

## Features

- Core
  - ARM® Cortex®-M3 revision 2.0 running at up to 96 MHz
  - Memory Protection Unit (MPU)
  - Thumb®-2 instruction set
- Memories
  - From 64 to 256 Kbytes embedded Flash, 128-bit wide access, memory accelerator, dual bank
  - From 16 to 48 Kbytes embedded SRAM with dual banks
  - 16 Kbytes ROM with embedded bootloader routines (UART, USB) and IAP routines
  - Static Memory Controller (SMC): SRAM, NOR, NAND support. NAND Flash controller with 4 Kbytes RAM buffer and ECC
- System
  - Embedded voltage regulator for single supply operation
  - POR, BOD and Watchdog for safe reset
  - Quartz or resonator oscillators: 3 to 20 MHz main and optional low power 32.768 kHz for RTC or device clock.
  - High precision 8/12 MHz factory trimmed internal RC oscillator with 4 MHz Default Frequency for fast device startup
  - Slow Clock Internal RC oscillator as permanent clock for device clock in low power mode
  - One PLL for device clock and one dedicated PLL for USB 2.0 High Speed Device
  - Up to 17 peripheral DMA (PDC) channels and 4-channel central DMA
- Low Power Modes
  - Sleep and Backup modes, down to 2.5 µA in Backup mode
  - Backup domain: VDDBU pin, RTC, 32 backup registers
  - Ultra low power RTC: 0.6 µA
- Peripherals
  - USB 2.0 Device: 480 Mbps, 4-kbyte FIFO, up to 7 bidirectional Endpoints, dedicated DMA
  - Up to 4 USARTs (ISO7816, IrDA®, Flow Control, SPI, Manchester support) and one UART
  - Up to 2 TWI (I2C compatible), 1 SPI, 1 SSC (I2S), 1 HSMCI (SDIO/SD/MMC)
  - 3-Channel 16-bit Timer/Counter (TC) for capture, compare and PWM
  - 4-channel 16-bit PWM (PWMC)
  - 32-bit Real Time Timer (RTT) and RTC with calendar and alarm features
  - 8-channel 12-bit 1MSPS ADC with differential input mode and programmable gain stage, 8-channel 10-bit ADC
- I/O
  - Up to 96 I/O lines with external interrupt capability (edge or level sensitivity), debouncing, glitch filtering and on-die Series Resistor Termination
  - Three 32-bit Parallel Input/Outputs (PIO)
- Packages
  - 100-lead LQFP, 14 x 14 mm, pitch 0.5 mm
  - 100-ball LFBGA, 9 x 9 mm, pitch 0.8 mm
  - 144-lead LQFP, 20 x 20 mm, pitch 0.5 mm
  - 144-ball LFBGA, 10 x 10 mm, pitch 0.8 mm



## AT91ARM Cortex M3-based Microcontrollers

### ATSAM3U Series

## Preliminary

## Summary

**NOTE:** This is a summary document. The complete document is available on the Atmel website at [www.atmel.com](http://www.atmel.com).

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# 1. SAM3U Description

Atmel's SAM3U series is a member of a family of Flash microcontrollers based on the high performance 32-bit ARM Cortex-M3 RISC processor. It operates at a maximum speed of 96 MHz and features up to 256 Kbytes of Flash and up to 52 Kbytes of SRAM. The peripheral set includes a High Speed USB Device port with embedded transceiver, a High Speed MCI for SDIO/SD/MMC, an External Bus Interface with NAND Flash controller, up to 4xUSARTs (SAM3U1C/2C/4C have 3), up to 2xTWIs (SAM3U1C/2C/4C have 1), up to 5xSPIs (SAM3U1C/2C/4C have 4), as well as 4xPWM timers, 3xgeneral purpose 16-bit timers, an RTC, a 12-bit ADC and a 10-bit ADC.

The SAM3U architecture is specifically designed to sustain high speed data transfers. It includes a multi-layer bus matrix as well as multiple SRAM banks, PDC and DMA channels that enable it to run tasks in parallel and maximize data throughput.

It can operate from 1.62V to 3.6V and comes in 100-pin and 144-pin LQFP and BGA packages.

The SAM3U device is particularly well suited for USB applications: data loggers, PC peripherals and any high speed bridge (USB to SDIO, USB to SPI, USB to External Bus Interface).

## 1.1 Configuration Summary

The SAM3U series differ in memory sizes, package and features list. [Table 1-1](#) summarizes the configurations of the six devices.

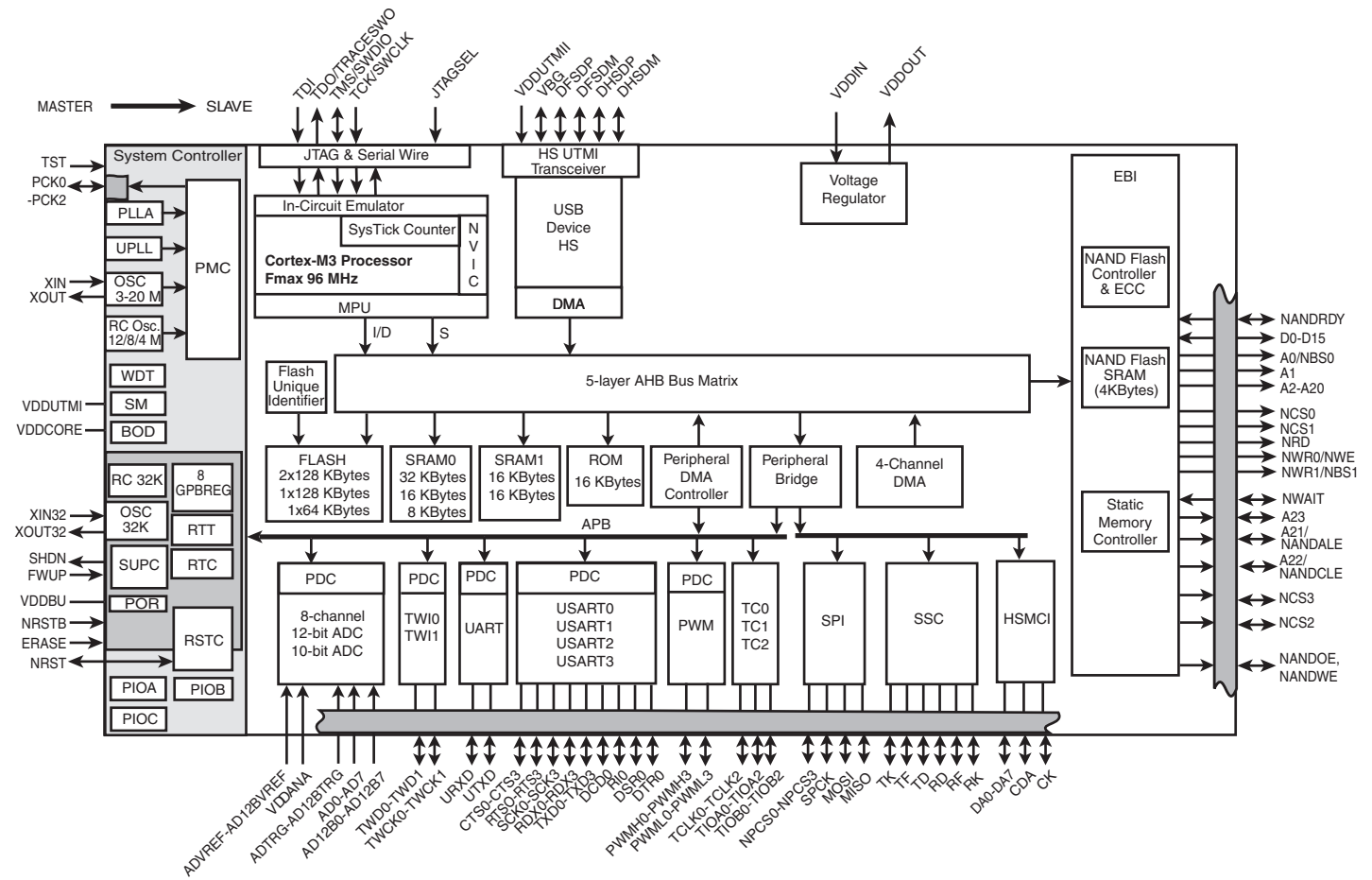
**Table 1-1.** Configuration Summary

| Device  | Flash          | Flash Organization | SRAM      | Number of PIOs | Number of USARTs | Number of TWI | FWUP, SHDN pins | External Bus Interface                       | HSMCI data size | Package        | ADC               |
|---------|----------------|--------------------|-----------|----------------|------------------|---------------|-----------------|--|-----------------|----------------|-------------------|
| SAM3U4E | 2x128 Kbytes   | dual plane         | 52 Kbytes | 96             | 4                | 2             | Yes             | 8 or 16 bits, 4 chip selects, 24-bit address | 8 bits          | LQFP144 BGA144 | 2 (8+ 8 channels) |
| SAM3U2E | 128 Kbytes     | single plane       | 36 Kbytes | 96             | 4                | 2             | Yes             | 8 or 16 bits, 4 chip selects 24-bit address  | 8 bits          | LQFP144 BGA144 | 2 (8+ 8 channels) |
| SAM3U1E | 64 Kbytes      | single plane       | 20 Kbytes | 96             | 4                | 2             | Yes             | 8 or 16 bits, 4 chip selects, 24-bit address | 8 bits          | LQFP144 BGA144 | 2 (8+ 8 channels) |
| SAM3U4C | 2 x 128 Kbytes | dual plane         | 52 Kbytes | 57             | 3                | 1             | FWUP            | 8 bits, 2 chip selects, 8-bit address        | 4 bits          | LQFP100 BGA100 | 2 (4+ 4 channels) |
| SAM3U2C | 128 Kbytes     | single plane       | 36 Kbytes | 57             | 3                | 1             | FWUP            | 8 bits, 2 chip selects, 8-bit address        | 4 bits          | LQFP100 BGA100 | 2 (4+ 4 channels) |
| SAM3U1C | 64 Kbytes      | single plane       | 20 Kbytes | 57             | 3                | 1             | FWUP            | 8 bits 2 chip selects, 8-bit address         | 4 bits          | LQFP100 BGA100 | 2 (4+ 4 channels) |

Note: 1. The SRAM size takes into account the 4-Kbyte RAM buffer of the NAND Flash Controller (NFC) which can be used by the core if not used by the NFC.

## 2. SAM3U Block Diagram

Figure 2-1. 144-pin SAM3U4/2/1E Block Diagram





## 3. Signal Description

Table 3-1 gives details on the signal names classified by peripheral.

**Table 3-1.** Signal Description List

| Signal Name                                 | Function   | Type   | Active Level | Voltage Reference | Comments  |
|---|--|--------|--------------|-------------------|---|
| <b>Power Supplies</b>                       |  |        |              |                   |   |
| VDDIO                                       | Peripherals I/O Lines Power Supply               | Power  |              |                   | 1.62V to 3.6V   |
| VDDIN                                       | Voltage Regulator Input                          | Power  |              |                   | 1.8V to 3.6V  |
| VDDOUT                                      | Voltage Regulator Output                         | Power  |              |                   | 1.8V  |
| VDDUTMII                                    | USB UTMI+ Interface Power Supply                 | Power  |              |                   | 3.0V to 3.6V  |
| GNDUTMII                                    | USB UTMI+ Interface Ground                       | Ground |              |                   |   |
| VDDBU                                       | Backup I/O Lines Power Supply                    | Power  |              |                   | 1.62V to 3.6V   |
| GNDBU                                       | Backup Ground                                    | Ground |              |                   |   |
| VDDPLL                                      | PLL A, UPLL and OSC 3-20 MHz Power Supply        | Power  |              |                   | 1.62 V to 1.95V   |
| GNDPLL                                      | PLL A, UPLL and OSC 3-20 MHz Ground              | Ground |              |                   |   |
| VDDANA                                      | ADC Analog Power Supply                          | Power  |              |                   | 2.0V to 3.6V  |
| GNDANA                                      | ADC Analog Ground                                | Ground |              |                   |   |
| VDDCORE                                     | Core, Memories and Peripherals Chip Power Supply | Power  |              |                   | 1.62V to 1.95V  |
| GND   | Ground   | Ground |              |                   |   |
| <b>Clocks, Oscillators and PLLs</b>         |  |        |              |                   |   |
| XIN   | Main Oscillator Input                            | Input  |              | VDDPLL            |   |
| XOUT  | Main Oscillator Output                           | Output |              |                   |   |
| XIN32                                       | Slow Clock Oscillator Input                      | Input  |              | VDDBU             |   |
| XOUT32                                      | Slow Clock Oscillator Output                     | Output |              |                   |   |
| VBG   | Bias Voltage Reference                           | Analog |              |                   |   |
| PCK0 - PCK2                                 | Programmable Clock Output                        | Output |              | VDDIO             |   |
| <b>Shutdown, Wakeup Logic</b>               |  |        |              |                   |   |
| SHDN  | Shut-Down Control                                | Output |              | VDDBU             | push/pull<br>0: The device is in backup mode<br>1: The device is running (not in backup mode) |
| FWUP  | Force Wake-Up Input                              | Input  | Low          |                   | Needs external pull-up  |
| <b>Serial Wire/JTAG Debug Port (SWJ-DP)</b> |  |        |              |                   |   |
| TCK/SWCLK                                   | Test Clock/Serial Wire Clock                     | Input  |              | VDDIO             | No pull-up resistor   |
| TDI   | Test Data In                                     | Input  |              |                   | No pull-up resistor   |
| TDO/TRACESWO                                | Test Data Out/Trace Asynchronous Data Out        | Output |              |                   |   |
| TMS/SWDIO                                   | Test Mode Select/Serial Wire Input/Output        | Input  |              |                   | No pull-up resistor   |
| JTAGSEL                                     | JTAG Selection                                   | Input  | High         | VDDBU             | Internal permanent pull-down  |

**Table 3-1.** Signal Description List (Continued)

| Signal Name   | Function                                       | Type   | Active Level | Voltage Reference | Comments  |
|---|--|--------|--------------|-------------------|---|
| <b>Flash Memory</b>                                       |  |        |              |                   |   |
| ERASE   | Flash and NVM Configuration Bits Erase Command | Input  | High         | VDDBU             | Internal permanent 15K pulldown   |
| <b>Reset/Test</b>   |  |        |              |                   |   |
| NRST  | Microcontroller Reset                          | I/O    | Low          | VDDIO             | Internal permanent pullup   |
| NRSTB   | Asynchronous Microcontroller Reset             | Input  | Low          | VDDBU             | Internal permanent pullup   |
| TST   | Test Select                                    | Input  |              |                   | Internal permanent pulldown   |
| <b>Universal Asynchronous Receiver Transceiver - UART</b> |  |        |              |                   |   |
| URXD  | UART Receive Data                              | Input  |              |                   |   |
| UTXD  | UART Transmit Data                             | Output |              |                   |   |
| <b>PIO Controller - PIOA - PIOB - PIOC</b>                |  |        |              |                   |   |
| PA0 - PA31  | Parallel IO Controller A                       | I/O    |              | VDDIO             | <ul style="list-style-type: none"> <li>•Schmitt Trigger <sup>(1)</sup></li> <li>Reset State:</li> <li>•PIO Input</li> <li>•Internal pullup enabled</li> </ul> |
| PB0 - PB31  | Parallel IO Controller B                       | I/O    |              |                   | <ul style="list-style-type: none"> <li>•Schmitt Trigger <sup>(2)</sup></li> <li>Reset State:</li> <li>•PIO Input</li> <li>•Internal pullup enabled</li> </ul> |
| PC0 - PC31  | Parallel IO Controller C                       | I/O    |              |                   | <ul style="list-style-type: none"> <li>•Schmitt Trigger <sup>(3)</sup></li> <li>Reset State:</li> <li>•PIO Input</li> <li>•Internal pullup enabled</li> </ul> |
| <b>External Bus Interface</b>                             |  |        |              |                   |   |
| D0 - D15  | Data Bus                                       | I/O    |              |                   |   |
| A0 - A23  | Address Bus                                    | Output |              |                   |   |
| NWAIT   | External Wait Signal                           | Input  | Low          |                   |   |
| <b>Static Memory Controller - SMC</b>                     |  |        |              |                   |   |
| NCS0 - NCS3   | Chip Select Lines                              | Output | Low          |                   |   |
| NWR0 - NWR1   | Write Signal                                   | Output | Low          |                   |   |
| NRD   | Read Signal                                    | Output | Low          |                   |   |
| NWE   | Write Enable                                   | Output | Low          |                   |   |
| NBS0 - NBS1   | Byte Mask Signal                               | Output | Low          |                   |   |
| <b>NAND Flash Controller - NFC</b>                        |  |        |              |                   |   |
| NANDOE  | NAND Flash Output Enable                       | Output | Low          |                   |   |
| NANDWE  | NAND Flash Write Enable                        | Output | Low          |                   |   |
| NANDRDY   | NAND Ready                                     | Input  |              |                   |   |

