

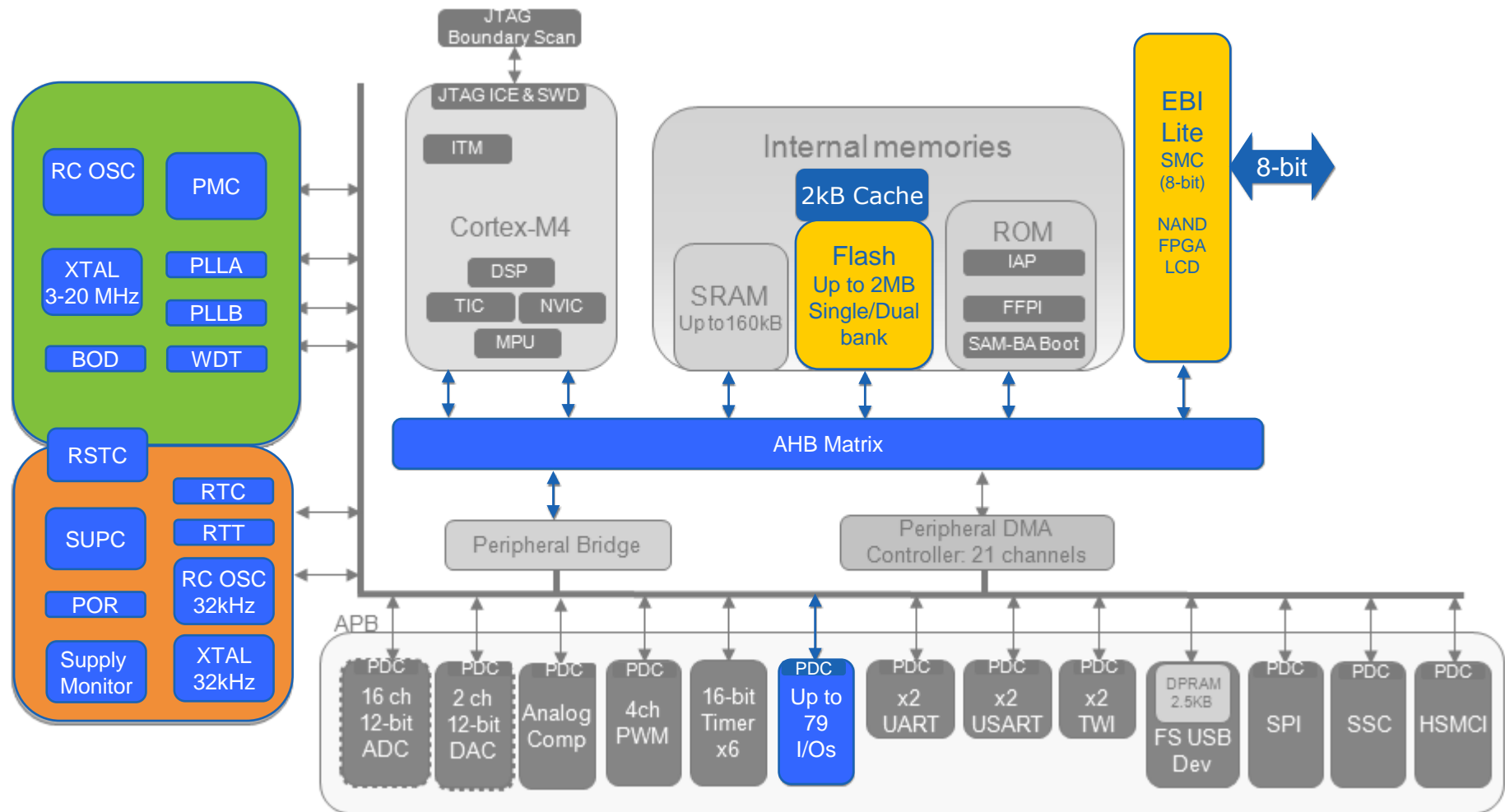


SAM4S System Peripherals

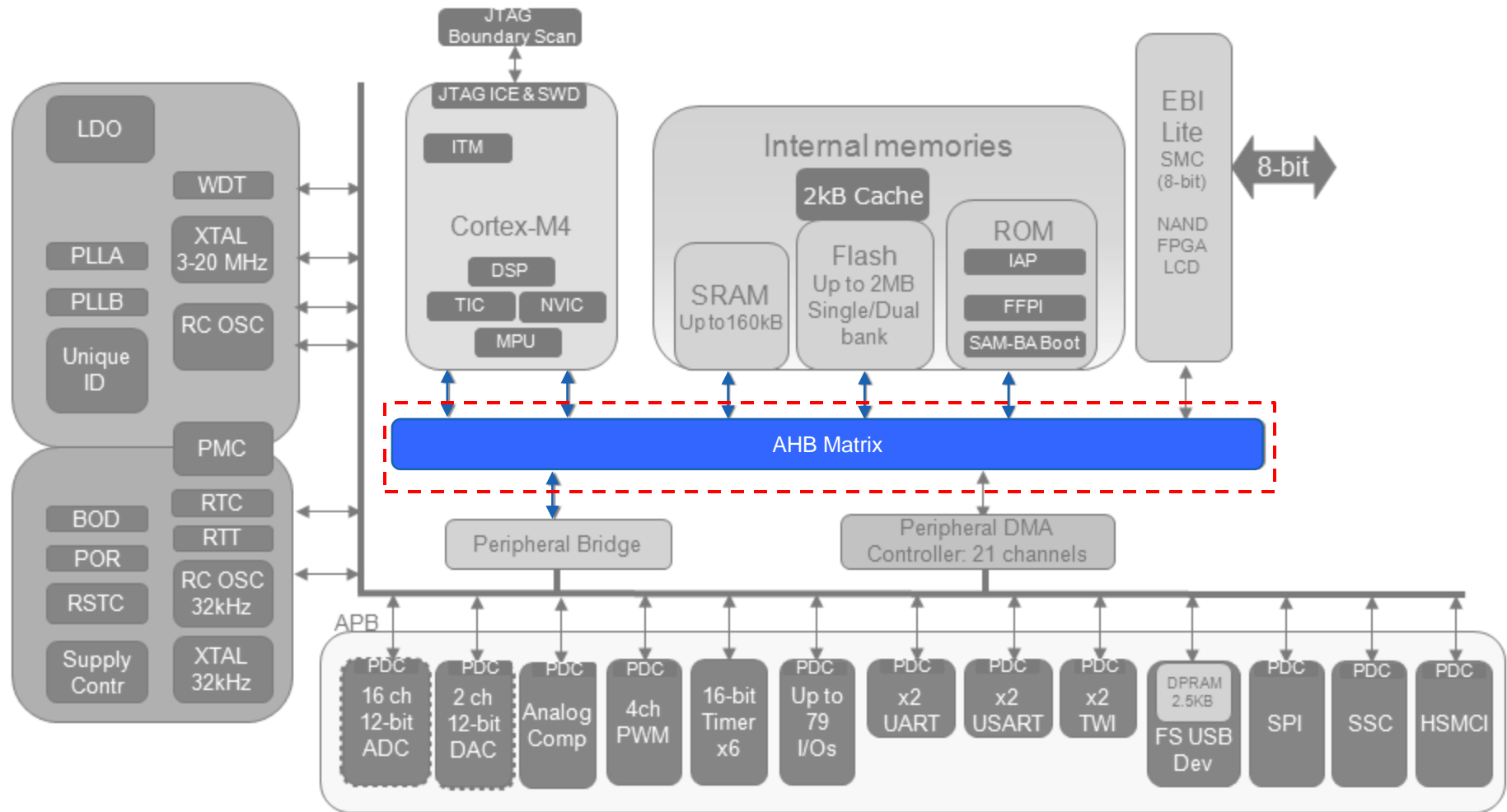
Presentation Outline

- SAM4S System Peripherals Block Diagram
- AHB Matrix
- System Controller
 - Supply Controller
 - Reset Controller
 - Power Management Controller
 - Watchdog Timer
 - Real Time Clock and Real Time Timer
- Static Memory Controller
- PIO Controllers

SAM4S System Peripherals Block Diagram



AHB Matrix (MATRIX)



