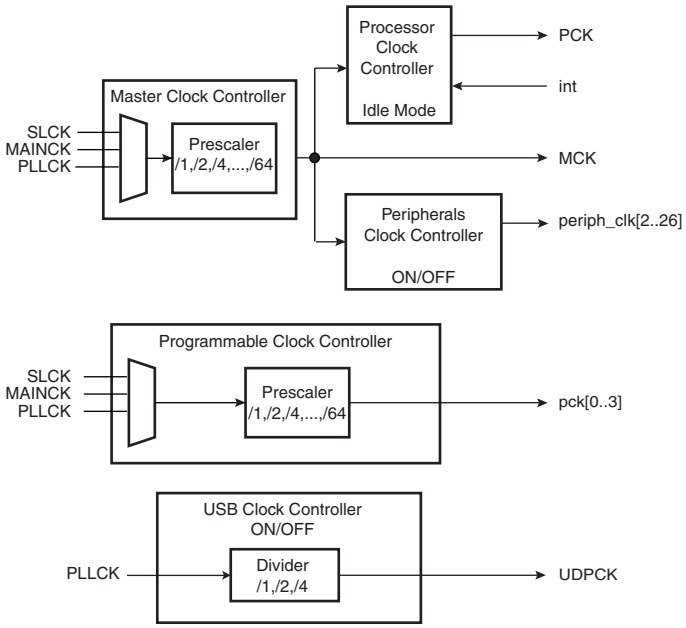
The Power Management Controller uses the Clock Generator outputs to provide:

- the Processor Clock PCK
- the Master Clock MCK
- the USB Clock UDPCK
- all the peripheral clocks, independently controllable
- four programmable clock outputs

The Master Clock (MCK) is programmable from a few hundred Hz to the maximum operating frequency of the device.

The Processor Clock (PCK) switches off when entering processor idle mode, thereby reducing power consumption while waiting an interrupt.

Figure 8. Power Management Controller Block Diagram



Advanced Interrupt Controller

- Controls the interrupt lines (nIRQ and nFIQ) of the ARM Processor
- Individually maskable and vectored interrupt sources
  - Source 0 is reserved for the Fast Interrupt Input (FIQ)
  - Source 1 is reserved for system peripherals (ST, PMC, DBGU, etc.)
  - Other sources control the peripheral interrupts or external interrupts
  - Programmable edge-triggered or level-sensitive internal sources
  - Programmable positive/negative edge-triggered or high/low level-sensitive external sources
- 8-level Priority Controller
  - Drives the normal interrupt nIRQ of the processor
  - Handles priority of the interrupt sources
  - Higher priority interrupts can be served during service of a lower priority interrupt
- Vectoring
  - Optimizes interrupt service routine branch and execution

  - One 32-bit vector register per interrupt source
  - Interrupt vector register reads the corresponding current interrupt vector
- Protect Mode
  - Easy debugging by preventing automatic operations
- Fast Forcing
  - Permits redirecting any interrupt source on the fast interrupt
- General Interrupt Mask
  - Provides processor synchronization on events without triggering an interrupt

Debug Unit

- Comprises
  - One two-pin UART
  - One interface for the Debug Communication Channel (DCC) support
  - One set of chip ID registers
  - One interface allowing ICE access prevention
- Two-pin UART
  - USART-compatible user interface
  - Programmable baud rate generator
  - Parity, framing and overrun error
  - Automatic Echo, Local Loopback and Remote Loopback Channel Modes
- Debug Communication Channel Support
  - Offers visibility of COMMRX and COMMTX signals from the ARM Processor
- Chip ID Registers
  - Identification of the device revision, sizes of the embedded memories, set of peripherals
  - Chip ID is 0x170A0940 (Version 0)

Period Interval Timer

- 20-bit programmable counter plus 12-bit interval counter

Watchdog Timer

- 12-bit key-protected Programmable Counter running on prescaled SLCK
- Provides reset or interrupt signals to the system
- Counter may be stopped while the processor is in debug state or in idle mode

Real-time Timer

- 32-bit free-running counter with alarm
- Programmable 16-bit prescaler for SCLK accuracy compensation