**Table 3-1.** Signal Description List (Continued)

| Signal Name   | Function                               | Type   | Active Level | Voltage Reference | Comments  |
|---|--|--------|--------------|-------------------|---|
| <b>High Speed Multimedia Card Interface - HSMCI</b>                     |  |        |              |                   |   |
| CK  | Multimedia Card Clock                  | I/O    |              |                   |   |
| CDA   | Multimedia Card Slot A Command         | I/O    |              |                   |   |
| DA0 - DA7   | Multimedia Card Slot A Data            | I/O    |              |                   |   |
| <b>Universal Synchronous Asynchronous Receiver Transmitter - USARTx</b> |  |        |              |                   |   |
| SCKx  | USARTx Serial Clock                    | I/O    |              |                   |   |
| TXDx  | USARTx Transmit Data                   | I/O    |              |                   |   |
| RXDx  | USARTx Receive Data                    | Input  |              |                   |   |
| RTSx  | USARTx Request To Send                 | Output |              |                   |   |
| CTSx  | USARTx Clear To Send                   | Input  |              |                   |   |
| DTR0  | USART0 Data Terminal Ready             | I/O    |              |                   |   |
| DSR0  | USART0 Data Set Ready                  | Input  |              |                   |   |
| DCD0  | USART0 Data Carrier Detect             | Input  |              |                   |   |
| RI0   | USART0 Ring Indicator                  | Input  |              |                   |   |
| <b>Synchronous Serial Controller - SSC</b>                              |  |        |              |                   |   |
| TD  | SSC Transmit Data                      | Output |              |                   |   |
| RD  | SSC Receive Data                       | Input  |              |                   |   |
| TK  | SSC Transmit Clock                     | I/O    |              |                   |   |
| RK  | SSC Receive Clock                      | I/O    |              |                   |   |
| TF  | SSC Transmit Frame Sync                | I/O    |              |                   |   |
| RF  | SSC Receive Frame Sync                 | I/O    |              |                   |   |
| <b>Timer/Counter - TC</b>   |  |        |              |                   |   |
| TCLKx   | TC Channel x External Clock Input      | Input  |              |                   |   |
| TIOAx   | TC Channel x I/O Line A                | I/O    |              |                   |   |
| TIOBx   | TC Channel x I/O Line B                | I/O    |              |                   |   |
| <b>Pulse Width Modulation Controller- PWMC</b>                          |  |        |              |                   |   |
| PWMHx   | PWM Waveform Output High for channel x | Output |              |                   |   |
| PWMLx   | PWM Waveform Output Low for channel x  | Output |              |                   | only output in complementary mode when dead time insertion is enabled |
| PWMFI0-2  | PWM Fault Input                        | Input  |              |                   |   |
| <b>Serial Peripheral Interface - SPI</b>                                |  |        |              |                   |   |
| MISO  | Master In Slave Out                    | I/O    |              |                   |   |
| MOSI  | Master Out Slave In                    | I/O    |              |                   |   |
| SPCK  | SPI Serial Clock                       | I/O    |              |                   |   |
| NPCS0   | SPI Peripheral Chip Select 0           | I/O    | Low          |                   |   |
| NPCS1 - NPC3  | SPI Peripheral Chip Select             | Output | Low          |                   |   |

**Table 3-1.** Signal Description List (Continued)

| Signal Name  | Function                     | Type   | Active Level | Voltage Reference | Comments |
|--|------------------------------|--------|--------------|-------------------|----------|
| <b>Two-Wire Interface - TWI</b>                    |                              |        |              |                   |          |
| TWDx   | TWlx Two-wire Serial Data    | I/O    |              |                   |          |
| TWCKx  | TWlx Two-wire Serial Clock   | I/O    |              |                   |          |
| <b>12-bit Analog-to-Digital Converter - ADC12B</b> |                              |        |              |                   |          |
| AD12Bx   | Analog Inputs                | Analog |              |                   |          |
| AD12BTRG   | ADC Trigger                  | Input  |              |                   |          |
| AD12BVREF  | ADC Reference                | Analog |              |                   |          |
| <b>10-bit Analog-to-Digital Converter - ADC</b>    |                              |        |              |                   |          |
| ADx  | Analog Inputs                | Analog |              |                   |          |
| ADTRG  | ADC Trigger                  | Input  |              |                   |          |
| ADVREF   | ADC Reference                | Analog |              |                   |          |
| <b>Fast Flash Programming Interface - FFPI</b>     |                              |        |              |                   |          |
| PGMEN0-PGMEN2                                      | Programming Enabling         | Input  |              | VDDIO             |          |
| PGMM0-PGMM3  | Programming Mode             | Input  |              |                   |          |
| PGMD0-PGMD15                                       | Programming Data             | I/O    |              |                   |          |
| PGMRDY   | Programming Ready            | Output | High         |                   |          |
| PGMNVALID  | Data Direction               | Output | Low          |                   |          |
| PGMNOE   | Programming Read             | Input  | Low          |                   |          |
| PGMCK  | Programming Clock            | Input  |              |                   |          |
| PGMNCMD  | Programming Command          | Input  | Low          |                   |          |
| <b>USB High Speed Device - UDPHS</b>               |                              |        |              |                   |          |
| DFSDM  | USB Device Full Speed Data - | Analog |              | VDDUTMII          |          |
| DFSDP  | USB Device Full Speed Data + | Analog |              |                   |          |
| DHSDM  | USB Device High Speed Data - | Analog |              |                   |          |
| DHSDP  | USB Device High Speed Data + | Analog |              |                   |          |

- Notes:
1. PIOA: Schmitt Trigger on all except PA14 on 100 and 144 packages.
  2. PIOB: Schmitt Trigger on all except PB9 to PB16, PB25 to PB31 on 100 and 144 packages.
  3. PIOC: Schmitt Trigger on all except PC20 to PC27 on 144 package.

### 3.1 Design Considerations

In order to facilitate schematic capture when using a SAM3U design, [Atmel provides a “Schematics Checklist” Application note.](#)

Please visit <http://www.atmel.com/products/AT91/> for additional documentation.



## 4. Package and Pinout

The SAM3U4/2/1E is available in 144-lead LQFP and 144-ball LFBGA packages.

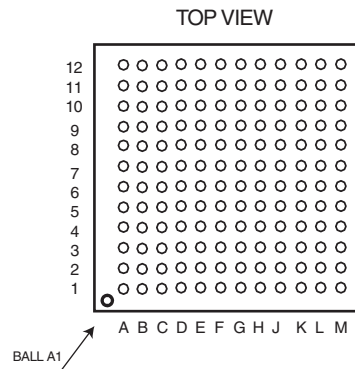
The SAM3U4/2/1C is available in 100-lead LQFP and 100-ball LFBGA packages.

### 4.1 SAM3U4/2/1E Package and Pinout

#### 4.1.1 144-ball LFBGA Package Outline

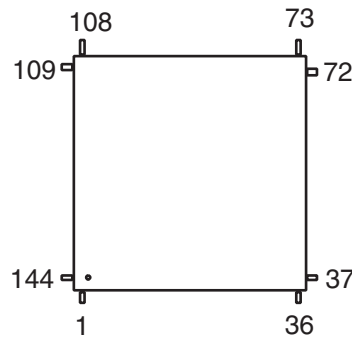
The 144-Ball LFBGA package has a 0.8 mm ball pitch and respects Green Standards. Its dimensions are 10 x 10 x 1.4 mm.

**Figure 4-1.** Orientation of the 144-ball LFBGA Package



#### 4.1.2 144-lead LQFP Package Outline

**Figure 4-2.** Orientation of the 144-lead LQFP Package



### 4.1.3 144-lead LQFP Pinout

**Table 4-1.** 144-pin SAM3U4/2/1E Pinout

|    |              |    |         |     |             |     |               |
|----|--------------|----|---------|-----|-------------|-----|---------------|
| 1  | TDI          | 37 | DHSDP   | 73  | VDDANA      | 109 | PA0/PGMNCMD   |
| 2  | VDDOUT       | 38 | DHSDM   | 74  | ADVREF      | 110 | PC0           |
| 3  | VDDIN        | 39 | VBG     | 75  | GNDANA      | 111 | PA1/PGMRDY    |
| 4  | TDO/TRACESWO | 40 | VDDUTMI | 76  | AD12BVREF   | 112 | PC1           |
| 5  | PB31         | 41 | DFSDM   | 77  | PA22/PGMD14 | 113 | PA2/PGMNOE    |
| 6  | PB30         | 42 | DFSDP   | 78  | PA30        | 114 | PC2           |
| 7  | TMS/SWDIO    | 43 | GNDUTMI | 79  | PB3         | 115 | PA3/PGMNVALID |
| 8  | PB29         | 44 | VDDCORE | 80  | PB4         | 116 | PC3           |
| 9  | TCK/SWCLK    | 45 | PA28    | 81  | PC15        | 117 | PA4/PGMM0     |
| 10 | PB28         | 46 | PA29    | 82  | PC16        | 118 | PC4           |
| 11 | NRST         | 47 | PC22    | 83  | PC17        | 119 | PA5/PGMM1     |
| 12 | PB27         | 48 | PA31    | 84  | PC18        | 120 | PC5           |
| 13 | PB26         | 49 | PC23    | 85  | VDDIO       | 121 | PA6/PGMM2     |
| 14 | PB25         | 50 | VDDCORE | 86  | VDDCORE     | 122 | PC6           |
| 15 | PB24         | 51 | VDDIO   | 87  | PA13/PGMD5  | 123 | PA7/PGMM3     |
| 16 | VDDCORE      | 52 | GND     | 88  | PA14/PGMD6  | 124 | PC7           |
| 17 | VDDIO        | 53 | PB0     | 89  | PC10        | 125 | VDDCORE       |
| 18 | GND          | 54 | PC24    | 90  | GND         | 126 | GND           |
| 19 | PB23         | 55 | PB1     | 91  | PA15/PGMD7  | 127 | VDDIO         |
| 20 | PB22         | 56 | PC25    | 92  | PC11        | 128 | PA8/PGMD0     |
| 21 | PB21         | 57 | PB2     | 93  | PA16/PGMD8  | 129 | PC8           |
| 22 | PC21         | 58 | PC26    | 94  | PC12        | 130 | PA9/PGMD1     |
| 23 | PB20         | 59 | PB11    | 95  | PA17/PGMD9  | 131 | PC9           |
| 24 | PB19         | 60 | GND     | 96  | PB16        | 132 | PA10/PGMD2    |
| 25 | PB18         | 61 | PB12    | 97  | PB15        | 133 | PA11/PGMD3    |
| 26 | PB17         | 62 | PB13    | 98  | PC13        | 134 | PA12/PGMD4    |
| 27 | VDDCORE      | 63 | PC27    | 99  | PA18/PGMD10 | 135 | FWUP          |
| 28 | PC14         | 64 | PA27    | 100 | PA19/PGMD11 | 136 | SHDN          |
| 29 | PB14         | 65 | PB5     | 101 | PA20/PGMD12 | 137 | ERASE         |
| 30 | PB10         | 66 | PB6     | 102 | PA21/PGMD13 | 138 | TST           |
| 31 | PB9          | 67 | PB7     | 103 | PA23/PGMD15 | 139 | VDDBU         |
| 32 | PC19         | 68 | PB8     | 104 | VDDIO       | 140 | GNDBU         |
| 33 | GNDPLL       | 69 | PC28    | 105 | PA24        | 141 | NRSTB         |
| 34 | VDDPLL       | 70 | PC29    | 106 | PA25        | 142 | JTAGSEL       |
| 35 | XOUT         | 71 | PC30    | 107 | PA26        | 143 | XOUT32        |
| 36 | XIN          | 72 | PC31    | 108 | PC20        | 144 | XIN32         |

## 4.1.4 144-ball LFBGA Pinout

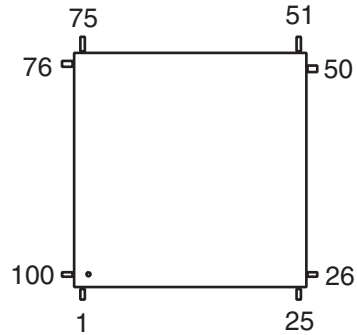
**Table 4-2.** 144-ball SAM3U4/2/1E Pinout

|     |              |     |            |     |               |     |             |
|-----|--------------|-----|------------|-----|---------------|-----|-------------|
| A1  | VBG          | D1  | DFSDM      | G1  | PB0           | K1  | PB7         |
| A2  | VDDUTMI      | D2  | DHSDM      | G2  | PC26          | K2  | PC31        |
| A3  | PB9          | D3  | GNDPLL     | G3  | PB2           | K3  | PC29        |
| A4  | PB10         | D4  | PC14       | G4  | PC25          | K4  | PB3         |
| A5  | PB19         | D5  | PB21       | G5  | PB1           | K5  | PB4         |
| A6  | PC21         | D6  | PB23       | G6  | GND           | K6  | PA14/PGMD6  |
| A7  | PB26         | D7  | PB24       | G7  | GND           | K7  | PA16/PGMD8  |
| A8  | TCK/SWCLK    | D8  | PB28       | G8  | VDDCORE       | K8  | PA18/PGMD10 |
| A9  | PB30         | D9  | TDI        | G9  | PC4           | K9  | PC20        |
| A10 | TDO/TRACESWO | D10 | VDDBU      | G10 | PA6/PGMM2     | K10 | PA1/PGMRDY  |
| A11 | XIN32        | D11 | PA10/PGMD2 | G11 | PA7/PGMM3     | K11 | PC1         |
| A12 | XOUT32       | D12 | PA11/PGMD3 | G12 | PC6           | K12 | PC2         |
| B1  | VDDCORE      | E1  | PC22       | H1  | PC24          | L1  | PC30        |
| B2  | GNDUTMI      | E2  | PA28       | H2  | PC27          | L2  | ADVREF      |
| B3  | XOUT         | E3  | PC19       | H3  | PA27          | L3  | AD12BVREF   |
| B4  | PB14         | E4  | VDDCORE    | H4  | PB12          | L4  | PA22/PGMD14 |
| B5  | PB17         | E5  | GND        | H5  | PB11          | L5  | PC17        |
| B6  | PB22         | E6  | VDDIO      | H6  | GND           | L6  | PC10        |
| B7  | PB25         | E7  | GND        | H7  | VDDCORE       | L7  | PC12        |
| B8  | PB29         | E8  | NRST       | H8  | PB16          | L8  | PA19/PGMD11 |
| B9  | VDDIN        | E9  | PB31       | H9  | PB15          | L9  | PA23/PGMD15 |
| B10 | JTAGSEL      | E10 | PA12/PGMD4 | H10 | PC3           | L10 | PA0/PGMNCMD |
| B11 | ERASE        | E11 | PA8/PGMD0  | H11 | PA5/PGMM1     | L11 | PA26        |
| B12 | SHDN         | E12 | PC8        | H12 | PC5           | L12 | PC0         |
| C1  | DFSDP        | F1  | PA31       | J1  | PB5           | M1  | VDDANA      |
| C2  | DHSDP        | F2  | PA29       | J2  | PB6           | M2  | GNDANA      |
| C3  | XIN          | F3  | PC23       | J3  | PC28          | M3  | PA30        |
| C4  | VDDPLL       | F4  | VDDCORE    | J4  | PB8           | M4  | PC15        |
| C5  | PB18         | F5  | VDDIO      | J5  | PB13          | M5  | PC16        |
| C6  | PB20         | F6  | GND        | J6  | VDDIO         | M6  | PC18        |
| C7  | PB27         | F7  | GND        | J7  | PA13/PGMD5    | M7  | PA15/PGMD7  |
| C8  | TMS/SWDIO    | F8  | VDDIO      | J8  | PA17/PGMD9    | M8  | PC11        |
| C9  | VDDOUT       | F9  | PC9        | J9  | PC13          | M9  | PA20/PGMD12 |
| C10 | NRSTB        | F10 | PA9/PGMD1  | J10 | PA2/PGMNOE    | M10 | PA21/PGMD13 |
| C11 | TST          | F11 | VDDCORE    | J11 | PA3/PGMNVALID | M11 | PA24        |
| C12 | FWUP         | F12 | PC7        | J12 | PA4/PGMM0     | M12 | PA25        |

## 4.2 SAM3U4/2/1C Package and Pinout

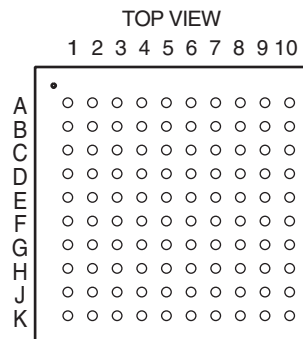
### 4.2.1 100-lead LQFP Package Outline

**Figure 4-3.** Orientation of the 100-lead LQFP Package



### 4.2.2 100-ball LFBGA Package Outline

**Figure 4-4.** Orientation of the 100-ball LFBGA Package



## 4.2.3 100-lead LQFP Pinout

**Table 4-3.** 100-pin SAM3U4/2/1C1 Pinout

|    |             |    |               |    |              |     |         |
|----|-------------|----|---------------|----|--------------|-----|---------|
| 1  | VDDANA      | 26 | PA0/PGMNCMD   | 51 | TDI          | 76  | DHSDP   |
| 2  | ADVREF      | 27 | PA1/PGMRDY    | 52 | VDDOUT       | 77  | DHSDM   |
| 3  | GNDANA      | 28 | PA2/PGMNOE    | 53 | VDDIN        | 78  | VBG     |
| 4  | AD12BVREF   | 29 | PA3/PGMNVALID | 54 | TDO/TRACESWO | 79  | VDDUTMI |
| 5  | PA22/PGMD14 | 30 | PA4/PGMM0     | 55 | TMS/SWDIO    | 80  | DFSDM   |
| 6  | PA30        | 31 | PA5/PGMM1     | 56 | TCK/SWCLK    | 81  | DFSDP   |
| 7  | PB3         | 32 | PA6/PGMM2     | 57 | NRST         | 82  | GNDUTMI |
| 8  | PB4         | 33 | PA7/PGMM3     | 58 | PB24         | 83  | VDDCORE |
| 9  | VDDCORE     | 34 | VDDCORE       | 59 | VDDCORE      | 84  | PA28    |
| 10 | PA13/PGMD5  | 35 | GND           | 60 | VDDIO        | 85  | PA29    |
| 11 | PA14/PGMD6  | 36 | VDDIO         | 61 | GND          | 86  | PA31    |
| 12 | PA15/PGMD7  | 37 | PA8/PGMD0     | 62 | PB23         | 87  | VDDCORE |
| 13 | PA16/PGMD8  | 38 | PA9/PGMD1     | 63 | PB22         | 88  | VDDIO   |
| 14 | PA17/PGMD9  | 39 | PA10/PGMD2    | 64 | PB21         | 89  | GND     |
| 15 | PB16        | 40 | PA11/PGMD3    | 65 | PB20         | 90  | PB0     |
| 16 | PB15        | 41 | PA12/PGMD4    | 66 | PB19         | 91  | PB1     |
| 17 | PA18/PGMD10 | 42 | FWUP          | 67 | PB18         | 92  | PB2     |
| 18 | PA19/PGMD11 | 43 | ERASE         | 68 | PB17         | 93  | PB11    |
| 19 | PA20/PGMD12 | 44 | TST           | 69 | PB14         | 94  | PB12    |
| 20 | PA21/PGMD13 | 45 | VDDBU         | 70 | PB10         | 95  | PB13    |
| 21 | PA23/PGMD15 | 46 | GNDDBU        | 71 | PB9          | 96  | PA27    |
| 22 | VDDIO       | 47 | NRSTB         | 72 | GNDPLL       | 97  | PB5     |
| 23 | PA24        | 48 | JTAGSEL       | 73 | VDDPLL       | 98  | PB6     |
| 24 | PA25        | 49 | XOUT32        | 74 | XOUT         | 99  | PB7     |
| 25 | PA26        | 50 | XIN32         | 75 | XIN          | 100 | PB8     |