AHB Matrix

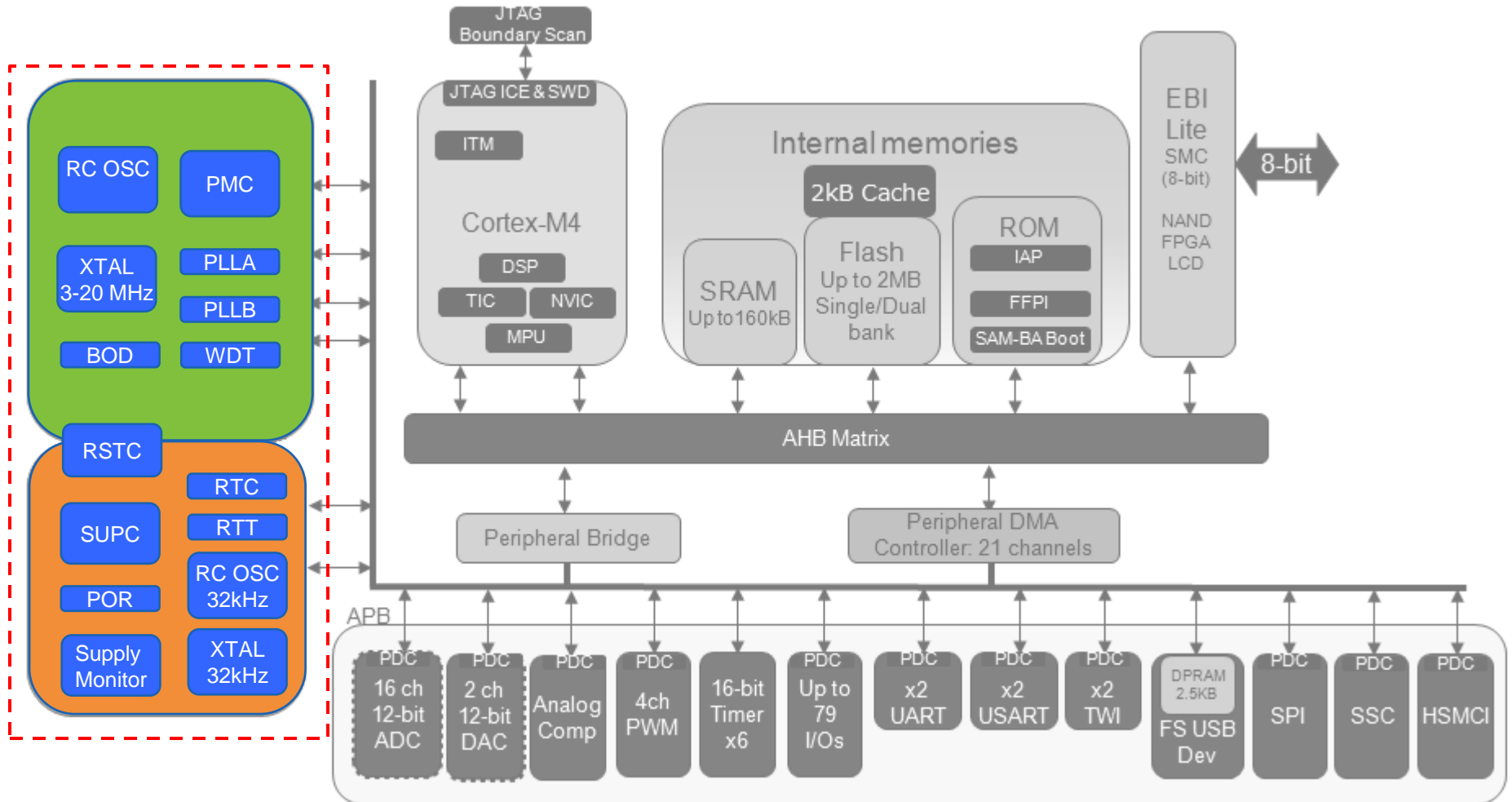
Overview

- The 4-layer Bus Matrix increases the system bandwidth by enabling parallel access paths between multiple AHB masters and slaves in the system

Slaves	Masters	0	1	2	3
		Cortex-M4 I/D Bus	Cortex-M4 S Bus	PDC	CRCCU
0	Internal SRAM	-	X	X	X
1	Internal ROM	X	-	X	X
2	Internal Flash	X	-	-	X
3	External Bus Interface	-	X	X	X
4	Peripheral Bridge	-	X	X	-

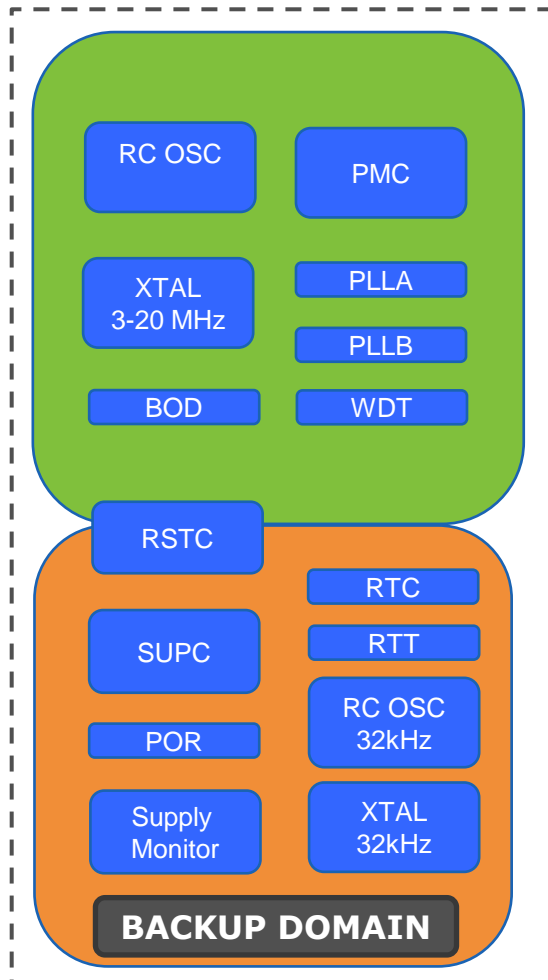
- The AHB Matrix Embeds an Arbitrary system (round robin, fixed priority) and speculative bus granting system for performance improvement according to application peripherals usage .

System Controller



System Controller

Overview



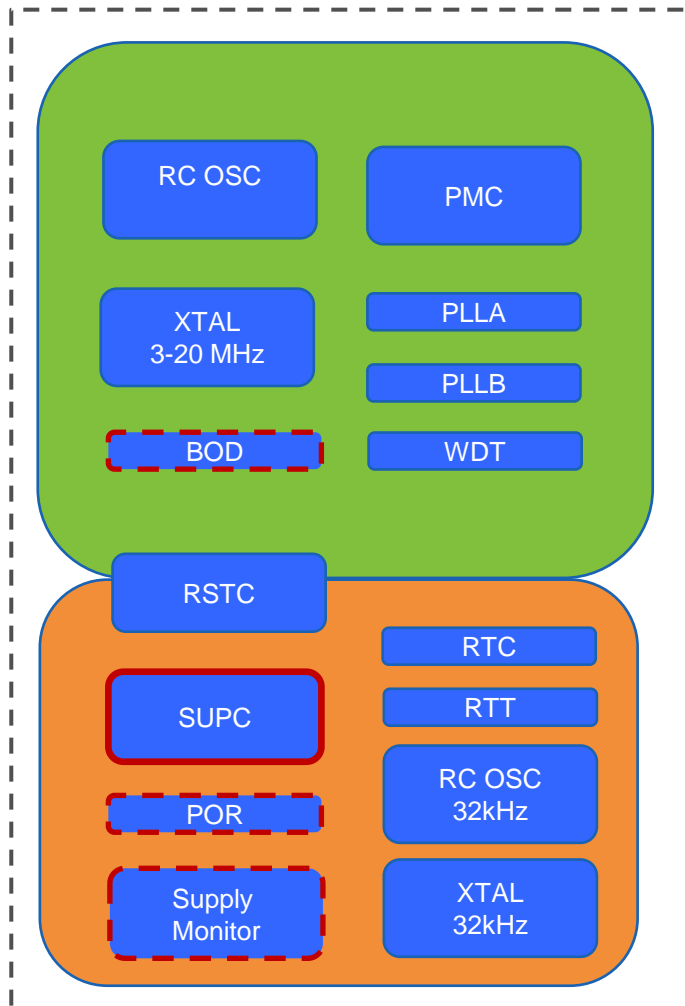
- The System controller (SYSC) is a set of peripherals and controllers that allows handling of key elements of the system :
 - System clocks control (32KHz, PLL, Main clock...)
 - Low Power modes management
 - System reliability (Resets, POR, BOD, Watchdog...)
- Part of the peripherals are supplied by the BACKUP power supply.

System Controller

Supply Controller (SUPC)

SAM4S Supply Controller

Overview



- Controls the embedded voltage regulator and the different power domains of the microcontroller.
- Manages device start-up & power supplies monitoring (POR, BOD, Supply Monitor).
- Controls system Slow clock generation.

SAM4S Supply Controller

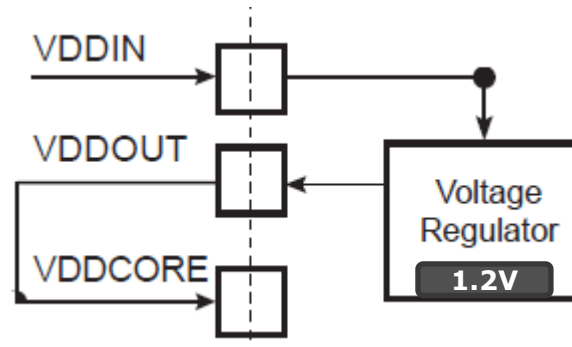
SAM4S Power Domain

- ***VDDIN (1.62V to 3.6V)***: Powers the internal Voltage Regulator, ADC, DAC and Analog Comparator.
- ***VDDCORE (1.08V to 1.32V)***: Powers the core, the embedded memories and the peripherals.
- ***VDDIO (1.62V to 3.6V)***: Powers the Backup part, Peripherals I/O lines (Input/Output Buffers), USB transceiver, 32 kHz crystal oscillator its pads.
- ***VDDPLL (1.08V to 1.32V)***: Powers PLLA, PLLB, the Fast RC and the 3-20MHz main oscillator.