Shutdown Controller

- Software programmable assertion of the SHDW open-drain pin
- De-assertion programmable with the pins WKUP0, WKUP1 and FWKUP

PIO Controllers A and B

- The PIO Controllers A and B respectively control 32 and 30 programmable I/O Lines
- Fully programmable through Set/Clear Registers
- Multiplexing of two peripheral functions per I/O Line
- For each I/O Line (whether assigned to a peripheral or used as general purpose I/O)
  - Input change interrupt
  - Half a clock period Glitch filter

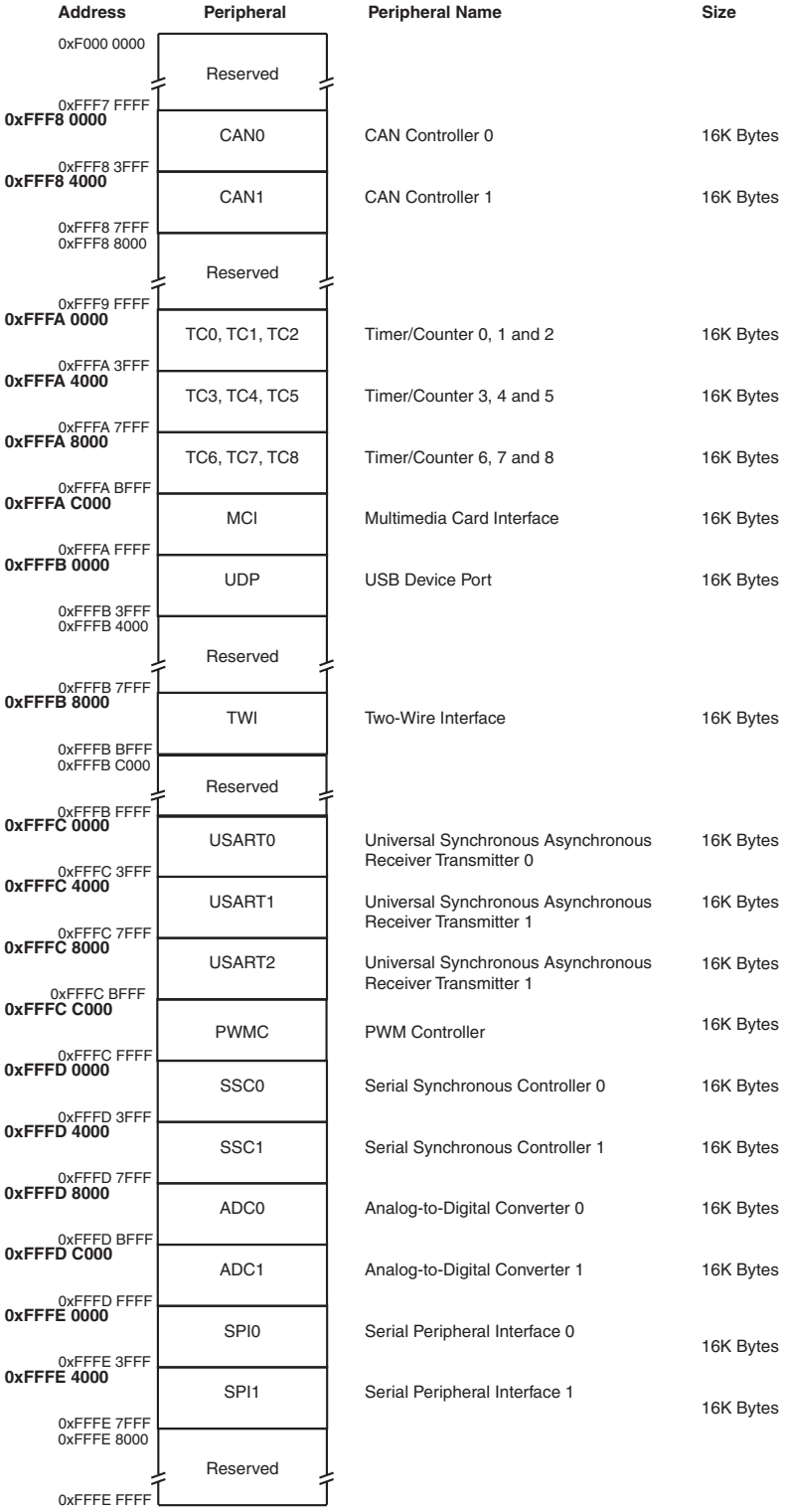
  - Multi-drive option enables driving in open drain
  - Programmable pull up on each I/O line
  - Pin data status register, supplies visibility of the level on the pin at any time
- Synchronous output, provides Set and Clear of several I/O lines in a single write

Peripherals

Peripheral Mapping

Each User Peripheral is allocated 16K bytes of address space.