#### 4.2.4 100-ball LFBGA Pinout

**Table 4-4.** 100-ball SAM3U4/2/1C Pinout

|     |              |     |            |     |               |     |             |
|-----|--------------|-----|------------|-----|---------------|-----|-------------|
| A1  | VBG          | C6  | PB22       | F1  | PB1           | H6  | PA15/PGMD7  |
| A2  | XIN          | C7  | TMS/SWDIO  | F2  | PB12          | H7  | PA18/PGMD10 |
| A3  | XOUT         | C8  | NRSTB      | F3  | VDDIO         | H8  | PA24        |
| A4  | PB17         | C9  | JTAGSEL    | F4  | PA31          | H9  | PA1/PGMRDY  |
| A5  | PB21         | C10 | VDDBU      | F5  | VDDIO         | H10 | PA2/PGMNOE  |
| A6  | PB23         | D1  | DFSDM      | F6  | GND           | J1  | PB6         |
| A7  | TCK/SWCLK    | D2  | DHSDM      | F7  | PB16          | J2  | PB8         |
| A8  | VDDIN        | D3  | VDDPLL     | F8  | PA6/PGMM2     | J3  | ADVREF      |
| A9  | VDDOUT       | D4  | VDDCORE    | F9  | VDDCORE       | J4  | PA30        |
| A10 | XIN32        | D5  | PB20       | F10 | PA7/PGMM3     | J5  | PB3         |
| B1  | VDDCORE      | D6  | ERASE      | G1  | PB11          | J6  | PA16/PGMD8  |
| B2  | GNDUTMI      | D7  | TST        | G2  | PB2           | J7  | PA19/PGMD11 |
| B3  | VDDUTMI      | D8  | FWUP       | G3  | PB0           | J8  | PA21/PGMD13 |
| B4  | PB10         | D9  | PA11/PGMD3 | G4  | PB13          | J9  | PA26        |
| B5  | PB18         | D10 | PA12/PGMD4 | G5  | VDDCORE       | J10 | PA0/PGMNCMD |
| B6  | PB24         | E1  | PA29       | G6  | GND           | K1  | PB7         |
| B7  | NRST         | E2  | GND        | G7  | PB15          | K2  | VDDANA      |
| B8  | TDO/TRACESWO | E3  | PA28       | G8  | PA3/PGMNVALID | K3  | GNDANA      |
| B9  | TDI          | E4  | PB9        | G9  | PA5/PGMM1     | K4  | AD12BVREF   |
| B10 | XOUT32       | E5  | GNDBU      | G10 | PA4/PGMM0     | K5  | PB4         |
| C1  | DFSDP        | E6  | VDDIO      | H1  | VDDCORE       | K6  | PA14/PGMD6  |
| C2  | DHSDP        | E7  | VDDCORE    | H2  | PB5           | K7  | PA17/PGMD9  |
| C3  | GNDPLL       | E8  | PA10/PGMD2 | H3  | PA27          | K8  | PA20/PGMD12 |
| C4  | PB14         | E9  | PA9/PGMD1  | H4  | PA22/PGMD14   | K9  | PA23/PGMD15 |
| C5  | PB19         | E10 | PA8/PGMD0  | H5  | PA13/PGMD5    | K10 | PA25        |

## 5. Power Considerations

### 5.1 Power Supplies

The SAM3U product has several types of power supply pins:

- VDDCORE pins: Power the core, the embedded memories and the peripherals; voltage ranges from 1.62V to 1.95V.
- VDDIO pins: Power the Peripherals I/O lines; voltage ranges from 1.62V to 3.6V.
- VDDIN pin: Powers the Voltage regulator
- VDDOUT pin: It is the output of the voltage regulator.
- VDDBU pin: Powers the Slow Clock oscillator and a part of the System Controller; voltage ranges from 1.62V to 3.6V. VDDBU must be supplied before or at the same time than VDDIO and VDDCORE.
- VDDPLL pin: Powers the PLL A, UPLL and 3-20 MHz Oscillator; voltage ranges from 1.62V to 1.95V.
- VDDUTMI pin: Powers the UTMI+ interface; voltage ranges from 3.0V to 3.6V, 3.3V nominal.
- VDDANA pin: Powers the ADC cells; voltage ranges from 2.0V to 3.6V.

Ground pins GND are common to VDDCORE and VDDIO pins power supplies.

Separated ground pins are provided for VDDBU, VDDPLL, VDDUTMI and VDDANA. These ground pins are respectively GNDBU, GNDPLL, GNDUTMI and GNDANA.

### 5.2 Voltage Regulator

The SAM3U embeds a voltage regulator that is managed by the Supply Controller.

This internal regulator is intended to supply the internal core of SAM3U but can be used to supply other parts in the application. It features two different operating modes:

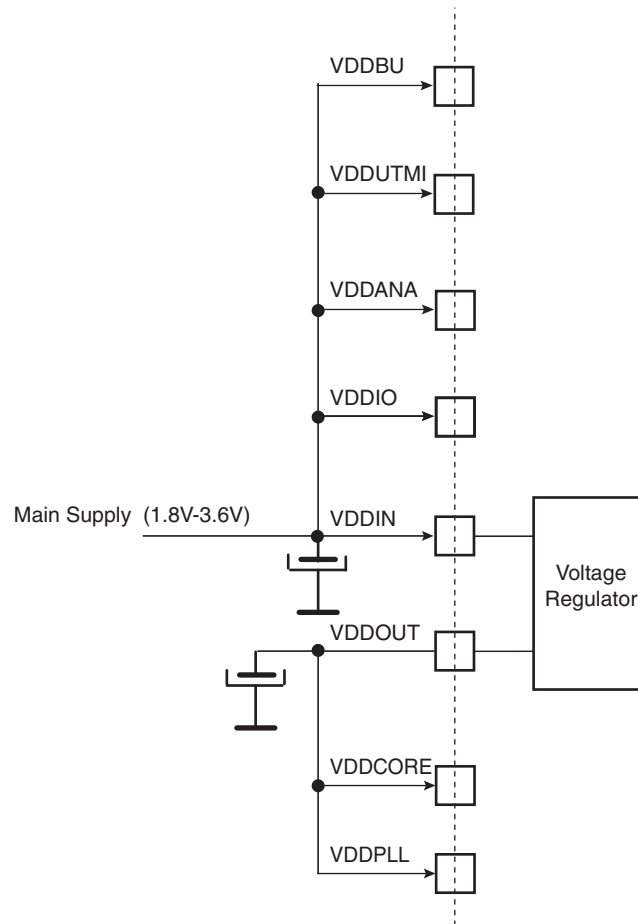
- In Normal mode, the voltage regulator consumes less than 700  $\mu$ A static current and draws 150 mA of output current. Internal adaptive biasing adjusts the regulator quiescent current depending on the required load current. In Wait Mode or when the output current is low, quiescent current is only 7 $\mu$ A.
- In Shutdown mode, the voltage regulator consumes less than 1  $\mu$ A while its output is driven internally to GND. The default output voltage is 1.80V and the start-up time to reach Normal mode is inferior to 400  $\mu$ s.

For adequate input and output power supply decoupling/bypassing, refer to “Voltage Regulator” in the “Electrical Characteristics” section of the product datasheet.

### 5.3 Typical Powering Schematics

The SAM3U supports a 1.8V-3.6V single supply mode. The internal regulator input connected to the source and its output feed VDDCORE. [Figure 5-1](#), [Figure 5-2](#), [Figure 5-3](#) show the power schematics.

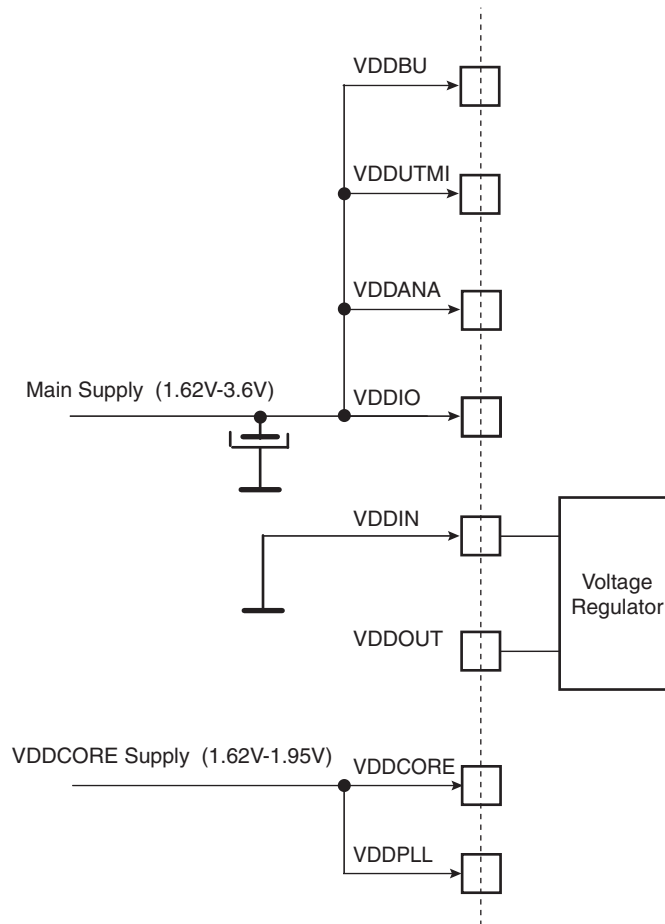
**Figure 5-1.** Single Supply



Note: Restrictions  
 With Main Supply < 2.0 V, USB and ADC are not usable.  
 With Main Supply  $\geq$  2.4V and < 3V, USB is not usable.  
 With Main Supply  $\geq$  3V, all peripherals are usable.

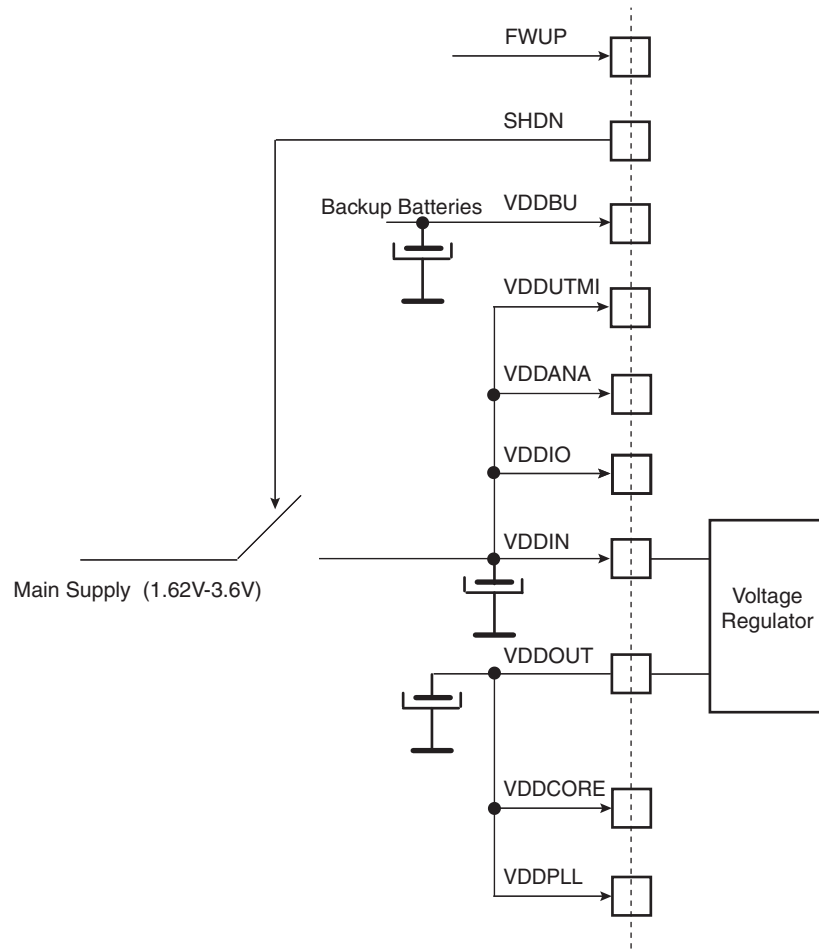


**Figure 5-2. Core Externally Supplied**



**Note: Restrictions**  
 With Main Supply < 2.0 V, USB and ADC are not usable.  
 With Main Supply  $\geq$  2.4V and < 3V, USB is not usable.  
 With Main Supply  $\geq$  3V, all peripherals are usable.

**Figure 5-3.** Backup Batteries Used



Note: Restrictions  
 With Main Supply < 2.0 V, USB and ADC are not usable.  
 With Main Supply  $\geq$  2.4V and < 3V, USB is not usable.  
 With Main Supply  $\geq$  3V, all peripherals are usable.

## 5.4 Active Mode

Active mode is the normal running mode with the core clock running from the fast RC oscillator, the main crystal oscillator or the PLLA. The power management controller can be used to adapt the frequency and to disable the peripheral clocks.

## 5.5 Low Power Modes

The various low power modes of the SAM3U are described below:

### 5.5.1 Backup Mode

The purpose of backup mode is to achieve the lowest power consumption possible in a system which is performing periodic wake-ups to perform tasks but not requiring fast startup time (<0.5ms).

The Supply Controller, zero-power power-on reset, RTT, RTC, Backup registers and 32 kHz Oscillator (RC or crystal oscillator selected by software in the Supply Controller) are running. The regulator and the core supply are off.

Backup Mode is based on the Cortex-M3 deep-sleep mode with the voltage regulator disabled.

The SAM3U Series can be awakened from this mode through the Force Wake-Up pin (FWUP), and Wake-Up input pins WKUP0 to WKUP15, Supply Monitor, RTT or RTC wake-up event. Current Consumption is 2.5  $\mu$ A typical on VDDBU.

Backup mode is entered by using WFE instructions with the SLEEPDEEP bit in the System Control Register of the Cortex-M3 set to 1. (See the “Power Management” description in The “ARM Cortex M3 Processor” section of the product datasheet).

Exit from Backup mode happens if one of the following enable wake up events occurs:

- FWUP pin (low level, configurable debouncing)
- WKUPEN0-15 pins (level transition, configurable debouncing)
- SM alarm
- RTC alarm
- RTT alarm

### 5.5.2 Wait Mode

The purpose of the wait mode is to achieve very low power consumption while maintaining the whole device in a powered state for a startup time of less than 10  $\mu$ s.

In this mode, the clocks of the core, peripherals and memories are stopped. However, the core, peripherals and memories power supplies are still powered. From this mode, a fast start up is available.

This mode is entered via Wait for Event (WFE) instructions with LPM = 1 (Low Power Mode bit in PMC\_FSMR). The Cortex-M3 is able to handle external events or internal events in order to wake-up the core (WFE). By configuring the external lines WKUP0-15 as fast startup wake-up pins (refer to [Section 5.7 “Fast Start-Up”](#)). RTC or RTT Alarm and USB wake-up events can be used to wake up the CPU (exit from WFE).

Current Consumption in Wait mode is typically 15  $\mu$ A on VDDIN if the internal voltage regulator is used or 8  $\mu$ A on VDDCORE if an external regulator is used.

Entering Wait Mode:

- Select the 4/8/12 MHz Fast RC Oscillator as Main Clock
- Set the LPM bit in the PMC Fast Startup Mode Register (PMC\_FSMR)
- Execute the Wait-For-Event (WFE) instruction of the processor

Note: Internal Main clock resynchronization cycles are necessary between the writing of MOSCRREN bit and the effective entry in Wait mode. Depending on the user application, Waiting for MOSCRREN bit to be cleared is recommended to ensure that the core will not execute undesired instructions.

### 5.5.3 Sleep Mode

The purpose of sleep mode is to optimize power consumption of the device versus response time. In this mode, only the core clock is stopped. The peripheral clocks can be enabled. This mode is entered via Wait for Interrupt (WFI) or Wait for Event (WFE) instructions with LPM = 0 in PMC\_FSMR.

The processor can be awakened from an interrupt if WFI instruction of the Cortex M3 is used, or from an event if the WFE instruction is used to enter this mode.

## 5.5.4 Low Power Mode Summary Table

The modes detailed above are the main low power modes. Each part can be set to on or off separately and wake up sources can be individually configured. Table 5-1 below shows a summary of the configurations of the low power modes.