SAM4S Supply Controller

Internal Voltage Regulator

- The voltage regulator is designed to supply the internal core power supply: VDDCORE.

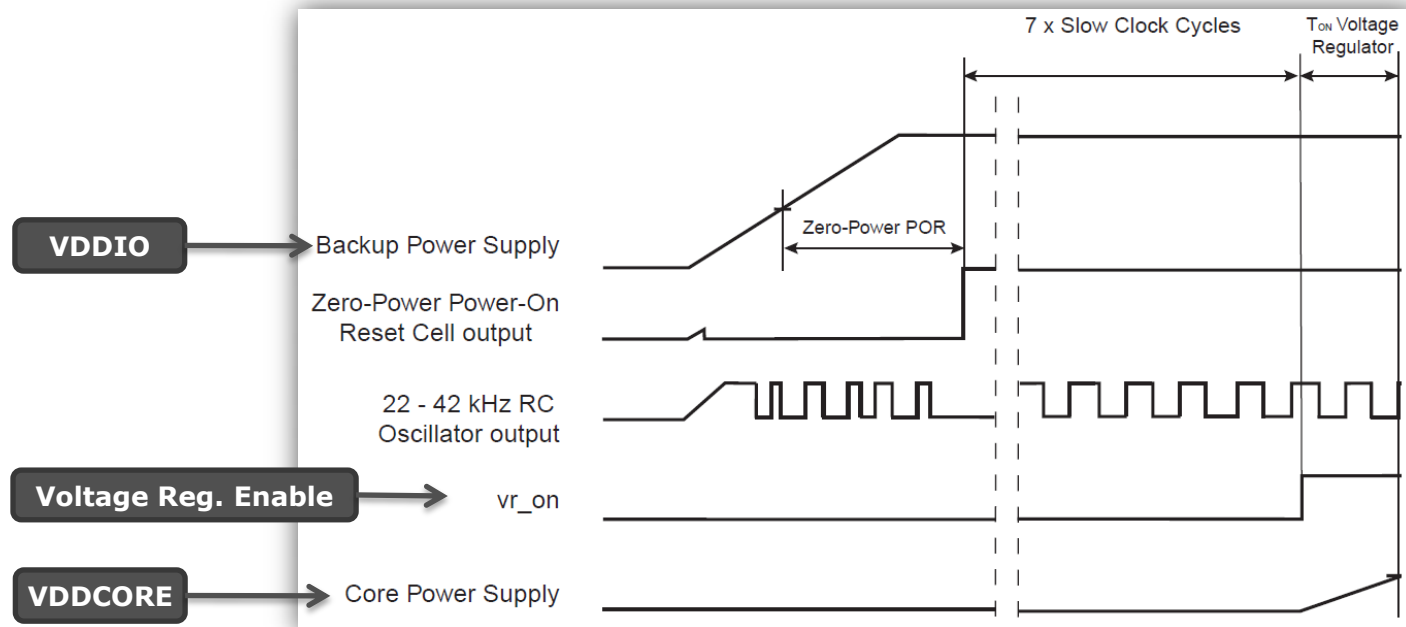


- It features two operating modes:
 - Normal mode: consumes less than 500 μ A.
 - Standby mode (Backup mode): consumes less than 1 μ A.
- In normal mode, the regulator has an automatic mode which adjusts its quiescent current depending on the required load current.
 - Quiescent current can go down to 5 μ A (Wait mode use).

SAM4S Supply Controller

Zero-Power On Reset (POR)

- At startup, the POR maintains its output low as long as the Backup Power Supply (VDDIO) has not reached its target voltage.
 - i.e Supply Controller is reset.

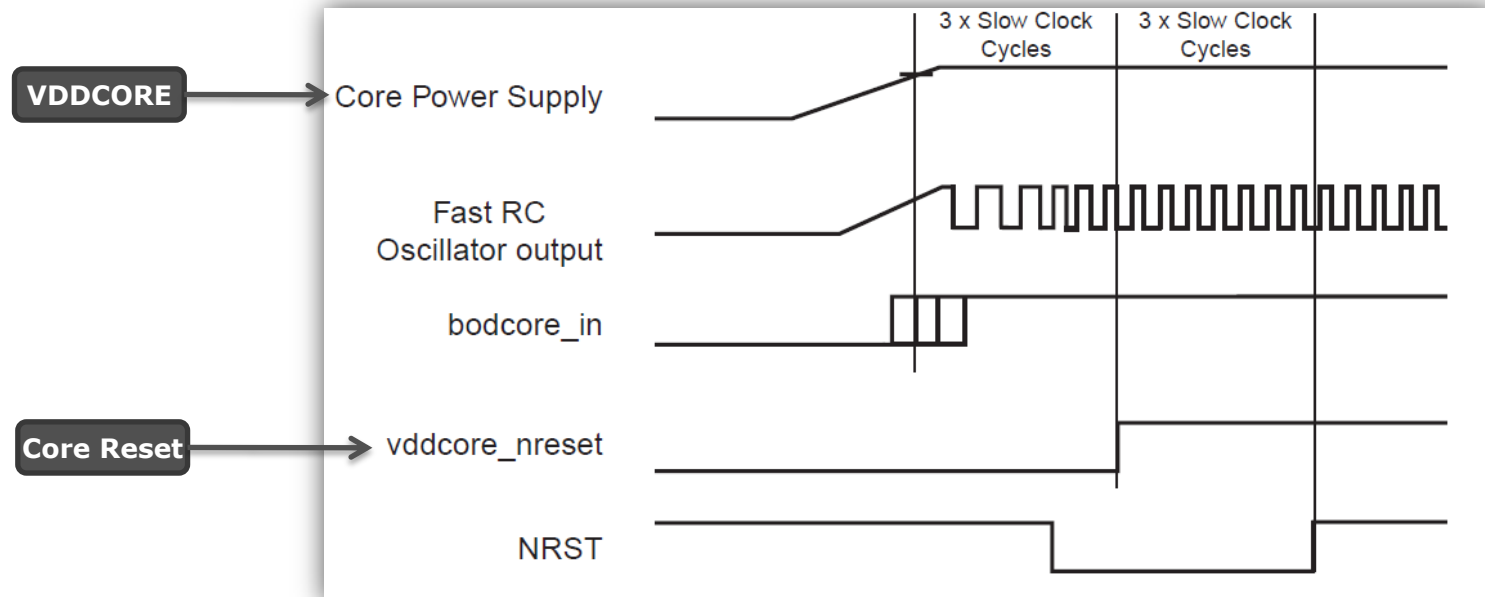


- Then, the Supply controller is started and the MCU voltage regulator is enabled after 7 slow clock cycles.

SAM4S Supply Controller

Brown Out Detector (BOD)

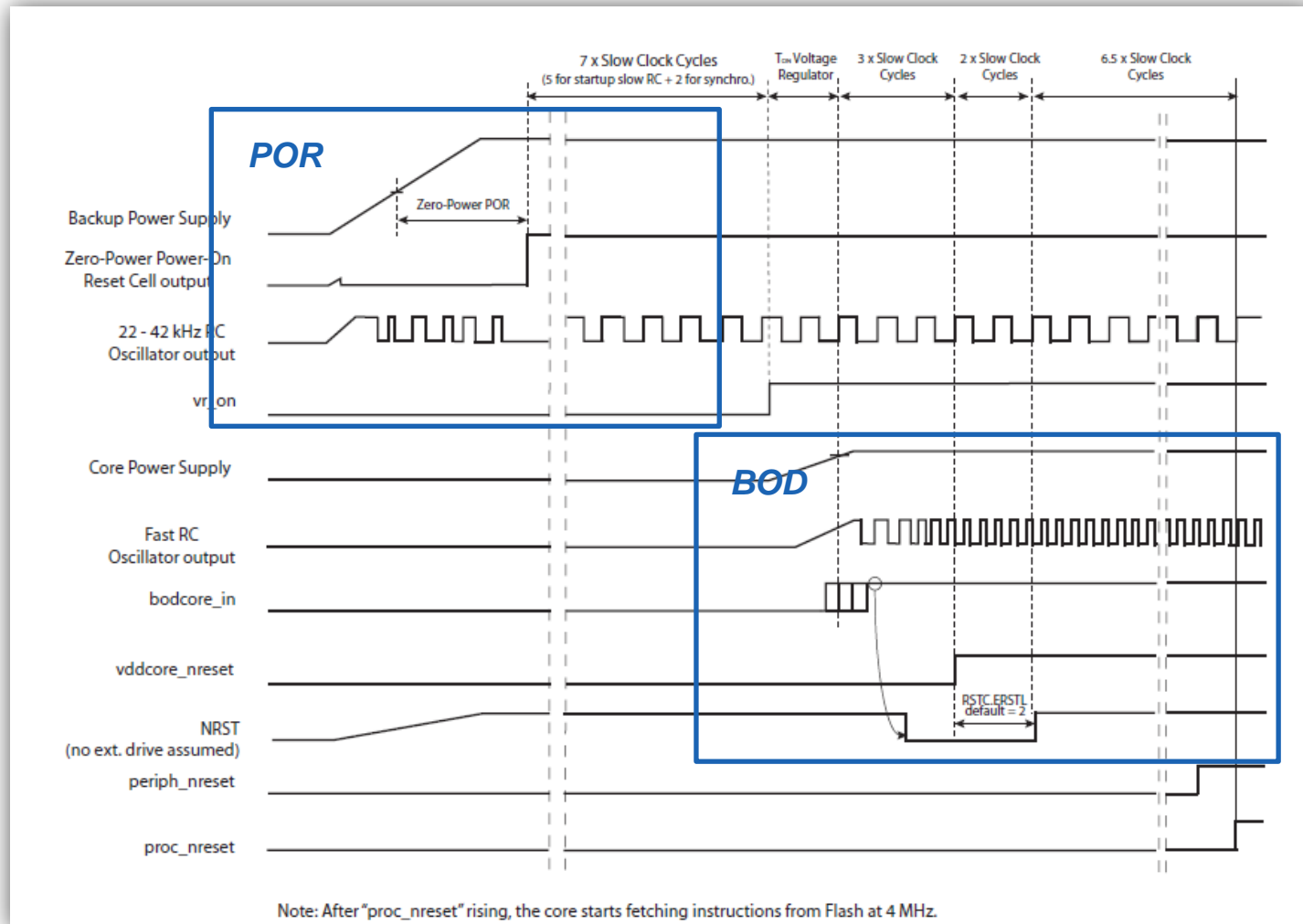
- The Brownout Detector monitors VDDCORE (enabled by default).
- It releases the core reset at start up 3 cycles after VDDCORE is stabilized.



