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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Active
Core Processor	ARM® Cortex®-M3
Core Size	32-Bit Single-Core
Speed	48MHz
Connectivity	I²C, IrDA, SPI, UART/USART
Peripherals	Brown-out Detect/Reset, DMA, POR, PWM, WDT
Number of I/O	47
Program Memory Size	32KB (32K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	8K x 8
Voltage - Supply (Vcc/Vdd)	1.62V ~ 3.6V
Data Converters	A/D 10x10b; D/A 1x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-LQFP
Supplier Device Package	64-LQFP (10x10)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atsam3n0ba-aur

2. SAM3N Block Diagram

Figure 2-1. SAM3N 100-pin version Block Diagram

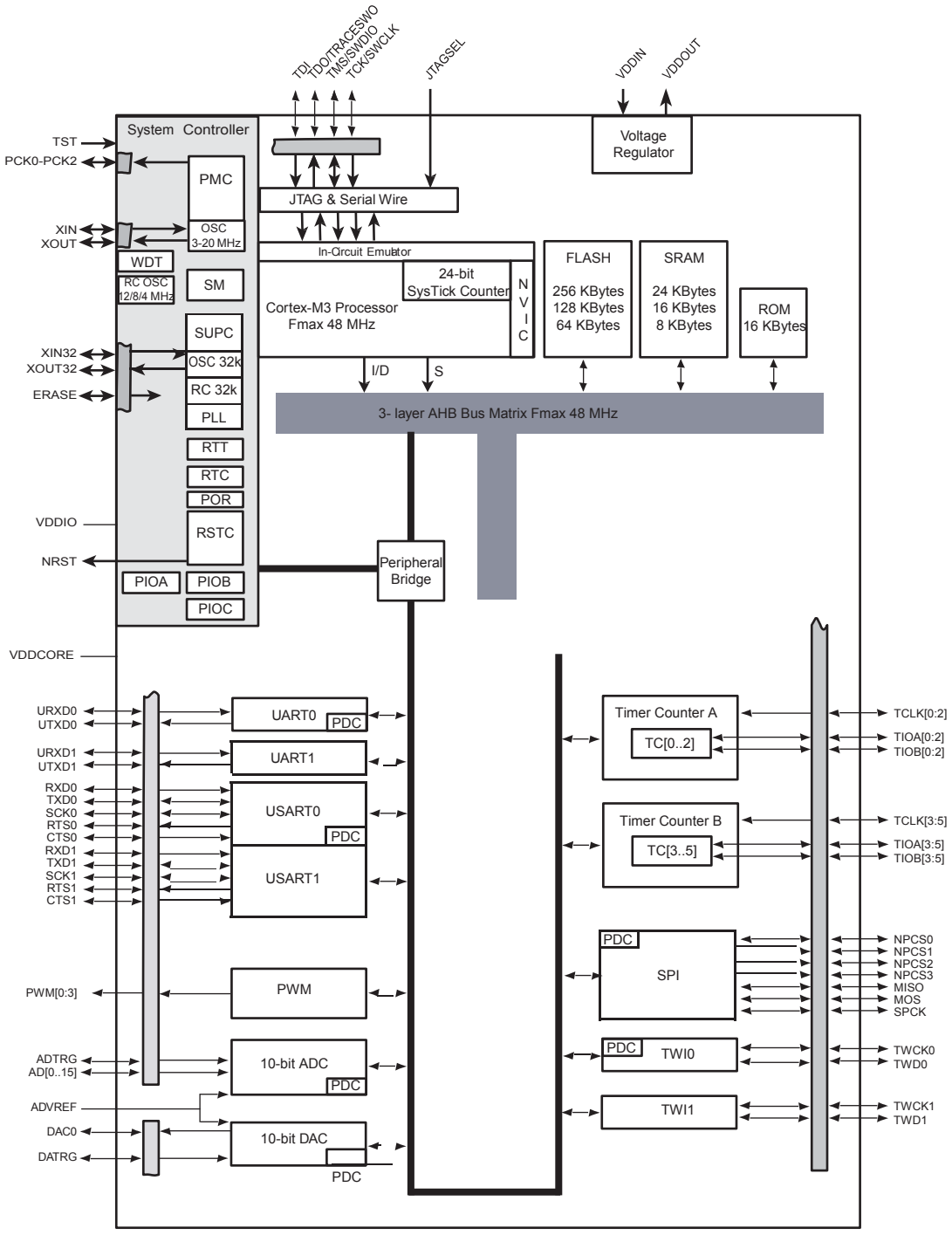


Figure 2-2. SAM3N 64-pin version Block Diagram

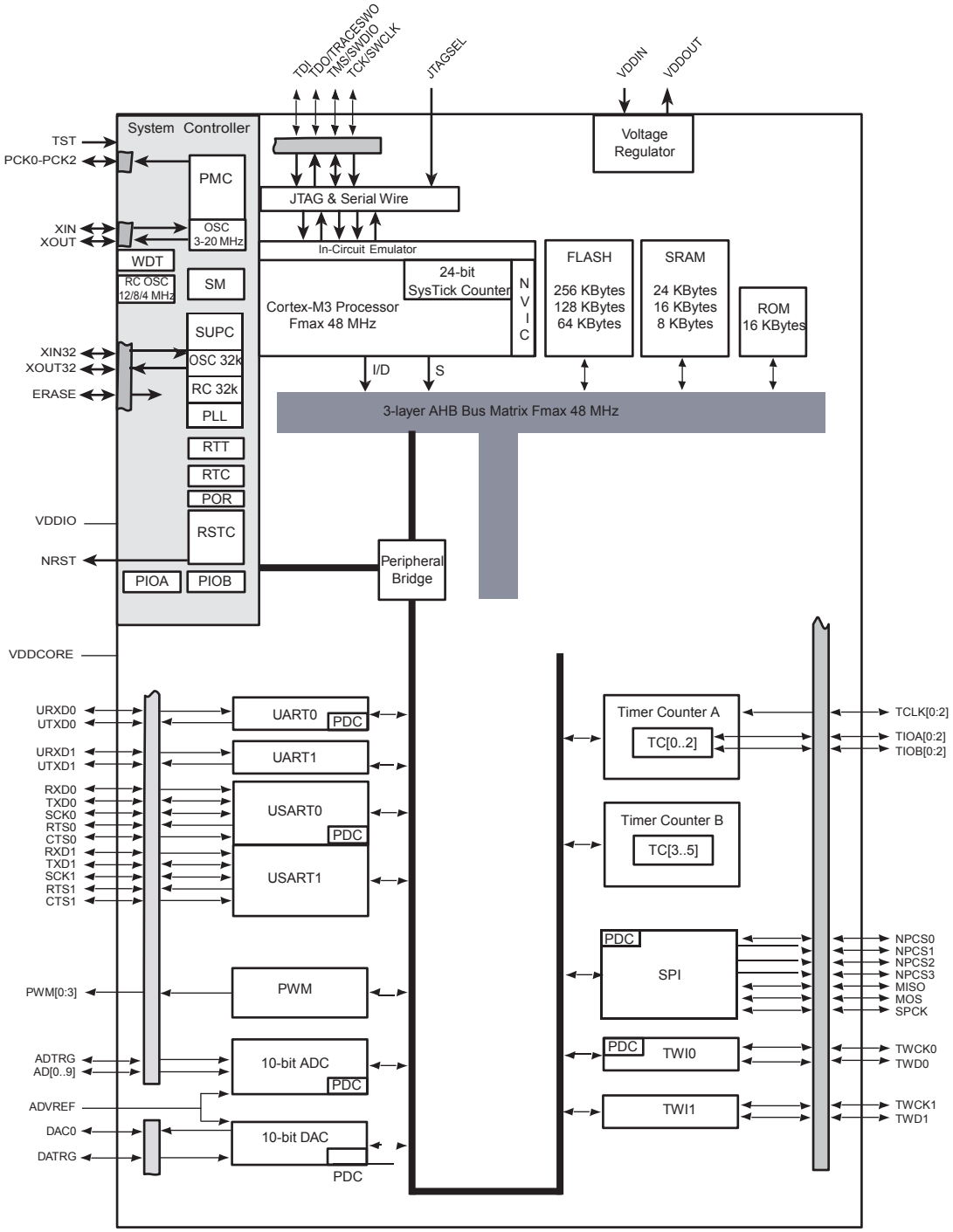


Table 3-1. Signal Description List (Continued)

Signal Name	Function	Type	Active Level	Voltage Reference	Comments
Serial Peripheral Interface - SPI					
MISO	Master In Slave Out	I/O			
MOSI	Master Out Slave In	I/O			
SPCK	SPI Serial Clock	I/O			
SPI_NPCS0	SPI Peripheral Chip Select 0	I/O	Low		
SPI_NPCS1 - SPI_NPCS3	SPI Peripheral Chip Select	Output	Low		
Two-Wire Interface- TWIx					
TWDx	TWIx Two-wire Serial Data	I/O			
TWCKx	TWIx Two-wire Serial Clock	I/O			
Analog					
ADVREF	ADC and DAC Reference	Analog			
10-bit Analog-to-Digital Converter - ADC					
AD0 - AD15	Analog Inputs	Analog			
ADTRG	ADC Trigger	Input		VDDIO	
Digital-to-Analog Converter Controller- DACC					
DAC0	DACC channel analog output	Analog			
DATRG	DACC Trigger	Input		VDDIO	
Fast Flash Programming Interface					
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		

Notes: 1. Schmitt Triggers can be disabled through PIO registers.
2. Some PIO lines are shared with System IOs.
3. See Section 5.3 “Typical Powering Schematics” for restriction on voltage range of Analog Cells.