Figure 9. User Peripherals Mapping



Peripheral Multiplexing on PIO Lines

The AT91SAM7A3 features two PIO controllers, PIOA and PIOB, which multiplex the I/O lines of the peripheral set.

PIO Controllers A and B control respectively 32 and 30 lines. Each line can be assigned to one of two peripheral functions, A or B. Some of them can also be multiplexed with Analog Input of both ADC Controllers.

Table 3 on page 23 and Table 4 on page 24 define how the I/O lines of the peripherals A, B or Analog Input are multiplexed on the PIO Controllers A and B. The two columns “Function” and “Comments” have been inserted for the user’s own comments; they may be used to track how pins are defined in an application.

Note that some peripheral functions that are output only may be duplicated within both tables.

At reset, all I/O lines are automatically configured as input with the programmable pull-up enabled, so that the device is maintained in a static state as soon as a reset occurs.

PIO Controller A Multiplexing

Table 3. Multiplexing on PIO Controller A

PIO Controller A				Application Usage	
I/O Line	Peripheral A	Peripheral B	Comment	Function	Comments
PA0	TWD	ADTRG0			
PA1	TWCK	ADTRG1			
PA2	RXD0				
PA3	TXD0				
PA4	SCK0	NPSC10			
PA5	RTS0	NPCS11			
PA6	CTS0	NPCS12			
PA7	RXD1	NPCS13			
PA8	TXD1	MISO1			
PA9	RXD2	MOSI1			
PA10	TXD2	SPCK1			
PA11	NPCS00				
PA12	NPCS01	MCDA1			
PA13	NPCS02	MCDA2			
PA14	NPCS03	MCDA3			
PA15	MISO0	MCDA0			
PA16	MOSI0	MCCDA			
PA17	SPCK0	MCCK			
PA18	PWM0	PCK0			
PA19	PWM1	PCK1			
PA20	PWM2	PCK2			
PA21	PWM3	PCK3			
PA22	PWM4	IRQ0			
PA23	PWM5	IRQ1			
PA24	PWM6	TCLK4			
PA25	PWM7	TCLK5			
PA26	CANRX0				
PA27	CANTX0				
PA28	CANRX1	TCLK3			
PA29	CANTX1	TCLK6			
PA30	DRXD	TCLK7			
PA31	DTXD	TCLK8			

PIO Controller B Multiplexing

Table 4. Multiplexing on PIO Controller B

PIO Controller B				Application Usage	
I/O Line	Peripheral A	Peripheral B	Comment	Function	Comments
PB0	IRQ2	PWM5			
PB1	IRQ3	PWM6			
PB2	TF0	PWM7			
PB3	TK0	PCK0			
PB4	TD0	PCK1			
PB5	RD0	PCK2			
PB6	RK0	PCK3			
PB7	RF0	CANTX1			
PB8	FIQ	TF1			
PB9	TCLK0	TK1			
PB10	TCLK1	RK1			
PB11	TCLK2	RF1			
PB12	TIOA0	TD1			
PB13	TIOB0	RD1			
PB14	TIOA1	PWM0	AD00		
PB15	TIOB1	PWM1	AD01		
PB16	TIOA2	PWM2	AD02		
PB17	TIOB2	PWM3	AD03		
PB18	TIOA3	PWM4	AD04		
PB19	TIOB3	NPCS11	AD05		
PB20	TIOA4	NPCS12	AD06		
PB21	TIOB4	NPCS13	AD07		
PB22	TIOA5		AD10		
PB23	TIOB5		AD11		
PB24	TIOA6	RTS1	AD12		
PB25	TIOB6	CTS1	AD13		
PB26	TIOA7	SCK1	AD14		
PB27	TIOB7	RTS2	AD15		
PB28	TIOA8	CTS2	AD16		
PB29	TIOB8	SCK2	AD17		

Peripheral Identifiers

The AT91SAM7A3 embeds a wide range of peripherals. Table 5 defines the Peripheral Identifiers of the AT91SAM7A3. Unique peripheral identifiers are defined for both the AIC and the PMC.