**Table 5-1.** Low Power Mode Configuration Summary

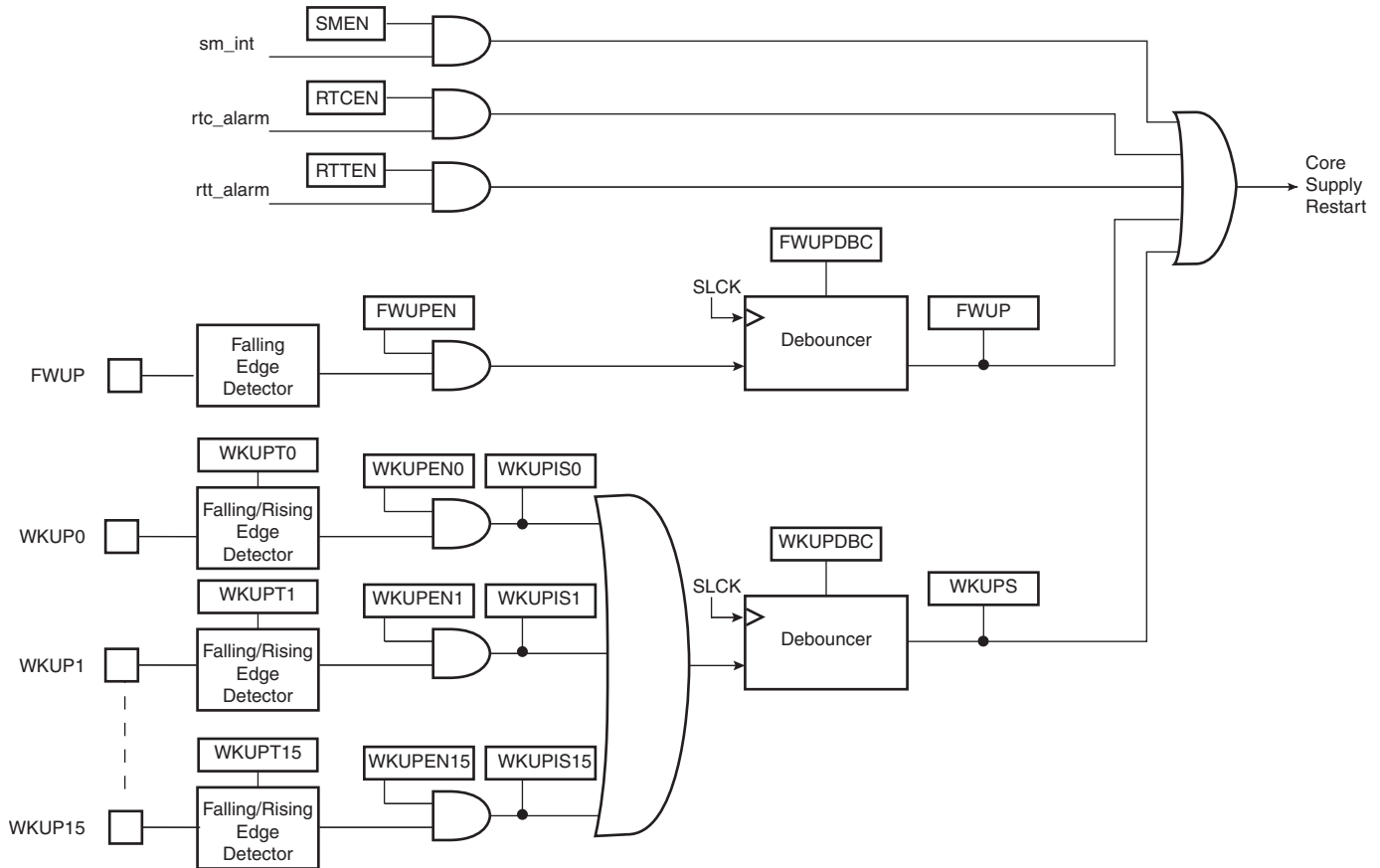
| Mode        | SUPC, 32 kHz Oscillator<br>RTC RTT Backup Registers, POR (VDDBU Region) | Regulator      | Core Memory<br>Peripherals              | Mode Entry                                       | Potential Wake Up Sources  | Core at Wake Up | PIO State while in Low Power Mode | PIO State at Wake Up                       | Consumption <sup>(2) (3)</sup>      | Wake-up Time <sup>(1)</sup> |
|-------------|---|----------------|---|--|--|-----------------|-----------------------------------|--|-------------------------------------|-----------------------------|
| Backup Mode | ON  | OFF<br>SHDN =0 | OFF<br>(Not powered)                    | WFE<br>+SLEEPDEEP bit = 1                        | FWUP pin<br>WKUP0-15 pins<br>BOD alarm<br>RTC alarm<br>RTT alarm   | Reset           | Previous state saved              | PIOA & PIOB & PIOC<br>Inputs with pull ups | 2.5 $\mu$ A typ <sup>(4)</sup>      | < 0.5 ms                    |
| Wait Mode   | ON  | ON<br>SHDN =1  | Powered<br>(Not clocked)                | WFE<br>+SLEEPDEEP bit = 0<br>+LPM bit = 1        | Any Event from: Fast startup through<br>WKUP0-15 pins<br>RTC alarm<br>RTT alarm<br>USB wake-up   | Clocked back    | Previous state saved              | Unchanged                                  | 8 $\mu$ A/15 $\mu$ A <sup>(5)</sup> | < 10 $\mu$ s                |
| Sleep Mode  | ON  | ON<br>SHDN =1  | Powered <sup>(7)</sup><br>(Not clocked) | WFE or WFI<br>+SLEEPDEEP bit = 0<br>+LPM bit = 0 | Entry mode =WFI<br>Interrupt Only; Entry mode =WFE<br>Any Enabled Interrupt and/or Any Event from: Fast start-up through<br>WKUP0-15 pins<br>RTC alarm<br>RTT alarm<br>USB wake-up | Clocked back    | Previous state saved              | Unchanged <sup>(6)</sup>                   | <sup>(6)</sup>                      | <sup>(6)</sup>              |

- Notes:
1. When considering wake-up time, the time required to start the PLL is not taken into account. Once started, the device works with the 4/8/12 MHz Fast RC oscillator. The user has to add the PLL start-up time if it is needed in the system. The wake-up time is defined as the time taken for wake up until the first instruction is fetched.
  2. The external loads on PIOs are not taken into account in the calculation.
  3. BOD current consumption is not included.
  4. Current consumption on VDDBU.
  5. 8  $\mu$ A total current consumption - **without** using internal voltage regulator.  
15  $\mu$ A total current consumption - **using** internal voltage regulator.
  6. Depends on MCK frequency.
  7. In this mode the core is supplied and not clocked but some peripherals can be clocked.

## 5.6 Wake-up Sources

The wake-up events allow the device to exit backup mode. When a wake-up event is detected, the Supply Controller performs a sequence which automatically reenables the core power supply.

**Figure 5-4.** Wake-up Source

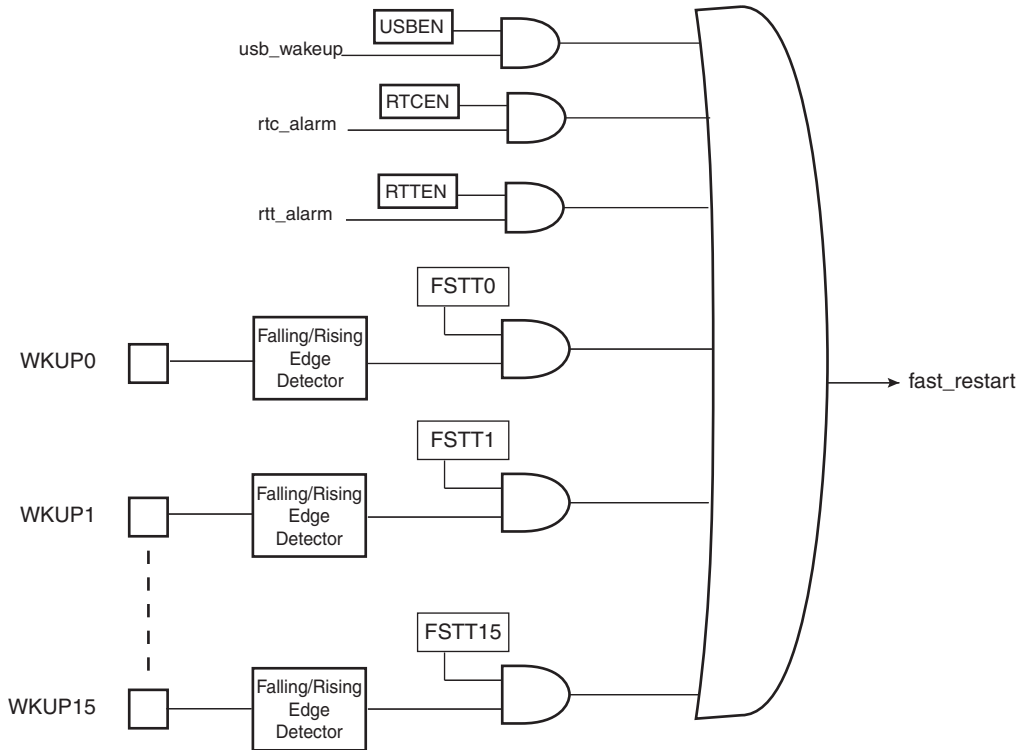


### 5.7 Fast Start-Up

The SAM3U allows the processor to restart in a few microseconds while the processor is in wait mode. A fast start up can occur upon detection of a low level on one of the 19 wake-up inputs.

The fast restart circuitry, as shown in Figure 5-5, is fully asynchronous and provides a fast start-up signal to the Power Management Controller. As soon as the fast start-up signal is asserted, the PMC automatically restarts the embedded 4/8/12 MHz fast RC oscillator, switches the master clock on this 4/8/12 MHz clock and reenables the processor clock.

Figure 5-5. Fast Start-Up Sources



## 6. Input/Output Lines

The SAM3U has different kinds of input/output (I/O) lines, such as general purpose I/Os (GPIO) and system I/Os. GPIOs can have alternate functions thanks to multiplexing capabilities of the PIO controllers. The same GPIO line can be used whether it is in IO mode or used by the multiplexed peripheral. System I/Os are pins such as test pin, oscillators, erase pin, analog inputs or debug pins.

With a few exceptions, the I/Os have input schmitt triggers. Refer to the footnotes associated with “PIO Controller - PIOA - PIOB - PIOC” on page 6 within Table 3-1, “Signal Description List”.

### 6.1 General Purpose I/O Lines (GPIO)

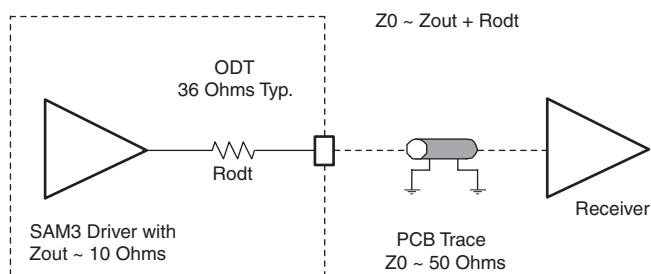
GPIO Lines are managed by PIO Controllers. All I/Os have several input or output modes such as, pull-up, input schmitt triggers, multi-drive (open-drain), glitch filters, debouncing or input change interrupt. Programming of these modes is performed independently for each I/O line through the PIO controller user interface. For more details, refer to the “PIO Controller” section of the product datasheet.

The input output buffers of the PIO lines are supplied through VDDIO power supply rail.

The SAM3U embeds high speed pads able to handle up to 65 MHz for HSMCI and SPI clock lines and 35 MHz on other lines. See “AC Characteristics” of the product datasheet for more details. Typical pull-up value is 100 kΩ for all I/Os.

Each I/O line also embeds an ODT (On-Die Termination), (see Figure 6-1 below). ODT consists of an internal series resistor termination scheme for impedance matching between the driver output (SAM3) and the PCB track impedance preventing signal reflection. The series resistor helps to reduce I/Os switching current (di/dt) thereby reducing in turn, EMI. It also decreases overshoot and undershoot (ringing) due to inductance of interconnect between devices or between boards. In conclusion, ODT helps reducing signal integrity issues.

**Figure 6-1.** On-Die Termination schematic



### 6.2 System I/O Lines

System I/O lines are pins used by oscillators, test mode, reset, flash erase and JTAG to name but a few.

### 6.3 Serial Wire JTAG Debug Port (SWJ-DP)

The SWJ-DP pins are TCK/SWCLK, TMS/SWDIO, TDO/SWO, TDI and commonly provided on a standard 20-pin JTAG connector defined by ARM. For more details about voltage reference and reset state, refer to Table 3-1, “Signal Description List”



The JTAGSEL pin is used to select the JTAG boundary scan when asserted at a high level. It integrates a permanent pull-down resistor of about 15 k $\Omega$  to GNDBU, so that it can be left unconnected for normal operations.

By default, the JTAG Debug Port is active. If the debugger host wants to switch to the Serial Wire Debug Port, it must provide a dedicated JTAG sequence on TMS/SWDIO and TCK/SWCLK which disables the JTAG-DP and enables the SW-DP. When the Serial Wire Debug Port is active, TDO/TRACESWO can be used for trace.

The asynchronous TRACE output (TRACESWO) is multiplexed with TDO. So the asynchronous trace can only be used with SW-DP, not JTAG-DP.

All the JTAG signals are supplied with VDDIO except JTAGSEL, supplied by VDDBU.

## 6.4 Test Pin

The TST pin is used for JTAG Boundary Scan Manufacturing Test or fast flash programming mode of the SAM3U series. The TST pin integrates a permanent pull-down resistor of about 15 k $\Omega$  to GND, so that it can be left unconnected for normal operations. To enter fast programming mode, see the “Fast Flash Programming Interface” section of the product datasheet. For more on the manufacturing and test mode, refer to the “Debug and Test” section of the product datasheet.

## 6.5 NRST 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. It will reset the Core and the peripherals, except the Backup region (RTC, RTT and Supply Controller). There is no constraint on the length of the reset pulse and the reset controller can guarantee a minimum pulse length.

The NRST pin integrates a permanent pull-up resistor to VDDIO of about 100 k $\Omega$ .

## 6.6 NRSTB Pin

The NRSTB pin is input only and enables asynchronous reset of the SAM3U when asserted low. The NRSTB pin integrates a permanent pull-up resistor of about 15 k $\Omega$ . This allows connection of a simple push button on the NRSTB pin as a system-user reset. In all modes, this pin will reset the chip including the Backup region (RTC, RTT and Supply Controller). It reacts as the Power-on reset. It can be used as an external system reset source. In harsh environments, it is recommended to add an external capacitor (10 nF) between NRSTB and VDDBU. (For filtering values refer to “I/O Characteristics” in the “Electrical Characteristics” section of the product datasheet.)

It embeds an anti-glitch filter.

## 6.7 ERASE Pin

The ERASE pin is used to reinitialize the Flash content and some of its NVM bits. It integrates a permanent pull-down resistor of about 15 k $\Omega$  to GND, so that it can be left unconnected for normal operations.

This pin is debounced by SCLK to improve the glitch tolerance. When the ERASE pin is tied high during less than 100 ms, it is not taken into account. The pin must be tied high during more than 220 ms to perform the reinitialization of the Flash.

Even in all low power modes, asserting the pin will automatically start-up the chip and erase the Flash.

## 7. Processor and Architecture

### 7.1 ARM Cortex-M3 Processor

- Version 2.0
- Thumb-2 (ISA) subset consisting of all base Thumb-2 instructions, 16-bit and 32-bit.
- Harvard processor architecture enabling simultaneous instruction fetch with data load/store.
- Three-stage pipeline.
- Single cycle 32-bit multiply.
- Hardware divide.
- Thumb and Debug states.
- Handler and Thread modes.
- Low latency ISR entry and exit.

### 7.2 APB/AHB Bridges

The SAM3U product embeds two separated APB/AHB bridges:

- low speed bridge
- high speed bridge

This architecture enables to make concurrent accesses on both bridges.

All the peripherals are on the low-speed bridge except SPI, SSC and HSMCI.

The UART, 10-bit ADC (ADC), 12-bit ADC (ADC12B), TWI0-1, USART0-3, PWM have dedicated channels for the Peripheral DMA Channels (PDC). These peripherals can not use the DMA Controller.

The high speed bridge regroupes the SSC, SPI and HSMCI. These three peripherals do not have PDC channels but can use the DMA with the internal FIFO for Channel buffering.

Note that the peripherals of the two bridges are clocked by the same source: MCK.

### 7.3 Matrix Masters

The Bus Matrix of the SAM3U device manages 5 masters, which means that each master can perform an access concurrently with others to an available slave.

Each master has its own decoder and specifically defined bus. In order to simplify the addressing, all the masters have the same decoding.

**Table 7-1.** List of Bus Matrix Masters

|          |                                 |
|----------|---------------------------------|
| Master 0 | Cortex-M3 Instruction/Data      |
| Master 1 | Cortex-M3 System                |
| Master 2 | Peripheral DMA Controller (PDC) |
| Master 3 | USB Device High Speed DMA       |
| Master 4 | DMA Controller                  |

## 7.4 Matrix Slaves

The Bus Matrix of the SAM3U manages 10 slaves. Each slave has its own arbiter, allowing a different arbitration per slave.

**Table 7-2.** List of Bus Matrix Slaves

|         |   |
|---------|---|
| Slave 0 | Internal SRAM0                            |
| Slave 1 | Internal SRAM1                            |
| Slave 2 | Internal ROM                              |
| Slave 3 | Internal Flash 0                          |
| Slave 4 | Internal Flash 1                          |
| Slave 5 | USB Device High Speed Dual Port RAM (DPR) |
| Slave 6 | NAND Flash Controller RAM                 |
| Slave 7 | External Bus Interface                    |
| Slave 8 | Low Speed Peripheral Bridge               |
| Slave 9 | High Speed Peripheral Bridge              |

## 7.5 Master to Slave Access

All the Masters can normally access all the Slaves. However, some paths do not make sense, for example allowing access from the USB Device High speed DMA to the Internal Peripherals. Thus, these paths are forbidden or simply not wired, and shown as “–” in [Table 7-3](#) below.

**Table 7-3.** SAM3U Master to Slave Access

| Slaves | Masters                                   | 0                 | 1               | 2   | 3                         | 4              |
|--------|---|-------------------|-----------------|-----|---------------------------|----------------|
|        |   | Cortex-M3 I/D Bus | Cortex-M3 S Bus | PDC | USB Device High Speed DMA | DMA Controller |
| 0      | Internal SRAM0                            | –                 | X               | X   | X                         | X              |
| 1      | Internal SRAM1                            | –                 | X               | X   | X                         | X              |
| 2      | Internal ROM                              | X                 | –               | X   | X                         | X              |
| 3      | Internal Flash 0                          | X                 | –               | –   | –                         | –              |
| 4      | Internal Flash 1                          | X                 | –               | –   | –                         | –              |
| 5      | USB Device High Speed Dual Port RAM (DPR) | –                 | X               | –   | –                         | –              |
| 6      | NAND Flash Controller RAM                 | –                 | X               | X   | X                         | X              |
| 7      | External Bus Interface                    | –                 | X               | X   | X                         | X              |
| 8      | Low Speed Peripheral Bridge               | –                 | X               | X   | –                         | –              |
| 9      | High Speed Peripheral Bridge              | –                 | X               | X   | –                         | –              |

## 7.6 DMA Controller

- Acting as one Matrix Master
- Embeds 4 channels:
  - 3 channels with 8 bytes/FIFO for Channel Buffering
  - 1 channel with 32 bytes/FIFO for Channel Buffering
- Linked List support with Status Write Back operation at End of Transfer
- Word, HalfWord, Byte transfer support.
- Handles high speed transfer of SPI, SSC and HSMCI (peripheral to memory, memory to peripheral)
- Memory to memory transfer
- Can be triggered by PWM and T/C which enables to generate waveforms through the External Bus Interface

The DMA controller can handle the transfer between peripherals and memory and so receives the triggers from the peripherals listed below. The hardware interface numbers are also given in [Table 7-4](#) below.