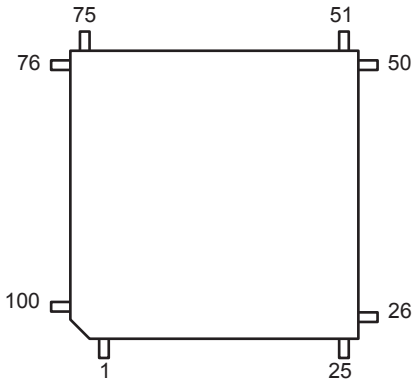
4. Package and Pinout

SAM3N4/2/1/0/00 series is pin-to-pin compatible with SAM3S products. Furthermore SAM3N4/2/1/0/00 devices have new functionalities referenced in italic inTable 4-1, Table 4-3 and Table 4-4.

4.1 SAM3N4/2/1/0/00C Package and Pinout

4.1.1 100-lead LQFP Package Outline

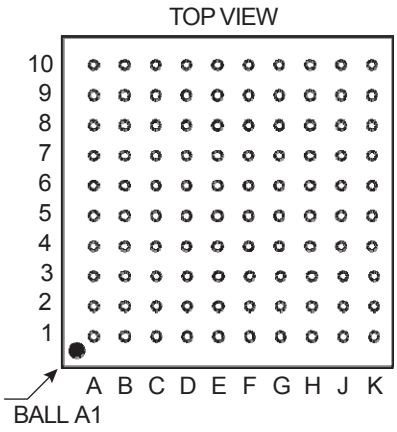
Figure 4-1. Orientation of the 100-lead LQFP Package



4.1.2 100-ball TFBGA Package Outline

The 100-Ball TFBGA package has a 0.8 mm ball pitch and respects Green Standards. Its dimensions are 9 x 9 x 1.1 mm.

Figure 4-2. Orientation of the 100-ball TFBGA Package



4.2.1 64-Lead LQFP and QFN Pinout

64-pin version SAM3N devices are pin-to-pin compatible with SAM3S products. Furthermore, SAM3N products have new functionalities shown in italic in Table 4-3.

Table 4-3. 64-pin SAM3N4/2/1/0/00B Pinout

1	ADVREF	17	GND	33	*TDI/PB4*	49	*TDO/TRACESWO/PB5*
2	GND	18	VDDIO	34	PA6/PGMNOE	50	JTAGSEL
3	*PB0/AD4*	19	PA16/PGMD4	35	PA5/PGMRDY	51	*TMS/SWDIO/PB6*
4	*PB1AD5*	20	PA15/PGMD3	36	PA4/PGMNCMD	52	PA31
5	*PB2/AD6*	21	PA14/PGMD2	37	PA27/PGMD15	53	*TCK/SWCLK/PB7*
6	*PB3/AD7*	22	PA13/PGMD1	38	PA28	54	VDDCORE
7	VDDIN	23	PA24/PGMD12	39	NRST	55	*ERASE/PB12*
8	VDDOUT	24	VDDCORE	40	TST	56	*PB10*
9	PA17/PGMD5/AD0	25	PA25/PGMD13	41	PA29	57	*PB11*
10	PA18/PGMD6/AD1	26	PA26/PGMD14	42	PA30	58	VDDIO
11	PA21/PGMD9/AD8	27	PA12/PGMD0	43	PA3	59	*PB13/DAC0*
12	VDDCORE	28	PA11/PGMM3	44	PA2/PGMEN2	60	GND
13	PA19/PGMD7/AD2	29	PA10/PGMM2	45	VDDIO	61	*XOUT/PB8*
14	PA22/PGMD10/AD9	30	PA9/PGMM1	46	GND	62	*XIN/PGMCK/PB9*
15	PA23/PGMD11	31	PA8/XOUT32/PGMM0	47	PA1/PGMEN1	63	*PB14*
16	PA20/PGMD8/AD3	32	PA7/XIN32/XOUT32/PGMNVALID	48	PA0/PGMEN0	64	VDDPLL

Note: The bottom pad of the QFN package must be connected to ground.