Table 5. Peripheral Identifiers

Peripheral ID	Peripheral Mnemonic	Peripheral Name	External Interrupt
0	AIC	Advanced Interrupt Controller	FIQ
1	SYSIRQ(1)		
2	PIOA	Parallel I/O Controller A	
3	PIOB	Parallel I/O Controller B	
4	CAN0	CAN Controller 0	
5	CAN1	CAN Controller 1	
6	US0	USART 0	
7	US1	USART 1	
8	US2	USART 2	
9	MCI	Multimedia Card Interface	
10	TWI	Two-wire Interface	
11	SPI0	Serial Peripheral Interface 0	
12	SPI1	Serial Peripheral Interface 1	
13	SSC0	Synchronous Serial Controller 0	
14	SSC1	Synchronous Serial Controller 1	
15	TC0	Timer/Counter 0	
16	TC1	Timer/Counter 1	
17	TC2	Timer/Counter 2	
18	TC3	Timer/Counter 3	
19	TC4	Timer/Counter 4	
20	TC5	Timer/Counter 5	
21	TC6	Timer/Counter 6	
22	TC7	Timer/Counter 7	
23	TC8	Timer/Counter 8	
24	ADC0(1)	Analog-to Digital Converter 0	
25	ADC1(1)	Analog-to Digital Converter 1	
26	PWMC	PWM Controller	
27	UDP	USB Device Port	
28	AIC	Advanced Interrupt Controller	IRQ0
29	AIC	Advanced Interrupt Controller	IRQ1
30	AIC	Advanced Interrupt Controller	IRQ2
31	AIC	Advanced Interrupt Controller	IRQ3

Note: 1. Setting SYSIRQ and ADC bits in the clock set/clear registers of the PMC has no effect. The System Controller and ADC are continuously clocked.

Serial Peripheral Interface

- Supports communication with external serial devices
  - Four chip selects with external decoder allow communication with up to 15 peripherals
  - Serial memories, such as DataFlash® and 3-wire EEPROMs
  - Serial peripherals, such as ADCs, DACs, LCD Controllers, CAN Controllers and Sensors
  - External co-processors
- Master or slave serial peripheral bus interface
  - 8- to 16-bit programmable data length per chip select
  - Programmable phase and polarity per chip select
  - Programmable transfer delays per chip select between consecutive transfers and between clock and data
  - Programmable delay between consecutive transfers
  - Selectable mode fault detection
  - Maximum frequency at up to Master Clock

Two-wire Interface

- Master Mode only
- Compatibility with standard two-wire serial memories
- One, two or three bytes for slave address
- Sequential read/write operations

USART

- Programmable Baud Rate Generator
- 5- to 9-bit full-duplex synchronous or asynchronous serial communications
  - 1, 1.5 or 2 stop bits in Asynchronous Mode or 1 or 2 stop bits in Synchronous Mode
  - Parity generation and error detection
  - Framing error detection, overrun error detection
  - MSB- or LSB-first
  - Optional break generation and detection
  - By 8 or by 16 over-sampling receiver frequency
  - Hardware handshaking RTS-CTS
  - Receiver time-out and transmitter timeguard
  - Optional Multi-drop Mode with address generation and detection
- RS485 with driver control signal
- ISO7816, T = 0 or T = 1 Protocols for interfacing with smart cards
  - NACK handling, error counter with repetition and iteration limit
- IrDA modulation and demodulation
  - Communication at up to 115.2 Kbps
- Test Modes
  - Remote Loopback, Local Loopback, Automatic Echo

Serial Synchronous Controller

- Provides serial synchronous communication links used in audio and telecom applications
- Contains an independent receiver and transmitter and a common clock divider

- Offers a configurable frame sync and data length
- Receiver and transmitter can be programmed to start automatically or on detection of different event on the frame sync signal
- Receiver and transmitter include a data signal, a clock signal and a frame synchronization signal

Timer Counter

- Three 16-bit Timer Counter Channels
- Wide range of functions including:
  - Frequency Measurement
  - Event Counting
  - Interval Measurement
  - Pulse Generation
  - Delay Timing
  - Pulse Width Modulation
  - Up/down Capabilities
- Each channel is user-configurable and contains:
  - Three external clock inputs
  - Five internal clock inputs as defined in Table 6.