**Table 7-4.** DMA Controller

| Instance name                         | Channel T/R      | DMA Channel HW interface Number |
|---------------------------------------|------------------|---------------------------------|
| HSMCI                                 | Transmit/Receive | 0                               |
| SPI                                   | Transmit         | 1                               |
| SPI                                   | Receive          | 2                               |
| SSC                                   | Transmit         | 3                               |
| SSC                                   | Receive          | 4                               |
| PWM Event Line 0                      | Trigger          | 5                               |
| PWM Event Line 1                      | Trigger          | 6                               |
| TIO Output of Timer Counter Channel 0 | Trigger          | 7                               |

## 7.7 Peripheral DMA Controller

- Handles data transfer between peripherals and memories
- Nineteen channels
  - Two for each USART
  - Two for the UART
  - Two for each Two Wire Interface
  - One for the PWM
  - 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 requirement

The Peripheral DMA Controller handles transfer requests from the channel according to the following priorities (Low to High priorities):

**Table 7-5.** Peripheral DMA Controller

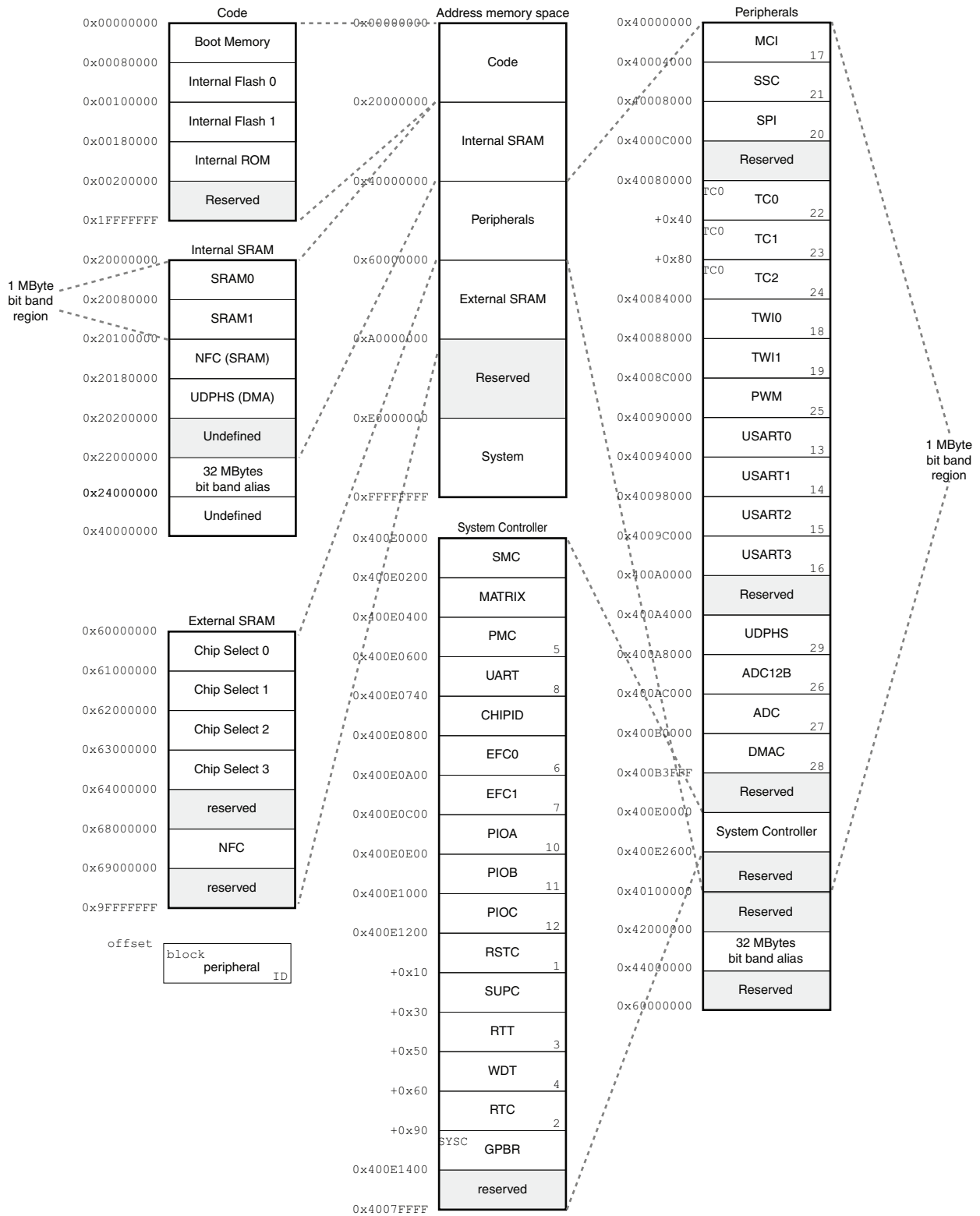
| Instance name | Channel T/R |
|---------------|-------------|
| TWI1          | Transmit    |
| TWI0          | Transmit    |
| PWM           | Transmit    |
| UART          | Transmit    |
| USART3        | Transmit    |
| USART2        | Transmit    |
| USART1        | Transmit    |
| USART0        | Transmit    |
| TWI0          | Receive     |
| TWI1          | Receive     |
| UART          | Receive     |
| USART3        | Receive     |
| USART2        | Receive     |
| USART1        | Receive     |
| USART0        | Receive     |
| ADC           | Receive     |
| ADC12B        | Receive     |

## 7.8 Debug and Test Features

- Debug access to all memory and registers in the system, including Cortex-M3 register bank when the core is running, halted, or held in reset.
- Serial Wire Debug Port (SW-DP) and Serial Wire JTAG Debug Port (SWJ-DP) debug access
- Flash Patch and Breakpoint (FPB) unit for implementing break points and code patches
- Data Watchpoint and Trace (DWT) unit for implementing watch points, data tracing, and system profiling
- Instrumentation Trace Macrocell (ITM) for support of printf style debugging
- IEEE® 1149.1 JTAG Boundary-scan on all digital pins

## 8. Product Mapping

Figure 8-1. SAM3U Memory Mapping



## 9. Memories

The embedded and external memories are described below.

### 9.1 Embedded Memories

#### 9.1.1 Internal SRAM

The SAM3U4 (256 KBytes internal Flash version) embeds a total of 48 Kbytes high-speed SRAM (32 Kbytes SRAM0 and 16 Kbytes SRAM1).

The SAM3U2 (128 KBytes internal Flash version) embeds a total of 32 Kbytes high-speed SRAM (16 Kbytes SRAM0 and 16 Kbytes SRAM1).

The SAM3U1 (64 KBytes internal Flash version) embeds a total of 16 Kbytes high-speed SRAM (8 Kbytes SRAM0 and 8 Kbytes SRAM1).

The SRAM0 is accessible over System Cortex-M3 bus at address 0x2000 0000 and SRAM1 at address 0x2008 0000. The user can see the SRAM as contiguous.

The SRAM0 and SRAM1 are in the bit band region. The bit band alias region is from 0x2200 0000 and 0x23FF FFFF.

The NAND Flash Controller embeds 4224 bytes of internal SRAM. If the NAND Flash controller is not used, these 4224 Kbytes of SRAM can be used as general purpose. It can be seen at address 0x2010 0000.

#### 9.1.2 Internal ROM

The SAM3U product embeds an Internal ROM, which contains the SAM-BA Boot and FFPI program.

At any time, the ROM is mapped at address 0x0018 0000.

#### 9.1.3 Embedded Flash

##### 9.1.3.1 Flash Overview

The Flash of the SAM3U4 (256 KBytes internal Flash version) is organized in two banks of 512 pages (dual plane) of 256 bytes.

The Flash of the SAM3U2 (128 KBytes internal Flash version) is organized in one bank of 512 pages (single plane) of 256 bytes.

The Flash of the SAM3U1 (256 KBytes internal Flash version) is organized in one bank of 256 pages (single plane) of 256 bytes.

The Flash contains a 128-byte write buffer, accessible through a 32-bit interface.

##### 9.1.3.2 Flash Power Supply

The Flash is supplied by VDDCORE.

##### 9.1.3.3 Enhanced Embedded Flash Controller

The Enhanced Embedded Flash Controller (EEFC) 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 Enhanced Embedded Flash Controller ensures the interface of the Flash block with the 32-bit internal bus. Its 128-bit wide memory interface increases performance.

The user can choose between high performance or lower current consumption by selecting either 128-bit or 64-bit access. It also manages the programming, erasing, locking and unlocking sequences of the Flash using a full set of commands.

One of the commands returns the embedded Flash descriptor definition that informs the system about the Flash organization, thus making the software generic.

The SAM3U4 (256 KBytes internal Flash version) embeds two EEFC (EEFC0 for Flash0 and EEFC1 for Flash1) whereas the SAM3U2/1 embeds one EEFC.

#### 9.1.3.4 Lock Regions

In the **SAM3U4** (256 KBytes internal Flash version) two Enhanced Embedded Flash Controllers each manage 16 lock bits to protect 32 regions of the flash against inadvertent flash erasing or programming commands.

The **SAM3U4** (256 KBytes internal Flash version) contains 32 lock regions and each lock region contains 32 pages of 256 bytes. Each lock region has a size of 8 Kbytes.

The **SAM3U2** (128 KBytes internal Flash version) Enhanced Embedded Flash Controller manages 16 lock bits to protect 32 regions of the flash against inadvertent flash erasing or programming commands.

The **SAM3U2** (128 KBytes internal Flash version) contains 16 lock regions and each lock region contains 32 pages of 256 bytes. Each lock region has a size of 8 Kbytes.

The **SAM3U1** (64 KBytes internal Flash version) Embedded Flash Controller manages 8 lock bits to protect 8 regions of the flash against inadvertent flash erasing or programming commands.

The **SAM3U1** (64 KBytes internal Flash version) contains 8 lock regions and each lock region contains 32 pages of 256 bytes. Each lock region has a size of 8 Kbytes.

If a locked-region's erase or program command occurs, the command is aborted and the EEFC triggers an interrupt.

The lock bits are software programmable through the EEFC User Interface. The command "Set Lock Bit" enables the protection. The command "Clear Lock Bit" unlocks the lock region.

Asserting the ERASE pin clears the lock bits, thus unlocking the entire Flash.

#### 9.1.3.5 Security Bit Feature

The SAM3U features a security bit, based on a specific General Purpose NVM bit (GPNVM bit 0). When the security is enabled, any access to the Flash, SRAM, Core Registers and Internal Peripherals either through the ICE interface or through the Fast Flash Programming Interface, is forbidden. This ensures the confidentiality of the code programmed in the Flash.

This security bit can only be enabled, through the command "Set General Purpose NVM Bit 0" of the EEFC User Interface. Disabling the security bit can only be achieved by asserting the ERASE pin at 1, and after a full Flash erase is performed. When the security bit is deactivated, all accesses to the Flash, SRAM, Core Registers and Internal Peripherals either through the ICE interface or through the Fast Flash Programming Interface are permitted.

It is important to note that the assertion of the ERASE pin should always be longer than 200 ms. As the ERASE pin integrates a permanent pull-down, it can be left unconnected during normal operation. However, it is safer to connect it directly to GND for the final application.



## 9.1.3.6 Calibration Bits

NVM bits are used to calibrate the brownout detector and the voltage regulator. These bits are factory configured and cannot be changed by the user. The ERASE pin has no effect on the calibration bits.

## 9.1.3.7 Unique Identifier

Each device integrates its own 128-bit unique identifier. These bits are factory configured and cannot be changed by the user. The ERASE pin has no effect on the unique identifier.

## 9.1.3.8 Fast Flash Programming Interface

The Fast Flash Programming Interface allows programming the device through either a serial JTAG interface or through a multiplexed fully-handshaked parallel port. It allows gang programming with market-standard industrial programmers.

The FFPI supports read, page program, page erase, full erase, lock, unlock and protect commands.

The Fast Flash Programming Interface is enabled and the Fast Programming Mode is entered when TST, NRSTB and FWUP pins are tied high during power up sequence and if all supplies are provided externally (do not use internal regulator for VDDCORE). Please note that since the FFPI is a part of the SAM-BA Boot Application, the device must boot from the ROM.

## 9.1.3.9 SAM-BA<sup>®</sup> Boot

The SAM-BA Boot is a default Boot Program which provides an easy way to program in-situ the on-chip Flash memory.

The SAM-BA Boot Assistant supports serial communication via the UART and USB.

The SAM-BA Boot provides an interface with SAM-BA Graphic User Interface (GUI).

The SAM-BA Boot is in ROM and is mapped in Flash at address 0x0 when GPNVM bit 1 is set to 0.

## 9.1.3.10 GPNVM Bits

The SAM3U features three GPNVM bits that can be cleared or set respectively through the commands “Clear GPNVM Bit” and “Set GPNVM Bit” of the EEFC User Interface.

The SAM3U4 is equipped with two EEFC, EEFC0 and EEFC1. EEFC1 does not feature the GPNVM bits. The GPNVM embedded on EEFC0 applies to the two blocks in the SAM3U4.

**Table 9-1.** General-purpose Non-volatile Memory Bits

| GPNVMBit[#] | Function  |
|-------------|---|
| 0           | Security bit  |
| 1           | Boot mode selection   |
| 2           | Flash selection (Flash 0 or Flash 1) Only on SAM3U4 (256 Kbytes internal Flash version) |

## 9.1.4 Boot Strategies

The system always boots at address 0x0. To ensure a maximum boot possibilities the memory layout can be changed via GPNVM.

A general purpose NVM (GPNVM1) bit is used to boot either on the ROM (default) or from the Flash.

The GPNVM bit can be cleared or set respectively through the commands “Clear General-purpose NVM Bit” and “Set General-purpose NVM Bit” of the EEFC User Interface.

Setting the GPNVM Bit 1 selects the boot from the Flash, clearing it selects the boot from the ROM. Asserting ERASE clears the GPNVM Bit 1 and thus selects the boot from the ROM by default.

GPNVM2 enables to select if Flash 0 or Flash 1 is used for the boot. Setting the GPNVM2 bit selects the boot from Flash 1, clearing it selects the boot from Flash 0.

## 9.2 External Memories

The SAM3U offers an interface to a wide range of external memories and to any parallel peripheral.

### 9.2.1 Static Memory Controller

- 8- or 16- bit Data Bus
- Up to 24-bit Address Bus (up to 16 MBytes linear per chip select)
- Up to 4 chips selects, Configurable Assignment
- Multiple Access Modes supported
  - Byte Write or Byte Select Lines
- Multiple device adaptability
  - Control signals programmable setup, pulse and hold time for each Memory Bank
- Multiple Wait State Management
  - Programmable Wait State Generation
  - External Wait Request
  - Programmable Data Float Time
- Slow Clock mode supported

### 9.2.2 NAND Flash Controller

- Handles automatic Read/Write transfer through 4224 bytes SRAM buffer
- DMA support
- Supports SLC NAND Flash technology
- Programmable timing on a per chip select basis
- Programmable Flash Data width 8-bit or 16-bit

### 9.2.3 NAND Flash Error Corrected Code Controller

- Integrated in the NAND Flash Controller
- Single bit error correction and 2-bit Random detection.
- Automatic Hamming Code Calculation while writing
  - ECC value available in a register
- Automatic Hamming Code Calculation while reading
  - Error Report, including error flag, correctable error flag and word address being detected erroneous

- Supports 8- or 16-bit NAND Flash devices with 512-, 1024-, 2048- or 4096-byte pages

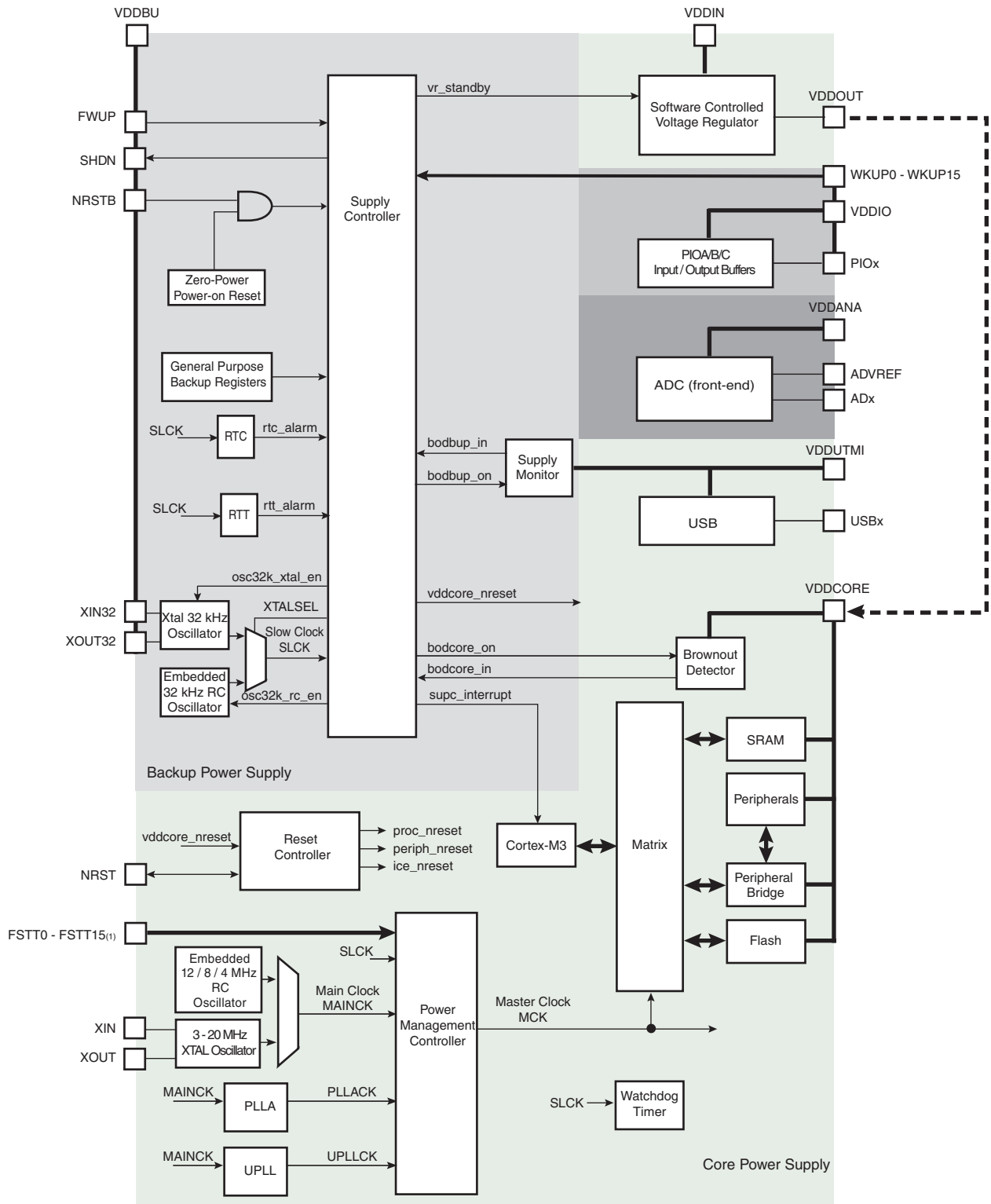
## 10. System Controller

The System Controller is a set of peripherals, which allow handling of key elements of the system, such as power, resets, clocks, time, interrupts, watchdog, etc...