4.3 SAM3N4/2/1/0/00A Package and Pinout

Figure 4-5. Orientation of the 48-pad QFN Package

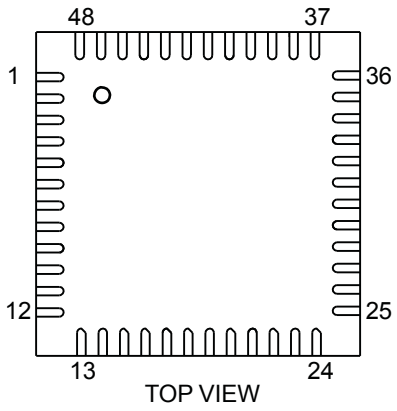
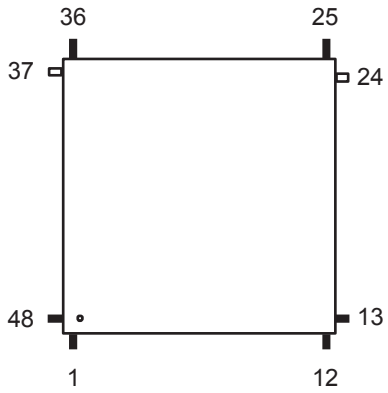


Figure 4-6. Orientation of the 48-lead LQFP Package



4.3.1 48-Lead LQFP and QFN Pinout

Table 4-4. 48-pin SAM3N4/2/1/0/00A Pinout

1	ADVREF	13	VDDIO	25	*TDI/PB4*	37	*TDO/TRACESWO/ PB5*
2	GND	14	PA16/PGMD4	26	PA6/PGMNOE	38	JTAGSEL
3	*PB0/AD4*	15	PA15/PGMD3	27	PA5/PGMRDY	39	*TMS/SWDIO/PB6*
4	*PB1/AD5*	16	PA14/PGMD2	28	PA4/PGMNCMD	40	*TCK/SWCLK/PB7*
5	*PB2/AD6*	17	PA13/PGMD1	29	NRST	41	VDDCORE
6	*PB3/AD7*	18	VDDCORE	30	TST	42	*ERASE/PB12*
7	VDDIN	19	PA12/PGMD0	31	PA3	43	*PB10*
8	VDDOUT	20	PA11/PGMM3	32	PA2/PGMEN2	44	*PB11*
9	PA17/PGMD5/AD0	21	PA10/PGMM2	33	VDDIO	45	*XOUT/PB8*
10	PA18/PGMD6/AD1	22	PA9/PGMM1	34	GND	46	*XIN/P/PB9/GMCK*
11	PA19/PGMD7/AD2	23	PA8/XOUT32/PG MM0	35	PA1/PGMEN1	47	VDDIO
12	PA20/AD3	24	PA7/XIN32/PGMN VALID	36	PA0/PGMEN0	48	VDDPLL

Note: The bottom pad of the QFN package must be connected to ground.

Figure 5-1. Single Supply

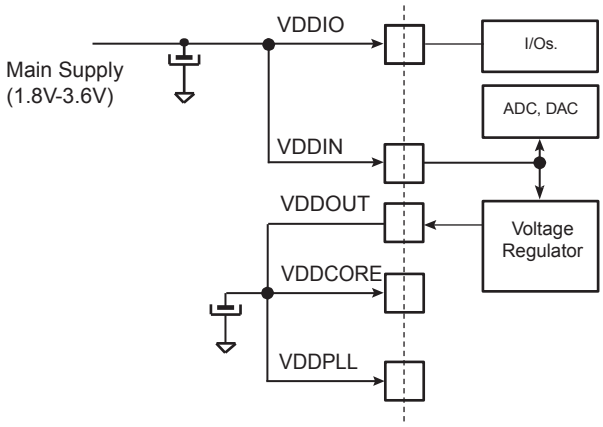
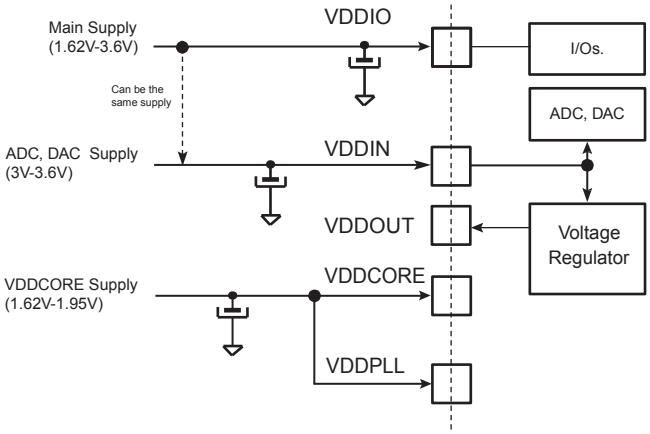