- It can also generate a core reset if any core voltage drops are detected for more than one Slow Clock cycle.

SAM4S Supply Controller

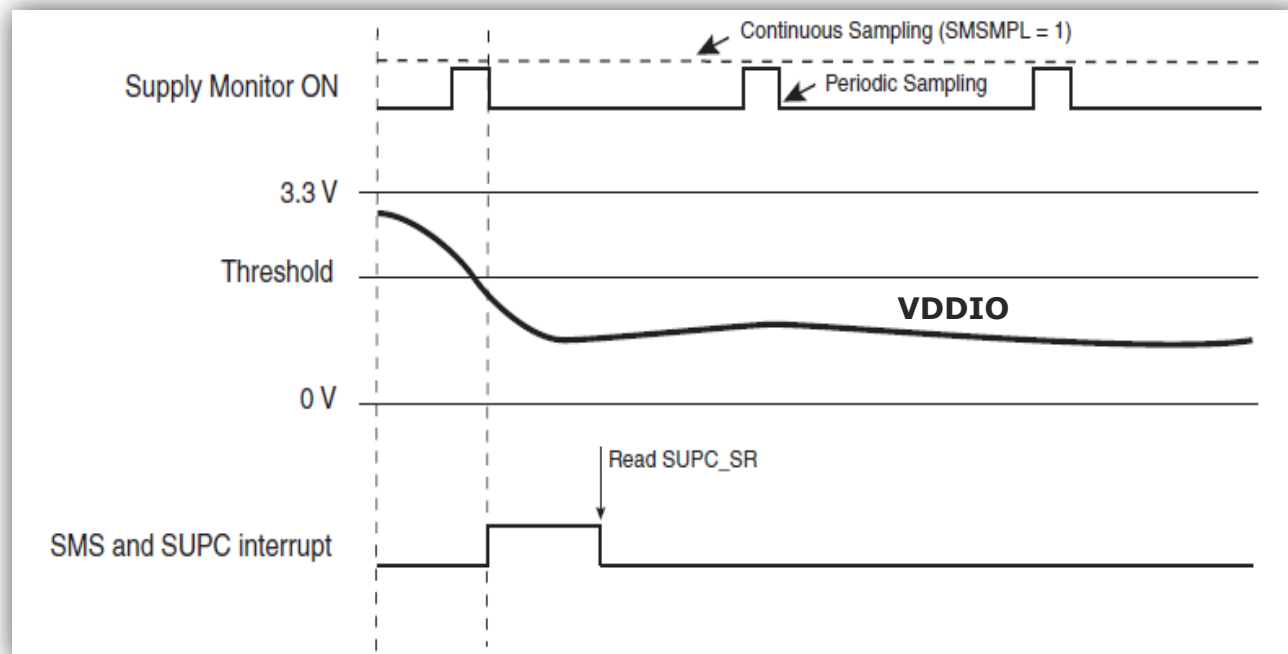
Startup Sequence (General Reset)



SAM4S Supply Controller

Supply Monitor

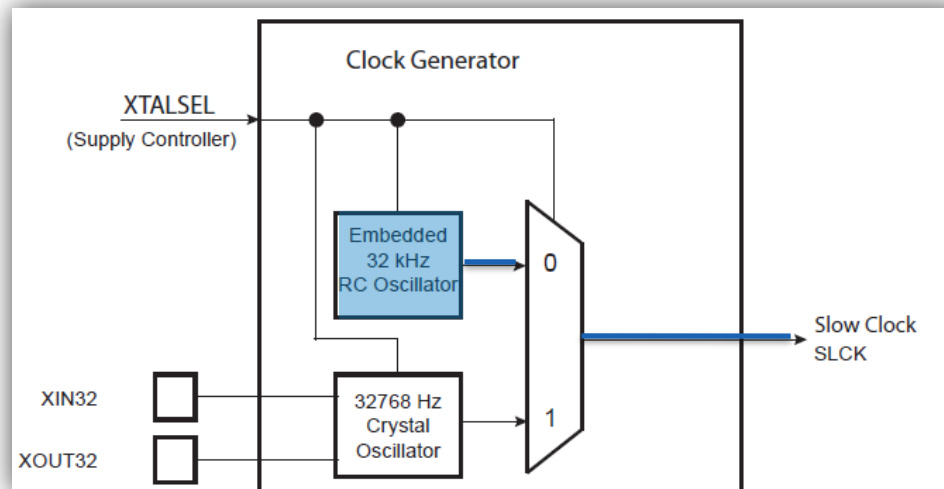
- Prevents the system from falling into an unpredictable state by resetting the core if VDDIO drops below a programmable threshold (from 1.9V to 3.4V).
 - Continuous or Periodic sampling (32, 256, 2048 Slow Clock periods)
 - Can also wake-up the core power supply from SAM4S backup mode.
- Disabled by default



SAM4S Supply Controller

Slow Clock Generator

- Supplied as soon as VDDIO is established.
- Several Slow Clock sources are possible:
 - Internal 32 kHz RC Oscillator
 - External 32 kHz crystal on XIN32/XOUT32
 - External clock on XIN32 (bypass mode)
- By default, the internal 32kHz RC is enabled.

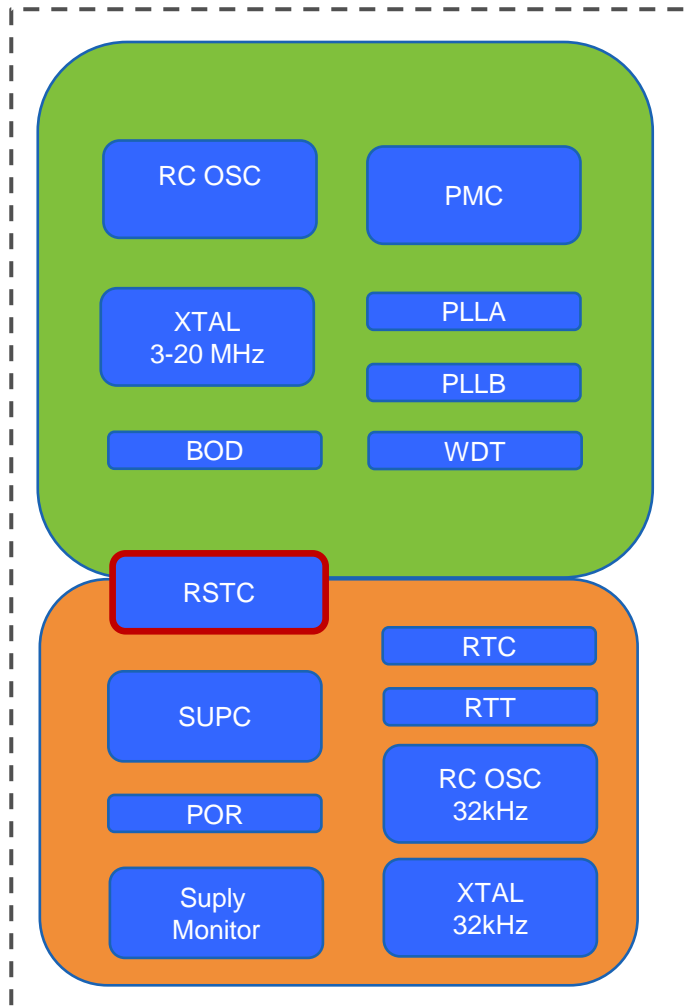


System Controller

Reset Controller (RSTC)

SAM4S Reset Controller

Overview

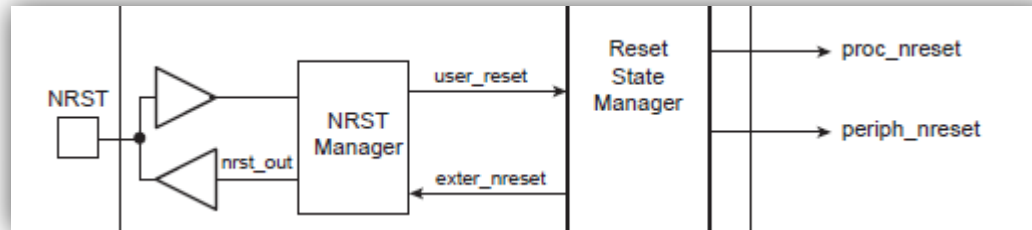


- Manages all Resets of the System, including:
 - General Reset
 - Backup Reset
 - Watchdog reset
 - User reset (NRST pin)
 - Software reset (NRST pin)
- Embeds
 - NRST pin Manager
 - Reset State Manager
 - Status of the latest reset

SAM4S Reset Controller

NRST pin Manager

- Manages NRST pin in input or output.