The System Controller User Interface also embeds the registers used to configure the Matrix.

See the system controller block diagram in [Figure 10-1 on page 37](#).

Figure 10-1. System Controller Block Diagram



FSTT0 - FSTT15 are possible Fast Startup Sources, generated by WKUP0-WKUP15 Pins, but are not physical pins.

## 10.1 System Controller and Peripheral Mapping

Please refer to [Figure 8-1 “SAM3U Memory Mapping” on page 30](#) .

All the peripherals are in the bit band region and are mapped in the bit band alias region.

## 10.2 Power-on-Reset, Brownout and Supply Monitor

The SAM3U embeds three features to monitor, warn and/or reset the chip:

- Power-on-Reset on VDDDBU
- Brownout Detector on VDDCORE
- Supply Monitor on VDDUTMI

### 10.2.1 Power-on-Reset on VDDDBU

The Power-on-Reset monitors VDDDBU. It is always activated and monitors voltage at start up but also during power down. If VDDDBU goes below the threshold voltage, the entire chip is reset. For more information, refer to the “Electrical Characteristics” section of the datasheet.

### 10.2.2 Brownout Detector on VDDCORE

The Brownout Detector monitors VDDCORE. It is active by default. It can be deactivated by software through the Supply Controller (SUPC\_MR). It is especially recommended to disable it during low-power modes such as wait or sleep modes.

If VDDCORE goes below the threshold voltage, the reset of the core is asserted. For more information, refer to the “Supply Controller” and “Electrical Characteristics” sections of the product datasheet.

### 10.2.3 Supply Monitor on VDDUTMI

The Supply Monitor monitors VDDUTMI. It is not active by default. It can be activated by software and is fully programmable with 16 steps for the threshold (between 1.9V to 3.4V). It is controlled by the Supply Controller. A sample mode is possible. It allows to divide the supply monitor power consumption by a factor of up to 2048. For more information, refer to the “Supply Controller” and “Electrical Characteristics” sections of the product datasheet.

## 10.3 Reset Controller

The Reset Controller is capable to return to the software the source of the last reset, either a general reset, a wake-up reset, a software reset, a user reset or a watchdog reset.

The Reset Controller controls the internal resets of the system and the NRST pin output. It is capable to shape a reset signal for the external devices, simplifying to a minimum connection of a push-button on the NRST pin to implement a manual reset.

## 10.4 Supply Controller

The Supply Controller controls the power supplies of each section of the processor and the peripherals (via Voltage regulator control).

The Supply Controller has its own reset circuitry and is clocked by the 32 kHz Slow clock generator.

The reset circuitry is based on a zero-power power-on reset cell. The zero-power power-on reset allows the Supply Controller to start properly.

The Slow Clock generator is based on a 32 kHz crystal oscillator and an embedded 32 kHz RC oscillator. The Slow Clock defaults to the RC oscillator, but the software can enable the crystal oscillator and select it as the Slow Clock source.

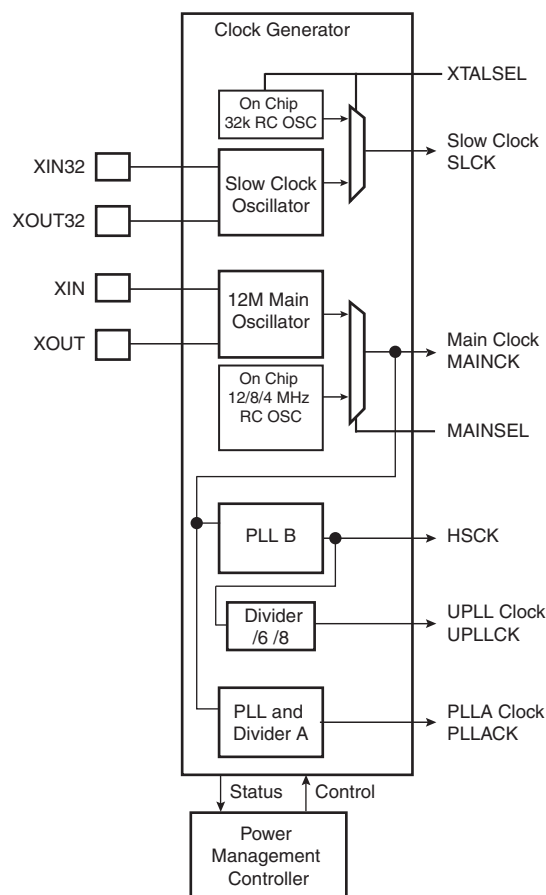
The Supply Controller starts up the device by enabling the Voltage Regulator, then it generates the proper reset signals to the core power supply. It also enables to set the system in different low power modes and to wake it up from a wide range of events.

## 10.5 Clock Generator

The Clock Generator is made up of:

- One Low Power 32768 Hz Slow Clock Oscillator with bypass mode
- One Low Power RC Oscillator
- One 3 to 20 MHz Crystal Oscillator, which can be bypassed
- One Fast RC Oscillator factory programmed, 3 output frequencies can be selected: 4, 8 or 12 MHz. By default 4 MHz is selected. 8 MHz and 12 MHz output are factory calibrated.
- One 480 MHz UPLL providing a clock for the USB High Speed Device Controller. Input frequency is 12 MHz (only).
- One 96 to 192 MHz programmable PLL (PLL A), capable to provide the clock MCK to the processor and to the peripherals. The input frequency of the PLL A is between 8 and 16 MHz.

**Figure 10-2.** Clock Generator Block Diagram



## 10.6 Power Management Controller

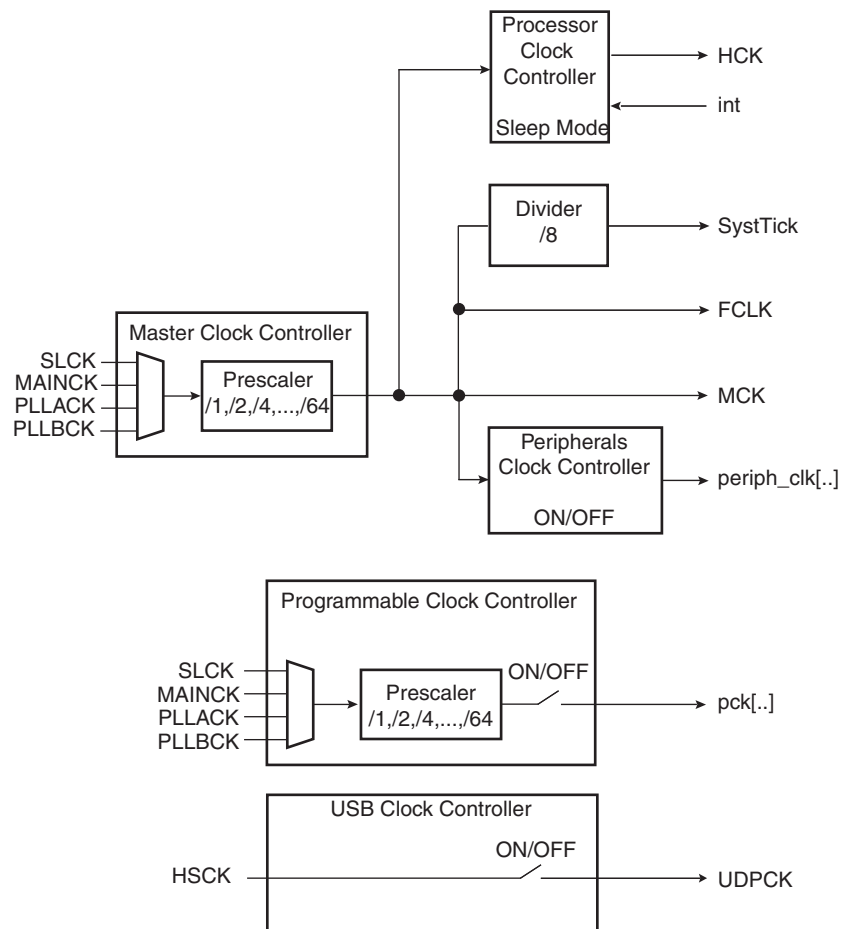
The Power Management Controller provides all the clock signals to the system. It provides:

- the Processor Clock HCLK
- the Free running processor clock FCLK
- the Cortex SysTick external clock
- the Master Clock MCK, in particular to the Matrix and the memory interfaces
- the USB Device HS Clock UDPCK
- independent peripheral clocks, typically at the frequency of MCK
- three programmable clock outputs: PCK0, PCK1 and PCK2

The Supply Controller selects between the 32 kHz RC oscillator or the crystal oscillator. The unused oscillator is disabled automatically so that power consumption is optimized.

By default, at startup the chip runs out of the Master Clock using the Fast RC Oscillator running at 4 MHz.

**Figure 10-3.** Power Management Controller Block Diagram



The SysTick calibration value is fixed at 10500, which allows the generation of a time base of 1 ms with SysTick clock to 10.5 MHz (max HCLK/8).



## 10.7 Watchdog Timer

- 16-bit key-protected once-only Programmable Counter
- Windowed, prevents the processor to be in a dead-lock on the watchdog access

## 10.8 SysTick Timer

- 24-bit down counter
- Self-reload capability
- Flexible system timer

## 10.9 Real-time Timer

- Real-time Timer, allowing backup of time with different accuracies
  - 32-bit Free-running back-up Counter
  - Integrates a 16-bit programmable prescaler running on slow clock
  - Alarm Register capable to generate a wake-up of the system

## 10.10 Real-time Clock

- Low power consumption
- Full asynchronous design
- Two hundred year calendar
- Programmable Periodic Interrupt
- Alarm and update parallel load
- Control of alarm and update Time/Calendar Data In

## 10.11 General-Purpose Back-up Registers

- Eight 32-bit general-purpose backup registers

## 10.12 Nested Vectored Interrupt Controller

- Thirty maskable interrupts
- Sixteen priority levels
- Dynamic reprioritization of interrupts
- Priority grouping
  - selection of preempting interrupt levels and non preempting interrupt levels.
- Support for tail-chaining and late arrival of interrupts.
  - back-to-back interrupt processing without the overhead of state saving and restoration between interrupts.
- Processor state automatically saved on interrupt entry, and restored on
  - interrupt exit, with no instruction overhead.

## 10.13 Chip Identification

- Chip Identifier (CHIPID) registers permit recognition of the device and its revision.

**Table 10-1.** SAM3U Chip IDs Register - Engineering Samples

| Chip Name       | Flash Size<br>KByte | Pin Count | CHIPID_CIDR | CHIPID_EXID |
|-----------------|---------------------|-----------|-------------|-------------|
| SAM3U4C (Rev A) | 256                 | 100       | 0x28000960  | 0x0         |
| SAM3U2C (Rev A) | 128                 | 100       | 0x280A0760  | 0x0         |
| SAM3U1C (Rev A) | 64                  | 100       | 0x28090560  | 0x0         |
| SAM3U4E (Rev A) | 256                 | 144       | 0x28100960  | 0x0         |
| SAM3U2E (Rev A) | 128                 | 144       | 0x281A0760  | 0x0         |
| SAM3U1E (Rev A) | 64                  | 144       | 0x28190560  | 0x0         |

- JTAG ID: 0x0582A03F

**Table 10-2.** SAM3U Chip IDs Register - Revision A Parts

| Chip Name       | Flash Size<br>KByte | Pin Count | CHIPID_CIDR | CHIPID_EXID |
|-----------------|---------------------|-----------|-------------|-------------|
| SAM3U4C (Rev A) | 256                 | 100       | 0x28000961  | 0x0         |
| SAM3U2C (Rev A) | 128                 | 100       | 0x280A0761  | 0x0         |
| SAM3U1C (Rev A) | 64                  | 100       | 0x28090561  | 0x0         |
| SAM3U4E (Rev A) | 256                 | 144       | 0x28100961  | 0x0         |
| SAM3U2E (Rev A) | 128                 | 144       | 0x281A0761  | 0x0         |
| SAM3U1E (Rev A) | 64                  | 144       | 0x28190561  | 0x0         |

- JTAG ID: 0x0582A03F

## 10.14 PIO Controllers

- 3 PIO Controllers, PIOA, PIOB, and PIOC, controlling a maximum of 96 I/O Lines
- Each PIO Controller controls up to 32 programmable I/O Lines
  - PIOA has 32 I/O Lines
  - PIOB has 32 I/O Lines
  - PIOC has 32 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, rising edge, falling edge, low level and level interrupt
  - Debouncing and 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

## 11. Peripherals

### 11.1 Peripheral Identifiers

Table 11-1 defines the Peripheral Identifiers of the SAM3U. A peripheral identifier is required for the control of the peripheral interrupt with the Nested Vectored Interrupt Controller and for the control of the peripheral clock with the Power Management Controller.

Note that some Peripherals are always clocked. Please refer to the table below.

Table 11-1. Peripheral Identifiers

| Instance ID | Instance Name | NVIC Interrupt | PMC Clock Control | Instance Description                        |
|-------------|---------------|----------------|-------------------|---|
| 0           | SUPC          | X              |                   | Supply Controller                           |
| 1           | RSTC          | X              |                   | Reset Controller                            |
| 2           | RTC           | X              |                   | Real Time Clock                             |
| 3           | RTT           | X              |                   | Real Time Timer                             |
| 4           | WDT           | X              |                   | Watchdog Timer                              |
| 5           | PMC           | X              |                   | Power Management Controller                 |
| 6           | EEFC0         | X              |                   | Enhanced Embedded Flash Controller 0        |
| 7           | EEFC1         | X              |                   | Enhanced Embedded Flash Controller 1        |
| 8           | UART          | X              | X                 | Universal Asynchronous Receiver Transmitter |
| 9           | SMC           | X              | X                 | Static Memory Controller                    |
| 10          | PIOA          | X              | X                 | Parallel I/O Controller A,                  |
| 11          | PIOB          | X              | X                 | Parallel I/O Controller B                   |
| 12          | PIOC          | X              | X                 | Parallel I/O Controller C                   |
| 13          | USART0        | X              | X                 | USART 0                                     |
| 14          | USART1        | X              | X                 | USART 1                                     |
| 15          | USART2        | X              | X                 | USART 2                                     |
| 16          | USART3        | X              | X                 | USART 3                                     |
| 17          | HSMCI         | X              | X                 | High Speed Multimedia Card Interface        |
| 18          | TWI0          | X              | X                 | Two-Wire Interface 0                        |
| 19          | TWI1          | X              | X                 | Two-Wire Interface 1                        |
| 20          | SPI           | X              | X                 | Serial Peripheral Interface                 |
| 21          | SSC           | X              | X                 | Synchronous Serial Controller               |
| 22          | TC0           | X              | X                 | Timer Counter 0                             |
| 23          | TC1           | X              | X                 | Timer Counter 1                             |
| 24          | TC2           | X              | X                 | Timer Counter 2                             |
| 25          | PWM           | X              | X                 | Pulse Width Modulation Controller           |
| 26          | ADC12B        | X              | X                 | 12-bit ADC Controller                       |
| 27          | ADC           | X              | X                 | 10-bit ADC Controller                       |
| 28          | DMAC          | X              | X                 | DMA Controller                              |
| 29          | UDPHS         | X              | X                 | USB Device High Speed                       |

## 11.2 Peripheral Signal Multiplexing on I/O Lines

The SAM3U features 3 PIO controllers, PIOA, PIOB and PIOC that multiplex the I/O lines of the peripheral set.

Each PIO Controller controls up to 32 lines. Each line can be assigned to one of two peripheral functions, A or B. The multiplexing tables in the following pages define how the I/O lines of peripherals A and B are multiplexed on the PIO Controllers. The two columns “Extra Function” and “Comments” have been inserted in this table for the user’s own comments, they may be used to track how pins are defined in an application.

Note that some peripheral functions which are output only, might be duplicated within the tables.

## 11.2.1 PIO Controller A Multiplexing

**Table 11-2.** Multiplexing on PIO Controller A (PIOA)

| I/O Line | Peripheral A | Peripheral B | Extra Function           | Comments                |
|----------|--------------|--------------|--------------------------|-------------------------|
| PA0      | TIOB0        | NPCS1        | WKUP0 <sup>(1)(2)</sup>  |                         |
| PA1      | TIOA0        | NPCS2        | WKUP1 <sup>(1)(2)</sup>  |                         |
| PA2      | TCLK0        | AD12BTRG     | WKUP2 <sup>(1)(2)</sup>  |                         |
| PA3      | MCCK         | PCK1         |                          |                         |
| PA4      | MCCDA        | PWMH0        |                          |                         |
| PA5      | MCDA0        | PWMH1        |                          |                         |
| PA6      | MCDA1        | PWMH2        |                          |                         |
| PA7      | MCDA2        | PWML0        |                          |                         |
| PA8      | MCDA3        | PWML1        |                          |                         |
| PA9      | TWD0         | PWML2        | WKUP3 <sup>(1)(2)</sup>  |                         |
| PA10     | TWCK0        | PWML3        | WKUP4 <sup>(1)(2)</sup>  |                         |
| PA11     | URXD         | PWMFI0       |                          |                         |
| PA12     | UTXD         | PWMFI1       |                          |                         |
| PA13     | MISO         |              |                          |                         |
| PA14     | MOSI         |              |                          |                         |
| PA15     | SPCK         | PWMH2        |                          |                         |
| PA16     | NPCS0        | NCS1         | WKUP5 <sup>(1)(2)</sup>  |                         |
| PA17     | SCK0         | ADTRG        | WKUP6 <sup>(1)(2)</sup>  |                         |
| PA18     | TXD0         | PWMFI2       | WKUP7 <sup>(1)(2)</sup>  |                         |
| PA19     | RXD0         | NPCS3        | WKUP8 <sup>(1)(2)</sup>  |                         |
| PA20     | TXD1         | PWMH3        | WKUP9 <sup>(1)(2)</sup>  |                         |
| PA21     | RXD1         | PCK0         | WKUP10 <sup>(1)(2)</sup> |                         |
| PA22     | TXD2         | RTS1         | AD12B0                   |                         |
| PA23     | RXD2         | CTS1         |                          |                         |
| PA24     | TWD1         | SCK1         | WKUP11 <sup>(1)(2)</sup> | Only on 144-pin version |
| PA25     | TWCK1        | SCK2         | WKUP12 <sup>(1)(2)</sup> | Only on 144-pin version |
| PA26     | TD           | TCLK2        |                          |                         |
| PA27     | RD           | PCK0         |                          |                         |
| PA28     | TK           | PWMH0        |                          |                         |
| PA29     | RK           | PWMH1        |                          |                         |
| PA30     | TF           | TIOA2        | AD12B1                   |                         |
| PA31     | RF           | TIOB2        |                          |                         |

- Notes: 1. Wake-Up source in Backup mode (managed by the SUPC).  
2. Fast Start-Up source in Wait mode (managed by the PMC).