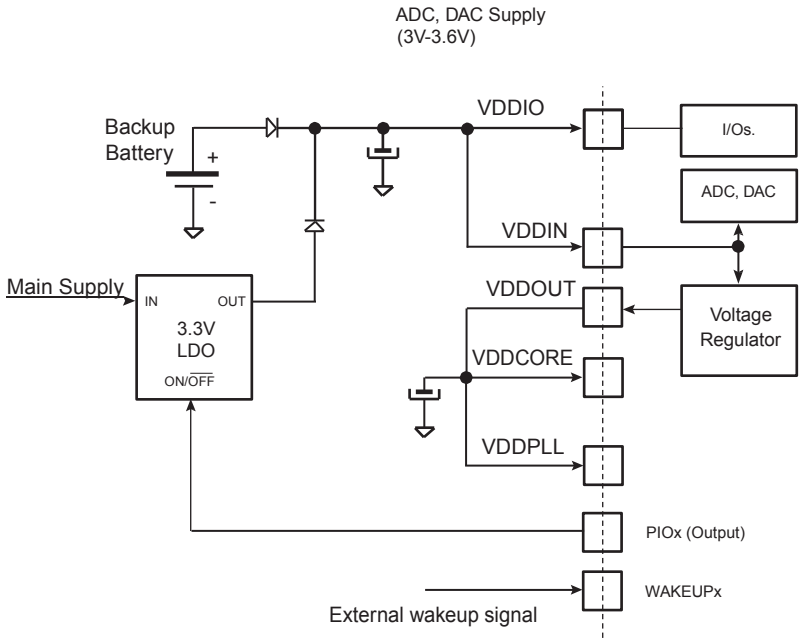
Figure 5-2. Core Externally Supplied



Note: Restrictions
With Main Supply < 3V, ADC and DAC are not usable.
With Main Supply >= 3V, all peripherals are usable.

Figure 5-3 below provides an example of the powering scheme when using a backup battery. Since the PIO state is preserved when in backup mode, any free PIO line can be used to switch off the external regulator by driving the PIO line at low level (PIO is input, pull-up enabled after backup reset). External wake-up of the system can be from a push button or any signal. See Section 5.6 “Wake-up Sources” for further details.TFBGA

Figure 5-3. Core Externally Supplied (backup battery)



Note: The two diodes provide a "switchover circuit" (for illustration purpose) between the backup battery and the main supply when the system is put in backup mode.

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 PLL. 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 SAM3N are described below:

5.5.1 Backup Mode

The purpose of backup mode is to achieve the lowest power consumption possible in a system that is performing periodic wakeups to carry out tasks but not requiring fast startup time (<0.1ms). Total current consumption is 3 µA typical.

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 SAM3N can be awakened from this mode through WUP0-15 pins, the supply monitor (SM), the RTT or RTC wake-up event.

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:

- WKUPEN0-15 pins (level transition, configurable debouncing)

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 and the SRAM power supply, if they are not already enabled.