Table 6. Timer Counter Clock Assignment

TC Clock input	Clock
TIMER_CLOCK1	MCK/2
TIMER_CLOCK2	MCK/8
TIMER_CLOCK3	MCK/32
TIMER_CLOCK4	MCK/128
TIMER_CLOCK5	MCK/1024

  - Two multi-purpose input/output signals
  - Two global registers that act on all three TC Channels

PWM Controller

- Eight channels, one 20-bit counter per channel
- Common clock generator, providing thirteen different clocks
  - A Modulo n counter providing eleven clocks
  - Two independent linear dividers working on modulo n counter outputs
- Independent channel programming
  - Independent enable/disable commands
  - Independent clock selection
  - Independent period and duty cycle, with double buffering
  - Programmable selection of the output waveform polarity
  - Programmable center or left aligned output waveform

USB Device Port

- USB V2.0 full-speed compliant,12 Mbits per second.
- Embedded USB V2.0 full-speed transceiver
- Six endpoints

- Endpoint 0: 8 bytes
- Endpoint 1 and 2: 64 bytes ping-pong
- Endpoint 3: 64 bytes
- Endpoint 4 and 5: 512 bytes ping-pong

- Embedded 2,376-byte dual-port RAM for endpoints
  - Ping-pong Mode (two memory banks) for isochronous and bulk endpoints
- Suspend/resume logic

Multimedia Card Interface

- Compatibility with MultiMedia card specification version 2.2
- Compatibility with SD Memory card specification version 1.0
- Cards clock rate up to Master Clock divided by 2
- Embeds power management to slow down clock rate when not used
- Supports up to sixteen slots (through multiplexing)
  - One slot for one MultiMedia card bus (up to 30 cards) or one SD memory card
- Supports stream, block and multi-block data read and write
- Supports connection to Peripheral Data Controller
  - Minimizes processor intervention for large buffer transfers

CAN Controller

- Fully compliant with CAN 2.0B active controllers
- Bit rates up to 1Mbit/s
- 16 object-oriented mailboxes, each with the following properties:
  - CAN specification 2.0 Part A or 2.0 Part B programmable for each message
  - Object-configurable as receive (with overwrite or not) or transmit
  - Local tag and mask filters up to 29-bit identifier/channel
  - 32-bit access to data registers for each mailbox data object
  - Uses a 16-bit time stamp on receive and transmit messages
  - Hardware concatenation of ID unmasked bit fields to speed up family ID processing
  - 16-bit internal timer for Time Stamping and Network synchronization
  - Programmable reception buffer length up to 16 mailbox object
  - Priority management between transmission mailboxes
  - Autobaud and listening mode
  - Low power mode and programmable wake-up on bus activity or by the application
  - Data, remote, error and overload frame handling

Analog-to-Digital Converter

- 8-channel ADC
- 10-bit 384K samples/sec Successive Approximation Register ADC
- -2/+2 LSB Integral Non Linearity, -1/+2 LSB Differential Non Linearity
- Integrated 8-to-1 multiplexer, offering eight independent 3.3V analog inputs
- Individual enable and disable of each channel
- External voltage reference for better accuracy on low-voltage inputs

- Multiple trigger sources
  - Hardware or software trigger
  - External pins: ADTRG0 and ADTRG1
  - Timer Counter 0 to 5 outputs: TIOA0 to TIOA5
- Sleep Mode and conversion sequencer
  - Automatic wakeup on trigger and back to sleep mode after conversions of all enabled channels
- All analog inputs are shared with digital signals

Ordering Information

Table 7. Ordering Information

Ordering Code	Package	Temperature Operating Range
AT91SAM7A3-AJ	100-lead LQFP	Industrial (-40°C to 85°C)

Document Details

Title	AT91SAM7A3 Summary
Literature Number	6042S

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