## 11.2.2 PIO Controller B Multiplexing

**Table 11-3.** Multiplexing on PIO Controller B (PIOB)

| I/O Line | Peripheral A | Peripheral B | Extra Function           | Comments                |
|----------|--------------|--------------|--------------------------|-------------------------|
| PB0      | PWMH0        | A2           | WKUP13 <sup>(1)(2)</sup> |                         |
| PB1      | PWMH1        | A3           | WKUP14 <sup>(1)(2)</sup> |                         |
| PB2      | PWMH2        | A4           | WKUP15 <sup>(1)(2)</sup> |                         |
| PB3      | PWMH3        | A5           | AD12B2                   |                         |
| PB4      | TCLK1        | A6           | AD12B3                   |                         |
| PB5      | TIOA1        | A7           | AD0                      |                         |
| PB6      | TIOB1        | D15          | AD1                      |                         |
| PB7      | RTS0         | A0/NBS0      | AD2                      |                         |
| PB8      | CTS0         | A1           | AD3                      |                         |
| PB9      | D0           | DTR0         |                          |                         |
| PB10     | D1           | DSR0         |                          |                         |
| PB11     | D2           | DCD0         |                          |                         |
| PB12     | D3           | RI0          |                          |                         |
| PB13     | D4           | PWMH0        |                          |                         |
| PB14     | D5           | PWMH1        |                          |                         |
| PB15     | D6           | PWMH2        |                          |                         |
| PB16     | D7           | PWMH3        |                          |                         |
| PB17     | NANDOE       | PWML0        |                          |                         |
| PB18     | NANDWE       | PWML1        |                          |                         |
| PB19     | NRD          | PWML2        |                          |                         |
| PB20     | NCS0         | PWML3        |                          |                         |
| PB21     | A21/NANDALE  | RTS2         |                          |                         |
| PB22     | A22/NANDCLE  | CTS2         |                          |                         |
| PB23     | NWR0/NWE     | PCK2         |                          |                         |
| PB24     | NANDRDY      | PCK1         |                          |                         |
| PB25     | D8           | PWML0        |                          | Only on 144-pin version |
| PB26     | D9           | PWML1        |                          | Only on 144-pin version |
| PB27     | D10          | PWML2        |                          | Only on 144-pin version |
| PB28     | D11          | PWML3        |                          | Only on 144-pin version |
| PB29     | D12          |              |                          | Only on 144-pin version |
| PB30     | D13          |              |                          | Only on 144-pin version |
| PB31     | D14          |              |                          | Only on 144-pin version |

Notes: 1. Wake-Up source in Backup mode (managed by the SUPC).  
 2. Fast Start-Up source in Wait mode (managed by the PMC).

### 11.2.3 PIO Controller C Multiplexing

**Table 11-4.** Multiplexing on PIO Controller C (PIOC)

| I/O Line | Peripheral A | Peripheral B | Extra function | Comments                |
|----------|--------------|--------------|----------------|-------------------------|
| PC0      | A2           |              |                | Only on 144-pin version |
| PC1      | A3           |              |                | Only on 144-pin version |
| PC2      | A4           |              |                | Only on 144-pin version |
| PC3      | A5           | NPCS1        |                | Only on 144-pin version |
| PC4      | A6           | NPCS2        |                | Only on 144-pin version |
| PC5      | A7           | NPCS3        |                | Only on 144-pin version |
| PC6      | A8           | PWML0        |                | Only on 144-pin version |
| PC7      | A9           | PWML1        |                | Only on 144-pin version |
| PC8      | A10          | PWML2        |                | Only on 144-pin version |
| PC9      | A11          | PWML3        |                | Only on 144-pin version |
| PC10     | A12          | CTS3         |                | Only on 144-pin version |
| PC11     | A13          | RTS3         |                | Only on 144-pin version |
| PC12     | NCS1         | TXD3         |                | Only on 144-pin version |
| PC13     | A2           | RXD3         |                | Only on 144-pin version |
| PC14     | A3           | NPCS2        |                | Only on 144-pin version |
| PC15     | NWR1/NBS1    |              | AD12B4         | Only on 144-pin version |
| PC16     | NCS2         | PWML3        | AD12B5         | Only on 144-pin version |
| PC17     | NCS3         |              | AD12B6         | Only on 144-pin version |
| PC18     | NWAIT        |              | AD12B7         | Only on 144-pin version |
| PC19     | SCK3         | NPCS1        |                | Only on 144-pin version |
| PC20     | A14          |              |                | Only on 144-pin version |
| PC21     | A15          |              |                | Only on 144-pin version |
| PC22     | A16          |              |                | Only on 144-pin version |
| PC23     | A17          |              |                | Only on 144-pin version |
| PC24     | A18          | PWMH0        |                | Only on 144-pin version |
| PC25     | A19          | PWMH1        |                | Only on 144-pin version |
| PC26     | A20          | PWMH2        |                | Only on 144-pin version |
| PC27     | A23          | PWMH3        |                | Only on 144-pin version |
| PC28     |              | MCDA4        | AD4            | Only on 144-pin version |
| PC29     | PWML0        | MCDA5        | AD5            | Only on 144-pin version |
| PC30     | PWML1        | MCDA6        | AD6            | Only on 144-pin version |
| PC31     | PWML2        | MCDA7        | AD7            | Only on 144-pin version |

- Notes: 1. Wake-Up source in Backup mode (managed by the SUPC).  
 2. Fast Start-Up source in Wait mode (managed by the PMC).



## 12. Embedded Peripherals Overview

### 12.1 Serial Peripheral Interface (SPI)

- Supports communication with serial external devices
  - Four chip selects with external decoder support 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 between consecutive transfers and between clock and data per chip select
  - Programmable delay between consecutive transfers
  - Selectable mode fault detection
- Very fast transfers supported
  - Transfers with baud rates up to MCK
  - The chip select line may be left active to speed up transfers on the same device

### 12.2 Two Wire Interface (TWI)

- Master, Multi-Master and Slave Mode Operation
- Compatibility with Atmel two-wire interface, serial memory and I<sup>2</sup>C compatible devices
- One, two or three bytes for slave address
- Sequential read/write operations
- Bit Rate: Up to 400 kbit/s
- General Call Supported in Slave Mode
- Connecting to PDC channel capabilities optimizes data transfers in Master Mode only
  - One channel for the receiver, one channel for the transmitter
  - Next buffer support

### 12.3 Universal Asynchronous Receiver Transceiver (UART)

- Two-pin UART
  - Implemented features are 100% compatible with the standard Atmel USART
  - Independent receiver and transmitter with a common programmable Baud Rate Generator
  - Even, Odd, Mark or Space Parity Generation
  - Parity, Framing and Overrun Error Detection
  - Automatic Echo, Local Loopback and Remote Loopback Channel Modes
  - Support for two PDC channels with connection to receiver and transmitter

## 12.4 Universal Synchronous Asynchronous Receiver Transmitter (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
  - Optional Manchester Encoding
- 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
- SPI Mode
  - Master or Slave
  - Serial Clock programmable Phase and Polarity
  - SPI Serial Clock (SCK) Frequency up to MCK/6
- IrDA modulation and demodulation
  - Communication at up to 115.2 Kbps
- Test Modes
  - Remote Loopback, Local Loopback, Automatic Echo

## 12.5 Serial Synchronous Controller (SSC)

- Provides serial synchronous communication links used in audio and telecom applications (with CODECs in Master or Slave Modes, I<sup>2</sup>S, TDM Buses, Magnetic Card Reader, ...)
- 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

## 12.6 Timer Counter (TC)

- 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
- Quadrature Decoder Logic
- Each channel is user-configurable and contains:
  - Three external clock inputs
  - Five internal clock inputs
  - Two multi-purpose input/output signals
- Two global registers that act on all three TC Channels

## 12.7 Pulse Width Modulation Controller (PWM)

- 4 channels, one 16-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
  - High Frequency Asynchronous clocking mode
- 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
  - Independent Output Override for each channel
  - Independent complementary Outputs with 12-bit dead time generator for each channel
  - Independent Enable Disable Commands
  - Independent Clock Selection
  - Independent Period and Duty Cycle, with Double Buffering
- Synchronous Channel mode
  - Synchronous Channels share the same counter
  - Mode to update the synchronous channels registers after a programmable number of periods
- Connection to one PDC channel
  - Offers Buffer transfer without Processor Intervention, to update duty cycle of synchronous channels
- Two independent event lines which can send up to 8 triggers on ADC within a period
- Four programmable Fault Inputs providing asynchronous protection of outputs

## 12.8 High Speed Multimedia Card Interface (HSMCI)

- Compatibility with MultiMedia Card Specification Version 4.3
- Compatibility with SD Memory Card Specification Version 2.0
- Compatibility with SDIO Specification Version V2.0.
- Compatibility with CE-ATA Specification 1.1
- Cards clock rate up to Master Clock divided by 2
- Boot Operation Mode support
- High Speed mode support
- Embedded power management to slow down clock rate when not used
- HSMCI has one slot supporting
  - One MultiMediaCard bus (up to 30 cards) or
  - One SD Memory Card
  - One SDIO Card
- Support for stream, block and multi-block data read and write
- Supports Connection to DMA controller
  - Minimizes Processor intervention for large buffer transfers
- Built in FIFO (32 bytes) with large Memory Aperture Supporting Incremental access
- Support for CE-ATA Completion Signal Disable Command

## 12.9 USB High Speed Device Port (UDPHS)

- USB V2.0 high-speed compliant, 480 Mbits per second
- Embedded USB V2.0 UTMI+ high-speed transceiver
- Embedded 4-Kbyte dual-port RAM for endpoints
- Embedded 6 channels DMA controller
- Suspend/Resume logic
- Up to 2 or 3 banks for isochronous and bulk endpoints
- Seven endpoints, configurable by software
- Maximum configuration: seven endpoints:
  - Endpoint 0: 64 bytes, 1 bank mode
  - Endpoint 1 & 2: 512 bytes, 2 banks mode, HS isochronous capable
  - Endpoint 3 & 4: 64 bytes, 3 banks mode
  - Endpoint 5 & 6: 1024 bytes, 3 banks mode, HS isochronous capable

## 12.10 Analog-to-Digital Converter (ADC)

Two ADCs are embedded in the product.

### 12.10.1 12-bit High Speed ADC

- 8-channel ADC
- 12-bit 1 Msamples/sec. Cyclic Pipeline ADC
- Integrated 8-to-1 multiplexer
- 12-bit resolution

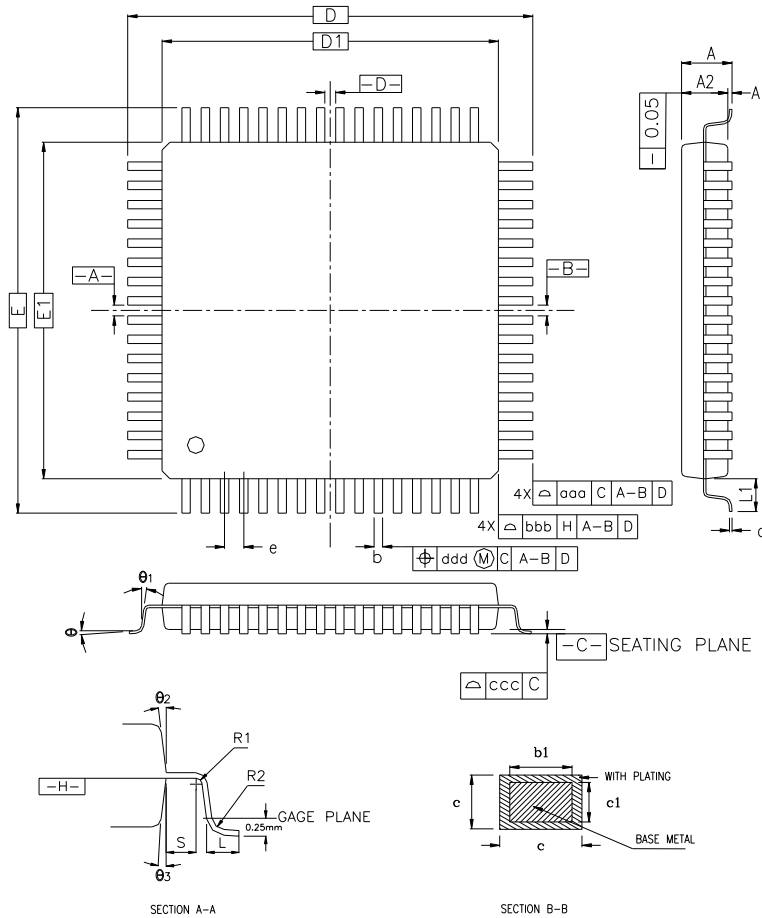
- Selectable single ended or differential input voltage
- Programmable gain for maximum full scale input range
- External voltage reference for better accuracy on low voltage inputs
- Individual enable and disable of each channel
- Multiple trigger sources
  - Hardware or software trigger
  - External trigger pin
  - Timer Counter 0 to 2 outputs TIOA0 to TIOA2 trigger
  - PWM trigger
- Sleep Mode and conversion sequencer
  - Automatic wakeup on trigger and back to sleep mode after conversions of all enabled channels

#### **12.10.2 10-bit Low Power ADC**

- 8-channel ADC
- 10-bit 384 Ksamples/sec. or 8-bit 533 Ksamples/sec. Successive Approximation Register ADC
- -2/+2 LSB Integral Non Linearity, -1/+1 LSB Differential Non Linearity
- Integrated 8-to-1 multiplexer
- External voltage reference for better accuracy on low voltage inputs
- Individual enable and disable of each channel
- Multiple trigger sources
  - Hardware or software trigger
  - External trigger pin
  - Timer Counter 0 to 2 outputs TIOA0 to TIOA2 trigger
  - PWM trigger
- Sleep Mode and conversion sequencer
  - Automatic wakeup on trigger and back to sleep mode after conversions of all enabled channels

## 13. Package Drawings

Figure 13-1. 100-ball LQFP Package Drawing



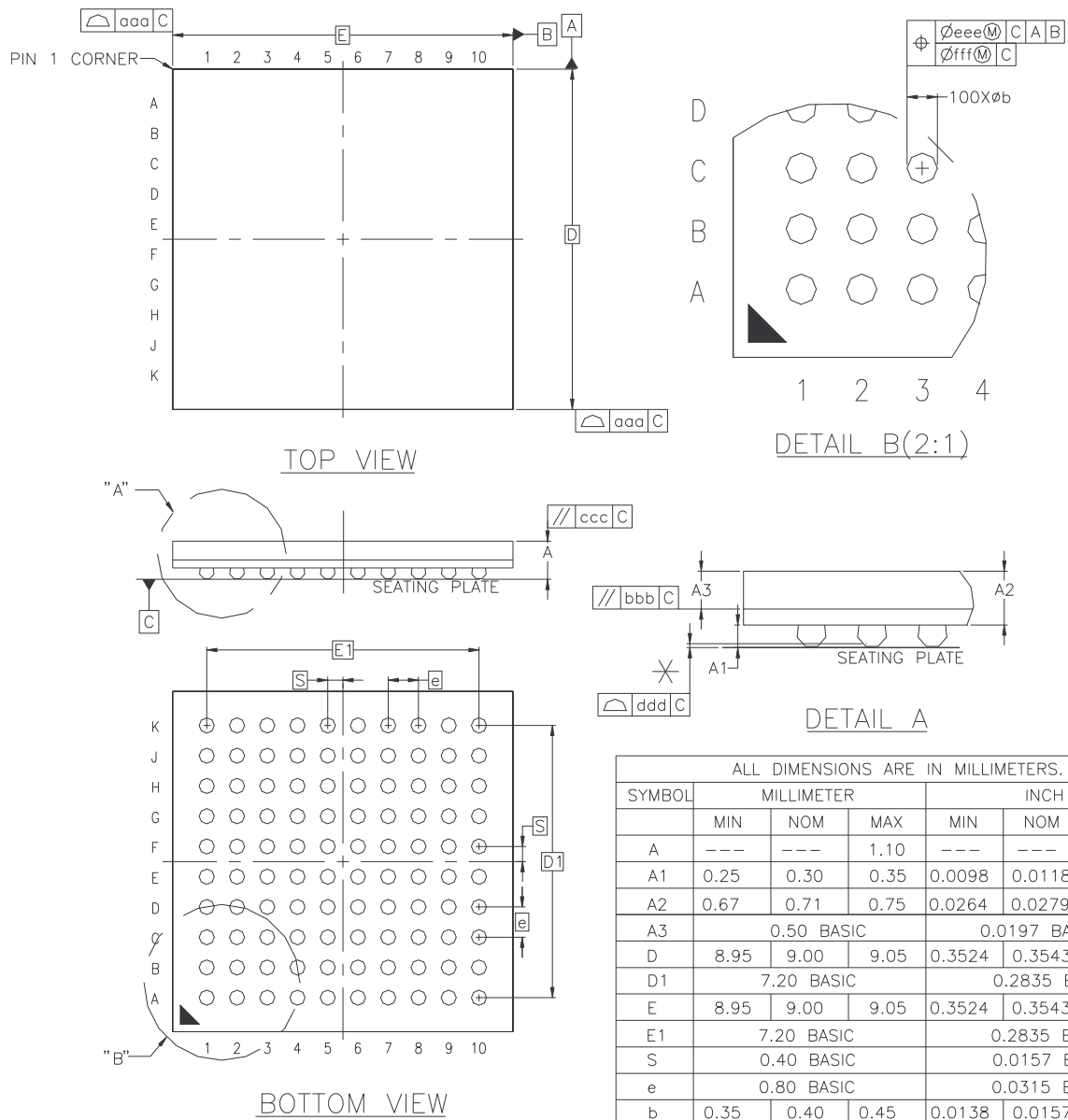
CONTROL DIMENSIONS ARE IN MILLIMETERS.