Figure 5-4. Wake-up Source

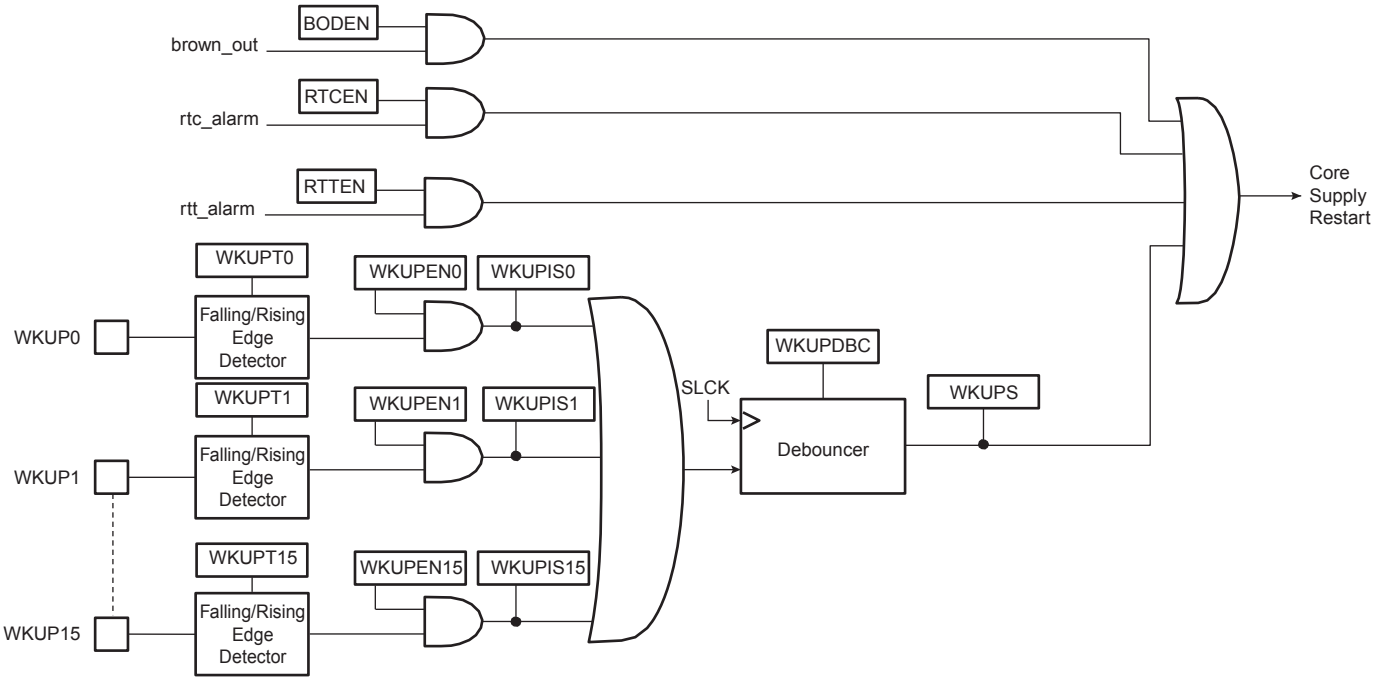


Table 6-1. System I/O Configuration Pin List.

SYSTEM_IO bit number	Default function after reset	Other function	Constraints for normal start	Configuration
12	ERASE	PB12	Low Level at startup(1)	In Matrix User Interface Registers (Refer to the System I/O Configuration Register in the Bus Matrix section of the product datasheet.)
7	TCK/SWCLK	PB7	-	
6	TMS/SWDIO	PB6	-	
5	TDO/TRACESWO	PB5	-	
4	TDI	PB4	-	
-	PA7	XIN32	-	See footnote (2) below
-	PA8	XOUT32	-	
-	PB9	XIN	-	See footnote (3) below
-	PB8	XOUT	-	

Notes:
1. If PB12 is used as PIO input in user applications, a low level must be ensured at startup to prevent Flash erase before the user application sets PB12 into PIO mode.
2. In the product Datasheet Refer to: Slow Clock Generator of the Supply Controller section.
3. In the product Datasheet Refer to: 3 to 20 MHZ Crystal Oscillator information in the PMC section.

6.2.1 Serial Wire JTAG Debug Port (SWJ-DP) Pins

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 on page 7.

At startup, SWJ-DP pins are configured in SWJ-DP mode to allow connection with debugging probe. Please refer to the Debug and Test Section of the product datasheet.

SWJ-DP pins can be used as standard I/Os to provide users more general input/output pins when the debug port is not needed in the end application. Mode selection between SWJ-DP mode (System IO mode) and general IO mode is performed through the AHB Matrix Special Function Registers (MATRIX_SFR). Configuration of the pad for pull-up, triggers, debouncing and glitch filters is possible regardless of the mode.

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 kΩ to GND, 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. For more information about SW-DP and JTAG-DP switching, please refer to the Debug and Test Section.

9. Memories

9.1 Embedded Memories

9.1.1 Internal SRAM

The SAM3N4 product embeds a total of 24-Kbytes high-speed SRAM.

The SAM3N2 product embeds a total of 16-Kbytes high-speed SRAM.

The SAM3N1 product embeds a total of 8-Kbytes high-speed SRAM.

The SRAM is accessible over System Cortex-M3 bus at address 0x2000 0000.

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

RAM size must be configurable by calibration fuses.

9.1.2 Internal ROM

The SAM3N product embeds an Internal ROM, which contains the SAM Boot Assistant (SAM-BA), In Application Programming routines (IAP) and Fast Flash Programming Interface (FFPI).

At any time, the ROM is mapped at address 0x0080 0000.

9.1.3 Embedded Flash

9.1.3.1 Flash Overview

The Flash of the SAM3N4 (256 Kbytes) is organized in one bank of 1024 pages of 256 bytes (Single plane).

The Flash of the SAM3N2 (128 Kbytes) is organized in one bank of 512 pages of 256 bytes (Single Plane).

The Flash of the SAM3N1 (64 Kbytes) is organized in one bank of 256 pages of 256 bytes (Single plane).

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 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.

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...

See the System Controller block diagram in Figure 10-1 on page 35.