- NRST pin in Input mode (enabled by default)
 - Allows MCU to be reset by external components (i.e. User Reset)
 - The user reset is programmable and an interrupt can be generated
- NRST pin in Output mode
 - Allows MCU to reset external components (i.e. Software Reset)
 - The NRST line is driven to low level during a programmable time

SAM4S Reset Controller

Reset State Manager

- The Reset State Manager handles the different reset sources and generates the internal reset signals.
- It reports the reset status in the RSTTYP field of the Status Register

RSTTYP in RSTC_SR	Reset Type	Comments
0	General Reset	First Power up Reset
1	Backup Reset	Return from backup mode
2	Watchdog Reset	Watchdog fault occurred
3	Software Reset	Processor reset required by SW
4	User Reset	NRST pin detected low

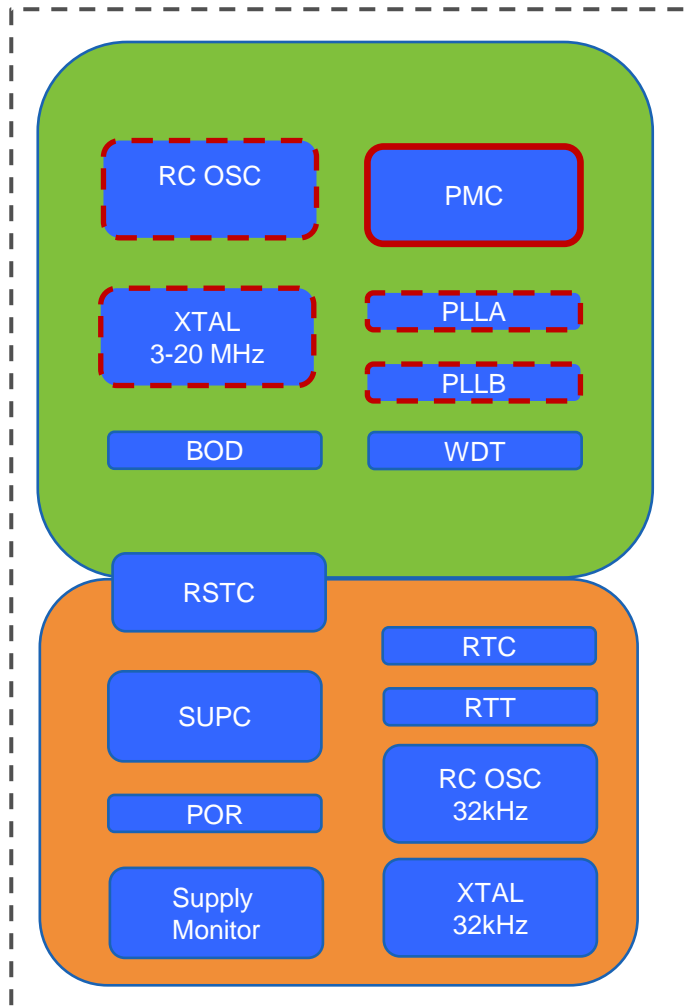
- Update of the RSTTYP field is performed when processor reset is released

System Controller

Power Management Controller (PMC)

SAM4S Power Management Controller

Overview



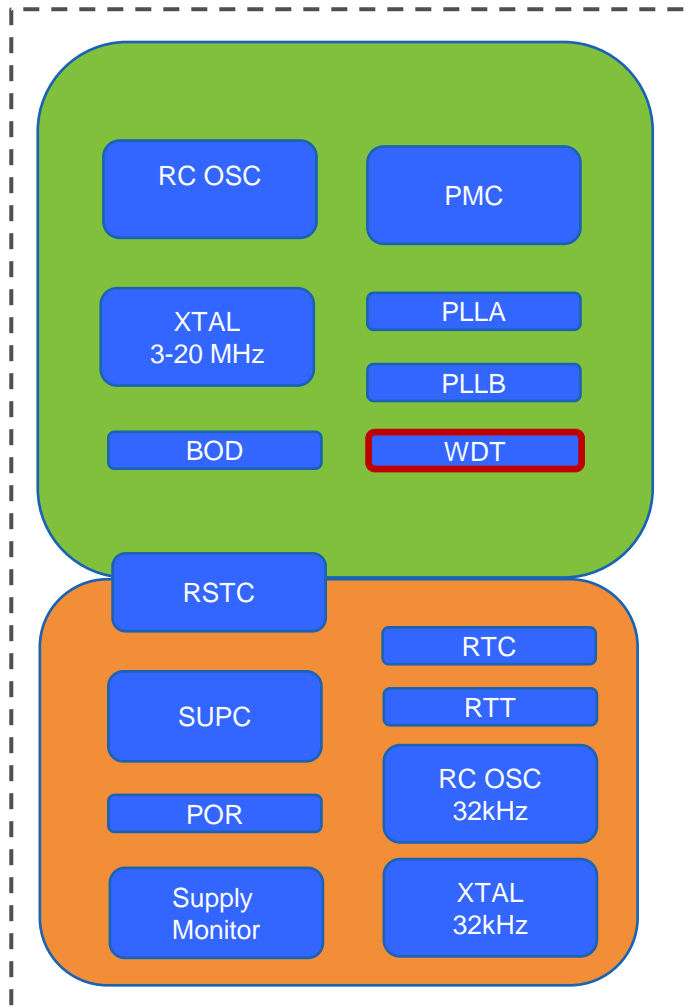
- Allows to optimize power consumption by controlling all the clocks of the system.
- Main features:
 - Clock Generator
 - System clocks generation/control
 - Main Crystal Clock Failure Detector to identify an oscillator defect.
 - Possibility to trim the 4/8/12 MHz Fast RC Oscillator.

System Controller

Watchdog Timer (WDT)

Watchdog Timer

Overview



- The Watchdog Timer (WDT) can be used to prevent system lock-up if the software becomes trapped in a deadlock.
 - 12-bit down counter based on 32KHz clock
 - Enabled by default after start-up with a period set to its maximum (i.e. 16 seconds).
 - Generates a processor, peripherals and NRST pin resets or a processor reset only.

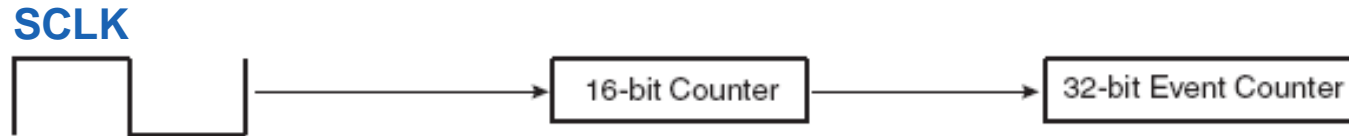
System Controller

Real Time Clock and Real Time Timer

Real Time Timer (RTT)

Overview

- The Real-Time Timer is built around a 32-bit counter fed by the Slow Clock divided by a programmable 16-bit value:
 - RTPRES field of Real-time Mode Register (RTT_MR)