| SYMBOL                          | MILLIMETER |       |      | INCH       |       |       |
|---------------------------------|------------|-------|------|------------|-------|-------|
|                                 | MIN.       | NOM.  | MAX. | MIN.       | NOM.  | MAX.  |
| A                               | —          | —     | 1.60 | —          | —     | 0.063 |
| A1                              | 0.05       | —     | 0.15 | 0.002      | —     | 0.006 |
| A2                              | 1.35       | 1.40  | 1.45 | 0.053      | 0.055 | 0.057 |
| D                               | 16.00 BSC. |       |      | 0.630 BSC. |       |       |
| D1                              | 14.00 BSC. |       |      | 0.551 BSC. |       |       |
| E                               | 16.00 BSC. |       |      | 0.630 BSC. |       |       |
| E1                              | 14.00 BSC. |       |      | 0.551 BSC. |       |       |
| R2                              | 0.08       | —     | 0.20 | 0.003      | —     | 0.008 |
| R1                              | 0.08       | —     | —    | 0.003      | —     | —     |
| $\theta$                        | 0°         | 3.5°  | 7°   | 0°         | 3.5°  | 7°    |
| $\theta_1$                      | 0°         | —     | —    | 0°         | —     | —     |
| $\theta_2$                      | 11°        | 12°   | 13°  | 11°        | 12°   | 13°   |
| $\theta_3$                      | 11°        | 12°   | 13°  | 11°        | 12°   | 13°   |
| c                               | 0.09       | —     | 0.20 | 0.004      | —     | 0.008 |
| c1                              | 0.09       | 0.127 | 0.16 | 0.004      | 0.005 | 0.006 |
| L1                              | 1.00 REF   |       |      | 0.039 REF  |       |       |
| L                               | 0.45       | 0.60  | 0.75 | 0.018      | 0.024 | 0.030 |
| S                               | 0.20       | —     | —    | 0.008      | —     | —     |
| b                               | 0.17       | —     | 0.27 | 0.007      | —     | 0.011 |
| b1                              | 0.17       | 0.20  | 0.23 | 0.007      | 0.008 | 0.009 |
| e                               | 0.50 BSC.  |       |      | 0.020 BSC. |       |       |
| TOLERANCES OF FORM AND POSITION |            |       |      |            |       |       |
| aaa                             | 0.20       |       |      | 0.008      |       |       |
| bbb                             | 0.20       |       |      | 0.008      |       |       |
| ccc                             | 0.08       |       |      | 0.003      |       |       |
| ddd                             | 0.08       |       |      | 0.003      |       |       |

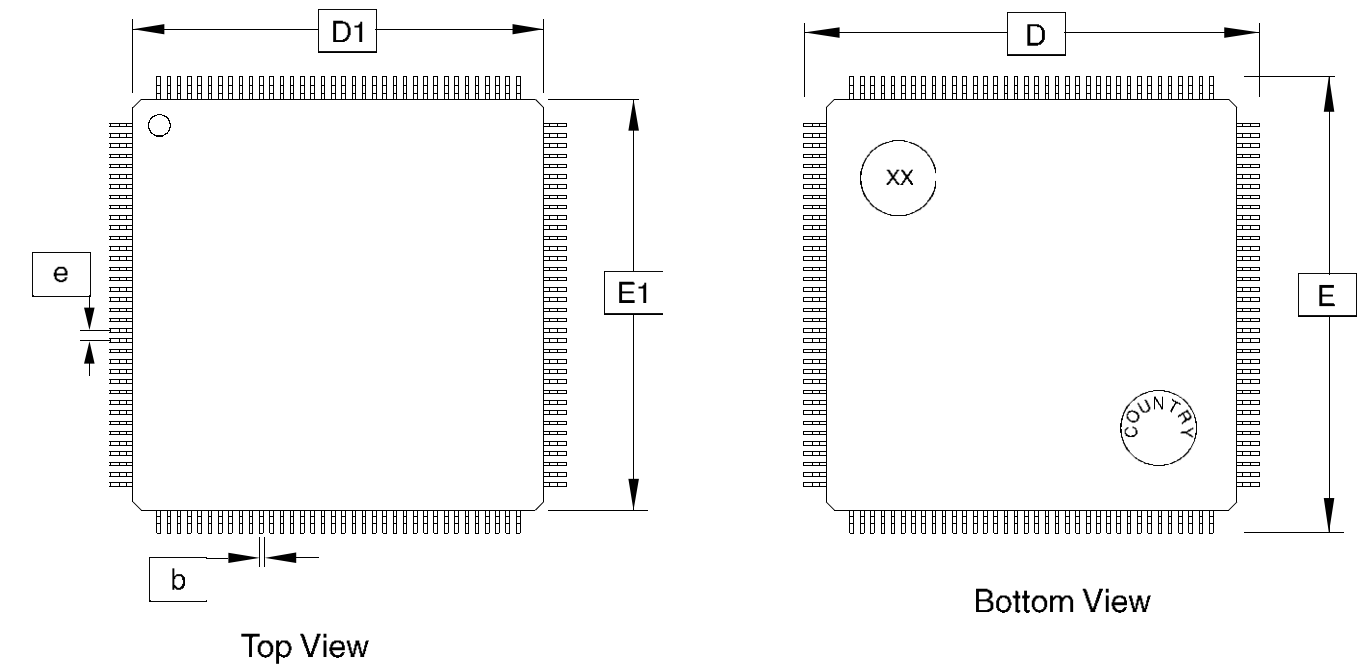
NOTES :

- DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION.  
ALLOWABLE PROTRUSION IS 0.25mm PER SIDE. D1 AND E1 DO INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE  $\square$
- DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION.  
ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08MM TOTAL IN EXCESS OF THE b DIMENSION AT MAXIMUM MATERIAL CONDITION.  
DAMBAR CAN NOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT

**Figure 13-2. 100-ball LFBGA Package Drawing**



**Figure 13-3.** 144-lead LQFP Package Drawing



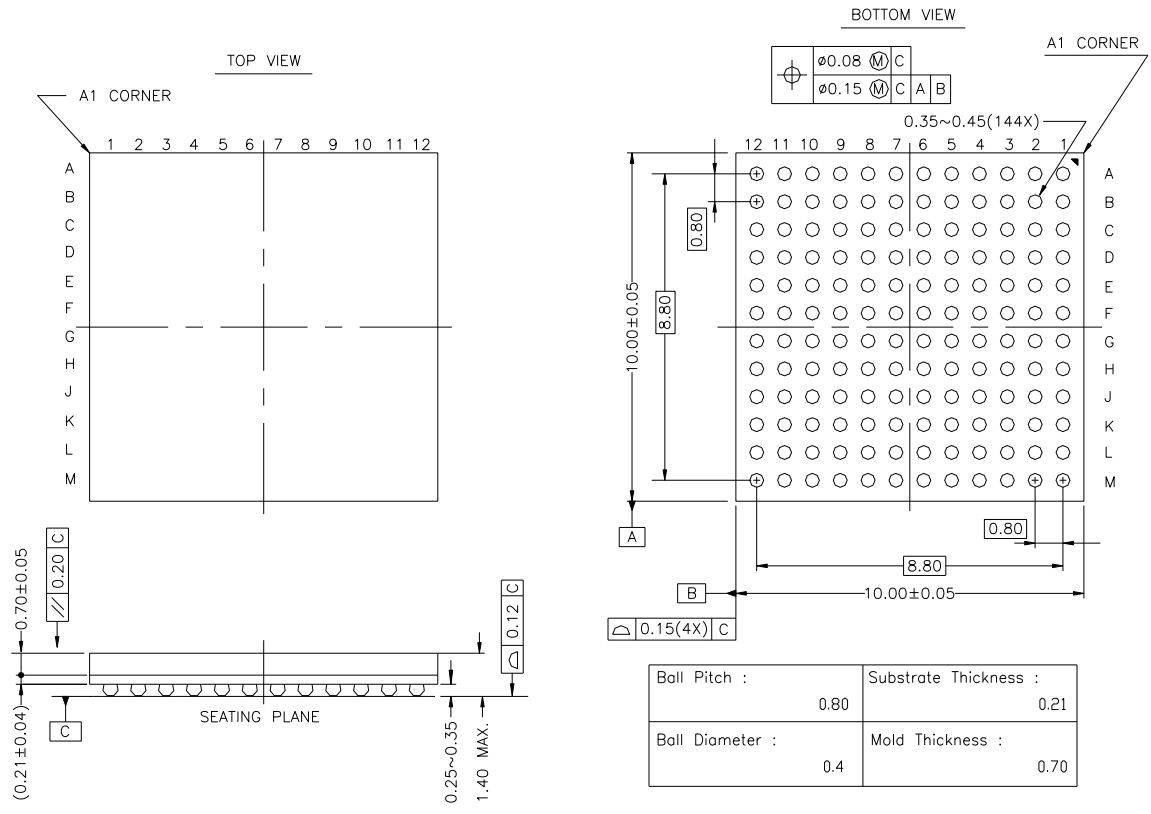
**COMMON DIMENSIONS**  
(Unit of Measure = mm)

| SYMBOL | MIN       | NOM  | MAX  | NOTE |
|--------|-----------|------|------|------|
| A1     | 0.05      |      | 0.15 | 6    |
| A2     | 1.35      | 1.40 | 1.45 |      |
| D      | 22.00 BSC |      |      |      |
| D1     | 20.00 BSC |      |      | 2, 3 |
| E      | 22.00 BSC |      |      |      |
| E1     | 20.00 BSC |      |      | 2, 3 |
| e      | 0.50 BSC  |      |      |      |
| b      | 0.17      | 0.22 | 0.27 | 4, 5 |
| L1     | 1.00 REF  |      |      |      |

- Notes:
1. This drawing is for general information only; refer to JEDEC Drawing MS-026 for additional information.
  2. The top package body size may be smaller than the bottom package size by as much as 0.15 mm.
  3. Dimensions D1 and E1 do not include mold protrusions. Allowable protrusion is 0.25 mm per side. D1 and E1 are maximum plastic body size dimensions including mold mismatch.
  4. b dimension by more than 0.08 mm. Dambar cannot be located on the lower radius or the foot. Minimum space between protrusion and an adjacent lead is 0.07 mm for 0.4 and 0.5 mm pitch packages.
  5. These dimensions apply to the flat section of the lead between 0.10 mm and 0.25 mm from the lead tip.
  6. A1 is defined as the distance from the seating plane to the lowest point on the package body.



**Figure 13-4. 144-ball LFBGA Package Drawing**



All dimensions are in mm.



## 14. Ordering Information

Table 14-1. ATSAM3U4/2/1 Ordering Information

| Ordering Code | MRL | Flash (Kbytes) | Package   | Package Type | Temperature Operating Range |
|---------------|-----|----------------|-----------|--------------|-----------------------------|
| ATSAM3U4EA-AU | A   | 256            | LQFP144   | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U4EA-CU | A   | 256            | LFBGA 144 | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U4CA-AU | A   | 256            | LQFP 100  | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U4CA-CU | A   | 256            | TFBGA100  | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U2EA-AU | A   | 128            | LQFP144   | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U2EA-CU | A   | 128            | LFBGA144  | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U2CA-AU | A   | 128            | LQFP100   | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U2CA-CU | A   | 128            | TFBGA100  | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U1EA-AU | A   | 64             | LQFP144   | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U1EA-CU | A   | 64             | LFBGA144  | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U1CA-AU | A   | 64             | LQFP100   | Green        | Industrial<br>-40°C to 85°C |
| ATSAM3U1CA-CU | A   | 64             | TFBGA100  | Green        | Industrial<br>-40°C to 85°C |

## Revision History

In the tables that follow, the most recent version of the document appears first.

“rfo” indicates changes requested during the review and approval loop.

| Doc. Rev | Comments  | Change Request Ref. |
|----------|---|---------------------|
| 6430CS   |   |                     |
|          | Section 2. "SAM3U Block Diagram", changed orientation of block diagrams.  | rfo                 |
|          | Section 5. "Power Considerations", fixed grammar in Voltage ranges.   |                     |
|          | Section 3. "Signal Description", USART signal DCD0 is an Input  | 6681                |
|          | Figure 5-1 "Single Supply", Main supply range is 1.8V-3.6V.   | 6698                |
|          | Figure 5-1, Figure 5-2, Figure 5-3, updated "Note" below figures, "With Main Supply <2.0V USB and ADC are not usable. |                     |
|          | Section 5.5 "Low Power Modes", stray references to WUPx pins, renamed WKUPx   | 6711                |
|          | Table 5-1, "Low Power Mode Configuration Summary", updated footnote "5".  | 6964                |
|          | Table 11-2, "Multiplexing on PIO Controller A (PIOA)", TWD1 and TWCK1 only available on 144-pin version.              | 6686                |
|          | Section 10.13 "Chip Identification"   | 6951                |
|          | Table 10-2, "SAM3U Chip IDs Register - Revision A Parts", added to datasheet.   |                     |
|          | Section 12.4 "Universal Synchronous Asynchronous Receiver Transmitter (USART)" ... "SCK up to MCK/6"                  | rfo-7097            |

| Doc Rev<br>6430BS | Comments  | Change Request Ref.         |
|-------------------|---|-----------------------------|
|                   | <p><b>Introduction:</b></p> <p><a href="#">Section 1. "SAM3U Description"</a>, Updated: 52 Kbytes of SRAM. 4x USARTs (SAM3U1C/2C/4C have 3), up to 2x TWIs (SAM3U1C/2C/4C have 1), up to 5x SPIs SAM3U1C/2C/4C have 4),</p> <p><a href="#">Table 1-1, "Configuration Summary"</a>, EBI column updated, 8 bits for SAM3U1C/2C/4C SAM3U4/3/2C rows FWUP replaces NO in FWUP,SHDN pins column</p>  | <p>6400</p> <p>6642</p>     |
|                   | <p><a href="#">Figure 2-1 "144-pin SAM3U4/2/1E Block Diagram"</a> and <a href="#">Figure 2-2 "100-pin SAM3U4/2/1C Block Diagram"</a> updated, SM cell removed; UART moved to peripheral area, added Flash Unique block, removed 12B from ADC block, added SysTick counter and Fmax 96 MHz to M3 block. FWUP replaces WKUP in fig 2-1, FWUP added to fig 2-2</p> <p><a href="#">Figure 2-2 "100-pin SAM3U4/2/1C Block Diagram"</a>, NWR1/NBS1, NXRPO, A0 removed from block diagram.</p>   | <p>6482/6642</p> <p>rfo</p> |
|                   | <p><a href="#">Table 3-1, "Signal Description List"</a>, Schmitt Trigger added "<a href="#">PIO Controller - PIOA - PIOB - PIOC</a>". exception details given in footnote.</p> <p>VDDIN, VDDOUT added to table.</p> <p><a href="#">"Serial Wire/JTAG Debug Port (SWJ-DP)"</a> replaced ICE and JTAG. This section of the table updated status of pulldowns and pullups specified.</p>   | <p>6480</p> <p>rfo</p>      |
|                   | <p><a href="#">Section 4. "Package and Pinout"</a>, reorganized according to product.</p> <p><a href="#">Section 4.1 "SAM3U4/2/1E Package and Pinout"</a> and <a href="#">Section 4.2 "SAM3U4/2/1C Package and Pinout"</a>, pinouts finalized in datasheet.</p>   | <p>6471/rfo</p> <p>6607</p> |
|                   | <p><a href="#">Section 5.5.1 "Backup Mode"</a>, BOD replaced by Supply Monitor/SM. FWUP → Falling Edge Detector.</p> <p><a href="#">Figure 5-4 "Wake-up Source"</a>, BODEN replaced by SMEN.</p> <p><a href="#">Table 5-1, "Low Power Mode Configuration Summary"</a>, PIO state in Low Power Modes, backup mode is; "Previous state saved.</p>   | <p>rfo</p> <p>6645</p>      |
|                   | <p><a href="#">Section 6.6 "NRSTB Pin"</a>, VDDIO changed to VDDBU</p> <p><a href="#">Section 6. "Input/Output Lines"</a>, replaces <a href="#">Section 5.8 "Programmable I/O Lines"</a>.</p> <p><a href="#">Section 6.1 "General Purpose I/O Lines (GPIO)"</a> and <a href="#">Section 6.2 "System I/O Lines"</a>, replace <a href="#">Section 6. "I/O Line Considerations"</a>.</p> <p><a href="#">Figure 6-1 "On-Die Termination schematic"</a>, added.</p> <p><a href="#">Section 6.8 "PIO Controllers"</a>, removed.</p> <p><a href="#">Section 8. "Product Mapping"</a>, title changed from "Memories".</p> <p><a href="#">Section 9. "Memories"</a>, now comprises <a href="#">Section 9.1 "Embedded Memories"</a> and <a href="#">Section 9.2 "External Memories"</a>.</p> <p><a href="#">Section 9.1.3.5 "Security Bit Feature"</a>, updated</p> | <p>6646</p> <p>6481/rfo</p> |
|                   | <p><a href="#">Table 7-3, "SAM3U Master to Slave Access"</a>, Slave 9, High Speed Peripheral Bridge line added.</p> <p><a href="#">Section 7.2 "APB/AHB Bridges"</a>, reference to ADC updated "10-bit ADC, 12-bit ADC (ADC12B)".</p> <p><a href="#">Table 11-3, "Multiplexing on PIO Controller B (PIOB)"</a>, ADC12B2, ADC12B3 properly listed.</p> <p><a href="#">Section 12.10.1 "12-bit High Speed ADC"</a>, <a href="#">Section 12.10.2 "10-bit Low Power ADC"</a>, titles changed.</p> <p><a href="#">"Quadrature Decoder Logic"</a> on page 51, properly stated in list of TC functions.</p>  | <p>6663</p> <p>6397</p>     |
|                   | <p><a href="#">Section 12.10.1 "12-bit High Speed ADC"</a>, 2nd item on list updated.</p> <p><a href="#">Section 12.10.2 "10-bit Low Power ADC"</a>, Ksample values updated on 2nd item of list.</p>  | <p>rfo</p>                  |

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