10.6 Power Management Controller

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

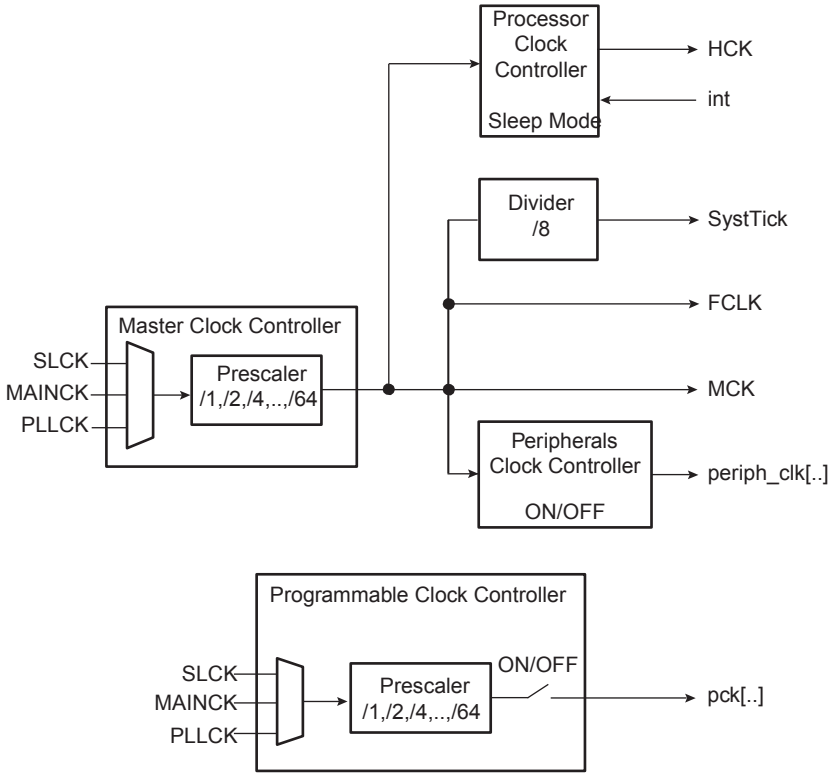
- the Processor Clock HCLK
- the Free running processor clock FCLK
- the Cortex SysTick external clock
- the Master Clock MCK, in particular to the Matrix and the memory interfaces
- independent peripheral clocks, typically at the frequency of MCK
- three programmable clock outputs: PCK0, PCK1 and PCK2

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.

The user can trim by software the 8 and 12 MHz RC Oscillator frequency.

Figure 10-3. SAM3N4/2/1/0/00 Power Management Controller Block Diagram



The SysTick calibration value is fixed at 6000 which allows the generation of a time base of 1 ms with SysTick clock at 6 MHz (48 MHz/8)

10.7 Watchdog Timer

- 16-bit key-protected only-once-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 through the Shut Down Controller

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 Backup Registers

- Eight 32-bit general-purpose backup registers

10.12 Nested Vectored Interrupt Controller

- Thirty Two maskable external interrupts
- Sixteen priority levels
- Processor state automatically saved on interrupt entry, and restored on
- Dynamic reprioritization of interrupts
- Priority grouping
  - selection of pre-empting interrupt levels and non pre-empting 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. SAM3N Chip ID Register

Chip Name	CHIPID_CIDR	CHIPID_EXID
ATSAM3N4C (Rev A)	0x29540960	0x0
ATSAM3N2C (Rev A)	0x29590760	0x0
ATSAM3N1C (Rev A)	0x29580560	0x0
ATSAM3N4B (Rev A)	0x29440960	0x0
ATSAM3N2B (Rev A)	0x29490760	0x0
ATSAM3N1B (Rev A)	0x29480560	0x0
ATSAM3N4A (Rev A)	0x29340960	0x0
ATSAM3N2A (Rev A)	0x29390760	0x0
ATSAM3N1A (Rev A)	0x29380560	0x0

- JTAG ID: 0x05B2E03F

10.14 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

10.15 PIO Controllers

- 3 PIO Controllers, PIOA, PIOB and PIOC (100-pin version only) controlling a maximum of 79 I/O Lines
- Each PIO Controller controls up to 32 programmable I/O Lines
- Fully programmable through Set/Clear Registers

Table 10-2. PIO available according to pin count

Version	48 pin	64 pin	100 pin
PIOA	21	32	32
PIOB	13	15	15
PIOC	-	-	32

- Multiplexing of four 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

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^2C 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 (for TWI0 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 (for UART0 only)