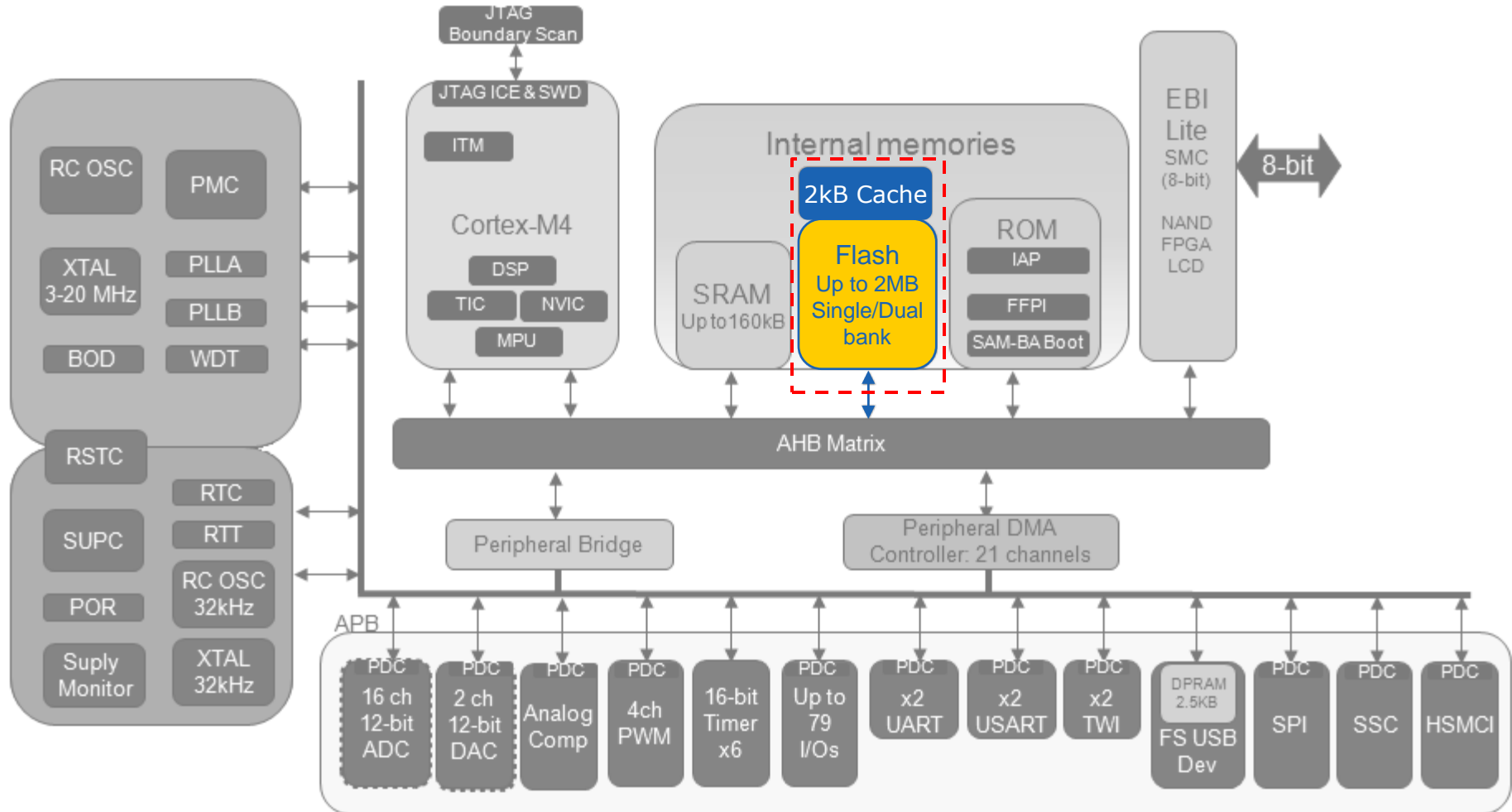
- It generates a periodic interrupt and/or triggers an alarm on a programmed value.

Real Time Clock (RTC)

Overview

- Two Hundred Year Gregorian or Persian Calendar with Programmable Periodic Interrupt
- Full Asynchronous Design based on external 32Khz crystal
- Crystal Oscillator drift correction circuitry to compensate temperature variation.
- Waveform Generation capability (1Hz, 32Hz, 64Hz and 512Hz) on RTC Output dedicated pins (RTCOUT0/1).
- On-The-Fly Time and Date Validity Check

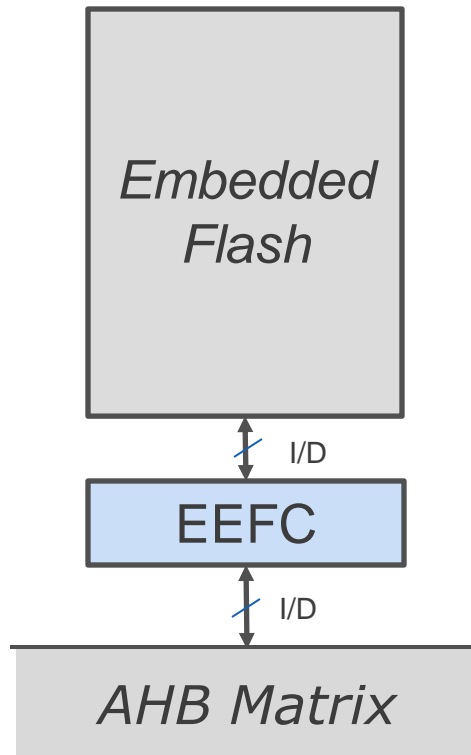
Enhanced Embedded Flash Controller (EEFC)



Enhanced Embedded Flash Controller

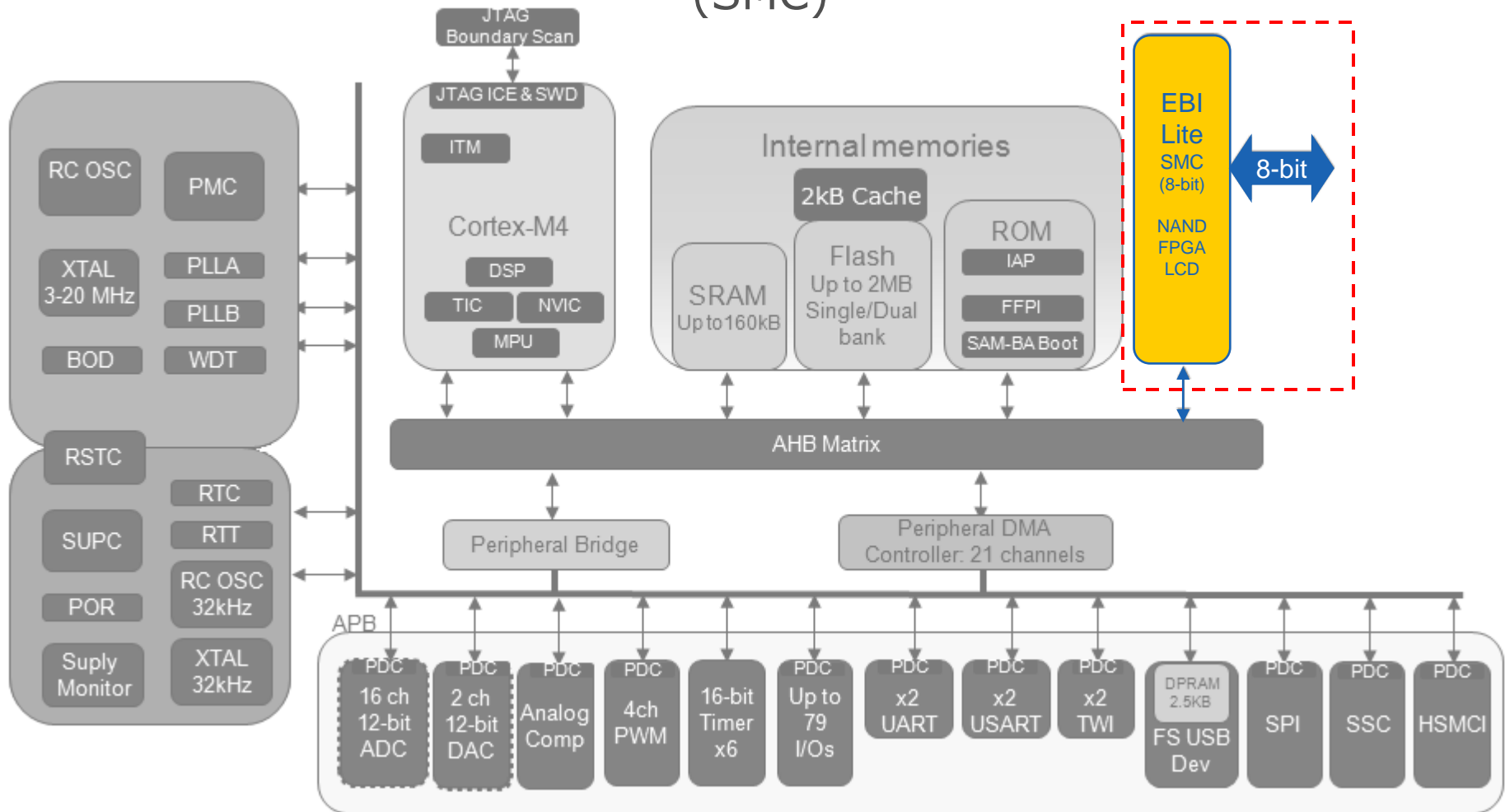
Overview

- Interfaces the Flash Block with the 32-bit Internal Bus



- Configurable 64/128 bits flash access
- Integrates Code loops optimization
- Integrates Sequential Code Optimization
- Manages :
 - Erases by Plane/Sector/Pages
 - Flash Locking/Unlocking Operations
 - General Purpose NVM bits

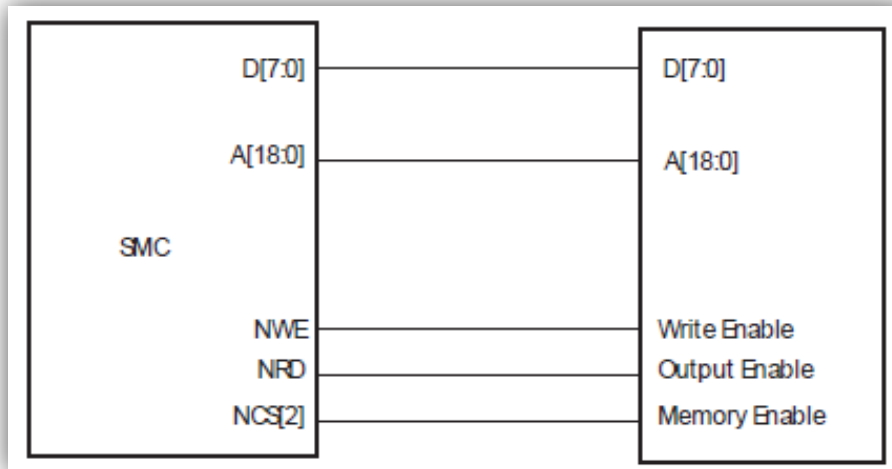
Static Memory controller (SMC)



Static Memory controller

Overview

- Ensures interfacing between SAM4S and external static memory devices.