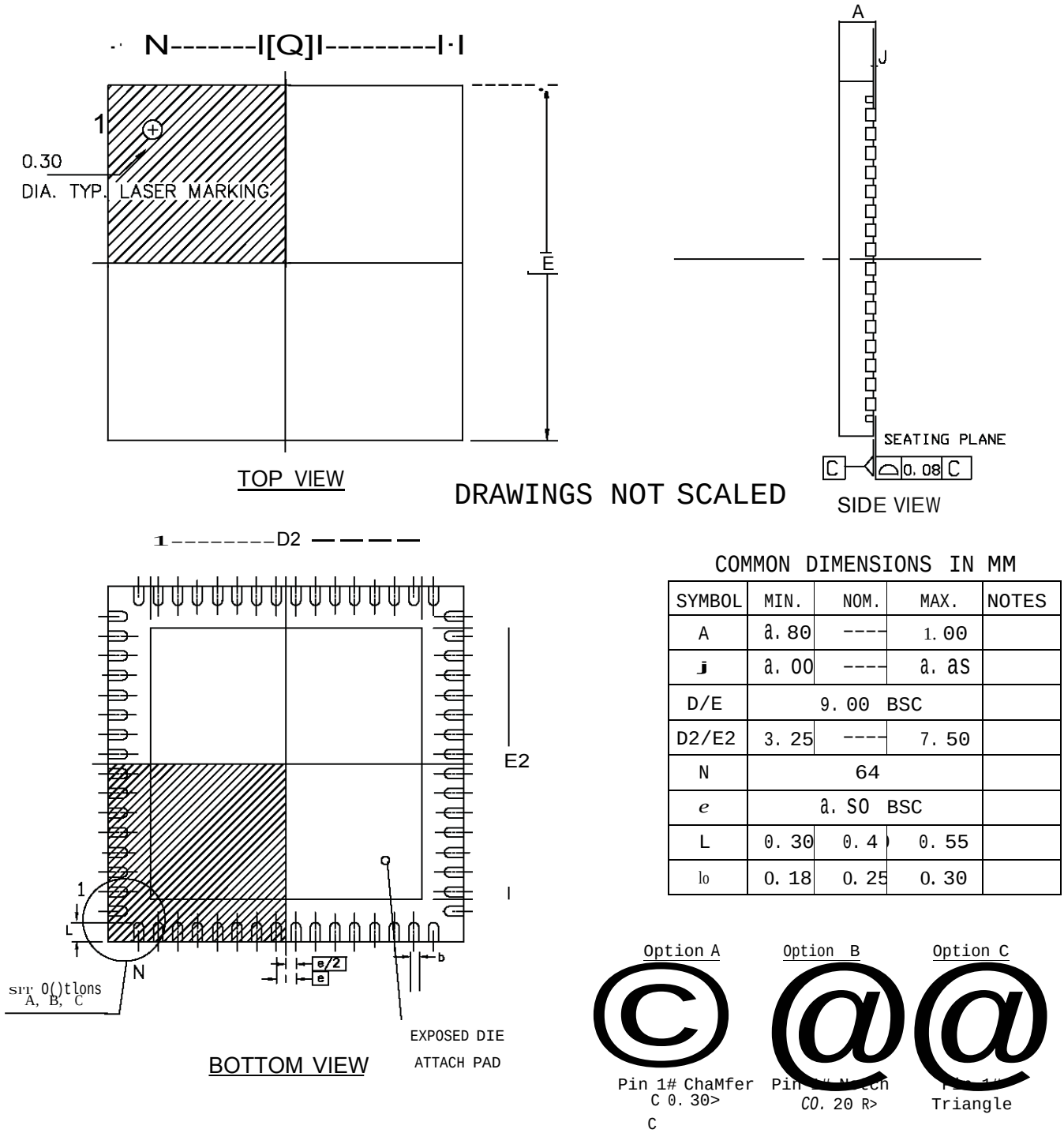
12.4 USART

- Programmable Baud Rate Generator
- 5- to 9-bit full-duplex synchronous or asynchronous serial communications
  - 1, 1.5 or 2 stop bits in Asynchronous Mode or 1 or 2 stop bits in Synchronous Mode
  - Parity generation and error detection
  - Framing error detection, overrun error detection
  - MSB- or LSB-first
  - Optional break generation and detection
  - By 8 or by-16 over-sampling receiver frequency
  - Hardware handshaking RTS-CTS
  - Receiver time-out and transmitter timeguard
  - Optional Multi-drop Mode with address generation and detection
- RS485 with driver control signal
- ISO7816, T = 0 or T = 1 Protocols for interfacing with smart cards (Only on USART0)
  - 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/4
- IrDA modulation and demodulation (Only on USART0)
  - Communication at up to 115.2 Kbps
- Test Modes
  - Remote Loopback, Local Loopback, Automatic Echo
- PDC support (for USART0 only)

12.5 Timer Counter (TC)

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

Figure 13-5. 64-pad QFN Package Drawing



COMMON DIMENSIONS IN MM

SYMBOL	MIN.	NOM.	MAX.	NOTES
A	0.80	----	1.00	
j	0.00	----	0.05	
D/E		9.00 BSC		
D2/E2	3.25	----	7.50	
N		64		
e		0.50 BSC		
L	0.30	0.40	0.55	
lo	0.18	0.25	0.30	

Revision History

Doc. Rev. 11011BS	Comments	Change Request Ref.
	Overview:	
	All mentions of 100-ball LFBGA changed into 100-ball TFBGA	8044
	Section 8. “Product Mapping”, Heading was ‘Memories’. Changed to ‘Product Mapping’	7685
	Section 4.1.4 “100-ball TFBGA Pinout”, whole pinout table updated	7201
	Updated package dimensions in ‘Features’	7965

Doc. Rev	Comments	Change Request Ref.
11011AS	First issue	