- 8- bit Data Bus
- 4 Configurable chip select
- Scrambling/Unscrambling Functionality
- Programmable wait state
- External Wait Request support
- Asynchronous Read in Page Mode
- Additional NAND Flash logic

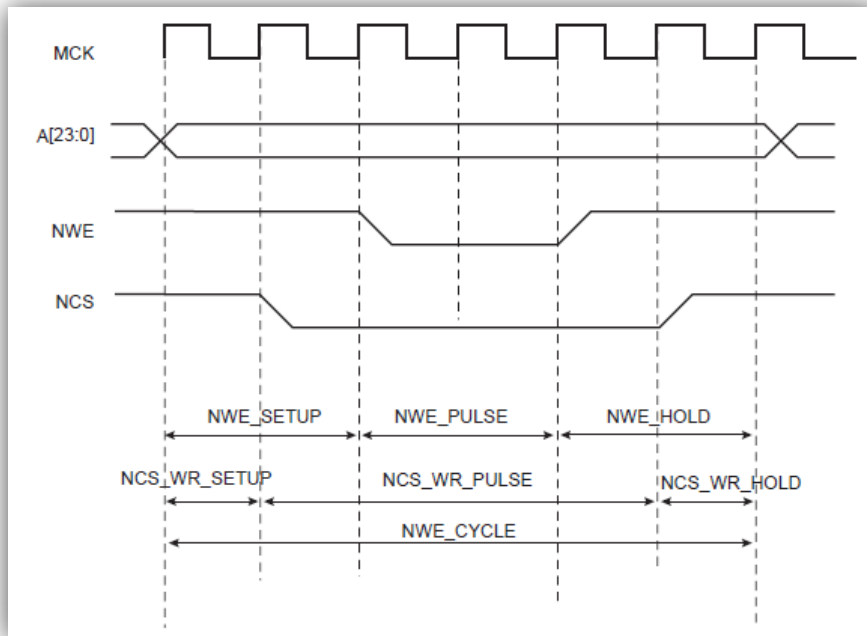
- Capable of handling several types of external memories :
SRAM,PSRAM, Rom based memories, LCD Module,
NOR Flash, NAND Flash, FPGA...

Static Memory controller

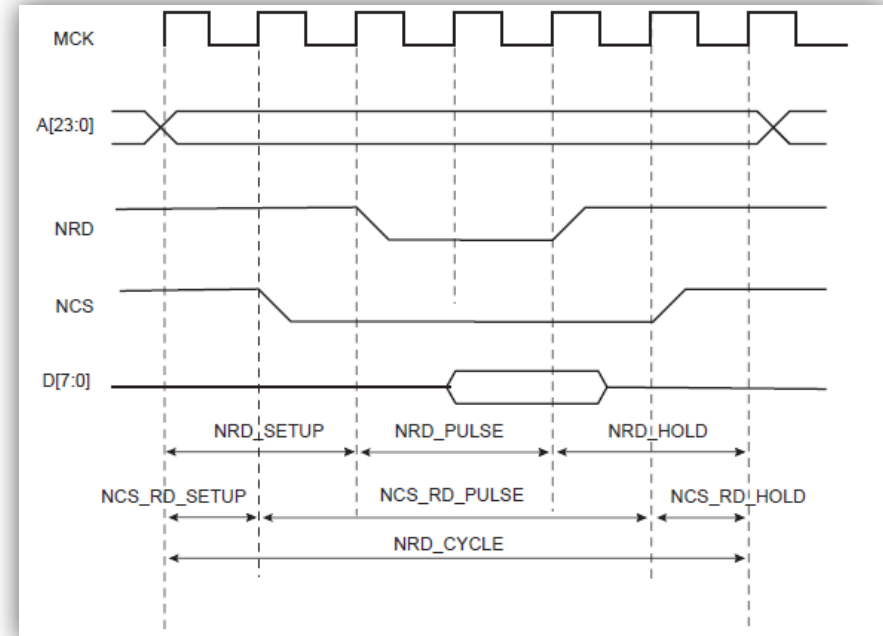
Adjustable Read/Write timings

- Adjustable SETUP, HOLD and PULSE timings

Standard Write



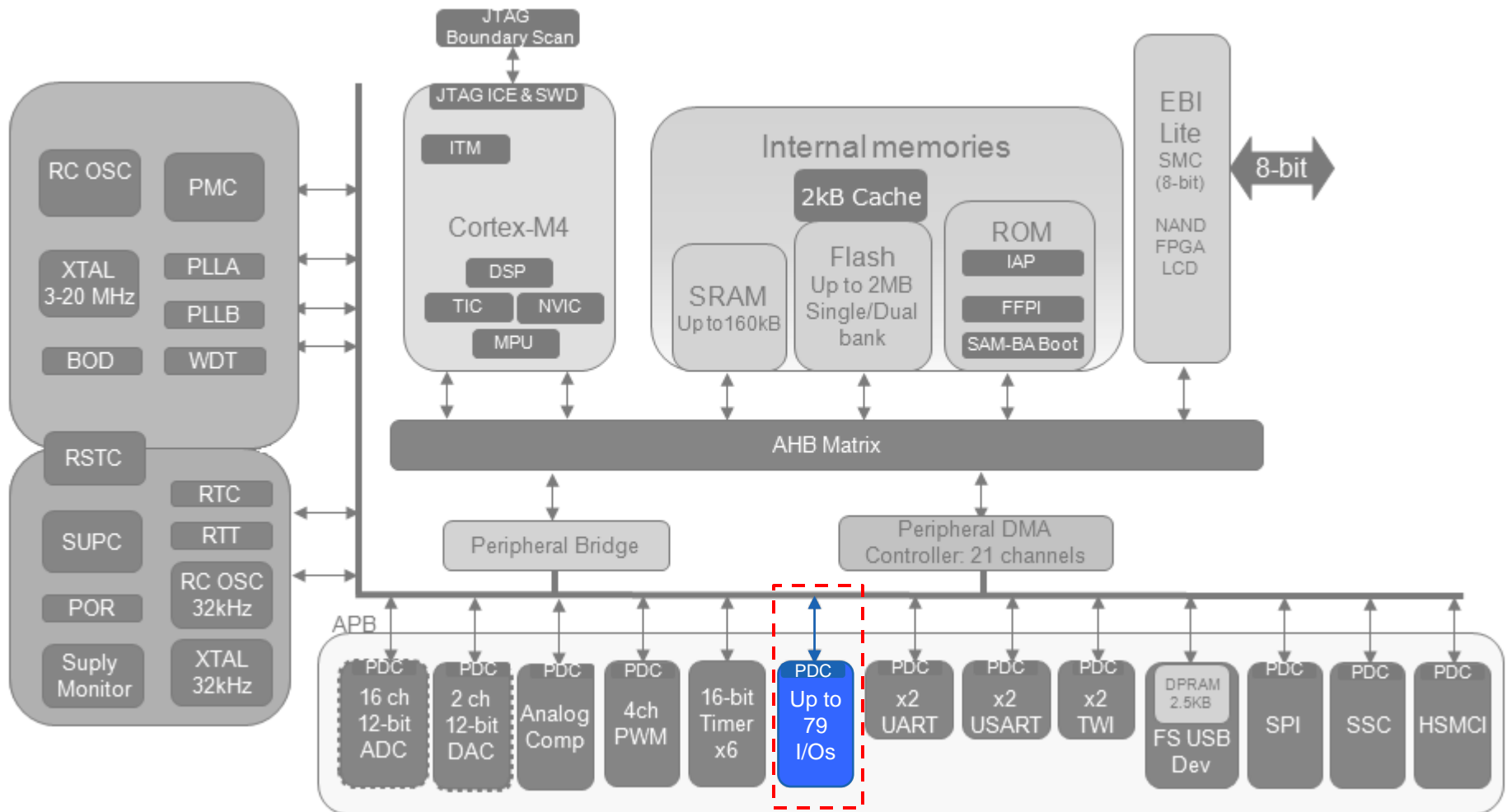
Standard Read



- Allows flexibility in communication

PIO Controllers

(PIO)



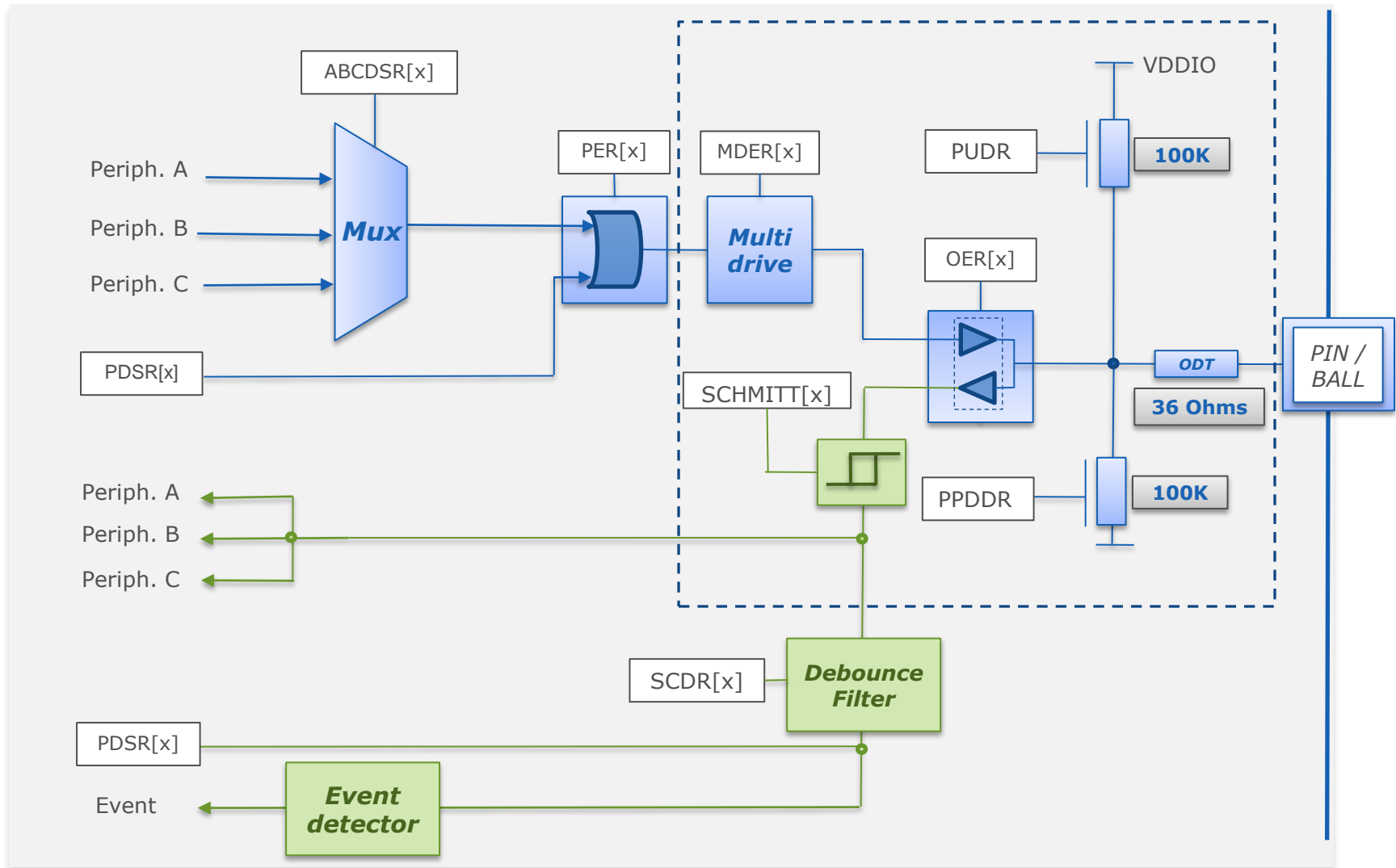
PIO Controllers

Overview

- Each Parallel Input/Output Controller (PIO) manages 32 independently programmable input/output lines.
 - Common Input/output Features :
 - On die termination resistor
 - Programmable Pull-up
 - Programmable Pull-down
 - Output Only Features :
 - Multi drive capability enabling drive in Open Drain
 - Input Only Features :
 - Programmable Schmitt triggers
 - Debounce filter
 - Event detector (Input Change Interrupt)

PIO Controllers

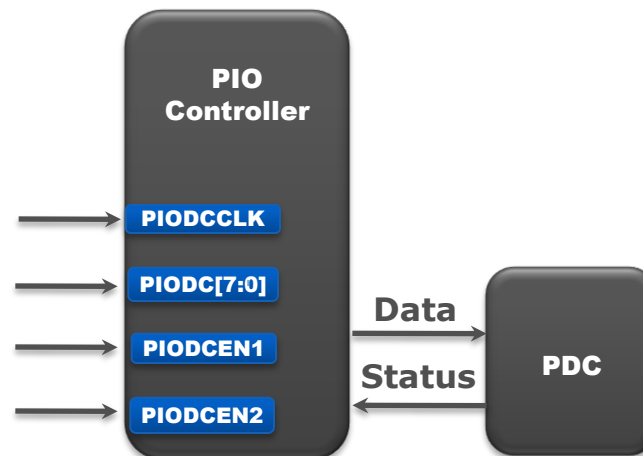
I/O Line Control Logic



PIO Controllers

Parallel Capture Mode

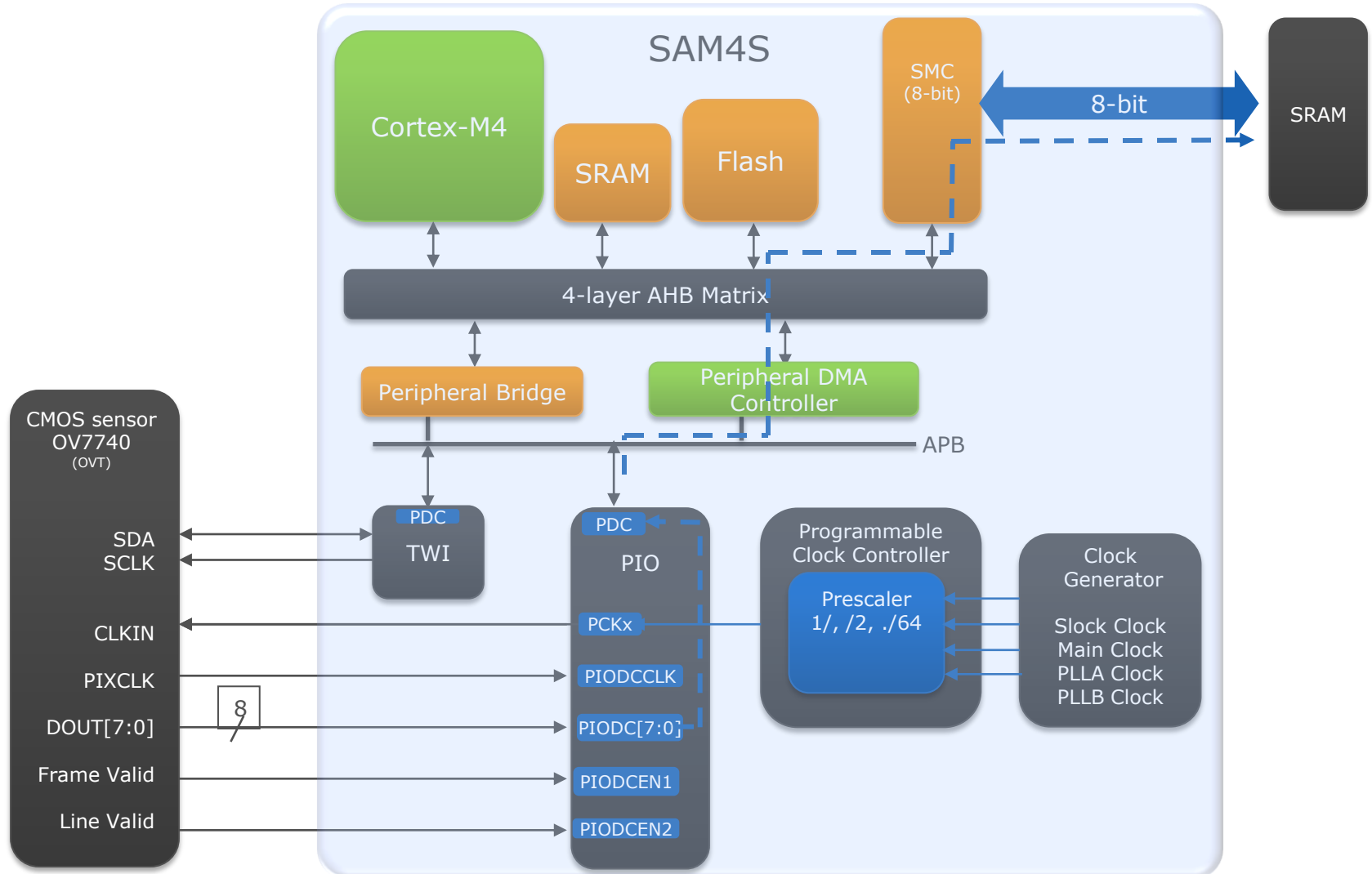
- Allows Capture of parallel data from an external peripheral (CMOS sensor, parallel ADC or a DSP)



- Can be linked to a specific PDC channel to allow data transfer without CPU intervention:
 - Up to $MCK/4$ data rate in Always sampling mode.
 - Up to $MCK/3$ data rate in Half sampling mode.

PIO Controllers

Parallel Capture Mode – PIR Camera Application





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